CARBON LIMIT

Carbon Dioxide Removal Purchase Application

Fall 2022

General Application - Prepurchase

(The General Application applies to everyone; all applicants should complete this)

Company or organization name

CARBON LIMIT

Company or organization location (we welcome applicants from anywhere in the world)

901 NW 35th St., Boca Raton, FL. 33431

Name(s) of primary point(s) of contact for this application

Tim Sperry

Brief company or organization description

Commercializing a concrete technology that actively attracts and stores atmospheric CO2 into concrete permanently.

1. Project Overview[1]

a. Describe how the proposed technology removes CO_2 from the atmosphere, including as many details as possible. Discuss location(s) and scale. Please include figures and system schematics. Tell us why your system is best-in-class, and how you're differentiated from any other organization working on a similar technology.

PROPOSED TECHNOLOGY:

Carbon Limit's concrete technology **CaptureCrete** is a CDR technology added to built environment concrete projects to give concrete CDR abilities/properties.

[1] We use "project" throughout this template, but note that term is not intended to denote a single facility. The "project" being proposed to Frontier could include multiple facilities/locations or potentially all the CDR activities of your company.

CaptureCrete gives concrete the ability to actively capture and rapidly mineralize ambient atmospheric CO2 via carbonation into concrete permanently by using a hybrid approach combining Direct Air Capture (DAC) together with Carbon Mineralization.

Concrete made with CaptureCrete has the ability to actively capture atmospheric CO2 via physical and chemical adsorption into the concrete. The CO2 reacts with the hydration products of the cement clinker and the CO2 reactive mafic and ultramafic lithologies in CaptureCrete to form precipitated calcium carbonate in the concrete where the CO2 is stored for >1000 years. The CO2 that is converted into calcium carbonates in the concrete is thermodynamically and kinetically stable at ambient pressure and a wide range of temperatures under 800 degrees Celsius, so it requires no additional monitoring.

CaptureCrete formula is composed of low impact mined & milled Class N pozzolans composed of calcium and magnesium silicate based materials as well as an enhanced metal oxide catalyst.

The atmospheric CO2 that is captured/adsorbed and then carbonated into the concrete is utilized by improving the compressive strength, reducing ingress of deleterious ions, and exhibiting self-healing properties by healing micro-cracks in the concrete. The precipitated calcium carbonate can also take part in further reactions with aluminosilicate SCMs/hydrates, resulting in the formation of carboaluminate phases, further improving long-term concrete properties.

Part of the proprietary enhancement process for the CaptureCrete materials, consists of using specialized grinding and milling equipment to reach a specific and desired particle size and surface area. This process increases the adsorptive surface area as well as carbonation capacity to atmospheric and dissolved CO2,

Additionally, the metal oxide catalyst results in a modification of the pore size distribution of the concrete, making it more selective to adsorbing CO2 into the concrete, and increasing the carbon sorption kinetics. These changes enhance and accelerate concrete's natural ability to sequester carbon dioxide in addition to allowing for a deeper depth of penetration.

FIGURES:

According to third party and university lab testing results, a ton of concrete made with a dose of CaptureCrete between 66 lbs to 132 lbs has a CDR rate of 0.06 to 0.1 tons per ton of CaptureCrete concrete. Additionally, CaptureCrete at that dosage rate, which is a pound for pound cement replacement of OPC or PLC, has up to an additional 27% avoidance of carbon footprint typically associated with the concrete manufacturing process compared to the same concrete design mix without CaptureCrete in it. This is because CaptureCrete is made up of Class N Pozzolans, which are non-calcinated, unlike Portland Cement and many other SCMs on the market today that do need calcination requiring additional fuel/energy and CO2 emission generation from heating/burning limestone to make OPC or PLC.

BEST-IN-CLASS:

CaptureCrete is a cement replacement composed of globally available materials that contain Class N pozzolans with carbon mineralization properties that converts atmospheric CO2 into precipitated calcium carbonate in concrete. Additionally, CaptureCrete currently replaces up to 30% of the Portland Cement required to manufacture concrete therefore avoiding up to 27% of the carbon footprint associated with manufacturing the concrete. CaptureCrete increases the efficiency, rate of carbon mineralization, and quantity atmospheric CO2 ingress into concrete and subsequent carbonation. The induced physicochemical changes also increase the compressive strength of concrete compared to the same concrete without CaptureCrete.

Other similar technologies include recarbonation methods that are implemented at the point of concrete manufacturing, which require additional equipment, as well as usually 3rd party feedstock food grade CO2 captured at offsite point source requiring processing and transportation to the concrete manufacturing. This method uses liquid CO2 to carbonate the cement clinker hydrates and other materials and stores the CO2 in the concrete and help lower the cement requirement. This method does not add additional costs or additional processes outside those of standard concrete manufacturing processes that today's concrete companies are set up for. CaptureCrete technology is a simple powered additive that does not require any additional equipment, processing, or 3rd party feedstock. It is a simple drop in additive that is added to concrete like OPC or PLC is. CaptureCrete achieves a higher level of carbonation of the hydration products of the cement clinker in addition to the carbonation of CaptureCrete's reactive materials post-cure.

Lastly, Carbon Limit's CaptureCrete solution does not require any arable land that was not otherwise selected for or already utilized for development purposes. CaptureCrete takes advantage of already planned or utilized concrete roadways, buildings, bridges, homes, concrete infrastructure, and any pre-cast concrete products. Additionally, our solution mitigates the larger Capex costs associated with developing direct air capture faculties, as well as the risks and unknown variables associated with in-situ CO2 storage. When using CaptureCrete concrete in a development/construction project once scale is achieved, the costs are anticipated to not have price disparity when compared to concrete without CaptureCrete.

Frontier's purchase commitment will allow for Carbon Limit to reach near scale COGS for CaptureCrete's formula materials, as well as cheaper cost of processing/enhancing these materials which is required to reach <$100 per tCO2 removed. This would also accelerate the rate of market adoption of CaptureCrete into the cement and concrete industries allowing for further scale.

b. What is the current technology readiness level (TRL)? Please include performance and stability data that you've already generated (including at what scale) to substantiate the status of your tech.

TRL of 7, as 11 tons of CaptureCrete have already been deployed into real world applications including a US MN-DOT project, where 142.8 cubic yards of concrete with 170 lbs of CaptureCrete per cubic yard was poured for a cell of I-94 West bound that is open to public traffic. The total weight of the US MN-DOT project was ~ 263 tons.

Performance of CO2 mineralization efficacy was gathered by testing CaptureCrete concrete samples via TGA to determine mass gain and loss, as well as XRD to determine the form of precipitated calcium carbonate, and GC MS to determine adsorption rates compared to the control concrete samples. Results from this data received is listed in 1.c (current observed value)

c. What are the key performance parameters that differentiate your technology (e.g. energy intensity, reaction kinetics, cycle time, volume per X, quality of Y output)? What is your current measured value and what value are you assuming in your nth-of-a-kind (NOAK) TEA?

