

# Hydrogen: Alternative Energy for Mining



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# Hydrogen Options for Mining

- Growing pressure to decarbonize mining – permitting issue?
- Total cost of ownership of hydrogen v. alternate low carbon fuels – *parity by 2030?*
- Accelerating growth in H2 deployments in mining – but how?
  - *Fueling/powering heavy mobile equipment, (mining trucks, trains, underground power with ventilation)*
  - *Microgrids*
  - *Power-to-X = production processes (metals/minerals refineries, etc.)*
  - *Energy storage*

# Hydrogen and Mining – Convergence?

Mining Equipment Makers Bet on Hydrogen as the Future of Energy

New blue hydrogen energy complex in Edmonton announced with \$1.3 billion investment

A \$ 1 Billion Green Hydrogen Project in Becancour

Groundbreaking \$5.2M hydrogen blending project aims to green Ontario's natural gas grid

Canadian underground mining likely to take hydrogen ventilation lead – HySA

Petronas eyes \$1.3B project in Alberta to export hydrogen to Asia

*Petronas and Japanese conglomerate Itochu would jointly market the ammonia produced at the Alberta facility*

Mining industry to contribute to Yukon's carbon neutrality

*Underground (Hydrogen) Economy – Canadian Mining Journal*

Komatsu aims for lead in hydrogen-powered mining trucks

Regional green hydrogen hub set to be developed in Nova Scotia, Canada

Canada Renewable Hydrogen Alliance reveals new consortium to support domestic fuel cell and green hydrogen supply chains

ATCO to build fuelling stations for CP Rail's hydrogen locomotive program

Rio Tinto, Sumitomo to assess hydrogen plant at Yarwun refinery

Hydrogen Is Here for the Long Haul

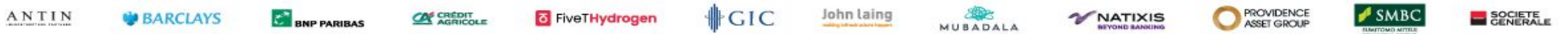
Continued development of hydrogen and fuel cell technology will aid decarbonization of heavy vehicles and equipment.

ArcelorMittal carries out successful hydrogen-derived DRI in Canada



# Resource Technologies Embrace Hydrogen

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# Hybrid Vehicle Technologies

- The 2 megawatt (MW) **hydrogen-battery hybrid** truck generates **more power** than its diesel predecessor and is capable of carrying a 290-tonne (320-ton) payload.
- The truck includes a 1.2 MWh battery pack, as the haul truck system uses multiple fuel cells, which deliver up to 800kW of power.
- The truck is part of Anglo American's nuGen Zero Emission Haulage Solution (ZEHS), a green hydrogen system at the mine site. The system will draw power from **a solar farm** to supply a hydrogen electrolyzer to split water, which will then provide the trucks with green hydrogen fuel.





# Testing Hydrogen-Powered Equipment at Antofagasta

Pilot project deploying hydrogen in large mining equipment, researchers are working on a stationary prototype that will be placed on site at Antofagasta PLC's Centinela copper mine.

Power will be modular plug-in system made up of **hydrogen fuel cells and batteries.**

Hydra Consortium consists of Engie SA, Australian mining research organization Mining3, Mitsui USA, Thiess Pty. Ltd., Ballard Power Systems Inc., Hexagon Purus ASA and Chile's Reborn Electric Motors



# Hydrogen-powered Equipment in Canadian Mining

- Teck Resources announced an agreement with Caterpillar Inc to develop, pilot and commence the operation of zero-emission large haul vehicles initially at the Elk Valley steelmaking coal operations in British Columbia, Canada.
- Hyzon Motors Inc. deploying a fleet of hydrogen-fueled coaches for iron major Fortescue Metals Group Ltd.
- NRCan studying H2 mining safety experimental mine in Val-d'Or, Quebec



Source



# Hydrogen Trains Coming to Canadian Mining?

- ATCO Group says it has reached a deal with Canadian Pacific Railway Ltd. to build two hydrogen production and refuelling stations in Alberta.
- The Calgary-based structures and logistics company says the stations will be built at CP Rail's Calgary and Edmonton rail yards. They will be used to supply CP's hydrogen powered locomotive program.
- The railway announced in December 2020 its plans to design and build North America's hydrogen-powered locomotive **using fuel cells and batteries** to power the locomotive's electric traction motors.
- The hydrogen infrastructure at each CP site will include a one megawatt electrolyzer, **compression, storage and dispensing infrastructure for locomotive refuelling.**





