[Praan] Carbon Removal Purchase Application

General Application

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

Company or organization name

Praan, Inc

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

San Francisco, California and Mumbai, India

Name of person filling out this application

Angad Daryani

Email address of person filling out this application

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Brief company or organization description

Capturing particulates and CO_2 from ambient air for micro-climate and macro-climate impact at costs <$100/tonne to make the future more hopeful and exciting.

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.

Praan's Direct Air Capture technology for CO2 is a derivation of our low cost, energy efficient, filter-less outdoor air purification system for particulate matter capture. This allows Praan to draw in ambient air at 65% less energy consumption, and use raw materials for the entire system at costs 0.3x to 0.5x of the US and EU.

Praan's DAC system is designed to be low-cost, modular, scalable, easily replicable, and easy to manufacture. Further, complete end to end use of all sorbent and CO2 ensures true-negative CO2 capture. While Praan relies on the use of fast-acting, longer-lifespan, solid amine based sorbents, we have carefully worked on ensuring that no toxic elements are released back into the atmosphere, and the exhausted amine-based sorbent bed is reused for secondary applications. Further, while almost all other amine based sorbents require expensive Silica-based links such as SBA-15 or fluidised beds, we have experimented with and demonstrated the same capture abilities with significantly inexpensive materials. While the costs at retail for our early experiments are closer to $3000/tonne of CO2, planned improvements in supply chain, sorbent performance, and scale have shown us a path to under $130/tonne of CO2 in under 5 years (as we get to over ten 1 tonne/day capture plants).

Even though our sorbent uses temperature swing for desorption, we do not rely on the use of high temperature steam for the same. We have been able to desorb CO2 from our sorbent at temperature of 85-110C and by reducing the depth of the sorbent bed, we are able to heat our bed with lower energy and higher rates - similar to that of a 3D printer heated bed. We've also been able to demonstrate our adsorption at room temperature of 27-30C. Carbon Engineering uses a hydroxide solution to capture the CO2, which requires a temperature of 1000˚C for desorption, 10x ours. Our energy requirement is comparable to Climeworks, however Climeworks has a capture efficiency of 1.41 mmol of CO2 per gram of sorbent whereas our sorbent has a capture efficiency of 1.71mmol of CO2 per gram or sorbent.

Since our entire system is low energy, it can constantly and entirely be run on renewable energy - Praan's internal investor and mentor network consists of several solar energy giants which we hope to tap into for our deployments.

Most DAC systems today are not weather and environment proof - they are deployed in clean air zones such as those in Switzerland and Iceland. This limits the scalability of the plant as they need unique spaces to capture and store CO2. They also need renewable geothermal energy to power their operations, which is not available as commonly. Placing any of those capture facilities in standard city/suburban environments would significantly affect their performance and sorbent lifespan due to the reactive pollutants, particulates, changing ambient temperature, and other factors. Praan's experience building filter-less, weatherproof, self-enhancing, outdoor particulate matter capture systems is helping boost the construction of a weather proof, self-enhancing, outdoor, Direct-Air CO2 capture system.

Praan built and tested its earliest CO2 capture sorbents at the Tata Institute of Fundamental Research (https://www.tifr.res.in/) in Mumbai, India. We rely on our sorbent raw material sourcing (and in future manufacturing) on our investors Laxmi Organic Industries Ltd (https://www.laxmi.com/) & Maharashtra Aldehydes and Chemicals Ltd (https://macl.co.in/). Additionally, we are associated with Chembond Chemicals Ltd (https://www.chembondindia.com/) who have supported our early low-cost sourcing of chemicals for our sorbent.

Praan has also partnered with Carbon Craft Design (https://www.carboncraftdesign.com/) to recycle all captured particulates which will be used as raw materials for these tiles. Further, all captured CO2 from the ambient air will be used to expedite the tile curing process from 28 days to 8 hours - access to these tiles will aid real estate projects to attain green building certification and as a result gain tax benefits while complying with ESG norms. .

Our first 1 tonne/day capture facility will be built and tested right outside Mumbai City in India. Our second 1 tonne/day capture facility will be placed close to our larger CO2 capture customer based in the United States or Europe. We plan to stick to our delivery dates and timelines irrespective of the country.

