

Stakeholder Review Session



Quantification Protocol for the Capture of CO₂ and Storage in Deep Saline Aquifers

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Presentation Outline

- Background
- Project Type Description
- Protocol Scope & Applicability
- Project & Baseline Conditions
- Flexibility mechanisms
- Alberta Offset System Eligibility Criteria
- Quantification Methodology
- Example Calculation
- Questions

Background

- **Initiating entities:** Shell Canada Energy (60%), Chevron Canada Limited (20%), and Marathon Oil Sands L.P. (20%) are planning to implement a carbon capture and storage project (“The Quest CCS Project”)

Protocol Development

- Industry TSD
- Technical working group:
 - Consultants
 - NGO’s (Pembina Inst.)
 - Academics
 - Government (NRCan)
 - Industry experts
- Iterative process

Seed Documents

- “Technical Seed Document for the Capture of CO₂ and Permanent Storage” Sept 2011
- World Resources Institute, *CCS Guidelines*, 2008
- IPIECA, *Part II: Carbon Capture and Geological Storage Emission Reduction Family*, 2007
- Pew Center, *A Greenhouse Gas Accounting Framework for Carbon Capture and Storage Projects DRAFT*, 2011
- AOS, *Quantification Protocol for EOR*, 2007

Technical Review

- 1st technical review – Sept 2011
- 2nd technical review – Oct 2011
- 3rd technical review – Nov 2011
- Additional stakeholder meetings

Project Type Description

The opportunity for generating carbon offsets arises from the **direct disposal of CO₂** from an industrial facility into deep saline aquifers.

- These volumes of CO₂ would normally have been emitted to the atmosphere
- **Source:** CO₂ source is from an industrial facility operating a primary process
- **Capture:** The carbon capture facility applies a capture technology that uses chemical solvent
- **Transport:** Pipeline network from the carbon capture facility to the injection sites
- **Storage:** Injected CO₂ is trapped within the pore spaces of the deep saline aquifer.

Protocol Scope & Applicability

To demonstrate that a project meets the requirements under this protocol, the following applicability criteria must be met:

- ✓ The Project capture CO₂ directly from industrial facilities
 - **Industrial facility** is one that produces anthropogenic GHG emissions resulting from a primary process
 - **Primary process** manufactures a primary product
 - Example: hydrogen production for bitumen upgrading
- ✓ The Project injects CO₂ into a deep saline aquifer capable of permanently storing CO₂ emissions. Applicants must have both:
 - Approved **Carbon Sequestration Lease** in accordance with the *Mines and Minerals Act* and the *Carbon Sequestration Tenure Regulation*
 - **Directive 65** approval for a CO₂ storage scheme from the ERCB

