General Application

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

Company or organization name

Ensyn Technologies Inc.

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

Ottawa (Ontario), Canada

Name of person filling out this application

J-C Amado, VP Finance and Corporate Development

Email address of person filling out this application

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Brief company or organization description

Biomass, the most abundant biological resource on Earth, is underutilized in current decarbonization solutions. Ensyn's RTP® fast pyrolysis technology is commercially proven to facilitate the efficient thermal conversion of biomass residues into products for low carbon fuel production and carbon sequestration, including biochar.

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.

The biochar produced using Ensyn's RTP® fast pyrolysis technology has a high degree of *devolatilization due to the high processing temperature in the RTP® process. This produces a biochar with a low oxygen content and a high fixed carbon content of 84.2wt%, making it an ideal product for permanent carbon sequestration applications such as soil enhancement, land remediation and bio-asphalt production.*

In this project, Ensyn proposes to produce and supply 120 metric tons of RTP® biochar for permanent carbon sequestration via bio-asphalt production in Canada. The biochar will originate from one of two RTP® facilities in Canada built by Ensyn and owned and operated by third-party groups. More specifically, the biochar is contained in a byproduct of the RTP® production process known as "RTP® filter cake". This RTP® filter cake is a carbon-rich, non-hazardous mixture with a biochar content of approximately 40% by weight.

Currently almost all road networks in Canada are surfaced with Hot-Mix Asphalt ("HMA") produced using petroleum-based binders. These conventional petroleum-based binders are highly carbon intensive products, and the production of HMA, where binders are mixed with aggregates, causes the release of volatiles and other air pollutants. To support Canada's transition to a low-carbon economy, finding cleaner, bio-based alternatives for asphalt production is essential. Due to its chemical stability and low vulnerability to oxidation, biochar is considered to be an effective, renewable asphalt binder (Zhao et al., 2014; Sanchez, et al., 2020).

The feedstock used in RTP® facilities includes forest residues from nearby sustainably harvested forests and plantations, and wood processing residues. A lifecycle Greenhouse Gas (GHG) emissions analysis by CAPOP Energy (now "Radicle", see https://radiclebalance.com/) on one of these RTP® facilities estimated that each dry metric ton of feedstock processed in the facility results in 89 kilograms of CO2e. Using the rated input and output capacity of that same facility, it follows that only 0.36 metric tons of CO2e are emitted to produce one metric ton of biochar. In addition, the use of biochar as a replacement for conventional, petroleum-based asphalt binders results in negative/avoided carbon emissions worth 0.025 metric tons of CO2e per ton of biochar added to asphalt mixes.

In this project, Ensyn is working with Dr. Xiomara Sanchez-Castillo from the University of New Brunswick and Canadian asphalt producers to replace petroleum-based binders with biochar. Recent research from Dr. Sanchez at the University of New Brunswick has shown that the use of biochar in asphalt mixtures can improve asphalt quality and durability, thus extending the service life of asphalt pavements and their capacity to withstand transportation loads and environmental stressors (Sanchez, et al., 2020). This project will leverage these recent findings and deploy a pilot application whereby RTP® biochar will be mixed with petroleum-based asphalt binders to produce bio-asphalt at incorporation rates of up to 20% by weight. The goal of this work will be to improve the current understanding of the physical characteristics of bio-asphalt produced with biochar and the scalability of bio-asphalt production with RTP® biochar in Canada.

On the basis of Ensyn's detailed analytical data on the biochar produced in existing RTP® facilities, it has been concluded that the Oxygen to Carbon (O/C) and Hydrogen to Carbon

(H/C) molar ratio values (0.09 and 0.43 respectively) are indicative of a highly stable carbon content. Using the confidence intervals for the equivalences between H/C molar ratios and long-term biogenic carbon storage values by the International Biochar Initiative (2013) it is estimated that 80% of the carbon mass in biochar results in long-term carbon removal. When used as a binder in bio-asphalt production, the stable carbon mass in RTP® biochar effectively "locks in" organic carbon in the asphalt mix applied to pavement on a permanent basis. This organic carbon remains stable even after the asphalt reaches the end of its service life when it is either demolished and returned to the geosphere or recycled to produce a new asphalt mix. Note that data from the asphalt industry indicates that in North America at least 95% of asphalt pavement removed from the road is either reused in new asphalt pavements or recycled as base or shoulder material (see Ontario Hot Mix Producers Association, 2010).

