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H_2 in Natural Gas Blending: Leak Survey, Gas Detection Technologies, and Regulatory Developments in Canada

Alain (Al) Hamon
CR Wall Business Development Manager – Gas and Leak Detection

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Fuelling the Future

H_2 in Natural Gas Blending: Leak Survey, Gas Detection Technologies, and Regulatory Developments in Canada

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Introduction

The transition toward net-zero greenhouse gas emissions has pushed governments, utilities, and industry to evaluate alternative low-carbon fuels and strategies.

Hydrogen blending into existing natural gas infrastructure has emerged as one pathway, since blending (rather than full replacement) can leverage existing pipelines, delivery systems, and end-use equipment. However, blending raises specific safety, measurement, detection, and regulatory issues, especially about leaks, material compatibility, and accurate metering.

Background: Hydrogen Blending in Natural Gas

Drivers and Goals

- **Emissions Reductions**: Blending hydrogen (especially low-carbon or renewable H_2) with methane reduces CO_2 emissions per unit of energy burned. It is seen as a "bridge" solution in the energy transition.
- **Decarbonization of heating, buildings, industry**: Particularly where electrification is difficult or expensive.
- **Utilization of existing infrastructure**: To avoid or defer large capital costs of constructing new H_2-only pipelines.

Canada's Hydrogen Strategy (federal) has committed to developing hydrogen as a tool to achieve net-zero by 2050.

Blend Levels Under Consideration

- Low levels (e.g. ≤ 5% by volume) are generally considered more "safe" in terms of impacts on infrastructure, metering, end-use appliances, and risk profiles. Many existing standards, tests, and certifications cover up to about 5%.
- Pilot projects have studied higher levels: for example the Fort Saskatchewan pilot by ATCO looking at ~5 vol% H_2 blending into a portion of the system, with possible increase to ~20% in some cases.
- Regulatory inquiries (e.g. by Alberta's AUC) have considered blending up to 20% by volume in distribution systems.

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Technical Challenges

- **Material compatibility**: Steel and metallic components may undergo hydrogen embrittlement; non-metallic components (seals, gaskets, adhesives) may have permeability or durability issues.
- **Leakage**: H_2 is a very small molecule, more mobile, diffuses more rapidly, has different flammability / explosion limits (wider range), and can increase leak rates especially where existing leakage is present.
- **Metering and measurement**: Hydrogen blending changes gas density, calorific value, Wobbe index, flame speed; many meters are calibrated for "natural gas" (mostly methane) and may be inaccurate with H_2 blends.

End-use appliances: Boilers, furnaces, stoves, gas engines may perform differently, potentially increasing leakage (e.g. around joints, burner seals) or leading to safety issues.

Leak Survey & Gas Detection: Key Issues with H_2 Blending

Leak Risks Specific to Hydrogen

- Hydrogen's properties (low molecular weight, small size, high diffusivity) make containment more challenging; leaks may occur through microscopic flaws that would be inert for methane.
- Hydrogen flame is nearly invisible, difficult to see in daylight, so visual detection is harder without tracer gas or sensors.
- The lower explosion limit (LEL) of hydrogen is lower and upper explosion limits higher than methane, making a wider range of concentrations flammable. Also, hydrogen mixes more easily, meaning properly assessing concentration gradients (e.g., in enclosed or semi-enclosed spaces) becomes more critical.

Infrastructure Integrity

- **Pipelines, welds, joints**: Older steel pipelines, aging welds, joints not designed for hydrogen service may suffer embrittlement or fatigue over time.
- **Seals, valves, regulators**: Parts that are not gas-tight against H_2 over long periods may leak more.
- **Appliance connections, burners**: The parts within homes or commercial buildings may allow greater leakage in presence of hydrogen.

Measurement and Metering Issues

- Meter types: Turbine, diaphragm, ultrasonic, thermal mass flow, etc. Each is differently affected by hydrogen blending. Certification is often only for natural gas or very low H_2 content.
- Heat content and energy vs. volume: Blended gas has altered calorific value, heating value, and flame speed. This can affect billing, safety, and performance.

Trade measurement: Ensuring that gas meters used for billing are accurate under H_2 blends. The regulatory entity Measurement Canada has produced policy (G-25) for temporary requirements of meters used in hydrogen-enriched natural gas.

