General Application

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

Company or organization name

Susewi Ltd.

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

London, United Kingdom

Name of person filling out this application

Raffael Jovine

Email address of person filling out this application

raffael@susewi.life

Brief company or organization description

Susewi sequesters carbon and produces planet positive food by creating large-scale natural algal blooms in desert environments. We are a team of 12 professionals based in London and have operated trial sites in South Africa, Oman and Morocco. Our current focus is Morocco.

Our patented technology uses large ponds in coastal deserts to grow algae at low cost. Approximately half of the algae biomass is suitable for processing into high quality protein for use as a human food ingredient (e.g. meatless burgers) and the other half is suitable for long-term carbon sequestration on site.

Please refer to our introductory video here.

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. *1500 words*

This application is not for BECCS, DAR, Ocean Alkalinization, or other natural biomass production methods, like biochar production, soil carbon amendment or kelp sinking.

Our team has developed a more sustainable mechanism that, in the desert:

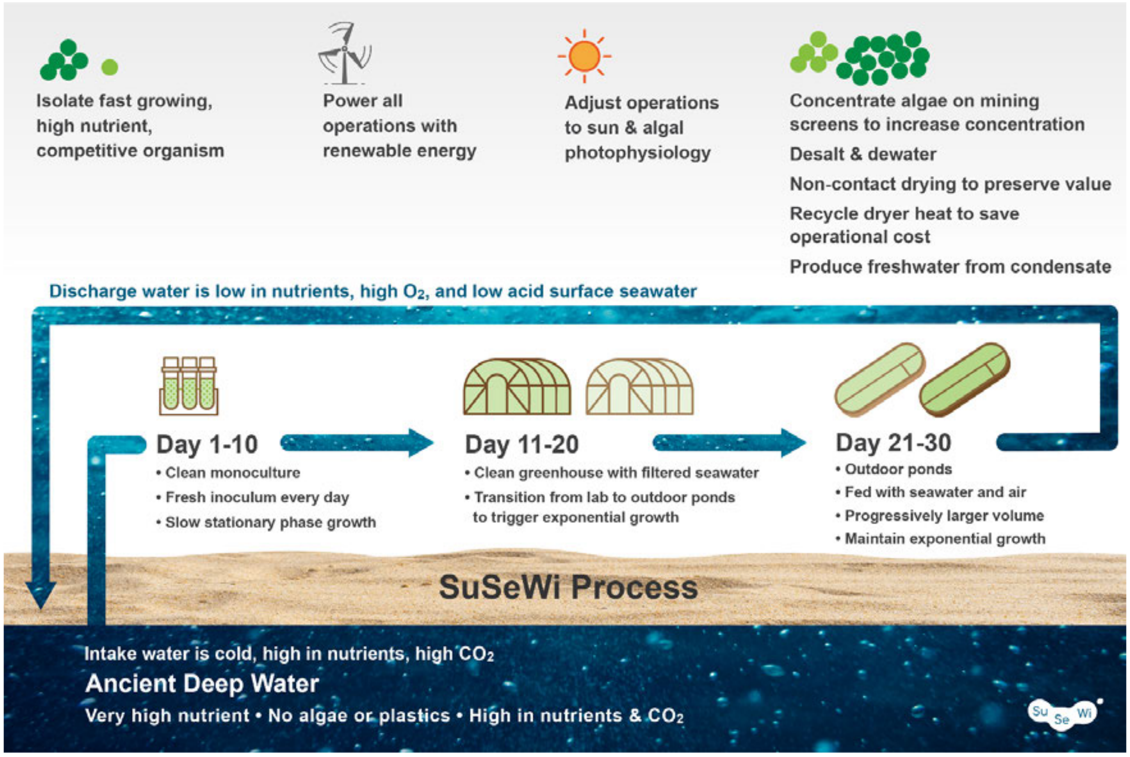
1) Sequesters carbon and produces transformative quantities of highly nutritious food,
2) … while also producing freshwater and employment
3) … using only seawater, sunlight and renewable energy.

Without creating negative externalities, we

1) Bind natural atmospheric CO_2
2) Restore local ocean acidity to pre-industrial levels
3) Have physical control of the biomass to specify how much we chose to sequester

Our method of cultivating microalgae is based on replicating natural algal ‘bloom’ phenomena, on land, year-round. The reasons for selecting this approach are:

1) The ocean drives nearly half of global Net Primary Productivity (NPP) and is the largest untapped resource to increase ‘new’ or ‘additive’ carbon fixation, that would otherwise not have happened naturally. In other words, it enables us to increase natural carbon capture (in particular, without using agricultural land).
2) Deep ocean water, from below the thermocline, is richer in CO_2 and nutrients than surface waters. This water is also colder, cleaner and ancient (relatively free of anthropogenic contaminants). For these reasons, we locate our production sites near areas of ‘upwelling’. Upwelling is when ocean currents and prevailing winds push seawater away from the coast. These surface waters are then replaced by deep, colder, water that rises to the surface.
3) In these areas of upwelling, there are countless microalgae that are specialised to take advantage of the higher nutrient availability during these upwelling events. These are called ‘r’ strategists that compete by growing rapidly for extended periods of time.
4) An algal ‘bloom’ is a phenomenon when a mixed community of competitors, predators and decomposers becomes dominated by a single, fast-growing organism. These are primary producers that grow faster than their competitors and predators.



Schematic of the nature-based microalgal growth process using only Sun Sea & Wind (hence SuSeWi)

Aerial photo of the current 3ha research site operating in Morocco on the Atlantic Coast

Applying these natural system features, enables Susewi to:

1) Select local, natural algae, for which there are no regulatory or approvals barriers;
2) To grow in very large, easy to build (low capex), open ponds,
3) With natural nutrients and CO_2 (free inputs)
4) At natural (lower) cell densities or standing stock,
5) Harvesting daily, as opposed to every 2-3 weeks, resulting in 12x greater net productivity per unit area than alternative algal production systems.

