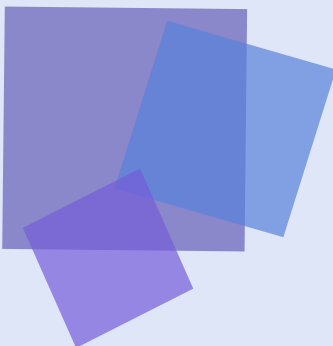




Progress on the Regulatory Roadmap for Geological Carbon Storage

Professor Grant D. Wach

Basin & Reservoir Lab, Dalhousie University

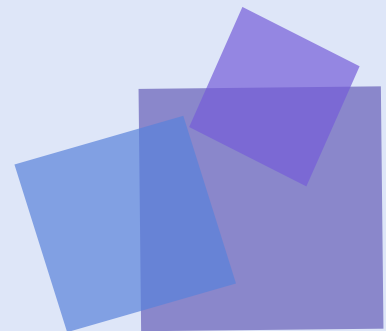
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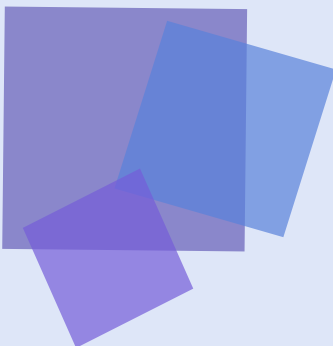


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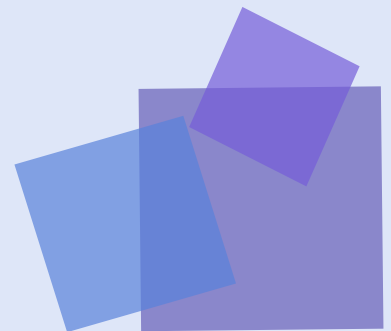
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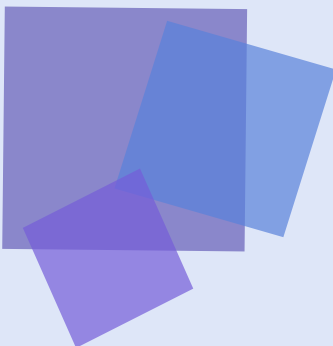




Acknowledgments

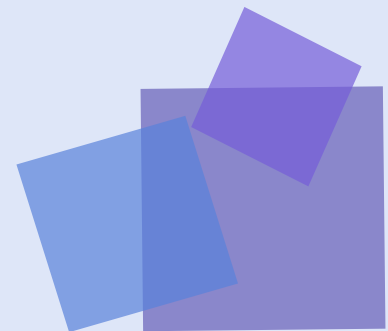
- Sproule-ERCE colleagues, including Richard Hares, Scott Carter, Jason Eleson, Gord Brasnett, and Hunter Brett, for their incredible work on the Phase 1 Summary Report, which forms the basis of this presentation
- Presenters and attendees at the 2023 Carbon Neutrality Forum
- Basin & Reservoir Lab Manager Lauren Wheaton

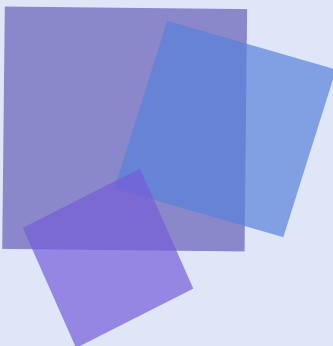




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- Regulatory Roadmap for Offshore Carbon Storage in Atlantic Canada
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 - CCS Value Chain
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 - Offshore CCS Value Chain
 - Key Lessons & Best Practices
 - Review of Atlantic Canada's Offshore Basins
- Conclusions & Next Steps





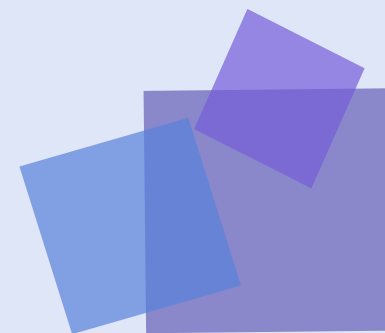
2023 Carbon Neutrality Forum

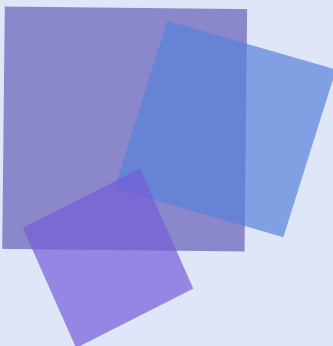
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2023 Carbon Neutrality Forum

