FEED Study of Carbon Capture Inc DAC and CarbonCure Utilization Technologies Using United States Steel's Gary Works Plant Waste Heat

(DE-FE0032154)

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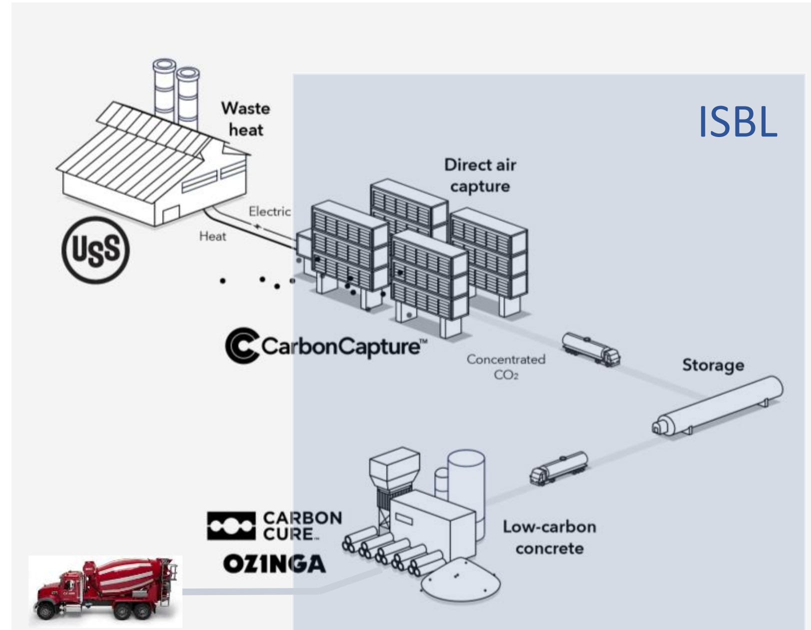
Project Overview

OBJECTIVES

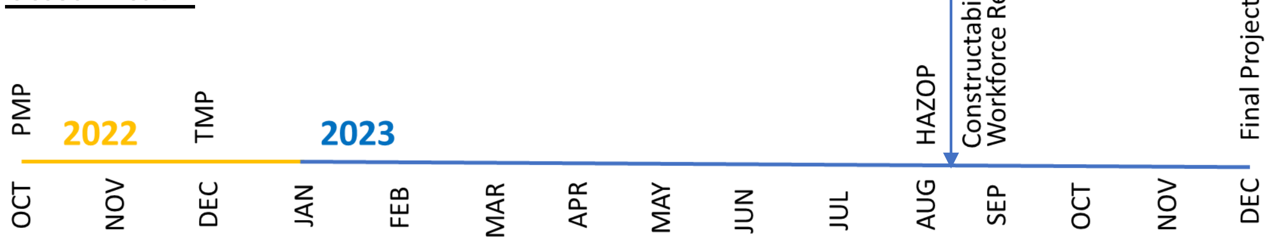
- FEED study for DACU (DAC + Utilization)
- Capture 5,000 tonnes/yr net CO_2 from air
- Utilize CO_2 in concrete and avoid cement production emissions
- Utilize waste heat from U. S. Steel in Gary, IN
- Demonstrate full CO_2 value chain
- Illustrate how full CO_2 value chain impacts job creation, regional economic development, and environmental justice



OVERVIEW

DOE: $3,459,554
Cost Share: $874,868
Work Period: 18 months

TIMELINE



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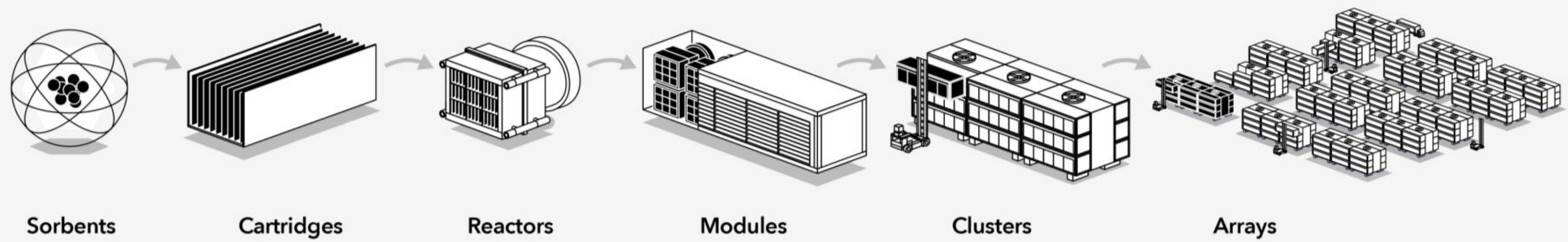
DAC Technology and Location



Core system: modular temperature vacuum swing adsorption system capable of accepting **multiple types of solid sorbents**

Go-to-market sorbent: **amine in a hydrophobic structure**

Anticipated costs: first generation capture costs of \$431 to \$570/t CO_2, falling to **\$73 to \$115/t CO_2 by 2030**

Low temperature: relatively low desorption heat of 100°C

Location of the DAC system

Tie-in to Waste Heat

Ozinga Plant Locations
U. S. Steel DAC Site Location
Storage/Hub Locations

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DAC Provider

CarbonCapture™

What we do

We develop and deploy direct air capture (DAC) machines that remove CO_2 from the atmosphere.

