stripe

Vandersanden (via Puro.earth)

APPLICATION FOR STRIPE 2020 NEGATIVE EMISSIONS PURCHASE

Section 1: Project Info and Core Approach

1. Project name

Carbo Facing Bricks and Slips

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

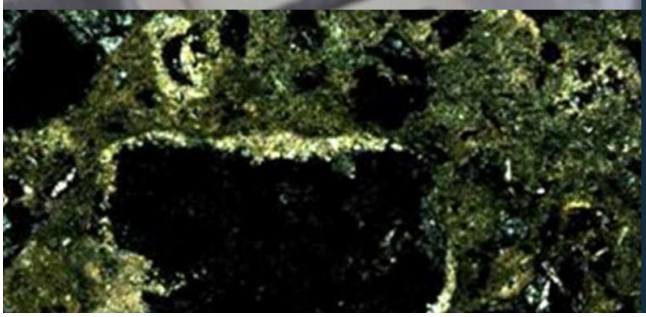
Development, production and sales of Facing Bricks and Slips by Carbonation

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)*

For the production of the Carbo Facing Bricks and Slips Vandersanden applies the Carbstone technology, owned and patented by Orbix. With this technology two "waste sources" namely slags and CO2 can be used for the production of building materials, in this case Facing Bricks and Slips. www.carbstonetechnology.be

The Carbstone technology is based on the chemical reaction of CO2 with CaO and MgO in the slags.
CaO + H20 -> Ca (OH)2 Ca(OH)2 + CO2 -> CaCO3 + H20
MgO + H2O -> Mg(OH)2 Mg(OH)2 + CO2 -> MgCO3 + H20



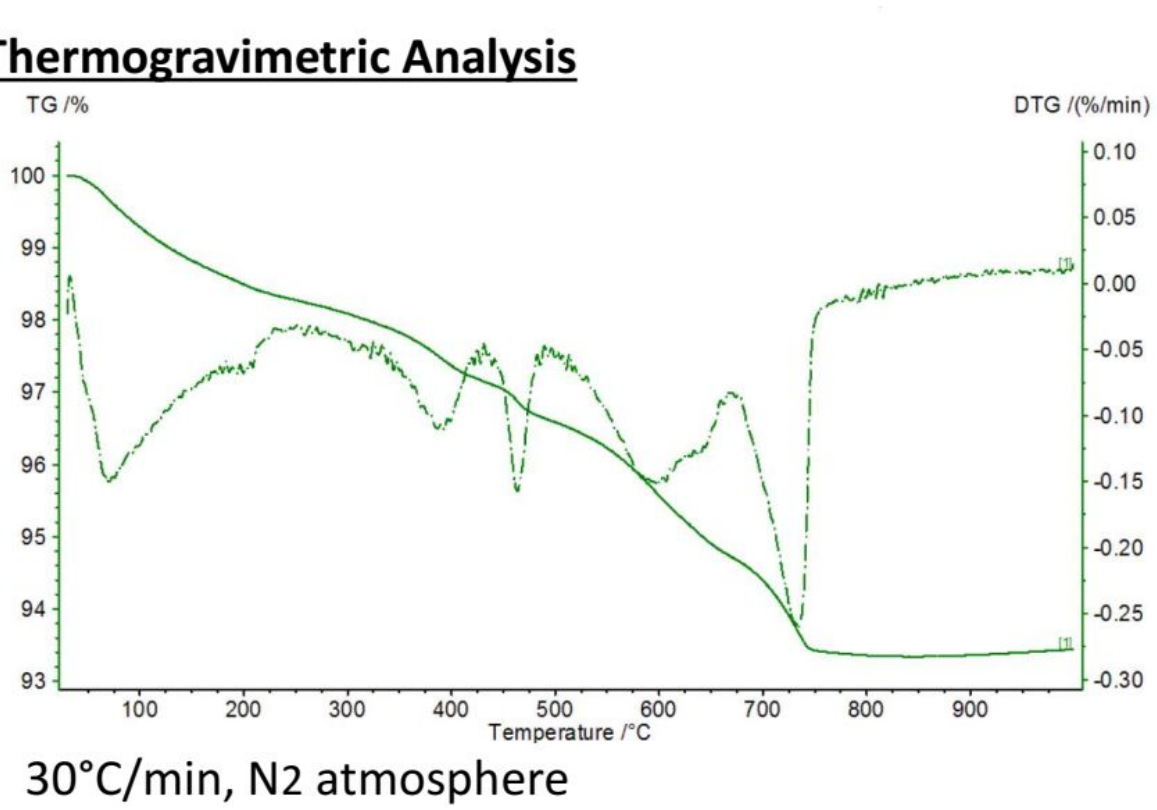
Carbonation technology is based on the reaction of elements like CaO, MgO and other chemical oxides with CO2 to form hard and solid carbonates. CO2 acts like a binder comparable with cement. The reaction can take place under atmospheric pressure or in an autoclave under high pressure.

