Biomass Burial (Pat.pend)

General Application

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

Company or organization name

Puro.earth and EBS

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

Puro.earth is domicile in Finland. EBS (Enhanced Biomass Sequestration) is domicile in, and the trial will be located in, Australia

Name of person filling out this application

Marianne Tikkanen and Antti Vihavainen of Puro.earth; Howard Carr and Simon Avenell of EBS

Email address of person filling out this application stripe

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Brief company or organization description

Puro.earth provides carbon removal by identifying projects, verifying them, issuing CO2 Removal Certificates (CORCs). EBS is a start-up CDR generator and supplier, seeking to demonstrate the veracity of its subterranean biomass burial methodology via a trial; the subject of this application.

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.

We are offering Stripe a possibility to kick-start the realization of biomass burial - a highly efficient and scalable solution for CDR. The substance of this offer is to test a key element of the scaled operations in a trial project - the monitoringand automated data gathering equipment regarding the inert state of the biomass after burial. This gives Stripe an opportunity to be the first customer in developing a new way to reverse climate change by marrying mining, forestry and broadacre farming competences.

Benefits of EBS burial solution over other (biomass-based) CDR solutions are durability (1000+ years), additionality and low cost per ton CO2 removed. In all processing of biomass you lose some carbon. The EBS system has minimal processing and thus low cost in carbon emissions and economically.

In the following the long-term EBS CDR solution (A) and the specific short-term trial project proposal (B) of this application will both be described.

(A) EBS biomass burial solution for Carbon Dioxide Removal

Overview

This CDR solution was developed by a geochemist after reviewing a wide range of existing and proposed CDR technologies and identifying the practical physico-chemical and economic challenges in harnessing these technologies to achieve globally significant CDR. The technology is based on combining two competences in a new way, namely planting trees and digging dirt. The process involves dedicated planting, growth and repeated harvesting above ground biomass (AGB) from coppicing Australian native woody plants. (See Figure 1) The biomass is buried and encapsulated in a subterranean burial chamber, engineered to close all of the pathways for biomass decomposition. (See Figure 2) The burial chamber conditions are anoxic and flooded with hypersaline groundwater. The biomass is essentially pickled similar to olives and onions in a jar. The buried biomass is monitored with sensors after burial to demonstrate that the contained C is inert and stable.. The subject of this project is to test the burial method and calibrate the monitoring equipment

Figure 1: High level EBS solution process overview

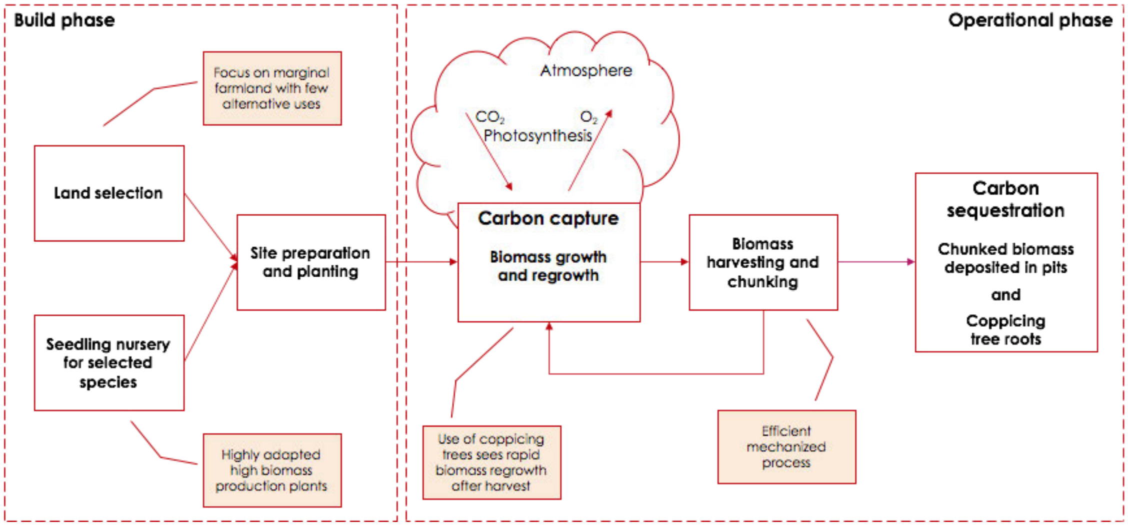
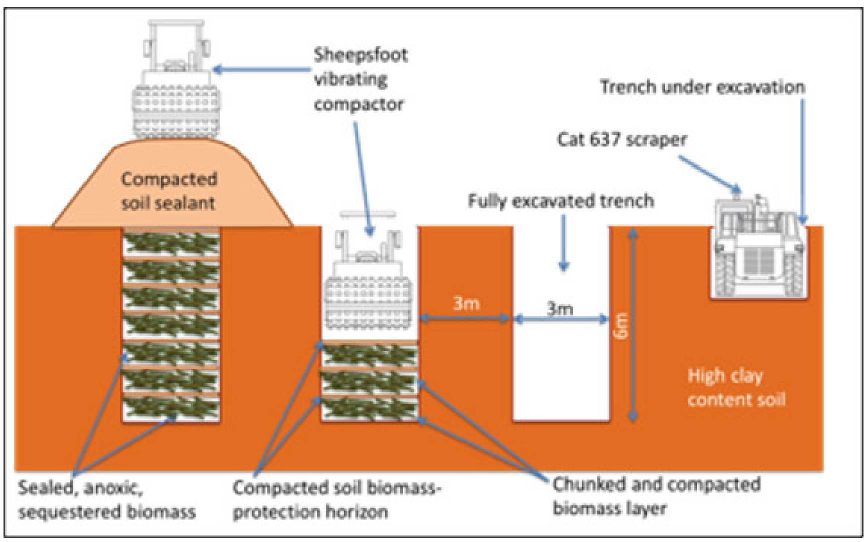


