# CLEAN FUEL REGULATIONS: QUANTIFICATION METHOD FOR $CO_2$ CAPTURE AND PERMANENT STORAGE

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Aussi disponible en français

# Preface

The proposed *Clean Fuel Regulations* would require fossil fuel primary suppliers (i.e., producers and importers) to reduce the carbon intensity of the fossil fuels they produce in and import into Canada. These proposed Regulations would also establish a credit market whereby the annual CI reduction requirement could be met via three main categories of credit-creating actions, including carrying out a Equivalent Carbon Dioxide ($CO_2e$) emissions reduction or removal project in respect of fossil fuels. Environment and Climate Change Canada (ECCC) provides the *Quantification Method for $CO_2$ Capture and Permanent Storage* to determine the reductions or removals from eligible projects of this type.

The full text of the proposed Regulations and associated documents are available on the Canadian Environmental Protection Act Registry website:

https://pollution-waste.canada.ca/environmental-protection-registry/regulations#page

If you have questions about the proposed *Clean Fuel Regulations*, please contact the following email address: ec.cfsncp.ec@canada.ca.

# Disclaimer

This document does not in any way supersede or modify the *Canadian Environmental Protection Act*, 1999 or the proposed *Clean Fuel Regulations*, or offer any legal interpretation of those proposed Regulations. Where there are any inconsistencies between this document and the Act or the Regulations, the Act and the Regulations take precedence.

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# Introduction

This quantification method (QM) is intended for use by participants applying to have a $CO_2$e Emissions Reduction or Removal Project recognized to create credits under the proposed *Clean Fuel Regulations* (proposed Regulations).

Carbon dioxide ($CO_2$) is emitted in many industrial production processes. It can be produced as a result of fuel combustion or as an inherent part of the industrial process. This $CO_2$ may be captured for other uses, or vented directly to the atmosphere. $CO_2$ may also be captured directly from the ambient air. Capturing $CO_2$ emissions and transferring them to permanent storage results in a reduction of anthropogenic $CO_2$ emissions in the atmosphere.

Carbon capture and storage projects eligible under this quantification method typically consist of four main components:

- Industrial processes or fuel combustion activities that generate $CO_2$;
- $CO_2$ capture and purification infrastructure, which can be included in a new-built facility or retrofitted to an existing facility;
- A $CO_2$ pipeline to transport $CO_2$ from the capture facility to the injection site(s); and
- Long-term geological storage at sites where $CO_2$ is injected for permanent storage.

# Terms and Definitions

**Carbon Capture and Storage (CCS) Project**: All $CO_2$ Capture, $CO_2$ Transport Systems, $CO_2$ Storage, $CO_2$ Injection, and related equipment.

**$CO_2$ Capture**: The capture, purification and compression of $CO_2$ directly from the ambient air or at a facility where it would otherwise be directly released to the atmosphere.

**$CO_2$ Injection**: An activity that places captured $CO_2$ into a long-term geological storage site.

**$CO_2$ Storage**: The long-term isolation of carbon dioxide in subsurface geological formations (synonymous with permanent storage).

**$CO_2$ Transport System**: Any mode of transport used to move captured $CO_2$ to the $CO_2$ injection site.

**Drilling Blowout**: An unintended flow of wellbore fluids (oil, gas, water or other substance) at surface that cannot be controlled by existing wellhead or blowout prevention equipment or a flow from one pool to another pool(s) (underground blowout) that cannot be controlled by increasing the fluid density.

**Drilling Kick**: Any unexpected entry of water, gas, oil or other formation fluid into a wellbore that is under control and can be circulated out.

**Electrical Network:** A network for the distribution of electricity that is subject to the standards of the North American Electric Reliability Corporation.

**Equivalent carbon dioxide emission ($CO_2e$)**: The quantity of carbon dioxide emission, measured in grams or in tonnes as the case may be, that would have a equivalent warming effect over a given period, as an emitted amount of a greenhouse gas or a mixture of greenhouse gases. The equivalent carbon dioxide emission is obtained by multiplying the emission of a greenhouse gas by its Global Warming Potential for the given time horizon. For a mix of greenhouse gases it is obtained by summing the equivalent carbon dioxide emissions of each gas.

**Fossil Fuel Facility:** a facility that produces, processes, stores, transports or distributes liquid, gaseous or solid fossil fuel products (either raw materials upstream of refining or finished fuels).

**Global Warming Potential (GWP)**: An index, based on radiative properties of greenhouse gases, measuring the radiative forcing following a pulse emission of a unit mass of a given greenhouse gas in the present-day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide. The GWP represents the combined effect of the differing times these gases remain in the atmosphere and their relative effectiveness in causing radiative forcing. The GWP characterization factors to use are provided in Appendix A of the *Fuel LCA Model Methodology*.

**Injected Gas**: The total quantity of $CO_2$ that is measured directly upstream of the injection wellhead. This quantity is from the project scenario and used to determine the baseline activity level.

**On-Site:** Means the buildings, other structures and stationary equipment - that are located on a single site or on contiguous or adjacent sites - associated with the Carbon Capture and Storage Project.

# Applicability and Eligibility

To demonstrate that a $CO_2e$ emission reduction or removal project meets the requirements under this quantification method, the participant must supply sufficient evidence that:

1. The project captures $CO_2$ directly from an emitting facility or from the ambient air using a technology that includes a mechanical system in Canada;
2. The project is injecting into a geological formation capable of permanently storing $CO_2$ gases in Canada as defined by the relevant regulations in the province(s) or territory(ies) where it is located;
3. The captured and injected $CO_2$ is from one or more of the following sources:
    a. Combustion $CO_2$ captured at a facility other than a Fossil Fuel Facility;
    b. All $CO_2$ captured at a Fossil Fuel Facility;
    c. Non-combustion $CO_2$ captured at a hydrogen production facility that supplies its hydrogen to a Fossil Fuel Facility for use as a feedstock, prorated based on the proportion of produced hydrogen supplied to the Fossil Fuel Facility as described in Appendix A;
    d. The ambient air using a technology that includes a mechanical system.
4. The capture and injection of CO2 started on or after July 1, 2017;

5. The project must be in good standing with all operating permits and relevant regulations in the province(s) or territory(ies) where it is located.

This quantification method is not applicable to projects injecting $CO_2$ for the purpose of enhanced oil recovery or to acid gas injection schemes associated with sour natural gas processing operation.

Facilities that are subject to the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations are not eligible for inclusion in a project under this quantification methodology.

The Minister may decline projects in province(s) or territory(ies) if it can not be demonstrated that they have relevant regulations to ensure permanent storage. This includes, but is not limited to, requirements for site characterization, well construction and operation, injection monitoring, well abandonment and post-injection site closure.

# Crediting

## Crediting Period

$CO_2e$ emission reduction or removal projects using this quantification method are eligible to create credits under the proposed Regulations for a period of 20 years from the day on which the project is recognized by the Minister. An extension of the crediting period may be permitted as per section 29(3) of the proposed Regulations.

## Credit Creators

The owner or operator of a facility that injects the $CO_2$ into the geological formation is the default creator. This person must register as a credit creator as per section 24 of the proposed Regulations before creating credits under the proposed Regulations.

If more than one participant applies for credits for the same project and it is not clear which party is entitled to register, no credits will be granted to that project until an agreement is reached by the participants designating the registered creator.

The registered creator may differ from the default, if the owner or operator of the facility that injects the $CO_2$ into the geological formation enters into an agreement with another participant to create credits for the $CO_2$ emission reduction or removal project in accordance with section 21 of the proposed Regulations.

## Class of Credits Created

The class of credits created depends on the source of the $CO_2$ being captured and injected.

For combustion $CO_2$ captured at a facility other than a Fossil Fuel Facility, credits will be created in the fuel class that corresponds to the physical state (at standard conditions) of the fuel that was combusted. Where $CO_2$ is captured from the combustion of more than one fuel, credits are prorated to the fuel classes corresponding to the combusted fuels on an emission basis. Emission factors can be found in the *Fuel LCA Model Methodology*.

For $CO_2$ captured at a Fossil Fuel Facility, credits can be allocated between any fuel classes that make up more than 10% of that Fossil Fuel Facility's products on an energy basis. Subsection 23(4) of the proposed Regulations applies regarding this election.

For non-combustion $CO_2$ captured at a hydrogen production facility that supplies its hydrogen to a Fossil Fuel Facility for use as a feedstock, credits can be allocated between any fuel classes that make up more than 10% of that Fossil Fuel Facility's products on an energy basis. Subsection 23(4) of the proposed Regulations applies regarding this election.

For $CO_2$ captured from the ambient air using a technology that includes a mechanical system, credits can be allocated between any fuel classes.

# Project Scenario

## Project Locations

A project consists of multiple interconnected locations, which may include:

- A facility where the generation of $CO_2$ that is captured by the project occurs;
- A facility where the $CO_2$ capture infrastructure, including compression/dehydration, is located (which may be at the same site as the $CO_2$ generation);
- A means of transporting $CO_2$ from the capture facility to the injection site(s);
- Compressor stations located along the $CO_2$ pipeline (where additional compression beyond what is provided at the capture facility is needed)
- The site(s) where $CO_2$ is injected into the geological formation.

Multiple $CO_2$ generation facilities, capture facilities, pipelines, and/or injection sites can be aggregated into a single project. See Appendix B for further details and example scenarios.

