



MEMBRANE
TECHNOLOGY & RESEARCH

Engineering Design of a Polaris Membrane CO₂ Capture System at a Cement Plant (DE-FE0031949)

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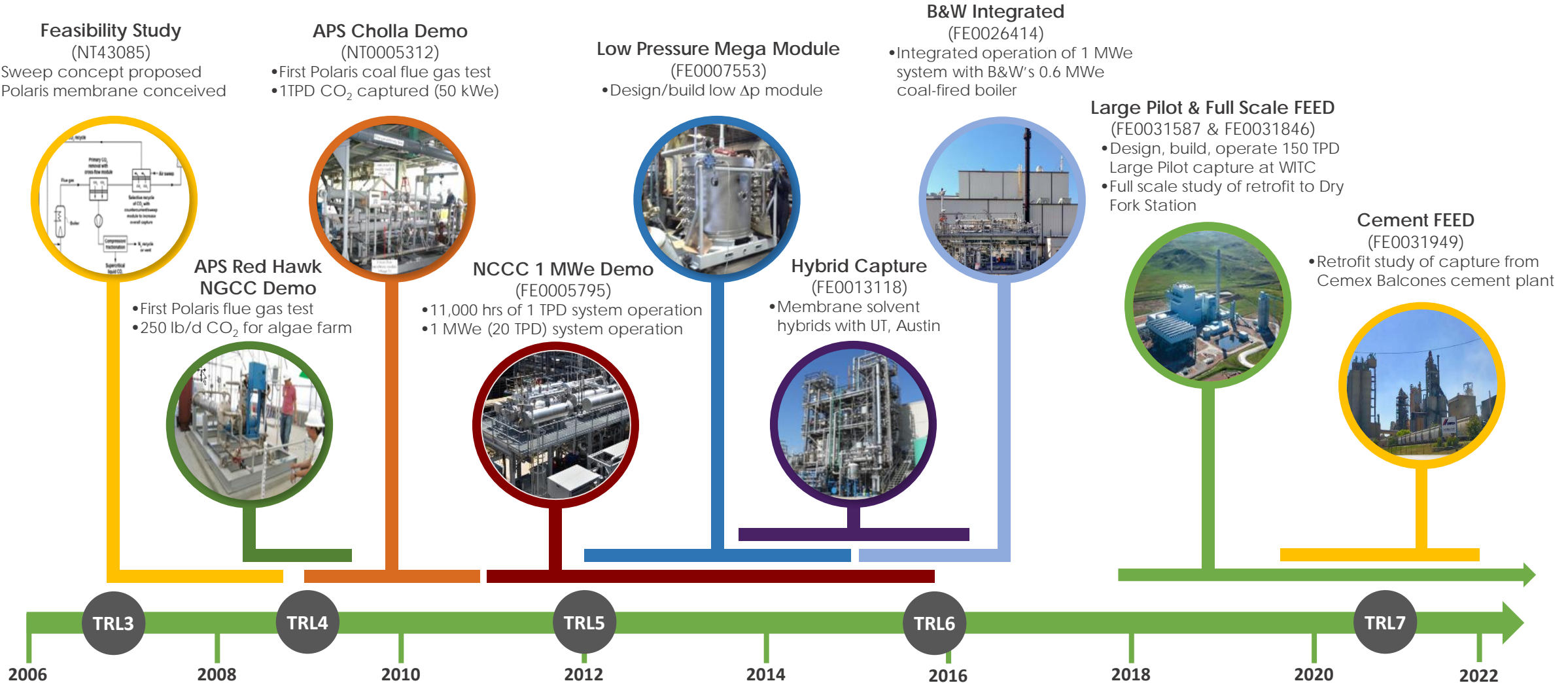
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DOE Review Meeting
August 3, 2021

Project Overview

- Award name:** Engineering Design of a Polaris Membrane CO₂ Capture System at a Cement Plant (DE-FE0031949)
- Project period:** 10/1/2020 to 3/31/2022 (18 months)
- Funding:** \$1.49 million DOE; \$0.37 million cost share (\$1.86 million total)
- NETL Federal project manager:** Carl Laird
- Participants:** MTR, Sargent & Lundy, and Cemex
- Project scope:** Conduct an engineering design study of MTR's CO₂ capture process applied to the Cemex Balcones cement plant in Texas
- Project goal:** The project will produce a design report with detailed engineering drawings, a completed NEPA study, a construction schedule, and an AACE Class 3 cost estimate (+30%/-20%) for a Polaris capture system installed at Balcones cement plant.

