Corporate Carbon

Carbon Removal Purchase Application

Spring 2022

General Application

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

Company or organization name

Corporate Carbon

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

Sydney, Australia, with operations across various Australian states

Name of person filling out this application

Julian Turecek

Email address of person filling out this application

[redacted]

Brief company or organization description

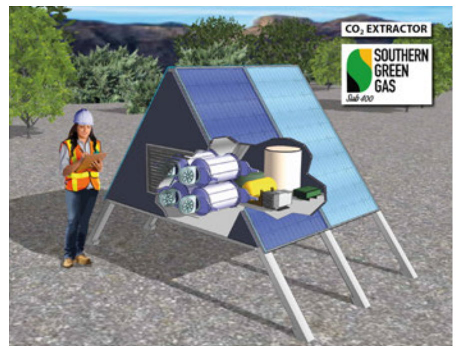
Carbon project developer with ~9 million credits created to date across a broad range of abatement methodologies in both the industrial and land sectors

1. Overall CDR solution (All criteria)

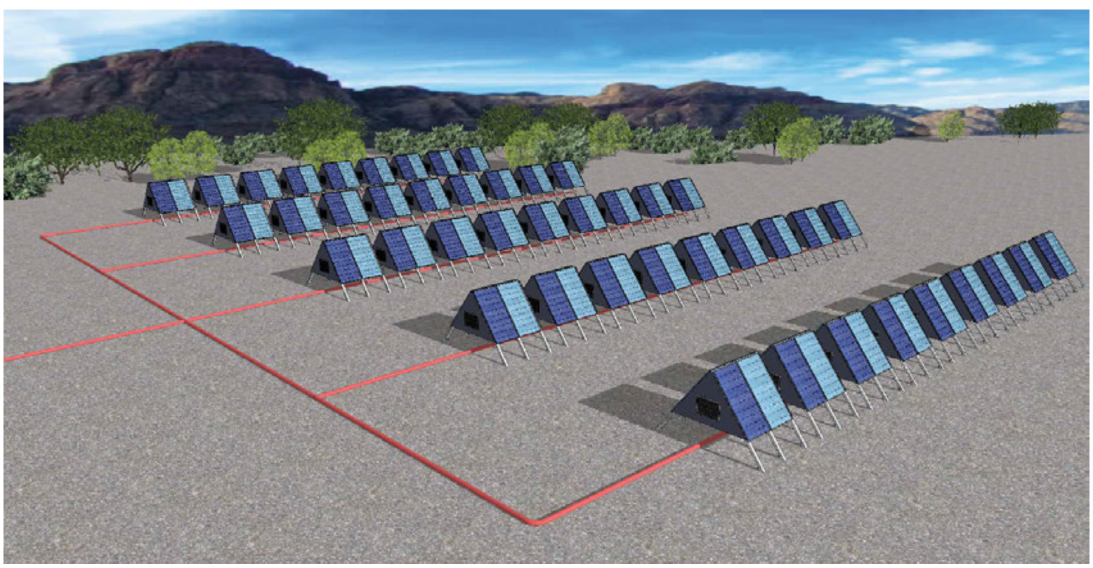
a. Provide a technical explanation of the proposed project, including as much specificity regarding location(s), scale, timeline, and participants as possible. Feel free to include figures and system schematics.

Corporate Carbon, in conjunction with technology supplier Southern Green Gas, and CCS Project Developer Santos Ltd, is developing the world's first solar-powered Direct Air Capture project, paired with permanent geological storage in depleted oil & gas reservoirs. Corporate Carbon is offering Stripe the opportunity to participate in this project as an offtaker.

The project is a 1tpd (330tpa) project, developed with Santos Ltd., located at Moomba in SA, alongside Santos's CCS project (and sharing certain compression, injection and storage infrastructure) which achieved financial close in November 2021. Refer https://www.santos.com/news/santos-announces-fid-on-moomba-carbon-capture-and-storage-project/. This first 1tpd DAC project has been partially funded by the Australian Government for A$4M.



The technology is a modular, solar-powered, low temperature absorption-desorption technology. But rather than just procuring renewable energy from the grid, the technology configuration embeds and integrates the energy supply, including solar panels and batteries to provide continuous 24/7 power, with the capture equipment. This avoids the multiple costs of grid connection, inverters, and network tariffs as it is an essentially behind-the-meter low-voltage DC configuration. This also means that the technology is immune to grid pricing and grid intensity of carbon emissions.



