Non-Confidential Final Report

C110117

Optimization of Enzymatic System for CO_2 Capture from Oil Sands Production

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A. Executive Summary

The Project was focused on advancing a new post-combustion CO_2 capture technology developed by CO_2 Solutions Inc. (CSI) which could provide substantial cost savings vis-à-vis conventional technology in application to in-situ oil sands production. In this regard, CSI's enzymatic CO_2 capture process was successfully advanced from the laboratory to the large-bench scale which prepared it for larger scale field pilot testing in 2015. The main goals of the Project per the Contribution Agreement (as amended) between CCEMC and CSI, along with the summary outcomes, are provided in the table below.

Goal	Description / Target	Outcome
1	At least 25% solvent regeneration energy savings vs. conventional technology with ability to achieve 90% CO_2 capture rate (at lab scale)	*Met and exceeded goal*; 33% energy savings
2	Soluble enzyme evolved to regeneration temperatures (at lab scale)	*Met goal*; CA enzyme can be deployed with sufficient lifespan
4	Demonstration of at least 25% solvent regeneration energy savings vs. MEA with 90% CO_2 capture rate (at large-bench scale)	*Met and exceeded goal*; 88% reduction in energy with use of waste heat and 31% overall savings in CO_2 capture costs
4	Conceptual Design of Field Pilot	*Met goal*; Executed Collaboration Agreement with Husky Energy to host ~10 tonne/day field pilot

As indicated, all stipulated goals of the Project were achieved or exceeded and a number of valuable technical and business lessons were learned. In this regard, the main conclusions are:

1. *The technology can provide a cost-effective solution for CO_2 capture from the oil sands and other large sources of emissions in Alberta and beyond as described previously*.

2. *Significant near-term GHG reductions are possible with the commercial implementation of the technology.* Based on the success of the Project, CSI plans to roll out a number of Enhanced Oil Recovery (EOR) projects in Alberta which are forecast to result in cumulative reductions of more than 3,400,000 tCO_2 by the end of 2024.

3. *The current GHG regulatory environment positions the technology for CO_2 utilization as a bridge to its implementation for further GHG reductions through CCS.* The continued lack of new regulations in the oil sands, and Canadian oil and gas sector more generally, necessitated a shift in CSI's focus from CCS to EOR and other CO_2 reuse applications in the short-term.

CSI estimates that CO_2 reuse applications represent an annual addressable market for its technology of at least \$3.3 billion. CSI intends to pursue these markets following the upcoming 2015 field pilot testing. Along with a much larger commercial demonstration for EOR, this will position the technology for broad application to a variety of industries where CO_2 is a required input.

The project was also a success from a financial standpoint. The total project costs were \$1,794,239, a difference from the budget of only \$5,114, or 0.2%. A full review of CSI's accounting procedures was carried out by CCEMC auditors with CSI receiving a favourable "G" rating indicating there were "no significant issues identified during the Auditors' work".

B. Introduction and Project Overview

Carbon capture and sequestration (CCS) has been identified as a tool for substantial greenhouse gas (GHG) emissions reductions in the Alberta oil sands[1]. Moreover, post-combustion, solvent-based carbon capture is generally accepted as the nearest term, retrofitable technology option as part of an overall CCS strategy[2] such as in existing in-situ oil sands operations employing Steam Assisted Gravity Drainage (SAGD). However, conventional solvents such as monethanolamine (MEA) and other amines that offer favorable capture kinetics require significant amounts of stripping heat to release the captured carbon dioxide (CO_2). This large energy requirement creates an inefficient process with high costs. Total amortized costs for a state-of-the-art conventional amine process applied to capture 90% of the CO_2 from the flue emissions of a typical SAGD once-through steam generator (OTSG) unit in the Alberta oil sands are approximately $70/tonne, excluding the costs of compression of the CO_2 for underground injection.[3]

In this regard, the oil sands industry faces a significant economic challenge in utilizing conventional CO_2 capture technology as its costs compare unfavourably with the current tax pricing regime or any envisioned future regime. This cost also compares unfavourably with a required price point for CO_2 of below approximately $50/tonne for the commercial viability of Enhanced Oil Recovery (EOR) in Alberta as both an oil production and carbon sequestration instrument.[4] In the latter, the cost barrier has been identified as one of the most critical issues to be resolved before the present nascent EOR industry in Alberta can be expanded.[5]

Less widely covered, conventional amine solvents also suffer from significant operational and environmental issues including degradation, toxic aerosol emissions, sensitivity to flue gas contaminants, and corrosivity which limit their practical utility as a CO_2 capture option.[6]

In this context, the Project, *Optimization of Enzymatic System for CO_2 Capture from Oil Sands Production*, was focused on advancing a new post-combustion CO_2 capture technology developed by CO_2 Solutions Inc. (CSI) which could provide substantial cost savings and improved operational properties vis-à-vis conventional technology. Over the course of the 24 month project, from May 2012 to May 2014, CSI's enzymatic CO_2 capture process was successfully advanced from the laboratory to the large-bench scale (~0.5 tonnes/day) for application to OTSG operations and other large emissions sources in the oil sands and beyond.

The Project prepared the technology for larger scale (~10 tonnes/day) pilot testing in the field which began in May 2015 in collaboration with Husky Energy Inc. In anticipation of the success of this pilot testing, a much larger (≥150 tonnes/day) fully commercial project integrated with EOR is being pursued.

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[1] Pembina Institute, *CCS Potential in the Oil Sands*, February, 2014, Pg. 7
[2] G. Ordorica-Garcia et. al., *Technology Options and Integration Concepts for Implementing CO_2 Capture in Oil-Sands Operations*, Journal of Canadian Petroleum Technology, September, 2012, Pgs. 365-366
[3] HTC Purenergy Inc., *1000 TPD CO_2 Capture Plant FEED Study for Devon Jackfish 1 Oil Sands Operations*, report to CCEMC, November, 2011, Pg. 4
[4] G BACH Enterprises and Amulet Solutions, *Overcoming the Barriers to Commercial CO2-EOR in Alberta, Canada, report to Alberta Innovates*, May, 2013, Pg. 44
[5] Alberta Carbon Capture and Storage Development Council, *Accelerating Carbon Capture and Storage Implementation in Alberta*, March, 2009, Pg. 10
[6] T. Grant, C. Anderson, and B Hooper, *Comparative life cycle assessment of potassium carbonate and monoethanolamine solvents for CO_2 capture from post combustion flue gases*, International Journal of Greenhouse Gas Control, No. 28, June, 2014, Pgs. 35-44

C. Project Goals

The main goals of the Project, per the Contribution Agreement (as amended) between CCEMC and CSI, along with the summary outcomes are provided in the table below. The goals were based on the application of CSI's technology to OTSG operations for in-situ oil sands production.