To amplify the overall impact, we have combined this system design with

1) Low cost, highly scalable engineering learned from shrimp farmers that move very large volumes of water across flat coastal land
2) Transferring seawater in the ponds by gravity, as opposed to pumping the water
3) Harvesting with gravity operated, 500-fold cell concentration mechanisms from mining applications, that remove ‘fines’ from large volumes of mining process water
4) At every stage Susewi has reduced energy demand (Opex) for system operations. We have selected
    a) Highly efficient, high volume, low-head pressure pumping solutions
    b) A collaboration with Southampton university to reduce paddlewheel and mixing energy demand
    c) Designed drying solutions that enable drying energy recapture and recirculation - importantly, this also captures condensate freshwater
    d) Because of the location of our production site in coastal desert areas, where hot desert land borders on cold, upwelled ocean water, renewable wind and solar energy is produced readily. Even at this early stage in Morocco, with our current 3ha site, we are operating on entirely renewable energy sources.

What differentiates Susewi is that it has established operating routines to combine all these factors year-round, throughout the seasons, in different locations like South Africa, Oman and Morocco, to produce biomass continuously regardless of location.

1) We are further developing remote sensing tools to monitor cellular photophysiology (health of the algae), to
2) Proactively feed operational, meteorological and oceanographic data into a Digital Twin system simulation, to
3) Forecast production, up to five days in advance, so that pond operators can proactively control the environment in the ponds
4) Combined with an AI system, the Digital Twin learns to optimise production and enables SCADA controlled automation of the (relatively simple) pond operations for additional Opex savings.

The combination of these different approaches has been reviewed by a LCA conducted by Imperial College and subsequently confirmed by Stirling University (reviewed later in this document). The significance is that our alternative biomass production method is significantly more sustainable than any other form of plant-based, insect-based or single-cell protein production. Our sustainability claims focus on:

1) Lowest CO2 equivalent per unit protein or food produced - importantly this includes the delivered carbon footprint, after the biomass has been exported from Morocco to Europe
2) Negative freshwater footprint - we produce 5.2 tons of freshwater per ton of dry biomass
3) Highly efficient land-use relative to any agricultural product

4) Strong social sustainability with local staff including 50% female employment

The lessons learned from the three pilot sites in South Africa, Oman and Morocco, and the insights from the Digital Twin have been combined in an engineering programme to design a 4th generation, full-scale production model, that:

1) Incorporates low cost civil engineering
2) Scale benefits of larger internal diameter seawater pipes
3) Energy saving measures
4) Quality Control and Quality Assurance measures
5) SCADA control and automation

This engineering design is intended to create operational modules that can be repeatedly deployed and linked together to increase scale-benefits while saving deployment and building costs.

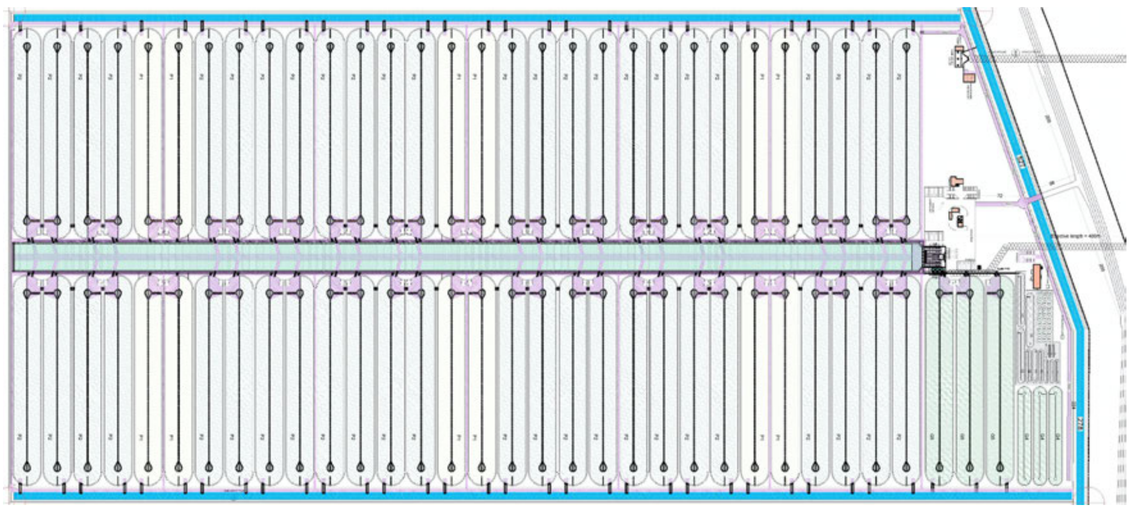


Illustration of a Module Design to cluster ponds

The current design is for 115 ha “modules” that produce 1,700 tons of dry biomass per year. In Morocco, on the 6,100 ha of land that has been assigned to Susewi, we plan to deploy up to 43 of these modules. These first set of modules will produce 70,000 tons of dry biomass, sufficient to capture and fix 102,000 tons of CO_2 from the environment, at a single production facility. There are millions of hectares of such land available along 14,000 km of coastline, in countries such as Mexico, Chile, Peru, Namibia, South Africa, Gulf Cooperation Countries, Australia, Mediterranean countries and many others, with the capacity to trap >>0.5 Gt of CO_2 per year.

To accelerate the building and expansion of these production facilities, Susewi is planning to extract high value food products from the raw biomass with which to initially subsidise the carbon capture. These products include:

1) High value pigments (organic and clean label) such as b-carotene & fucoxanthin
2) Soluble protein (e.g., vegan egg-white substitute), (15% - 20% of biomass)
3) Lipids and fatty acids (e.g., nutraceuticals & technical aides) (10% - 15% of biomass)

There are well-established markets, with global demand. Susewi has developed multiple prospective off-taker relationships. These products have significant value and can generate as much as $3,200 / ton of blended product. Which is especially important in the beginning to finance the building and scaling of the first production modules and to generate sufficient income during the initial production stages.

For these first modules, before significant operational and capital scale savings can be achieved, the financing for the detailed engineering design, local bathymetry, topography and site development, procurement of long-lead items (like the seawater pipeline), labour and construction, can be raised based on the sale of these food ingredient products.

Of course we recognise that if we extract, process and sell food ingredients, there are additional CO2 emissions (in the processing) and associated CO2 re-emission when these food ingredients are digested. Between 40% - 60% of the biomass may leak or be lost to food production as opposed to carbon sequestration. The corollary of this position is that approximately 50% of the biomass is available for long-term storage and sequestration. These carbon losses are captured in our LCA and the pricing to valorise the remaining biomass for burial is the focus of this application.