Each project location must be uniquely identified using the civic address or the global positioning system (GPS) coordinates (3 decimals), or in the case of a pipeline, using a map that allows for the determination of the GPS coordinates to 3 decimal places for any location along the pipeline. A boundary file demonstrating the project location(s) must also be provided that includes aerial photographs, maps or satellite imagery.

## Project Boundary

The project scenario is the capture, compression, transport and injection of the $CO_2$ into a geological formation for permanent storage. Project emissions associated with capture, compression, transport, and injection are subtracted from the baseline emissions to determine the net greenhouse gas reduction achieved by the project. The full list of sources is included in Figure 1 with further descriptions in Table 1.

Carbon capture and storage projects primarily reduce carbon dioxide emissions, but small amounts of methane and nitrous oxide emissions may also be emitted because of combustion and upstream production emissions. The project must quantify the percent concentration of three species of greenhouse gas emissions - carbon dioxide, methane and nitrous oxide.

*Figure 1: Project Scenario Sources and Sinks*

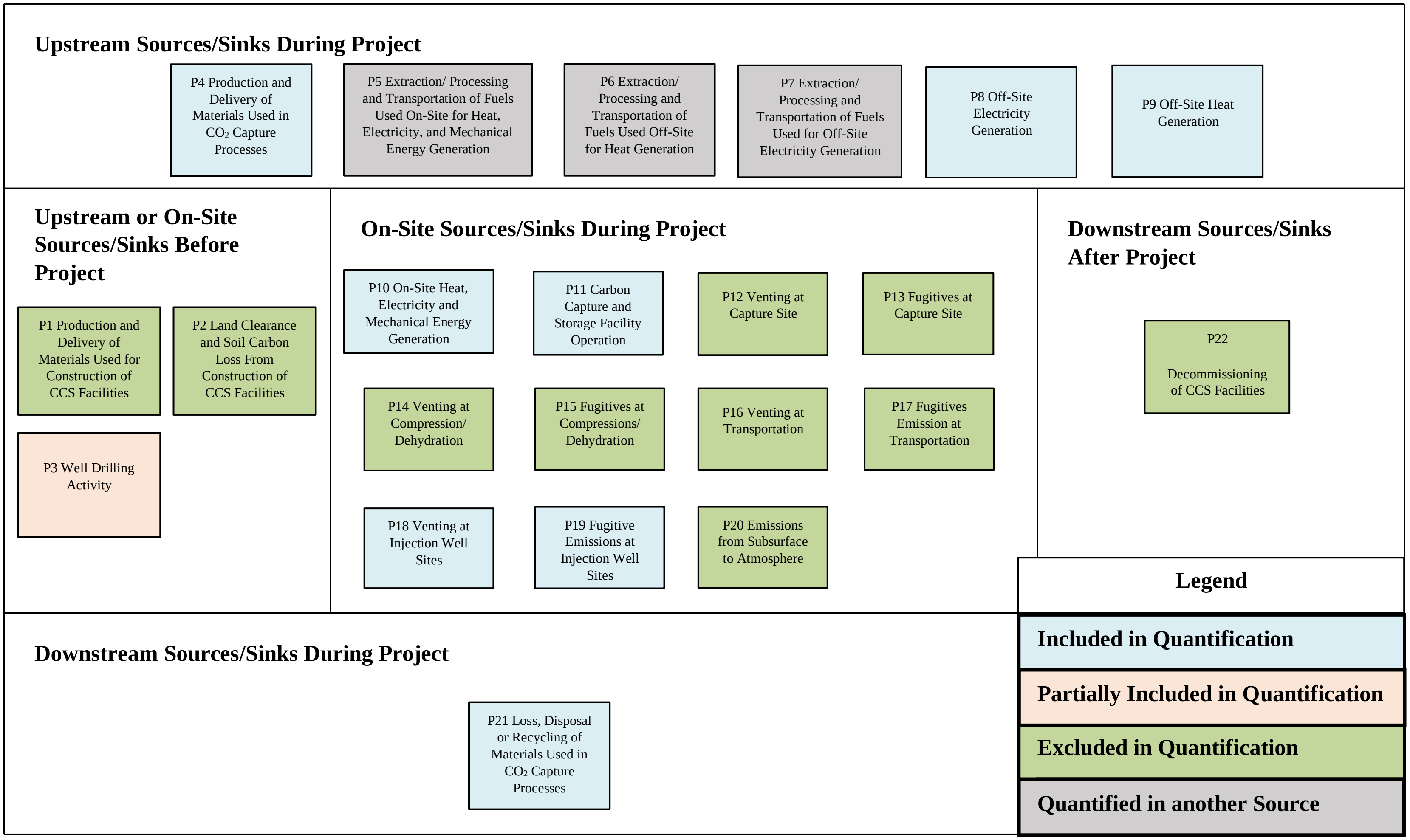


*Table 1: Descriptions of Sources and Sinks*

| 1. SS | 2. Description | 3. Included or Excluded from Quantification |
|---|---|---|
| **Upstream Sources and Sinks before Project** | | |
| P1 - Production and Delivery of Materials Used for Construction of Carbon Capture and Storage Facilities | Materials used in the construction of carbon capture and storage facilities such as steel and concrete will need to be manufactured and delivered to the site. Emissions are attributed to fossil fuel and electricity consumption for material manufacture and fossil fuel consumption for material delivery. | Excluded |
| **On-site Sources and Sinks Before Project** | | |
| P2 - Land Clearing and Soil Carbon Loss from Construction of Carbon Capture and Storage Facilities | The clearing of vegetative or forest land for site preparation may cause soil to release carbon dioxide into the atmosphere that was previously stored in soil. | Excluded |
| P3 - Well Drilling Activity | Site construction will require a variety of heavy equipment, smaller power tools, cranes, generators and well drilling operations. The operation of this equipment will have associated greenhouse gas emission from the use of fossil fuels and electricity and from the potential kick or blowout event that could release hydrocarbons during the drilling of injection and monitoring wells. | Partially included |
| **Upstream Sources and Sinks During Project** | | |
| P4 - Production and Delivery of Material Inputs used in $CO_2$ Capture Process | Material inputs, including specialized chemicals or additives such as amine sorbents, are required for $CO_2$ capture and processing. Greenhouse gas emissions are attributed to the fossil fuel consumption for transport of these materials, and the electricity and fossil fuel inputs for their production. | Included |
| P5 - Extraction/Processing and Transportation of Fuels Used On-Site for Heat, Electricity, and Mechanical Energy Generation | The fuels used for on-site heat, electricity and mechanical energy generation will need to be extracted, processed, and delivered to the site. Delivery may include shipments by truck, rail or pipeline. $CO_2$, $CH_4$ and $N_2O$ emissions are associated with these activities. | Excluded |
| P6 - Extraction/Processing and Transportation of Fuels Used Off Site for Heat Generation | The fuels used for off-site heat generation will need to be extracted, processed, and delivered to the off-site facility. Delivery may include shipments by truck, rail or pipeline. $CO_2$, $CH_4$ and $N_2O$ emissions are associated with these activities. | Excluded |
| P7 - Extraction/Processing and Transportation of Fuels Used Off Site for Electricity Generation | The fuels used for the generation of off-site electricity must be extracted, processed, and delivered to the generating stations. Delivery may include shipments by truck, rail or pipeline. $CO_2$, $CH_4$ and $N_2O$ emissions are associated with these activities. | Excluded |
| P8 - Off-Site Electricity Generation | Emissions associated with the off-site generation of electricity that is consumed at project facilities. | Included |

| | | |
|---|---|---|
| P9 - Off-Site Heat Generation | Emissions associated with the off-site generation of heat that is consumed at project facilities. | Included |
| **On-Site Sources and Sinks During Project** | | |
| P10 - On-Site Heat, Electricity, and Mechanical Energy Generation | Heat, electricity, and mechanical energy inputs may be required for $CO_2$ capture, processing, compression, dehydration, transportation and injection. These energy types may be generated independently or from cogeneration within the project boundary, resulting in greenhouse gas emissions. | Included |
| P11 - Carbon Capture and Storage Facility Operation | The $CO_2$ pipeline and injection well must undergo regular inspection and monitoring for leaks. The geological formation must also be monitored and tested regularly for signs of $CO_2$ leakage and/or migration consistent with all relevant requirements in the jurisdiction. Greenhouse gas emissions are released from fossil fuels consumed for maintenance activities for leak prevention and repair. These stationary and mobile sources may have natural gas, propane, and diesel energy inputs. | Included |
| P12 - Venting of $CO_2$ at Capture Site | Some $CO_2$ is vented during the project scenario. $CO_2$ venting may also be necessary for equipment maintenance or emergency shutdowns. | Excluded |
| P13 - Fugitive Emissions at Capture Site | Unintended leaks of gas from the $CO_2$ capture and processing unit may occur through faulty seals, loose fittings, or equipment. | Excluded |
| P14 - Venting of $CO_2$ During Compression/ Dehydration | Planned and emergency $CO_2$ venting may be necessary for compressor and dehydrator maintenance and/or emergency shutdowns. | Excluded |
| P15 – Fugitive Emissions During Compression/ Dehydration | Unintended leaks of gas from the compressor and/or dehydrator may occur through seals, loose fittings, equipment, or compressor packing. These gases will be composed primarily of $CO_2$ with trace amounts of other gases. | Excluded |
| P16 - Venting of $CO_2$ During Transportation | Planned and emergency $CO_2$ venting may be necessary for pipeline maintenance and/or shutdowns. | Excluded |
| P17 - Fugitive Emissions During Transportation | Unintended leaks of gas from the $CO_2$ pipeline, transportation equipment, and additional compressors may occur through seals, loose fittings, equipment, or compressor packing. These gases will be composed primarily of $CO_2$ with trace amounts of other gases. | Excluded |
| P18 - Venting of $CO_2$ at Injection Well Sites | Planned and emergency $CO_2$ venting may be necessary for injection well work overs, mechanical integrity checks, and maintenance. | Included |
| P19 - Fugitive Emissions at Injection Well Sites | Unintended leaks of gas at the $CO_2$ injection well sites may occur through valves, flanges, pipe connections, mechanical seals, or related equipment. These gases will | Included |

