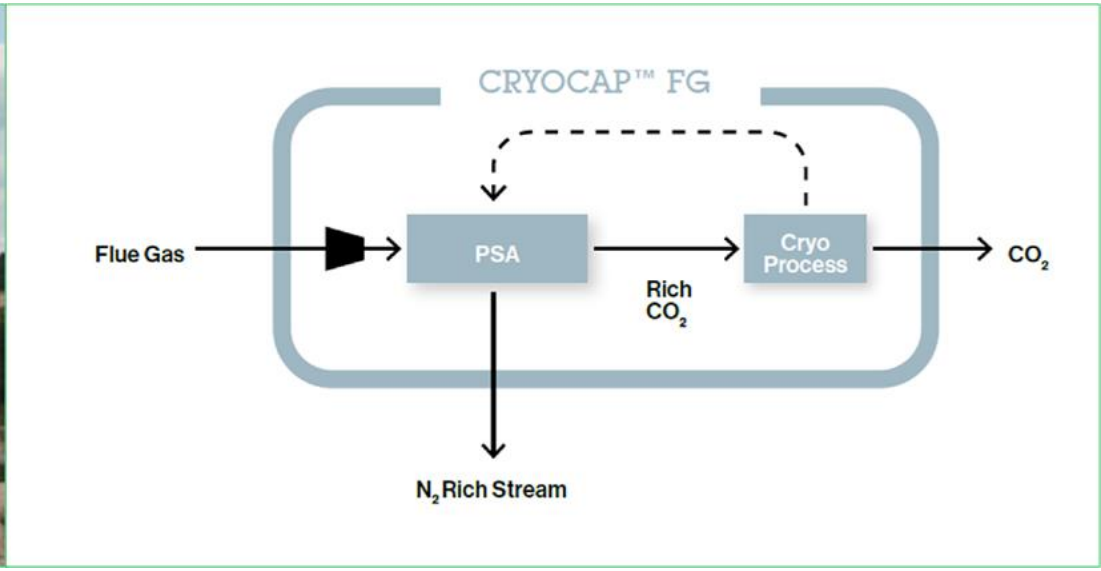
Industrial Carbon Capture from a Cement Facility Using the Cryocap™ FG Process



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U.S. Department of Energy, National Energy Technology Laboratory
2023 FECM / NETL Carbon Management Research Project Review Meeting
August 28 – September 1, 2023

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Project Overview & Objectives

- **Cooperative Agreement No**. DE-FE0032136
- **Total Funding**: $4,999,585
  - DOE: $3,999,585
  - Non-DOE: $1,000,000
  - Cost Share: 20%

- Performance Period:
  April 1, 2022– March 31, 2024
  24 months, 1 Budget Period (Including 6 Mon. NCE)

- **<u>Main objective</u>**: To execute and complete a front-end engineering and design (FEED) study for a commercial-scale, carbon capture system that separates 95% of the total CO2 emissions at Holcim Ste Genevieve Cement Plant using Air Liquide's Pressure Swing Adsorption (PSA) assisted Cryocap™ FG technology

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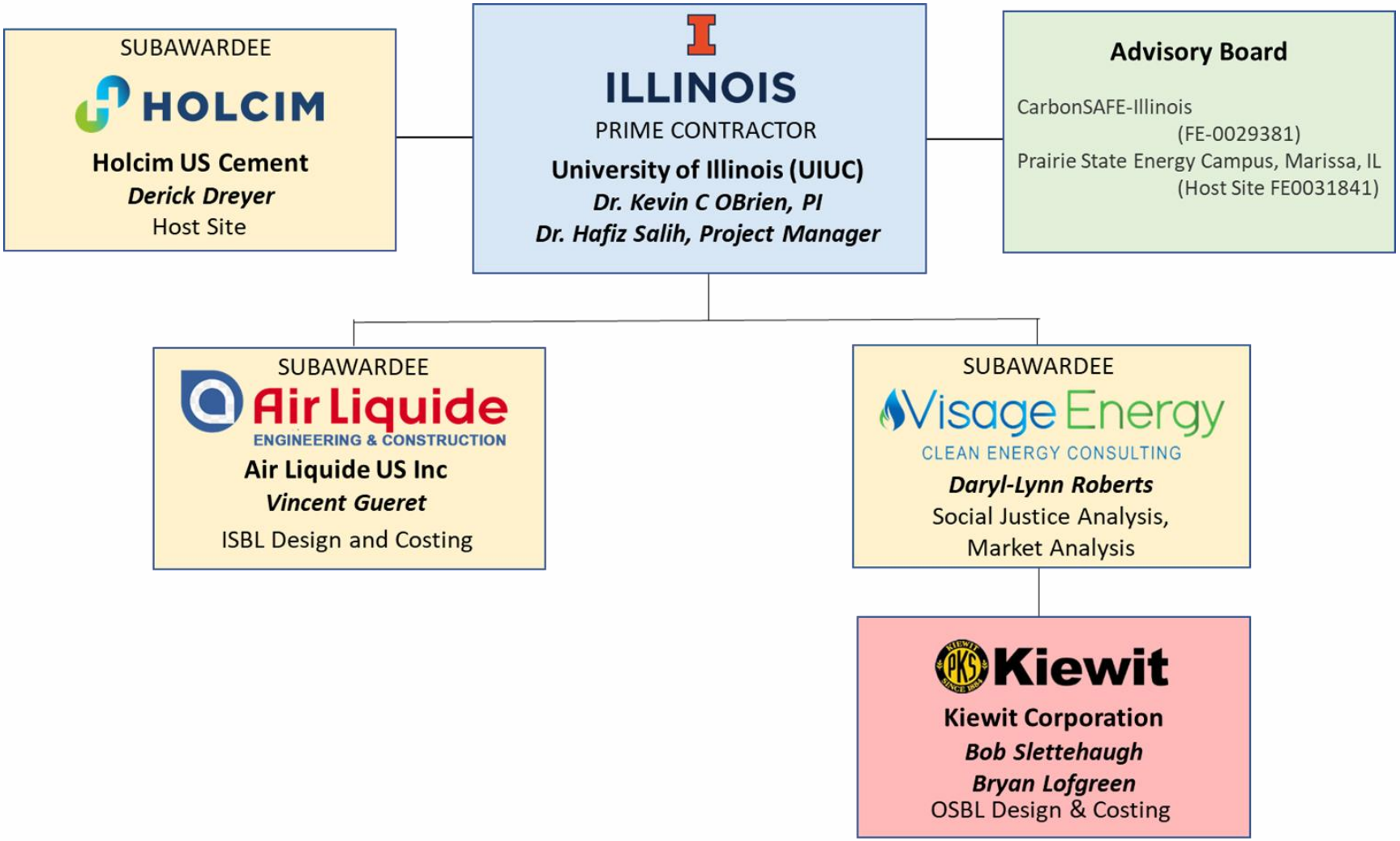
Project Overview



