Carbon Removal Purchase Application

General Application

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

Company or organization name

Mission Zero Technologies Ltd

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

London, United Kingdom

Name of person filling out this application

Nicholas Chadwick

Email address of person filling out this application

info@missionzero.tech

Brief company or organization description

Efficient & Modular Direct Air Capture for <$100/t to save the world.

1. Overall CDR solution (All criteria)

a. Provide a technical explanation of the proposed project, including as much specificity regarding location(s), scale, timeline, and participants as possible. Feel free to include figures. (1500 Words)

Mission Zero's breakthrough Direct Air Capture (DAC) approach reduces energy consumption 3–5x compared with incumbent techs, and it is ultracompact, modular, and cost effective at just 1000 t/y scale (see comparison chart at the end of this document). Our sorbent is cheap, scalable, and fast-acting. Altogether this allows Mission Zero to capture CO_2 directly from the atmosphere at $100/t in the near-term assuming an electricity price of $0.05/kWh. Because we don't use thermal energy, the system can easily be powered with 100% renewable electricity. In the future at larger scales, with further system optimization, and if powered by ultracheap renewables ($0.015/kWh), $50/t$CO_2$ is achievable within the decade. Mission Zero's has the lowest carbon footprint of all DAC technologies currently deployed.

For comparison, traditional DAC processes using temperature-swing regeneration incur significant additional emissions of up to 50 kgCO_2e/tCO_2 captured due to natural gas combustion, resulting in a poor emissions/removal ratio for these processes. To illustrate this, Stripe's most recent DAC purchase with Climeworks had an emissions/removal ratio of 0.1; ours is 0.02. These processes are designed in a fundamentally limited manner and are constrained by the energy required to regenerate CO_2 from their capture medium, wasting a minimum of $140/t in addition to the aforementioned high carbon intensity. Furthermore, their sorbents are too slow, which requires oversizing contactors and complex processes which drives up CAPEX.

Mission Zero has developed a proprietary carbon capture solvent which enables efficient capture rates from the atmosphere, surpassing hydroxide-based capture solvents by an order of magnitude, and a separation process which allows for the efficient regeneration of CO_2 at room temperature, driven by renewable electricity using 3-5x less energy than incumbent DAC technologies. Furthermore, the capture solvent is integratable with existing cooling tower infrastructure as well as bespoke air-contacting technologies - thus our technology has the potential for wide proliferation in a distributed and decentralised fashion. Thus our technology addresses all the constraints of traditional DAC technologies.

In the medium-term we are connecting CO_2 users who value-add by generating products that have CO_2 sequestered in them with a commoditised source of atmospheric emissions at commodity prices to realise it as a carbon source for carbon negative products. Specifically, carbon negative building aggregate markets could be worth $550bn by 2040. [1] In these markets CO_2 has value as a commodity and is permanently stored as a carbonate in solid form. This allows the built environment to become a carbon sink and CO_2 cured concrete and aggregates have the potential to store 1-5 GtCO_2/year permanently. [2] All that is required is access to atmospheric emissions in a commoditized form.

Our first project on this roadmap is with O.C.O. Technology in the UK to demonstrate the integration of atmospheric CO_2 emissions with established industrial processes to produce carbon-negative building aggregates through the carbonation of waste fly ashes as shown in Figure 1.

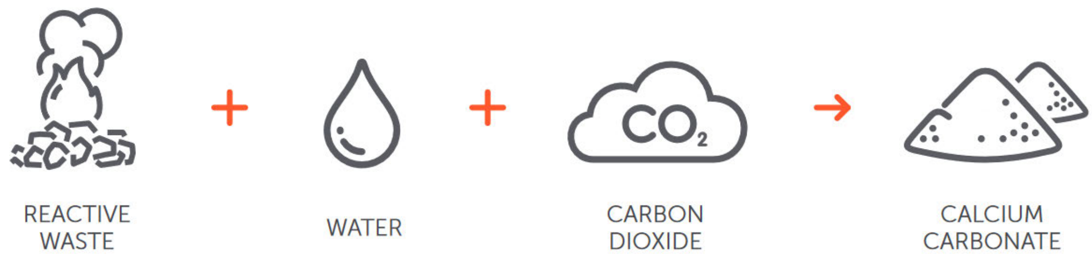


Figure 1: O.C.O. Technology's process to valorize waste concurrently with sequestering CO_2.

Last year O.C.O. produced 310,000 tons of carbonated aggregates. They are one of the largest users of CO_2 in the UK and expanding internationally - having been chosen as one of four companies internationally to be part of Mitsubishi's green concrete consortium.

