Challenge Synopsis:

Canada's Oil Sands Innovation Alliance (COSIA) members are committed to accelerating the improvement in environmental performance of their industry through collaborative action and innovation. Carbon capture is one of the greenhouse gas (GHG) innovation opportunities that would contribute to COSIA's environmental aspirations.

Challenge Statement:

COSIA's member companies are looking for new transformative technology to capture CO_2 from flue gas streams from natural gas combustion in a once through steam generator (OTSG) or potentially a gas turbine.

Context:

COSIA is ideally seeking transformative CO_2 capture technologies that significantly outperform today's state-of-the art advanced amines. The ultimate fate of the CO_2 could be geological storage or conversion to useful products, for which purity, contaminants, and required delivery pressure may vary. Modularization and offsite fabrication is preferable given the remote location of Canada's Athabasca oil sands.

Oil sands operations consume large quantities of natural gas to produce steam for in situ bitumen extraction. A typical 33,000 bpd (barrels per day) in situ facility would operate six once through steam generators (OTSGs) requiring 1600 GJ/h (lower heating value) of combined energy input and emitting ~2,200 tonnes CO_2 per day. Conventional air supply (containing 21% O_2) for combustion of pipeline specification natural gas in OTSG's produces flue gas with a low CO_2 content (~7-8% by volume) at atmospheric pressure. OTSG flue gas contains 10 to 15% (volume) water, has a temperature ~185°C and can have 25 – 30 ppm SO_2 resulting from burning produced gas from the bitumen reservoir. OTSGs are also used for steam generation in oil sands mining and extraction operations. Gas turbines, with heat recovery steam generators, are also applied in some oil sands in situ or mining operations in place of one or more OTSGs. While gas turbine flue gas is a candidate for CO_2 capture, CO_2 concentration in the flue gas is much lower (4% by volume).

Criteria:

- Perform >50% (preferably > 75%) better than benchmark amines (30% monoethanolamine (MEA)) based post-combustion capture technologies on an energy and cost basis i.e. >50% reduction in capital expenses, operating expenses, capture energy requirements and CO_2 avoided cost. **CO_2 avoided costs must account for both direct and indirect CO_2 reductions. **
- Achieve high level of CO_2 purity (e.g. ~>95vol % CO2), although somewhat lower levels will be acceptable, depending on the end use of the CO_2 and if there are significant CAPEX/OPEX savings.
- Capture > 90% of CO_2, although lower capture levels will also be considered if there are significant CAPEX/OPEX savings.
- Have a minimal land-based footprint and have no adverse environmental or safety impacts (e.g. increased NOx emissions, toxic chemical release).
- Have minimal impact on or beneficial integration opportunities with existing operations.
- Technologies at all stages of technical maturity are of interest.
- Technologies not of interest include pre-combustion technologies, oxy-combustion technologies, CO_2 conversion technologies, and fuel cell technologies.
    - Also, not of interest are incremental improvements to advanced (next generation) amine-based capture systems.

The Opportunity:

- Potential to pitch your technology (if selected) to an alliance which represents 9 of the biggest oil sands producers in Canada. These companies account for over 90% of the oil sands product in Canada.
- Meet new customers and enter new markets with your product.

About COSIA:

COSIA accelerates the pace of environmental performance improvement in Canada's oil sands through collaborative action and innovation. We bring together innovators and leading thinkers from industry, government, academia, and the wider public to identify and advance new transformative technologies. Challenges are one way we articulate an actionable innovation need, bringing global innovation capacity to bear on global environmental challenges.

***Only non-confidential information should be included in your response ***

APPENDIX:

CO2 Avoided Cost:

The CO_2 avoided cost is the overall cost measure most commonly reported in carbon capture and storage (CCS) studies. It compares a plant with CO_2 capture (CC) to a "reference plant" without CC and quantifies the average cost of avoiding a unit (typically in tonnes) of atmospheric CO_2 emissions while still producing the same quantity of useful product. The CO_2 avoidance cost can be directly compared with market carbon price or regulatory carbon compliance cost. The Cost of CO_2 Avoided ($/tonnes CO_2) is calculated as follows.

$$\text{Cost of } CO_2 \text{ Avoided} = \frac{\text{Cost of Plant with CC} - \text{Cost of Reference Plant (no capture)}}{CO_2 \text{ emissions from Reference Plant} - CO_2 \text{ emissions from Plant with CC}}$$

Capturing carbon dioxide requires energy which is generally produced by the combustion of a fuel. Therefore, CO_2 is created to facilitate the capture process. This additional CO_2 produced is not included in the avoided cost calculation because it is additional emissions to the reference case with no CO_2 capture. The Avoided CO_2 emissions from Plant with CC is the difference between the amount of CO_2 captured and the CO2 emitted by the operation of the CO_2 Capture Plant (including both direct and indirect** CO_2 emissions).

The avoided cost of your technology must be compared to a reference case of post combustion CO_2 capture at a SAGD (steam-assisted gravity drainage) facility using 30% MEA. As COSIA members must compare capture costs on an equal and consistent basis, use the avoided cost calculations found in the Alberta Innovates – Energy and Environment Solutions report "ECM Evaluation Study" (Case 1B). This report can also inform your key assumptions and avoided cost calculation methodology.

Case 1B provides you the cost build up and avoided cost calculation methodology for the 30% MEA case as applied to OTSG flue gas CO_2 capture. To evaluate your technology on a comparable basis, please provide the following in your submission:

Base Case: Your estimate for the avoided cost for the base 30% MEA capture case (Case 1B). If your assessment of the Base Case is different from Case 1B above, please provide supporting documentation to support your claims.

New Capture Technology Case: Provide an assessment of your proposed capture technology using the same methodology as used to assess the Base Case. A comparison of the avoided cost and operating performance against the Base Case will be required. The CO_2 will be delivered at the facility battery limits at the same operating and purity specifications as Case 1B.

Ensure to provide COSIA with a breakdown of the cost calculations and assumptions for your technology. Submissions that do not include an assessment of both the Base Case and New Capture Technology Case using the referenced methodology described above will be rejected.

Indirect Emissions:

For any power consumption within the capture process, an electricity grid GHG intensity factor of 0.64 t CO_2e/MWh can be assumed, as per the Alberta Government's "Carbon Offset Emission Factors Handbook, 2015, No.1."

See SAGD Template & Energy Flow diagrams below.