Each module is roughly the size of a two person tent and contains sufficient canisters of adsorbent to capture around 2tpa of CO_2. 170-180 modules are therefore required to create a field sufficient for 1tpd / 330tpa. Modules are arranged with the 'spine' in a north-south alignment to maximise solar production on the east and west facing panels.

The sorbent used is a Metal Organic Framework (MOF), a class of compound able to be manufactured from common chemical ingredients but which, once engineered, has excellent properties as a nano (ie molecular scale) sponge for CO_2, with low grade heat in the form of resistive or IR energy at ~90ºC to perform the desorption.

A test unit has been built to demonstrate this technology, as have 3D printing trials and MOF synthesis trials, to prove the various components of the solution. The FEED program of work has just been initiated (late March) which when completed will see three demonstration modules constructed and capturing CO_2 at a manufacturing facility in Brisbane (QLD, Australia), by the end of June 2022.

Australia is an ideal location to develop this technology as it is blessed with strong solar irradiation and also with multiple promising geological sequestration basins as well as significant potential for mineral carbonation.

In many ways, the deployment of this technology is analogous to that of utility scale solar photovoltaic, which has seen a tenfold reduction of costs over two decades. Although the first project will cost over $1,000/t, the pathway to US$100/t for DAC is achievable through the ramp up to larger and larger projects (1ktpa, 5ktpa, 20ktpa, 100ktpa, 1Mtpa) which will require mass manufacture of canisters and modules. High volume automotive manufacturing techniques and low cost components can be leveraged, such as ensuring low cost non-customised parts and other off-the-shelf equipment (such as solar panels).

We are aiming for a Final Investment Decision (FID) in Q3 2022, contingent on securing a suitable offtake agreement. After a 12 month build and commissioning program, this will see first injection (and carbon removal) in early 2024.

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.)*

Julian Turecek is the Project Director for DAC, responsible for delivering Direct Air Capture projects. Julian is also a Director of Corporate Carbon.

We have partnered with technology company Southern Green Gas for the supply of DAC equipment. Collaboration Agreement and Works Agreement (EPC contract for delivery of first 1tpd project) were executed between the parties in mid-March 2022 but not as yet publicly announced.

We also partner with sites on commercial terms for the compression, transportation, injection and permanent geological sequestration of CO_2 (incl Monitoring & Verification).

We are seeking (and at time of writing have secured but not yet publicly announced for the first 1tpd project) project finance investment for each project. In future, a range of project debt and infrastructure-style equity financing will be utilized for the build-out of larger and larger projects.

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

1. This DAC technology has been proven to capture CO_2 from the atmosphere, using MOF based adsorbents shaped by 3D printing into a “cartridge”. The interchangeable cartridge forms the building block of a 2tpa solar-powered module that leverages economies of manufacture for cost reduction. Uncertainties remain in relation to energy use, pressure drop and sorbent performance, but these will all be proven prior to commercial manufacture of modules. The project has just initiated its FEED program of work, which will result in the construction of three modules to demonstrate the performance metrics prior to larger scale deployment to the first 1tpd project.

2. A key uncertainty with this (and is the case with all other DAC technologies) is the longevity of the adsorbent in the field. This will be further tested prior to deployment via accelerated degradation studies. The successful management of water vapor in ambient air by the DAC technology provides inherent durability.

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

PCT Patent Application No. PCT/AU2022/050017 "Atmospheric Carbon Dioxide Extractor Assembly

PCT Patent Application No. PCT/AU2021/051267 "A Gas Separation Apparatus

PCT Patent Application No. PCT/AU2021/050780 "An Atmospheric Water Generator and Carbon Dioxide Extractor

PCT Patent Application No. PCT/AU2019/050546 "Renewable Methane Production Module

PCT Patent Application No. PCT/AU2020/051097 "Renewable Methanol Production Module

e. Who’s the team working on this? What’s your team's unfair advantage in building this solution? What skills do you not yet have on the team today that you are most urgently looking to recruit?

The technology team is led by Southern Green Gas, with MD Rohan Gillespie having extensive experience in technology development and deployment, engineering and upstream oil & gas.

SGG has partnered with the team at University of Sydney’s “Sydney Sustainable Carbon”, a team with extensive R&D background in the use of MOFs for DAC, led by Professor Deanna D’Alessandro. Refer https://www.deannadalessandrogroup.com/research-themes/sydney-sustainable-carbon and https://www.sydney.edu.au/news-opinion/news/2021/11/10/usd-250-000-from-elon-musk-to-sydney-students--for-carbon-remova.html

SGG is soon to recruit a project manager for the project and has recently recruited manufacturing expertise and chosen a manufacturing joint venture partner.