The current manifestation of this process incorporates commodity CO_2 that is typically generated via fossil fuel combustion and thus only tackles present-day emissions; the ability to integrate historical emissions via scalable and affordable DAC-sourced CO_2 would allow the buildings of tomorrow to be built by sequestering the emissions of yesterday in a world first.

We can thus turn the built environment into a carbon sink, and build homes for people in the process. This pilot which is being offered for Stripe's consideration will be for a 365 t/yr DAC process situated at one of O.C.O.'s UK sites from 2023 onwards; to this end both parties have signed a Technology Evaluation Agreement (TEA) signalling commercial impetus to make this happen. The project will sequester 100% of the CO_2 removed from the air into O.C.O.'s products and is thus eligible to generate carbon credits; these are preferentially being offered to Stripe.

b. What is your role in this project, and who are the other actors that make this a full carbon removal solution? *(E.g. I am a broker. I sell carbon removal that is generated from a partnership between DAC Company and Injection Company. DAC Company owns the plant and produces compressed CO_2. DAC Company pays Injection Company for storage and long-term monitoring.)*

Mission Zero is a DAC company who is a solutions provider partnering with and piloting its proprietary DAC technology with O.C.O. Technology, an established company in the CO_2 to aggregates market. O.C.O. Technology is a leader in advanced carbonation processes to recycle waste materials into value added and carbon negative building aggregates, thereby achieving long-lived CO_2 capture. They sell a Manufactured Limestone (M-LS) product with a lower CO_2 footprint than its substitutes.

c. What are the three most important risks your project faces?

1. Buyers of Carbon Credits for small-scale pilot projects like this are few and far

between, Stripe meets the criteria for the level of capture envisioned in our project and legitimises the voluntary CDR credits a project like this would generate, providing a roadmap and future for projects like this but at larger scales of capture and cheaper credit prices. 2. This project would be the first of a kind (FOAK) for DAC to aggregates which comes with inherent project and financial risks as the outputs (DAC-based aggregates as well as carbon credits) will be brand-new products on the market; having Stripe as a buyer of at least one product would go a long way in mitigating this risk. 3. Earning the credibility to access capital to realise the project - support early on from Stripe would legitimise the overall fundraising efforts needed to realise the project.

d. If any, please link to your patents, pending or granted, that are available publicly.

Our first patent is pending; it was filed on 18th March 2021 in the UK with application number 2103806.2. (It may not yet be viewable publicly)

2. Timeline and Durability (Criteria #4 and Criteria #5)

a. Please fill out the table below.

	Timeline for Offer to Stripe
Project duration *Over what duration will you be actively running your DAC plant, spreading olivine, growing and sinking kelp, etc. to deliver on your offer to Stripe? E.g. Jun 2021 - Jun 2022. The end of this duration determines when Stripe will consider renewing our contract with you based on performance.*	Jun 2023 - May 2024
When does carbon removal occur? *We recognize that some solutions deliver carbon removal during the project duration (e.g. DAC + injection), while others deliver carbon removal gradually after the project duration (e.g. spreading olivine for long-term mineralization). Over what timeframe will carbon removal occur?*	Jun 2023 - May 2024

E.g. Jun 2021 - Jun 2022 OR 500 years.	
Distribution of that carbon removal over time *For the time frame described above, please detail how you anticipate your carbon removal capacity will be distributed. E.g. "50% in year one, 25% each year thereafter" or "Evenly distributed over the whole time frame". We're asking here specifically about the physical carbon removal process here, NOT the "Project duration". Indicate any uncertainties, eg "We anticipate a steady decline in annualized carbon removal from year one into the out-years, but this depends on unknowns re our mineralization kinetics".*	Carbon removal occurs evenly over the timeframe of the project.
Durability *Over what duration you can assure durable carbon storage for this offer (e.g, these rocks, this kelp, this injection site)? E.g. 1000 years.*	Carbonated Building Materials: 1000 years

b. What are the upper and lower bounds on your durability claimed above in table 2(a)?

Lifetimes once landfilled (>1000 yrs) Lifetime as a building material (Up to 200 yrs)

c. Have you measured this durability directly, if so, how? Otherwise, if you're relying on the literature, please cite data that justifies your claim. *(E.g. We rely on findings from Paper_1 and Paper_2 to estimate permanence of mineralization, and here are the reasons why these findings apply to our system. OR We have evidence from this pilot project we ran that biomass sinks to D ocean depth. If biomass reaches these depths, here's what we assume happens based on Paper_1 and Paper_2.)*

The standard lifetime of housing stock, where the M-LS is first incorporated, is a minimum of 60 years. After the building is dismantled the building blocks are either recycled multiple times to make roads or other low grade concrete products. If it is unable to be recycled it is landfilled, returning the stored carbon back to the Earth's crust which ensures capture for >1000 years.

d. 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?

