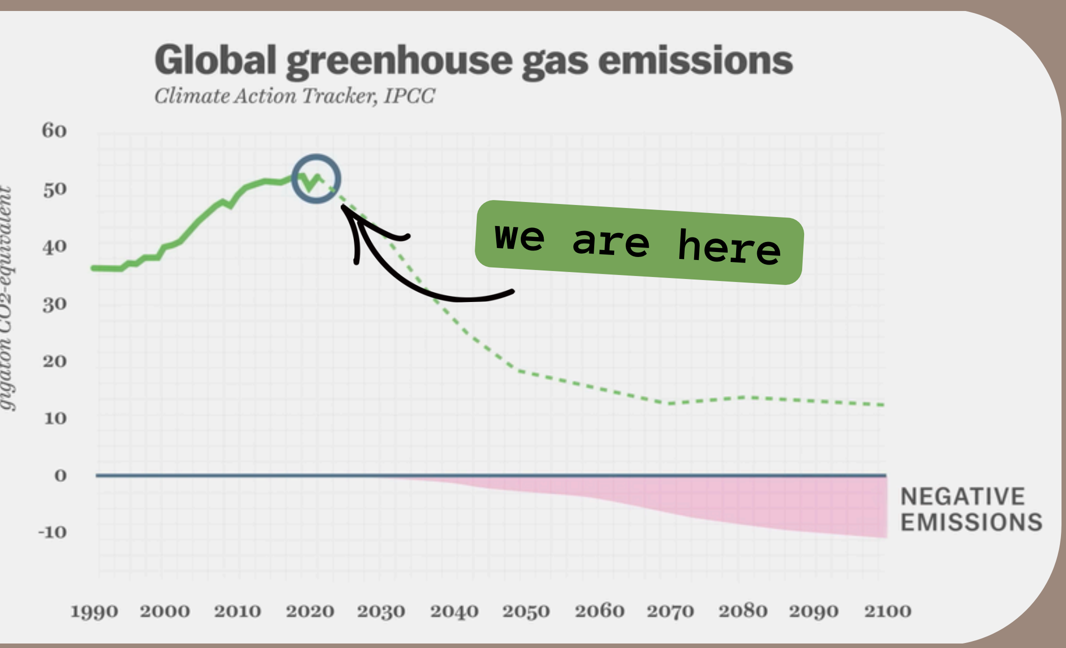
THE ALGAE PHOTOBIOREACTOR

REVOLUTIONISING CARBON CAPTURE

The Problem



Carbon emissions have been growing at an alarming rate since industrialisation - wrecking havoc on our planet through accelerating global warming and decreasing air quality. While reducing carbon emissions remains a critical goal, it's clear that mitigation alone may not be enough. We need to actively remove carbon from the atmosphere. Our plan is to harness the power of algae to remove carbon from the air whilst also minimising the space we take up - co-existing in urban spaces.

Firstly, Why use Algae?

Algae has many uses across different industries from pharmaceuticals to industrial products. However, one of it's most powerful qualities has not yet been fully realised. Algae is the most efficient carbon capture 'plant' we know of - it can capture the same CO2 as 50 trees in the space of just 1! This powerful ability makes it perfect for reducing carbon emissions and helping us clean our polluted cities. The algae in our photobioreactor is called spirulina, we are using this variety for it's high growth rate and great photosynthetic efficiency. Spirulina thrives in high CO2 environments, making it ideal for carbon capture in cities.

