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# Hydrogen Safety in Canada – CNL Perspective

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# Outline

- CNL hydrogen safety
- Canadian landscape
- Evolving trends and opportunities
- Improvements and capabilities of future
- A National coordinated approach



Attendees of Hydrogen Safety Workshop, November 25, 2022



# CNL's Hydrogen Safety Experience and Capabilities

Supporting hydrogen safety in Canada with 50 years of experience in nuclear and other industries

- Comprehensive R&D Program on large-scale experimentation of H<sub>2</sub> behavior and safety analysis codes
- Unique experimental techniques of hydrogen interaction with materials, from CANDU™ reactors experience
- Proven catalytic H<sub>2</sub>/air recombiner technologies for hydrogen mitigation and risk management
- Core experience and capabilities for hydrogen risk assessments and hazard analysis



**Hydrogen Behavior Testing & Modelling**



**Hydrogen in Materials**



**Hydrogen Safety Management**



**Hydrogen Risk Assessments**

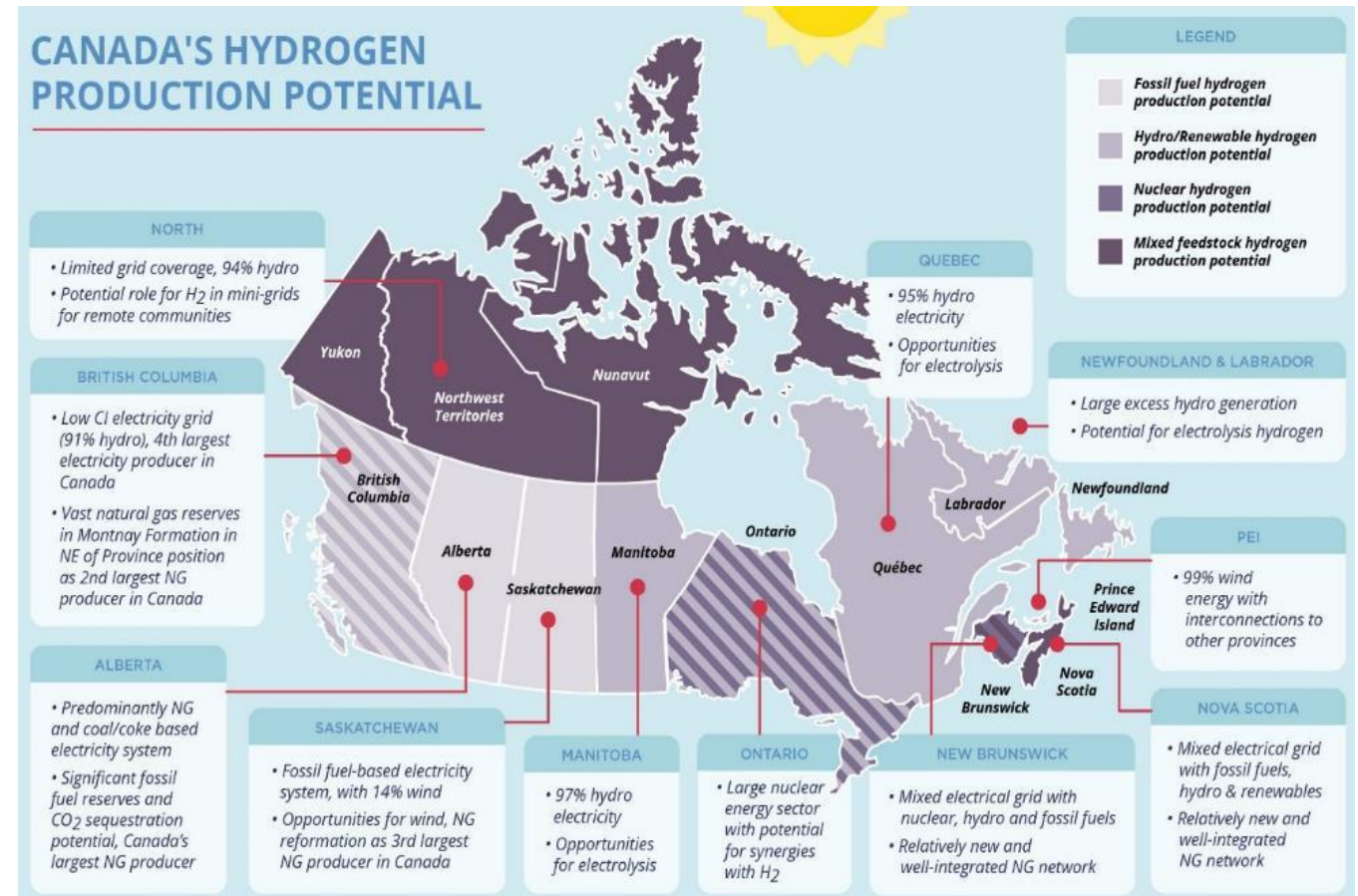


# Hydrogen Landscape in Canada

## Existing Industry

- Total revenues of \$527 M
- \$412 M in revenues from product sales
- \$98 M in revenues from the provision of services
- \$17 M in revenues from R&D contracts and other sources
- RD&D expenditures of \$125 M
- Employment of ~ 4,300 FTEs

## New Industry



NRCan, "Hydrogen Strategy for Canada - Seizing the Opportunities for Hydrogen," Natural Resources Canada, Ottawa ON, 2020 December.

# Current Hydrogen Safety Landscape in Canada

## Sample of the landscape

Organization	Capabilities	Operating Structure
<b>CNL</b>	<ul style="list-style-type: none"> <li>Hydrogen materials development, testing and modelling</li> <li>Hydrogen safety device development and sale</li> <li>Hydrogen behaviour experimentation and analysis</li> <li>Safety risk assessment and RCS gaps identification</li> </ul>	<ul style="list-style-type: none"> <li>Private operator, government owned entity</li> <li>Activities in hydrogen production, storage, materials and safety. Hydrogen area is one of the pillars within the Science and Technology.</li> </ul>
