stripe

General Application

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

Company or organization name

Kepler Carbon ReCapture, LLC

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

We are incorporated in Austin, TX with participants around the US, Canada, Portugal, and India

Name of person filling out this application

Richard Barrera

Email address of person filling out this application

[redacted]

Brief company or organization description

R&D company registered for the $100M XPRIZE Carbon Removal Competition.

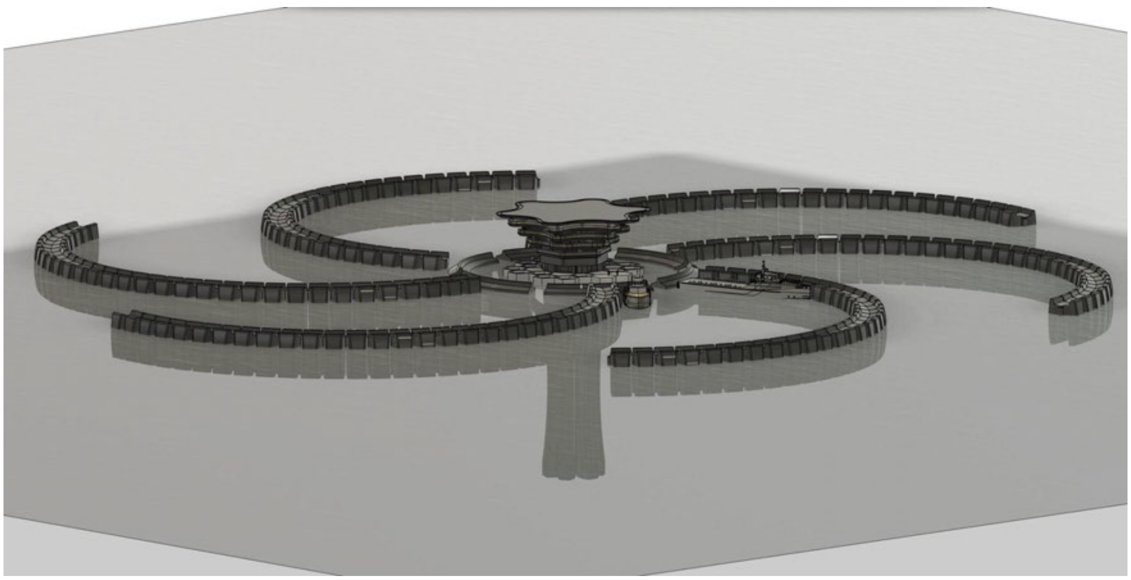
1. Overall CDR solution (All criteria)

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.

1. Executive Summary

Kepler Carbon ReCapture is constructing a constellation of marine platforms to harvest energy from waves and solar and oceanic thermal gradients. Together, this "green energy" permits on-site carbon capture from both air and seawater, along with biological harvesting.

The platform is a vertical SPAR design that extends well below the ocean surface, ensuring a stable and robust structure. The deep platform provides a gateway for sequestering carbon-enhanced compounds into the deep sea and sea bed. Radiating outward from the central spar at the ocean surface, high-tensile "spokes" provide support for an outer ring, with multiple wave-powered generators that produce additional energy regardless of the orientation of the local sea state. The outer ring encloses ocean space, protecting it for intensive, managed cultivation of biologicals, including kelp & algae processed for food, biocomposites, and carbon capture. The multiple energy sources provide redundancy while generating power to produce freshwater, salt, carbonates for cement, and other high-durability products with high global demand. The first platforms will operate relatively close to densely-populated coastal areas where there is immediate need for freshwater and other ReCapture products.



"Nereid" class modular prototype platform.

A key component of our vision is its multi-faceted approach to energy extraction that enables these platforms to generate carbon-negative precursors for a range of end uses. When appropriate, platform production capacity can be towards building new platforms or other ocean-based structures, a replication process enabling efficient growth and expansion of our technology. The ease of initial construction of the platforms enables large-scale manufacturing, allowing for rapid up-scaling to ensure carbon capture at the relevant kilotonne to gigatonne scales to meet societal needs.

