

SilviaTerra

APPLICATION FOR STRIPE 2020 NEGATIVE EMISSIONS PURCHASE

Section 1: Project Info and Core Approach

1. Project name

SilviaTerra NCAPX

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

Empowering every landowner to participate in forest carbon rental markets

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)

The "Trillion Trees" initiative has put a renewed focus on forests as a powerful way to slow climate change. Much of the media attention has been on massive-scale tree planting projects, but quantitative analysis reveals that **extending the rotation age** of existing forests is a far more immediate, scalable, and efficient way to mobilize forests to store more carbon. For **\$1/ton/year**, the potential scale of impact is **300 million tons a year** in the US alone.

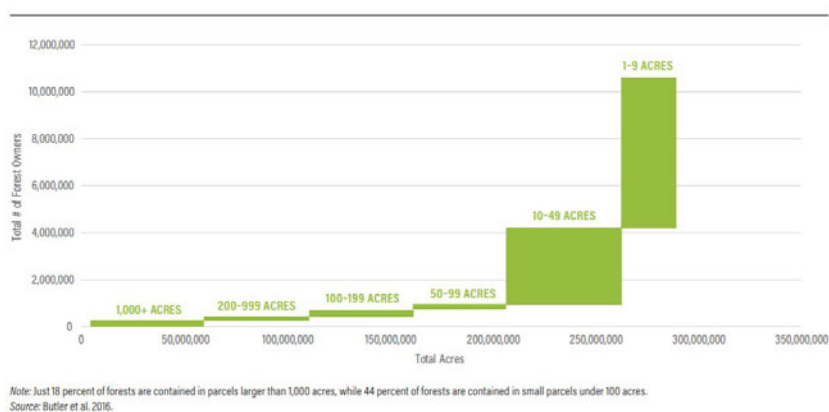
Two notable extant forest-based climate programs are Reducing emission from deforestation and forest degradation (REDD) and the California Air Resources Board (CARB) forest carbon program. Unfortunately, both of these programs lack the scalability or immediacy of impact

required to meet society's demand for carbon sequestration. CARB forest carbon projects also have significant issues with additionality and leakage

Scalability

The boutique, single landowner project-based model for forest carbon is not scalable. Each CARB forest carbon project currently takes \$200,000 and 2 years to set up. The overhead costs are so high that only landowners with more than 5,000 acres can sell enough carbon to justify the expense of setting up a project. This is especially a problem in the US where roughly half of the total forested acreage is owned by small landowners below that acreage threshold as shown in the image below.

Figure 1. Distribution of forest land by forest size¹



Immediacy

Furthermore, the climate impact of REDD and CARB projects is delayed by decades because of long project terms. CARB projects require a 100 year commitment with the bulk of the payment being made to landowners upfront and potential change to landowner forest management behavior happening many years in the future (if ever). With these types of projects buyers are spending money today to sequester carbon decades in the future rather than maximizing present-day carbon sequestration.

Fixing Forest Carbon

To oversimplify a bit, our society needs to maximize present-day carbon sequestration for the lowest possible price per ton. An ideal forest carbon mechanism would be:

- **Scalable** - low overhead to allow every landowner and every acre of forest to participate to unlock gigatons of additional forest carbon.
- **Immediate** - spend dollars today for carbon sequestration today.

¹ Table from: Mulligan, J., G. Ellison, R. Gasper, and A. Rudee. 2018. "Carbon Removal in Forests and Farms in the United States." Working Paper. Washington, DC: World Resources Institute. Available online at <https://www.wri.org/publication/land-carbon-removal-usa>

- **Efficient** - use markets to access the lowest-cost carbon on the landscape and take the time value of money and carbon into account.
- **Real** - change individual landowner behavior and increase the aggregate amount of carbon on the landscape.

SilviaTerra's Natural Capital Exchange (NCPAX) is a data-driven forest carbon "rental" market that creates **immediate, scalable climate impact**. For the first time, **every landowner** in America is empowered to participate in an annual **1-year term** timber harvest deferral program. As **hundreds of millions of acres** are newly mobilized to sequester carbon, an annual auction optimizes for the **lowest price per ton**. NCPAX is designed to fix the structural issues with prior forest carbon programs, with clear additionality and limited possibilities for leakage.

