Direct Air Carbon Dioxide Capture and Geological Storage

Federal Offset Protocol

Public Consultation
Preliminary Draft
January 2025

Canada's Greenhouse Gas Offset Credit System

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Canada

Cat. No.: En14-564/2024E-PDF
ISBN: 978-0-660-74530-5
EC24060

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Foreword

Canada's Greenhouse Gas (GHG) Offset Credit System is established under Part 2 of the *Greenhouse Gas Pollution Pricing Act*, to provide an incentive to undertake projects that result in domestic GHG reductions that would not have been generated in the absence of the project, that go beyond legal requirements and that are not subject to carbon pollution pricing mechanisms.

Canada's GHG Offset Credit System consists of:

- The *Canadian Greenhouse Gas Offset Credit System Regulations* (the Regulations) which establish the system, implement the operational aspects and set the general requirements applicable to all project types;
- Federal offset protocols, included in the *Compendium of Federal Offset Protocols* (the Compendium), each containing requirements for project implementation and methods for quantifying GHG reductions for a given project type; and
- The Credit and Tracking System (CATS) to register offset projects, issue and track offset credits, and share key information through Canada's GHG Offset Credit System Public Registry.

Only projects following a federal offset protocol included in the Compendium and meeting all requirements outlined in the Regulations can generate GHG reductions for which federal offset credits may be issued under the Regulations.

Text in blue boxes throughout this preliminary draft protocol present additional context and questions on specific topics on which input is sought.

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1.0 Introduction

Direct air carbon dioxide (CO_2) capture is a technology that captures CO_2 directly from the atmosphere using chemical, mechanical and/or electrochemical processes. The captured CO_2 can be injected underground and many subsurface geological formations in Canada present a reliably permanent solution to storing CO_2. The storage of direct air captured CO_2 in subsurface geological formations constitutes a technology-based CO_2 removal (CDR) approach that reduces the levels of CO_2 in the atmosphere to complement greenhouse gas (GHG) emission reduction efforts.

The *Direct Air Carbon Dioxide Capture and Geological Storage* (DACCS) federal offset protocol will be intended for use by a proponent undertaking a project to capture CO_2 directly from the atmosphere and store it in subsurface geological formations. The result will be GHG removals compared to a business-as-usual scenario for which federal offset credits may be issued under the *Canadian Greenhouse Gas Offset Credit System Regulations* (the Regulations).[1]

The proponent must follow the methodology and requirements set out in this protocol, including those to quantify and report GHG removals generated by the eligible project activities. The requirements contained in this protocol are part of the Regulations and must be read in conjunction with provisions in the Regulations.

This protocol is designed to ensure the project generates GHG removals that are real, additional, quantified, verified, unique and permanent. This protocol is also developed in accordance with the principles of ISO 14064-2:2019 *Greenhouse gases – Part 2 – Specification with guidance at the project level for quantification, monitoring and reporting greenhouse gas emission reductions or removal enhancements* to ensure reported GHG removals generated as a result of implementing a project are relevant, complete, consistent, accurate, transparent, and conservative.

A project under this protocol can only generate GHG removals from the storage of CO_2 captured directly from the atmosphere in onshore, subsurface geological formations. A project under this protocol cannot take place on land that is not covered by a CO_2 geological storage regulatory framework.[2] GHG removals cannot be generated under this protocol from the storage of point-source captured CO_2 (e.g. an industrial facility), the storage of CO_2 in any materials or products (e.g. concrete and mining waste), or the use of CO_2 for the purposes of enhanced oil recovery.

[1] In the Regulations, the term “GHG reductions” includes reductions generated by preventing GHG emissions or removing GHGs from the atmosphere, but the term “GHG removals” is used throughout this preliminary draft protocol as it is more applicable to the project type.
[2] A project on land without a CO_2 geological storage regulatory framework is ineligible under this protocol. Once there is CO_2 geological storage regulatory framework that covers the land, eligibility under this protocol may be considered.

2.0 Terms and definitions

Captured carbon dioxide (CO_2)

means CO_2 from the atmosphere captured at a capture facility within the project site.

Capture facility

means the equipment and supporting buildings for direct air CO_2 capture, including for the isolation, purification, compression and/or dehydration of the captured CO_2.

Capture operator

means the entity responsible for the operation of the capture facility; this entity may be the proponent and may be the same entity as the transport operator and/or the storage operator.

Carbon dioxide (CO_2) geological storage regulatory framework

means one or more acts, regulations and/or other legal instruments established by a provincial or territorial government, detailing requirements, approvals and/or permits necessary for a storage operator to store CO_2 in a storage reservoir.

Injection infrastructure

means the injection well(s) and supporting equipment and buildings for CO_2 injection into an associated storage reservoir.

Permanence monitoring period

means the period of time for which the proponent must monitor the permanence of GHG removals generated by the project in accordance with subsection 22(1) of the Regulations.

Permanent

means GHG removals generated by a project and for which federal offset credits have been issued are not affected by a release for 100 years after the end of the project's crediting period.

Point of injection

means the aboveground location within an injection infrastructure (e.g. the injection well) from which CO_2 is injected into the associated storage reservoir.

Project period

means the period of time for which the proponent is subject to the Regulations for a registered project, inclusive of the crediting period and the permanence monitoring period.

Project site

means the combination of the capture facility, transport infrastructure, injection infrastructure and associated storage reservoir used for the purposes of the project.

Release

means either the escape of CO_2 stored by a project from the storage reservoir to the atmosphere, or the subsurface migration of CO_2 stored by a project outside the storage reservoir.

Reversal

means a release during the permanence monitoring period, or the portion of a release, during the second reporting period and subsequent reporting periods, that exceeds the net CO_2 stored by a project during the respective calendar year.

Storage hub

means a shared injection infrastructure and associated storage reservoir that can be used to store captured CO_2 from multiple sources.

Storage operator

means the entity responsible for the operation of the injection infrastructure and for the monitoring and oversight of the associated storage reservoir; this entity may be the proponent and may be the same entity as the capture operator and/or the transport operator.

Storage reservoir

means the extent of the subsurface geological formation within which the injected CO_2 is expected to migrate, as delineated and permitted under the CO_2 geological storage regulatory framework in the jurisdiction where the project site is located.

Transport operator

means the entity responsible for the operation of the transport infrastructure; this entity may be the proponent and may be the same entity as the capture operator and/or the storage operator.

Transport infrastructure

means the section of pipeline or the mobile equipment transporting CO_2 from the capture facility to the injection infrastructure.

Waste heat

means heat produced as a byproduct of industrial processes and released to the environment in the absence of the project.

3.0 Baseline scenario

3.1 Baseline condition

For a project to be eligible under this protocol, the following baseline condition must be met before the project start date:

- CO_2 has never been captured at the capture facility within the project site.

4.0 Project scenario

4.1 Project conditions

For a project to be eligible under this protocol, the following project conditions must be met:

- The CO_2 captured and stored by a project comes directly from the atmosphere.
- The project site is located in Canada, in a single province or territory.
- The project site is located in an eligible storage jurisdiction, as per Section 4.2.
- The project site includes only one capture facility and one injection infrastructure with an associated storage reservoir.
- CO_2 captured at the capture facility within the project site has not been injected into any storage reservoir or used for purposes other than CO_2 geological storage prior to the project start date.
- The capture facility within the project site must not be within another project site under this protocol.
- The capture facility within the project site must not be within a project registered in a GHG offset credit program other than the one set out in the Regulations.
- The capture facility within the project site began operating on or after January 1, 2022.
- The injection infrastructure and associated storage reservoir within the project site are assessed, approved, permitted, and operated in accordance with all applicable requirements of the CO_2 geological storage regulatory framework in the relevant eligible storage jurisdiction.
- The injection infrastructure and associated storage reservoir within the project site have site-specific monitoring requirements established and approved under the CO_2 geological storage regulatory framework in the relevant eligible storage jurisdiction that remain in force/effect for the duration of the project period.[3]
- The injection of captured CO_2 into the storage reservoir within the project site cannot be for the purpose of enhanced oil recovery.
- The current storage operator of the storage reservoir within the project site has never been responsible for or associated with a voluntary reversal under the Regulations.

[3] The term “monitoring requirement” is intended to be general and correspond to all/any requirements related to the operation and/or surveillance of the injection infrastructure and the associated storage reservoir under a CO_2 geological storage regulatory framework, which may individually use a different term. These monitoring requirements can exist in various forms, such as in an act; regulation; directive; license or permit; approved monitoring, measurement and verification plan; and/or approved closure plan.

- The proponent has the necessary agreements in place to access all information and data on the permanence of the GHG removals in the storage reservoir and any releases from the storage reservoir for the duration of the project period.

Text box 1: Possible business models and proponents

Across the DACCS industry chain, the direct air capture of CO_2, the transport of CO_2, and the geological storage of CO_2 can be non-integrated, meaning each part of a project may be under the ownership and operation of a different entity. As a result, the business models for DACCS projects could take different forms.

Regardless the business model, each project must have a single proponent. The proponent is legally responsible for the project and the offset credits issued, and must ensure all requirements in the Regulations and the protocol are met, including having the exclusive entitlement to claim the offset credits issued for the GHG removals generated by the project. Further, the proponent is responsible for ensuring the permanence of the GHG removals generated by the project, even if they are not the storage operator, and would be responsible for certain reversals that could occur within the project period.

There is no restriction on who the proponent of a project can be; it could be the capture operator, the storage operator (including of a storage hub), or a different entity such as a project developer undertaking the project in partnership with the operators.

Depending on who the proponent is, they may or may not be directly in control of all or any of the operations and activities of a DACCS project. This would require the collaboration of all entities involved in a DACCS project to meet all requirements under the Regulations and the DACCS federal offset protocol. Agreements, contracts, or partnerships would be required between the proponent and other entities involved for the proponent to be able to meet all requirements, such as those related to authorizations, exclusive entitlement, measurement and data, and permanence monitoring.

Questions:

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?

1.2. Will it be feasible for a proponent for this project type to establish agreements with all other entities involved in a project to satisfy requirements under the Regulations and protocol, such as the authorization to carry out the project activities, exclusive entitlement to the credits issued for the project, all data requirements, permanence monitoring, etc.? What type of authorizations will be required for the project activities? If not the proponent, who else will request the authorizations?

4.2 Eligible storage jurisdictions

An eligible storage jurisdiction is a province or territory in Canada where a project under this protocol may occur.

A designated jurisdiction, as set out under subsection 127.44 (13) of the *Income Tax Act*, is a jurisdiction determined by the Minister of the Environment to have sufficient environmental laws and enforcement (i.e. a CO2 geological storage regulatory framework) governing the permanent storage of captured CO_2.

The eligible storage jurisdictions under this protocol are the Canadian designated jurisdictions set out under the *Income Tax Act*.

4.3 Eligible project activities

Eligible project activities are the:

- Operation of a capture facility within the project site.
    - There is no restriction on the specific direct air CO_2 capture processes used; the capture technology may employ liquid solvents, solid sorbents, or any other existing or emerging methods.
    - During the crediting period, the capture facility within the project site may provide captured CO_2 for purposes/end uses other than CO_2 geological storage.[4]
- Operation of transport infrastructure within the project site (e.g. pipeline, rail, truck).
    - The transport infrastructure within the project site used to transport the captured CO_2 may have been operating prior to January 1, 2017, and for purposes unrelated to the project.
- Operation of injection infrastructure within the project site.
    - The injection infrastructure within the project site may have been injecting CO_2 into the associated storage reservoir prior to January 1, 2017, and can be a storage hub accepting CO_2 from sources unrelated to the project (i.e. other direct air or point source capture facilities).
- Management of a storage reservoir within the project site.
    - Other than enhanced oil recovery being ineligible, there is no restriction on the geological type of storage reservoir used.

[4] The captured CO_2 provided to an injection infrastructure outside the project site or for purposes unrelated to the project type cannot generate federal offset credits for the project.

5.0 Additionality

5.1 Legal additionality

GHG removals generated by a project must not occur as a result of federal, provincial or territorial laws or regulations, municipal by-laws, or any other legally binding mandates.

If at any time after project registration the GHG removals generated by the project become required by law or the result of a legal requirement, the GHG removals will no longer be additional and, therefore, federal offset credits can only be issued for GHG removals generated up to the date immediately preceding the date on which the law or the legal requirement comes into force.

5.2 Provincial or federal pricing mechanisms for GHG emissions

GHG reductions resulting from reducing or displacing fuels subject to a regulatory charge on fuel or another pricing mechanism for GHG emissions are not eligible for federal offset credits.

6.0 General requirements

6.1 Project start date

The start date of a project corresponds to the first day that CO_2 captured from the capture facility within the project site is injected into the storage reservoir within the project site.

To be eligible under this protocol, a project must have a start date that is on or after January 1, 2022.

6.2 Project site location and geographic boundaries

The proponent must document and report the location and geographic boundaries of the project site and submit a site plan.

The geographic boundary of the project site must be established as per the Regulations.

The site plan must show the location of all elements of the project site; this includes the capture facility, transport infrastructure, injection infrastructure and associated storage reservoir. The site plan must also show the location and arrangement of all project components associated with direct air CO_2 capture and CO_2 geological storage such as the direct air CO_2 capture equipment, CO_2 pipeline, CO_2 injection well(s), measuring devices and any other equipment associated with the GHG sources, sinks and reservoirs (SSRs) within the project GHG boundary.

For the storage reservoir within the project site, the site plan must include details on the geological type, confinement or trapping mechanisms, and all wells penetrating the storage reservoir.

Text box 2: Cross-border transport of CO_2

For some DACCS projects, CO_2 can have to be transported long distances to optimize the location of the capture and storage operations with availability of renewable energy and geological potential, respectively. This can include transport across provincial or territorial borders. However, the Regulations currently require a federal offset project to be located in one jurisdiction.

Question:

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?

6.3 Aggregation

Aggregation of two or more DACCS projects is not eligible under this protocol.