The team has three “unfair” (although these have been by design) advantages:

i. Utilising MOFs as the sorbent, providing unique tunable performance characteristics
ii. Utilising “behind-the-meter” solar energy as the power source, at low voltage and DC, with no need for grid connection, inverters etc
iii. Adopting a small-scale modular approach, which thereby leverages large scale manufacture to achieve cost savings

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 2022 - Jun 2023. The end of this duration determines when Stripe will consider renewing our contract with you based on performance.*	Will start production in early 2024 and aim to run for 10 years
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?* *E.g. Jun 2022 - Jun 2023 OR 100 years.*	During project duration, via permanent geological sequestration. CO_2 is compressed, injected and stored as it is captured
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*	Steady state: 330 tpa (1tpd)

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".	
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.*	Permanent geological sequestration (>1000 years)

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

CO_2 is stored in reservoirs that have previously held hydrocarbons for millennia. Lower bound is 1,000 years, upper bound is unknown (but has been modelled to be many tens of thousands of years, due to in situ long term mineralization)

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.)*

Santos, Moomba CCS Project Owner and Operator, has performed injection trials

https://www.santos.com/news/moomba-carbon-capture-and-storage-injection-trial-successful/

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 main risk is the integrity of the injection well, which can be managed by appropriate engineering design with multiple factors of safety

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.)*

a M&V regime is in place, in order to manage Santos's 1.7Mtpa CCS project, and this will equally apply to CO2 captured by our project.

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	330tpa for 10 years Shorter durations would be considered, however, a long term offtake contract is preferred
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	n/a

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)*

1 tonne per day, 90.5% capacity factor = 330 tonnes per year

90.5% capacity factor allows for some downtime for maintenance (eg cartridge replacement, solar panel cleaning etc) and/or certain periods of low solar production

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).

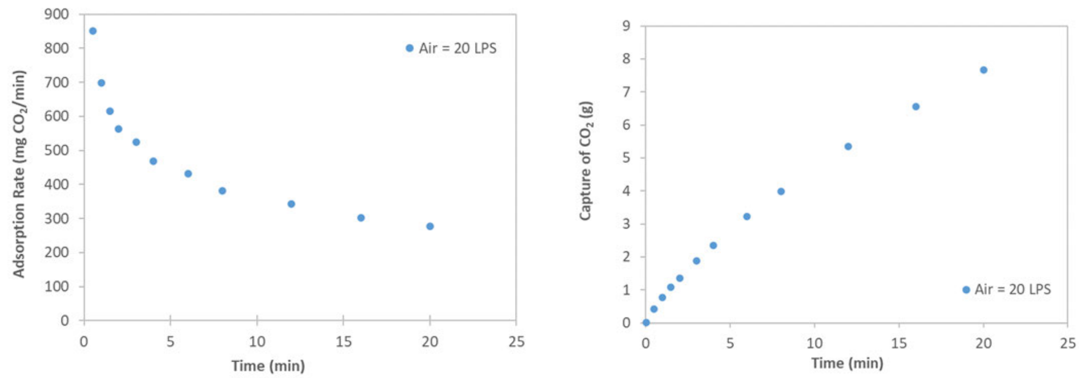
1tpd = 365 tpa

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.)*

The modules are designed so as to achieve 2tpa each. The initial trailer-mounted demonstration unit has achieved 1.7tpa (refer picture in 5b). Initial assumptions are as follows:

- Air flow per (50mm pipe) canister = 0.023m3/s or 49cfm (based on 12m/s air velocity)
- 50% CO2 adsorbed in a 20min period = 10g per cycle CO2 absorption per cannister
- Total production per canister = 173kg per annum (assuming 30min cycle, w 10min for purging, desorption & cooling)
- 2tpa requires 12 canisters

These assumptions are based on observed results from the production and testing of canisters at the University of Newcastle. The chart on the left is the breakthrough curve which shows the CO2 adsorption rate, with very fast initial adsorption tailing over the 20 minute adsorption period. The chart on the right shows the cumulative adsorbed CO_2 showing 8 grams after 20 minutes, noting that these canisters are smaller than those that will be designed for the 1tpd and 2tpd projects.