Praan is also currently evaluating the use of 100% recycled and anodized aluminum for the construction of our capture plant. Should this become financially feasible at scale, we would be able to build our ~500 sqft capture on top of flat building terraces (Very common in >50% of the world's cities), allowing for the deployment of a large number of DAC systems without the requirement of new land.

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.)*

We are the deeptech company building the core-capture technology and process system to capture and store the CO2 from Ambient Air. We are currently working with companies in our network & investor pool to source and develop raw materials (chemicals) for our sorbents, and large process engineering companies to manufacture the parts needed for our capture plant - many of these vendors are shared with our Direct Air capture System for Particulate Matter.

We work with third party companies such as Carbon Craft Design to reutilize the captured particulates (and now CO2) for use in the formation and curing of flooring tiles and bricks, allowing for long term storage of CO2.

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

1. Limited buyers for Direct-Air-Capture CO2 outside of Stripe, Microsoft, Shopify which may prevent revenue growth rate, hindering the business from being late-stage (post Seed round) venture investable. Having stripe as a buyer today, and in the future would help mitigate some of this risk.

2. To meet our internal goal of <$100/tonne of CO2, we must improve the source and manufacturing processes for the raw materials used in our sorbent and ensure zero-toxicity at scale (something we are actively working on). Much of this has not been done before and is unchartered territory for the DAC application. We are actively working alongside professors from top tier research institutions, along with hiring exceptional talent (As shared with Ryan Orbuch on call) to help add order to this uncertainty.

3. Today, we are using our very limited resources from our Pre-seed round (funded by Social Impact Capital, Better Capital, and other angel investors) for particulate matter capture and sharing some of them into our DAC project which has also made good progress. In order to accelerate this progress and meet the promised timelines, we must hire quickly and set up a lab quickly on the US-Side. In order to do this, accessing the right kind of venture capital would be very helpful. Stripe's purchase of our system would go a long way in adding legitimacy to our efforts in DAC of CO2, and help us raise that financing on the US side.

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

We have applied for a utility patent for our core-technology in filterless particulate removal under the patent ID US16833205. This was applied for in March 2020 (may not be reflected on the US-PTO website yet).

Praan is currently drafting additional patents for outdoor pollutant flow, DAC Sorbent, and Praan's DAC Device.

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.*	January 2023 - January 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*	January 2023 - January 2024

mineralization). Over what timeframe will carbon removal occur? *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 throughout the duration of the project (Everyday)
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.*	Current tiles: 50+ years Future Building Materials: 1000yrs

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

Carbon Tiles when used as flooring: 50+ years Carbon Tiles when reach landfill: 150-200 years Building Materials cured using CO2 (while in use): 100-200 years Building Materials cured using CO2 (once disposed): 1000+ years **Note:** Praan does not build these materials internally. It is currently done by a company called Carbon Craft Design, and in future as Praan scales, the CO2 will be shared with other companies in material science looking to develop raw materials for green buildings or public streets.

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.)*

We are currently relying on knowledge derived from the Carbon Craft Design team about the lifespan of their product which is promised to be a minimum of 50 years. The tiles themselves are made from Recycled Carbon Black (or other particulates captured from ambient air) along with other materials such as marble chips, glue, etc.

Using CO_2 to cure the tiles significantly shortens the curing process from 28 days days to 8 hours. Further, it improves the structural strength and lifespan of the flooring tiles. As Carbon Craft Design scales, it would need to cure its tiles faster and as a result need more CO_2 for the process. As per the Carbon Craft Design team, broken tiles can be repurposed to make new tiles, multiplying the captured CO_2 lifespan.

1 carbon tile uses particulate matter worth 15 minutes of air pollution from a car tailpipe and prevents emission of 5kGCO2e through the reuse of these particulates. Additionally CO_2 is also used to cure the tiles (number not shared with Praan).

Similarly, Building blocks have a typical lifespan of 70-100 years and are usually recycled to serve as raw materials for low-grade applications such as roads, hence adding multiplicity to it's the CO_2 storage lifespan as well. Lastly, if for whatever reason the tiles or building blocks are landfill, they return to the earth's crust allowing storage 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?

No immediate physical risk reported to us. The CO_2 reacts with moisture and calcium in the tile formation process to make stable Calcium Carbonate as a permanent fixture. Significant source heating is required to manually decompose the reacted $CaCO_3$ into CaO and CO_2.

