



PROJECT CAFE

COFFEE & CLEANTECH CRIN Network Innovative Projects

October 15, 2024

powered by

CRIN
Clean Resource
Innovation Network

Network of Networks

CRIN does not replicate or compete, we are committed to amplifying and supporting the existing networks in the cleantech ecosystem, providing opportunities to collaborate, convene and collide.



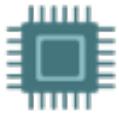
A few of CRIN's active industry members (including Canada's largest oil & gas producers):

- Arc Resources
- Cenovus Energy
- ConocoPhillips Canada
- Canadian Natural Resources Limited
- Imperial Oil Limited
- Pacific Canbriam Energy
- Suncor Energy
- Tourmaline Oil

7 Technology Themes across 5 Sectors



CLEANER FUELS - REDUCING CARBON INTENSITY



DIGITAL OIL AND GAS TECHNOLOGY



CARBON CAPTURE AND VALUE-ADDED PRODUCTS



METHANE MONITORING, QUANTIFICATION AND ABATEMENT



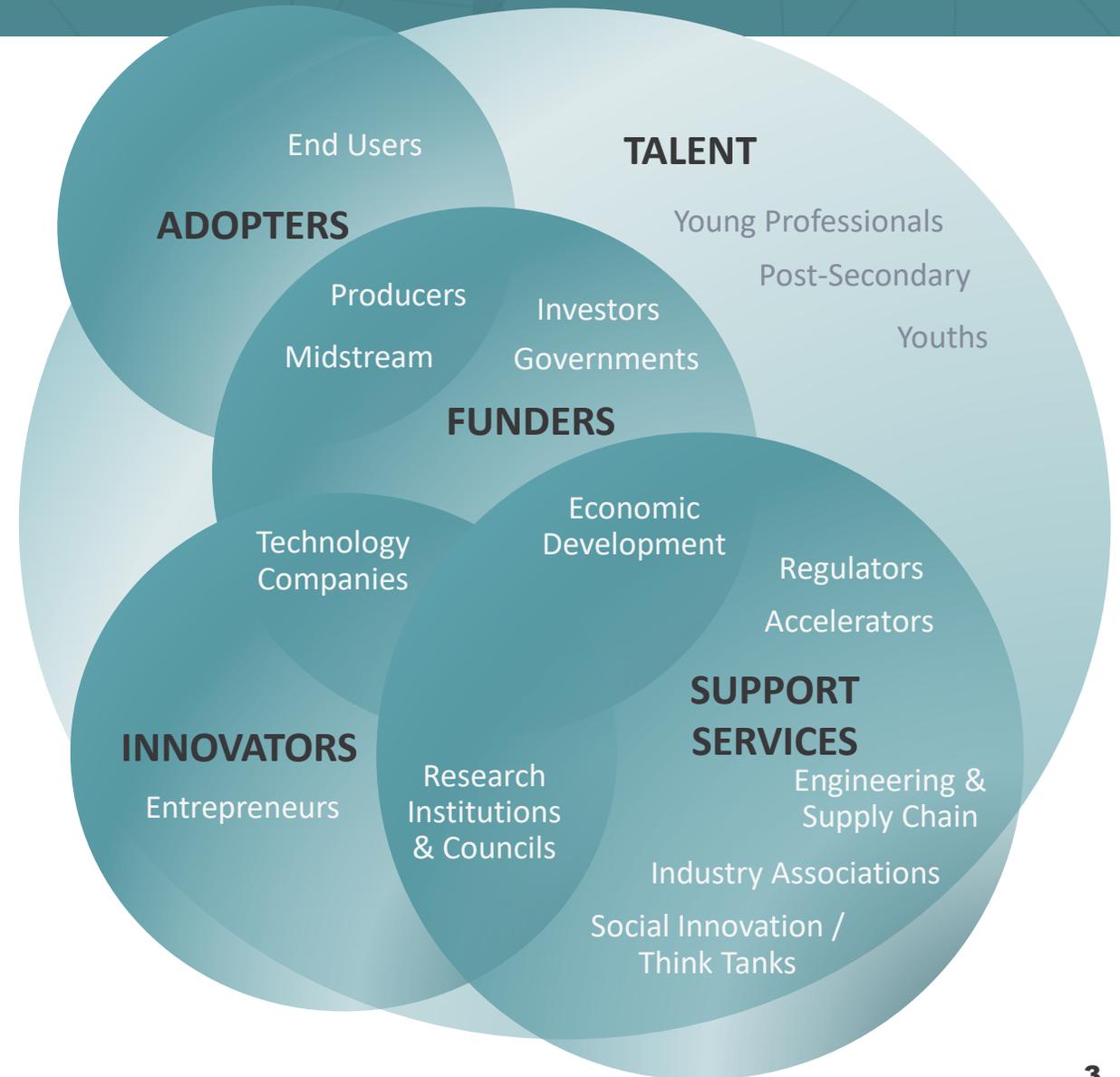
NOVEL HYDROCARBON EXTRACTION



NOVEL LAND AND WELLSITE RECLAMATION



WATER TECHNOLOGY DEVELOPMENT

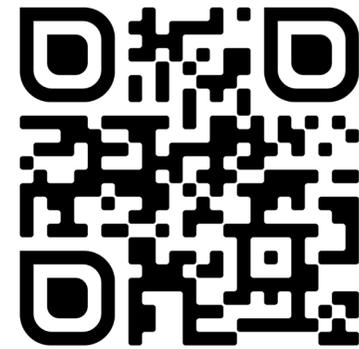


Join CRIN



- Free to join
- Network with members across the ecosystem
- Access CRIN discussion groups on LinkedIn
- Access CRIN events calendar
- Marketing opportunities for your organization
- Participate in events/panels
- CRIN newsletters
- Follow CRIN on LinkedIn

Join the CRINetwork!