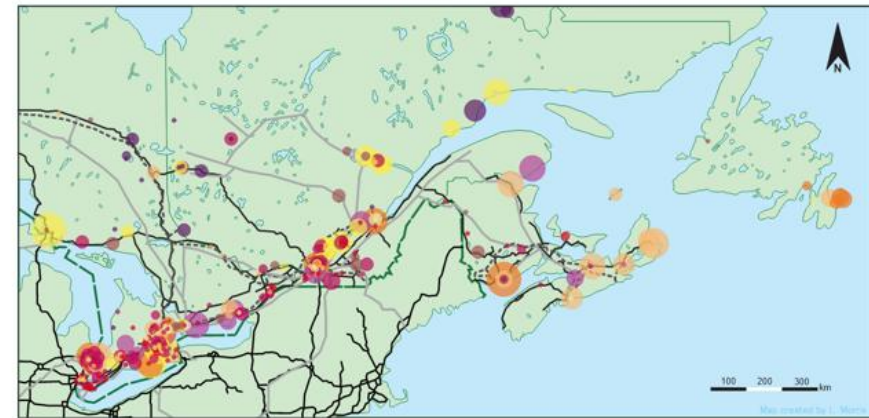


Held in April 2023, the Carbon Neutrality Forum, hosted by Dalhousie & Net Zero Atlantic with support from NRCan and NS DNRR, with the intent to share best practices and technologies that may lessen costs and promote Canada's vision of a cleaner energy future, helping guide Canada to carbon neutrality.



2023 Carbon Neutrality Forum

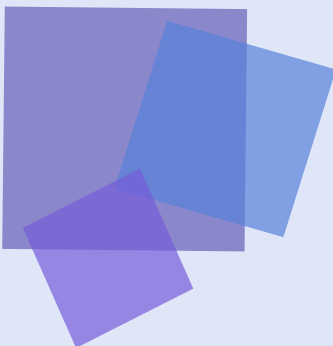
Hearing from industry, academic, and government experts from across Canada and around the globe, discussing federal and provincial perspectives, defining CCS and geostorage, and reviewing successful international initiatives – from this, a white paper was prepared outlining the current state of affairs and identifying a path forward



CARBON SOLUTIONS FOR EASTERN CANADA

RECORD OF THE 2023 CARBON NEUTRALITY FORUM AND ASSOCIATED MATERIAL

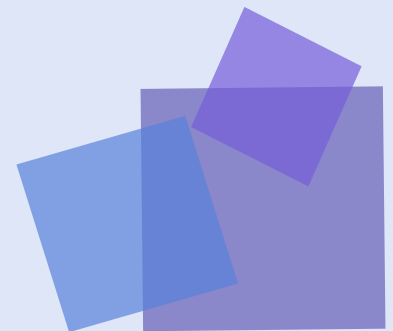
G. WACH, L. MORRIS, J. DICKIE, M. DUSSEAU*
DALHOUSIE UNIVERSITY, *UNIVERSITY OF WATERLOO

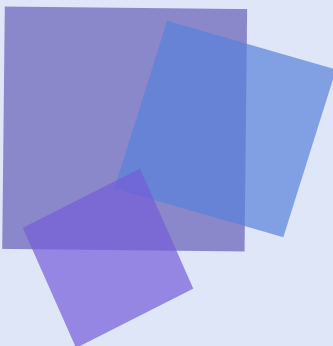


2023 Carbon Neutrality Forum

The main consensus from the forum, in regard to how Canada (and Atlantic Canada in particular) can move forward with CCS and our net-zero goals, was the need for a defined regulatory and policy framework – establishing clear authorities, roles, and responsibilities of specific government departments and agencies at the federal, provincial, and municipal levels