Key performance parameter	**Current observed value (units)**	**Value assumed in NOAK TEA (units)**	**Why is it feasible to reach the NOAK value?**
Adsorption (physically & chemically) of	160% to 171% more CO2 adsorbption compared to	180% to 256% more CO2 adsorption compared to	Increasing the percentage of CaptureCrete as a cement replacement will create an increase

ambient atmospheric CO2 into concrete with CaptureCrete vs control concrete without CaptureCrete.	control concrete.	control concrete.	in adsorption surface area. Initial observed results from 3rd party verifiers were based on a 20% cement replacement with CaptureCrete, and currently deployed CaptureCrete projects are at a 30% cement replacement rate. Additionally, testing is being conducted at 45% cement replacement rate. Further increases are possible through optimization of formulations through research that is currently being performed. Further modifications which will increase CO2 capture include direct blending with cement, use as a mineral admixture, and increase of carbon capture in aggregates.
Post-Cure carbon mineralization of concrete with CaptureCrete.	0.06 to 0.1 tons of CO2 per ton of CaptureCrete concrete.	0.1 to 0.15 tons of CO2 per ton of CaptureCrete concrete.	Increasing the percentage of CaptureCrete as a cement replacement in concrete will add more CO2 reactive materials increasing the quantity of CO2 carbonation into the concrete. Initial observed results from 3rd party verifiers were based on a 20% cement replacement with CaptureCrete, and currently deployed CaptureCrete projects are at a 30% cement replacement rate. Additionally, testing is being conducted at 45% cement replacement rate. Further increases are possible through optimization of formulations through research that is currently being performed. Further modifications which will increase CO2 capture include direct blending with cement, use as a mineral admixture, and increase of carbon capture in aggregates.
Improved compressive strength of concrete with CaptureCrete vs control concrete	CaptureCrete had an 13% increase in compressive strength over the control concrete at day 28.	An increase in compressive strength up to 20% over concrete concrete at day 28.	Adding 50% more CaptureCrete's N type pozzolans to the concrete design mix should increase the compressive strength of the cured concrete.

without CaptureCrete.			Initial observed results from 3rd party verifiers were based on a 20% cement replacement with CaptureCrete, and currently deployed CaptureCrete projects are at a 30% cement replacement rate. Additionally, testing is being conducted at 45% cement replacement rate.

d. Who are the key people at your company who will be working on this? What experience do they have with relevant technology and project development? What skills do you not yet have on the team today that you are most urgently looking to recruit?

Tim Sperry, the founder of Carbon Limit, will be leading the project development. He is the inventor of Carbon Limit's carbon capturing concrete technology CaptureCrete. He has expertise in negative emission technologies (NET), carbon dioxide removal (CDR) technologies, and carbon mineralization.

Previous works include an inorganic material based NET that he invented for Smog Armor Co. in the form of a powder additive that adsorbs CO2 and specific VOCs physically and chemically. Additional complimentary skills from another material scientist and/or chemical engineer would add value for further optimization of the technology.

Carbon Limit is also currently working with multiple project and technology consultants including professors, assistant professors, and PHD graduates from multiple universities, as well as 3rd party concrete R&D labs and batching plants to further test and optimize CaptureCrete to improve CO2 removal efficacy and improve concrete performance.

e. Are there other organizations you're partnering with on this project (or need to partner with in order to be successful)? If so, list who they are, what their role in the project is, and their level of commitment (e.g., confirmed project partner, discussing potential collaboration, yet to be approached, etc.).

Partner	**Role in the Project**	**Level of Commitment**
Cement & concrete manufacturers.	Cement manufacturers blend CaptureCrete formulations with Ordinary Portland Cement (OPC) or Portland Limestone Cement (PLC) for use in concrete manufacturing. Concrete manufacturers integrate CaptureCrete into the concrete mixture designs to create carbon capturing concrete.	Confirmed pilot and project partners, in addition to three proof of concepts with four cement/concrete manufacturers. We are currently under NDA with all four and in the process of testing.
Public and private end users for new concrete projects.	To drive customer demand, to spec in CaptureCrete for specific concrete construction projects, and to deploy concrete made with CaptureCrete into	Confirmed project partners (already completed first US DOT project on I-94 West of total weight 263 tons). We are also

	construction projects globally.	negotiating other concrete projects for concrete roadway projects, sidewalks, and pre-cast concrete products for deployment for private projects. Additionally, we are currently creating a feasibility report and techno-economic report for the Army/US Army Corps of Engineers to deploy CaptureCrete into pilots/projects for our X-TEC SBIR Phase 1 grant with the US Army.
Universities/Consultants.	Working with university professors and PH.D. graduates with experience on SCMs, cement, concrete, as well as CCS and CCU to explore the carbon capture efficacies of different formulations; further understand fundamentals of carbon capture and the impacts on performance in concrete; and optimize formulations for cost, carbon capture, strength, and durability for different real world applications.	Confirmed project partners at IUPUI and University of Miami.

f. What is the total timeline of your proposal from start of development to end of CDR delivery? If you're building a facility that will be decommissioned, when will that happen?

12 to 18 months as we have already started production as well as deployment of the CaptureCrete product into real world applications/projects.

g. When will CDR occur (start and end dates)? If CDR does not occur uniformly over that time period, describe the distribution of CDR over time. Please include the academic publications, field trial data, or other materials you use to substantiate this distribution.

Each project will have an estimated CDR based on the quantity of CaptureCrete concrete, with a start date based on concrete production. Our first real world CDR project/deployment started 08/0/2022 and will be measured for CDR over a 48 month period. CDR starts during concrete curing and continues during its service life. As atmospheric CO2 is adsorbed into CaptureCrete concrete it chemically react with the cement hydration products and CaptureCrete's CO2 reactive materials. Mineral carbonation will occur transforming the CO2 into solid carbonates in the concrete in the pores and voids in the concrete. (Publications: At least 1 - 2 white papers are anticipated to result from this work and corresponding lab work that aims to provide a better understanding of the carbonation process and its optimization.)

h. Please estimate your gross CDR capacity over the coming years (your total capacity, not just for this proposal).

Year	Estimated gross CDR capacity (tonnes)
2023	6000
2024	30000
2025	100000
2026	250000
2027	1000000
2028	10000000
2029	60000000
2030	120000000

i. List and describe at least three key milestones for this project (including prior to when CDR starts), that are needed to achieve the amount of CDR over the proposed timeline.

	Milestone description	Target completion date (eg Q4 2024)
1	Establish supply chain of materials with consistent COGS in FL, MS, TX, CA, NV, AZ, and other states.	Q4 2022
2	Secure contracts with DOT, DOD, and other agencies for large scale concrete projects with CDR over 1,000 tCO2 per project.	Q1 2023
3	Licensing deals with large cement, SCM, and concrete companies/manufacturers.	Q2 2023

j. What is your IP strategy? Please link to relevant patents, pending or granted, that are available publicly (if applicable).

