New Brunswick Hydrogen Roadmap

Clean Energy NEW BRUNSWICK

New Nouveau Brunswick

New Brunswick Hydrogen Roadmap

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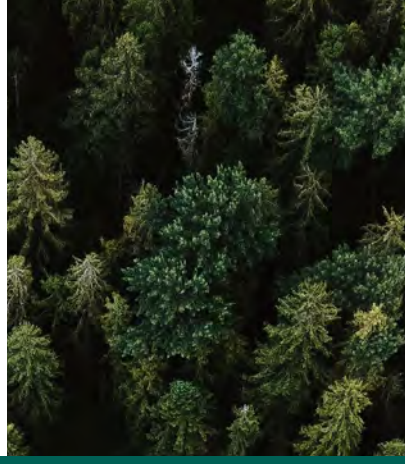


Powering our Economy and the World with Clean Energy

We are very pleased to have the opportunity to share with you New Brunswick's Hydrogen Roadmap.

As we build on our strengths, develop new economic opportunities and work towards establishing a clean, diverse and secure energy future for New Brunswick, hydrogen will be an important element.

Our Vision of being able to **POWER OUR ECONOMY AND THE WORLD WITH CLEAN ENERGY** is founded on six guiding principles. Each supports the development and use of hydrogen thus this Roadmap is a critical part of our Energy strategy.

The Roadmap outlines 13 Key Actions that will be completed over the next five years and are designed to help develop and incubate the hydrogen industry here in New Brunswick.

Our province's location, vast natural resources including wind and our leading-edge work on Small Modular Reactors (SMRs) positions our province to be a clean hydrogen leader and innovator. We intend to seize on that opportunity.

The New Brunswick Hydrogen Roadmap will serve as the foundation for developing a viable and sustainable hydrogen industry here in New Brunswick that drives economic development and supports a critical part of our Climate Change Action Plan.

We look forward to getting these actions under way and engaging all of you as part of this process.

PRINCIPLE 1:
Leverage New Brunswick's unique assets, location, and natural resources to develop lower carbon energy solutions for Provincial, Regional and Global use.

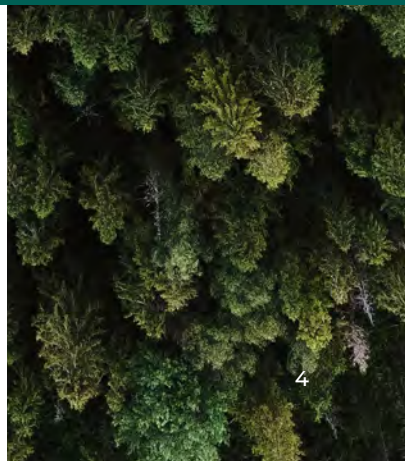
PRINCIPLE 2:
Develop hydrogen and sources of clean energy to build and attract new businesses.

PRINCIPLE 3:
Implement Small Modular Reactors (SMRs) as safe and reliable low carbon generation.

PRINCIPLE 4:
Build new Clean Energy Supply Chains to drive growth.

PRINCIPLE 5:
Grow Economic Relationships with First Nation communities.

PRINCIPLE 6:
Achieve both Energy Security and net-zero.



Premier Blaine Higgs

Honourable Mike Holland
MINISTER OF NATURAL RESOURCES AND ENERGY DEVELOPMENT

Executive Summary

HYDROGEN IS A RAPIDLY EMERGING SOLUTION FOR CARBON EMISSION REDUCTION

New Brunswick intends to grow its position as a leader of clean energy solutions while continuing to diversify its energy mix to achieve net-zero. New Brunswick's 2022-2027 Climate Change Action Plan outlines our next steps to ensure New Brunswick will thrive in a resilient, low-carbon economy. Reducing the carbon content of our electricity and expanding its use are key parts of the plan. However, achieving greenhouse gas (GHG) emissions reductions beyond 2030 will require investments in new and emerging low-carbon technologies and solutions, including hydrogen.

Hydrogen has many advantages. It can be readily stored. It is ideally suited for long-distance trucking and heavy transportation applications. When it is compressed, liquified, or used to make ammonia, a hydrogen derivative, it can be shipped long distances to export markets. Where industrial energy processes require intense heat, it can be used to replace natural gas, and as part of our on-going energy transition it can be blended with natural gas using our province's existing natural gas distribution infrastructure.

Hydrogen today is mainly made from natural gas and has a significant carbon intensity. However, new processes can substantially reduce and even eliminate the carbon, which will make hydrogen a key element in future energy systems in New Brunswick and around the world. The carbon intensity of hydrogen processes depends upon the carbon content in the energy resource used to make hydrogen. Non-carbon resources such as wind, hydro and nuclear using electrolyzers produce a virtually carbon-free source of hydrogen. However, processes that use natural gas or other carbon-based resources as a feedstock can also be low carbon if the carbon is captured and stored.

Having low or zero carbon intensity, hydrogen is well placed to serve our climate change objectives given its potential for use in energy intensive industries and long-distance transportation. The development of hydrogen will provide New Brunswick with an important energy source on our path to net-zero while at the same time provide opportunities to attract new industries and grow our green economy.

At present, the cost of producing carbon-free hydrogen is expensive, but low-cost renewable resources such as wind, ongoing economies of scale and developing new ways to separate hydrogen from water are expected to lower costs dramatically. New Brunswick has the resources and advantages to be cost competitive in the hydrogen market . Combining our existing low-carbon intensity electricity system with new carbon-free electricity resources will allow us to produce hydrogen that is low in carbon intensity today, and carbon-free in the future.

Our advantages in producing carbon-free hydrogen are significant. New Brunswick has substantial wind resources both on land and offshore, and we are leaders in developing advanced Generation IV Small Modular Reactors (SMRs). Our ports provide year-round, ice-free, and deep-water access to Europe and abroad for export opportunities. We have a highly trained and skilled workforce with deep experience in the energy industry. Finally, we can provide a supportive policy, regulatory and investment environment for clean energy projects, including hydrogen.

A NEW BRUNSWICK HYDROGEN ROADMAP FOR EARLY ACTION

To build upon our needs, our strengths, and opportunities, and after initial consultation and expert advice, we have designed the New Brunswick Hydrogen Roadmap as a catalyst for Early Action.

The Roadmap has four key areas for strategic focus:

Creation of an Effective Regulatory Environment

Developing a viable domestic and export low-carbon hydrogen industry requires regulatory certainty. The Roadmap will ensure that existing legislation and regulations are updated. Government will develop the necessary processes to ensure that hydrogen is produced, stored, transported, and used with the highest possible safety and environmental standards. In addition, domestic and international best practises will be used to develop and adopt new industry codes and standards.

Engagements and Partnerships

The Roadmap acknowledges the importance of partnering with local First Nations, businesses, and communities in identifying and acting on rapidly emerging and evolving clean energy opportunities. Partnership and outreach efforts will include the creation of a plan to optimize supply chain, job creation, and skill development opportunities for New Brunswick associated with the adoption of low-carbon hydrogen technologies. Developing a plan to maximize First Nations opportunities will be a priority. The Province will also launch stakeholder outreach sessions and conduct community-based education and awareness campaigns.

Build the Foundation for Success

New Brunswick is positioned to be an early mover in the development of hydrogen applications based on our existing industrial base. The Saint John refinery is expanding its hydrogen capacity, with plans to offer hydrogen fuelling infrastructure in Atlantic Canada. This will make the company the first to introduce hydrogen to the regional market. Belledune and Saint John are well positioned to support the development of hydrogen hubs in both southern and northern New Brunswick. The Hubs will combine low-carbon intensity energy inputs, production facilities, and users of hydrogen in one location. New Brunswick is also a North American leader in the development of advanced Generation IV SMR technologies, which can also be used to produce hydrogen in the future.

Focus on Action and Accountability

Early action and accountability are required to successfully implement the New Brunswick Hydrogen Roadmap. Roadmap actions will be coordinated though the Department of Natural Resources and Energy Development's Clean Energy group. This new group will provide a single point of contact for companies and organizations looking to invest in emerging clean energy technologies while providing technical and regulatory leadership and assistance to industry proponents.

