PROJECT CAFE

COFFEE & CLEANTECH

CRIN Network Innovative Projects

October 15, 2024

powered by

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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

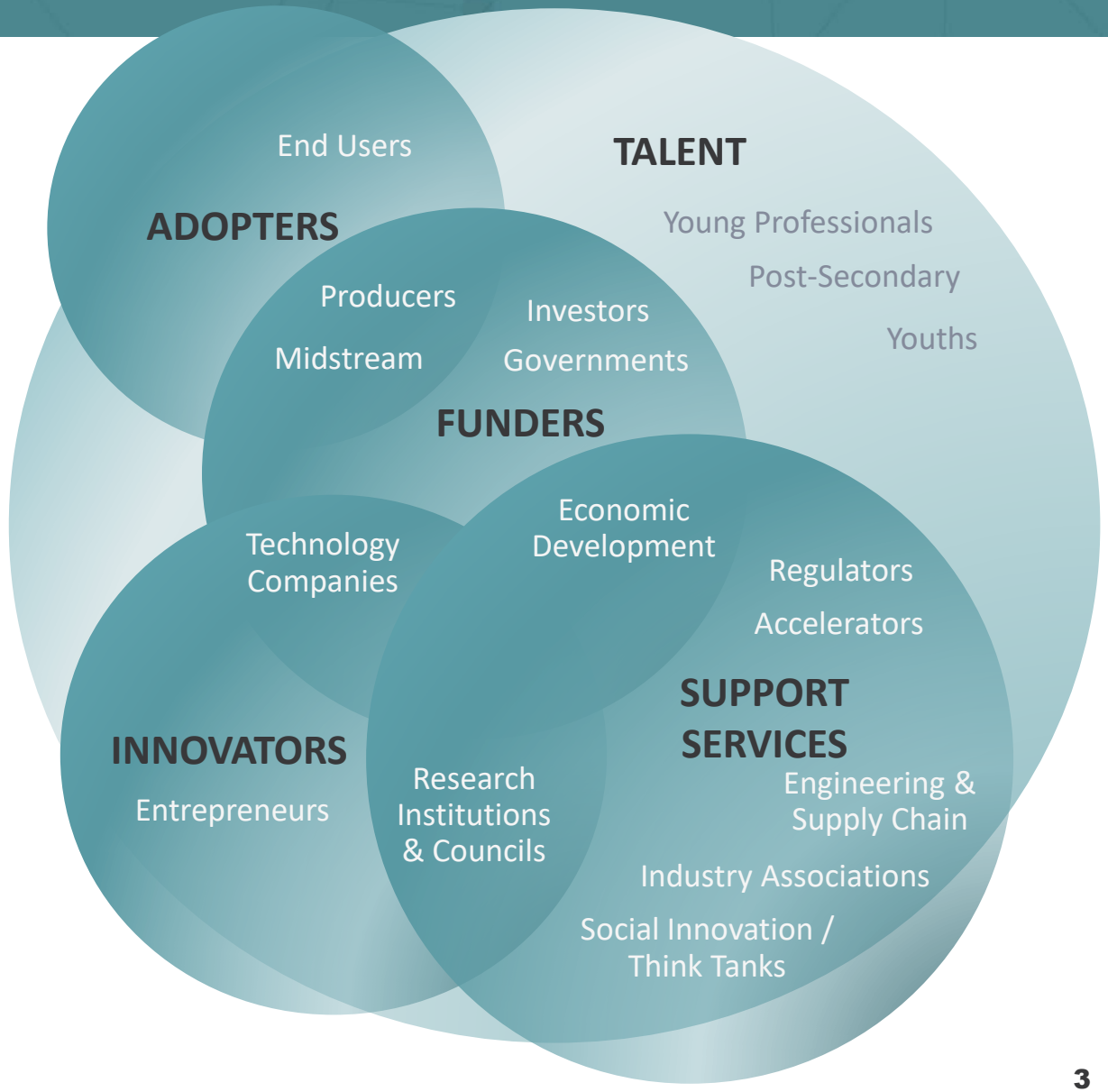
Pacific Canbriam Energy

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 *Development Of an Integrated Mobile System (MMS) for Methane Utilization and Produced-Water Treatment*	Jerry Yao
3. New Wave Hydrogen Inc. *A New Wave in Hydrogen Production*	Lowy Gunnewick
4. BreakWater Vantage *Methane Monitoring Technology*	Omar Moussa
5. VL Energy *Field Demonstration of AI Powered Predictive Emissions Monitoring Systems (PEMSs)*	Ling Bai
6. InnoTech Alberta *Accelerated Advancement of a Dimethyl Ether (DME) Assisted In Situ Bitumen Recovery Process*	Haibo Huang
5. Q&A, Wrap-up, Coffee!	

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A New Wave in Hydrogen

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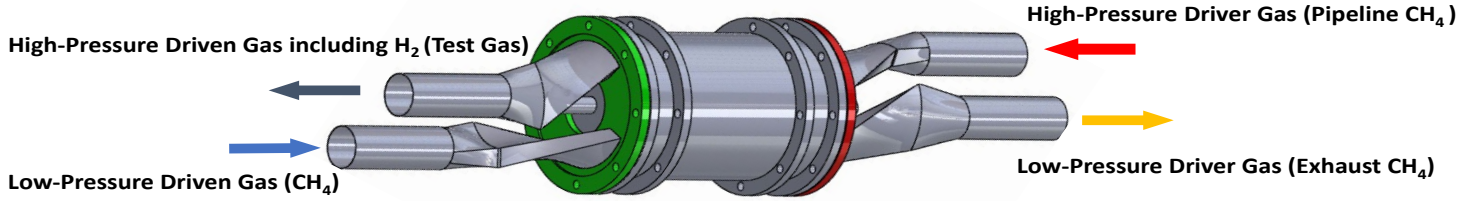
New Wave Hydrogen – A New Energy Paradigm

Shock Wave Compression Heating for Methane Pyrolysis



Wave Rotor – Rotating Bank of Shock Tubes

No Water

No CO_2

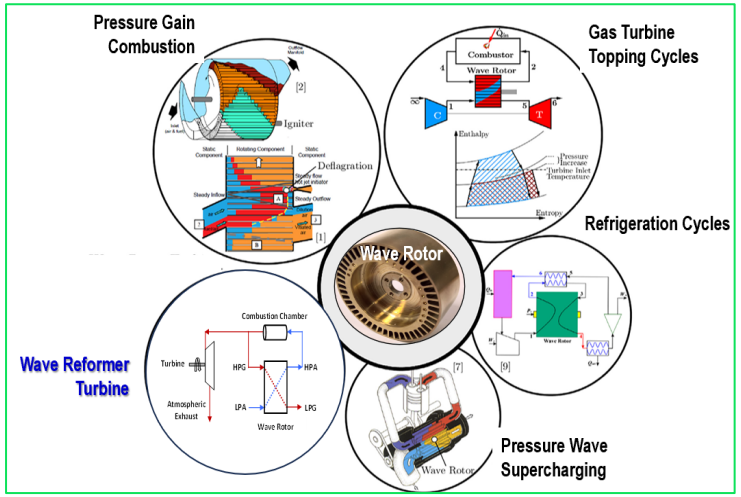
Methane Pyrolysis is a Near Term Solution with Rapid Growth Potential