2. A Marine Approach: project overview

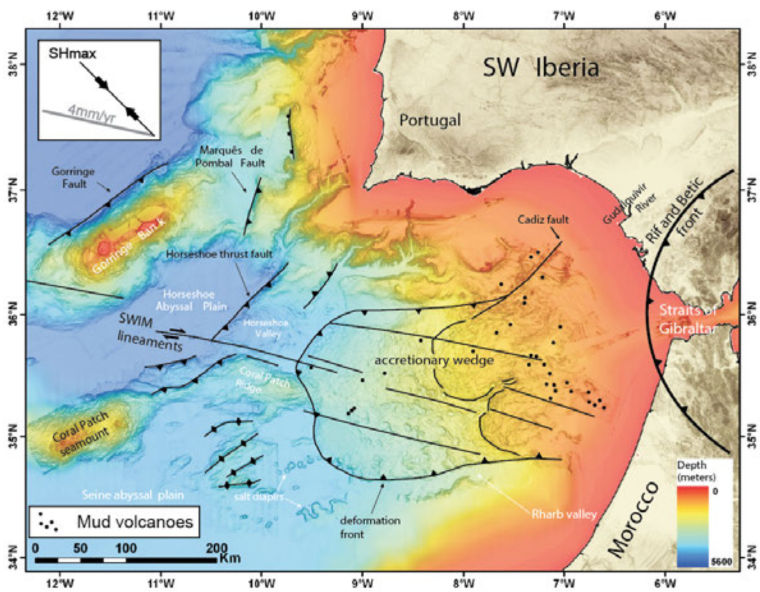
School children learn that nearly three-quarters of the Earth is covered with water. At Kepler Carbon ReCapture (KCR), we believe the world ocean provides the key to solving the excess carbon threat. In particular, the oceans contain up to 39,000 GtC (gigatonnes of carbon) whereas the atmosphere contains around 750 GtC, and that efforts to capture carbon via seawater would contribute to reductions in the atmosphere (Straatman & van Sark, 2021). Because our platforms operate almost anywhere in the marine environment, our approach can expand globally, capturing carbon and sequestering it in deepwater while producing carbon-related byproducts to provide additional value.

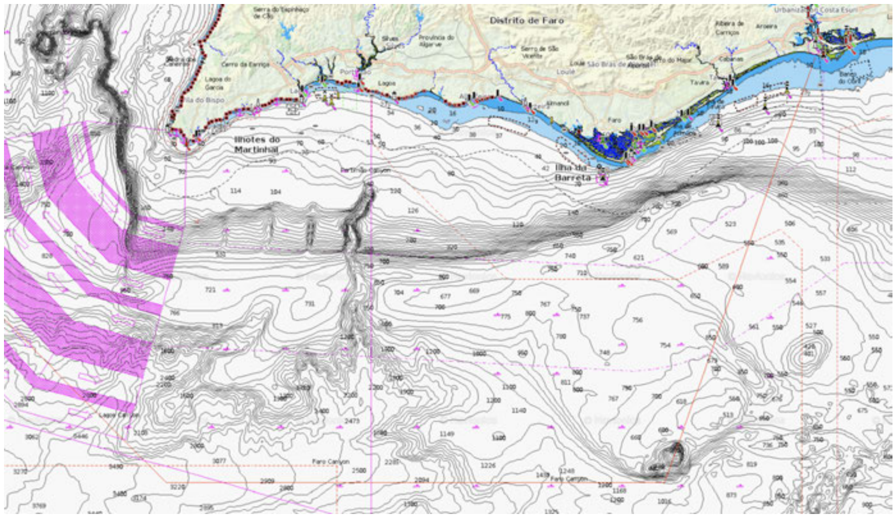
Our design can be deployed strategically to meet the needs of coastal populations where freshwater and construction products are essential for expanding harbors and ports, and seawalls and levees in response to sea-level rise.

In this section we provide a general overview of the KCR spar design, describe how it is energized, and describe the resulting enclosed "lagoon" where biologicals are grown. Justification for the Gulf of Cadiz prototype site selection off of Portugal is next, followed by rationale for our multi-faceted approach and methodologies for carbon capture, extraction, harvesting, and deep-sea sequestration.

3. Project Rationales

Justification for Gulf of Cadiz





Portimão Canyon within the Gulf of Cadiz is the proposed site for the marine SPAR platform that we intend to utilize for the capture of carbon dioxide. The Canyon is close to several ports and harbors. This location offers an ocean temperature difference from 20°C at the surface to 10°C at depths of 400-500 meters (Marches *et al.* 2007), a sufficient thermal gradient to power our process. Solar heating of the surface water, combined with waste heat regeneration, can further enhance thermal energy production. The canyon site is also close to several shipyards along the coast of Portugal, where the spar platform will be built, and where products, including captured carbon dioxide (in some form) and desalinated water will be transported to fulfill local needs.