6.4 Environmental and social safeguards

6.4.1 Compliance with applicable requirements

The proponent must ensure the project activities comply with any acts, regulations, directives, leases, licenses, permits and other requirements applicable to the capture facility, transport infrastructure, injection infrastructure and storage reservoir within the project site. This includes those related to technical, environmental, health and safety considerations.

6.4.2 Avoiding the displacement of renewable energy

If the proponent procures renewable energy for a project (e.g. for the operation of the capture facility), they must ensure and demonstrate that the renewable energy is additional, meaning the renewable energy is generated explicitly for the project and is not displaced and removed from the grid or pre-existing end users.

The additional renewable energy procured by the proponent for a project must be produced in the same province or territory as the project. In cases where the renewable energy is delivered through the grid, the project and the energy production facility must be connected to the same grid within the province or territory of the project.

The proponent must also have exclusive claim to the attributes of any renewable energy being procured for the project to ensure that they are not being claimed by another entity (e.g. through renewable energy credits/certificates).

Text box 3: Procurement of renewable energy

Due to the energy intensity of direct air CO_2 capture, the source of electricity used to power these projects is impactful. Use of renewable energy rather than non-renewable energy (i.e. from combustion of fossil fuels) is key to maximizing the net negative emissions benefit. While

not required, the protocol does facilitate the use of renewable energy by recognizing an energy-specific emission factor, provided the project proponent can demonstrate that the renewable energy is additional.

A possible means of procuring renewable energy is through a power purchase agreement (PPA), an agreement between an energy buyer-consumer (in this protocol, the proponent or the capture operator) and an energy producer, covering the delivery of renewable energy for a predetermined period and an agreed-upon price.

For the purpose of this discussion, PPA arrangements include a “direct’’ PPA, whereby the energy producer and the buyer-consumer are connected to the same grid; or an ‘‘indirect’’ PPA, whereby the energy producer and the buyer-consumer are not connected to the same grid. In direct PPAs, the buyer-consumer receives the energy through the grid and the corresponding environmental attributes. In indirect PPAs, the buyer-consumer only receives the environmental attributes of the energy.

The use of PPAs in the way needed for DACCS projects is not widespread in Canada; programs or policies in this area may be needed to enable or facilitate such mechanisms and grid authorities may need to be involved. The provisions of a PPA would need to ensure the additionality of the renewable energy and the exclusive claim of the buyer-consumer to the environmental attributes of the energy. Furthermore, as stated in Section 6.4.2, in the context of this proposed protocol, any energy procured for the project must be produced within the same province or territory and within the same grid as the project; this would prevent the use of indirect PPAs.

Questions:

In the context of the proposed DACCS federal offset protocol:

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

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

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?

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

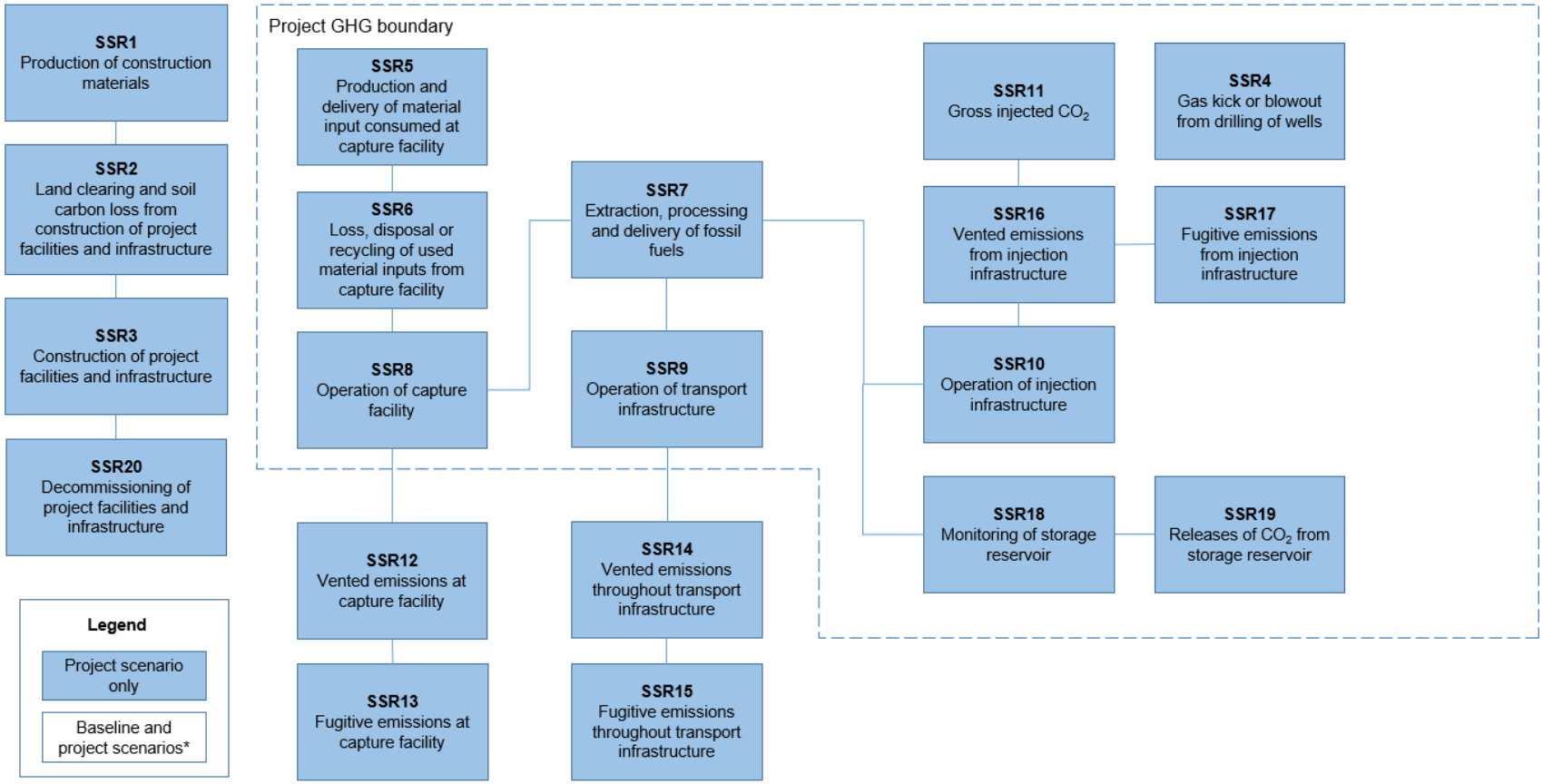
7.0 Project GHG boundary

The project GHG boundary (Figure 1) contains the GHG sources, sinks and reservoirs (SSRs) that must be included or excluded in the baseline and/or the project scenarios to determine the GHG removals generated by the project.

Table 1 provides additional details on the SSRs identified for the project scenario, as well as justification for their inclusion or exclusion in the quantification of GHG removals. As per Section 3.0, since there is no storage of captured CO_2 in the baseline scenario of a project under this protocol, there are no identified baseline scenario SSRs.

Three GHGs are relevant to the SSRs in this protocol: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

Figure 1: Illustration of the project GHG boundary



* For this project type, and as per Section 3.0 and 8.1, there are no baseline scenario SSRs.

Table 1: Details on project scenario SSRs

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
1	Production of construction materials	Emissions from the production and delivery of construction materials for the capture facility, transport infrastructure and injection infrastructure within the project site	Related	Project	CO_2 CH_4 N_2O	**Excluded:** GHG emissions from this source are assumed to be negligible over the lifetime of the project
2	Land clearing and soil carbon loss from construction of project facilities and infrastructure	Emissions from land clearing and soil carbon loss from the construction of capture facility, transport infrastructure and injection infrastructure within the project site	Controlled	Project	CO_2	**Excluded:** GHG emissions from this source are assumed to be negligible over the lifetime of the project
3	Construction of project facilities and infrastructure	Emissions from equipment and activities required for the construction of capture facility, transport infrastructure and injection infrastructure within the project site	Controlled	Project	CO_2 CH_4 N_2O	**Excluded:** GHG emissions from this source are assumed to be negligible over the lifetime of the project

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
4	Gas kick or blowout from drilling of wells	Emissions from gas kick or blowout from the drilling of wells for the injection infrastructure within the project site	Controlled	Project	CO_2 CH_4	**Included:** Quantified based on the volume of the gas kick or blow out, using Equation 9.
5	Production and delivery of material input consumed at capture facility	Emissions associated with fossil fuels and electricity used to produce and deliver material inputs (e.g. solvents, sorbents) to the capture facility within the project site	Related	Project	CO_2 CH_4 N_2O	**Included:** Quantified based on the quantity of consumed material input and an associated emission factor, using Equation 10.
6	Loss, disposal or recycling of used material inputs from capture facility	Emissions associated with fossil fuels and electricity used to process the loss, disposal and recycling of used material inputs (e.g. solvents, sorbents) from the capture facility within the project site	Related	Project	CO_2 CH_4 N_2O	**Included:** Quantified based on the quantity of used material input and an associated emission factor, using Equation 11.
7	Extraction, processing and delivery of fossil fuels	Emissions associated with the extraction, processing and delivery of fossil fuels used on-site for the generation of heat, electricity and energy consumed by the project	Related	Project	CO_2 CH_4 N_2O	**Included:** Quantified as per Equation 12.

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
8	Operation of capture facility	Emissions from the on-site or off-site combustion of fossil fuels (for heat, electricity or energy) or consumption of off-site generated electricity for the operation of the capture facility within the project site including all capture, isolation, purification, compression and dehydration processes.	Fossil Fuels: Controlled Electricity: Related	Project	CO_2 CH_4 N_2O	**Included:** This is a substantial energy input, quantified as per Equation 14.
9	Operation of transport infrastructure	Emissions from the on-site or off-site combustion of fossil fuels (for heat, electricity or energy) or consumption of off-site generated electricity for the operation of all transport infrastructure within the project site.	Fossil Fuels: Controlled Electricity: Related	Project	CO_2 CH_4 N_2O	**Included:** Quantified as per Equation 18.
10	Operation of injection infrastructure	Emissions from the on-site or off-site combustion of fossil fuels (for heat, electricity or energy) or consumption of off-site generated electricity for the operation of the injection infrastructure within the project site.	Fossil Fuels: Controlled Electricity: Related	Project	CO_2 CH_4 N_2O	**Included:** Quantified as per Equation 23.

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
11	Gross CO_2 injected	Quantity of CO_2 from the capture facility within the project site injected into the storage reservoir within the project site	Controlled	Project	CO_2	**Included:** Quantified as per Equation 3 or 4, depending on the unit of measurement of CO_2.
12	Vented emissions at capture facility	Intentionally released emissions during maintenance or emergency shutdowns of equipment related to capture, isolation/purification, compression and/or dehydration of CO_2 at the capture facility within the project site.	Controlled	Project	CO_2	**Excluded:** Occur upstream from the point of CO_2 measurement so do not need to be quantified.
13	Fugitive emissions at capture facility	Unintentionally released emissions through faulty or loose seals and/or fittings from equipment related to capture, isolation/purification, compression and/or dehydration of CO_2 at the capture facility within the project site.	Controlled	Project	CO_2	**Excluded:** Occur upstream from the point of CO_2 measurement so do not need to be quantified.

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
14	Vented emissions throughout transport infrastructure	Intentionally released emissions during maintenance or emergency shutdowns of equipment related to the transport infrastructure within the project site.	Controlled	Project	CO_2	**Excluded:** Occur upstream from the point of CO_2 measurement so do not need to be quantified.
15	Fugitive emissions throughout transport infrastructure	Unintentionally released emissions through faulty or loose seals and/or fittings from equipment related to the transport infrastructure within the project site.	Controlled	Project	CO_2	**Excluded:** Occur upstream from the point of CO_2 measurement so do not need to be quantified.
16	Vented emissions from injection infrastructure	Intentionally released emissions during maintenance or inspections of equipment related to the injection of CO_2 into the storage reservoir within the project site.	Controlled	Project	CO_2	**Included:** Emissions occur after the point of CO_2 measurement and need to be deducted. Quantified based on the volume of each venting event, using Equation 26.

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
17	Fugitive emissions from injection infrastructure	Unintentionally released emissions through faulty or loose seals and/or fittings from equipment related to the injection of CO_2 into the storage reservoir within the project site.	Controlled	Project	CO_2	**Included:** Emissions occur after the point of CO_2 measurement and need to be deducted. Quantified based on fugitive emission rates by source, using Equation 27.
18	Monitoring of storage reservoir	Emissions from the on-site or off-site combustion of fossil fuels (for heat, electricity or energy) or consumption of off-site generated electricity for the monitoring of the storage reservoir within the project site.	Fossil Fuels: Controlled Electricity: Related	Project	CO_2 CH_4 N_2O	**Included:** Quantified as per Equation 22.
19	Releases of CO_2 from storage reservoir	The escape of CO_2 stored by a project from the storage reservoir to the atmosphere, or the subsurface migration of CO_2 stored by a project outside the storage reservoir.	Controlled	Project	CO_2	**Included:** Quantified based on an engineering estimate and using Equation 28 and/or Equation 29, as applicable.

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
20	Decommissioning of project facilities and infrastructure	Emissions associated with the use of fossil fuels or electricity for the disassembly, demolition, disposal and/or restoration of the capture facility, transport infrastructure, injection infrastructure or associated storage reservoir within the project site.	Controlled	Project	CO_2 CH_4 N_2O	**Excluded:** GHG emissions from this source are assumed to be negligible over the lifetime of the project

Text box 4: Exclusion of construction GHG emissions

Depending on the size and complexity of the capture facility, transport infrastructure and injection infrastructure within a project site, the GHG emissions associated with the construction of the project infrastructure and facilities may be large.