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.)*

Ensyn will purchase the biochar from one of two RTP® facilities located in Canada. Ensyn will contract a third-party trucking company to transport the biochar material to an asphalt production site. The asphalt producer will be responsible for handling and mixing the biochar with the asphalt binders and aggregates to produce bio-asphalt. The University of New Brunswick will provide analytical support to study the characteristics of the final bio-asphalt mix.

Ensyn is in the process of establishing confidentiality and commercial agreements with its project partners, including the RTP® facility that is to supply the biochar, as well as the final asphalt producer(s). As soon as these agreements are in place, Ensyn will be able to publicly disclose the names of its carbon removal partners.

Ensyn already has a partnership in place with University of New Brunswick. The bio-asphalt research laboratory headed by Dr. Xiomara Sanchez has the required physical resources and equipment to support this project.

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

Some uncertainty remains about the long-term stability of biochar, but the current application relies on detailed analytical data on RTP® biochar from woody biomass feedstocks produced in facilities using Ensyn's RTP® technology, as well as the latest knowledge about how to interpolate carbon stability from H/C and O/C molar ratios. For instance, using the confidence intervals for the equivalences between H/C molar ratios and long-term biogenic carbon storage values by the International Biochar Initiative (2013) it is estimated that at least 80% of the carbon mass in RTP® biochar results in permanent carbon removal (>1,000 years).

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

- *https://patents.google.com/patent/US5792340?oq=RTP+barry+freel*
- *https://patents.google.com/patent/US9670413?oq=RTP+barry+freel*
- *https://patents.google.com/patent/US8961743?oq=RTP+barry+freel*

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

a. Please fill out the table below.

	Timeline for Offer to Stripe
Project duration *Over what duration will you be actively running your DAC plant, spreading olivine, growing and sinking kelp, etc. to deliver on your offer to Stripe? E.g. Jun 2021 - Jun 2022. The end of this duration determines when Stripe will consider renewing our contract with you based on performance.*	*1 June 2021 – 31 May 2022*
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 2021 - Jun 2022 OR 500 years.*	*1 June 2021 – 31 May 2022*
Distribution of that carbon removal over time *For the time frame described above, please detail how you anticipate your carbon removal capacity will be distributed. E.g. “50% in year one, 25% each year thereafter” or “Evenly distributed over the whole time frame”. We’re asking here specifically about the physical carbon removal process here, NOT the “Project duration”. Indicate any uncertainties, eg “We anticipate a steady decline in annualized carbon removal from year one into the*	*100% in year 1*

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.*	*1,000 years*

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

On the basis of the 95% confidence interval provided by the International Biochar Initiative in its 'Biochar Stability Test Method' publication from 2013 the upper and lower bound values for the durability of RTP® biochar are 88.2% and 72.6% of the carbon mass sequestered respectively.

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.)*

Ensyn has completed detailed analyses on RTP® filter cake and RTP® biochar products. Each metric ton of filter cake contains approximately 40% biochar by weight. This biochar has a measured carbon content of 84.2% by mass. Its measured H/C and O/C molar ratios are 0.43 and 0.09 respectively. In line with the 95% confidence intervals for the equivalences between H/C molar ratios and long-term biogenic carbon removal values (>1,000 years) provided by the International Biochar Initiative in its 'Biochar Carbon Stability Test Method' publication of 2013, for a H/C molar ratio of 0.40 (the H/C molar ratio value for RTP® biochar is 0.43 rounded to the nearest 100th), the mean value for permanent carbon removal content is 80.5wt% of the carbon mass sequestered. The same publication concludes that no other assessment method is needed when biochar has an organic carbon content of at least 60wt%, and RTP® biochar has a very low inorganic ash content of 2.49wt%. Hence, it is estimated that each metric ton of RTP® biochar contained in RTP® filter cake results in 2.50 metric ton of CO2e of permanent carbon removal.