The New Brunswick Hydrogen Roadmap is intended to establish the path for concrete action items and the associated outcomes over the next five years. In addition, the Roadmap, will be reviewed annually to measure progress and to establish specific action items and goals to be completed and achieved within each of the next five years. The Province of New Brunswick looks forward to working with all communities and stakeholders as we begin this exciting journey of establishing hydrogen as a future clean energy solution for our province and our global trading partners.

Acronyms and Abbreviations

Acronyms	Meaning
BEV	Battery Electric Vehicle
CCAP	Climate Change Action Plan
CCS	Carbon Capture and Storage
CNER	Centre for Nuclear Energy Research
DNRED	Department of Natural Resources and Energy Development
EV	Electric Vehicle
FCEV	Fuel Cell Electric Vehicle
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWh	Gigawatt-hours (1 billion watt-hours)
GNB	Government of New Brunswick
GT	GigaTonne
GW	Gigawatt (1 billion watts)
HFCEV	Hydrogen Fuel Cell Electric Vehicle
ICE	Internal Combustion Engine
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
kW	Kilowatt (1,000 watts)

Acronyms	Meaning
kWh	Kilowatt-hours (1,000 watt-hours)
LCOE	Levelized Cost of Energy
LCOH	Levelized Cost of Hydrogen
LDV	Light Duty Vehicles
MJ	Megajoule (1 million joules)
Mt	MegaTonne
MW	Megawatt (1 million watts)
MWh	Megawatt-hours (1 million watt-hours)
NRCan	Natural Resources Canada
ONB	Opportunities New Brunswick
PJ	Petajoules (1 quadrillion joules)
R&D	Research and Development
RNG	Renewable Natural Gas
RPP	Refined Petroleum Products
SJPA	Saint John Port Authority
SMR	Small Modular Reactors
TJ	Terajoule (1 trillion joules)
TWh	Terrawatt-hours (1 trillion watt-hours)

1. Introduction

1.1
CLIMATE CHANGE IN NEW BRUNSWICK

New Brunswick is a leader in acting against climate change. The Province's recently released *Climate Change Action Plan – Our Pathway Towards Decarbonization and Climate Resilience* builds on progress to date and lays out the next steps to ensure New Brunswick is positioned to thrive in a resilient, low-carbon economy. New Brunswick aims to embrace the local climate response as an opportunity to transition to a stronger, more diverse, and competitive economy, leading to sustainable growth in terms of new jobs, technologies, and exports.

New Brunswick's greenhouse gas (GHG) emissions in 2021 were 11.9 Mt per capita. New Brunswick emits less GHGs than the Canadian average, however it is among the most energy intensive economies in Canada per unit of gross domestic product (GDP), and the most energy intensive in Atlantic Canada. Importantly, over 50 per cent of the provincial energy demand is attributable to the industrial sector where GHG emissions are typically characterized as harder to abate and can pose a significant decarbonization challenge.

New Brunswick's Climate Change Action Plan includes a commitment to reach net-zero GHG emissions by 2050. Making a commitment to net-zero emissions by 2050 signals that New Brunswick is committed to decarbonization and realizing the opportunities that accompany these efforts. The current action plan puts the province on the path to reaching its 2030 GHG target of 10.7Mt or a 46 per cent reduction from 2005 levels. Achieving GHG emissions reductions beyond 2030 will require strong additional measures and investments in new and emerging low-carbon technologies and solutions. Hydrogen is expected to play an important role in New Brunswick's net-zero future.

1.2
WHAT ROLE CAN HYDROGEN PLAY IN NEW BRUNSWICK DECARBONIZATION

As stated in the Hydrogen Strategy for Canada, hydrogen is the most abundant element on Earth, accounting for approximately 75 per cent of all mass. Hydrogen has the highest energy per mass of any fuel, but at the same time has a relatively low energy density per unit of volume, which makes it challenging to distribute and store in a cost-efficient manner. Approximately three times the volume of hydrogen is required in comparison to natural gas to yield the same amount of energy. From an energy transition perspective, hydrogen offers multiple benefits and an opportunity to decarbonize sectors where electrification is currently viewed as difficult to implement. From a New Brunswick policy perspective, this means that hydrogen adoption can complement electrification efforts in delivering a transition to net-zero by solving hard to electrify applications.

The key benefits of hydrogen use are as follows:

- **Carbon-free at the point of use**: it can be used to generate electricity with limited byproducts or to be combusted without corresponding process pollutants or carbon emissions.
- **Transportable over long distances**: when compressed or liquified, it can also be transported over long distances, something that to date has proved difficult with electricity.
- **Suitable for energy-intensive applications**: where electrification potential is currently viewed as difficult or limited (i.e. heavy industry) it can replace natural gas feedstock, while also potentially leveraging existing transportation and distribution infrastructure networks (e.g. existing gas pipeline infrastructure).
- **Energy dense fuel:** when used as a fuel for fuel-cell electric vehicles (FCEV), hydrogen currently requires less mass than existing electrification and battery technology, offering a compelling zero-emission alternative for high-utilization and long-distance vehicles such as heavy- duty trucks and transit buses.

The World Energy Council's 2021 working paper on national hydrogen strategies confirms that hydrogen industry development is top of mind across the globe. Countries generally recognize that hydrogen can help achieve multiple climate and other policy objectives at the same time, including:

- Emission reduction
- Integration of renewables
- Diversification and security of energy supply
- Fostering of economic growth

These objectives are not only consistent with the Hydrogen Strategy for Canada and its potential application in New Brunswick, but also confirm that net energy importer countries have a renewed focus on security of energy supply. Hydrogen export markets therefore represent an incremental economic opportunity and incentive for Canada in driving hydrogen adoption. New Brunswick and other provinces have the opportunity to leverage Canada's established reputation as a reliable trading partner and the potential for hydrogen's seaborne transportation to the fullest, to foster economic growth and increase domestic renewable power generation potential.

1.3
PRODUCTION PATHWAYS AND HYDROGEN DESIGNATIONS

From a production perspective, there are multiple pathways to produce hydrogen but none of these pathways have any impact on its final application as the hydrogen molecules produced via each of these pathways are the same. The different production pathways determine the carbon intensity (CI) of the hydrogen produced and the ultimate decarbonization potential it offers. Hydrogen labels provide a universally accepted way to distinguish between the CI of the produced hydrogen and are determined based on the following two factors:

- Feedstock requirements – These are differentiated based on the GHG emissions during the production of the input materials themselves. This may include non- or low-emission inputs such as water, wind, solar, other low carbon energy sources, or GHG emitting inputs such as natural gas or other fossil fuels.
- Production technology – Production pathways may generate GHG emissions while processing fossil fuel feedstocks or alternatively, be non-GHG emitting via the processing non-fossil inputs. Currently, the overwhelming majority of New Brunswick and global hydrogen production uses fossil fuel as the input for a process called steam methane reforming which, in turn, generates significant GHG emissions. There are, however, multiple alternative production technologies which will allow producers to lower the GHG emissions associated with hydrogen production.

The following presents a summary of the typical hydrogen labels along with the respective hydrogen production technologies, feedstock requirements, and ranking by CI. Typically, all hydrogen labels from the table below are considered clean or low carbon apart from grey hydrogen.

Figure 1. Hydrogen Production Pathways and Carbon Intensity

Feedstock	Production Pathway	Hydrogen Label	Carbon Intensity
Fossil Fuels	*Steam Methane Reforming* (this is the most used technology due to high hydrogen yield efficiency and cost competitiveness)	Grey	High
Fossil Fuels	*Steam Methane Reforming + Carbon Capture & Sequestration* (combines the high hydrogen yield with carbon capture technology to lower the CI of the produced hydrogen)	Blue	Medium/Low
Fossil Fuels	*Pyrolysis* (employs heat to decompose natural gas to produce hydrogen and solid carbon)	Turquoise	Low
Fossil Fuels / Methanol	*Electricity for Microwave + Carbon Capture & Sequestration*	Teal	Low
Water + Nuclear	*Electrolysis* (electricity and fresh water as feedstock to produce hydrogen)	Pink	Low/None
Water + Renewable Power	*Electrolysis (*electricity and fresh water as feedstock to produce hydrogen)	Green	Low/None
Biomass	*Biomass gasification* (uses heat and steam to convert renewable organic biomatter to low CI hydrogen)	Green	Low/None

1.3.1 Hydrogen Production – Energy Requirements

Based on the energy losses in converting one form of energy to hydrogen gas, the most energy efficient way of producing hydrogen with today's technology is through the electrolysis process. The following table describes the energy required to produce one kilogram of hydrogen using each of the available technologies along with the respective hydrogen label that each process yields. (Note that biomass gasification has not been identified on the table below due to limited data on its energy requirements.)

