PEMBINA Institute

SUBMISSION

Direct Air Carbon Capture and Geological Storage: Clarity and Expansion Opportunities

Pembina Institute comments and recommendations

Submitted to Environment and Climate Change Canada

Regarding: Preliminary Draft Federal Offset Protocol: Direct Air Carbon Dioxide Capture and Geological Storage

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Direct Air Carbon Capture and Geological Storage: Clarity and Expansion Opportunities

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Recommendations

The Pembina Insitute has several recommendations on the draft federal offset protocol for direct air carbon dioxide capture and geological storage. This protocol is a critical step in developing a vibrant carbon removal industry in Canada, as it would allow these projects to generate offset credits.

- We recommend temporary, initial flexibility in renewable energy requirements with increasing stringency over time. This would acknowledge the current limitations of securing renewable energy in several jurisdictions.
- We recommend that offshore geologic storage be included within the scope of this protocol, as long as the requisite safety criteria are met by a project. Offshore geologic storage has a long history in other jurisdictions.
- We request clarification on the project condition in section 4.1 that requires the capture facility not be registered under any other GHG offset credit program. Direct air carbon dioxide capture and geological storage (DACCS) projects should be able to sell to different buyers seeking credits that can comply with various programs, and measures can be put in place to ensure credits are not double counted.
- We request clarification on the criteria for determining which jurisdictions have adequate regulations and enforcement mechanisms for the federal DACC protocol to be applicable. Defining what constitutes sufficient regulatory standards will help accelerate progress across other provinces, ensuring clarity in their efforts to move forward.

Context

On February 3, 2025, the Government of Canada released a preliminary draft of the federal offset protocol for direct air carbon dioxide capture and geological storage (DACCS).[1] This protocol would incentivize the development of DACCS projects by enabling them to generate offset credits, issued under the Canadian Greenhouse Gas Offset Credit System Regulations.

The development of a federal DACCS protocol is a significant step forward in supporting carbon removal technologies. It recognizes the importance of these solutions for Canada to achieve net-

[1] Government of Canada, "Federal offset protocol: Direct air carbon dioxide capture and geological storage," https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/federal-greenhouse-gas-offset-system/protocols/direct-air-carbon-dioxide-capture-geological-storage.html

zero. It also presents a valuable opportunity to clearly define what appropriate DACCS development looks like and how to mitigate potential unintended consequences.

The Pembina Institute welcomes the opportunity to provide input on the preliminary draft of the DACCS protocol, version 1.0.

Overarching recommendations and comments

Inclusion of offshore storage

We recommend that offshore storage be included within the scope of this protocol.

Expanding the scope of the federal DACCS protocol to include offshore storage would enable Canada to maximize its carbon sequestration potential, while aligning with global best practices.

Offshore carbon storage is a well-established practice internationally. The Sleipner project, located in the North Sea off the coast of Norway, has been storing carbon dioxide (CO_2) beneath the seabed since 1996, and has helped lead to a supportive policy framework in Norway. Australia has also enabled offshore carbon capture and storage in sub-seabed geological formations through the Offshore Petroleum and Greenhouse Gas Storage (OPGGS) Act 2006 and the Environment Protection (Sea Dumping) Act 1981.[2] These international examples provide a model for Canada to allow exploration for suitable geological storage formations offshore.

Canada has vast offshore CO_2 storage capacity, which remains largely untapped. Studies estimate that the Scotian Basin, off the shore of Nova Scotia, has a median CO_2 storage capacity of 177 billion tonnes.[3] Storage potential also exists along other coastal regions, particularly off the coast of British Columbia, where organizations like Solid Carbon are already exploring *in situ* mineralization in subsea basalt formations.

Additionally, offshore projects might not have an ability to generate credits within provincial offset systems, if they take place in waters that fall under federal jurisdiction. For these projects, a protocol within the federal GHG Offset System might be the only way for them to generate credits within a carbon compliance system.

[2] Australian Government, "Offshore carbon capture and sequestration." https://www.dcceew.gov.au/environment/marine/sea-dumping/dispose-co2

[3] Government of Canada, "Carbon capture, utilization and storage in Nova Scotia." https://natural-resources.canada.ca/energy-sources/carbon-management/carbon-capture-utilization-storage-nova-scotia

Generating credits for multiple crediting programs

We request clarification on the project condition in section 4.1 that requires the capture facility not be registered under any other GHG offset credit program.