Our aim is to develop the first commercial production facility and then to license the technology worldwide, in order to scale and amplify the impact. Continued research, site development and acceleration of the development will be financed through the application of these license fees.

Further background information including photos, videos and interviews can be found here: SuSeWi - Media

b. What is your role in this project, and who are the other actors that make this a full carbon removal solution?

I am the company founder and Chief Science Officer that invented the alternative algal growth technology. Based on my training as a Molecular Biochemist & Biophysicist I became a Marine Biologist. I am the author of the original patent families and have developed the algal growth technology from its inception. I have guided the growth of the microalgae in the desert, using seawater-based nutrients, sun and renewable energy, to produce the lowest footprint food while also producing an excess of freshwater. From the beginning of the programme Susewi's rola has been to focus on scaling the technology and to maximise the social, economical and environmental impact of microalgal cultivation in the desert.

Our team includes scientists and engineers that optimise the growth of the algae on natural resources and ensures that our operations are responsive to weather, season and operational changes. Together with a wholly-owned subsidiary in Morocco (Feed Algae Maroc SA), our team has learned how to produce biomass in very different remote desert environments (South Africa, Oman and Morocco), including how to scale production, work with locally-isolated, natural microalgae, limitless natural nutrients, CO2 and local workforces. I also direct our product development team to ensure that we produce customer-focused extracts, concentrates and isolates of high value food ingredients that finance the growth of our company.

We work closely with engineering service providers, our customers and governments to implement our process as rapidly as possible.

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

The largests risks are:

1) **Access to large areas of coastal land and seawater**, in potential production countries including amongst many others Mexico, Chile, Peru, South Africa, Namibia, Angola, Saudi Arabia and the Gulf Countries, Australia and Mediterranen countries. Susewi has secured 6,100 ha of land in Morocco and 3,200 ha of land in Oman, that is ideally suited for production. We emphasize the use of non-arable land that has no alternative land-use or economic value, is not obstructed by coastal cliffs and has access to deep seawater. We have identified 14,000+ km of ideal coastline in both hemispheres.
2) **Project financing,** given this is a novel technology.
3) **Carbon markets** that are volatile and prices are not predictable yet (which is why we are applying here). At scale, we estimate that we can sequester a ton of CO_2 for approximately $29 operational cost, depending on local conditions and how much biomass residual is sequestered. However, this is mitigated by our food ingredient revenue stream.
4) **Customer acceptance** of algae-based food ingredients. On the one hand, we will sell to food manufacturers, not end consumers. Food manufacturers focus on the technical specifications of ingredients (for which we have a strong proposition) and are not expected to be resistant to algae-based sources. On the other hand, large food manufacturers can be slow to change and so effort is required by any new supplier to cultivate these enterprise customers

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

- *https://worldwide.espacenet.com/patent/search/family/040134044/publication/GB2464763A?q=ap%3DGB0819865A*
- *https://worldwide.espacenet.com/patent/search/family/049323797/publication/US2013269244A1?q=pn%3DUS2013269244A1*

In addition to the patents, Susewi:

1) Owns a library of proprietary algae that have been isolated from the local cultivation environment and are acclimated and adapted to the highly specific challenges of growing in the desert, perform in our production system and have the ability to bloom or grow exponentially
2) Has both operational experience and engineering designs to reduce operational, civil engineering and construction costs for large-scale facilities (covering tens of thousands of hectares of desert)
3) Has know-how of how to produce different species, in different locations according to customer specifications

First Patent Family "Method of Carbon Sequestration"

Jurisdiction	App/patent no.	Status
Australia	2009309476	Granted

Chile	00948-2011	Granted
UK	0819865.7	Granted
GCC	2009/14586	Granted
Morocco	32827	Granted
Mexico	311987	Granted
Namibia	2011/0011	Granted
USA	8278082	Granted
USA	8440439	Granted
South Africa	2011/03638	Granted

Second Patent Family "Method of Culturing Algae"

Jurisdiction	App/patent no.	Status
Namibia	AP/P/2014/008045	Granted
Australia	2013246659	Granted
Chile	2014-02744	Cleared for grant
UK	1206466.3	Granted
GCC	2013/24095	Granted
Morocco	PV/37499	Granted
Mexico	MX/a 2014/012270	Granted
USA	9295206	Granted

As part of the use off proceeds of our next fundraising round we plan to expand and renew our patent portfolio

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

a. Please fill out the table below.

	Timeline for Offer to Stripe
Project duration	Oct 2022 - Oct 2023
When does carbon removal occur?	Trial volumes starting late 2022. Commercial volumes starting late 2023 Carbon removal is >1,000 years
Distribution of that carbon removal over time	Evenly distributed over the whole time frame. The capture and sequestration cycle requires less than one month.

	Uncertainties - exact growth rates and carbon content can vary slightly.
Durability	The durability of our burial site is 1,000+ years (as dry, salty and sealed biomass in caves, cultural artefacts and desert graves prove)

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

1,000 - 5,000 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.

We have not yet measured the sequestration durability, and cannot perform these tests today. We have stored biomass from our first experiments ourselves for 5 years. However, we are confident that we can robustly verify the capture, carbon content and stability of our sequestered carbon, because:

1) In the desert production locations we have secured, there is excess (elevated) land not suitable for algal cultivation, where the sequestered biomass is effectively solar dried, stored (in a water and air sealed manner) to prevent degradation or re-release.
2) Our biomass is hyper-saline (30%-40% salt), dry and can be buried and covered with a waterproof membrane to prevent remineralisation or biological breakdown. The desert locations are dry and free of biological activity, and alternative economic use, reducing the repurposing of the land.
3) All of the sequestered biomass is accessible for verification and can be physically validated - and - remotely monitored.
4) There is no soil respiration, or biological activity in the sequestered biomass due to the absence of water and inability to access air.
5) We have stored bags of biomass now for 5 years under ambient (room temperature) conditions and they have not degraded, volatilized or broken down.

For these reasons, we are confident that we will be able to quantify and confidently demonstrate the durability of the sequestered biomass on site, or alternate HTL and soil carbon applications. This proposal is also intended to fully demonstrate these benefits.

d. What durability risks does your project face?