<b>NRC</b>	<ul style="list-style-type: none"> <li>Safety risk assessment and RCS gaps identification</li> <li>Pipeline materials testing, bio-corrosion and coatings</li> </ul>	<ul style="list-style-type: none"> <li>Federal government entity</li> <li>Activities in hydrogen are focused within the Energy, Mining and Environment Research Centre</li> </ul>
<b>UQTR</b>	<ul style="list-style-type: none"> <li>CFD simulations and models to optimize sensor position, ventilation set-up, leak events, and ignition behaviour</li> <li>Analytical models including hydrogen and methane jets extent, gas stratification in enclosure</li> </ul>	<ul style="list-style-type: none"> <li>Academic institution</li> <li>UQTR operates three institutes, one of which is the Hydrogen Research Institute</li> </ul>
<b>Alberta Innovates</b>	<ul style="list-style-type: none"> <li>Pipeline test facilities for flow and corrosion characteristics</li> <li>High pressure testing of materials with hydrogen</li> <li>Underground test capabilities for pipeline and storage</li> </ul>	<ul style="list-style-type: none"> <li>Alberta government entity</li> <li>Activities in hydrogen are focused within two sister organizations – C-FERtech and InnoTech</li> </ul>
<b>CSA Group</b>	<ul style="list-style-type: none"> <li>Standards development through participation on hydrogen related task forces, review of upcoming research and feedback on draft standards</li> <li>Hydrogen codes and standards working group</li> </ul>	<ul style="list-style-type: none"> <li>Standards organization, independent entity</li> <li>Develops standards in 57 areas including hydrogen</li> </ul>

# National Hydrogen Safety Workshop

## Objectives and Outcomes

- Look into **gaps, skills, opportunities, and funding mechanisms** for hydrogen deployment
- **Identify safety gaps** that should be addressed using existing or future Canadian capabilities
- **Leverage unique capabilities** and expertise of nuclear hydrogen initiatives
- Discuss **emerging opportunities and potential areas of future collaboration** between organizations
- **Network with international stakeholders** with an interest in hydrogen safety



H<sub>2</sub> Safety Workshop 2022, November, Ottawa  
**68 Canadian and international attendees**