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?

Biochar durability and recalcitrance is a function of the nature of the pyrolysis process as well as the level of post-production oxidation. In Ensyn's RTP® fast pyrolysis process the biochar is not oxidized during production and is highly aromatic. This means its organic carbon content is very stable, and is not subject to oxidation and degradation in soil or in other products. This stability is confirmed by the measured O/C and H/C molar ratios of RTP® biochar.

In this project, Ensyn will work with the University of New Brunswick (Canada) and local asphalt producers to mix biochar with conventional asphalt binders to produce bio-asphalt, and therefore permanently sequester carbon in asphalt pavement. Existing operating standards and procedures and regulations for the asphalt industry in Canada will contribute to ensure carbon permanence in this project, since old asphalt is not combusted when it reaches its end of life, and is either rejunivated or recycled into other asphalt products. These measures will mitigate any potential physical leakage risk to the project.

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.)*

Ensyn has developed a full cradle-to-grave Chain of Custody system to track and report on quantities and sources of biomass feedstocks used to produce RTP® filter cake containing RTP® biochar, quantities and dates of RTP® filter cake shipments (including Bill of Lading documents and invoices) and final quantities and dates of RTP® filter cake delivered and sequestered. As part of the data monitoring and reporting system in place, Ensyn will provide completed Certificate of Analysis documents for each shipment of RTP® filter cake containing RTP® biochar with the appropriate elemental analysis to determine biochar quantities and confirm organic carbon stability. Finally, Ensyn is working with its commercial partners to establish on-site monitoring and reporting standards and practices for biochar additions to asphalt mixes. As mentioned above, University of New Brunswick will provide analytical support on final bio-asphalt mixes and end-uses.

In the future, Ensyn wishes to develop a fully digitalized system to track, trace, verify and sell/trade quantities of permanent carbon removal using Blockchain technology.

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	*300 tCO2e*
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	*A carbon lifecycle analysis of conventional asphalt products shows a carbon intensity of approximately 0.01 metric tons of CO2e per metric ton of asphalt. A large portion of these emissions would be avoided by replacing conventional, petroleum-based binders with biochar. See [Ontario Hot Mix Producers Association, 2010]*

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)*

In this project, Ensyn aims to purchase, transport and mix 300 metric tons of RTP® filter cake with asphalt binders to produce a bio-asphalt mix for application on surface pavements. Each metric ton of RTP® filter cake contains 40% RTP® biochar by weight. RTP® biochar contains 84.2wt% organic carbon. Based on the O/C and H/C molar ratio values for RTP® biochar, it is estimated that 80% of the organic carbon mass results in permanent carbon sequestration for over 1,000 years. It follows that each metric ton of RTP® biochar would result in the permanent carbon sequestration of 2.50 metric tons of CO2e based on the mean value of 95% confidence interval estimates provided by the International Biochar Initiative.

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).

Currently, the installed RTP® biochar capacity in Canada is equivalent to approximately 4,200 metric tons a year for a total permanent carbon removal potential of approximately 10,500 *metric tons of CO2e each year, using a permanent carbon removal factor of 2.50 metric tons of CO2e for each metric ton of RTP® biochar mixed in asphalt.*

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 estimates above are based on actual existing installed RTP® capacity in Canada and historical operating conditions in these facilities. If Ensyn were to purchase and incorporate in asphalt mixes the entire RTP® filter cake production available in Canada to produce bio-asphalt and generate permanent carbon removal credits, it would yield an approximate quantity of 10,500 metric tons of CO2e each year.

