

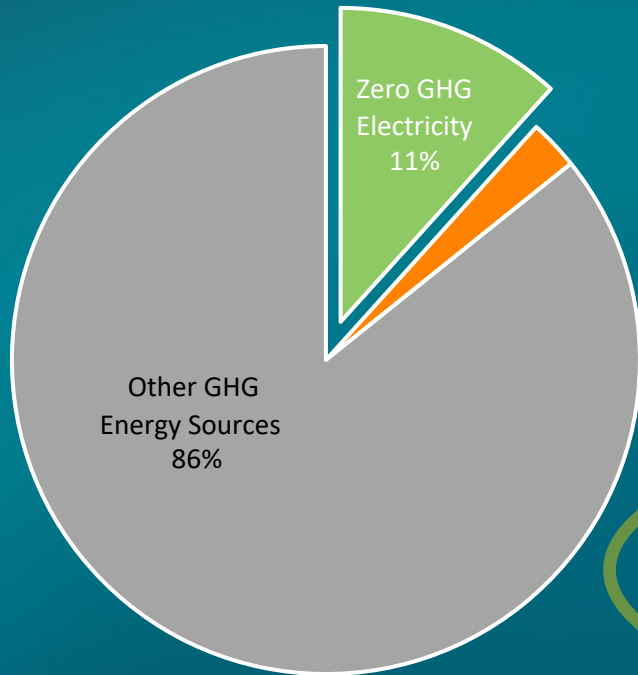


ADAPTING TO THE ENERGY FUTURE – WHY CORRIDORS?

CANADA'S LOW CARBON CORRIDOR

Decarbonizing Canada's energy supply by 2050 is unlikely to be achieved through electrification alone, hydrogen with CCUS is a critically important tool

CANADA ENERGY USE TODAY VS 2050



Today

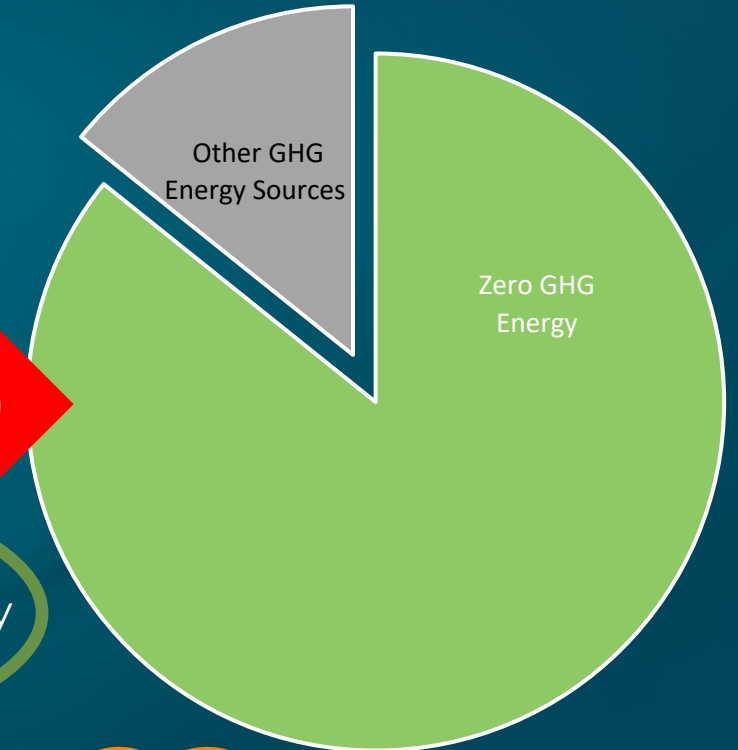
Electrification only with H₂ by Electrolysis

- ~ 8-10x growth over current capacity
 - Equivalent of 653 Site-C dams or
 - ~ 220,000 4MW wind turbines

Moon Shot Decarbonization Goal – Net Zero by 2050

Electricity + H₂ Derived from Hydrocarbons

- ~ 2x growth over current electricity capacity
- Conversion of current NG supply to H₂
 - CCUS critical to success



2050

- Cost effective
- Fast
- Efficient

ESTABLISHING A ROBUST CLEAN ENERGY SYSTEM

The rapid increase in clean energy requirements will drive the need for a more integrated energy system using electricity and hydrogen as energy carriers to bring low-cost electricity and hydrogen from diverse and distant sources to markets.



