Mitchell Cement Plant Carbon Capture FEED

Project Number DE-FE0032222

2024 Carbon Management Research Project Review Meeting
Pittsburgh, PA | Gregory Ronczka, Sathish Krishnamoorthy
August 05 – August 09, 2024

Heidelberg Materials

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Agenda

1. Project Overview
2. Project Status
3. Project Scope
4. Technical Studies
5. Lessons Learned

Project Overview – Goals

Award name : Mitchell Cement Plant Carbon Capture FEED (DE-FE0032222)

Project period : Aug 18, 2023 to Feb 19, 2025

Funding : $5,755,831 total, DOE $3.699,323, Cost share $2,056,508 (36%)

Federal Project Manager : Dylan Leary

Participants : Heidelberg Materials, Sargent & Lundy, Mitsubishi Heavy Industries America

Project Objective :

- Design to capture 2M mt CO_2/ year at 95% capture efficiency from the flue gases coming from the newly renovated cement plant and from NG aux boiler
- Perform a FEED Study for commercial scale CO_2 capture retrofitted to the Mitchell cement plant
- Develop a AACE Class 3 Estimate (-20% to +30%)
- The Industrial Demonstration of this project would serve as an example for other cement plants to adapt CO_2 capture technology

Project Overview – About Mitchell

- New cement plant at Mitchell, Indiana
- 7,000 mt/day clinker production
- More efficient process – lower energy consumption
- Illinois basin CO_2 storage – three formations being studied
- Large property holding
- Community construction awareness
- Several DOE awards
  - *DE-FE0032222 FECM Carbon Capture FEED*
  - *DE-FE0032268 FECM CarbonSAFE Phase II*
  - *DE-CD0000009 OCED Integrated FEED*
  - *DE-CD0000090 OCED Industrial Demonstration (in negotiation)*

Project Overview – About Mitchell

- Carbon Capture on right bottom (red box)
- CarbonSAFE test well on left (orange fill)
- CO_2 transport to injection well(s) within plant boundary
- Quarry lake in the center, source of water

Project Organization Chart

FECM/NETL Office
- Project management

Dylan Leary - Project Manager
Angela Bosley – Contract Officer
Shane Buchanan – Contract Specialist

Heidelberg Materials
Prime / Host Site
- Project management and planning
- Business case analysis

Gregory Ronczka – Principal Investigator
Sathish Krishnamoorthy – Project Manager
Anuj Jain – Engineering Manager
Lydia Vollmann – Grants Management

Mitsubishi Heavy Industries America
- Process and Technology
- ISBL detailed design of CC equipment