Figure 2. Energy Requirements for Hydrogen Production

Production Technology	Energy requirements to produce hydrogen (kWh/kg H2)	Hydrogen label produced
Steam methane reforming	51	Grey
Steam methane reforming + CCS 85%	74	Blue
Steam methane reforming + CCS 52%	62	Blue
Pyrolysis	76	Turquoise
Pyrolysis + CCS 85%	99	Teal
Pyrolysis + CCS 52%	87	Teal
Nuclear Electrolysis	50	Pink
Renewable Electrolysis	50	Green

1.3.2 Hydrogen Production – Greenhouse Gas Emission Intensity

In addition to the energy intensity required to produce hydrogen, another significant point of consideration is the level of GHG emissions that are associated with specific production technologies. Figure 3 describes the current GHG emission intensity of various clean hydrogen production pathways in New Brunswick. Given the degree of fossil fuel-based power generation present in New Brunswick today, grid-based electrolysis has a relatively high CI compared to other clean hydrogen production pathways, while renewable energy-based electrolysis (wind and nuclear) is expected to yield the lowest CI. As New Brunswick utilities move to be net-zero by 2035 under the federal Clean Electricity Regulations, grid-based Electrolysis CI will significantly reduce.

Figure 3. Hydrogen Production Methodology vs. GHG Emission Intensity

Production technology	Energy Source	GHG emission intensity ($kg\text{-}CO_2^e/kg\text{-}H_2$)
Electrolysis	100% Grid	10.50
	40% Wind + Grid	6.80
	Onshore/Offshore Wind at 40% Capacity Utilization Factor	0.00
	Nuclear	0.00
Steam Methane Reforming + CCS	Renewable Electricity	0.29
	Natural Gas	1.73
Pyrolysis	Renewable Electricity	0.20
	Natural Gas	2.70
Biomass Gasification	Biomass	0.82

2. Opportunities

2.1
DEMAND AND APPLICATIONS

From a national perspective, the Hydrogen Strategy for Canada is projecting between 8.3 and 20Mt-H2/year in Canadian demand by 2050, which is between 106 to 256 times more than what is currently being produced in New Brunswick. The strategy has identified wide-spread use of hydrogen beyond industrial applications, estimating that demand will be spread across the following industries:

- Transportation Fuel (10 per cent)
- Low-Carbon Liquid Fuel (15 per cent)
- Natural Gas Replacement (50 per cent)
- Grey Crude (traditional refining using grey hydrogen) Production (15 per cent)
- Other Industrial Uses (10 per cent)

In terms of energy demand in New Brunswick, in 2022 the province had a total energy demand of 228 petajoules (PJ), with 55 per cent (131PJ) of the demand resulting from the industrial sector, while the second largest sector, transportation, accounted for 21 per cent (51PJ).

The New Brunswick energy mix in 2022 was dominated by refined petroleum products (RPP) at 45 per cent of total energy demand. The remaining demand was made up of electricity at 23 per cent, biofuel at 17 per cent, natural gas at 14 per cent and 1 per cent other. RPP is expected to see the largest decline in demand by 2050, from 113PJ to 92PJ (-19 per cent), due to the uptake in electric vehicles (EVs) as well as carbon reduction policy and legislative incentivization of RPP reduction.

With an eye to the future and the application of hydrogen as part of New Brunswick's net-zero solution, analysis shows that our province could potentially support up to 53 per cent hydrogen adoption for natural gas substitution, 16 per cent adoption as transportation fuel and 20 per cent adoption for electric generation/grid balancing by 2050.

2.1.1 Hydrogen for Natural Gas Replacement in New Brunswick

The use of natural gas accounted for 13 per cent (29PJ) of New Brunswick's energy demand in 2022. A larger portion of this demand stems from the industrial sector which accounts for 89 per cent of natural gas demand, with the commercial and residential sectors combined accounting for 10 per cent.

By 2050, under the most optimistic scenarios, it is estimated hydrogen could replace up to 53 per cent of natural gas energy demand in New Brunswick. This equates to a GHG emission reduction of nearly 374,000t-$CO2^e$/year. To put this level of emission reductions in perspective, it is estimated that a gasoline powered passenger vehicle has, on average, annual emissions of 4.6 t-$CO2^e$/year, therefore 374,000 t-$CO2^e$/year of emission reduction would be equivalent to that achieved by eliminating approximately 81,000 gasoline powered passenger vehicles from New Brunswick's roadways. Under a more incremental scenario in which seven per cent of natural gas energy demand is replaced by hydrogen, GHG emissions reductions would equate to 49,000 t-$CO2^e$/year or on a similar comparison to above, emissions equivalent to the elimination of approximately 10,600 passenger vehicles.

Hydrogen's potential in decarbonizing New Brunswick's natural gas grid is projected to be achieved through two possible avenues:

Hydrogen blending into the existing natural gas grid:

- There are a broad range of natural gas applications across the industrial sector in New Brunswick, many of which are not suitable for electrification, nor can they be practically retrofitted with low carbon solutions such as hydrogen fuel. In these cases, hydrogen blending is seen as a possible solution. Hydrogen blending refers to the process of mixing hydrogen with natural gas and transporting via existing natural gas grids. This is typically done to increase the proportion of hydrogen in the natural gas supply with the goal of reducing GHG emissions.

Substituting natural gas with 100 per cent hydrogen through construction of new infrastructure or through the use of compressed gas delivery systems:

- A complete substitution of natural gas with hydrogen has the potential to provide greater decarbonization benefits compared to hydrogen blending. This would be achieved by constructing new infrastructure specifically designed for the transportation and distribution of pure hydrogen.

2.1.2 Hydrogen as a Transportation Fuel

Transportation is the second largest sector in New Brunswick in terms of energy demand, accounting for 21 per cent (51PJ) of demand in 2022. Nearly 100 per cent of this demand is fulfilled by RPP, which has the highest GHG emissions per petajoule of energy used, which translates to the transportation sector having the highest average GHG emission intensity across all sectors.

By 2050, under ideal conditions it is estimated hydrogen could replace up to 16 per cent of energy used in transportation in New Brunswick, equating to a GHG emission reduction of 1,180,000t-$CO2^e$/year. Under a more incremental scenario allowing for four per cent of the energy used in transportation to be replaced by hydrogen, GHG emission reduction would equate to 366,000t-$CO2^e$/year.

Decarbonization of the transportation sector will primarily be driven by the replacement of RPP fueled internal combustion engine (ICE) vehicles with zero emission alternatives such as battery electric vehicles (BEV) or hydrogen fuel cell electric vehicles (HFCEV).

HFCEV will require extensive new infrastructure to enable both end user vehicle refueling and the delivery of hydrogen to fueling stations. This is a disadvantage compared to BEVs, which already have fast charging infrastructure available, and most provinces are expanding their charging networks.

HFCEVs do however have advantages over BEVs; they have lower efficiency loss in cold weather, they are less reliant on scarce materials such as lithium and can have a higher energy storage density, meaning they have the potential to carry more fuel and thus have a longer trip range. HFCEV also benefit from fast refueling rates as opposed to the extended charging times of BEVs. These technological advantages indicate HFCEV may be suitable for use in cases with longer journeys and/or high vehicle utilization requirements (i.e. transit buses benefit from reduced refueling/recharging time, enabling more in-service time).

2.1.3 Hydrogen for Electricity Generation and Grid Balancing

New Brunswick electricity customers are served by approximately 80 per cent clean electricity including in-province wind, hydro and nuclear and out-of-province electricity purchases from Québec. Moving to a net-zero electricity system by 2035 poses challenges for the utility as competition for out-of-province clean electricity increases and emitting assets within the province are retired or transitioned away from fossil fuels.

By 2050, again under the most optimistic scenario allowing for 20 per cent hydrogen adoption for power generation in New Brunswick, GHG emission reduction would equate to 2,290,000t-$CO2^e$/year in New Brunswick. Under a more incremental scenario, in which five per cent of power generation in the province is achieved via hydrogen, GHG emission reductions would equate to 572,000t-$CO2^e$/ year.