- Leading U.S. DAC company
- Founded in 2019
- HQ in Los Angeles, staff of 55+
- Funding of $43m
- Technology platform accelerates innovation via open systems approach to sorbents
- Focus on developing CO_2 storage and utilization projects in North America
- DAC-only, no point source or EOR

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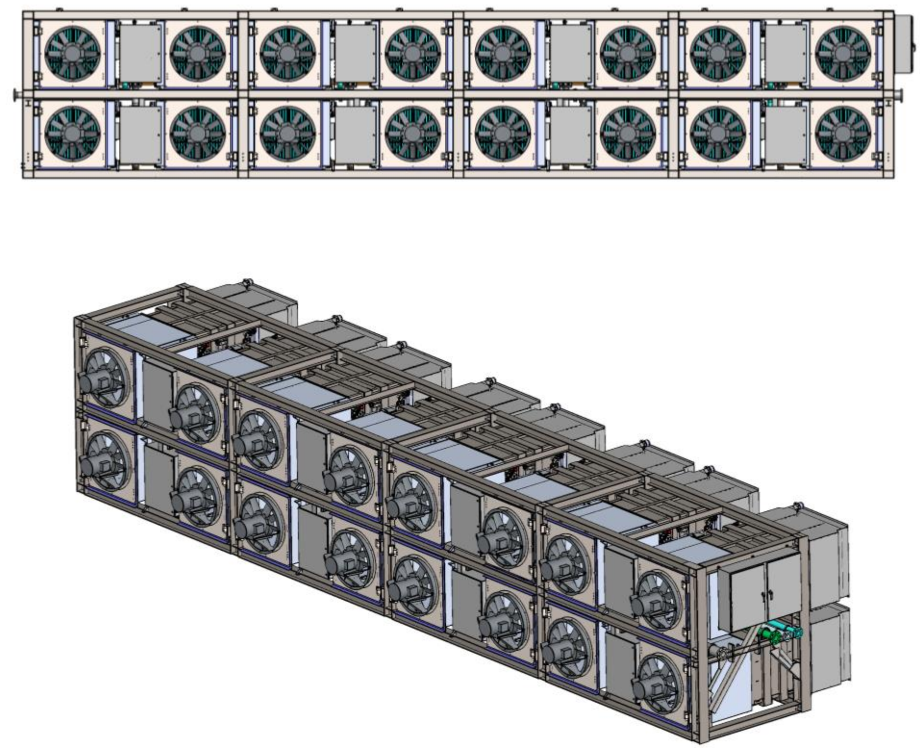
DAC Progress