| | | |
|---|---|---|
| | be composed primarily of $CO_2$ with trace amounts of other gases. | |
| P20 - Emissions from Subsurface to Atmosphere | Accidental emissions to the atmosphere may occur from gas migration through undetected faults, fractures and/or subsurface equipment resulting from compromised casing/cement/wellhead or packer/tubing. | Excluded |
| **Downstream Sources and Sinks During Project** | | |
| P21 - Loss, Disposal, or Recycling of Materials Used in $CO_2$ Capture Processes | Material inputs are either disposed or recycled at the end of their useful life. Greenhouse gas emissions result from the transportation of materials to industrial landfill and/or material recycling processes. Emissions are also associated with the loss of material during project operation. | Included |
| **Downstream Sources and Sinks After Project** | | |
| P22 - Decommissioning Carbon Capture and Storage of Facilities | Infrastructure is decommissioned at the end of project operations. This involves the disassembly of the equipment, demolition of on-site structures, landfill disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials off-site. Greenhouse gas emissions result from fossil fuels combustion and electricity use. | Excluded |

# Baseline Scenario

## Baseline Identification and Selection

The baseline scenario for this quantification method is the continued emission of $CO_2$ to the atmosphere or presence of $CO_2$ in the atmosphere that is captured and injected in the project.

*Figure 2: Baseline Sources and Sinks*

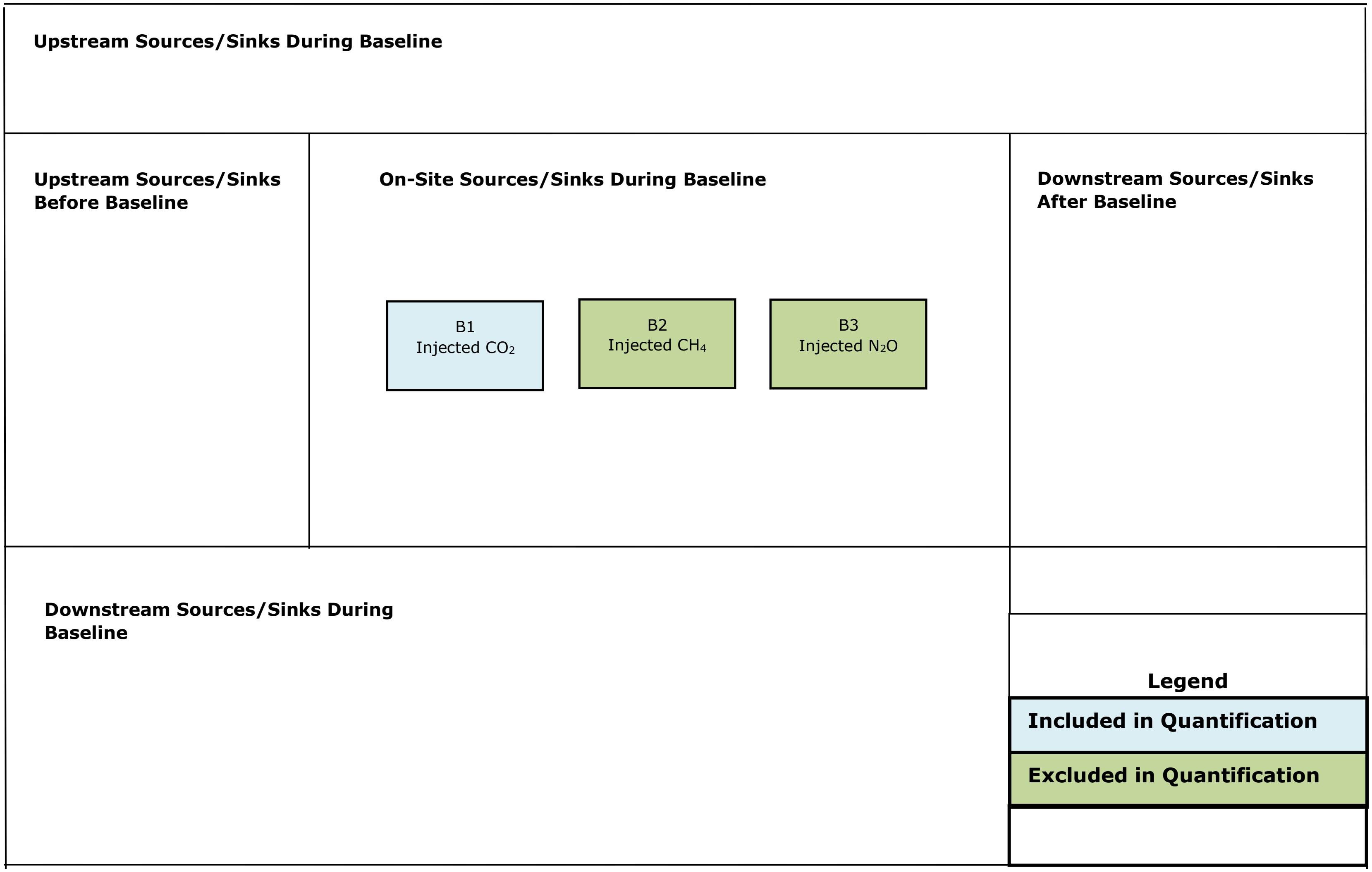


*Table 2: Baseline SS*

| 1. SS | 2. Description | 3. Included or Excluded from Quantification |
|---|---|---|
| **Upstream Sources and Sinks During Baseline Operation – Not Applicable** | | |
| **On-Site Sources and Sinks During Baseline** | | |
| B1 Injected $CO_2$ | All $CO_2$ captured directly from the ambient air using a technology that includes a mechanical system or that would have been released to the atmosphere in the baseline that is captured and subsequently injected during the project. These emissions are a portion of the total emissions from the emission source during the baseline period, since only a portion of total emissions will be captured and ultimately injected during the project. | Included |
| B2 Injected $CH_4$ | All $CH_4$ emissions released to the atmosphere in the baseline that are captured and subsequently injected during the project. These emissions are a portion of the total emissions from the emission source during the baseline period, since only a portion of total emissions will be captured and ultimately injected during the project. | Excluded |
| B3 Injected $N_2O$ | All $N_2O$ emissions released to the atmosphere in the baseline that are captured and subsequently injected during the project. These emissions are a portion of the total emissions from the emissions source during the baseline period, since only a portion of total emissions will be captured and ultimately injected during the project. | Excluded |
| **Downstream Sources and Sinks During Baseline – Not Applicable** | | |
| **Downstream Sources and Sinks After Baseline – Not Applicable** | | |

# Quantification Methods

The quantification for each of the greenhouse gases uses the methodologies outlined below. These calculation methodologies use the following four equations to calculate the emission reductions based on a comparison of the baseline and project scenarios. The calculations should only consider the emissions related to the capture, transportation and storage of the eligible portion of $CO_2$.

## Emission reduction quantification

To determine the total emission reductions for the compliance period, the following equation must be used:

$$\text{Emission Reduction } (tCO_2e) = \text{Emissions}_{\text{Baseline}} - \text{Emissions}_{\text{Project}}$$

## Quantification of the project emissions

To determine the total emissions from the project for the compliance period, the following equation must be used:

$$Emissions_{Project} = Emissions_{Production\ and\ Delivery\ of\ Material\ Inputs} + Emissions_{Well\ Drilling\ Activity} + Emissions_{Off\text{-}Site\ Electricity\ Generation} + Emissions_{Off\text{-}Site\ Heat\ Generation} + Emissions_{On\text{-}Site\ Heat,\ Electricity\ and\ Mechanical\ Energy\ Generation} + Emissions_{Carbon\ Capture\ and\ Storage\ Facility\ Operation} + Emissions_{Venting\ of\ CO2\ at\ Injection\ Well\ Sites} + Emissions_{Fugitives\ from\ Injection\ Well\ Sites} + Emissions_{Loss,\ Disposal\ or\ Recycling\ of\ Material\ Inputs}$$

$$Total\ CO_2\ Equivalent\ Emissions = \sum (CO_2\ emissions) * GWP_{CO2} + \sum (CH_4\ emissions) * GWP_{CH4} + \sum (N_2O\ emissions) * GWP_{N2O}$$

Where:

$Emissions_{Project}$ = sum of the emissions under the project scenario

$Emissions_{Well\ Drilling\ Activity}$ = emissions under P3 Well Drilling Activity

$Emissions_{Production\ and\ Delivery\ of\ Material\ Inputs}$ = emissions under P4 Production and Delivery of Materials Used in the $CO_2$ Capture Process

$Emissions_{Off\text{-}Site\ Electricity\ Generation}$ = emissions under P8 Off-Site Electricity Generation

$Emissions_{Off\text{-}Site\ Heat\ Generation}$ = emissions under P9 Off-Site Heat Generation