Figure 2 below: Schematic of the end of the EBS supply chain including burial chamber construction and operation



Performance

Throughout the development of this solution attention has focused on the following criteria:

1. Affordability
2. Efficiency
3. Scalability
4. Robusticity
5. Acceptability

Affordability

Every aspect of the solution has been considered from a cost point of view while not losing focus on robusticity and acceptability. As a result projected costs are below US$25/t CDR (actual projected cost modelling will be shared with bona fide investors). This is driven by the combination of:

- Low cost land with no, poor performing and/or unsustainable alternative uses
- Minimal processing of the biomass leads to maximum net-negativity (emission/stored ratio = 1:40)
- High biomass production coppicing woody plants adapted to grow fast in the low rainfall and poor soils.The application and adaptation of efficient broadacre harvesting practices and best in class machinery
- Burial chamber built by utilisation of site-adjacent salt-affected land with no alternative use and saline groundwater available on-site
- A practical, workable and manageable sequestration method that involves very short biomass transportation distances.

The use and regular harvesting (and regrowth) of coppicing woody plants means that this system effectively acts as a carbon pump, continuously drawing carbon from the atmosphere and returning it to underground storage outside the biosphere. In a sense this solution is a combination of nature-based and engineering solutions,designed to work with natural processes not against them.

Efficiency
Over 25 years this system captures at least twice the CO2 a perpetual woodland of the targeted species would and over 100 years time span the cumulative CO2 sequestration is about 10x i compared with a perpetual woodland stand.

Scalability

This solution is modular. The minimum efficient scale module being 25,000 hectares (about 61,000 acres). Each module will produce roughly 400,000 metric tons of CDR every year dependent on a range of factors, particularly rainfall. The total global potential for this solution is well over 1 billion metric tons of CDR pa (> 1 Gton CO2eq. per year) there being hundreds of millions of suitable marginal land world wide, primarily in Australia, Africa, North America and India. Australia is only the best place to start for a range of reasons including low sovereign risk, secure land access arrangements, saline soils and groundwater and access to technical expertise in forestry and mining.

Robusticity

All aspects of this solution are subject to direct measurement, including above and below ground biomass) and the contained C of this biomass which will be determined by independent industrial laboratories (over both time and space). This results in the straightforward determination of CDR quantities and a high level of confidence in the associated certificates.

The engineering of the process and burial chamber draws from the industrial mining practises of double-safety standards. By design, the system has multiple mechanisms deployed to stop atmospheric oxygen from entering the chamber and thus preventing microbial biomass decomposition. All decomposition pathways are closed .

In-chamber monitoring of the buried biomass is done continuously and automatically by permanently positioned temperature probes. The immediate detection of a temperature rise in buried biomass acts as an early warning system because all biomass decomposition pathways are exothermic. Any detected temperature anomalies can be readily investigated and corrective action taken given that the burial chambers are near surface and accessible for remedial action if required.

Acceptability

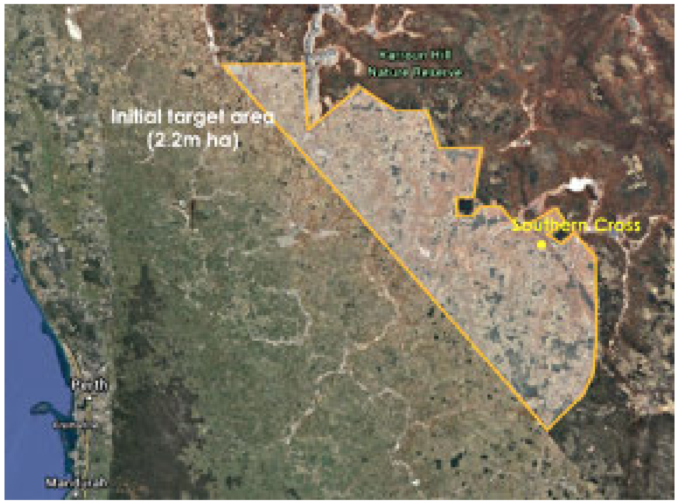
A high level of support is anticipated for this solution. It should only be deployed where it represents a higher value and more sustainable land use in economic, environmental and social terms. For example, in the initial target area (see below) the native woodland was cleared over 100 years ago to create agricultural farmland primarily focused on growing exotic cereal crops like wheat and barley for export markets. This activity has always been economically marginal which is being progressively exacerbated by increasing competition from rising grain production in superior agro-economic locations and damaging impacts from climate change. Environmentally the existing land use has caused the loss of initially arable land to secondary salination of valley floors and increased risk of desertification. The poor and in some cases worsening economic and environmental consequences of the current land use have led to adverse social trends. The aging farmer community looking to retire is often unable to sell their properties or pass them onto their children, the local population is in long term decline, health outcomes are poor and in decline, and services of all kinds are being reduced.

The EBS solution on the other hand offers a higher value and more sustainable land use in economic, environmental and social terms. Economically the solution delivers more value per hectare and an increase in local employment and opportunity generally. Environmentally, mono-culture cereal cropping will be replaced by managed multi-species woodland plantations that will halt and eventually reverse secondary salination and reduce the risk of desertification. And socially the solution will support increased community vibrancy and reverse the poor trends in health and educational outcomes and help to support more services for local communities.