Carbon Limit has filed a non-provisional utility patent for CaptureCrete's formula materials and catalyst based on a previously issued provisional patent. Additionally, a method patent for the enhancement process of CaptureCrete's formula materials and functionality has also been filed based on the previously issued non-provisional patent.

Carbon Limit will also file for additional non-provisional patents, and/or trade secrets that cover substitute/replacement materials related to CaptureCrete's formula(s) to allow for global market reach for a sales & licensing approach to gigaton scale.

(Patents not publically available at this time)

k. How are you going to finance this project?

Funding for this project has already been raised as a portion of the completed Pre-Seed funding round for Carbon Limit. The capital requirements are currently directly related to the material costs, grinding/milling/enhancement, fulfillment, and transport for each tCO2 mitigated. For FOAK and this project we do not require a facility/arable land to fulfill orders of our CaptureCrete to cement and concrete companies or end users, as we have a network of mining partners/processing facilities that mine, grind, enhance, blend, and ship our CaptureCrete product directly to our customers. Additional funding is available through current investors if required.

l. Do you have other CDR buyers for this project? If so, please describe the anticipated purchase volume and level of commitment (e.g., contract signed, in active discussions, to be approached, etc.).

A primary focus on getting Frontier to pre-purchase for this project to help get CaptureCrete to scale in terms of material COGS as well as secure commitments on volume of material requirements from mining partners to reach CDR gross removal goals, and to allow for a cost per Carbon Credit to reach <$100.

m. What other revenue streams are you expecting from this project (if applicable)? Include the source of revenue and anticipated amount. Examples could include tax credits and co-products.

Other revenue streams from the project include the sale of the tangible CaptureCrete product to SCM, cement and concrete companies at an initial sales price between $125 to $300, as well as B to C via retail (example; Home Depot & Lowes) at a retail price range between $150 to $390 per ton of CaptureCrete, depending on if in pre-cast or ready-mix form (taking in consideration a gross profit margin averages of >30%) Another additional potential revenue stream would be in the form of the 45Q tax credits once IRS approval is procured based on the upcoming regulations and conveying a clear identification of what the “facility” and “equipment” is in regards to CaptureCrete’s product to satisfy the requirements for 45Q approval (legal council has been secured). Potential sales to concrete admixture companies is also being researched, as CaptureCrete’s catalysts are currently being tested as admixture products.

n. Identify risks for this project and how you will mitigate them. Include technical, project execution, ecosystem, financial, and any other risks.

Risk	Mitigation Strategy

Material availability and fluctuation of material costs.	Identify substitute materials in each region for global scaling. Having a broad range of materials to choose from will also provide robustness in case of fluctuation of material costs beyond a determined percentage.
Consistent accountability of CDR for projects done with CaptureCrete.	Because each concrete project made with CaptureCrete can have different specs, different locations (where RH, temperatures, and CO2 concentrations are variable), as well as the thickness of concrete (which will lead to changes in the depth of CO2 MC) as variables, this makes it challenging to determine a statistical conservative average of CDR per ton of concrete that uses CaptureCrete. To mitigate this risk we will determine the conservative average of the project size, concrete thickness, environmental variables (RH, temp, CO2 concentration) and create a basis for CDR per project per ton of concrete that uses CaptureCrete. We also will keep our percentage/amount of CaptureCrete integration into concrete consistent to ensure the CDR is easily quantifiable per project. We will also develop a model that better links CDR to project parameters which can be used going forward for consistent accountability.
Market adoption and pricing acceptance for the purchase of CaptureCrete's product by end users.	As a partial cement replacement that is intended to replace OPC, if a higher price point above the current market price of OPC for CaptureCrete is not broadly accepted by the market, the mitigation strategy will be to sell CaptureCrete at or below the current market price of OPC. Investment into strategically placed facilities close to major markets with grinding/milling equipment will also allow us to reduce COGS up to 60%. Additionally, as licensing of CaptureCrete's formula is being explored there is the potential to establish a royalty model, or revenue share for every cubic yard of concrete with CaptureCrete technology, or to sell only the catalyst material in CaptureCrete, which represents approximately 1% of the formula, allowing for a lower cost to Carbon Limit and the end customer. This strategy would minimize costs of procuring the other formula materials, grinding/milling, blending, and transporting 99% of the CaptureCrete formula materials. Potential use of the CaptureCrete catalyst in a liquid form is also being explored, which will allow us to sell to admixture companies, thus increasing our consumer base while still supplying smaller amounts of materials on an increased cost basis.

2. Durability

a. Describe how your approach results in permanent CDR (> 1,000 years). Include citations to scientific/technical literature supporting your argument. What are the upper and lower bounds on your durability estimate?

CaptureCrete gives concrete the ability to adsorb atmospheric CO2 physically and chemically, and then chemically react with the cement hydration products and the mafic and ultramafic lithologies in

the CaptureCrete. This results in CO_2 turning into a solid carbonate in the form of calcite and other stable polymorphs (exact polymorphs depend on cement and SCM chemistry) through Mineral Carbonation. The CDR is thermodynamically stable and will result in a >1000 year permanence at temperatures below 800 C. Even if the concrete is recycled, the carbonated products are able to be used as is (for aggregate) and will continue to adsorb CO_2 due to increased surface area. Publications:

b. What durability risks does your project face? Are there physical risks (e.g. leakage, decomposition and decay, damage, etc.)? Are there socioeconomic risks (e.g. mismanagement of storage, decision to consume or combust derived products, etc.)? What fundamental uncertainties exist about the underlying technological or biological process?

<200 words: The durability risk exists for the stored CO_2 in the event that concrete is incinerated at high temperatures (> 800 C) at the end of its service life or sooner. The high temperature would allow the captured CO_2 to be re-emitted back into the atmosphere, but this is an issue for almost any CDR process. Today, most concrete is recycled largely through grinding, which will not cause CO_2 decomposition. Rather, the concrete will have a similar CDR ability in its second life as more surface area of the concrete is exposed when the concrete materials are ground down.

3. Gross Removal & Life Cycle Analysis (LCA)

a. How much GROSS CDR will occur over this project's timeline? All tonnage should be described in **metric tonnes** of CO_2 here and throughout the application. Tell us how you calculated this value (i.e., show your work). If you have uncertainties in the amount of gross CDR, tell us where they come from.