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

Clean, Cost-effective, Scalable and Near-term

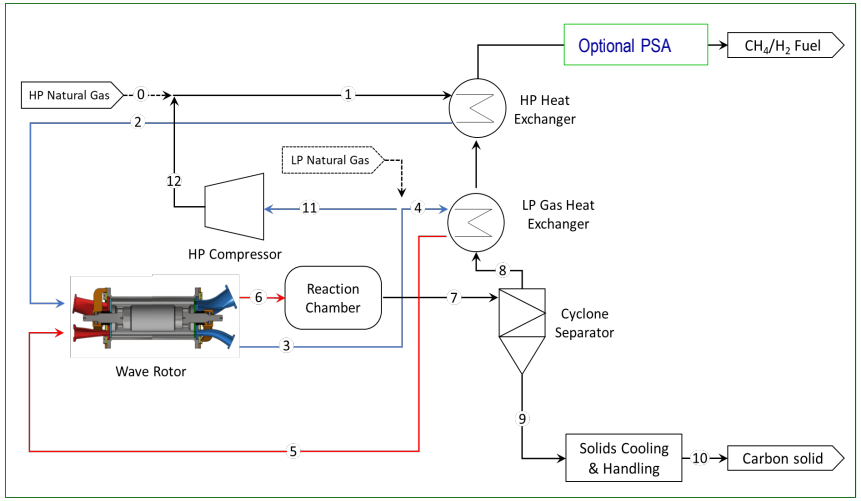
NWH2 is Building off of Proven Processes and Components

- 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

CLEAN POWER
Central or Distributed/Remote

NG:H2 BLEND
Methane Slippage Mitigation

Clean H_2

GREEN CARBON

- COKE REPLACEMENT
- GREEN CARBON BLACK
- SOIL ADDITIVE

DISTRIBUTION OPTIONS

GRID EDGE ON-SITE | VIRTUAL PIPELINE | MOBILE FUELING STATION

REFINERY | **TRANSPORTATION** | **AMMONIA** | **POWER** | **STEEL**

SUSTAINABLE FUELS
SUSTAINABLE AVIATION

SUSTAINABLE AGRICULTURE

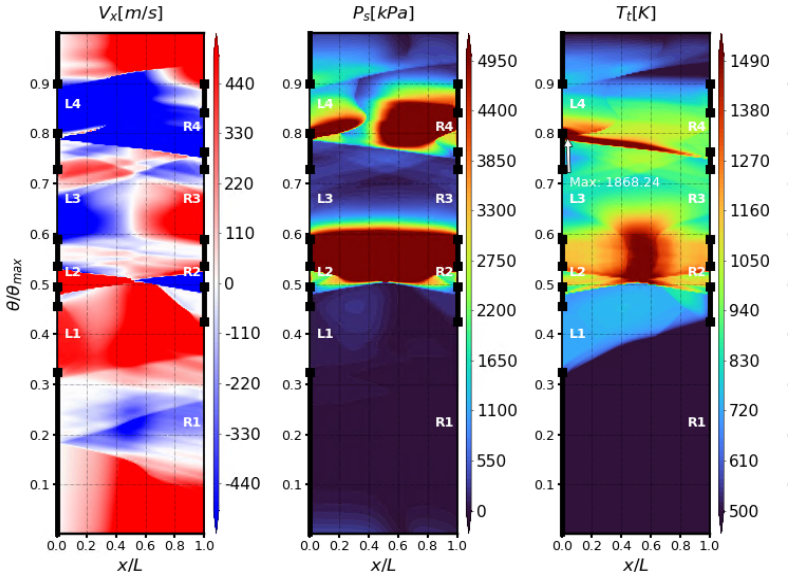
SUSAINABLE MANUFACTURING

INTEGRATED CROSS-SECTOR & REGIONAL BENEFITS

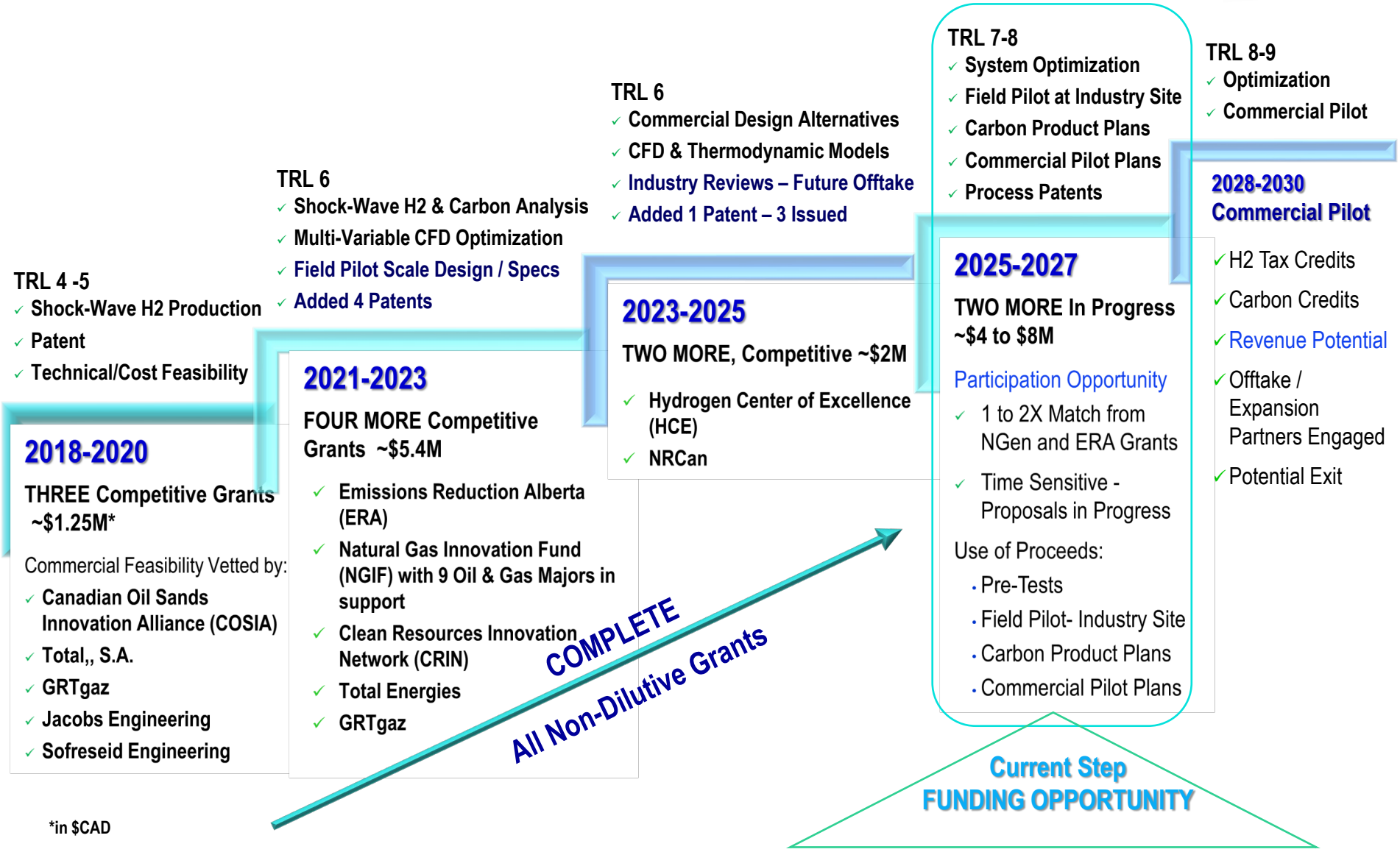
- ✓ CO2 Reduction
- ✓ No Water Use
- ✓ CH4 Mitigation
- ✓ Low Electricity
- ✓ Remote Power
- ✓ Wave Rotor Lab – Extended Mkts
- ✓ New C Products
- ✓ Green Exports
- ✓ Clean Tech Growth