	Goal	Setting	Description / Target	Outcome	Related Report
1	Go/No Go Decision 1	Laboratory	At least 25% solvent regeneration energy savings vs. MEA with ability to achieve 90% CO_2 capture rate	*Met and exceeded goal*; 33% savings with carbonate solvent accelerated by carbonic anhydrase (CA) enzyme	"Report on Go/No-Go Decisions 1 and 2" submitted August 9, 2013
2	Go/No Go Decision 2	Laboratory	Soluble enzyme evolved to desorber/regeneration temperatures or potential for bench-scale filtration of 90% of soluble or particle-based enzyme	*Met goal*; CA enzyme can be deployed homogeneously (with sufficient lifespan) throughout carbonate process	"Report on Go/No-Go Decisions 1 and 2" submitted August 9, 2013
3	Go/No Go Decision 3	Large-Bench testing	Demonstration of at least 25% solvent regeneration energy savings vs. MEA with 90% CO_2 capture rate	*Met and exceeded goal*; 88% reduction in solvent regeneration energy when considering waste energy streams from OTSG heat sources and 31% overall savings in CO_2 capture costs	"Final Report" (final technical report) submitted May 8, 2014
4	Preliminary Engineering of Field Pilot	Engineering based on Large-Bench testing	Conceptual Design of Field Pilot, including preliminary sizing and integration with Husky Energy facilities; Review of applicable codes and regulations and initiation of permitting process; Preparation of Engineering Services bid package	*Met goal*; Executed Collaboration Agreement with Husky Energy to host the ~10 tonne/day field pilot at its Lashburn, SK heavy oil production site in 2015	"Final Report" (final technical report) submitted May 8, 2014 and herein

As described above, all stipulated goals of the Project were achieved. From a technology performance standpoint, the process energy savings and cost reduction goals were exceeded.

Project Changes

Further to the above, the Contribution Agreement underwent two amendments to reflect a "Major Change" in each case. The first amendment dated July 26, 2013 was related to a shift in spending between milestone items (>10%) although the total Project costs remained unchanged. This was due to changes in timing of tasks related to Go/No Go Decision 1; however, the milestone remained on schedule. The second amendment dated March 25, 2014 was due to the replacement of CSI's industry field pilot testing partner related to goal 4 above.

D. Project Final Outcomes

The primary technical goals of the Project along with the summary outcomes were provided in the previous section. As such, discussions related to the final outcomes of the Project will focus on business related outcomes and related lessons learned. From a business and strategic standpoint, by far the largest unexpected development over the course of the Project was a shift in focus on commercial applications of the technology. While application to OTSGs remained the same, the focus on the geologic sequestration of CO_2 in Alberta solely for GHG reductions was replaced by a focus on beneficial CO_2 reuse through EOR. This was dictated out of necessity by CSI to remain a viable business concern. The shift was precipitated by the continuing delay in more stringent carbon emissions regulations for the oil sands and the Canadian oil and gas industry generally. When CSI initiated the project in 2012, it was widely anticipated that the Government of Canada (as it had stated) would introduce new, first-ever regulations on the oil and gas industry mandating the reduction in GHG emissions. Similarly, the Government of Alberta also spoke of increased regulations beyond the current \$15/tonne-CO_2 intensity-based Specified Gas Emitter Regulation. Individually and/or combined, these measures were widely expected to significantly spur the commercial adoption of CCS.

However, as time passed with no regulatory action on either front, the oil sands producers CSI was engaged with for discussions on pilot testing and longer-term commercial partnership were increasingly reluctant to invest funds in GHG-related technologies. This was the case with many oil sands producers who did not have the opportunity for the large-scale reuse of CO_2 as an economic resource for EOR or otherwise, and thus in absence of significant carbon emissions penalties, viewed GHG reduction efforts only as a source of additional cost.

The challenge to locate an OTSG/SAGD pilot at an Alberta oil sands producer site was further exacerbated with concerns by producers over any potential disruption to production and the situation where logistically they couldn't burden their operations with further work on site due to existing scheduled production related construction work.

It was in this environment that Husky Energy emerged as a partner. Husky has significant EOR operations in Saskatchewan. At the same time, Husky operates numerous OTSGs for in-situ heavy oil production which are located near EOR sites.

In April 2014, CSI entered into a Collaboration Agreement with Husky for an approximate 10 tonnes/day field pilot test of CSI's technology[7]. The pilot will run for approximately 5 months, beginning in May 2015 in Salaberry-de-Valleyfield near Montreal. Subject to the success of the pilot test, the Collaboration Agreement provides for Husky to consider the use of CSI's technology for commercial carbon capture projects. The pilot testing and future commercial plans for CSI's enzymatic CO_2 capture technology are discussed further in Section H.

The deployment of CSI's technology for EOR effectively provides a 'bridge' to its availability for CCS projects should Alberta adopt more stringent carbon emissions regulations which would adequately incentivize CCS.

[7] http://www.co2solutions.com/uploads/file/644633cb0f326ea6b816a7d4c57251d841e8bf83.pdf

E. Scientific Achievements

The table below provides a listing of the scientific achievements of the Project.

	Type of Achievement	Date	Description
1	Conference presentation	September 24, 2013	Presentation entitled *Harnessing Nature for Efficient Carbon Capture* at Alberta Power Symposium, Edmonton AB; http://www.co2solutions.com/uploads/file/CO2_Solutions_Alberta_Power_Symposium_Sept_24-2013.pdf
2	Conference presentation	October 23, 2013	Presentation entitled *Harnessing Nature for Efficient Carbon Capture* at Carbon Management Technologies Conference, Alexandria VA; http://www.co2solutions.com/uploads/file/CO2_Solutions_Carbon_Management_Technologies_Conference_Oct_23-2013.pdf
3	Conference presentation	January 26, 2014	Presentation entitled *Harnessing Nature for Efficient Carbon Capture* at VerdeXchange, Los Angeles CA; http://www.co2solutions.com/uploads/file/CO2_Solutions_VerdeExchange_2014_2.pdf
4	Conference presentation and chair	February 19, 2014	Presentation entitled *Enzymatic Technology for Low-Cost CO_2 Capture* at Carbon Dioxide Utilization Congress, San Diego CA; http://www.co2solutions.com/uploads/file/c6334b8645bdf4e4cd401b651d3b47feb6bd731d.pdf
5	Patent filing	2014	The patent covers the application of CSI's enzymatic technology to the capture of CO_2 from OTSG units in the oil sands and heavy oil operations in Western Canada resulting from the learnings in the Project.
6	Poster presentation	April 29, 2014	Poster entitled *Efficient Solvent Technology for Post-Combustion CO_2 Capture and Utilization* at 13th Annual Carbon Capture, Utilization & Storage Conference, Pittsburgh PA; http://www.co2solutions.com/uploads/file/CO2_Solutions_CCUS_Conference_Poster_April_29-2014_Final.pdf
7	Conference presentation	May 6, 2014	Presentation entitled *Harnessing Nature for Carbon Capture* at Canada - U.S. Clean Energy Dialogue 3rd Binational CCS Conference, Edmonton AB
8	Conference presentation	May 15, 2014	Presentation entitled *Harnessing Nature for Carbon Capture* at 11th Annual World Congress on Industrial Biotechnology, Philadelphia PA; http://www.co2solutions.com/uploads/file/JCarley_CO2_Solutions_Bio_World_Congress_2014_Breakout_Session_May_15-2014_Final.pdf

F. Greenhouse Gas Impacts

1. Background of Greenhouse Gas Reduction Potential

The Project supports the industrial utilization and sequestration of waste CO_2. The Project successfully demonstrated that CSI's patented enzymatic CO_2 capture and recovery technology has the ability to capture approximately 90% of the CO_2 from flue gases significantly more cost effectively than conventional amine based processes. The capture efficiency and the improvement in operational costs result in improved capture economics for the supply of industrial volumes of CO_2 for beneficial use.