Further reducing emissions associated with electricity generation in New Brunswick will primarily be achieved through the implementation of advanced Generation IV SMRs and increasing the renewable generation capacity. These changes will reduce the reliance on higher emitting generation such as coal and oil. Given that renewable generation is intermittent (the wind doesn't always blow) and as dependence on wind generation increases, New Brunswick will likely experience excess energy during periods of high wind, and energy deficits when there is less wind than expected. It is during these periods of energy deficits where hydrogen could play a role for New Brunswick with respect to power generation. In periods where there is an excess of grid power, this excess power supply could be used to produce hydrogen which, in turn, could be stored until there is a grid deficit, at which point the stored hydrogen could be used to generate power.

Although this use of hydrogen is not viewed as an efficient or cost-effective method to produce electricity on a full-time basis, having access to hydrogen for electricity generation would be a valuable tool for New Brunswick as a means to potentially meet peak power demand periods in the future.

2.1.4 Demand for Hydrogen – Export Opportunities

The International Renewable Energy Agency (IRENA), is projecting that the global demand for green hydrogen will be 600 Mt by 2050, which is expected to fulfill 12 per cent of the global energy needs. IRENA is also projecting that in 2050, 75 per cent (450 Mt) of global hydrogen demand (600 Mt) will be addressed domestically, and 25 per cent (150 Mt) will be fulfilled through international hydrogen trade. This means that global hydrogen trade is set to represent a market 7.5 times greater than the domestic Canadian consumption, as projected by NRCan for 2050.

NRCan anticipates major import markets to emerge internationally especially in areas where there are limited renewable resources available to produce clean hydrogen. Some key target markets for Canadian-produced hydrogen may include parts of the United States (US), Japan, South Korea, China, Europe, and potentially South America. These projections are consistent with IRENA's forecasts on global hydrogen trade, indicating there will be large hydrogen import demand in Europe.

New Brunswick's location on the Atlantic Basin provides the opportunity to ship hydrogen to export markets in Europe and potentially the US and South America. The Port of Rotterdam in the Netherlands and the Port of Hamburg in Germany are potential destinations of hydrogen export from New Brunswick. Two New Brunswick locations, Belledune and Saint John, are considered to have the capabilities to become significant hydrogen hubs due to their regional asset base and existing infrastructure combined with water access through their port facilities.

When assessing various criteria for processing hydrogen exports in Canadian ports, NRCan has focused on several key factors. These include the port's ability to accommodate deep drafts, access to rail infrastructure, land for development, existing hydrocarbon infrastructure, and proximity to nearby hydrogen production. Based on these criteria, New Brunswick's Saint John Port Authority (SJPA), in conjunction with the industrial base in the City of Saint John, and Belledune are considered amongst the highest potential energy export hubs in Canada.

2.2
BUILDING ON NEW BRUNSWICK'S NATURAL RESOURCES AND UNIQUE ASSETS

To deliver hydrogen production at scale in New Brunswick, local feedstock availability will be one of the key drivers behind the choice of production technology deployed and cost competitiveness. In consideration of the feedstock requirements for hydrogen production, New Brunswick is very well positioned when compared to other jurisdictions both in Canada and globally. Due to its abundant renewable energy potential, New Brunswick will have an advantage in the production of green hydrogen, which uses renewable power as a process input. Additionally, the province could develop an advantage in pink hydrogen production, with the development of the advanced Generation IV SMR technologies underway in the province, which in turn will make nuclear power more abundant and create a competitive advantage in New Brunswick.

Wind Energy

Wind energy is likely to be an important source of electric input for hydrogen production in Atlantic Canada, including in New Brunswick, which has relatively favourable wind resources in the region.

Current installed wind capacity in New Brunswick is about 397 MW, which represents a small percentage of the province's total generating capacity of about 4,600 MW. Given that fossil fuel currently accounts for about 2,400 MW of New Brunswick's capacity, increased installation of wind power generation will play a significant part in the province's future energy generation mix required to achieve net-zero by 2035. This anticipated growth in wind power generation will benefit future hydrogen producers in providing an increased opportunity for use of renewable energy in their production processes.

Studies have shown that New Brunswick has a significant abundance of additional wind power generation available. A December 2015 study conducted by Barrington-Leigh and Ouliaris estimated the availability of various renewable energy resources, including wind across Canada. For New Brunswick, present installed onshore wind capacity was shown to be approximately 10 per cent of New Brunswick's land-based wind generation potential, while offshore wind capacities for the province were estimated to be five to six times that of the onshore capacity. With the advent of larger turbines this capacity for both onshore and offshore will continue to grow. Figure 4 summarizes the study's findings for New Brunswick.

Figure 4. Wind Energy Potential in New Brunswick

Estimated Capacity		
Onshore (38%)	MW	3,004
Offshore (49%)	MW	17,240
Current Capacity 2023	MW	397
Percent of Potential		1.96%

Nuclear Power

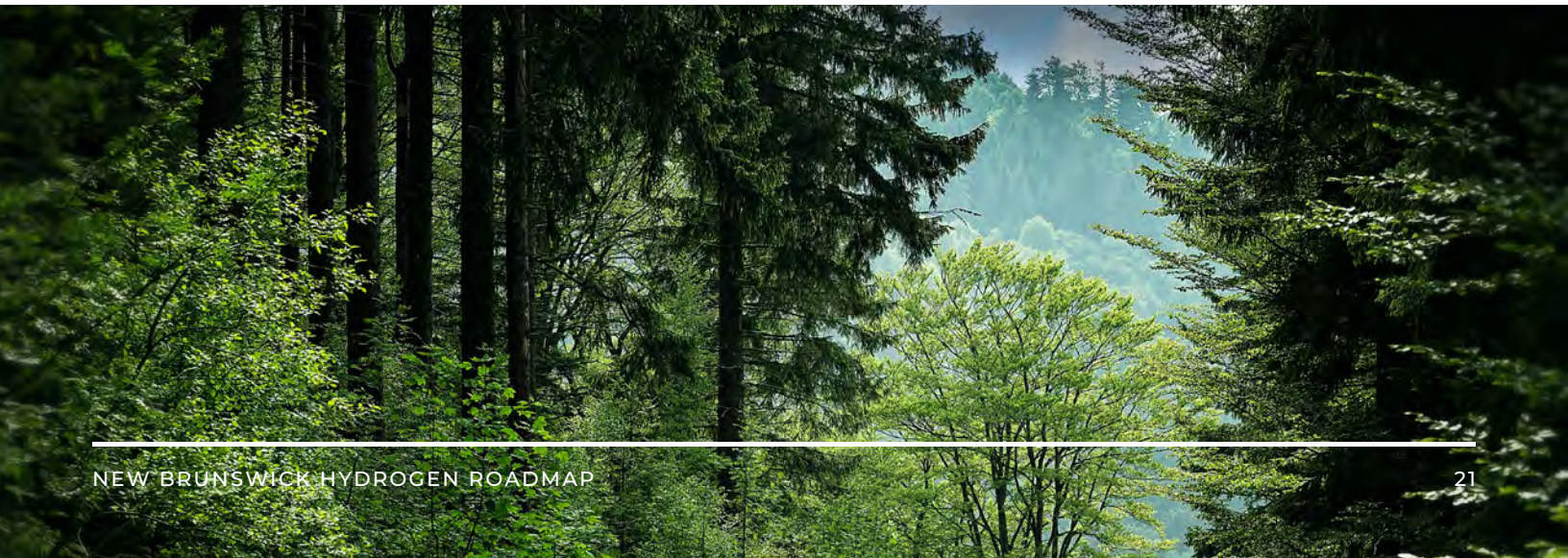
New Brunswick's current in-province power generation mix is based on a diverse fuel mix that combines gas fired power plants, nuclear energy, hydro and renewable electricity generation. Nuclear will continue to be a stable source of electricity for New Brunswick as Canada has recently confirmed that nuclear will continue to be considered as a clean source of energy in their policy approach. Nuclear energy generated at the Point Lepreau Nuclear Generating Station currently accounts for approximately 26 per cent of New Brunswick's electricity. The Province has identified SMRs as a key technology in advancing the next generation of nuclear power with the addition of fourth-generation advanced SMRs being identified for future installation in New Brunswick. Beyond power generation, advanced Generation IV SMRs generate high heat, making them ideal for industrial decarbonization. This includes district heating, high-quality steam for heavy industrial applications as well as hydrogen production. New Brunswick's existing expertise in nuclear power generation, in addition to the province's commitment to adding SMRs for future power generation, puts the province in a strong position for future decarbonization and economic growth opportunities associated with hydrogen production.

