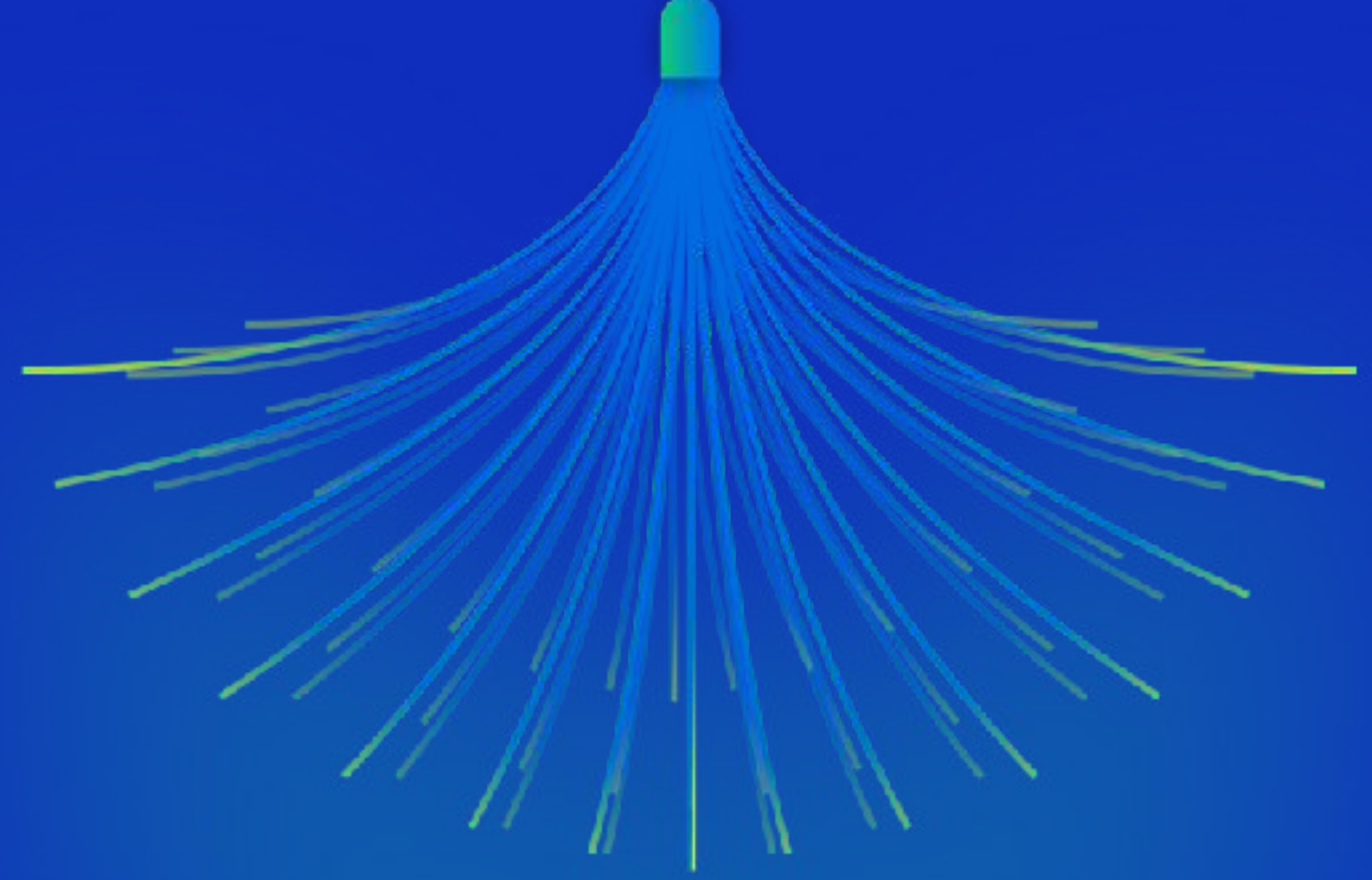
A simple global solution to excess atmospheric CO_2



Earth Climate Optimisation Productivity Island Array

ECOPIA

GREEN OASES IN THE DESERTS OF THE OCEAN

Meet the team

calum@myocean.co.uk

Calum Fitzgerald

Tech Entrepreneur

Calum trained as a Marine Biologist, Oceanographer and Environmental Scientist. Moved into the Tech sphere and then founded a Tech Scale-Up 13 years ago.