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



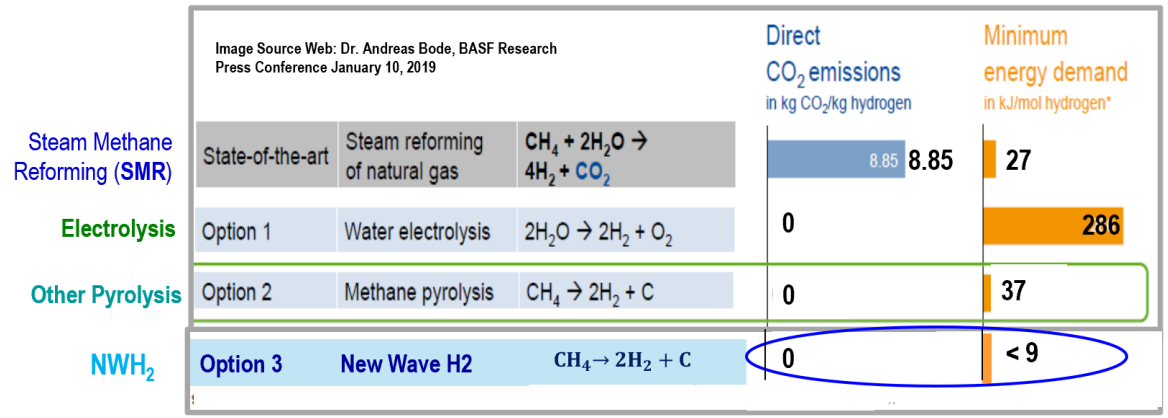
*in $CAD

Competitive Comparisons

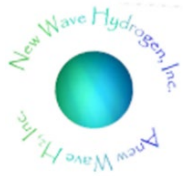
Cost and Risk				
				Electrolysis
			Plasma	
	Pulse Combustion	Molten Metals		
NEW WAVE H2	Microwave			SMR w CCS

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								
SMR/ATR with CCS								
Electrolysis								
Competing Methane Pyrolysis:								
Pulse Combustion								
Electricity-Heated Plasma								
Molten Metal Catalysts								
Electricity-Heated Microwave								



DIVERSE SECTOR SUPPORT - CO-FUNDING PARTNERS & TEAM



EMISSIONS REDUCTION ALBERTA

Natural Resources Canada | Ressources naturelles Canada
Canada

Alberta's Hydrogen Centre of Excellence

ALBERTA INNOVATES

NGIF
NATURAL GAS INNOVATION FUND
GAZ NATUREL FINANCEMENT INNOVATION

TotalEnergies

GRTgaz

CRIN Clean Resource Innovation Network

Natural Gas Distribution Investors

Stanford University

K'UUL POWER

CGA | ATCO | ENBRIDGE

PARKLAND

SaskEnergy | Pacific Northern Gas Ltd. | FORTIS BC

SFU SIMON FRASER UNIVERSITY ENGAGING THE WORLD

SFU CLEAN HYDROGEN HUB

BALZER'S CANADA BCI

Natural Gas Production Investors

BIRCHCLIFF ENERGY | Canadian Natural | UNIVERSITY OF CALGARY | NREL

Coanda
A TETRA TECH COMPANY

TOURMALINE

CAL POLY

TANGENT DESIGN ENGINEERING

TSE

New Wave H_2 Breaking Barriers - Accelerating the Transition

- ✓ Novel Integration of Proven Components
- ✓ No Water, Low Electricity
- ✓ No Direct CO_2 , Low Cost
- ✓ No Parallel Build-Out Lags
- ✓ RAPID Route to GHG Reductions
- ✓ Broad and Diverse Sector Support

Thank You!

Contact:
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PoMELO: Past, Present, Future (This is not a Ghost Buster Truck)

Omar Moussa, P.Eng.
Director Carbon Strategy & Emissions

CRIN Project Café
October 15, 2024

BREAKWATER VANTAGE

Indigenous Owned & Operated

Agenda

- What is a PoMELO ?
- PoMELO – The Past: Building a Solid Foundation
- PoMELO – The Present: Meaningful Methane Reductions
- Pomelo – The Future: Working Together
- So What?

What is a PoMELO ?