Within the context of an offset project, there are challenges with quantifying these GHG emissions since they may have occurred prior to the project start date and may be associated with a facility or infrastructure that may be shared in the present and over time. The emissions associated with shared facilities or infrastructure may need to be partly allocated to a project undertaken in another offset program or carbon pricing mechanism or operating for other purposes/end uses. Furthermore, capture facilities and transport and injection infrastructures are likely to be covered by governmental environmental impact assessments, requiring reduction or mitigation efforts for the construction of these facilities and infrastructures. Finally these GHG emissions may ultimately be negligible over the lifetime of the offset project.

Given these considerations, the current preliminary draft proposes to exclude construction GHG emissions from the quantification.

Questions:

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

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?

8.0 Quantification methodology

This section contains the quantification methodology that the proponent must follow to quantify baseline and project scenario GHG removals, which are subsequently used to quantify the total GHG removals generated by the project.

Baseline scenario GHG removals are the GHG removals that would have occurred in the absence of the project, quantified based on SSRs within the project GHG boundary. Project scenario GHG removals are the actual GHG removals that occur from SSRs within the project GHG boundary. The GHG removals generated by the project are quantified by deducting the baseline scenario GHG removals from the project scenario GHG removals as outlined in Section 8.4.

The quantification of both the baseline and project scenario GHG removals must include all the GHG removals that would have likely occurred in the absence of the project (baseline scenario) and did occur (project scenario) during the reporting period and must include sub-totals in tonnes of CO_2 equivalent (t CO_2e) for each full or partial calendar year to support issuance of the resulting offset credits by calendar year.

Some emission factors and reference values that are used in the quantification are provided in the *Emission Factors and Reference Values* document.

8.1 Baseline scenario GHG removals

The baseline scenario GHG removals must capture the aggregate of all GHGs emitted to (sources) and removed from (sinks) the atmosphere in the baseline scenario. Since there are no baseline scenario SSRs, the baseline scenario GHG removals for a project under this protocol (Equation 1) are equal to zero and the value for BR_C in Equation 32 of Section 8.4 is zero.

Equation 1: Baseline scenario GHG removals

$$\mathrm{BR_C} = 0$$

Parameter	Description	Units
$\mathrm{BR_C}$	Baseline scenario GHG removals for a calendar year covered by the reporting period	t CO_2e

8.2 Project scenario GHG removals

The project scenario GHG removals must capture the aggregate of all GHGs emitted to and removed from the atmosphere in the project scenario.

The proponent must use Equation 2 and the subsequent equations in this section to quantify the project scenario GHG removals for each full or partial calendar year covered by the reporting period, based on the included SSRs outlined in Table 1.

The project scenario GHG removals are quantified by deducting the project emissions and releases of CO_2 from the gross CO_2 injected into the storage reservoir.

Equation 2: Project scenario GHG removals

$$PR_C = INJ_{CO_2} - PE_C - REL_{CO_2}$$

Parameter	Description	Units
PR_C	Project scenario GHG removals for a calendar year covered by the reporting period	t CO_2e
INJ_{CO_2}	Gross CO_2 injected into the storage reservoir for the purposes of the project for a calendar year covered by the reporting period, as per Equation 3 or 4 (SSR11)	t CO_2e
PE_C	Project emissions for a calendar year covered by the reporting period, as per Equation 5	t CO_2e
REL_{CO_2}	Releases of CO_2 associated with the project for a calendar year covered by the reporting period, determined through estimation and using Equation 28 and/or 29, as applicable (SSR19)	t CO_2e

The proponent must use Equation 3 or 4 to quantify the gross CO_2 injected into the storage reservoir for the purposes of the project for a calendar year covered by the reporting period. The choice of equation depends on the measuring device used to measure the injected CO_2. If a volumetric flow meter is used, the proponent must use Equation 3; if a mass flow meter is used, the proponent must use Equation 4.

Equation 3: Gross CO_2 injected – volumetric flow

$$INJ_{CO_2} = \frac{VOL_{CO_2} \times CONC_{CO_2} \times \rho_{CO_2}}{1000}$$

Parameter	Description	Units
INJ_{CO_2}	Gross CO_2 injected into the storage reservoir for the purposes of the project for a calendar year covered by the reporting period (SSR11)	t CO_2e
VOL_{CO_2}	Volume of CO_2 injected into the storage reservoir for the purposes of the project for a calendar year covered by the reporting period	m^3
$CONC_{CO_2}$	Concentration of CO_2 injected into the storage reservoir for the purposes of the project for a calendar year covered by the reporting period	%
ρ_{CO_2}	Density of CO_2	kg/m^3
1000	Conversion factor, kilograms to tonnes	kg/t

Equation 4: Gross CO_2 injected – mass flow

$$INJ_{CO_2} = \frac{MASS_{CO_2} \times CONC_{CO_2}}{1000}$$

Parameter	Description	Units
INJ_{CO_2}	Gross CO_2 injected within the project site for a calendar year covered by the reporting period (SSR11)	t CO_2e
$MASS_{CO_2}$	Mass of CO_2 injected into the storage reservoir for the purposes of the project for a calendar year covered by the reporting period	kg

$\mathrm{CONC}_{\mathrm{CO_2}}$	Concentration of CO_2 injected into the storage reservoir for the purposes of the project for a calendar year covered by the reporting period	%
1000	Conversion factor, kilograms to tonnes	kg/t

The proponent must use Equation 5 and the related equations to quantify the project emissions, which include those from well drilling; from the production and disposal of material inputs for direct air CO_2 capture; from the operation of the capture, transport, injection and storage infrastructure and facilities; and from venting and fugitive releases from the injection infrastructure. The value achieved by deducting the project emissions (Equation 5) from the gross CO_2 injected (Equation 3 or 4) is referred to within this protocol as the net CO_2 stored.

Equation 5: Project emissions

$$\mathrm{PE_C} = \mathrm{DR} + \mathrm{MI_{PD}} + \mathrm{MI_{LDR}} + \mathrm{EPD_{FF,GHG}} + \mathrm{DACCS_{op,GHG}} + \mathrm{VENT_{INJ}} + \mathrm{FUG_{INJ}}$$

Parameter	Description	Units
$\mathrm{PE_C}$	Project emissions for a calendar year covered by the reporting period	t CO_2e
DR	Emissions from gas kick or blowout from drilling of wells for the injection infrastructure within the project site, as per Equation 9 (SSR4)	t CO_2e
$\mathrm{MI_{PD}}$	Emissions from the production and delivery of material input consumed at the capture facility within the project site for a calendar year covered by the reporting period, as per Equation 10 (SSR5)	t CO_2e
$\mathrm{MI_{LDR}}$	Emissions from the loss, disposal or recycling of used material input from the capture facility within the project site for a calendar year covered by the reporting period, as per Equation 11 (SSR6)	t CO_2e
$\mathrm{EPD_{FF,GHG}}$	Emissions from the extraction, processing and delivery of fossil fuels consumed on-site for the operation of the DACCS project for a calendar year covered by the reporting period, as per Equation 12 (SSR7)	t CO_2e
$\mathrm{DACCS_{op,GHG}}$	Emissions from the operation of the capture facility, transport infrastructure, injection infrastructure and associated storage reservoir within the project site, for a calendar year covered by the reporting period, as per Equation 13 (SSR8, SSR9, SSR10, SSR18)	t CO_2e
$\mathrm{VENT_{INJ}}$	Vented emissions from the injection infrastructure within the project site for a calendar year covered by the reporting period, as per Equation 26 (SSR16)	t CO_2e
$\mathrm{FUG_{INJ}}$	Fugitive emissions from the injection infrastructure within the project site for a calendar year covered by the reporting period, as per Equation 27 (SSR17)	t CO_2e

As Equation 5 quantifies the project emissions, each parameter must be prorated to the CO_2 associated with the project in the case of shared facilities and infrastructure. The proponent must use Equations 6, 7 and 8 to determine a proration factor for the project emissions associated with a capture facility, transport infrastructure, and injection infrastructure within the project site, based on the quantity of CO_2 associated with the project. Any CO_2 unassociated

with the project that is captured at a shared capture facility or injected at shared injection infrastructure within the project site, cannot generate federal offset credits for the project.

Equation 6: Proration factor for shared capture facility

$$\mathrm{PF}_{\mathrm{CAP}} = \frac{\mathrm{CAP}_{\mathrm{CO}_2}}{\mathrm{CAP}_{\mathrm{total,CO}_2}}$$

Parameter	Description	Units
$\mathrm{PF}_{\mathrm{CAP}}$	Proration factor for project emissions from a shared capture facility. If the capture facility is used exclusively by the project, this value is 1.	-
$\mathrm{CAP}_{\mathrm{CO}_2}$	Volume of CO_2 captured at the capture facility within the project site and sent to the injection infrastructure within the project site for the purposes of the project for a calendar year covered by the reporting period	m^3
$\mathrm{CAP}_{\mathrm{total,CO}_2}$	Total volume of CO_2 captured at the capture facility for a calendar year covered by the reporting period	m^3

Equation 7: Proration factor for shared transport infrastructure

$$\mathrm{PF}_{\mathrm{TRA}} = \frac{\mathrm{TRA}_{\mathrm{CO}_2}}{\mathrm{TRA}_{\mathrm{total,CO}_2}}$$

Parameter	Description	Units
$\mathrm{PF}_{\mathrm{TRA}}$	Proration factor for project emissions from a shared transport infrastructure. If the transport infrastructure is used exclusively by the project, this value is 1.	-
$\mathrm{TRA}_{\mathrm{CO}_2}$	Volume of captured CO_2 transported by the transport infrastructure from the capture facility to the injection infrastructure within the project site for the purposes of the project for a calendar year covered by the reporting period	m^3
$\mathrm{TRA}_{\mathrm{total,CO}_2}$	Total volume of CO_2 transported by the transport infrastructure for a calendar year covered by the reporting period	m^3

Equation 8: Proration factor for shared injection infrastructure and associated storage reservoir

$$\mathrm{PF}_{\mathrm{INJ}} = \frac{\mathrm{INJ}_{\mathrm{CO}_2}}{\mathrm{INJ}_{\mathrm{total,CO}_2}}$$

Parameter	Description	Units
$\mathrm{PF}_{\mathrm{INJ}}$	Proration factor for project emissions from a shared injection infrastructure and associated storage reservoir. If the injection infrastructure and associated storage reservoir are used exclusively by the project, this value is 1.	-
$\mathrm{INJ}_{\mathrm{CO}_2}$	Gross CO_2 injected into the storage reservoir from the capture facility within the project site, for a calendar year covered by the reporting period, as per Equation 3 or 4 (SSR11).	t CO_2e
$\mathrm{INJ}_{\mathrm{total,CO}_2}$	Gross CO_2 injected into the storage reservoir, from all sources, for a calendar year covered by the reporting period.	t CO_2e

The proponent must use Equation 9 to quantify emissions from gas kick or blow out from drilling wells within the project site.

Equation 9: Emissions from gas kick or blowout from drilling of wells

$$DR = \frac{\sum_{g=1}^{n} (VOL_{GB} \times GB_{\%GHG,g} \times \rho_{GHG,g} \times GWP_{GHG,g}) \times PF_{INJ}}{1000}$$

Parameter	Description	Units
DR	Emissions from gas kick or blowout from the drilling of wells for the injection infrastructure within the project site (SSR4)	t CO_2e
VOL_{GB}	Volume of gas kick or blowout from drilling of wells for the injection infrastructure within the project site	m^3
$GB_{\%GHG,g}$	Concentration of GHG, g, in the gas kick or blowout from drilling of wells for the injection infrastructure within the project site	%
$\rho_{GHG,g}$	Density of GHG, g	kg/m^3
$GWP_{GHG,g}$	GWP of GHG, g, as set out in Column 2 of Schedule 3 of the Act	-
PF_{INJ}	Proration factor for project emissions at a shared injection infrastructure and associated storage reservoir, as per Equation 8. If the injection infrastructure and associated storage reservoir are used exclusively by the project, this value is 1.	-
1000	Conversion factor, kilograms to tonnes	kg/t
g	Specific GHG in the gas kick or blowout from drilling	-
n	Number of GHGs in the gas kick or blowout from drilling	-

The proponent must use Equations 10 and 11 to quantify the emissions related to the production and delivery, and the loss, disposal or recycling of material inputs consumed at the capture facility within the project site. If there are multiple material inputs, the summation must be used. The proponent must also ensure that material- and project-specific emission factors are determined and used for each material input.

Equation 10: Production and delivery of material input consumed at the capture facility

$$MI_{PD} = \sum_{m=1}^{n} (MI_{consumed,m} \times EF_{MIPD,m}) \times PF_{CAP}$$

Parameter	Description	Units
MI_{PD}	Emissions from the production and delivery of material input consumed at the capture facility within the project site for a calendar year covered by the reporting period (SSR5)	t CO_2e
$MI_{consumed,m}$	Quantity of material input, m, consumed at the capture facility for a calendar year covered by the reporting period	kg
$EF_{MIPD,m}$	Emission factor for production and delivery of material input, m, consumed at the capture facility. This factor must be material- and project-specific.	t CO_2e/kg
PF_{CAP}	Proration factor for project emissions from a shared capture facility, as per Equation 6. If the capture facility is used exclusively by the project, this value is 1.	-
m	Specific material input consumed at the capture facility	-
n	Number of material input consumed at the capture facility	-

Equation 11: Loss, disposal or recycling of used material input from the capture facility

$$\mathrm{MI_{LDR}} = \sum_{\mathrm{m=1}}^{\mathrm{n}} (\mathrm{MI_{used,m}} \times \mathrm{EF_{MILDR,m}}) \times \mathrm{PF_{CAP}}$$

Parameter	Description	Units
$\mathrm{MI_{LDR}}$	Emissions from the loss, disposal or recycling of used material input from the capture facility within the project site for a calendar year covered by the reporting period (SSR6)	t CO_2e
$\mathrm{MI_{used,m}}$	Quantity of used material input, m, from the capture facility for a calendar year covered by the reporting period	kg
$\mathrm{EF_{MILDR,m}}$	Emission factor for loss, disposal or recycling of used material input, m, from the capture facility. This factor must be material- and project-specific.	t CO_2e/kg
$\mathrm{PF_{CAP}}$	Proration factor for project emissions from a shared capture facility, as per Equation 6. If the capture facility is used exclusively by the project, this value is 1.	-
m	Specific used material input from the capture facility	-
n	Number of used material input from the capture facility	-

The proponent must use Equation 12 to quantify the emissions from the extraction, processing and delivery of fossil fuels used on-site for the operation of the DACCS project. This includes the operation of the capture facility, transport infrastructure and injection infrastructure and the monitoring of the associated storage reservoir. If there are multiple fossil fuels used with different emission factors, the summation must be used.