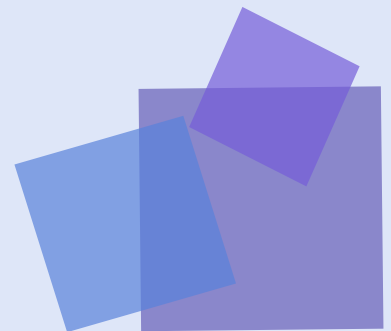
Thus, the idea for the *Regulatory Roadmap for Offshore Carbon Storage in Atlantic Canada* project was initiated

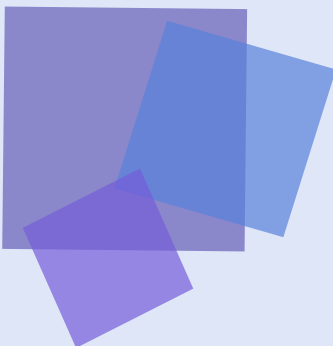




Regulatory Roadmap for Offshore Carbon Storage in Atlantic Canada

The Project

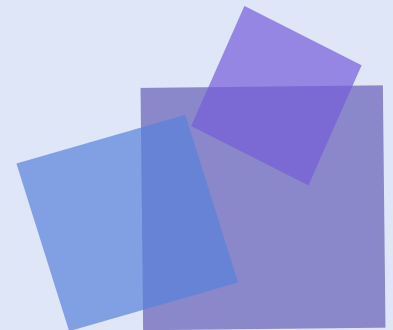




Regulatory Roadmap for Offshore Carbon Storage in Atlantic Canada



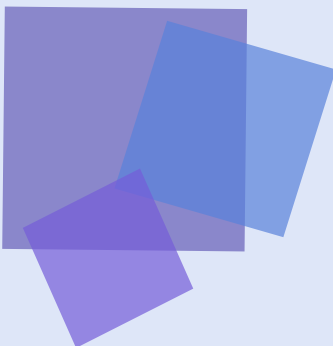
Officially announced in July by the Honourable Tim Hodgson, Minister of Energy and Natural Resources, along with a number of other energy projects in Nova Scotia, Prince Edward Island, and New Brunswick, with funding through the Energy Innovation Program



Regulatory Roadmap for Offshore Carbon Storage in Atlantic Canada



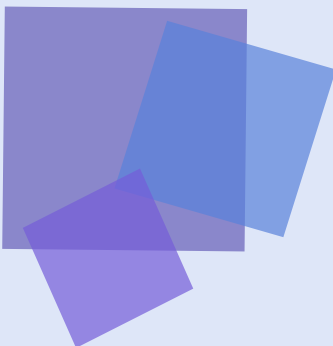
The project will develop a roadmap for policies and regulations to better support a regulatory framework for offshore carbon storage, paving the way for innovation that will help offshore industries reduce emissions



Regulatory Roadmap for Offshore Carbon Storage in Atlantic Canada

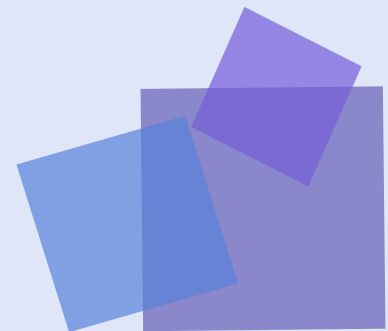
- The project is broken down into three main phases:
 - Phase 1: Project Scope and Resources
 - Identify components of offshore CCUS value chain to address errors/omissions, screening existing national and international storage projects for best practices.
 - Phase 2: Regulatory Research
 - Analysis and comparison of regulatory framework offshore/onshore, identify key regulations for safe and secure transport, review legal issues, London Protocol, IEA guidelines, roles of provincial and federal regulatory agencies.
 - Phase 3: Report and Recommendations
 - The final CCUS regulatory framework roadmap report & presenting final research.
- Along with our partners at Sproule-ERCE, we will submit a CCUS Regulatory Framework Roadmap Report by 2027