The only risk that may trigger the release of CO_2 is the heating of the resulting M-LS to 900°C to cause degradation of the solid carbonate. Prior to M-LS' integration into concrete production it is unlikely for the material to deliberately be subject to such temperatures. Furthermore the resulting concrete during its operational lifetime or once returned to the earth crust won't be subjected to temperatures high enough to cause degradation. Durability of concrete itself may be affected by a range of factors such as acidification or steel rebar corrosion, but CO_2 release is not anticipated.

The project will have a positive socio-economic benefit as the carbon-negative building materials created are used to make concrete building blocks. To date O.C.O. has facilitated the production of enough building blocks for 8,000 three bedroom houses in the UK. If incorporating atmospheric CO_2 the built environment will also become a carbon sink, providing extra socio-economic benefits by reducing CO_2 and cleaning the air in the local area.

e. How will you quantify the actual permanence/durability of the carbon sequestered by your project? 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.)*

The project integrates with a patented, established and well-understood industrial process scaled from peer-reviewed research for the carbonation of waste fly ash residues. Carbonation rates are monitored closely by our partner O.C.O. Technology for auditing purposes to ensure regulatory compliance within the markets they sell their M-LS to. We should thus be able to comment with a high degree of certainty as to the amount of CO_2 permanently captured during the CDR project. After the M-LS product enters the market place we rely on a combination of auditing of structures made using the concrete blocks and literature reports commenting on the LCA of concrete either recycled or disposed of in landfill.

3. Gross Capacity (Criteria #2)

a. Please fill out the table below. **All tonnage should be described in metric tonnes here and throughout the application.**

	Offer to Stripe (metric tonnes CO_2) over the timeline detailed in the table in 2(a)

Gross carbon removal Do not subtract for embodied/lifecycle emissions or permanence, we will ask you to subtract this later	365 tCO_2 in one year of operation
If applicable, additional avoided emissions e.g. for carbon mineralization in concrete production, removal would be the CO_2 utilized in concrete production and avoided emissions would be the emissions reductions associated with traditional concrete production	7 tCO_2 per year additional emissions avoided by use of produced building aggregate in concrete production

b. Show your work for 2(a). How did you calculate these numbers? If you have significant uncertainties in your capacity, what drives those? *(E.g. This specific species sequesters X tCO_2/t biomass. Each deployment of our solution grows on average Y t biomass. We assume Z% of the biomass is sequestered permanently. We are offering two deployments to Stripe. X*Y*Z*2 = 350 tCO_2 = Gross removal. OR Each tower of our mineralization reactor captures between X and Y tons CO_2/yr, all of which we have the capacity to inject. However, the range between X and Y is large, because we have significant uncertainty in how our reactors will perform under various environmental conditions)*

Our proposed DAC facility will extract 365 tCO_2/yr from the air that will feed directly into O.C.O.'s waste valorization process to produce Manufactured LimeStone (M-LS). Their process sequesters 100% of this CO_2; hence we offer 365 tCO_2/yr gross removal.

When O.C.O.'s M-LS is used as a substitute for limestone in cement and thus concrete production, an additional 2% (7 tCO_2/yr in this case) of traditional emissions are avoided associated with the harvesting and use of natural limestone, as estimated by [Woodall et al., 2019](#).

c. What is your total overall capacity to sequester carbon at this time, e.g. gross tonnes / year / (deployment / plant / acre / etc.)? Here we are talking about your project / technology as a whole, so this number may be larger than the specific capacity offered to Stripe and described above in 3(b). We ask this to understand where your technology currently stands, and to give context for the values you provided in 3(b).

POC R&D Stage DAC Device <1 tCO_2/yr

stripe

d. We are curious about the foundational assumptions or models you use to make projections about your solution's capacity. Please explain how you make these estimates, and whether you have ground-truthed your methods with direct measurement of a real system (e.g. a proof of concept experiment, pilot project, prior deployment, etc.). We welcome citations, numbers, and links to real data! *(E.g. We assume our sorbent has X absorption rate and Y desorption rate. This aligns with [Sorbent_Paper_Citation]. Our pilot plant performance over [Time_Range] confirmed this assumption achieving Z tCO_2 capture with T tons of sorbent.)*

Proof-of-concept work here

e. Documentation: If you have them, please provide links to any other information that may help us understand your project in detail. This could include a project website, third-party documentation, project specific research, data sets, etc.

