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ECOERA (via Puro.earth)

APPLICATION FOR STRIPE 2020 NEGATIVE EMISSIONS PURCHASE

Section 1: Project Info and Core Approach

1. Project name

ECOERA Millennium Biochar Carbon Removal

2. Project description. ***Max 10 words***

Biochar production from PYREG P500 and PYREG P1500

3. Please describe your negative emissions solution in detail, making sure to cover the following points:
   a) Provide a technical explanation of the project, including demonstrations of success so far (preferably including data), and future development plans. Try to be as specific as possible: all relevant site locations (e.g. geographic regions), scale, timeline, etc. Feel free to include figures/diagrams if helpful. Be sure to discuss your key assumptions and constraints.
   b) If your primary role is to enable other underlying project(s) (e.g. you are a project coordinator or monitoring service), describe both the core underlying technology/approach with project-specific details (site locations, scale, timeline, etc.), and describe the function provided by your company/organization with respect to the underlying technology/approach.
   c) Please include or link to supplemental data and relevant references.

Max 1,500 words *(feel free to include figures)*

One PYREG 500 pyrolysis unit
One PYREG P1500 pyrolysis unit
Currently the largest biochar production facility in the EU. State of the art technology from leading pyrolysis technology supplier PYREG GmbH.
Feedstock: biomass residues from an award winning pellet facility (Stemming from our BIOAGRO project awarded "Best of the best" by the EU Commission in 2011.)

Produces a total of 2000 tonnes of EBC (European Biochar Certificate) certified biochar per year along with district heating. Generates a +5000 tonnes CO2eq per year of carbon sink. (2,57 tonnes CO2eq per tonne biochar.)
The system is possible to be replicated at many new sites and the process is started to establish one in west

sweden with approximately the same capacity.

ECOERA does not own the pyrolysis technology infrastructure, but we are a subsidiary to the owner of the infrastructure Skånefrö. ECOERA has a power of attorney right to the carbon sink and has been selling biochar carbon sink certificates for + 5 years. Our cash flow enables the work to establish new biochar production sites and support sustainable agriculture using biochar as a soil amendment.

An overview of the production facility can be viewed here: https://vimeo.com/387794862

Section 2: 2020 Net-Negative Sequestration Volume

See Stripe Purchase Criteria 1: The project has volume available for purchase in 2020.

4. Based on the above, please estimate the **total net-negative sequestration volume** of your project (and/or the underlying technology) in 2020, in tons of CO2. (Note: We're looking for the net negative amount sequestered here, net lifecycle emissions. In Section 3; you'll discuss your lifecycle and why this number is what it is).

5000

5. Please estimate how many of those tons are still available for purchase in 2020 (i.e. how many tons not yet committed). This may or may not be the same as the number above.

2000

6. (Optional) Provide any other detail or explanation on the above numbers if it'd be helpful. ***Max 100 words.***

We are having two large industrial customers to purchase our current certificates and we reserve volume for those customers.

Section 3: Life Cycle Analysis

See Stripe Purchase Criteria 2: The project has a carbon negative complete lifecycle (including energy use, etc).

7. Provide a life cycle analysis of your negative emissions solution demonstrating its carbon negativity, as complete as possible given limited space, and making sure to cover the following points:

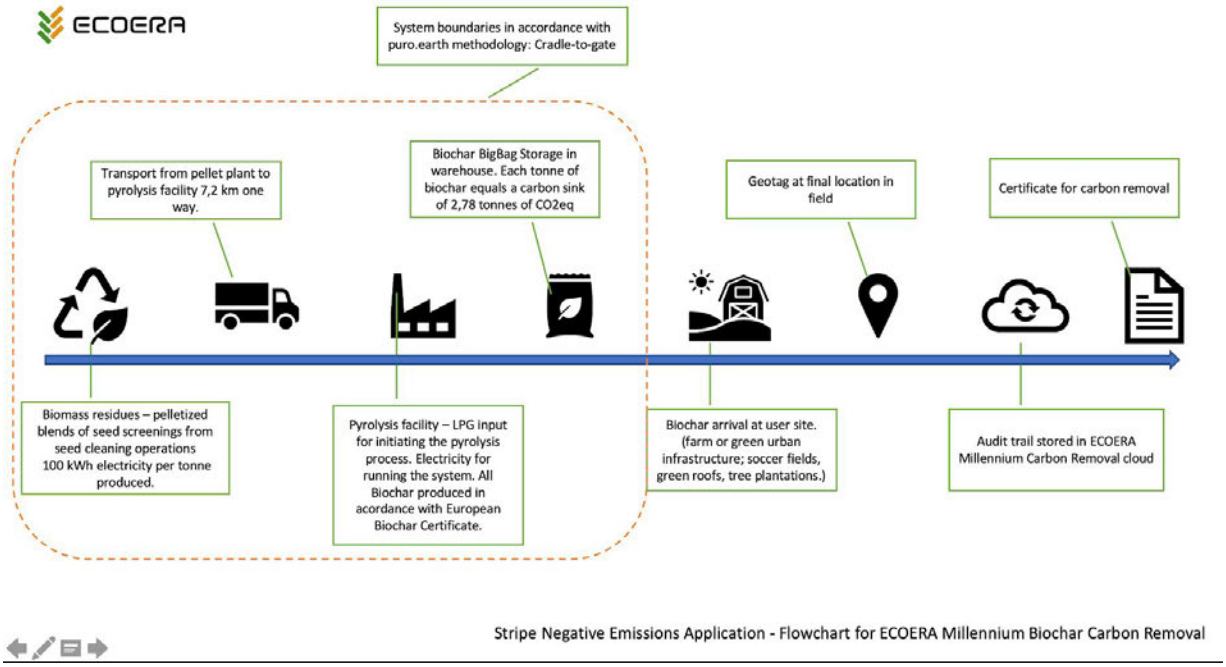
a) Include a flow sheet diagram of direct ingoing and outgoing flows (GHG, energy, materials, etc) that bear on the LCA.
b) Please be explicit about the boundary conditions of your LCA, and implications of those boundaries on your life cycle. Let us know why the conditions you've set are appropriate to analyze your project.
c) Make sure to identify assumptions, limitations, constraints, or factors that relate to ingoing and outgoing flows, citing values and sources (for example: land and resource scarcity, limitations on a required chemical, energy requirements). Also identify key sources of uncertainty in determining these values.
d) If your solution results in non-CO2 GHG emissions, please be sure to separately specify that (e.g. in units of GWP 20 or 100 years, ideally both).
e) For solutions that rely on modular components (for example: incoming energy flows or outgoing CO2 streams), feel free to cite values associated with those interfaces instead of fully explaining those

components. For these values, please identify the upstream and downstream life cycle emissions of the component.

f) Explain how you would approach a more comprehensive LCA by citing references and underlying data needed for the analysis.

Max 1,000 words *(feel free to include figures or link to an external PDF)*

A: Flow sheet: Flow Chart ECOERA Millennium Biochar Carbon Removal



Stripe Negative Emissions Application - Flowchart for ECOERA Millennium Biochar Carbon Removal

B: The system boundary is as required by Puro.earth Cradle-to-gate i.e. from the point of biomass residue creation in the grain crops production to the storing of the biochar product in our warehouse. Boundary conditions: we do not include the transportation of the crops taken into the cleaning facility as these would be transported regardless, and also accounted for in another business operation (grain crops production).

C: We are assuming the biomass residues would - if not converted to biochar - be used for either direct burning or landfill. We limit the system to the creation of the biomass residue to the storing of biochar in our warehouse. After production, the transport emission from gate is to be considered the be customer's responsibility. We assume the energy consumption and thus emissions from the crops residue pellet production is in the same level as wood pellet production. (The biomass is however softer/smoother than wood, rendering in a real lower energy use than wood pellet production.)

Pre-treatment:
The production of the pelleted material is made using electricity from renewable sources. The pelleting is done to make the transport of crop biomass residues more efficient as seen below. A pelleting plant needs electric energy mainly for the milling and the densification of raw material. The amount of electricity needed can vary between 100 to 200 kWh per ton of produced pellets, depending on the raw material used. (EUBIA, 2014; Obernberger & Thek, 2010). In this case we have a soft material, needing less pressure on the pelleting die. We therefore assume 100kWh/tonne of pellet produced. Meaning approx 300kWh/tonne resulting biochar at a 30% conversion rate from biomass residue to biochar. The nordic energy mix has 0,125 kg

CO2eq/kWh. The emission per tonne biochar produced is therefore:
300 * 0,125 = 37,5kg CO2eq = 0,0375 tonnes CO2eq per tonne biochar.