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Holcim Ste. Genevieve Cement Plant

- The host site (Ste Genevieve) and Holcim Company are highly committed to this project and their Net Zero commitments which includes the need for large scale carbon capture
- The Holcim company is publicly committed to capture and store 5Mtpa by 2030 across their global operations
- The Ste Genevieve project is currently one of their top global CCS projects in their portfolio under development
- The largest single cement kiln in the world, commissioned in 2009
- Annual cement production capacity of 4.5 million metric tons
- A 4,000-acre site containing more than 100 years of limestone supply, in addition to 2,000 acres conservation area

- CO_2 transportation and storage partnership under development for storing CO2 close to potential geological storage locations

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Cryocap™

A complete product range to capture and/or liquefy CO_2 from industrial gas streams

A world premiere

Cryocap™ is a technological innovation for CO_2 capture that is unique in the world, using a cryogenic process (involving low temperatures to separate gases). Cryocap™ can be adapted to specific applications combining a variety of Air Liquide technologies.

CRYOCAP™ H_2
Hydrogen production

CRYOCAP™ FG
> 15% flue gas
(Cement, Refineries, H_2)

CRYOCAP™ Oxy
Oxycombustion

CRYOCAP™ Steel
Steel production

CRYOCAP™ XLL
CO_2 liquefaction

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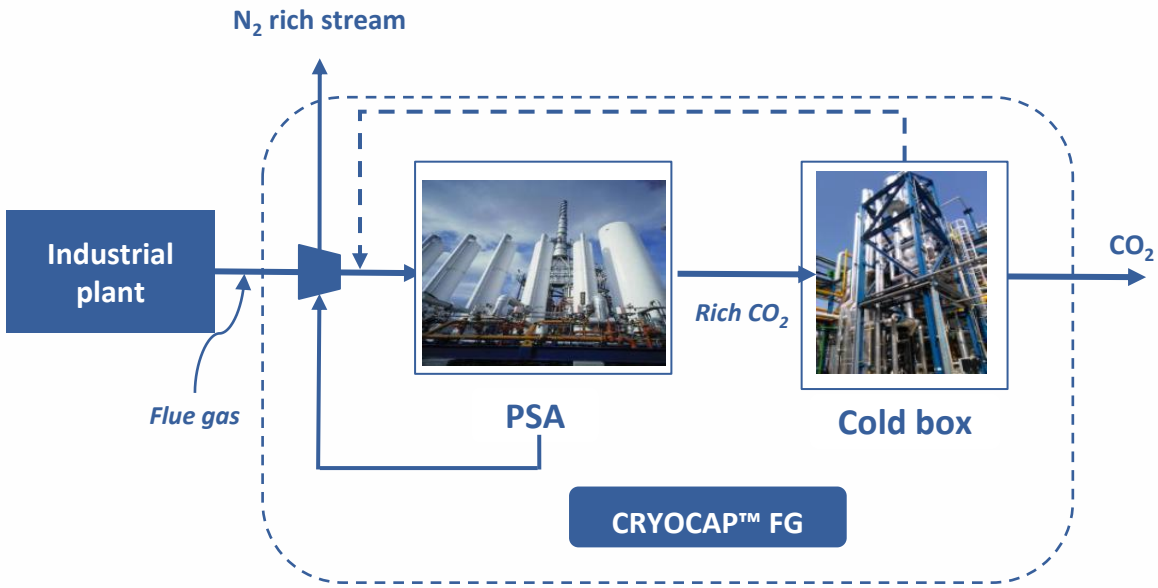
Cryocap™ FG: CO_2 Capture from Flue Gas (~15% to 40% dry mol CO_2)

- Suitable for Cement, Lime, SMR (flue gas), FCC, …
- PSA as a preconcentration brick
- HSE friendly (no chemicals and no flammables)
- Electricity powered (no steam needed)
- Compact & Flexible footprint: Compressors, PSA and Coldbox can be located in 3 different plots
- NO_x Smart Management
- Gaseous or liquid CO_2
- CO_2 capture rate: 95%+