Technologies for Leak Detection and Monitoring

Traditional Detection and Survey Methods

- **Walking / foot patrols**: Field technicians with handheld combustible gas detectors that measure %LEL or ppm; visually inspect visible signs.
- **Using tracer gases**: (e.g. adding a detectable tracer or using existing minor component) to help locate leaks.
- **Annual or periodic leak surveys**: Scheduled surveys of distribution networks to detect leaks in mains, services, laterals, etc.

Advanced and Remote / Aerial Sensing

- **Mobile leak detection vehicles**: Vehicles outfitted with laser-based detection (e.g. tunable diode laser absorption spectroscopy, TDLAS) that "sniff" from road along pipelines or distribution lines. Example: Manitoba Hydro pilot where a specially outfitted SUV detected leaks that traditional walking methods missed.
- **Aerial / UAV / fixed wing / helicopter surveys**: Equipping aircraft or drones with sensors to fly over pipelines or facilities to detect methane / blended gas leaks. Technologies include optical gas imaging, hyperspectral imaging, LiDAR, etc.
- **Fixed sensors / continuous monitoring**: Stationary sensors at critical infrastructure, compressor stations, valves, joints. Some projects in methane LDAR (Leak Detection and Repair) use fixed sensors, continuous monitoring to quickly detect and localize leaks.

Emerging Technologies & Research

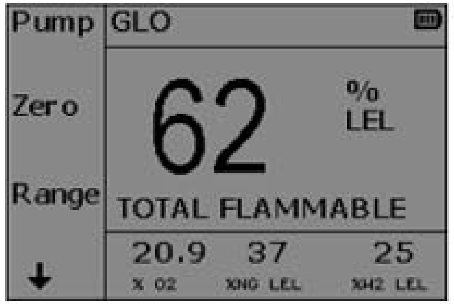
- **Hyperspectral imaging**: e.g. LSI's GasRecon, which uses thermal infrared hyperspectral imaging systems (airborne) to detect and quantify methane leaks. Though focused on methane, similar imaging systems may be adapted for H_2 or blended gas detection.
- **Photoacoustic spectroscopy**, tunable lasers: These offer high sensitivity (ppb level), faster response times, small sample volume, and potential for multi-species detection. Some recent work internationally focuses on multi-species detection (so could distinguish H_2, CH_4, etc.).
- **Sensor fusion and artificial intelligence**: Combining multiple sensor modalities (gas sensors, imaging, acoustic) plus environmental data (wind, temperature) to detect, localize, classify leaks, reduce false positives. Some studies show significant improvements via this path.

Available Technology – Canadian Market

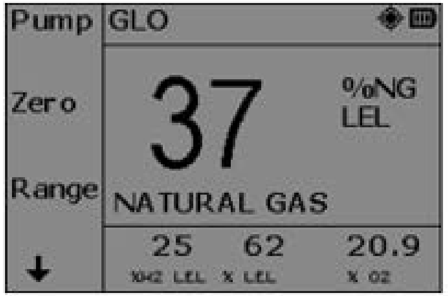
Teledyne GMI GS700 Hydrogen

- CSA C22.2 approved
- Measures 0-100% V. CH_4 and 0-100% V. H_2
- IR Sensor for CH_4, Custom TGMI sensor for H_2

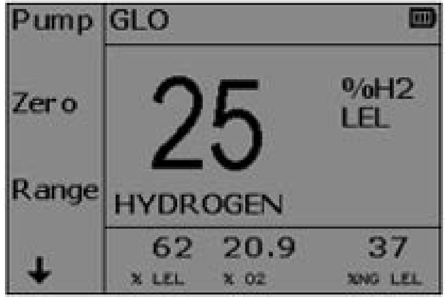
- TOTAL FLAMMABLE reading
  natural gas (37%) + hydrogen (25%)