Measurements make markets and NCPAX is made possible by recent "big data" and AI developments. SilviaTerra collaborated with Microsoft to create the [first high-resolution forest inventory of the United States](#). This annually updated dataset **quantifies the forest carbon and timber volume on every acre in America**. For the first time, it is possible to pay landowners to defer their timber harvest for one year and to measure and monitor their compliance. When every landowner and forested acre can participate, **"leakage" of timber harvests is reduced**.

These acre-level measurements of timber volume are combined with mill locations, timber prices, and other data sources to estimate each landowner's "business as usual" (BAU) timber harvest behavior. This highly targeted, data-driven assessment of BAU delivers much **clearer additionality** than the coarse thresholds in traditional forest carbon protocols. NCPAX is an efficient way to create real change on the landscape by paying individual landowners to modify their forest management. Critically, landowners do not have to cease harvesting completely. They can generate carbon credits for even partial reductions in harvest activity. Landowners maintain flexibility to adjust their operations in a way that makes sense given their particular ownership.

NCPAX makes it possible to pay landowners to reduce their annual forest harvest activity below their specific "business as usual" forest management - effectively and efficiently removing carbon from the atmosphere and preventing further emissions.

As landowners defer harvests, the average age of forests across the landscape increases. Even small increases in the average age of actively managed forests across the landscape results in gigaton-scale increases in the amount of carbon. For example, increasing the average age of just pine plantations in the US South from 13 to 15 would remove an additional 400M tons of CO₂e from the atmosphere. NCPAX is unique in its ability to include highly biologically productive pine plantations in a carbon program.

Benefits of Carbon "Rental" in Natural Systems

Natural systems are dynamic and complex. This makes carbon "rental" a natural fit for a wide range of natural climate solutions. It has also been long understood as the most efficient means of sequestering carbon in forest systems^{2,3}. In the context of forestry, rental possesses four key advantages:

- **Immediacy of impact** - dollars spent today result in management changes today (not years in the future).
- **Target low-cost time windows** - extending a timber rotation a year or two beyond its timber-only optimum costs little money (e.g. \$100/acre for southern yellow pine) and keeps large amounts of carbon (e.g. 100 tons/acre) on the landscape. One-year rentals enable the market to target payments towards the lowest-cost times during a timber rotation.
- **Ease of participation** - many landowners are reluctant to make long-term commitments. Shrinking the term to one year gets inside landowners' microeconomic decision cycles and increases participation rates.
- **Epistemological humility** - the last two decades have seen an enormous amount of unpredictable technological, societal, and economic change (9/11, the smartphone revolution, COVID-19, etc.). A rental market reduces the need to make long-term commitments and the epistemological risks they entail.

Pennsylvania 2019 Pilot Implementation

In 2019, a Fortune 50 company's sustainability program bought over 300,000 ton-years of carbon at an average of \$0.97/ton-year from a pilot implementation in 6 counties in Pennsylvania. Carbon was supplied by a wide range of landowners, from a municipal water authority and a large timber investor to individual landowners - the smallest of whom owned 25 acres of forest.

2020 Expansion

In 2020, SilviaTerra NCAPX is expanding to 11 states in the US South. SilviaTerra has obtained letters of intent from landowners to anchor supply at over 8 million ton-years of CO₂e to NCAPX in 2020. Total supply is expected to reach 15 million ton-years by the end of the enrollment period in September.

Future expansions will include the rest of the US and ultimately every forest on the planet.

Section 2: 2020 Net-Negative Sequestration Volume

² Sohngen, Brent and Mendelsohn, Robert, (2003), An Optimal Control Model of Forest Carbon Sequestration, *American Journal of Agricultural Economics*, **85**, issue 2, p. 448-457.

³ Marland, Gregg, Kristy Fruit, and Roger Sedjo. "Accounting for sequestered carbon: the question of permanence." *Environmental Science & Policy* 4.6 (2001): 259-268.

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).

15 million ton-years

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.

15 million ton-years

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

In 2020 NCAPX will include plantation pine forests in the US South only. We already have letters of intent for the provision of 8 million ton-years from large industrial landowners. We are currently filling in supply with smaller landowners. Supply will be allocated to buyers through a uniform price auction held on September 15, 2020.