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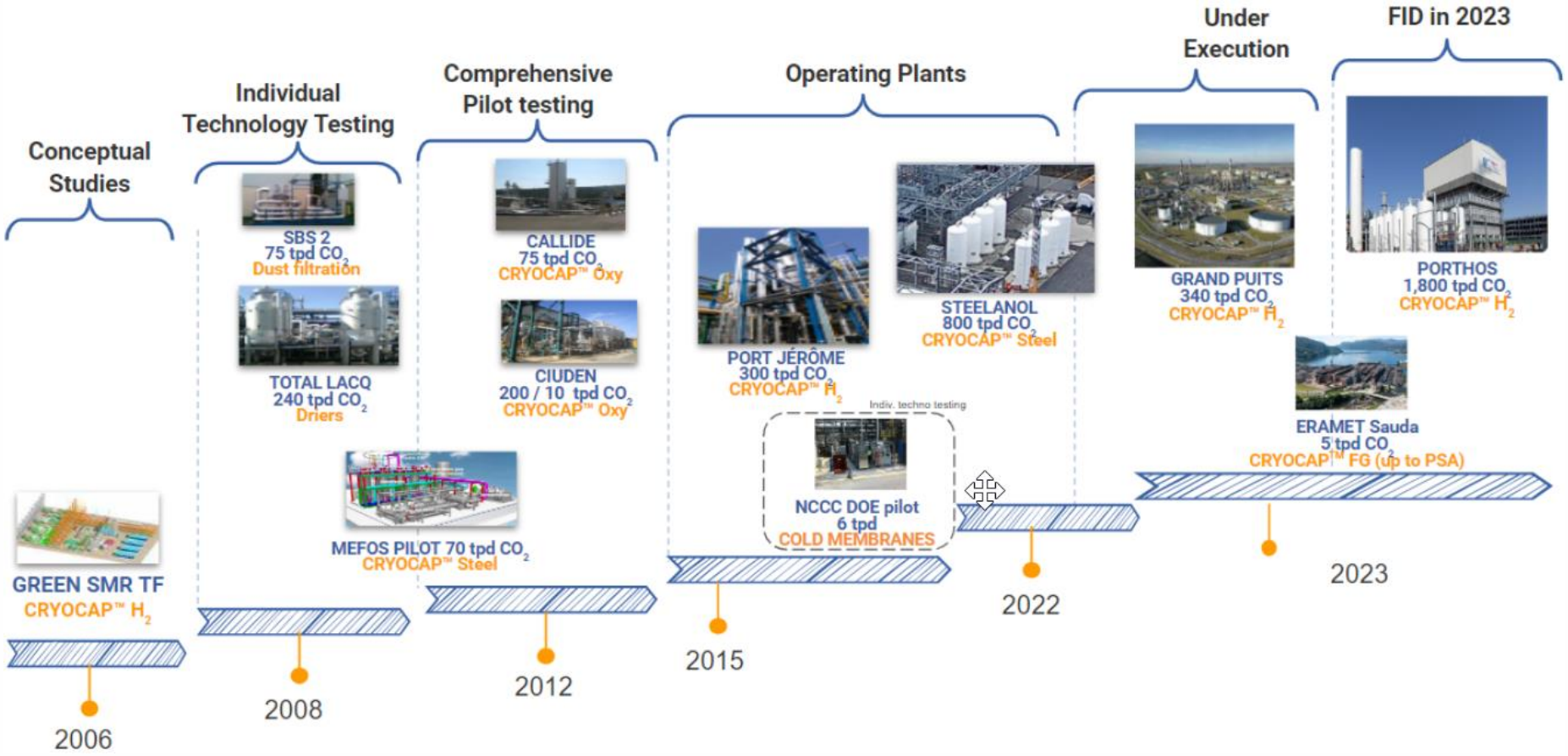
Cryocap™: 18 years of legacy



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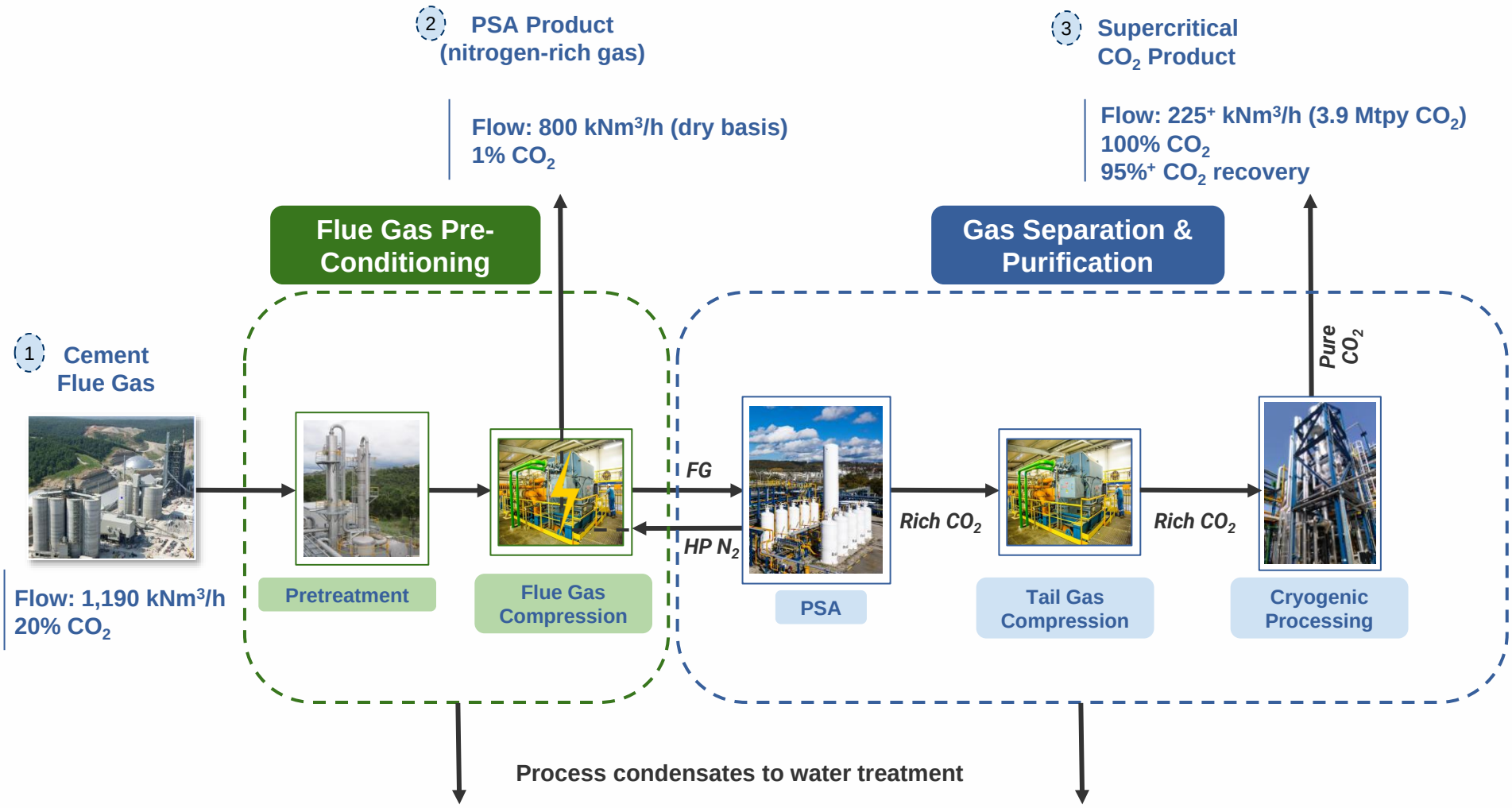
Cryocap™ High View Block Flow Diagram