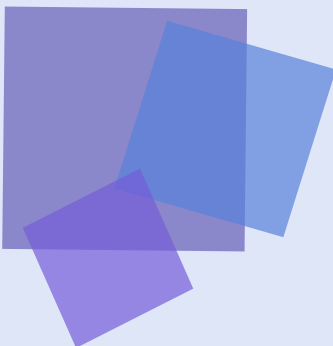




Phase 1 Summary

The Progress

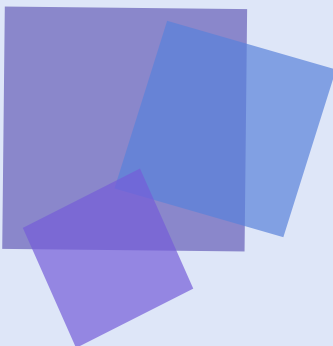




Phase 1 Summary Report

- Sections in the Phase 1 Summary Report include:
 - Overview of the CCS Value Chain
 - Overview of the Existing Regulatory Framework
 - Analysis of Offshore CCS Value Chain
 - Overview of Global Offshore CO₂ Storage Projects
 - Atlantic Canada Geoscience and Literature Review
 - Offshore CCS Geoscience Analogs and Comparables to Atlantic Canada
 - Summary & Conclusions





The CCS Value Chain

- Encompasses CO₂ capture, transport, and subsurface injection for long-term geological storage – each of which carries unique technical, economic, and regulatory risks
 - Capture cost-effectiveness; high purity process gas vs. post-combustion CO₂
 - Compression infrastructure for transport; pipelines vs. shipping networks
 - Storage considerations of containment, injectivity, and long-term monitoring
 - Early-stage public investment, coupled with carbon pricing and incentives to improve economic viability
 - Cross-chain coordination, robust measurement, monitoring, and verification (MMV), and alignment of project timelines are essential to derisking development



The CCS Value Chain

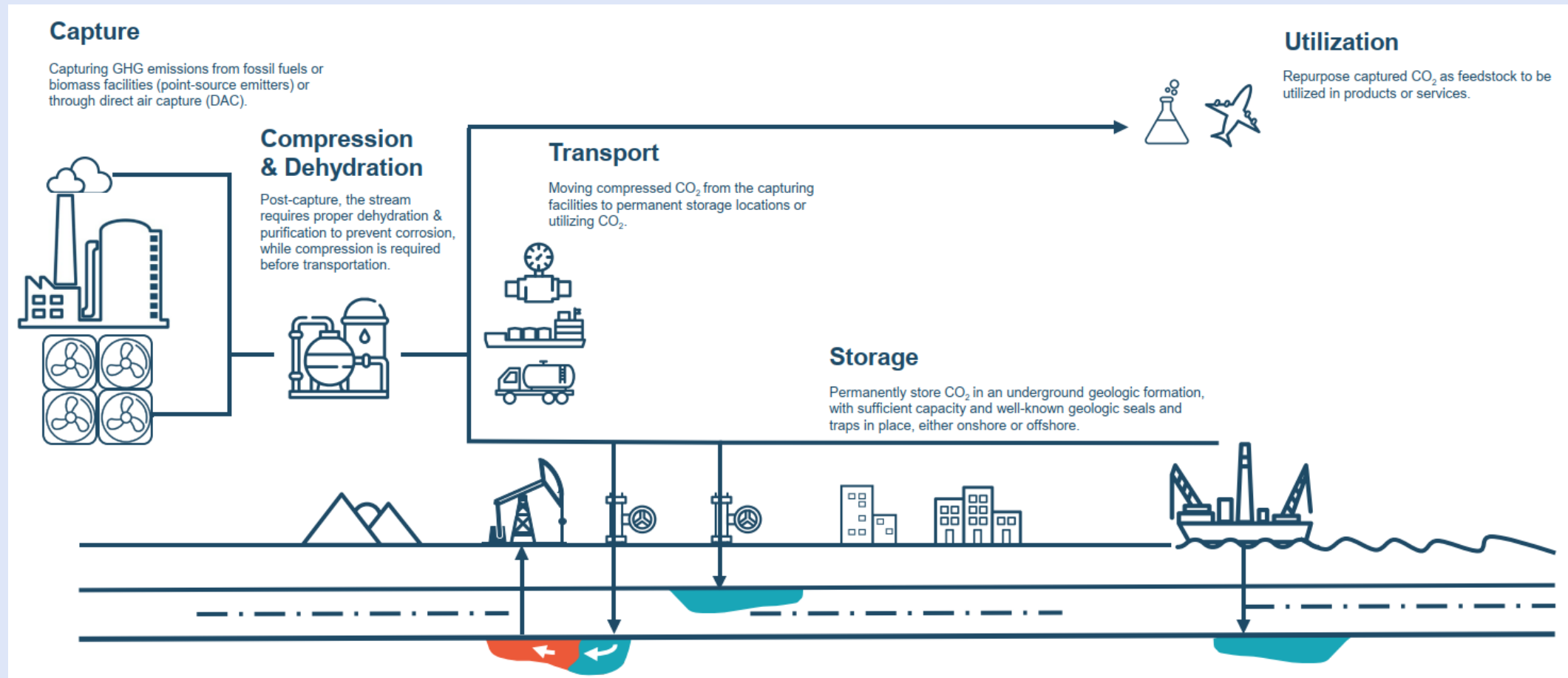
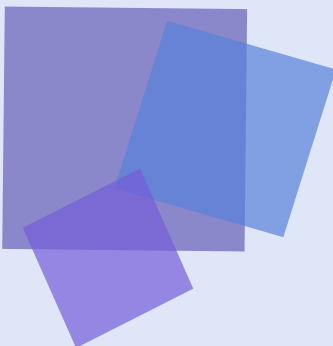
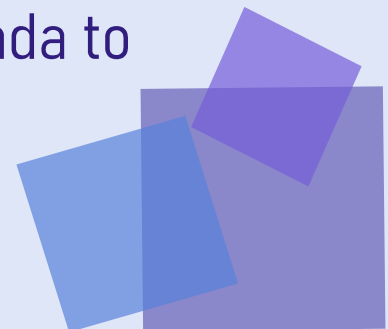