$Emissions_{On\text{-}Site\ Heat,\ Electricity\ and\ Mechanical\ Energy\ Generation}$ = emissions under P10 On-Site Heat, Electricity and Mechanical Energy Generation

$Emissions_{Carbon\ Capture\ and\ Storage\ Facility\ Operation}$ = emissions under P11 Carbon Capture and Storage Facility Operation

$Emissions_{Venting\ CO2\ at\ Injection\ Well\ Sites}$ = emissions under P18 Venting at Injection Well Sites

$Emissions_{Fugitives\ from\ Injection\ Well\ Sites}$ = emissions under P19 Fugitives at Injection Well Sites

$Emissions_{Loss,\ Disposal\ or\ Recycling\ of\ Material\ Inputs}$ = emissions under P21 Emissions from Loss, Disposal or Recycling of Materials Used in $CO_2$ Capture Process

$CO_2$ Equivalent Emissions = sum of all greenhouse gas emissions converted to $CO_2$ equivalent terms

## Quantification of the baseline emissions

To determine the total emissions from the baseline for the compliance period, the following equation must be used:

$$Emissions_{Baseline} = Emissions_{Injected\ CO2}$$

Where:

$Emissions_{Baseline}$ = emissions projected from the measured quantity of $CO_2$ injected in the project scenario, but does not include $CH_4$ and $N_2O$

$Emissions_{Injected\ CO2}$ = emissions under B1 Injected $CO_2$

# Monitoring Requirements

## Data Requirements

The following Table 3 provides monitoring, measurement, and quantification information that must be used to quantify the baseline and project emissions. Table 4 provides guidance on the measurement and monitoring requirements for injected gas. Table 5 lists the general monitoring requirements for fossil fuel and electricity inputs. All requirements of the proposed Regulations apply, including the requirements set out in section 122 related to the monitoring plan.

*Table 3: Sources and Sinks*

All gas volumes must be at standard temperature and pressure conditions.

| **1.0 Project/ Baseline SS** | **2. Parameter / Variable** | **3. Unit** | **4. Measured / Estimated** | **5. Method** | **6. Frequency** | **7. Justification for measurement or estimation and frequency** |
|---|---|---|---|---|---|---|
| *Baseline Sources and Sinks* | | | | | | |
| B1 - Injected $CO_2$ | $Emissions_{\text{Injected CO2}} = \sum (Vol._{\text{Injected Gas}} * \%_{\text{injected CO2}} * \rho_{\text{injected CO2}})$ | | | | | |
| | Emissions $_{\text{Injected CO2}}$ | tonnes of $CO_2e$ | N/A | N/A | N/A | Quantity being calculated. |
| | Volume of injected gas / Vol. $_{\text{Injected Gas}}$ | L / $m^3$ / other | Measured | Direct metering of volume of gas using a meter located as close as possible to each injection wellhead. | Continuous metering | Direct metering is standard practice. Frequency of metering is highest level possible. |
| | Concentration of injected $CO_2$ / $\%_{\text{Injected CO2}}$ | %Volume | Measured | Directly measured downstream of the capture and processing equipment. | Daily | A minimum of daily samples averaged monthly on volumetric basis. |
| | Density of injected $CO_2$ / $\rho_{\text{Injected CO2}}$ | $kg/m^3$ | Estimated | Must use a reference density, corrected to the conditions at which the volumes of gas are reported. Data conversions from all pressure and temperature compensated instruments must use the same pressure or temperature used for the specific meter calibration. | N/A | Densities must be used consistently throughout project. |

| 1.0 Project/ Baseline SS | 2. Parameter / Variable | 3. Unit | 4. Measured / Estimated | 5. Method | 6. Frequency | 7. Justification for measurement or estimation and frequency |
|---|---|---|---|---|---|---|
| *Project Sources and Sinks* | | | | | | |
| P3 - Well Drilling Activity | *Emissions $_{Well\ Drilling\ Activity}$ = ∑ (Vol. $_{Gas\ Kick}$ * % $_{CO2,\ CH4}$ * ρ $_{CO2,\ CH4}$)* | | | | | |
| | Emissions $_{Well\ Drilling\ Activity}$ | tonnes of $CO_2$e | N/A | N/A | N/A | Quantity being calculated. |
| | Volume of Vent Gas / Vol. $_{Gas\ Kick}$ | L / m$^3$ / other | Estimated | If the drilling activity resulted in a kick or a blowout, the volume of gas released must be estimated according to the relevant rules in the injection site jurisdiction. | Engineering estimate per event, as they occur before the project. | The measurement approach should be as frequent as the event. |
| | Concentration of $CO_2$, $CH_4$ in Vent Gas % $_{CO2,\ CH4}$ | %Volume | Measured | Based on the results of the most recent well test. | Per event | The measurement approach should be as frequent as the event. |
| | | | Estimated | Must be determined based on process knowledge and/or engineering estimates. | Per event | |
| | Density of vented gas / ρ $_{CO2,\ CH4}$ | kg/m$^3$ | Estimated | Must use a reference density, corrected to the conditions at which the volumes of gas are reported. Data conversions from all pressure and temperature compensated instruments must use the same pressure or temperature used for the specific meter calibration. | N/A | Densities must be used consistently throughout project. |

| **1.0 Project/ Baseline SS** | **2. Parameter / Variable** | **3. Unit** | **4. Measured / Estimated** | **5. Method** | **6. Frequency** | **7. Justification for measurement or estimation and frequency** |
|---|---|---|---|---|---|---|
| P4 - Production and Delivery of Material Inputs used in $CO_2$ Capture Process | *$Emissions_{Production\ \&\ Delivery\ of\ Material\ Inputs} = \sum (Input_i * EF\ Input_{i\ CO2,\ CH4,\ N2O})$* | | | | | |
| | $Emissions_{Production\ \&\ Delivery\ of\ Material\ Inputs}$ | tonnes of $CO_2e$ | N/A | N/A | N/A | Quantity being calculated. |
| | Quantity of material inputs consumed for carbon capture and storage facility operation / $Input_i$ | tonnes/L/ $m^3$/ Other | Estimated | Estimation of the quantity of material inputs consumed for the carbon capture and storage project based on engineering design documents. | Annual | Engineering report will specify the quantity of material input required for an appropriately sized carbon capture and storage facility. Represents most reasonable means of estimation. |
| | Emission factors for each type of material input / $EF\ Input_{i\ CO2,\ CH4,\ N2O}$ | tonnes $CO_2e$ per t/L/ $m^3$/other | Estimated | | Annual | |
| P8 - Off-Site Electricity Generation | *$Emissions_{Off\text{-}Site\ Electricity\ Generation} = Electricity_{Delivered} * EF_{Electricity} / 1000000$* | | | | | |
| | Emissions Off-Site Electricity Generation | tonnes $CO_2e$ | N/A | N/A | N/A | Quantity being calculated. |
| | Total quantity of delivered electricity from the electrical network or a directly connected source | MJ | Measured | Direct measurement of delivered electricity consumed at each facility involved in the capture, compression, transport, injection, and storage of $CO_2$. The total | Continuous metering | Continuous direct metering represents the industry practice and the highest level of detail. |

| 1.0 Project/ Baseline SS | 2. Parameter / Variable | 3. Unit | 4. Measured / Estimated | 5. Method | 6. Frequency | 7. Justification for measurement or estimation and frequency |
|---|---|---|---|---|---|---|
| | consumed for carbon capture and storage project / Electricity $_{Delivered}$ | | | electricity consumption is the sum of electricity consumption across individual components of the carbon capture and storage project. Projects require an individual meter for delivered electricity. | | |
| | Emission intensity factor for electricity generation / EF $_{Electricity}$ | g $CO_2e$/MJ | Estimated | Emission intensity factors for each year. The emission intensity factors are provided in the *Fuel LCA Model Methodology*. | Annual | Reference value adjusted periodically. |
| P9 - Off-Site Heat Generation | $Emissions_{\text{Off-Site Heat Generation}} = \sum (Heat_i * EF_i)$ | | | | | |
| | Emissions $_{\text{Off-Site Heat Generation}}$ | tonnes $CO_2e$ | N/A | N/A | N/A | Quantity being calculated. |
| | Quantity of off-site heat consumed by the project / Heat $_i$ | GJ | Measured | Direct measurement of the quantity of heat used by the carbon capture and storage project. | Continuous metering | Continuous metering is standard for boundary transfer. |
| | Emission intensity factor associated with heat / EF $_i$ | tonnes $CO_2e$/GJ | Estimated | A benchmark emission intensity factor of 0.06299 t/GJ may be used. | Annual | Reference value |
| P10 - On-Site Heat, Electricity, and | $Emissions_{\text{On-Site Heat, Electricity and Mechanical Energy Generation}} = \sum (Fuel_{i, CCS} * EF\ Fuel_{i, CO2, CH4, N2O})$<br>Where:<br>$Fuel_{i, CCS} = (Heat_{i, CCS} / Heat_{i, T}) * Fuel_{i, H} + (Elec_{i, CCS} / Elec_{i, T}) * Fuel_{i, E} + Fuel_{i, M}$ | | | | | |

