Algae-Powered Green Buildings

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Introduction

In 2011, a pioneering architectural project in Germany, the BIQ Algenhaus, was deemed as "the first algae-powered building." The design of this apartment building was based off the extraordinary efficiency of algae in capturing and storing solar energy, which then can be harvested as biofuel.

The performance of the BIQ Algenhaus was marginal, but the underlying science is compelling and sound, leading the way for the development of a highly efficient building.

Methodology

The project has 3 goals:

1. Optimizing energy consumption in algae cultivation

2. Designing highly efficient building systems

3. Establishing symbiosis between algae cultivation, the building's operation, and the needs of the human occupants.

Currently, we are focusing on Goal 1. We began our project by designing a 2'x 3' elongated octagonal tank, focusing on optimal design for its scalability.

At the same time, we are using preexisting data and our own experimentation to find the best conditions for the fastest reproduction of our algae species, *Tetraselmis*.

Calculated Growth Model

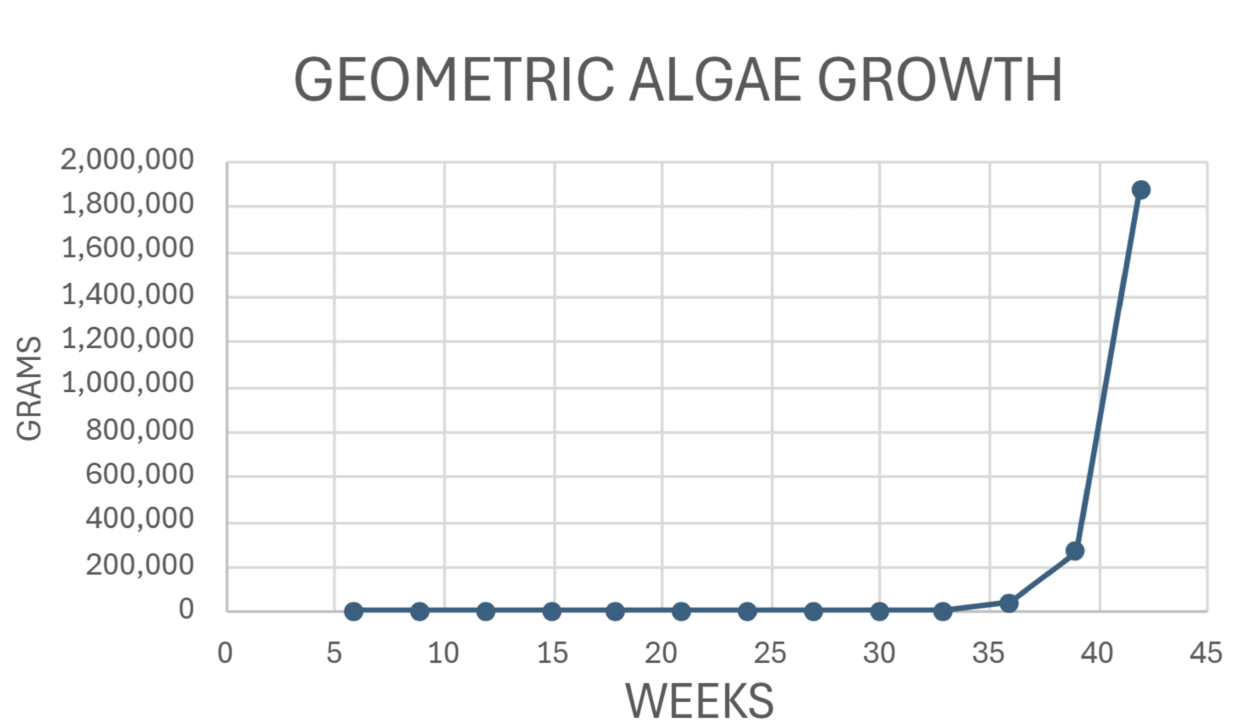


Fig. 1 Approximate Growth Model of *Tetraselmis* over 45 weeks.

