From Province to Planet:
Exploring Alberta's Hydrogen Technology Transfer Potential

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H
Hydrogen

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Research Question

Are there opportunities for transfer of key hydrogen technologies developed in Alberta?

Context

Global Context

- Current Demand: ~95 Mt/yr
  - 41Mt – Refining
  - 32 Mt – Ammonia
  - 16 Mt – Methanol
  - 5 Mt - DRI
- Forecast Demand:
  - 150 Mt/year by 2030
- CO2 Reduction Potential:
  - 7 Gt/year by 2050
- Cumulative CO2 Emissions Avoided:
  - 80 Gt until 2050

Canada Context

- Federal Hydrogen Strategy (2020)
- Current Production:
  - 3.5 Mt/yr
- Forecast Production:
  - 4.5 Mt/year (2030)
  - 20.5 Mt/year (2050)
- CO2 Reduction Potential:
  - 2030 - 45Mt/year
  - 2050 - 190Mt/year
- British Colombia – "Cradle" of the fuel cell industry

Alberta Context

- Hydrogen Roadmap (2021)
- Global Low-Cost Producer
- Abundant Natural Resources
- Current Production:
  - ~2.5 Mt/yr
- Forecast Production:
  - 4 Mt/year (2035)
- CO2 Reduction Potential:
  - 14Mt/year (2030)
- Invested $150M thru:
  - ERA & Alberta Innovates

Methodology

Key Question to Answer	Assessment	Sources
Are technologies developed in Alberta **competitive**?	Review of provincially funded hydrogen technologies developed in Alberta	• Technology funding details received from ERA • IEA Clean Energy Technology Guide • Industry, Academic and Country reports, publications, papers, news articles, online searches, etc.
	Review of Global Technological Readiness Levels (TRL) and deployment status of these and similar technologies	
Is there a **market** for technologies developed in Alberta?	Review of regions/countries seeking to increase adoption of specific hydrogen technologies	Industry, Academic and Country reports, publications, papers, news articles, online searches, etc.
	Review of regions/countries possibly interested in Alberta technologies	Industry, Academic and Country reports, publications, papers, news articles, online searches, etc.
Are there **policy mechanisms** to support these technologies?	Review of global hydrogen policy/strategy landscape	Industry, Academic and Country reports, publications, papers, news articles, online searches, etc.
Are there **intermediaries** to support transfer opportunities?	Review of locally and globally available technology/innovation intermediary support	Industry, Academic and Country reports, publications, papers, news articles, online searches, etc.

Motivation and Pillars

Definition

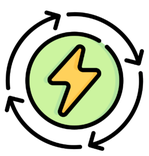
Transfer of **physical devices, processes, 'know-how'** (set of technical skills) or **proprietary information** from **one entity to another**, and **vice versa** *(Bozeman, 2000)*

Benefits of TT

Promotes **sustainable development**, which positively impacts **economic growth** suggesting there is **no trade-off** between **environmental** and **economic** objectives *(Fernandes et al., 2021)*

Early adoption of policy **by developed countries** leads to the **development of new technologies** that makes it **easier for developing countries to reduce pollution** *(Popp, 2011)*

Environment



Energy

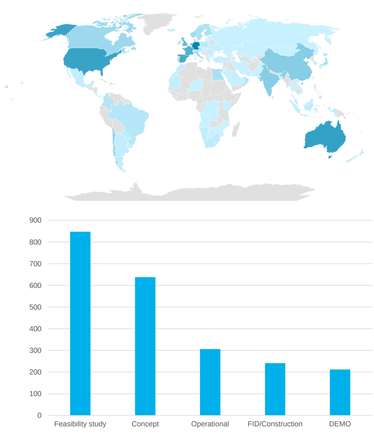
Technology Transfer

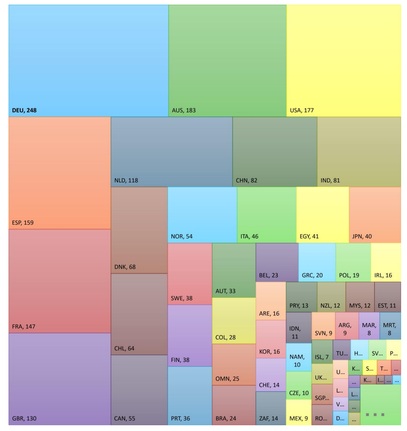
7 AFFORDABLE AND CLEAN ENERGY

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

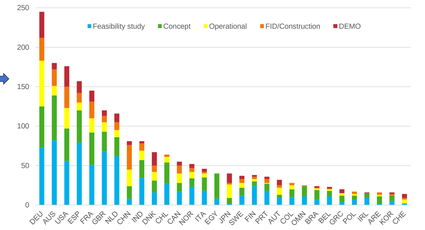
17 PARTNERSHIPS FOR THE GOALS

Global Hydrogen Landscape
(92 Countries, 2280 Projects)

