

Barriers to Large-scale CCUS Project Deployment in Western Canada Summary Report 2024

Carbon Management Canada



Executive Summary

On April 23 to 25, 2024 more than 120 participants attended a workshop examining the barriers to CCUS deployment in Western Canada. Carbon Management Canada (CMC) and the Petroleum Technology Research Centre (PTRC) jointly organized the workshop, which was hosted at Svante's *Centre of Excellence for Carbon Capture and Removal* in Burnaby, British Columbia and was sponsored by Natural Resources Canada. The discussion focused on four relevant topics:

1. Uncertainty over policies and related financial incentives.

Policy uncertainty is a significant barrier to project deployment. Investment decisions are impacted negatively by slow policy implementation, delayed decisions on tax credits and other incentives, changes in government leadership, as well as the inability to project adequate returns for investors. Exclusion of enhanced oil recovery (EOR) from policy incentives is viewed critically as a missed opportunity.

2. Regulatory frameworks.

Clarity over storage and other regulatory requirements is important for the sector, with pore space ownership and post-operational liability being two key topics. Regulatory (and policy) requirements should not be overly complex or prescriptive.

3. Public outreach and social license.

Public outreach is a fundamental requirement for CCUS projects, with the potential for project delays and cancellations with poor engagement with local and Indigenous communities. Outreach should commence at the earliest conceivable stage in the project life cycle, even before definitive project plans have been drawn up.

4. Technical challenges

Government-funded R&D programs have a crucial role to play. Dedicated geological storage at a commercial scale has been proven, but challenges remain at both project and regional levels. Publicly funded R&D and field demonstration sites still have a vital role to play in providing knowledge sharing for industry and regulators, with better predictive modelling capabilities or improved technology integration and design of cost-effective monitoring programs and as important engagement tools for outreach and education. Cost for capture technologies is a barrier, although existing commercially available technologies are mature and unlikely to yield major cost reductions. Low-technology readiness level (TRL) technologies could offer future cost optimization but require extensive support and dialogue with industry to achieve commercialization.

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1.0 Introduction

Barriers to Large-Scale CCUS Project Deployment in Western Canada was a hybrid workshop with both in-person and online participants. The event was held in-person at Svante's *Centre of Excellence for Carbon Capture and Removal* in Burnaby, BC with 50 attendees and an additional 70 online. Participants included representatives from industry, government, applied research organizations and academia. Organized by Carbon Management Canada (CMC) and the Petroleum Technology Research Center (PTRC), the workshop was sponsored by National Resources Canada (NRCan). The workshop was comprised of seven sessions, focused on aspects of ongoing concern for CCUS projects. Topics included: policy and regulation, financial incentives, industry feedback, public engagement and outreach, and technical challenges surrounding capture and storage. The workshop aimed to bring industry, government, and research organizations together into one space to open a dialogue regarding challenges and potential or tested solutions. The workshop also addressed conversation around regulatory frameworks and policy incentives. While the status of CCUS policy, regulation and deployment varies across the four western provinces of British Columbia, Alberta, Saskatchewan and Manitoba, presentations and discussions over the two days highlighted some common themes that can delay or complicate large-scale CCUS project deployment. The speakers shared knowledge and learnings from their experience. A link to access speaker presentations that have been authorized to share is enclosed in Appendix A.

2.0 Agenda

| Day One – Tuesday, April 23 | | |
|-----------------------------|---|--|
| Time | Item | Speakers |
| 7:30-8:30 | Registration & Breakfast | |
| 8:30-9:00 | Welcome | <ul style="list-style-type: none"> • Neil Wildgust, President & CEO, Carbon Management Canada (CMC) • Erik Nickel, M.Sc., P.Geo, Chief Operating Officer, Petroleum Technology Research Centre (PTRC) • Colleen Nitta, Director, Marketing & Communications, Svante |
| 9:00 – 10:00 | Session 1: Provincial Perspectives on CCUS Deployment | <p>Moderator: Neil Wildgust, CMC</p> <ul style="list-style-type: none"> • Amanda Wilson Director General, Office of Energy Research and Development, Natural Resources Canada (NRCan) • Michelle Schwabe, Executive Director, BC Public Service • Kyle Worth, Director, Emissions Management and Compliance, Ministry of Environment, Government of Saskatchewan |
| 10:00 – 10:20 | Break | |
| 10:20 – 12:00 | Session 2: Policy and Incentives for CCUS | <p>Moderator: Erik Nickel, PTRC</p> <ul style="list-style-type: none"> • Mac Walton, Senior Policy Analyst, International CCS Knowledge Centre • Caitlin Olsen, Principal Policy and Regulatory Strategist, Energy & Environmental Research Centre • Randy Brunet, KC, MLT Aikins • J.P. Jepp, Principal, Nexus Climate and Energy Strategy • Saviz Mortazavi, Energy Policy, NRCan |
| 12:00 – 1:00 | Lunch | |
| 1:00 – 2:30 | Session 3: Industry Perspectives on Key Deployment Challenges | <p>Moderator: Norm Sacuta, PTRC</p> <ul style="list-style-type: none"> • Candice Paton M.Sc., P.Eng., Vice President, Corporate Affairs, Enhance Energy • Kristin Rennie, Vice President, Land, Tundra Oil & Gas |