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.

- http://www.ensyn.com/ for more information about the *RTP® process*
- *Sanchez, et al., 2020 for details about biochar use in bio-asphalt production*
- *Zhao et al., 2014 for details about biochar use in bio-asphalt production*

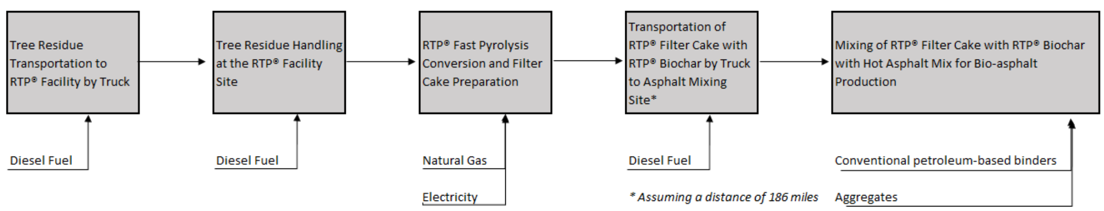
4. Net Capacity / Life Cycle Analysis (Criteria #6 and Criteria #8)

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	*300 metric tons*
Gross project emissions	*40 metric tons*
Emissions / removal ratio	*0.132*

Net carbon removal	*260 metric tons*

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



All carbon flows and sources provided are based on estimates from a third party carbon lifecycle analysis conducted by Radicle on an existing RTP® facility in 2019.

- *Tree residue transportation to RTP® facility by truck and tree residue handling at the RTP® facility = 26 kilograms of CO2e per metric ton of biomass feedstock processed*
- *RTP® fast pyrolysis conversion and filter cake preparation = 63 kilograms of CO2e per metric ton of biomass feedstock processed*
- *Transportation of RTP® filter cake containing RTP® biochar to asphalt mixing location by diesel truck assuming a distance of 186 miles = 25 kilograms of CO2e per metric ton of RTP® filter cake*
- *Mixing of RTP® filter cake containing RTP® biochar with asphalt mix = avoided emissions of 0.01 metric ton of CO2e per metric ton of filter cake*

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 RTP® facilities from which Ensyn will procure the RTP® biochar use tree residues from lumber mills that process forest or managed plantations, namely sawdust and other woody debris generated during milling operations. These residues require no additional processing before delivery to the RTP® facilities. In this carbon lifecycle analysis these tree residues are treated as low-value residual products that account for a very small fraction of a lumber mill's total output both in terms of mass and revenues. Any upstream energy use and emissions from logging and sawmill operations would therefore be de minimis once allocated to sawdust used in the RTP® facilities on either a mass or a revenue basis. Therefore these wood residues are considered to be carbon neutral at the point at which they are mobilized at the site of a lumber mill for transportation to the RTP® facility.

The carbon lifecycle analysis used in this proposal starts with the loading and transportation of tree residues to the RTP® facility by truck. At the lumber mill sites where they originate, tree *residues are delivered automatically to the sawdust storage bin through a conveyance system designed to clear the milling area of sawdust. From the bin they are loaded onto walking floor trailers using front-end loaders through an expedient process. Carbon emissions for the tree residue handling and loading process at lumber mill sites are based on diesel-run equipment used and run-time estimates from personnel familiar with these activities. Transportation from the lumber mills to the RTP® facility is done by truck with an estimated average distance between mill sites and RTP® facilities of 55 miles. The estimate assumes a feedstock moisture content of approximately 45%. Note that one of the RTP® facilities located in Canada is adjacent to a sawmill, and therefore has no biomass transportation-related carbon emissions.*

On-site at the RTP® facility tree residues arrive via truck with walking floor style trailers, and are typically offloaded directly into the receiving unit of the facility. However, depending on plant operations and feedstock availability, some loads are deposited in a temporary storage location nearby, and then transferred to the receiving unit using front end loaders. The average diesel fuel use for on-site residue handling is based on historical operations.