* rounded figures, for the purpose of the presentation only

Site Data & Basis of Design Documents

Site Data

- Kiewit and Air Liquide engaged with Holcim to collect relevant site data.
  - Applicable Codes / Norms for Project
  - Ambient Conditions
  - Electrical Sourcing & Interconnection Details
  - Preliminary Info later firmed up or revised based on subsequent investigation
- Initial Revision: June 2022, updated June 2023
- Final Revision to be included with report package

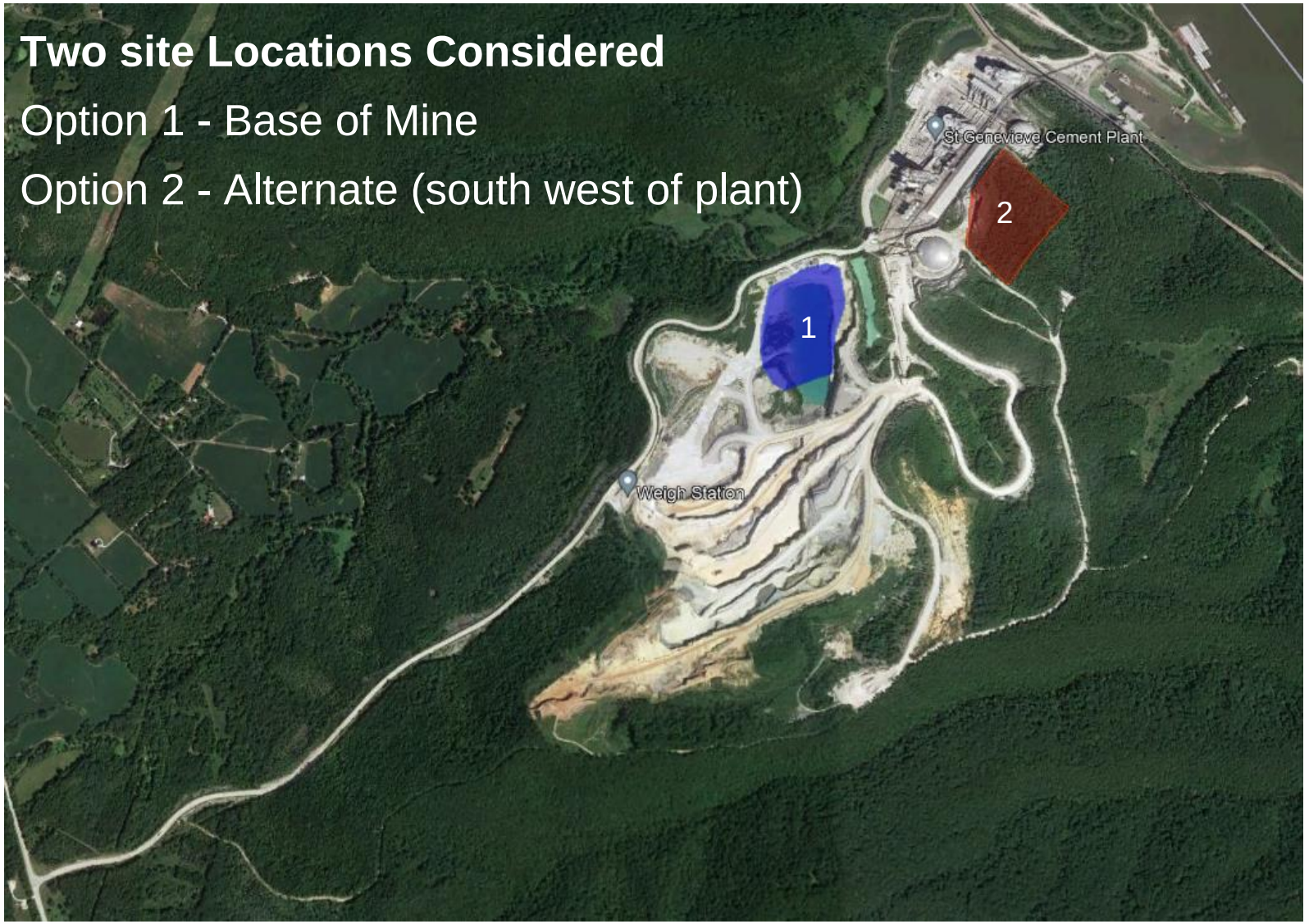
ISBL Detailed Engineering

- Flue Gas Quencher
- Flue gas compressor + turbine (compander)
- Cooling & Driers
- CO_2 PSA
- Tail gas compressor
- Distillation cold end
- CO_2 product compressor

OSBL Detailed Engineering

- Utility Flow Diagram
- Plot Plan
- FG Tie-In & Ductwork
- Water Balance & Water Treatment / ZLD
- One-Line
- Overall Progress Update