| | | |
|-------------|--|---|
| | | <ul style="list-style-type: none"> • Al Shpyth, Executive Director, International Minerals Innovation Institute (IMII) • Warren MacPhail, COO & EVP Engineering, Reconciliation Energy Transition Inc (RETI) |
| 2:30 – 2:45 | Break | |
| 2:45 – 4:15 | Session 4: Regulatory Frameworks and Cross-border Issues | <p>Moderator: Norm Sacuta, PTRC</p> <ul style="list-style-type: none"> • Caitlin Olsen, Principal Policy and Regulatory Strategist, Energy & Environmental Research Centre • Adlai Majer, Director, New Energy, Whitecap Resources Inc. • Ron Stefik, BC Energy Regulator • J.P. Jepp, Principal, Nexus Climate and Energy Strategy |

| Day Two – Wednesday, April 24 | | |
|--------------------------------------|--|---|
| Time | Item | Speakers |
| 7:30 – 9:00 | Networking Breakfast | <ul style="list-style-type: none"> • Neil Wildgust, President and CEO, Carbon Management Canada |
| 9:00 – 10:00 | Session 5: Social Licence | <p>Moderator: Neil Wildgust, CMC</p> <ul style="list-style-type: none"> • Nicole Baker, Senior Advisor Community and Indigenous Engagement, Enbridge Inc. • Colleen Nitta, Director, Marketing & Communications, Svante • Norm Sacuta, Director, Communications, Petroleum Technology Research Centre |
| 10:00 – 10:30 | Break | |
| 10:30 – 12:00 | Session 6: Technical Challenges – Capture | <p>Moderator: Saviz Mortazavi, NRCan</p> <ul style="list-style-type: none"> • Jennifer Chen, Emissions Reduction Alberta • Matt McCulloch, Director, ESG and Decarbonisation, Norda Stelo • James Martin, VP Engineering, Entropy • Mania Neisiani, VP Project Engineering, Svante • Bruce Hesselink, Sask Power |
| 12:00 – 1:00 | Lunch | |
| 1:00 – 2:45 | Session 7: Technical Challenges – Storage, Geoscience and Pore Space Competition | <p>Moderator: Norm Sacuta</p> <ul style="list-style-type: none"> • Richard Truman, Vice President, External Relations, Geoscience BC |

| | | |
|-------------|---|--|
| | | <ul style="list-style-type: none"> • Gonzalo Zambrano Narvaez, University of Alberta • Tony Grimison, BC Tenure • Brendan Kolkman-Quinn, M.Sc., Geophysicist I.T., Carbon Management Canada • Dr. Robin Hughes Senior Research Scientist CanmetENERGY, Natural Resources Canada |
| 2:45 – 3:00 | Break | |
| 3:00 – 4:00 | Session 8: Overcoming Barriers – The Path Forward | <p>Moderator: Neil Wildgust, CMC</p> <ul style="list-style-type: none"> • J.P. Jepp Principal, Nexus Climate and Energy Strategy • Al Shpyth Executive Director, International Minerals Innovation Institute (IMII) • Adlai Majer Director, New Energy, Whitecap Resources Inc • Erik Nickel, COO, Petroleum Technology Research Centre • Mania Neisiani VP Project Engineering, Svante • Nicole Baker Senior Advisor of Community and Indigenous Engagement Enbridge Inc. • Taylor Berezowski Senior Geologist, Carbon Alpha |

Day Three – Thursday, April 25

| Time | Item | Tour Guide |
|--------------|--|---|
| 9:00 – 10:30 | Tour of Svante’s R&D Centre of Excellence Address: 3021 Underhill Ave Burnaby, BC, Canada V5A 3C2 | <ul style="list-style-type: none"> • Dr. Sabereh Rezai, Advanced Process Development Manager, Svante |

3.0 Summary of Presentations

3.1 Session 01: Provincial Perspectives on CCUS Deployment

1. **“Carbon Management Strategy for Canada” by Amanda Wilson** *Director General, Office of Energy Research and Development, Natural Resources Canada*

Amanda Wilson gave an overview of Canada’s Carbon Management Strategy and highlighted federal priorities for accelerating innovation and RD&D, advancing policy and regulations, attracting investment and trade opportunities, scaling-up projects and infrastructure, building partnerships and growing inclusive workforces.