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.

https://www.deannadalessandrogroup.com/research-themes/sydney-sustainable-carbon

https://pubs.rsc.org/en/content/articlelanding/2021/TA/D1TA08777K

https://www.southerngreengas.com.au/news

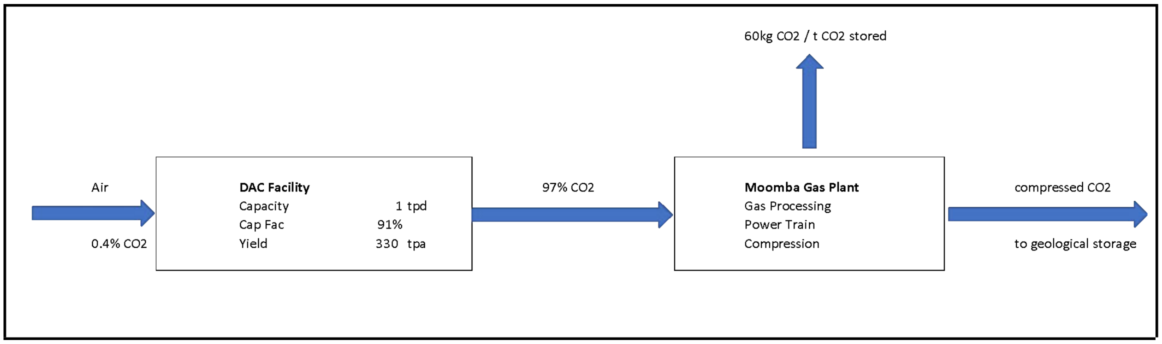
4. Net Capacity / Life Cycle Analysis (Criteria #6 and Criteria #8)

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	3,300 tonnes over 10 years
Gross project emissions	20tpa (gas-fired compression, assuming 132kWh/t CO_2 @ 0.45t CO_2/MWh* = 60kg CO_2 emitted per tCO_2 stored)
Emissions / removal ratio	0.94

Net carbon removal	310 tonnes per annum = 3,100t over 10 years

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 2020 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?

The LCA performed here is consistent with that required by the Puro.earth standard for creating CORCs from Direct Air Capture with permanent storage. This does not require going back in time for example to calculate the silicon used in the solar panels. Refer https://connect.puro.earth/geologically-stored-carbon-direct-air-capture Compression is by far the most energy intensive (and therefore emission-intensive) process involved. Note that emissions involved in sorbent manufacture have not been estimated at this stage

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.

132kWh/tCO2 is the estimate quoted in Keith et al 2018 for compression to 15Mpa (p7). Intensity of power of 0.45t/MWh is as per typical Combined Heat & Power (CHP), given the heat from the compressor will be reused in the Moomba plant. This will be cross-referenced with emissions intensity calculations of the main Moomba CCS compressor.

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.

A more thorough LCA will be performed prior to FID

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 progress.)

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

We are measuring in tonnes of DAC capacity per year. Each module is 2tpa.

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.

Year	Units deployed (#)	Unit cost ($/unit)	Unit gross capacity (tCO_2/unit)	Notes
2022	*3*	*N/A*	*2 tpa*	*FEED program initiated, will be completed by June 2022*
2021	1	N/A	1.7 tpa	A demonstration solar-powered trailer was commissioned in late 2021. It utilizes solar hot water as the heat transfer medium, however in the updated design it will be electric only.

				
2021	1	N/A	140kg pa	prototype
2020	1	N/A	35kg pa	prototype

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.)*

We are not currently measuring deployment costs as this is in technology demonstration phase. Deployment costs will be tracked from the first 1tpd project onwards.

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)**
500	2tCO_2 per unit per annum

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

We are open to purchasing high cost carbon removal today with the expectation the cost per ton will rapidly decline over time. We ask these questions to get a better understanding of your potential growth and the inflection points that shape your cost trajectory. There are no right or wrong answers, but we would prefer high and conservative estimates to low and optimistic. If we select you for purchase, we'll expect to work with you to understand your milestones and their verification in more depth. If you have any reservations sharing the information below in the public application format, please contact the Stripe team.

a. What is your cost per ton of CO_2 today?

>$1,000/t

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, non-levelized CAPEX costs, assumptions around energy costs, etc.