Gross tonnes of CDR over project lifetime	CaptureCrete concrete will have 0.06 to 0.1 gross tonnes of CDR per ton of concrete over project lifetime.
Describe how you calculated that value	Mortar mixtures following typical mortar mixture designs were made with a control cement and with ~20% mass replacement of CaptureCrete. After carbonation curing of these mortars, thermogravimetric analysis (TGA) was performed to measure the $CaCO_3$ contents in the mortars. Due to dilution and potential pozzolanic reactions, one would expect there to be lower $Ca(OH)_2$, which reacts to form $CaCO_3$ in the mixture with CaptureCrete. However, the reverse was observed. Specifically, $CaCO_3$ amounts in the mortar with CaptureCrete were 22.2%, compared to 13.6% for the control material. After corrections for limestone present in precursor materials, we estimated that the CaptureCrete mortars sorbed 0.095 ton CO_2/ton mortar. Results from other testing conditions and using other materials gave similar values of carbon sorption. The mortars

	had 36% by mass cement paste content; corresponding values for concrete are 24% to 54%. This gives a range of 0.063 - 0.142 ton/ton of CDR, which we conservatively approximate to 0.06 - 0.1 tons (current) and 0.1 - 0.15 tons (future projections).

b. How many tonnes of CO_2 have you captured and stored to date? If relevant to your technology (e.g., DAC), please list captured and stored tons separately.

We have deployed our first project with MN-DOT and Mn-ROAD for a highway cell on I-94 West-bound in Minnesota on 08/03/2022. It is projected to capture up to 24 tonnes of CO2 which will be stored in the concrete over 48 to 72 months in the form of solid carbonates.

c. If applicable, list any avoided emissions that result from your project. For carbon mineralization in concrete production, for example, removal would be the CO_2 utilized in concrete production and avoided emissions would be the emissions reductions associated with traditional concrete production. Do not include this number in your gross or net CDR calculations; it's just to help us understand potential co-benefits of your approach.

For every ton of concrete made with a dose of 66 lbs to 132 lbs of CaptureCrete, which is a pound for pound replacement of OPC or PLC, there is up to a 27% reduction of carbon footprint associated with the concrete manufacturing process compared to the same concrete design mix without CaptureCrete in it. Carbon Limit's CaptureCrete is made up of Class N Pozzolans, which are non-calcinated, unlike Portland Cement and many other SCMs on the market today that do need calcination requiring additional fuel/energy and CO2 emission event from burning the limestone to make OPC or PLC.

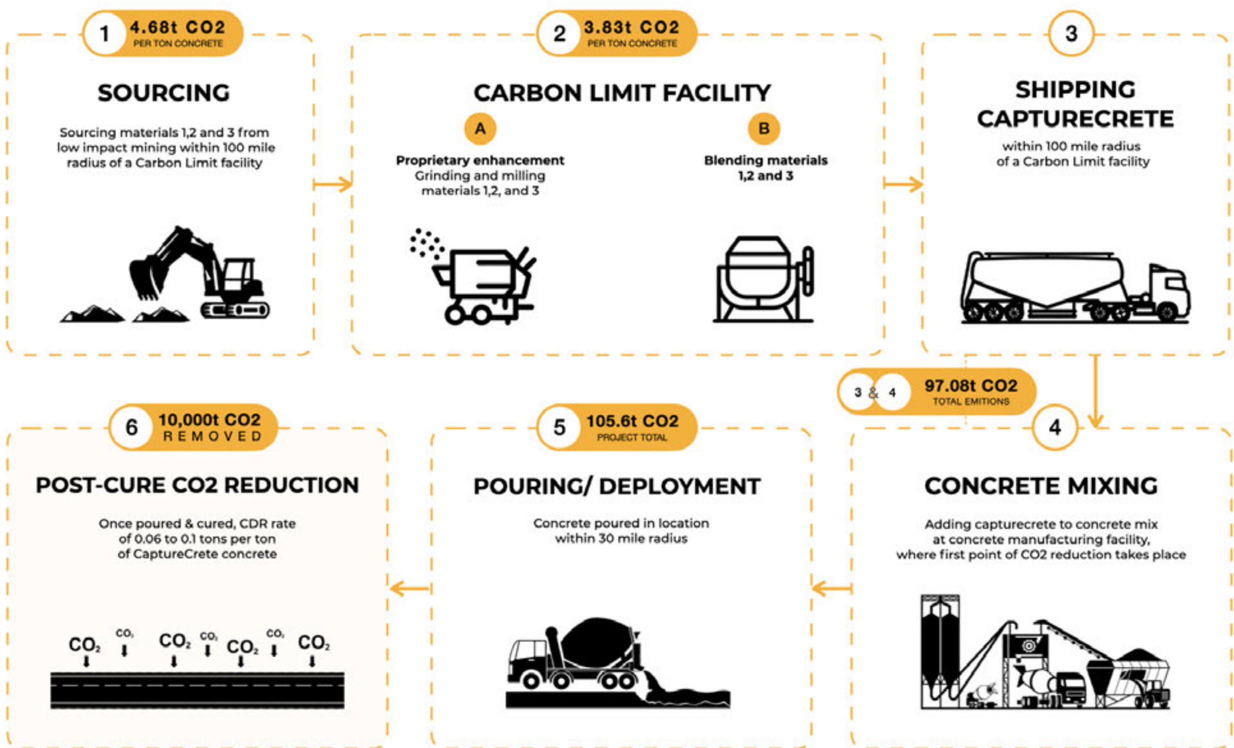
d. How many GROSS EMISSIONS will occur over the project lifetime? Divide that value by the gross CDR to get the emissions / removal ratio. Subtract it from the gross CDR to get the net CDR for this project.

Gross project emissions over the project timeline *(should correspond to the boundary conditions described below this table)*	105.59 tons of CO2 emitted over the project timeline
Emissions / removal ratio *(gross project emissions / gross CDR–must be less than one for net-negative CDR systems)*	105.59/9894.41 = 0.01067
Net CDR over the project timeline *(gross CDR - gross project emissions)*	10000 - 105.59 = 9894.41

e. Provide a process flow diagram (PFD) for your CDR solution, visualizing the project emissions numbers above. This diagram provides the basis for your life cycle analysis (LCA). Some notes:

- The LCA scope should be cradle-to-grave

- For each step in the PFD, include all Scope 1-3 greenhouse gas emissions on a CO_2 equivalent basis
- Do not include CDR claimed by another entity (no double counting)
- For assistance, please:
  - Review the diagram below from the CDR Primer, Charm's application from 2020 for a simple example, or CarbonCure's for a more complex example
  - See University of Michigan's Global CO_2 Initiative resource guide
- If you've had a third-party LCA performed, please link to it.



f. Please articulate and justify the boundary conditions you assumed above: why do your calculations and diagram include or exclude different components of your system?

<100 words: Because CaptureCrete is only added to already planned built environment concrete projects as well as pre-cast concrete products to give concrete CDR abilities/properties. Calculations for CaptureCrete project emissions on diagram include any additional carbon footprint created from mining, grinding, blending, transportation, as well as the related percentage of the concrete mixing and deployment of CaptureCrete's formula materials in the concrete required for each project. Typical emissions from cement and concrete processing and production have been excluded

from calculations as the project would have been completed regardless of CaptureCrete's integration. (Diagram project emission calculations based in dose rate of 132 lbs of CaptureCrete per ton of concrete)

g. Please justify all numbers used to assign emissions to each process step depicted in your diagram above. Are they solely modeled or have you measured them directly? Have they been independently measured? Your answers can include references to peer-reviewed publications, e.g. [Climeworks' LCA paper](#).