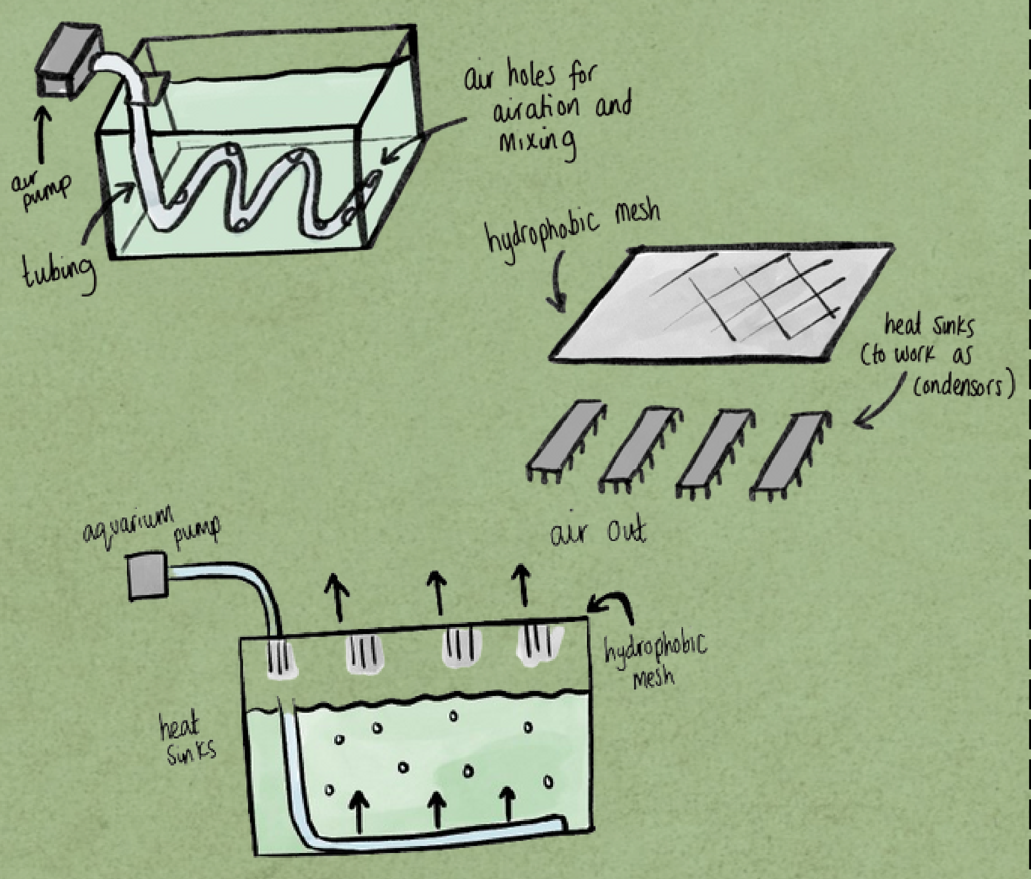
How will it be powered?

The whole point of carbon capture is to minimise our carbon footprint so we knew it would not make sense to be using non renewable energy - our photobioreactor will be completely solar powered. Whilst this does increase the initial cost of the design, it aligns with the vision we had for the project. The final product must be sustainable; we acquired a second hand solar panel for our first finished prototype and have been calculating the average energy usage of the model to buy an appropriate battery. When scaling up to the final model, we must scale up the energy usage and battery size. To ensure the photobioreactor is on 24/7, we are employing the use of batteries. They will be charged during the day and discharge throughout the night as they power LED lights. Not only allowing CO2 capture throughout the night but also improving the visual look of the product.

How Is It Different From Naturally Growing Algae?

Algae can only be optimised under specific conditions so by putting it in a closed system, it will allow us to control these conditions. Our tubing system maximises surface area and we will be employing heaters during winter/coolers during summer to regulate the temperature. Additionally, we control the amount of CO2 passing through and the pH/light to maximise it's photosynthetic ability.

Air Filtration System



The algae needs a constant supply of outside air, this could have been done by simply keeping the lid open but we decided to optimise this process by using an air filtration system to maximise the surface area of the algae that is exposed to CO2. This results in our photobioreactor being incredibly efficient though we are compromising on energy usage as it will require more to power the pump.

Equipment Needed

SOLAR PANEL, WIRING, ESP32 MICROCONTROLLER, DUAL PERISTALTIC PUMP, SIMPLE BREADBOARD, SENSORS, TANK, BATTERY, AIR FILTRATION SYSTEM INCLUDING PUMPS, TUBING AND HYDROPHOBIC MESH

The Sensors

What we are measuring

1 Light Absorption

Algae uses light to perform photosynthesis so we need constant reading about how much light the tank is getting, we will be using a stirring system to ensure the algae is moving and all parts are getting access to sunlight.