Protocol Scope & Applicability

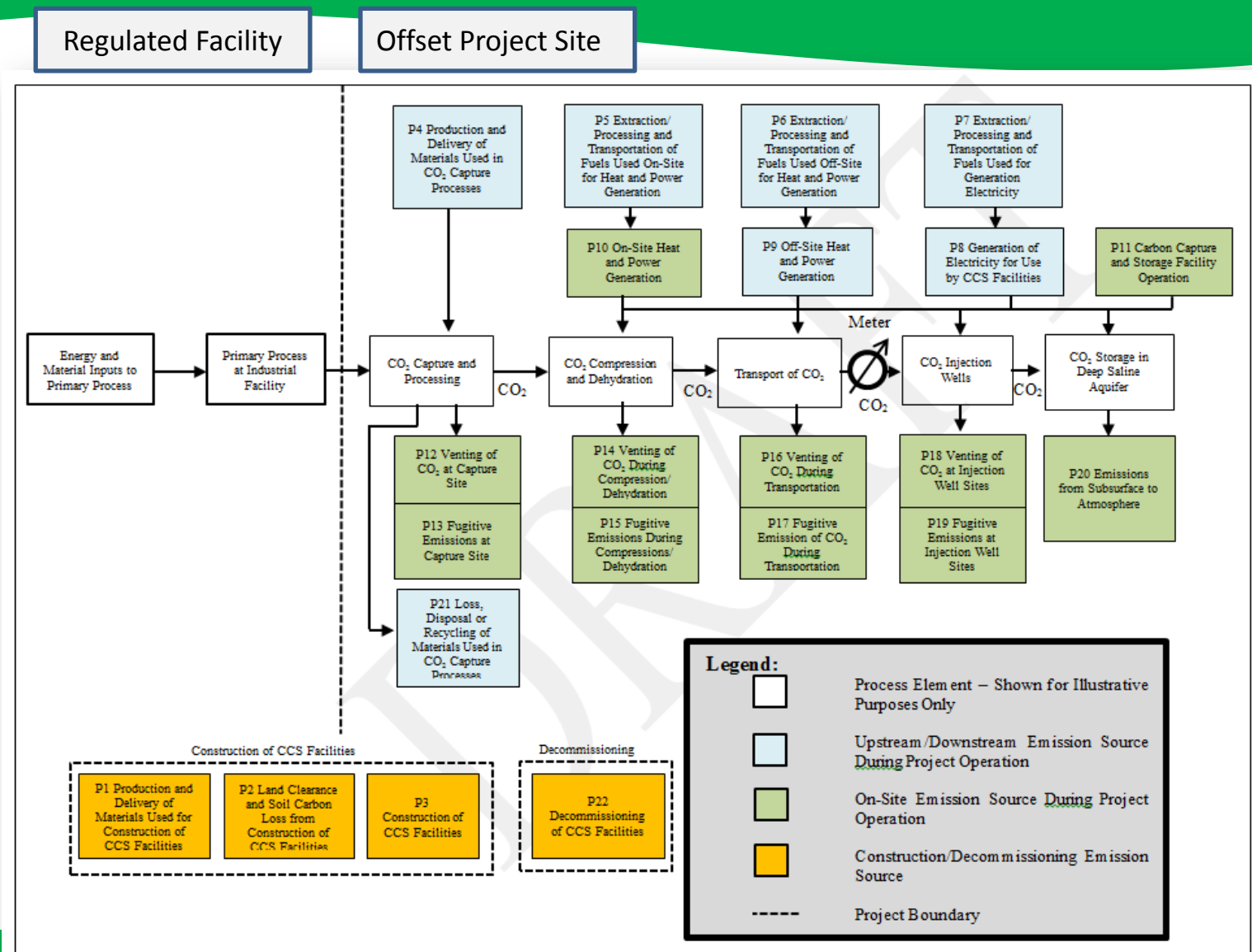
To demonstrate that a project meets the requirements under this protocol, the following applicability criteria must be met:

- ✓ The Project must be in compliance with all operating permits and relevant regulations in Alberta
 - Ex: Directive 65, 51, 7, 17 & 20
- ✓ The quantification of reductions achieved by the project is based on actual measurement and monitoring
- ✓ Metering of injected gas volumes takes place upstream of the wellhead and as close to the injection point as is reasonable
- ✓ The Project meets the eligibility criteria stated in section 7.0 of the *Specified Gas Emitters Regulation*

AOS Eligibility Criteria

Alberta Offset System Criteria (as implemented by protocol)	
Real	Project must occur in Alberta and must be implemented according to ministerial guidelines
Not required by law	Only those projects that are not required by any applicable regulation will be eligible for crediting
Start Date	Must result from actions taken on or after January 1, 2012
Demonstrable and quantifiable	Project emissions determined using actual measurement and monitoring
Ownership	Have clearly established ownership including, if applicable, appropriate documented transfers of ownership from the land owner to land lessee
Counted once	Offsets can only be counted once for compliance
Verifiable	All credits must be verified by a third-party