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:

- Include a flow sheet diagram of direct ingoing and outgoing flows (GHG, energy, materials, etc) that bear on the LCA.
- 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.
- 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.
- 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).
- 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.
- 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)

The lower-bound LCA for SilviaTerra NCAPX is very simple by design because it is a one year rental program. The forest carbon on every acre is assessed at the end of each one year "rental" period. This final stocking assessment is compared with the business-as-usual assessment to determine the amount of creditable carbon ton-years.

The carbon footprint of operations to run this program is minimal relative to the scale of the

negative emissions potential. The key inputs are:

- Office staff of 10 (~200 tons/yr)
- Field staff and field visits (~400 tons/yr)
- Compute for satellite image analysis (0 - Microsoft Azure is [carbon neutral](#))

Some rough US boundary conditions:

- 600M acres of forest
- 30 gigatons of above-ground forest carbon on landscape
- ~510M tons CO₂e of timber growth each year
- ~500M tons CO₂e of timber harvested each year

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.

1:1,000

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:

Lower bound: 1 year
Upper bound: 10 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

The one year term makes the quantification of impact straightforward. NCAPX generates carbon ton-year (CTY) credits: 1 ton of CO₂e sequestered for 1 year. Thus, the lower-bound on permanence is 1 year.

There are good reasons to believe that the true durability of 1 CTY is significantly more than 1 year. Most timber mills run close to full capacity already and don't have the ability to rapidly scale up production. Spinning up a new mill takes years. Timber mills cannot instantly "eat through" the additional biomass that each CTY creates on the landscape. This is clearly demonstrated by the "wall of wood" phenomenon created by the 2008 recession (and drop in housing starts). Many southern states still haven't fully cut through the "wall of wood" over 10 years later.

Achieving "Permanence" with Carbon Ton-Years

Taking the CARB standard that 1 ton rented for 100 years is equivalent to a "permanent" ton, there are several straightforward ways to use 1 year forest carbon "rentals" to achieve permanence. Here are the three key "Paths to Permanence":

- 1) **Rent 1 CTY per year for 100 years** - This method has the advantage of being physically identical to the CARB 100-year term model. However unlike the CARB model, this method has the advantage of deploying capital over time rather than all upfront. The disadvantage is that the commitment period is very long and the buyer is exposed to uncertainty in the price of a carbon ton-year in the future.
- 2) **Rent 1 CTY per year until permanent retirement** - This method is similar to the first, but includes the possibility of achieving permanence earlier if economically viable. For example, if a buyer believed that \$1/ton direct air capture would be available 10 years from now, it could make sense to rent a CTY for 10 years and then retire it permanently for \$1. This option is attractive for buyers who believe that technology will bring down the cost of direct air capture (or other technologies) and are looking to "buy time" cheaply.
- 3) **Buy 15 CTYs today** - Using the "time value of carbon" framework presented by the WRI working paper ["The Time Value of Carbon and Carbon Storage"](#), a far smaller number of present-day CTY's are required to equal the climate impact of a 100 year 1 CTY "annuity." Using the EPA's "social cost of carbon" discount rate, 15 CTYs bought today are equivalent to 1 "permanent" ton.

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

Algorithmic assessments of the timber stocking at the beginning and end of each annual performance period are made with a combination of third-party field measurements and remote-sensing. SilviaTerra has performed this type of forest inventory work for over a decade for many of the largest timber landowning companies in the United States as well as for the US Forest Service. Since remote sensing estimates are benchmarked openly against verified field measurements, there is no "black box" element to the offer or crediting phase of each annual NCAPX cycle.

Assessing "business as usual" is the other critical component for accurate accounting of additional forest carbon. NCAPX uses a highly-detailed, acre-by-acre algorithmic assessment

of BAU the incorporates the following types of data to build models of landowner timber harvest behavior:

- **Forest inventory** - from SilviaTerra Basemap and field measurements for enrolled acres
- **Growth rates** - from published regional growth models
- **Market prices** - quarterly mill price data by timber product
- **Distance from mill** - mill locations database
- **Terrain operability** - assessed from National Land Cover Database and digital elevation maps
- **Landowner type** - public vs. private, large vs. small, etc.
- **Discount rate** - financial discount rate
- **Past behavior** - from World Resources Institute maps of historic harvest activity

All measurements, algorithms, and calculations that contribute to the creation of CTY units will be open to review. Potential improvements will be openly benchmarked and incorporated year over year to contribute to improved offset quality.