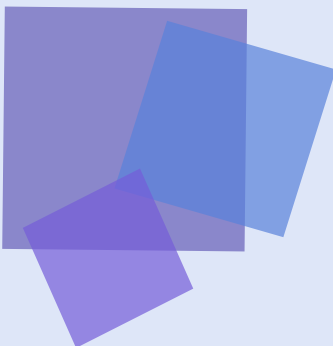
Image from Sproule-ERCE



Canada's Regulatory Environment

- The current environment for CCS in Canada (Alberta & Saskatchewan) builds on frameworks originally developed for oil and gas
 - Federal-Provincial joint regulators (CNSOER & C-NLOPB) oversee the responsible development of offshore oil and gas resources in Atlantic Canada, making them well positioned to regulate CCS given their expertise, jurisdictional authority, and alignment with offshore development mandates
 - CSA Z741-12 – national standard aligned with ISO 27914, outlining processes for site screening, characterization, risk assessment, well integrity, MMV and closure
 - Clear and supportive regulatory pathways – like those developed for offshore CCS in Europe or onshore CCS in Alberta – will be vital for Atlantic Canada to advance CCS





Offshore CCS Value Chain

- CCS in the offshore specifically presents both unique challenges and strategic opportunities
 - Significantly higher capital and operating costs and logistical complexity compared with onshore CCS
 - While presenting the same risks of containment, induced seismicity, faulting, and the presence of legacy wells
 - Need for effective risk management, which required effective site screening, comprehensive characterization for prospective regions, and geologic modelling
 - To scale, repurposing existing infrastructure and building on oil & gas capabilities is key
 - Capture, transport, and storage infrastructure must co-develop in synchrony