Process Step	CO_2(eq) emissions over the project lifetime (metric tonnes)	Describe how you calculated that number. Include references where appropriate.
Mining	4.68 tons of CO2	Each ton of CaptureCrete produces 1.72 kg of CO2 - Project uses 6000 tons of CaptureCrete (rate use is based on 10% cement usage and 60% replacement using Capturecrete) 6000 X 1.72 = 10320 kgs of CO2 or 4.68 tons
Grinding	3.83 tons of CO2	1.41 kg per ton X 6000 = 8460 kgs of CO2 or 3.83 tons
Blending	Included in grinding	
Transportation	97.08 tons of CO2	Average CO2 emitted by Freight is 161.8 grams of CO2 per mile/ton 250 pneumatic trucks carrying 24 tons each (max weight 48000 pounds) Project max distance will be 100 miles 161.8 X 24 X 100= 388320 grams of CO2 per truck 388320 X 250= 97 million grams of CO2/1000000 grams in a ton 97.08 tons of CO2 emissions
Concrete Mixing	Included in transportation	Emissions for Concrete mixing are based on fuel consumption which is already accounted for in transportation.

4. Measurement, Reporting, and Verification (MRV)

Section 3 above captures a project's lifecycle emissions, which is one of a number of MRV considerations. In this section, we are looking for additional details on your MRV approach, with a particular focus on the ongoing quantification of carbon removal outcomes and associated uncertainties.

a. Describe your ongoing approach to quantifying the CDR of your project, including methodology, what data is measured vs modeled, monitoring frequency, and key assumptions. If you plan to use an existing protocol, please link to it. Please see [Charm's bio-oil sequestration protocol](#) for reference, though note we do not expect proposals to have a protocol at this depth at the prepurchase stage.

<300 words: To determine the CDR of our project, we will test core samples of the produced CaptureCrete concrete compared to the control concrete without CaptureCrete to determine the amount of adsorbed CO_2 & carbonation above and beyond the adsorption and carbonation of the control concrete sample. Testing is done through GC MS to determine the amount of adsorbed CO_2, TGA to determine weight/mass loss of the samples (due to the decomposition of the precipitated calcium carbonate ($CaCO_3$) and other carbonates from carbonation), and XRD to identify the type and amount of precipitated calcium carbonate in the form of calcite, dolomite, or magnesite. Testing frequencies can be every 6 or 12 months for up to 72 months. Based on TGA and XRD results and stoichiometric results, we will also be able to differentiate the CO_2 captured by calcium hydroxide, calcium silicate hydrate, and by the CaptureCrete product. Lab based testing will be used to complement field testing results and findings.

b. How will you quantify the durability of the carbon sequestered by your project discussed in 2(b)? If direct measurement is difficult or impossible, how will you rely on models or assumptions, and how will you validate those assumptions? *(E.g. monitoring of injection sites, tracking biomass state and location, estimating decay rates, etc.)*

<200 words:

The carbon sequestered in the concrete made with our CaptureCrete is thermodynamically more stable. Atmospheric CO_2 that is adsorbed physically and chemically into the concrete with Carbon Limit's CaptureCrete chemically reacts with the cement hydrates and the reactive mafic & ultramafic lithology materials in Carbon Limit's CaptureCrete composition that turns atmospheric CO_2 into precipitated calcium carbonate $CaCO_3$ in the form of calcite, and other carbonates. No further monitoring is needed after the carbon mineralization process has taken place to ensure storage with no leakage. We will perform lab testing under various storage conditions (including long-term), grinding, and heating/cooling to verify that the carbonates are stable till 800 C and under grinding conditions.

c. This tool diagrams components that we anticipate should be measured or modeled to quantify CDR and durability outcomes, along with high-level characterizations of the uncertainty type and magnitude for each element. We are asking the net CDR volume to be discounted in order to account for uncertainty and reflect the actual net CDR as accurately as possible. Please complete the table below. Some notes:

- In the first column, list the quantification components from the Quantification Tool relevant to your project (e.g., risk of secondary mineral formation for enhanced weathering, uncertainty in the mass of kelp grown, variability in air-sea gas exchange efficiency for ocean alkalinity enhancement, etc.).
- In the second column, please discuss the magnitude of this uncertainty related to your project and what percentage of the net CDR should be discounted to appropriately reflect these uncertainties. Your estimates should be based on field measurements, modeling, or scientific literature. The magnitude for some of these factors relies on your operational choices (i.e., methodology, deployment site), while others stem from broader field questions, and in some cases, may not be well constrained. We are not looking for precise figures at this stage, but rather to understand how your project is thinking about these questions.
- See this post for details on Frontier's MRV approach and a sample uncertainty discount calculation and this Supplier Measurement & Verification Q&A document for additional guidance.

Quantification component Include each component from the Quantification Tool relevant to your project	**Discuss the uncertainty impact related to your project** Estimate the impact of this component as a percentage of net CDR. Include assumptions and scientific references if possible.
Kinetics of CDR	Kinetics of CDR unknown and variable in the long-term, which may impact calculations.
Depth of carbonation	Depth of carbonation when considering projects with significant depth is unknown.
RH, temperature	Effects of RH and temperature on CDR are in the process of being quantified.
CDR in aggregates	Additional CDR in aggregates is unclear.
Effect of PLC, SCM compositions	Effects of mixture design parameters on CDR unknown.

d. Based on your responses to 4(c), what percentage of the net CDR do you think should be discounted for each of these factors above and in aggregate to appropriately reflect these uncertainties?

<50 words: Given that our CDR (current and future) values are provided as a range, it does not appear that significant discounting is necessary at this time. This will be confirmed through further testing.

e. Will this project help advance quantification approaches or reduce uncertainty for this CDR pathway? If yes, describe what new tools, models or approaches you are developing, what new data will be generated, etc.?

<200 words: Yes, this project will advance determining the average CDR per ton of concrete made with CaptureCrete. The approaches we are developing include determining how the average environmental conditions/variables, the relative humidity RH, temperature, as well as thickness of the concrete will ultimately affect the CDR quantifications on a project by project basis.

f. Describe your intended plan and partners for verifying delivery and registering credits, if known. If a protocol doesn't yet exist for your technology, who will develop it? Will there be a third party auditor to verify delivery against that protocol or the protocol discussed in 4(a)?

<200 words: We are already in process with VERRA to get our carbon credits verified under an already approved (by VERRA) methodology VM-0043, as our CDR method and process can fit into the methodology as it is currently approved. Currently we plan on using SCS Global as our third party auditor for VERRA.