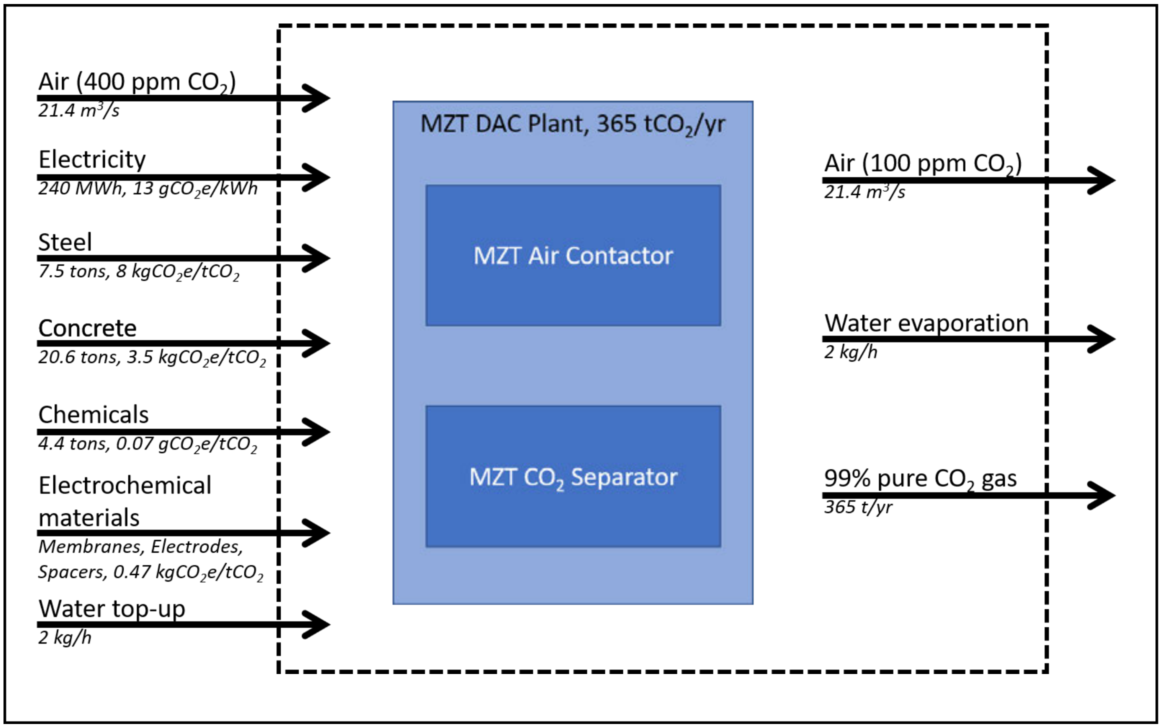
Our partner O.C.O. Technology's brochure is available here to better understand their process.

4. Net Capacity / Life Cycle Analysis (Criteria #6 and Criteria #8)

a. Please fill out the table below to help us understand your system's efficiency, and how much your lifecycle deducts from your gross carbon removal capacity.

	Offer to Stripe (metric tonnes CO_2)
Gross carbon removal	365 tCO_2
Gross project emissions	7.5 tCO_2
Emissions / removal ratio	0.02
Net carbon removal	357.5 tCO_2

b. Provide a carbon balance or "process flow" diagram for your carbon removal solution, visualizing the numbers above in table 4(a). Please include all carbon flows and sources of energy, feedstocks, and emissions, with numbers wherever possible *(E.g. see the generic diagram below from the CDR Primer, Charm's application from last year for a simple example, or CarbonCure's for a more complex example).* If you've had a third-party LCA performed, please link to it.



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

We focus only on the DAC plant here as it is the change in the status quo; our partner O.C.O.'s operations would continue with or without this plant. Doing so also produces a direct basis of comparison with existing DAC plants.

In the cradle-to-grave system boundaries, we account for the embedded emissions in all raw materials and utilities needed for constructing and operating the plant to arrive at an estimation for the gross project emissions.

d. Please justify all numbers used 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.

The numbers provided are the outputs of our internal techno-economic modelling and life-cycle assessment. In places we have direct first-hand data and elsewhere we adapt and scale modelled estimates from peer-reviewed publications as detailed below. All net usage figures pertain specifically to the 365 tCO_2/yr DAC plant.

Air flow: internal modelling; Carbon Engineering TEA paper

Electricity: usage data from TRL4 rig; emissions intensity consolidated across UK Government estimates and Carbon Engineering TEA paper

Steel and Concrete: usage and emissions intensities estimated from Climeworks LCA paper

Chemicals: usage data from TRL4 rig; emissions intensity estimated from Climeworks LCA paper. Further sources were consulted but are not disclosed due to commercial sensitivity. Note that chemicals remain in a closed loop; here one-off masses are quoted and future LCA work will explore chemical lifetimes to update this.

