ALBERTA INNOVATES

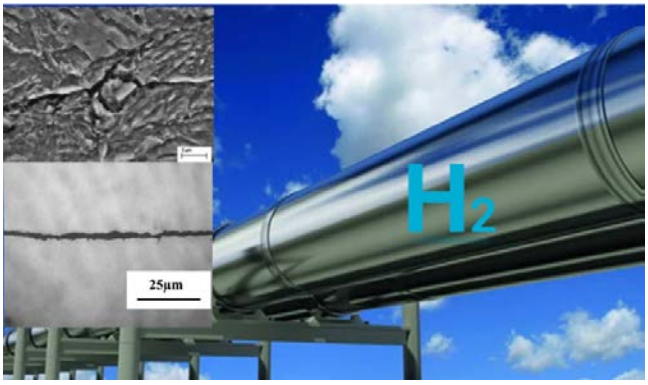
# CLEAN RESOURCES

CLEAN TECHNOLOGY

HYDROGEN

## Development of a Technical Assessment Program for the Suitability of Existing Natural Gas Pipelines for Hydrogen Transport

Repurposing existing natural gas pipelines provides “a low-cost option for delivering large volumes of hydrogen” over wide ranges and long distances. Hydrogen embrittlement (HE) can occur on pipelines transporting hydrogen in either pure or blended form, causing cracking and pipeline failures. Existing pipelines usually contain corrosion defects and dents, serving as effective "traps” to hydrogen atoms to initiate cracks. Thus, existing pipelines must be assessed to determine the HE susceptibility prior to their conversion for hydrogen service. Currently, the assessment technique is not available. This project will fill the gap.




### FUNDING DETAILS

**RECIPIENT:**
Frank Cheng

**PARTNERS:**
ATCO Gas
Surerus Murphy
TC Energy

**TOTAL BUDGET:**
$450,000

**AI HCOE FUNDING:**
$225,000

**PROJECT DATES:**
FEB 2023 – JAN 2025

**PROJECT TRL:**
Start: 3
End: 7

## APPLICATION

The project will address the pipe materials degradation and pipeline cracking caused by hydrogen embrittlement when converting the existing natural gas pipelines for hydrogen transport. The developed assessment technique will help pipeline operators evaluate, mitigate, and eliminate the risk to hydrogen embrittlement, improving pipeline integrity and operating safety for sustainable hydrogen transmission.

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## PROJECT GOALS

- Develop a technical assessment technique, determining the suitability of existing "aged" natural gas pipelines for hydrogen transport from the materials safety perspective.
- Evaluate the possibility of hydrogen atom generation from hydrogen molecules in high-pressure gaseous environments under pipeline operating conditions.
- Develop numerical models to quantify the distributions of hydrogen atoms at corrosion defect and dent present on the aged pipelines.
- Estimate the threshold hydrogen atom concentration at corrosion defect and dent to initiate cracks under given stressing and metallurgical conditions.
- Assess the susceptibility of the aged pipelines to hydrogen embrittlement in hydrogen service.
- Recommend appropriate operating conditions to mitigate and avoid hydrogen embrittlement occurrence.

## BENEFITS TO ALBERTA

- The project is an essential part of the National Hydrogen Strategy and integral to the Alberta Hydrogen Roadmap.
- The research outcomes will contribute to safe and effective hydrogen delivery by existing pipelines, significantly saving the initial capital cost to build new pipelines, fully using the available infrastructure and established knowledge and experiences in gas pipeline operation and accelerating realization of a full-scale hydrogen economy.
- The developed technique will help Albertan energy and pipeline industry to implement the clean energy strategy for some benchmark hydrogen blending projects, ensuring a safe and reliable hydrogen delivery by pipelines for industry and community applications.
- The project will place Alberta a leading position in development of hydrogen pipeline technology in the world.

**6 Publications**

**3 Students Trained**

**3 Patents**

**5-10 Project Jobs**

**20-30 Future Jobs**

**3 New Products/Services**

**1 Spinoff Company**

**0.01–0.1 kt/yr Project GHGs Reduced**

**1-5 kt/yr Future GHGs Reduced**

## CURRENT STATUS

### JAN 2023

- Establishing the method for calculations of the hydrogen dissociative reaction free energy and develop extensive experiences in investigations of hydrogen embrittlement of pipelines.
- Equipment purchases and updates underway.
- Modeling of the hydrogen atom distribution at lattice and defect sites in steel, and *in-situ* visualization of hydrogen atoms in microphases, micro-indentation and grain boundaries all underway.