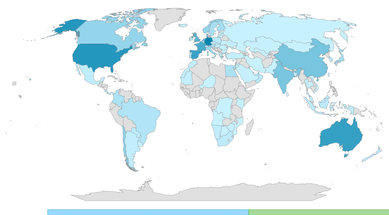


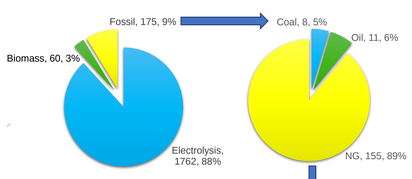


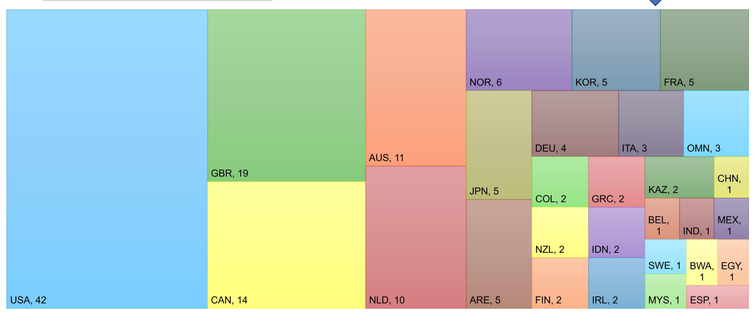
- Projects include: Production, Pipelines, Blending, Infrastructure, Storage, Ports
- **Top 30 Countries**
  - Represent 90% of all projects
  - 24 OECD ~ 78% of global projects
  - All countries have published H2 Strategies except Greece and Switzerland



Global Production Landscape
(90 Countries, 1997 Projects)



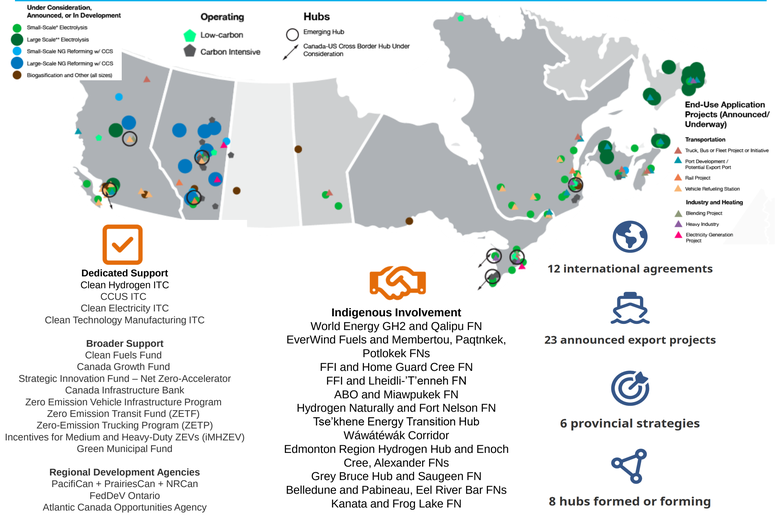




NG Project Landscape – 29 Countries, 155 Projects

20 OECD Countries – 89% of all projects. All have H2 Strategies except: Greece, Mexico & Botswana

Canadian Landscape



Dedicated Support
Clean Hydrogen ITC
CCUS ITC
Clean Electricity ITC
Clean Technology Manufacturing ITC

Broader Support
Clean Fuels Fund
Canada Growth Fund
Strategic Innovation Fund – Net Zero-Accelerator
Canada Infrastructure Bank
Zero Emission Vehicle Infrastructure Program
Zero Emission Transit Fund (ZETF)
Zero-Emission Trucking Program (ZETP)
Incentives for Medium and Heavy-Duty ZEVs (iMHZEV)
Green Municipal Fund