Land Acknowledgement

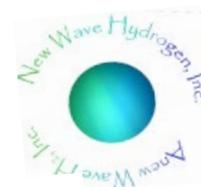
Acknowledgement of the land is an important step toward reconciliation. Today, we are gathering from across Canada, please take a moment to recognize the land where you reside and work.

This event is being hosted from Calgary, where we acknowledge and pay tribute to the traditional territories of the peoples of Treaty 7, which include the Blackfoot Confederacy (comprised of the Siksika, the Piikani, and the Kainai First Nations), the Tsuut'ina First Nation, and the Stoney Nakoda. The City of Calgary is also home to the Métis Nation of Alberta (Districts 5 and 6).



AGENDA

1. Welcome	Sally Dawoud
2. University of Regina <i>Development Of an Integrated Mobile System (MMS) for Methane Utilization and Produced-Water Treatment</i>	Jerry Yao
3. New Wave Hydrogen Inc. <i>A New Wave in Hydrogen Production</i>	Lowy Gunnewick
5. VL Energy <i>Field Demonstration of AI Powered Predictive Emissions Monitoring Systems (PEMSs)</i>	Ling Bai
6. InnoTech Alberta <i>Accelerated Advancement of a Dimethyl Ether (DME) Assisted In Situ Bitumen Recovery Process</i>	Haibo Huang
5. Q&A, Wrap-up, Coffee!	



A New Wave in Hydrogen

October 15, 2024

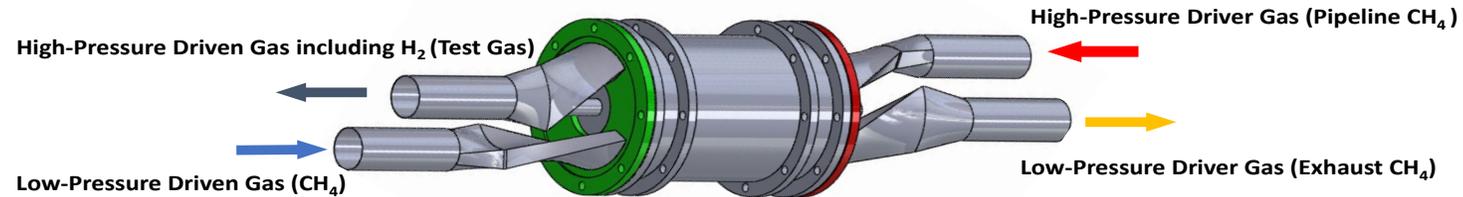
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New Wave Hydrogen – A New Energy Paradigm



Shock Wave Compression Heating for Methane Pyrolysis



Wave Rotor – Rotating Bank of Shock Tubes



No Water

No CO₂

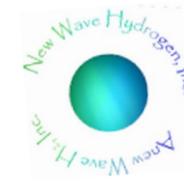


Methane Pyrolysis is a Near Term Solution with Rapid Growth Potential

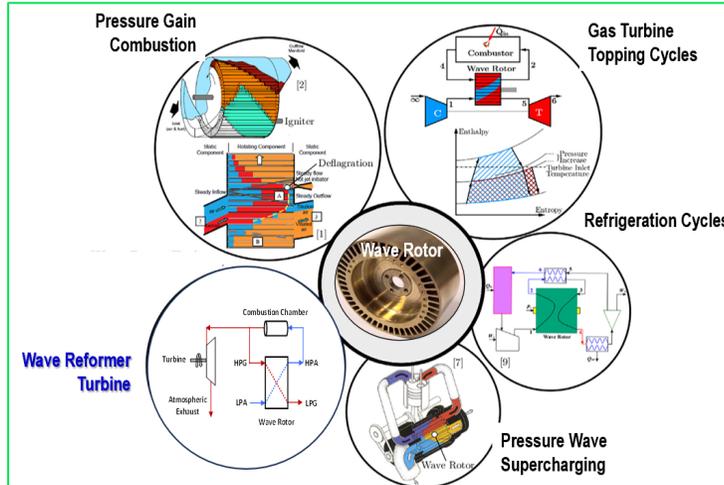
A Fit for “Hard to Decarbonize” Industries that Require both Hydrogen and Carbon

Clean, Cost-effective, Scalable and Near-term

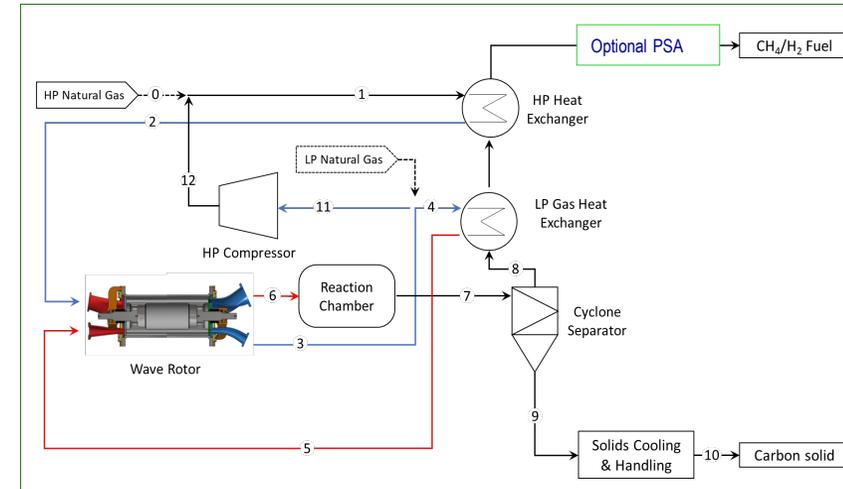
NWH2 is Building off of Proven Processes and Components



- Lowering the Development Risk



Core Technology – A Wave Rotor
In Use for Over 50 Years, Proven



New Wave System – Standard Components

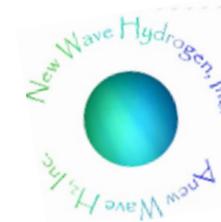
- Wave Reformer (Wave Rotor) - Cyclone
- Compressors - Heat Exchangers
- Fluidized Bed Reactor with Self-Seeding Carbon Catalyst