# Localized Wind Turbines Support Microgrids

## Diavik Diamond Mine, NWT

- **four 2.3 MW wind turbines** to supply 10% of its electric power. It has been reported that this investment resulted in a \$31 million dollar capital cost.,
- the wind power generation system was reported to save \$5 million dollars (3.8 million liters of fuel) in 2013.
- The payback period of the project is estimated to be eight years

## Raglan Mine, Quebec

- **Two 3 MW wind turbine generators** coupled with a multi-storage system with a combination of flywheel, Li-ion battery, and renewable hydrogen technologies



# Localized H2 from hydropower

- An Australian mining giant has signed agreements with three Canadian Indigenous nations to determine the viability of building green hydrogen projects as the company attempts to reinvent itself as a supplier of clean renewable energy.
- Fortescue Future Industries (FFI) sees Canada as potentially one of the largest sources of renewable energy in the world and is hoping to develop multiple large-scale green energy projects here.
- FFI signed three memoranda of understandings with the Lheidli T'enneh First Nation in British Columbia, northern Manitoba's Homeguard Cree First Nations and the Innu Nation in Newfoundland and Labrador.
- The agreements give FFI the right to set up **hydroelectric dams** and wind-farm sites to determine if they can be used to produce green hydrogen to power everything from ships, locomotives, trucks and heavy industry. While other forms of hydrogen produce emissions, green hydrogen is carbon-free.



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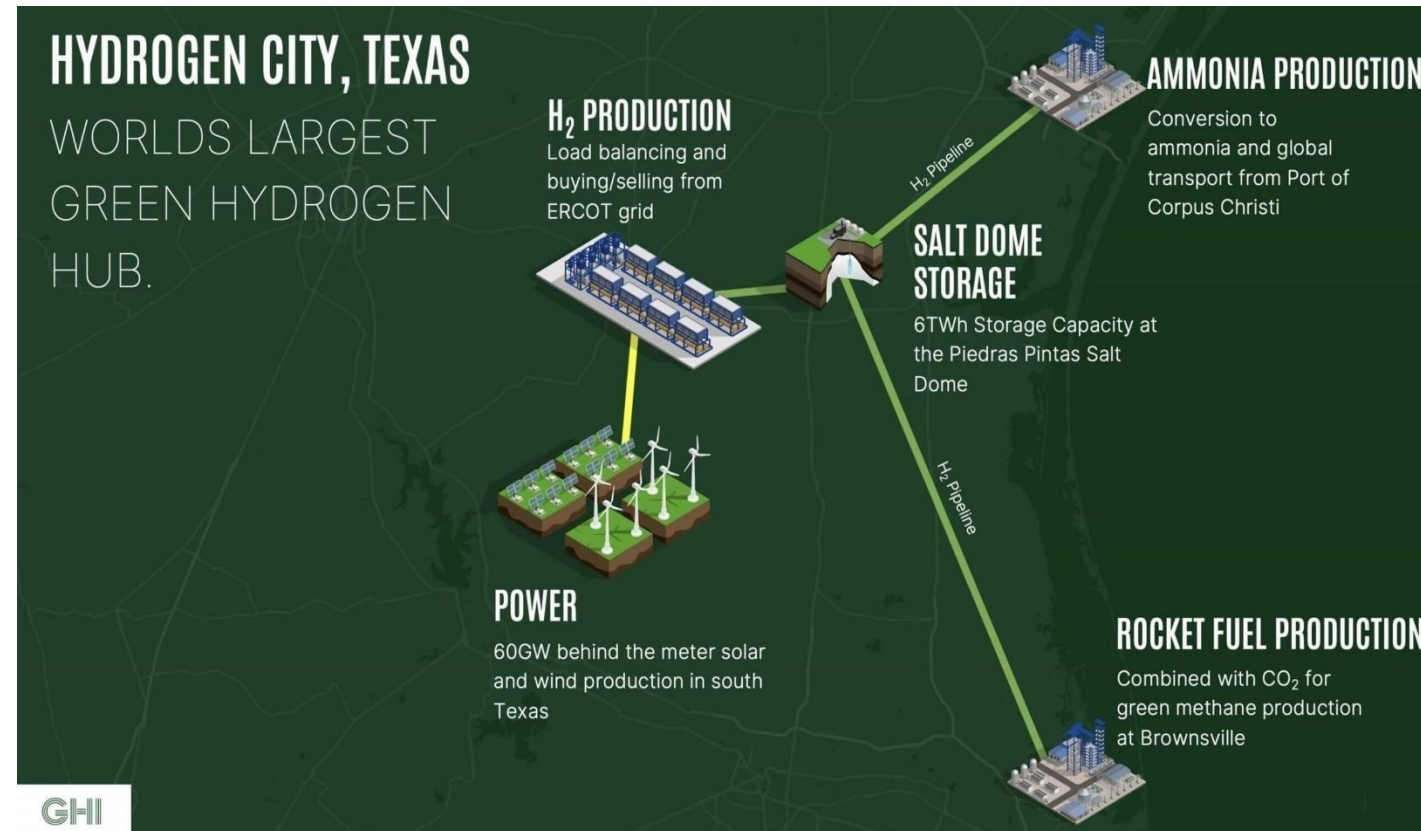
# Clean Hydrogen Into Metals/Minerals Refining