Equation 12: Emissions from the extraction, processing and delivery of fossil fuels consumed on-site for the operation of the DACCS project

$$\mathrm{EPD_{FF,GHG}} = \sum_{\mathrm{f=1}}^{\mathrm{n}} \begin{bmatrix} (\mathrm{FF_{DACCS,on,f}} \times \mathrm{EF_{CO_2,EPD,f}}) \\ +(\mathrm{FF_{DACCS,on,f}} \times \mathrm{EF_{CH_4,EPD,f}} \times \mathrm{GWP_{CH_4}}) \\ +(\mathrm{FF_{DACCS,on,f}} \times \mathrm{EF_{N_2O,EPD,f}} \times \mathrm{GWP_{N_2O}}) \end{bmatrix} \div 1000$$

Parameter	Description	Units
$\mathrm{EPD_{FF,GHG}}$	Emissions from the extraction, processing and delivery of fossil fuels consumed on-site for the operation of the DACCS project for a calendar year covered by the reporting period (SSR7)	t CO_2e
$\mathrm{FF_{DACCS,on,f}}$	Volume of fossil fuel, f, consumed on-site for the generation of heat, electricity or energy for the operation of the DACCS project, for a calendar year covered by the reporting period. This corresponds to the parameters $FF_{CAP,on,f}$, $FF_{TRA,on,f}$, and/or $FF_{INJ,on,f.}$	m^3
$\mathrm{EF_{CO_2,EPD,f}}$	CO_2 emission factor for the extraction, processing and delivery of fossil fuel, f, as set out in the Emission Factors and Reference Values document.	kg CO_2/m^3
$\mathrm{EF_{CH_4,EPD,f}}$	CH_4 emission factor for the extraction, processing and delivery of fossil fuel, f, as set out in the Emission Factors and Reference Values document.	kg CH_4/m^3
$\mathrm{GWP_{CH_4}}$	GWP of CH_4, as provided in Column 2 of Schedule 3 to the Act	-

$EF_{N_2O,EPD,f}$	N_2O emission factor for the extraction, processing and delivery of fossil fuel, f, as set out in the Emission Factors and Reference Values document.	kg N_2O/m^3
GWP_{N_2O}	GWP of N_2O, as provided in Column 2 of Schedule 3 to the Act	-
1000	Conversion factor, kilograms to tonnes	kg/t
f	Specific fossil fuel consumed on-site for the operation of the DACCS project	-
n	Number of fossil fuels consumed on-site for the operation of the DACCS project	-

The proponent must use Equations 13 to 25 to quantify the emissions from the operation of the DACCS project, which includes the operation of the capture facility, transport infrastructure, injection infrastructure, and associated storage reservoir.

Equation 13: Emissions from the operation of the DACCS project

$$DACCS_{op,GHG} = CAP_{op,GHG} + TRA_{op,GHG} + INJ_{op,GHG}$$

Parameter	Description	Units
$DACCS_{op,GHG}$	Emissions from the operation of the capture facility, transport infrastructure, injection infrastructure and associated storage reservoir within the project site, for a calendar year covered by the reporting period (SSR8, SSR9, SSR10, SSR18)	t CO_2e
$CAP_{op,GHG}$	Emissions from the operation of the capture facility within the project site for a calendar year covered by the reporting period, as per Equation 14 (SSR8)	t CO_2e
$TRA_{op,GHG}$	Emissions from the operation of the transport infrastructure within the project site for a calendar year covered by the reporting period, as per Equation 18 (SSR9)	t CO_2e
$INJ_{op,GHG}$	Emissions from the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site for a calendar year covered by the reporting period, as per Equation 22 (SSR10, SSR18)	t CO_2e

The proponent must use Equation 14 to quantify the emissions from the operation of the capture facility within the project site.

Text box 5: Capture and storage of CO_2 from project emissions

Direct air CO_2 capture requires energy that may, depending on the source, have GHG emissions associated with its production and use. These project emissions are accounted for in SSR8, in order to be deducted from the gross CO_2 injected and determine the net CO_2 stored by the project. However, ECCC understands that in some cases CO_2 from these project emissions may not be released to atmosphere, but may be captured by a point source CO_2 capture system and combined with the direct air captured CO_2 for geological storage.

As per the project conditions, only the storage of direct air captured CO_2 can generate credits under this protocol.

Question:

5.1. How should the protocol consider the point source capture and geological storage of CO_2 from project emissions? How could the quantification account for this reduction in project

emissions being released to atmosphere, given the measurement and quantification challenges that may arise from intermingling both sources of CO_2 from the capture facility?

Equation 14: Emissions from the operation of the capture facility

$$\mathrm{CAP_{op,GHG}} = (\mathrm{EL_{CAP,off,GHG}} + \mathrm{HEAT_{CAP,off,GHG}} + \mathrm{FF_{CAP,on,GHG}}) \times \mathrm{PF_{CAP}}$$

Parameter	Description	Units
$\mathrm{CAP_{op,GHG}}$	Emissions from the operation of the capture facility within the project site for a calendar year covered by the reporting period (SSR8)	t CO_2e
$\mathrm{EL_{CAP,off,GHG}}$	Emissions from the off-site generation of electricity for the operation of the capture facility for a calendar year covered by the reporting period, as per Equation 15	t CO_2e
$\mathrm{HEAT_{CAP,off,GHG}}$	Emissions from the off-site generation of heat for the operation of the capture facility for a calendar year covered by the reporting period, as per Equation 16	t CO_2e
$\mathrm{FF_{CAP,on,GHG}}$	Emissions from the on-site combustion of fossil fuels for the generation of heat, electricity or energy for the operation of the capture facility for a calendar year covered by the reporting period, as per Equation 17	t CO_2e
$\mathrm{PF_{CAP}}$	Proration factor for project emissions from a shared capture facility, as per Equation 6. If the capture facility is used exclusively by the project, this value is 1.	-

The proponent must use Equation 15 to quantify the emissions from the off-site generation of electricity for the operation of the capture facility. If there are multiple sources of off-site generated electricity, the summation must be used.

Equation 15: Emissions from the off-site generation of electricity for the operation of the capture facility

$$\mathrm{EL_{CAP,off,GHG}} = \frac{\sum_{e=1}^{n}(\mathrm{EL_{CAP,off,e}} \times \mathrm{EF_{CAP,EL,GHG,e}})}{1000}$$

Parameter	Description	Units
$\mathrm{EL_{CAP,off,GHG}}$	Emissions from the off-site generation of electricity for the operation of the capture facility for a calendar year covered by the reporting period	t CO_2e
$\mathrm{EL_{CAP,off,e}}$	Off-site generated electricity from source, e, consumed for the operation of the capture facility for a calendar year covered by the reporting period	MWh
$\mathrm{EF_{CAP,EL,GHG,e}}$	Emission factor for the off-site generated electricity from source, e, consumed for the operation of the capture facility. This may be the GHG consumption intensity emission factor for grid electricity from the project jurisdiction, or an emission factor for electricity procured through a power purchase agreement (Section 6.4.2).	kg CO_{2e}/MWh
e	Specific source of electricity	-

n	Number of sources of electricity used by the capture facility	-
1000	Conversion factor, kilograms to tonnes	kg/t

The proponent must use Equation 16 to quantify the emissions from the off-site generation of heat for the operation of the capture facility. If there are multiple sources of off-site generated heat, the summation must be used.

The emission factor used may be as provided in the *Emission Factors and Reference Values* document, or a process-specific value provided by the producer of the heat. In the case of waste heat, the emission factor is zero as all emissions are attributed to the original industrial process. No emissions from the production of the waste heat are attributed to the project, since the heat which would have been released to the environment in the absence of the project.

Equation 16: Emissions from the off-site generation of heat for the operation of the capture facility

$$\mathrm{HEAT}_{\mathrm{CAP,off,GHG}} = \frac{\sum_{\mathrm{h=1}}^{\mathrm{n}} (\mathrm{HEAT}_{\mathrm{CAP,off,h}} \times \mathrm{EF}_{\mathrm{CAP,HEAT,GHG,h}})}{1000}$$

Parameter	Description	Units
$\mathrm{HEAT}_{\mathrm{CAP,off,GHG}}$	Emissions from the off-site generation of heat for the operation of the capture facility for a calendar year covered by the reporting period	t CO_2e
$\mathrm{HEAT}_{\mathrm{CAP,off,h}}$	Off-site generated heat from source, h, consumed for the operation of the capture facility for a calendar year covered by the reporting period	MJ
$\mathrm{EF}_{\mathrm{CAP,HEAT,GHG,h}}$	Emission factor for the off-site generated heat from source, h, consumed for the operation of the capture facility. This may be as provided in the Emission Factors and Reference Values document, or by the producer of the heat.	kg CO_{2e}/MJ
1000	Conversion factor, kilograms to tonnes	kg/t
h	Specific heat source used at the capture facility	-
n	Number of heat sources used at the capture facility	-

The proponent must use Equation 17 to quantify the emissions from the on-site combustion of fossil fuels for the generation of heat, electricity or energy for the operation of the capture facility within the project site. If there are multiple fossil fuels used at the capture facility, the summation must be used.

Equation 17: Emissions from the on-site combustion of fossil fuels for the generation of heat, electricity or energy for the operation of the capture facility

$$\mathrm{FF}_{\mathrm{CAP,on,GHG}} = \sum_{\mathrm{f=1}}^{\mathrm{n}} \begin{bmatrix} (\mathrm{FF}_{\mathrm{CAP,on,f}} \times \mathrm{EF}_{\mathrm{CO_2,f}}) \\ +(\mathrm{FF}_{\mathrm{CAP,on,f}} \times \mathrm{EF}_{\mathrm{CH_4,f}} \times \mathrm{GWP}_{\mathrm{CH_4}}) \\ +(\mathrm{FF}_{\mathrm{CAP,on,f}} \times \mathrm{EF}_{\mathrm{N_2O,f}} \times \mathrm{GWP}_{\mathrm{N_2O}}) \end{bmatrix} \div 1000$$

Parameter	Description	Units
$\mathrm{FF}_{\mathrm{CAP,on,GHG}}$	Emissions from the on-site combustion of fossil fuels for the generation of heat, electricity or energy for the operation of the capture facility for a calendar year covered by the reporting period	t CO_2e

$FF_{CAP,on,f}$	Volume of fossil fuel, f, consumed on-site for the generation of heat, electricity or energy for the operation of the capture facility for a calendar year covered by the reporting period	m^3
$EF_{CO_2,f}$	CO_2 emission factor for fossil fuel, f, as set out in the Emission Factors and Reference Values document	kg CO_2/m^3
$EF_{CH_4,f}$	CH_4 emission factor for fossil fuel, f, as set out in the Emission Factors and Reference Values document	kg CH_4/m^3
GWP_{CH_4}	GWP of CH_4, as provided in Column 2 of Schedule 3 to the Act	-
$EF_{N_2O,f}$	N_2O emission factor for fossil fuel, f, as set out in the Emission Factors and Reference Values document	kg N_2O/m^3
GWP_{N_2O}	GWP of N_2O, as provided in Column 2 of Schedule 3 to the Act	-
1000	Conversion factor, kilograms to tonnes	kg/t
f	Specific fossil fuel consumed at the capture facility	-
n	Number of fossil fuels consumed at the capture facility	-

The proponent must use Equation 18 to quantify the emissions from the transport infrastructure within the project site.

Equation 18: Emissions from the operation of the transport infrastructure

$$TRA_{op,GHG} = ((EL_{TRA,off,GHG} + FF_{TRA,on,GHG}) \times PF_{TRA}) + TRA_{mobile,GHG}$$

Parameter	Description	Units
$TRA_{op,GHG}$	Emissions from the operation of the transport infrastructure within the project site for a calendar year covered by the reporting period (SSR9)	t CO_2e
$EL_{TRA,off,GHG}$	Emissions from the off-site generation of electricity for the operation of the transport infrastructure for a calendar year covered by the reporting period, as per Equation 19	t CO_2e
$FF_{TRA,on,GHG}$	Emissions from the on-site combustion of fossil fuels for the generation of heat, electricity or energy for the operation of the transport infrastructure for a calendar year covered by the reporting period, as per Equation 20	t CO_2e
PF_{TRA}	Proration factor for project emissions from a shared transport infrastructure, as per Equation 7. If the transport infrastructure is used exclusively by the project, this value is 1.	-
$TRA_{mobile,GHG}$	Emissions from combustion of fossil fuels for the operation of mobile transport infrastructure for a calendar year covered by the reporting period, as per Equation 21	t CO_2e

The proponent must use Equation 19 to quantify the emissions from the off-site generation of electricity for the operation of the transport infrastructure.