5. Cost

We are open to purchasing high-cost CDR today with the expectation the cost per tonne will rapidly decline over time. The questions below are meant to capture some of the key numbers and assumptions that you are entering into the separate techno-economic analysis (TEA) spreadsheet (see step 4 in Applicant Instructions). There are no right or wrong answers, but we would prefer high and conservative estimates to low and optimistic. If we select you for purchase, we'll work with you to understand your milestones and their verification in more depth.

a. What is the levelized price per net metric tonne of CO_2 removed for the project you're proposing Frontier purchase from? This does not need to exactly match the cost calculated for "This Project" in the TEA spreadsheet (e.g., it's expected to include a margin), but we will be using the data in that spreadsheet to consider your offer. Please specify whether the price per tonne below includes the uncertainty discount in the net removal volume proposed in response to question 4(d).

$/tonne CO_2: $224.13 FOAK

b. Please break out the components of this levelized price per metric tonne.

Component	Levelized price of net CDR for this project ($/tonne)
Capex	$168
Opex (excluding measurement)	$27
Quantification of net removal (field measurements, modeling, etc.)[2]	$11
Third party verification and registry fees (if applicable)	$18.13
Total	$224.13

c. Describe the parameters that have the greatest sensitivity to cost (e.g., manufacturing efficiencies, material cost, material lifetime, etc.). For each parameter you identify, tell us what the current value is, and what value you are assuming for your NOAK commercial-scale TEA. If this includes parameters you already identified in 1(c), please repeat them here (if applicable). Broadly, what would need to be true for your approach to achieve a cost of $100/tonne?

Parameter with high impact on cost	Current value (units)	Value assumed in NOAK TEA (units)	Why is it feasible to reach the NOAK value?
Composition materials COGS	>$120	<$72	COGS at scale, as well as grinding & blending cost for materials at scale.

[2] This and the following line item is not included in the TEA spreadsheet because we want to consider MRV and registry costs separately from traditional capex and opex.

Grinding & Blending materials	>$66	<$15	At scale or with our own ball mill the cost will reduce to at or below Value assumed in NOAK. This cost could also be assumed by the cement or concrete plant with our licensing model.
Transport costs	>$24	<$12	At scale and through licensing this cost can be reduced or fully mitigated by identifying multiple starting materials for CaptureCrete. Reduced with close proximity fulfillment facilities, or can change transport on the customer purchasing CaptureCrete for use.

d. What aspects of your cost analysis are you least confident in?

<100 words:

COGS of the different materials in CaptureCrete's composition as price fluctuations, cost by region, and availability in all major global markets can be inconsistent.

e. How do the CDR costs calculated in the TEA spreadsheet compare with your own models? If there are large differences, please describe why that might be (e.g., you're assuming different learning rates, different multipliers to get from Bare Erected Cost to Total Overnight Cost, favorable contract terms, etc.).

<200 words:

The calculated CDR costs with our model compared to the TEA vary as a result of additional O&M expenses, as well as COGS & processing/enhancement projections at scale.

f. What is one thing that doesn't exist today that would make it easier for you to commercialize your technology? (e.g., improved sensing technologies, increased access to X, etc.)

<50 words:

AI/ML to optimize the concrete design mix and water content to allow for optimizing the carbonation process in all different environments, RH, and average temperature ranges when project/deployment will take place.

6. Public Engagement

In alignment with Frontier's Safety & Legality criteria, Frontier requires projects to consider and address potential social, political, and ecosystem risks associated with their deployments. Projects with effective public engagement tend to:

- Identify key stakeholders in the area they'll be deploying
- Have mechanisms in place to engage and gather opinions from those stakeholders, take those opinions seriously, and develop active partnerships, iterating the project as necessary

The following questions help us gain an understanding of your public engagement strategy and how your project is working to follow best practices for responsible CDR project development. We recognize that, for early projects, this work may be quite nascent, but we are looking to understand your early approach.

a. Who have you identified as relevant external stakeholders, where are they located, and what process did you use to identify them? Please include discussion of the communities potentially engaging in or impacted by your project's deployment.

<300 words:

External stakeholders include directors of procurement for the DOT, DOD, and other agencies, as well as directors of quality & R&D for cement, concrete, and admixture manufacturers. We have active conversations with public works & engineering departments in municipalities, and heads of built environment with large corporations. Stakeholders have been identified through meetings, conferences, collaborations with universities, among other means and we will continue with this effort over the coming years.

b. If applicable, how have you engaged with these stakeholders and communities? Has this work been performed in-house, with external consultants, or with independent advisors? If you do have any reports on public engagement that your team has prepared, please provide. *See Project Vesta's community engagement and governance approach as an example and Arnestein's Ladder of Citizen Participation for a framework on community input.*

<300 words:

Engagement with stakeholders has been performed in-house by identifying and interviewing key stakeholders and decision makers within the Army, DOTs, cement and concrete companies, as well as municipal and corporate end users. We have also had discussions with stakeholders and collaborating universities for scaling and R&D. (Enter link to reports)

c. If applicable, what have you learned from these engagements? What modifications have you already made to your project based on this feedback, if any?

<100 words:

We have learned by making our product similar in particle size to Portland cement that it is easier for the cement and concrete manufacturers to adopt and use based on their standard procedures and operational processes. Additionally, we are evaluating how it would be possible to sell under ASTM C618 and other specs until any new ASTM standards that our project product will classify under are passed to gain further adoption and confidence for project use in the US and internationally.

d. Going forward, do you have changes to your processes for (a) and (b) planned that you have not yet implemented? How do you envision your public engagement strategy at the megaton or gigaton scale?

<100 words:

One potential change is the transformation of the CaptureCrete material into a liquid admixture, which will reduce cost and increase usage in greater concrete volumes. Currently, strategies will be at the megaton scale.

7. Environmental Justice[3]

As a part of Frontier's Safety & Legality criteria, Frontier seeks projects that proactively integrate environmental and social justice considerations into their deployment strategy and decision-making on an ongoing basis.

a. What are the potential environmental justice considerations, if any, that you have identified associated with your project? Who are the key stakeholders? Consider supply chain impacts, worker compensation and safety, plant siting, distribution of impacts, restorative justice/activities, job creation in marginalized communities, etc.

<200 words:

As deployment of CaptureCrete concrete will typically be in and around dense built environment locations, larger cities, and roadways (unlike many other DAC projects that are in open rural areas) there is overlay with CaptureCrete project locations and lower income areas. These roadways and dense city locations have higher CO2 concentrations from transport and industrial CO2 emission activities. When CaptureCrete concrete is deployed in environments with higher levels of CO2, it will increase the rate and efficiency of CO2 carbonation into the concrete and ultimately improve quality of living in these areas.

b. How do you intend to address any identified environmental justice concerns and / or take advantage of opportunities for positive impact?