| 1.0 Project/ Baseline SS | 2. Parameter / Variable | 3. Unit | 4. Measured / Estimated | 5. Method | 6. Frequency | 7. Justification for measurement or estimation and frequency |
|---|---|---|---|---|---|---|
| Mechanical Energy Generation | *In the case of combined heat, electricity, and/or mechanical energy generation (cogeneration), the following equations are used instead of separately metered Fuel i, H , Fuel i, E , and Fuel i, M values:* $Fuel_{i,H} = Fuel_{i,H,E\&M} * (Heat_{i,T} / e_H) / (Heat_{i,T} / e_H + Elec_{i,T} / e_E + Mech_{i,T} / e_M)$ *Where: e = efficiency* $Fuel_{i,M} = Fuel_{i,H,E\&M} * (Mech_{i,T} / e_M) / (Heat_{i,T} / e_H + Elec_{i,T} / e_E + Mech_{i,T} / e_M)$ $Fuel_E = Fuel_{i,H,E\&M} - Fuel_H - Fuel_{i,M}$ | | | | | |
| | $Emissions_{\text{On-Site Heat, Electricity and Mechanical Energy Generation}}$ | tonnes of $CO_2e$ | N/A | N/A | N/A | Quantity being calculated. |
| | Proportionate Volume of Fossil Fuels Consumed to Generate Heat, electricity and mechanical energy at On-Site Generation Facilities for Use by the CCS Project / $Fuel_{i,CCS}$ | L/ $m^3$/ Other | Calculated | Use specified equation. | Monthly | Allocation of Project Emissions based on proportion of total energy output that is supplied to the carbon capture and storage project is appropriate given that multiple energy users may source thermal energy or electricity from a single combined heat and power plant. Direct metering of thermal energy and electricity is appropriate. |
| | Volume of Fossil Fuels Consumed to Generate Heat at | L/ $m^3$/ Other | Measured (non-cogeneration) | Direct measurement of the volume of fossil fuels consumed at the heat generation facility | Continuous metering | Continuous direct metering represents the industry practice |

| 1.0 Project/ Baseline SS | 2. Parameter / Variable | 3. Unit | 4. Measured / Estimated | 5. Method | 6. Frequency | 7. Justification for measurement or estimation and frequency |
|---|---|---|---|---|---|---|
| | On-Site Generation Facilities for Use by the CCS Project / Fuel $_{i, H}$ | | | and/or other direct connected facilities that provide heat to the carbon capture and storage project. | | and the highest level of detail. |
| | | | Calculated (cogeneration) | Use specified equation. | Monthly | Calculated according to best practice guidance. |
| | Volume of Fossil Fuels Consumed to Generate Electricity at On-Site Generation Facilities for Use by the CCS Project / Fuel $_{i, E}$ | L/ $m^3$/ Other | Measured (non-cogeneration) | Direct measurement of the volume of fossil fuels consumed at the electricity generation facility and/or other direct connected facilities that provide electricity to the carbon capture and storage project. | Continuous metering | Continuous direct metering represents the industry practice and the highest level of detail. |
| | | | Calculated (cogeneration) | Use specified equation. | Monthly | Calculated according to best practice guidance. |
| | Total Volume of Fossil Fuels Consumed to Generate Heat, Electricity and/or Mechanical Energy at Cogeneration Facilities / Fuel $_{i, H, E \& M}$ | L/ $m^3$/ Other | Measured | Direct measurement of the volume of fossil fuels consumed at a cogeneration facility and/or other direct connected facilities that provide heat and/or electricity to the carbon capture and storage project. | Continuous metering | Continuous direct metering represents the industry practice and the highest level of detail. |
| | Total Quantity of Thermal Energy Supplied to the CCS | GJ | Measured | Direct metering of quantity of thermal energy received by the carbon capture and storage | Continuous metering | Direct metering of thermal energy is standard practice |

| 1.0 Project/ Baseline SS | 2. Parameter / Variable | 3. Unit | 4. Measured / Estimated | 5. Method | 6. Frequency | 7. Justification for measurement or estimation and frequency |
|---|---|---|---|---|---|---|
| | Project from Generation Facilities / Heat $_{i, CCS}$ | | | project from connected heat generation facilities, including from dedicated cogeneration facilities and other industrial facilities etc. Metering of the thermal energy must account for the type of heat transfer medium (steam, hot water, oil, etc.) and the net heat transfer based on mass/volume flow rates of the heat transfer medium to and from the carbon capture and storage equipment (e.g., accounting for the enthalpy of feedwater, boiler blow down and condensate return), temperatures, pressures for superheated steam and other relevant thermodynamic properties as necessary. | | when thermal energy is provided to a user under a contractual agreement. Frequency of metering is highest level possible. Accounting for the net heat transfer from the heat distribution system based on the specific temperatures and pressures of the heat transfer medium is consistent with best practices. |
| | Total Quantity of Electricity Supplied to the CCS Project by Generation Facilities / Elec $_{i, CCS}$ | GJ | Measured | Direct metering of the quantity of electricity delivered to the carbon capture and storage Project from on-site electricity generating facilities or other direct connected power generation facilities. Note that regional electricity network usage is accounted for under a separate source/sink and should not be included in this calculation. | Continuous Metering | Continuous direct metering represents the industry practice and the highest level of detail. |

| **1.0 Project/ Baseline SS** | **2. Parameter / Variable** | **3. Unit** | **4. Measured / Estimated** | **5. Method** | **6. Frequency** | **7. Justification for measurement or estimation and frequency** |
|---|---|---|---|---|---|---|
| | Total Quantity of Thermal Energy Supplied to End Users by the Generation Facility in the Project Scenario / $Heat_{i,T}$ | GJ | Measured | Direct metering of quantity of thermal energy delivered to all end users by the generation plant (including the carbon capture and storage facilities). Metering of the thermal energy must account for the type of heat transfer medium (steam, hot water, oil, etc.) and the net heat transfer based on mass/volume flow rates of the heat transfer medium to and from the capture facility (e.g., accounting for the enthalpy of feedwater, boiler blow down and condensate return), temperatures, pressures for superheated steam and other relevant thermodynamic properties as necessary. | Continuous Metering | Direct metering of thermal energy is standard practice when thermal energy is provided to a user under a contractual agreement. Frequency of metering is highest level possible. Accounting for the net heat transfer from the heat distribution system based on the specific temperatures and pressures of the heat transfer medium is consistent with best practices. |
| | Total Quantity of Electricity Supplied to End Users by the Generation Facility in the Project Scenario / $Elec_{i,T}$ | GJ | Measured | Direct metering of quantity of electricity delivered to all direct connected facilities from the generation plant; including the direct metering of the total electricity distributed to the carbon capture and storage facilities, the regional electricity network and an industrial system designation. | Continuous Metering | Continuous direct metering represents the industry practice and the highest level of detail. |
| | Efficiency of Heat Generation at On- | - | Estimated | Estimated based on total quantity of thermal energy output from generation unit and input energy | Annual | Estimation is reasonable given consistency of |

| 1.0 Project/ Baseline SS | 2. Parameter / Variable | 3. Unit | 4. Measured / Estimated | 5. Method | 6. Frequency | 7. Justification for measurement or estimation and frequency |
|---|---|---|---|---|---|---|
| | site Generation Unit / $e_H$ | | | content of fuels combusted by the generation unit. If a site-specific heat generation efficiency is unavailable, use a default efficiency of 80%.[1] | | generation unit operations. |
| | Efficiency of Electricity Generation at On-site Generation Unit / $e_E$ | - | Estimated | Estimated based on total quantity of electricity output from generation unit and input energy content of fuels combusted by the generation unit. If a site-specific electric efficiency is unavailable use a default efficiency of 35%.[2] | Annual | Estimation is reasonable given consistency of generation unit operations. |
| | Total Volume of Fossil Fuels Consumed to Generate Mechanical Energy/ $Fuel_M$ | L/ $m^3$/ Other | Measured (non-cogeneration) | Direct measurement of the volume of fossil fuels consumed for compression. | Continuous metering | Continuous direct metering represents the industry practice and the highest level of detail. |
| | | | Calculated (cogeneration) | Use specified equation. | Monthly | Calculated according to best practice guidance. |

[1] A default thermal efficiency of 80% may be used to allocate emissions to purchased thermal energy used by the carbon capture and storage project if a site-specific thermal efficiency cannot be obtained.
[2] A default electrical efficiency of 35% may be used to allocate emissions to electricity purchased from third party cogeneration units for use by the carbon capture and storage project if a site-specific electrical efficiency cannot be obtained.