Equation 19: Emissions from the off-site generation of electricity for the operation of the transport infrastructure

$$\mathrm{EL}_{\mathrm{TRA,off,GHG}} = \frac{(\mathrm{EL}_{\mathrm{TRA,off}} \times \mathrm{EF}_{\mathrm{TRA,EL,GHG}})}{1000}$$

Parameter	Description	Units
$\mathrm{EL}_{\mathrm{TRA,off,GHG}}$	Emissions from the off-site generation of electricity for the operation of the transport infrastructure for a calendar year covered by the reporting period	t CO_2e
$\mathrm{EL}_{\mathrm{TRA,off}}$	Off-site generated electricity consumed for the operation of the transport infrastructure for a calendar year covered by the reporting period	MWh
$\mathrm{EF}_{\mathrm{TRA,EL,GHG}}$	Emission factor for the off-site generated electricity consumed for the operation of transport infrastructure. This may be the GHG consumption intensity emission factor for grid electricity from the project jurisdiction, or an emission factor for electricity procured through a power purchase agreement (Section 6.4.2).	kg CO_{2e}/MWh
1000	Conversion factor, kilograms to tonnes	kg/t

The proponent must use Equation 20 to quantify the emissions from the on-site combustion of fossil fuels for the generation of heat, electricity or energy for the operation of the transport infrastructure within the project site. If there are multiple fossil fuels used at the transport infrastructure, the summation must be used.

Equation 20: Emissions from the on-site combustion of fossil fuels for the generation of heat, electricity or energy for the operation of the transport infrastructure

$$\mathrm{FF}_{\mathrm{TRA,on,GHG}} = \sum_{\mathrm{f=1}}^{\mathrm{n}} \begin{bmatrix} (\mathrm{FF}_{\mathrm{TRA,on,f}} \times \mathrm{EF}_{\mathrm{CO_2,f}}) \\ +(\mathrm{FF}_{\mathrm{TRA,on,f}} \times \mathrm{EF}_{\mathrm{CH_4,f}} \times \mathrm{GWP}_{\mathrm{CH_4}}) \\ +(\mathrm{FF}_{\mathrm{TRA,on,f}} \times \mathrm{EF}_{\mathrm{N_2O,f}} \times \mathrm{GWP}_{\mathrm{N_2O}}) \end{bmatrix} \div 1000$$

Parameter	Description	Units
$\mathrm{FF}_{\mathrm{TRA,on,GHG}}$	Emissions from the on-site combustion of fossil fuels for the generation of heat, electricity or energy for the operation of the transport infrastructure, for a calendar year covered by the reporting period	t CO_2e
$\mathrm{FF}_{\mathrm{TRA,on,f}}$	Volume of fossil fuel, f, consumed on-site for the generation of heat, electricity or energy for the operation of the transport infrastructure for a calendar year covered by the reporting period	m^3
$\mathrm{EF}_{\mathrm{CO_2,f}}$	CO_2 emission factor for fossil fuel, f, as set out in the Emission Factors and Reference Values document	kg CO_2/m^3
$\mathrm{EF}_{\mathrm{CH_4,f}}$	CH_4 emission factor for fossil fuel, f, as set out in the Emission Factors and Reference Values document	kg CH_4/m^3
$\mathrm{GWP}_{\mathrm{CH_4}}$	GWP of CH_4, as provided in Column 2 of Schedule 3 to the Act	-
$\mathrm{EF}_{\mathrm{N_2O,f}}$	N_2O emission factor for fossil fuel, f, as set out in the Emission Factors and Reference Values document	kg N_2O/m^3
$\mathrm{GWP}_{\mathrm{N_2O}}$	GWP of N_2O, as provided in Column 2 of Schedule 3 to the Act	-
1000	Conversion factor, kilograms to tonnes	kg/t
f	Specific fossil fuel consumed at the transport infrastructure	-
n	Number of fossil fuels consumed at the transport infrastructure	-

The proponent must use Equation 21 to quantify the emissions from the combustion of fossil fuels for the operation of mobile transport infrastructure within the project site. Mobile transport infrastructure excludes pipelines, and includes modes such as truck or rail. If there are multiple modes of mobile transport infrastructure used in a project site, the summation must be used.

Equation 21: Emissions from the operation of mobile of transport infrastructure

$$\mathrm{TRA}_{\mathrm{mobile,GHG}} = \sum_{\mathrm{t=1}}^{\mathrm{n}} \begin{bmatrix} (\mathrm{TKM}_{\mathrm{CO_2,t}} \times \mathrm{EF}_{\mathrm{CO_2,mobile,t}}) \\ +(\mathrm{TKM}_{\mathrm{CO_2,t}} \times \mathrm{EF}_{\mathrm{CH_4,mobile,t}} \times \mathrm{GWP}_{\mathrm{CH_4}}) \\ +(\mathrm{TKM}_{\mathrm{CO_2,t}} \times \mathrm{EF}_{\mathrm{N_2O,mobile,t}} \times \mathrm{GWP}_{\mathrm{N_2O}}) \end{bmatrix} \div 1000$$

Parameter	Description	Units
$\mathrm{TRA}_{\mathrm{mobile,GHG}}$	Emissions from combustion of fossil fuels for the operation of mobile transport infrastructure for a calendar year covered by the reporting period	t CO_2e
$\mathrm{TKM}_{\mathrm{CO_2,t}}$	Tonne-kilometers for mobile transport infrastructure, t, for CO_2 attributed to the project, for a calendar year covered by the reporting period	tkm
$\mathrm{EF}_{\mathrm{CO_2,mobile,t}}$	CO_2 emission factor for mobile transport infrastructure, t, as set out in the Emission Factors and Reference Values document	kg CO_2/tkm
$\mathrm{EF}_{\mathrm{CH_4,mobile,t}}$	CH_4 emission factor for mobile transport infrastructure, t, as set out in the Emission Factors and Reference Values document	kg CH_4/tkm
$\mathrm{GWP}_{\mathrm{CH_4}}$	GWP of CH_4, as provided in Column 2 of Schedule 3 to the Act	-
$\mathrm{EF}_{\mathrm{N_2O,mobile,t}}$	N_2O emission factor for mobile transport infrastructure, t, as set out in the Emission Factors and Reference Values document	kg N_2O/tkm
$\mathrm{GWP}_{\mathrm{N_2O}}$	GWP of N_2O, as provided in Column 2 of Schedule 3 to the Act	-
1000	Conversion factor, kilograms to tonnes	kg/t
t	Specific mobile transport infrastructure	-
n	Number of mobile transport infrastructure	-

The proponent must use Equation 22 to quantify the emissions from the operation of the injection infrastructure and monitoring of the storage reservoir within the project site.

Equation 22: Emissions from the operation of the injection infrastructure and monitoring of the associated storage reservoir

$$\mathrm{INJ}_{\mathrm{op,GHG}} = (\mathrm{EL}_{\mathrm{INJ,off,GHG}} + \mathrm{HEAT}_{\mathrm{INJ,off,GHG}} + \mathrm{FF}_{\mathrm{INJ,on,GHG}}) \times \mathrm{PF}_{\mathrm{INJ}}$$

Parameter	Description	Units
$\mathrm{INJ}_{\mathrm{op,GHG}}$	Emissions from the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site for a calendar year covered by the reporting period (SSR10, SSR18)	t CO_2e
$\mathrm{EL}_{\mathrm{INJ,off,GHG}}$	Emissions from the off-site generation of electricity for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site for a calendar year covered by the reporting period, as per Equation 23.	t CO_2e
$\mathrm{HEAT}_{\mathrm{INJ,off,GHG}}$	Emissions from the off-site generation of heat for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site for	t CO_2e

	a calendar year covered by the reporting period, as per Equation 24.	
$FF_{INJ,on,GHG}$	Emissions from the on-site combustion of fossil fuels for the generation of heat, electricity or energy for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site for a calendar year covered by the reporting period, as per Equation 25.	t CO_2e
PF_{INJ}	Proration factor for project emissions at a shared injection infrastructure and associated storage reservoir, as per Equation 8. If the injection infrastructure and associated storage reservoir are used exclusively by the project, this value is 1.	-

The proponent must use Equation 23 to quantify the emissions from the off-site generation of electricity for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site.

Equation 23: Emissions from the off-site generation of electricity for the operation of the injection infrastructure and monitoring of the associated storage reservoir

$$EL_{INJ,off,GHG} = \frac{(EL_{INJ,off} \times EF_{INJ,EL,GHG})}{1000}$$

Parameter	Description	Units
$EL_{INJ,off,GHG}$	Emissions from the off-site generation of electricity for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site, for a calendar year covered by the reporting period	t CO_2e
$EL_{INJ,off}$	Off-site generated electricity consumed for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site for a calendar year covered by the reporting period	MWh
$EF_{INJ,EL,GHG}$	Emission factor for the off-site generated electricity consumed for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site. This may be the GHG consumption intensity emission factor for grid electricity from the project jurisdiction, or an emission factor for electricity procured through a power purchase agreement (Section 6.4.2).	kg CO_{2e}/MWh
1000	Conversion factor, kilograms to tonnes	kg/t

The proponent must use Equation 24 to quantify the emissions from the off-site generation of heat for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site.

Equation 24: Emissions from the off-site generation of heat for the operation of the injection infrastructure and monitoring of the storage reservoir

$$\mathrm{HEAT}_{\mathrm{INJ,off,GHG}} = \frac{(\mathrm{HEAT}_{\mathrm{INJ,off}} \times \mathrm{EF}_{\mathrm{INJ,HEAT,GHG}})}{1000}$$

Parameter	Description	Units
$\mathrm{HEAT}_{\mathrm{INJ,off,GHG}}$	Emissions from the off-site generation of heat for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site for a calendar year covered by the reporting period	t CO_2e
$\mathrm{HEAT}_{\mathrm{INJ,off}}$	Off-site generated heat consumed for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site for a calendar year covered by the reporting period	MJ
$\mathrm{EF}_{\mathrm{INJ,HEAT,GHG}}$	Emission factor for the off-site generated heat consumed for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site. This may be as provided in the Emission Factors and Reference Values document, or by the producer of the heat.	kg CO_{2e}/MJ
1000	Conversion factor, kilograms to tonnes	kg/t

The proponent must use Equation 25 to quantify the emissions from the on-site combustion of fossil fuels for the generation of heat, electricity or energy for the operation of the injection infrastructure within the project site. If there are multiple fossil fuels used at the injection infrastructure, the summation must be used.

Equation 25: Emissions from the on-site combustion of fossil fuels for the generation of heat, electricity or energy for the operation of the injection infrastructure and monitoring of the associated storage reservoir

$$\mathrm{FF}_{\mathrm{INJ,on,GHG}} = \sum_{\mathrm{f=1}}^{\mathrm{n}} \begin{bmatrix} (\mathrm{FF}_{\mathrm{INJ,on,f}} \times \mathrm{EF}_{\mathrm{CO_2,f}}) \\ +(\mathrm{FF}_{\mathrm{INJ,on,f}} \times \mathrm{EF}_{\mathrm{CH_4,f}} \times \mathrm{GWP}_{\mathrm{CH_4}}) \\ +(\mathrm{FF}_{\mathrm{INJ,on,f}} \times \mathrm{EF}_{\mathrm{N_2O,f}} \times \mathrm{GWP}_{\mathrm{N_2O}}) \end{bmatrix} \div 1000$$

Parameter	Description	Units
$\mathrm{FF}_{\mathrm{INJ,on,GHG}}$	Emissions from the on-site combustion of fossil fuels for the generation of heat, electricity or energy for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site for a calendar year covered by the reporting period	t CO_2e
$\mathrm{FF}_{\mathrm{INJ,on,f}}$	Volume of fossil fuel, f, consumed on-site for the generation of heat, electricity or energy for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site for a calendar year covered by the reporting period	m^3
$\mathrm{EF}_{\mathrm{CO_2,f}}$	CO_2 emission factor for fossil fuel, f, as set out in the Emission Factors and Reference Values document	kg CO_2/m^3
$\mathrm{EF}_{\mathrm{CH_4,f}}$	CH_4 emission factor for fossil fuel, f, as set out in the Emission Factors and Reference Values document	kg CH_4/m^3
$\mathrm{GWP}_{\mathrm{CH_4}}$	GWP of CH_4, as provided in Column 2 of Schedule 3 to the Act	-

$EF_{N_2O,f}$	N_2O emission factor for fossil fuel, f, as set out in the Emission Factors and Reference Values document	kg N_2O/m^3
GWP_{N_2O}	GWP of N_2O, as provided in Column 2 of Schedule 3 to the Act	-
1000	Conversion factor, kilograms to tonnes	kg/t
f	Specific fossil fuel consumed at the injection infrastructure and associated storage reservoir	-
n	Number of fossil fuels consumed at the injection infrastructure and associated storage reservoir	-

The proponent must use Equation 26 to quantify the vented emissions from the injection infrastructure within the project site that occur after the measurement of the CO_2 to be injected. Vented emissions are estimated for each event that occurs. VOL_{vent} must be the summation for all venting events at the injection infrastructure in a calendar year covered by a reporting period

Equation 26: Vented emissions from the injection infrastructure

$$VENT_{INJ} = (VOL_{vent} \times CONC_{vent,CO_2} \times \rho_{CO_2}) \times PF_{INJ}$$

Parameter	Description	Units
$VENT_{INJ}$	Vented emissions from the injection infrastructure within the project site for a calendar year covered by the reporting period (SSR16)	t CO_2e
VOL_{vent}	Volume of vented gas for all venting events at the injection infrastructure within the project site in a calendar year covered by a reporting period	m^3
$CONC_{vent,CO_2}$	Concentration of CO_2 in the vent gas at the injection infrastructure within the project site	%
ρ_{CO_2}	Density of CO_2	kg/m^3
PF_{INJ}	Proration factor for project emissions at shared injection infrastructure and associated storage reservoir, as per Equation 8. If the injection infrastructure is used exclusively by the project, this value is 1.	-

The proponent must use Equation 27 to quantify the fugitive emissions from the injection infrastructure within the project site that occur after the measurement of the CO_2 to be injected. Fugitive emissions are estimated for each source within the project site, based on an estimated emission rate for each fitting or component.