Mike Fowler – Business Manager
Masaki Yamashita – Project Manager

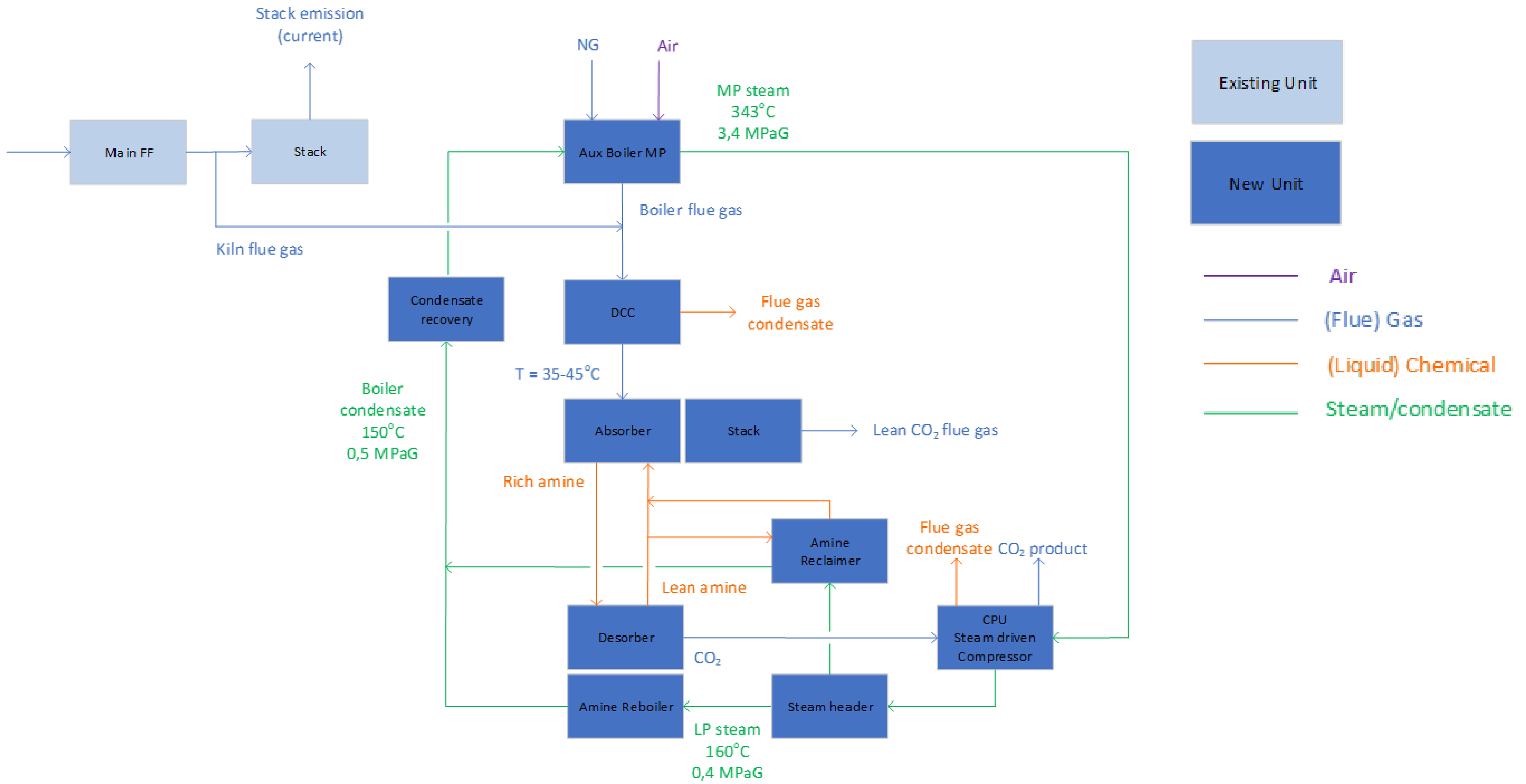
Sargent & Lundy
- OSBL detailed design
- Capital cost estimate
- O&M cost estimate

Kevin Lauzze – Project Director
Dana Pierik – Project Manager

Project Status – Performance Dates

Task	Deliverable Title	Due Date
1.1	Project Management Plan	Updated 30 days after award.
1.2	Initial Technology Maturation Plan (TMP)	Due 90 days after award.
1.2	Final Technology Maturation Plan (TMP)	Due 90 days prior to project completion.
2.1	Initial Engineering Design Package	Due 180 days after award.
5.0	Initial Life Cycle Analysis (LCA)	Due 180 days after award.
1.3	Initial Workforce Readiness Plan	Due 12 months after award.
2.2	Final Engineering Design Package	Due 90 days prior to project completion.
3.0	Business Case Analysis	Due 90 days prior to project completion.
4.0	Technology EH&S Analysis	Due 90 days prior to project completion.
5.0	Final Life Cycle Analysis (LCA)	Due 90 days prior to project completion.
6.0	Environmental Justice Analysis	Due 90 days prior to project completion.
7.0	Economic Revitalization and Job Creation Outcomes Analysis	Due 90 days prior to project completion.
1.3	Final Workforce Readiness Plan	Due at project completion.
	Final Report / Final Presentation	Due at project completion.