CANADA'S LOW CARBON CORRIDOR

DECARBONIZED ENERGY CONCEPT MAP - INTEGRATED ENERGY SYSTEM

Future Electricity Demand

- Electrification
 - Passenger Vehicles
 - Commercial/Industry
- Electrolysis
 - Hydrogen Supply

Future Hydrogen Demand

- Heat - Replacing Carbon Fuels
 - Buildings
 - Commercial/Industry
- Fertilizer
- Heavy Load/Weight Vehicles
 - Trucks/Machines
 - Rail
 - Marine Vessels
 - Aircraft

Mature Market

- Existing Supply
- Existing Demand
- Existing Delivery
- Major Expansion

Immature Market

- Limited Supply
- Limited Demand
- Limited Delivery
- Future Unwritten

Electricity Supply

- Current
 - 80% Emissions Free
 - 20% Hydrocarbon
- Future
 - Wind, Solar, Hydro
 - Natural Gas
 - Nuclear

Renewable Source

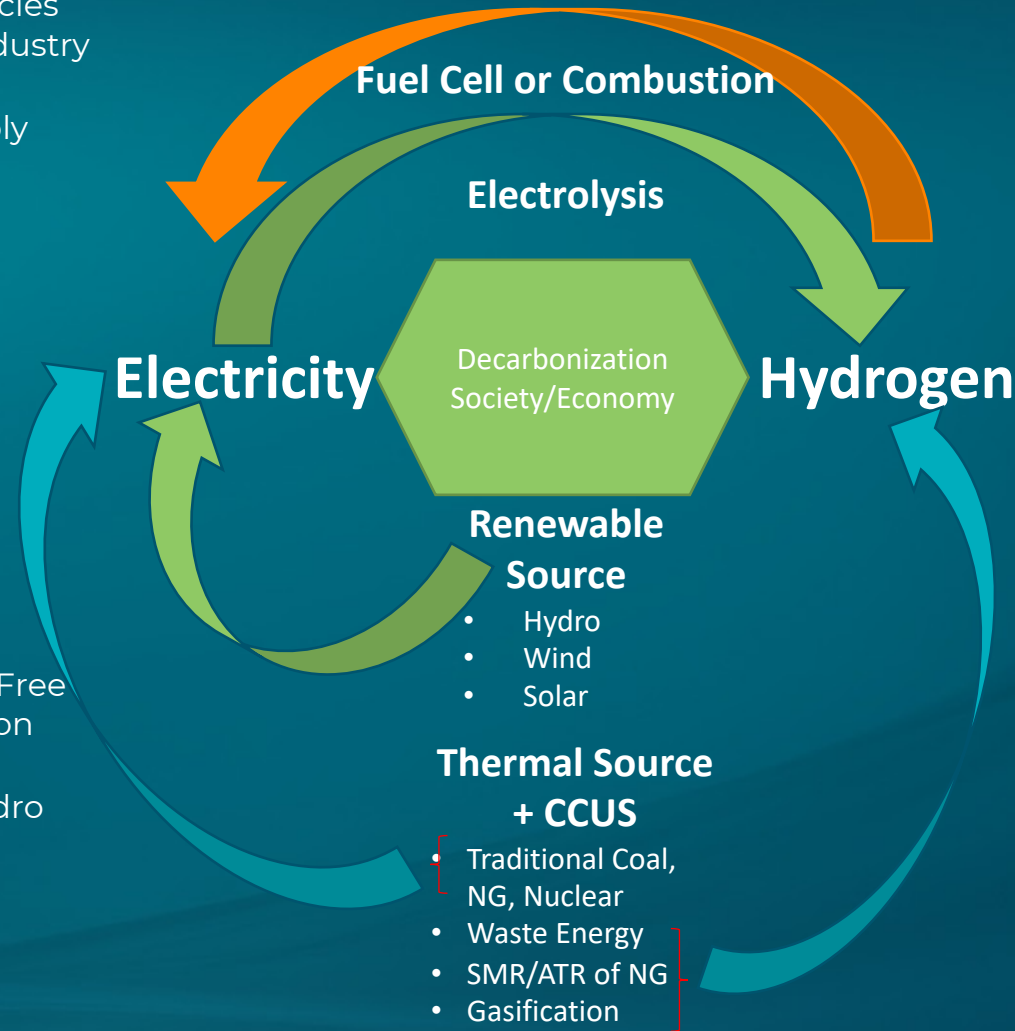
- Hydro
- Wind
- Solar

Thermal Source + CCUS

- Traditional Coal, NG, Nuclear
- Waste Energy
- SMR/ATR of NG
- Gasification

Hydrogen Supply

- Current
 - 80% Hydrocarbon
 - 20% Electrolysis
- Future
 - Natural Gas
 - Gasification
 - Electrification