Passionate about trying to find ways to make the world a better place. Though immersed in the world of business and Tech, he pursues projects and ideas to do just that with his colleague John.

john@myocean.co.uk

Dr John Allen

Senior Research Scientist

Predominantly an observational physical oceanographer, John has been at the forefront of research on upper-ocean physical properties and its impacts on biogeochemical processes for over a decade. He was made a Fellow of the Challenger Society for Marine Science in 2004.

John has a long track record of facilitating successful knowledge exchange between leading edge marine scientific research and the exploitation of this knowledge. He pursues such projects and ideas with Calum.

Anthropogenic CO_2 input

- 9 GTonnes of atmospheric Carbon as CO_2 annually (*problem we have to solve*)
- Comes mainly from fossil fuel consumption and cement production

Land & Ocean plant biomass uptake

Combined they take up approximately 180-200 Gtonnes of atmospheric CO_2 each year as part of the Earth's natural carbon cycle

Ocean is responsible for around 90 Gtonnes of uptake in this cycle

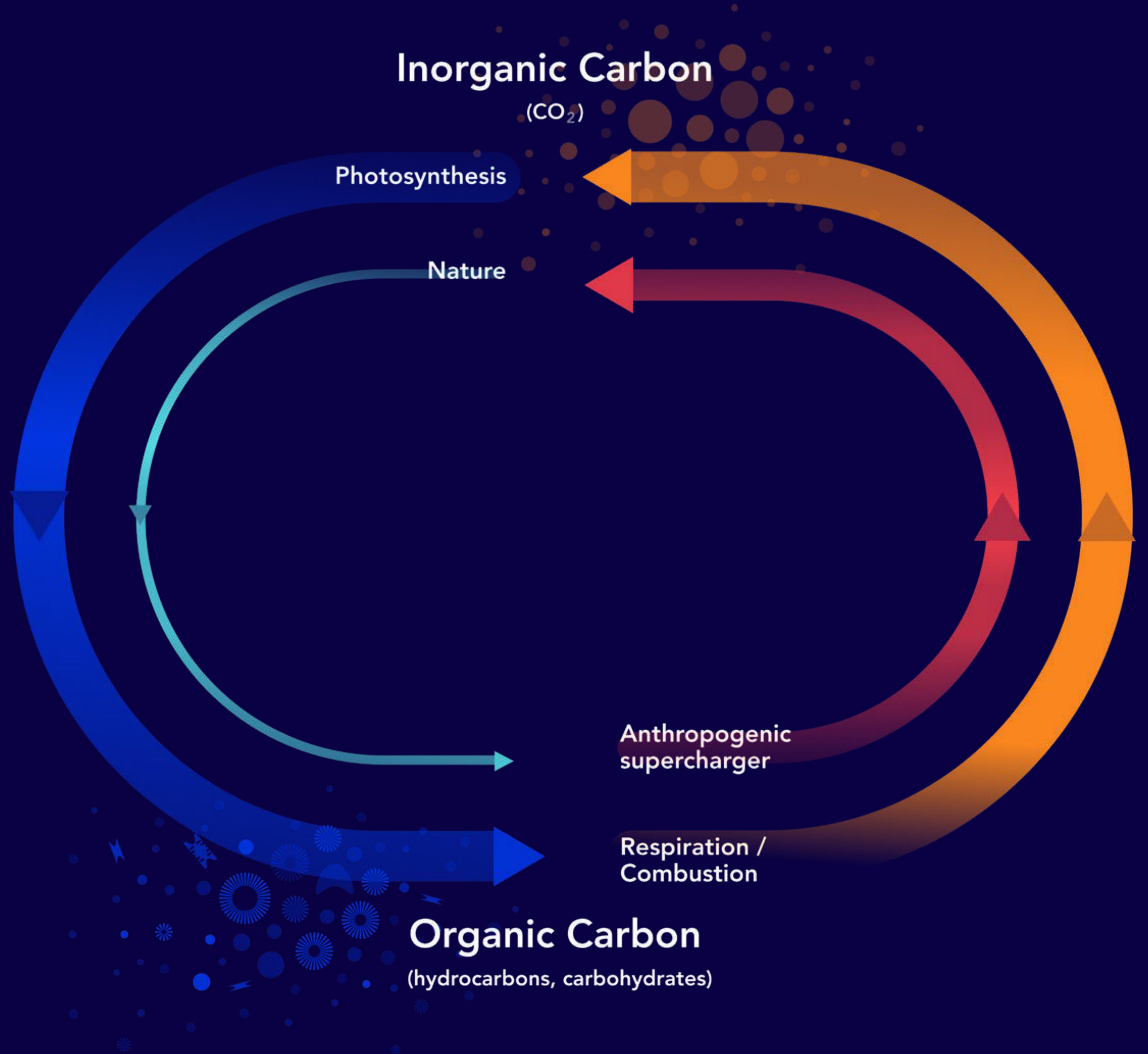
Ocean contains **only 3%** of planetary plant biomass at any one instant