Equation 27: Fugitive emissions from the injection infrastructure

$$FUG_{INJ} = \sum_{u=1}^{n} ((RATE_{FUG,u} \times months) + OTHER_{FUG}) \times PF_{INJ}$$

Parameter	Description	Units
FUG_{INJ}	Fugitive emissions from the injection infrastructure within the project site for a calendar year covered by the reporting period (SSR17)	t CO_2e
$RATE_{FUG,u}$	Fugitive emission rate for source, u, at the injection infrastructure	t CO_2e /month
$months$	Number of months in a calendar year covered by the reporting period	-

$OTHER_{FUG}$	Other fugitive releases at the injection infrastructure in a calendar year covered by the reporting period	t CO_2e
PF_{INJ}	Proration factor for project emissions at shared injection infrastructure and associated storage reservoir, as per Equation 8. If the injection infrastructure is used exclusively by the project, this value is 1.	-
u	Specific source of fugitive emissions	-
n	Number of sources of fugitive emissions	-

The proponent must determine the magnitude of releases associated with the project for a calendar year covered by the reporting period. Direct measurement of a release is likely not possible; therefore, the magnitude of the release must be determined by an engineering estimate.

In the case of a shared storage reservoir, the proponent must determine the proportion of the total releases from the storage reservoir that are associated with the project. If the proponent is not the storage operator, they must have access, during the entire project period, to information and data from the storage operator such as the total releases from the storge reservoir and the total CO_2 injected. The proponent must then use Equation 28 to determine the projects relative contribution to the total CO_2 injected into the storage reservoir throughout all historical operations and quantify the releases of CO_2 associated with the project. The equation includes the parameter $INJ_{CO2,c}$, whose value is the result of Equation 3 or 4 for each calendar year of project operation up to final calendar year of current reporting period.

Equation 28: Releases of CO_2 associated with the project using a shared storage reservoir

$$REL_{CO_2} = \frac{\sum_{c=1}^{n} INJ_{CO_2,c}}{TINJ_{CO_2}} \times TREL_{CO_2}$$

Parameter	Description	Units
REL_{CO_2}	Releases of CO_2 associated with the project for a calendar year covered by the reporting period (SSR19)	t CO_2e
$INJ_{CO_2,c}$	Gross CO_2 injected into the storage reservoir for the purposes of the project for calendar year, c, of project operation. This value is the result of Equation 3 or 4 for a specific calendar year of project operation.	t CO_2e
$TINJ_{CO_2}$	Total CO_2 injected into the shared storage reservoir considering all historical operations up to final calendar year of current reporting period	t CO_2e
$TREL_{CO_2}$	Total releases of CO_2 from the shared storage reservoir for a calendar year covered by the reporting period, determined through estimation and adjusted as per Equation 29 if applicable.	t CO_2e
c	Specific calendar year	-
n	Number of calendar years of project operation up to final calendar year of current reporting period	-

The overall uncertainty of the estimated releases must be within a range of ±7.5%. In the case that the overall uncertainty of the estimated releases exceeds the acceptable range of ±7.5%,

the uncertainty adjustment set out in Equation 29 shall be applied to REL_{CO2} prior to the use of Equation 2 (in the case of an exclusive-use storage reservoir) or $TREL_{CO2}$ prior to the use of Equation 28 (in the case of a shared storage reservoir)

Equation 29: Uncertainty adjustment to estimation of release

$$\mathrm{REL}_{\mathrm{CO}_2}\text{or } \mathrm{TREL}_{\mathrm{CO}_2} = \mathrm{EREL}_{\mathrm{CO}_2} \times (1 + \frac{\mathrm{UNC}_{\mathrm{EREL}}}{100})$$

Parameter	Description	Units
$\mathrm{REL}_{\mathrm{CO}_2}$	Releases of CO_2 associated with the project for a calendar year covered by the reporting period (SSR19)	t CO_2e
$\mathrm{TREL}_{\mathrm{CO}_2}$	Total releases of CO_2 from the shared storage reservoir for a calendar year covered by the reporting period	t CO_2e
$\mathrm{EREL}_{\mathrm{CO}_2}$	Estimated release(s) of CO_2 (associated with the project, or total from the storage reservoir) for a calendar year covered by the reporting period, unadjusted for uncertainty	t CO_2e
$\mathrm{UNC}_{\mathrm{EREL}}$	Uncertainty (above 7.5%) of the estimated releases of CO_2 (associated with the project, or total from the storage reservoir) for a calendar year covered by the reporting period	%

The result of Equation 2 will be zero or positive if the releases of CO_2 associated with the project during a calendar year covered by the reporting period are less than or equal to the net CO_2 stored during the respective calendar year. In this case, the releases have not resulted in a reversal and have only reduced the project scenario GHG removals to a value of zero or greater.

In the first reporting period, the result of Equation 2 may be negative if the releases of CO_2 during a calendar year exceed the net CO_2 stored during the respective calendar year. However, releases during the first reporting period cannot result in a reversal, regardless of their magnitude, since no credits have yet been issued for the project. The negative GHG removals for the first reporting period quantified using Equation 2 must be carried forward to the next reporting period in accordance with subsection 20(5) of the Regulations. The absolute value of the negative GHG removals (i.e., the net increase in GHG emissions) corresponds with variable Di in subsection 29(2) of the Regulations. This balance will apply to the issuance of offset credits in the first calendar year of the next reporting period and is subsequently carried forward to each calendar year until enough GHG removals have been generated to account for the entirety of the initial negative GHG removals.

In the second reporting period and subsequent reporting periods, the result of Equation 2 may be negative if the releases of CO_2 during a calendar year exceed the net CO_2 stored during the respective calendar year, resulting in a reversal. Refer to Section 10.3 for provisions for quantifying GHG removals in this situation.

8.3 Leakage

Since the baseline scenario of a project is the absence of the geological storage of direct air captured CO_2 within the project site, there is no leakage risk for projects under this protocol.

As a result, there is no leakage discount factor (which corresponds to variable Ci in the formula in subsection 20(2) of the Regulations) to be applied for the quantification of GHG removals generated by a project undertaken under the protocol.

8.4 Project GHG removals

The proponent must use Equation 30 to quantify the GHG removals (REM_C) generated by the project, which correspond to the GHG reductions determined in accordance with section 20 of the Regulations.

Equation 30: Project GHG removals

$$\mathrm{REM_C} = \mathrm{PR_C} - \mathrm{BR_C}$$

Parameter	Description	Units
$\mathrm{REM_C}$	Project GHG removals for a calendar year covered by the reporting period	t CO_2e
$\mathrm{PR_C}$	Project scenario GHG removals for a calendar year covered by the reporting period, as per Equation 2	t CO_2e
$\mathrm{BR_C}$	Baseline scenario GHG removals for a calendar year covered by the reporting period, as per Equation 1	t CO_2e

9.0 Measurement and data

9.1 Measuring devices

The proponent must ensure the appropriate measuring devices are installed and operated as per the requirements in the following subsections. The proponent must have access to all information and data from measuring devices regarding the capture, transport and storage of CO_2 during the project period in order to meet all applicable requirements in the Regulations and this protocol.

9.1.1 Meters

CO_2 injection meters: The project must include permanent CO_2 injection meters that continuously measure the volume or mass of CO_2 injected by the project at the injection infrastructure within the project site.

Custody transfer meters: When necessary, the project must make use of data from custody transfer meters within the project site to acquire relevant and accurate measurements of the captured and transported CO_2 associated with the project.

Other meters: The volume of any fossil fuels consumed at the capture facility, transport infrastructure and/or injection infrastructure must be determined using purchasing records or

measured by permanent flow meters. Volume data must be converted into cubic metres (m^3) to align with the quantification methodology presented in Section 8.0. The project must also include permanent meters that continuously measure the quantity of off-site generated electricity or heat consumed at the capture facility, transport infrastructure and/or injection infrastructure within the project site.

Text box 6: Best practices for measurement frequency

The requirement for continuous measurement included in this preliminary draft protocol is best practice in other existing protocols for similar project types.

Question:

6.1. Should the protocol maintain the requirement for continuous measurement of key data (e.g. volume or mass of CO_2, CO_2 concentration), or is a different approach more appropriate for DACCS projects? If so, what requirements should be included?

9.1.2 CO_2 analyzers

The project must include permanent CO_2 analyzers (e.g. non-dispersive infrared sensor) that continuously measure the composition of the CO_2 stream from the capture facility within the project site.

9.1.3 Temperature and pressure measurement devices

If a mass flow meter is used to measure the CO_2, or if a volume flow meter automatically corrects the volume of CO_2 to standard temperature and pressure conditions associated with the density value to be used, no additional temperature and pressure measurement is required. If a volume flow meter is used that does not automatically correct the CO_2 volume, permanent temperature and pressure measurement devices must be installed to measure temperature and pressure at the same measurement frequency as the uncorrected volume of CO_2 (Section 9.2).

9.1.4 Arrangement of measuring devices

CO_2 injection meters: Must be placed upstream of the point of injection at the injection infrastructure within the project site. Must also be placed as close to the point of injection as possible, to measure a value that is accurately representative of the CO_2 associated with the project. If the project is making use of shared transport infrastructure or a shared injection infrastructure (e.g. a storage hub), this may require placing CO_2 injection meters further upstream from the point of injection to measure the CO_2 associated with the project separate from all other non-project CO_2 transported to and injected at the injection infrastructure within the project site.

Custody transfer meters: Must be placed or selected at a point that will provide data that is accurate and representative of the project parameter being measured, separate from all other non-project CO_2 transported to and injected at the injection infrastructure within the project site (e.g. prior to tie-in point with non-project CO_2).

CO_2 analyzers: Must be placed downstream of the capture facility and:

- In the case of the capture facility providing CO_2 to the injection infrastructure through exclusive-use transport infrastructure, can be as far downstream as the injection infrastructure, as it is presumed that the CO_2 concentration does not change throughout transport.
- In the case of the capture facility providing CO_2 to the injection infrastructure through shared transport infrastructure, must be placed immediately downstream of the capture facility, prior to the tie-in point with other sources of CO_2 within the transport infrastructure.

9.2 Measurement and estimation method and frequency

Table 2 identifies the parameters in the quantification methodology that must be measured or estimated and provides details regarding the relevant method and frequency.

Table 2: Measurement and estimation method and frequency for quantification parameters for a DACCS project

Parameter	Description	Units	Measurement method and frequency	Equations
VOL_{CO_2}	Volume of CO_2 injected into the storage reservoir for the purposes of the project for a calendar year covered by the reporting period	m^3	Volume of CO_2 must be continuously measured at the injection infrastructure, upstream and as close to the point of injection as possible, as per Section 9.1.4. Continuous measurement requires a value recorded at least once every 15 minutes.	3
MASS_{CO_2}	Mass of CO_2 injected into the storage reservoir for the purposes of the project for a calendar year covered by the reporting period	kg	Mass of CO_2 must be continuously measured at the injection infrastructure, upstream and as close to the point of injection as possible, as per Section 9.1.4. Continuous measurement requires a value recorded at least once every 15 minutes.	4
CONC_{CO_2}	Concentration of CO_2 injected into the storage reservoir for a calendar year covered by the reporting period	%	Composition of gas must be continuously measured downstream of the capture facility, as per Section 9.1.4. Continuous measurement requires a value recorded at least once every 15 minutes.	3, 4

Parameter	Description	Units	Measurement method and frequency	Equations
CAP_{CO_2}	Volume of CO_2 captured at the capture facility within the project site and sent to the injection infrastructure within the project site for the purposes of the project for a calendar year covered by the reporting period	m^3	Measured at custody transfer point to transport infrastructure destined for the injection infrastructure within the project site, as per Section 9.1.4.	6
CAP_{total,CO_2}	Total volume of CO_2 captured at capture facility for a calendar year covered by the reporting period	m^3	Cumulative value for the calendar year provided by capture operator.	6
TRA_{CO_2}	Volume of captured CO_2 transported by the transport infrastructure from the capture facility to the injection infrastructure within the project site for the purposes of the project for a calendar year covered by the reporting period	m^3	Measured at custody transfer point to the injection infrastructure within the project site, as per Section 9.1.4.	7
TRA_{total,CO_2}	Total volume of CO_2 transported by the transport infrastructure for a calendar year covered by the reporting period	m^3	Cumulative value for the calendar year provided by transport operator.	7
INJ_{total,CO_2}	Gross CO_2 injected into the storage reservoir, from all sources, for a calendar year covered by the reporting period.	t CO_2e	Cumulative value for the calendar year provided by storage operator.	8
VOL_{GB}	Volume of gas kick or blowout from drilling of wells for the injection infrastructure within the project site	m^3	Value provided by storage operator per event, based on engineering estimate.	9
$GB_{\%GHG,g}$	Concentration of GHG, g, in the gas kick or blowout from drilling of wells for the injection infrastructure within the project site	%	Values provided by storage operator, per event, based on direct measurement and gas analysis or engineering estimate.	9

Parameter	Description	Units	Measurement method and frequency	Equations
$MI_{consumed,m}$	Quantity of material input, m, consumed at the capture facility for a calendar year covered by the reporting period	kg	Cumulative value for the calendar year provided by capture operator.	10
$MI_{used,m}$	Quantity of used material input, m, from the capture facility for a calendar year covered by the reporting period	kg	Cumulative value for the calendar year provided by capture operator.	11
$FF_{DACCS,on,f}$	Volume of fossil fuel, f, consumed on-site for the generation of heat, electricity or energy for the operation of the DACCS project, for a calendar year covered by the reporting period.	m^3	This corresponds to the parameters $FF_{CAP,on,f}$, $FF_{TRA,on,f}$, and/or $FF_{INJ,on,f}$	12
$EL_{CAP,off,e}$	Off-site generated electricity from source, e, consumed for the operation of the capture facility for a calendar year covered by the reporting period	MWh	Measured using meter and summed for each calendar year covered by the reporting period. OR Calculated from electricity purchasing records and/or equipment specifications and summed for each calendar year covered by the reporting period.	15
$HEAT_{CAP,off,h}$	Off-site generated heat from source, h, consumed for the operation of the capture facility for a calendar year covered by the reporting period	MJ	Measured continuously using meter, with value recorded at least once every 15 minutes and summed for each calendar year covered by the reporting period. OR Calculated from heat purchasing records and/or equipment specifications	16