2. **“BC Perspectives CCUS” by Michelle Schwabe** *Executive Director, BC Public Service*

Michelle Schwabe shared British Columbia’s perspective on CCUS by providing insights on BC’s emissions reduction targets to 2050 and the province’s focus on different sectors, namely oil and gas, transportation, buildings and communities, and industry. Michelle also shared the extensive study conducted by the province to evaluate storage in the provinces north-east.

3. **“Saskatchewan Summary of Carbon Capture Utilization and Storage” by Kyle Worth** *Director, Emissions Management and Compliance, Ministry of Environment, Government of Saskatchewan*

Kyle Worth summarized the CCUS initiative upheld by the Saskatchewan government such as the OBPS Program, MRGHG Standard, Royalty Credit Programs, OGPII, OIIP, PII and enhanced oil recovery (EOR) Royalty Regime Structure. Kyle also gave a detailed overview of the regulatory framework governing credits in Saskatchewan with a focus on proposed amendments to three existing standards which will focus on treatment of electricity facilities, CCUS credits and a prescribed quantification and sampling method for regulated emitters.

3.2 Session 02: Policy and Incentives for CCUS

1. **“Summary of CCS Incentives in Canada” by Mac Walton** *Senior Policy Analyst, International CCS Knowledge Centre*

Mac Walton focused his presentation on the existing elements that enable CCS development in Canada. Mac highlighted the Canadian incentive framework including tax incentives, government

programs and regulatory requirements. He discussed business cases for capture, transportation, storage and utilization, focusing on credit opportunities. Mac identified a need for the CCUS investment tax credit (ITC) to be extended beyond 2031 and to include EOR.

Q: What does break-even mean in CCS projects? What is the range for Internal Rate of Return (IRR)?

A: Break-even for CCS would mean the same as for other projects, revenue equating to expenses. As for IRR, it depends on the industry in which the CCS project has been established and what the specific risks are, but it is wise to assume the annual rate of growth for the investment would be in the 18-20 per cent range.

Q: What would be the consequences of axing the carbon price on an industrial scale?

A: If this is concerning the federal carbon tax policy, provinces that have based their credit system on the federal carbon tax regulation will be affected. Alberta TIER will still support CCS projects. Carbon contracts for differences can provide certainty for these things. ACCIP has a provision in their budget saying that a federal program must be in place for ACCIP to fit in, therefore this will have to be either revised or taken off.

2. “Policy and Incentives in CCUS, North Dakota” by Caitlin Olsen *Principal Policy and Regulatory Strategist, Energy & Environmental Research Centre*

Caitlin Olsen highlighted the federal and state incentives in the United States of America. Caitlin discussed groundbreaking programs such as the 45Q Tax Credit and North Dakota State Tax Breaks which have fuelled CCUS development in the country.

3. “Contract Barriers to Large-Scale CCUS Project Deployment in Western Canada” by Randy Brunet, K.C. *Partner, MLT Aikins LLP*

Randy Brunet provided a critical perspective to the challenges of deploying large-scale CCUS projects by highlighting the contract barriers. Randy discussed a contract matrix focused on each aspect of a CCUS project, such as capture, transportation, utilization, storage, technology licensing, and risk reduction.

4. “Carbon Dioxide Removal: Opportunity, Policy and Incentives” by J.P. Jepp *Principal, Nexus Climate and Energy Strategy*

J.P. Jepp expanded the concept of CCUS to carbon dioxide (CO₂) removal by listing its need and the supply and demand of carbon removal credits. J.P. discussed opportunities laid out by the Canadian

government to support CO₂ removal market through the tax credit programs and funding possibilities available to the industry.

Q; What are some of the new opportunities in Bioenergy with Carbon Capture and Storage (BECCS)?