However, the ocean biomass has a very fast turnover (grows and gets eaten)

The **very fast turnover** of ocean biomass is **the key** to its enormous atmospheric CO_2 uptake to biomass ratio

Carbon cycle
60 Plant respiration
120 + 3 Photosynthesis
9
Human
Emissions
90 + 2
60 Atmosphere
90
60
Air-sea gas exchange
1,000
Surface ocean
Microbial respiration
& decomposition
Soil carbon 2,300
Ocean sediments
Deep ocean 37,000
Fossil carbon 10,000
Reactive sediments 6,000

Carbon cycle



What do we need to do

Solve the problem of too much CO_2 by increasing uptake of CO_2 by global plant biomass by 10%

Focus on the ocean given its unique properties and significant advantages rather than the land

Why not the land?

Rate of biomass turnover is low, when compared to the ocean, giving it a low ratio of atmospheric CO_2 uptake to plant biomass

- Land production is largely limited by atmospheric CO_2 concentration
  - So to increase productivity with same area of land you would have to increase concentration of CO_2 in the air
  - This is not the direction we want to go in

- 2D space (single plane/surface) for growing the biomass
- Difficult to 'lock away' the carbon - much is recycled over 'short' timeframes - 10s-100s of years or less
- Geopolitical challenges to increasing the available space for growing plant biomass to increase uptake

Why the ocean?

Rate of plant biomass turnover is much greater in the ocean than on the land

Just a small change in total plant biomass solves the problem, go from 3% -> 3.3% of instantaneous global biomass

Ocean production is ***limited by light*** not CO_2

- Typically only top 50m has enough light
- We can take the light deeper than 50m to stimulate productivity
- We can absorb enough CO_2 to solve the problem

3D space for growing the biomass

- Stack the production by vertically farming the ocean

Why the ocean?


Alex Mustard/amustard.com

Carbon sequestration in the ocean depths

Easier to 'lock away' the carbon

~10% of carbon uptake in the surface waters gets locked away, similar to a 1:9 ratio of "lock away" to "released back"

By stimulating productivity deeper, below the thermocline, we can hugely increase the carbon 'lock away'

We believe we may be able to invert the ratio to something more like 9:1 in favour of "lock away"

Carbon exported to the deep sea and seafloor sediments is securely locked away – 1000s-10,000s of years or more