A pressurised chamber is used to cure the tiles. As far as the rate of introduction and adsorption of CO_2 into the tiles is taken into consideration, the solution should be fail-safe.

There is a significant socio-economic advantage of using these carbon tiles
(1) They look great (https://www.carboncraftdesign.com/)
(2) They aid architecture firms and real estate developers to attain green building certification
(3) They store away air pollution and CO_2 for decades
(4) They are a great economic opportunity with growing demand globally (As reported by Carbon Craft Design)
(5) They help companies comply with ESG norms
(6) They prevent particulate matter pollution from going back into the atmosphere

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.)*

Praan shares a strong working relationship with Carbon Craft Design and will also be supporting them in the design and development of their new pressurised tile curing system. Through this we will install flow rate sensors as well as ambient CO2 measurement sensors inside the curing chamber. This will also allow us to accurately measure the rate at which CO2 is being absorbed by the tiles, and ensure that the exact amount of required CO2 is pushed into the curing chamber, preventing waste-age and leaks of direct air capture CO2.

Praan and Carbon Craft Design will carry out extensive stress testing for the decomposition of the CO2 cured tiles to understand edge case conditions (Temperature & Pressure) under which CO2 is emitted from the tiles, if any at all. Both chemical indicators as well as high-resolution CO2 sensors will be used in these edge case tests.

Carbon Craft Design is expected to generate and publicly publish lifespan information on their tiles in mid 2022 as they begin large scale sales for their product. They are currently using the 28 day curing process and have demonstrated curing time reduction to 8 hours using commercially available CO2 (not captured CO2). We will rely on them to publish durability and permanence information as it is their core business.

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 tonnes of CO2 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	This number to be shared by carbon craft design. Each tile to prevent >5kgCO2e, hence a project which uses >1000 tiles to prevent >5tonnes CO2e. We don't have officially published numbers from carbon craft design yet.

b. Show your work for 3(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)*

Praan's proposed DAC system will extract 365 tonnes of CO2/year from ambient air. Our model assumes 100% of that captured CO2 will be utilised in the curing of the flooring tiles with Carbon Craft Design. As a result, we are suggesting that we will be removing 365 tonnes of CO2/year permanently.

As reported on the Carbon Craft Design website https://www.carboncraftdesign.com/carbontile) an additional 5kgCO2e is reduced in the process of building 1 tile of 200mmx200mm. As a result, a single office flooring which can use between 100 to 10000 tiles can prevent emission of 0.5tCO2e to 50tCO2e.

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).

We do not have a large plant yet. We have demonstrated lab tests showing that our sorbent can capture CO2 from source, from ambient air, with and without moisture. We have also demonstrated that we are easily able to use our sorbent for 50 cycles recurrently and up to 200 cycles with decreased performance. Our current POC device is less than 1 tonne capture capacity per year.

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.)*

Please find all our science, data, calculation, designs, and references here: *https://docs.google.com/document/d/1ZjJ_DAg3XAYlI4nWhnF7xn0KmxPz96lElljN0lkDK-g/edit?usp=sharing*

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.