MTR's CO₂ Capture Development Timeline

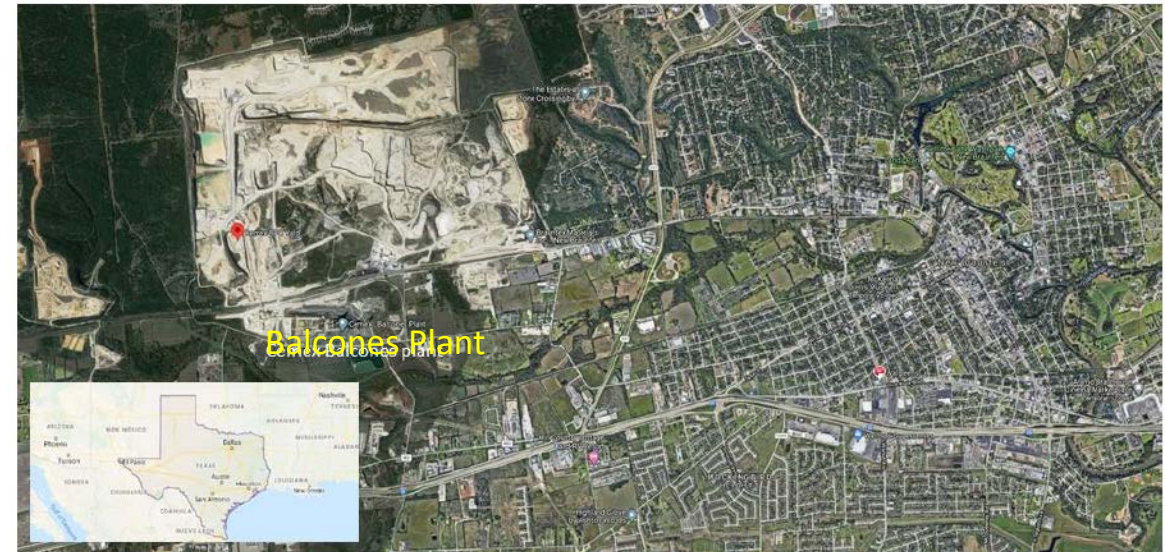


CEMEX Balcones Cement Plant

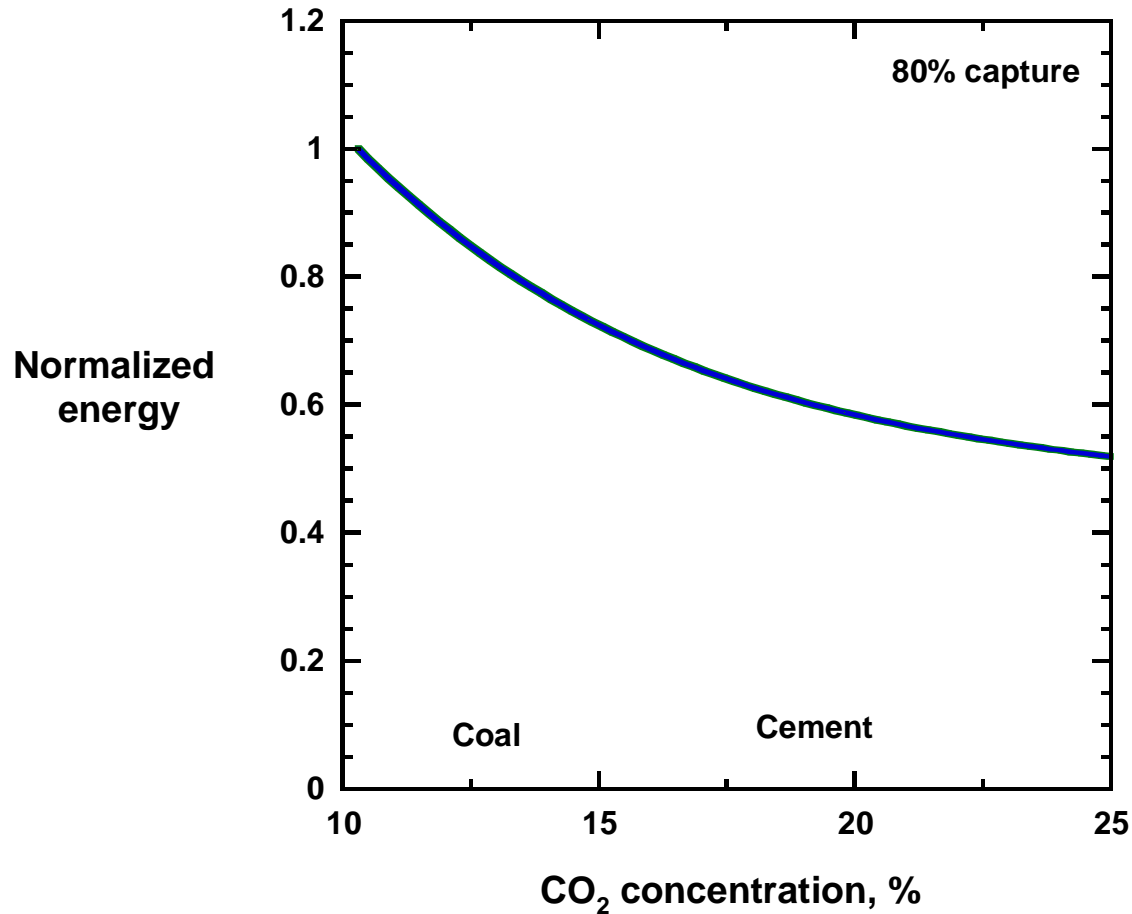


- Produces ~1.1 million tonnes of cement/yr
- Flue gas from kiln #2 contains ~16% CO₂ at ~2700 tonnes/day

- Located in New Braunfels, Texas adjacent to the Balcones Quarry, which is the top crushed stone producer in the US
- Close proximity to residential areas highlights the importance of capture system environmental impact
- Eagle Ford shale with EOR opportunities is nearby