This is where the carbon from fossil fuel consumption came from originally

Inconvenient truth

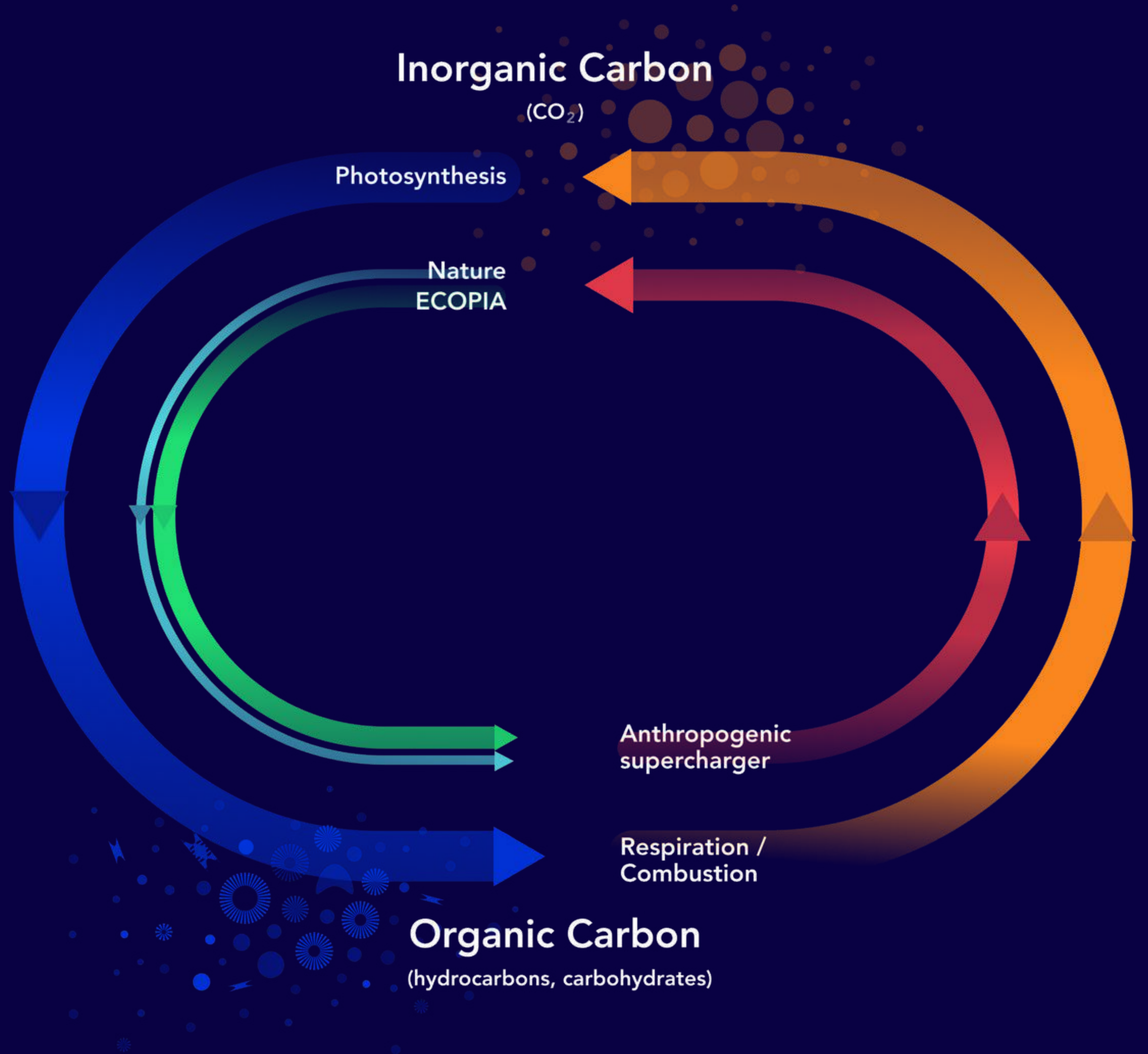
Reducing atmospheric CO_2 concentrations to pre-Industrial Levels would not produce enough food for our current population

Increased CO_2 levels have allowed us to feed the ever increasing human population by increasing crop production

So ***what is the right number*** for atmospheric CO_2 concentration?

- PreIndustrial CO_2 levels were around 284 ppm
- Current levels are at 408 ppm and rising
- Need to find the right ***balance point*** within this range to mitigate climate change and also feed the world
- Therefore level of CO_2 needs to be ***controlled*** and ***regulated***, not just moved in one direction or the other
  - This is both a technology and a geopolitical challenge

Our proposal
Ecopia


Inorganic Carbon
(CO_2)
Photosynthesis
Nature
ECOPIA
Anthropogenic
supercharger
Respiration /
Combustion
Organic Carbon
(hydrocarbons, carbohydrates)

How?

How?

We plan to 'green' the deep blue deserts of the oceans

Oligotrophic Gyres (the deserts) exist in each of the world's oceans

- 5 major gyres in total taking up one seventh of the ocean surface area - and they're getting bigger
- These are giant ocean circulations
- Have a stable water column that locks nutrients below the thermocline (100-300m deep)
- Currently contribute disproportionately little to overall ocean CO_2 uptake with respect to their surface area
- Exist in International waters
- Home to the sprawling ocean garbage patches

Subtropical Gyres & Associated Ocean Currents

How?