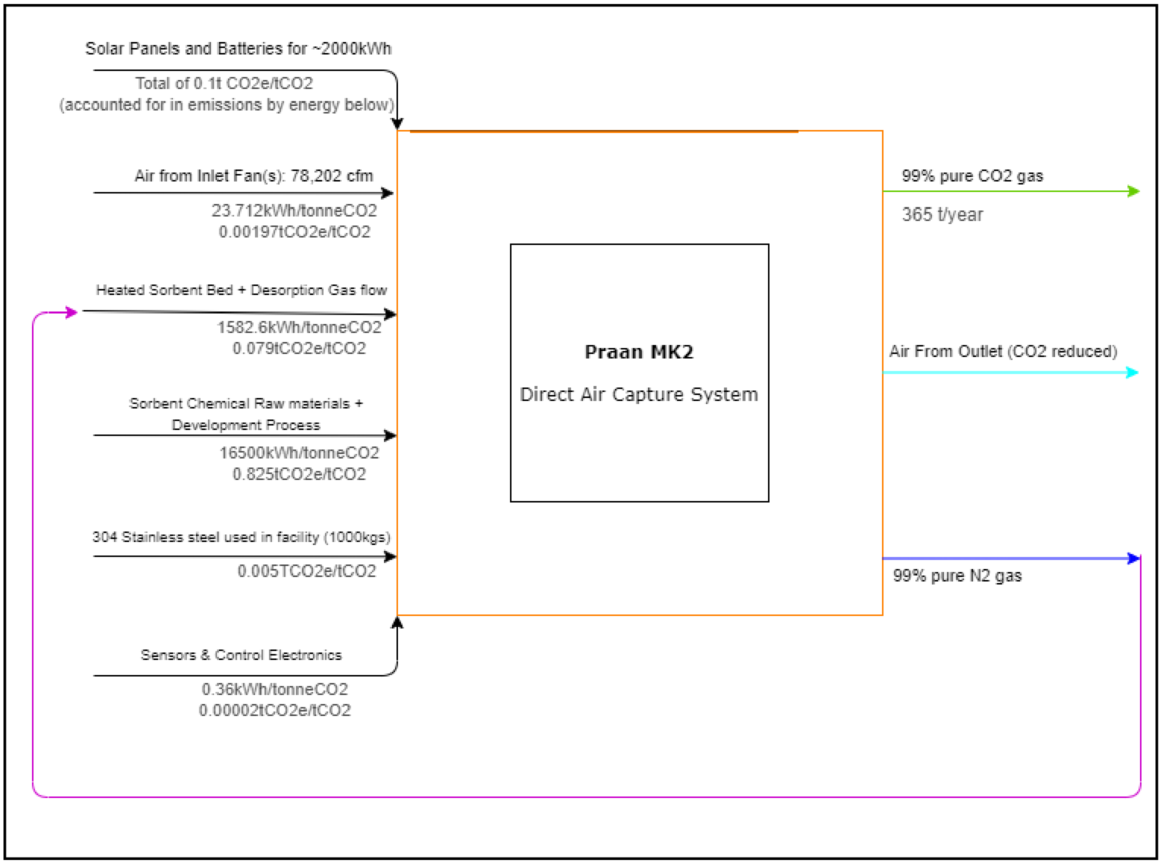
> While Carbon Craft Design has not yet publicly published a paper, we are confident in their abilities and will support all their engineering efforts with our own team (to ensure consistency in permanent carbon storage and durability). Their product and offerings can be explored here: https://www.carboncraftdesign.com/

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 tonnes of CO2/yr
Gross project emissions	3.52 tonnes of CO2 (Carbon emission from solar energy, and one time construction discounted beyond Year 1 since it will run on renewable energy)
Emissions / removal ratio	0.01
Net carbon removal	361.48

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?

Praan is directly responsible for the design, construction, and operation of the DAC facility only. We have not accounted for the processes involved in the development and formation of the Carbon Tiles made by Carbon Craft Design - as the process is their own. We will still hold the company accountable for the numbers committed to us and carry out due diligence in order to ensure that their technology and process is net-negative, i.e. it is run on renewable energy and does entirely store away our captured CO2. We have accounted for the CO2 emitted for all raw materials used in the facility: Stainless Steel, Chemicals, Airflow, Energy used in Air flow, Heating and Desorption. We do not currently have sight on the CO2 emissions to transport the raw materials and finished parts to and from different vendor facilities, since we are exploring multiple options at the moment.

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](#).

Many of the numbers are estimations or from internal techno-economics of each component/part being used.

Stainless Steel: Base requirement is 800kgs + 200kgs for flow chambers. This report states than 1.9T of CO_2 is emitted for 1T of Stainless Steel (https://bellona.org/news/ccs/2019-03-is-steel-stealing-our-future)

Solar Power:
https://gvecsolarservice.com/how-clean-is-the-solar-panel-manufacturing-process-how-much-carbon-dioxide-is-produced/

Fan (Modelled): a 24000cfm fan in our office draws 1.3kW. We would need 3.25 such fans to run our 78202 cfm system for 16 hours (time of adsorption). This would consume 4.235kW of power per hour. Since we use BLDC fans instead of standard fans, the energy consumption is 65% lower, as a result we would draw 0.35*4.235*16 = 23.712kWh of electricity. Since the cost of this energy on solar is 50g/kWh of solar, we would emit 21.577kgs of CO_2 (only in year 1).