Key Points – Proven Technologies Applied to a New Process

- Shock-Wave Pyrolysis - Known for decades
- Wave Rotors – Known Heater & Reactor
- Fluidized Beds – Well Known, Commercial Uses
- Extensive Heat Integration

Integrated Sector Benefits of CH4 Pyrolysis

Green H2, Green Carbon, Green Ammonia



- Natural Gas
- Biogas/RNG
- Ammonia Carrier Gas



Innovation in Grid-Edge Production

**GREEN
CARBON**

**COKE
REPLACEMENT**

**GREEN
CARBON BLACK**

**SOIL
ADDITIVE**

CLEAN POWER
Central or
Distributed/Remote

NG:H2 BLEND
Methane Slippage
Mitigation

Clean H₂

DISTRIBUTION OPTIONS

GRID EDGE ON-SITE VIRTUAL PIPELINE MOBILE FUELING STATION

INTEGRATED CROSS-SECTOR & REGIONAL BENEFITS

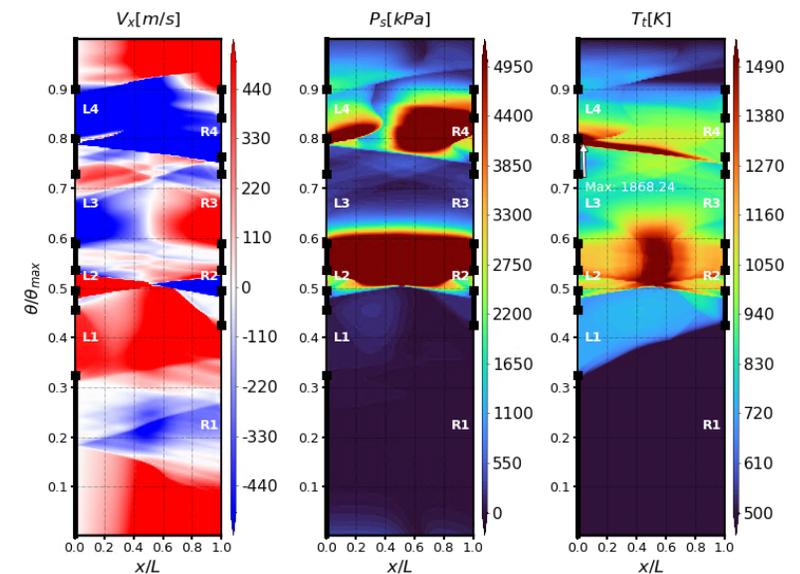
- ✓ CO2 Reduction
- ✓ No Water Use
- ✓ CH4 Mitigation
- ✓ Low Electricity
- ✓ Remote Power
- ✓ Wave Rotor Lab – Extended Mkts
- ✓ New C Products
- ✓ Green Exports
- ✓ Clean Tech Growth

REFINERY TRANSPORTATION AMMONIA POWER STEEL
SUSTAINABLE FUELS SUSTAINABLE AGRICULTURE SUSTAINABLE AVIATION SUSTAINABLE MANUFACTURING