Dramatic electrification growth in most forecasts is fueled by remote and often intermittent resources – interconnection of source to market

FORECAST GLOBAL POWER BY SOURCE – GOLDMAN SACHS

Growth in Electrical Energy

- 3x current electrical demand

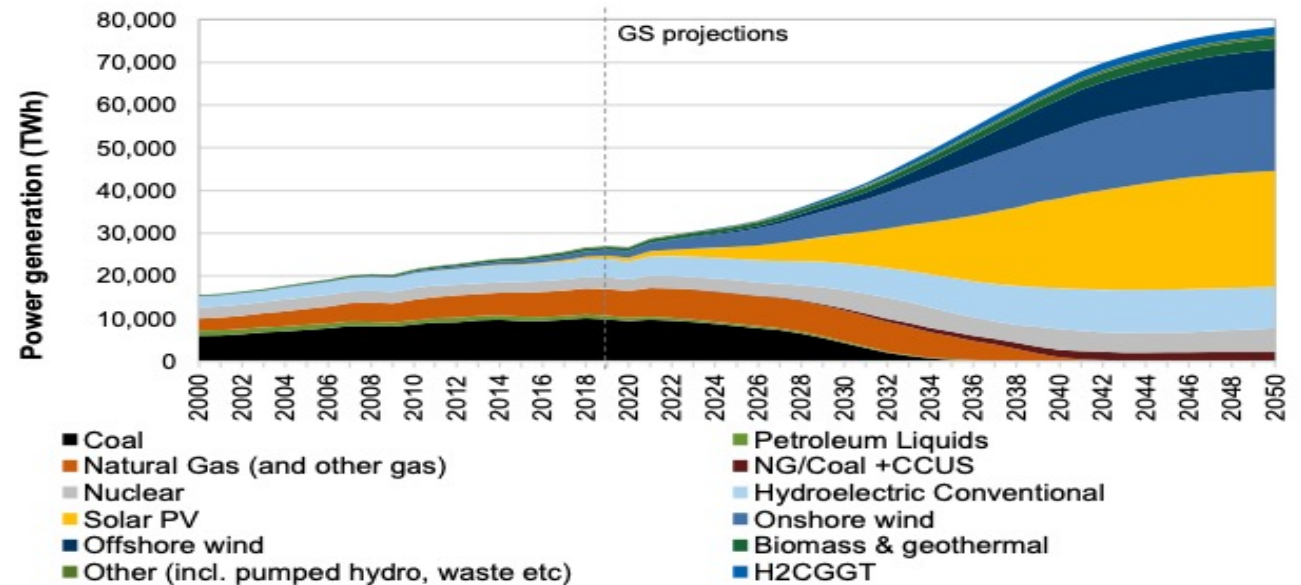
Traditional Sources Retired

- Coal gone by 2032
- Gas gone by 2040
- HC fueled + CCUS continues

Replacement and Growth

- Solar PV (intermittent)
- Wind (intermittent)
- Geothermal & Biomass (base)
- Hydro (load following)

Exhibit 8: Power generation needs to de-carbonize, while power demand grows c.3x to 2050E....
Global power generation (TWh)



Source: BP Statistical Review, Goldman Sachs Global Investment Research

From: Goldman Sachs Carbonomics CEO Conference, Models June 2021

EUROPEAN HVDC INTERCONNECTIONS - CURRENT AND PLANNED

Europe and other nations such as China and Australia are accelerating electrical interconnection to balance loads & increase cost effective renewable penetration