# Understanding Industry Needs for Hydrogen Safety

A listening campaign based on interviews, surveys and discussions

1	Enbridge [Gas distribution, Pipeline]	11	Evraz North America [Steel and Pipeline OEM]	21	TSSA (Technical Standards and Safety Authority) [Regulator]
2	TC Energy [Gas distribution, Pipeline]	12	HTEC [Hydrogen Refueling Stations, Engineering]	22	CSA Group [Standards Developer]
3	ATCO [Engineering, Logistics, Holding]	13	Next Hydrogen [Electrolyser OEM]	23	SCC (Standards Council of Canada) [Government]
4	Fortis BC [Gas distribution, Pipeline, BC]	14	Hatch [Professional Services, EPC]	24	Transport Canada (MVTC) [Government, Research Institute]
5	Gazifere [Gas distribution, Pipeline, Quebec]	15	Thor Hydrogen [Professional Services, EPC]	25	ABS (American Bureau of Shipping) [Marine Regulator]
6	Energir [Gas distribution, Pipeline, Quebec]	16	Atura Power [Ontario Energy Company]	26	AECOM [Professional Services, EPC]
7	C-FER (Alberta Innovates) [Research Institute, Oil & Gas]	17	CHFCA (Canadian Hydrogen & Fuel Cell Association) [Industry Association]	27	Jacobs [Professional Services, EPC]
8	NRC [National Lab, Research Institute]	18	CAFC (Canadian Association of Fire Chiefs) [Industry Association]	28	Lakeside Process Controls
9	UQTR [University]	19	Energy Safety Canada (ESC) [Industry Association]	29	Canada Trade Commissioners Office, Mexico City [Government]
10	WSP [Professional Services, EPC]	20	PRCI (Pipeline Research Council International, US) [Industry Association]	30	HSL (Health & Safety Labs, UK) [National Centre]
				31	NRCan [Government]

# New Opportunities for Hydrogen Safety Expertise (1/2)

## 5 Canadian Sectors that overlap with International Energy Transition

### 1. Natural gas displacement:

- Increased blending of hydrogen in gas pipelines
- Replace natural gas used as a H<sub>2</sub> feedstock for NH<sub>3</sub>, steel, chemicals production

### 2. Synthetic petroleum products:

- New synthetic diesel and kerosene products (sustainable aviation fuel) for maritime and aviation industries
- H<sub>2</sub> to be produced from different locations and transported

### 3. Energy transition economic products:

- Low carbon intensity H<sub>2</sub> for oil production and enrichment in the medium-term



Source: [Swagelok](#)



# New Opportunities for Hydrogen Safety Expertise (2/2)

## 5 Canadian Sectors that overlap with International Energy Transition

### 4. Transport vehicular fuel:

- H<sub>2</sub> used as a fuel – hard to decarbonize with other alternatives
- Transport trucks, buses, rail, boats, aviation, and domestic shipping

### 5. Renewable electricity storage:

- Avoid the intermittency and to capture the energy from renewable sources such as wind and solar
- H<sub>2</sub> as a storage medium for short-term and long-term applications