Progress to date

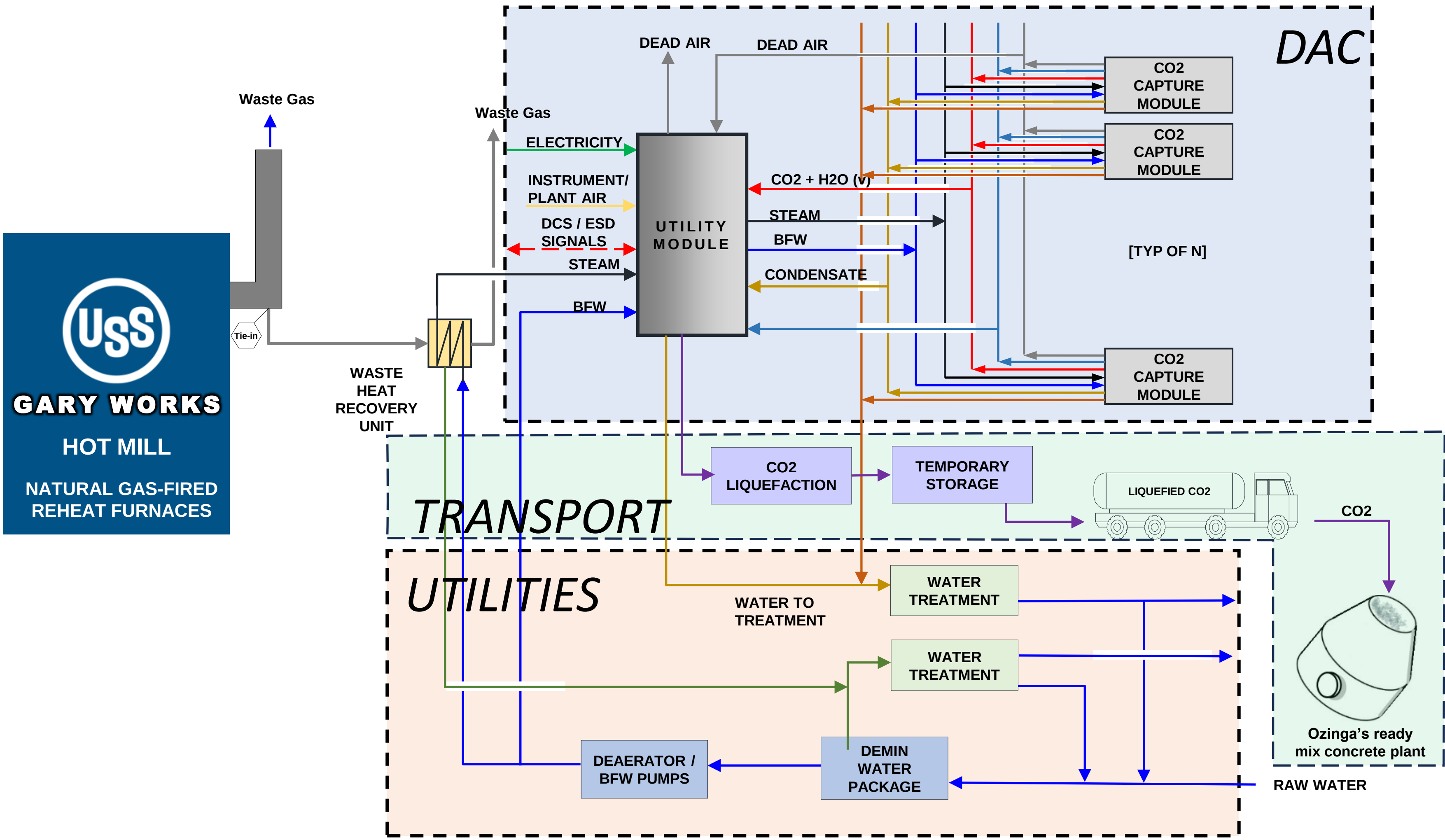
The team has completed preliminary engineering of the DAC (ISBL) scope and is working on detailed designs for the first full-scale modules, including:

- Refinement of the reactor & module designs; refinement of key process deliverables (e.g., heat & material balances, PFDs)
- Specification of key equipment & instrumentation; refinement of P&IDs
- Development of the control narrative and sequencing of reactor sets
- Finalization of interfaces with the OSBL, including both process and software interfaces
- Development of ISBL cost estimates
- Definition of operating procedures, including required training



Preliminary rendering of the DAC module

Block Flow Diagram



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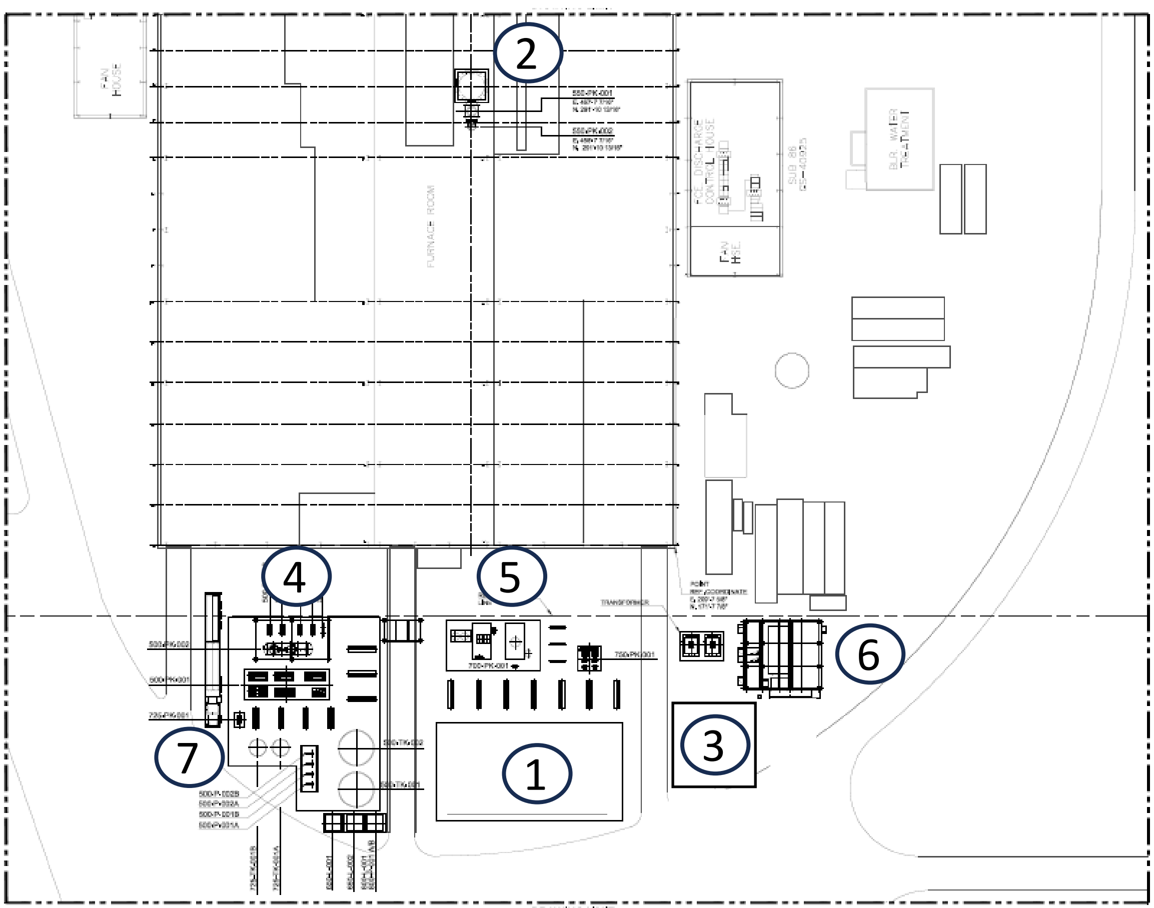
Plant Layout



