Carbon Capture and Storage (CCS) Emission Reduction Quantification Methodology

Alberta Offset System Protocol Review

October 29-30, 2009

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Presentation Outline

- Policy Considerations
- Protocol Development Overview
- Applicability Criteria
- Project and Baseline Conditions
  - Process Flow Diagrams
- Consistency With Alberta Offset System Criteria
- Flexibility Mechanisms
- Quantification Approach & Sample Calculation
- Questions

Specific Policy Considerations

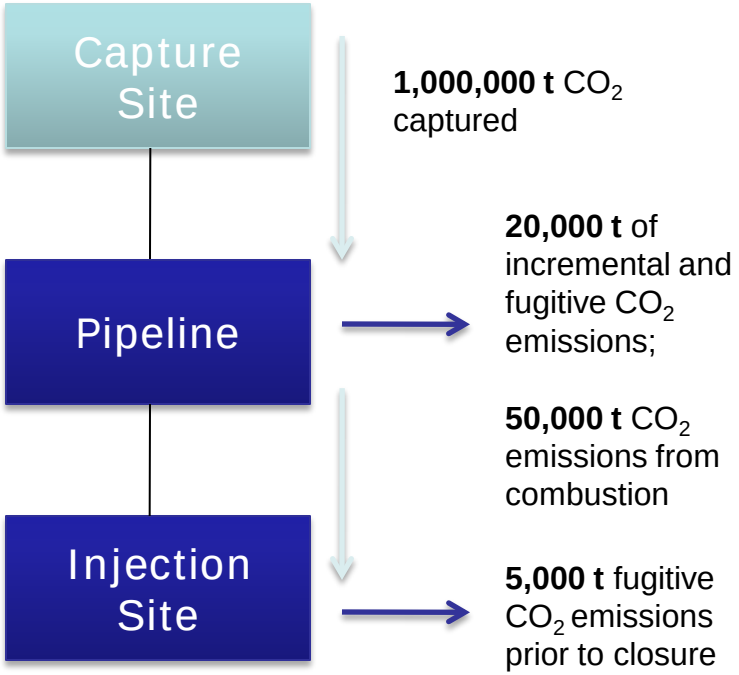
- Majority of CO_2 sourced for CCS will originate from sites regulated under SGER
  - Offset system may not be the venue to commercialize emission reductions associated with CCS,
    - Some 'unregulated' GHG sources are good candidates for CCS
    - Industrial Process emissions are unregulated
  - Reporting and regulatory scope of SGER presently does not facilitate the complete accounting of all 'project emissions' related to a CCS Project
    - Some 'facilities' will emit < 100,000 tCO2e/year

Possible CCS Project Configurations

Unregulated Facility

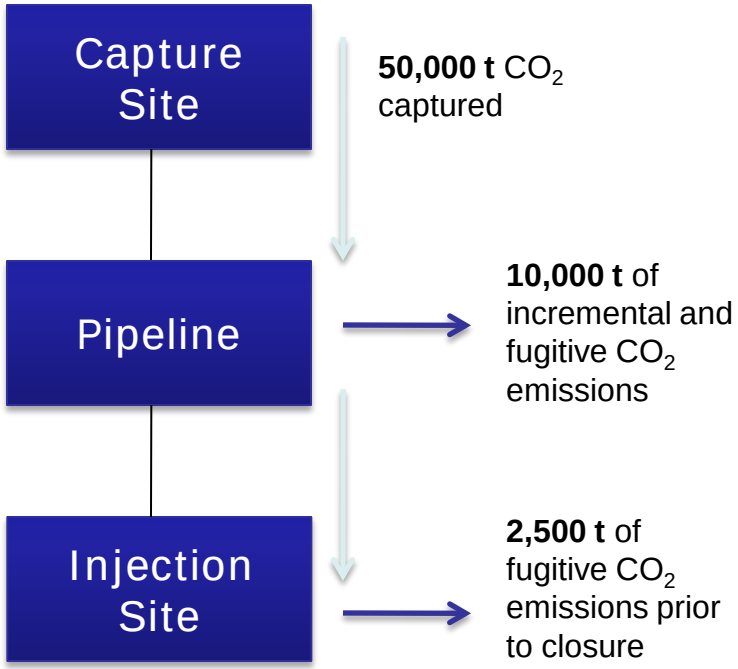
Regulated Facility

Regulated Emissions Source:
Emissions Performance Credit



Net project benefit = *925,000 t CO_2*

Unregulated Emissions Source:
Offset Credit



Net project benefit = *37,500 t CO_2*

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Process Overview

Methodology Development:

- Based on ISO 14064-2 guidelines
- Methodology framework based on the Alberta Specified Gas Reporting Framework for Regulated Facilities

Seed Documents:

- Oil and Natural Gas Industry Guidelines for Greenhouse Gas Reduction Projects: Part II: Carbon Capture and Geological Storage-Emission Reduction Family (IPIECA, June 2007)
- Alberta Offset System Quantification Protocol for Acid Gas Injection Projects (AENV, 2008)
- Alberta Offset System Quantification Protocol for Enhanced Oil Recovery Projects (AENV, 2007)

Technical Review

- Limited technical review within ICO2N conducted during draft preparation
- Technical Stakeholder Review Session held March 18, 2009

Applicability Criteria

The protocol applies to:

- All components of CCS projects that occur outside the boundaries of facilities subject to the SGER
- New facilities with CCS designed into construction
- Retrofits to integrate CCS into existing facilities
- CO_2 injection into producing and non-producing reservoirs
- Project must have obtained approvals from ERCB and demonstrate ongoing compliance with approval(s).

The protocol **does not** apply to:

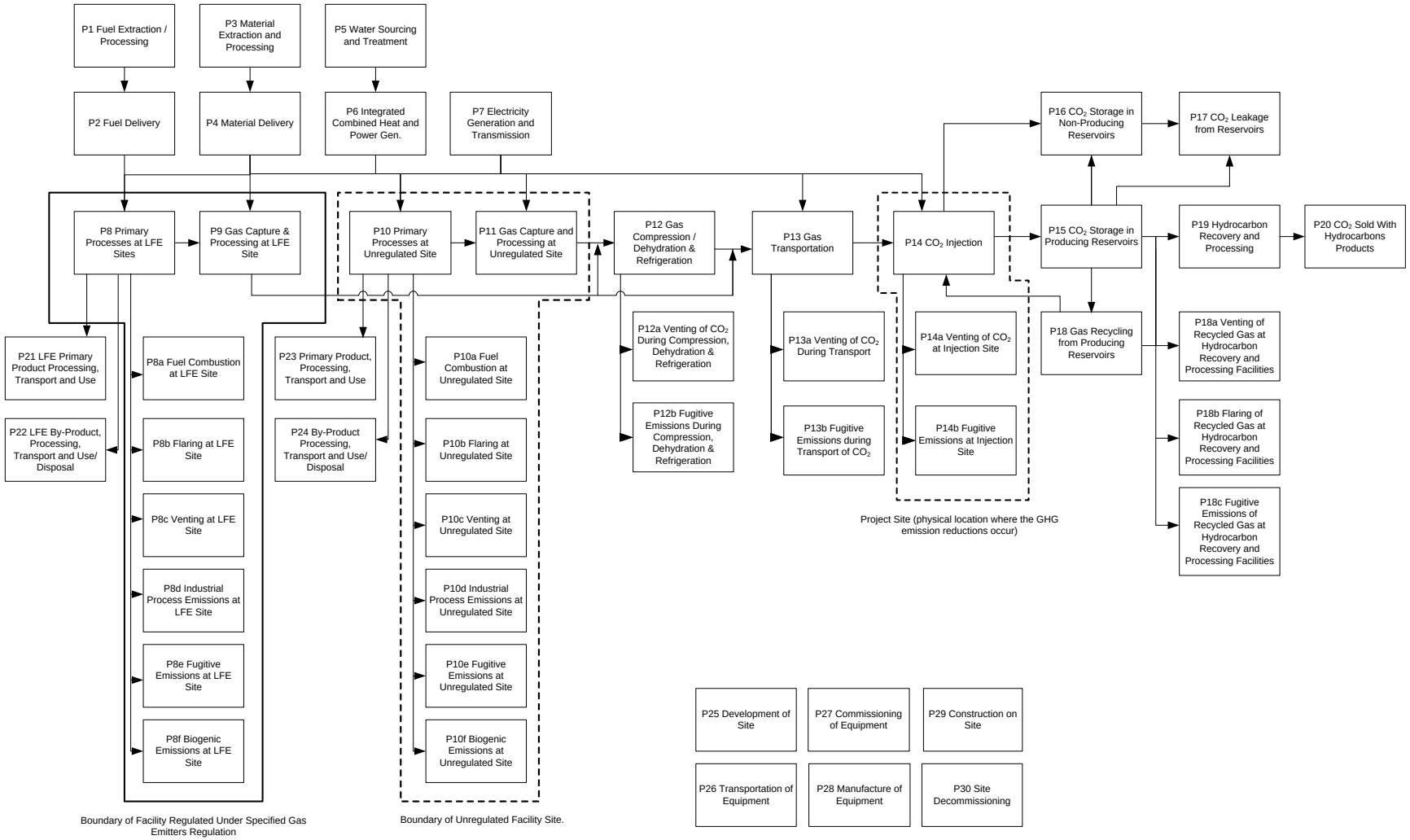
- Facilities where regulations mandate the implementation of CCS
- Emission sources already accounted for at the capture site and reported under the SGER (to avoid double counting)