If this only refers to provincial industrial output-based pricing systems, then we agree with the condition given the intent of the federal offset system as complementary to these programs.

However, if this extends to other programs, then we would recommend a different approach. There may be DACSS projects that seek to market credits to multiple buyers, and each buyer may have a different use or need for those credits. While some may choose to generate credits under this protocol, others may use the credits for other compliance obligations such as industry-specific systems like Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). Measures can be put in place to ensure that each generated credit is only issued within one program, to avoid double counting. There is precedence for this with renewable energy projects in Alberta, which can change which system they generate environmental attributes under on a monthly basis.[4] Barring a project from generating credits within these other schemes would artificially limit the market for the credits, thus reducing the project's viability.

Enabling DACCS in new jurisdictions

We request clarification on the criteria used to determine what is an eligible storage jurisdiction.

While we applaud the development of this protocol and recognize its potential impact in signalling the importance of DACCS, we would note that at this current point in time, there may be limited applicability of this protocol due to emerging protocols within jurisdictions with eligible storage regulations that recognize DACCS projects. In B.C., the carbon capture and sequestration protocol that is under development would recognize DACCS projects to generate credits within the B.C. Carbon Registry. In Alberta, the recently revised CO_2 capture and permanent geologic sequestration protocol recognizes DACCS projects. And in Saskatchewan, the CCUS Credit Standard recognize DACCS projects due to its flexibility of CO_2 sourcing. Depending on how these protocols are evaluated, the federal DACCS protocol might end up not applying to any of the jurisdictions with eligible storage regulations.

[4] Climate Regulation and Carbon Markets, "Avoidance of Double Registration in Alberta Emission Offset System and Western Renewable Energy Generation Information System," memo, April 22, 2024. https://www.alberta.ca/system/files/epa-director-notice-alberta-offsets-and-wregis-recs.pdf

Where this protocol could provide additional value for jurisdictions developing carbon storage regulations is by clearly defining the criteria by which regulations are deemed to be sufficient. This could serve as a target for jurisdictions developing their own carbon storage regulations. In this way, the protocol could accelerate the expansion of jurisdictions where this protocol, and more generally the safe geologic storage of CO_2, can take place.

Responses to Questions

We have responded to a subset of the questions posed, as listed below.

1.1. What are the likely business models that DACCS projects will follow in Canada (e.g. partnerships, storage hubs, vertically integrated projects), and who is likely to be the proponent for the project?

We anticipate many project developers — primarily small and medium-sized enterprises (SMEs) — are focused on direct air capture (DAC), leaving the underground storage development to a partner. Many of these developers are in the process of building their first or second of a kind, and so project volumes are relatively small. Many will likely prefer to aggregate their captured carbon dioxide for a single storage site, to achieve cost savings through economies of scale. There may be a small number of developers building larger DACCS projects that will prefer to remain vertically integrated.

2.1. Should a DACCS project that crosses provincial/territorial boundaries (e.g. where the capture facility and the injection infrastructure and associated storage reservoir are in different jurisdictions) be eligible as a federal offset project? If so, what are the issues or considerations that need to be taken into account in this context?

Yes, a DACCS project that spans provincial boundaries should be eligible as a federal offset project. Optimal sites for CO_2 capture and storage do not always align geographically. In some cases, the most suitable storage reservoirs may be located in a different jurisdiction than the capture facility. Additionally, underground storage formations can naturally extend across borders. Restricting projects to a single jurisdiction could create unnecessary barriers that exclude potentially optimal project designs, thus increasing development costs.

If cross-border projects are allowed, then clarity on where the removal credit is generated will be required, i.e., if the removal is generated at the point of atmospheric capture or at the point of sub-surface injection. Care will need to be taken to ensure double counting of removed carbon dioxide does not occur between provincial inventories.

3.1. How could PPAs be used to procure renewable energy to the capture facilities of DACCS projects?

Virtual power purchase agreements (vPPAs) are a versatile tool for enabling consumers to directly and credibly purchase renewable energy, while removing the physical complexities of directly connecting the clean electrons from the new generator to the buyer. Alongside set additionality criteria, they can improve the access to renewable energy for DACCS projects, while also providing new renewable energy criteria to the grid.