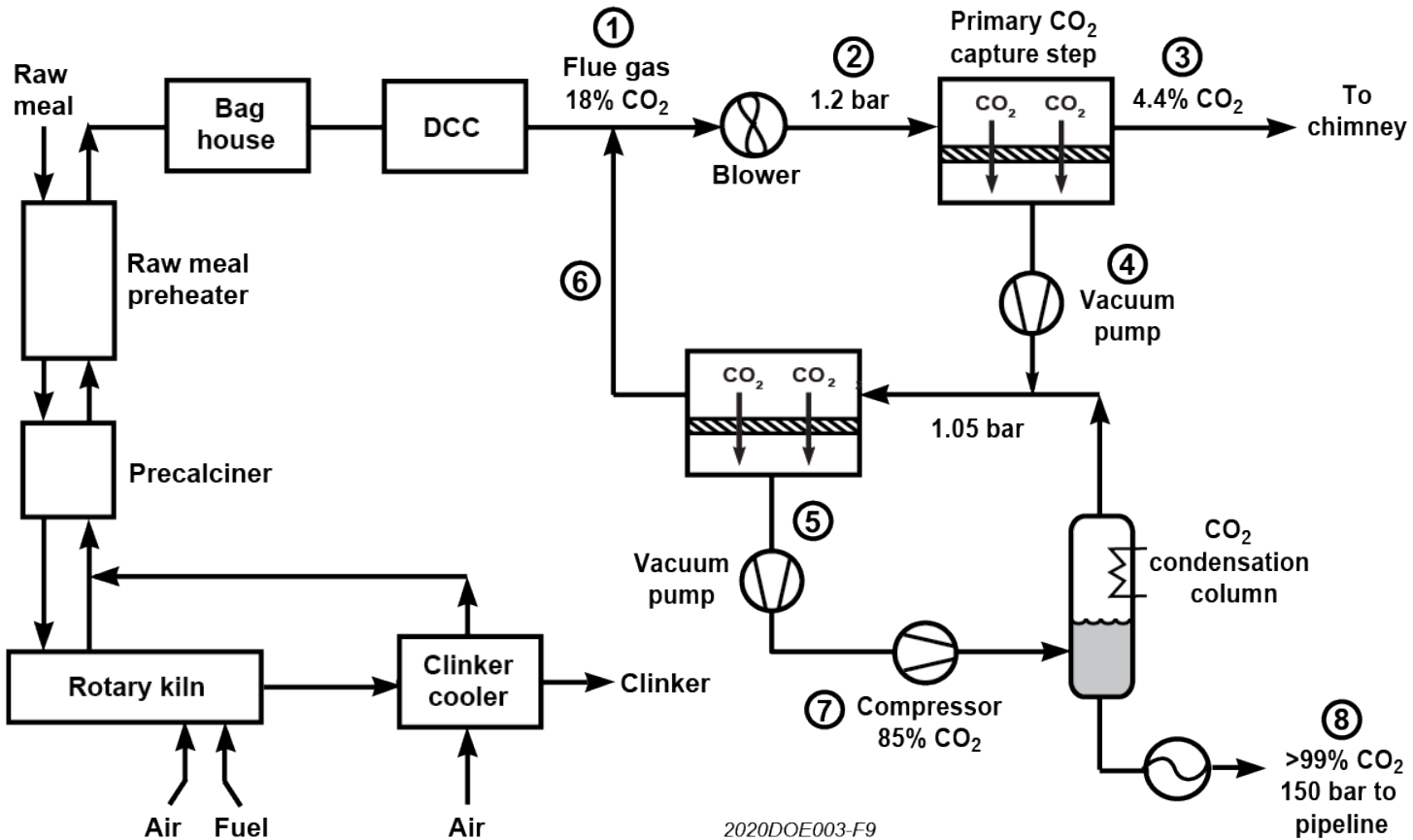


Why Membranes for Industrial Capture?



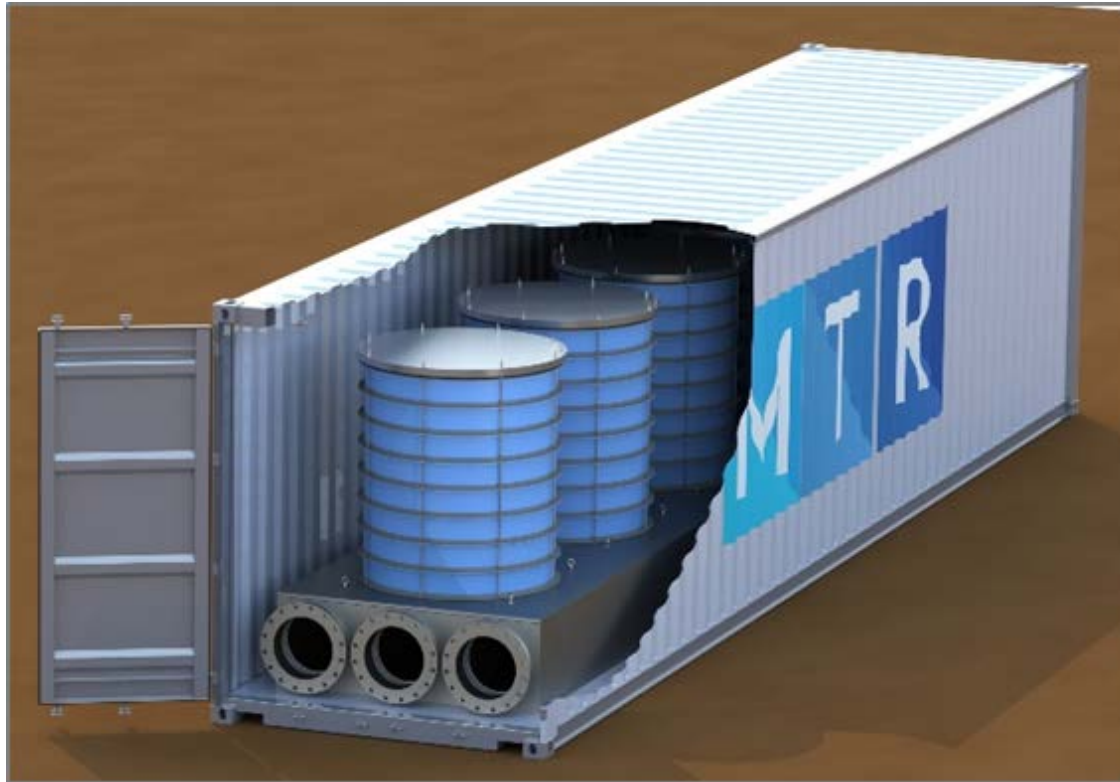
- Cost and energy use for membrane systems depend strongly on CO₂ concentration (partial pressure)
- Energy use for 80% capture from flue gas with 20% CO₂ is ~30% less than at 13% CO₂
- MTR and others (SINTEF, Favre, etc.) estimate relatively low capture costs for membranes from generic cement or steel plants

— Preliminary Design for Polaris System at Balcones



- Feed is 2700 tonnes CO₂/day at 16% CO₂ (dry) from Kiln #2 at Balcones
- Two stage Polaris membrane system with CO₂ liquefaction
- Base case examines 75% capture of plant CO₂ emissions (~2000 TPD or 0.71 million TPY captured)
- High purity CO₂ (>99.5%) available for offtake at 150 bar