Site Location Options for Capture Facility



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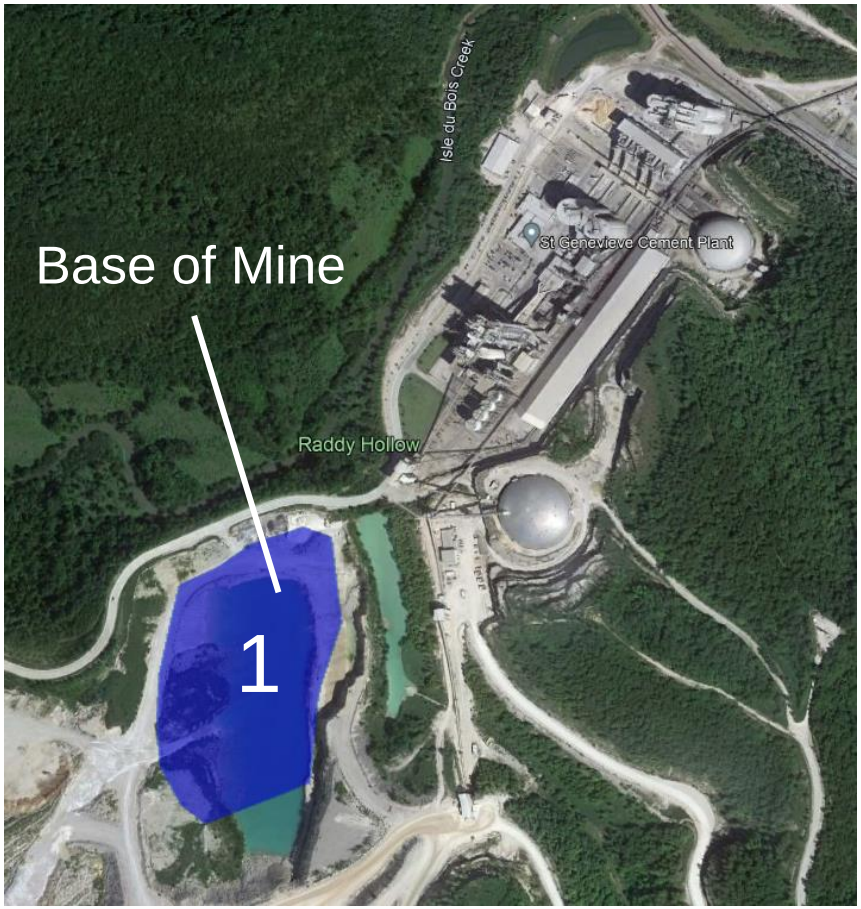
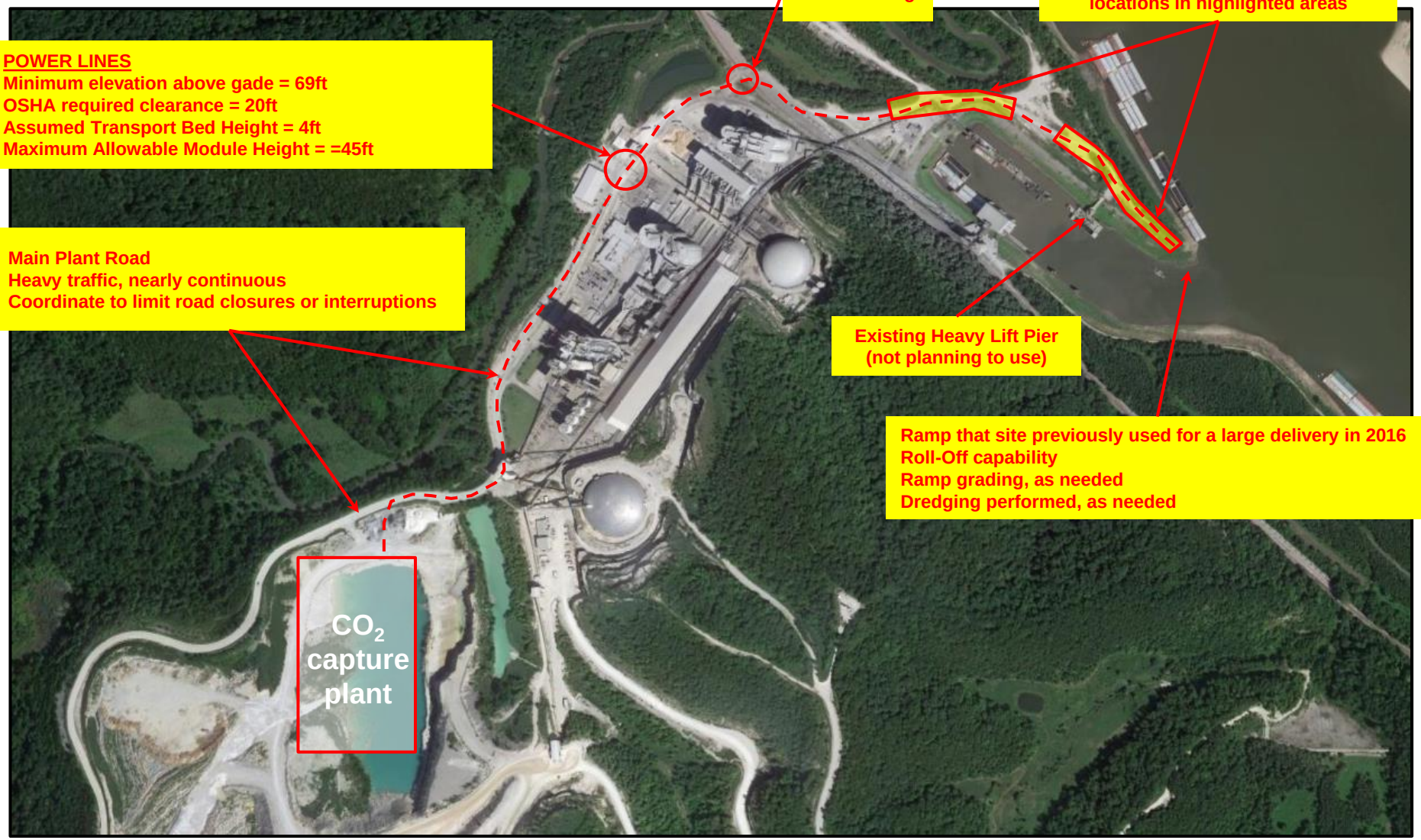
Option 1: Preferred Location