However, the availability of PPAs is currently limited. As of March 2025, Alberta is the only province in which a buyer can enter into a PPA with a generator. Nova Scotia allows for renewable procurement through their Green Choice Program, which is a green tariff program in which subscribers pay an administration fee on their utility bill to acquire environmental attributes from a set of renewable energy projects. This program just completed its first round of procurement and has not announced plans for a second round yet. These policy limitations restrict the options that DACCS developers have for securing power, likely resulting in project delays or cost increases.

To enable project development and acknowledge limitations in securing additional renewable energy, we recommend temporary flexibility in energy requirements. One option could be to temporarily allow procurement of power from jurisdictions different from that of the DACCS project, until more provinces have policies in place to support power procurement through market-based methods. This would help enable project development in the near term while also ensuring supportive action towards grid decarbonization. Considerations should be made to ensure that this additional load does not result in the increased use of power generation sources that increase the carbon intensity of the grid.

Separately, recognition of other types of corporate procurement options outside of power purchase agreements should be included. Each electricity grid system is unique and not all are well-suited for enabling vPPAs. Some may be better suited for a more centralized green tariff program, which transfers environmental attributes to a large number of consumers in exchange for an additional fee on their utility bills. This is seen in Nova Scotia through the Green Choice Program. Others might opt for a sleeve-deal model, in which a contract between a buyer and developer are facilitated by the central utility. This model is being contemplated in Ontario as well as Saskatchewan. Although these systems differ in design, they can all credibly attribute a buyer's load to renewable sources if designed correctly.

3.2. How should the additionality of renewable energy be defined?

Additionality in renewable energy procurement for DACCS projects should mean that the procurement is enabling new generating capacity that would not have existed without a buyer. While this can be difficult to prove outright with vPPAs, one simple signal is if the procured energy comes from a new or existing generating facility.

To allow for practical implementation, some flexibility should be considered. A common benchmark across various standards such as EU CRCF[5], Puro.earth[6] and Isometric[7] is that the renewable energy source should have started operating no more than 36 months before the DACCS project begins. Isometrics goes further to allow the use of existing assets older than 36 months only if they are "stranded" and would otherwise be partially or full non-operational without the DACCS project's contract.

The Business Renewables Centre-Canada, an initiative of the Pembina Institute that aims to support grid decarbonization through corporate power procurement, features a Deal Tracker that logs corporate purchases across Canada. The Deal Tracker's inclusion criteria stipulates that the power purchase agreement must be publicly announced no later than six months after the generating facility's operational date, in order to demonstrate sufficient additionality.[8] This threshold was set based on the timing of deal announcements seen over the history of Alberta's vPPA market.

3.3. How can PPAs ensure the additionality of renewable energy and the exclusive claim to the environmental attributes by a proponent for a project?

PPAs involve a buyer agreeing to purchase a set amount of power from a generating facility at a fixed unit price for a long period of time. For the generating facility, this represents committed, predictable, long-term revenue. By contrast, revenues from selling power to the grid based on the spot price, or the real-time price of electricity based on generators bidding at the time, is difficult to predict because the spot price can fluctuate significantly. The stable revenue that PPAs provide can allow a renewable energy project to access project financing, which covers upfront capital costs and enables the project to be built.

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[5] European Commission, Commission Delegated Regulation (EU) 2023/1184, Article 5. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32023R1184

[6] Puro.earth, "Geologically Stored Carbon: Methodology for CO2 Removal." Edition 2024 version 2, 68. https://7518557.fs1.hubspotusercontent-na1.net/hubfs/7518557/Supplier%20Documents/Puro_Geologically_Stored_Carbon_Methodology.pdf

[7] Isometric, "Energy Use Accounting," v1.2, Section 5.3. https://registry.isometric.com/module/energy-use-accounting#eligibility-criteria-for-low-carbon-power-procurement

[8] Business Renewables Centre-Canada, "Deal Tracker." https://businessrenewables.ca/deal-tracker/about-short

For virtual PPAs, the transaction happens on paper. Electrons from the generating facility do not physically go to the buyer. Rather, the buyer and seller settle on payments that reflect the fixed price of the PPA, and the buyer receives the environmental attributes from the power they purchased. These attributes are serialized and logged within a registry to prevent double counting.

One potential barrier for DACCS project proponents looking to secure renewable energy through vPPAs is that buyers typically to have investment-grade credit ratings, meaning they are deemed to have a low risk for defaulting on financial obligations. This is often required for the vPPA to be recognized as sufficiently reliable future revenue by financiers.