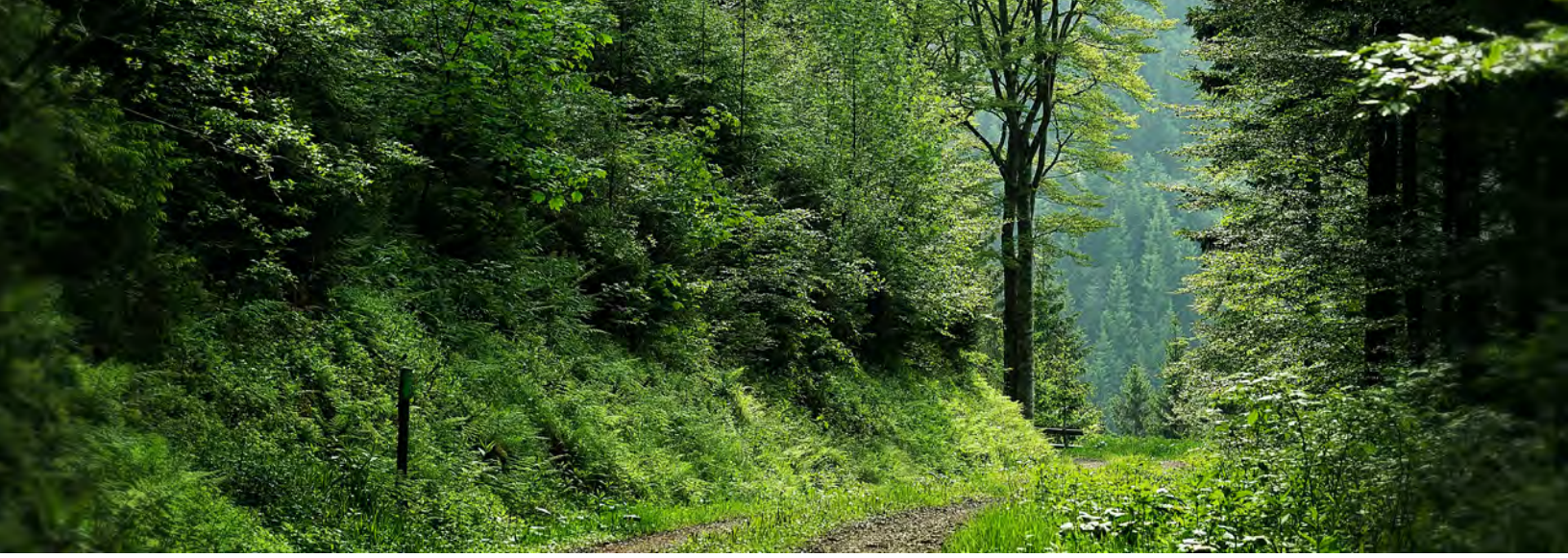
Solar and Biomass

The province does have significant future capability with both solar and biomass as potential feedstocks for hydrogen production, however present delivery costs of these energy sources remain prohibitive for use in the production of hydrogen.

Current electricity generation from solar power accounts for approximately 8 MW of electricity per year; 0.2 per cent of New Brunswick's electricity mix. The use of solar power is expected to increase in the province with the aid of federal government incentives and net metering programs. Recent innovations and breakthrough commercialized technologies have significantly reduced the cost of producing solar panel modules which is expected to make solar energy more competitive in the future.

In addition to its use as a biofuel for electricity production, biomass has the potential to be employed as a feedstock for hydrogen production through biomass gasification. It should be noted, however, that transportation costs are often prohibitive when gathering and transporting biomass for electricity generation. In addition, biomass gasification has been found to have better energy efficiency for direct natural gas blending, rather than conversion to low-carbon hydrogen. These two factors may limit the use of this resource for future hydrogen production; however, the use of biomass as an energy source will remain a key resource in helping New Brunswick achieve net-zero by 2035.





Natural Gas

The Government of New Brunswick (GNB) introduced a cessation and prohibition of all types of hydraulic fracturing throughout the province in 2014 which is currently preventing shale gas extraction apart from one area that was exempted from the prohibition commencing in 2019. While New Brunswick has experienced decreasing gas production over the last 10 years, a report from the federal government estimates that the province has approximately 77.9 trillion cubic feet of gas reserves. Should conditions change, the province would have access, to a major local supply of natural gas which could be used both as a transitional fuel and as a hydrogen production feedstock to be combined with carbon capture utilization and storage; a similar process to that being employed for clean hydrogen production in Western Canada. This could be another important tool for New Brunswick when working to achieve net-zero in the province.

Water Resources

To produce hydrogen via electrolysis, demineralized water is required as a feedstock. Hydrogen production via electrolysis requires approximately 10 kg of demineralized water for each kg of hydrogen produced.

To its advantage, New Brunswick is rich in water supply, having approximately 60,000 km of rivers and streams, and 2,500 lakes and ponds totalling 1,460 km2 of surface water, representing ample resource availability. In addition, the province has a long coastline consisting of thousands of kilometers between the Gulf of St. Lawrence and the Bay of Fundy with available ground water access.

Early investigations have shown that New Brunswick has several water sources capable of supplying a calculated water usage of 0.10-0.33m3/second to meet a projected hydrogen production of 215,000 tonnes per year by 2050. It should be noted that although supply is more than available, access to water resources for future industrial hydrogen production sites would be subject to the completion of successful environmental impact assessments by hydrogen production proponents.

2.3
NEW BRUNSWICK'S COST COMPETITIVE POSITION

New Brunswick hydrogen cost drivers are in line with global hydrogen industry cost drivers due to the global supply chain of hydrogen production and supply equipment (i.e. equipment producers are globally specialized companies and not based in New Brunswick). As well, the province is viewed as having an advantage in green hydrogen over the long term based on the renewable energy potential that exists in New Brunswick.

The cost of hydrogen production is dependent on technical and economic factors such as feedstock costs, capital expenditures, and operational costs. Findings indicate that New Brunswick has the potential to produce competitively priced green hydrogen based on projected levelized cost of hydrogen (LCOH), green feedstock potential and access to fresh water sources.

A major factor in hydrogen production cost competitiveness is the cost of electricity. Electricity input costs are estimated to account for approximately 40 to 70 per cent of the levelized cost to produce hydrogen. New hydrogen production facilities can either use power from the local power grid or develop their own power source. Hydrogen developers will most likely pursue a dual strategy where they can achieve higher overall utilization and more cost-efficient operations by connecting to the grid and newly developed electricity sources (i.e. wind farms). To meet its GHG targets, the Government of New Brunswick understands the need to develop an electricity policy framework which recognizes the unique needs and characteristics of potential hydrogen producers. Future hydrogen production in the province, likely based on the use of electrolysers, will require access to or the ability to generate a supply of competitively priced clean electricity.

2.4
IMPACT ON ECONOMIC DEVELOPMENT IN NEW BRUNSWICK

In addition to potentially abating up to 29 per cent of provincial GHGs, an evolving local hydrogen industry could yield significant revenues. Domestic sales of New Brunswick hydrogen could reach up to C$349 million in 2050 and a total of C$1.9 billion with an export market. Revenues would have a cascading effect both along the supply chain and with the development of new industrial growth in manufacturing, service, and knowledge-based industries.

Such a build out of the local hydrogen industry will require important capital expenditures for the development of both onshore and offshore wind capacity and green hydrogen production through electrolysis, all of which could benefit the local supplier base.