Project Condition

Project Condition:

- GHG emission reductions from the implementation of carbon capture and storage (CCS) projects
  - Deliberately generic to account for the full range of CCS projects
- Capture, processing, transportation, injection and sequestration of captured CO_2 in geological formations
  - Includes producing reservoirs used for EOR or reservoirs used solely for geological sequestration
- Intended to allow for multiple sources of CO_2 injected and defines both regulated facilities (subject to SGER) as well as unregulated facilities

Process Flow Diagram for the Project Condition



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Baseline Condition

Existing Facilities retrofit with CCS

- Baseline condition is the facility continuing to operate without carbon capture and storage
- The quantity of CO_2 that would have been vented to the atmosphere in the baseline may be projected based on the quantity of CO_2 captured in the project condition and sequestered.
- This projection based approach is project and site specific and provides a reasonable estimate of baseline emissions if all project emissions are accounted for.

*Parasitic loads that result in incremental CO2 generation are accounted for as project emissions

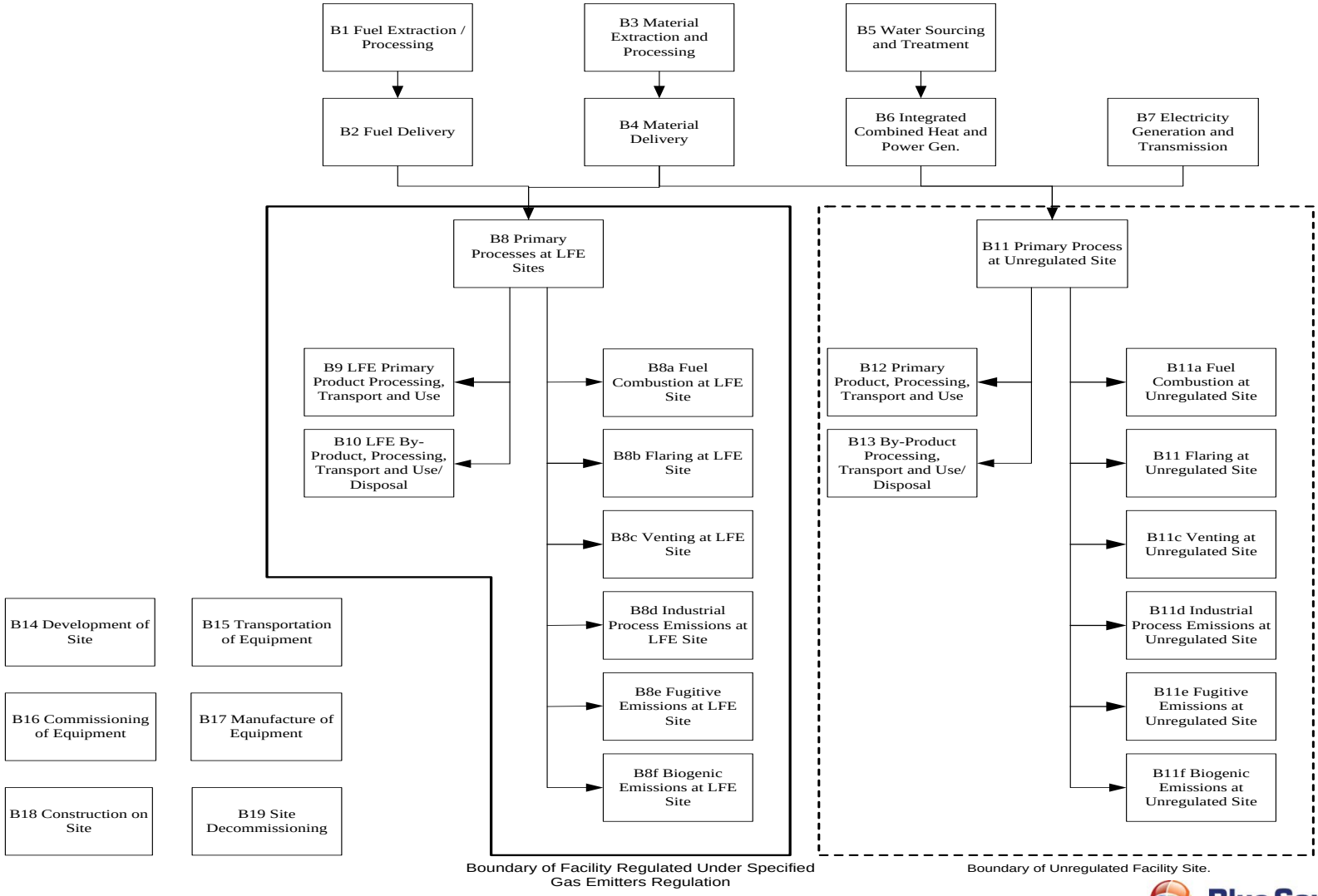
Baseline Condition Cont..

New Facilities with CCS

- No historic data available, baseline will depend on assumed baseline technology: conventional technology or 'CCS-Ready' technology
  - Choice of baseline technology depends on GHG cost and expectation of regulations
  - CCS could enable more carbon intensive fuel/feedstock use in the primary process

- Baseline for new facilities is defined as the lowest carbon fuel predominantly used as a fuel/feedstock for that type of primary process.
  - If regulated under SGER or if regulation has been announced, the baseline would be the operation of the 'CCS-compatible' technology without CO_2 capture
  - For facilities not currently regulated under SGER, baseline would be the best available technology that does not incorporate CCS, which may have a higher or lower efficiency.

Process Flow Diagram for the Baseline Condition



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AB Offset System Eligibility Criteria

Real:

- Baseline emissions must represent the most likely scenario that would occur in the absence of CCS
- Regulated facilities required to reduce emissions cannot generate offsets

Quantifiable:

- Quantification based on the tonnes of CO_2 emissions sequestered underground (minus project emissions) that normally would be emitted to the atmosphere

Not Required By Law/ Counted Once:

- Facilities that are required to reduce emissions under the SGER cannot generate offsets

Flexibility Mechanisms

Primary Flexibility Mechanisms:

- Projects may incorporate alternative means of CO_2 transport beyond transport in pipeline, such as the trucking of liquid CO_2 to the injection site

- Site specific emission factors may be substituted for the generic emission factors indicated in the methodology

- Measurement and data management procedures may be modified as long as the specified minimum standards for data quantity, frequency and quality are met