1. Carbon Capture Modules
2. Waste Heat Recovery
3. Electrical / Control Room
4. Raw, Demin, Boiler feed water
5. CO2 Compression, Conditioning, Liquefaction
6. Maintenance / Office Building
7. Liquid CO2 Unloading

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Plant Layout Details

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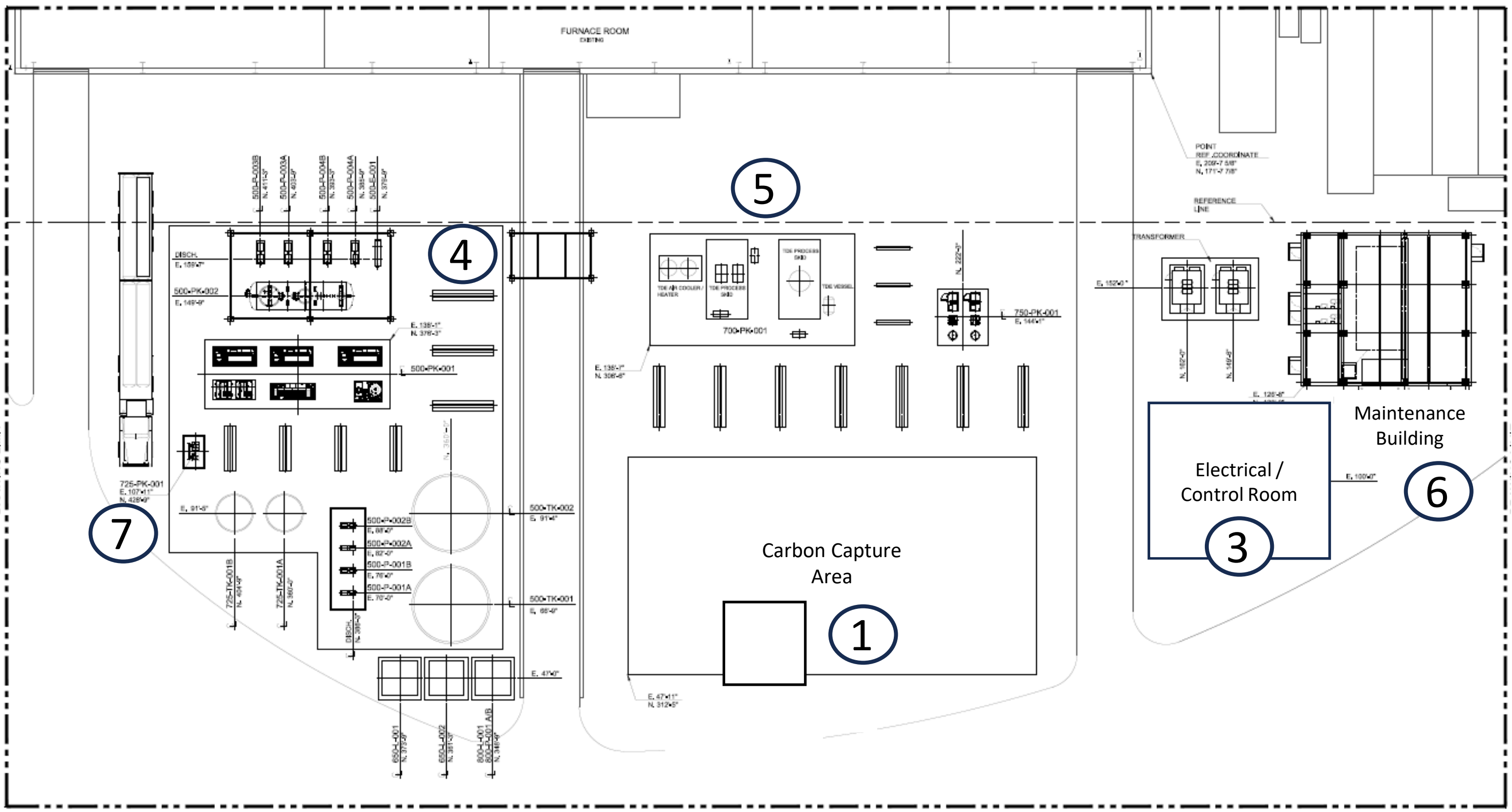
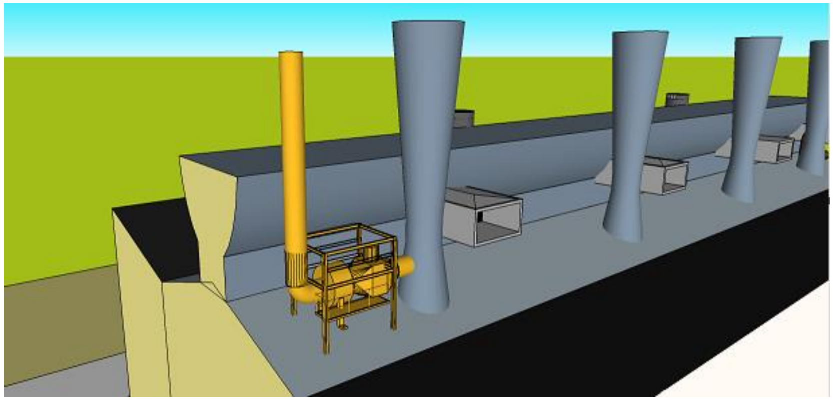
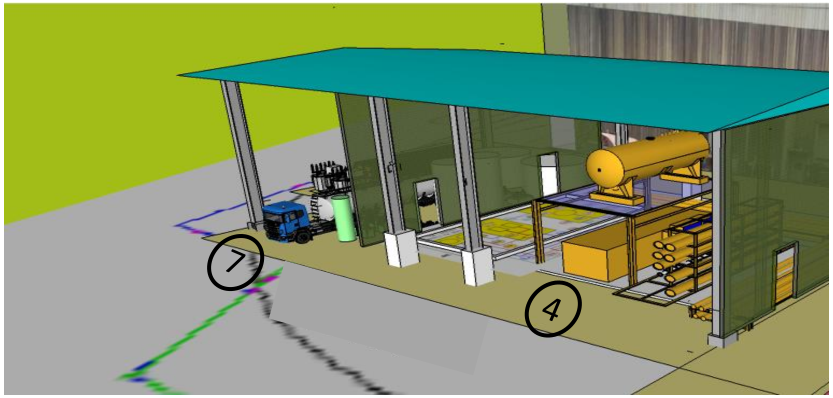