Offshore CCS Value Chain

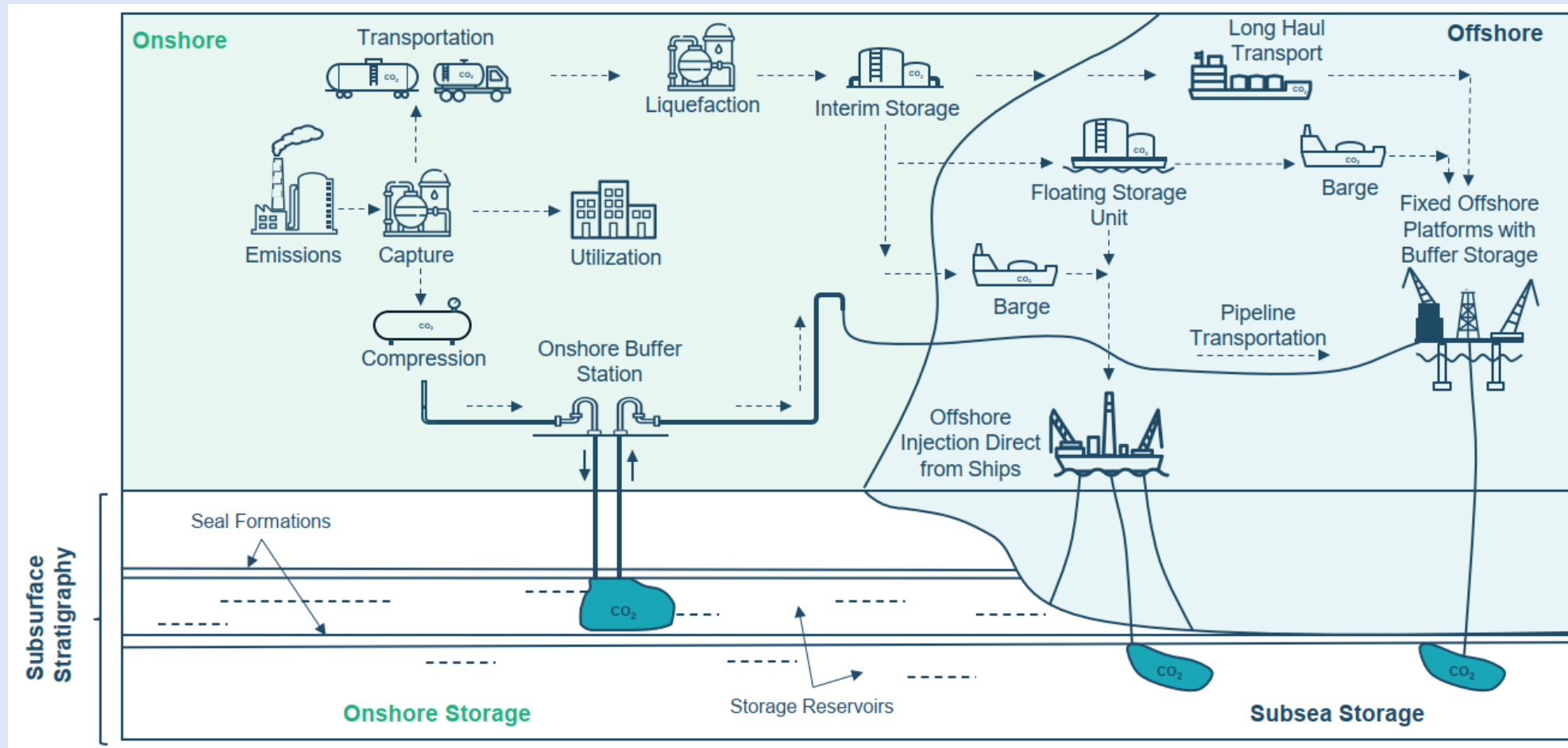
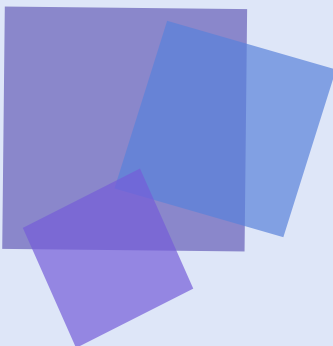