The use of waste CO_2 has many applications in Alberta, including enhanced oil recovery (EOR) and carbon capture and storage (CCS). The development of these projects will result in a large volume of emissions reductions as both of these activities result in permanent sequestration of a large fraction of injected CO_2 in underground reservoirs.

Alberta's Climate Change Strategy (2008) noted that the province can meet its emissions reduction goals through an aggressive adoption of CO_2 capture sequestration (CCS) activities. As discussed in Section D, at the outset of this Project, CSI intended to play a major role in this strategy by facilitating a cost reduction across all CCS projects. However, since the adoption of the 2008 strategy, little implementation has been observed, and it is likely that the province will be refocusing its climate change strategy to place more emphasis on other reduction mechanisms such as energy efficiency and renewable energy. That said there is still a large opportunity for CSI's technology in the EOR sector. At the same time, the deployment of CSI's technology for EOR provides a 'bridge' to its availability for CCS projects should Alberta adopt more stringent carbon emissions regulations which would adequately incentivize CCS.

EOR generally refers to the injection of fluids into an existing hydrocarbon production reservoir to increase the pressure and / or mobilize the hydrocarbons for production. Water and CO_2 are common injection fluids. CO_2 has the desirable property of being miscible with hydrocarbon fluids above a certain pressure, so it can work both to increase reservoir pressure and to decrease viscosity which helps mobilize fluids for production. CO_2 can therefore be a more desirable fluid for EOR compared to other commonly used fluids such as water. At the conclusion of an EOR project, the majority of CO_2 that was injected into the reservoir remains permanently sequestered, effectively removing it from the biosphere. This long term sequestration can be valued as a climate change mitigation action.

CO_2 is typically more expensive and this cost is often preventative when considering EOR projects. CSI's technology is thus valid for reducing the costs of EOR projects since the capture of CO_2 is the first step in procurement of CO_2 for these projects. CSI is confident that demand for CO_2 for EOR projects will generate significant uptake of its technology. In that regard, the cost reductions achieved with the technology will enable many more EOR projects to be economical compared to without this technology.

Alberta's Offset System has quantification protocols for both EOR (*Quantification Protocol for Enhanced Oil Recovery)* and CCS (*Quantification Protocol for Carbon Capture and Storage* projects). The EOR protocol is currently flagged for revision, which means proponents who wish to develop emission reduction credits must directly contact AESRD prior to registration. These two documents are important contributors to the regulatory framework that can support and encourage the deployment of CSI's technology.

As mentioned, at the outset of the Project, estimates for indirect emission reductions were developed based on an increasingly stringent carbon emissions regulatory environment leading to incremental demand for CSI's technology in coming years. This has yet to materialize and therefore requires the deployment rate to be adjusted and indirect emission reductions are now different as a result. While the original target market (CCS) for this technology has become less relevant due to changing political and regulatory frameworks, markets such as EOR, greenhouse atmosphere enrichment and beverage industries show promise and have comparable emissions reduction potential.

2. Mechanism for GHG Reductions

The enzymatic process used by CSI will result in increased CO_2 recovery from flue gas from many projects throughout Alberta and internationally. The baseline condition for each project is the continued release of CO_2 from flue gas into the atmosphere. The project condition is the capture of CO_2 from flue gas for the use in industrial applications. CSI's technology enables capture activities to occur because the economics are improved to the point where beneficial use of CO_2 is profitable in many common applications.

3. Methodology

There are several quantification methods with which one can determine the emission reductions associated with a CCS or EOR project. Most are based on the ISO 14064-2 standard. This standard focuses on GHG projects or activities that will reduce GHG emissions or increase the removal of GHGs from the atmosphere. It includes principles and requirements for planning a GHG project, including those for determining project baseline scenarios, and for qualifying project performance relative to those baseline scenarios. The requirements presented in this ISO standard are in the context of several key principles:

- *Relevance*: of sources, sinks, reservoirs, data used, and methodologies used
- *Completeness*: all project emissions and removals are to be included
- *Consistency*: to enable meaningful comparisons
- *Accuracy*: to reduce bias and uncertainties
- *Transparency*: to make decisions with reasonable confidence
- *Conservativeness*: of assumptions, values, and procedures, in order to ensure that GHG assertions are not overstated.

In general, the difference between the baseline emissions of an industrial process (the emissions scenario before a GHG project is initiated) and the emissions of the process in the project condition is the emission reduction. This is illustrated in Figure 1 below.

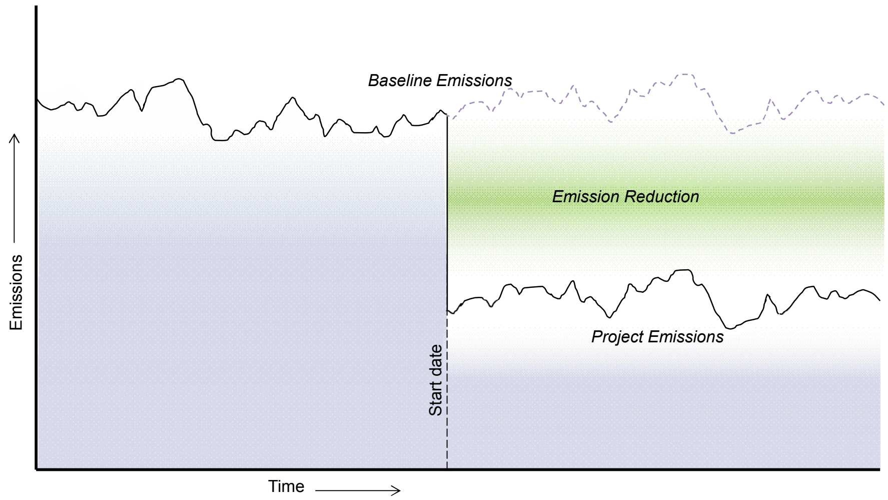


Figure 1 - The emissions reduction is considered the difference between the baseline condition emissions and the project condition emissions.

There are two approaches to determining the baseline and project emissions in a project, namely the 'Atmosphere Balance' approach and the 'Reservoir Balance' approach.

'Atmosphere Balance' Approach

The "Atmosphere-Balance" quantification approach takes into account all potential sources of CO_2 emissions, leaks or vents into the atmosphere that would be associated with a CCS project, and deducts these from the total CO_2 emissions to determine the amount of carbon ultimately sequestered.

There are many sources of emissions to account for in CCS activities. Emissions are generated as a result of fuels used on-site or off-site to power the carbon capture and storage facility, for dehydration of CO_2, or for compression, transportation, and injection of CO_2 into a storage reservoir. Some CO_2 may be vented to the atmosphere throughout this process during events that may be planned or un-planned. Finally, connection points along the CO_2 transportation network between the capture and injection points are susceptible to fugitive leaks, and these leaks must be estimated. Therefore, in order to determine the amount of CO_2 sequestered, each source of emission, vent, or fugitive leak must be measured, or in some cases estimated. Then, the aggregate total of all emission sources can be subtracted from the amount of CO_2 captured, in order to determine the volume of CO_2 that was injected into the reservoir.