We plan to use light to 'irrigate' the ocean

Light trees are the key technology

Pipe light down to below the thermocline to access essentially unlimited nutrients

Creates vertically stacked green fields of phytoplankton

Control the amount of light in order to control productivity and carbon uptake

Can pipe some heat as well as light, creating mixing

- Allows for nutrients to access the surface waters enabling further productivity

Glass lens 1 m in diameter at the surface

Fibre optic bundle from the lens down to required depths

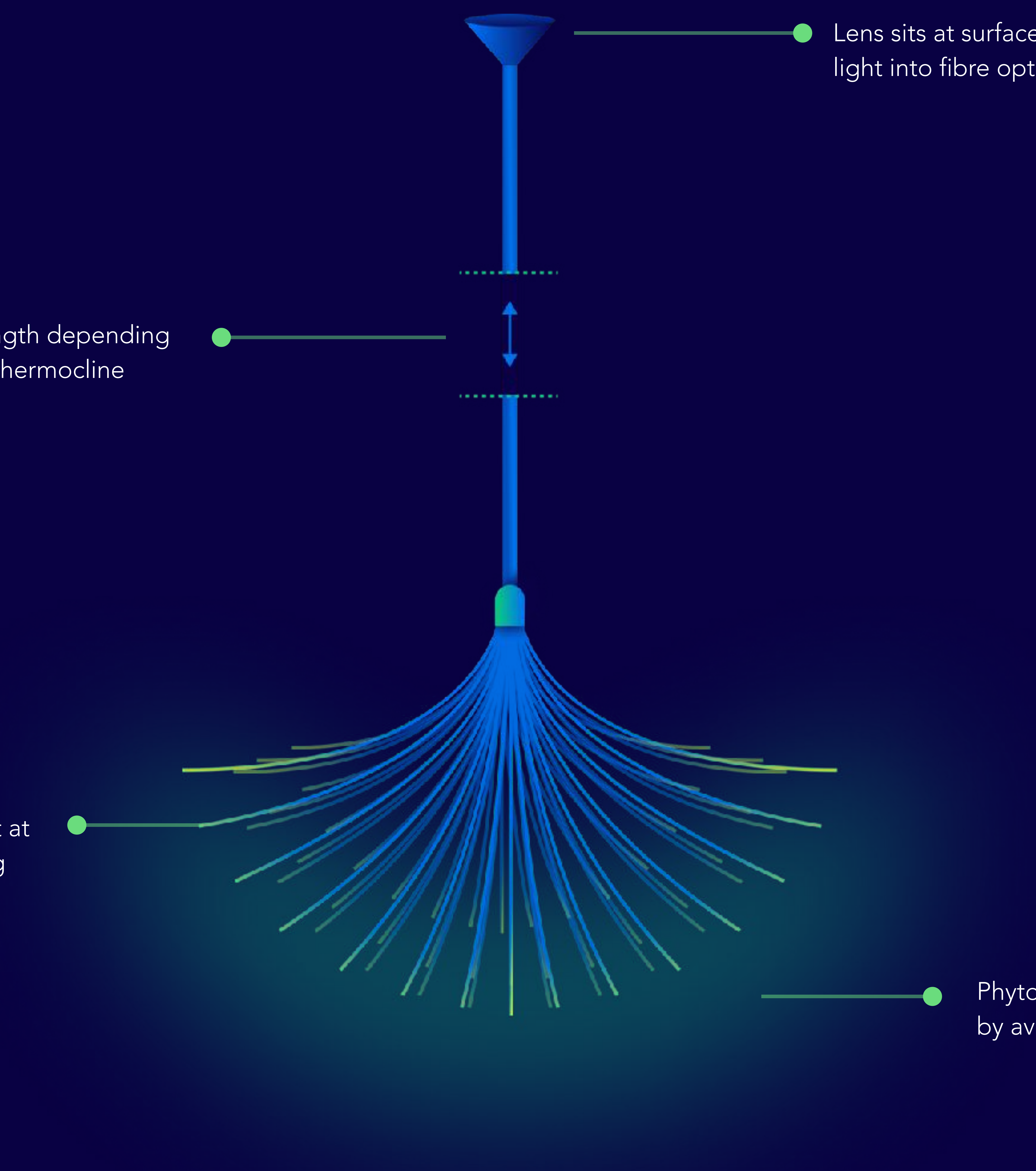
Construction predominantly of iron and glass

- Does not pollute the environment
- Decomposes to nutrients needed by the phytoplankton

Each light tree stimulates carbon uptake of ~50 kg Carbon per year

Technology for construction exists today, just needs scaling

Light tree


Lens sits at surface funnelling light into fibre optic bundle
100-300m length depending on depth of thermocline
Fibre optic bundle fans out at required depth illuminating the surrounding water
Phytoplankton growth stimulated by available light and nutrients