Uncertainty in BAU and carbon stock calculation are assessed algorithmically and incorporated in CTY unit creation. The value of reduced uncertainty is balanced with the cost of input data and modeling. Since CTY units are derived from all participants, each unit inherits the improved precision attributes from the entire project. As the program scales, less measurement effort and cost is required per CTY unit, further reducing transaction costs.

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

When landowners enroll in the annual program, they sign a contract obligating them to bring a specified number of carbon ton-years at a specified price to the NCAPX market at the end of the performance period. One of the contract terms is that the enrolled acreage must not be encumbered by provisions which restrict the ability to harvest timber. If harvest restrictions are in place, they must be disclosed and are factored into the "business as usual" assessment.

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

The one-year term for NCAPX contracts mitigates many types of risk. The short time frame also enables NCAPX to dynamically adapt to changing social, legal, economic, and environmental circumstances.

One interesting aspect of NCAPX is that many of America's forest owners live in rural communities that often have very different views about climate change than urban areas on the coasts. NCAPX is a novel type of "climate diplomacy" that helps all Americans work together to be part of the solution to our changing climate. For America's millions of forest owners, carbon becomes a welcome source of demand that their acreage can fulfill.

Another second-order effect of NCAPX is that timber market dynamics may be impacted. Demand for carbon (a non-extractive value) competes with demand for timber (an extractive value). Demand for carbon will likely also increase the total amount of biomass on the landscape (simultaneously increasing the potential supply of timber). Over some period of time, a new equilibrium in both markets will be reached.

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 \$)	\$15	\$10-100	\$10-100
Est. Net-negative volume (in tons of CO2)	2MT to 10MT	100MT - 500MT	3GT -16GT

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

Demand for carbon (a non-extractive value) competes with demand for timber (an extractive value). The cost of paying landowners to defer their timber harvest depends on the interactions of supply and demand in both the carbon and timber markets. Increasing the

number of acres exposed to the NCAPX market will increase the supply of carbon and reduce costs. On the other hand, a significant increase in demand for carbon (or timber) will increase the cost.

Ultimately there is a limit to how much NCAPX can decrease carbon removals from forests. There are 500 million tons CO₂e removed from US forests each year and roughly 2.5 gigatons globally. Those numbers represent fairly strong limits on the ability of NCAPX to change forest management across the landscape this decade.

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

NCAPX 2020 is limited to 11 states in the US South: Tennessee, Alabama, Arkansas, Texas, Oklahoma, Mississippi, Georgia, South Carolina, North Carolina, Florida, and Louisiana. Future expansion in the US and globally is planned.

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

All landowners can participate in NCAPX but not all landowners will bring the same number of additional tons of CO₂e to the market. Landowners contract with NCAPX to modify their forest management to provide a specified number of carbon-ton years at the end of the annual performance period.

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

NCAPX 2020 will focus on southern yellow pine in the US South because the business as usual assessment is particularly straightforward. Note that NCAPX is not a tree-planting mechanism - it is instead focused on extending the rotation ages of existing forests.

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

Deferral of timber harvest does not significantly change the albedo of the existing forest.

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

NCAPX has the supply-side anchored and measurement methodology in place. Guaranteed annual demand would be great. Expedited regulatory approval of the protocol for regulated carbon markets would also be a big win.

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

Max 500 words

NCAPX represents a significant improvement over existing forest carbon programs like CARB. Key differences include:

- 1) Every landowner can participate. This is important not just for reasons of scalability, but also to avoid leakage.
- 2) Immediate impact - dollars spent this year create climate impact this year. CARB's 100 year term results in an inefficient capital allocation where dollars this year are spent for climate impact decades in the future.
- 3) Improved additionality through targeted acre-level "business as usual" assessment. CARB's coarse BAU assessment creates the potential for adverse selection and low additionality.

NCAPX also benefits from SilviaTerra's 10+ years of expertise in operational remote-sensing forest inventory. SilviaTerra's technology is trusted by many of America's largest forest landowners, including the US Forest Service. For a recent showcase of SilviaTerra's technology, see <https://focusforests.microsoft.com/>

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)

Date on which application is submitted

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.