Rationale for multi-faceted approach

Capturing carbon dioxide is not a new venture. Several technologies exist to capture carbon dioxide from a variety of media (industrial exhaust, air, water). However, these current approaches utilize a single approach, e.g. algae, air mining, etc. and as such have not yet been able to achieve carbon capture beyond the kilotonne range. As such, a multifaceted approach is necessary to ensure the scalability and feasibility of carbon capture approaching the gigatonne range.

<u>Approach #1: Mechanical extraction using solar power and temperature gradients through a Uehara Cycle OTEC plant.</u>

We propose to use an Augmented-OTEC following the method of Haruo Uehara (Japan, 1990's). OTEC is Ocean Thermal Energy Conversion and is "an advanced technology to generate electricity from seawater and, at the same time, it can also provide us with fresh water from the seawater upwelled for OTEC power generation system" (Ikegami et al. 2002). Coupled with other technologies, it can be used to extract hydrogen (Ikegami et al. 2002) and carbon dioxide (Green & Guenther, 1990) from seawater.

Floating OTEC power plants have been examined for the generation of 1MW gross power (electricity) in India (Jayashankar et al. 1998) and 100MW in Sri Lanka (Ikegami et al. 1998). Several studies have been done on the desalination potential of OTEC power plants (Ikegami et al. 2002; Uehara et al. 1996) and for the performance optimization of these entities (Jitsuhara et al. 1994; Nakamura et al. 1991; Uehara & Ikegami, 1990).

The rate at which carbon dioxide is extracted is tied to the rate of production of desalinated (fresh) water (Green & Guenther, 1990; Straatman & van Sark, 2021). Gas extraction using OTEC is not limited to carbon dioxide but can potentially include other economically viable gasses such as nitrogen, oxygen, hydrogen, and argon as well (Ikegami et al. 2002; Green & Guenther, 1990; Straatman & van Sark, 2021). One paper estimates an average of 38.5g CO_2/kWh generated due to differences in CO_2 concentrations in seawater of different temperatures with flow rates ranging from 2,580-5,710 kg/s (Green & Guenther, 1990). The brine, containing non-condensables (salt, etc.), is shown to have on average 7.3% CO_2 remaining, accounting for temperature fluctuations and CO_2 content of incoming seawater (Straatman & van Sark, 2021).

Approach #2: Biological extraction of carbon dioxide using algae inside and outside of photobioreactors

We propose to grow macroalgae in the lagoon enclosed by the outer ring of wave generators encircling the marine spar platform. There will be multiple seawater intakes that the macro algae will be well positioned to take advantage of any local variations in CO_2 concentration that may be encountered as the spar platform moves water to the central SPAR for OTEC utilization. Additionally, microalgae in photobioreactors are expected to provide a way to obstruct marine life from entering water intakes while also filtering and preconditioning the seawater prior to the OTEC process. The utilization of macro- and micro algae in this way is expected to contribute significantly to the overall CO_2 capture potential of each marine spar platform in combination with other processes.

In its pilot program aimed at southern Portugal, seaweed harvest is restricted to *Gelidium* sp. (Araujo et al 2021), KCR expects to cultivate this species, or take advantage of European coastal species that include *Laminaria digitata, L. hyperborea, Ascophyllum nodosum,* and *Gelidium corneum,* or the economically important edible seaweed on Spain's Atlantic coast including mainly *Undaria pinnatifida, L. ochroleuca, Ulva* spp., *H. elongata* and also *C. crispus*. Moreover, KCR platforms are ideal for production of macroalgae species in the surface layer with shellfish and other cultivars lower down, consistent with Europe's emerging integrated multi-trophic aquaculture (IMTA), that has been shown to reduce nutrient and organic matter requirements.

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Approach #3: Other mechanical and chemical extraction of carbon dioxide from water and biologicals including sequestration methods

Other mechanical extraction techniques for the bulk extraction of carbon dioxide or organic carbonaceous compounds from water potentially involves the use of cavitation processes to degas the water and foam out organic carbons, such as might be found in outputs from photobioreactors for further processing.