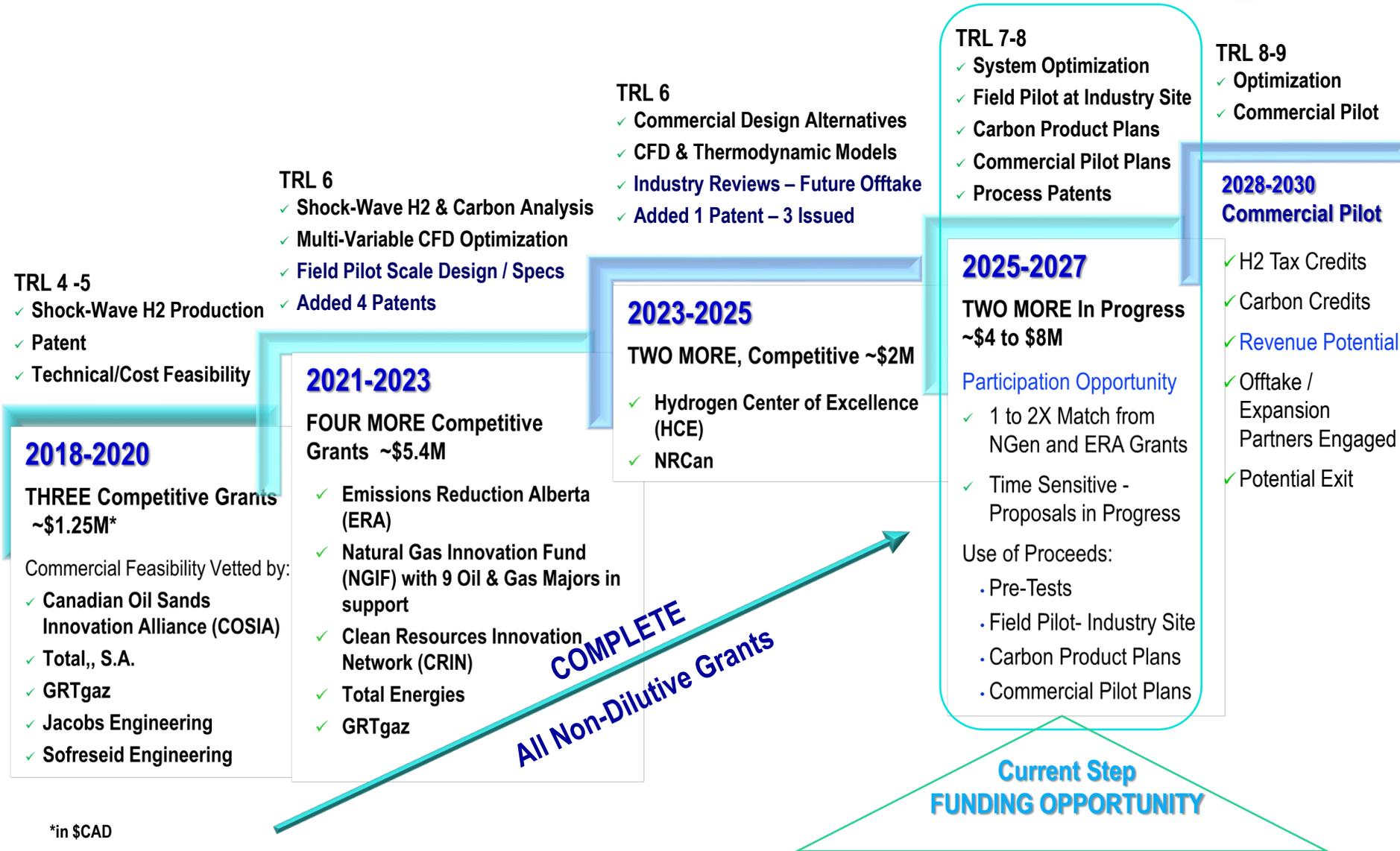
Key Accomplishments



- Lab-based shockwave testing demonstrating H_2 and C production, including the development of complex kinetic reaction models and sensors.
- The development of a suite of CFD models that support the development and design of the NWH2 wave reformer:
 - Includes the integration of a reduced-order kinetics model,
 - Validated using the laboratory data.
- Development and design of field pilot and commercial designs, including a first-of-a-kind wave reformer and test system built in Canada.
- Expanded and grew industrial end-use applications for both the produced hydrogen and carbon.
- Significant IP portfolio growth with 6 new patents and 10 peer-reviewed papers.



Strategic Technology Advancement



*in \$CAD

Competitive Comparisons

				Electrolysis
			Plasma	
	Pulse Combustion	Molten Metals		
NEW WAVE H2	Microwave			SMR w CCS

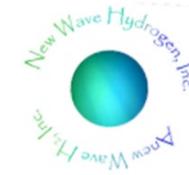
GHG Emission, Water Demand, Electricity Use

Competitive Analysis New Wave H2 Shock Wave Heating vs Current and Emerging Technologies	Electricity Demand	No Direct CO2	No Water Demand	Ease in Scaling	Low Cost, Distributed	Low Cost, Large Scale	No Carbon Impurities or Recovery Issues	Electrode or Equip. Longevity
New Wave H2	Green	Green	Green	Green	Green	Green	Green	Green
SMR/ATR with CCS	Green	Red	Red	Red	Red	Green	Green	Green
Electrolysis	Red	Green	Red	Red	Red	Red	Green	Red
Competing Methane Pyrolysis:								
Pulse Combustion	Yellow	Red	Green	Yellow	Yellow	Green	Green	Green
Electricity-Heated Plasma	Red	Green	Green	Green	Yellow	Green	Yellow	Red
Molten Metal Catalysts	Red	Green	Green	Green	Green	Green	Red	Red
Electricity-Heated Microwave	Red	Green	Green	Green	Green	Green	Yellow	Green

Image Source Web: Dr. Andreas Bode, BASF Research Press Conference January 10, 2019

			Direct CO ₂ emissions in kg CO ₂ /kg hydrogen	Minimum energy demand in kJ/mol hydrogen*
Steam Methane Reforming (SMR)	State-of-the-art	Steam reforming of natural gas $\text{CH}_4 + 2\text{H}_2\text{O} \rightarrow 4\text{H}_2 + \text{CO}_2$	8.85	27
Electrolysis	Option 1	Water electrolysis $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$	0	286
Other Pyrolysis	Option 2	Methane pyrolysis $\text{CH}_4 \rightarrow 2\text{H}_2 + \text{C}$	0	37
NWH ₂	Option 3	New Wave H2 $\text{CH}_4 \rightarrow 2\text{H}_2 + \text{C}$	0	< 9

DIVERSE SECTOR SUPPORT - CO-FUNDING PARTNERS & TEAM



Natural Gas Distribution Investors



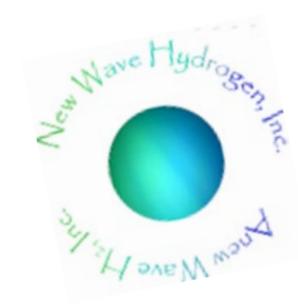
Natural Gas Production Investors



New Wave H₂ Breaking Barriers - Accelerating the Transition

- ✓ Novel Integration of Proven Components
- ✓ No Water, Low Electricity
- ✓ No Direct CO₂, Low Cost
- ✓ No Parallel Build-Out Lags
- ✓ RAPID Route to GHG Reductions
- ✓ Broad and Diverse Sector Support





Thank You!