Process Flow Diagram for the Project Condition

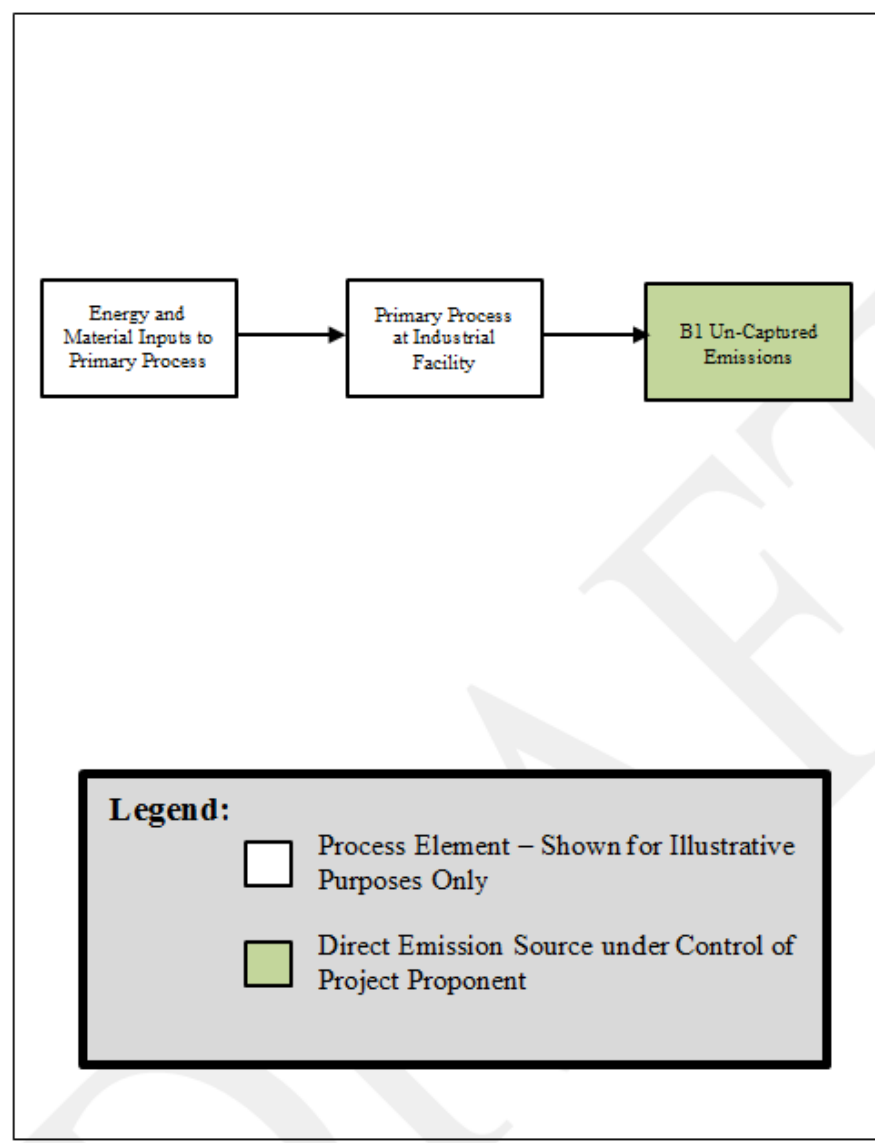


Project Condition

Project condition activities:

- GHG emissions (historically emitted to atmosphere) are captured from an industrial facility
- Carbon capture facility processes the waste gas stream and captures CO₂ using chemical solvents
- CO₂ is compressed and transported to injection sites
- Injection and permanent storage in deep saline aquifer

Process Flow Diagram for the Baseline Condition



Baseline Condition

The baseline scenario is the continued practice of emitting CO₂ to the atmosphere from industrial facilities operating a primary process