Transport:
The transport of the biomass pellets is 7,2 km one way. This is 5,27 kg CO2eq per trip. (Ref. Swedish EPA) Meaning 10,6 kg CO2eq per round trip. These transports carry 35 tonnes of biomass pellets. This equals approx 10,5 tonnes of biochar at conversion of about 30%. Each tonne of biochar produced requires 1 kg CO2eq per tonne in transport emissions.

Production:
The biochar production is generating a process gas, which is combusted in a so called FLOX burner. The heat is returned to facilitate the continuous pyrolysis process and the excess heat is transferred to a district heating grid warming homes in the nearby village. The startup of the units require LPG as of today, but this will be changed to liquid biogas (from anaerobic digestion) to use a renewable alternative. The LPG emissions are included in the system boundary.

We are using 0,125 kg CO2eq/kWh in the nordic energy mix. (reference Swedish EPA)) 15 kW electricity consumption for conveyors and pyrolysis equal 112500 kWh/year.
This equals 14 tonnes CO2eq per year. Given a production volume of 2000 tonnes per year, each tonne of biochar produced produces 0,007 tonnes of CO2eq from electricity generation.

Carbon Sink
Each tonne of biochar has 78% carbon content.
The stability is calculated using O/C ratio.
A O/C ratio below 0,2 indicates a half life over 1000 years. The biochar produced in our facility has a O/C ratio of 0,039. One could assume it would be 5 times more stable than a biochar of a ratio of 0,2. However, we use an uncertainty principle and assume conservatively it is twice as stable, meaning a half life of over 2000 (two thousand) years.

We therefore assume the carbon sequestered in the biochar to be very near permanent.

The biochar produced amounts to approx 2000 tonnes per year. The carbon content is 78% and given a high near permanent stability we assume this to generate a carbon sink of 3,67 * 0,78 = 2,86 tonnes CO2eq per tonne biochar. Puro.earth methodology uses a buffer of 2,5% for biochar with stability factor O/C below 0,2 . 2,86 * 0,975 = 2,7885 tonnes CO2eq/tonne biochar.

Final carbon storage and shipping.
On the user side, we assume that containers shipped to private customers can not be traced properly and therefore possibly burned if the biochar in a pot of soil is discarded in a normal trash bin.
Therefore we use only biochar shipped to business customers through the big bag format. We trace the biochar to the physical location of the customer where biochar was applied. In some cases we can also use drone monitoring ECOERA Millennium CarbonEyes™ when delivering to a farm site, where the biochar is added to the agricultural soils.

The transport emission from our warehouse gate to the customer is to be considered the customer's responsibility and accounted for in his carbon footprint.

Negative emissions:
-2,7885 tonnes CO2eq embodied per tonne biochar + 0,0375 tonnes (electricity pre-treatment) + 0,001 tonnes (transport) + 0,007 tonnes (electricity pyrolysis) = **-2,743 tonnes CO2eq sequestered per tonne biochar.**

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References:

Greenhouse gas emissions for Swedish pellet production.
http://pelletsforbundet.se/wp-content/uploads/2015/01/IVL-V%C3%A4xthusgasemissioner-f%C3%B6r-svensk-pelletsproduktion.pdf

Swedish Environmental Protection Agency - Emissions from heavy duty transport:
https://www.naturvardsverket.se/Stod-i-miljoarbetet/Vagledningar/Luft-och-klimat/Berakna-dina-klimatutslapp/

Swedish Environmental Protection Agency - Emissions from fuel sources.
https://www.naturvardsverket.se/upload/stod-i-miljoarbetet/bidrag-och-ersattning/bidrag/klimatklivet/berakna-utslappsminskning-vagledning-klimatklivet-2018-09-04.pdf

World Biomass Association: Energy use for pellet production:
https://worldbioenergy.org/uploads/Factsheet%20-%20Pellets.pdf

European Biochar Certificate - Guideline for a Sustaionable Production of Biochar
http://www.european-biochar.org/biochar/media/doc/ebc-guidelines.pdf

Puro.earth methodology for quantification of carbon sequestered in biochar
https://puro.earth/supplier-verification/

8. Based on the above, for your project, what is the ratio of emissions produced as any part of your project life cycle to CO2 removal from the atmosphere? For true negative emissions solutions, we'd expect this ratio to be less than 1.

0,016

Section 4: Permanence and Durability

See Stripe Purchase Criteria 3: The project provides durable, long-term storage of carbon.