A: BECCS is considered best to utilize biomass if you have biomass and suitable geology. One of the best things about BECCS is it produces two products: carbon removal credit and low carbon intensity electricity. With carbon removals at \$480/tonne, the electricity can be sold with a premium.

5. “CCUS/ Carbon Management in Canada – Overview of Policies and Incentives” by Saviz Mortazavi Ph.D., P.Eng. *Office of Energy Research and Development, Energy Policy, Natural Resources Canada*

Saviz Mortazavi presented an overview of Canada’s growing carbon management strategy and the country’s emissions reduction milestones. Saviz discussed key points on the federal government’s support for industrial decarbonization, CCUS program and policy supports and the CCUS Investment Tax Credit (ITC).

Q: Do you have a timeline when the ITC technical guidelines will be public?

A: June 1st, as soon as legislation is good to go.

3.3 Session 03: Industry Perspectives on Key Deployment Challenges

1. “CCUS: I Said Hey, What’s Going On?” Candice Paton M.Sc., P.Eng. *Vice President, Corporate Affairs, Enhance Energy*

Candice Paton provided an overview of the 10 ongoing CCUS projects, namely Alberta Carbon Trunk Line Project/Enhance Clive Sequestration Facility, Entropy: Glacier Gas Plant, Shell QUEST, Boundary Dam/Weyburn Midale, Climeworks Orca DAC, Equinor Sleipner & Snøhvit, Gorgon LNG and CCS, Port Arthur Refinery, Occidental/Mitchell Group: Century Plant, and Petrobras: Santos Basin.

Note: A copy of this presentation is not available for distribution.

Q: What is the carbon intensity of the Clive project oil?

A: Carbon intensity of the Clive project is significantly lower than typical oil production. Associated storage is optimized in the Clive Field.

2. “Industry Perspective on Key Deployment Challenges” by Kristin Rennie *Vice President,
Land, Tundra Oil & Gas*

Kristin Rennie shared industry’s perspective on CCUS projects by highlighting Tundra’s active participation in this space. Kristin discussed the CCUS deployment challenges industry faces, which include: carbon pricing and regulatory uncertainty, pore space and liability management, infrastructure shortage, public confidence and competition vs. coordination. Kristin placed emphasis on Manitoba’s pathway to CO₂ sequestration and the technical certainty in their plan forward.

Q: If there was a greater reward for storage with EOR would that influence your plan to expand this project?

A: Additional support would be required. Tundra has the capability to handle both EOR and saline storage projects, but at a larger scale we would be looking to gain more industry and government support.

Q: What is the depth of the storage facility? What about miscibility?

A: The depth of the storage facility is 850 metres. We have faced some challenges with the miscibility of CO₂.

Q: What is your oil American Petroleum Institute (API)?

A: 38-39

3. “Industry Perspective on Key Deployment Challenges” by Al Shpyth *Executive Director,
International Minerals Innovation Institute (IMII)*

Al Shpyth shared the mineral industry’s perspective on key development challenges with CCUS focusing on the uncertainty in geology, economics of capture and transportation, lack of policies supporting RD&D, the barriers with social and environmental acceptance, and crucial Indigenous support.

Q: Where is Saskatchewan potash found?

A: South of Regina, along Highway 16. Saskatchewan has a very large sedimentary basin so great potential in the region.

4. “East Calgary Region Carbon Transportation & Sequestration Hub” by Warren MacPhail,
COO & EVP Engineering, Reconciliation Energy Transition Inc (RETI)

Warren provided an introduction to RETI and their goal to assess, invest in and develop sustainable low-carbon energy transition projects through meaningful Indigenous participation. Warren highlighted the capacity, scope and scale of operations, capital investment, and the phased deployment plan for RETI’s East Calgary Region Carbon Sequestration Hub.

Note: This presentation is not available for distribution of this report.

Q: What’s your biggest hold up on final investment decision (FID)?

A: A lot of the technical details need to be satisfied, along with baseline observations and well test results. From an oil and gas perspective these things can be technically resolved, but getting started on work that’s needed to satisfy the FID is the bigger stress.

Q: What geological information would have been helpful about the site to accelerate the FID phase?

A: No additional information is required but the amount of work is significant. All the data is available to us through exploration. Some targeted and purposed well testing is important but this is part of the progress.

3.4 Session 04: Regulatory Frameworks and Cross-border Issues

1. “North Dakota Regulatory Frameworks and Cross-border Issues” by Caitlin Olsen *Principal Policy and Regulatory Strategist, Energy & Environmental Research Centre*

Caitlin Olsen framed a new perspective on cross-border issues by highlighting the discrepancies in regulatory development between different states in the U.S. Caitlin expanded on North Dakota’s geological capabilities to sequester CO₂ for neighbouring states and provide a feasible carbon removal solution.