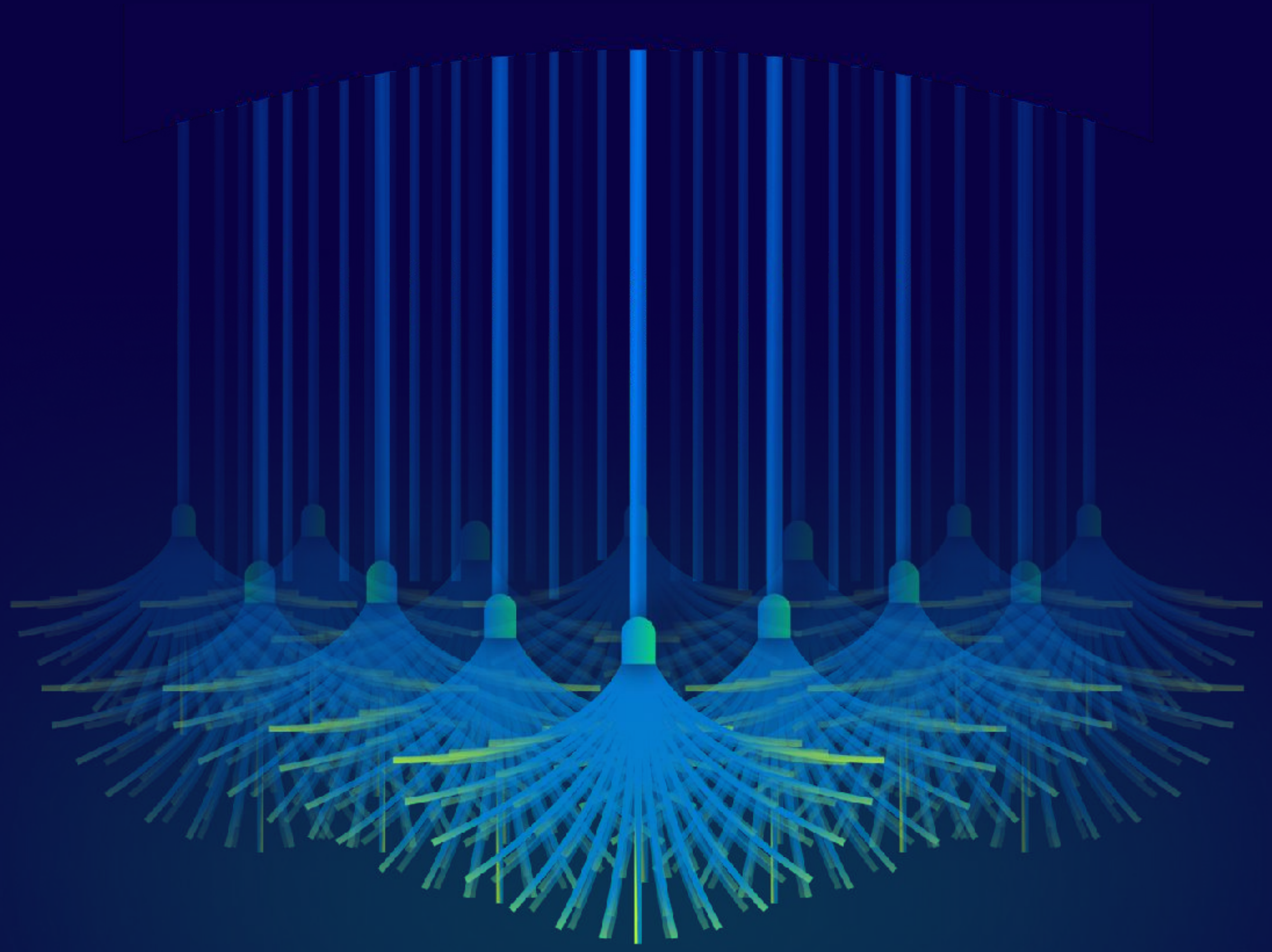
How?