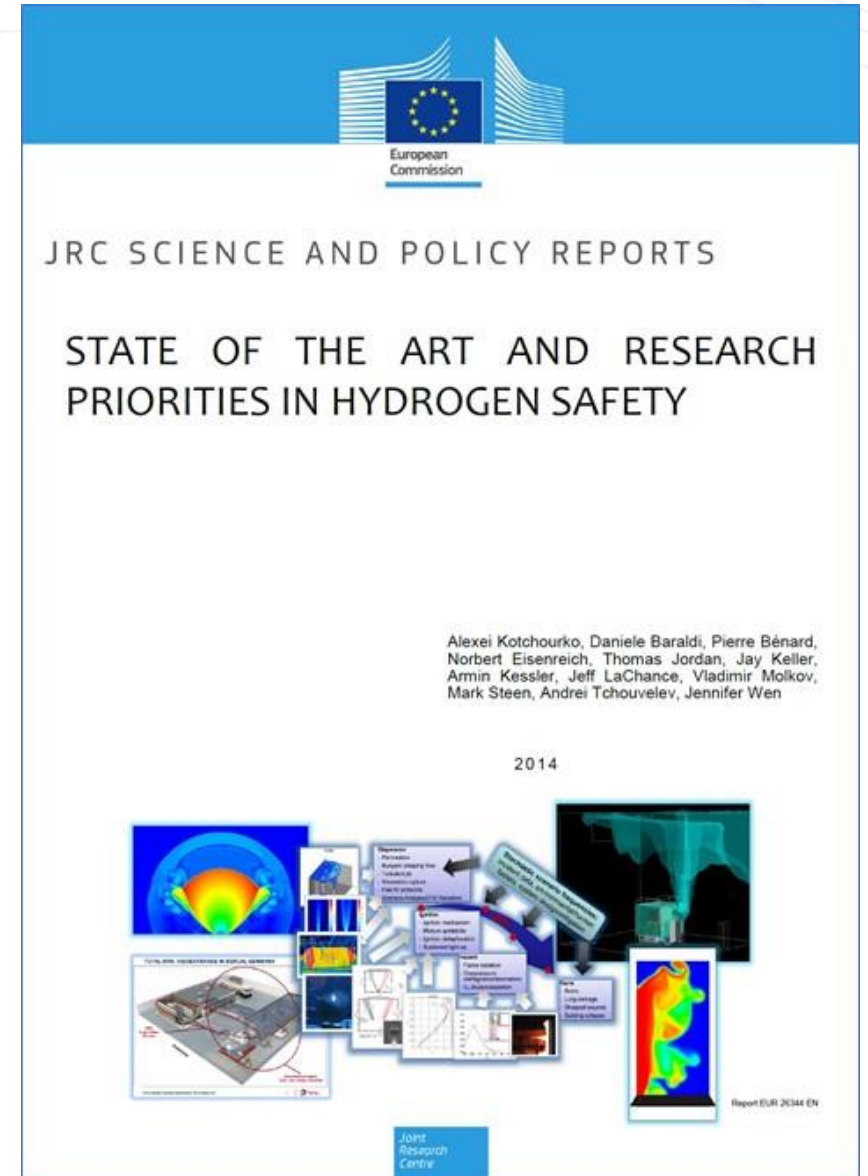


Source: [NRDC](#)

# Hydrogen Safety Expertise (1/3)

## Strategic Improvements:

- **Hydrogen safety knowledge** with entities or companies for consultation to setup hydrogen facilities.
- **Regional and national process or procedure** to setup new hydrogen facilities
- **National coordination** to alleviate gaps in Regulations, Codes, and Standards (RCS) to standardize risk assessments
- **Experts and R&D facilities** on hydrogen safety to meet the industry demand
- Specific and holistic strategy on hydrogen safety, **forecasting the need to grow safety expertise**