Q: What type of data needs to be submitted to the government for certification? (North Dakota)

A: All the injection data submitted to the government of North Dakota is public. You would need to provide the government with monthly injection data, quarterly and yearly injection data and textualize how this information ties together. Every five years there is a re-evaluation of the site and injection data.

2. “Whitecap Sequestration Hubs, Regulatory Frameworks and Cross-border Issues” by Adlai Majer, Director, New Energy, Whitecap Resources Inc.

Adlai Majer discussed his perspective on cross-border issues including carbon markets and incentives for emitters to make investment decisions in CCUS projects.

Note: A copy of this presentation is not available for distribution.

Q: With the Alberta hubs, are there any concerns with the pressure interference if lots of these projects go ahead, that you might have that as a limiting factor?

A: When we’re modeling these projects, you’re not going to be able to move forward without demonstrating to the government that you understand the interference and what it might do. I think Whitecap has considered this and developed an approach to understand pressure interference. It is a big issue.

Q: What is the balance between customers doing EOR and geological storage?

A: Hard to comment. Whitecap has the ability to measure EOR and geological storage separately and there are protocols governing both of them independently. The regulations are good to include EOR as a pathway to generate credits, but it is tough to sell EOR as a business case because the government has withdrawn credits from EOR.

3. “Carbon Capture and Sequestration – BC Energy Regulator Status” by Ron Stefik, P.L.Eng. Supervisor, Reservoir Engineering BC Energy Regulator

Ron Stefik shared the BC perspective on the topic of cross border issues. Ron’s discussion highlighted BC’s best location to sequester CO₂ and provided thorough guidelines on how industry can perform CCS with the support of BC Energy Regulator.

Q: When you do the BC Energy Regulators, “Consult with Land Owners & Rights Holders” Program with Indigenous stakeholders, do you have a Q&A section?

A: Yes, first nations people came in with questions, some who have worked with the oil and gas industry and others looking to learn. So far, the First Nations have had very positive feedback to the upcoming and ongoing CCS activities.

Q: How big is your disciplinary team?

A: We are not a very big team right now. We have a four- to six- week turnaround as a regulator.

Q: How is British Columbia’s geological modelling capability?

A: We rely on professionals from the client’s company. The parameters and scope are determined by us along with the client. We don’t run the software, but we know what it should look like and what to look for to validate a project. We know the right questions to ask.

Q: What other data needs to be submitted?

A: The measurement, monitoring, and verification (MMV) data has to be submitted on a monthly basis. There is also a six-month and one-year progress report. We also conduct case by case assessments, but this is a very risk-based assessment.

4. “Interprovincial Transfer of CO₂: Regulatory Frameworks and Challenges” by J.P. Jepp *Principal, Nexus Climate and Energy Strategy*

J.P. Jepp provided a fresh perspective to the cross-border issues within Canada by first comparing this concept with the restrictions on transporting wine between provinces and then providing potential solutions to sharing CO₂ sequestration pore space. J.P.’s suggested solutions led to a discussion which helped the audience understand the complexities behind cross border CO₂ trading and sequestration.

3.5 Session 05: Social Licence

1. “Wabamun Carbon Hub” Nicole Baker *Senior Advisor of Community and Indigenous Engagement Enbridge Inc.*

Nicole Baker shared the partnerships Enbridge has built over the years with the neighbouring Indigenous communities through their Wabamun Hub project. Nicole shared key learnings from her interactions with various communities and the importance of meaningful engagement between industry and Indigenous people.

Q: What are your thoughts on the capacity within Enbridge to support these engagements?

A: At Enbridge we have worked on setting up Indigenous reconciliation action plan with hard targets, this plan has five major pillars. Everyone within Enbridge must look through the pillars/goals and address one of them. We also encourage our employees to go out to the community, spend a day with the people, learn how their land is important to them and how they see themselves as a part of the Wabamun Hub.

Q: Is there a need for a best practices manual for engagement with Indigenous communities?

A: I believe going out and talking to Indigenous people is the best way. They are worried that their thoughts might be seen as confrontational so instead of following a guide it better to have an open discussion. Organizing focus groups with the Indigenous people in their comfort setting helps them open up more naturally.