Chemicals: This was a very high estimation based on drawing parallels from other chemicals, we will have more clarity as we purchase at scale and are able to work more closely with the manufacturer. We suspect our numbers to be far lower than the ones mentioned - this is absurdly high since true data for the same doesn't currently exist online and we've been too small in purchase size for vendors to feel comfortable sharing with us.

Controller Electronics: These work at 5V 3A and hence draw 15 watts of energy per hour. In a day this would equate to use of 360Wh in 24 hours of use.

We have not yet accounted for the carbon cost for logistics involved in the construction of this facility. We would have clarity on this, and firm numbers for all others within 12 months. These are high estimates for each.

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)*

We have a Single test rig put together in August 2021 with inflow of gas (pure CO2+N2 or Air Pump), moisture trap, HEPA filter, non-return valve, absorbent bed, another HEPA filter, and air outlet. The test rig was built, and successfully demonstrated in <$1000 at the Tata Institute of Fundamental Research in Mumbai under the observation of Dr. Vivek Polshettiwar. Tests were carried out and validated on TGA and GC machines.

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	$1000	~kgCO2/yr	POC demonstrated with inhouse sorbent development, custom test rig, air pumps, CO2 and N2 source gases, temperature sensors, moisture traps, and thermogravimetric analysers for adsorption and desorption rates
2020	-	-	-	-
2019	-	-	-	-
...				

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.*)

Current costs are the same since we are buying in low volume through online vendors, as a result paying at least 2-3x of what the true cost of raw materials for the sorbent is. They will

decrease significantly as we scale.

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: <1tCO2/yr/unit Unit #2: 365tCO2/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/tonne CO_2 (about $3000/tonne)

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." Consider describing your CAPEX/OPEX blend, assumptions around energy costs, etc.

Included: Costs of Sorbent (all 3 chemicals constituting it) Excluded: One-time capex cost of hardware, Energy Costs (Renewable energy installation), Payroll for employees managing the facility.

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	~kgCO2/day demonstration and lab scale pilot for	This will be a scaled down near-replica of the larger	Latest by March 2022.	We can send you a video + a report + you can

	sorbent performance optimization, failure point identification, and pilot with Carbon Craft Design.	1tonne/day capture system allowing us to validate that the chemistry scales and to identify possible points of failure at 1000x the scale. It will also help us put out scientific documentation on our core technology and file a patent for the same. The edge case real-world test data will help optimize our 1tonne/day capture plant design		visit us and validate it yourself.
2	FEED study, industrial scale (1 tonne/day) pilot plant deployment and testing + on-site utilisation of Praan CO2 with Carbon Craft Design	This first plant will help us refine our scaling process, our supply chain, our 24x7 operations, understand points of failure of the plant, and will bring accuracy to our techno-economics and LCA.	December 2022/Jan 2023	Stripe CO2 will be captured on the refined variant of this plant where problems are fixed. You can visit the install site and validate it.
3	Build order book with other companies and industries like airline, oil & gas, construction, etc to scale and capture 10 tonnes/day	We hope to build and replicate multiple 1 tonne/day capture plants with learnings from our 1 tonne/day capture plant in Dec'22/Jan'23. The order book will support raising the next financing round and allow us to tap into multiple keen geographies for this market. Eg: UK, EU.By building an additional 1	April 2023	More of Stripe CO2 will be captured on the new facility, hence you can come visit the site to validate it.

		tonne/day capture facility by April 2023 and fixing some of the challenges seen in the first plant, we would compensate for any lost time and double our CO2 capture capacity. If all scales well we hope to 10x the capacity by April 2024.		

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	~kgCO2/year	~tCO2/year	Moving from lab testing to the first scale model of the proposed capture plant. Allowing for several kg/day capture ability. This will help us understand how the chemistry scales, physically and if there are any discrepancies with the theory.
2	~tCO2/year	1 tonne CO2/day	Post design analysis and FEED study, we will begin the construction of our proposed project which can capture 365 tonnes CO2/yr. At this point we are also operating at preliminary economies of scale for our raw materials (in the sorbent)
3	1 tonneCO2/day	2 tonne CO2/day	Here we improve our design/manufacturing/operations based on real world

			feedback from the first 1 tonne/day plant and put out V2 of the large scale plant. The volume of daily capture doubles, costs for sorbent are expected to be similar.