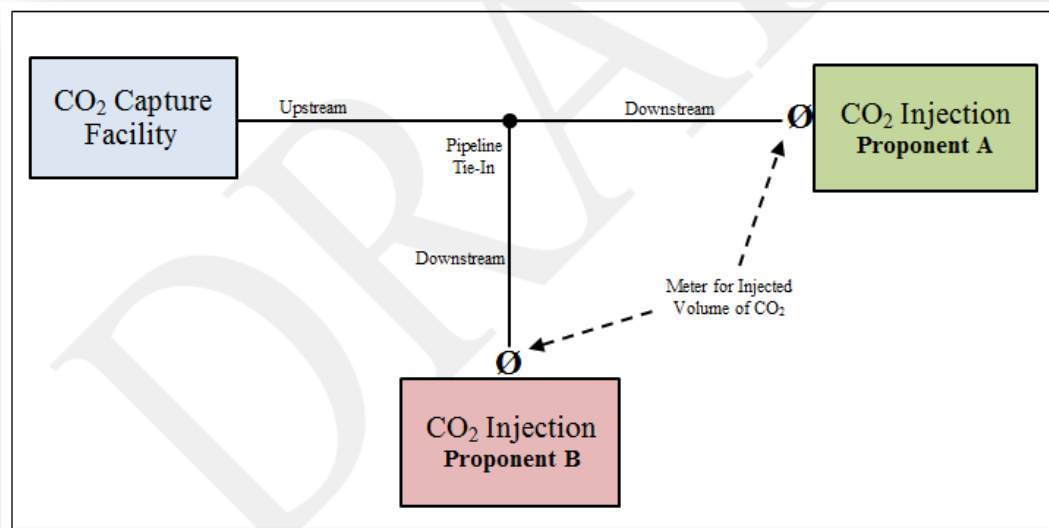
Projection-based baseline condition

- Baseline emissions are quantified using direct measurements of the quantity of CO₂ that is being injected into the deep saline aquifer
- Metering occurs directly upstream of the wellhead
- Justification:
 - Direct measurement allows for the highest level of accuracy
 - Dynamic in approach

Flexibility Mechanisms

Injection of CO₂ by multiple proponents:

- In the case of a CO₂ system or network, all emissions from that network would have to be accounted for in the project condition.
- A system emission factor may be applied whereby the project emissions are prorated proportionally across each project proponent participating in the network.



Quantification Methodology

Quantification Methodology

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

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Un-captured Emissions}}$$

$$\begin{aligned} \text{Emissions}_{\text{Project}} = & \text{Emissions}_{\text{Production and Delivery of Material Inputs}} + \\ & \text{Emissions}_{\text{Fuel Extraction and Processing}} + \\ & \text{Emissions}_{\text{Electricity Consumption}} + \\ & \text{Emissions}_{\text{Off-Site Heat and Power Co-Generation}} + \\ & \text{Emissions}_{\text{On-Site Heat and Power Co-Generation}} + \\ & \text{Emissions}_{\text{Carbon Capture and Storage Facility Operation}} + \\ & \text{Emissions}_{\text{Venting CO}_2 \text{ at Injection Well Sites}} + \\ & \text{Emissions}_{\text{Fugitives from Injection Well Sites}} + \\ & \text{Emissions}_{\text{Subsurface to Atmosphere}} + \\ & \text{Emissions}_{\text{Loss, Disposal or Recycling of Material Inputs}} \end{aligned}$$

Sample Calculation

Baseline	B1 – Un-Captured Emissions	1,080,000 t CO_{2e}
	Σ Emissions Baseline	1,080,000 t CO_{2e}
Project	P4 – Production & Delivery of Material Inputs	740 t CO_{2e}
	P5 & 6 – Fuel Extraction & Processing	14,893 t CO_{2e}
	P8 – Electricity Consumption	30,735 t CO_{2e}
	P9 – Off-site Heat & Power	26,484 t CO_{2e}
	P10 – On-site Heat & Power	26,484 t CO_{2e}
	P11 – CCS Facility Operation	35,000 t CO_{2e}
	P18 – Venting at Injection Wells	1,080 t CO_{2e}
	P19 – Fugitives at Injection Wells	108 t CO_{2e}
	P20 – Emissions from Subsurface	0 t CO_{2e}
	P21 – Loss, Disposal or Recycling of Materials	79 t CO_{2e}
	Σ Emissions Project	135,603 t CO_{2e}
Baseline – Project		944,397 t CO_{2e}