Parameter	Description	Units	Measurement method and frequency	Equations
			and summed for each calendar year covered by the reporting period.	
$FF_{CAP,on,f}$	Volume of fossil fuel, f, consumed on-site for the generation of heat, electricity or energy for the operation of the capture facility for a calendar year covered by the reporting period	m^3	Measured continuously with volume recorded at least once every 15 minutes and summed for each calendar year covered by the reporting period. OR Calculated from fossil fuel purchasing records and/or equipment specifications and summed for each calendar year covered by the reporting period.	17
$EL_{TRA,off}$	Off-site generated electricity consumed for the operation of the transport infrastructure for a calendar year covered by the reporting period	MWh	Measured using meter and summed for each calendar year covered by the reporting period. OR Calculated from electricity purchasing records and/or equipment specifications and summed for each calendar year covered by the reporting period.	19
$FF_{TRA,on,f}$	Volume of fossil fuel, f, consumed on-site for the generation of heat, electricity or energy for the operation of the transport infrastructure for a calendar year covered by the reporting period	m^3	Measured continuously with volume recorded at least once every 15 minutes and summed for each calendar year covered by the reporting period. OR Calculated from fossil fuel purchasing	20

Parameter	Description	Units	Measurement method and frequency	Equations
			records and/or equipment specifications and summed for each calendar year covered by the reporting period.	
$TKM_{CO_2,t}$	Tonne-kilometers for mobile transport infrastructure t, for CO_2 attributed to the project, for a calendar year covered by the reporting period	tkm	Value for the calendar year provided by transport operator.	21
$EL_{INJ,off}$	Off-site generated electricity consumed for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site for a calendar year covered by the reporting period	MWh	Measured using meter and summed for each calendar year covered by the reporting period. OR Calculated from electricity purchasing records and/or equipment specifications and summed for each calendar year covered by the reporting period.	23
$HEAT_{INJ,off}$	Off-site generated heat consumed for the operation of the injection infrastructure and monitoring of the associated storage reservoir within the project site for a calendar year covered by the reporting period	MJ	Measured continuously using meter, with value recorded at least once every 15 minutes and summed for each calendar year covered by the reporting period. OR Calculated from heat purchasing records and/or equipment specifications and summed for each calendar year covered by the reporting period.	24
$FF_{INJ,on,f}$	Volume of fossil fuel, f, consumed on-site for the generation of heat, electricity or energy for the operation of	m^3	Measured continuously with volume recorded at least once every 15 minutes	25

Parameter	Description	Units	Measurement method and frequency	Equations
	the injection infrastructure and monitoring of the associated storage reservoir within the project site for a calendar year covered by the reporting period		and summed for each calendar year covered by the reporting period. OR Calculated from fossil fuel purchasing records and/or equipment specifications and summed for each calendar year covered by the reporting period.	
VOL_{vent}	Volume of vented gas for all venting events at the injection infrastructure within the project site in a calendar year covered by a reporting period	m^3	Value provided by storage operator, based on engineering estimate informed by specifications of each event. Value is a summation of venting events throughout the calendar year.	26
$CONC_{vent,CO_2}$	Concentration of CO_2 in the vent gas at the injection infrastructure within the project site	%	Composition of gas must be continuously measured downstream of the capture facility. Continuous measurement requires a value recorded at least once every 15 minutes.	26
$OTHER_{FUG}$	Other fugitive releases at the injection infrastructure in a calendar year covered by the reporting period	t CO_2e	Value provided by storage operator per calendar year, based on engineering estimate.	27
REL_{CO_2}	Releases of CO_2 associated with the project for a calendar year covered by the reporting period	t CO_2e	Cumulative value for the calendar year provided by storage operator of exclusive use storage reservoir based on engineering estimate. OR Quantity associated with the project determined based on $TREL_{CO2}$ and using Equation 31 for a shared storage reservoir.	2, 28, 29, 31

Parameter	Description	Units	Measurement method and frequency	Equations
$\mathrm{TINJ}_{\mathrm{CO}_2}$	Total CO_2 injected into the shared storage reservoir considering all historical operations up to final calendar year of current reporting period	t CO_2e	Cumulative value for shared injection infrastructure provided by storage operator, based on continuous measurements upstream and as close to point of injection as possible. Continuous measurement requires a value recorded at least once every 15 minutes. Value must be converted to t CO_2e depending on units of measurement.	28
$\mathrm{TREL}_{\mathrm{CO}_2}$	Total releases of CO_2 from the shared storage reservoir for a calendar year covered by the reporting period	t CO_2e	Cumulative value for shared storage reservoir provided by storage operator, based on engineering estimate and adjusted for uncertainty as per Equation 31 if applicable. Converted to t CO_2e depending on units of estimation.	28
$\mathrm{EREL}_{\mathrm{CO}_2}$	Estimated release(s) of CO_2 (associated with the project, or total from the storage reservoir) for a calendar year covered by the reporting period, unadjusted for uncertainty	t CO_2e	Cumulative value for all releases in a calendar year provided by the storage operator.	29
$\mathrm{UNC}_{\mathrm{EREL}}$	Uncertainty (above 7.5%) of the estimated releases of CO_2 (associated with the project, or total from the storage reservoir) for a calendar year covered by the reporting period	%	Value associated with the estimated releases provided by the storage operator.	29

9.3 Quality assurance and quality control

The proponent must have documented quality assurance and quality control (QA/QC) procedures and must implement them to ensure that all measurements and calculations are made in accordance with this protocol and can be verified.

All meters and CO_2 analyzers used for the purposes of the project must be:

- Checked for accuracy by following manufacturer specifications at least once each calendar year, with the last occurring no more than 2 months before or after the end of the reporting period; and
- Calibrated by the manufacturer or by a third party certified for that purpose and following manufacturer specifications, in accordance with the manufacturer specified frequency or every 5 years, whichever is more frequent.

The measurement accuracy of all measuring devices must show that the measuring device provides a reading that is within a ± 5% accuracy range. When the accuracy of the measuring device deviates from the ± 5% range, appropriate corrective action(s) must be taken, in accordance with the manufacturer specifications.

After corrective action(s), the measuring device must be rechecked for accuracy. If the accuracy of the measuring device is still not within the ± 5% range, the measuring device must be calibrated by the manufacturer or by a third party certified for that purpose and following manufacturer specifications, no more than two months after the end of the reporting period.

When the measurement accuracy of a measuring device indicates a reading outside of a ± 5% accuracy range, the following rules must be applied to the measured values for the entire period from the last time the measuring device showed a reading within ± 5% accuracy until the measuring device shows a return to ± 5% accuracy:

- When the inaccuracy of the measuring device indicates an under-reporting, the measured values must be used without correction.
- When the inaccuracy of the measuring device indicates an over-reporting, the measured values must be corrected by the percentage that the accuracy of the measuring device deviated from the ± 5% range.

9.4 Missing data

If a measuring device fails to produce data as required in Section 9.2, missing data may be substituted using the methodology in this section. If missing data is not substituted, no GHG removals may be quantified for offset credit issuance for the period during which data is missing.

Missing data from a measuring device may only be substituted if the operational status and proper functioning of the injection wells and any other custody transfer or injection meters within the project site can be demonstrated with appropriate information and data.

Additionally, missing data from a CO_2 injection meter or CO_2 analyzer may only be substituted in accordance with the following rules:

- CO_2 flow data may be substituted when CO_2 concentration data is not missing and the CO_2 analyzer is demonstrated to be functioning properly; or
- CO_2 concentration data may be substituted when CO_2 flow data is not missing and the injection meter is demonstrated to be functioning properly.

In the case that all the above conditions are met, data can be substituted in the following manner depending on the duration of the period of missing data.

- Data missing for less than 6 consecutive hours: Use the average of the 4 hours immediately prior to **and** after the missing data period.

- Data missing for 6 to 24 consecutive hours: Use the 95% upper or lower confidence limit of the 72 hours prior to **or** after the missing data period, whichever results in greater conservativeness.
- Data missing for 1 to 7 consecutive days: Use the 90% upper or lower confidence limit of the 72 hours prior to **or** after the missing data period, whichever results in greater conservativeness.

No data may be substituted after the 7th consecutive day of missing data, and no GHG removals may be quantified for offset credit issuance.

If periods of missing data occur more than once during the reporting period, data may be substituted for:

- No more than 5% of the GHG removals for the reporting period, if the GHG removals are less than 100,000 t CO_2e; or
- No more than 2% of the GHG removals for the reporting period, if the GHG removals are equal to or greater than 100,000 t CO_2e.

Text box 7: Best practices for missing data

The missing data provisions included in this preliminary draft protocol are typical for other data-based protocols, such as the *Landfill Methane Recovery and Destruction* federal offset protocol. ECCC understands that this may not be common in other existing protocols that include CO_2 geological storage.

Question:

7.1. Should the protocol include provisions for the substitution of missing data (i.e. volume or mass of CO_2 and concentration of CO_2)? If so, are the above detailed provisions applicable to and appropriate for this project type, or if not, what other provisions and conditions would be more appropriate?

10.0 Permanence and reversals

While CO_2 geological storage is a reliably permanent solution, there is still the risk of releases of CO_2 from the storage reservoir; this includes the release of stored CO_2 from the storage reservoir into the atmosphere, or the subsurface migration of stored CO_2 outside the storage reservoir. Depending on the magnitude and timing of a release, it might cause a reversal (Section 10.3).

Reversals can be voluntary or involuntary. A voluntary reversal occurs as a result of an activity or action within the control or responsibility of the proponent or a failure to implement or ensure the implementation of a reversal risk management plan (RRMP). This includes cases where risk mitigation measures and monitoring activities are undertaken by another party on behalf of the proponent (e.g. a storage operator causes a release from the storage reservoir within a DACCS project), since the proponent ultimately remains responsible for their implementation.

An involuntary reversal occurs as a result of an activity or action not within the control or responsibility of the proponent and where there was no failure to implement the RRMP, such as natural disturbances (e.g. seismic activity).

10.1 Reversal risk management plan

As per section 21 of the Regulations, the proponent must establish an RRMP based on the relevant risk types for CO_2 geological storage and implement this plan throughout the project period. In the RRMP, the proponent must identify the reversal risks throughout the project life for the storage reservoir within the project site, including consideration for:

- Potential sources/pathways of releases from the storage reservoir, including:
    - Active, inactive and abandoned wells (e.g. injection or monitoring);
    - Faults, fractures and other geological weaknesses;
    - Current and existing resource development (e.g. oil and gas production);
- Induced and natural seismic risk;
- Plume migration and pressure front risk;

For each identified reversal risk, the proponent must, in the RRMP, list and describe the appropriate **reversal risk mitigation measures** that will be implemented throughout the project period to reduce the likelihood, magnitude and/or frequency of reversals. The proponent must also list and describe the **monitoring activities** that will be implemented throughout the project period to monitor each identified reversal risk and to ensure any reversals are caught in a timely manner.

Under the CO_2 geological storage regulatory framework in the relevant eligible storage jurisdiction, monitoring requirements will be established for the injection infrastructure and the associated storage reservoir to ensure the safe operation of the injection infrastructure and the surveillance and permanence of CO_2 stored across the project life. **The proponent must set out, in the RRMP, reversal risk mitigation measures and monitoring activities that are aligned with the content and stringency of the monitoring requirements established for the injection infrastructure and the associated storage reservoir under the CO_2 geological storage regulatory framework for all storage project stages during the entire project period (e.g. injection to post-closure).**

Further, as per subsection 21(3) of the Regulations, reversal risk mitigation measures and monitoring activities set out in the RRMP must never be removed or decrease in stringency, and the proponent must never cease implementing any of the measures or activities.

> ***Note:*** *ECCC understands the above requirement as per subsection 21(3) of the current Regulations may not be consistent with some requirements in* CO_2 *geological storage regulatory frameworks. See text box 8 for context on this issue as well as guiding questions for comment.*

10.2 Permanence monitoring

As per the Regulations, the proponent must meet all requirements for the monitoring of the permanence of GHG removals within the project site for the entire permanence monitoring period, which is 100 years after the end of the last crediting period. Subsection 22(1) of the Regulations requires that the proponent of a sequestration project (called removal project in this preliminary draft protocol) monitor the quantity of GHGs emitted or GHGs removed from the atmosphere and submit a monitoring report with each project report submitted during the

crediting period and every six years during the permanence monitoring period. Refer to Section 13.2 for details on the content of a monitoring report.

> ***Note:*** *ECCC understands the above requirement of a 100-year permanence monitoring period as per the current Regulations may not be consistent with some requirements in* CO_2 *geological storage regulatory frameworks. See text box 8 for context on this issue as well as guiding questions for comment.*

Text box 8: Permanence monitoring activities and duration

Some requirements in the Regulations and this preliminary draft protocol may be different from or conflict with some in CO_2 geological storage regulatory frameworks. This may present a barrier for projects to register in Canada's GHG Offset Credit System or issues in projects meeting all requirements.

As per paragraph 5(1)(b) of the Regulations, the crediting period for sequestration (removal) projects other than those related to forestry is 20 years, unless otherwise specified by a protocol. As per section 16(6) of the Regulations, the crediting period may be renewed twice, resulting, in this case, in a total crediting period of 60 years.

As per subsection 22(1) of the Regulations, the permanence monitoring period for sequestration projects using a tonne-tonne quantification method (the method provided for in Section 8.0) is 100 years. This means that a proponent for a DACCS federal offset project must meet requirements related to project implementation, project reports, monitoring reports, and compensating for certain reversals, if applicable, for a maximum of 160 years depending on crediting period renewals.

As outlined in Section 10.1 above, subsection 21(3) of the Regulations requires that risk mitigation measures and monitoring activities set out in the RRMP must never be removed from the RRMP or decrease in stringency, and the proponent must never cease implementing any of the measures or activities. Under subsection 40(2) of the Regulations, failure to do so would be considered a voluntary reversal and could result in an obligation to replace all credits issued to the project and the cancellation of the project.