| 1.0 Project/ Baseline SS | 2. Parameter / Variable | 3. Unit | 4. Measured / Estimated | 5. Method | 6. Frequency | 7. Justification for measurement or estimation and frequency |
|---|---|---|---|---|---|---|
| | Total Quantity of Mechanical Energy Supplied by the Generation Facility using fuel type i in the Project Scenario / $Mech_{i, T}$ | GJ | Estimated | Measurements of the rpm and operating hours of the generation unit.<br><br>The torque, load or power are either measured by equipment such as a recip-trap or specialized sensors or estimated based on manufacturer's specifications or simulators | Continuous metering for rpm and operating hours<br><br>Monthly engineering estimate for the torque, load or power | Continuous direct metering represents the industry practice and the highest level of detail.<br><br>Estimation is reasonable given consistency of generation unit operations. |
| | Efficiency of Mechanical Energy Generation at On-site Generation Unit / $e_M$ | - | Estimated | Estimated based on total quantity of mechanical energy output from generation unit and input energy content of fuels combusted by the generation unit. If a site-specific mechanical energy generation efficiency is unavailable use a default efficiency of 30%. | Annual | Estimation is reasonable given consistency of generation unit operations. |
| | Emissions Factor Each Type of Fuel / $EF\ Fuel_{i\ CO2,\ CH4,\ N2O}$ | tonnes $CO_2e$ per $m^3$/ MJ/other | Estimated | Refer to the *Fuel LCA Model Methodology*. | Annual | Reference values represent best available emission factors for fuels |
| P11 - Carbon Capture and Storage | $Emissions_{\text{Carbon Capture and Storage Facility Operation}} = \sum (Fuel_i * EF\ Fuel_{i\ CO2,\ CH4,\ N2O})$ | | | | | |

| **1.0 Project/ Baseline SS** | **2. Parameter / Variable** | **3. Unit** | **4. Measured / Estimated** | **5. Method** | **6. Frequency** | **7. Justification for measurement or estimation and frequency** |
|---|---|---|---|---|---|---|
| Facility Operation | Emissions $_{\text{Carbon Capture and Storage Facility Operation}}$ | tonnes of $CO_2e$ | N/A | N/A | N/A | Quantity being calculated. |
| | Volume of Each Type of Fuel Used for CCS Facility Operation/ Fuel $_i$ | L / $m^3$ / other | Estimated | Volumes of fuel consumed by each piece of equipment used during the operating activities of the CCS facility may be estimated. | Annual | Quantity being estimated in aggregate form as fuel used at CCS facility is likely aggregated for each source. |
| | Emissions Factor each Type of Fuel / EF Fuel $_{i\ CO2,\ CH4,\ N2O}$ | tonnes $CO_2e$ per $m^3$/ MJ/other | Estimated | Refer to the *Fuel LCA Model Methodology*. | Annual | Reference values represent best available emission factors for fuels |
| P18 - Venting at Injection Well Sites | $Emissions_{\text{Venting at Injection Well Sites}} = \sum (Vol._{\text{Gas Vented}} * \%_{CO2} * \rho_{CO2})$ | | | | | |
| | Emissions $_{\text{Venting at Injection Well Sites}}$ | tonnes of $CO_2e$ | N/A | N/A | N/A | Quantity being calculated. |
| | Volume of Vent Gas / Vol. $_{\text{Gas Vented}}$ | L / $m^3$ / other | Estimated | Estimate volume based on the pressure, length and diameter of the pipe being serviced. | Per event | This vented gas is downstream of the injection meter during maintenance blowdowns and should be as frequent as the maintenance event. |

| 1.0 Project/ Baseline SS | 2. Parameter / Variable | 3. Unit | 4. Measured / Estimated | 5. Method | 6. Frequency | 7. Justification for measurement or estimation and frequency |
|---|---|---|---|---|---|---|
| | Composition in Vent Gas / % $_{CO2}$ | % | Measured | The gas composition shall be directly measured downstream of the capture and processing equipment and as close as possible to the point where $CO_2$ is injected into the geological formation. | A minimum of daily samples averaged monthly on volumetric basis | Composition may vary throughout the injection of gas stream. Frequent gas composition measurement is reasonable for operation of an injection facility. |
| | Density of Vent Gas / $\rho_{CO2}$ | tonnes/m$^3$ | Estimated | Must use a reference density, corrected to the conditions at which the volumes of gas are reported. Data conversions from all pressure and temperature compensated instruments must be sure to use the same pressure or temperature used for the specific meter calibration. | N/A | Densities must be used consistently throughout project. |
| P19 - Fugitives at Injection Well Sites | *Emissions $_{Fugitives\ at\ Injection\ Well\ Sites}$ = ∑ (Source $_i$ * ER $_{Source\ i}$ * % $_{CO2,\ CH4,\ N2O}$) + Other Fugitive Releases* | | | | | |
| | Emissions $_{Fugitives\ at\ Injection\ Well\ Sites}$ | tonnes of $CO_2e$ | N/A | N/A | N/A | Quantity being calculated. |
| | Other Fugitive Releases | tonnes of $CO_2$ | Estimated | Engineering estimate. | Per occurrence | This is from unintended/unplanned events, and accounts for $CO_2$ released after the meter and wellbore but not from |

| 1.0 Project/ Baseline SS | 2. Parameter / Variable | 3. Unit | 4. Measured / Estimated | 5. Method | 6. Frequency | 7. Justification for measurement or estimation and frequency |
|---|---|---|---|---|---|---|
| | | | | | | the geological formation. Estimated based on the most detailed information available. |
| | Number of Sources after Injection Meter / Source $_i$ | N/A | Estimated | Project-specific design. | Once | Estimated based on the number of sources after the injection meter and above the subsurface. |
| | Emission Rate for Source / ER $_{Source\ i}$ | tonne gas /source/year | Estimated | Emission rate in Appendix C | Annual | Estimates made for project specifics represent the most accurate means. |
| | Composition in Fugitive Gas / % $_{CO2,CH4,N2O}$ | % | Measured | The gas composition shall be directly measured downstream of the capture and processing equipment and as close as possible to the point where $CO_2$ is injected into the geological formation. | A minimum of daily samples averaged monthly on volumetric basis | Composition may vary throughout the injection of gas stream. Frequent gas composition measurement is reasonable for operation of an injection facility. |
| P21 - Loss, Disposal or Recycling of Material Used | $Emissions_{\ Loss,\ Disposal\ or\ Recycling\ of\ Material\ Used} = \sum (Vol.\ Used_{\ i} * EF\ Used_{\ i\ CO2,\ CH4,\ N2O})$ | | | | | |

| 1.0 Project/ Baseline SS | 2. Parameter / Variable | 3. Unit | 4. Measured / Estimated | 5. Method | 6. Frequency | 7. Justification for measurement or estimation and frequency |
|---|---|---|---|---|---|---|
| | Emissions $_{Loss, Disposal or Recycling of Material Used}$ | tonnes of $CO_2e$ | N/A | N/A | N/A | Quantity being calculated. |
| | Total Volume of Material Lost, Disposed or Recycled from the Carbon Capture and Storage Facility/Vol. Used $_i$ | L/ $m^3$/ Other | Estimated | Estimation of the volume of material inputs lost, disposed or recycled for the carbon capture and storage project. | N/A | Engineering report will specify the volume of material input lost, disposed or recycled for an appropriately sized carbon capture and storage facility. Represents most reasonable means of estimation. Loss, disposal or recycling estimates for the emission factors for the materials used. |
| | Emissions factor for each type of material input / EF Used $_{i\ CO2,\ CH4,\ N2O}$ | tonnes $CO_2e$ per L / $m^3$ / other | Estimated | Project-specific design. | Annual | Production and delivery estimates for the emission factors for the material inputs. |

*Table 4: Measurement and Monitoring Guidance for Injected Gas*

| Variable | Units of Measurement | Measurement Frequency | Additional Guidance |
|---|---|---|---|
| Flow rate of gas stream | L / $m^3$ / other | Continuous measurement of the gas flow rate, gas composition, and gas density where continuous measurement is defined as a minimum of one measurement every 15 minutes. | • Meter readings may need to be temperature and pressure compensated such that the meter output is set to standard reference temperatures and pressures. Estimates of composition and density are not permissible;<br>• Flow meters must be placed based on manufacturer recommendations:<br>○ Flow meters should be located at the input to the gas transport equipment such that they are downstream of all capture and compression equipment to account for any fugitive losses or venting; and<br>○ Flow meters should be as close as possible to the injection wellheads to ensure accurate measurement of the injected volumes;<br>• Flow meters must be calibrated according to manufacturer specifications. Meters must be checked/calibrated at regular intervals according to these specifications and industry standards; and<br>• Ownership transfer must be clearly documented for $CO_2$ transferred (third party injection activity). |
| Concentration of gas stream | % | Continuous measurement of the gas composition and density where continuous measurement is defined as a minimum of one measurement every 15 minutes. | The gas composition shall be metered downstream of the capture and processing equipment while the volume is measured as close as possible to the point where $CO_2$ is injected into the geological formation. |

*Table 5: Measurement and Monitoring Guidance for Energy Inputs*

| Variable | Units of Measure | Measurement Frequency | Additional Guidance |
|---|---|---|---|
| Volume of fossil fuels combusted (gaseous) | $ft^3$ or $m^3$ or other | Continuous measurement of the gas flow rate where continuous measurement is defined as one measurement every 15 minutes. | • The flow meter readings must be corrected for temperature and pressure. Density estimates used for emission quantification purposes must be adjusted to corrected standardized temperatures and pressures;<br>• Flow meters shall be placed based on manufacturer recommendations and shall operate within manufacturers specified operating conditions at all times; and<br>• Flow meters must be calibrated according to manufacturer specifications and shall be checked and calibrated at regular intervals according to these specifications. |
| Volume of fossil fuels combusted (liquid or solid) | L, $m^3$ or other | Reconciliation of purchasing records on a quarterly basis and inventory adjustments as needed. | Volume or mass measurements are made at purchase or delivery of the fuel. Reconciliation of purchase receipts or weigh scale tickets is an acceptable means to determine the volumes of fossil fuels consumed to operate the carbon capture and storage project. |
| Electricity Consumption | MWh | Continuous measurement of electricity consumption or reconciliation of maximum power rating for each type of equipment and operating hours. | • Electricity consumption must be from continuously metered data wherever possible; however, in certain cases other loads may be tied into the same electricity meter. Where this occurs, estimates with justification are required. In these cases, the maximum power rating of each piece of equipment is used in conjunction with a conservative estimate of operating hours to estimate the electricity consumption; and<br>• Electricity meters must be calibrated by an accredited third party in accordance with manufacturer specifications. |