Initial target area

Figure 3 below shows the initial target area covering approximately 2.2 million ha of marginal low rainfall freehold farmland on the eastern margins of Western Australian Wheatbelt. The first full scale production module would cover a contiguous area of about 25,000 ha, located within this initial target area. The largest town in this area, Southern Cross (population of about 600 people) has coordinates of 31.2° S 119.3° E.

Figure 3: Initial target area: The eastern margins of the central Western Australian Wheatbelt



The initial target area is approximately the same area as New Jersey or Wales. The total population of this area fell from 3,540 people in 2001 to 2,520 people in 2019, a close to 30% decline in just 18 years. (These population data are for the Local Government Areas of Yilgarn, Mount Marshall, Mukinbudin and Westonia which broadly align to the initial target area.) The asking price for land in this area is about US$300/ha. In comparison, Iowa farmland sells for an average of around US$18,000/ha. This area has average annual rainfall around 300mm pa compared to 660mm in Iowa.

Timelines

The lead time from financial investment decision to planting is about 12 months; coordinated with the local winter planting season (June, July and August). The first harvest of AGB is 3 years after planting. Harvests take place every 2 years after that. CDR credits related to root biomass accrue from planting. CDR credits (CORCs) related to harvested AGB accrue from the first harvest and burial. Full annual production occurs from year 6. Average annual CDR production (net of all allowances) is about 400,000 metric tons pa across a 25 year project life cycle.

(B) The proposed trial project

This trial project has three key objectives:

1. Demonstrate the carbon retention efficacy (1: 40) of the burial of biomass in subterranean chambers engineered to close all of the pathways for biomass decomposition
2. Calibration of an appropriate CDR credit calculation, in CO_2e terms, to reflect losses of the carbon contained in biomass buried in subterranean chambers. The scientifically informed hypothesis is that some decomposition (1-3%) will occur during the first weeks in the chamber before biomass reaches its inert state, but the resulting CO_2 is contained within the gas-tight chamber.
3. Refine the Puro.earth methodology for the verification and quantification of carbon dioxide removal and execute a 3rd party audit of the trial site under that methodology

These objectives will be pursued in a 50t CDR scale biomass burial trial. All relevant aspects of the proposed method related to the chamber will be included: chamber dimensions, soil and biomass compaction, flooding with hypersaline groundwater and monitoring systems. The harvesting automation is not part of the trial. The design and operation of the trial will be conducted with the support of a suitability qualified and peer reviewed research scientist. This scientist will independently review and verify all trial results.

Further information

- Additional detailed information on the EBS solution will be provided to interested investors and potential off-take customers on a confidential basis. Please contact Simon Avenell via email at simon.avenell@forest-logic.com or call +61 414 345 210 (time UTC +8).

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.)*

Puro.earth is a standard for engineered carbon removals that represents EBS in this application. The Puro.earth framework for developing a suitable methodology and using third party auditors will be deployed. EBS will execute the trial project and do all things necessary to generate the Puro.earth CORCs (CO2 removal Certificates) . Subject to the successful achievement of the trial objectives, Puro.earth will include this process within its standard.

***Puro.earth** issued CORCs are for-sale-by-owner, supply companies set the price. Puro.earth charges a service fee per CORC when a sales transaction happens. Puro.earth does not charge the project upfront for verification, registration or methodology development.*

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

The most significant risks to achieving the objectives of the trial are:

1. Cost of hand-harvesting the above ground biomass (AGB). The trial relies upon the near ground level, chainsaw-felling of the AGB contained in around 2100 trees. This will be physically challenging and could be relatively expensive. (Commercial scale operations will not have this issue. A mechanised 4-row biomass harvester will be used and; all materials handling will be mechanised as per Australian mining practices.)
2. Preservation of buried biomass within the subterranean chamber prior to sealing. This will require backfilling and compaction of layers of soil on top of each day's biomass harvest and deposition. Soil compaction will be achieved by hand held plate compactors operating in the chamber.
3. Decomposition of the contained plant starch and soluble sugars (non structural carbohydrates "NSC") of the harvested and buried biomass. NSC is generally less than 3% of total biomass of the targeted species (Smith 2018) NSC are identified as

the likely dominant source of biomass decomposition and CO2 leakage risk before reaching inert stage.

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

EBS has lodged an Australian Provisional Patent. Application No: 2019901126

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.*	Total Offer: 5,000t CDR Part 1: 50t CDR (storage only) from May to December 2021 Part 2: 4,950t CDR (CORC)from August 2022 to December 2025
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.*	Trial: Carbon removal occurs over the 43 days of harvesting and burial and is complete by December 2021 Commercial: Carbon removal commences with the dedicated planting in July 2022, ramps up with the first AGB harvest and burial in 2025 and continues for the 25 year project life of this first-of-its-kind unit.
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*	Part 1: 50t CDR (storage only) from May to December 2021

one, 25% each year thereafter" or "Evenly distributed over the whole time frame". We're asking here specifically about the physical carbon removal process here, NOT the "Project duration". Indicate any uncertainties, eg "We anticipate a steady decline in annualized carbon removal from year one into the out-years, but this depends on unknowns re our mineralization kinetics".	Part 2: 4,950t CDR (CORC) from August 2022 to December 2025*, completed in December 2025*
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)?

1,000-6,000 years

C sequestered in EBS buried biomass will remain inert as long as the preservation conditions are maintained. The burial chamber is protected by freehold title with a caveat to prevent sale and development of the site for all time. A rock ballast-plated, optimally compacted, extreme soil density, burial mound is predicted to be preserved for several thousand years. The abundance of neolithic (>4,000 BCE) human burial mounds ("tumuli" or "barrows") in Western Europe and Turkey testify to the longevity of similar earthen mounds (even if not plated with rock ballast and not formally compacted) and their ability to protect buried material.

