Reactive CO_2 Capture via Inorganic Carbonate Crystallization

2023, Phase 1, Release 2
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Carbon To Stone

Project Review Meeting

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CTS CARBON TO STONE

U.S. DEPARTMENT OF ENERGY | Office of Science

SBIR·STTR America's Seed Fund™

Urgent Need for Transformative Solutions

for carbon management and resource recovery

Carbon Dioxide Emissions

2 Billion Tonnes/Year

CO_2 emitted by industry

Flue Gas Capture

CO_2 Removal from Air

Industrial Residues

20 Billion Tonnes/Year

alkaline industrial residue generated

Steel Slag

Aluminum Dross

Cement Kiln Dust

Mining Ore/Tailings

Coal Fly Ash

Produced Water

Let’s Close The Loops, Together.

Carbon To Stone’s Innovative Technology Transforms Residues to Value

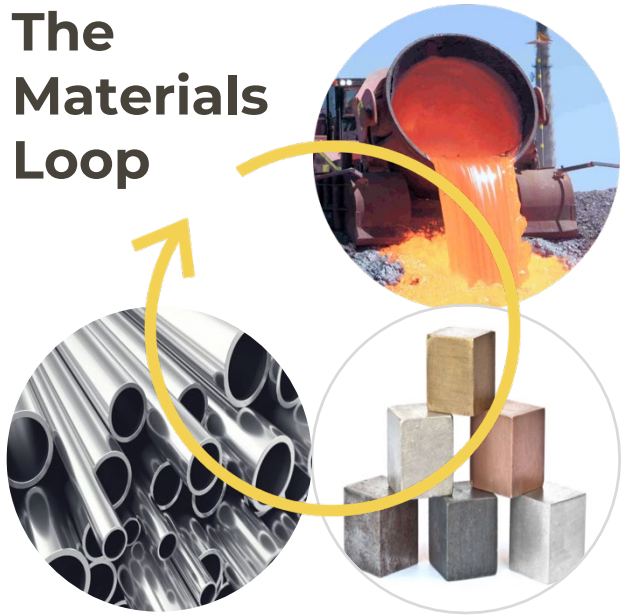
RE

repurposed
reused
reevaluated

The Carbon Loop

From Direct Air Capture or Point Source Capture, into stone.

The Materials Loop

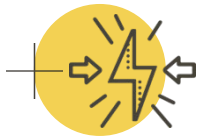


From Industrial Residues, into valuable resources.

Current Methods

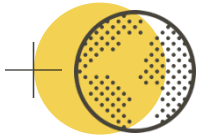
Encounter Environmental & Economic Limitations

Capture



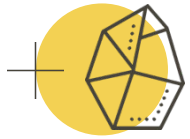
demands significant energy

Transport



creates logistical burden

Store



involves slow mineralization

Utilize

ineffective use of CO_2 & industrial residues

leading to a less sustainable and economically taxing operation

Multi-Step Process

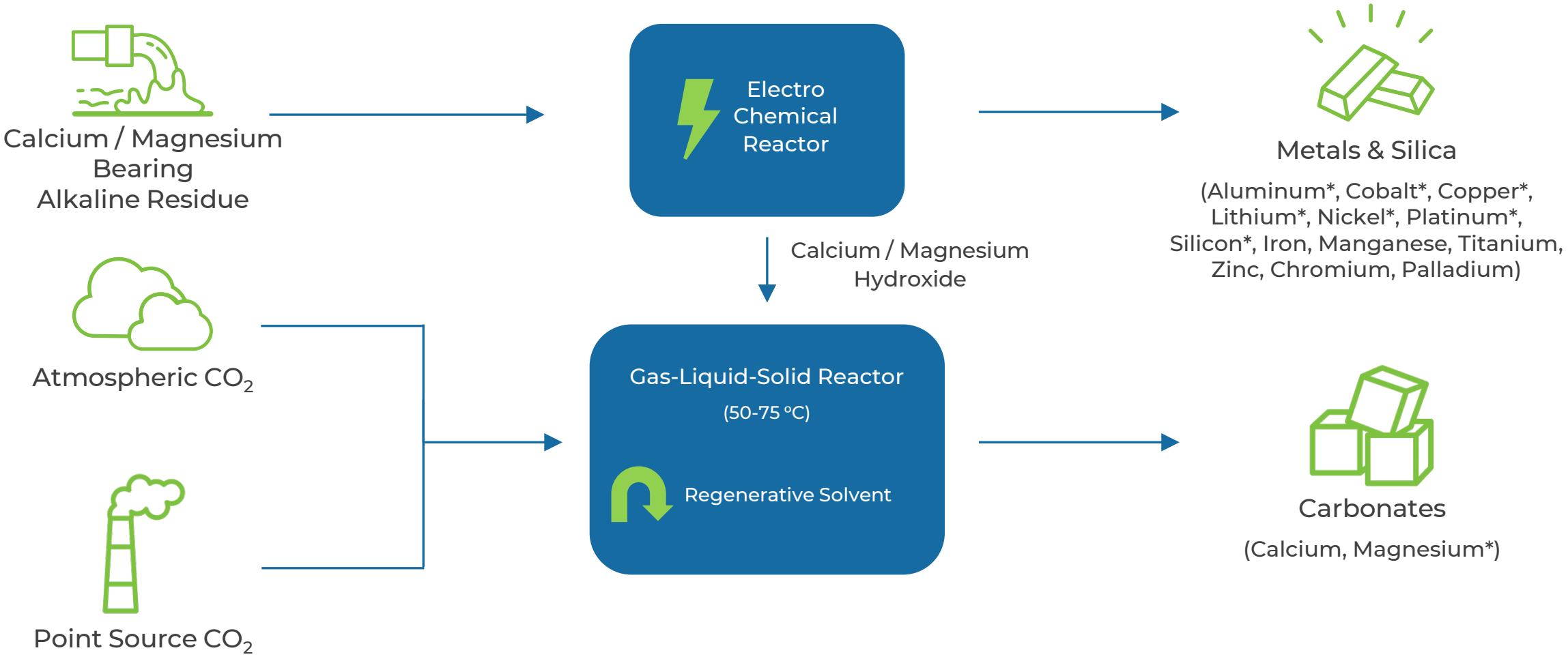
Separation, Compression, and Transportation of CO_2 for Storage or Utilization.