Visuals

Fig. 2 BIQ Algenhaus in Hamburg, Germany

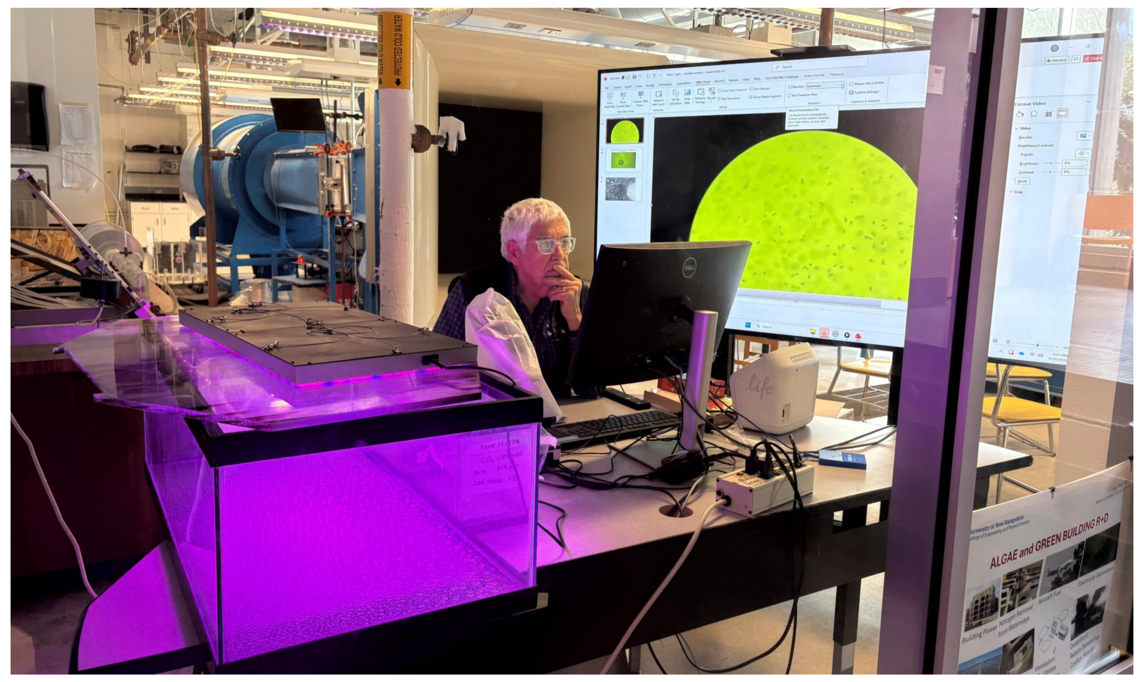


Fig. 3 Data Collection and Observation of Trial 1 Tank

Tank Design

Our tank design centered around the following constraints:

- Scalability for commercial use
- Availability of materials for manufacturing
- Minimizing sharp corners(greater stress)
- Most optimal for light absorption
- Mostly airtight

From a decision matrix, we chose an elongated octagonal shape:

- Distributed pressure across more edges to imitate cylindrical shape
- More surface area for light
- Scalable