Carbon Dioxide Levels 2

CO2 is being measured not just for the carbon offsetting amounts but also to know how well the algae is performing, low CO2 absorption may suggest a problem with the algae.

3 pH

The acidity of the solution impacts the algae's performance so it is a factor we must measure and adjust if needed.

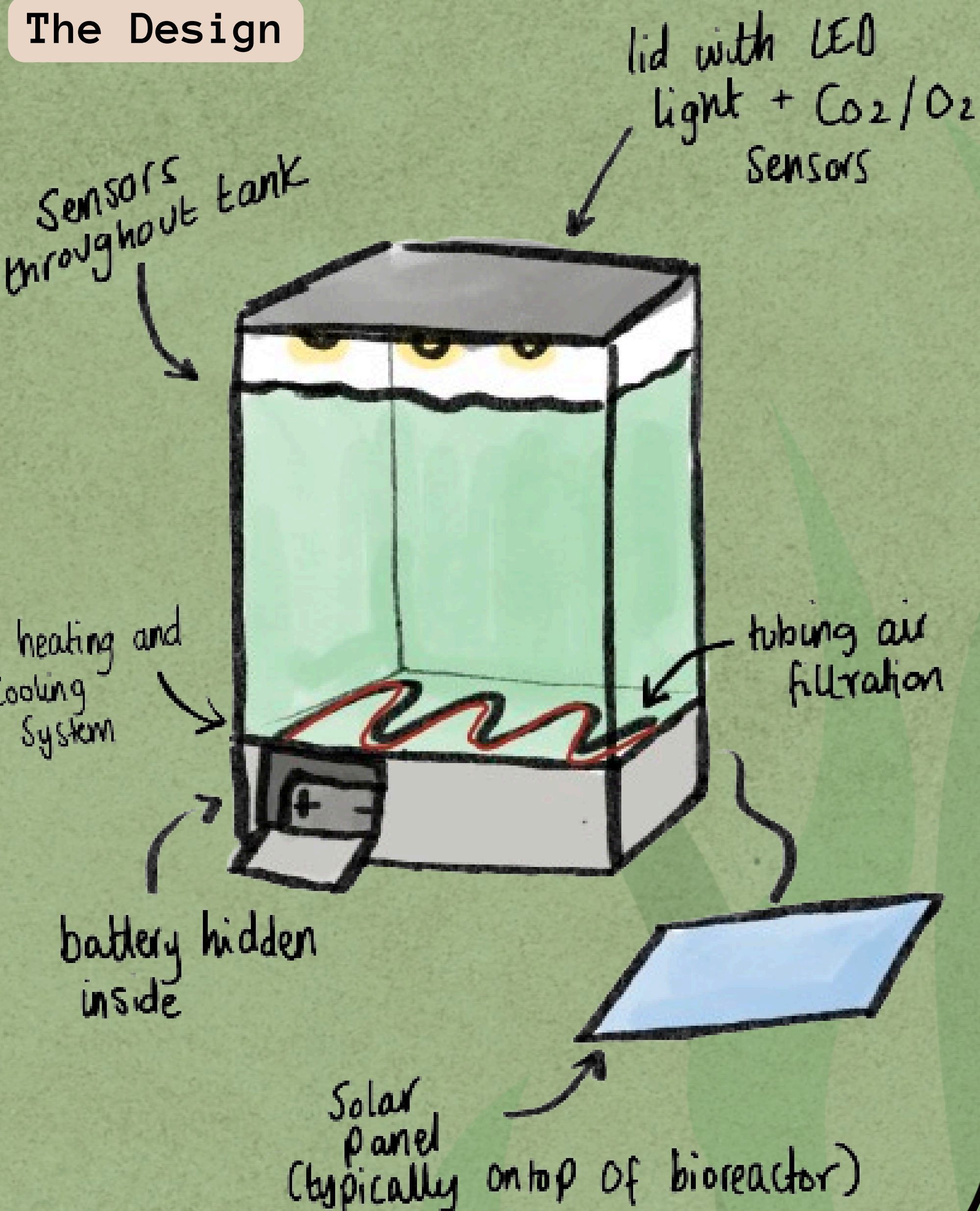
Oxygen Levels 4

By measuring oxygen, we will know exactly how much CO2 has been converted. It is a good back up measure to check our carbon offset calculations.