The RTP® conversion process is almost completely energy self-sufficient. Co-products such as the non-condensable gas generated by the RTP® fast pyrolysis process are burned for process heat, leaving only a small fraction of process heat requirements to be supplied by an external energy source such as natural gas. Natural gas use is therefore limited to water and air heating, and process heat requirements when the plant is shut down and needs to be restarted. On average these start-ups only occur 3 to 4 times a year. Electricity use comes from the local distributor and benefits from a very low carbon grid intensity. Carbon emissions associated with natural gas and electricity use are based on historical operating data.

In this project, the RTP® filter cake containing the RTP® biochar will be packaged into super sack bags and prepared for shipping, loaded onto trucks and transported to an asphalt mixing site by truck, where it will be offloaded for final mixing. This carbon lifecycle analysis assumes that transportation of the final RTP® product to the asphalt mixing site will occur over a distance of 186 miles, which will be subject to final commercial agreements with asphalt producers. Note that each metric ton of RTP® filter cake mixed is assumed to displace the embodied carbon emissions of conventional, fossil-based asphalt binders, resulting in some negative carbon emissions.

d. Please justify all numbers used in your diagram above. Are they solely modeled or have you measured them directly? Have they been independently measured? Your answers can include references to peer-reviewed publications, e.g. Climeworks LCA paper.

The carbon lifecycle analysis estimates provided are based on a third party Greenhouse Gas emissions calculation provided by CAPOP Energy (now "Radicle", see https://radiclebalance.com/) in 2019 on an existing RTP® facility in Canada. The document is not available for public release, but Ensyn will be able to share it with Stripe to demonstrate the robustness of its lifecycle carbon emission estimates.

For the avoided carbon emissions related to the displacement of conventional, fossil-based asphalt binders with biochar, see Ontario Hot Mix Producers Association, 2010

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

See above

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

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

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

Number of standalone RTP® facilities

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

Year	Units deployed (#)	Unit cost ($/unit)	Unit gross capacity (tCO_2/unit)	Notes
2018	1 *RTP® facility with a biomass input capacity of 200 metric tons a day*	US$80 million	9,200tCO2e in total permanent carbon removal potential / year	*Unit cost refers to the approximate historical, non inflation-adjusted construction cost for the facility*
2006	1 *RTP® facility with a biomass input capacity of 60 metric tons a day*	US$30 million	1,300tCO2e in total permanent carbon removal potential / year	*Unit cost refers to the approximate historical, non inflation-adjusted construction cost for the facility*

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.*)

Ensyn is working to expand its RTP® production capacity in North America with new facilities in strategic locations where an abundant supply of low-grade biomass residuals exists. As part of this plan, Ensyn aims to increase the biochar production capacity of future RTP® facilities. Its next generation of RTP® facilities will have a biomass input capacity similar to the existing largest RTP® facility, but will generate up to 1.70x times the quantity of high quality RTP® biochar thanks to improvements in facility design and biochar handling.

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**	*300*tCO2e in total gross permanent carbon removal potential / year*

** In this pilot project, the RTP® biochar will be procured from an existing RTP® facility in Canada. However, Ensyn is looking to reach Final Investment Decision on a new RTP® facility in Eastern Canada, and the intent is that a portion of the forecasted production and revenue stream for this new facility would be biochar for bio-asphalt production. Sales of Carbon Removal Credits to Stripe under this project would play an essential role in confirming project financing as an indication of viability of the business model and forecast for biochar and Carbon Removal Credit sales for this new project.*

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

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

a. What is your cost per ton CO_2 today?

$600 / metric ton of CO2e

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."