Barriers to Project Implementation and Co-benefits

- Technological Barriers
  - Lack of commercial scale operations with integrated capture, transport and storage
- Financial Barriers
  - High capital costs
  - Increased operating costs and energy consumption (parasitic loads)
- Regulatory Barriers
  - Long-term liability framework has not yet been established
  - Rights to store or dispose of CO_2
  - Limited Alberta experience with CCS
- Infrastructure Barriers
  - Significant changes to facility infrastructure and design
  - Development of CO_2 pipelines will be required
  - New equipment for compression, injection and monitoring required for storage

Review of Existing Projects

- In Alberta, the natural gas processing industry has significant experience in acid gas injection into depleted oil and gas reservoirs and has some experience injecting CO_2 into producing reservoirs for enhanced oil recovery.
- In the Permian Basin in Texas, USA and in Weyburn, Saskatchewan, commercial scale CO_2-enhanced oil recovery projects have also been operating for many years.
- CO_2 sequestration in deep saline formations, however, has not yet been commercially tested in North America.

Quantification Approach

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

- $\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Fuel Combustion at Unregulated Site}}$
- $\text{Emissions}_{\text{Project}} = \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Integrated Combined Heat and Power Generation}} + \text{Emissions}_{\text{Gas Capture \& Processing at LFE Site}} + \text{Emissions}_{\text{Flaring at Unregulated Site}} + \text{Emissions}_{\text{Venting at Unregulated Site}} + \text{Emissions}_{\text{Gas Capture at Unregulated Site}} + \text{Emissions}_{\text{Gas Compression}} + \text{Emissions}_{\text{Venting During Compression}} + \text{Emissions}_{\text{Gas Transport}} + \text{Emissions}_{\text{Venting During Transport}} + \text{Emissions}_{\text{CO2 Injection}} + \text{Emissions}_{\text{Venting at Injection Site}} + \text{Emissions}_{\text{CO2 Storage in Producing Reservoirs}} + \text{Emissions}_{\text{CO2 Storage in Non-Producing Reservoirs}} + \text{Emissions}_{\text{Gas Recycling from Producing Reservoirs}} + \text{Emissions}_{\text{Venting of Recycled Gas}} + \text{Emissions}_{\text{Flaring of Recycled Gas}} + \text{Emissions}_{\text{CO2 Sold with Hydrocarbon Products}}$
- $CO_{2\ \text{Equivalent}}\ \text{Emissions} = \Sigma\ (CO_2\ \text{emissions}) + \Sigma\ (CH_4\ \text{emissions}) * \text{GWP}_{CH4} + \Sigma\ (N_2O\ \text{emissions}) * \text{GWP}_{N2O}$

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Sample Calculation

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

SSR	Activity Data	GHG Emissions
Baseline Condition	N/A	0
Project Condition	CO_2 Storage in Non-Producing Reservoirs	-1,000,000
	Fuel Combustion for Gas Capture & Processing	100,000
	Fuel Combustion for Gas Compression, Dehydration, Refrigeration & Transport	100,000
	Venting of CO_2	10,000
Net GHG Reduction		790,000 tCO2e/year

Other Considerations

- Eventual harmonizing of SGER and Offset GHG accounting mechanisms
- Permanence issue will need to be addressed in policy or in methodology
- Liability over CO_2 : Capture site versus Storage site
- CO_2 recycling is very important in the quantification and in the issue of permanence
- Indirect emissions from electricity usage may be significant for large CCS projects, and may need to be quantified to get real environmental benefit
- CCS projects will likely need a different crediting period (>8 years)
- CO_2 -EOR projects may not be suitable for annual reporting due to likelihood for > 1 year time between injection and CO_2 recycling

Future Discussions

CCS Workshop, November 18th in Calgary

Agenda

- Accelerating Carbon Capture and Storage Implementation in Alberta
- Developments in CCS Policy and Programs across North America
- Project Implementation Roundtable
- CCS – EOR Methodology and Commercial/Policy Issues Update
- Background Presentation on CCS Commercial/Policy Issues
- Facilitated Roundtable Discussion of Commercial and Policy Issues

Questions?

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