The project lifecycle of CO_2 geological storage operations typically follows a pre-injection phase, an injection phase, a post-injection phase, and a post-closure phase. CO_2 geological storage regulatory frameworks typically establish and approve site-specific and risk- and performance-based land tenure, operating permits and monitoring requirements that can iteratively respond to the performance and status of the stored CO_2 throughout the project life.

For the pre-injection and injection phases, the proponent of a project must apply for and receive all approvals for exploration, drilling and injection in order to carry out these operations. During the post-injection phase, operations have ended, but monitoring and other activities continue at the storage reservoir to ensure and demonstrate the integrity of the storage reservoir and the low CO_2 release risk of the site in advance of closure. The post-injection phase is typically not a set length for all operations, and instead extends until the stability and permanence of the CO_2 can be demonstrated; this may be as soon as 10-50 years post-injection in some CO_2 geological storage regulatory frameworks. Once CO_2 is assessed under a CO_2 geological storage regulatory framework and determined as stable with low residual risk, the site can be closed. Site closure marks the end of the post-injection phase, and the beginning of the post-closure phase. During this phase, site monitoring as required by the CO_2 geological storage regulatory framework can be reduced to a minimum

level sufficient to identify any substantial reversals, and long-term liability for the site may be transferred to the government.

The permanence monitoring requirements under the Regulations would likely exceed a storage operator's monitoring requirements under a typical CO_2 geological storage regulatory framework in both duration and stringency. However, requirements and approvals for appropriately site-specific and performance-based monitoring requirements fall under these CO_2 geological storage regulatory frameworks. A federal offset protocol, therefore, cannot override and should not duplicate the CO_2 geological storage regulatory frameworks. A DACCS federal offset protocol must co-exist with CO_2 geological storage regulatory frameworks.

As per Sections 4.1 and 4.2, a CO_2 geological storage regulatory framework must be in place and applicable on the project site and must be approved as an eligible storage jurisdiction. In addition to this criterion, there are likely to be additional protocol requirements and links with the CO_2 geological storage regulatory frameworks to appropriately satisfy requirements for monitoring and permanence, which are critical for the integrity of federal offset credits. See Section 10.0 for proposed provisions for permanence and reversals to address this need.

Questions:

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

8.2. How could permanence monitoring requirements reflect the reversal risk profile of DACCS projects, without compromising the need for GHG removals to be permanent and the environmental integrity of federal offset credits? For example, should a performance-based permanence monitoring period (e.g. one aligned with site closure) be considered for DACCS projects? If so, how could such an approach be implemented, and what related conditions are needed to achieve this outcome?

8.3. Should requirements related to RRMPs allow for flexibility and iteration throughout the crediting period and project lifecycle? If so, how?

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?

In order to meet requirements for permanence monitoring, the proponent must retain access to information and data related to the injection infrastructure, the associated storage reservoir and the stored CO_2 for the entire project period, which may extend beyond site closure and into the post-closure period of the injection infrastructure and the associated storage reservoir.

> ***Note:*** *ECCC understands that the above requirements that must be satisfied by a proponent may not be consistent with some requirements in CO_2 geological storage regulatory frameworks which allow post-closure transfer of liability from the storage operator to the government. See text box 9 for context on this issue as well as guiding questions for comment.*

Text box 9: Transfer of long-term liability

CO_2 geological storage regulatory frameworks may have processes in place to transfer certain liability from the storage operator to the government at the time of site closure (in some cases, as soon as 10-50 years post-injection), provided the performance and behaviour of the CO_2 has been determined as stable through performance-based monitoring.

Under the Regulations, the proponent is the entity who is legally responsible and liable for the project and the federal offset credits, and must ensure all requirements under the Regulations and the protocol are met throughout the entire project period (comprised of the crediting period and the permanence monitoring period, the latter being 100 years). This includes permanence monitoring and compensating for certain reversals for 100 years after the crediting period.

Questions:

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

9.2. As discussed in text box 8, and **if a performance-based permanence monitoring period were to be enabled by the Regulations**, should **site closure** under a CO_2 geological storage regulatory framework and the **transfer of liability to the government** for the injection infrastructure and the associated storage reservoir within the project site of a DACCS project be **a condition under the Regulations** for the **end of the permanence monitoring period** in order to ensure there is oversight of the stored CO_2 and maintain environmental integrity?

9.3. After a transfer of liability occurs under a CO_2 geological storage regulatory framework, should ECCC continue to be notified of involuntary reversals? In such cases, what actions should be taken to maintain the environmental integrity of the federal offset credits and by who?

10.3 Identification of a reversal

Reversals can occur from a release in the second reporting period and onward.

If during a calendar year in the second reporting period and subsequent reporting periods the releases of CO_2 associated with the project exceed the net CO_2 stored by the project during the respective calendar year, the result of Equation 2 (Section 8.2) will be negative; this means a reversal has occurred with the magnitude of the negative result. In the calendar year of a reversal, the value for the parameter PR_C to be used in Equation 30 (i.e. the project scenario GHG removals) is zero. The reversal portion of the release (the negative result of Equation 2 or the result of Equation 31 below) must be addressed as per the Regulations.

After the crediting period has ended, the entirety of any release of CO_2 constitutes a reversal.

Equation 31: Determining magnitude of a reversal

$$\mathrm{REV}_{\mathrm{CO}_2} = \mathrm{REL}_{\mathrm{CO}_2} + \mathrm{PE}_{\mathrm{C}} - \mathrm{INJ}_{\mathrm{CO}_2}$$

Parameter	Description	Units
$\mathrm{REV}_{\mathrm{CO}_2}$	Reversal portion of releases of CO_2 associated the project for a calendar year covered by the reporting period	t CO_2e
$\mathrm{REL}_{\mathrm{CO}_2}$	Releases of CO_2 associated with the project for a calendar year covered by the reporting period, determined through estimation and using Equation 28 and/or 29, as applicable (SSR19)	t CO_2e
PE_{C}	Project emissions for a calendar year covered by the reporting period, as per Equation 5	t CO_2e
$\mathrm{INJ}_{\mathrm{CO}_2}$	Gross CO_2 injected into the storage reservoir for the purposes of the project for a calendar year covered by the reporting period, as per Equation 3 or 4 (SSR11)	t CO_2e

11.0 Environmental integrity account

For the purposes of determining variable Ci in subsection 29(2) of the Regulations, a percentage will be set out under this protocol that corresponds to the involuntary reversal risk for a project for a calendar year. A value of 3% must be added to obtain the final percentage to be used in the calculation of the number of offset credits that must be deposited into the environmental integrity account for each calendar year.

Text box 10: Contribution of DACCS projects to Environmental Integrity Account

For sequestration (removal) projects for which a tonne-tonne method is used, the contribution to the environmental integrity account is equal to the sum of 3% and a percentage set out in the protocol that corresponds to the involuntary reversal risk for that project type. While CO_2 geological storage can be highly permanent, the risk of involuntary reversals is not zero. An additional percentage must account for the involuntary reversal risk of CO_2 geological storage projects. Further analysis and study will be undertaken to determine a value that reflects the involuntary reversal risk associated with CO_2 geological storage.

Question:

10.1. ECCC welcomes any relevant studies to inform internal analysis, or any suggested values for this additional percentage with supporting scientific rationale for consideration.

12.0 Records

In addition to the record keeping requirements in the Regulations, the proponent must retain the data and records that support the implementation of a project set out in the following sections at the location and for the period of time specified in the Regulations.

Text box 11: DACCS-specific record requirements

The following sections include DACCS-specific record requirements for projects under this protocol. As this is a preliminary draft, the following sections should not be considered

complete. The final version of this protocol may contain different or additional DACCS-specific record requirements to expand upon and complement the general record requirements set out in the Regulations.

12.1 Project conditions and general requirements

The proponent must retain the following records in relation to Sections 4.0 and 6.0:

- Documentation of all leases, licenses, permits and/or approvals for the injection infrastructure and the associated storage reservoir within the project site under the CO_2 geological storage regulatory framework in the project jurisdiction.
    - Documentation must indicate the point(s) of injection and the subsurface bounds of the associated storage reservoir as set out under the CO_2 geological storage regulatory framework.
    - Documentation must include details on the geological assessment and characterization of the storage reservoir under the CO_2 geological storage regulatory framework.
- Documentation of all leases, permits and/or approvals for the capture facility within the project site, as required in the project jurisdiction.
- Documentation of all leases, permits and/or approvals for the transport infrastructure within the project site, as required in the project jurisdiction.
- Documentation demonstrating that the project activities are in compliance with any acts, regulations, directives, leases, licenses, permits and/or other requirements applicable to the capture facility, transport infrastructure, injection infrastructure and storage reservoir within the project site.
- All data sharing agreements/contracts between the proponent and all operators of project activities not owned by the proponent (capture, transport, injection, storage)
- Documentation demonstrating the date of the first day CO_2 is captured from the atmosphere at the capture facility within the project site.
- Documentation demonstrating the date of the first day that CO_2 captured from the capture facility within the project site is injected into the storage reservoir within the project site.

12.2 Quantification, measurement and data

The proponent must retain the following records in relation to Sections 8.0 and 9.0:

- Details of electricity, heat or fossil fuels consumed including.
    - Documentation describing all electricity, heat or fossil fuel meters used, including the meter model number or serial number.
    - Manufacturer specifications for the maintenance and calibration of each meter.
    - Documentation indicating the proper functioning of each meter in accordance with the manufacturer specifications.
    - Documentation describing the location and arrangement of all electricity, heat or fossil fuel meters.

    - Metered quantities or purchase records that indicate the quantity and types of electricity, heat or fossil fuels consumed by the project.
    - Documentation related to waste heat procured for the project activities.
    - Documentation (e.g. power purchase agreements) related to renewable energy procured for the project activities, demonstrating provisions surrounding additionality and exclusive entitlement to the environmental characteristics of the energy.
- Details about the CO_2 measuring devices including:
    - Documentation describing the device type, model number and/or serial number for each measuring device included in the project, including CO_2 injection meters, custody transfer meters, CO_2 analyzers, or temperature and pressure measurement devices.
    - Manufacturer specifications for the maintenance and calibration of each measuring device included in the project.
    - Documentation describing the location and arrangement of all measuring devices included in the project.
    - Documentation indicating the proper functioning of each measuring device included in the project in accordance with the manufacturer specifications.
    - The maintenance records for each measuring device, including records of accuracy checks.
    - Documentation describing the corrective measures applied if a measuring device fails to meet the requirements for measurement accuracy.
    - The calibration certificates and/or other records from either the manufacturer or a third-party certified for that purpose for each measuring device which indicate calibration date, time, and results.

- All information and data used to support the quantification of the GHG removals including:
    - All uncorrected CO_2 volume or mass data, if a flow meter does not correct automatically.
    - Measured temperature and pressure data for the CO_2, if a flow meter does not correct automatically.
    - All CO_2 volume or mass data, corrected to the reference temperature and pressure (automatically or using measured temperature and pressure data).
    - All CO_2 concentration data.
    - Information and data related to any gas kick or blow out from drilling wells for the injection infrastructure.
    - Data related to the material input for the capture facility, including quantity of material input consumed and used, and documentation supporting the material- and project-specific emission factors.
    - Total and proportionate quantities of CO_2 captured at the capture facility, CO_2 transported by transport infrastructure, and CO_2 injected into the storage reservoir for the quantification of proration factors, if applicable.
    - Information and data related to all venting events at the injection infrastructure.
    - Information and data related to fugitive emission rates and other fugitive emissions at the injection infrastructure.
    - All information, data, and estimation methodology and uncertainty regarding the total releases of CO_2 from the storage reservoir and the releases associated with the project from all reporting periods.

- Data related to the total CO_2 injected at a shared injection infrastructure into the associated storage reservoir considering all historical operations.

12.3 Permanence monitoring

The proponent must retain the following records in relation to Section 10.0:

- Documentation of monitoring requirements established under the CO_2 geological storage regulatory framework in the project jurisdiction, applicable to the injection infrastructure and the associated storage reservoir within the project site, and all storage project stages within the project period.

13.0 Reporting

Text box 12: DACCS-specific reporting requirements

The following sections include DACCS-specific reporting requirements for projects under this protocol. As this is a preliminary draft, the following sections should not be considered complete. The final version of this protocol may contain different or additional DACCS-specific reporting requirements to expand upon and complement the general reporting requirements set out in the Regulations.

13.1 Project reports

In addition to the reporting requirements specified in the Regulations, the proponent must include the following additional information in a project report:

- The data, values and calculations (e.g. engineering estimate) used to quantify any releases during the reporting period, if applicable.

13.2 Monitoring reports

As per subsection 22(3) of the Regulations, a monitoring report must, among other requirements, include:

- a description of any reversal risk mitigation measures and monitoring activities that were implemented during the period covered by the monitoring report.
- a declaration by the proponent that, during the period covered by the monitoring report, the RRMP was implemented and no reversals occurred, should this be the case.

If a reversal did occur, the proponent must prepare and submit a reversal report as per Section 13.3.

13.3 Reversal reports

As per subsection 37(2) of the Regulations, a reversal report must, among other requirements, include:

- The circumstances and causes of the release that resulted in a reversal.
- The location within the project site where the release occurred.
- The date on which the release started, and if applicable, the date on which it ended.
- A list of the reversal risk mitigation measures and monitoring activities implemented between the last monitoring report and the start of the release, and their date of implementation.
- The quantity of GHGs (t CO_2e) in the release and the reversal.
- The data, values and calculations (e.g. the engineering estimate) used to quantify the release and the reversal.

13.4 Corrected project reports

The content of a corrected project report is specified in subsection 32(4) of the Regulations.

14.0 Verification

14.1 Competency requirements for verification teams

In addition to the verification requirements in the Regulations, the verification team of the verification body conducting the verification of a project under this protocol must include a licensed professional geoscientist or an equivalent professional who practices within the same jurisdiction as the project site.