Susewi aims to determine the highest sequestration-to-durability ratio, by evaluating three options:

(a) direct on-site burial (outlined in this proposal- low risk but may not realize the full opportunity)

(b) HydroThermal Liquefaction (HTL) to bury coal and recycle nutrients (with TerraNova Energy) a specialist HTL provider with pertinent experience and

c) soil carbon preparation (with OCP the Moroccan fertilizer conglomerate) to improve African soils.

Risks:

1) Physical risks - there are very few physical risks, as the storage areas are elevated, distant from earthquake centers and highly unlikely to be developed.. Suswi already has secured a 30 year lease for its first site and can seek to enter into longer-term agreements. The closest settlement is 20 km from the first site and the land can be readily labelled and sealed.
2) Socioeconomic risks are low, as the sequestration site can be protected and actively guarded, creating small but long-term employment and therefore is actively sought after by local communities. The material is difficult to separate and process and a poor fuel source.
3) There are countless precedents for similar biological materials being stored in deserts for cultural or funerary purposes for thousands of years (pharaonic or other burial site). This programme will determine the optimum balance between processing effort and durability.
4) Susewi has full control of the process and can indefinitely monitor, account and validate the stability of the sequestered biomass.

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?

Carbon accounting will be conducted in three different places:

1) **Solids-based** carbon measurements of the biomass before burial and periodically collected core samples after burial
    a) Total Organic Combustion analysis of dry samples, combined with a
    b) Total Nitrogen attachment, to ensure that elemental ratios are maintained
2) **Total Organic Carbon analysis** - of buried biomass cores (Shimadzu TOC-L)
3) **Solid Sample Combustion -** on dried sample (Shimadzu SSM-5000A) for dried organic carbon
4) Tracking of gases indicating decomposition (methane, CO_2 or N_2O) evolved from a sample well from the buried samples
5) On the seawater intake side, to create a **carbon mass balance,** we will measure **seawater-based** carbon measurements that determine how much CO_2, bicarbonate and carbonate was absorbed from the incoming seawater will be determined by
6) **Total Alkalinity** - we do not remove Ca and Mg based on two phase curve of pKa values Hanna Instruments pH titration to determine the buffering capacity of seawater both on the intake and discharge side of the ponds

It is important to note that we do not grow cells that remove alkalinity from seawater, such as Coccolithophorids. This means we bind the inorganic carbon (CO_2 and HCO_3) while returning

(de-acidified) discharge water at pH 9.2. For every unit of discharge water we deacidify 5.1 units of surface seawater.

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	**Total tons CO2 bound** 2023 - 145 2024 - 145 2025 - 8,223 2026 - 16,591 2027 - 52,774 2028 - 117,302 2029 - 234,150 2030 - 390,479 2031 - 569,833 2032 - 783,287 2033 - 1,009,008 2034 - 1,210,193 2035 - 1,372,124
If applicable, additional avoided emissions	**Million ton CO2** emission avoided by the food ingredient fraction: Fish - Poultry - Pork - Beef 2026 - 0.04 - 0.4 - 0.6 - 3.3 2027 - 0.1 - 1.2 - 1.9 - 10.4 2028 - 0.3 - 2.6 - 4.1 - 21.1 2029 - 0.6 - 5 - 8 - 46 2030 - 0.9 - 9 - 14 -77 2031 - 1.4 - 13 - 20 - 112 2032 - 1.9 - 18 - 28 - 154 2033 - 2.4 - 23 - 36 - 198 2034 - 2.9 - 27 - 43 - 238 2035 - 3.3. - 31 - 48 - 270

b. Show your work for 2(a). How did you calculate these numbers? If you have significant uncertainties in your capacity, what drives those?

Our select microalgae absorb ambient carbon dioxide from the environment by photosynthesis (they are not mixotrophic or heterotrophic). When dried the biomass is 44% carbon (due to a relatively high lipid (20%) and protein content (50%)).

For table 3a - we calculate total dry biomass produced / year * 44% (proportion of carbon in biomass) * 3.66 (ratio of carbon to CO_2 bound) = gross CO_2 captured / year

The net CO_2 buried (table 4a) is calculated:
For 50% of the biomass that is buried, we calculate the total biomass produced in that year,, the relative proportion of that which is carbon 44% and multiply 3.67 (MW of CO_2 relative to C), subtract the CO_2 emission associated with burial, to determine Net CO_2 sequestered).

50% Yearly Biomass * (biomass carbon content (44%) * 3.67) - (Domestic CO_2 emissions associated with sequestration) = CO_2 sequestered

For table 3b (meat analogue offsets) - when we fractionate the algae, we remove ~50% of the biomass for the meat analogues. Combining (a) the protein adjustment of algal protein to the meat analogue and (b) the correlated CO_2 emissions for that meat (WRI data) creates four conversion factors (fish - 8, poultry - 73, pork - 114 and beef - 635). We then multiple 50% of the total biomass by this factor to determine what the offset will be in these sectors for that year.

50% Yearly Biomass * (protein adjustment * meat-specific offset) - (Export-related CO_2 emissions) = t CO_2 emission avoided

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).

On the 3ha trial site in Morocco today, we can produce 20 tons dry biomass per year. At a 100% burial the theoretical capacity would be 31 tons CO_2 sequestered per year (20 * 44% * 3.66) - 1 (carbon burial emissions).

In Morocco we currently have 6,100 ha of land on which to expand
In Oman we currently have 3,200 ha of land on which to expand

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!

The assumptions below are based on current production at our demonstration facility in Morocco. Our current research program centers on increasing that productivity per m^2 further. 1) Today we produce 24 g dry biomass per m^2 at 50 cm depth per production pond (500 l) per operational day 2) We will increase pond operational depth to 85 cm and productivity to 32 g / m^2 / per operational harvesting day 3) This equates to a 3-day growth cycle - we fill, grow, harvest each production pond every 3 days 4) 315 operational days (this is conservative - since we have operated year round in 2018/19) 5) Ratio of production pond area relative to total available area is 22.3% This means - 22.3% of the facility land is harvested at 24 g / m^2 (dry biomass) in a 3-day growth cycle for 315 days / year.

e. Documentation: If you have them, please provide links to any other information that may help us understand your project in detail. This could include a project website, third-party documentation, project specific research, data sets, etc.