'Reservoir Balance' Approach

The 'Reservoir-Balance' quantification approach considers the quantity of greenhouse gas emissions injected into the storage reservoir, deducting the greenhouse gases produced or vented from the reservoir, in order to determine the mass of CO_2 sequestered.

By using a metering device, CCS project operators can accurately measure the rates and volumes of CO_2 injected into the reservoir. Fugitive emissions and venting events from the capture and transportation processes need not be quantified in order to accurately determine the amount of CO_2 sequestered. However, fugitive emissions from infrastructure downstream of the metering facility are taken into account. Incremental emissions associated with CCS project activities are still measured and deducted from the total CO_2 injected for crediting purposes.

The calculation requirements for the 'Atmosphere-Balance' quantification protocol for a hypothetical CCS project are as follows:

Source, Sink or Reservoir	CO_2 (tonnes)	Relative Uncertainty
Captured	98.66	2%
Direct Industrial Emissions	10	2%
Fugitive emissions and vents from gas processing and dehydration	0.1	10%
Fugitive emissions and vents from pipeline flange #01	0.01	10%
Fugitive emissions and vents from compression facility #02	0.01	10%
Fugitive emissions and vents from pipeline facility	0.01	10%
Fugitive emissions and vents from compression facility #03	0.01	10%
Fugitive emissions and vents from pipeline flange #04	0.01	10%
Fugitive emissions and vents from compression facility #05	0.2	10%
Fugitive emissions and vents from pipeline flange #06	0.1	10%
Fugitive emissions and vents from distribution compressor system	0.1	10%
Fugitive emissions and vents from transportation flange #07	0.1	10%
Fugitive emissions and vents from injection facility	0.01	10%
Incremental emissions: gas processing and dehydration	2.4	2%
Incremental emissions: compressors	1.5	2%
Incremental emissions: on-site electricity generation	0.35	2%
Incremental emissions: distribution compression system	0.65	2%
Incremental emissions: compressors	1.6	2%
Incremental emissions: injection facility	1.5	2%
Sequestered	*80*	*2.48*

Conversely, the calculation requirements for the 'Reservoir-Balance' quantification protocol for a hypothetical CCS project are:

Source, Sink or Reservoir	CO_2 (tonnes)	Relative Uncertainty
Injected	88.01	2%
Fugitive emissions and vents from injection facility	0.01	10%
Incremental emissions: gas processing and dehydration	2.4	2%
Incremental emissions: compressors	1.5	2%
Incremental emissions: on-site electricity generation	0.35	2%
Incremental emissions: distribution compression system	0.65	2%
Incremental emissions: compressors	1.6	2%
Incremental emissions: injection facility	1.5	2%
Sequestered	*80*	*2.20*

As demonstrated by the above tables, the 'Atmosphere-Balance' quantification methodology requires many more measurements and estimations than does the 'Reservoir- Balance' method. The advantage of the 'Reservoir-Balance' methodology is the reduced number of measurements that need to be made, and particularly the reduced number of estimations that need to be made. The 'Reservoir-Balance' method relies on fewer variables, most of which are measured. This methodology is more in line with the ISO 14064-2 principles of *accuracy*, as uncertainty is reduced when measurements are used instead of estimations. The method is still in line with the ISO 14064-2 principle of *completeness*, as all necessary GHG emission sinks and sources are included in order to accurately determine the amount of CO_2 sequestered in the storage reservoir as well as the emissions associated with the CCS project activities.

In the case of EOR projects designed to sequester carbon, produced CO_2 can be captured and measured at the gas handling facility, and likely will then be processed to be re-injected into the reservoir. In both quantification methodologies, the amount of produced CO_2 is deducted from either the total industrial emissions ('Atmosphere-Balance') or from the injected CO_2 ('Reservoir-Balance'). Produced CO_2 and the resulting deductions occurring after injection and crediting has ceased must be accounted for transparently. Produced CO_2 can be extracted in gaseous form or in solution with reservoir fluids (oil and water). Upon depressurization of reservoir fluids (this may occur downstream of the project site), dissolved CO_2 and natural gas will effervesce and the CO_2 fraction must be quantified as a deduction.

The uncertainty associated with a measurement is less than the uncertainty associated with an estimate. In the models presented in the tables above, a relative uncertainty value of 2% is associated with measured values, and an uncertainty of 10% is associated with estimated values. The estimation uncertainty of 10% is conservative; material uncertainties could be expected when estimating fugitive emissions. When calculating the sequestered volume of CO_2, the uncertainties from each measurement or estimation are summed (using the square root of the sum of squares method) to provide an uncertainty for the volume of CO_2 sequestered.

The sum of uncertainties for the 'Reservoir-Balance' method is calculated in this hypothetical example to be 2.20%, compared to 2.48% for the 'Atmosphere-Balance' method. These relative percentages would change depending on the specific project, but this example demonstrates that the 'Reservoir-Balance' methodology would have a lower relative uncertainty inherent to the calculation method.

Specifically in the Project, the equipment and activities served as an isolated bench-scale facility where the onsite energy requirements were metered. Based on the energy consumption of the facility, a modest amount of energy was required to capture 1 tCO_2. Assumptions can be made in association with these energy consumption rates to extrapolate the emissions associated with capturing the CO_2.

To extrapolate the emissions reductions of the Project, the downstream application must be known. The reductions associated with use of waste CO_2 will be different for EOR, CCS or other industrial applications. The sources and sinks of these applications will lead to different emissions reductions in the project condition. In the Alberta Offset System, the two previously discussed protocols will account for the lifecycle losses and emissions reduced through their respective methodologies. In general, based on existing projects in the Alberta system, approximately 60% of injected CO_2 is retained permanently in EOR projects, while in CCS projects the net emissions reduction benefit is anticipated to be over 80% of the net injected CO_2.

Currently, CO_2 is a commodity that can be purchased at various grades and quality for various purposes throughout the industry. The price varies significantly depending on where it is sourced and the purity (defined by the intended use). CSI has demonstrated that the enzymatic process it has developed will decrease the cost per tonne to capture CO_2. Improving the economics to capture CO_2 will increase the market for EOR and CCS projects.

Compared to traditional monethanolamine (MEA) CO_2 capture technology, the energy required decreases using CSI's enzymatic recovery process. This translates into an estimated 31% decrease in total CO_2 capture costs.

As described in Section B, if the cost of CO_2 decreases below \$50/tonne, the profitability of EOR projects in Alberta would be significantly enabled. Based on a 31% reduction in the cost of CO_2 recovered relative to a state-of-the-art MEA process, this would imply a cost of approximately \$48/tonne with the CSI technology[8], thus meeting the EOR cost target. With the development of the CSI technology and deployment of EOR projects, a substantial quantity of emissions reduction can be achieved in Alberta and beyond. This is discussed in more detail below.

4. Direct Reductions

There are no emissions reductions that directly resulted from the Project. This was a pre-pilot (laboratory and large bench-scale) project to determine the viability and efficiency of capturing waste CO_2 from OTSG flue gases. The large bench-scale testing in Project verified that 90% of CO_2 can be captured from flue gas. The volume of CO_2 captured was determined by measuring both the %CO_2 in the rich incoming flue gas and the lean outgoing flue gas. Additionally, the flow rate of the CO_2 in the solvent was also measured (i.e. both the reservoir balance and atmospheric balance approaches). The rich incoming flue gas contained 8.6% CO_2 and the outgoing lean flue contained 1.1% CO_2. In the Project, the captured CO_2 was not used in any industrial applications and was rejected to the atmosphere after measurement.