Option 1 - Base of Mine Location

- Advantages
  - Access
  - Minimal Site Preparation
- Disadvantages
  - Duct Length
  - Proximity to Active Mine
    - Consulted with blasting subcontractor on safe distances
    - Operations would not be required to clear area.
  - Potential Vibration
    - Vibration Testing Conducted



Transportation Review



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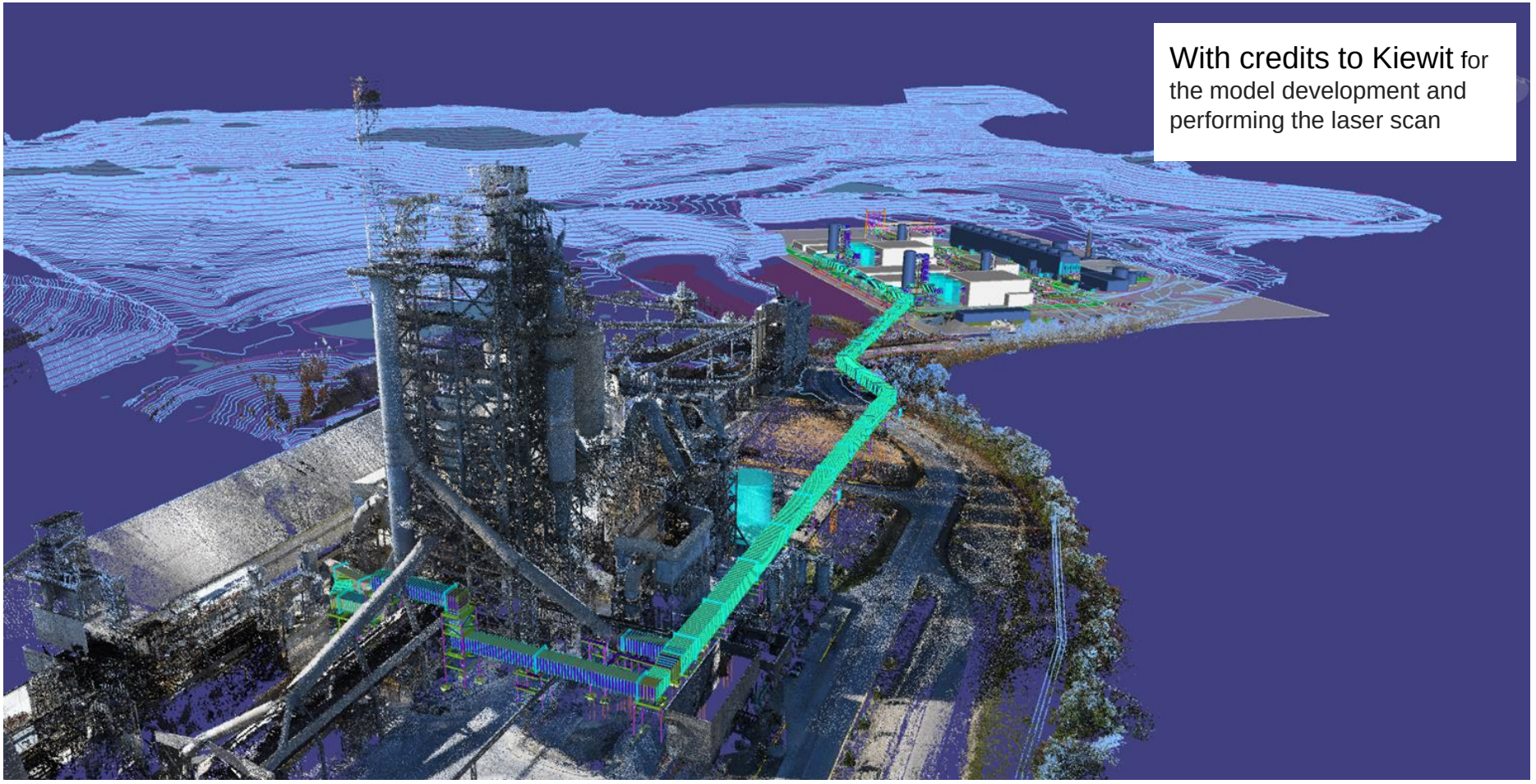
Plant integration (plot w/ Laser Scan Incorporated) - 1/2