- Rio Tinto and Sumitomo Corporation today announced a partnership to study the construction of a hydrogen pilot plant at Rio Tinto's Yarwun alumina refinery in Gladstone and explore the potential use of hydrogen at the refinery.
- The two global companies have signed a letter of intent that focuses on Yarwun as the location for a Gladstone hydrogen plant that Sumitomo has been studying. If the project proceeds, the pilot plant would produce hydrogen for the recently announced Gladstone Hydrogen Ecosystem.
- The study supports the efforts of Australian, Queensland and local governments to establish Gladstone as a clean hydrogen hub of the future



# H2 Storage in Underground Caverns

- The “world’s largest” green hydrogen production and storage hub is set to be developed in Texas with a capacity of 60GW.
- Integrated green hydrogen production, storage, and transportation capabilities with a 60GW capacity- 2.5 billion kilograms of green hydrogen each year.
- The project will include the development of a **hydrogen storage** facility in the Piedras Pintas Salt Dome.
- Pipelines will deliver the green hydrogen to Corpus Christi and Brownsville for **green ammonia, sustainable aviation fuel and other fuels**.
- There will be opportunities for the hydrogen to potentially be directly transported to hydrogen power plants.





# Northern Mining's Energy Transition continues

- Troilus engaged Tugliq Energy to conduct an inventory of its historical and current GHG emissions and develop a roadmap towards a future carbon neutral mining operation Tugliq provides alternative energy solutions for autonomous networks, including remote communities and mining operations that rely on fossil fuels for energy generation, transportation and heat.
- Agnico Eagle Recently announced plans to build a wind turbine at the Hope Bay Gold Mine site near Cambridge Bay, Nunavut



# Community Involvement – Indigenous-led Clean Fuels Program

The Program was launched in March 2022, part of the broader \$1.5 billion Clean Fuels Fund, provides funding for clean fuels projects up to the following thresholds:

- **Feasibility Assessment:** 75% funding available up to max of **\$5M** which includes feasibility studies and front-end engineering design studies new facilities, facility expansions or facility conversions, including feasibility studies to assess the techno-economic feasibility of blending hydrogen into natural gas systems would be eligible.
- **Production Projects:** 50% funding available up to max of **\$150M** which includes the expansion or conversion of existing facilities, and buildout of new clean fuel production capacities/facilities.

## Minimum Production Capacity Thresholds

The Program targets commercial-scale projects in advanced states of technological readiness. As such, the Program has set a minimum production capacity threshold for liquid fuel facilities, renewable natural gas and hydrogen facilities eligible for both production and feasibility projects:

- 30,000 gigajoules (GJ) per year for hydrogen from biomass gasification;
- 500,000 gigajoules (GJ) per year for hydrogen from natural gas, or petroleum, with carbon abatement; and,
- 1MW of installed capacity for hydrogen produced using electrolyzers



# Community Involvement – Indigenous-led Clean Fuels Program

## ***Priorities Under the Clean Fuels Fund***

- Increased domestic clean fuel production capacity, supporting jobs in Canada and reducing reliance on imports;
- Increased utilization of sustainable Canadian biomass feedstocks;
- Increased competitiveness of Canadian clean fuel and biomass feedstock suppliers;
- Greenhouse gas reductions;
- Increased compliance flexibility for regulated parties under federal regulations (e.g. Output-Based Carbon Pricing System Regulations, Clean Fuel Regulations); and,
- Delivery of early actions outlined in the *Hydrogen Strategy for Canada*.

## ***Eligible Applicants and Projects***

- Eligible applicants for the Program include Indigenous organizations or registered Indigenous businesses or communities including not-for-profit and for-profit organizations that can demonstrate a minimum of 50% Indigenous ownership. Such applicants can include:
- Indigenous Communities; Development corporations; Electricity or gas utilities; Private sector companies; Industry associations; Research associations; Standards organizations; and Academic institutions.

## ***Project Completion Deadline***

- *The Project completion deadline under the Program is **March 31<sup>st</sup>, 2026** for each of the following:*

# Thank You

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