<300 words:

Carbon Limit will use the environmental justice concerns as an opportunity to boost adoption with municipal and federal projects that have requirements including social and environmental justice. Additionally, we will use PR and marketing to convey that project owners are satisfying social and environmental justice in their communities to gain additional exposure and adoption rates with CaptureCrete. We and our partners also aim to engage with schools and universities to provide education regarding carbon and carbon capture for students, thus helping develop the next-generation of workforce to fight climate change. When applying to specific calls, as example, the DOE, we will work together with project partners to make sure that environmental justice and inclusion of underserved communities are achieved throughout the project, in line with the US Justice40 Initiative.

[3] For helpful content regarding environmental justice and CDR, please see these resources: C180 and XPRIZE's Environmental Justice Reading Materials, AirMiners Environmental and Social Justice Resource Repository, and the Foundation for Climate Restoration's Resource Database

8. Legal and Regulatory Compliance

a. What legal opinions, if any, have you received regarding deployment of your solution?

<100 words:

As deployment of CaptureCrete relies more on required specs and performance of the concrete, the decision to use it is in the hands of the project owner/stakeholders. As long as specs and performance criteria are met, no legal issues are anticipated.

b. What permits or other forms of formal permission do you require, if any, to engage in the research or deployment of your project? What else might be required in the future as you scale? Please clearly differentiate between what you have already obtained, what you are currently in the process of obtaining, and what you know you'll need to obtain in the future but have not yet begun the process to do so.

<100 words:

Permits are not required. CaptureCrete products must meet ASTM specs (C618 as example) and the concrete must satisfy performance requirements (for strength as example). As long as these are satisfied, scalability depends not on permits but on identifying material sources, and fully understanding the CDR based on various variables.

c. Is your solution potentially subject to regulation under any international legal regimes? If yes, please specify. Have you engaged with these regimes to date?

<100 words:

Initial conversations with the City of Helsinki in Finland has identified that since CaptureCrete is an SCM that it required no CE certification for deployment in projects in Finland. In most other locations, a preliminary search suggests that the material would be accepted as an SCM for most specs.

d. In what areas are you uncertain about the legal or regulatory frameworks you'll need to comply with? This could include anything from local governance to international treaties. For some types of projects, we recognize that clear regulatory guidance may not yet exist.

<100 words:

The majority of decision for adoption and integration of CaptureCrete ultimately falls on the cement and concrete manufacturers as using CaptureCrete changes the standard concrete design mixes which also affects the contractors when it comes to taking responsibility for new concrete mixture designs with a new SCM material.

e. Do you intend to receive any tax credits during the proposed delivery window for Frontier's purchase? If so, please explain how you will avoid double counting.

<50 words: We currently do not anticipate receiving any tax credits during the proposed delivery window for Frontier's purchase.

9. Offer to Frontier

This table constitutes your **offer to Frontier**, and will form the basis of contract discussions if you are selected for purchase.

Proposed CDR over the project lifetime (tonnes) *(should be net volume after taking into account the uncertainty discount proposed in 4(c))*	10,000
Delivery window *(at what point should Frontier consider your contract complete? Should match 1(f))*	by June 30, 2024
Levelized Price ($/metric tonne CO_2) *(This is the price per tonne of your offer to us for the tonnage described above)*	$224.13

Application Supplement: DAC

(Only fill out this supplement if it applies to you)

Note: these questions are with regards only to air capture: e.g. your air contactors, sorbents or solvents, etc. Separately, there exist Geologic Injection and CO_2 Utilization supplements. We anticipate that most companies filling out this DAC supplement should ALSO fill out one of those supplements to describe their use of the CO_2 stream that's an output of the capture system detailed here.

Physical Footprint

1. What is the physical land footprint of this project, and how do you anticipate this will change over the next few years? This should include your entire physical footprint, i.e., how much land is not available for other use because your project exists. Also, what is the estimated footprint if this approach was removing 100 million tons of CO_2 per year?

Land footprint of this project (km^2)	0
Land footprint of this tech if scaled to 100 million tons of CO_2 removed per year (km^2)	0, because additional usage of land is not needed for this technology. CaptureCrete integrated into concrete that is deployed into planned development projects requiring concrete, redevelopment projects, infrastructure projects, roadways, bridges, and pre-cast concrete that is also a tangible project required for use.

Capture Materials and Processes

1. What material(s) is/are you using to remove CO_2?

<50 words: CO2 selective and reactive mafic and ultramafic lithology minerals as well as an enhanced metal oxide catalyst that enhances the concrete's ability to sequester and mineralize atmospheric CO2.

2. How do you source your material(s)? Discuss how this sourcing strategy might change as your solution scales. Note any externalities associated with the sourcing or manufacture of it (e.g., hazardous wastes, mining, etc.). You should have already included the associated carbon intensities in your LCA in Section 3.

<300 words: As locally as possible within 100-200 miles from the end customers (with the exception of the metal oxide as the sourcing radius is able to be larger, as it only represents 1% of the composition of CaptureCrete). Low impact mining is used to extract the materials, and then a ball mill is used to grind down and resize the particle size of the materials to between 5 to 40 microns. As CaptureCrete is only around 3% of the materials in concrete in order to reach the gigaton scale (9,000,000,000 tons of

concrete with 3% of CaptureCrete per ton) it is estimated that approximately 270,000,000 tons of raw materials will be required. Currently Carbon Limit is sourcing from 9 mines that all have millions to hundreds of millions of tons of the required CaptureCrete materials in reserve.

3. How much energy is required for your process to remove 1 net tonne of CO_2 right now (in GJ/tonne)? Break that down into thermal and electrical energy, if applicable. What energy intensity are you assuming for your NOAK TEA?

<100 words:

The process for CaptureCrete to remove 1 net tonne of CO2 actually requires less energy than industry standard OPC & PLC concrete production would typically require, since the CaptureCrete materials are mines and sources with a similar carbon intensity and do not require calcination, there is an avoidance of up to 27% of the carbon footprint for CaptureCrete concrete production.

For NOAK as we increase the dosage amount of CaptureCrete into concrete manufacturing as well as operational & logistical efficiency the energy requirements and associated carbon footprint will continue to be reduced (by reducing the amount of OPC & PLC production in the concrete design mix, as a result of using a higher dosage of CaptureCrete as a pound for pound cement replacement, there is a net reduction in energy requirement in the calcination process for the reduced amount of limestone to create the OPC & PLC with CaptureCrete).

4. What is your proposed source of energy for this project? What is its assumed carbon intensity? How will this change over the duration of your project? (You should have already included the associated carbon intensities in your LCA in Section 3).

<100 words:

Based on CaptureCrete's current mining & fulfillment partners, transportation, as well as the cement & concrete companies the sources of energy for this project include electricity from the grid around the US, and diesel.

5. Besides energy, what other resources do you require (if any, such as water)? Where and how are you sourcing these resources, and what happens to them after they pass through your system? (You should have already included the associated carbon intensities in your LCA in Section 3).