Portable Methane Leak Observatory

Truck-based measurement system which produces

- ✓ Emission Detection
- ✓ Quantification

Best in class detection limit

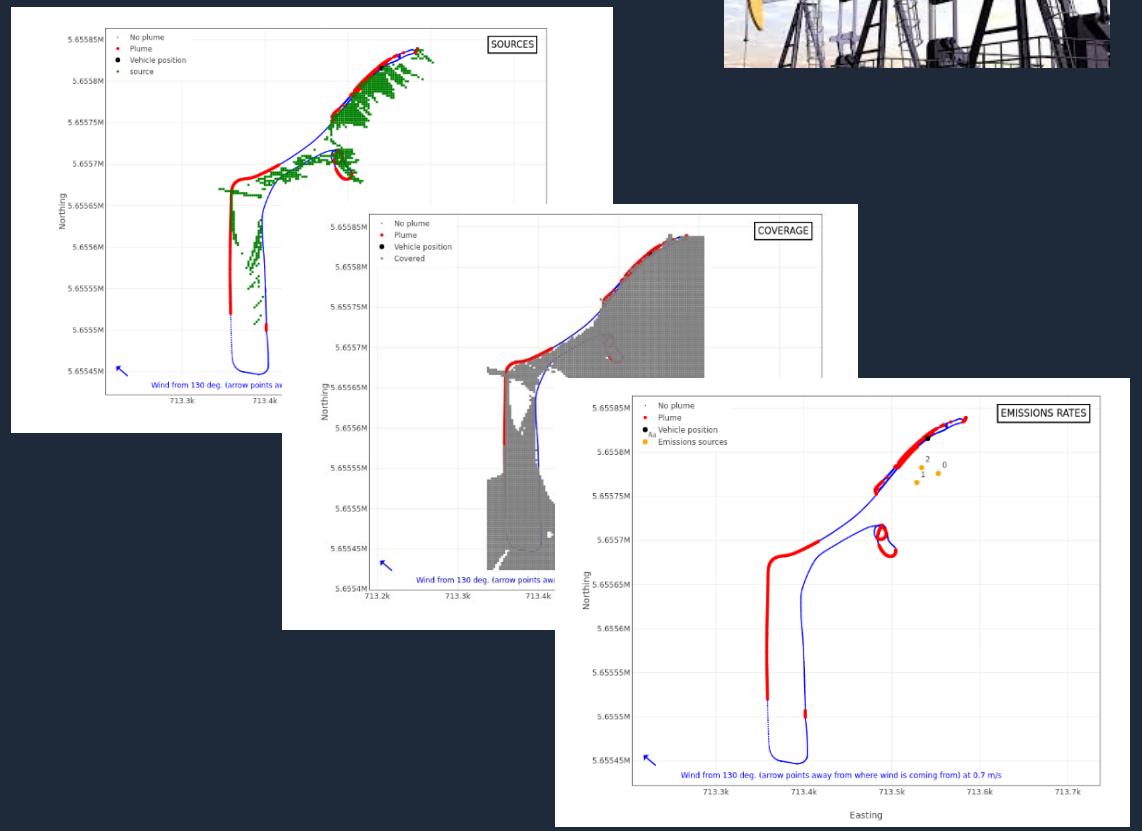
- ✓ 0.3 scfh (0.2 m3/day, 5.76 grams/hr)

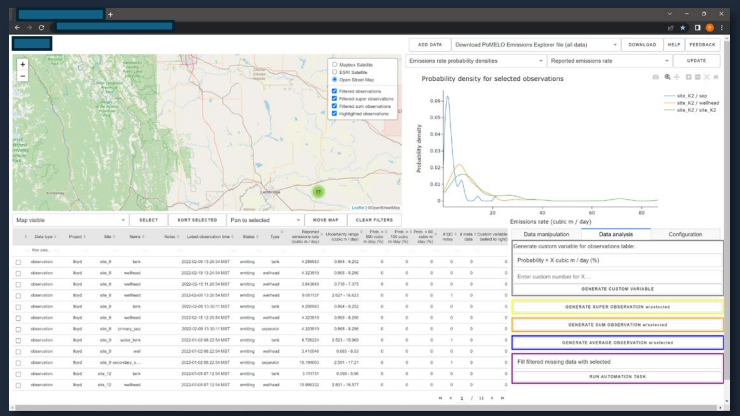
Field based solutions

- ✓ Padmapper: on-pad emissions localization + quantification

Remote & live Feed:

- ✓ Emissions Explorer: office and field data analysis





PoMELO – The Past: Building a Solid Foundation

2017-2024

2017 – Present: Made in Alberta Technology

✓ Invention at the University of Calgary by Dr. Thomas Barchyn & Dr. Chris Hugenholtz

2017-2021: Extensive Research & Development

✓ 5 years R&D

2019-2022: Comprehensive Test Campaigns

✓ 10+ Controlled release test campaigns (METEC, PTAC AMFC, Sandford/EDF MMC)

2021 – 2023: Regulatory Approval

✓ Approved for 2500+ sites Oil & Gas upstream sites in Alberta – AER (Alt-FEMP Pilot Program)

2021 – 2024: Operational & Reliable LDAR system

✓ 5 systems in full-time across Alberta (4 X producers + 1 X Regulator)

✓ 5000+ hrs uptime

PoMELO – The Present: Meaningful Methane Reductions

Survey

~ 4 minutes/site
10-15 sites/day with OGI F/U

Tech	2021	2022
PoMELO	650	650
Aerial	650	650

Follow up

PoMELO	2021	2022	Aerial	2021	2022
# Follow ups	459	316	# Follow ups	161	105
Days	0	0	Days	77	64

Verify

Verified Emissions by OGI

2021: 780 Verifications Triggered By

- PoMELO= 506
- Aerial = 274

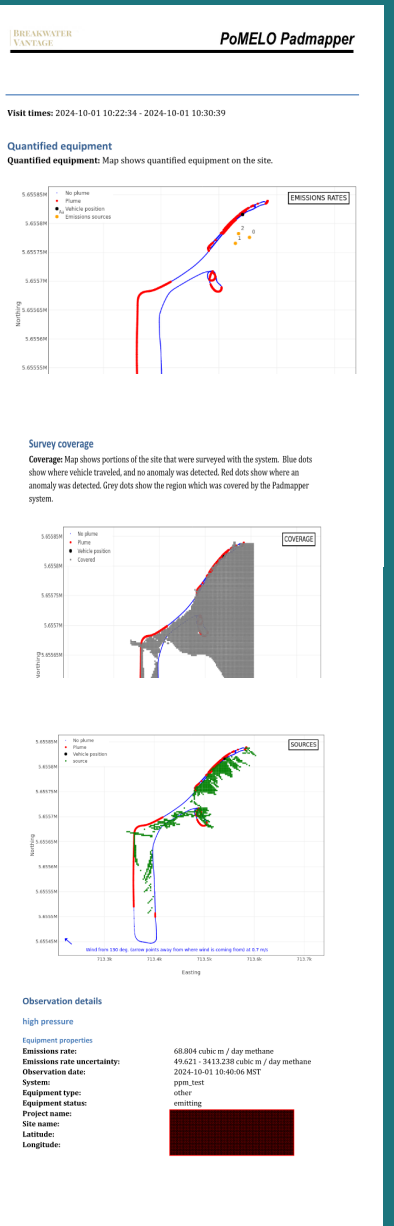
2022: 862 Verifications Triggered By

- PoMELO= 662
- Aerial = 200

Tag & Reduce

Reduction	PoMELO	OGI
E3M3/Year CH4	267	167
tCO2e/Year	7500	4600

Survey → Follow up → Verify → Tag & Reduce


BREAKWATER VANTAGE

PoMELO Padmapper

Visit times: 2024-10-01 10:22:34 - 2024-10-01 10:30:39

Quantified equipment

Quantified equipment: Map shows quantified equipment on the site.