Polaris Membrane Containers

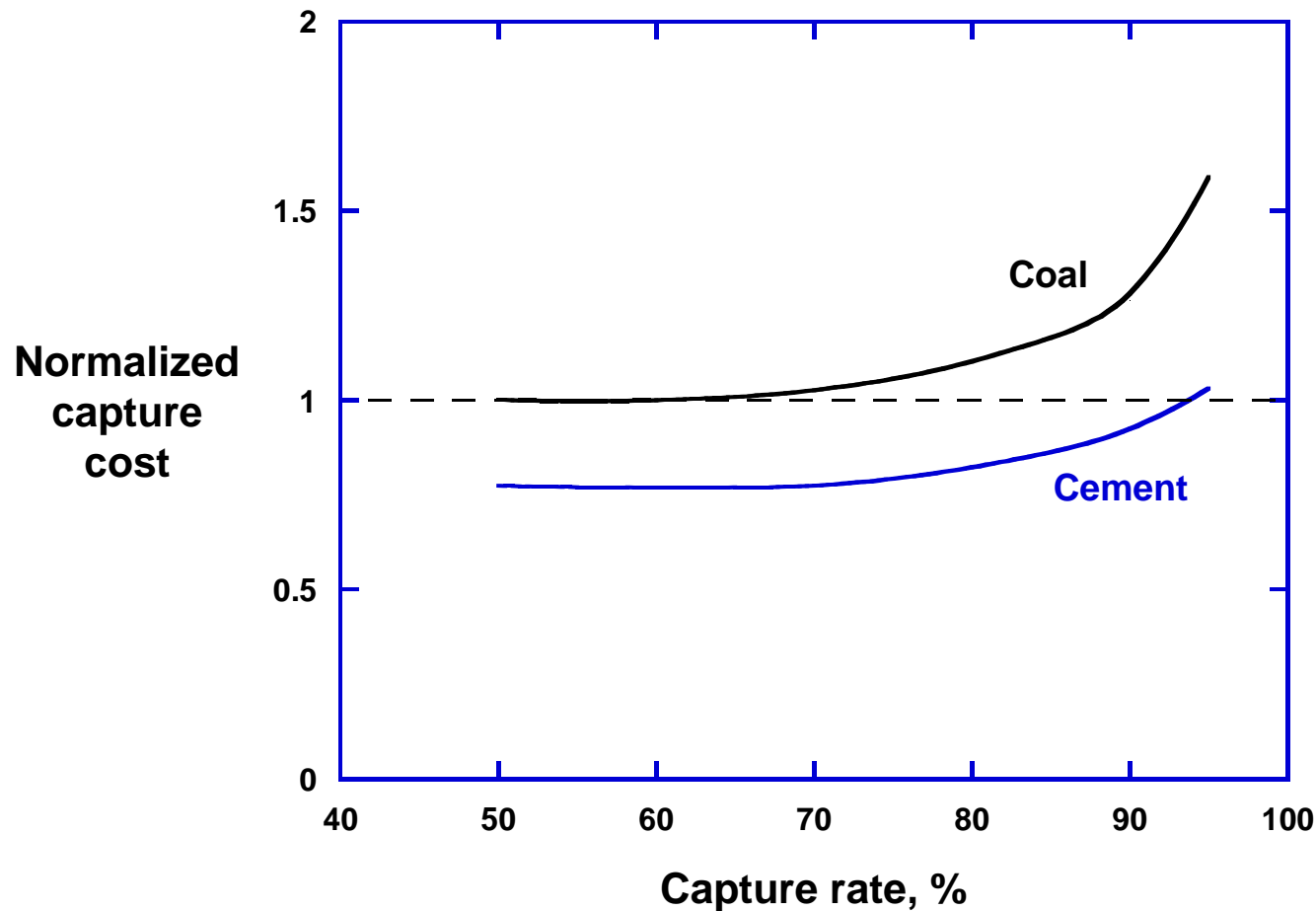


- Container with membrane stacks is the final modular unit for this capture technology
- Cemex study will use this configuration with today's Polaris membranes

- Test system in operation at TCM in Norway uses a single container of membrane stacks
- Cemex full scale system would use multiples of this unit building block



Capture Cost vs Capture Rate



Capture cost is normalized to 60% capture from coal using today's Polaris membranes