Ensyn's business model for biochar sales is scalable so long as there is a viable way to *monetize the permanent carbon removal benefits of using biochar in hot asphalt mixes. Until the performance of bio-asphalts produced with biochar is established at commercial volumes, asphalt producers will not pay premium prices for biochar as a renewable alternative to conventional asphalt binders. The Carbon Removal Credit revenues from this project will enable to cover the costs of purchasing the RTP® filter cake from RTP® facilities, including the associated cost of handling and preparing the RTP® filter cake for shipping, transporting the RTP® filter cake to asphalt mixing sites, and incentivizing asphalt producers to incorporate biochar in their asphalt mixes. It will also provide the necessary resources to cover time and material costs for the researchers at University of New Brunswick to provide analytical support.*

The long-term business model is that asphalt producers would pay for biochar as a green alternative to their conventional, fossil-based binders, thus reducing the price of Carbon Removal Credits with a target price of $300 to $100 per metric ton of CO2e. We also expect this to be possible thanks to increasing carbon costs on fossil fuels and derived asphalt binders projected in Canada and the rest of North America over the coming years.

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

Milestone #	Milestone description	Why is this milestone important to your ability to scale? (200 words)	Target for achievement (eg Q4 2021)	How could we verify that you've achieved this milestone?
1	*Carbon Removal Credit purchase agreement with Stripe*	*This is an essential financing pre-requisite for the completion of final commercial agreements with asphalt producers for this pilot project*	Q1 2021	
2	*Execution of final commercial agreements with asphalt producers for the sale and transfer of biochar for use as an asphalt binder*	*It will establish the necessary commercial terms and conditions for the sale of biochar as an asphalt binder to ashphalt producers*	Q2 2021	*We can share final commercial agreements with asphalt producers*
3	*Completion of first commercial scale carbon*	*Project results should spur asphalt producers to*	Q2 2022	*We can share the final Chain of Custody*

	sequestration pilot in asphalt in Canada and negotiation of long-term offtake agreements with buyers	*establish long-term offtake agreements for biochar with a pricing structure that accounts for Ensyn's ability to monetize permanent carbon sequestration benefits through the sales of Carbon Removal credits*		*documentation and final analytical results on the biochar mixed in asphalt and the final bio-asphalt produced with biochar*

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

Milestone #	Anticipated total gross capacity prior to achieving milestone (ranges are acceptable)	Anticipated total gross capacity after achieving milestone (ranges are acceptable)	If those numbers are different, why? (100 words)
1	*0*	*0*	*<100 words*
2	*0*	*0 to 260 metric tons of CO2e*	*Completion of the purchase agreement with Stripe is the essential condition to execute and realize permanent carbon removal in bio-asphalt production*
3	*260 metric tons of CO2e*	*1,000 to 10,500 metric tons of CO2e per year*	*Once completion of this pilot project, and after demonstration of the commercial scalability of biochar use in asphalt mixes, Ensyn intends on fully commercializing this permanent carbon removal pathway up to the current installed capacity for RTP® filter cake and biochar in Canada*

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

Milestone #	Anticipated cost/ton prior to achieving milestone (ranges are acceptable)	Anticipated cost/ton after achieving milestone (ranges are acceptable)	If those numbers are different, why? (100 words)
1	*$600 per metric ton of CO2e*	*$600 per metric ton of CO2e*	
2	*$600 per metric ton of CO2e*	*$600 per metric ton of CO2e*	
3	*$600 per metric ton of CO2e*	*$100 to $300 per metric ton of CO2e*	*Upon demonstration of the commercial scalability of biochar use in asphalt mixes, Ensyn anticipates that biochar pricing will integrate not just permanent carbon removal benefits but also current asphalt binder pricing and implied biochar transportation costs, so that a smaller portion of the full product price is borne by Carbon Removal Credit buyers*

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

Apart from Stripe's role in providing an essential revenue stream for the permanent carbon removal benefits of replacing conventional, petroleum-based asphalt binders with biochar, governments can play a critical role in incentivizing bio-materials like bio-asphalts via public procurement rules and requirements for construction materials. Some government authorities are starting to encourage the construction industry to green their production processes and materials, and some procurement policies and standards are starting to integrate green standards to effect positive change. Much more needs to be done though, including setting appropriate price signals that compensate green alternatives like biochar for asphalt.