At small scale, upfront CAPEX is the predominant cost input. Assumptions on project life and cost of capital are the main determinants of the unit cost per CO_2 stored. Corporate Carbon has already procured the first 1tpd project at an agreed fixed cost from Southern Green Gas under the Works Agreement.

c. How do you expect your costs to decline over time? Specifically, what do you estimate your cost range will be as you reach megaton and then gigaton scale? We recognize that at this point, these are speculative and directional estimates, but we would like to understand the shape of your costs over time.

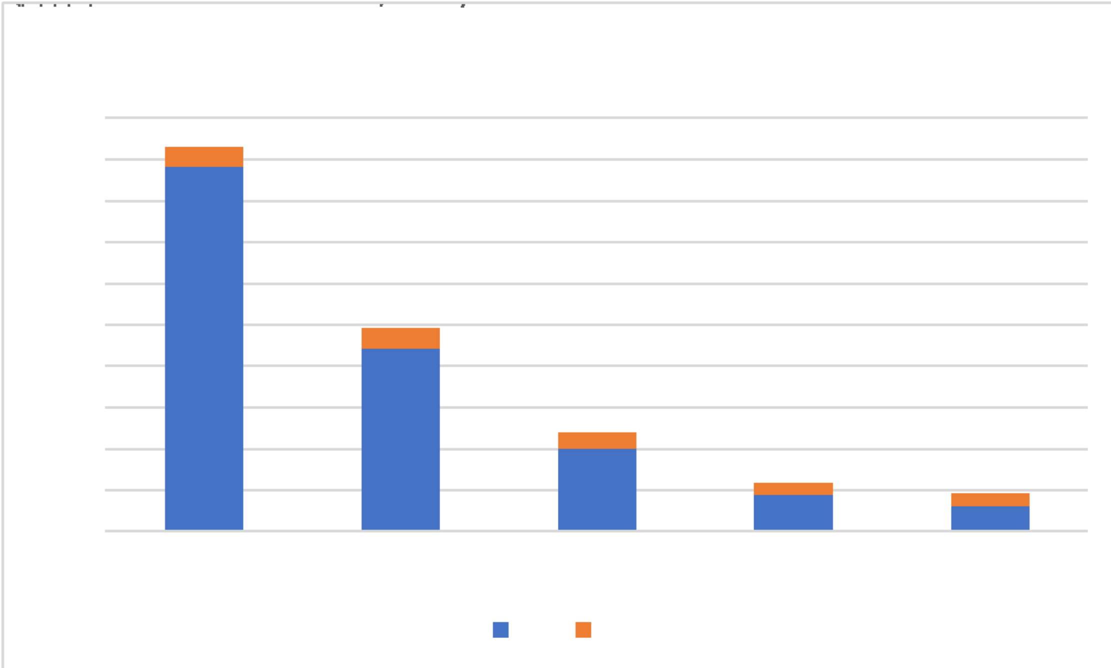
We are aiming to halve costs each time we scale up by a factor of at least 2. This is achieved by large scale manufacture, including utilising approaches used in automotive manufacture. This approach is backed by Lackner in his 2021 paper "Buying down the cost of DAC"

https://pubs.acs.org/doi/abs/10.1021/acs.iecr.0c04839

This is demonstrated already in that we have estimates for a Stage 2 project with the same capex as the Stage 1 project but with twice the output, effectively halving the cost per unit of capacity and halving the capital component of the carbon removal cost per ton of carbon.

As we scale out, we also plan to increase the longevity of the projects (from 10 years to 12 to 15) which will also bring down the capital cost per unit of CO_2 stored.

This chart below shows the pathway from current costs down to $100/t, assuming a cost of capital of 9% for commercial (non demonstration) projects.



*Note does not include Puro.earth Service Fee, nor any discount for direct government funding.

d. Where are the primary areas you expect to be able to achieve cost declines? E.g., what are the primary assumptions and sensitivities driving your cost projection? What would need to be true for a long-term cost of <$100/ton to be achievable with your technology? (i.e., you are able to negotiate an x% reduction in CAPEX at scale and purchase renewable electricity at $y/kWh)

The unique aspect of SGG technology is that the energy costs are embedded in the capital cost because energy supply (including storage to facilitate continuous operation) is integrated into the module design. Costs are designed to reduce through increasingly large-scale manufacture, which is the mechanism that has brought down the cost of solar pv tenfold in two decades (from $350/MWh to $35/MWh) as it has been deployed globally at scale. Costs will be driven down by replicating automotive techniques including the use of off-the-shelf componentry.

e. In a worst case scenario, what would your range of cost per ton be? We've been doing a lot of purchasing over the past few years and have started to see a few pieces that have tripped people up in achieving their projected cost reductions: owned vs leased land, renewable electricity cost, higher vendor equipment costs, deployment site adjustments, technical performance optimization, supporting plant infrastructure, construction overruns, etc. As a result, we'll likely push on the achievability of the cost declines you've identified to understand your assumptions and how you've considered ancillary costs. We would love to see your team kick the tires here, too.