EMISSIONS RATES

Survey coverage

Coverage: Map shows portions of the site that were surveyed with the system. Blue dots show where vehicle traveled, and no anomaly was detected. Red dots show where an anomaly was detected. Grey dots show the region which was covered by the Padmapper system.

COVERAGE

SOURCES

Observation details

high pressure

Equipment properties

Emissions rate:	68.804 cubic m / day methane
Emissions rate uncertainty:	49.621 - 3413.238 cubic m / day methane
Observation date:	2024-10-01 10:40:06 MST
System:	ppm_test
Equipment type:	other
Equipment status:	emitting
Project name:	
Site name:	
Latitude:	
Longitude:	

Time to Survey/Report

< 15 minutes/site

Cost for Survey

~$20/site/month - Opex

Cheaper than Netflix

Tailored Autogenerated Reports in minutes

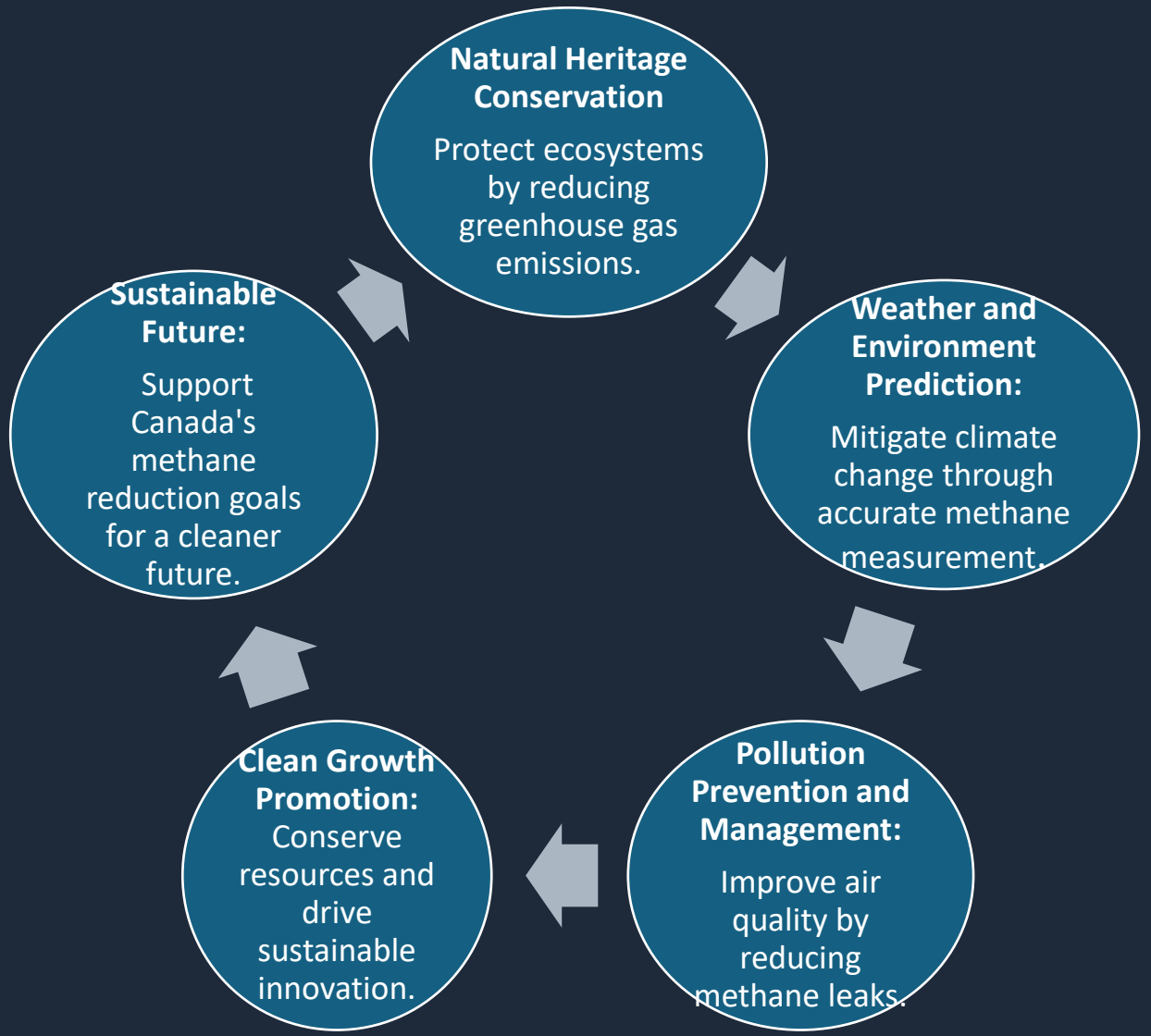
Emissions Tracker

Dashboard/Follow-up

Survey 1 Survey 2 Survey 3

Well: 500.0 m^3/day **Tank 2:** 34.5 m^3/day

PoMELO- The Future : Working Together



So What?