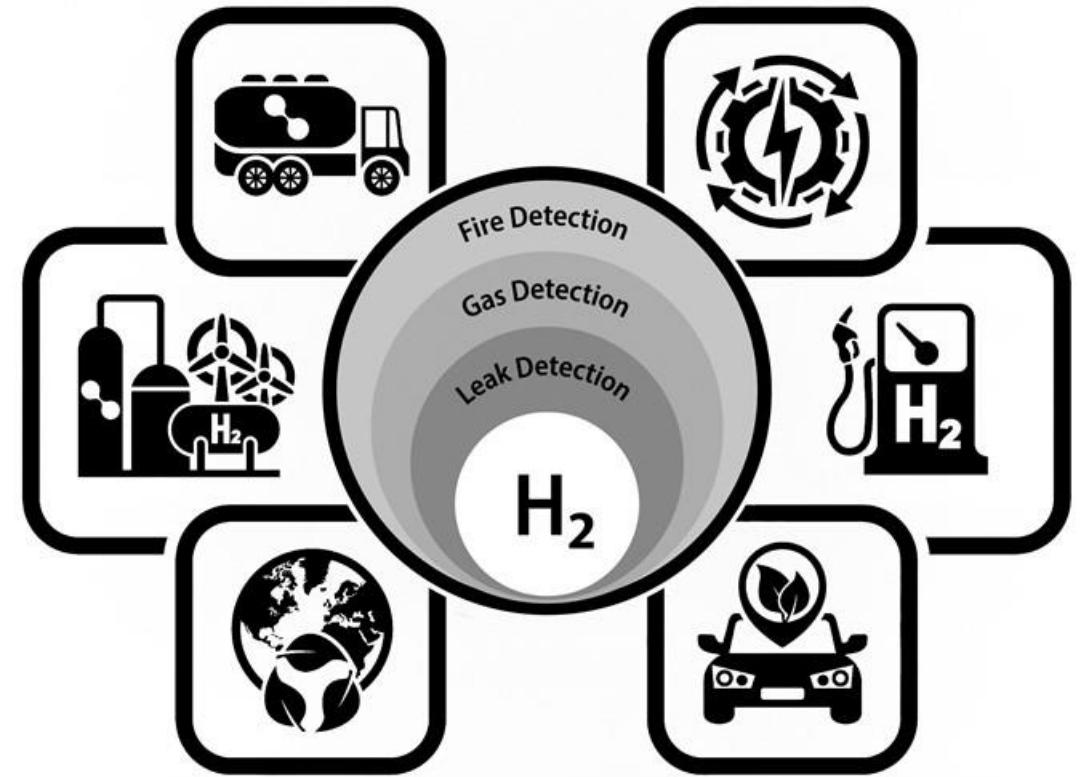


Source: [Joint Research Centre](https://ec.europa.eu/jrc/en/research-and-innovation/reports-and-publications/publications/state-of-the-art-and-research-priorities-in-hydrogen-safety)

# Hydrogen Safety Expertise (2/3)

## Capabilities to Support Deployment:

- **Need Hydrogen Safety Implementation plans** on Major Hydrogen Infrastructure Projects in Canada
- **Need R&D support for advancing existing safety standards** relating to hydrogen or natural gas or blended gases
- **Need Risk assessment and modelling** of hazards from leaks in pipelines carrying hydrogen and other gas blends
- **Need Emergency or accident scenario mitigation** protocols and tools for specific hydrogen end-use or application



Source: MSA [Hydrogen Safety: Standards and Technologies](#)

# Hydrogen Safety Expertise (3/3)

## Case Studies for Pipeline Industry:

- **High-Temperature Hydrogen Attack (HTHA)** damage investigations in carbon steels and mitigation
- Estimation of **hydrogen blending limits based on embrittlement testing** of materials used in existing natural gas pipelines
- Leak **detection** and leak **mitigation** in pipelines carrying hydrogen and natural gas blends
- **Materials compatibility testing and qualification** for in-service equipment to handle blended hydrogen



Source: [Elsevier](#)

To find out more or learn how to get involved,  
visit

[www.ch2cs.ca](http://www.ch2cs.ca)

or email us at

[hydrogen@cni.ca](mailto:hydrogen@cni.ca)

We look forward to hearing from you

# THE CANADIAN HYDROGEN SAFETY CENTRE

ENABLING CANADA'S HYDROGEN FUTURE



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# Canadian Hydrogen Safety Centre

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## **Mission:**

Deliver tangible hydrogen safety solutions across multiple industrial sectors and regions

## **Objectives:**

- **Forecast industry needs** and prioritize activities to align with sector growth
- **Coordinate** Canada's hydrogen safety expertise and capabilities
- **Support the development and implementation** of codes, standards, and regulations
- **Enable access** to infrastructure, facilities, and expertise to develop, test, validate, qualify, and certify safety equipment and systems
- **Serve in an advisory capacity** to governments, regulators, policy makers, and industry on safety issues, events, and solutions



# Summary

## Canada is mobilizing on H<sub>2</sub> Safety

- **Actively engage in H<sub>2</sub> Safety**
- Preparing the foundation for the needs of the emerging H<sub>2</sub> sectors
- **Maintain a level of safety on the existing traditional hydrogen sectors**
- Working as one team to create a Canadian Hydrogen Safety Centre for the Nation!



Thank you! Merci!

Hydrogen Safety Section Head

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