

Commercial supply chain and hydrogen strategy roadmap for Americas - USA & Canada

Part-14 (Global demand clusters, international trade and development hydrogen strategy roadmaps for different geographies)

Americas

The United States has long been a leader in global energy innovation and has led the world in the production & distribution of gaseous liquid hydrogen

USA

Fuel cell technologies and hydrogen energy are being commercialized in the US and abroad. The US is among the leading countries in moving towards broad commercialization of fuel cells and hydrogen energy. With over 7,600 fuel cell electric vehicles (FCEVs) currently on the road – more than any other country – the US is home to more than half of the global FCEV stock. In addition, the US is a global leader in the development of fuel cell applications that compete with incumbent technologies. For example, more than 25,000 fuel cell-powered material handling products, such as forklifts, are operating in warehouses and distribution facilities across the country.

There are over 8,000 small-scale fuel cell systems operating across 40 states, primarily for cell phone towers and remote communications networks. In total, there are over 550 MW of installed or planned fuel cells for large-scale stationary power. for backup power, critical loads, and combined heating and power applications. The US is home to several leading fuel cell, electrolyzer, and hydrogen component and system manufacturers as well as large multinational hydrogen companies with liquid and compressed hydrogen production and distribution equipment.

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In the ambitious scenario, hydrogen demand potential across all these applications could reach 17 million metric tons by 2030 and 63 million metric tons by 2050

- US Hydrogen Roadmap

Hydrogen strategy roadmap and targets for USA – A landscape view till 2030

Hydrogen Utilization Objective

A. Mobility



Fuel Cell Electric Vehicles (FCEVs) -

150,000 units by 2025
1,200,000 units by 2030

Objective



Material Handling FCEVs-

125,000 units by 2025
300,000 units by 2030



Refuelling Stations -

1000 stations by 2025 (stations of 500 kg/day)
4300 stations by 2030 (stations of 1000 kg/day)



Material Handling Refuelling Stations -

600 stations by 2025
1500 stations by 2030

Hydrogen Demand Objective

A. Hydrogen Demand

Objective



H2 demand in metric tonnes -

13 MMTs by 2025
17 MMTs by 2030

Hydrogen Investment Objective

A. Investments

Objective



Annual Investments -

USD 2 Billion by 2025
USD 8 Billion by 2030

Landscape of Hydrogen in USA in 2022



~30,000 FCEVs



~50,000 Material Handling FCEVs



~165 Refueling STs of 500kg/day



~300 Material handling fueling stations



~12 MMTs Hydrogen Demand



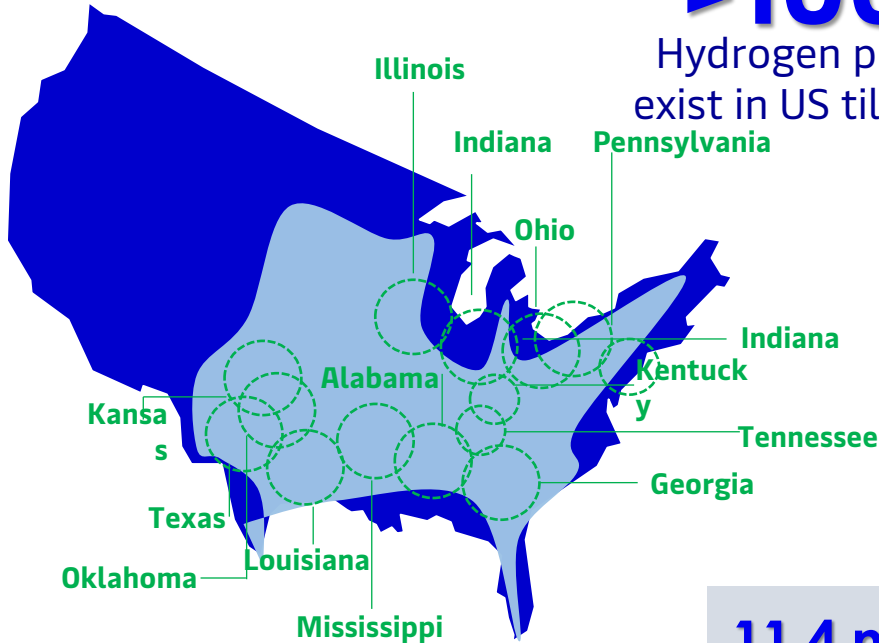
~1 Billion Annual Investment

Hydrogen strategy roadmap and targets for USA – A landscape view till 2030 (Contd.)