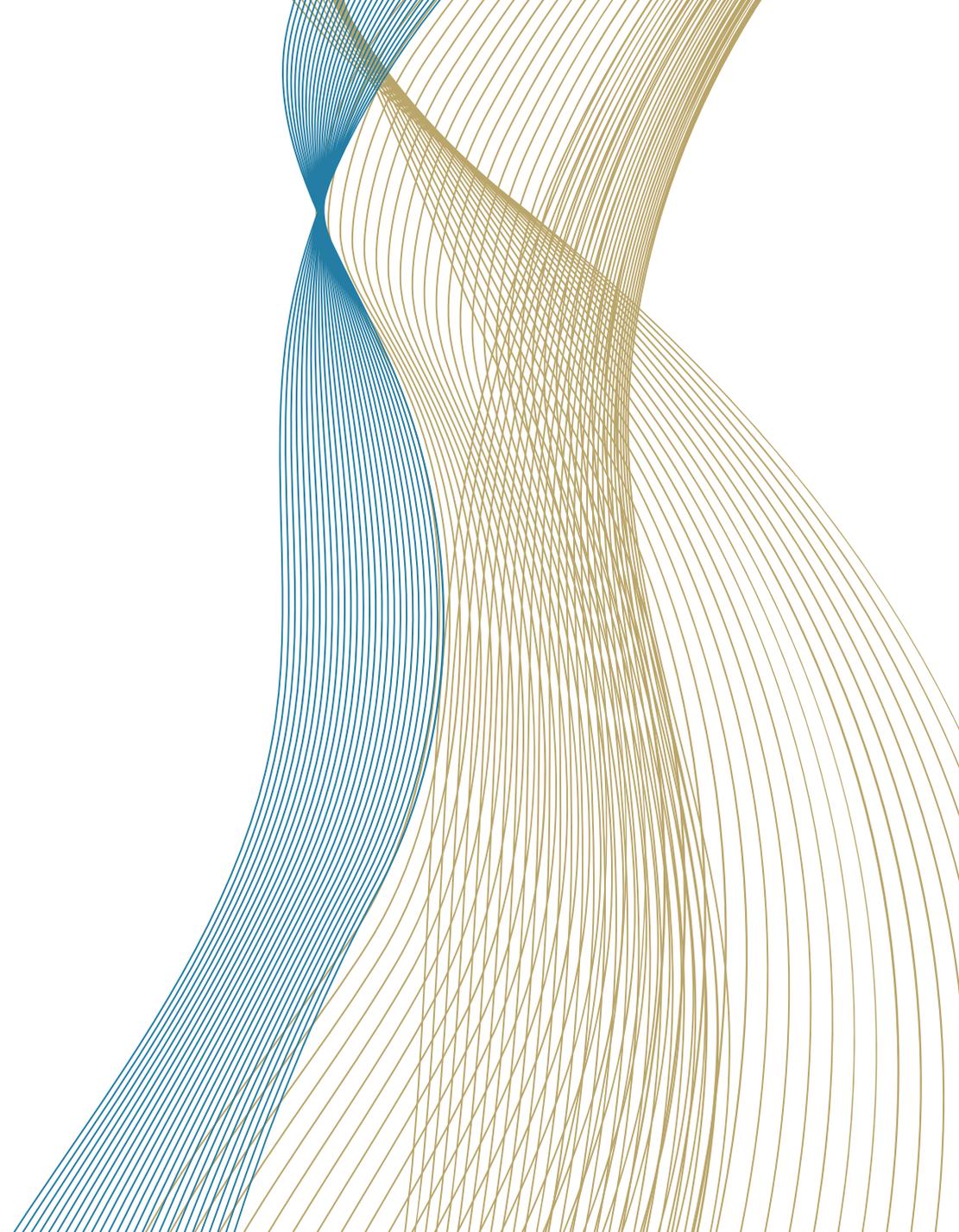
Contact:
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VL ENERGY

Presented By:

Ling M.Eng MBA
Paünder,
CEO



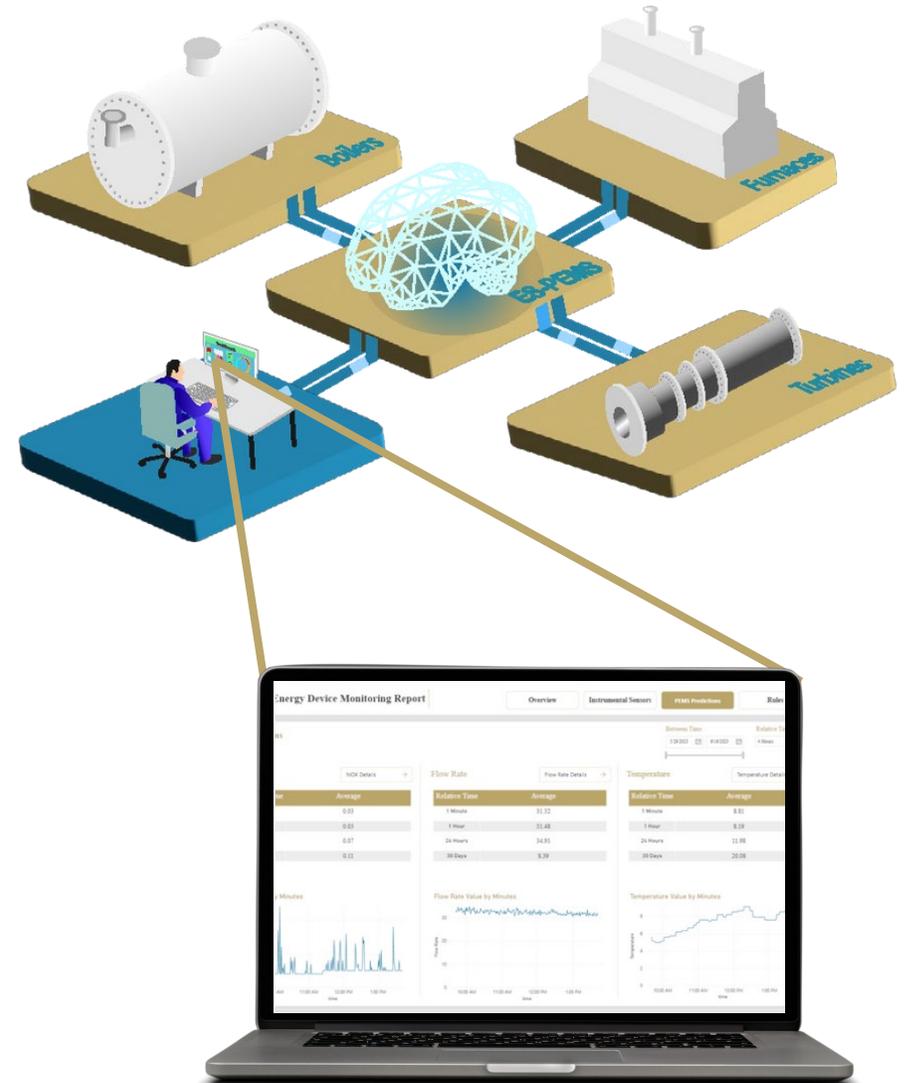
WHAT DO WE DO

REAL-TIME MULTI-GAS EMISSIONS
MONITORING (SAAS)

ES-PEMS

Efficient and Secure Predictive Emissions Monitoring System

- **CONTINUOUSLY MONITOR & PREDICT** emissions in real-time, with data insights for optimization opportunities
- Utilizes Artificial Intelligence, Machine Learning, and Cloud Computing
- A Software-based Solution (SaaS)
- ES-PEMS is:
 - Accurate
 - Compliant
 - Cost Effective
 - 99.5% Emissions Data Availability



DIGITAL OIL AND GAS CRIN PROJECT

Current Situation

- Current emissions monitoring methods need to have increased accuracy, decreased downtime, and enhanced abilities to detect potential equipment issues/failures.
- There was no viable solution for this problem in the Canadian market.