Additionally, mechanical and chemical extractions will be essential in ensuring that algal biomass is harvested and prepared for further processes to utilize carbon. Further exploration of other chemical processes could include using carbon dioxide to lower the pH of solutions to "shock" calcium carbonate ($CaCO_3$) and/or magnesium carbonate ($MgCO_3$) out of solution;

converting CO_2 to calcium carbonate, polycarbonates, ethylene/polyethylene, and other carbonaceous intermediates for further processing or manufacturing.

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.)*

I am the Vice President of Global Business Development for Kepler Carbon ReCapture. I play a large role developing the team, planning commercial objectives, and establishing strategic relationships with technology partners like Dassault Systeme and AutoDesk. Our team is a unique mix of scientific experts in Marine and Ocean science and technology, marine engineering, as well as senior commercial and financial executives from the water and renewable energy industry. We have built an extremely qualified team to address all aspects of the development and commercialization of this critical process.

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

Access to pre commercial development capital:

While we intend to finance the full-scale SPAR deployment utilizing a traditional project finance structure and have identified financial partners for that purpose, securing pre-commercial and early commercial stage development capital is challenging. We are seeking non-dilutive development capital to reach our first milestones. Failure to secure this development investment is a risk to the overall business.

Potential supply chain issues for critical instrumentation and materials of construction:
We have experienced supply chain challenges and anticipate that we will continue to experience issues with materials such as stainless steel. In addition, key instrumentation to support the operation of the operating platforms and demonstration units has been delayed and could further delay the project timeline.

Delays in Permitting by Regulatory Authorities:
While we do not anticipate the level of permitting typically associated with land based and atmospheric carbon removal technologies, there are marine based permits that will be required. Any delay in the permitting process could result in delay of the project timeline

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

KCR is in the process of filing for a number of process and utilization patents that will support the integration of the technology stack. Our process is based on proprietary knowledge / intelligence & trade secrets, and we are working with patent attorneys to develop patents and other IP protection.

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?

We are a global, interdisciplinary team of professionals from the fields of biochemistry, ocean chemistry, oceanography, naval architecture, engineering, IT, business, and finance. Extremely skilled across critical domains, we represent a dynamic collaboration between academic training and field experience. Our unfair advantage is our obsessive drive for excellence and success. Multiple team members are already working full-time on this project at significant personal expense. We are always communicating; we never leave each other hanging on deadlines. We cultivate personal pride and ownership of the project. While we strive to continuously improve our practices, we are proud of the team's hard work and dedication to our vision. KCR's esprit de corps is a critical strength. Despite our distributed footprint, we communicate daily. This creates a close collaborative environment. Our engineers understand the business objectives; our commercial team understands the R&D objectives. We are looking to recruit marketing and communications talent, as well as a process engineer to bolster our systems integration design.

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.*	The expected timelines around the manufacture of the prototype spar platform is between April 2022 to April 2025 (phase 1) with the goal of removing 1 kilotonne of carbon as required by the XPrize competition.
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.*	Most Carbon Removal will take place post-deployment of our technology in the ocean, expected April 2024. Once the technology is in place it will begin carbon removal immediately and carry on for approximately 30 years until its replacement. Some CO_2 will be extracted and sequestered as part of the testing and early MVP development process.
Distribution of that carbon removal over time	Phase 2, after the XPRIZE Carbon Removal Project will continue for 10 or 20 years past that

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".	at several KT per year. A commercialization plan for MT scale and GT scale platforms will follow this KT scale Platform. Distribution of GT scale platforms along continental coastlines and island nations will produce an impact towards the IPCC goals of 10 gigatonnes per year by 2050.
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.*	Carbonate storage; 100-10,000 years. Bio-composites; 100-10,000 years Organic Bio-carbon storage; 100-750 Years.

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

The lower bound of our durability claimed is 100 years; the upper bound is 10,000 years. What carbon material that is not sold is converted to calcium carbonate and concrete.