2. “Key Considerations for Getting Social Buy-in for CCUS” by Colleen Nitta *Director, Marketing & Communications, Svante*

Colleen Nita provided an overview of Svante’s efforts to understand people’s perspective on carbon management by sharing a survey Svante conducted in the US along with the results. Colleen drew on next steps for the industry and government professionals to consider increasing public engagement in this space.

3. “Understanding CCUS Communications” by Norm Sacuta *Director, Communications, Petroleum Technology Research Centre*

Norm Sacuta shared PTRC’s experience in establishing public communication around CCUS and highlighting its importance in educating, influencing, and demonstrating the key advantages of CCUS in today’s industry climate.

Q: What are your thoughts on communications regarding subsidy on EOR?

A: Regardless of whether it is a subsidy and it probably is in the strictest terms, you're still getting an oil that's far less impactful than conventional.

3.6 Session 06: Technical Challenges – Capture

1. “Carbon Capture and Sequestration Program” by Jennifer Chen *GHG Impact Qualification Lead, Emissions Reduction Alberta*

Jennifer Chen gave an overview of past CCUS investments made by the ERA and results from their Carbon Capture Kickstart Program. Jennifer shared the status on multiple projects and highlighted their key accomplishments and current challenges.

Q: *Do you share any specifics of the projects that you support?*

A: No, but the projects have to report to ERA. This information is aggregated for industry news whenever there are key learnings.

2. “Navigating CO₂ Capture and Storage Challenges and Opportunities” by Matthew

McCulloch *Director, ESG and Decarbonisation, Norda Stelo*

Matthew McCulloch gave a detailed breakdown of the technology decision-making framework listing the most common challenges faced by industry during capture technology adoption. Matthew goes on to identify potential areas of opportunity within these challenges which allow for an innovative and critical approach to capture.

Q: In terms of knowledge sharing, are there any recommended activities, venues, or ways to do this for carbon capture?

A: I believe the more acute the driver the more willingness to collaborate, the organization leading this will have to establish a firm and realistic approach. Knowledge sharing takes trust, and such relationships are built over time. Executing such projects and establishing knowledge sharing platforms need good facilitation, people willing to share, inclusive events, etc. More so, the organization executing the knowledge sharing platform needs to recognize the people worth talking to, who will openly share their learnings. There are a lot of non-confidential information that can be shared.

Q: What is the state of capture in terms of risk?

A: Performance guaranties should be a far bigger driver than they currently are. There is a higher level of motivation to succeed. In terms of risk, what is really required is a joint industry and technology developer approach, both need to be answering each other's questions and reassuring themselves on various aspects of the project.

3. “Barriers to CCUS Deployment” by James Martin *VP Engineering, Entropy*

James Martin shared key accomplishments of the Entropy Glacier project, a first-of-a-kind post combustion CCS on natural gas project. James began a very open discussion around the barriers to development, laying emphasis on the potential risk factors.

Q: Is there a difference between a newly built modern facility vs. a brownfield project for Entropy’s Glacier project?

A: It comes down to the technology you’re using and the location of the facility. It is entirely based on facts such as proximity to the emissions source and access to electricity.

Q: Any sense of what the future carbon prices will be?

A: The price has to be sufficient to gain a minimum in rate of return to unlock the investment. Three parties are involved and require effective communication.

Q: In a first of a kind deployment, what are the challenges of getting these projects underway?

A: Between Entropy and the counter party, there have been no internal barriers but mostly external such as the credit structure and feedstock, etc. The most common barrier has been to establish a level of trust in the regulations. Return on investment (ROI) is also a factor – if it is perceived there is little or no ROI, investment is unlikely to be made.

4. “CCS Challenges” by Mania Neisiani *VP Project Engineering, Svante*

Mania Neisiani shared the innovation that led to Svante’s carbon capture technology and the RD&D efforts behind revolutionizing a solid sorbent. Mania also gave an overview of the challenges with CCS development that Svante has encountered, namely project economics and industry adaption challenges.

5. “Overcoming Technical Challenges at Canada’s Flagship Carbon Capture Facility” by Bruce Hesselink *Specialist, Environment & Sustainability, SaskPower*

Bruce Hesselink gave an overview of the Boundary Dam Unit 3 project, and the technical challenges SaskPower has faced over the years with managing fly ash buildup, and its effects on equipment and process. Bruce discussed the complexities behind building a CCS facility and SaskPower’s efforts to sustain reliable operations. Key learnings include adding redundancy, addressing contamination and full understanding of process chemistry and metallurgy. Another critical thing is to match the production and capture units (e.g., the right size of the equipment).

