Remediating the Issue of Dead Zones through the Utilization of *Vargula hilgendorfii* Bioluminescence in Sync with Underwater Grätzel Cells to Induce Visible-Light Water Electrolysis

Dead Zones?

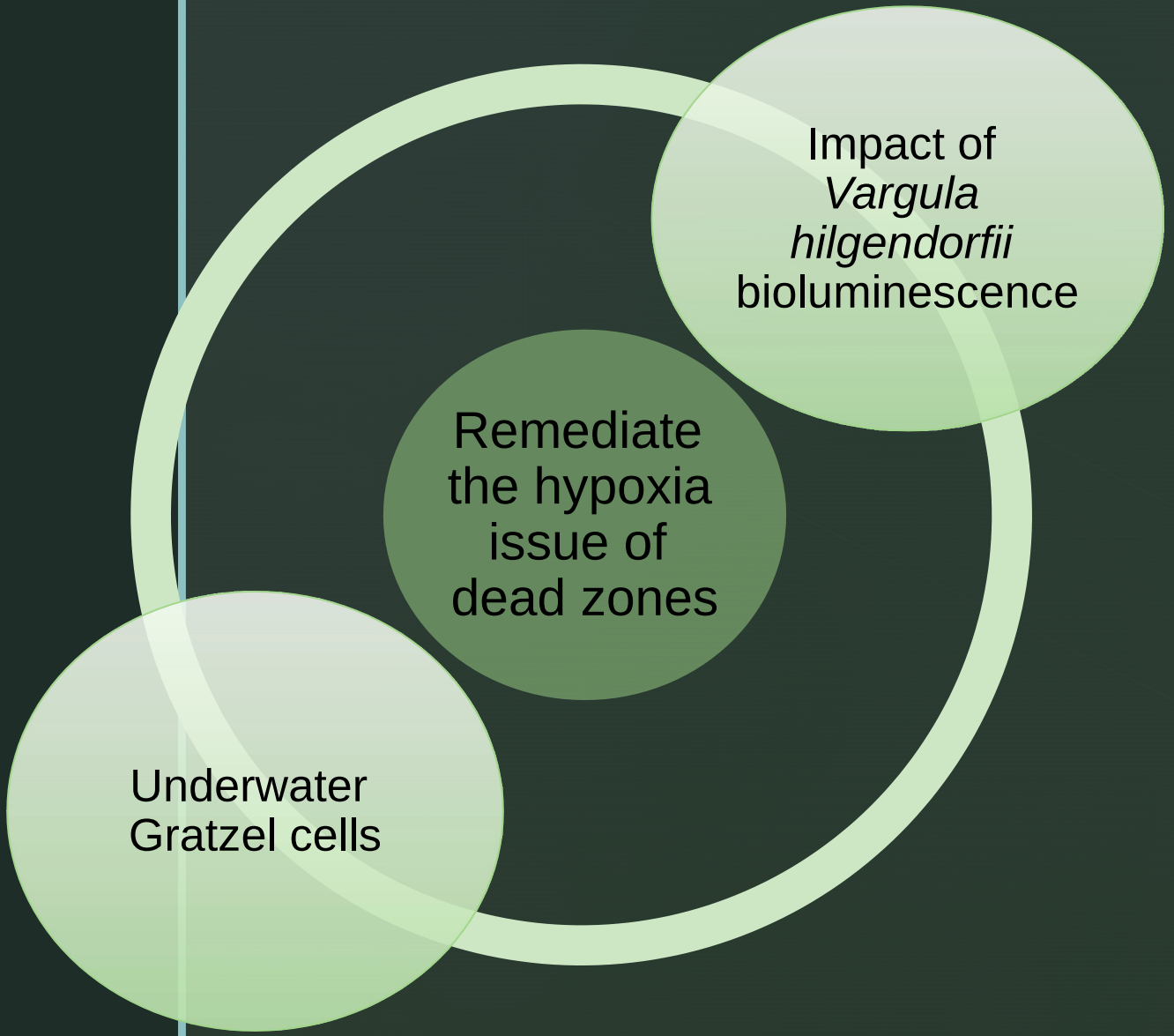
z

Phosphorous and nitrogenous runoff

Algal blooms

Hypoxia

Primary Goals