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.)*

KRC is looking to produce products or intermediates with durability over time and are currently referencing the following paper https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_chapter6-1.pdf to provide an assessment of the durability of our products. Of course, when we reference "intermediates", this reflects that the intermediate will require some control as to whether it gets manufactured into a final product of greater durability. Recognizing the flux that is available in terms of the durability and risk of CO_2 re-emissions, the KRC R&D team will be putting together a program to monitor and assess the lifecycle carbon emissions of our products as well as a sample of the products our clients/customers are producing from our feedstocks in order to continually adjust and improve the durability of the CO_2 sequestration. Reference for above paper: Caldeira, K., Akai, M., Brewer, P. G., Chen, B., Haugan, P. M., Iwama, T., ... & Thomson, J. (2005). Ocean storage.

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 leading risk is damage to the platform structure from storms, high wind and waves, or collisions with vessels.

Adverse socioeconomic risks are low due to our offshore implementation. Construction and installation of modules will have the typical onshore concerns of ship building. Offshore, ship building, and maintenance infrastructure is available in the proposed areas of the Algarve. Increased industrial and human activity may have a socioeconomic cost. This cost will be offset by community and workforce development resulting from the project. Economic improvements to local communities through cleaner energy and water access and job creation will address any adverse impacts. Moving components from the harbor to deployment site will be another set of risks to be assessed.

The fundamental uncertainties in the underlying technological processes of carbon removal revolve around their integration and implementation in the marine environment. Our Chief engineer is a ship builder and is aware of the issues and solutions to external accretions of marine life on external surfaces. Internally, salt buildup and corrosion from seawater requires careful planning and operations.

The uncertainties of the biological processes surrounding the platform have been preliminarily assessed. Carbon removal from growing sea algae is a mature technology to be implemented around the platform as appropriate. Time for the biomass to build up and anomalous events that knock down growth are concerns to be addressed further.

To date, most of our work has been designing and integrating the modular infrastructure necessary to scale to the GT level. Global deployment requires replicable processes in order to meet and exceed the IPCC goals of 10 gigatonnes per year by 2050.

Current fundamental uncertainties pertain to accurizing our mass and energy balance equations, as well as process integrations.

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

The goal of KRC's carbon recapture activities is to convert the carbon into a state that is difficult to back-transform to CO_2. Our technology provides the energy and environment needed to force CO_2 reactions with other concentrated extractables generated by the spar platforms to produce carbon-rich products and intermediates. These products (e.g. $CaCO_3$, graphene) and intermediates (e.g. ethylene) will be further used towards the manufacture of value-added products with long lifespans and recyclable endpoints. The R&D team will undertake a lifecycle monitoring and assessment process that will directly test products, intermediates, and a selection of the manufactured products that our customers produce in order to determine durability and whether the carbon will eventually be emitted as CO_2. The intent of the lifecycle monitoring and assessment process is to continuously identify risks and work with customers to mitigate the risk that CO_2 will be re-released.

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	1,000 metric tonnes CO_2 / year
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	Our platform is designed to be carbon-negative. By generating its own power (roughly 32MW/day), we are able to estimate through the EPA carbon emissions calculator that we avoid the emission of roughly 4,900+ metric tonnes of CO_2 a year. For example, if we had used electricity/energy from conventional sources, we would have contributed to the emission of 4,900+ metric tonnes of CO_2 This assumes that we use all of the 32MW in our daily operations, which will not be the case as we intend to market the surplus electricity.

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)*

These numbers are derived from the gross water flow expected to move through the prototype spar platform. Gross water flow data is derived from the available literature as well as discussions with current OTEC power plant operators in Hawaii. As KRC's proprietary technology stack is a combination of established technologies utilized in a unique configuration, we defend our numbers through a number of scientific peer-reviewed literature and actual performance metrics of the individual pieces. We anticipate that we will be able to manage these individual components together, but until we do, this represents an area that is largely unknown. Please see the appendix for more detailed information.

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).

Our current capture and sequestration is measured in grams. We are at Technology Readiness Level 4. To support our Milestone application for the XPRIZE competition, we constructed a desktop-scale direct ocean capture unit for proof of concept (POC). This POC was verified through the Universidade do Algarve. The data is presently being leveraged through our work with Dassault Systemes, and we are using this data to confirm and refine simulation and engineering fidelity while we design a project plan for our Phase 1 MVP platform.

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.)*

Because the CO_2 is physically captured from seawater (e.g. not mechanically through membranes or via chemical processes), the principal limitation is the volumetric flow of water through the SPAR platform and the maintenance of the appropriate temperature differential needed to generate electricity via OTEC.

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.