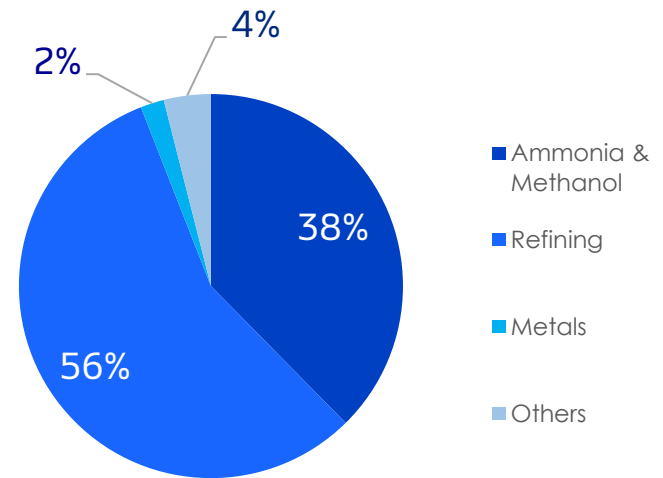
Key Demand Centers

>100

Hydrogen plants exist in US till 2021



US Hydrogen Market Currently in US w.r.t end use



East coast states in the US have heavy dominance w.r.t. hydrogen development . Over 70 hydrogen plants exists across the east coast spreading from Texas in the down south to Philadelphia at the coast to Ohio Indiana and Pennsylvania in the north side of the east coast

11.4 m metric tons of H2 is currently consumed annually in the US market

~17.6 Billion Total value of the H2 market in the US today

77% Served by SMR H2

23% Served by product H2 from refining

The estimated value of the domestic market of hydrogen in Canada is expected to be almost \$50 billion per year by 2050

CANADA

To evaluate the role hydrogen can play in reaching Canada's goal of becoming net-zero by 2050, modelling analysis was undertaken for an incremental scenario and a transformative scenario, to understand hydrogen's potential in the broader energy system, alongside electrification and other low-carbon fuels. These scenarios are more likely to be achieved with strong pricing and regulatory incentives to drive hydrogen adoption, and alignment action across government and industry. Considering only the domestic demand for hydrogen production and revenues from the local manufacturing and services, the hydrogen and fuel cell sector has the potential to generate almost \$50 billion in sector revenue in 2050 under the Transformative scenario in Canada. The estimated value of the domestic market is expected to be almost \$50 billion per year by 2050.

This does not take in to account how the hydrogen market will indirectly benefit several other adjacent industries that would also contribute to economic growth and could lead to manufacturing opportunities in Canada, including SMR and CCUS facilities and equipment, H2 pipeline development, and end-use applications in buildings, industry, and the natural gas grid. The focus of the next 5 years will be on laying the foundation for the hydrogen economy in Canada. This includes developing new hydrogen supply and distribution infrastructure to support early deployment HUBs in mature applications while supporting Canadian demonstrations in emerging applications. Early actions are fundamental to driving investment in the sector, as is the introduction of policies, such as carbon pricing and regulatory measures needed to move Canada forward on a path to achieve net zero targets.

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In the 2030-2050 timeframe, Canada will start to realize the full benefits of a hydrogen economy as the scale of deployments increase and number of new commercial applications grows, supported by Canada's foundational backbone supply and distribution infrastructure.