5. Indirect Reductions

The market for EOR will be significant with the development of CSI's technology. The technology will decrease the cost to recover CO_2 from flue gases to less than \$50/tonne, the general EOR economic threshold. CSI has plans to develop multiple EOR projects in Alberta over the next 10 years.

CSI is pursuing an initial commercial deployment of the technology for EOR where *at least* 150 tonnes of CO_2 (tCO_2) would be injected per day (also see Section H). This would result in a reduction of approximately 90 tCO_2 per day due to a 60% crediting factor to account for lifecycle losses, or a reduction of 32,000 tCO_2 annually. Over 10 years, that would result in a reduction of at least 320,000 tCO_2.

Over the next 10 years (2015-2024), CSI plans to roll out a total of 23 similar EOR projects in Alberta. This would result in a cumulative reduction of more than **3,400,000 tCO_2** by the end of 2024.

G. Overall Conclusions

The Project was deemed by CSI to be highly successful and also resulted in valuable lessons learned towards the ultimate commercial deployment of the technology. The main conclusions are described below.

1. *CSI's enzymatic technology can provide a cost-effective, operationally elegant solution for CO_2 capture from the oil sands and other large sources of emissions in Alberta and beyond*

[8] 31% reduction from \$70/tonne for the HTC Purenergy process in OTSG application

In the Project, CSI demonstrated at pre-pilot scale several significant benefits which position its enzyme-accelerated carbonate solvent process as an efficient new option for the capture and production of pure CO_2 for reuse and sequestration vis-à-vis conventional amine processes, including:

- ✓ 30%+ savings on CO_2 capture costs (CAPEX and OPEX), or <$50/tonne vs. $70 for conventional amine technology, in line with CO_2 price point required for EOR and other reuse applications. This included a ~90% reduction in energy costs resulting from the ability of the process to operate using waste heat streams;
- ✓ High solvent stability and no susceptibility to heat degradation;
- ✓ No toxic aerosol (nitrosamine) emissions;
- ✓ No degradation products to send to landfill;
- ✓ Lower corrosivity;
- ✓ Operationally elegant design through eliminating the need for amine aerosol and reclamation related components;
- ✓ Simple operation with the enzyme catalyst flowing homogeneously with the solvent and low temperature operation provides for long lifespan of enzyme;
- ✓ The ability to produce high purity CO_2 for industrial application.

2. *Significant near-term GHG reductions are possible with the commercial implementation of the technology*

As described in Section F, reductions of greater than 1.1Mt CO_2 are possible by 2025 given the capture cost reductions brought about by CSI's technology for the EOR industry. Should Alberta adopt more stringent GHG reduction legislation, which would incentivize the deployment of CCS projects, even further reductions would be possible.

3. *The current GHG regulatory environment positions CO_2 utilization as a bridge to CCS*

The shift in CSI's market focus from CCS to EOR and other CO_2 reuse applications necessitated by a continuing delay in new GHG regulations on the oil sands and Canadian oil and gas sector generally was described in Section D.

Despite the regulatory delay, the fact remains that the oil sands, particularly in-situ operations are the fastest growing source of emissions in the country. CSI believes that increased carbon regulation in Canada is inevitable as other nations around the world coalesce around binding reduction targets. Spurred by the recent United States – China agreement on GHG reductions, the December 2014 United Nations Framework Convention on Climate Change (COP 20) in Lima, Peru produced the Lima Call for Climate Action agreed to by 196 participating countries towards a new universal treaty on GHG reductions. The draft treaty binds participants to individually submit their proposed emissions reductions targets by 2015. On the basis of individual commitments, a treaty would be ratified by leaders of the nations at a meeting in Paris in December 2015 with it coming into effect in 2020. Given that U.S. and China, as the world's largest emitters, have committed to reductions of least 26% by 2025 and absolute reductions beginning 2030, respectively, it is viewed that a binding global treaty is likely.

Ultimately, this means that CCS as a key tool in reducing emissions from the Canadian oil and gas sector is likely to see significant uptake in the post-2020 time horizon. By CSI being able to scale up and profitably commercialize its technology in the interim based on captured CO_2 as an economic resource for EOR, it will be ready to migrate technology to large-scale CCS projects without delay when new carbon regulation dictates it.

H. Next Steps

As a result of the Project, CSI's technology is positioned for initial commercial deployment in 2016. The table below provides an overview of the steps and timeline of the commercialization program along with the supporting external partnerships involved.

	Scale	Milestones	Partners
2012-2014	Lab	✓ Initial solvent selection ✓ Initial techno-economics for in-situ oil sands ✓ Performance target exceeded: >33% energy savings vs. MEA	• CCEMC • ecoENERGY Innovation Initiative (ecoEII) • CO_2 Capture Project • Statoil
2013-2014	Bench (0.5 tonne-CO_2/day (tpd))	✓ Enzyme compatibility established ✓ Performance target exceeded: 88% energy savings and >30% overall cost savings vs. MEA ✓ Collaboration Agreement with Husky Energy for field pilot	• CCEMC • ecoENERGY Innovation Initiative (ecoEII) • CO_2 Capture Project • Statoil
Dec. 2014 – Jan. 2015	Small Pilot (1tpd)	✓ Extended process testing using proprietary 1T1 enzyme ✓ Coal and natural gas flue gases ✓ Results forecast $39/tonne CO2 captured including compression to 2250psi for coal-fired power application	• Energy & Environmental Research Center (EERC) • U.S. Department of Energy
Q2-Q4 2015	Field Pilot (10tpd)	✓ Commissioned May 2015 ✓ <1 year from engineering to commissioning and on budget ➢ 2,500 hours using OTSG flue gases (planned)	• ecoEII • Husky Energy
2016+	Commercial (300+tpd)	➢ Deployment(s) at 10-300tpd scale for various CO_2 utilization applications (beverage, mineralization, algae, and others) (planned) ➢ Initial 300tpd deployment with EOR integration (planned) ➢ Large-scale (1000+tpd) deployments in Alberta and beyond for EOR and CCS (planned)	• To be announced

This program comprises a number of key elements including a proposed larger follow-up project for which additional CCEMC funding has been applied for as initially discussed in Section F. As described previously, the Project covered the 2012 to Q2 2014 period, which entailed lab and large-bench scale process optimization and testing work. This was supported primarily by the CCEMC, but also included funding from the Government of Canada's ecoENERGY Innovation Initiative (ecoEII). Additionally, private sector support was provided by the energy industry consortium the CO_2 Capture Project (CCP) (www.co2captureproject.org) as well as the Norwegian state oil company Statoil ASA (www.statoil.com).

Moving forward following the completion of the Project, the main tasks in CSI's commercialization program include the following (running concurrently in certain cases):

1. *Large Scale Production of High Performance Enzyme (Q4 2014 – Q3 2016)*

Utilizing separate funding from the Government of Canada's Industrial Research Assistance Program (IRAP), CSI has internally developed a high performance CA enzyme, named '1T1'. This enzyme has exhibited stability and activity in demanding carbon capture process conditions which significantly outperforms enzymes used to date by external suppliers. *Figure 3* below illustrates the exceptional stability of 1T1 in this regard.