Electrochemical materials: usage corroborated between TRL4 rig and Digdaya et al.; emissions intensity estimated from Tristan et al.

Water consumption: usage data from TRL4 rig.

These result in an emissions footprint of 20.5 $kgCO_2e/tCO_2$ captured. It is planned for a more comprehensive LCA to be undertaken including O.C.O.'s process once detailed plant designs are completed over the next 12 months.

e. If you can't provide sufficient detail above in 4(d), please point us to a third-party independent verification, or tell us what an independent verifier would measure about your process to validate the numbers you've provided. (We may request such an audit be performed.)

N/A

5. Learning Curve and Costs (Backward-looking) (Criteria #2 and #3)

We are interested in understanding the learning curve of different carbon removal technologies (i.e. the relationship between accumulated experience producing or deploying a technology, and technology costs). To this end, we are curious to know how much additional deployment Stripe's procurement of your solution would result in. (There are no right or wrong answers here. If your project is selected we may ask for more information related to this topic so we can better evaluate your progress.)

a. Please define and explain your unit of deployment. (*E.g.* # of plants, # of modules) *(50 words)*

1 x POC device as of 2021, within 6 months of incorporation.

b. How many units have you deployed from the origin of your project up until today? Please fill out the table below, adding rows as needed. Ranges are acceptable if necessary.

Year	Units deployed (#)	Unit cost ($/unit)	Unit gross capacity (tCO_2/unit)	Notes
2021	1	£5000	~ $kgCO_2$/year	Integrated POC of concept device demonstrating energy consumption KPIs included pumps, sensors, flow meters, power supply, fittings, tools.
2020	-	-	-	
2019	-	-	-	*<50 words*
...				

c. Qualitatively, how and why have your deployment costs changed thus far? *(E.g. Our costs have been stable because we're still in the first cycle of deployment, our costs have increased due to an unexpected engineering challenge, our costs are falling because we're innovating next stage designs, or our costs are falling because with larger scale deployment the procurement cost of third party equipment is declining.)*

Our costs have been stable because we are still in the first cycle of deployment; costs will fall with larger scale deployment and innovations in new designs and materials.

d. How many additional units would be deployed if Stripe bought your offer? The two numbers below should multiply to equal the first row in table 3(a).

# of units	Unit gross capacity (tCO_2/unit)
2 additional units	Unit 1: ~ tCO_2/yr/unit Unit 2: 365 tCO_2/yr/unit

6. Cost and Milestones (Forward-looking) (Criteria #2 and #3)

We ask these questions to get a better understanding of your growth trajectory and inflection points, there are no right or wrong answers. If we select you for purchase, we'll expect to work with you to understand your milestones and their verification in more depth.

a. What is your cost per ton CO_2 today?

>$1000/$tCO_2$

b. Help us understand, in broad strokes, what's included vs excluded in the cost in 6(a) above. We don't need a breakdown of each, but rather an understanding of what's "in" versus "out."

Included - cost of device, pumps, consumables and energy Excluded - lifetime of absorbent, materials

c. List and describe **up to three** key upcoming milestones, with the latest no further than Q2 2023, that you'll need to achieve in order to scale up the capacity of your approach.

Milestone #	Milestone description	Why is this milestone important to your ability to scale? (200 words)	Target for achievement (eg Q4 2021)	How could we verify that you've achieved this milestone?
1	~ $kgCO_2$/day Demonstrator & Lab-scale pilot trial with O.C.O.	This is the minimum viable scale in which all off the shelf components of our envisaged pilot system obey linear or well documented scaling laws. It is also the scale required to begin lab trials with our partner O.C.O. This will allow us to refine the results of the FEED study with first-hand data prior to beginning plant construction.	Q1 2022	We can supply first-hand data and video evidence of our demonstrator in operation.
2	FEED study for 365 tCO_2/yr pilot unit and industrial scale pilot trial with O.C.O.	Completing a FEED study is critical for laying out the detailed engineering work delivering the project proposed in this application and	Q2 2022	We can supply data and documentation pertaining to the outcome of the FEED study.

		will bring greater accuracy to our techno-economics and LCA.		
3	Take orders for first commercial scale implementation @ 1000+t/year	It will build out our orderbook to demonstrate to lenders and investors that large-scale demand is there, in order to persuade them to agree to fund us in fulfilling it.	Q2 2023	We can provide proof of pre-purchase agreements for our DAC technology

i. How do these milestones impact the total gross capacity of your system, if at all?