Secondary Goals

- Environmentally Friendly
- Cost-Efficient
- Noninvasive

Previous Methods

- Ultrasonic irradiation
- Algaecides
- Drum Filters
- Disc Filters

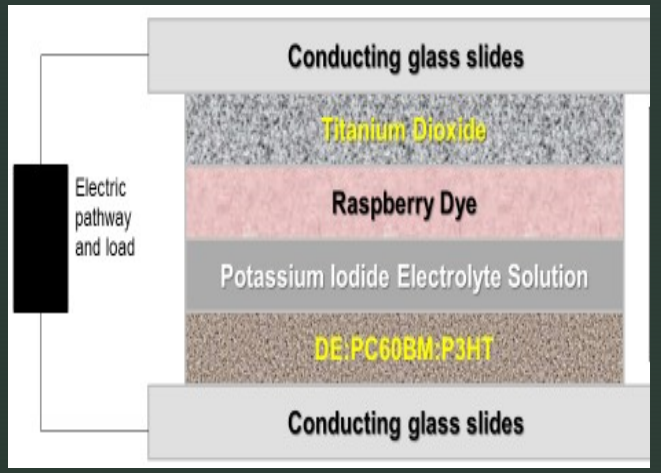
Two questions:

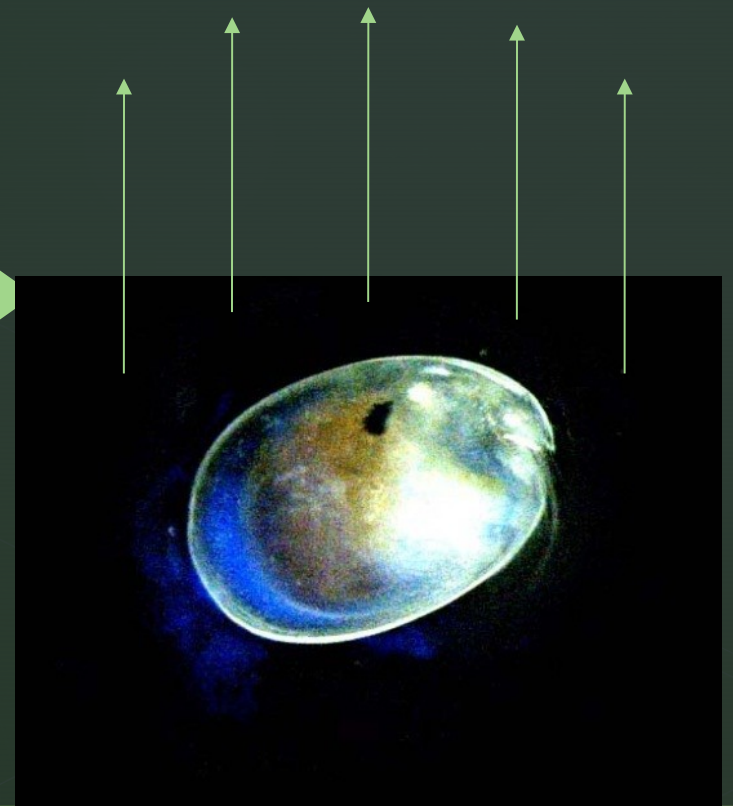
1. What is the cost range?
2. Can it be placed in the ocean?