Many DACCS developers are new SMEs and may not meet this threshold, which could make it difficult for them to enter into these long-term contracts. While alternative mechanisms exist to demonstrate creditworthiness such as letters of credit or surety bonds, they can introduce additional barriers and development costs.

There may be a benefit to providing flexibility in how renewable energy can be procured in order to enable DACCS projects to generate credits through this protocol. For example, there are options to purchase environmental attributes from sellers that can demonstrate the additionality of those attributes, without having the end-buyer directly involved in a long-term vPPA.

3.4. What criteria should be established for the temporal matching of the consumption and production of renewable energy?

While annual matching may be insufficient in the long term, it is not clear that hourly matching is the optimal or most feasible solution for all regions and projects. Given the limitations of current grid infrastructure and market structures, we recommend adopting a phased approach that aligns with emerging international standards, revising this requirement in the coming years.

Several leading frameworks have recognized the need for a gradual transition:

- EU CRCF requires monthly matching until 2029 after which hourly matching will be mandated.
- Isometric sets a similar timeline, requiring hourly matching only after 2028.

In Alberta, there has only been one vPPA announced to date that provides hourly matching of load and supply. In 2023, TC Energy and Loblaw's entered an agreement where Loblaw's load in Alberta would be matched on an hourly basis through a combination of wind, solar and pumped hydro storage facilities. These generating facilities are not yet operating.

Given these references and the evolving nature of grid capacity, we suggest scheduling increasing stringency of temporal matching once market conditions allow. This approach would ensure that DACCS projects can secure high-quality renewable energy while avoiding significant barriers that could delay deployment.

4.1. Should the protocol include construction GHG emissions in the quantification? Why/why not?

Yes, embodied emissions from construction should not be overlooked, as they contribute to the overall climate impact of a facility. Though they may be relatively small in comparison to the net removal generated by a project, a full life cycle assessment of emissions is critical for ensuring the transparency and credibility of DACCS projects.

Studies estimate that construction emissions for direct air capture facilities range from 6 to 16 g CO_2 per kg CO_2 captured.[9] While relatively small compared to operational emissions, these are not negligible when considering large-scale deployment of DACCS.

If construction emissions are accounted for, DACCS developers will have an incentive to optimize materials, processes, and energy sources to minimize embodied carbon. This could lead to better design choices, such as using low-carbon concrete and steel, improving efficiency, and reducing emissions from transportation and assembly.

4.2. If so, what are best practices and possible approaches for their quantification, given the challenges with shared facility or infrastructure? e.g. Should they be included only in the case of exclusive use facilities or infrastructure? Should a discount factor be applied to all projects throughout their crediting period?

When infrastructure is shared, a proportional allocation of emissions based on usage is a best practice for quantification. This ensures that emissions are fairly distributed among users rather than being attributed solely to one entity. The allocation method could be based on relevant metrics such as operational time, capacity utilization, or throughput.

5.1. How should the protocol consider the point source capture and geological storage of CO2 from project emissions? How could the quantification account for this reduction in project emissions being released to atmosphere, given the measurement and quantification

[9] Melinda M.J. de Jonge, Juul Daemen, Jessica M. Loriaux et al. "Life cycle carbon efficiency of Direct Air Capture systems with strong hydroxide sorbents," *International Journal of Greenhouse Gas Control* 80 (2019), 25-31. https://www.sciencedirect.com/science/article/abs/pii/S1750583618301464

challenges that may arise from intermingling both sources of CO2 from the capture facility?

The DACCS protocol should clearly differentiate between atmospheric CO_2 capture and point source CO_2 captured from project-related emissions. Any capture and storage of emissions related to the use of fuel within a DACCS project should not contribute to the generation of removal credits, but rather should be reflected in the lower carbon intensity of the energy used by the DACCS project. Separate measurement of the carbon dioxide captured from the atmosphere and that captured from the point source will be required.

6.1. Should the protocol maintain the requirement for continuous measurement of key data (e.g. volume or mass of CO2, CO2 concentration), or is a different approach more appropriate for DACCS projects? If so, what requirements should be included?

Yes, the protocol should maintain the requirement for continuous measurement of key data, such as CO_2 volume, mass and concentration, to ensure accuracy in CO_2 storage, prevent over-crediting, and minimize the risk of leakage. Continuous monitoring provides transparency and strengthens the credibility of DACCS projects.

