ION Clean Energy, Inc.
Commercial Carbon Capture Design & Costing FEED Study
Global CCS Institute 9th Annual DC Forum

March 3, 2020

Buz Brown, PhD, CEO
ION Clean Energy (ION-CE) is a leading, Boulder, Colorado based, CO₂ capture company commercializing its low aqueous, solvent technology.

Initial target markets:
• Large utility and industrial CO₂ emitters positioned to utilize 45Q tax credits

Company mission:
• Eliminate 1 billion tonnes of CO₂ emissions by 2050

ION-CE has recently completed an initial FEED Study, “Commercial Carbon Capture Design & Costing” (C3DC-1), funded by DOE/NETL, DE-FE0031595, ION-CE and partners

Host site: Nebraska Public Power District (NPPD) Gerald Gentleman Station (GGS) Unit #2, 700MW coal-fired generation

Most significant results to date:
• Initial design & costing for 300 MW slipstream of GGS Unit #2
• $36.6/tonne to $32.5/tonne

Presently continuing as C3DC-2 to capture 700 MW from GGS Unit #2, funded by DOE/NETL, DE-FE0031840, ION-CE and partners
Commercial Carbon Capture Design & Costing Study
(C3DC-1) Project Team and Roles

- Technology Developer
- Process Design and Project Management

- Carbon Capture Program Funding

- Host Site – Gerald Gentleman Station
- Power Generation Engineering, Operational & Financial Expertise

- Balance of Plant (BOP) Engineering
- Overall Cost Estimate Development

- Carbon Capture Pilot Experience & Expertise
- Capture Process Oversight, Design & Costing

- Supersonic CO₂ Compressor Design & Costing

- Design Basis
  - 300 MW CO₂ Capture Island
  - Fully integrated into GGS Unit 2

- Tasks
  - Process Design & Engineering
  - BOP Design
    - Steam/Condensate System
    - Cooling Water System
    - Flue Gas Tie-in
    - Electricity Tie-in

- Design Challenges
  - Cooling Water Integration
  - Steam Supply Integration

- Costing
  - AACE Class 3: -20 to +30% Accuracy
### Commercial Carbon Capture Design & Costing Study

<table>
<thead>
<tr>
<th></th>
<th>CO₂ Island</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Slipstream</td>
<td>300</td>
<td>MW e</td>
</tr>
<tr>
<td>EPC Capital Cost</td>
<td>$438,000,000</td>
<td>$</td>
</tr>
<tr>
<td>Loan Term</td>
<td>20</td>
<td>years</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>7.0%</td>
<td>%</td>
</tr>
<tr>
<td>Total OPEX</td>
<td>$28,200,000</td>
<td>$/yr</td>
</tr>
<tr>
<td>Total Annual Cost</td>
<td>$69,500,000</td>
<td>$/yr</td>
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<tr>
<td>Total Annual CO₂ Production at 85% CF</td>
<td>1,900,000</td>
<td>tonne/yr</td>
</tr>
<tr>
<td><strong>Cost of CO₂ Capture</strong></td>
<td><strong>$36.60</strong></td>
<td>$/tonne</td>
</tr>
</tbody>
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Currently Operating
Recently Proposed

Boundary Dam
Petra Nova
Shand
ION - TEA (rev 4)
ION - C3DC (4.5%)
ION - C3DC (7%)
Carbon Engineering
Carbon Engineering (Nth)

Cost of CO₂ Capture ($/Tonne)


DOE Capture Goal
Air Capture Goal

Direct Air Capture
Currently Operating
Recently Proposed
• C3DC-1 provided key engineering and costing details for final FEED study
  • Resource needs
  • Plant specific challenges
  • $32-36/tCO₂ (-20% to +30%) for our business models

• C3DC-2 will provide engineering and costing (-15% to +20%) for Firm Fixed Price (FFP) proposal

• ION is continuing to develop additional utility and industrial sites for CO₂ capture, sequestration and utilization that can take advantage of 45Q Tax Credits
TO: GLOBAL CCS INSTITUTE  
FROM: ION CLEAN ENERGY TEAM AND PARTNERS  

WE THANK YOU FOR THE OPPORTUNITY TO PARTICIPATE IN YOUR 9TH ANNUAL DC FORUM  

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Numbers DE-FE0031595 and DE-FE0031840.