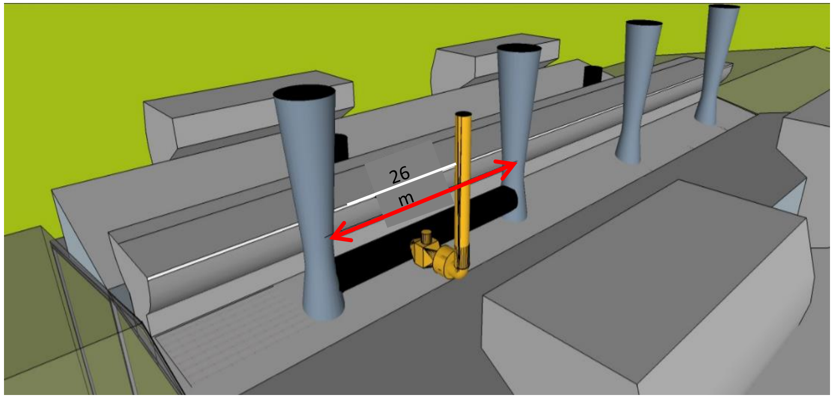
General Views

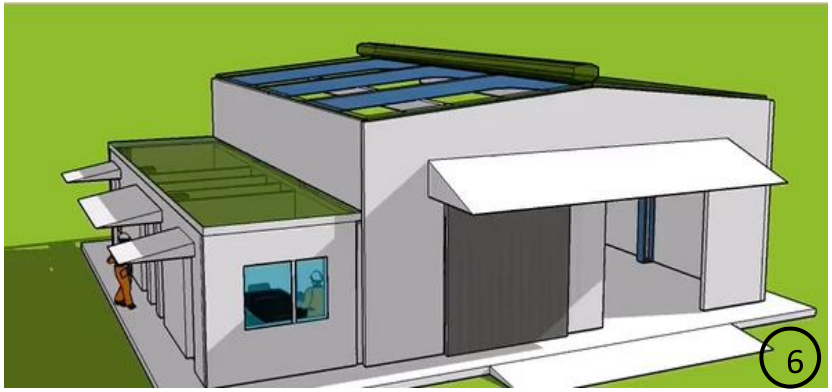


Waste Heat Recovery
(connected to one or two stacks)