The level of the hypersaline brine that floods the biomass burial chamber is static. The only route to lower this water level is to pump it out at significant economic cost. The brine has no commercial use; it is too saline for agriculture or industrial use and too low in concentration of valuable salts (KCl, LiCl) to warrant extraction. The brine is too saline for plant-pumping via photo-evapotranspiration. Thus the buried biomass is predicted to remain flooded with hypersaline brine for millenia.

For these reasons it can be asserted that the durability of the buried biomass will be in the range of 1,000 to 6,000 years.

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.)*

Key sources for durability projections include:

Ximenes, F. et al (2017) “The decay of engineered wood products and paper excavated from landfills in Australia”, Waste Management, December 2017.

Ximenes, F. et al (2019) “Improving understanding of carbon storage in wood in landfills: Evidence from reactor studies”, Waste Management Volume 85, February 2019.

Zeng, N., (2008), `Carbon sequestration via wood burial` Carbon Balance and Management, 3:1, January 2008.

Recall that the key objective of the planned trial is to demonstrate the carbon retention efficacy of the burial of biomass in subterranean chambers as described above.

d. What durability risks does your project face? Are there physical risks (e.g. leakage, decomposition and decay, damage, etc.)? Are there socioeconomic risks (e.g. mismanagement of storage, decision to consume or combust derived products, etc.)? What fundamental uncertainties exist about the underlying technological or biological process?

The carbon contained in the buried biomass will remain stable as long as the preservation conditions (anoxic with hypersaline water immersion) are maintained. The high clay content soils have extreme rheology when optimally compacted and thus are extremely resistant to erosion. For further protection against potential erosion of the mounds, surface water diversion bunding is constructed around the mounds and the mounds are covered with a layer of coarse-crushed crystalline rock (similar to railway line rock ballast).

The hypersaline groundwater brines are naturally resident at or within 0.5m of the existing ground level. Thus the two key components that maintain the preservation conditions are near permanent.

The selected biomass has less than 3% volatile organic compounds which are at risk of decomposition. The remainder of the biomass (lignin, hemi-celllose, cellulose) is inherently resistant to decomposition.

There appears to be no meaningful socioeconomic risks. Burial sites are in remote and very hostile environments. Access can be controlled under the laws of trespass.

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.)*

Once the buried biomass is stable, and as long as the preservation conditions are maintained, there is no reason to believe it should ever become unstable. As a natural analogue coal is

buried biomass that has been stable for millions of years. The EBS system is designed and constructed to ensure that the biomass preservation conditions are maintained. Monitoring of the injection/burial site is performed by direct measurement of temperature (aproxy for the maintenance of preservation conditions). The scope of this proposed trial is to test and calibrate the monitoring. Additionally, we generate data over time in the large scale system to calibrate the scientific models and projection of decay of woody biomass under the conditions referred to in 2c. The buried biomass, burial chamber and contained hypersaline brine will be sampled from airtight sampling sites, accessible from the surface. The sampled biomass and enveloping material will be assayed for total C content and the results compared to those of the buried biomass at the point of deposition and burial. Mass balance calculations will quantify the quantity and proportion of C removed from the atmosphere and contained C in the buried biomass that has potentially escaped from the burial chamber, and thus the quantity of C in the buried biomass that is stable and inert. Buried biomass and environs sampling and assaying over time, will generate data to create C escape and C stability curves, against time.

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	5,000t CDR
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	While no additional avoided emissions are claimed, the EBS solution replaces a net positive emissions land use, namely broadacre cereal grain production, an activity which on average over the Western Australian wheatbelt generates around 0.5 t CO2 / ha pa (after Brock, B et al (2012), `Greenhouse gas emissions profile for 1 tonne of wheat produced in Central Zone (East) New South Wales: a life cycle assessment approach` Crop

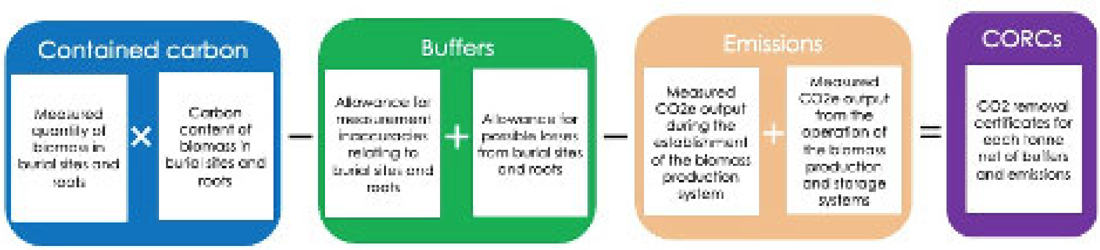
production	and Pasture Science 63(4), June 2012.)

b. Show your work for 2(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 essence: AGB is harvested, weighed, representatively sampled, and assayed for total C content. C removal is: AGB weight multiplied by C content minus agreed buffers for measurement uncertainty and post-burial C leakage and an allowance for production process emissions. Biomass is buried in an axonic, hypersaline flooded burial chamber. Buried Biomass is sampled from airtight sampling sites within the burial chamber at agreed regular time intervals and assayed for contained C. The inert, stabilized C content of buried Biomass is ascertained and the relevant buffer is adjusted accordingly.