# Reporting Requirements

## Application for Recognition of $CO_2$e Emissions Reduction or Removal Project

1. Application as per section 29 of the Regulations with the requirements in Schedule 4
2. Applicant, Owner and Operator Name and Contact Information of the $CO_2$ generation facilities, capture facilities, pipelines, and/or injection sites
    a. Civic address or GPS coordinates
    b. Mailing address
    c. Name, telephone number and, if any, email address and fax number, of a contact person
3. Project Location of the $CO_2$ generation facilities, capture facilities, pipelines, and/or injection sites as described in the section ***Project Locations*** of this quantification method.
4. Evidence that the capture and injection of $CO_2$ started on or after July 1, 2017.
5. Whether the project is stand-alone or aggregated
6. Baseline and Project Scenario Description
    a. Start date of the project including capture at the capture facilities and injection at the injection sites;
    b. Project components (e.g., equipment, systems, processes, technologies)
    c. Material and energy inputs, outputs, and flows within the project boundary.
    d. All inputs into project scenario and baseline scenario listed in Table 3
    e. Estimated Credit Creation
    f. Quantity of $CO_2$ emitted from the capture site;
    g. Quantity of $CO_2$ input into the $CO_2$ transport pipeline;
    h. Quantity of $CO_2$ sold to third parties (e.g., for enhanced oil recovery) including sufficient measurements to support data required; and
    i. Quantity of $CO_2$ injected into each well in the project metered at the wellhead.

## Annual Credit Creation Report

1. Report required as per section 103 of the Regulations with the requirements in Schedule 8
2. All inputs into project scenario and baseline scenario listed in Table 3

# Record Keeping Requirements

Refer to sections 102 and 159 to 161 of the proposed Regulations and the Monitoring Plan referred to in section 122 and Schedule 19.

# Permanence

A discount factor of 0.5% of credits created will be applied to the total emission reduction calculated in accordance with this quantification method. These credits are never returned to the registered creator.

# Validation and Verification

For the validation of an Application or for the verification of a Report, referring to a $CO_2e$ Emission Reduction or Removal Project; in addition to the applicable requirements set out in sections 113 to 148 of the proposed Regulation, and to the specifications set out in the *Method for Validation, Verification and Certification − Clean Fuel Regulation*, the following requirements apply.

## Materiality Thresholds

**Quantitative materiality thresholds**
The quantitative materiality thresholds to be applied while verifying the Credit Creation Report for a $CO_2e$ Emission Reduction or Removal Project, as per section 142, are as follows:

1. Percent relative error that equals or exceeds 1% of the corrected number of credits or relative error that exceeds one credit, whichever is greater.

*Note: additional quantitative materiality thresholds are under development.*

**Qualitative materiality thresholds**
The qualitative materiality thresholds to be applied in validating an Application for a CO2e Emission Reduction Project are set in subsection 145(2) of the proposed Regulation.

The qualitative materiality thresholds to be applied in verifying the Credit Creation Report for a CO2e Emission Reduction or Removal Project are set in paragraph 145(4)(a) of the proposed Regulations.

*Note: additional qualitative materiality thresholds are under development.*

# APPENDIX A: Proration of Eligible $CO_2$ and Emissions

### Prorating Eligible $CO_2$ – Hydrogen Used as a Feedstock

Where non-combustion $CO_2$ is captured at a hydrogen production facility, a portion of that $CO_2$ is eligible for credit creation using this quantification method. This portion is related to the amount of produced hydrogen supplied to a Fossil Fuel Facility for use as a feedstock relative to the total hydrogen production and is described by the following equation.

$$Eligibility\ Factor\ (\%) = \frac{Produced\ H2\ supplied\ as\ a\ feedstock\ to\ a\ Fossil\ Fuel\ Facility\ \left(\frac{kg\ H2}{year}\right)}{Total\ H2\ production\ \left(\frac{kg\ H2}{year}\right)} * 100$$

This Eligibility Factor describes what portion of the injected non-combustion $CO_2$ can create credits as well as what portion of emissions related to this non-combustion $CO_2$ is to be included in the project scenario.

### Prorating Eligible $CO_2$ and Emissions – Aggregation of Multiple Projects

Where multiple projects overlap in their project boundary, participants must demonstrate that all SSs are properly accounted for and must ensure all emissions have been included and have not been double counted. For a complex $CO_2$ system or network, the emissions from that network must be included in the project scenario using a proration of emissions across the network. Proration must occur on the basis of the mass of $CO_2$. The participants must provide verifiable justification for the method and values used to determine the system emission factor used.

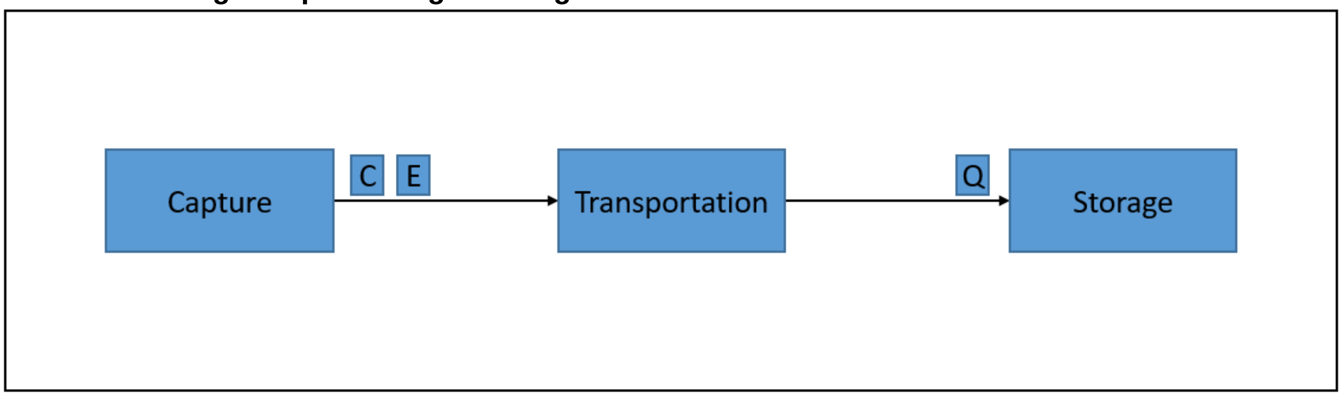
For example, if 50% of the $CO_2$ in a pipeline is associated with Project A, 40% with Project B and 10% is $CO_2$ ineligible to create credits, the emissions associated with transporting that $CO_2$ should reflect those proportions in the project scenario account of each project.

# APPENDIX B: Aggregation of Multiple Projects

The following provides guidance for projects in which $CO_2$ is being transported for use in CCS projects.

Gas flow and quantity measurement, $CO_2$ concentration measurement, location of sample points, and tracking of eligible $CO_2$ quantities must be carefully considered in complex networks. Scenarios 1 through 4 depict the gas flow measurement, $CO_2$ concentration measurement, location of sample points and tracking of eligible $CO_2$ quantities in a variety of project configurations from simple to more complex.

**Scenario 1: Single Capture Single Storage**

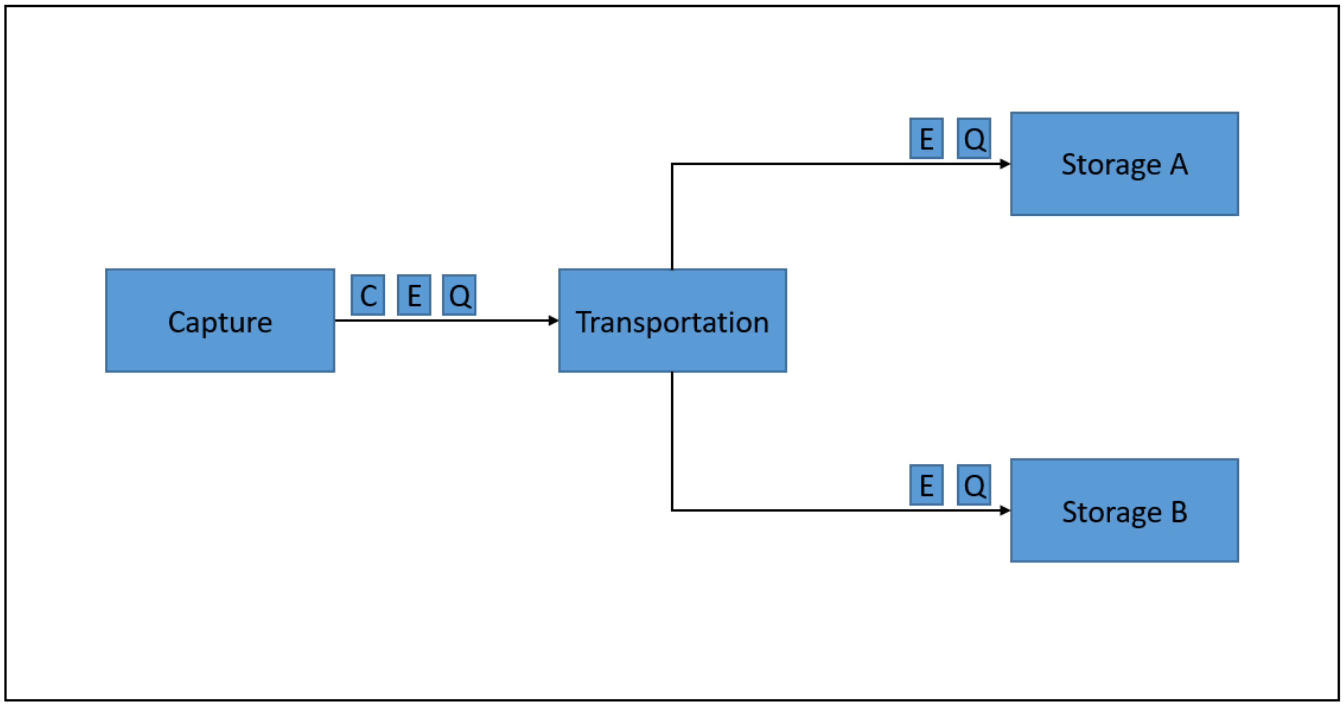



Must measure $CO_2$ concentration or gas composition (C). The sample point may be downstream of capture or at the storage location (injection well).