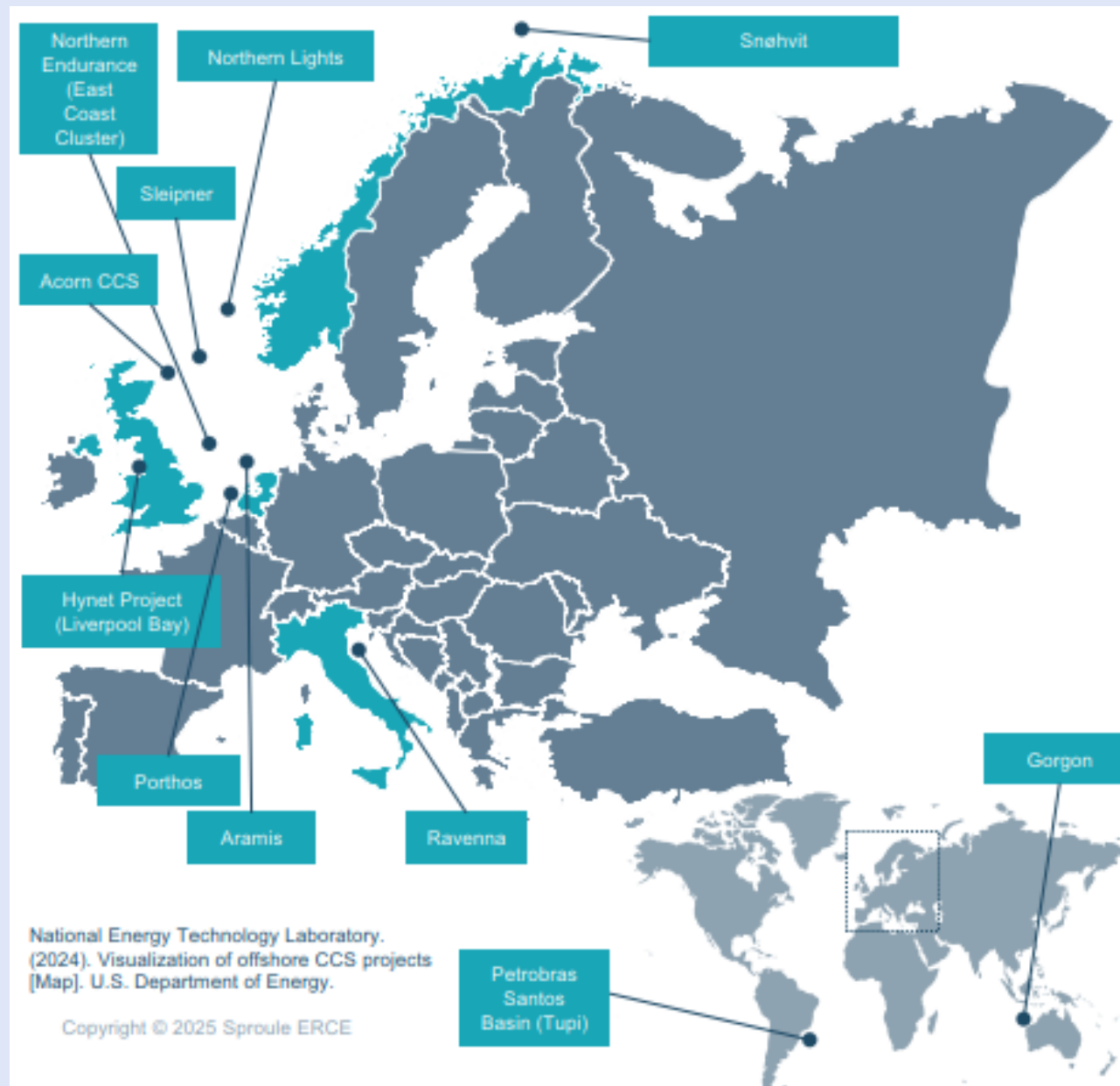
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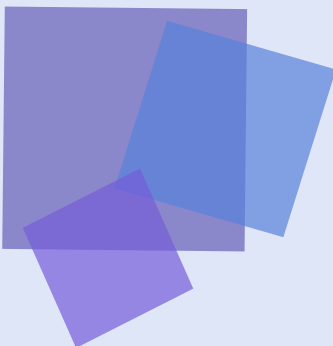


Key Lessons & Best Practices

- Current onshore CCS projects in Canada and offshore CCS projects in Europe will inform the best practices for Atlantic Canada
 - **Quest** demonstrates the importance of direct public funding, two-for-one carbon credit incentives, and extensive community engagement
 - **Sleipner** and **Snøhvit** both highlight the value of carbon pricing certainty, storage co-location with capture, and regulatory mandates to spur development
 - **Porthos** as an example of how integrated infrastructure and multi-sector collaboration can accelerate development, supported by targeted subsidies
 - **Ravenna** emphasizes the reuse of existing infrastructure and depleted fields to reduce costs and subsurface uncertainty