PoMELO's Potential

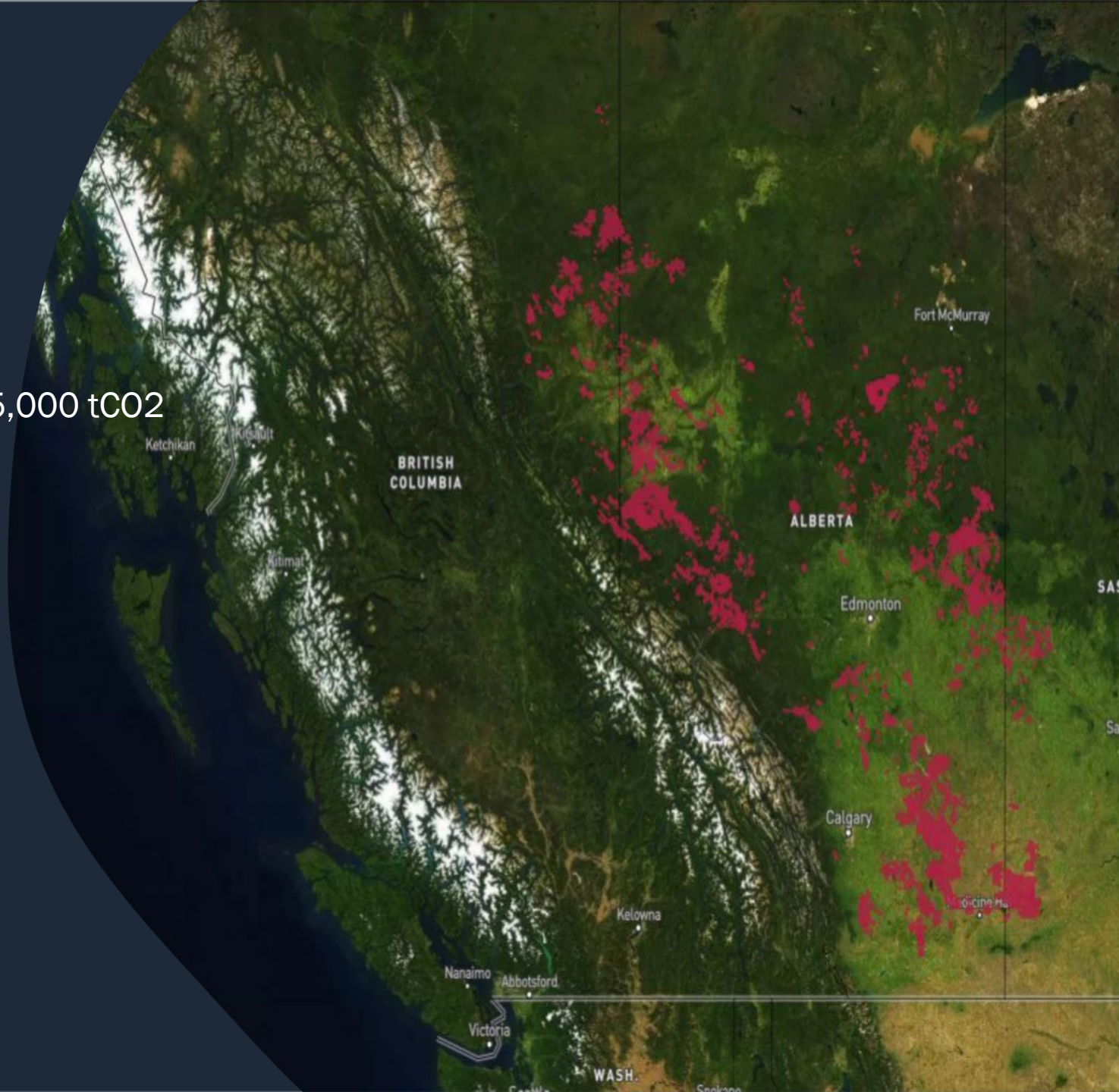
Wider site coverage
- ✓ 3,650 – 5,500 sites/year

Real Emissions Reduction
- ✓ Up to 1,500 – 2,260 e3m3/year → 30,000 – 45,000 tCO2

Reporting
- ✓ Instant Reporting

Operating Window
- ✓ All Year at range -25 C to 40 C
- ✓ Snow – Rain – Cloudy - Sunny

Low Abatement Cost
- ✓ $3.3/ ton CH4



Thank You

Questions ?

VL ENERGY

Presented By:

Ling Bai M.Eng MBA
Founder, CEO

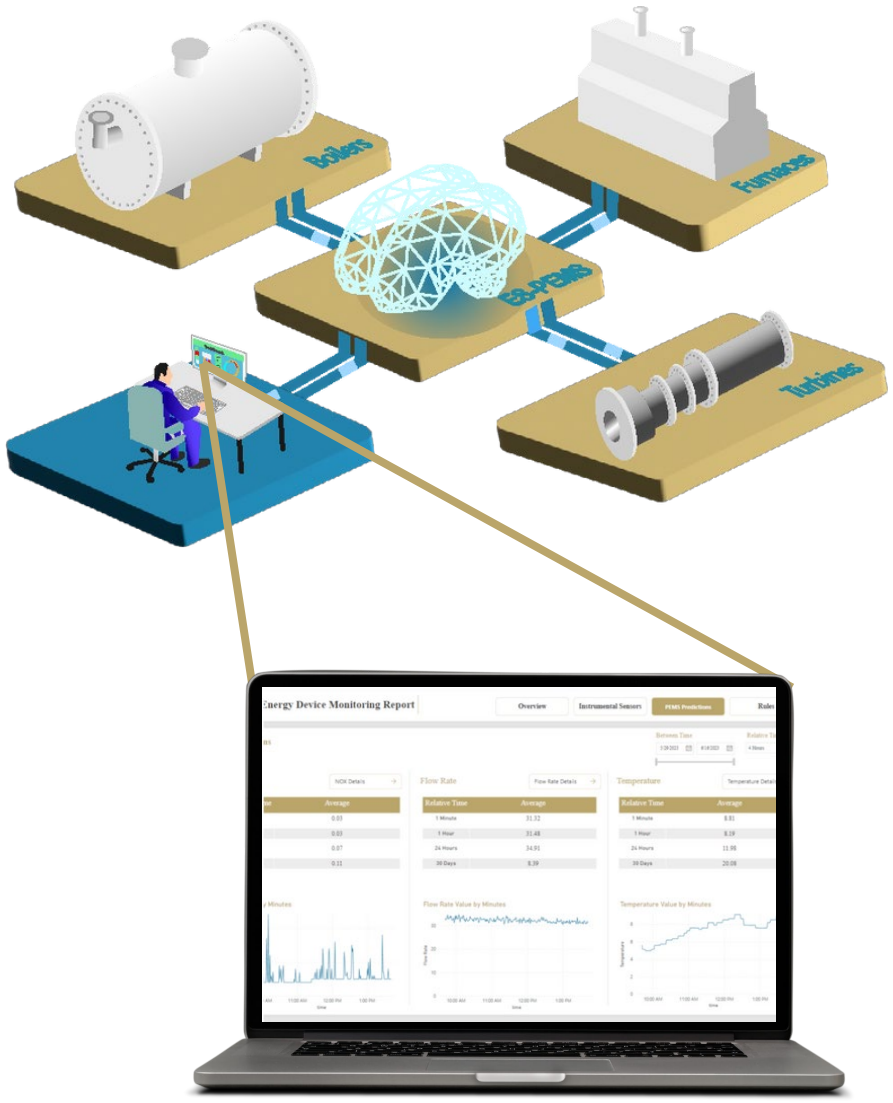
WHAT DO WE DO

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**



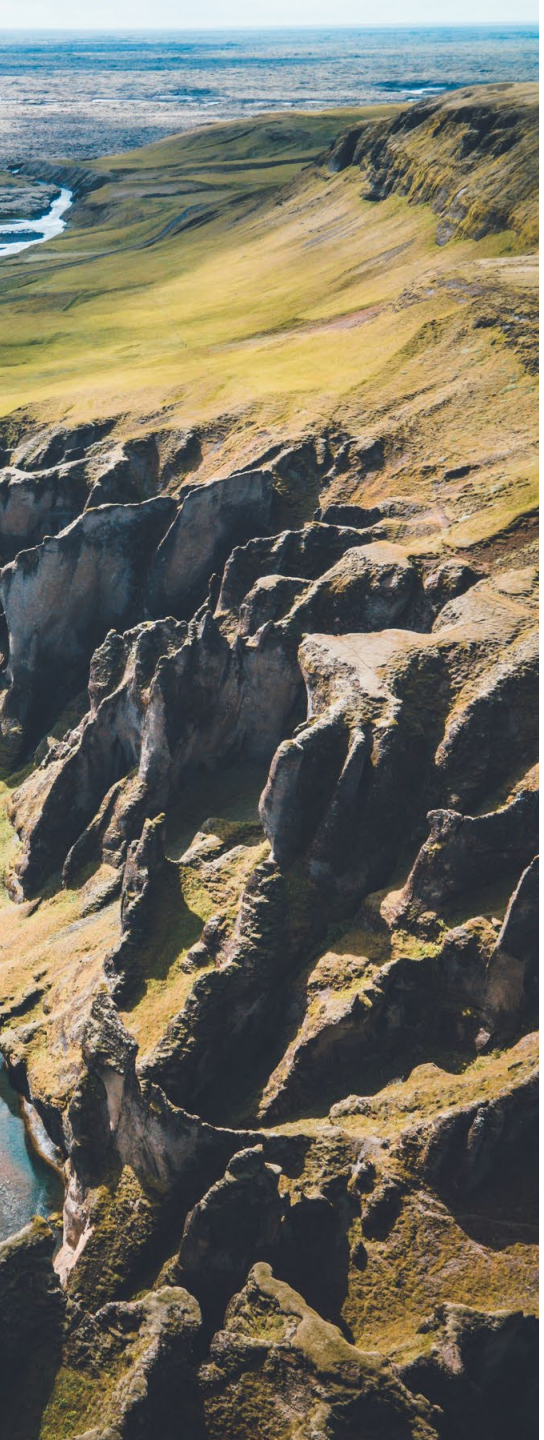
DIGITAL OIL AND GAS CRIN PROJECT

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



SUCCESSES

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

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CRIN Project Café Reboot

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

Oct 15, 2024

InnoTech ALBERTA
A SUBSIDIARY OF ALBERTA INNOVATES

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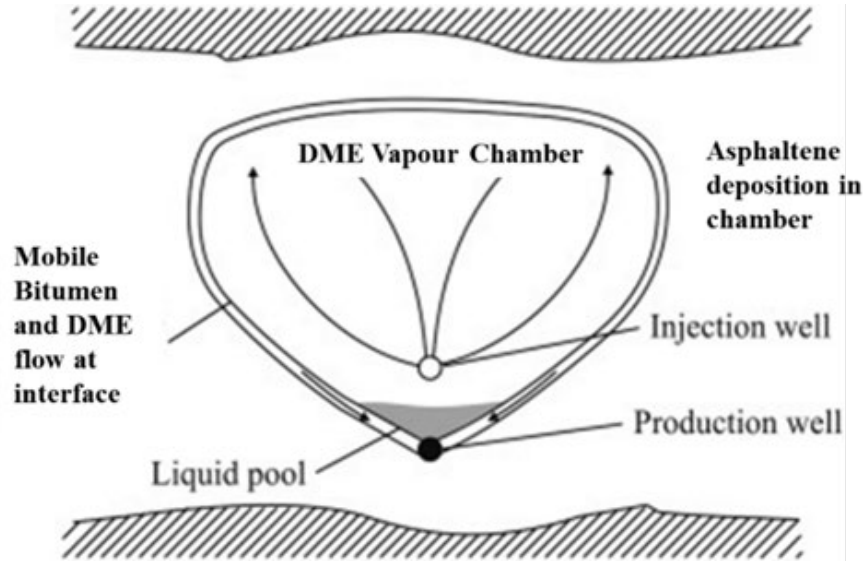
DME Assisted in-situ Bitumen Recovery Process

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

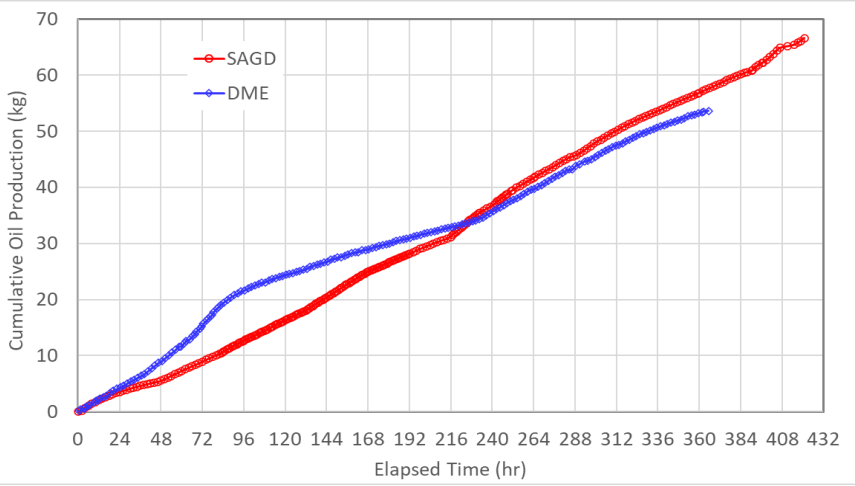
- Project milestone deliverables
  1. Comparative semi-field scale physical model expt. on DME injection & SAGD processes
  2. DME injection process initialization method
  3. DME bitumen recovery process simulation model & field performance prediction
  4. Recovery process optimization
  5. Surface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