The frequency of monitoring could be adjusted over time based on a storage risk assessment performed early in the project development as well as the continuous assessments. For instance, monitoring intervals may be more frequent in the early years of a project when risks are higher and could be gradually spaced out as long-term storage stability is demonstrated.

To enhance reliability, third-party verification should be required to independently assess reports and validate the data, ensuring compliance with protocol requirement and best practices.

8.1. Is a 100-year permanence monitoring period appropriate and achievable for DACCS projects? Why or why not?

A fixed 100-year monitoring period for sequestered CO_2 is significantly longer than what is seen in comparable jurisdictions regulating underground carbon storage. This may not be the most effective approach. Instead, we recommend establishing a default monitoring period of 20 to 50 years, with flexibility for adjustments based on project-specific risk assessment. Most

jurisdictions, including Alberta[10], the European Union[11], and the United States[12], follow this risk-based approach, allowing monitoring requirements to be reduced once sufficient evidence confirms the permanent containment and stability of the stored CO_2. This ensures early detection of potential issues, while also balancing costs and feasibility for project developers.

The risk of CO_2 decreases over time, as pressure stabilizes and secondary trapping mechanisms, such as solubility and mineral trapping, take effect. An overly long monitoring period could discourage investment in DACCS projects by increasing uncertainty around long-term costs. Additionally, there is a reasonable risk that project proponents are unable to maintain these commitments, meaning the commitments would fall to the Crown. To support investment, monitoring requirements should be clearly defined, transparent, and predictable from the outset, with clear assessment schedules and criteria for adjusting the timeframe. This balanced approach would safeguard environmental integrity while ensuring feasibility of DACCS projects.

8.4. Should there be any requirements included in the DACCS federal offset protocol with respect to CO_2 geological storage above and beyond CO_2 geological storage regulatory frameworks to ensure sufficient monitoring and permanence of GHG removals generated by projects as well as the integrity of federal offset credits? If so, what should they be?

No, additional requirements beyond existing provincial CO_2 geological storage regulations should not be necessary if those frameworks are deemed sufficient by the protocol. However, if offshore CO_2 storage is included in future protocol iterations, federal oversight may be required for projects on the federal seabed to ensure appropriate regulatory coverage. Otherwise, aligning with provincial frameworks should provide the necessary safeguards without adding redundant requirements.

9.1. If, under a CO_2 geological storage regulatory framework, a storage operator transfers liability to the government for the injection infrastructure and the associated storage reservoir within the project site of a DACCS project, what arrangements and agreements should the

[10] Government of Alberta, "Carbon capture, utilization and storage – Leadership." https://www.alberta.ca/carbon-capture-utilization-and-storage-leadership

[11] European Parliament and Council, *Directive 2009/31/EC on the geological storage of carbon dioxide*, Article 18, Transfer of responsibility. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02009L0031-20181224

[12] U.S. Environmental Protection Agency (EPA), *UIC Program Class VI Well Plugging, Post-Injection Site-Care, and Site Closure Guidance*, Section 3.2.1, Duration of PISC, p.31 (2016) https://www.epa.gov/sites/default/files/2016-12/documents/uic_program_class_vi_well_plugging_post-injection_site_care_and_site_closure_guidance.pdf

proponent have with the government to continue meeting all permanence monitoring requirements under the current Regulations and this protocol?

If liability is transferred to the government, data-sharing agreements should be in place to ensure ongoing access to storage performance data for transparency.

Financial security should also be arranged through a dedicated fund to which all project operators contribute. The fund would provide financial means for continuing monitoring as well as potential liabilities held by the Crown, mitigating risks associated with operator insolvency. Similar financial security mechanisms exist in Alberta and the European Union to ensure project safety, safeguard public interest and reduce financial risk for governments while maintaining investor confidence in DACCS projects.

Conclusion

In closing, we would like to express our gratitude for the development of a federal DACCS protocol. It is an important signal of the need to develop carbon removal capacity so Canada can achieve its net-zero targets.

We recommend that offshore carbon storage is included, provided that the project can meet the same safety criteria required of onshore projects.

We also recommend more flexibility in the additional renewable energy requirement across temporal matching and the types of market instruments recognized. This flexibility should be tightened over time.

Lastly, we request clarification on the requirement of a capture facility not being registered under any other GHG offset credit program, as well as what is necessary for a jurisdiction to be deemed having a sufficient storage regulatory framework.

Thank you for the opportunity to provide written comments. We look forward to continued engagement in this issue.