In the commercial operation of the EBS solution contained carbon in root systems is also credited. Below ground biomass is representatively, destructively sampled (over space and time) weighed and assayed for total C content. C removal is: BGB weight multiplied by C content minus agreed buffers for measurement and modelling uncertainty. An existing BGB production model is updated as real BGB production and C content data is gathered and incorporated into the model.

Figure 4: Calculation for Carbon Dioxide Removal Certificates (CORCs)



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).

As of this submission, EBS is a start up and has no installed capacity. However, the solution has enormous upside, potentially in the Gigatonne range. Across the world there are hundreds

of millions of hectares of degraded lands with the right climatic characteristics. Allocation of just 30 million hectares of this land to this solution will deliver 0.5 Gigatonnes of CDR pa.

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.)*

AGB and BGB production data are based on published relevant scientific papers.

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.

Additional detailed information on all aspects of the EBS solution will be provided to interested investors and potential off-take customers on a confidential basis. Please contact Simon Avenell via email at simon.avenell@forest-logic.com or call +61 414 345 210 (time UTC +8). A selected bibliography of the peer-reviewed research papers reviewed in the development of the EBS solution is attached

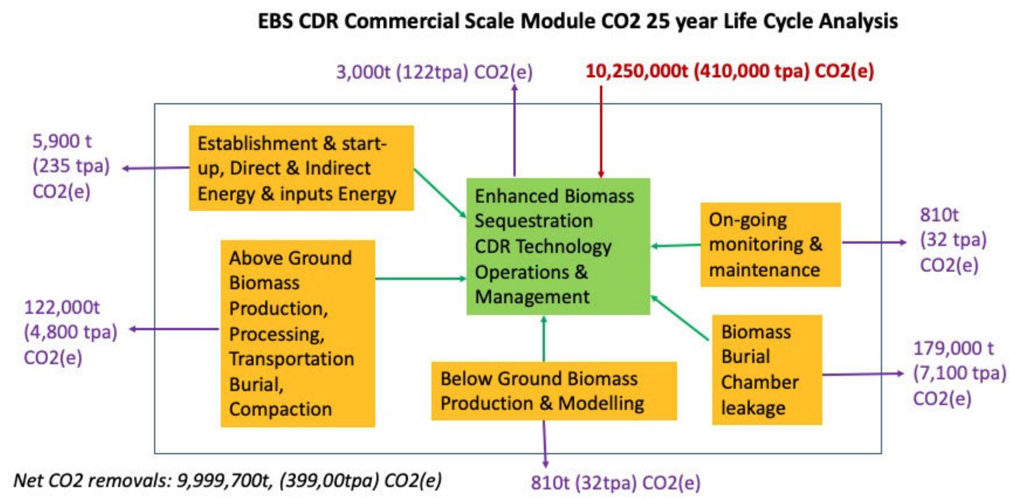
4. Net Capacity / Life Cycle Analysis (Criteria #6 and Criteria #8)

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	Trial: 5,000 t CDR Commercial scale module: 10,250,000 t CDR (CORC) Note: Additional gross carbon removal will be made to allow for measurement and uncertainty buffers to be agreed as part of developing the Puro.earth methodology during the course of this trial.

Gross project emissions	Trial: 75t CO_2 Commercial scale module: 250,000 t CO_2
Emissions / removal ratio	Trial: 75 / 50 = 150% and 121/4950 = 2.44% 196/5000 = (1:25) = **3.94%** Commercial scale module: 250,000 / 10,250,000 = (1:40) = 2.44% (including buffers)
Net carbon removal	Trial: 5,000t CDR Commercial scale module: 10,000,000 t CDR (CORC)

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.



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?

EBS's CO2 boundary is defined as that which includes all direct and indirect inputs and activities related to the technology and its operation. No establishment or operational emissions have been excluded. The carbon footprint for the manufacture and recycling of mobile equipment (earthmoving, light vehicle etc.) equipment have not been included at this stage, but can be calculated and included prior to the final carbon audit, if necessary.

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.

Given the remote location and reliance on mobile equipment, diesel is the dominant fuel source used. Emissions are calculated on the industry benchmark of 2.7kg CO2 /l diesel used.

Leakage of CO2 from the decomposition of buried biomass in the burial chamber is based upon a published estimated average value (1.5%) for Australian native biomass buried within less rigidly engineered burial chambers (Ximenes, et al 2016) and subsequent discussions with the lead researcher regarding emissions from an EBS burial chamber. These potential CO2 leakage values reflect the predicted partial-to-complete decomposition of the non-inert organic compounds (starch and soluble sugars or Non Structural Carbohydrates “NSC”) of the biomass. NSC is around 3% of native Australian woody biomass, and the remaining 97% (lignin, hemi-cellulose, cellulose) is highly resistant to decomposition in anoxic and hypersaline conditions.

CO2 removed from the atmosphere and captured in the biomass is based upon the following industry benchmarks:

Average Australian native woody AGB moisture content: 36% (ie bone dry biomass weight = 64% of green biomass weight)

Average Australian native woody bone dry biomass CO_2(e): 1.7t CO_2 / t dry biomass

Average Australian native green biomass CO_2(e): 1.1t CO_2 / t green biomass

EBS will use 13 different species of Australian native woody plants; the numeral average performance of which is in accordance with the figures quoted above.

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.)