Project Scope and Tie-in

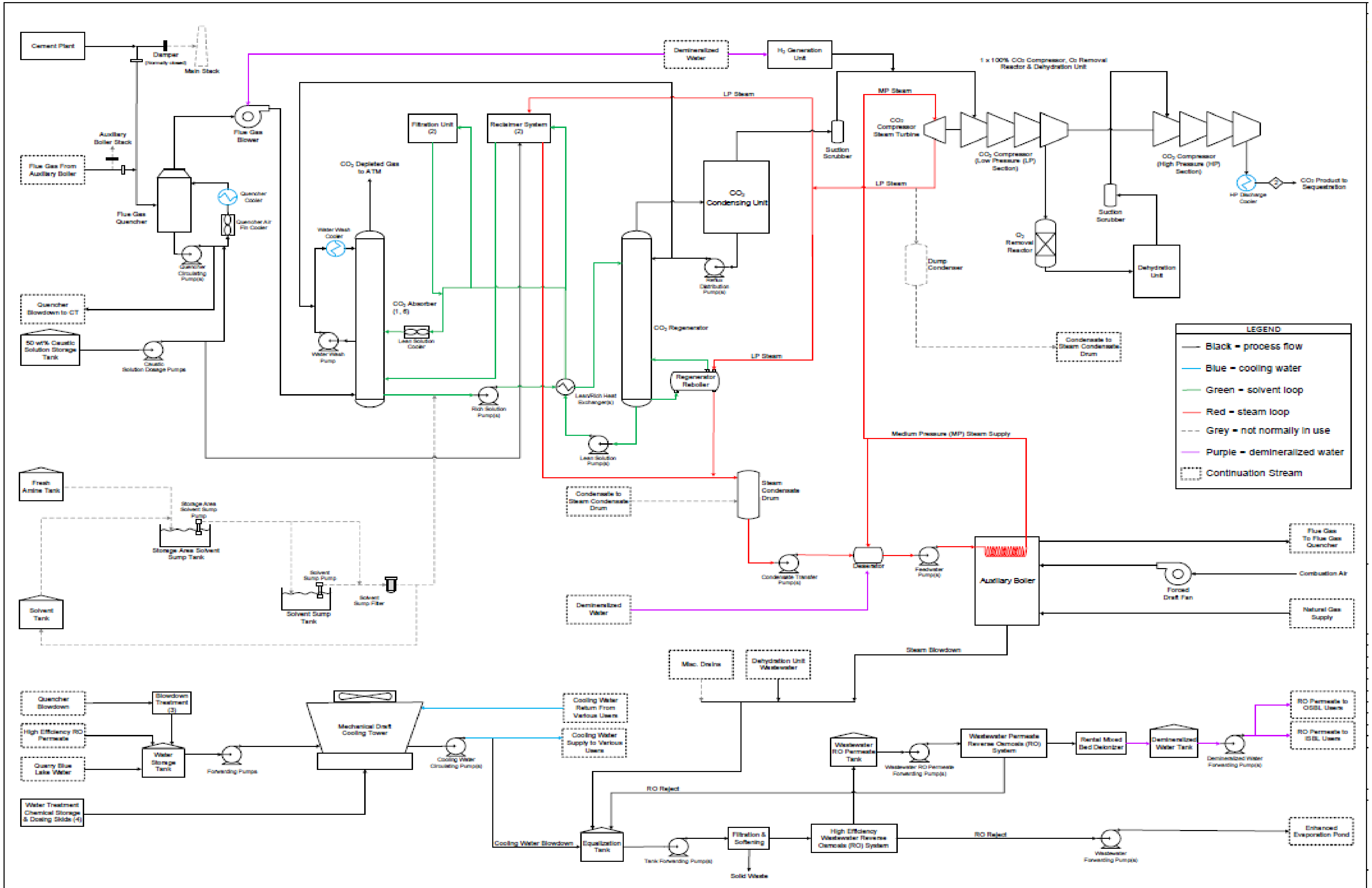


Project Scope – Technical deliverables

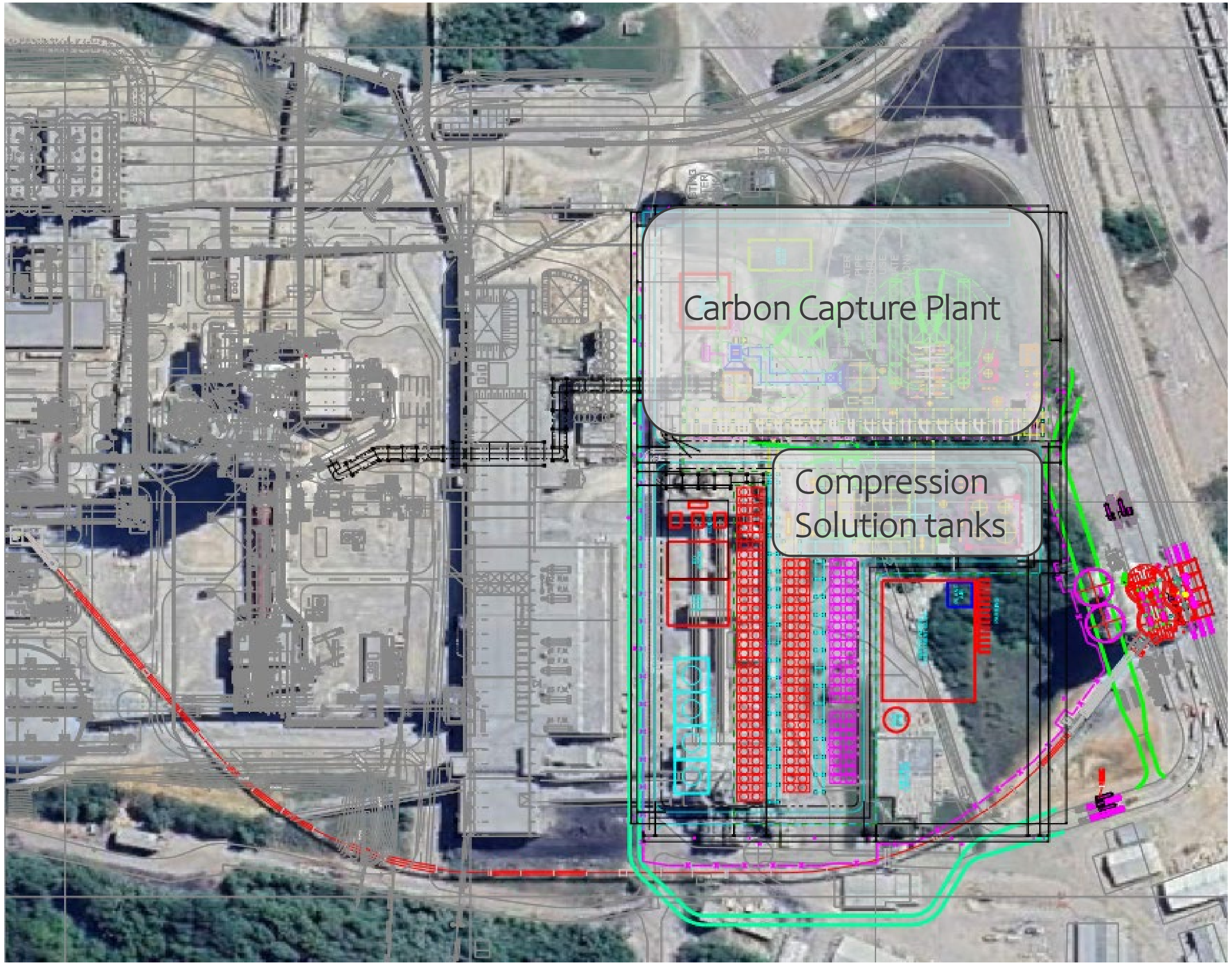
Deliverable Title	Due Date
Project Effective Date	18-Aug-23
Project Management Plan	29-Sep-23
Project Kick-off Meeting	17-Oct-23
Basic Engineering Desgin Document	16-Nov-23
Preliminary Process Design Review	16-Feb-24
FEED - CO_2 Capture Island Process Design	05-Jul-24
FEED - Balance of Plant Design	23-Aug-24
Cost Estimating	08-Nov-24
Technology Maturation Plan	18-Nov-24
Buisness Case Analysis	18-Nov-24
Pre-Final Engineering Design Complete (to DOE)	18-Nov-24
Final Project Reporting	14-Feb-25