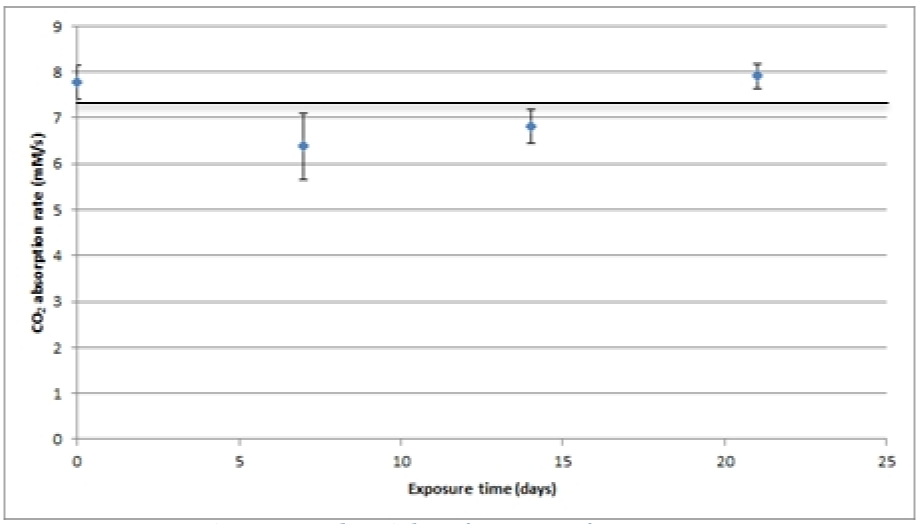


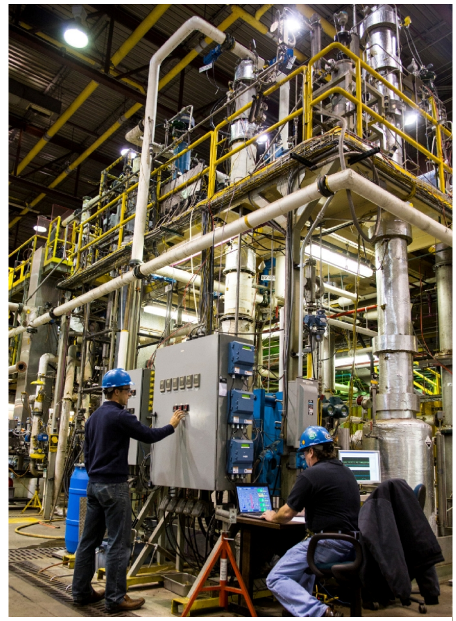
Figure 2 - Industrial Performance of 1T1 Enzyme
Carbonate solvent, lean conditions with 40 - 70°C cycling

The result is an enzyme that has a longer lifespan in the CO_2 capture process to meet the required specifications for CO_2 capture efficiency. At the same time, tens-of-kilogram batches have been manufactured at a cost that is materially less per kg of enzyme protein than the third-party enzymes. When combined, these benefits should lead to a lower operating cost.

The availability of the 1T1 enzyme also frees CSI from reliance on external CA providers. Not only does this eliminate the unnecessary cost to CSI imposed by the profit margin required by the suppliers, it provides greater autonomy and flexibility in providing a complete technology solution to customers. With the 1T1 enzyme, CSI will have the flexibility to enter into contract manufacturing relationships with a number of potential companies while controlling the intellectual property related to the enzyme. This will result in a better profit opportunity for CSI, as well as a better value proposition for the customer. 1T1 is being used in Tasks 2 through 6 below.

2. *Packed Column Small Pilot Testing and Updated Techno-Economics (Q4 2014 – Q2 2015)*

In order to obtain further process performance information over a longer period of time than was achieved in the Project, CSI entered into an agreement with the University of North Dakota Energy and Environmental Research Center (EERC) (http://tinyurl.com/qc2jsu5). With the Agreement, CSI joined EERC's program *Advancing CO_2 Capture Technology: Partnership for CO_2 Capture (PCO_2C) Phase III* as a sponsor. The program's goal is to evaluate several CO_2 capture technologies that are among the most advanced systems under development for application to power and steam generation plants. Under the program, CSI tested certain enzyme-accelerated solvents at EERC's state-of-the-art packed column CO_2 capture testing facility using natural gas and coal flue gases over a period of three weeks. The scale of the testing was approximately 1 tonne-CO_2/day.



Energy & Environmental Research Centre (EERC) CO2 Capture Pilot Test System used by CSI

In April, 2015, CSI announced the techno-economic results of the testing, which included:

- A conservative cost estimate of approximately \$39 per tonne of CO_2 based on 90% CO2 capture from flue gases of a typical coal-fired power plant at full scale, including CO_2 compression to 2250 psi. This surpasses the U.S. Department of Energy (DOE) target of \$40/tonne by the year 2025 for new carbon capture processes;
- Approximately ten-times reduction in the parasitic load on the power plant through the use of low-grade, nil-value heat from outside of the power plant's steam cycle compared to the reference amine case;
- Stable performance of CSI's proprietary 1T1 enzyme over the test period with no enzyme replacement;
- Constant CO_2 capture performance over the test period with no solvent make up and no toxic waste products generated;
- Significantly reduced power plant retrofit costs as the use of low-grade heat greatly reduces the requirement for additional coal combustion to maintain the net output of the power plant.

The programme represented the largest scale test to date of an enzyme-based CO_2 capture process. It was also the first enzyme-based CO_2 capture demonstration involving a complete configuration representative of industrial capture with flue gases, incorporating reduced pressure stripping and the enzyme employed in both absorption and stripping. The results will benefit the field pilot testing described below in Task 3 in terms of determining the ideal solvent and process conditions to be run.

3. *Larger Field Pilot Testing (Q2 – Q4 2015)*

CSI's field pilot unit in operation in Salaberry-de-Valleyfield, May 2015

Following on the excellent results achieved in the pilot testing with EERC, in May, 2015 CSI announced a change in scope to its field pilot which would accelerate the test program in order to bring forward the pursuit of commercial opportunities for the technology. In this regard, initial operation of the demonstration, involving the capture of approximately 10 tonnes per day of CO_2, will now take place for at least 1000 hours in Salaberry-de-Valleyfield near Montreal, where the pilot unit was constructed. Following this accelerated start-up phase, the pilot unit will be moved to the Husky Energy facilities in Saskatchewan, as originally planned. The operation of the pilot unit will involve the capture of up to 90% of the CO_2 from the flue gases of a natural gas fired steam generator. In that regard, the technical conditions and testing parameters will be materially identical to those the Company had planned for initial operation of the unit in Saskatchewan. Data from the re-scoped demonstration project will be used for determining operating parameters and costing for commercial units and will undergo third party validation prior to submission to the various project collaborators. The change was made in agreement with Husky Energy and the Government of Canada's ecoENERGY Innovation Initiative.

Additional photos of the pilot unit in Salaberry-de-Valleyfield can be viewed at http://bit.ly/1cioOxS

The pilot test is expected to further confirm the positive techno-economics of the technology realized in the Project and will provide an operational basis to compare the process against other new and conventional CO_2 capture processes.