9. Provide an upper and lower bound on the likely durability / permanence of sequestered carbon provided by your project, in years:

500 - 4000 years

10. Please provide a justification for your estimates, and describe sources of uncertainty related to: the form of storage, effects of environmental or climatic variability, difficulty in monitoring or quantification, etc. Specifically, discuss the risks to permanence for your project, the estimated severity/frequency of those risks (e.g. 10% of the acres of forest in this forest type are burned by fire over a 100 year period), and the time-horizon of permanence given those risks.

Max 500 words

Each tonne of biochar has 78% carbon content. The stability is calculated using O/C ratio. A O/C ratio below 0,2 indicates a half life over 1000 years. The biochar produced in our facility has a O/C ratio of 0,039. One could assume it would be 5 times more stable than a biochar of a ratio of 0,2. However, we use an uncertainty principle and assume conservatively it is twice as stable, meaning a half life of over 2000 (two thousand) years.
We therefore assume the carbon sequestered in the biochar to be very near permanent.
Reference: O/C ratio in an analysis from Eurofins (as basis for European Biochar Certificate):

https://skanefro.se/wp-content/uploads/biokolsanalys-till-hemsida.pdf

Section 5: Verification and Accounting

See Stripe Purchase Criteria 4: The project uses scientifically rigorous and transparent methods to verify that they're storing the carbon that they claim, over the period of time they claim to.

11. Provide detailed plans for how you will measure, report, and verify the negative emissions you are offering. Describe key sources of uncertainty associated with your monitoring, and how you plan to overcome them.
Max 500 words

We are using the PURO.earth methodology for verification and accounting. The audit will be done by DNV GL as suggested by PURO.earth. Puro methodology for biochar is based on carbon footprint LCA cradle-to-gate and laboratory test results of biochar (Corg content, H/C).

12. Explain your precise claim to ownership of the negative emissions that you are offering. In particular, explain your ownership claim: 1) in cases in which your solution indirectly enables the direct negative emissions technology and 2) when, based on the LCA above, your solution relies on an additional upstream or downstream activity before resulting in negative emissions. Please address the notion of "double counting" if applicable to your project, and how you'll prevent it.
Max 200 words

We are owning the carbon sink generated from the facility at Hammenhög. Location: 55.506702, 14.154831. The Biochar stored in big bags and delivered to business customers is the basis for the sink in this calculation.

Double counting is prevented by Puro.earth rules. When the carbon removal attribute is attached from the physical biochar product, the physical product is then accounted for as carbon neutral. The verification process checks that the packages or web-page do not present biochar as carbon net-negative.

Section 6: Potential Risks

This section aims to capture Stripe Purchase Criteria 5: The project is globally responsible, considering possible risks and negative externalities.

13. Describe any risks or externalities, any uncertainties associated with them, and how you plan to mitigate them. Consider economic externalities, regulatory constraints, environmental risk, social and political risk. For example: does your project rely on a banned or regulated chemical/process/product? What's the social attitude towards your project in the region(s) it's deployed, and what's the risk of negative public opinion or regulatory reaction?
Max 300 words

I don't see big social or political risks for biochar production or application in Sweden.

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Section 7: Potential to Scale

This section aims to capture Stripe Purchase Criteria 6: The project has the potential to scale to high net-negative volume and low cost (subject to the other criteria).

14. Help us understand how the cost and net-negative volume of your solution will change over time. Note that we aren't looking for perfect estimates. Instead, we're trying to understand what the long-term potential is and what the general cost curve to get there looks like. (Note: by "cost" here we mean the amount Stripe or any other customer would pay for your solution):

	Today	In ~5 years	In ~20 years
Est. Cost per net-negative ton (in $)	100	70	40
Est. Net-negative volume (in tons of CO2)	4 000	8 000	200 000

15. What are the drivers of cost? Which aspects of your costs could come down over the next 5 years, and by how much? Do you think your eventual scale potential is limited by cost or by volume? Why? Refer to any relevant constraints from question #7, like land or materials scarcity, and specify the boundary conditions for which you consider those constraints.

Max 300 words

Cost of pyrolysis equipment is today high but would come down as automation in production sets in. Scarcity of biomass residues is a clear risk as there will be more industries wanting to utilize the same material.

Section 8: Only for projects with significant land usage

See Stripe's Purchase Criteria 2: The project has a net cooling effect on the climate (e.g. carbon negative complete life cycle, albedo impact, etc.) ***This section is only for projects with significant land usage requirements: Forest, Soil, and BECCS/Biochar/Biomass sequestration projects.***

16. Location: Please provide baseline information about the geographic location(s) of your project; and link shapefile(s) of project area(s).