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

Stripe's role in disseminating information about scalable and impactful carbon removal solutions, such as this one, is important to influence governments and other companies in

taking more aggressive climate actions.

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

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

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

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

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

Key stakeholders for this project include asphalt producers and industry groups, local governments and local residents where bio-asphalt will be produced and applied to surface pavement. We also consider employees in and local residents around RTP® facilities as our stakeholders. This is the result of a stakeholder mapping assessment considering all interests involved in this project.

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

The stakeholder mapping assessment for this project has been done in-house drawing from our experience building RTP® facilities in Canada and selling RTP® products for decarbonization market applications.

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

One of the early lessons learnt from our stakeholder mapping assessment is that active, meaningful engagement of asphalt producers is key to understanding their asphalt binder requirements, pricing sensitivity and interest in developing new bio-asphalt mixes. As a result, we have established a long-term engagement process with asphalt producers and University of New Brunswick whereby thanks to Carbon Removal Credit sales we will be looking for opportunities to deploy this bio-asphalt production pathway at no additional cost to asphalt producers, and provide the required analytical support to study the biophysical characteristics of the final bio-asphalt product.

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 a need to fully engage with local government authorities and/or private owners where the final bio-asphalt product will be applied to surface pavements once the final asphalt mixing location and asphalt producing partner has been selected. This will include providing existing data and information on the proven durability and performance of bio-asphalt produced with biochar, drawing from research outputs by the University of New Brunswick.

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

The use of biomass residues in RTP® facilities as well as the use of RTP® biochar in asphalt production are relatively non-contentious opportunities to deliver immediate net zero carbon benefits in the construction sector, with no negative environmental or equity consequences.

11. Legal and Regulatory Compliance (Criteria #7)

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

Ensyn has consulted local asphalt producers and industry experts in Canada about the use of biochar in asphalt mixes. Local rules about asphalt specifications vary across cities, but generally speaking it is possible to mix small quantities of biochar in asphalt mixes for certain pavement end uses.

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

No permitting is required but there will be a need to confirm with asphalt producers and local government authorities the quantity of biochar allowed, and the authorized end-uses for the final bio-asphalt.

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

Biochar being a new product for asphalt producers, there are no explicit rules around its use in hot asphalt mixes. Working with asphalt producers, Ensyn will establish with targeted local governments the allowed quantities of biochar in asphalt mixes, as well as the authorised pavement end-uses for the bio-asphalt produced.

12. Offer to Stripe

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

	Offer to Stripe
Net carbon removal (metric tonnes CO_2)	*260 metric tons*
Delivery window (at what point should Stripe consider your contract complete?)	*Between June 1, 2021, and May 31, 2022*
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.*	*$600 / metric ton*

Application Supplement: Biomass

Feedstock and Physical Footprint (Criteria #1)

1. What type of biomass does your project rely on?

The project will rely on RTP® biochar produced from tree residues sourced from wood processing operations (e.g. sawmills), as well as sustainable harvested forests and managed plantations. Ensyn's biomass sourcing philosophy relies on using exclusively sustainable, low-grade residual biomass that would otherwise be left to decompose or combusted and result in near-term carbon emissions.

2. Are you growing that biomass yourself, or procuring it, and from whom?

RTP® facilities in Canada procure the residual biomass from either sawmills or directly from harvesters. Ensyn has full Chain of Custody documentation for the biomass used to produce RTP® products. Canada has some of the world's most stringent forest management standards and practices in place, and all of Ensyn's RTP® products are sourced from sustainably harvested biomass.

3. Please fill out the table below regarding your feedstock's physical footprint. If you don't know (e.g. you procure your biomass from a seller who doesn't communicate their land use), indicate that in the table.

