

ALBERTA INNOVATES CLEAN RESOURCES

CLEAN TECHNOLOGY
HYDROGEN CENTRE OF EXCELLENCE

FUNDING
DETAILS

Safe Hydrogen Agile Pipeline Engineering (SHAPE): Digital Transformation and Leak Detection Through Artificial Intelligence and Digital Twin

Global concerns regarding greenhouse gas emissions necessitate innovative approaches to hydrogen production, storage, and transportation to tackle safety and efficiency issues. Safely moving hydrogen from production sites to consumers presents a challenge. This project proposes an innovative pipeline health monitoring system using digital twin technology, integrating real-time data for risk assessment and improved hydrogen transportation safety and efficiency. Through virtual and mixed reality interfaces, the system offers spatial visualization for both a comprehensive understanding and informed decision-making. Combining information management with advanced detection methods, it serves as a comprehensive toolkit for accident detection, risk assessment, and structural health monitoring.



RECIPIENT:
University of
Calgary



PARTNERS:
Plains Midstream,
ECC (formerly
CEPA)



TOTAL BUDGET:
\$1,252,000



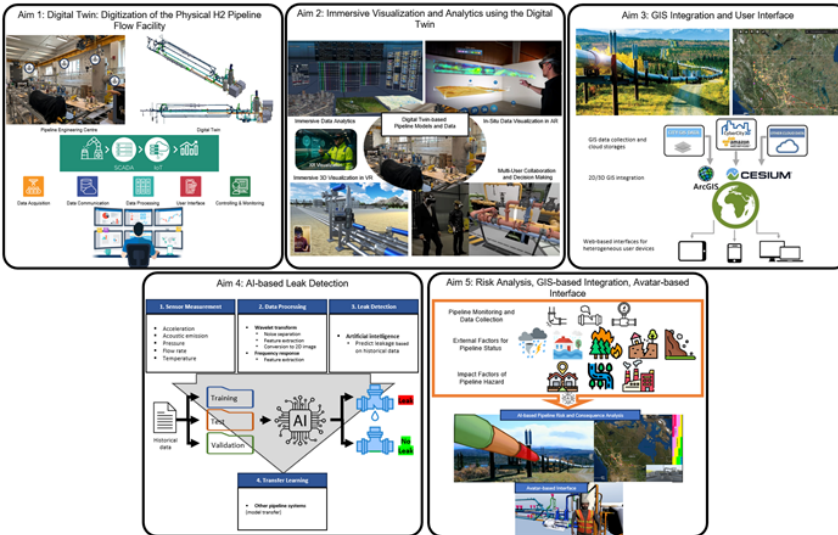
AI HCOE FUNDING:
\$610,000



PROJECT DATES:
APR 2024 –
DEC 2026



PROJECT TRL:
Start: 4
End: 6



APPLICATION

Integrating hydrogen into Alberta's extensive natural gas pipeline network generates immediate, significant market demand, driving sectoral advancement. Enhanced safety and efficiency further bolster this demand. The project utilizes advanced digital twin technology and AI-driven leak detection systems to optimize hydrogen transportation, improving safety, efficiency, and cost-effectiveness. Leveraging abundant natural gas resources and strategic advantages, it promotes economic growth, job creation, and environmental stewardship, solidifying Alberta's position in the global hydrogen market while tackling critical pipeline integrity and monitoring challenges.

Learn how albertainnovates.ca



CLEAN RESOURCES

CLEAN TECHNOLOGY

HYDROGEN CENTRE OF EXCELLENCE

PROJECT GOALS

The project aims to digitize a physical hydrogen pipeline flow facility using digital twin technology, empowered by SCADA interfaces, to enhance operational efficiency and safety. It focuses on immersive visualization and analytics using the digital twin, leveraging AR/VR interfaces for intuitive data interpretation. The system provides interactive visualization, enabling exploration of the pipeline infrastructure virtually. Additionally, it integrates GIS with AI onto the digital twin for environmental monitoring and risk assessment. Furthermore, the project aims to develop an AI-based leak detection system for hydrogen pipelines and conduct risk analysis using the E-RTTM method. Lastly, it assesses H2 risk through Bayesian theory and Monte Carlo simulation, ensuring safe transportation amidst environmental challenges.

BENEFITS TO ALBERTA

The project aligns with Alberta’s strategic objectives, providing a pathway for tapping into the North American hydrogen market. By leveraging abundant natural gas resources, clean hydrogen production can be facilitated, promoting economic growth, and diversifying the energy sector. Transitioning to hydrogen reduces greenhouse gas emissions, leading to improved public health outcomes. Integration of hydrogen into existing pipelines creates market demand and export opportunities, positioning Alberta as a leader in sustainable energy innovation. Implementation of digital twin technology enhances safety, operational efficiency, and intuitive data interpretation, while reducing downtime due to false alarms. These advancements boost Alberta’s reputation globally, attracting collaborations with international partners and advancing the province’s clean energy agenda.



5 Publications



6 Students Trained



1 Patents



1-5 Project Jobs



10-100 Future Jobs



2 New Products/Services



1 Spinoff Companies



10-100 kt/yr Project GHGs Reduced



100-1000 kt/yr Future GHGs

CURRENT STATUS

MAR 2026

The University of Calgary team has developed the first version of the Digital Twin for the flow facility, incorporating extended reality modeling and a leak detection system. Real-time sensor data and cloud-based simulations are now integrated into the Digital Twin for comparison. In parallel, a risk model is being developed for the Alberta product pipeline, simulating it as a hydrogen/natural gas blend pipeline while considering multiple static and dynamic factors. The next step is to optimize the AI-based leak detection model for hydrogen/natural gas blend and further improve the XR and risk analysis components.

Disclaimer • Alberta Innovates (AI) and His Majesty the King in right of Alberta make no warranty, express or implied, nor assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information contained in this publication, nor that use thereof infringe on privately owned rights. The views and opinions of the author expressed herein do not necessarily reflect those of AI or His Majesty the King in right of Alberta. The directors, officers, employees, agents and consultants of AI and the Government of Alberta are exempted, excluded and absolved from all liability for damage or injury, howsoever caused, to any person in connection with or arising out of the use by that person for any purpose of this publication or its contents.