entso-e Ten Year Network Development Plan

Key boundaries identified in the system needs analysis of the TYNDP 2016

Transmission network expansion projects in TYNDP

New overhead lines, underground/subsea cables

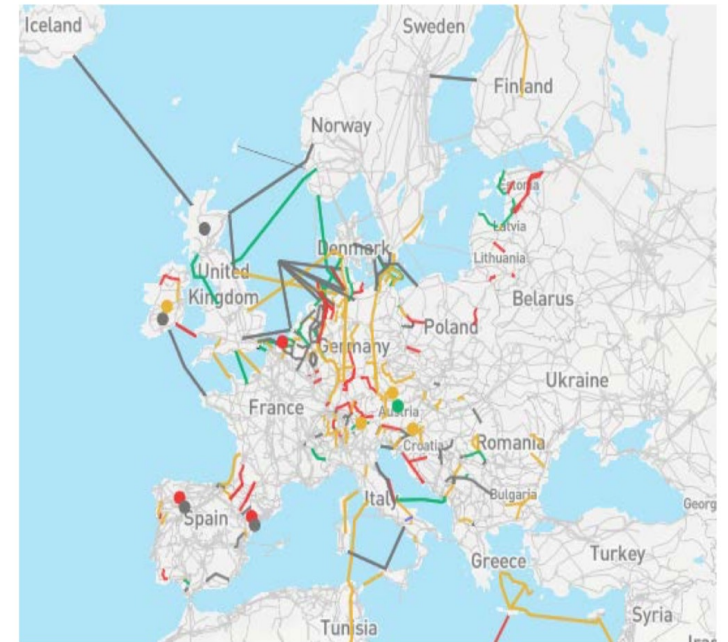
143 projects in permitting, under construction or commissioned

- >20% HVDC projects (32 in total)
- 24 subsea HVDC cables
- 7 underground HVDC cables
- 1 HVDC OHL

136 projects under consideration or planned, but not permitted

- >25% HVDC projects (37 in total)
- 30 subsea HVDC cables
- 3 underground HVDC cables
- 3 HVDC OHL

Source: [entso-e Ten Year Network Development Plan 2018](#)



©ABB

June 1, 2018

| Slide 5

ABB

H₂ advantages: dual fuel capability, performance in heavy load power/weight ratio applications and normal capital stock turnover

GS FORECAST OF H₂ DEMAND

Combustion (Thermal, existing capital stock)

- Heat
- Industrial Processes
- Combined Cycle Power
- Transportation (current vehicles)

Direct (Multiple forms, Fuel Cell etc.)

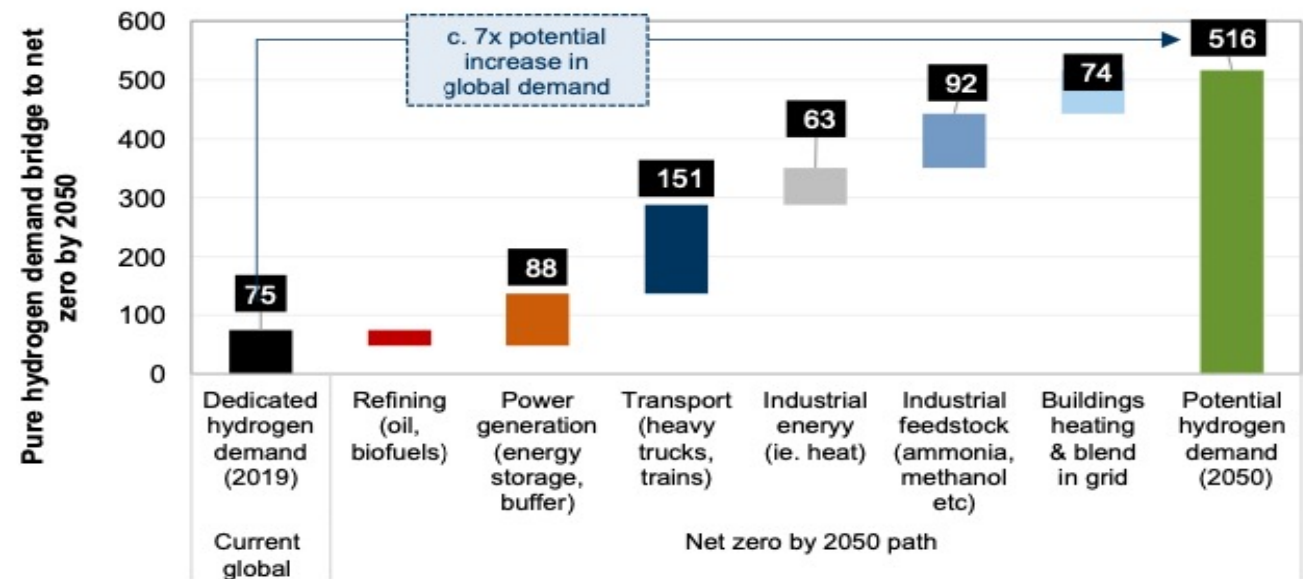
- Transportation
- Combined Heat and Power
- Feedstock to Chemicals

Capital Stock Turnover

- Normal
 - Utilizes existing infrastructure
 - Utilizes existing vehicles, plant and equipment

Exhibit 10: We expect hydrogen demand to increase 7-fold on the path to Net Zero...