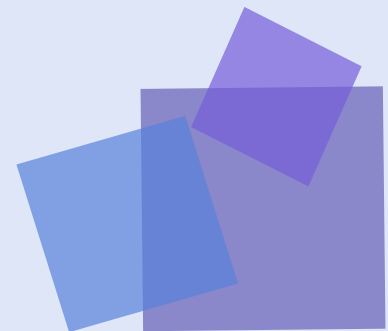


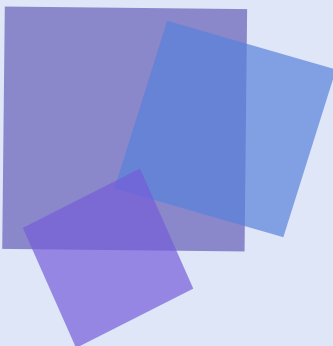




Review of Atlantic Canada's Offshore Basins

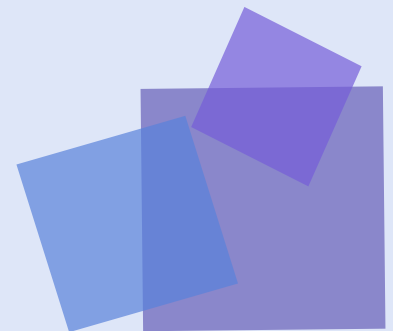
- Reviewing the existing literature on potential offshore basins to determine ultimate suitability and where more research is needed
 - The Sable Basin and Jeanne D'Arc Basin are considered highly suitable, due to the thick, porous deltaic and fluvio-deltaic sandstones, existing hydrocarbon infrastructure, and proven seal integrity
 - Past exploration highlights the importance of detailed geophysical and geomechanical assessments
 - Regional initiatives should prioritize well-characterized basins with favorable geological and logistical profiles

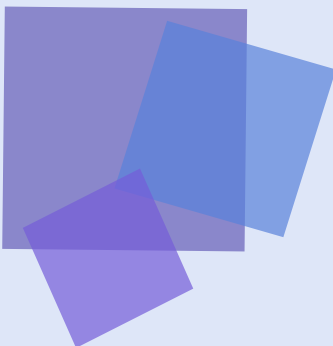




Conclusions & Next Steps

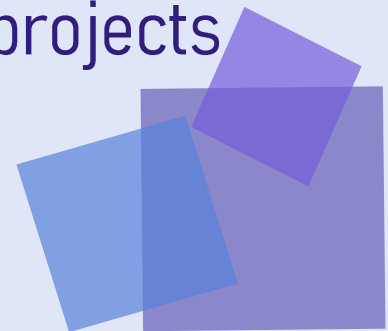
The Future

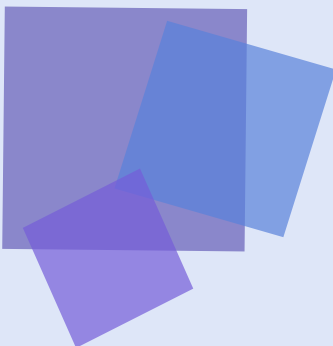




Conclusions

- A well-defined, transparent, and standardized regulatory environment is essential to attract CCS investment and ensure long-term safety
- Success hinges on strategic planning, and minimizing risk through integrated infrastructure and policy coordination
- Global leaders have shown success relies on thorough geological assessment and strong government support
- Atlantic Canada has potential for offshore geologic storage of CO₂ but requires a policy framework to underpin project development
- Transferability of technology and practices from successful CCS projects in Europe show strong potential





Next Steps

- Continued analysis of existing regulatory framework
- Identify the main hurdles and opportunities as they relate to transportation and storage
- Build multiple scenarios of potential emitters through source and sink analysis; determine key emitters and supply considerations
- Draft the proposed regulatory framework; permitting approaches, rights, obligations, and mechanisms for public engagement and consultation; identify priority issues for regulators

