



HYDROGEN ENERGY IN ALBERTA



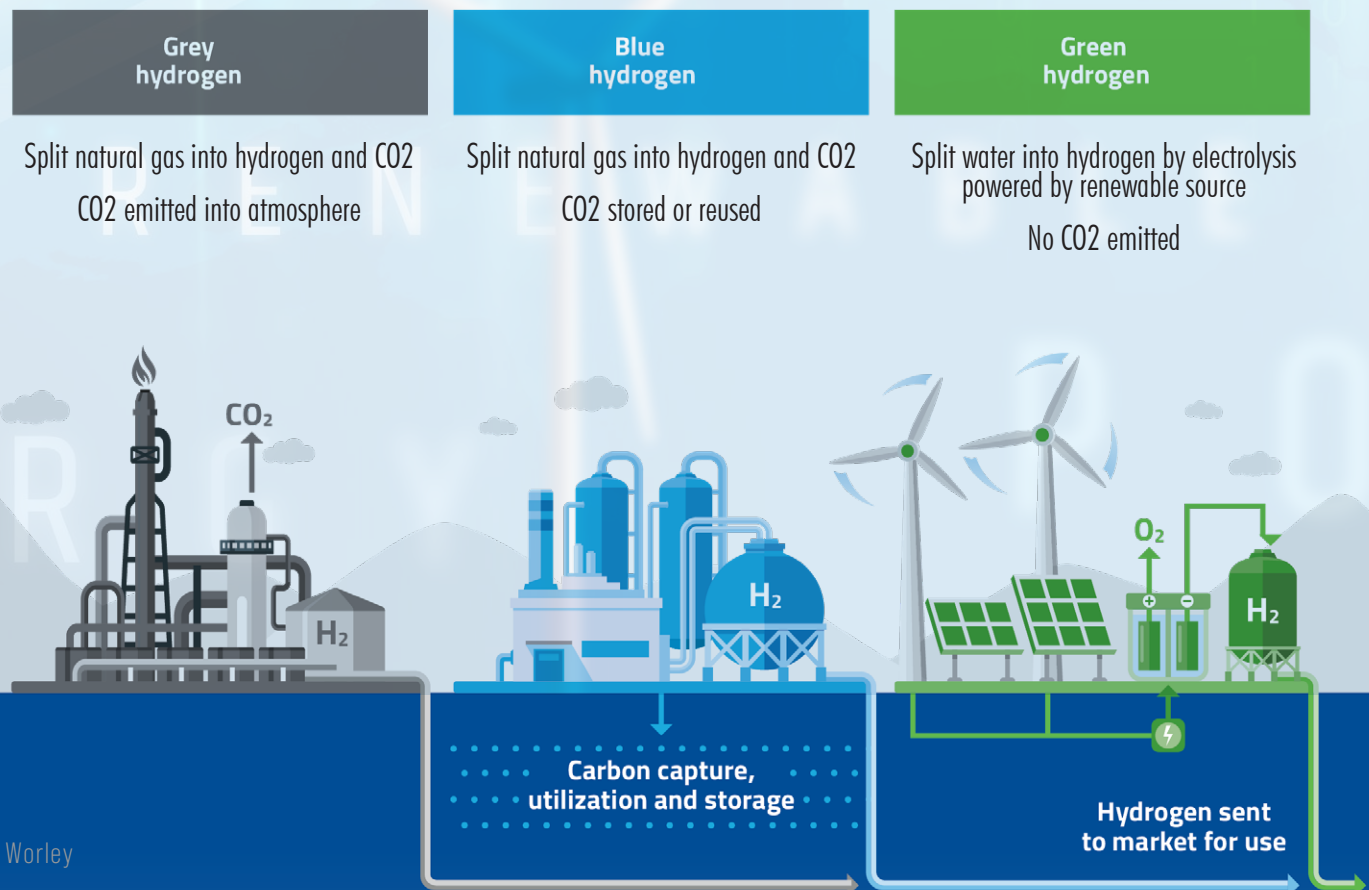
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INTRODUCTION

Hydrogen based energy production is an increasingly hot topic that is gaining traction across Canada. The advantages of hydrogen use are especially apparent in sectors where decarbonization is difficult and alternatives are limited. Canada has certain advantages that positions the nation to lead the global hydrogen movement, including high hydroelectric generation and freshwater capacity, production resources, and proximity to international markets. Canada is within the top 10 hydrogen producers in the world today. A large part of Canada's ability to produce hydrogen comes from Alberta's fossil fuel reserves, coupled with carbon capture and storage systems.