We will deploy numerous light trees to create ‘light forests’

Use a modular approach and scale up in size

- Allows for experimentation to different approaches to scaling and construction
- Start small, prove then scale to massive forests as we learn
- Start addressing the problem even as we learn and scale
- Use the build fast and break things approach, not the slow monolithic build approach
- Lean on the shipping, oil rig, and maritime construction industries
  - Explore 3D printing techniques for construction
  - Start small and scale up building of structures
  - Find suitable materials that will survive long term in a marine environment

- Build modules one step at a time, have massive global cooperation & achieve incredible outcomes
- Technology for construction exists today, just needs scaling

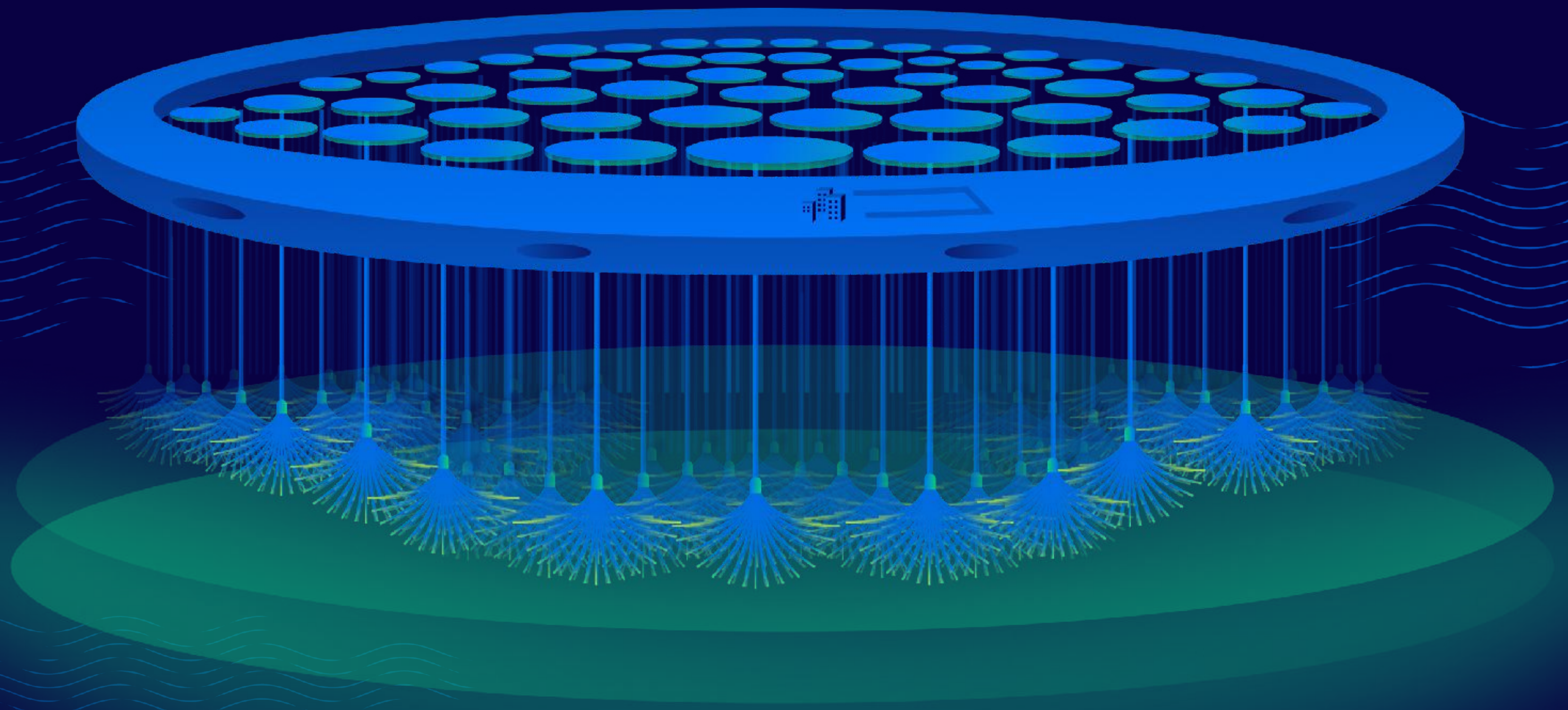


We will aggregate these forests to create 'oases' in these deserts

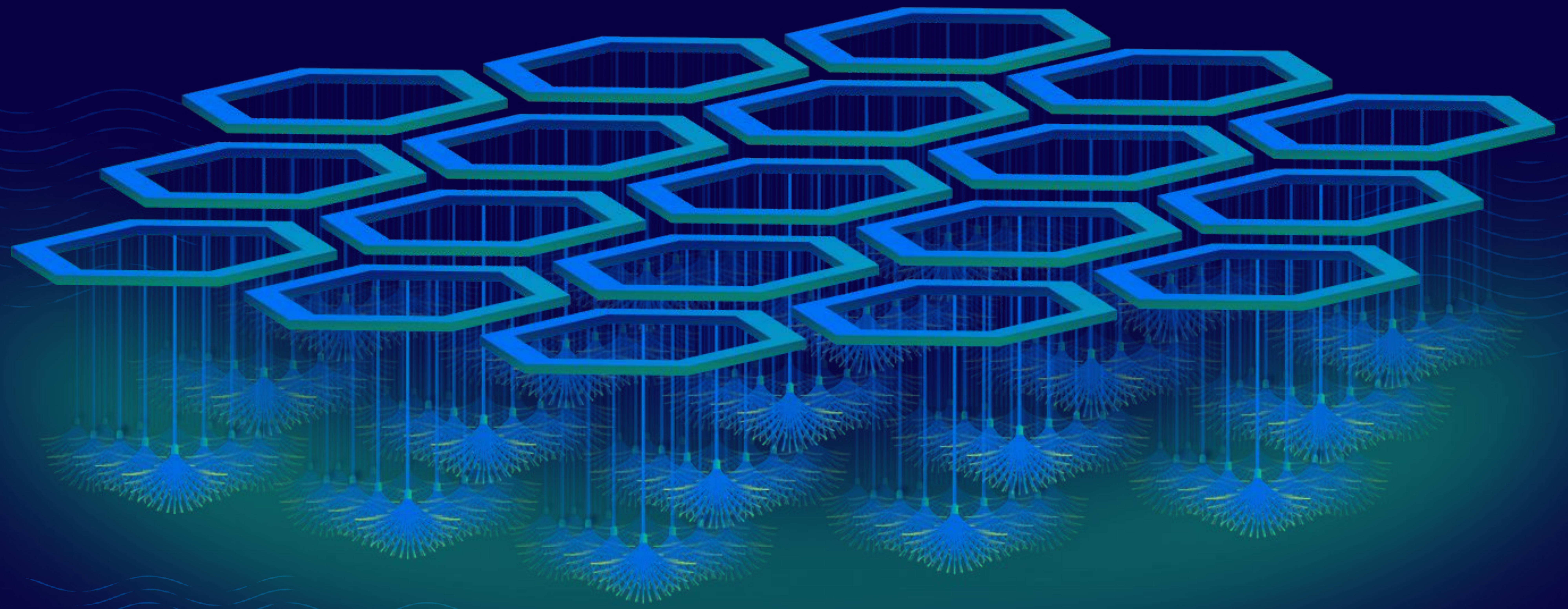
How?

Create EcoPINs (~100 in total)

- Ring Donut shaped artificial islands with a diameter of 50KM
  - Internal moon pool of 46KM diameter
- Houses a range of carbon capture technology but mainly light trees
- Maintain position within gyre - 'geostationary'
  - Can be achieved with conventional technology
  - Appropriate size and scale for technology such as magnetohydrodynamics or vertical wings
- Could be classed as vessels