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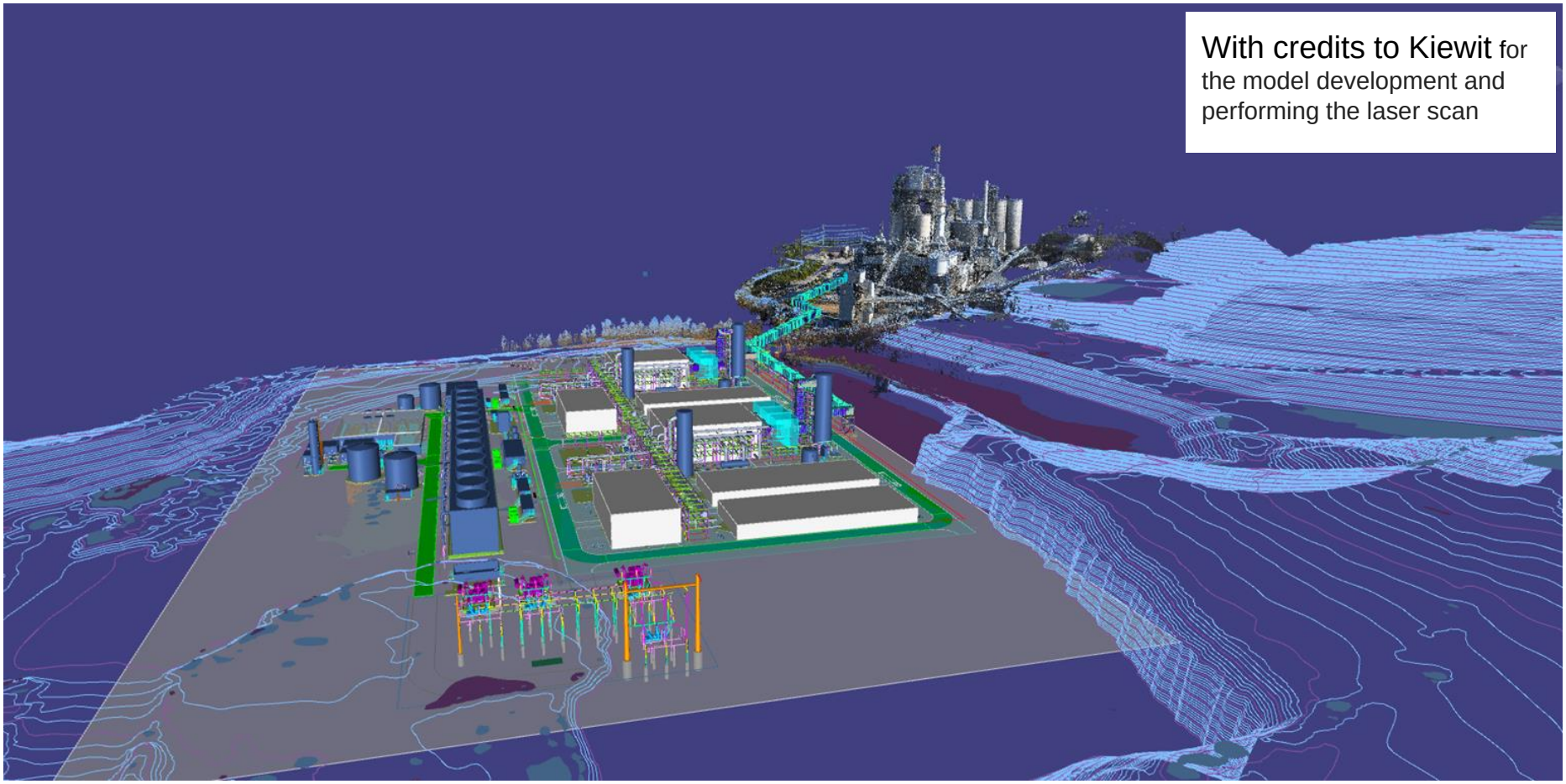
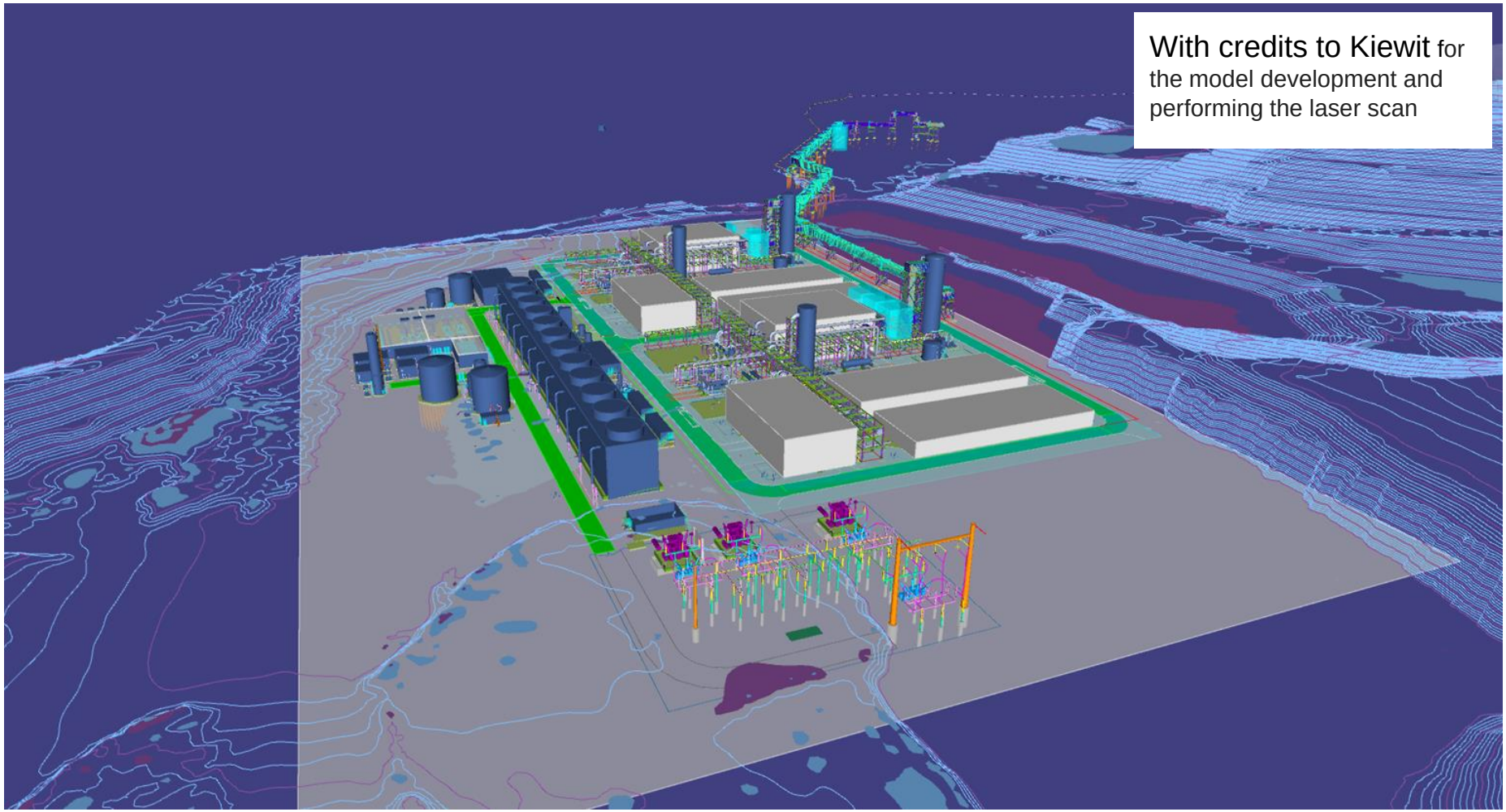
Plant integration (plot w/ Laser Scan Incorporated) - 2/2