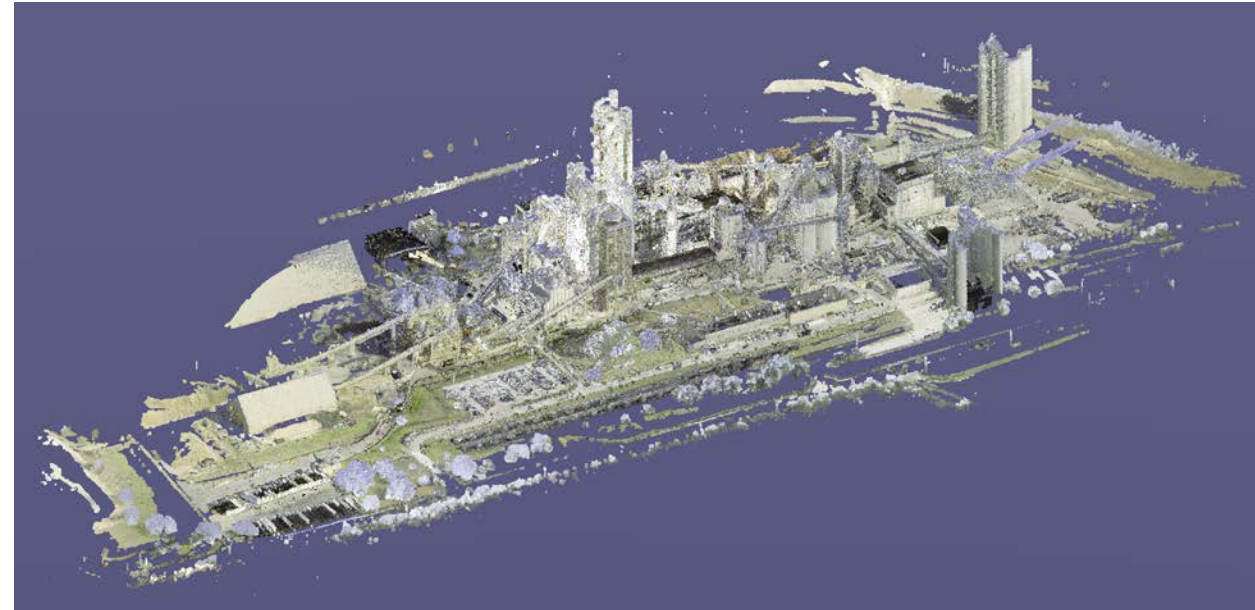
- Preliminary capture cost versus capture rate calculations were performed to help set the target for the Cemex Balcones study
- Membrane costs are sensitive to the feed CO₂ content
- Minimum cost is about 20% lower for cement compared to coal
- Membrane cost is less sensitive to capture rate for higher feed CO₂ content; higher capture is more affordable for cement