Hydrogen demand bridge to 2050E on our global net zero path



Source: Goldman Sachs Global Investment Research

From: Goldman Sachs Carbonomics CEO Conference, Models June 2021

A wide variety of H₂ sources are available, lowest cost H₂ fuel will require efficient transportation from source/CCUS to markets

HYDROGEN SOURCE COST COMPARISON

Electrolysis

- Requires more electricity
- Water – key component
- Compression required
- Electricity cost is crucial

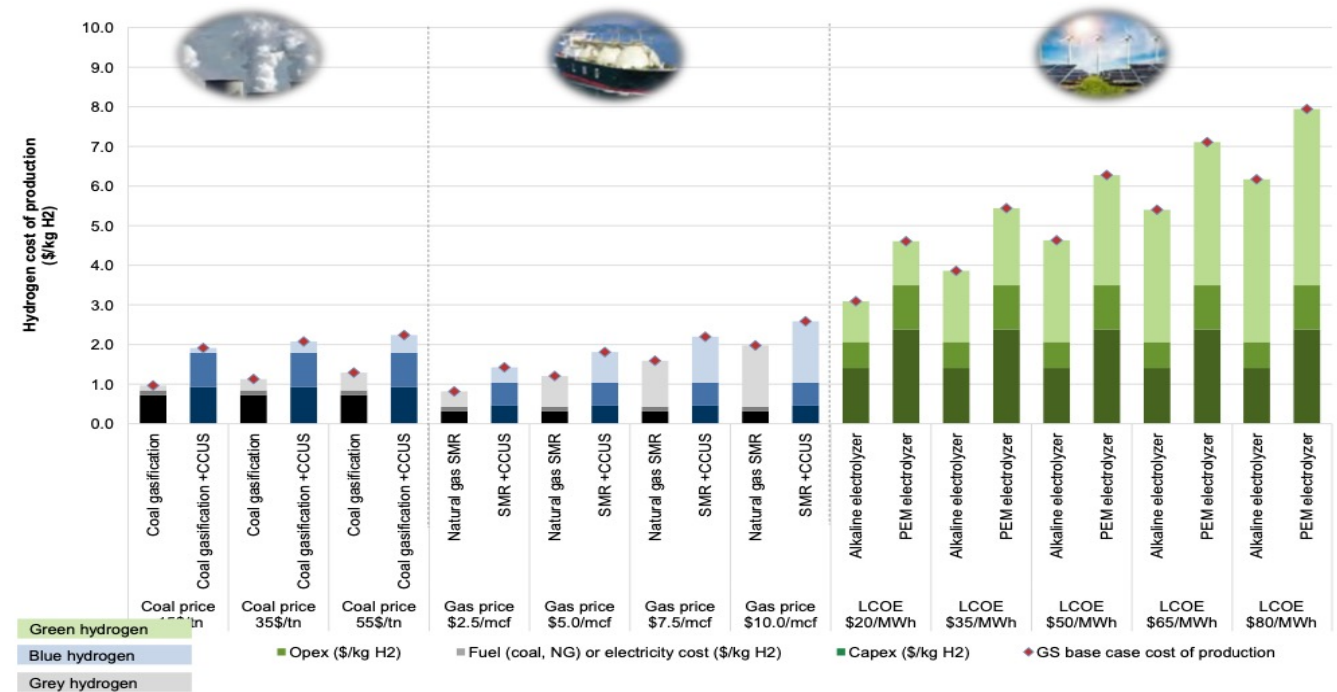
Hydrocarbons (N. Gas)