5 Temperature + Optical Sensitivity

Temperature is an important factor to measure to keep algae health optimised all throughout the day/year and the optical sensitivity sensor ensures accuracy and robustness.

The Design



Brief Overview Of Design

This design is a basic overview that does not include all the sensors and circuitry. Factors such as the shape of the tank are customisable to each clients needs, however our initial photobioreactor to go on university campus will be a cuboid as it is easy to obtain a tank in that shape. The sensors are to go on the top and bottoms of the tank, with CO2 and O2 sensors at the top and temperature/pH/light sensors throughout. The heating and cooling system is yet to be finalised as we have only been testing the prototype indoor and need funding to begin making the large outdoor tank + acquire a large solar panel to power it. The battery will be stored inside a compartment (for aesthetic reasons) and power the photobioreactor overnight. For the final design on campus, we hope to incorporate the reactor into a useable design - such as a bench wrapping around the reactor.

SCHOOL INTIATIVES

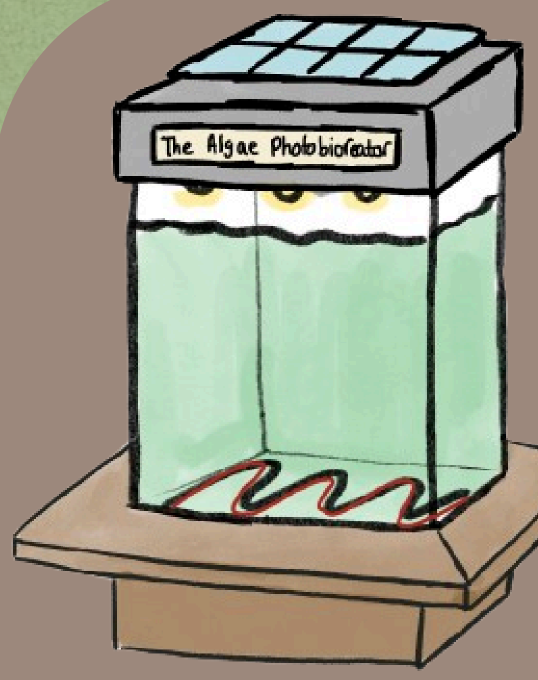
we have secured our first sponsor for the classroom initiatives, the founder of Bee1!

The inspiration for the school initiatives came from seeing how excited children were about our photobioreactor prototype at university open days. They wanted to learn more about the science and engineering behind it and even create their own algae cultures at home!

So far, we have been reaching out to schools and doing some workshops with families at university outreach events. We've also successfully done a classroom workshop with an overwhelmingly positive response from kids, parents and teachers. Since engaging so much in these outreach events, we really understand what engages children in learning and will be creating the sponsored lesson plans with that in mind. Our goal is to get kids passionate about engineering, climate change solutions and to gain an appreciation for plants and the environment.

For the companies, this is a great opportunity to sponsor something that really makes a difference - it truly makes for a great form of publicity and for us, an opportunity to inspire children.

Future Of The Project



We are currently in talks with Cardiff Council, in particular J Cole from Cardiff Council who heads their net zero project, who are keen to get involved and help with our business. Therefore granting us permission to house our photobioreactor in a public space and also to connect us with more schools to provide classroom kits. We have also been approached by Mark Douglas, founder of Bee1, who wants to set up a bioreactor somewhere on his premises once we have set up our first model on campus. We have also been involved with many university outreach events; connecting with various schools who want to try the lesson plans and workshops.

We are eager to create our large outdoor model but are limited by funding since purchasing the solar panel and tank will be more expensive than for the smaller prototype. Once we complete the tank, we plan to invite local primary schools who have completed the lesson plans to visit the campus and see the algae work in person! We can then begin working with Cardiff Council on the school initiatives side of things or with companies on a potential model. Our biggest goal is just to simply showcase all the ways that we can be actively fighting climate change with engineering and piquing the curiosity of the next generation to get involved in engineering and think about novel new climate solutions.