3. Hydrogen Roadmap Early Actions

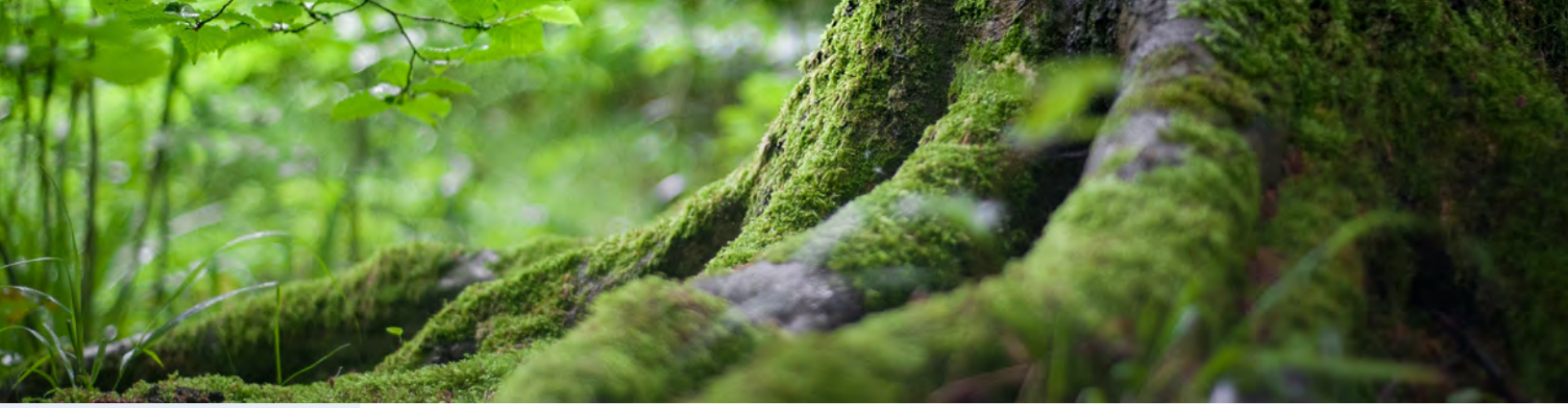
Our Hydrogen Roadmap lays out a series of actions that will enable and facilitate the growth of this important source of energy in the Province of New Brunswick.

Timeline:

New Brunswick is entering a period of energy transition. Hydrogen is very much in its infancy and is expected to develop at an exponential rate over the next decade. Accordingly, our Roadmap is detailed with key Action Items spanning over the next five years that are designed to be responsive to changes in market conditions and to the overall cost competitiveness of hydrogen over the five-year period.

Goal:

The goal of the Hydrogen Roadmap is to establish hydrogen as a source of clean energy for New Brunswick. Development of a hydrogen sector in the province will bring new business investment, helping to grow the economy of New Brunswick, while providing our province with an opportunity for significant decarbonization and energy security for the future. This goal is fully aligned with our net-zero objectives and the New Brunswick Climate Change Action Plan and will enable New Brunswick to power our economy and the world with clean energy.



3.1
ROADMAP ACTION ITEMS

The intent of the Hydrogen Roadmap is to provide clear and concise action items for delivery by the Government of New Brunswick which, when complete, will facilitate the establishment and growth of the hydrogen sector in the province. Although this Roadmap is intended to be a GNB action plan, it is understood that continued dialogue and partnership with all interested New Brunswick communities and industry proponents will be essential in successfully achieving the hydrogen goals for the province.

In advance of drafting the Hydrogen Roadmap, GNB did initiate early engagement with New Brunswick based energy interests and environmental groups, public and community representatives, First Nation communities, industry proponents, and technology providers. Based on the feedback received through this preliminary engagement process, five key principles were determined as being critical in the development of the New Brunswick Hydrogen Roadmap.

Provision of Leadership – The Hydrogen Roadmap must translate the clean energy vision and opportunity for New Brunswick into effective policy and action, all within a five-year period.

Creation of an Effective Regulatory Environment – GNB will need to update all applicable Acts and regulations and manage the permitting and approval processes efficiently while collaborating with our federal counterparts to modify national codes and standards for future hydrogen use.

Engagements and Partnerships – The Province will carry out its Duty to Consult and support proponents to engage with First Nation communities on economic opportunities that may be presented with hydrogen development in the province. GNB will also develop a comprehensive public engagement plan, and work with industry to grow our local businesses to support the hydrogen sector, including the deployment of this energy source and the development of end uses for hydrogen.

Build the Foundations for Success – It is essential that the Province leverage existing industrial and transport infrastructure to develop hubs for hydrogen activity. The Province will foster innovation, assess resources, support advanced Generation IV SMRs, collaborate on the development and promotion of export markets, and strengthen New Brunswick's advantage through workforce training, investment attraction, and supply chain development.

Focus on Action and Accountability – The Province will provide support and a focus on hydrogen and clean technology development by establishing a dedicated GNB team responsible for the promotion of the hydrogen sector in New Brunswick and to provide coordination, facilitation, and measurement of progress on the Hydrogen Roadmap actions.

3.2
HYDROGEN ROADMAP ACTION ITEMS – DETAILS

3.2.1 Creation of an Effective Regulatory Environment

In the absence of a revised regulatory environment, hydrogen development in the province would be very limited, leaving New Brunswick at a competitive disadvantage when compared to other jurisdictions in the hydrogen sector. Safety and environmental protection rules require change and to be streamlined to explicitly cover hydrogen and its future uses. It is essential that while making these changes, all protections with respect to the environment and safety are maintained. In conjunction with the revised regulations, the Province will also need to establish acceptable and competitive approval thresholds and timelines for the hydrogen sector and its future technology advances.

The objective of enacting these amendments is to ensure that hydrogen is fully integrated into the provincial regulatory framework. The amendments will position New Brunswick to be consistent and competitive with other neighbouring jurisdictions in the promotion and development of the hydrogen industry. Finally, as part of establishing a competitive environment, GNB must provide the regulatory mechanisms for hydrogen industry proponents to source the necessary renewable electricity as required by their processes.

ACTION 1:

The Government will amend all relevant Acts and Regulations to support the development of the hydrogen industry in New Brunswick and to enable the integration of hydrogen into the provincial energy systems. This will include amendments to the *Gas Distribution Act*, the *Pipeline Act*, the *Electricity Act* and the *Underground Storage Act*.

TIMELINE: 2024 - 2026

3.2.2 Development of Processes for Timely and Effective Regulatory Decisions

Effective regulation requires the establishment of processes and technical resource assignment for the processing of applications and the verification of activities and results including environmental permitting.

Regulatory effectiveness and certainty are necessary elements in achieving public approval and investor attraction with respect to hydrogen development in New Brunswick. However, it should be noted that the full scope of the hydrogen regulatory system goes well beyond New Brunswick's authority. To ensure the Province is well positioned from a regulatory perspective, in addition to making changes to New Brunswick regulations, extensive work will be required with our Canadian partners to update national codes and standards.

ACTION 2:

The Province will ensure that the existing government permitting and regulatory bodies develop the necessary processes and technical resources to ensure that hydrogen development permitting relating to environmental approvals, project development, transportation, storage and the use of hydrogen are completed with a high standard of technical expertise and a timely manner.