Q: Some institutions use the term “dense phase CO₂” instead of “supercritical CO₂”, what is the difference?

A: Dense phase CO₂ and supercritical CO₂ refer to the same thing. For communicating with the public, it is best to avoid both terms and describe the CO₂ as compressed until it moves and acts like a liquid.

3.7 Session 07: Technical Challenges – Storage, Geoscience and Pore Space

1. “Independent Public Geoscience to Assess Carbon Storage Potential in BC” by Richard Truman *Vice President, External Relations, Geoscience BC*

Richard Truman provided an outline of Geoscience BC and their contribution to assessing and identifying storage potential in the province. Richard shared Geoscience BC’s focus areas, emphasizing their efforts in carbon storage research, the research reports available on their website and discussed next steps to promote storage in BC.

Q: Are there any seismic restrictions or considerations with the Northeast BC storage potential?

A: With the Northeast BC Atlas, which is the only project to date that we've completed, one of the considerations we included were the opportunities and the risks. We have included an initial assessment of the potential for the seismic issues. This work is being done by the Simon Fraser University in BC, so I don't have the numbers or solid answers for you yet.

Q: For the Georgia Basin, what do you think the next steps are? What is the path forward to mobilize characterization of the basin?

A: Simon Fraser University is doing the research on Georgia Basin to answer these questions and Geoscience BC isn't directly involved in that. There are definitely many technical and social challenges which need to be addressed with industry collaboration.

2. “Technical Challenges with Carbon Storage in Alberta” by Gonzalo Zambrano Narvaez, **PhD, P.Eng.** *Assistant Professor of Geotechnical Engineering, Dept. Civil and Environmental Engineering, University of Alberta*

Gonzalo Zambrano Narvaez presented on the technical challenges with carbon storage in Alberta by first giving a landscape of CCS in Alberta and then diving into the details of pore space competition. Gonzalo shared his learnings from detailed assessment of elements in CO₂ effective mass storage and storage efficiency factors.

Q: When you talk about different wells causing contracting pressure, what should be the distance between the wells?

A: The answer to this question goes back to how the pore space is managed. A model needs to be prepared to determine the area and the distance.

3. “Carbon Capture and Storage: An Applicant’s Guide to BC’s Regulatory Framework for Storing or Disposing of CO₂” by Tony Grimison, P.Geo *Tenure and Resources Stewardship Branch, Ministry of Energy BC*

Tony Grimison provided an overview of British Columbia’s CleanBC Roadmap to 2030 and the identification of CCS as an important emissions reduction strategy. Tony shared in detail in significance of BC’s regulations which assists in deployment of large-scale CCS projects.

Q: Is there any provision for required consultation and reporting on such, under the reservoir exploration or lease regulations?

A: This is not required but we recommend conversations with the First Nations.

4. “MMV Challenges for Geologic CO₂ Storage” by Brendan Kolkman-Quinn M.Sc. *Geophysicist I.T., Carbon Management Canada*

Brendan Kolkman-Quinn presented details on the geochemical and geophysical monitoring at Carbon Management Canada’s storage facility. Brendan gave an overview of the different monitoring technologies used on-site, namely 3D Seismic, VSP and SPARSE.

Q: What, in your perspective, is the better method to monitoring?

A: I would always prefer a baseline 3D survey. I would view this this kind of method as you know a more frequent monitoring on a core scale that can then trigger more focused target-oriented surveys including repeats of portions if not the full 3D seismic survey. There’s nothing in the rule book that requires 3D baseline surveys or 3D monitoring surveys at all. 3D surveys are often beneficial to CCS projects for reservoir characterization in the first-place development of reservoir models. But it's possible that if risks are deemed low enough, then there's no identified need by an operator for a 3D baseline they may choose to go without.

Q: There is an assumption that all seismic surveys are the same and there are more cost-effective options. What would you say?

A: Each site's costs will be different. Generally, with 3D seismic you can reduce that cost fractionally, by optimizing the design and minimizing repetitive tests. But our optimal goal is to support and maybe defray the costs of continued 3D monitoring shooting, from the current assumed \$10-30 million range to a more acceptable \$1-3 million range.

5. “Technical Challenges for Storage” by Erik Nickel, M.Sc., P.Geo., COO, Petroleum Technology Research Centre

Erik Nickel shared the technical challenges with CO₂ storage by enlightening the audience in difference between cap and reservoir rocks and the design restrictions with the latter. Erik’s discussion established theoretical and operational challenges with storage expanding from pre-drill and well design to the importance of monitoring pressure and chemistry within the reservoir.