- Oceanic garbage patch material will be incorporated into EcoPIN structure
  - Helps clean up our current mess
- These 'oases' would take up less than 0.05% of ocean surface area
  - ~0.38% of oligotrophic gyres surface area
- Technology for construction exists today, just needs scaling



Modular EcoPIN



Our Proposal

Create a global carbon regulation system that utilises the Ocean Plant Biomass through our Ecopia* technology

- Needs to be controlled by an independent international body

This solves:

- The excess atmospheric CO_2 levels
- Ocean acidification (*saves the coral reefs*)
- Providing a solution to ensure we don't get in this mess again
- Impact of over-exploitation of deep sea fisheries

* United Kingdom Patent Application No 2018151.7

Our Bonus

The world only has to freeze CO_2 output at 2030 expected levels and Ecopia can still solve the problem

> The effect of the Ecopia regulatory mechanism would bring levels back down to 2000 levels by 2080.

This allows:

> Time for business and governments to act
>
> For economies to still grow and flourish
>
> For achievable, sustainable goals for CO_2 output for all global economies
>
> For us all to save the world

* United Kingdom Patent Application No 2018151.7

Call to Action

Call to Action

Please help us

1 Find the right funding route

2 Build a consortium to take this forward

3 Save the world

Contact:

calum@myocean.co.uk / john@myocean.co.uk

Thank you