Milestone #	Anticipated total gross capacity prior to achieving milestone (ranges are acceptable)	Anticipated total gross capacity after achieving milestone (ranges are acceptable)	If those numbers are different, why? (100 words)
1	~ $kgCO_2$/yr	~ tCO_2/yr	Completion of scaled ~$kgCO_2$/day demonstrator increases capture rates and hits necessary capture rates for early pilot R&D trials.
2	~ tCO_2/yr	365 tCO_2/yr	Completion of the FEED study will put us in position to begin construction of the proposed plant for this project with 365 tCO_2/yr capacity.
3	365 tCO_2/yr	>1 $ktCO_2$/yr	This represents first commercial scale implementations of the technology to provide CO_2aaS

d. How do these milestones impact your costs, if at all?

Milestone #	Anticipated cost/ton prior to achieving milestone (ranges are acceptable)	Anticipated cost/ton after achieving milestone (ranges are acceptable)	If those numbers are different, why? (100 words)
1	>$1000/t	<$1000/t	The successful operation of the proposed demonstrator will include improved efficiencies in CO_2 contacting and separation and benefit from cost scaling from the previous benchtop setup.
2	<$1000/t	~$275/t	The FEED study will provide more accurate cost estimates at industrial scale for our plant including lower unit costs for materials, electricity, and so on.
3	~$275/t	<$100/t	Pre-purchase agreements with offtakers will provide a roadmap to widespread implementation of our technology at the required scale to deliver sub $100 capture costs.

e. If you could ask one person in the world to do one thing to most enable your project to achieve its ultimate potential, who would you ask and what would you ask them to do?

We'd ask Joe Biden to support the upcoming SCALE act for developing industrial CCS clusters in the US. This is a working model already deployed in the UK and would greatly increase commercial interest and financing opportunities for large-scale DAC facilities that lead directly to sequestration instead of just EOR for the world's largest emitter of CO_2 per capita.

f. Other than purchasing, what could Stripe do to help your project?

We'd love to explore methods of automated auditing of carbon capture leading to sequestration, such as by increasing access through democratisation of carbon credits on a public and immutable blockchain-powered ledger, solving the issue of double counting which plagues current offset markets. As the market for CDR credits is largely voluntary - help in shaping the industry to a point where the government can visualise how the system might work is incredibly important. We'd also love to explore with Stripe how an integrated and streamlined means for payment through Stripe's payment systems would enable Stripe's customers to rapidly access CDR through normal transactions.

7. Public Engagement and Environmental Justice (Criteria #7)

In alignment with Criteria 7, Stripe requires projects to consider and address potential social, political, and ecosystem risks associated with their deployments. Projects with effective public engagement tend to do the following:

- Identify key stakeholders in the area they'll be deploying
- Have some mechanism to engage and gather opinions from those stakeholders and take those opinions seriously, iterating the project as necessary.

The following questions are for us to help us gain an understanding of your public engagement strategy. There are no right or wrong answers, and we recognize that, for early projects, this work may not yet exist or may be quite nascent.

a. Who are your external stakeholders, where are they, and how did you identify them?

Based on our LCA we do not foresee any ecosystem risks of note as our process is designed to minimize waste streams or the use of materials with significant ecological impacts. We recognize that DAC is in general a land-intensive technology and for future scaled deployment we must engage with social and political stakeholders before proliferating. For the purposes of this project we are to integrate into our partner's existing private land and so they are our key stakeholder; we have engaged with them to receive authorization for the project to be carried out as such.

As carbon credit generation is a key aspect to our project, the wider industry as well as members of the public are also stakeholders of interest when considering the credits market - it is envisioned that public engagement to disseminate the new availability of reliable and permanent sequestration credits through our project will be key for drumming up support for future projects and scaling up.

b. If applicable, how have you engaged with these stakeholders? Has this work been performed in-house, with external consultants, or with independent advisors?

At this stage Mission Zero has begun engaging directly with corporate stakeholders and RTOs in-house. Carbon credits input has come from policymakers, independent advisors, and think-tanks in an informal capacity.

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?

One major outcome of these engagements is the recognition of more key corporates following in Stripe's footsteps in seeking out projects that combine CO_2 removal and sequestration with reliability and genuine permanence. While a traditional CO_2 removal technology's route to market would have involved looking to commoditize CO_2 for circularization, this has catapulted us to going straight to a sequestration focus even for our early projects; the sooner we can start having a net emissions reduction impact, the better.