Capital- and Energy-Intense

Thermodynamically Uphill, Energy-Intensive, and Require >75 °C.
Chemical Looping at >700 °C.

Our Patented Platform Technology

Drives Modular, Customizable Use

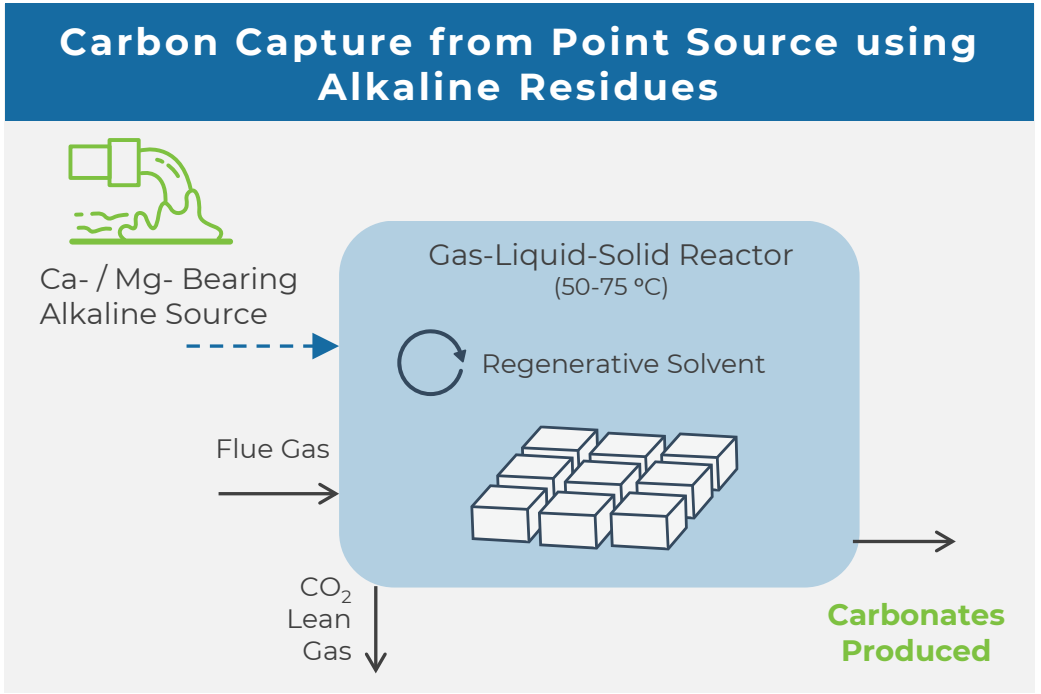


* U.S. Department of Energy's 2023 Critical Materials List

Technical Approach for Reactive Capture

Single-Step capture, conversion, and storage of CO_2 as Ca- or Mg-carbonate at 25-75 °C

Solvent selectively increases the concentration of dissolved CO_2 while being continuously regenerated as solid carbonates are precipitated



Schematic representation of CO_2 capture, and carbonate formation, using Carbon To Stone's single-step process.