- Schedule on track with base configuration
- Scope includes:
  - Basic Design Basis – Flue Gas, Site Conditions, Product Specifications
  - Process Diagram w/ Heat and Mass Balance
  - Utility Flow Diagram – Steam, DMW, Nitrogen, Water, Air
  - Utility and Chemical Consumption List
  - Plot Plan and Layout
  - Preliminary Emission and Effluent List
  - Process Hazard Analysis Review
  - Preliminary Electrical Load List
  - Engineering Studies – CHP, Water
- Next milestone *site visit early November* with all project partners and DOE for design and constructability review

Equipment Flow Diagram



Overall Plot Plan



- Proximity to existing stack
- Demo old plant(s), sub-surface investigation
- Maintain access to shipping and truck movement
- CCP – Main plant, Admin, Pipe rack
- CS – Compressor, Storage tanks
- Air fin coolers – Majority of space
- Cooling towers
- Auxiliary boiler
- Waste water treatment facility

Project Risks

Perceived Risk	Risk Rating			Mitigation / Response Strategy
	Probability	Impact	Overall	
Financial Risks:				
Availability of Cost Share	Low	Medium	Low	An estimated spend plan has been developed based on the proposed schedule and firm price proposals, allowing Heidelberg Materials to plan for expected spend. FFED study will set the project scope, CAPEX and OPEX. Heidelberg Materials has committed resources to support this project.
Budget Overruns	Low	Medium	Low	Firm priced proposals have been received from all major participants based on the SOPO. Additional costs, if any, will be evaluated based on business case.
Cost/Schedule Risks:				
→ Schedule Delays	Low	High	Medium	A Level 3 schedule has been developed for the project and continue to update based on project progress. The project team has experience conducting various FEED studies on budget and time. Any addition or changes to the scope or design basis for the project would have potential to delay the progress.
Resource Availability	Low	Medium	Low	Core project team members have been designated from each organization that will be assigned to support the project through its duration. Recruitment is in progress.
Technical/Scope Risks:				
→ Feasibility of Applying CC Technology to cement plant at full-scale	Medium	Medium	Medium	A preliminary TEA was completed prior to award with inputs from project partners. In addition, the experience of this technology in Natural Gas and Coal applications is certain extent relevant to cement kiln flue gas.
Unidentified Trace Constituents in the Flue Gas, impact on CC Performance/Costs	Low	Medium	Low	As part of the project, trace constituents in the flue gases were measured and identified in the design criteria document. Constituents of major concern were addressed by the technology suppliers for appropriate pre-treatment of flue gases.
→ Water demand	Medium	High	Medium	Various options for cooling water system configuration were studied to minimize the use of fresh water (sustainability initiative) and as well its source (from existing quarry lake or new well). With Hybrid cooling arrangement, there is increase in cost and complexity.
→ Steam and Power demand	Medium	Medium	Medium	Various options for steam and power sourcing are being stuided to lower the operating cost and scope 2 emissions. This would have impact on both Capital cost and Schedule.
Management, Planning, and Oversight Risks:				
Lack of Coordination Between Participants	Low	Medium	Low	All organizations have a historical working relationship, and recurring status updates are planned.