All harvested biomass is weighed, sampled and assayed for total C content. All buried biomass and the chamber boundary material is sampled and assayed for total C content. This allows for total C mass balance calculations. CDR are simply the measured and agreed inert C contained within the burial chamber. EBS CDR is *empirical.*

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)*

Commercial scale units of deployment:

- Full scale production module: 25,000ha managed multiple species plantation involving a total of 25 million trees
- Average production per module 400,000 CDR tpa
- Our initial goal for Australia is 400 modules, averaging over 150 million CDR tpa

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
2021				EBS is a start up
2020				NA
2019				NA
…				NA

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.*)

NA

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 commercial unit of 400,000tpa CDR (CORC)	Stripes purchase will not directly allow EBS to expand. EBS will however leverage Stripe's purchase (as described above) to raise the required capital to start up our first full scale production module, with CapEx of around US$30m. This unit will have average capacity of 400,000t CDR pa far in excess of our contracted liability to Stripe of 4,950t CDR (CORC)

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?

Trial production costs: US$250,000 per 50t CDR (storage only) equaling US$2,000/t

EBS commercial scale production costs are confidential, but our financial model indicates they will be less than USD $25/t

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."

EBS (confidential) full production costs have been calculated on an all-in basis including:

- Full operating costs (fixed and variable) including contingencies
- Depreciation and amortization of equipment
- Financing costs (interest and fees)
- Taxation

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.

1. Q4 2021: Successful demonstration and validation of the scientific models that postulate a high proportion of C in the buried biomass is preserved in an inert state within the burial chamber
2. Q4 2021: Certification of buried biomass for Puro.earth CORCs
3. Q1 2022: Off take agreements for a full scale scale commercial module to allow for commercial start up investment

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	50 t CDR	50 t CDR	NA
2	50 t CDR	50 t CDR	NA

3	50 t CDR	450 000 tpa CDR (CORC)	Certification and generation of Puro.earth CORC's and offtake agreements with CDR customers will allow EBS to raise start-up capital for its first commercial scale module. Due diligence and media exposure will further assist EBS in securing pre-production offtake agreements.

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	US$2,000/t	US$2,000/t	NA
2	US$2,000/t	US$2,000/t	NA
3	Off take agreements terms US$25/t CDR. Production costs <US$25/t	Off take agreements terms US$25/t CDR. Production costs <US$25/t	Industrial volumes and economies of scale will lower the cost dramatically. Next module is a step change - 9,000 times the size of this project.

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?

Any credible counterparty to enter into an EBS CDR off take agreement for 400,000 tpa Puro.earth certified CORC's for any time period up to 25 years at US$25/t for delivery from 2023 onwards

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

Comprehensively scrutinise the cost, scale and social acceptability advantages we offer.

If, after thorough vetting you agree with our claims, then co-promote our story to the general public.

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?

Our key external stakeholder groups are:

1. The communities in our initial target area including Aboriginal communities
2. The State Government of Western Australia and local governments in our initial target area
3. Organisations and members of the general public with interests in the environment and action on climate change

These stakeholder groups have been primarily identified from wide ranging conversation with the State Government agencies, community members, various representative organisations and individuals, and media and communications specialists.

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

To date this work has been undertaken by the in-house team in dedicated meetings

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?

Strong support for the EBS solution is expected, given its positive economic impacts on the local community and strong environmental and social co-benefits. As a result of these engagements land purchase agreements will include the option for landholders to swap land for equity in the EBS CDR company and the option to remain in their homes on the property at no charge if they wish to do so.

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?

For the specific project envisaged in this proposal little change is anticipated to the processes described in (a) and (b) above. However, once funding has been obtained for a full scale commercial module extensive engagement and communications plans will be developed and progressively executed.

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

Economic stress is being created for businesses and communities in our initial target area by reduced rainfall during the cereal crop growing session. Farm debt is rising and land prices are falling. What have always been marginal farming businesses are increasingly economically, environmentally and socially unsustainable. The change in land use implicit in the EBS solution is intentionally targeted to improve the lot of these communities by giving farmers a viable exit option, increasing local employment and bringing back native plants adapted to a harsh low rainfall landscape that probably should never have been cleared in the first place.

11. Legal and Regulatory Compliance (Criteria #7)

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

The targeted land is freehold title. There are no legal impediments to planting or harvesting trees, digging holes and backfilling on private property. Based upon this logic, no legal opinion has been sought to date regarding the deployment of the EBS solution. A legal and regulatory compliance assessment can and will be conducted prior to any final investment decision.

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.

We have made enquiries to relevant State Government agencies regarding formal permissions. No required formal permissions have been identified to date. The tree planting and burial chamber earthworks are allowed for under existing farm land use regulations.The Western Australian government has granted EBS "Project of State Significance" status, ensuring whole of government approvals support if and as required.

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.

At present the only area of uncertainty is CDR (CORC) certification. The EBS solution is currently not covered by a CO2 removal verification and quantification methodology. The aim of this trial project is to generate data to allow EBS to meet the requirements of Puro.earth's Subterranean Biomass methodology, and thus to generate its first certified CDR (CORCs) for sale to Stripe.

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)	5,000t CDR
Delivery window (at what point should Stripe consider your contract complete?)	50t t CO2eq. (storage only**) in 2022 and research results 4950 tCO2 (CORC) in 2025
Price ($/metric tonne CO_2) ***Note on currencies:*** *while we welcome applicants from anywhere in the world, our purchases will be executed exclusively in USD ($). If your prices are typically denominated in another currency, please convert that to USD and let us know here.*	US$50 per t CDR (CORC*) Paid for by Stripe, prior to the commencement of the Trial, for delivery in 2 stages by EBS as described above. **CORC is a registered trademark of Puro.earth. It represents one metric tonne (mt) CO2eq removed from circulation for the long term. Subject to auditing according to Puro.earth methodology Subterranean Biomass Puro.earth will issue CORCs to EBS and those will be transferred to the ownership of Stripe.* *** Biomass stored in the roots in the commercial system compensate for the manual-harvesting emissions of the trial phase.This tree species grows long roots which help stabilize the soil and reach deep for underground water, which explains why they are the native plants in these arid areas.*

Application Supplement: Biomass

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

Feedstock and Physical Footprint (Criteria #1)

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

Purpose-grown harvested above ground biomass (AGB) and preserved ground biomass (BGB) from plantations of Australian native woody plant biomass, including Eucalypts and Acacias. All selected plant species have the capacity to "coppice", that is for the preserved roots to regrow new AGB after harvesting the AGB.