These engagements have also helped us identify the pain points that our technology needs to solve and the KPIs it needs to deliver: a low $/t$CO_2$ competitive with commodity prices, technology viability at various usage scales, and a compact technology footprint able to deliver carbon credits with a high level of surety on carbon capture and lifetime of capture. Distinctions between short term capture and long term capture are being priced into the market - the ramifications of responsibility for re-emission have also been highlighted. Overall the market for CDR is nascent and no codified system is in place - it must be a community-led endeavor to coalesce around standardized systems and metrics for CDR to provide a roadmap for government acceptance, shaping regulations and creating a level playing field.

d. Going forward, do you have changes planned that you have not yet implemented? How do you anticipate that your processes for (a) and (b) will change as you execute on the work described in this application?

Apart from technological innovations, there may be business model changes affecting the future execution of similar projects e.g. licensing our technology to third parties to develop DAC plants on their own.

e. What environmental justice concerns apply to your project, if any? How do you intend to consider or address them?

Traditional CO_2 capture from point sources raises environmental justice concerns as communities most affected by climate change are unable to access or afford them, with value capture often centralised with corporates and present only in more industrialized nations. DAC technology that is decentralized and scalable will, when mature, be accessible and deployable at any location, helping to level the carbon removal playing field and allow communities to mitigate their carbon footprint while industrializing concurrently. This will add to economic prosperity and develop DAC expertise in these communities ahead of other places in the world, future-proofing their workforce and allowing decarbonization technologies to become part of environmentally-positive and responsible industrialization pathways.

11. Legal and Regulatory Compliance (Criteria #7)

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

The system should comply with local and national UK regulations on noise, chemical control and health and safety.

b. What permits or other forms of formal permission do you require, if any? 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.

We are currently unaware of any permits required to implement our solution. We have permission from O.C.O. to work on their site.

c. 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.

The UK does not yet have a specific regulatory framework pertaining to DAC so we will continue to monitor updates on this front. Our partner O.C.O. is fully compliant with relevant frameworks for their aggregates production business.

12. Offer to Stripe

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

	Offer to Stripe
Net carbon removal (metric tonnes CO_2)	Milestone 2: Pilot Trial with O.C.O.: 357.5 tCO_2 in 2023-2024 operating for 12 months
Delivery window (at what point should Stripe consider your contract complete?)	2025 - specific window to be confirmed depending on confirmation mechanism of CO_2 sequestration and/or carbon credit generation.
Price ($/metric tonne CO_2) ***Note on currencies:*** *while we welcome applicants from anywhere in the world, our purchases will be executed exclusively in USD ($). If your prices are typically*	\$275/tCO_2 (£200/tCO_2) - our anticipated unit cost ceiling during operation of the DAC pilot.

denominated in another currency, please convert that to USD and let us know here.	

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 (Criteria #1 and #2)

1. What is the physical land footprint of your 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.

Year	Land Footprint (km^2)
2021	-
2022	0.000002 km^2
2023	0.000044 km^2 Caveat - This is the footprint taken up on an established industrial site for CO_2 to aggregate site. This is an early estimate and we are currently working with an engineering company on detailed design of the plant.

2. What is the volumetric footprint of your contactor? (How big is your physical machine compared to how much you're capturing?) and how do you anticipate this will change over the next few years? These numbers should be smaller than (1) above.

Year	Contactor Footprint (m^3)
2021	0.00005 m^3 (Benchtop POC) for ~ kg/year
2022	2 m^3 (Demonstrator/small-scale pilots) for ~ t/year

2023	60 m^3 (Commercial pilot) for 365 t/year

2. Capture Materials and Processes (Criteria #5, #7, and #8)

1. What sorbent or solvent are you using?

We are using water-soluble sorbents. A range of materials is available to fulfil this requirement, and the exact recipe for our capture solvent is proprietary IP.

2. What is its absorption capacity? *(grams CO_2 per grams material/cycle)*

Depending on the particular material it can range from 0.01 - 0.2 $gCO_2/g_{sorbent}$/hour under process conditions.

3. What is its desorption capacity? *(grams CO_2 per grams material/cycle)*

Depending on the material and operational conditionsl, desorption rates can be from 0.01-0.2 $gCO_2/g_{sorbent}$/hour under process conditions.

4. How do you source your sorbent or solvent? Discuss how this sourcing strategy might change as your solutions scales. Note any externalities associated with the sourcing or manufacture of it (hazardous wastes, mining, etc. You should have already included the associated carbon intensities in your LCA in Section 6)

The sorbent is currently sourced from one of the largest chemical companies in the world; it is not a novelty or highly-specialized/low-volume material so we have confidence in the supply chain when scaling up and supply chain agreements will be fleshed out as the business grows. Its manufacturing process is comparable to that of Climeworks' sorbents and our LCA assumes similar externalities to theirs in its procurement: 0.07 gCO_2e/tCO_2.