There are three main types of hydrogen: grey, green and blue. Grey hydrogen is the most traditional form of hydrogen and the least environmentally friendly option of all hydrogen types. Green and blue hydrogen are cleaner energy alternatives that are becoming increasingly popular on a global scale. Demand and application for green and blue hydrogen is expected to grow significantly. Green hydrogen uses electricity from a renewable energy source to separate water into oxygen and hydrogen molecules via electrolysis. The oxygen is released into the air while the hydrogen is stored for later use. Blue hydrogen is the process of splitting natural gas into carbon dioxide and hydrogen. Blue hydrogen reduces carbon emissions when compared to grey hydrogen production since the emissions in blue hydrogen are utilized through carbon capture and storage.

Sources: Natural Resources Canada, The Narwhal & Petrofac



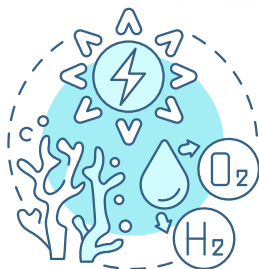
Source: Worley

TYPES OF HYDROGEN PRODUCTION



ELECTROLYTIC HYDROGEN

Produced from water via electrolysis and clean electricity.



FOSSIL FUELS

Combining current fossil fuel systems with carbon capture processes. Provinces best suited for this type of hydrogen production is AB, BC, SK, and the Atlantic provinces.



BIOMASS

Hydrogen from the gasification of dry biomass (renewable source).



INDUSTRY BY-PRODUCT HYDROGEN

Chlor-alkali and sodium chlorate production can be captured, purified, and used directly.

END USE EXAMPLES



TRANSPORTATION

Fueling hydrogen cell vehicles. The improved energy density of hydrogen fuel cells compared to electric batteries offers potential solutions for heavy duty applications where periodic electric charging is not feasible. Examples include trucks, rail, ships, and airplanes.



POWER GENERATION

Hydrogen combustion in turbines or electrochemical conversion in stationary fuel cell power plants.



HEAT FOR INDUSTRY

Substituting hydrogen instead of fossil fuel combustion, particularly in applications where high grade heat is needed and where electric heating is not technically or economically viable. This type of substitution reduces carbon intensity and emissions. Examples of potential industry applications include upstream oil and gas operations, cement and steel manufacturing, and pulp and paper.



HEAT FOR BUILDINGS

Decarbonizing the natural gas grid by introducing hydrogen as alternative low-carbon chemical fuels.



FEEDSTOCK

Hydrogen based systems processing heavy hydrocarbon chains into lighter components and reducing the carbon intensity of crude oil.

THE ALBERTA ADVANTAGE



On a provincial scale, Alberta is well positioned to capitalize on the growing hydrogen industry. Alberta's Industrial Heartland is a region located northeast of Metro Edmonton, Alberta and contains Canada's largest hydrocarbon processing centre. The heartland is managed by an association of five municipalities: The cities of Edmonton and Fort Saskatchewan, and the counties of Sturgeon, Strathcona, and Lamont. The association has assigned a Hydrogen Task Force responsible for planning and implementing hydrogen economies in the region. The task force estimates that the Canadian hydrogen industry has a wholesale potential of up to \$100 billion per year, with Edmonton as the best launch point for a pan-Canadian hydrogen economy. Blue hydrogen is a growing industry that the heartland can take advantage of, particularly due to its connection to the Alberta Carbon Trunk Line, which runs directly through the heartland. This line is a large-scale carbon capture utilization and storage system, where carbon is stored underground or used to recover ultra low carbon oil in depleted reservoirs. Currently, about 41.6% of hydrogen production in the heartland is considered blue. With low cost production of low carbon hydrogen, advanced infrastructure, innovation, and skilled workers, Alberta's Industrial Heartland and surrounding regions are well positioned to lead the province to a low emissions energy future.