*Data based on Shell Quest draft SMART Lite Analysis

Data Monitoring

Project Monitoring Plan

- The proponent must establish a comprehensive monitoring plan that includes methods to measure and quantify project data such as:
 - ✓ Incremental energy inputs required to capture, transport, inject and store CO₂
 - ✓ Quantity of CO₂ emitted from the capture site (un-captured CO₂)
 - ✓ Quantity of CO₂ input into the CO₂ transport pipeline
 - ✓ Quantity of CO₂ sold to third parties (if any)
 - ✓ Quantity of CO₂ injected into each well in the deep saline aquifer (metered at the wellhead)

Data Monitoring

Measurement, Monitoring and Verification Plan

- The proponent must demonstrate that an MMV plan has been prepared and approved in accordance with Alberta regulatory requirements.
- The MMV plan is to be submitted as part of the tenure application under the Mines and Minerals Act, as amended by the Carbon Capture and Storage Statutes Amendment Act.
- The Quest CCS project has an extensive and thorough MMV plan (over 100 pages)

Liability & Reversals

Liability:

- Upon obtaining a closure certificate after completion of injection activities, liability is transferred from the project proponent to the GoA
- The project proponent retains liability for all climate obligations resulting from events occurring during project execution and during the closure period prior to issuance of the closure certificate
- The GoA is developing policy guidelines on climate CO₂ liability for the post closure period and will update the regulation

Reversals:

- Sources and Sinks in the protocol provide mechanisms to quantify reversals (see Section 3.1) and Appendix D provides a method for accounting for uncertainty in the quantification of reversals

Recap of Key Issues

Description of Issue	Response to Issue
<p>Scope: CO₂ Source</p> <ul style="list-style-type: none"> - Changed from industrial process emissions → industrial facility operating a primary process 	<p>Agreement to expand scope and broaden CO₂ sources through discussions between Shell and AENV.</p>
<p>Scope: CO₂ Storage</p> <ul style="list-style-type: none"> - Changed from non-hydrocarbon producing formations → deep saline aquifer 	<p>Policy decision by AENV to tie storage to Carbon Sequestration Tenure Regulation and Directive 65</p>
<p>Glossary of terms</p> <ul style="list-style-type: none"> - Glossary needs to describe terms such as: Deep saline aquifer, permanent storage, primary process, primary product, trapping mechanisms 	<p>Key terms that were added, see section 1.4 of the protocol.</p>
<p>CO₂ Injection by multiple proponents</p> <ul style="list-style-type: none"> - Make sure all project emissions are accounted for in the case of a CO₂ network 	<p>Flexibility mechanism was added to protocol. Project emissions will be prorated across proponents participating in the network, see Appendix C for further guidance.</p>
<p>Source/Sink P20</p> <p>How to estimate emissions from subsurface equipment and deep saline aquifer?</p>	<p>Uncertainty equation is used to estimate emissions, see protocol Appendix D for guidance.</p>

Recap of Key Issues

Description of Issue	Response to Issue
The issue of liability as it pertains to any possible reversals throughout the entire lifetime of the sequestered CO ₂	These issues are policy related and cannot be resolved at the protocol level. These issues should be directed to Alberta Environment and Water.
Ensure no double counting for P8 – Generation of Electricity for Use by Carbon Capture and Storage Facilities .	Added guidance in the protocol surrounding generation of electricity from renewable sources: “If the electricity is generated from a renewable source that has already claimed greenhouse gas benefits, the emission intensity factor will be the same as the grid emission intensity factor”.
Location of injection meter	The intent of the protocol is ensuring that metering takes place upstream and as close to the wellhead as possible. See Table 8 in the protocol for additional guidance surrounding meter placement.



Questions?