

# NOVEL UPCYCLED CO<sub>2</sub>-NEGATIVE CONCRETE PRODUCTION SYSTEM CONSTRUCTED

Utilizing CO<sub>2</sub> and industrial byproducts to create CO<sub>2</sub>-negative upcycled concrete that performs as well, or better, than traditional construction materials

## NEW, VALUE-ADDED PRODUCT FOR THE COAL INDUSTRY TO REDUCE EMISSIONS AND OPEN MARKETS

Flue gas-borne CO<sub>2</sub> and repurposed abundant industrial wastes, such as crystalline slags and fly ash, can be used to create “upcycled concrete.” This value-added product **provides the coal power industry with a viable path to significantly reduce its carbon emissions.**

The “upcycled concrete” production process also **minimizes external energy needs** by fully utilizing low-grade heat sourced from the flue gas, which **decreases operating costs.**

### Examples of Industrial Waste Feedstocks



Basic Oxygen Furnace Slag



Co-Mingled Steel Slag

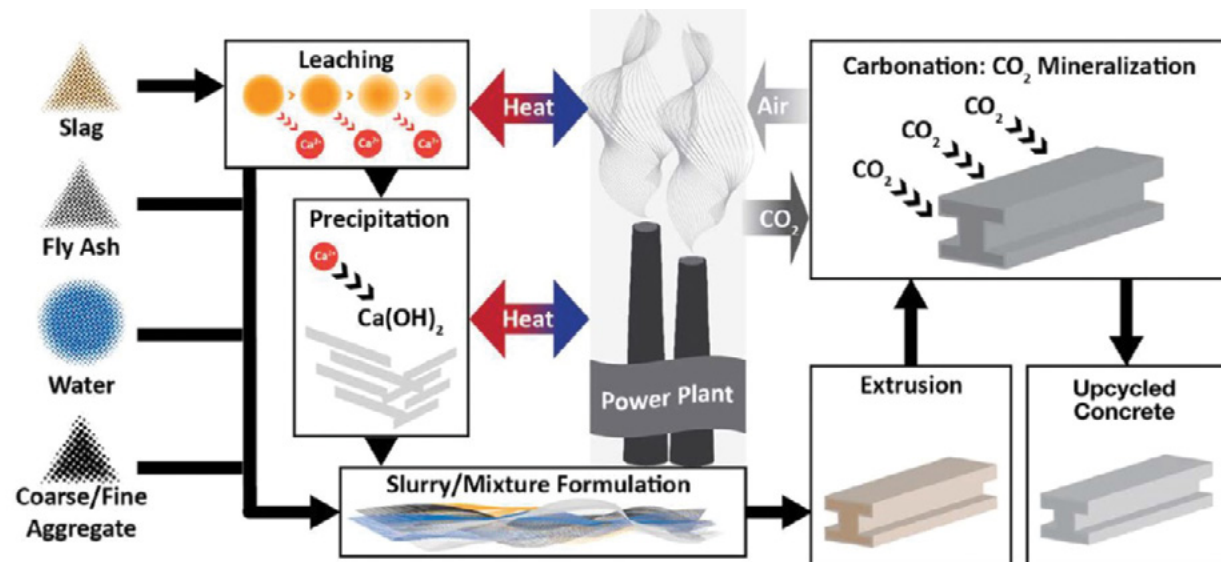
### Upcycling Process Outcome



Cylindrical Mortar Specimens

## INTEGRATED TECHNOLOGY PRODUCTION PROCESS

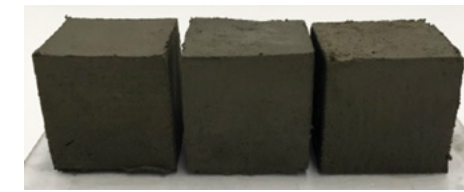
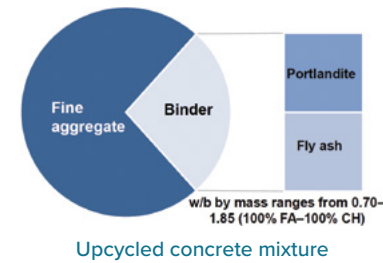
- Completed construction of a novel laboratory-scale upcycled concrete production system.
- The integrated “bolt-on” technology incorporates calcium leaching, portlandite precipitation, mixture formulation, and structural shape stabilization—while maximizing CO<sub>2</sub> uptake.



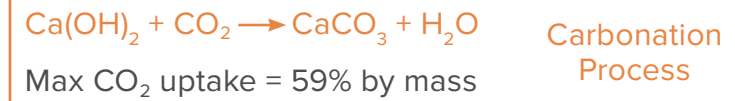
## CARBONATED MORTARS HAVE HIGHER COMPRESSIVE STRENGTH THAN TRADITIONAL MORTARS

Mechanical compaction tests of **carbonated** and non-carbonated mortar samples composed of fly ash-portlandite binders show that **compressive strength increased upon mineral carbonation** (>15 MPa target achieved).

- Direct correlation between strength and CO<sub>2</sub> uptake and carbonate formation; higher CO<sub>2</sub> uptake is attributed to higher levels of portlandite (Ca(OH)<sub>2</sub>) in the mixture.



Compacted 2-inch cube specimens



## REDUCED EMISSIONS AND LOWER COSTS

While maintaining **equivalent or superior performance** to ordinary Portland cement (OPC)-based concrete, “Upcycled Concrete” enables the following:

- CO<sub>2</sub> uptake >6% by mass** due to an integrated CO<sub>2</sub> mineralization process that facilitates low-temperature portlandite precipitation.
- Reduces the 100-year Global Warming Potential by 175–250 kg CO<sub>2</sub>e/m<sup>3</sup>, equivalent to a **57–82% CO<sub>2</sub> emissions reduction.**
- The fully loaded production cost for 140 m<sup>3</sup>/day of upcycled concrete is estimated at **\$97/m<sup>3</sup>**, which is below the OPC concrete block market price (\$100–170/m<sup>3</sup>).
- Utilization of flue gas CO<sub>2</sub> and the ability to repurpose abundant industrial wastes **opens new markets for coal products.**

### PARTNERS



AWARD NUMBER  
**DE-FE0029825**

### PROJECT BUDGET

FY20 FUNDING



- DOE .....\$999,999
- UCLA .....\$300,000
- ASU .....\$50,000

### CONTACTS

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### CORE COMPETENCIES