- www.keplerrecapture.com
- Additional information regarding verification is provided in the "Verification" section in appendix A.
- Additional information regarding the modeling is provided in the "Simulation" section in appendix A.

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	1000 metric tonnes CO_2 / year
Gross project emissions	Negligible *Should correspond to the boundary conditions described below this table in 4(b) and*

	4(c)
Emissions / removal ratio	Our direct E / R ratio is 0. Because the platform only uses renewable energy inputs, our only emissions are those associated with platform construction and production, but not operations.
Net carbon removal	1000 metric tonnes CO_2 / year

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.

Please see appendix 4.b

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?

Please see appendix 4.c

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.

Please see appendix 4.d

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.

Please see appendix 4.e

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)

> The unit of deployment is in the form of a prototype spar platform that will remove and sequester between, 1 and 3.4 Kt of CO_2 /year.

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
2023	Prototype Spar	$150M	1000 tonne/unit	<50 words
2022	1 (MVP test platform)	$250,000	0.1 tonne/unit	This unit will be deployed for testing and technology validation purposes. While this testing is ongoing, the unit will remain operational, and will be capturing and sequestering CO2.
2021	0			The team formed in May 2021. Design was developed.
2020	0			

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

> Our direction of deploying on the Ocean means we are not subject to volatile real estate prices associated

with land based projects. The only cost change will be in scaling from kilotonne up to Gigatonne, other than that our development costs have been fairly stable up till now.

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)
1	1-3.4Kt tCO_2/unit

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 tonne 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 tonne of CO_2 today?

Projected costs are $1,650.00/tonne CO_2

b. Help us understand, in broad strokes, what's included vs excluded in the cost in 6(a) above. We don't need a breakdown of each, but rather an understanding of what's "in" versus "out." Consider describing your CAPEX/OPEX blend, non-levelized CAPEX costs, assumptions around energy costs, etc.

Projected costs assume zero energy costs, a 30 year platform lifecycle, total platform Capex of $150M, Opex costs of %1.5 Capex, and replacement costs of 15%. We have not included revenue from freshwater or energy sales.

c. How do you expect your costs to decline over time? Specifically, what do you estimate your cost range will be as you reach megatonne and then gigatonne 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.

KCR anticipates that the cost per tonne of CO_2 will decline over time principally because the larger platforms intended for the megatonne and gigatonne removal levels will be capable of increasing volumetric flows of water that is required to achieve the desired CO_2 removal.

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/tonne 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)

First generation platforms will be constructed from materials that have a carbon footprint greater than our planned materials, such as steel and Glass Fiber Reinforced Plastics (GFRP). With subsequent iterations of our design, renewable materials such as Bio-derived composites, such as hemp, flax, bamboo, and geopolymers, all of which will be produced on the larger Megatonne & Gigatonne scale platforms. The kilotonne platforms are too small to grow these precursor crops in order to produce these bio-composites. The geopolymer output will increase in quantity as our volumetric flow increases, as such the associated cost will drop. Cost of energy will also decrease as the volumetric flow increases, as OTEC relies upon mass flow of water through the system, so the more Carbon we remove from that water flow, the more energy we produce.

e. In a worst case scenario, what would your range of cost per tonne 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.

In the worst case scenario, our real costs per tonne of CO_2 removed would be roughly half again of the value we are currently estimating (~$2,500). Based on the lifetime of the platform, we calculate a worst case range of cost / tonne of $1450 - $2150. The reason for this is we have already been conservative in our estimates such that the current value is higher than calculated within a margin of error. Currently the estimates are extrapolated from large water processing plants and better estimates will be generated once the prototype has been deployed. Any increase over original estimates would be due to unforeseen or unanticipated events outside of our control.

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	MVP project - demonstration	While the processes and systems are all currently in use, they	Q3 2022	Construction and successful demonstration of

		have never been combined in this way. Systems integration in the MVP module will provide the parameters necessary for extrapolation to the KT scale platform.		carbon removal.
2	Building scale model for wave tank testing for design and stability verification	Marine environments are varied and dynamic and unpredictable. To ensure that the design will withstand the violent forces of the ocean, a wave tank test is necessary.	Q4 2022	Analysis of the stability of the overall prototype design and indications for improving the seaworthiness of the platform
3	Completed construction and launch of 1KT/year prototype platform	The majority of our net carbon removal will be produced by the platform.	Q4 2023	Deployment and implementation of the 1KT prototype spar platform

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	0-100 kg CO_2	100kg of CO_2	This is a proof of concept demonstration
2	100kg CO2 (from milestone 1)	0 CO2 removed	This is a non-functional scale platform model for ocean wave simulation, zero carbon will be removed as part of this step. Ongoing demonstration platforms may

			still be performing.
3	100kg CO2 (from milestone 1)	1000tonne of CO2	This is the first deployment of the functional prototype SPAR platform.