Opex assumptions include $14/t for compression and storage and $36/t for cartridge replacement (assuming replacement every 3 years), totaling $50/t in operational cost. If the longevity assumption is pessimistic, eg 2 year replacement, Opex could be an additional $20/t. The chart in 6(c) assumes also that costs can come down over time, from $50/t to $30/t with learnings and sorbent improvement and compression economies of scale. If this is too aggressive an assumption, an additional $20/t could be added to Opex.

In relation to Capex, the key determinants are the assumption on cost reductions, but also the project life and the cost of capital. To the extent that project life does not extend to 15 years, this would increase cost of carbon removal at the 1Mtpa scale by +$15/t. Equipment supply costs have been estimated from a credible Bills of Materials from Southern Green Gas, assuming a module run of 50,000 modules (for the 100,000tpa project). Even a +10% increase would increase the 100ktpa cost by $10/t CO_2.

f. 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	Manufacture of three demonstration modules	Proves the technology and the ability to optimise for sorbent performance	Q3 2022	Observe the modules in operation, in Brisbane (QLD, Australia), in June 2022
2	FID for 1tpd project	Demonstrates ability to secure offtake, regulatory approvals, credible Project Execution Plan, and commercial arrangements for full project	Q3 2022	FID is an objective test, will also see investment committed ($4M in total, as well as $4M from Govt)
3	First module deliveries	Demonstration of manufacturing, delivery to site, installation and commissioning	Q1 2023	Physical assets in place and operational

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

Milestones do not impact total gross capacity

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

Milestones do not impact costs. The cost reduction pathway assumes successful completion of the milestones.

h. 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?

Ask Elon Musk to lend us his best and brightest automotive manufacturing engineers for a month (at least!) in order to fast-track our plans for large scale manufacture using Tesla-style techniques

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

Purchasing offtake is the most important action Stripe could take to help our project. Stripe's actions in purchasing, once made public, greatly encourages the DAC industry and validates its importance in our global efforts towards net zero and the critical role of Carbon Removal.

7. Public Engagement (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 mechanisms 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 and how your project is working to follow the White House Council on Environmental Quality's draft guidance on responsible CCU/S development. We recognize that, for early projects, this work may be quite nascent, but we are looking to understand your early approach.

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

- Governments (Local, State and Federal)
- Statutory bodies (EPA, WorkSafe)
- Storage site operator(s), their commercial, engineering, project and operations teams
- Local communities and landowners, including Cultural Heritage issues
- Investors
- Insurance providers
- Offtakers
- Technology supplier: Southern Green Gas (and by association, University of Sydney and manufacturing partners)
- Media

Our DAC project(s) will be leveraging existing relationships and capabilities:

Santos is the operator for Moomba CCS and already has in place extensive stakeholder engagement strategies, processes and activities. Santos will be the field operator for the DAC Project and proposes to take a controlling interest in the project should the initial year of operation be successful.

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

This work has all been done in house, in conjunction with site owners. Note that the site has hosted upstream (oil & gas, storage) operations for decades.

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?

Siting considerations have been informed by these early engagements.

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?

There will be optimisation activities to be undertaken based on feedback from landowners and other stakeholders.

8. Environmental Justice (Criteria #7)

a. What are the potential environmental justice considerations, if any, that you have identified associated with your project? Who are the key stakeholders?

Land use is the key consideration, with particular focus on Cultural Heritage and multiple uses on land.

b. How do you intend to address any identified environmental justice concerns?

Extensive consultation and engagement to understand any concerns. As per solar or wind projects, ensure that land use is optimised and not unreasonably impacting the rights of existing users or owners. We will aim to place module arrays in areas not already under valuable arable land or intense high value agricultural activity.

9. Legal and Regulatory Compliance (Criteria #7)

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

We have had extensive legal advice to support the negotiation of access to storage sites as well as the structuring of our commercial arrangements. No issues have been raised in relation to the deployment. Local regulatory approvals (eg for Works) will need to obtained as part of the project go-ahead.

b. What domestic permits or other forms of formal permission do you require, if any, to engage in the research or deployment of your project? 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.