Capture System Site Selected

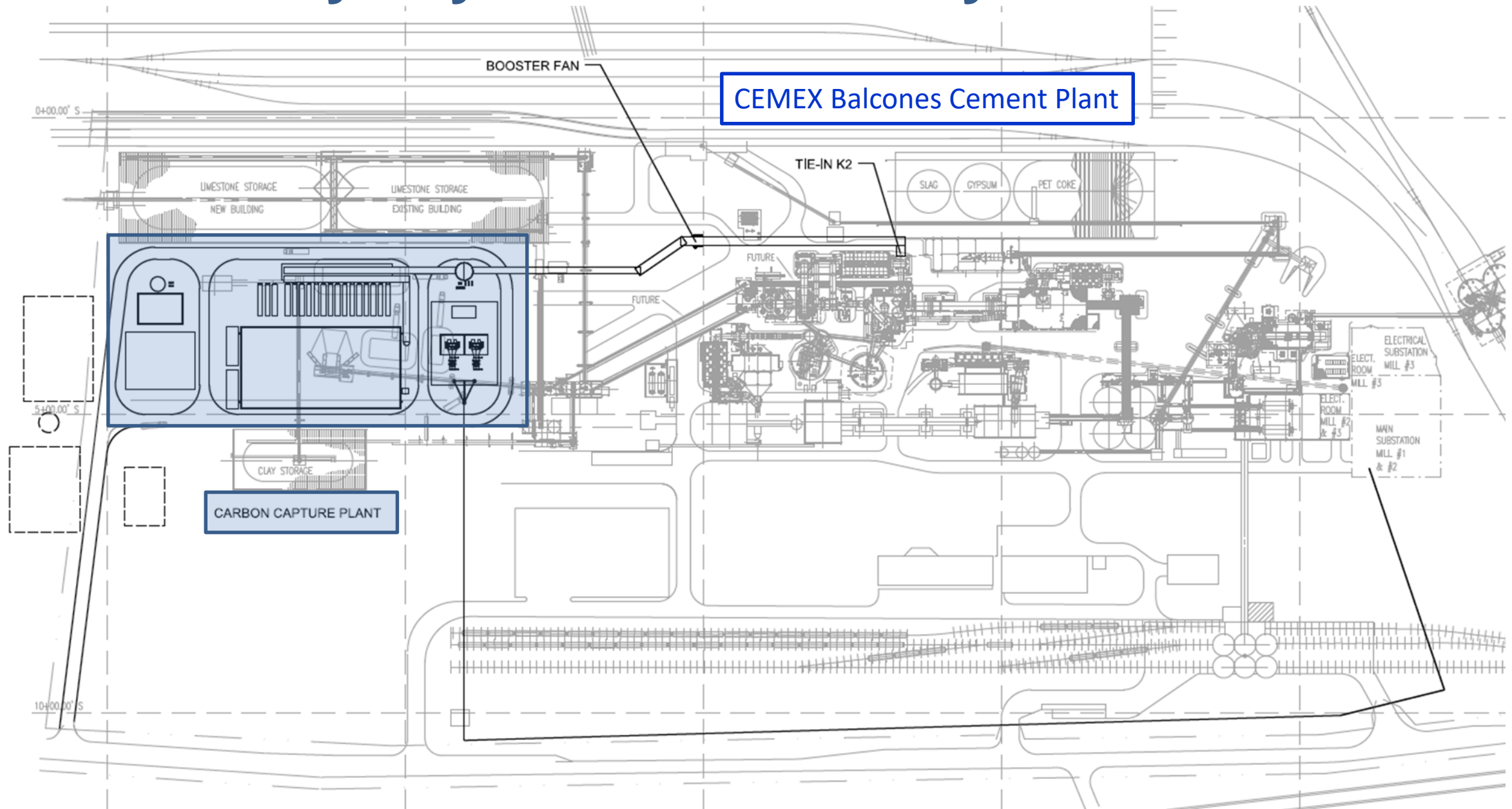


- S&L conducted a laser scan of the Balcones site
- Will aid detailed design and general arrangement layout of capture system and interconnections with cement plant