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/tonne (~$3000/tonne)	~$1000/tonne	When we did our first experiment, we had no investors. One of our investors is a large chemical manufacturer and exporter who has been helping us find lower-cost sources for our sorbent material, while studying ways to manufacture them locally even more inexpensively.
2	$1000/tonne	$570-$800/tonne	Here we would have improved our sorbent performance, reduced the amount of sorbent needed, and would have economies of scale while purchasing raw material.
3	$570-$800/tonne	$570-$800/tonne	This system would be a near replica of the previous one deployed within 4 months of the first system. Not much changes here. At scale we hope to go down to $130/tonne.

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?

Patrick & John Collison: To help convince the largest technology company CEOs to purchase DAC credits at early stages from companies like Praan, and contingent on annual deliverables by DAC companies, sign a 10-20 year financial pledge with each of the DAC companies. This is the true way to scale - committed business continent to performance would also help raise venture debt, better quality and easier equity financing for Series B, C, D rounds. If Facebook, Google, Microsoft, Apple, Tesla, SpaceX, Amazon, Virgin Group, Goldman Sachs, Blackrock, Snapchat, Twitter, Zoom, Ford, HP, Dell, etc. committed to the same, this space would explode. It would also make those companies look good.

Praan does not believe in relying on politicians for making an impact.

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

1. Automatically calculate/estimate the carbon emissions for each transaction made by a stripe customer and offer them the option to offset the emissions for the same (Eg: If an end-customer bought a T-Shirt from a business, the end-customer and the business would both get the option to offset)
2. Introduce Praan to the best VCs who are passionate in this space
3. Introduce Praan to other leaders in the industry who would be open to pre-purchase our CO2 credits.

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?

Praan recognises that it's important to work with every individual stakeholder while building and deploying impact technologies - Governments, NGOs, Impact organisations, ESG Organisations, Green Building Certification Firms, Architecture Firms, Carbon Accounting Companies, Environmental Consulting Companies, Environmentally Compliant manufacturers (such as those Praan works with), Environmentally Compliant Chemical Manufacturing Companies (such as those Praan works with), Renewable Energy Suppliers, and key software companies which support startups building innovative climate technologies.

Fortunately, during the development of our particulate matter capture system, Praan already built key networks in all of the above.

Government: Praan is recognised by the Principal Scientific Advisor to the PM of India (https://www.agnii.gov.in/innovation/praan-mk-one)

Impact/ESG/ECC/GBCFs & Architecture Firms: Praan has been repeatedly financially backed by Tyler Cowen's Emergent Ventures, and has built strong networks with C40 Cities, Clean Air Asia, and Lung Care Foundation. The founder of India's second largest architecture firm (DSP Design Architects) is an investor in Praan.

Environmentally Compliant manufacturers: Praan only works with export-quality manufacturers in India who are required by the government and customers to comply with the highest grade of environmental and public health safety norms. We cannot reveal the names of the vendors publicly but are happy to share the same with Stripe for any diligence purposes.

Environmentally Compliant chemical manufacturers: Our raw material sourcing companies are public companies who are required to comply with the highest environmental and public health standards. We cannot reveal the names of the vendors publicly but are happy to share the same with Stripe for any diligence purposes.

Renewable Energy Suppliers: Praan has strong relations with one of India's largest solar panel manufacturers (Photon Energy Systems Limited - also known as PhotonSolar) and Mr. Surya Panditi (CEO of EnelX - the world's second largest renewables company) is an investor in Praan.

Key Software Partnerships: Praan has received backing from ANSYS for its simulation activities and efforts for particulates and CO2, has received backing from Autodesk for its design engineering efforts, and from Microsoft for its IoT and Self-enhancing technology efforts.

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

Our engagement with these stakeholders is mentioned above. 100% of work has been done inhouse. Many engagements with C40 cities, Lung Care Foundation, Clean Air Asia, CBRE, JLL, etc. have been in capacity where they are trying to support us with advice and sharing what their expectations would be while working with a new startup. No formal agreement exists between these entities and Praan.

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?