- Canada Hydrogen Roadmap

Hydrogen strategy roadmap and targets for Canada – A landscape view till 2030

Hydrogen Production Objective

A. Production



Production –

3 MTs/Year till 2025 with high CI
 4 MTs/Year till 2030 with low CI
 20 MTs/Year till 2050 with low CI

Objective



Cost of delivered hydrogen –

USD 5-12/kg by 2025
 USD 1.5-3.5/kg by 2030

Hydrogen Distribution & Storage Objective

A. Distribution



Gaseous hydrogen –

250 bar by 2025
 450+ bar by 2030



Liquid hydrogen –

Till east coast by 2025
 Canada wide by 2030



Hydrogen supply via pipeline –

H2/NG Blended by 2025
 Blended + Dedicated H2 by 2030

Hydrogen Utilisation Objective

A. Mobility

Objective



Zero Emission Vehicles for light duty vehicle (LDV) category –

10% of LDV sales per year by 2025
 30% of LDV sales per year by 2030

Zero Emission Vehicles for Medium to heavy duty vehicle (M/HDV) category –

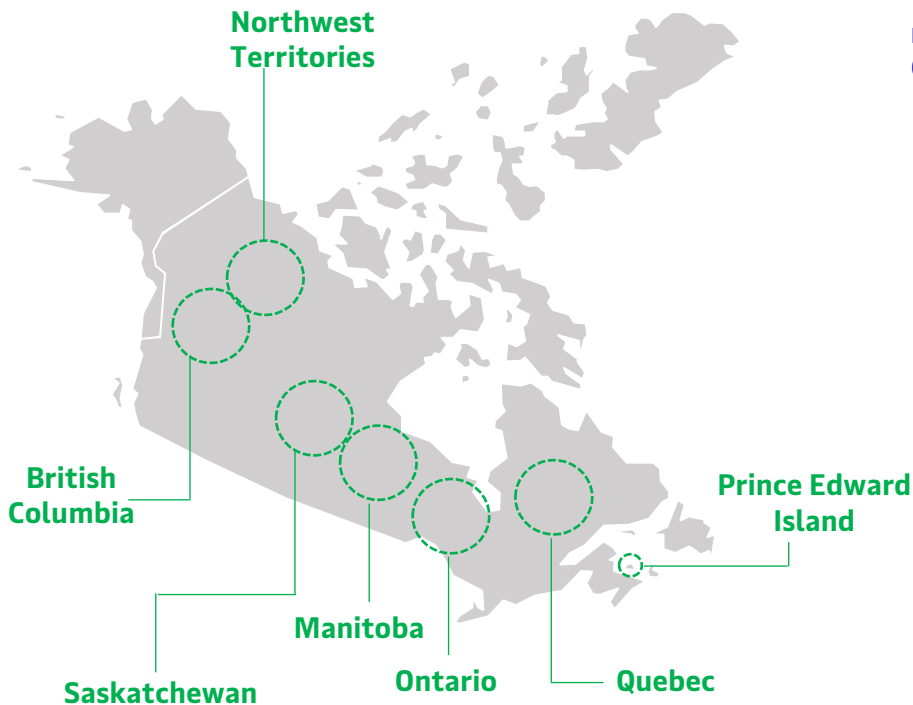
1000 hydrogen powered buses by 2025
 5000 hydrogen powered buses by 2030

Quick Facts about key developments for LDVs in Canada till 2020

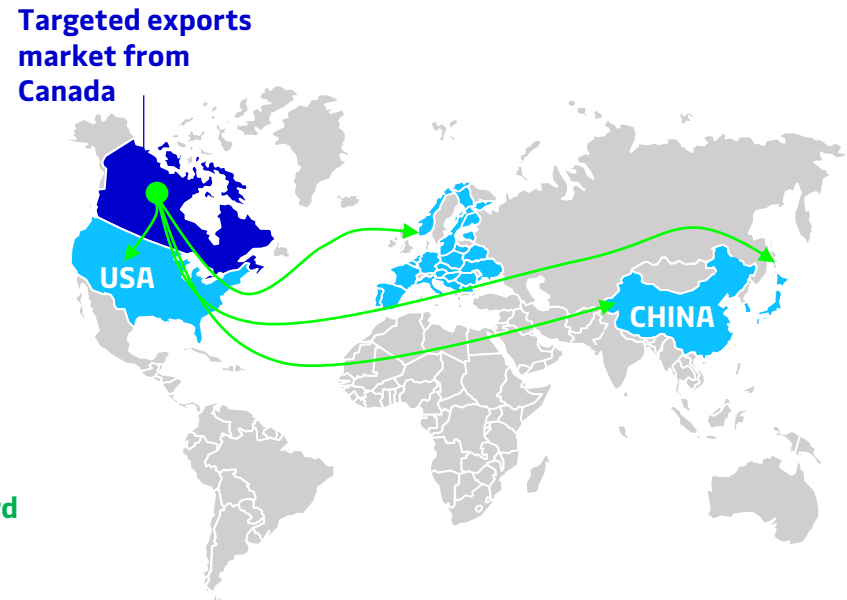
Till 2020, approximately 110 light-duty vehicles are in operation in Canada, supported by 3 retail fuelling stations in British Columbia (BC), 1 in Quebec, and 1 in Ontario. Four new stations are under development in BC, which will represent an important milestone as vehicle OEMs have indicated that 7-8 stations are needed in a region for coverage and redundancy to enable wider rollout of vehicles. BC also announced funding for an incremental 10 new stations to continue to expand the network till 2021. It is expected that an additional ~150 LD vehicles will be deployed in 2021 as the new stations come online.

Hydrogen strategy roadmap and targets for Canada – A landscape view till 2030 (Contd.)

Key Demand Centers for Hydrogen in Canada



Key Target Markets for Canada to Export Hydrogen



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