Utilities Building





Maintenance / Offices Building

Logistics

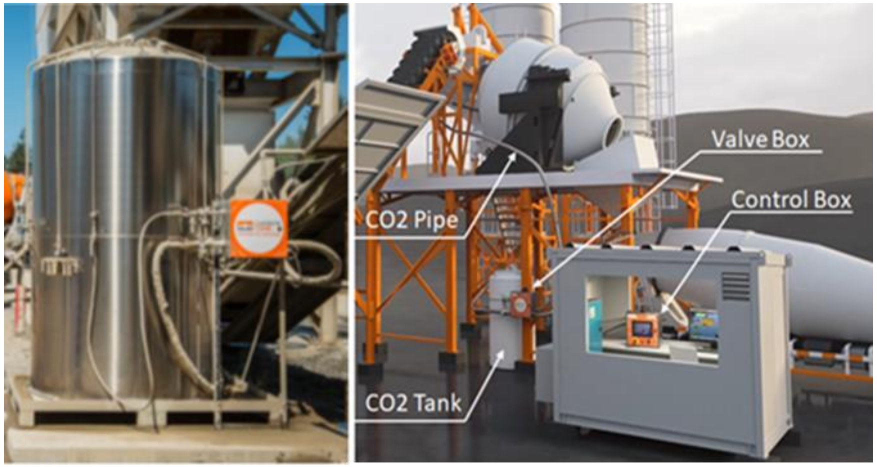
- Ozinga Plant Locations
- U. S. Steel DAC Site Location
- Storage/Hub Locations

CURRENT DIRECTION

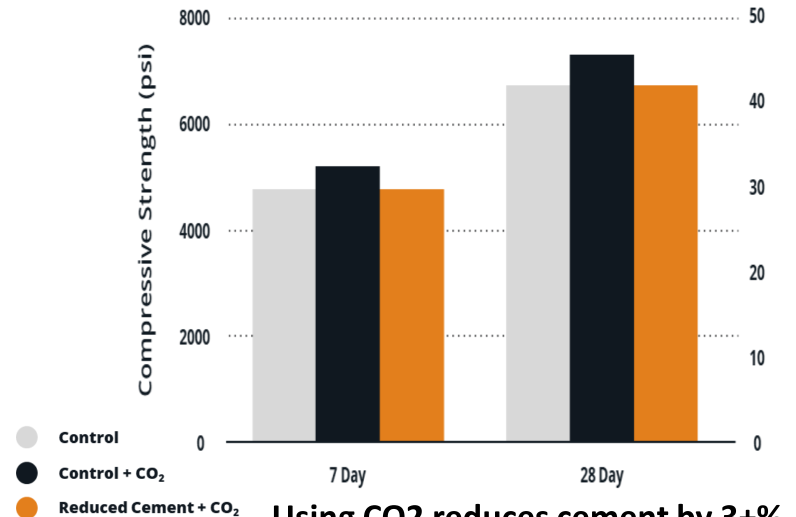
- Pipe from U. S. Steel to IN hub
- Truck from IN hub to IL hub
- Small delivery trucks from hubs to batch plants
- Use CNG trucks with Ozinga RNG

CarbonCure Cement Carbonization Technology

UTILIZATION



CarbonCure's retrofitted equipment into concrete plants

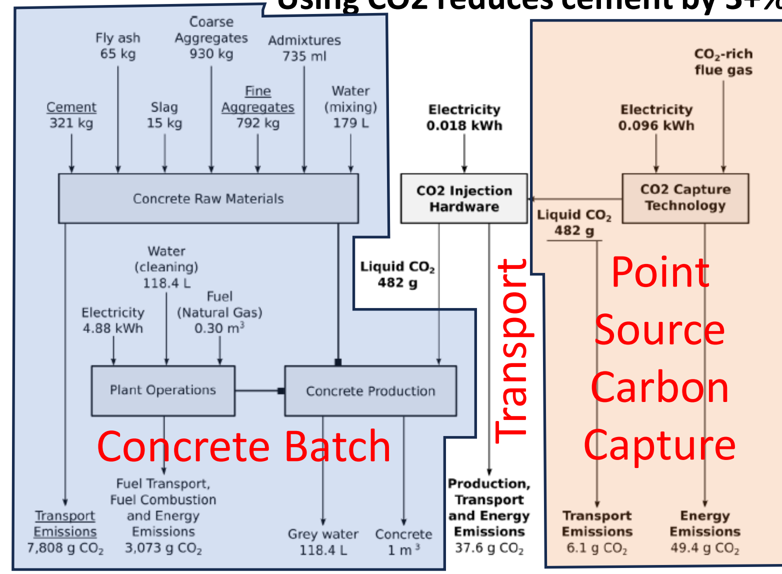


Using CO2 reduces cement by 3+%

Table 6
Summary of the Environmental Impact on 1 cubic meter of concrete.