What we've learned

1. Government is a slow but large customer, work with them in parallel while you work with

Businesses - use them for access to barren land, tax benefits, grants, etc.

2. A strong business case must be built for companies to adopt clean technologies or products: Example, tax and construction benefits from attaining green building certification

3. CSR (Corporate Social Responsibility) is a good starting point for small funding, but can never be a business model. Find a more scalable business approach

4. DAC of CO_2 will only scale when the price point is comparable to that of purchasing carbon credits, ie. <$50/tonne.

5. Don't optimise for everything on day 1, and don't try to solve everything on day 1. I.e. Capture + Power + Storage + Mineralisation + Project Commissioning + Manufacturing.

6. Move very quickly as time is running out

7. The VCs and angels who understand this space are very few - sometimes if they don't move quickly, try to raise smaller checks from angels and keep the ball rolling - don't stall.

8. South-east Asian market is not ready to pay for DAC CO_2 - primary fast growing markets are North America, UAE, and Europe

9. Make in south-east Asian countries to drive down costs significantly, buy sell credits in the dominant markets to allow for company scalability, low cost capture, low CAPEX, and company profitability

10. Most Climate Impact ESG Funds are not up to date with technical know-how to move quickly and are primarily interested in research rather than scalability - Use the network but don't rely on them for opportunities, financing, or business scaling.

11. There are significant resources available in academia if you can tie up your business-case R&D with academia funding and publishing: Many professors will be willing to support you with their labs, know-how, and even funding

12. More companies like Stripe must exist who buy at an early stage: Almost all other CO_2 purchasers are not willing to take risks this early.

Praan has implemented/acted on all of the above.

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?

1. We must finalise partners in each country who will support project commissioning with respect to real-estate
2. We must finalise partners in each country who will support renewable energy provision at each facility

3. We hope to license the technology under strict impact norms to as many large, reputable, process engineering firms as possible in the hope of scaling DAC as quickly as possible.
4. We may add a B2C element to this business to help leverage the social media communities to go net-zero.

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

1. Manufacture your devices/plants with fair labour laws and the appropriate safety for workers
2. Any disposal of materials must be done without damaging air,water, soil resources in the countries of raw material production
3. The DAC facilities must be scalable globally: Hence Praan is developing the self enhancing, dynamic performance regulating DAC facility
4. It is preferred to carry out all project and operation logistics using Electric Vehicles charged using renewable energy sources
5. No DAC facility must be run on coal/non-renewable sources of energy
6. There must be end-to-end reusability of the CO2 and sorbent waste - allowing it to be stored away for >200 years
7. No water pollution or waste must exist in the process of capturing CO2
8. Praan will not convert the captured CO2 to fuels which would be burned to emit CO2 again.
9. The technology must be accessible to countries of all financial backgrounds.
10. The materials used to make the DAC facilities must have a very long lifespan requiring near-zero maintenance or replacement of parts.

11. Legal and Regulatory Compliance (Criteria #7)

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

Based on the countries we choose to later deploy in, we would have to comply with the noise, chemical safety, and health regulations. In India, we are required to have licenses for each chemical we purchase/use, Eg. Methanol.

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.

Running our own laboratory for these tests requires a list of permissions. In order to expedite testing and development, we work with companies in our investor and business network who

already have permissions for these in their labs, and we lease the lab resources for the time duration we need. In parallel, we are actively pursuing the applications for each of those permits. We are required to give an undertaking document which states that certain chemicals and technologies will not be used to make explosives or any form of contraband. We have a government approved import/export license, a shops act license, and are currently working on getting a methanol license.

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.

There are no norms for DAC in India at the moment. As we finalise install sites towards Q3 of 2022, we will look into the local regulatory norms for the finalised country and sites.

d. Does the project from which you are offering carbon removal receive credits from any government compliance programs? If so, which one(s)? (50 words)

None that we are aware of from the India side - the DAC thesis is extremely nascent here.

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)	361.48 tonnes/year
Delivery window (at what point should Stripe consider your contract complete?)	By May 2024 (worst case)
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*	$800/tonne (as mentioned our cost will be between $570-$800/tonne) since it would be year 2 of our efforts in CO2 capture without venture capital financing. Should our price be lower than $800/tonne, we would compensate for the same by capturing and sharing more CO2 equivalent to the difference in price. The $800/tonne mark

denominated in another currency, please convert that to USD and let us know here.	is the most realistic target given that Praan's efforts started in an accelerated manner only in 2021.We hope to reach $100 by 2026-2027.