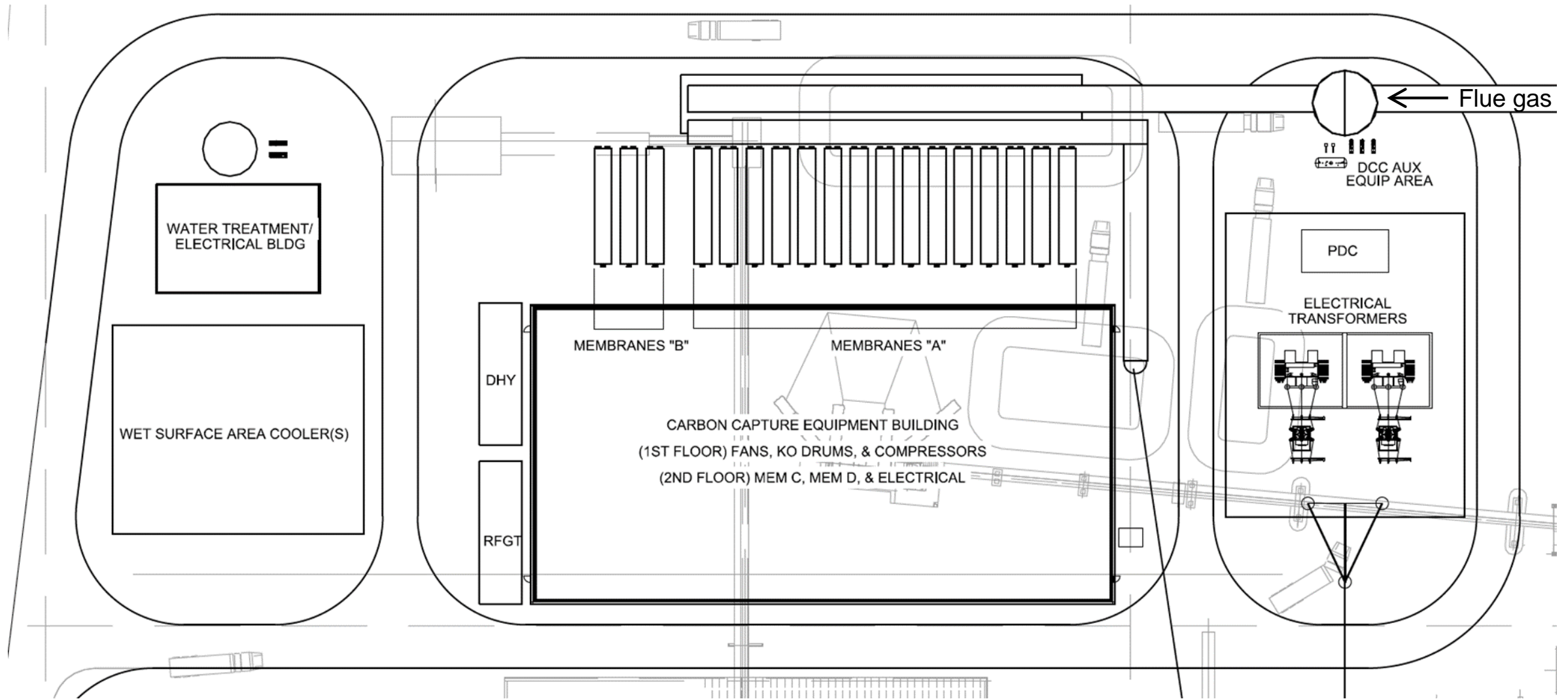
- Three locations were considered for the capture system at Balcones
- Although not immediately adjacent to Kiln 2, Site B – currently used for bulk limestone and clay storage – was selected as least disruptive to plant operations