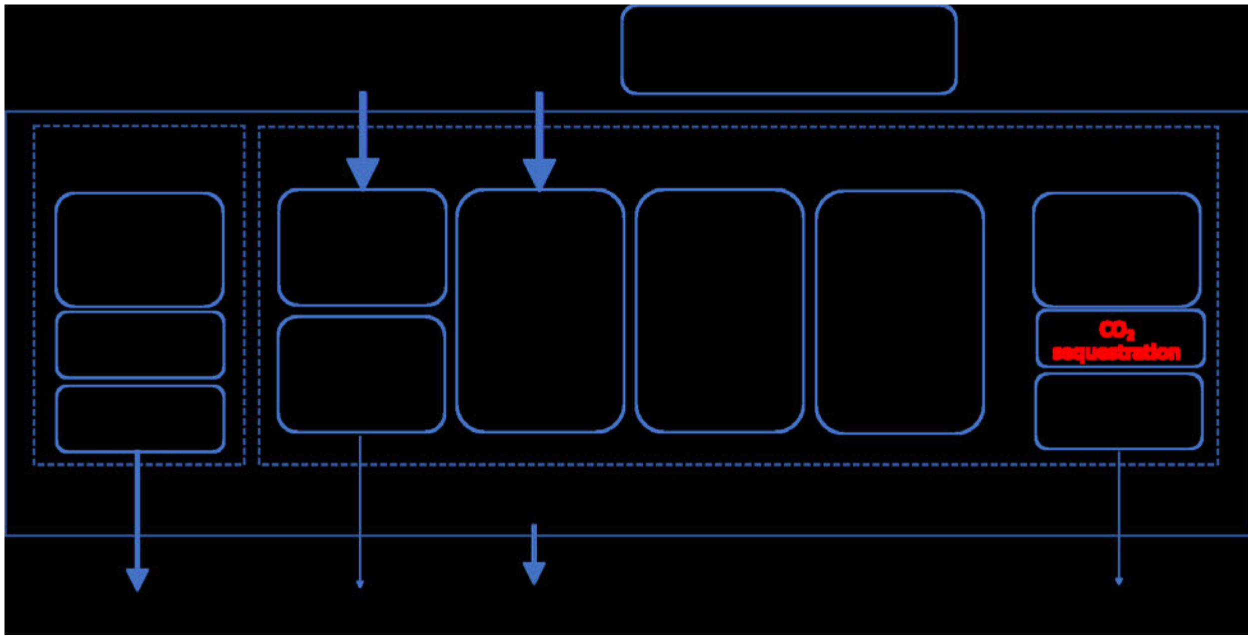
• Stirling University LCA report • Imperial College environmental report

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.

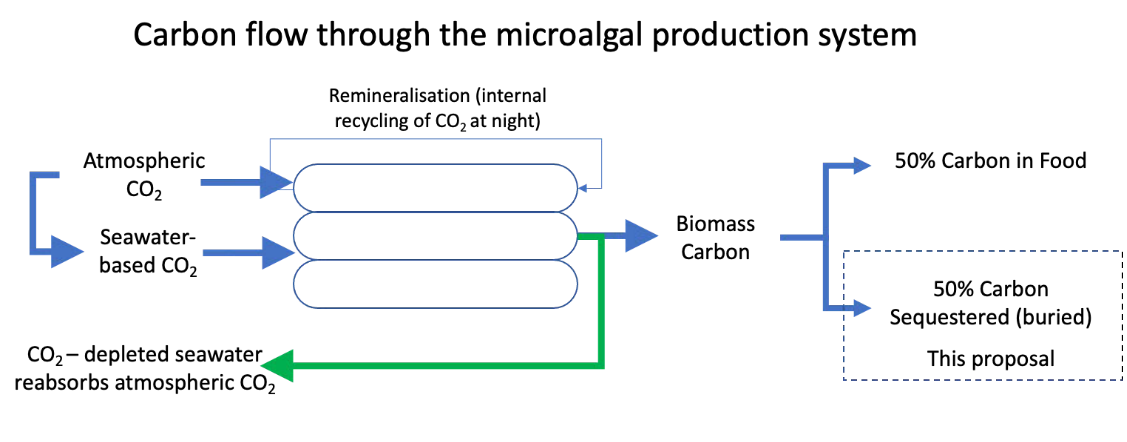
	Offer to Stripe (metric tonnes CO_2)
Gross carbon removal	**145** tonnes CO2 bound / year 1
Gross project emissions	1) 4.65 tonnes CO2 emitted for 50% of biomass sequestered on site 2) 18.62 tonnes CO2 emitted for 50% of biomass exported and metabolised in Europe Total is (4.65 + 18.62 + 72.) = **95.8 of 145** tonnes CO2 emitted year 1
Emissions / removal ratio	95.8 / 145 = **33.9%** CO2 removed
Net carbon removal	145 - 95.8 = 49.2 tonnes CO2 removed Y1

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



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?

Please see the LCA from Imperial College and analysis by Stirling University attached in the links above. Note, the closest 440 MW wind farms are 20 km from our site (and their power lines run through our site). This Moroccan state produces >4 GW of wind power and the capacity is rapidly expanding. This is supplemented by the largest solar power program in the world. On the emissions side the system boundaries included the CO2 embedded in material, CO2 emitted in transport and product consumption, CO2 generated during algal growth processing and drying (including on-site burial related emissions) and CO2 emitted in the production and application of seasonal fertilizers (to supplement seawater nutrients during periods of low natural upwelling). On the carbon absorption side, the system boundaries include atmospheric CO2 and seawater-based CO2, that is bound within the dry biomass. The cleaned discharge seawater is 100% available to capture atmospheric CO2 again. Please see the carbon flow diagram below.



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](#).

While we are a small start-up, these numbers are not modelled. We actively measure biomass produced, processed and stored and have done so under operational, field conditions in South Africa, Oman and Morocco, throughout 6° C winters and 50° C summers. We measure the changes in seawater pH and the associated carbon budget. We also measure the composition of our algal biomass. All aspects of the system are verifiable both directly (on the physical biomass and land-based seawater system) and soon, by remote sensing, as we can correlate productivity (CO_2 capture) with pond colour.

We have enabled and supported a study by Imperial College and Stirling University, the results of which are both attached. All numbers in this document are based on these and our own measurements.