$$CaO + H_2O \rightarrow Ca(OH)_2$$
$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

$$MgO + H_2O \rightarrow Mg(OH)_2$$
$$Mg(OH)_2 + CO_2 \rightarrow MgCO_3 + H_2O$$

$$(Ca, Mg)_xSi_yO_{(x+2y)} + xCO_2 \rightarrow x(Ca, Mg)\,CO_3 + ySiO_2$$

The reaction will form Ca and Mg carbonates that are very hard and can be used as building materials. The Carbstone technology is patented in 2009 as high pressure application (autoclave) and in 2016 as atmospheric application. Based on the amount of Ca, Mg and their chemical complexes in the mix of building product the uptake of CO2 can be measured and calculated. The calculation starts from the CaO and MgO content of the binder Carbinox. 1 m3 or 2 tons of Carbinox can bind 300 kg of CO2. In the Carbo bricks and slips Vandersanden is using 70 % of Carbinox so the CO2 uptake will be ca. 100 kg /ton bricks or 10 % of the product mass. The bounded CO2 can also be measured by TGA where the carbonated product will be heated to over 850 °C. At that temperature the bounded CO2 will be released and the mass can be measured.



Orbix has licensed the technology to CRH in 2016 to produce building blocks in a pilot installation. In 2018 the technology is licensed to VANDERSANDEN for facing bricks and strips. Other partners with the license will produce pavers and curb stones (1 plant), building blocks(1 plant) in Belgium starting from 2021. VANDERSANDEN starts his pilot in June 2020 and a real industrial plant in 2021 for 50.000 tons of Bricks and ca 5.000 tons of CO2/year. In case of success in the Market, in 2023 a plant of 100.000 tons is in the planning and so on.... Once these plants are running full scale Orbix can license the technology to partners in other countries in Europe and abroad.

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).

10 tons

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.

10 tons

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

We plan to produce ca 100 tons of carbo bricks and slips on the lab installation this year.

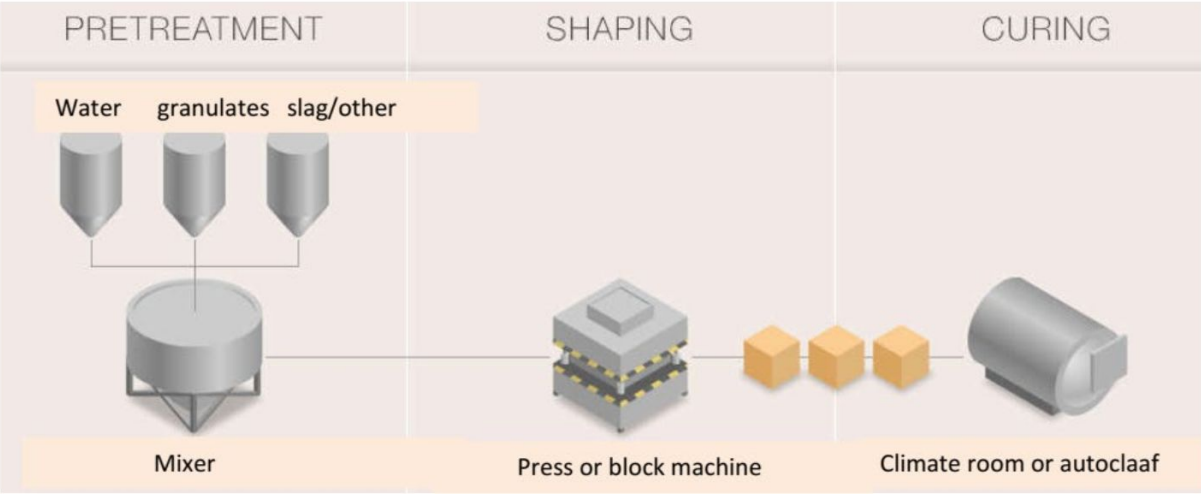
Section 3: Life Cycle Analysis

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)*

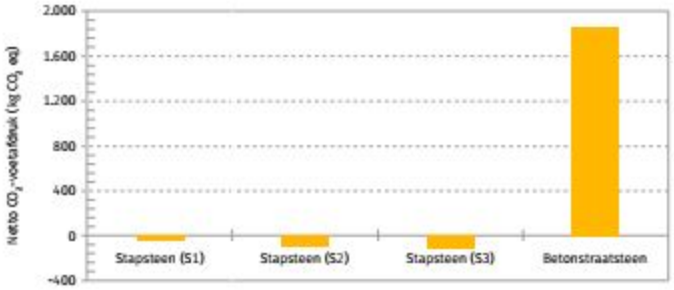


With the Carbstone technology the above pictured production process for most building products as pavers and bricks is used. It is a process similar to the existing cement bounded alternatives.
The big difference with the alternatives is that for the Carbo products no cement nor heat or steam is needed for curing. The carbonation reaction while binding CO2 is exotherm and produces water and heat.
For pavers and building blocks LCA has been calculated and in fact the products take more CO2 then they produce over 75 years.