— Preliminary Layout for Polaris System at Balcones —



Preliminary Layout of Polaris Capture System



Engineering Study Design Basis Completed

Engineering Study:

- Builds upon prior pre-FEED and FEED studies on MTR capture process at coal plants (Duke East Bend, Basin Dry Fork Station)
- Includes the same team members at Sargent & Lundy responsible for prior MTR FEED studies
- Preliminary design basis completed on schedule in project Q3



Task Schedule

Oct 2020

- Preliminary Capture Plant Process Design ✓
- Capture Site Location Selected ✓
- Set Project Design Basis ✓
- Detailed Design / Equipment Selection / General Arrangement Completed (12/31/21)
- Construction Cost Estimate and Schedule (12/31/21)
- EH&S and Permit Review (9/30/21)
- Final Cost Estimates and Reporting (3/31/22)



March 2022

Project Milestones

Milestone Number	Task/ Subtask No.	Milestone Description	Planned Completion	Actual Completion	Verification Method	Notes
Budget Period 1 Milestones						
1	1.1	Updated Project Management Plan completed	10/31/20	10/30/20	Revised PMP	Completed on time
2	1.2	Complete Technology Maturation Plan Report	12/31/20	12/22/20	Topical Report	Completed on time
3	2.0	Capture Plant Power Source Selected	3/31/21	3/31/21	Quarterly Report	Completed on time
4	2.0	Pre-treatment Requirements Determined	3/31/21	3/31/21	Quarterly Report	Completed on time
5	2.0	Project Design Basis is Set	6/30/21	6/17/21	Quarterly Report	Completed on time
6	4.0	Detailed Process Design is Completed	12/31/21		Quarterly Report	On schedule
7	6.0	All Site Environmental Issues and Permitting Resolved	9/30/21		Quarterly Report	On schedule
8	1.2	Complete Final Technology Maturation Plan Report	6/30/22		Topical Report	On schedule
9	8.0	Complete Techno-Economic Analysis Report	6/30/22		Topical Report	On schedule
10	9.0	Submit Final Report	6/30/22		Final Report	On schedule

Summary and Next Steps

- Engineering study is examining MTR membrane capture of 75% of CO₂ emissions from Kiln 2 at CEMEX Balcones cement plant
- Project is on schedule – preliminary process design completed, capture plant location selected, and design basis set
- Over the next 6 months, detailed design, costing and environmental/permitting review will be completed
- Reporting of project findings will occur in Spring 2022
- If techno-economics are favorable, the next step would be a pilot demonstration test at Balcones

Acknowledgements

Acknowledgement

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Role of Participants

DOE Office of Fossil Energy <i>NETL Federal Project Management, Carl Laird</i>		
Membrane Technology & Research, Inc. <i>Co-Principal Investigators, Tim Merkel, Brice Freeman</i>		
The Project Team		
CEMEX <i>Host Site</i> Nestor Mora Lucia Renau <ul style="list-style-type: none">• Cement plant technical information	MTR <i>Technology Provider</i> Alicia Breen Thomas Hofmann <ul style="list-style-type: none">• Engineering design of membrane system	S&L <i>EPCM</i> Dana Pierik Kevin Lauzze <ul style="list-style-type: none">• BOP engineering• Costing• Permitting

Project Tasks and Schedule