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.)

We welcome 3rd party verification and as we develop will be able to provide samples and materials for review. Stripe could review our claims with

1) OCP (the Moroccan phosphate company) for local operational context
2) IFEU - The Institute for Energy and Environmental Research at the U Heidelberg that can perform an environmental, processing & transport & food-consumption related LCA
3) Woods Hole Oceanographic Institution (WHOI) for bloom physiology and algal bloom related verification
4) UCSB Bren School of Environmental Sciences - for the oceanic, environmental and ecological considerations

We would be delighted to make provide relevant contacts, make introductions and provide contextual information.

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.

Our unit of deployment is m^2 of harvesting pond. Available land, production facility size and number of ponds per production module can vary. In contrast production per pond is highly predictive and reproducible for carbon fixation and biomass production.

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 (m^2)	Unit cost ($/unit)	Unit gross capacity (tCO_2/unit)	Notes
2020	8000	1.30	0.0039	The cost will drop to 0.025 / unit in the first 115 ha production module
2018	8000	1.48	0.0032	These were research & installation related costs
2016	650	110.3	0.0030	These costs include species isolation & research cost
2014	3.5	1,901	0.0028	These costs include species isolation & research cost

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.)*

We have developed a new growth methodology that operates with natural ingredients in variable and complex environments. Susewi has increased the yield, scale and stability of the system since its inception. It will continue to do so, to gain very large scale benefits. To date, increasing the scale has increased operational stability and productivity of the system, just like the real ocean.

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)
1,010,000 units - or m^2 of harvesting ponds in Year 1 (101 hectares)	0.016 tCO2/unit (m^2 harvesting pond)

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?

Current demo facility 3 ha: $ 800/ ton CO_2

Note:
16ha trial facility (2022) using today's technology: $600/t
1,100ha commercial-scale facility (2024) using today's technology: $29/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."

This cost includes all direct costs e.g. consumables, energy, labour, shipping & land rental. It excludes a) fixed overheads e.g. R&D and senior executives, which will be spread over multiple projects and b) capex. Our fixed overheads have very significant economies of scale.

Capex is calculated as $7,795 per tonne of annual CO2 sequestration capacity installed. We expect to decrease this amount by 25-50% over the next 2-3 years by lowering build cost through further refining engineering. Depreciated over 20 years $7,795 results in a capex attribution of $390 per tonne CO_2 sequestered.

As discussed later, the significant decrease in operating cost per tonne ($800 -> $600 -> $29) is due to simple economies of scale & fully utilizing staff. As a hypothetical example: at 16ha a member of staff capable of maintaining 200 ponds would be maintaining only 10 and would

spend most of the day idle. Phrased another way, there is a minimum commercially viable scale of ~1,000ha.

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

Milestone #	Milestone description	Why is this milestone important to your ability to scale? (200 words)	Target for achievement (eg Q4 2021)	How could we verify that you've achieved this milestone?
1	*16 hectare trial production facility construction*	*- Attracts further financing* *- Produces sufficient biomass volume for final food ingredient customer trials* *- Demonstrates ability to construct facilities on-time and on-budget*	Construction: Q1-3 2022 Operate: Q4 2022 onwards	*Physical verification that the production facility is operational*
2	Verify sequestration stability	Customer requirement	Q2 2022 onwards	Independent report

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

Milestone #	Anticipated total gross capacity prior to achieving milestone (ranges are acceptable)	Anticipated total gross capacity after achieving milestone (ranges are acceptable)	If those numbers are different, why? (100 words)
1	31 tons CO_2 / year capacity	183 - 263 tonnes / year capacity (variation according to what proportion of product is directed to food)	An increase in pond area from 0.8 hectares (current) to 16 hectares (trial facility) will provide a larger production/sequestration area

2	Residual (non-food) biomass is solar dried and stored 1 year	Biomass is unchanged	N/A

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	3ha - $800 / tonne	16ha - $600 / tonne	*Economies of scale in overheads and capex - this economy of scale benefits will increase with larger-scale deployment*
2	N/A		

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?

We do not have one particular person in mind but having the founder of any large successful tech company apply their experience of rapid scaling to the project would be helpful. Or their chequebook! The company's current constraint is capital to reach minimum viable scale, rather than engineering/science. After that hopefully scaling will be the constraint.

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

Generate awareness of the project and/or invest directly.

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?

Critical stakeholders include the governments e.g., in Oman we established a relationship with the Ministry of Agriculture and Sultan Qaboos University. SQU provided us with a research site with a pipeline and the ministry assigned the deed to 3,200 ha of coastal desert. Similarly in Morocco, we are supported by the National Marine Fisheries Institute (INRH), the National Aquaculture Development Agency (ANDA) and the National Resources Ministry to secure 6,100 ha of land. We also engage the state governor, regional director and local community to identify staff, suppliers and resolve local and conflicting priorities. As we operate on remote desert land with no alternative use and produce very limited negative externalities we have a lower than typical number of external stakeholders.

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

This has been completed primarily in-house, with the assistance of some local service providers. . Susewi has a dormant subsidiary in South Africa, a Branch in Oman and an operating company in Morocco called Feed Algae Maroc (FAM). On the board of FAM is the former Minister of Finance in Morocco. Also engaged is OCP, the Moroccan state phosphate company to provide institutional support. As a result we have had assistance with introductions at all levels of state and local government and civil institutions.

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?

In our experience, hiring engineering, biomass processing and other intermediaries to develop local relationships and to outsource core activities including engineering and contract management has not been efficient with 3rd parties. To grow the company we are seeking to develop an 'owners-team' of core capabilities within the company to ensure more effective timeline management and alignment of priorities.

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?

Yes, ultimately we will continue process and product research to increase the effectiveness of our system, perform advance site development and accelerate the build out of our production

facilities. For this reason, we are seeking to develop key staff within our company. Similarly, we are seeking to develop key strategic relationships with key customers to ensure that we can maximise the value of our ingredients. The higher the value and longer we can maintain the value of the algal ingredients the more rapidly we can scale production and sequester carbon.

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

The communities within which we operate are typically food insecure and often lack basic public services such as appropriate healthcare and education. The company will be guided in its actions to address these issues by a broad-based multi-stakeholder dialogue supported by professional social development advisors.