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

Milestone #	Anticipated cost/tonne prior to achieving milestone (ranges are acceptable)	Anticipated cost/tonne after achieving milestone (ranges are acceptable)	If those numbers are different, why? (100 words)
1	$1,650.00 per tonne CO_2 per year	$1,650.00 per tonne CO_2 per year	These milestones do not impact our costs as they are not included in the final output of 1kilotonne per year.
2	$1,650.00 per tonne CO_2 per year	$1,650.00 per tonne CO_2 per year	This milestone is not dependent upon removal of carbon, but validation of the seaworthiness of the platform design.
3	$1,650.00 per tonne CO_2 per year	$1,650.00 per tonne CO_2 per year	This is the final stage of our kilotonne phase, this is the point where our projected cost per tonne of Carbon will be met.

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?

I would ask Stripe to put us in touch with a founding executive team at Tesla or similarly ambitious manufacturing startup. Tesla embarked on a logistically-challenging project, where high levels of execution were necessary for success. I would love to learn more about how Tesla organized their priorities and project plan and implemented the right processes to encourage innovation while maintaining structure, growth, and team cohesion.

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

We would love to leverage Stripe's network to make connections with grassroots environmental and non-governmental organizations. Regulatory bodies like the California Coastal Commission will have to approve our project, and we would love to start developing those relationships now.

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.

Our external stakeholders include the Universidade do Algarve, due to its proximity to suitable test sites off the southern coast of Portugal, their desire to formally partner with our project, and their expertise in marine science and research. The Portuguese government is also exploring engagement with KCR in support of the Mar-Portugal Plan, after multiple positive conversations with municipal leaders, such as the mayor of Faro, in the Algarve region. We also have the Port of Portimao director and the Commandant of the Naval Police of Portimao. We also consider Dassault Systemes, headquartered in Paris, France, and AutoDesk, headquartered in San Rafael, California, as external stakeholders due to the time and energy they are investing to support our project development. We anticipate significant engagement with local communities to foster the development of the technical skills needed to build, operate, and maintain our platforms.

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.*

All engagement thus far has been performed in-house; we have cultivated relationships with local stakeholders who are helping carry the project further.

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?

Initial conversations with stakeholders indicated early that communities were more interested in our energy and water production capacity than carbon capture, as well as environmental impact concerns. Based on this feedback, KCR adjusted the process and platform design to increase water and energy capacity and create a more modular framework to allow for assembly at sea.

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?

Due to the size constraints of the first-generation platforms, there are many aspects of the project as a whole that have been placed on a back burner until the next, larger generation platform is ready. As the larger, subsequent platforms are built these other changes and components will be brought into play.

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?

The team has deliberately and concertedly created a closed loop system whose "waste products" are of high value. The operation of the project itself, being deployed offshore and generating its own electricity and other resources will have its primary impact on the marine environment, with increased noise level under water being the most dramatic. Water temperature variations, sea water content variations, and increased biological growth may also be significant, with mixed impacts. The construction of the demonstration platform is the primary onshore environmental impact. Offshore and ship building and maintenance infrastructure is already available in the proposed areas of Algarve. Increased industrial and human activity will have a natural impact that should be manageable by the community and the overall economic improvements brought by the project to only facilitate any foreseen or unforeseen detrimental impacts.

The key stakeholders will be the clients and the people who reside in the area being serviced by the platforms.

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

By working closely with universities and environmental groups to ensure these concerns are recognized and addressed. We also intend to survey and engage the local population to ensure that their perspectives are considered within the context of running and manning the platforms as well as the impact on local economies.

9. Legal and Regulatory Compliance (Criteria #7)

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

We have not obtained any formal legal opinions at this stage but anticipate seeking formal opinions in the near future as we progress into subsequent Technology Readiness Levels.

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.