Fig. 4 Top-view of original tank

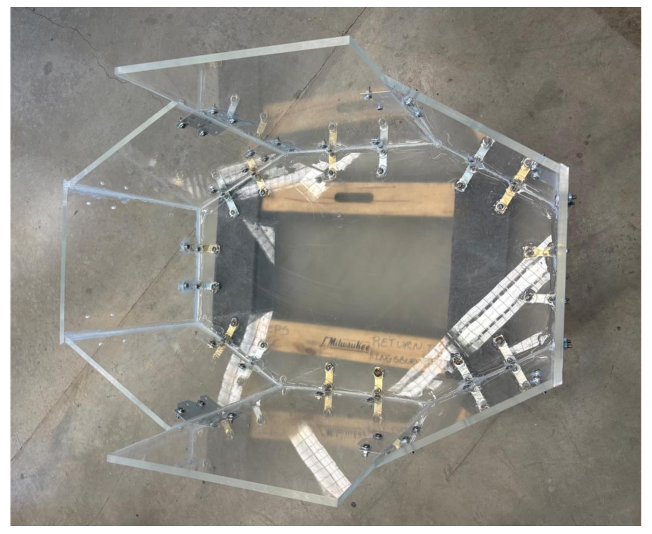
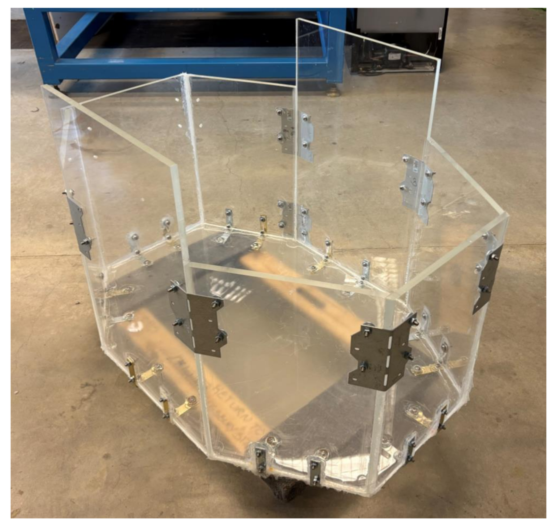


Fig. 5 Side-view of original tank



Unfortunately, due to a miscommunication when creating the prototype, brackets were added to hold it in place, and the large number of holes made the tank impossible to leakproof. We continued experimentation in normal tanks. However, we believe that this design would still be optimal, especially with professional manufacturing instead of DIY.

Algae Growth Trials - How Can We Optimize Growth?

Trial 1: Pond Water

For this trial, we put *Tetraselmis* in local seawater. The algae died in a matter of days, likely due to the presence of a 'predator':

Fig. 6 Picture of "predator"

From this, we learned that our design may need to plan for a potential contamination.

Trial 2: Airtight

For this second trial, we set up another tank by inoculating it for 17 days, ensuring that the environment is safe and ready for the *Tetraselmis* to be inserted.

Fig. 7 Trial 2 Tank Set-up

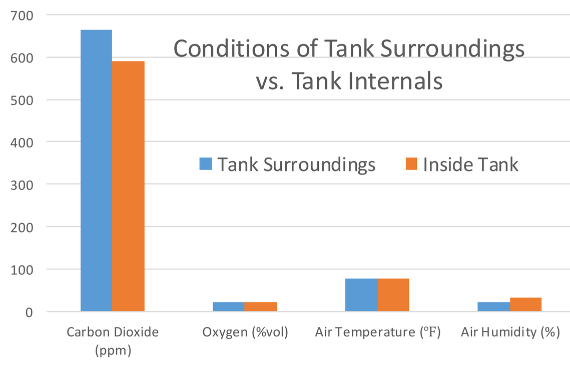


Fig. 8 Comparison chart of Trial 2

Results

While this project is only an early-stage prototype within a broader group, several key findings emerged from our trials and design process:

Our growth model showed strong potential for exponential biomass increase under ideal conditions. The elongated octagonal tank design improved light exposure and scalability, though prototype fabrication issues limited full testing.

Experimental trials using pond water led to rapid algae death, likely due to contamination, highlighting the need for controlled conditions.

In a second, airtight setup, environmental factors were stabilized, creating suitable conditions for *Tetraselmis* growth.

Conclusions

Algae-based building systems show promise as a sustainable energy solution, but more research is required to optimize biofuel production. Challenges such as contamination and tank reliability must be addressed for scalability.

Future work will reference the study "*Optimization of cultivation conditions for Tetraselmis striata and biomass quality evaluation for fish feed production*" to find optimal conditions. Collaborating with other algae teams at UNH and combining our research to work to a common goal will also be achieved.

With more time and effort, algae integration into buildings could become a viable sustainable technology.

Acknowledgements

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References

[1] Sedighi, M., et al. (2023). *Algae-powered buildings: A review of an innovative, sustainable approach in the built environment*. Sustainability. https://doi.org/10.3390/su15043729

[2] Patrinou, V., et al. (2022). *Optimization of cultivation conditions for Tetraselmis striata and biomass quality evaluation for fish feed production*. Water. https://doi.org/10.3390/w14193162