- NATURAL GAS reading



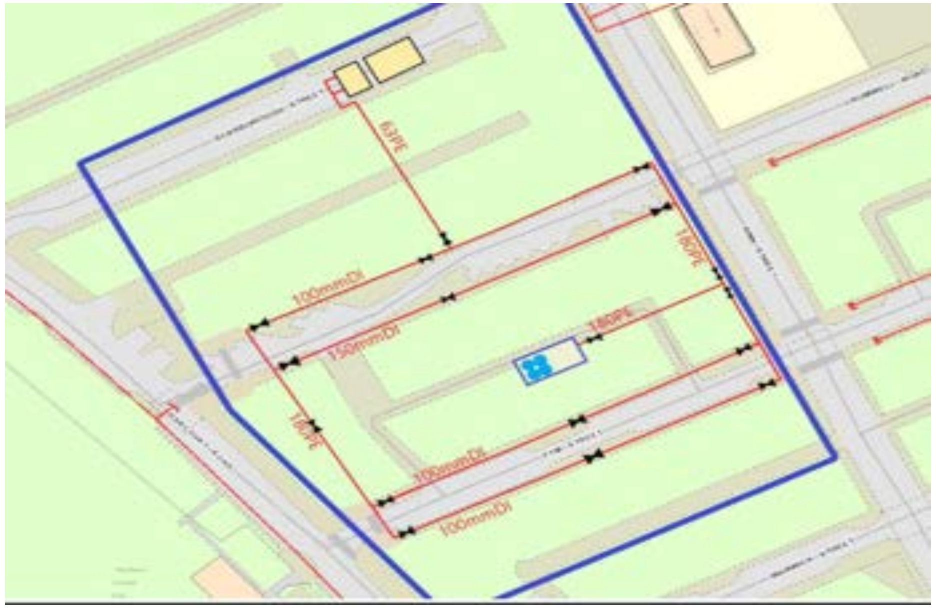
- HYDROGEN reading



Available Technology – Canadian Market

Field Trial – 100% H_2

H21 Phase 2b: UK - Existing site with mix of old / new pipes



GS700-Hydrogen used to support project activities:

- ✓ Indirect / Direct Purging - Commissioning / Decommissioning / Branch Purging / Conversion Style Purging
- ✓ Finding Leaks - Gas detection / Barholing / Rock Drilling
- ✓ Accessing Leaks - Atmospheric Sampling / Dispersion Monitoring
- ✓ Live Gas Operations - Under Pressure Drilling / Live Service Insertion / Live Mains Insertion
- ✓ Flow Stop - Squeeze Off / Bag Stop / Service Isolation

Field Trial – 100% H_2

TELEDYNE
GAS AND FLAME DETECTION
Everywhereyoulook™

UK 'laboratory' testing

Hy4Heat - Department of Business Energy and Industrial Strategy (BEIS)

Vol H2 % vol H2	GMI reading % vol H2
0.0%	0%
9.8%	9%
18.8%	18%
27.2%	27%
36.9%	37%
47.0%	46%
57.1%	57%

GS700-Hydrogen used for:

- PPM / LEL tracking – room dispersion
- Purging

"...The readings from this were expected to be more dependable, consistent, and accurate. It is also able to reliably detect higher concentrations of hydrogen.

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Data, Analytics, and Operational Integration

- Software platforms for mapping, tracking leak locations, integrating surveys, archival of leak repair work, estimating emissions, prioritizing repairs.
- Real-time / near-real-time detection → quicker response.
- Integration with regulatory reporting requirements and risk management.

Regulatory, Codes & Standards Developments in Canada

A number of regulatory and standards developments are underway to address or prepare for hydrogen blending. Key areas include metering, safety codes, material standards, and approvals.

Federal Policies and Strategies

- **Hydrogen Strategy for Canada**: Sets out broad framework, including aspirations for hydrogen use, clean hydrogen production, and roles for blending.
- **Natural Resources Canada and related funding programs**: Supporting R&D, pilot projects, detection / mitigation (e.g. methane), innovation for hydrogen-ready infrastructure and codes.

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Metering / Measurement Regulation (Measurement Canada)

- In April 2023, Measurement Canada issued **Policy G-25 – Policy on the use of gas meters in hydrogen-blending activities in the natural gas network**: temporary requirements & conditions for gas meters used in trade measurement when supplied with hydrogen-enriched natural gas.
- The draft policy (earlier) proposed modifications to sample selection, reverification periods, identification of meter lots used for hydrogen-enriched gas, etc.

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Provincial / Regional Safety Codes, Standards, and Regulatory Bodies

- **CSA B149 Code Series (Natural Gas and Propane Installation Code, etc.)**: The 2025 updates include provisions aimed at preparing for hydrogen in gas installations.
- **Canadian Hydrogen Codes and Standards Roadmap**: A government resource mapping what standards exist, where gaps are, what needs to be developed, including regarding leakage, infrastructure, end-use appliances.
- **Technical Standards and Safety Authority (TSSA) in Ontario**: Enhancing regulatory framework for hydrogen distribution and utilization: pipelines, installations, licensing, training. As of Feb 2025 several licensing and inspection enhancements.

Safety Regulations Specific to Hydrogen Installations

- Codes covering hydrogen handling, storage, piping: for example, the CAN/BNQ 1784-000/2022 Canadian Hydrogen Installation Code.
- Regulations for compressed gas, safety distances, hazard classification, worker safety, contractor certification.