Cryocap™ (plot w/ Laser Scan Incorporated)



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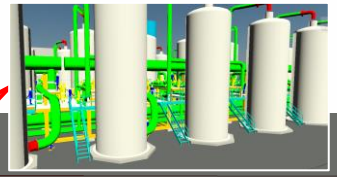
Cryocap™ plant layout (2 trains)

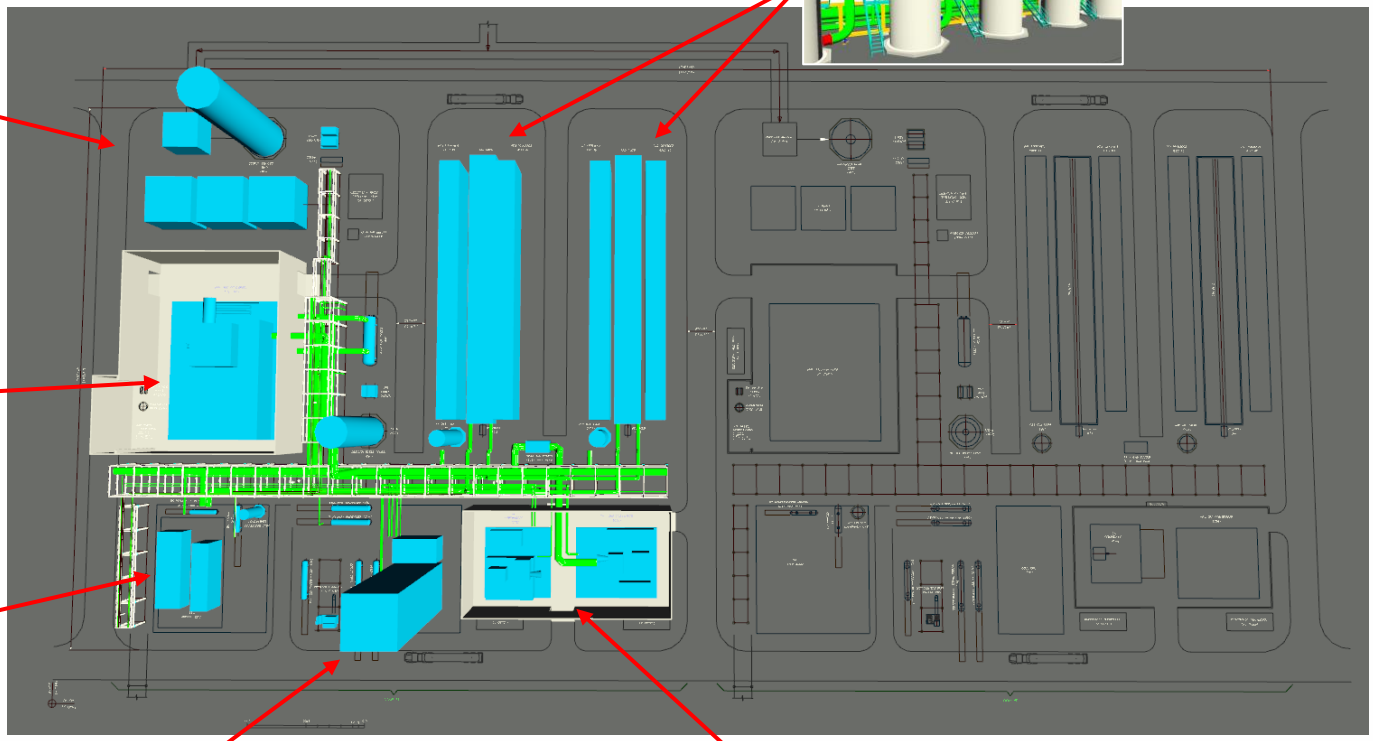


CO_2 PSA

Flue gas pre-treatment

Flue gas compressor

Cooling & Dryers



Cold end

PSA tail gas & CO_2 product compressors

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Summary

- Industrial capture FEED on track and on budget
- Complete tasks:
  - Design basis
  - Preliminary engineering
  - Detailed ISBL/OSBL design
  - Interface HAZOP and ISBL HAZID

Moving Forward/In-Progress

- **Completion of remaining Studies and Investigations**
  - Constructability Review
  - Cost Assessment
  - Schedule Development
- **Business Case Analysis**
- **Technology EH&S Risk Assessment**
- **TEA and LCA**
- **Preliminary Environmental Justice Analysis**
- **Preliminary Economic Revitalization and Job Creation Outcomes Analysis**

Acknowledgements

Name	Organization
Krista Hill, Andy O'Palko, Jodi Collins	National Energy Technology Laboratory / US Department of Energy
Bajio Varghese Kaleeckal, Vinod Patel, Jim Dexter, Stephanie Brownstein, Jason Dietsch, Ryan Larimore, Scott Prause, Sebastiano Giardinella, Maholy Echeto Palmer, Mary Terese Campbell	University of Illinois
Derick Dreyer, Erin Watson, Suhail Akhtar, Alessandro Ferrari, Fathesha Sheikh	Holcim Cement
Vincent Gueret, Michelle Jones, Lindsey Turney, Abigail Bonifacio, Timothy Henderson, Pierre-Philippe Guerif	Air Liquide
Will Johnson, Daryl-Lynn Roberts	Visage Energy
Bryan Lofgreen, Alan Donovan, Bob Slettehaugh, Dalton Sivilis	Kiewit

This project is supported by the U.S. Department of Energy / National Energy Technology Laboratory (DOE/NETL) through Cooperative Agreement No. DE-FE0032136

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