ES-PEMS Solution Application at Suncor Firebag Powerplant

- Collected 135 sensors data
- Cogeneration Units
- Parameters Measured: temperature, pressure, flow rate, humidity, moisture, etc.
- Verified the data and developed a stacked deep learning model
- Tested the result:
 - R2 must be equal to or greater than 0.64
 - Our model R2 for the three DL models exceed 0.9
- Identify Sensor Drift
 - Ability to label sensor failures or drift and to define threshold values



SUCCESSSES

Proof of Operation

Successful deployment in a large-scale setting with Suncor, showing significant **cost reduction, operational efficiency, and compliance reliability**

White Paper Published

Documenting project details, validating ES-PEMS's ability to meet regulatory requirements, and matching measured data.

LESSONS LEARNED

Cross-Department Collaboration

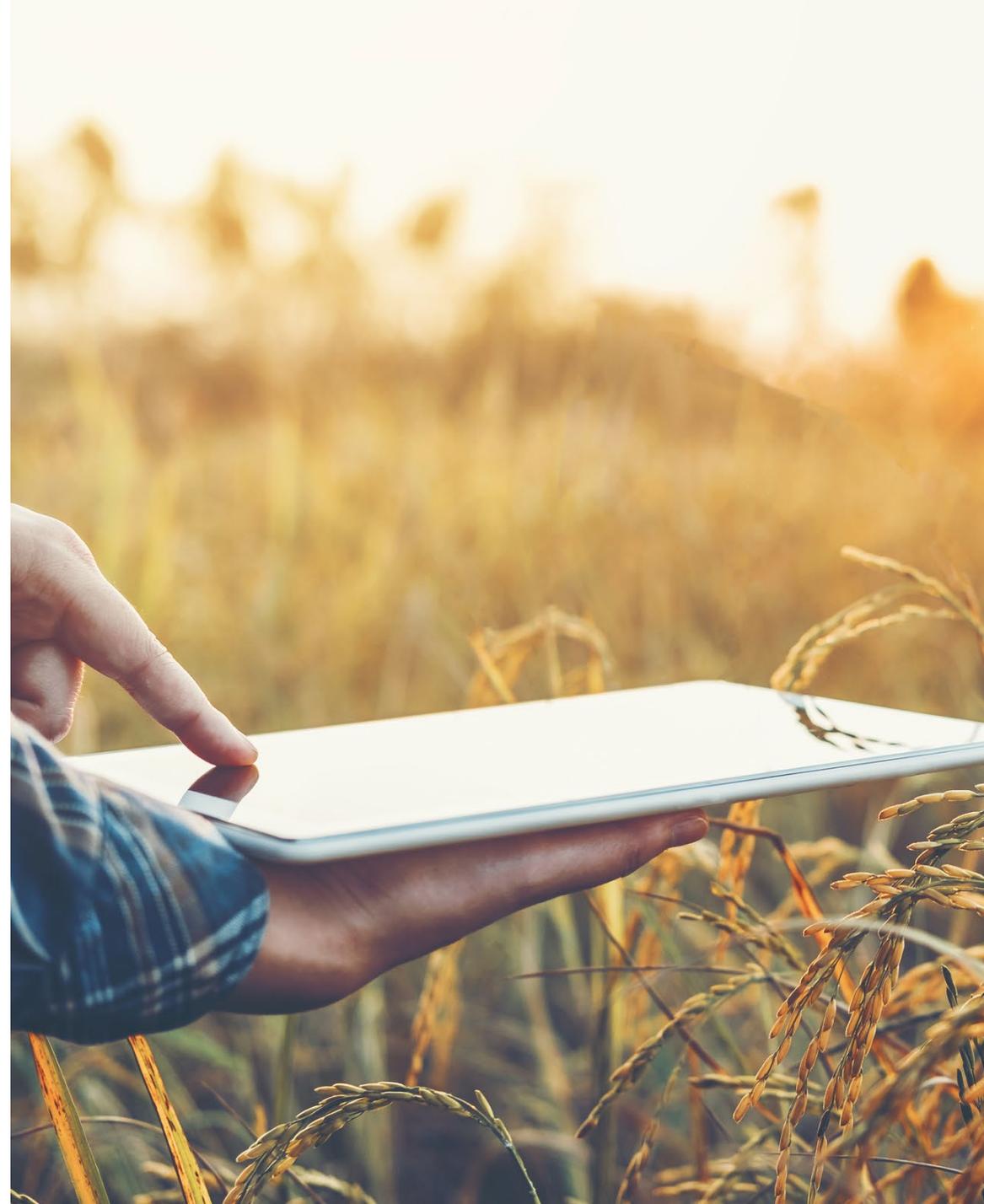
We learned that successful integration requires engagement across various departments within these organizations, such as **Health and Safety, Environmental, Regulatory Compliance, and Operations**, to ensure alignment and seamless implementation.

Adoption Resistance

Resistance in conservative oil and gas companies to shift from traditional CEMS to a more innovative/approved approach.

OUR ASK

- New Collaborations
- Pilot Projects
- Commercial Contracts





WHAT IS NEXT

Timing:

- Next 6-12 months: Expanding deployment to new industries (unregulated and regulated), building on pilot success.

Budget:

- Closed first round of seed funding allowing for further project development.