Source: Alberta's Industrial Heartland & Strathcona County

ALBERTA'S INDUSTRIAL HEARTLAND



The government of Alberta has announced the Natural Gas and Vision Strategy, and anticipates large scale hydrogen production with carbon capture, utilization, storage, and deployment by 2030. They have launched the Alberta Petrochemicals Incentive Program (APIP), which aims to attract hydrogen production facilities. Under APIP, the government of Alberta covers up to 12% of capital costs for investments in decarbonization solutions.

THE ALBERTA HYDROGEN ADVANTAGE



The world's largest carbon dioxide pipeline



Carbon capture and storage infrastructure



One of the world's largest producers of hydrogen for domestic industrial processes



World class expertise in producing low-cost, low-emissions hydrogen



Geology for carbon sequestration and hydrogen utilization

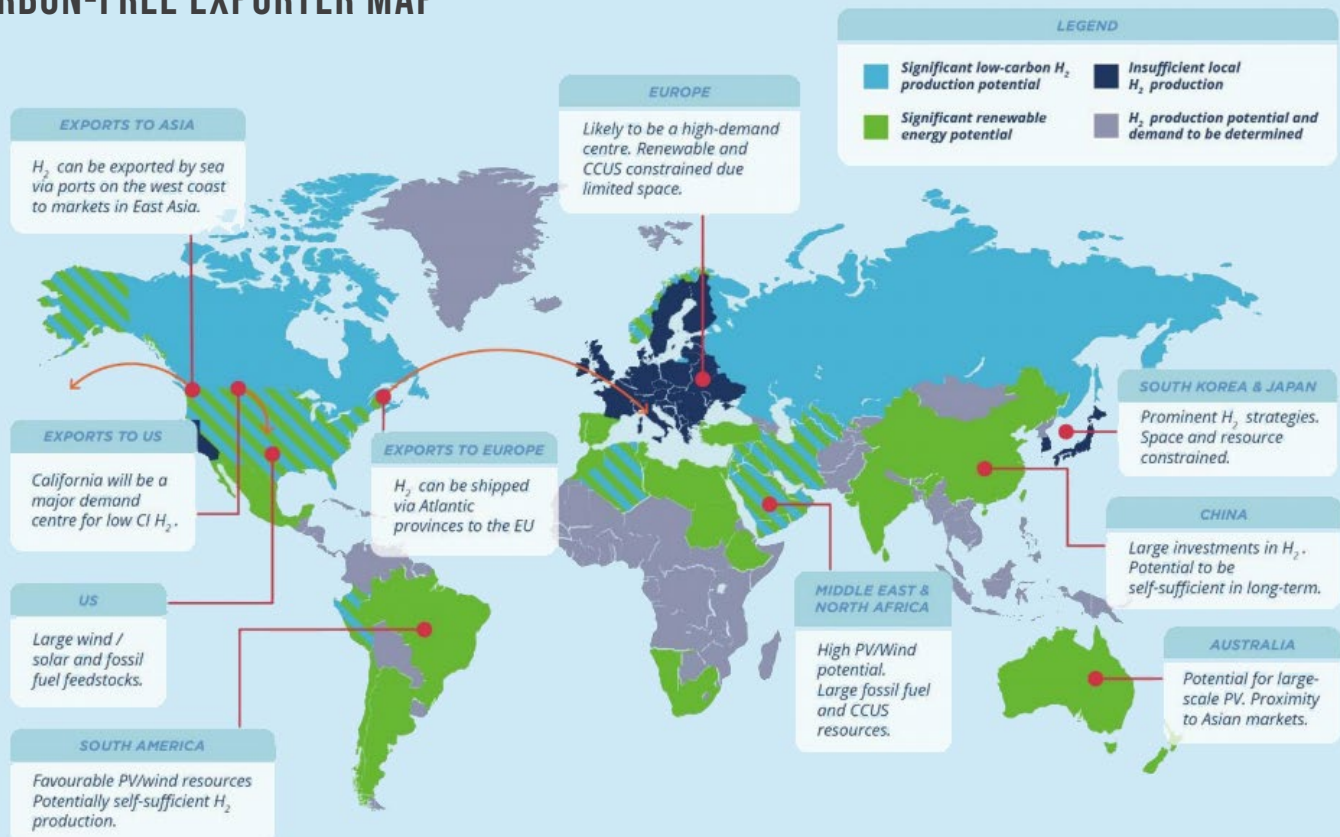


Significant overseas market potential

The emerging hydrogen industry provides new opportunities for Alberta to expand and integrate natural gas operations. As the hydrogen industry grows in the province, it is expected to create more jobs and revenue, while contributing to a cleaner energy future.