In terms of direct economic impact, Susewi will provide meaningful employment to a large number of local residents (100's) at significantly above living wages and opportunities for professional development. Within the community, in order to secure Susewi's social license to operate and mitigate any social service pressures created by the company's presence we will both support existing healthcare and education infrastructure as well as directly increasing capacity through community investment. The company will draw on it's senior executives' deep experience working in both commercial and developmental capacities in Sub Saharan Africa.

By design and core to its commercial framework, Susewi provides an opportunity not only to advance climate change goals but also food security and development in vulnerable rural areas.

11. Legal and Regulatory Compliance (Criteria #7)

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

With regard to our production process and legal framework, we retain UK-based IP and corporate advice (for license and government agreements). In Morocco we retain local counsel to ensure compliance with local law. We have secured a land agreement with the Moroccan government and license agreements with our subsidiary.

In addition, we collaborate with INRH, the Moroccan fisheries research institution to ensure we are in compliance with local marine and coastal regulations.

We have also completed an approved Environmental Impact Assessment (EIA) that was ratified by 27 Moroccan government agencies.

An independent legal opinion can be commissioned on request and we would not expect any material issues.

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.

In Morocco, to operate in a coastal environment and on public domain land, we required approval from INRH the marine fisheries agency and ONYM the Mining ministry. Both granted exclusivity, and ONHYM made eight 10 km x 10 km plots available indefinitely. These were the basis for a land agreement with the Moroccan government, EIA and approval by the Hydraulics agency. Susewi and Feed Algae Maroc SA (our subsidiary) do not require additional approvals to proceed.

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.

Construction of additional sites in new countries will require compliance with the laws and regulations of each new jurisdiction. To the best of our knowledge there are no significant regulatory barriers in any of the expected future locations. On the food production side, we will require support for gain 'novel ingredient' status in the EU for the 50% of the product sold as a protein food ingredient. We view the progression of carbon pricing as an unknown and believe that by participating in these carbon markets (as we are doing with this proposal), we will determine the best mix of food ingredient production versus carbon sequestration.

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)	49.2 tons
Delivery window (at what point should Stripe consider your contract complete?)	*Supply: evenly throughout 2023:* *Completion: upon confirmation of burial of 49.2 / 3.67 * 44*

	= 5.9 tons of dry biomass.
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.*	Base case: \$660 / tonne (10% markup over cost) However, this base case is financially very modest. As an alternative we would propose discussing purchasing a stream of production capacity, i.e. a 49.2 ton per year supply for 20 years (equipment lifespan), rather than 49.2 tons as a once-off. This would be the most helpful way to contribute to Susewi's upfront investment costs, catalyzing the project.

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?

We rely on marine microalgal biomass grown in desert ponds. It does not contain leaves, stems, roots, bark or other components that might be discarded. It is composed of approximately 50% protein, 15-20% lipids, 15% carbohydrates and the remaining 15% (nitrogen free extract, water, salt) are not easily valorised. Because of the high lipid content, the elemental composition is approximately 44% carbon, 22% oxygen, 6% nitrogen and others. This proposal outlines an uncommon approach where ~50% of the biomass (fatty acids and soluble proteins) is extracted to generate revenue for the programme by sale as a high-protein food ingredient and the remaining 50% is solar dried and sequestered on site for carbon sequestration.

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

Yes, Susewi has developed the nature-based growth methodology, isolated the local production organisms and developed the valorisation. Production, processing, distribution and sequestration of our biomass is entirely controlled by Susewi. We do not rely on limiting inputs from 3rd parties. Almost all of our inputs (air, desert land, deep seawater and sunlight) are available in abundance and there are no restrictions to accessing these in our chosen production locations. In the process the seawater we use is deacidified, cleaned of organic biomass and enriched in oxygen. In effect we take deep seawater and turn it into deacidified surface water. The entire

system design is entirely based on making natural primary producers, absorb natural resources (seawater nutrients and CO2) to fix them in biomass, that would not otherwise have grown. This is new or 'additive' primary productivity. It does not compete with or replace any biological or economic activity on the desert land. Therefore, it creates biomass that would not otherwise have been grown, potentially at a very large scale.

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	3 ha - 30,000 m^2	Not applicable - we work in coastal desert salt pans that cannot grow a blade of grass.
Processing	90 m^2 - harvesting station 170 m^2 - processing & drying	As above
Long-term Storage	*De minimis*	As above

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	1,500 lab facilities with local strains require approximate 200 m^2 each (1,500 x 200 = 300,000 m^2 - 30 ha Greenhouses to increase inoculum production will require approximately 1,500 ha land 4,464,000 ha - total land (assuming 50% CO2 burial and 50% for food production) Approximately the size of Estonia (which although large is less than 10% of our preferred desert operating areas and less than 0.2%	None - isolated desert

	of all of the world's hot desert area).	
Processing	5km^2 or 1,500 facilities of the current 3,500 m^2 size each (however at 100Mt fewer larger facilities would be developed)	None - hot desert
Long-term Storage	At a density of ~600 kg / m^3 would require a heap of - 10m deep and 4,000 m a side (or 16 km^2)	None - hot desert

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.)

> The on-site carbon processing and storage cost are included in the LCA and include the fuel for digging the pits and covering them plus the energy to pump ($3/ton C) the highly concentrated slurry for solar drying from the processing plant, to the drying fields. After extraction of the high value proteins, fatty acids and pigments either a thick slurry (wet extraction) or a dry gange (dry process) are available for burial. In Morocco the long term storage areas are less than a km from the processing facilities and can be blown, pumped or transported with a conveyor belt.
> The long term storage is similar to any dry biomass being buried, covered and sealed in desert limestone and karst cliffs. Cultural, historic artefacts (like pharaonic graves) have preserved biomass in this manner for thousands of years. Many of these engineering details will be determined with the support of this contract.

6. (Criteria 6) If you didn't exist, what's the alternative use(s) of your feedstock? What factors would determine this outcome?

> Given that this is new production, that would not happen otherwise, and that the land areas have not been and are not being used, indicate that there are no known alternative uses today (by Susewi or the local communities).