RESULTS

Impact category	Unit	A1	A2	A3	A4	A5	B1	B2	B3	C2	C4	D	Total
ADPE	kg Sb eq.	6.54E-6	3.97E-6	1.09E-6	1.18E-5	1.40E-6	0.00E+0	0.00E+0	0.00E+0	3.88E-6	1.07E-7	3.67E-7	2,92E-05
ADPF	kg Sb eq.	5.07E-2	1.47E-2	2.89E-2	2.93E-2	5.66E-3	0.00E+0	0.00E+0	0.00E+0	9.65E-3	2.77E-4	1.83E-3	1,41E-01
GWP	kg CO_2eq.	-1.75E+1	2.17E+0	2.81E+0	4.05E+0	-2.34E-1	0.00E+0	0.00E+0	0.00E+0	1.34E+0	4.65E-2	2.62E-1	-7,06E+00
ODP	kg CFK-11 eq.	6.62E-7	3.00E-7	1.54E-7	6.49E-7	9.22E-8	0.00E+0	0.00E+0	0.00E+0	2.14E-7	8.12E-9	2.86E-8	2,11E-06
POCP	kg ethene eq.	5.93E-3	1.45E-3	8.40E-4	2.98E-3	5.99E-4	0.00E+0	0.00E+0	0.00E+0	9.83E-4	5.69E-5	1.82E-4	1,30E-02
AP	kg SO_2 eq.	2.65E-2	1.33E-2	6.58E-3	2.19E-2	3.68E-3	0.00E+0	0.00E+0	0.00E+0	7.22E-3	1.07E-4	1.08E-3	8,04E-02
EP	Kg PO_4^{3-} eq.	7.03E-3	3.02E-3	1.42E-3	5.01E-3	9.12E-4	0.00E+0	0.00E+0	0.00E+0	1.65E-3	1.89E-4	4.13E-4	1,96E-02
HTP	kg 1,4 DB eq.	2.01E+0	5.90E-1	5.33E-1	1.17E+0	2.34E-1	0.00E+0	0.00E+0	0.00E+0	3.87E-1	1.68E-2	1.10E-1	5,05E+00
FAETP	kg 1,4 DB eq.	3.18E-2	2.46E-2	1.13E-2	5.00E-2	8.00E-3	0.00E+0	0.00E+0	0.00E+0	1.65E-2	7.36E-4	2.59E-3	1,46E-01
MAETP	kg 1,4 DB eq.	4.25E+2	1.19E+2	1.98E+2	2.05E+2	4.77E+1	0.00E+0	0.00E+0	0.00E+0	6.76E+1	2.14E+0	1.53E+1	1,08E+03
TETP	kg 1,4 DB eq.	5.90E-2	6.66E-3	1.03E-2	1.32E-2	4.88E-3	0.00E+0	0.00E+0	0.00E+0	4.36E-3	1.18E-4	1.69E-3	1,00E-01

LCA building block where GWP is negative.



LCA paver STAPSTEEN in comparison with a cement paver

In general we can state that the bounded CO2 is permanently bounded and stored. The products can be crushed and reused without losing their CO2 content. The CO2 bounded is stored for ever.

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.

Depending on the mix of the Carbo products we have always more uptake then production of CO2, see above.
Ratio: 0,4 -0,8

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:

The sequestered carbon will be stored for ever.

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.

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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

All the analyses are provided and studied by our partner VITO, a well known knowledge center in Belgium. We also work together with the University of Ghent and Leuven.

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

With PURO EARTH Vandersanden will organize an audit in the pilot plant to set up procedures to measure, report and verify the CO2 stored.

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

Vandersanden claims the ownership of the negative emissions with the products produced by the Carbstone technology licensed by Orbix. There is a measurable uptake of CO2 in the carbonated products: bricks and slips.

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

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For the Carbstone technology Orbix is using slags (by- products from steel production) so the carbonated products have to apply to the environmental rules in each country. In Belgium we are closely collaborating with OVAM. Also the carbonated products have no technical normes to apply to. All existing EN norms are only valid for cement bounded products.

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 $)	20	35	50
Est. Net-negative volume (in tons of CO2)	10	25.000	> 1.000.000

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

At the moment VANDERSANDEN is using industrial food grade CO2 at a high price of € 75/ton. This price is too high for changing from cement to carbonation. On top the technology works with CO2 at a purity >70 % so food grade is not necessary. Also liquefaction is not needed. To have a good business model price of CO2(gas) should be lower than €5/ton. Therefor building a plant close to a CO2 emitter is an option but not easy to do.

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

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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

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

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.

Max 150 words

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

Working with industrial CO2 at € 0/ton so we can build a profitable business model.

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

Max 500 words

It is a very innovative technology and project using two "waste" sources (slags and CO2) to make building products with permanent CO2 storage.

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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.