Source: Government of Alberta

CARBON-FREE EXPORTER MAP



Source: Natural Resources Canada

MAJOR HYDROGEN PROJECTS

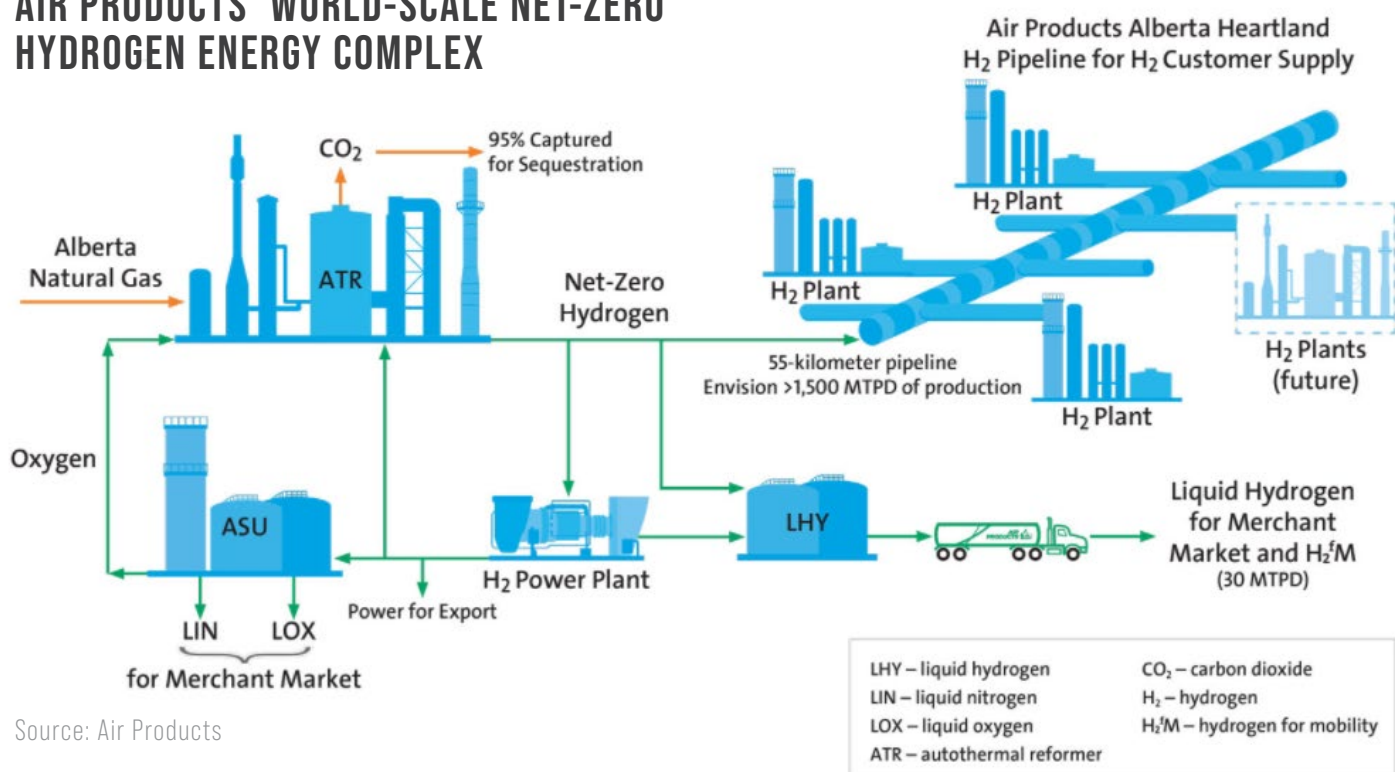


While still relatively new, the idea of hydrogen serving as an innovative energy source has attracted significant interest in the province of Alberta. ATCO is planning to build a hydrogen blending facility in the Fort Saskatchewan region with a total estimated cost of \$6 million, of which \$2.8 million is from Emission Reductions Alberta. Construction is expected to commence in 2021 and once completed, would be the largest hydrogen blending project in Canada. The facility is estimated to inject up to an additional 5% of the total hydrogen production levels in Fort Saskatchewan's existing natural gas distribution system. The additional hydrogen would enable the overall system to operate on lower carbon energy, thereby reducing the greenhouse gas intensity of the natural gas system.


On June 9, 2021, Air Products confirmed the construction of a \$1.3 billion-dollar blue hydrogen production and liquefaction facility in Edmonton. The facility's target completion date is 2024 and will create 2,500 jobs during the construction phase. Upon completion, the facility will produce 547,000 tonnes of hydrogen per year and capture 3,000,000 tonnes of carbon dioxide per year. The facility aims to achieve net zero emissions through auto-thermal reforming, which enables 95% of the carbon to be captured, moved, and stored. The design incorporates a hydrogen fueled power generation facility, which would reduce the carbon intensity level to near-zero. The facility will produce clean electricity for itself and export certain amounts to the grid, which would offset the 5% of non-captured carbon. The project will position Edmonton as the focal point in Western Canada's hydrogen economy and serve as a landmark complex in Alberta.

Source: Alberta Major Projects

AIR PRODUCTS' WORLD-SCALE NET-ZERO HYDROGEN ENERGY COMPLEX



Source: Air Products