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	- (Insignificant because it's a table-top lab setup)
2022	4.65×10^{-5} km^2 : Should specific additional space be needed for solar energy + battery storage, that would be added here
2023	3.71×10^{-5} km^2 : Should specific additional space be needed for solar energy + battery storage, that would be added here

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	- (Insignificant because it's a table-top lab setup)
2022	141.5m^3

2023	$113.26m^3$

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

1. What sorbent or solvent are you using?

Solid Amine based sorbent combined with a specific type of Silica.

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

20kg CO2 captured for 266 kgs of sorbent/cycle.

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

20kg CO2 desorbed for 266 kgs of sorbent/cycle.

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)

Currently sourced from environmentally compliant (as claimed on their website) public companies who are chemical manufacturers and suppliers. In the long term we will require them to make our sorbent through renewable energy use ONLY, and would buy directly from the manufacturer instead of online vendors.

5. How do you cycle your sorbent/solvent? How much energy is required?

We turn off the inlet fan, heat the sorbent bed, and pass nitrogen gas as a desorption gas through the bed, which carries the captured CO2 with it. This mixed gas is then sent to a nitrogen separator where the captured nitrogen is sent back for future desorption, and CO2 is stored. As mentioned in the LCA diagram, this is expected to consume 1582.6kwh for the 8 hours of daily desorption.

6. What is your proposed source of energy? What is its assumed carbon intensity? What is its assumed cost? 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)

Praan will be completely relying on solar energy. As mentioned in the LCA section, the carbon cost of solar energy per kwh is 50gCO_2e.

7. Besides energy, what other resources do you require in cycling (if any), e.g water, and what do they cost? 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)*

Answered in question 5.

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

During our tests with the TGA, we were using a flow rate of 100ml/min. However, this was excessive since we could not go below this rate due to TGA system limitations. We do not currently have an accurate number for the final Nitrogen requirements. The nitrogen is used just to channel (Act as a forcing gas) the CO_2 which has been de-linked from the sorbent bed when it's heated. The final flow rate for the large size bed will be a function of the porosity, pressure drop, and dynamic friction offered by the sorbent bed for a flowing gas. The nitrogen will be separated at a later stage and recirculated for future cycle desorption.

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

50 cycles/day

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

Degradation by cycling - 1% degradation over 50 cycles from our experiments

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

We are estimating it to be once in 7 days (as of today), we hope to make it once in a month.

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.

It is known to not be safe for aquatic life and hence will not be disposed of but recycled. We are yet to test this out, but it can be used to make adhesives: https://bioresources.cnr.ncsu.edu/wp-content/uploads/2016/06/BioRes_07_1_0789_Treusch_P_Combin_PEI_Phenolic_Adhesive_Panels_2329.pdf

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.

Primary differences
- The DAC facility should be scalable globally, anywhere: Currently, none of the DAC facilities have that ability: Hence they need to adapt to changing weather conditions, protect themselves from extreme weathers, and optimize their performance dynamically

- We desorb at lower temperatures than other companies using temperature swings - we are able to do the same from 85C to 120C.

- We don't use any water in our entire sorbent formation or operating process

- Our CO2 is used immediately for curing tiles and bricks, our waste sorbent will be used to make adhesives, and our plant will run entirely on renewable energy.

- Our core technology platform will be low cost, possibly allowing other companies to use the same platform for their own sorbents/capture technologies.

Carbon Engineering uses a hydroxide solution to capture the CO2, which requires a temperature of 1000˚C for desorption - 10 times ours. Praan's DAC's energy requirement is comparable to Climeworks. However, Climeworks has a capture efficiency of 1.41 mmol of CO2 per gram of sorbent whereas our sorbent has a capture efficiency of 1.71mmol of CO2 per gram or sorbent.This 20% difference becomes significant at scale.

For detailed differences, please refer to this document our chemical engineers put together: https://docs.google.com/document/d/17pKDe8VpPTYum8JvftSiPT8viu4LPdhT/edit?usp=sharing&ouid=109165740671428820433&rtpof=true&sd=true