To be obtained:

- Works Approval under the SA EPA and/or SafeWork and/or the SA Department of Energy and Mines

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

No

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

For these projects, the regulatory framework is clear. For future projects (5ktpa onwards), other jurisdictions may need to implement similar CO_2 storage regulations as apply in SA.

e. Has your CDR project received tax credits from any government compliance programs to-date? Do you intend to receive any tax credits during the proposed delivery window for Stripe's purchase? If so, which one(s)? (50 words)

No tax credits are available in Australia, but direct grant funding has been received for the 1tpd project (US$3M).

10. 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*	3,100 tonnes
Delivery window *at what point should Stripe consider your contract complete?*	10 years (2024-2033) Payment upon delivery of CORCs (Carbon Removal certificates, audited and verified under the Puro.earth DAC methodology). No upfront payment required. Commitment to 10-year offtake can be paired with rights (to be negotiated) for future larger volume projects (eg 5ktpa, 20ktpa, 100ktpa) at lower prices.
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 denominated in another currency, please convert that to USD and let us know here.*	US$1,000/t

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	n/a
2022	n/a
2023	1 acre for 1tpd in Moomba
2024	as above
2025	add in 15tpd (5,000tpa) over 15 acres = 6ha = 0.06 km^2

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	n/a
2022	n/a
2023	500 modules, each of ~2m^3 = 1,000 m^3

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

1. What sorbent or solvent are you using?

Metal Organic Framework (MOF)

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

10g CO_2 per cycle for 500g adsorbent per cartridge

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

As above. Assumes 2% (g of CO2 per 100g of sorbent) working capacity

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)

MOF is manufactured in-house (subcontracted to University of Sydney) either by spray-drying or twin-screw extrusion. The input chemicals required to manufacture the MOF are common chemicals, inexpensive to source. As discussed earlier, the LCA of MOF manufacture has not as yet been factored into the analysis.

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

TVSA (temperature vacuum swing adsorption) up to 90ºC is required for desorption. Energy applied via resistive heating, supplied at low voltage DC from the solar panels / battery system. First instance of the technology observed 2.28MWh/t CO_2 energy requirement. Losses are being minimized by reducing the mass of non-adsorbent materials being temperature-cycled. We are ultimately aiming for 1.0MWh/t CO_2.

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)

Southern Green Gas technology is powered by its own solar panels, coupled to batteries within the modules to provide continuous 24/7 power. This involves no grid connection and no network losses. It is therefore assumed that the carbon intensity is zero. We are not assuming a variable cost of energy ($/MWh) as the energy supply is capitalized into the module cost.

We are aiming also for compression to ultimately be solar-powered as well. The first project will be gas-fired as part of the larger CCS project, but we aim for future projects to be exclusively powered by renewable energy.

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)*

There are no other resources required to cycle. These units are completely stand-alone.

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

n/a

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

30 minute cycles, 48 cycles per day.

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

R&D focus is on maintaining longevity, and ensuring resilience in humid environments. All sorbents are expected to degrade to some extent over time, but the extent to which this will happen with MOF is at this stage unknow in the field. Accelerated degradation experiments will be performed prior to FID. MOF in the DAC application has been demonstrated for 12 months operation without any degradation.

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

Unknown at this stage. The module design facilitates easy replacement of cartridges, analogous to changing the ink cartridges in an ink jet printer. This also allows for sorbent optimization and improvement over time, with the infrastructure already in place to accept fresh and improved sorbents (if required) as it becomes available through additional R&D.

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 sorbent will be recycled.

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.