Case Studies and Pilot Projects in Canada

ATCO Fort Saskatchewan Pilot

- ATCO’s Fort Saskatchewan H_2 Blending Project aims to blend ~5 vol% H_2 into a portion of the natural gas system serving ~2,100 customers. Plans considered increasing up to ~20%.
- Risk assessments were undertaken to evaluate safety, material compatibility, regulatory compliance.

Quebec / Enbridge and Other Pilots

- In Quebec, Énergir has green hydrogen injection pilot projects. Ontario via Enbridge Gas has blending plans. These are referenced in the Hydrogen Codes & Standards Roadmap.

Alberta Utilities Commission Hydrogen Inquiry

- The AUC's inquiry (Proceeding 27256) looked at blending up to 20% by volume, roles of regulators, safety, thresholds, delivery of services (especially in rural areas), legislative changes, regulatory barriers.

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Gaps, Uncertainties, and Risks

- Long-term material behaviour: hydrogen embrittlement, fatigue, and aging under blended gas exposure are not fully characterized, especially in older pipelines.
- Appliance and end-use behaviour: how existing gas appliances will perform over time with hydrogen blends; increase in leakage, safety margins, combustion stability.
- Leakage quantification: current leakage surveys, measurement technologies are more developed for methane; less data exists for hydrogen leaking from the blended network or from appliances.
- Environmental impacts: hydrogen itself is not a greenhouse gas, but leaked hydrogen can affect atmospheric chemistry (can extend CH_4 lifetime, oxidants, etc.). These indirect effects are less well quantified. The Codes & Standards Roadmap notes "Hydrogen Leakage and Environmental Consequences" as a gap.
- Regulatory harmonization: provinces and territories have different standards, code adoption rates; the need for uniformity or at least interoperability.

Metering accuracy and trade measurement: ensuring fairness to consumers and businesses; existing meters may have unknown errors under certain blend levels.

Recommendations for Stakeholders

For Utilities and Gas Operators

- Conduct thorough material audits of their infrastructure: identify parts likely to be vulnerable to hydrogen (steel grade, seal materials, joints, etc.).
- Monitor current leakage rates (methane + any existing hydrogen pilot leaks) and quantify changes when moving to blended gas.
- Deploy or pilot advanced detection technologies: mobile leak detection, aerial surveys, fixed continuous sensors.
- Engage with appliance manufacturers to determine performance and safety of burners, connections, and seals under hydrogen blends.
- Plan for phased blending; begin with low blend levels (≤5%) and gradually increase as knowledge, monitoring, and regulatory framework mature.

For Regulators and Policy Makers

- Continue developing and updating codes and standards to address hydrogen blending (installation codes, safety codes, metering, materials).
- Ensure regulatory requirements for meter accuracy and trade measurement are adapted (e.g. via policies like G-25) and enforce them.
- Foster R&D into leakage quantification, environmental and health impacts of hydrogen leakage, and accelerated risk assessment.
- Harmonize standards across provinces / territories to reduce regulatory uncertainty and allow scaling.
- Incentivize or require LDAR (Leak Detection and Repair) programs, including continuous monitoring, for utilities engaged in hydrogen blending.

For Technology Developers and Researchers

- Focus on detection technologies that are sensitive to hydrogen (or blended gas) leak signatures, including low concentration leaks, fast response time, durable in various environmental conditions.
- Investigate sensor fusion and AI to reduce false positives, improve localization.
- Research into environmental impacts of hydrogen leakage (direct and indirect), and establish methods to include these in lifecycle GHG assessments.
- Engage with standardization bodies to ensure new technologies meet or anticipate regulatory requirements.

Conclusion

Hydrogen blending into natural gas systems offers a promising pathway to reduce emissions while leveraging existing infrastructure. But to deploy this safely and effectively in Canada at scale, there must be strong attention to leak survey and detection, to measurement and metering accuracy, to infrastructure integrity, and to robust and harmonized regulatory and standards frameworks.

Pilot projects underway in several provinces, as well as regulatory developments (e.g. Measurement Canada's G-25 policy, CSA Code updates, provincial safety authority actions) are important steps. Yet gaps remain, especially around material aging, appliance behavior, leakage quantification, and environmental consequences.

With coordinated effort among utilities, regulators, researchers, and technology providers, these challenges can be addressed. Canada's regulatory system is already adapting, but continuous vigilance, learning from pilots, and investment in detection/monitoring technologies will be essential to ensure safety, environmental integrity, and public confidence.