	Area of land or sea (km^2) in 2021	**Competing/existing project area use (if applicable)**
Feedstock cultivation	*N/A (Procuring residual biomass from third parties)*	*None*
Processing	*RTP® facilities in Canada occupy a land area of approximately 3 to 5 acres (0.01 to 0.02 km2) on existing industrial sites*	*None - RTP® facilities are sited on industrial sites, adjacent to existing facilities with available biomass residuals, such as sawmills or pulp mills*
Long-term Storage	*RTP® filter cake are prepared, conditioned and stored on-site in super sack bags so they are ready for transportation*	*None*

	Final mixing of RTP® filter cake in asphalt will occur in existing asphalt production sites	

4. Imagine, hypothetically, that you've scaled up and are sequestering 100Mt of CO_2/yr. Please project your footprint at that scale (we recognize this has significant uncertainty, feel free to provide ranges and a brief description).

	Projected # of km^2 enabling 100Mt/yr	**Projected competing project area use (if applicable)**
Feedstock cultivation	*Not applicable - biochar production would occur in RTP® facilities that primarily produce low-carbon fuels from biomass. As such, biochar production in RTP® facilities is a by-product stream that is minimal compared to low carbon fuel outputs either on a revenue or mass basis*	*None - RTP® facilities only use residual biomass streams*
Processing	*Not applicable - biochar production would occur in RTP® facilities that primarily produce low-carbon fuels from biomass. The production and preparation of RTP® biochar products would require minimal additional space*	*None - RTP® facilities are sited on industrial sites, adjacent to existing facilities with available biomass residuals, such as sawmills or pulp mills* *Final biochar mixing in asphalt will occur in existing asphalt production sites*
Long-term Storage	*The storage of RTP® biochar products would require minimal additional space in existing facilities*	*None - RTP® facilities are sited on industrial sites, adjacent to existing facilities with available biomass residuals, such as sawmills or pulp mills* *Final biochar mixing in asphalt will occur in existing asphalt production sites*

Permanence, Additionality, Ecosystem Impacts (Criteria #4, #6, and #7)

5. How is your biomass processed to ensure its permanence? What inputs does this process require (e.g. energy, water) and how do you source these inputs? (You should have already included their associated carbon intensities in your LCA in Section 6.)

All relevant information about the lifecycle impact of our production process is provided in Section 6.

6. (Criteria 6) If you didn't exist, what's the alternative use(s) of your feedstock? What factors would determine this outcome? *(E.g. Alternative uses for biomass include X & Y. We are currently the only party willing to pay for this biomass resource. It's not clear how X & Y would compete for the biomass resources we use.* OR *Biomass resources would not have been produced but for our project.)*

Existing RTP® facilities only source low-grade residual biomass that would otherwise be left to decompose or combusted for energy. It follows that RTP® products, including biochar, result in immediate avoided carbon emissions in addition to permanent carbon removal.

7. We recognize that both biomass production and biomass storage can have complex interactions with ecological, social, and economic systems. What are the specific negative impacts (or important unknowns) you have identified, and what are your specific plans for mitigating those impacts (or resolving the unknowns)? *(200 words)*

Not relevant - RTP® facilities source little to no biomass feedstock on-site. Biomass storage occurs earlier on in the production chain at the site of sawmills, pulp mills or harvested woodlots. RTP® filter cake containing RTP® biochar is packaged in super sack bags, and its storage requires little space.

8. Biomass-based solutions are currently being deployed around the world. Please discuss the merits and advantages of your solution in comparison to other approaches in this space.

We believe this solution for biochar-based permanent carbon removal stands out with its innovation and potential for scale up and uptake across the world. Asphalt pavement is a large source of carbon emissions and other pollutants, and currently there is little to no renewable alternative to conventional, petroleum-based asphalt binders. Furthermore, by virtue of existing pavement disposal and recycling practices in place in Western countries, especially North America, there is little risk of carbon leakage since more than 95% of asphalt pavement is re-used and/or recycled.