Scope:

- Scaling ES-PEMS across different sectors ([data centers, manufacturing, etc.](#)).
- Enhancing system flexibility for broader applications.

Benefits:

- Environmental Impact: Help companies reduce their carbon footprint and meet sustainability goals.
- Continuous model improvement from obtained projects and data.

Partnerships Sought:

- Collaboration with technology and infrastructure partners to support scaling and deployment.

SCAN & FOLLOW TO
KEEP UPDATED!



VL ENERGY

THANK YOU |

<https://vlenergy.ca>



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CRIN Project Café Reboot

DME Assisted In-Situ Bitumen Recovery Process – A Low GHG Technology

Oct 15, 2024



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DME Assisted in-situ Bitumen Recovery Process

Injection of vaporized warm DME-water at below 100 °C in well configuration like the SAGD process

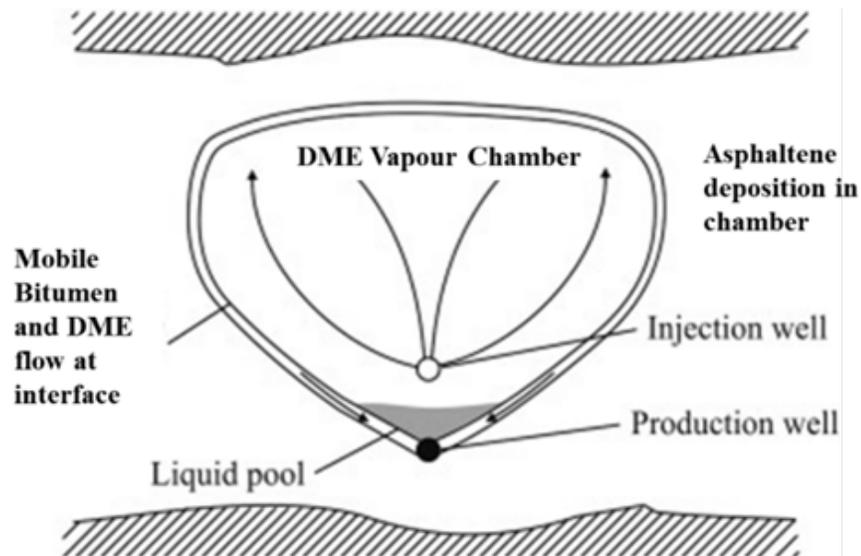
- Delivers the same economic performance compared to SAGD
- 86% reduction in direct GHG emission
- 79% reduction in water requirements

Project objective

- To advance this technology to TRL-7 by completing the exptl. & engineering analysis to assess the viability of commercial application, and a preliminary field test design

Project milestone deliverables

1. Comparative semi-field scale physical model expt. on DME injection & SAGD processes
2. DME injection process initialization method
3. DME bitumen recovery process simulation model & field performance prediction
4. Recovery process optimization
5. Surface facilities design & cost estimates
6. Environment impact assessment, IP development

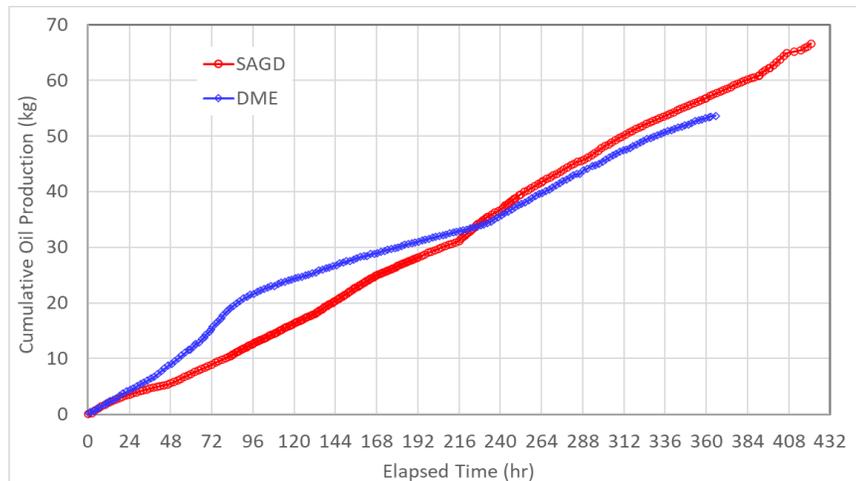


Project Progress

Comparative semi-field scale experiments

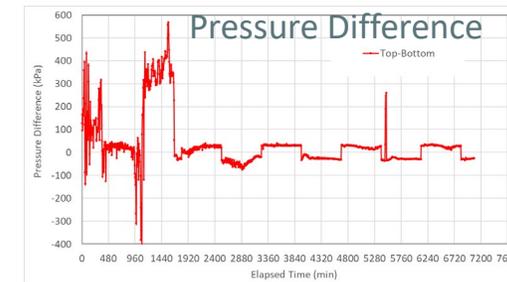
- Warm DME injection process at 80 °C
- SAGD process at 210 °C
- Physical model conditions
 - 150 cm-L x 80 cm-H x 40 cm-W (half chamber configuration)
 - 6 Darcy permeability
 - Dead Athabasca bitumen

Cumulative Oil Production



Process initialization method development

- Numerical simulations to assess the initialization options – identified a scheme - alternating cyclic injection of warm DME between the inj. & prod. wells
- Conducted 2D physical model experiment on the selected initialization scheme
 - 5 cm-diameter x 100 cm-long, 6 Darcy sand, Athabasca bitumen



- History matched the 2D experiment to test-validate the key mechanisms
- Built field scale numerical model to predicate performance – communication between the inj. & prod. wells could be established in 4 months