6. “National CCUS Assessment Framework: Case Studies for Western Canada” by Dr. Robin Hughes Senior Research Scientist CanmetENERGY, Natural Resources Canada

Dr. Robin Hughes gave an overview of how CanmetENERGY is working today to accelerate decarbonization in Canada at the lowest cost using existing and new CCS technologies. Dr. Hughes shared NRCan’s perspective of the CCS value chain and how they’re managing CO₂ capture, storage and transportation.

4.0 Panel Discussion

The workshop concluded with a 45-minute panel discussion where five questions were debated. The panel was moderated by Neil Wildgust, President and CEO of CMC and included:

J.P. Jepp *Principal, Nexus Climate and Energy Strategy*

Al Shpyth *Executive Director, International Minerals Innovation Institute (IMII)*

Adlai Majer *Director, New Energy, Whitecap Resources Inc*

Erik Nickel, *COO, Petroleum Technology Research Centre*

Mania Neisiani *VP Project Engineering, Svante*

Nicole Baker *Senior Advisor of Community and Indigenous Engagement Enbridge Inc.*

Taylor Berezowski *Senior Geologist, Carbon Alpha*

Question 1: What measures might best address investor concerns for CCUS?

The panel agreed that adequate returns from projects are essential; discussions highlighted how uncertainty was a major barrier to investment decisions. Even technically viable sites cannot progress through FID if there are significant policy and regulatory uncertainties; this is not just about permitting, but also policies and incentive programs that may be altered with changes of government. The panel also noted that CCUS projects require significant up-front investments, for example to characterize storage sites, that increase the perception of risk. Concern was also expressed that associated storage with EOR is not included within federal CCUS policy incentives.

So, providing stable policy and regulatory environments with adequate economic incentives would address investor concerns.

Question 2: What are the significant regulatory gaps across the four western provinces?

Concern was expressed that current regulatory and policy regimes are complex so further regulatory burdens may exacerbate this, particularly in an environment where economic incentives and carbon pricing are not enabling project deployment. The panel identified several specific issues, with pore space ownership a key factor in some jurisdictions. Post-operational liability is another challenge, with the mining industry providing an analogue where provincial authorities may be more

comfortable and willing to accept transfers of liability in a reasonable timeframe. Long duration post-operational monitoring requirements may be a significant disincentive to investors.

The panel also noted that Indigenous communities appreciate early and full involvement in decision-making.

Question 3: How should project proponents engage with the public, especially local and Indigenous communities?

The panel agreed that public engagement should be conducted at the earliest opportunity in the life cycle of a project, or even before a specific project is conceived. Communities appreciate an approach that emphasizes listening to their concerns, being approachable, and forming partnerships. Educational and training opportunities are helpful; time and emotional energy is required to build trust. Project proponents that delay community engagement until advanced planning stages are more likely to meet local resistance or be perceived as trying to engage only out of legal necessity.

Question 4: How may innovations in capture technology benefit CCUS deployment?

Many capture technologies have reached maturity, so further innovation may only yield marginal gains in efficiency. However, the emerging technologies that require support could still lead to significant future cost reductions and deployment opportunities.

Technology developers must focus on providing industry with a clear picture of how any given technology is likely to be deployed and the benefits that will result over a project timeframe. The panel speculated that a forum for better dialogue between industry and technology developers would be valuable.

Question 5: How can storage resources best be de-risked into bankable capacity to support project deployment?

De-risking storage sites requires significant data and some prospective storage formations (e.g., the Basal Cambrian) have relatively low numbers of prior well penetrations and associated records, so initial characterization from existing data is challenging. The panel agreed that further applied RD&D, including publicly funded demonstration projects such as the PTRC Aquistore and CMC Newell County sites that provide shared learnings, still have an important role to play supporting CCUS deployment. Examples of the technical challenges which benefit from these approaches include the refinement of predictive modelling techniques to evaluate plume evolution and containment risks,

and the development of cost-effective MMV strategies that can satisfy regulatory and stakeholder requirements.

To conclude the debate, panellists were asked in no more than three words to state what they think the single-biggest barrier is to CCUS deployment in Western Canada.

- Carbon price uncertainty
- Public acceptance
- Carbon markets
- Transparency and communication
- Cost
- Insufficient carbon price
- Economic, regulatory uncertainty