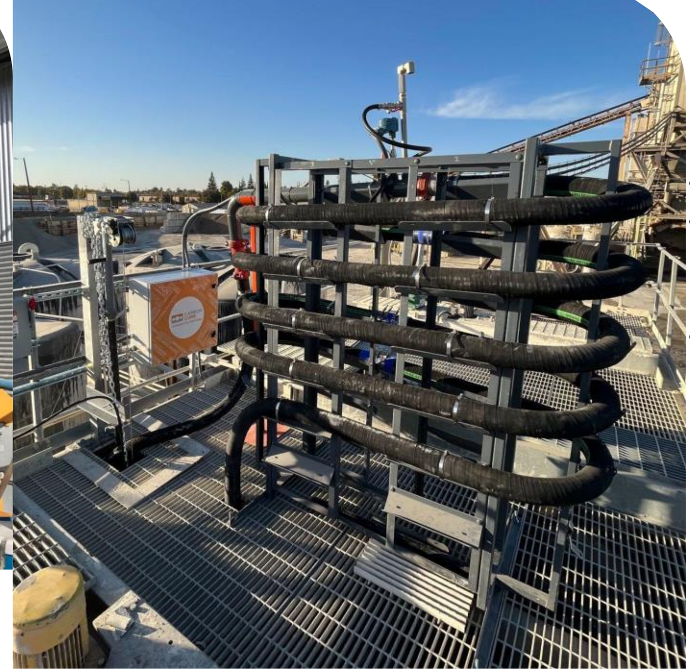
Factor	g CO_2/m^3 concrete
Emissions – CO_2 from gas processing	49.4
Emissions – CO_2 from gas transport	6.1
Emissions – CO_2 from equipment production	0.1
Emissions – CO_2 from equipment transport	0.0
Emissions – CO_2 from equipment operation	9.2
Emissions – Avoided CO_2 from materials transport	−123.6
CO2AB: CO_2 absorbed	−289.1
CO2AV: Avoided CO_2 emissions from cement	−17584.8
Total CO_2 avoided and absorbed	−17997.4
CO2EM: Total CO2 produced	64.7
Net CO_2 reduction	−17932.7

Largest Impact = Avoidance



Previous literature indicated significant CO2 reduction by curing concrete with captured CO2

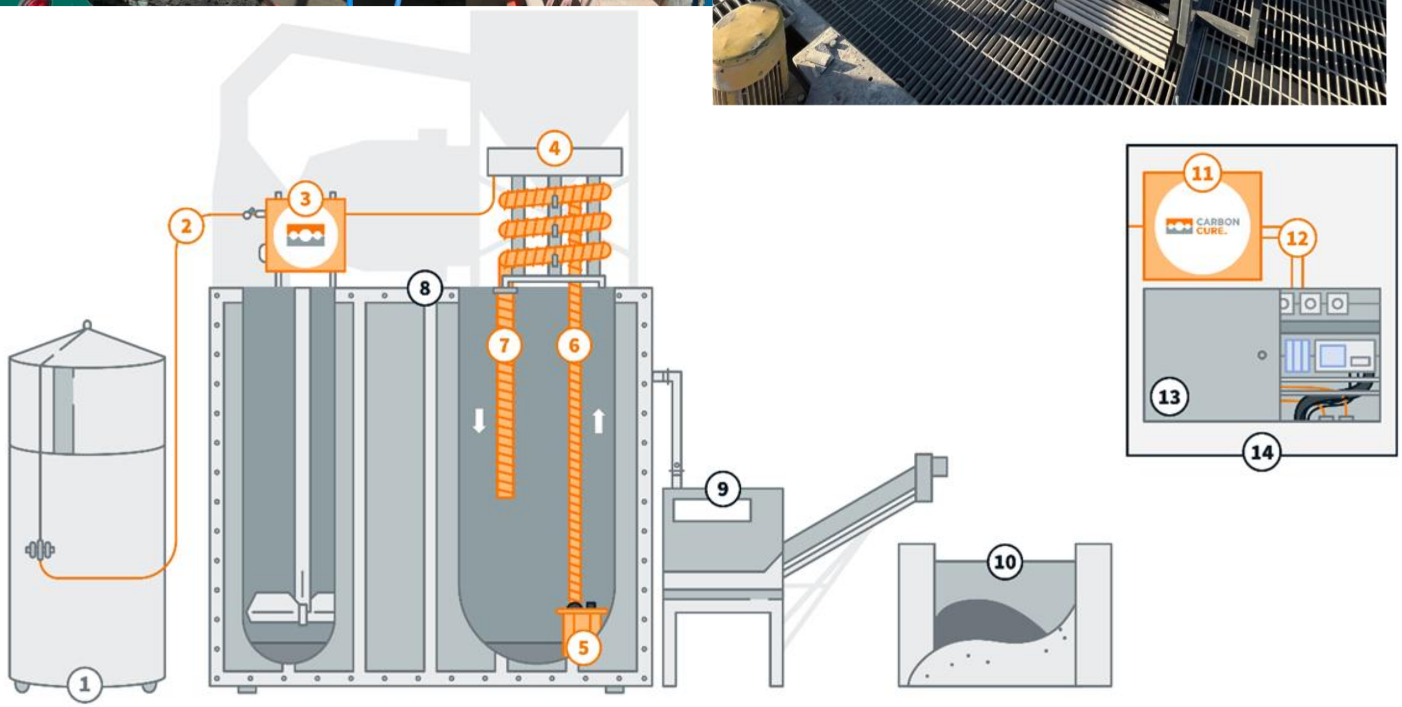
S. Monkman, M. MacDonald / Journal of Cleaner Production 167 (2017) 365-375