Subject to a positive review by Husky of the results of the pilot test, the Collaboration Agreement provides for Husky to consider the use of CSI's technology for commercial carbon capture projects.

4. *Development of Advanced Process Configuration*

CSI's enzyme-accelerated solvent technology has been applied to date in a conventional configuration with packed columns where the energy quality used in the regeneration of the solvent, and hence operating cost, is significantly reduced vis-à-vis amine solvents.

While a packed tower configuration provides good performance, CSI believes that an opportunity exists for a next-generation equipment approach which can significantly reduce the physical footprint associated with the plant and in turn the capital cost. CSI believes that using this advanced equipment configuration in conjunction with the energy-efficient properties of an enzyme-accelerated solvent has the potential for further significant cost savings.

5. *Initial Commercial-Scale Deployment for EOR*

As initially described in Section F, CSI is pursuing opportunities to commercially deploy the technology at the 150 tonnes-CO_2/day (or greater) scale in conjunction with an EOR project. The project would beneficially leverage the previous successful work and learnings therein conducted with CCEMC funding.

The project would launch CSI's technology to full commercial availability for EOR and other carbon sequestration initiatives in Alberta and at the same time would result in material direct GHG reductions.

6. *Commercial Deployment Generally (Q4 2015 and beyond)*

Subsequent to the field pilot testing described in Task 3, CSI has identified several initial smaller scale (~10-60 tonnes-CO_2/day) commercial deployment opportunities for its technology which could be based on the same design as the pilot. This, along with the larger commercial demonstration for EOR mentioned above in Task 5, will position the technology for broad application to a variety of industries where CO_2 is a required input. CSI estimates that CO_2 reuse represents an annual addressable market for its technology of at least $3.3 billion. Later, as described in Section G, with global GHG reduction efforts, application of the technology for CCS will also be possible. Each of the market opportunities are described briefly below.

A. <u>Enhanced Oil Recovery (EOR)</u>

In Canada, substantial CO_2 EOR reserves are located in Saskatchewan and Eastern Alberta. Analysis by the Integrated CO_2 Network (ICO_2N) reveals that these regions could use approximately 1 billion tonnes of CO_2 over the life of the oil fields based on CO_2 that could be available from existing local anthropogenic sources.[9] This potential was recently bolstered by the start of construction of the Alberta Carbon Trunk Line, a 240-kilometre pipeline which will transport CO_2 from Northern Alberta to key EOR locations to the south.[10]

In the United States, existing EOR operations consume approximately 50 million tonnes of CO_2 annually and produce nearly 110 million barrels of crude oil in locations ranging from Wyoming and North Dakota to Louisiana and Mississippi, the vast majority of the CO_2 coming from natural geologic formations.[11] According to a recent study by EOR consultancy Advanced Resources International, U.S. production is expected to more than double in 2020 to 640,000 barrels per day. This in turn would require approximately 117 million tonnes of CO_2 annually.[12]

Given declining natural CO_2 sources combined with increasing demand, oil producers are increasingly looking at anthropogenic sources[13], where cost-effective carbon capture technology can provide a substantial opportunity for profitable hydrocarbon recovery. As such, CSI's technology is well positioned to serve this important and growing EOR market.

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[9] ICO_2N, A Carbon Capture and Storage Deployment Plan for Saskatchewan, September, 2013 (http://www.ico2n.com/wp-content/uploads/2010/10/A-CCS-Deployment-Plan-for-Saskatchewan-.pdf)
[10] http://www.enhanceenergy.com/
[11] U.S. Department of Energy National Energy Technology Laboratory, Next Generation CO2 Enhanced Oil Recovery, February, 2014 (no URL available)
[12] Advanced Resources International, Inc., The CO2-EOR Oil Recovery and CO2 Utilization "Prize", April, 2014 (no URL available)
[13] Ibid

CSI has estimated that the addressable CO_2 EOR market for its technology is at least $1.8 billion annually.

B. Greenhouses

Greenhouses require CO_2 as a critical component of photosynthesis to generate economic plant production yields. Greenhouse operators typically supplement CO_2 at a rate of up to 1,000 ppm resulting in plant yields being increased by approximately 50%.[14]

CO_2 for greenhouses is traditionally obtained by burning fossil fuels such as natural gas in specialized CO_2 generators, where after complete combustion, the flue gases are introduced directly into the greenhouse. The downsides of using natural gas are that moisture is produced during combustion, which may be disadvantageous for growing certain plants, and if combustion is incomplete, contaminants may be present in the flue gases and detrimental to the culture. Alternatively, pure CO_2 may be used. This has traditionally been supplied to greenhouses by truck in liquid form and has become popular amongst growers due the elimination of crop damage potential, lack of moisture production, more precise control over CO_2 levels and more flexibility to introduce the CO_2 when needed. A drawback of this approach however is that liquid CO_2 is typically more expensive than CO_2 directly generated from natural gas combustion.[15]

CSI's technology solves these challenges by allowing CO_2 to be captured and concentrated at lower cost from both natural gas combustion gases on site as well as from nearby sources of effluent gas sources. CSI estimates that the greenhouse addressable market for its technology in Canada, the U.S. and Europe is approximately $1.4 billion annually.

C. Pulp and Paper

The utilization of CO_2 in the pulp and paper industry is widespread and includes the following main uses:

- Regulating and stabilizing pH. Over the last few years, more and more pulp and paper mills have started to use CO_2 to regulate and stabilize pH while reducing their use of problematic mineral acids.
- Reducing $CaCO_3$ dissolution. Calcium carbonate ($CaCO_3$) is present in most papermaking systems. CO_2 can be added to the process to reduce its dissolution and eliminate mineral deposits.
- CO_2 pulp-washing. CO_2 pulp-washing technology is widely used in fibre lines, providing better operability, lower steam consumption, reduced wash water volumes, lower volume use of foam inhibitors and pitch dispersants, and lower maintenance costs.
- CO_2 for soap acidulation. Sulphuric acid consumption for soap acidulation in the production of crude tall oil (CTO) can be reduced by 30 to 50% by using CO_2. This also allows the pulp mill to have better control of its sulphur-sodium balance.

Most pulp and paper producers currently obtain CO_2 at a significant cost from external bulk gas suppliers. For these producers, CSI's process can be implemented to capture CO_2 from black liquor boiler

[14] Ontario Ministry of Agriculture, Food and Rural Affairs, Carbon Dioxide in Greenhouses, December 2002 (http://www.omafra.gov.on.ca/english/crops/facts/00-077.htm#cultu)

[15] Ibid

operations, where nil-value process heat can provide the energy for the CO_2 recovery process. The result is lower CO_2 acquisition costs, reduced dependence on external supply sources, and a lower carbon footprint of the pulp operation.

CSI estimates that the pulp and paper addressable market for its technology in Canada, the U.S. and Europe is at least $34 million annually.

D. Beverage Carbonation

Soft drink bottlers and canners are significant users of external CO_2 for carbonation, which is typically costly to obtain, and in many locations can present challenging logistics. In this context, the opportunity exists for soft drink producers to utilize CSI's technology to replace their external CO_2 with a more economical and secure source of CO_2 obtained from the exhaust gases of their boiler operations. At the same time, this CO_2 recycling provides a means of improving their environmental footprint.

CSI estimates that the beverage carbonation addressable market for its technology in Canada, the U.S. and the United Kingdom is greater than $20 million annually.