<100 words:

Water is already required for manufacturing concrete, and CaptureCrete could slightly increase water demand between 1% to 10% depending on the concrete design mix, which could be mitigated with a superplasticizer in the concrete design mix.

6. Do you have experimental data describing how your system's CDR performance changes over time? If so, please include that data here and specify whether it's based on the number of cycles or calendar life.

<100 words: CDR performance in CaptureCrete concrete is affected by differences in relative humidity RH and precipitation levels where the concrete is deployed. Lower RH and precipitation levels reduce the rate of carbonation in the concrete. The kinetics of CDR and dependance on various variables is currently being investigated.

7. What happens to your capture medium at end-of-life? Please note if it is hazardous or requires some special disposal, and how you ensure end-of-life safety.

<100 words: CaptureCrete concrete at the end of its service life has a secondary life with additional CDR capacity, that can have the same efficacy as its first service life because the concrete is ground down and used as recycled concrete aggregate (RCA) after its first service life.

8. Several direct air technologies are currently being deployed around the world. Why does your DAC technology have a better chance to scale and reach low cost than the state of the art?

<200 words: Because concrete is the second most used material on the planet, it allows for easy adoption and integration of CaptureCrete globally by simply adding CaptureCrete at the point of concrete manufacturing (as a cement replacement, but other options, such as liquid admixtures are being researched). Additionally, CaptureCrete does require an additional equipment, processing outside of common concrete manufacturing processing, or third party CO2 feedstock to function as a CCU solution in concrete, unlike other recarbonization/carbonation solutions on the market. It is also compatible with other solutions and the additional Capex required is minimal. The global cement and concrete associations commitments in October 2021 to reach Net Zero by 2050 and reduce 25% of carbon footprint of concrete by 2030 creates a huge opportunity for deployment ready solutions like CaptureCrete to gain mass market adoption, reach global scale, and achieve gigaton CDR scale.

Application Supplement: Surface Mineralization and/or Enhanced Weathering

(Only fill out this supplement if it applies to you)

Source Material and Physical Footprint

1. What source material are you using, and how do you procure it?

<100 words: We are using CO2 selective and reactive mafic and ultramafic lithology minerals that we are procuring via low impact mining from one of our mining partners that would be closest to the end customer.

2. Describe the ecological impacts of obtaining your source material. Is there an existing industry that co-produces the minerals required?

<100 words: Currently these minerals are already being mined for other commercial purposes/applications some with different sizing requirements from what CaptureCrete requires.

3. Do you process that source mineral in any way (e.g., grinding to increase surface area)? What inputs does this processing require (e.g. water, energy)? You should have already included their associated carbon intensities in your LCA in Section 3.

<200 words: The materials need to be ground/milled down with a ball mill to a particle size <100 microns (surface areas and particle size similar to cement) to increase surface area.

4. Please fill out the table below regarding your project's physical footprint. If you don't know (e.g. you procure your source material from a mining company who doesn't communicate their physical footprint), indicate that in the table below.

	Land area (km^2) in 2021	Competing/existing project area use (if applicable)
Source material mining	Sources from existing mining operations, so no additional increase in land area required	Existing mining locations

Source material processing	For FOAK all material processing is done with suppliers/3rd parties. For NOAK it is possible to have 3 to 6 strategically located grinding/milling/blending facilities that would require in total <1 km2. Through a licensing model the grinding/milling/blending is likely to be done by the licensees (cement & concrete manufactures) as they typically already have the required equipment and already perform such operations.	
Deployment	Does not require any additional physical footprint above and beyond the required footprint for the already planned concrete built environment project.	

5. How much CDR is feasible globally per year using this approach? Please include a reference to support this potential capacity.

> <100 words: The CDR based on experiments and calculations is 0.06 - 0.1 ton/ton concrete. It is generally agreed that concrete production is ~ 20 billion tons/year. If all concrete produced worldwide uses CaptureCrete, this will result in CDR ~ 1.6 billion tons/year.

6. If you weren't proceeding with this project, what's the alternative use(s) of your source material? What factors would determine this outcome?

> <50 words: Concrete has global applications for roadways, buildings, bridges, infrastructure, wells, stucco, and any pre-cast concrete product. The mined products can be used as feedstock for cement, concrete, and other related industries.

Human and Ecosystem Impacts, Toxicity Risk

7. What are the estimated environmental release rates of heavy metals (e.g. Cr, Ni, Pb, Hg)? Dust aerosol hazards? P loading to streams? How will this be monitored?

> <100 words: N/A for post-cure concrete made with CaptureCrete.

8. If minerals are deployed on croplands, what are the estimated effects on crop yields? Include citations to support this claim. How will actual effects be monitored?

<100 words: N/A

9. How will you monitor potential impacts on organisms in your deployment environment? (e.g. health of humans working in agricultural contexts, health of intertidal species, etc.)

<100 words: Impacts would be the same as any other concrete deployments and are not affected by use of CaptureCrete.

Application Supplement: CO_2 Utilization

(Only fill out this supplement if it applies to you)

CO_2 Feedstock

1. How do you source your CO_2, and from whom? If your approach includes CO_2 capture and it's described above (e.g., general application and one of the supplements), simply respond N/A here.

<200 words: CaptureCrete concrete sequesters atmospheric CO2 directly from the air into the concrete post-cure/post deployment into the environment.

2. What are alternate uses for this CO_2 stream?

<100 words: Not applicable for CaptureCrete (would remain in the atmosphere).

Utilization Methods

3. How does your solution use and permanently store CO_2? What is the gross CO_2 utilization rate? *(E.g. CO_2 is mineralized in Material at a rate of X tCO_2 (gross) / t storage material).*

<100 words: CaptureCrete concrete utilizes ingressed CO2 that is transformed into a solid carbonate in the concrete to increase the concrete's compressive strength, as well as help micro-cracks that form in the concrete over time. A majority of the CO2 is modeled to mineralize at a rate of 0.06 to 0.1 tCO2 per ton of CaptureCrete concrete post-cure/deployment within the first 48 to 72 months.

4. What happens to the storage material (e.g. concrete) at the end of its service life, and how does that impact its embodied carbon storage over time? How do you know?

<100 words: CaptureCrete concrete can be utilized as recycled concrete aggregate (RCA) after its first service life, where additional adsorption surface area is exposed after the CaptureCrete concrete is ground down for use in concrete production as an RCA. Additional CO2 is adsorbed and carbonized into the concrete on the second service life. Unless the concrete is incinerated (which is an uncommon disposal method), the CO2 will not be released.

5. How do you ensure that the carbon benefits you are claiming through a CO_2 utilization process are not double counted? *(E.g. If sourcing CO_2 from a DAC system, or selling your product to a user interested in reducing their carbon footprint, who claims the CDR benefits and how could an independent auditor validate no double counting?)*

<200 words: Based on current commercialization methods only atmospheric CO_2 is adsorbed and mineralized into CaptureCrete concrete, so there is no additional party claiming or sourcing this atmospheric CO_2 source.