TIMELINE: 2024 - 2026

3.2.3 New Codes and Standards

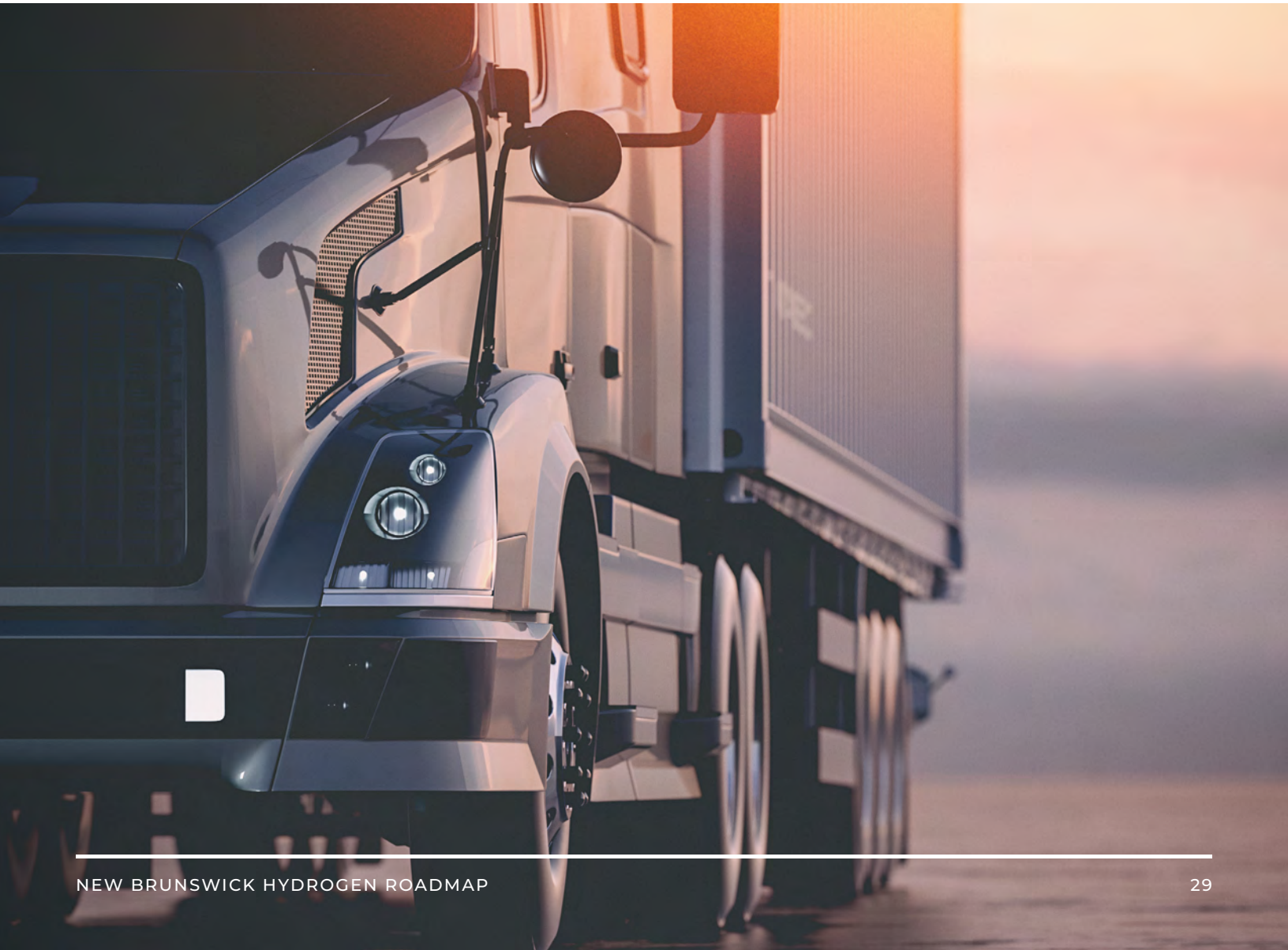
With the anticipated growth in new hydrogen applications (i.e. feedstock for industrial applications, fuel for transportation for trucking and shipping, and blending of hydrogen into natural gas pipelines), New Brunswick will require new safety standards and regulations to ensure the use of hydrogen for these new applications meets all safety thresholds.

Much of the work on new technical standards is already underway in a multi-industry, multi-government process. The work, being conducted on a national scale, includes integration with international standards and the adoption of national codes, standards, and best practices to maintain safe and efficient production, storage, transportation, and use of hydrogen.

ACTION 3:

The Province of New Brunswick will work collaboratively within the region to ensure codes and standards are harmonized. Much of this work will be completed by the federal government through a series of technical working groups with provinces adopting relevant codes and standards once they are developed. New Brunswick will continue to support the development of relevant codes and standards and commit to adopting them in a timely manner.

TIMELINE: 2024 TO 2029



3.2.4 Engage and Partner

Key elements of the Hydrogen Roadmap will not be achieved without full engagement and alignment. New Brunswick's public interest groups, business stakeholders, communities, and First Nations all must be part of the shaping and delivery of Roadmap actions. It is also incumbent upon the Province to provide the information and education materials that all New Brunswickers will require to better understand how hydrogen can assist the province to decarbonize and what future opportunities hydrogen will provide to New Brunswick.

Work with First Nations

We believe First Nations communities will play a vital role in providing valuable perspectives, insights, and inputs throughout the process of hydrogen development and deployment. New Brunswick First Nations communities are currently active participants of renewable energy holdings and have experience in managing renewable energy projects in areas such as supply chain and project construction. The opportunity to build on that base of expertise quickly and effectively will be a priority in our discussions.

We are also open to consider and support other initiatives that ensure the First Nations communities, their organizations, businesses, and people benefit from the growth of clean energy supplies and hydrogen. It is the goal of all dialogue to explore any concerns and find ways to address those issues.

ACTION 4:

Working with First Nation Communities, the Province will collaboratively develop a plan to identify opportunities for First Nation partnerships in hydrogen development projects in New Brunswick to support first nations participation in the emerging sector.

TIMELINE: 2024 TO 2026

3.2.5 Work with Industry

A roadmap to support the development of an industry would be ineffective without the direct involvement of industry partners. The Province needs to understand from industry what hydrogen work or projects are achievable, and how the growth of the hydrogen industry can be executed to maximize the benefit for the people of New Brunswick. As industry will be the project developers and the driving force in realizing hydrogen opportunities, providing support to our industry partners will be essential.

To ensure the Province is well positioned to support industry, the capabilities and capacities on New Brunswick business will need to be well understood. Given that supply chain shortages are common in many sectors today, the Province will need to ensure that plans are in place to have adequate supply chain capability for the support of the New Brunswick hydrogen industry. It is essential that New Brunswick have the resources in place, (people and businesses) to seize hydrogen related opportunities. Finally, it will be incumbent upon the Province to have a deep understanding of economic benefits and impacts derived from hydrogen projects and future opportunities.

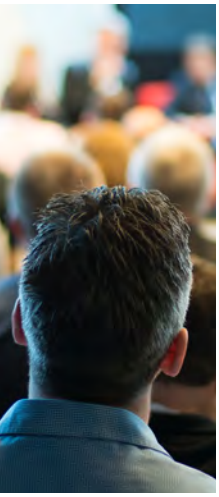
ACTION 5:

GNB will develop an Industry Partnership Plan. The Plan will include a full supply chain assessment, investment attraction strategy, and opportunity review related to the establishment of the hydrogen industry in the province. As part of its strategy to facilitate the growth of the hydrogen sector in New Brunswick, GNB will work to establish a formal New Brunswick energy cluster, which will include hydrogen interests, bringing together industry proponents, supply chain representatives, academia, research and development, and technology developers with the goal of working across the entire energy ecosystem to enhance collaboration and generate growth.

TIMELINE: 2024 TO 2025

3.2.6 Public Engagement

For most of the population of New Brunswick, hydrogen use as an energy source is a relatively new concept. All fuels have some degree of risk when combusted to produce energy whether for use in space heating, transportation, or electricity generation. With the development of new regulations and safety standards, known risks can be addressed and properly mitigated. The New Brunswick Hydrogen Roadmap will act to drive public education on the future uses of hydrogen and address any risks associated with using this new energy source through changes in the regulatory system.



ACTION 6:

The Province will undertake a public engagement initiative that will include public sessions to gather feedback and information to help build the hydrogen sector in the province. GNB will host roundtables as well as education and awareness campaigns to share information about the hydrogen opportunities for the province. This information will include environmental and safety aspects of the new technologies to help educate the public about the emerging industry. This Engagement Plan will be integrated with other energy-related policy processes.

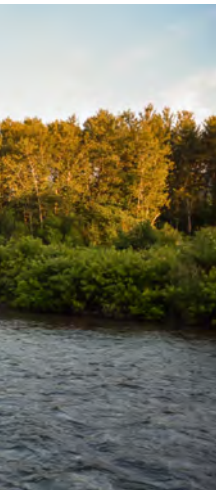
TIMELINE: 2024 TO 2025

3.2.7 Build the Foundations for Success

Assess Resources

New Brunswick has distinct competitive advantages when compared to other jurisdictions when considering the requirements for hydrogen production and transportation. As discussed earlier in this document, the province has tremendous wind power capacity potential (both onshore and offshore), significant water resources, natural gas deposits, excellent deep-water ports, and a wealth of operating experience in nuclear power.

To properly plan and optimize the hydrogen opportunities for New Brunswick, detailed assessments will be required to better define the true potential of these resources.



ACTION 7:

The Province will undertake assessments for resource availability required for hydrogen production. This will include water, onshore wind power generation, offshore wind power generation, electricity grid capacity, natural gas and carbon capture and storage. These assessments will include factors such as resource availability and environmental considerations. They will help guide the future development of hydrogen by identifying the best locations for development and any future needs to support development and ensure the reduction of greenhouse gasses.