We are currently working with key permitting authorities in Portugal in support of the initial deployment. We intend to work with appropriate agencies governing territorial waters in other geographies including EPA, Coastal Agencies, and Coast Guard.

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?

Yes, the project deployment and prototype operations are in Portugal. The team has been interacting with local officials from the municipalities and upwards from there. The Universidade do Algarve has offered support and facilities.

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.

Most of the project is expected to fall within existing regulatory guidance. And while we have the support of the local governance officials, the actual process and timelines are yet unknown.

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 have been received to date. None have been targeted and we have not researched any yet.

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*	1,000 metric tonnes CO_2 / year
Delivery window *at what point should Stripe consider your contract complete?*	Given how we are working to the Carbon Xprize timeframe to capture 1 kilotonne of CO_2 in one year, we will complete our kilotonne phase in April 2025
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.*	$1,650.00 USD per tonne of CO_2 captured

Application Supplement: Ocean

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

Physical Footprint (Criteria #1)

1. Describe the geography of your deployment, its relationship to coastlines, shipping channels, other human or animal activity, etc.

The primary test site is off the Algarve coast, Portugal. The deployment will be situated 5km off Faro, at the top of an undersea drop off to about 700m. The area is frequented by the local fishing fleet, however our platform footprint is minimal in comparison utilized by the fishing fleet. The site is also well away from shipping lanes. The area is also a transit zone for marine mammals, however our platform has little in way of hazards for larger marine animals. The disturbing of smaller marine life is mitigated with careful intake design.

2. Please describe your physical footprint in detail. Consider surface area, depth, expected interaction with ocean currents and upwelling/downwelling processes, etc.
    a. If you've also filled out the Biomass supplement and fully articulated these details there, simply write N/A.

The overall platform footprint is 160m diameter, scaling up to 500m diameter as more capacity is added. The draft of the platforms are 60-75m for the central spar, and 8-12m for the outer ring. However the cold deep ocean water required for our Augmented-OTEC, is from a minimum of 500m depth, this will be in the form of a pipe lowered to that depth.

3. Imagine, hypothetically, that you've scaled up and are sequestering 100Mt of CO_2/yr. Please project your footprint at that scale, considering the same attributes you did above (we recognize this has significant uncertainty, feel free to provide ranges and a brief description).
    a. If you've also filled out the Biomass supplement and fully articulated these details there, simply write N/A.

The above platform design is for Kt CO_2/year level. Our Mt CO_2 / year design has a footprint of 1.5km with a draft of 1km, and an above water height of 200m. This design is capable of housing 5-10,000 people, and capable of producing Terawatts of electricity, and billions of cubic meters of desalinated water, in addition to capturing 100+Mt CO_2/year.

Potential to Scale (Criteria #2 and #3)

4. Building large systems on or in the ocean is hard. What are your core engineering challenges and constraints? Is there any historical precedent for the work you propose?

The basic design of the elements of our platform are based upon existing offshore oil industry technology, however in our case the main challenge is building the platform in a carbon negative or carbon neutral manner. To this we are utilizing Bio-derived composite materials, Bioepoxy resins, Biological reinforcements such as hemp & flax fibers. The biggest issue with bio-composites is we can only use them for the kilotonne level platforms, for the Megatonne level we're developing geopolymers for the construction of the Mt platforms.

Externalities and Ecosystem Impacts (Criteria #7)

5. How will you quantify and monitor the impact of your solution on ocean ecosystems, specifically with respect to eutrophication and alkalinity/pH, and, if applicable, ocean turbidity?

Our design is expected to enhance the ocean ecosystem in the vicinity of the platform. Similar to marine structures deliberately placed in the ocean to attract marine species, our platform is highly likely to attract upper trophic level predators including commercial fish species that depend on each platform's specific location. A marine sampling program (CTD or AUV with sensor package) will determine any changes from historical baseline information and can be conducted monthly for the first year and biannually thereafter. We expect to reduce ocean acidification because of our fundamental design. Turbidity, oxygen, and pH measurements in the surrounding waters are an inherent part of our deployment strategies to meet capacity. Eutrophication is not expected with mixing rates and turbulence at the air sea interface significant to ensure a continued supply of oxygen to the upper layer. In short, systematic monitoring will allow us to quantify the health of the local ocean ecosystem, and assess oxygen, pH levels, and turbidity levels. We expect ecosystem enhancement with no significant local changes in oxygen, pH or turbidity.