- Carbon Engineering is uneconomic at scales less than 1Mtpa and is also by design natural gas fired, requiring 0.5MT of emissions to capture 1.5Mt CO2 for a net 1Mtpa carbon removed. First project is estimated at over US$1,300M, whereas SGG technology pathway involves a much smaller capital investment to get to 1MTpa. SGG technology also avoids the requirement for large balance sheet finance to support offtake or for the requirement to source a long term cost-competitive source of natural gas in a very volatile global energy market
- Global Thermostat and ClimeWorks both require higher temperatures and steam as the solvent, entailing higher losses and equipment required in desorption (including separation). Clearly ClimeWorks is the leader in the field having commissioned the 4,000tpa Orca facility in Iceland. However, SGG's technology accesses solar and CCS sites, which are both more ubiquitous than geothermal (for energy supply) and mineral carbonation (via CarbFix) for storage. Therefore, it is harder to see the pathway to $100/t for either CW or GT.
- Sustaera is the closest competitor to Corporate Carbon / Southern Green Gas. Both use a modular approach, accessing the "learning curve" described in Lackner's paper (as referenced earlier in section 6c) by investing smaller capital amounts to progress to the next stage. It remains to be seen how Sustaera's alkali sorbents perform relative to SGG's MOFs. Sustaera appears to have larger machines than SGG modules, more of a scale-up rather than scale-out approach. But the most important difference is that SGG embeds and integrates its energy supply with its capture infrastructure, whereas Sustaera is reliant on grid electricity, and therefore exposed to grid electricity and grid emission intensity. Apart from wholesale costs (eg $60/MWh) if able to be procured at that level for long term, getting power to a facility also requires transmission and other network costs as well as utility charges. By way of example, it is difficult to see how 0.025t/MWh grid power can be accessed for $60/MWh, given most grids in the US have much higher underlying grid intensities. In addition, it is not clear in Sustaera's solution how continuous power is provided for (eg battery or other storage) and whether this is factored into the energy costs, or whether the machines only run when wind or solar power is available, in which case DAC machine capacity factors would be significantly lower than 90% and more likely 30-50% (at best), which would increase the capital cost per unit ton of CO_2 captured.

Note that while SGG technology uses more land acreage per ton of captured CO_2, this also includes all the land required for energy supply, which doesn't appear to be included in the other modular technologies submissions (but is included in Carbon Engineering's technology).

Application Supplement: Geologic Injection

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

Feedstock and Use Case (Criteria #6 and 8)

1. What are you injecting? Gas? Supercritical gas? An aqueous solution? What compounds other than C exist in your injected material?

Supercritical CO_2

2. Do you facilitate enhanced oil recovery (EOR), either in this deployment or elsewhere in your operations? If so, please briefly describe. Answering Yes will not disqualify you.

No

Throughput and Monitoring (Criteria #2, #4 and #5)

3. Describe the geologic setting to be used for your project. What is the trapping mechanism, and what infrastructure is required to facilitate carbon storage? How will you monitor that your permanence matches what you described in Section 2 of the General Application?

> As part of the CCS Project at Moomba, Project Owner and Operator Santos has recently been granted a licence to inject CO_2. This granting was subject to a comprehensive Environmental Impact Report which is available at the link below and fully examines key environmental risks.
>
> *https://www.petroleum.sa.gov.au/regulation/projects-of-public-interest/cooper-basin-carbon-storage*
>
> *https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/samref/sarig1/image/DDD/PGER003212021.pdf*
>
> *https://www.afr.com/companies/energy/santos-books-co2-disposal-capacity-20220208-p59ums*

The DAC project will be reliant on the broader CCS project for assurances on environmental integrity and the various obligations under the relevant legislation and regulations that Santos operates under.

Corporate Carbon will have a contract in place with Santos for the compression, injection and storage of carbon dioxide, with provisions in place to demonstrate performance, along the lines of what is required for Santos to retain its injection licence under relevant State legislation and regulation.

4. For projects in the United States, for which UIC well class is a permit being sought (e.g. Class II, Class VI, etc.)?

n/a

5. At what rate will you be injecting your feedstock?

1 ton per day

Environmental Hazards (Criteria #7)

6. What are the primary environmental threats associated with this injection project, what specific actions or innovations will you implement to mitigate those threats, and how will they be monitored moving forward?

As part of the CCS Project at Moomba, Project Owner and Operator Santos has recently been granted a licence to inject CO_2. This granting was subject to a comprehensive Environmental Impact Report which is available at the link below and fully examines key environmental risks.

https://www.petroleum.sa.gov.au/regulation/projects-of-public-interest/cooper-basin-carbon-storage

https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/samref/sarig1/image/DDD/PGER003212021.pdf

https://www.afr.com/companies/energy/santos-books-co2-disposal-capacity-20220208-p59ums

The DAC project will be reliant on the broader CCS project for assurances on environmental integrity and the various obligations under the relevant legislation and regulations that Santos operates under,

7. What are the key uncertainties to using and scaling this injection method?

The CCS project has an injection capacity of some 1.7Mtpa, so has ample scale to cater for additional volumes from DAC activities, at least until DAC reaches the megaton scale (around 2030).