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

For the commercial scale operation we will purpose-grow the biomass: purchase the land required for our entire supply chain, and plant, grow, and harvest our own biomass. Preserved roots of our plantation are included in the CDR calculation. For the stage 1 of the trial envisaged in this proposal biomass from existing plantations will be purchased. This AGB will be harvested and buried in chambers on land under a long term lease. Roots from this stage of the trial are not included in the CDR calculation.

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	Trial: 2 ha biomass plantation Commercial Scale: 25,000ha biomass cultivation	Low yielding cereal, dominantly wheat production for export markets with poor economics
Processing	NA/ Biomass processing (chunking) equipment is mobile	N/A
Long-term Storage	Trial: ~100m2	Secondary hyper-salinated valley floors, of no commercial,

	Commercial Scale: 195 ha (over 25 yrs)	environmental or social use. Less than 1% of the forest stand area.

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	1 ha = 17t CDR pa 100 000 000 t CO2 = 58,823 km2 Note this, and more, is achievable within Australia alone	Low yielding cereal, dominantly wheat, production characterised by increasing farm debt and falling farm equity
Processing	NA. Biomass processing (chunking) equipment is mobile	N/A
Long-term Storage	460 km2 (25 yr burial site surface area: plantation area = 1:127)	No competing land use as burial sites will be on salt affected land

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.)

ABG is "chunked", that is cut into pieces 600mm in length for the purpose of facilitating handling and transport to the burial chamber. The buried biomass is compacted in layers (~300mm thick) within the burial chamber and backfilled with layers of high clay content soil which is compacted in situ. The chamber is covered with a mound of compacted high clay content soil optimally compacted around 3.5m thick. The chamber is flooded with hypersaline brine resident at ground level in the secondary hyper-salinated valley floor. Clay-rich soil and brine are sourced in the area.

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 resource would not have been produced but for our project.)*

This feedstock would not exist without this project. The plantation biomass is specially planted and grown for the purpose of harvesting and burial. It has no other existing commercial use. The selected plant species are not suitable for lumber or timber use. The economics are not favourable for its use as biomass fuel in this area due to processing and transport cost to port for export markets, and the cost of rebuilding the local electricity transmission grid to accommodate regional biomass-fuelled electricity generation centres and competition from solar energy and wind turbines able to be more favourably sited within the local electricity grid.

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)*

No identified negative ecological interactions or unknowns. The EBS change of landuse increases biodiversity and fauna habitats. Exotic, potentially invasive plants such as wheat are replaced by locally adapted reliable native plants.

No identified negative social interactions or unknowns. EBS provides a market for stalled and declining land sales, and a viable exit strategy for ageing, financially stressed grain farmers. EBS creates many more jobs in the target area simply because there is more than 10 times more material to be handled under the new land use.

No identified negative economic interactions. Although the value of biomass for CDR is around ⅕ that of wheat on a per tonne basis, this is far outweighed by the greater than 10 times yield per hectare increase. CDR is a growth industry with predicted future price increases, whereas wheat producers are constantly driven to find cost savings as input costs rise faster than received global wheat prices.

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.

The principle advantages of the EBS solution over most existing biomass based systems and many other CDR solution include:

1. **Durability 1000+ years:** The biomass is in inert state and remains intact for 1000+ years. Other systems where carbon is stored in living biomass are inherently dynamic, unstable.
2. **Cost at scale**: A vast amount of CDR is going to be required if we are to meet the IPCC 1.5°C pathway and eventually correct the carbon concentration in the atmosphere, probably in the range of 10 to 15 Giga tonnes of CDR pa by 2050 and probably in that range for at least another 100 years from 2050. In this light many solutions will be required and, at that scale, cost really matters.

3. **Minimal energy use:** The combined nature-based and engineered EBS solution is the best of both. It rests on the best known technology for capturing CO_2 from the atmosphere, namely photosynthesis, combined with an engineered storage that eliminates the greatest weakness of most nature-based solutions, namely the living biomass stock within the biosphere. In addition, the EBS solution makes almost no transformation of the biomass as it goes from the biosphere into engineered storage. This feature minimises "in transition" energy usage and CO_2 losses and drives down costs per tonne of CDR.
4. **Wider scope for CDR**: Potentially the most important aspect of the EBS solution is that it brings into the mix a whole class of land that has previously hardly been considered for its CDR potential, i.e. highly degraded semi-arid areas where the woodland cover has been overwhelmingly lost to deliberate clearing and/or overgrazing. To date the focus of plant-based CDR has largely been high rainfall tropical and temperate zones currently or previously covered with forests. EBS solution results in access to low cost land with few or no alternative uses and excellent secondary environmental benefits.
5. **Helping the most vulnerable**: Also following on from the above the EBS solution has the potential to make a material positive difference for many of the communities most disadvantaged by climate change. The continuous production nature of the solution and labour requirement means long-term high value jobs and multiplied economic benefits for local communities

Further advantages of the EBS solution derive from:

1. Use of high-growth biomass (native Australian woody plants. These plants are drought pest and disease tolerant. Selected plants regrow (coppicing) AGB after harvest allowing for a new harvest every two years and support high biomass growth and C capture.
2. Effectively a continuous production system EBS out performs perpetual forest CDR by a factor of 10 over 100 years of operation. The EBS solution is therefore relatively land efficient, using less land for any given quantity of CDR particularly compared with perpetual forest solutions.
3. Realistic potential to massively scale as a result of the use of poor land with few if any alternative uses and relatively low costs.
4. Low fire risk, in part due to plantation layout and regular removal of AGB. Only below ground contained carbon is counted in determining CDR.
5. Selected plants have high cellulose, crystalline cellulose and lignin contents and are inherently resistant to decomposition.
6. Use of automated mechanised planters to establish the very large plantation within the local narrow weather-favorable planting window.
7. Use of mechanised large capacity harvesting and chunking machinery to harvest four rows of trees at once, to minimise harvesting costs.
8. Likely high levels of social acceptability largely driven the use of land with few if any alternative uses.
9. Amenable to direct sampling and simple and reliable measurement of contained carbon for accurate quantification of CDR.

10. Robust storage outside the biosphere by the use of high clay content hypersalinated soils at the bottom of the valley for the construction and operation of biomass burial chambers with anoxic hypersaline saturated conditions ideal for the preservation and stabilisation of inert biomass and its contained C.
11. Use of temperature probes buried with the biomass to act as an early warning system for incipient exothermic hydrolysis; the starting point of all known biomass decomposition pathways.
12. The potential to take corrective action if biomass decomposition is detected.

Application Supplement: Geologic Injection

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

Feedstock and Use Case (Criteria #6 and 8)

1. What are you injecting? Gas? Supercritical gas? An aqueous solution? What compounds other than C exist in your injected material?

EBS is burying solid raw green biomass into an engineered anoxic hypersaline brined flooded chamber. The biomass is composed of long chain organic molecules dominantly combinations of C, H, O, N.

2. Do you facilitate enhanced oil recovery (EOR), either in this deployment or elsewhere in your operations? If so, please briefly describe. Answering Yes will not disqualify you.

No. The plantation and burial site are stand alone and are not connected to any other activity

Throughput and Monitoring (Criteria #2, #4 and #5)

3. Describe the geologic setting to be used for your project. What is the trapping mechanism, and what infrastructure is required to facilitate carbon storage? How will you monitor that your permanence matches what you described in Section 2 of the General Application?

The burial chamber is constructed in the bottoms of ancient valleys overlying or proximal to palaeo-drainage channels. There is no bedrock within the burial site. The soils are ancient alluvial sediments and residual soils from the weathering of Archaean granite/greenstone terrains. The valley soils have a high clay/silt and low (<5%) sand content. The soils are highly amenable to compaction and the formation of hardpan with extremely low hydraulic conductivity. Compaction tests demonstrate we can achieve hydraulic conductivities of $<10^{-10}$m/s (lower hydraulic conductivity than hotmix bitumen). The biomass-filled burial chamber will be covered in >3.5m of suitably compacted soil to create an anoxic environment within the sealed burial chamber. The valley floors are also characterised by hypersaline groundwaters (<250,000 ppm TDS; cf seawater = 35,000 ppm TDS) between zero and 0.5m below surface. During excavation of the chamber the immediate area is dewatered via pumping from an enveloping ring of shallow bores. After biomass filling, sealing and compaction the pumping and dewatering is stopped and the chamber floods with hyper-saline brine. The buried biomass is preserved in the anoxic, hypersaline conditions, similar to the pickling and preservation of vegetable food products in a jar, such as olives and onions.

The decomposition of biomass starts with the exothermic chemical process “hydrolysis” (cf compost or silage formation). The biomass is buried with a network of electronic temperature probes which acts as a decomposition “early warning system”. If hydrolysis is initiated, a biomass temperature anomaly will be identified and site managers alerted. This will signify that the chamber has experienced an air leak and the chamber is resealed with clay based mortar and re-compacted.

The burial chambers mound will contain a number of airtight biomass sampling sites accessible from the surface. Periodically buried biomass, the chamber wall, and the trapped hypersaline brine, will be sampled and removed from the chamber for total C content analysis and comparison against the raw biomass total C content to validate the stabilized inert C content within the burial chamber. This data generation is a valuable part of the EBS system to inform the biomass conservation science community.

4. For projects in the United States, for which UIC well class is a permit being sought (e.g. Class II, Class VI, etc.)?

NA

5. At what rate will you be injecting your feedstock?

Trial: 42 t green biomass over a 43 day period: ~1 t green biomass per calendar day.

Commercial scale: ~1100t green biomass buried and sealed per calendar day per module

Environmental Hazards (Criteria #7)

6. What are the primary environmental threats associated with this injection project, what specific actions or innovations will you implement to mitigate those threats, and how will they be monitored moving forward?

> We have presented our plans to the Western Australian Department of Water and Environmental Regulation. No environmental threats were identified. Dewatering hypersaline brines will be temporarily stored in sumps adjacent to the burial site. Bunding will be constructed around the burial site direct sporadic surface flood water around the burial site and prevent erosion of the sealing mound.
>
> The plantation of a very large area of native trees upslope from the burial site will over time recreate native fauna habitats lost when the land was cleared for cropping around 120 years ago.

7. What are the key uncertainties to using and scaling this injection method?

> The purpose of this trial is to demonstrate that the biomass buried in the engineered subterranean chamber is preserved in an inert state as predicted by the science. This is the key uncertainty of the project, which will be addressed and quantified by the trial.