5. How do you cycle your sorbent/solvent?

The solvent is pumped continuously in a closed loop system and, after air contacting to capture CO_2, it is continuously regenerated *in situ* in our electrochemical separation process and then circulated back into the air contactor to continue the process.

6. What is your proposed source of energy? 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 6

Utility electricity or renewable electricity; as reflected in our LCA the assumed carbon intensity is 13 gCO_2e/kWh.

7. Besides energy, what other resources do you require in cycling (if any), e.g 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 6) *(100 words)*

The system is a closed loop. There will be some loss of water through prolonged usage but this can easily be replaced.

8. Per (7), how much of these resources do you need per cycle?

Water: The capture solvent is 90-95% water which isn't consumed. At the moment we are using 50 mL of capture solvent to achieve a CO_2 production rate of 0.2 gCO_2/hour. 0.2 gCO_2/hour is equivalent to 1.75 $kgCO_2$/year. Therefore we only require 28.5 mL of solvent for every kg per year capacity.

9. How often do you cycle your sorbent/solvent?

Current experiments have been conducted with a flow rate between 1-10 mL min^{-1}, therefore the solvent is cycled every 5-50 minutes.

10. Does your sorbent or solvent degrade over time? Is degradation driven primarily by cycling, environmental conditions, or both?

We anticipate minimal degradation of our solvent. The carbon capture species eventually degrades over time when cycled from high to low temperatures when used in conventional CO_2 capture processes, but our process has been tested to work effectively at 20-30°C with little to no fluctuation in temperature environment. We anticipate degradation to be of minimal concern.

11. In practical operation, how often do you need to replace your sorbent or solvent material, if at all?

The Climeworks LCA paper assumed that 7.5 grams of sorbent is consumed for every 1 kg of CO_2 capture. However, given the low temperature operation of our process, the sorbent replenishment rate should be drastically lower.

12. Per (11), what happens to your sorbent/solvent at end-of-life? Please note if it is hazardous or requires some special disposal, and how you ensure end-of-life safety.

The carbon capture solvent waste can either be chemically disposed of via traditional routes of incineration or they can be anaerobically digested if at low concentration which produces nitrogen enriched end-products that could be used to fertilise soil.

13. Several direct air technologies are currently being deployed around the world (e.g. Climeworks, which Stripe purchased from in 2020). Please discuss the merits and advantages of your system in comparison to existing systems.

Company	Technology/ Approach	Energy Consumption (kWh/tCO_2)	Temperature conditions for regeneration	Batch vs. Continuous	Constraints	Minimum scale for sub-$100/t capture	Capture Costs
Carbon Engineering	Hydroxide: Temp swing	1750 - 2000	850°C	Batch	Natural gas, cheap electricity. 0.5t of CO_2 emissions produced for every 1t captured from atmosphere	1,000,000 t/yr (assuming access to 45Q tax credit)	$232/t (current)
Climeworks	Solid Sorbent Amine: Temp & Moisture Swing	1750 - 2000	100°C	Batch	Steam/waste heat	Unreported	$750/t (current)
Global Thermostat	Solid Sorbent Amine: Temp & Moisture Swing	1500 - 1750	75 - 85°C	Batch	Steam/waste heat	100,000 t/yr (assuming access to 45Q tax credit)	~$200/t (current)
Mechanical Trees/ Silicon Kingdom Holdings	Solid Sorbent Amine: Vacuum Swing	630	Room temp (moisture swing)	Batch	Large areas of land required; natural wind	10,000 - 1,000,000+ t/yr (assuming access to 45Q tax credit)	~$100/t (projected)
Verdox	Electrochemical: Solid state CO_2 adsorption/ desorption	Up to 568 with 2 caveats: 1. 6000 ppm CO_2 inlet - 15x higher conc. than air 2. air contacting not considered	Room temp (electrochemical dissociation)	Batch	Renewable electricity. Specialised electrode. Immature production capability	Unreported	$50-100/t (projected)
Noya	Temp Swing - further details unreported	Unreported	Waste heat, if temp swing 80°C (predicted)	Continuous	Access to existing industrial cooling tower infrastructure, waste heat.	Unreported	~$100/t (projected)
Mission Zero Technologies (MZT)	*Electrochemical Separation*	*400 - 650*	*Room temp (electrochemical separation)*	*Continuous*	*Access to utility or renewable electricity*	*500 t/yr (subsidy-free)*	*$50 - $100/t depending on scale. (projected)*