Technical Studies – Cooling Water Study

Baseline

- Natural gas fired aux-boiler as steam source for the Amine plant. Natural gas flow 945 mmBtu/hr.
- Sufficient cooling water available to employ "Wet cooling method"
- Lower power to operate CCS facility with steam driven compressor and wet cooling system

Precondition

- Plant currently uses ~ 550 gpm for the cement operation that would continue, entirely from quarry lake
- Ambient temperature range -20 C to 40 C
- Water available for CCS facility is ~ 130 million gallons/year
- Cooling water temperature to CCS facility < 32 C and max 40 C (impact on capture efficiency, emissions)
- Optimal balance for water demand, CAPEX and OPEX cost
- Lower size / cost for the water storage tank

Technical Studies – Cooling Water Study

Cooling System	Study Findings
100% Wet cooling	• Water demand ~ 900 million gallon/year, *not feasible* • Capture efficiency not compromised • Lower CAPEX and OPEX
100% Dry cooling	• Capture efficiency decreases by 4% during hot summer months, *not feasible* • Huge real estate requirement • Highest CAPEX and OPEX
Refrigeration System	• Equipment size too large and vendors cannot support, *not feasible* • Huge real estate requirement • Highest CAPEX and OPEX
Hybrid Cooling	• Water demand ~ 135 million gallon/year • Capture efficiency not compromised • Moderate CAPEX and OPEX • Storage tank ~ 6 million gallon is needed • Storage tank can be significantly minimized or eliminated with additional ~ 135 million gallon/year • Hydrology study and water well are planned

Technical Studies – Steam and Power Study

Cooling System	Study Findings
Aux-boiler Medium Pressure	○ Design basis ○ Overall power requirement ~ 42 MW (excluding CO_2 compressor) ○ Electricity from the grid, potential for increased scope 2 emission ○ Lower CAPEX and higher OPEX
Gas Turbine	○ Produces ~ 86 MW power to generate required steam ○ Lower CO_2 concentration and higher volume of flue gas ○ Larger CO_2 capture facility and huge real estate requirement, *not feasible* ○ Highest CAPEX and lower OPEX
Aux-boiler High Pressure	○ Extension of design basis ○ Produce 65 – 70 MW power to generate required steam ○ CO_2 capture facility size could remain similar ○ Moderate CAPEX and lower OPEX
Other CHP	○ Depleted gas boiler ○ SMR ○ Moderate CAPEX and lower OPEX ○ Schedule challenges (complexity, FOK, permitting)

Lessons Learned

Study	Issue Addressed
Steam & Electric Sourcing:	○ Higher steam demand and no existing steam source, appropriate assessment needed ○ Influences flue gas composition ○ Optimal balance for steam and power generation, impact on CAPEX and OPEX ○ CHP is best method to provide necessary power to the CO_2 capture facility and reduce Scope 2 emissions
Water and Wastewater Treatment:	○ Re-use use as much of the process water as possible ○ Water balance **Zero Liquid Discharge**: Quencher blowdown, Cooling tower blowdown, Steam generator blowdown are treated to re-use ○ Detailed water quality required by CO_2 capture and support facilities ○ Wastewater streams from cooling tower blowdown has higher salt concentration and difficult to use in the cement kiln without pre-treatment ○ Evaluating permitting issues for wastewater discharges
Cooling water:	○ Water demand significantly higher compared to cement plant use ○ Evaluated several options for cooling water system - Hybrid cooling ○ Moderate CAPEX and OPEX ○ Planning to install water well to support CCS needs ○ Evaluating plant permit for discharges
Flue gas testing:	○ Detailed stack testing with mill ON and mill OFF (few repeats) ○ Understand the requirements for MDL and choose right EPA test methods ○ Stringent requirement on flue gas impurities (ex. NO_2, SO_3, PM, UHC, PAH's) – having right pre-treatment methods

Success Criteria

Completed Tasks

- Process design review completed including technology validation
- Evaluated Cooling Water System technologies and chosen a preferred concept

Ongoing Tasks

- Perform Steam and Power studies to finalize scope integration
- Complete final engineering design package
- Complete AAA Class 3 cost estimate at the end of capture FEED
- Share overall results of the FEED Study through DOE/ NETL
- Business Case Analysis – FEED study outcome and the cost estimates to be used to evaluate the economic viability of the project
- Project Development – determined to be viable, will move ahead directly into OCED Integrated FEED (Phase I), Budget Period 3

Acknowledgement

This project is Heidelberg Materials' first Cooperative Agreement as a prime recipient!

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