Max 100 words

N/A

17. Land ownership: Please describe the current (and historical as relevant) land ownership and management for the area(s) provided in (16). If your project is not the landowner, describe your relationship to the landowner.

Max 150 words

We are not the land owner. We received grain/crops biomass residues from grain processing facility of Skånefrö and and deliver biochar in large bags to farmers to be applied to their fields. Other destinations for the biochar are new developments of soccer fields or in green urban infrastructure such as tree plantations or green roofs.

18. Land use: For forest projects, please provide details on forest composition as well as forest age and basal crop area/density. For soil projects, please provide details on land use and crop type (if agricultural), soil organic carbon baselines, and regenerative methodology. For BECCS, biochar, or wooden building materials projects, please provide details on biomass crop type and methodology as applicable.

Max 500 words

Our biochar is made of biomass residues from crop/grain production. Less land is required to produce the same volume of grains due to increased productivity per hectare after biochar application.

19. Net effect on climate: Please discuss the non-CO2 impacts of your project that may not be covered in your LCA, such as your impact on albedo.

LCA system boundary as required by Puro.earth covers cradle-to-gate GHG impact: Outside of LCA our biochar has the following climate impacts:
1) avoided decomposing of feedstock biomass to GHG: our biochar is made of biomass residues from grain production which would otherwise be composted or burnt. Those emissions are avoided by stabilizing the GHG into our biochar.

2) Replacement of materials and their emissions: Use of Biochar can displace use of fertilizer, filters or building materials that would have caused emissions. Most of our biochar is applied to farm lands and avoid N20 emissions from fertilizers.

3) Short-lived impact on albedo: Biochar when applied to farmlands needs to be ploughed down into the soil. This is typically done when normal tillage is carried out and the land is already “black”. It can decrease the albedo effect (reflectivity) slightly. However, this is typically a short period (day of spreading).

4) Yield increase impacts: 10% yield increases reported with biochar. Crop productivity impacts carbon sequestered in crop biomass as well as reduction in land-use requirements for food production.

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Section 9: Other

20. What one thing would allow you to supercharge your project's progress? This could be anything (offtakes/guaranteed annual demand, policy, press, etc.).

Max 100 words

Short term: guaranteed annual demand for carbon removal credits (for example Puro CORCs). This would enable investing in rapid capacity increase of biochar production.
Long term: A true carbon tax where emitters pay tax and sequesters get a tax refund.

21. (Optional) Is there anything else we should know about your project?

Max 500 words

This biochar production facility is the largest in the EU. We are based in south sweden near copenhagen airport. The location is well known for the food and art society with several White Guide restaurants with nice food and drinks. We are also Stripe customers, since our platform is using stripe for card transactions. (www.ecoera.se)
Our customer Max Burgers in Sweden won a prize for their innovative use of negative emissions including our ECOERAs system for biochar carbon removal. .Reference UN Prize:
https://unfccc.int/climate-action/momentum-for-change/climate-neutral-now/max-burgers

Section 10: Submission details

*This section **will not** be made public.*

22. Please insert below the name and title of the person submitting this application on behalf of your company (or, if you are submitting this application on your own behalf, your own details). By submitting this application, you confirm that you have read and accept the Project Overview (available HERE), as well as the further conditions set out below. As a reminder, all submitted applications will be made public upon Stripe's announcement. *Once you've read and completed this section, submit your application by March 20th by clicking the blue "Share" button in the upper right, and share the document with **nets-review-2020@stripe.com**.*

Name of company or person submitting this application

[redacted]

Name and title of person submitting this application (may be same as above)

[redacted]

Date on which application is submitted

[redacted]

We intend to make the selection process as informal as possible. However, we do expect that (a) the content of your application is, to the best of your knowledge, complete and correct; (b) you do not include any content in your application that breaches any third party's rights, or discloses any third party's confidential information; (c) you understand that we will publicly publish your application, in full, at the conclusion of the selection process. You also understand that Stripe is not obliged to explain how it decided to fund the projects that are ultimately

funded, and - although extremely unlikely - it is possible that Stripe may decide to not proceed, or only partially proceed, with the negative emissions purchase project. Finally, if you are selected as a recipient for funding, Stripe will not be under any obligation to provide you with funding until such time as you and Stripe sign a formal written agreement containing the funding commitment.