TIMELINE: 2024 - 2026

3.2.8 Establish Hydrogen Hubs

Hydrogen hubs are viewed as an important part of Canada's hydrogen strategy. The concept of a hub contemplates not only having hydrogen production facilities at a particular location, but for that location to also host industries that provide inputs for hydrogen generation as well as potential end users that use hydrogen in their processes. In addition, a hydrogen hub is ideally positioned should it have fully integrated supply chain capabilities for hydrogen transport embedded on the site. In this integrated model, the entire operation is more cost effective given that there is little need for significant hydrogen transmission or storage. Given these efficiency gains and the cost effectiveness provided, hydrogen hubs are central to most hydrogen strategies or roadmaps.

Additional Benefits from Hubs

Innovation and Growth Accelerators

Establishing hydrogen hubs in New Brunswick will also provide incubation sites for hydrogen-use start-ups. Technology demonstrations and innovation will flourish given the local supply of hydrogen present at the hubs.

Hydrogen hubs are key to the Hydrogen Roadmap because they will be central to the growth of hydrogen production, attract both private and public investments and accelerate growth. Properly established and funded, hubs will help optimize costs, increase hydrogen supply, and promote local hydrogen supply chain development throughout the province.

Belledune

Belledune has an established deep-water port in northeastern New Brunswick which supports the export of forest and mineral products. The region has access to land for the development of future industrial processes, has at its disposal an abundant supply of water for use by industry and is in an area with significant onshore wind power potential. Given these attributes, Belledune is ideally positioned to host future hydrogen production facilities and other green industries reliant on hydrogen, while serving as an export facility for the shipment of hydrogen to global markets.

Saint John

Saint John is home to Canada's largest refinery, which not only has experience in hydrogen production but is also expanding its hydrogen production capacity. In addition, Saint John is home to Canada's only operational liquefied natural gas facility, a major container and bulk port and has connectivity to major railroads and a major industrial base, all of which make it an ideal location to serve as a hydrogen hub.

ACTION 8:

The Province will support the establishment of two major hydrogen hubs in the province. One will be located at Belledune and the other at Saint John. The Province will promote these locations as leading hydrogen hubs across Canada. With the existing hydrogen production at the Saint John Refinery and their plans for expansion, the hubs will build on the expertise already established in the province and advocate for federal support to further establish the hubs. Each hydrogen hub will be required to create a development plan that includes input from the community.

TIMELINE: ONGOING

3.2.9 Support Innovation

By fostering innovation, New Brunswick will help develop hydrogen as a competitively priced fuel for clean energy solutions. New Brunswick's leadership in energy innovation has been seen in the Centre for Nuclear Energy Research, (CNER) at the University of New Brunswick for SMRs and in the Smart Energy Sector where NB Power, Siemens, the Province, and other parties have fostered a collaborative research agenda. Their initiative led to the Smart Grid Innovation Network (SGIN), which has now evolved into a national organization supporting smart energy solutions across Canada, while still being based in New Brunswick.

A similar approach would see New Brunswick helping to create a strong base of industry and research for collaboration on hydrogen innovation projects. With the completion of successful innovation projects, New Brunswick would be well positioned to seek new relationships with other researchers and industry partners in the region and across Canada.

ACTION 9:

The Province of New Brunswick will establish a new fund, for innovation, research and support for domestic pilot projects. The pilot projects would showcase the potential for hydrogen to replace existing fossil fuels in the province, either through transportation projects or end-use projects. The funds may be used to leverage additional federal funding and may be expanded to include future clean technology development in the province. All pilot projects will be required to demonstrate the reduction of domestic greenhouse gasses.

TIMELINE: 2024 - 2029

3.2.10 Support Advanced Generation IV Small Modular Reactors

Building on its long history of nuclear operational knowledge and as part of the pan-Canadian SMR Plan, New Brunswick is working to lead the development of Generation IV Advanced SMR technology.

New Brunswick's investment in next-generation modular and scalable advanced SMR technology began in 2018 with the provision of $10 million in funding to two companies, ARC Clean Technology and Moltex Energy Canada. This funding was provided to support the development and design of the technologies as part of the provincial plan to achieve the clean energy standard in 2035.

We expect to have 150 MW of SMR generated power coming on line 2030/31 with 600 MW of total generation by 2035.

Advanced Generation IV SMRs are viewed as an integral component in New Brunswick's energy future. This technology will be essential in assisting in the province's decarbonization initiatives as the gains from implementation of the technology will be twofold; not only will the technology allow for clean electricity generation and replace that currently generated by fossil fuel, advanced Generation IV SMRs also have the capability of producing clean hydrogen for energy use in New Brunswick.

ACTION 10:

The Province will continue to support the development of advanced Generation IV Small Modular Reactor technology as a source of non-intermittent clean energy generation that can be used for hydrogen production.

TIMELINE: ONGOING

3.2.11 Strengthen New Brunswick's Advantage

New Brunswick already has many of the resources and attributes required for hydrogen development. It is critical to ensure that the people and businesses of New Brunswick are positioned to seize all opportunities. Additionally, it is paramount that New Brunswick promote its capabilities and opportunities to investors and export markets. These actions will serve to strengthen the province's already considerable advantage.

Promote Workforce and Skills Readiness

Establishing workforce skills and readiness requires an assessment of what resources and skills are present in New Brunswick and what the future requirements will be.

This work will be fully integrated with the Government's commitments in the Climate Change Action Plan: *Promote workforce and skills readiness by Conducting a Clean Technology Skills Gap Assessment by 2025 to determine the skills and training programs needed and begin implementation of any new programs identified by 2027*.

Hydrogen skills and workforce readiness will be among the first to be assessed and acted upon.

ACTION 11:

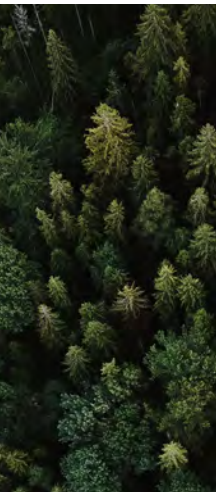
The Province will conduct a thorough assessment and identify any training and workforce gaps. The assessment will be used to develop a labour force strategy in addition to identifying any local companies that may be able to support the hydrogen industry in the province with the objective of ensuring that the opportunities for New Brunswick from the development of the hydrogen industry are maximized.

TIMELINE: 2024 - 2025

3.2.12 Promote New Brunswick Hydrogen Sector Exports

To fulfill New Brunswick's domestic hydrogen needs in the future, hydrogen production facilities will be required to be built to a scale in which the production costs of New Brunswick hydrogen are competitive on a regional basis. To achieve this market competitiveness, many of the hydrogen proponents will be required to build facilities having production capacities significantly more than that required by New Brunswick consumers. This will result in large volumes of hydrogen being available for markets outside of the province.

It will be incumbent upon New Brunswick to support its hydrogen industry partners, and to actively promote and work to establish alliances for the New Brunswick hydrogen industry throughout Canada and in international markets. The province needs to take an active role in supporting industry partners by promoting New Brunswick as a dependable and competitive provider of clean hydrogen for the world's economy.



ACTION 12:

The Province will continue to work independently in addition to collaborating with its regional counterparts and the federal government to explore opportunities in international markets. The Province will continue to participate in working groups that includes First Nations participation. The Province will also promote the New Brunswick hydrogen industry on a global basis and work in conjunction with the federal government in the establishment of international trade agreements for the benefit of hydrogen producers located in New Brunswick.

TIMELINE: ONGOING

3.2.13 Focus on Action and Accountability

For expedient and efficient execution of the New Brunswick Hydrogen Roadmap, dedicated leadership is required. To meet all the requirements in the Roadmap, GNB will need to ensure actions are coordinated, with accountability, follow-up, and reporting in place. This leadership responsibility will reside within the Department of Natural Resources and Energy Development and will represent GNB's ongoing focus on the development of hydrogen and other clean energy alternatives for the province.

ACTION 13:

The Government of New Brunswick will establish a clean energy group within the Department of Natural Resources and Energy Development. This new group will act as a single point of contact for companies and organizations looking to invest in clean energy technology in the province. The clean energy group will help facilitate hydrogen business development activities with the appropriate GNB departments while providing technical and regulatory leadership and assistance to industry proponents.

TIMELINE: 2024