Characterized commercially relevant flue gases

Component	Natural Gas fired boilers	Oil fired boilers	Coal fired boilers	Cement Kiln
CO_2	7-10%	11-13%	11%	22.4 %
N_2	78-80%	78-80%	76%	68.1 %
O_2	2-3%	2-6%	6%	2.3%
H_2O	--	--	6%	7.2%
Ar	--	--	1%	--
NO_x	--	--	1%	--

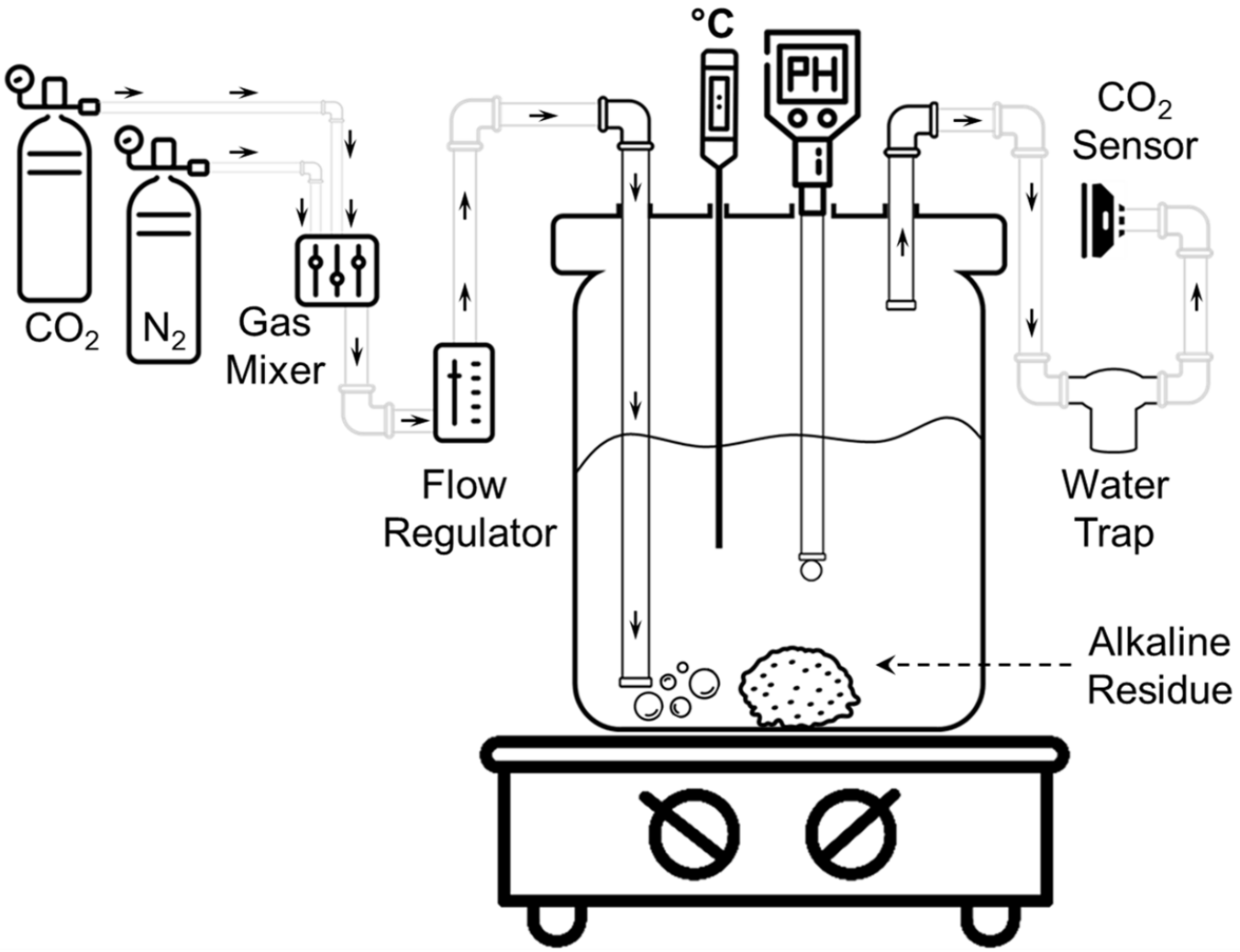
Following flue gas compositions are selected to run the initial experiments.

Component	Gas 1	Gas 2	Gas 3	Gas 4	Gas 5	Gas 6	Gas 7	Gas 8
CO_2	100%	80 %	60 %	40 %	20 %	15 %	10 %	5 %
N_2	0 %	20 %	40 %	60 %	80 %	85 %	90 %	95 %

- The effect of impurities (NO_x, SO_x & O_2) in the flue gas stream will be tested with the optimized reaction parameters (> 80% extent of carbonation).

Patricio J. et al., *Journal of CO_2 Utilization* 2017;22:330-345

Developed Initial Reactor Configuration



Temperature, pH and CO_2 levels are continuously monitored during the reactions

Key Considerations to Advance Technology

Manage Variance in Feedstock Compositions (Flue Gas, Alkaline Residues)

Enhance Solvent Recyclability

Increase Usability of Carbonates

Let’s close the loops, together.

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Acknowledgments

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