E. Water Treatment

Desalinated and demineralised water plants are becoming ever more common as the load on natural water sources is outstripped by population and industrial needs. The use of CO_2 for water treatment mirrors its use in the pulp and paper industry in terms of pH control. CO_2 provides a weak natural acid when dissolved in water. This means that its use in the provision of potable water is generally acceptable and its introduction as a gas allows for easy control. It is also regarded as more environmentally friendly than the use of mineral acids. As such, CSI's technology can be implemented to provide an efficient and secure on-site source of CO_2 in conjunction with co-located boiler operations.

F. Emerging Uses of CO_2

In addition to established uses of CO_2, many novel uses are under development or early demonstration. These include algae production for making products ranging from nutraceuticals to biodiesel, the production of bioplastics, the carbonation and reuse of mineral wastes, and the combination of CO_2 with hydrogen to produce liquid fuels, amongst other applications. The CSI technology is positioned as an ideal front-end solution to provide the lowest possible cost CO_2 feedstock required by these new processes.

G. CCS for Climate Change Mitigation

In addition, the current 'business-driven' markets for CO_2 as an industrial input, a future opportunity for the CSI technology exists for the efficient capture of CO_2 and its geologic sequestration for the principal purpose of GHG reduction in efforts to combat climate change.

With 70% of global energy demand currently met through the burning of carbon-based fuels, and demand predicted to double by 2035[16], the world faces a growing challenge: How to reduce carbon dioxide emissions which cause climate change while not damaging a global economy dependent on fossil fuels. A central issue to this carbon emissions problem is the fact that approximately 8,200 large stationary sources of CO_2 worldwide, such as coal and natural gas-fired power plants, oil and gas production facilities and

[16] U.S. Energy Information Administration

other large industrial plants generating 14.7 billion tonnes of annual emissions, or half of all total global anthropogenic CO_2 emissions.[17]

As such, to deal effectively with the issue of climate change, these existing large sources of emissions must be addressed. In its Fifth Assessment Report entitled Climate Change 2014: Mitigation of Climate Change, the Intergovernmental Panel on Climate Change (IPCC) recognized carbon capture and storage (CCS) as a key part of the mix of various technologies necessary to solve this challenge and reduce the impacts of climate change.[18] The process of CCS involves selectively removing CO_2 from the effluent gases of a power plant or other industrial source and permanently storing the emissions deep underground, most commonly in saline formations. The IPCC has previously estimated that there is at least 2 trillion tonnes of CO_2 storage capacity in appropriate geological formations globally.[19] Based on this, there is approximately 136 years of storage for present worldwide large-source CO_2 emissions.[20]

As governments around the globe begin to grapple with the magnitude of the climate change challenge, CCS will increasingly play an important role as a key mitigation option. Assuming a US $50/tonne globally implemented carbon tax, CSI estimates that the addressable CCS market for its technology would exceed $19 billion annually.

H. Communications Plan

Further to the conference presentations made so far and described in Section E, CSI will continue to share non-confidential results of the Project with industry, the academic community, and government through conferences. Not only will this highlight the success of the Project, but it will raise awareness of the technology amongst future customers and potential partners. In addition to conference presentations, the following additional communications channels will be utilized:

1. *Technical Papers*

Going forward, as the field pilot testing building from the Project is realized, results are expected to be synthesized into papers and submitted to major journals. Targeted journals will include:

- International Journal of Greenhouse Gas Control; the leading publication for new carbon capture technology developments amongst industry and academia.
- Current Opinion in Biotechnology; a respected biotech journal with a strong focus on industrial applications, including the utilization of enzymes
- Energy Procedia; a new publication focused on disseminating energy related conference proceedings to the larger industry and academic community

2. *Press Releases and Media Coverage*

As a publicly traded company which regularly announces important events, CSI has a growing following of analysts and market researchers. As a result of CSI's growing recognition, important future events,

[17] International Energy Agency (IEA) GHG Program; large source defined as >100,000 tonnes-CO_2 emissions annually
[18] http://www.globalccsinstitute.com/news/institute-updates/role-ccs-explained-latest-ipcc-report
[19] IPCC, Special Report on Carbon Dioxide Capture and Storage, 2005 (http://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf)
[20] Ibid

such as the results of the upcoming field pilot testing will be disclosed through press releases that will likely garner excellent coverage both in Canada and internationally. In this regard, CSI has released all significant news to date pertaining to the Project and its follow-on activities:

http://www.co2solutions.com/uploads/file/27f0ab49d01a39b6ccf52e8c0e658c1c059c009b.pdf
http://www.co2solutions.com/uploads/file/a1f87d5b82755c37c9e1358ce46057a3810fc773.pdf
http://www.co2solutions.com/uploads/file/644633cb0f326ea6b816a7d4c57251d841e8bf83.pdf
http://www.co2solutions.com/uploads/file/7e05d17fa7a9c4005e97a355224e024281c2721d.pdf
http://www.co2solutions.com/uploads/file/c53321852be29866ba8515bc1466eb74eefdc7cb.pdf

CSI has also been successful in attracting coverage from numerous media publications related to the project which can be viewed at http://www.co2solutions.com/media-coverage/list.html. Going forward, these publications will be valuable in promoting the follow-on activities resulting from the Project.

3. *Web Site and Social Media*

CSI maintains a web site at www.co2solutions.com which contains all relevant, publicly available information the Project and related developments as they occur. In addition, CSI has an active presence on Twitter (https://twitter.com/CO2SolutionsInc), LinkedIn (https://www.linkedin.com/company/co2-solutions-inc) and Facebook (https://www.facebook.com/CO2Solutions) through which it promotes its news.

I. Final Financial Report

The project, Optimization of Enzymatic System for CO_2 Capture from Oil Sands Production, was started in May 2012 and completed, according to the schedule permitted under the contribution agreement (as amended), May 2014. Estimated cost for the project was $1,789,125, with agreed funding support coming from CCEMC of $500,000, or 28%. The total project costs, upon completion, were $1,794,239, a difference from that budgeted of only $5,114, or 0.2%.

On May 22, 2014, CCEMC Auditors issued their report after a comprehensive review of the project management and accounting. The objective of the project audit was to verify that project funds were being properly managed and accounted for by CSI and that project financing was progressing in accordance with the contribution agreement, cost guidelines and other relevant documents such as financial statements related to the project.

Elements of a good control environment that were noted by the Auditor with respect to CSI:

1. Proactive communication between CSI's Vice-President of Business Development, Jonathan Carley and Alberta Innovates' Project Advisor regarding project status. Amendments to Contribution Agreement have been proactively initiated when required.
2. Project Manager was actively involved in monthly financial management of project by comparing actual cost expenditure to date to the budget set forth in the Contribution Agreement Schedule A and providing detailed explanations of variances.
3. Project Accountant tracked eligible expenses through project specific activity codes in the accounting system. The segregated codes allowed the Company to easily review project expenses and provide active cost management.
4. Employees were required use a separate time code to charge time relating to the project. Timesheets were approved by supervisors.

In conjunction with CCEMC's Senior Management, the Auditors have introduced a formal risk rating system to the CCEMC Project Audit function. CSI received an overall "G" (green=favorable) rating. No exceptions were noted by the Auditors and there were no significant issues identified during their work.