Must record the proportion of eligible $CO_2$ (E) at the capture site.

Must measure gas quantity (Q) at storage location (injection well).

**Scenario 2: Single Capture Multiple Storage**

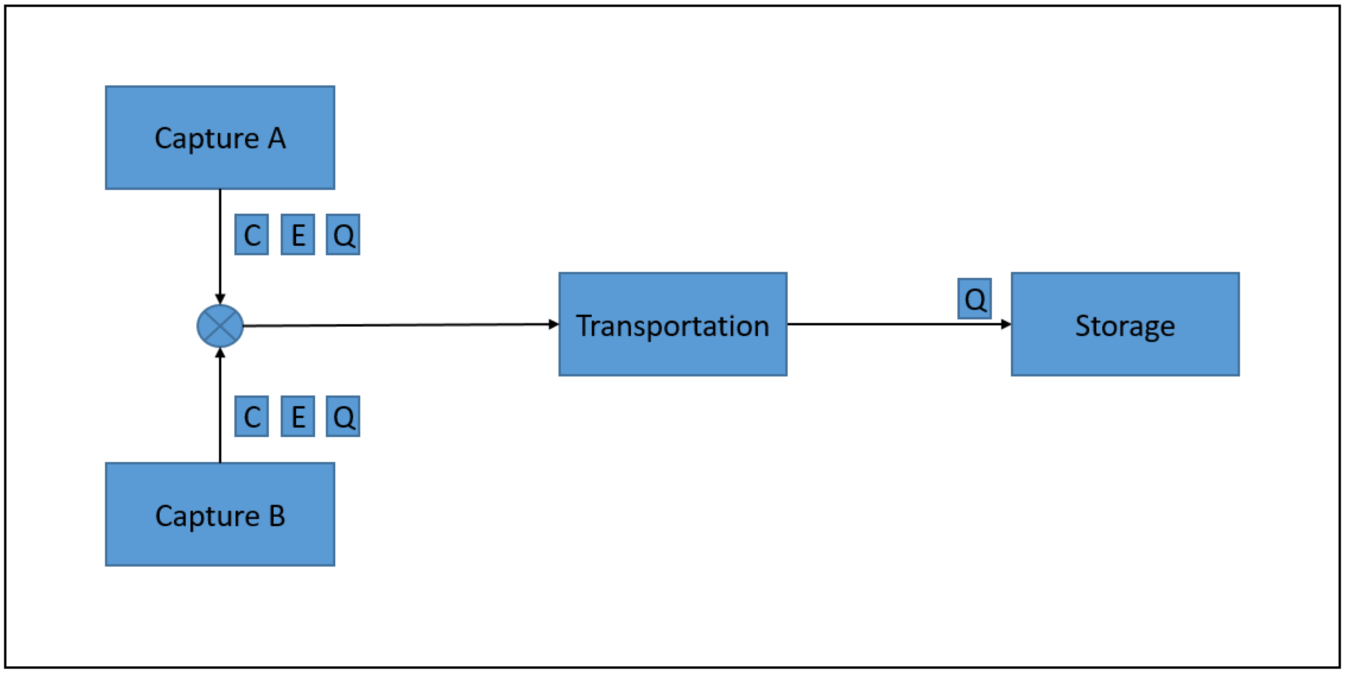



Must measure $CO_2$ concentration or gas composition (C) at either the capture site or storage locations (injection wells). It is not required to measure C at both locations as the $CO_2$ concentration does not change.

Must record the proportion of eligible $CO_2$ (E) at the capture site and at each storage location (injection well).

Must measure gas quantity (Q) at the capture site and at each storage location (injection well).

**Scenario 3: Multiple Capture Single Storage**




Must measure $CO_2$ concentration or gas composition (C) at each capture site upstream of the point of aggregation.

Must record the proportion of eligible $CO_2$ (E) at each capture site upstream of the point of aggregation and at the storage location (injection well).

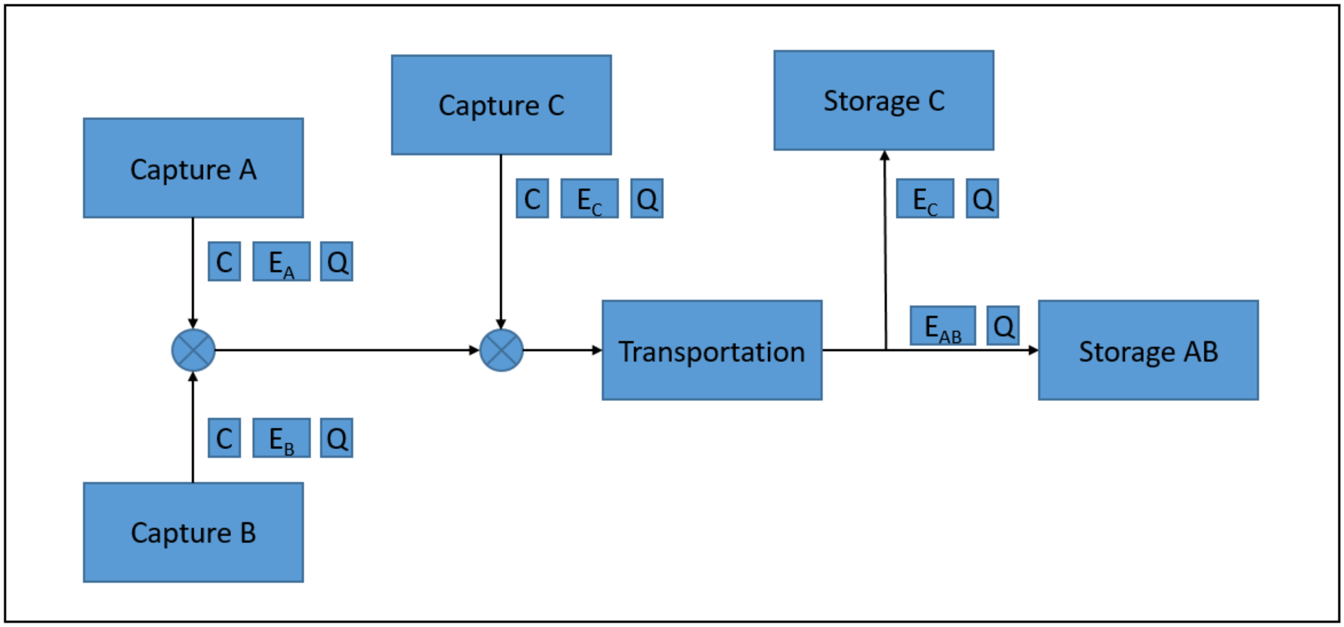
Must measure gas quantity (Q) at each capture site upstream of the point of aggregation.

Allowable to calculate the $CO_2$ concentration and the proportion of eligible $CO_2$ (E) of the aggregated stream based on the weighted average of the incoming streams to be aggregated in a single variable, mass balance equation.

Must measure gas quantity (Q) at storage location (injection well). $CO_2$ concentration at storage is the calculated concentration of the aggregated stream. The proportion of eligible $CO_2$ (E) at storage is the calculated proportion of eligible $CO_2$ of the aggregated stream.

If using weighted average, must be completed downstream of each new capture site that is added to the network.

**Scenario 4: Multiple Capture Multiple Storage**




Must measure $CO_2$ concentration or gas composition (C) at each capture sites upstream of the point of aggregation.

Must record the proportion of eligible $CO_2$ (E) at each capture site upstream of the point of aggregation and at the storage location (injection well).

Must measure gas quantity (Q) at each capture site upstream of the point of aggregation.

Allowable to calculate the $CO_2$ concentration of the aggregated stream based on the weighted average of the incoming streams to be aggregated in a single variable, mass balance equation.
Weighted average calculation must be completed downstream each new capture site is added.

Must measure gas quantity at storage location (injection well). $CO_2$ concentration at storage is the calculated concentration of the aggregated stream. Must measure gas quantity at each capture site upstream of the point of aggregation

# APPENDIX C: Reference Tables

## Fugitive Emission Factors

Emission factors for fugitive emissions from a variety of component types can be found in the Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Natural Gas Industry published by the American Petroleum Institute in 2009. Of particular note is Table 6-12: EPA Average Oil and Natural Gas Production Emission Factors which provides emission factors of tonnes of gas emitted. Other tables found in this section are often on the basis of the hydrocarbon portion of the gas and may require adjustments before they're applicable for reflecting emissions from $CO_2$ systems. Section 6.1.4 describes how to convert methane emission factors on a mass basis to $CO_2$ emission factors for $CO_2$ pipelines.