UTILIZATION

Reclaimed Water Technology

- Approx. 3% concrete is unused
- Reclaimers recover aggregates and recover cementitious slurry (Reclaimed Water)
- Can avoid 3% cement



Orange: Supplied by CarbonCure
Black: Supplied by Concrete Producer
Grey: Supplied by CO_2 Supplier

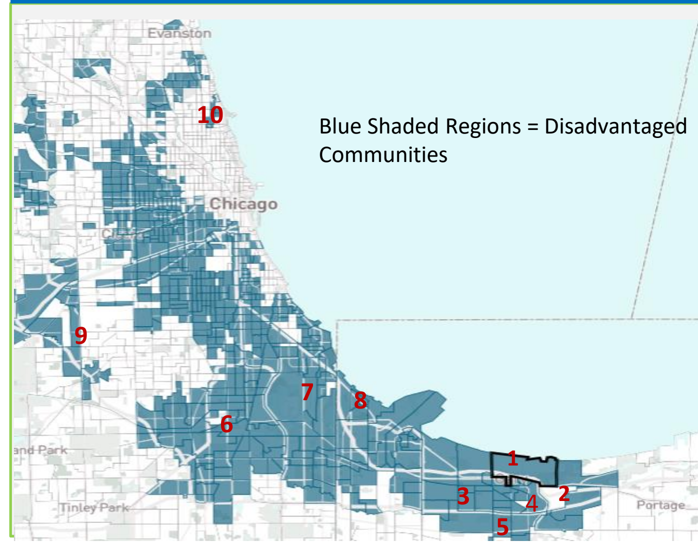
Legend

1. CO_2 Tank – Sized according to anticipated CO_2 usage
2. Gas CO2 Transfer Line
3. CarbonCure Valve Box
4. Reclaimed Water Treatment System
5. Slurry Pump
6. Slurry Infeed Pipe
7. Treated Slurry Return
8. Reclaimed Water Slurry Tank
9. Aggregate Reclaimer
10. Reclaimed Aggregate
11. CarbonCure Control Box
12. Process Monitoring Sensors
13. Reclaimer Control Panel
14. Reclaimer Control Room

Environmental Justice Analysis

- Objective: Analyze the impact of proposed DACU project on the local/surrounding communities and assess the potential distribution of Justice40 benefits and disbenefits.
- Identified local communities that have been disproportionately impacted through Stakeholder Mapping process.
  - Specific focus on Disadvantaged Communities (DAC) near both **Gary Indiana** U. S. Steel host site and Ozinga utilizations sites in **Chicagoland region.**
- Develop strategy for engagement of surrounding communities involving information exchanges and mixture of engagement techniques
  - Focused on EJ issues from a granular level.

EJ Characteristics
Surrounding the Facility



EJ Profile of Surrounding Communities

	Census Tracts	City	DAC	Water Discharge	Climate Hazards Loss of Life estimate	RMP Proximity	Job Access	Less High School Education	Low Income Population	Outage Duration
1	18089010205	Gary	1	67.54584742	24.79550173	4.14556	-7.8	0.10983264	0.6339286	0
2	18089011500	Gary	0	5.347620509	23.23925267	0.4134	-6.2	0.07897664	0.4355401	0
3	18089021800	Hammond	1	8.79048E-06	30.50083174	0.43947	-6.6	0.18703704	0.4664804	0
4	18089041700	Lake Station	1	0.021150634	44.50844801	0.17284	-5.3	0.16077044	0.4762955	0
5	18089042100	Hobart	0	0.010867705	44.95112663	0.16714	-5.3	0.1795825	0.1704918	0
6	17031820202	Hodgkins village	1	24.47545198	52.36668087	3.86801	-8.3	0.20405465	0.3304094	4487
7	17031838800	Chicago	1	0.005783617	50.95478354	3.50506	-8	0.25687104	0.6737589	4487
8	18089040200	Whiting	1	8.46733E-05	28.37542446	5.41235	-6.5	0.16851228	0.2092352	0
9	17043845803	Bridgeview village	1	0.115776886	65.8697535	1.1047	-7	0.07834101	0.2456286	4487
10	17031810200	Evanston	1	15.43014316	45.79249096	1.08785	-9.2	0.14474865	0.3082251	4487

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