Suncor and ATCO have partnered to build a hydrogen production facility in Fort Saskatchewan. The facility would produce 300,000 tonnes of hydrogen annually and would capture over 90% of the emissions generated in the hydrogen production process. The project will face an investment decision in 2024 and construction could begin as early as 2028. Approximately 60% of the hydrogen production will be allocated to refining processes and co-generation of steam and electricity at the Suncor Edmonton Refinery. This allocation is expected to reduce the refinery emissions by up to 60%. 20% of hydrogen production is planned to be used in the natural gas grid to reduce Alberta's carbon dioxide emissions by approximately 2,000,000 tonnes per year.

PROJECT NAME	REGION	INVESTMENT TOTAL	AFFILIATIONS
Hydrogen Blending Project	Fort Saskatchewan	\$6.0M	ATCO Emissions Reduction Alberta
Hydrogen Production and Liquefaction Facility	Edmonton	\$1.3B	Air Products Government of Canada Government of Alberta
Hydrogen Production Facility	Fort Saskatchewan	TBD	Suncor ATCO

Source: Alberta Major Projects

THE EDMONTON ADVANTAGE

On April 14, 2021, the city of Edmonton launched a local hydrogen hub to kick-start the region's low-carbon hydrogen economy. Backed by \$1.2 million from Western Economic Diversification Canada, \$600,000 from Alberta's Industrial Heartland, and \$450,000 from the Province of Alberta. The hub is comprised of government officials, the indigenous community, academics, and economic experts. The hub collectively aims to position Edmonton for success in a low-carbon future. The partnership efforts involved in the creation of this hub indicate an important point: Edmonton is collaborating locally to compete on a global scale. The hub envisions a future where buses, trains, trucks, home heating, and machinery run on zero-emissions hydrogen fuel. Working with both policy makers and industry experts, the hub continues to plan a clean hydrogen-based future that is as efficient and profitable as possible. Currently, there are plans underway for more than 25 projects, which will help Edmonton move forward on the path to net-zero emissions and pave some insight for the future of the energy industry. The Edmonton region is an example of an early hydrogen hub that will likely serve as a blueprint for other regions to use in the transition to low carbon hydrogen. The city's sustainable policies, coupled with the hydrogen hub, position Edmonton as a forefront for hydrogen innovation.



Sources: Edmonton Region Hydrogen HUB, Edmonton Global

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