Project Progress

Comparative semi-field scale experiments

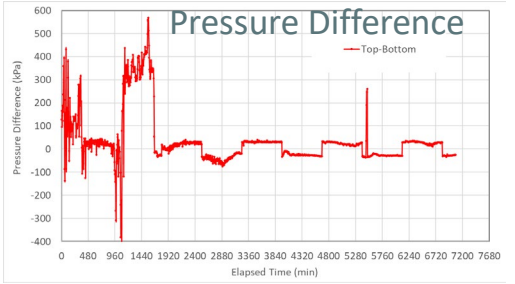
- Warm DME injection process at 80 ^{o}C
- SAGD process at 210 ^{o}C
- Physical model conditions
  - 150 cm-L x 80 cm-H x 40 cm-W (half chamber configuration)
  - 6 Darcy permeability
  - Dead Athabasca bitumen

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



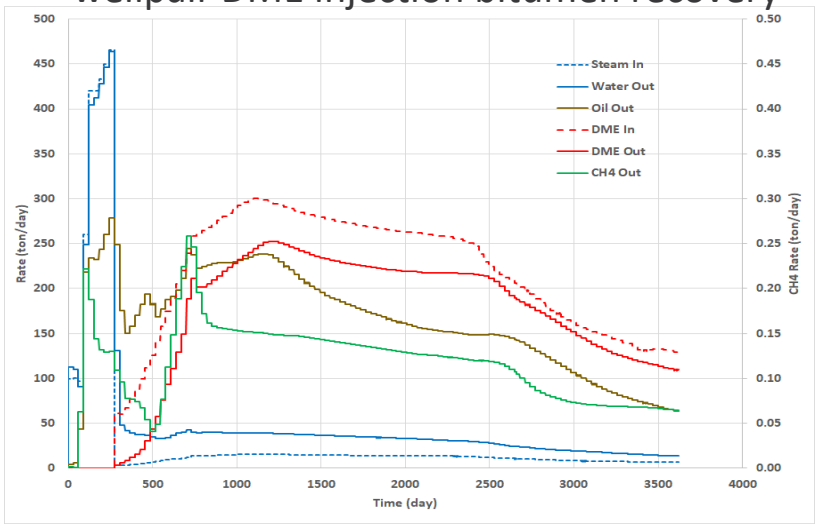
- History matched the 2D experiment to test-validate the key mechanisms
- Built field scale numerical model to predicate performance – communication between the inj. & prod. wells could be established in 4 months

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

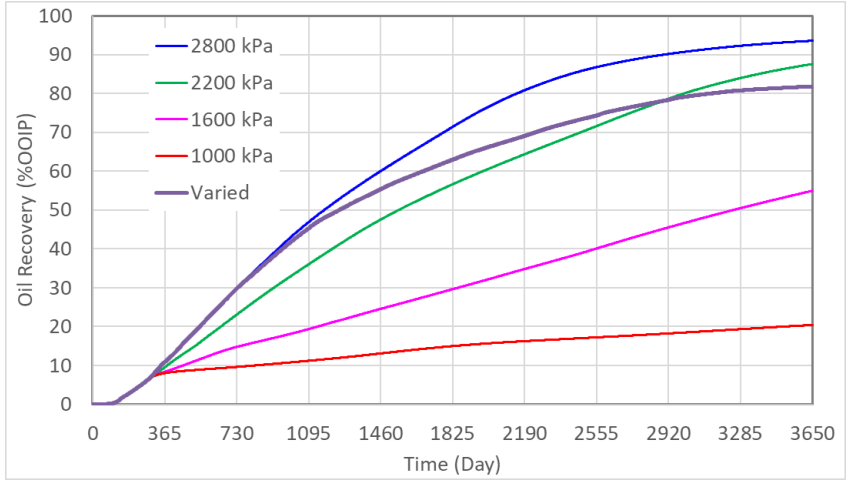
Injection & production history of a single wellpair DME injection bitumen recovery



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

Simulation study of DME injection process optimization

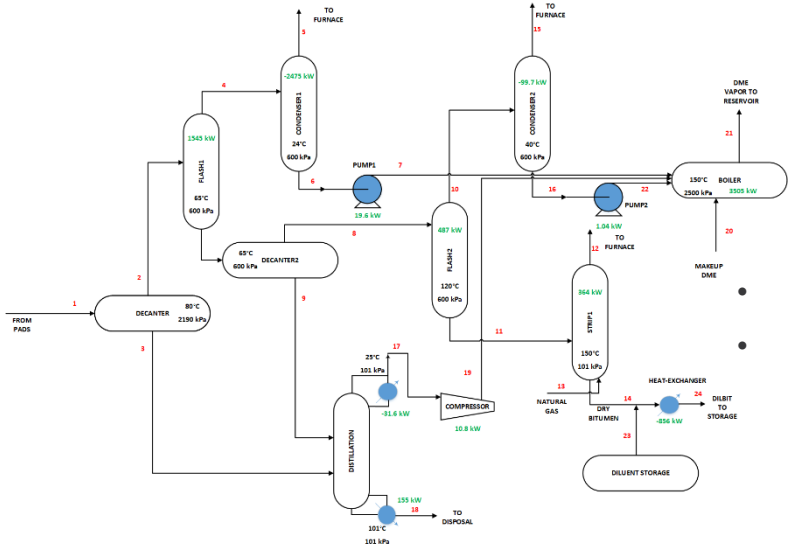
- Operating parameters
  - Water conc. In the injectant
  - Injection temp. & operating pressure
  - NCG co-injection in late stage
- Observations
  - Higher oil recovery with increasing operating pressure
  - Lower SolOR with gradually decreasing operating pressure



Project Progress

Preliminary design & estimate cost of surface facilities

- Developed production fluids processing scheme & surface facilities using the results of field scale DME injection process simulation
- Class V (+/- 50 – 100%) cost estimates for 1,500 bbl/day bitumen pilot – done
- Class V cost estimates for 40,000 bbl/day bitumen production commercial operation – in progress



- DME in dry bitumen – 100 ppm
- DME recovery from production fluid – 97%

IP development

- Process initialization method is assessed with strong IP potential
- Materials for IP disclosure are being prepared

Environmental impact assessment of the DME in-situ bitumen recovery process – in progress

Project Progress Summary

Milestone Deliverable	Status
1	Complete
2	Near complete
3	Complete
4	Near complete
5	Near complete
6	In progress

Acknowledgement

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

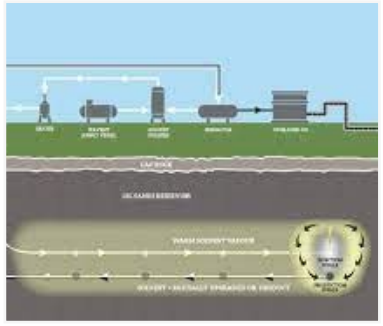
Next Steps (Commercialization)

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

CRIN

How did we do today?

October 15, 2024
9:00am MT

CRIN

Clean Resource Innovation Network

Are you a member?
Join us today!