- CCUS dependent
- Gas cost dependent
- Water – lower use
- Process at Pressure

Waste Gas

- Industrial Processes

Exhibit 50: 'Blue' and 'green' hydrogen set the stage for de-carbonization, with 'blue' currently having a lower cost of production compared with 'green' hydrogen, but both being more costly than traditional 'grey' hydrogen

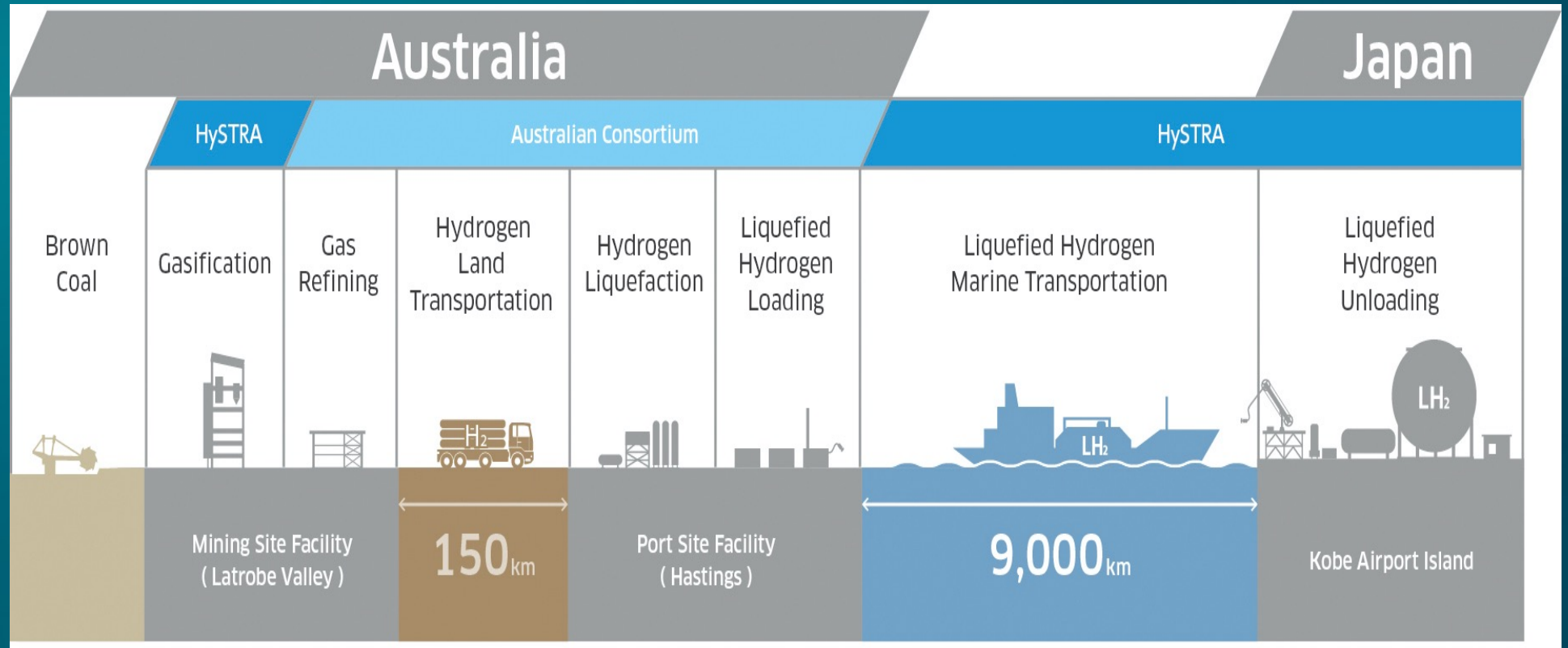


Source: Company data, Goldman Sachs Global Investment Research

From: Goldman Sachs Carbonomics CEO Conference, Nov 2020

Energy export is critical to Canada - Australia and Saudi Arabia are moving quickly to capture future H₂ market share in Asia and EU

KAWASAKI LAUNCHED LH₂ CARRIER (JAPANESE-AUSTRALIAN PARTNERSHIP)



Source: <http://www.hystra.or.jp/en/project/>

Fundamental changes are happening in underlying energy markets for Electricity and Hydrocarbons – more discussion on this available below

ONGOING EVOLUTION OF OUR ENERGY SYSTEMS – CVP VIEW

Electrical Market
Dynamics

[Learn More](#)

Hydrocarbon Market
Dynamics

[Learn More](#)