Regional Development Agencies
PacifiCan + PrairiesCan + NRCan
FedDeV Ontario
Atlantic Canada Opportunities Agency

Indigenous Involvement
World Energy GH2 and Qalipu FN
EverWind Fuels and Membertou, Paqtnkek, Potlokek FNs
FFI and Home Guard Cree FN
FFI and Lheidli-T'enneh FN
ABO and Miawpukek FN
Hydrogen Naturally and Fort Nelson FN
Tse'khene Energy Transition Hub
Wáwátéwák Corridor
Edmonton Region Hydrogen Hub and Enoch Cree, Alexander FNs
Grey Bruce Hub and Saugeen FN
Belledune and Pabineau, Eel River Bar FNs
Kanata and Frog Lake FN

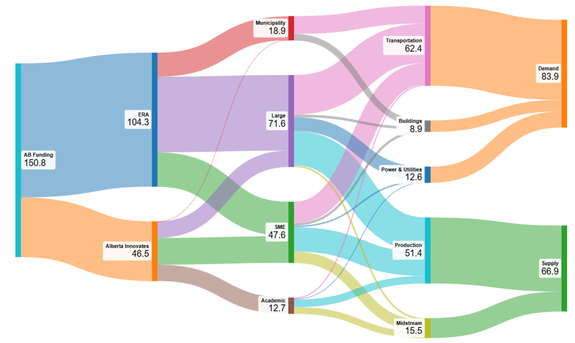
12 international agreements

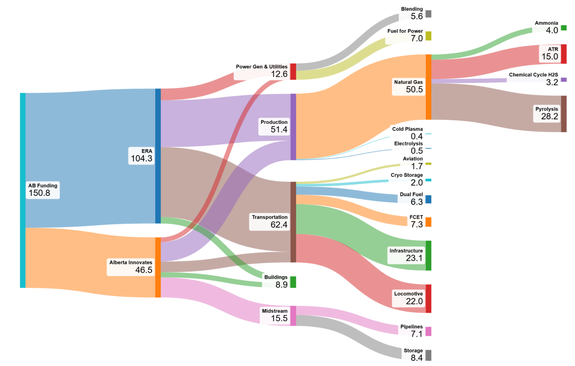
23 announced export projects

6 provincial strategies

8 hubs formed or forming

Alberta Funding





Assessment Summary

Transportation

Technology	Competitive?	Market?	Policy Support?	TT Potential?
Locomotive	✓	✓	✓	👍
Infrastructure – Fleet/FCEBs	✓	✓	✓	👎
Infrastructure – Fuelling Stations	✓	✓	✓	👍
Fuel Cell Electric Trucks (FCETs)	✓	✓	✓	👎
Dual-Fuel	✓	✓	✓	👍
Cryo-Compressed Storage	✓	✓	✓	👎
Aviation	✓	✓	✓	👎

Production

Technology	Competitive?	Market?	Policy Support?	TT Potential?
Pyrolysis	✓	✓	✓	👍
ATR	✓	✓	✓	👍
Ammonia/Methanol	✓	✓	✓	👍
Chemical Cycle	✓	✓	✓	👍
Electrolysis	✓	✓	✓	👎
Cold Plasma	✓	✓	✓	👎

Midstream

Technology	Competitive?	Market?	Policy Support?	TT Potential?
Pipelines	✓	✓	✓	👎
Storage - Geological	✓	✓	✓	👍
Storage - Cylinders/Vessels	✓	✓	✓	👎
LOHC	✓	✓	✓	👎
Solid State	✓	✓	✓	👍

Power Generation & Utilities

Technology	Competitive?	Market?	Policy Support?	TT Potential?
Blending	✓	✓	✓	👎
Fuel for Power	✓	✓	✓	👍
Buildings	✓	✓	✓	👍

Conclusion

- Are technologies developed in Alberta **competitive**?
  - **Yes & No**
- Is there a **market** for technologies developed in Alberta?
  - **Yes**
- Are there **policy mechanisms** to support these technologies?
  - **Yes**
- Are there **intermediaries** to support transfer opportunities?
  - **Yes**

"Are there opportunities for transfer of key hydrogen technologies developed in Alberta?"

YES

TT opportunity may already exist **within Canada**