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)*

Because of careful site selection and diligent efforts to external resources and energy demand, the negative impacts are very limited. The EIA identified 1) temporary dust release during construction, 2) the need to space overhead electrical lines sufficiently far apart to prevent risks for migrating birds. At early stages (sub-scale) production, the growers will need to transport the (value-generating) biomass-extract to port in 40ft containers, increasing local truck traffic. At full-scale, we are evaluating whether to provide a floating dock facility for freighters to load the extracts directly off-shore of the production site (eliminating the need for road transport). However, the carbon emissions with trucking the value-generating portion of the biomass and then shipping it to Europe have already been included in the LCA.

Of course there are unforeseen consequences that will yet have to be exposed. For these, strong governance with the local licensors, remote sensing and service level agreements can be established to ensure that these are actively addressed when they arise.

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.

All biomass solutions have to balance biodiversity losses with the cultivation of regional crops that may increase the use of biomass at the expense of natural habitats and the associated ecological communities. Given that our biomass is growing in deserts in on-land ponds, outside of the ocean, and returns clean, oxygenated and deacidified water to the local surface ocean, it supports natural communities and does NOT trade off habitat loss with biomass production.

Similarly, Susewi does not substitute food production with biomass production, rather it performs both and creates both high value, healthy nutrition and residual, excess biomass for CO_2 sequestration.

Susewi does not engage in value destruction, by substituting a high income stream with a lower value one in contrast to some subsidised, crop-based biofuel schemes. In contrast, we will create a high margin return to investors and produce ‘new’ value that would not have grown naturally or through manmade economic activity.

Outside of carbon sequestration, if one takes the carbon offset generated by the replacement of animal biomass with meat replacement (the 50% product side of our biomass product) into account we create a very large impact for a very small investment, while avoiding any trade-offs between food versus biomass production.

Application Supplement: Ocean

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

Physical Footprint (Criteria #1)

1. Describe the geography of your deployment, its relationship to coastlines, shipping channels, other human or animal activity, etc.

Our algal ponds are commonly within 100s of meters and will be within 10 km from the shore. The sites are coastal salt flats (sabkha), clay pans or desert plains. Once on land, we transport the seawater in geomembrane sealed canals. Shrimp farmers move seawater through similar systems over hundreds of km.

We source seawater from below the thermocline (that in these environments is significantly below the mixed layer depth and the euphotic zone). This is a passive pipeline, meaning that it is filled by gravity draining into a seawater sump. This land-based seawater sump is based on-shore and is deep enough for the pipeline to gravity drain into the sump. We actively pump the water from this beach sump. The advantage of this system is that there are no submerged pumps and pipeline installation is dramatically simplified. The sump is cleanable, the pump stations can be made redundant (to service and maintain) and the system requires net net much less energy because the sump fills by gravity. The pumps then fill the central seawater canal from where the water cascades through the system, again by gravity. In other words, we pump once to distribute the seawater to all stages of production. This also protects the microalgal cells that never have to pass through a pump.

2. Please describe your physical footprint in detail. Consider surface area, depth, expected interaction with ocean currents and upwelling/downwelling processes, etc.
    a. If you've also filled out the Biomass supplement and fully articulated these details there, simply write N/A.

To expand on the previous section, our land-based ponds are 1 m deep (in contrast to conventional biofuel ponds that are 10-15 cm deep, and therefore our ponds require much lower tolerances - to reduce civil engineering costs). The total elevation difference between the ponds across an entire production facility is approximately 2m from the intake canal to the harvesting stations, again reducing civil engineering costs. The detail engineering and hydraulics of the entire production facility optimises the hydraulic design (to enable gravity transfers) while minimising earth movement. This allows us to reduce the cost of the pond construction from >$200,000 / ha for biofuel ponds to <$20,000 / ha for our ponds, as demonstrated by the largest desert-based shrimp farms in the world. These costs do not include the geomembrane and paddlewheel charges, however, they do illustrate how important the earth movement and civil engineering are. For this reason, we have conducted very high resolution 3D topography of 81 km^2 for our designated production site in Morocco.

Importantly, these structures use the local clay and salt precipitates instead of concrete to further reduce fill material, transport and construction costs.

3. Imagine, hypothetically, that you've scaled up and are sequestering 100Mt of CO_2/yr. Please project your footprint at that scale, considering the same attributes you did above (we recognize this has significant uncertainty, feel free to provide ranges and a brief description).
   a. If you've also filled out the Biomass supplement and fully articulated these details there, simply write N/A.

Already answered - please see biomass section

Potential to Scale (Criteria #2 and #3)

4. Building large systems on or in the ocean is hard. What are your core engineering challenges and constraints? Is there any historical precedent for the work you propose?

The marine engineering of the seawater pipeline is the most extensive investment of this programme. We require large internal diameter pipelines that have to be secured to the seafloor and tunnel through the shoreline, where waves break and the tides create the highest energy environment. We have had extensive conversations with marine pipeline specialists to identify the challenges of scheduling, commissioning and deploying the ships needed for the installation of these pipelines, considering seasonality, geology and bathymetry. The pipeline materials cost is the smallest portion of the pipeline installation cost, and local conditions vary between sites. Opportunities for reducing the Capex associated with the pipelines exist where the infrastructure can be shared (with desalination plants, seawater cooling water, or large aquaculture (on the intake side)).

Externalities and Ecosystem Impacts (Criteria #7)

5. How will you quantify and monitor the impact of your solution on ocean ecosystems, specifically with respect to eutrophication and alkalinity/pH, and, if applicable, ocean turbidity?

As described earlier, we already monitor our local intake water and the quality of our discharge by measuring pH, Chlorophyll content, temperature, conductivity (salt content) and turbidity to determine the seawater quality (and how it changes seasonally with natural upwelling events). Susewi has been awarded a large GBP5.2 m research grant from UK Innovate to model local upwelling, forecast nutrients and seawater quality and to automate the operational adjustment to these natural inputs. The lesson learned from these investigations is that we: 1) Return cleaned surface water to the local environment, that is 2) deacidified to pre-industrial levels of pH 8.22, without 3) reducing alkalinity,

4) and we would need to operate for 100 years, to reduce the nutrient loading by 1% within 1km of the shoreline in front of our site.

We are very conscious of unintended consequences and have been working under real-life operational conditions for more than six years. For the last four years we have been working in Morocco where we intend to build the first large production facility.