Project Progress

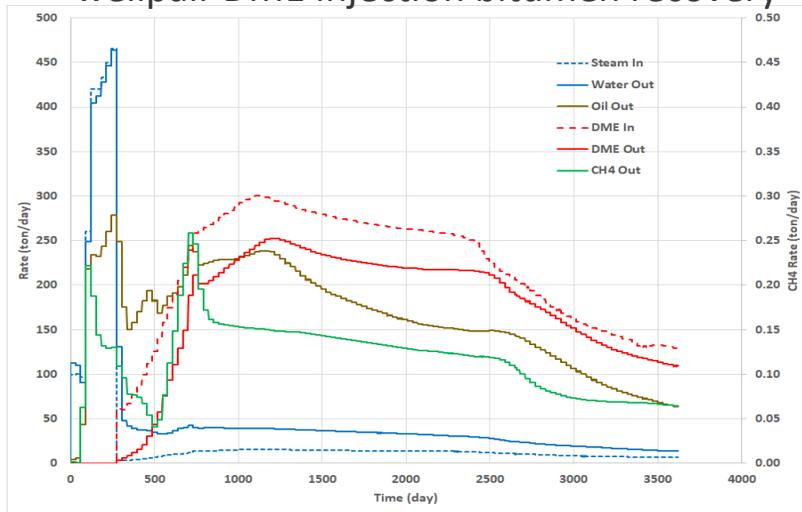
Field scale simulation model development & DME injection process performance prediction

- Detailed history matching of the expt. to test the key process mechanisms
- Built field scale simulation model for the DME injection process with the key process mechanisms

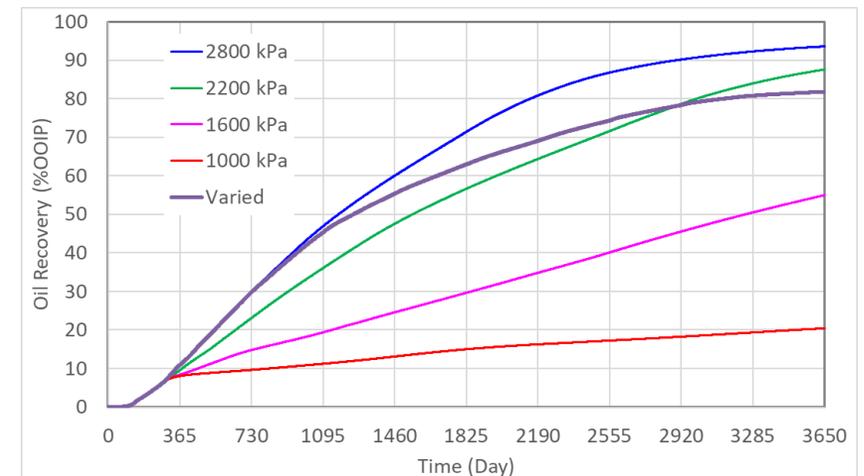
Simulation study of DME injection process optimization

- Operating parameters
 - Water conc. In the injectant
 - Injection temp. & operating pressure
 - NCG co-injection in late stage
- Observations
 - Higher oil recovery with increasing operating pressure
 - Lower SolOR with gradually decreasing operating pressure

Injection & production history of a single wellpair DME injection bitumen recovery



Oil rate: 950 bbl/day
SolOR: 2.1 (vol/vol)



Acknowledgement

- Alberta Innovates/InnoTech Alberta, AACI Research Program, & CRIN - funding support
- Project partners (CNRL, Suncor, IOL, CMG) – technical support
- Scovan Engineering – technical services

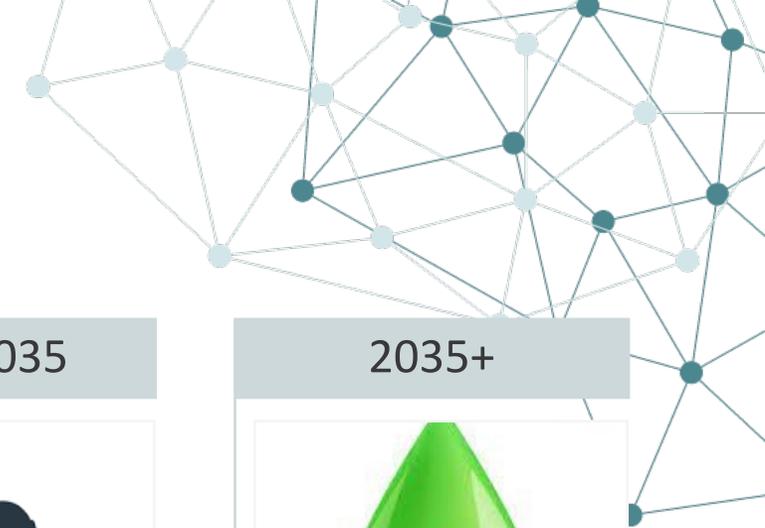
The image shows the CRIN logo and the text 'Clean Resource Innovation Network' on a dark teal background with a glowing network of nodes and lines. The logo 'CRIN' is in large white letters, and the full name is below it in smaller white letters.

CRIN
Clean Resource Innovation Network



Are you a member?
Join us today!

Next Steps (Commercialization)



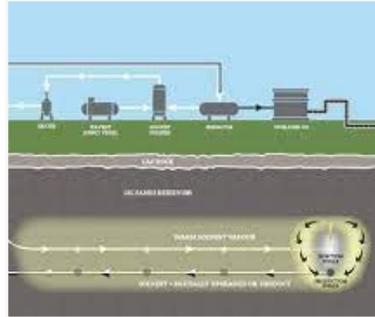
2022-2024



De-Risk

- CRIN project
- TRL-6 to TRL-7

2025-2029



Field Pilot

- Form consortium
- Open sharing of results
- Early engagement with potential owners of DME plant
- TRL-7 to TRL-8

2030-2031



Commitment to the Technology

- Off take agreements between DME Plant Owner and producers

2032-2035



Construct DME Plant

Commence Construction of Field Facilities

2035+



2035 first oil
2038 – 5% of in situ bitumen production (165,000 bbl/d)

- TRL 9

How did we do today?



October 15, 2024

9:00am MT

CRIN

Clean Resource Innovation Network



Are you a member?
Join us today!