Hypotheses

Organism

Phenomenon





Diatomaceous Earth

- siliceous sedimentary rock made of aquatic diatoms

$$C = \frac{\varepsilon A}{d}$$

Where,

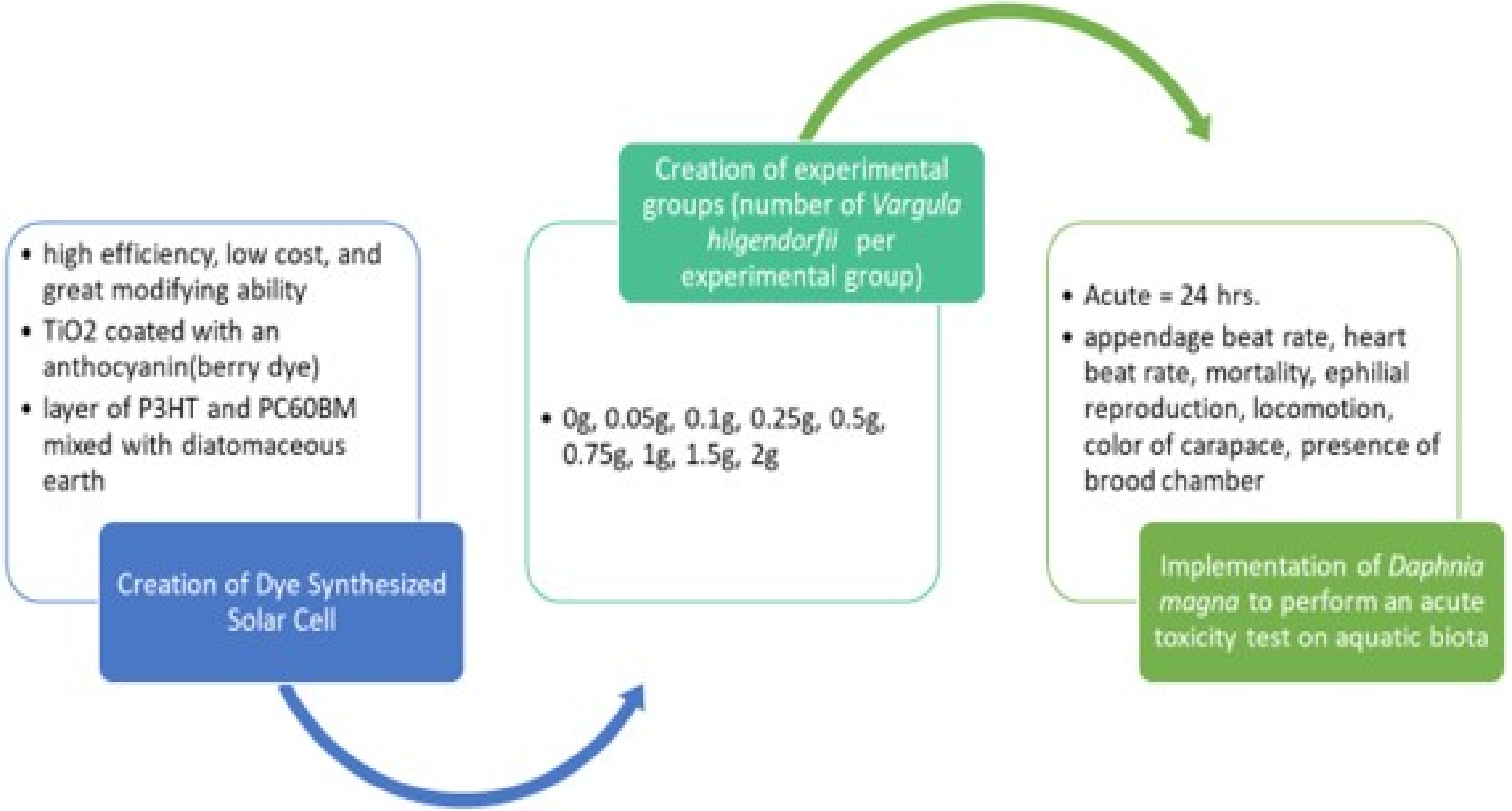
C = Capacitance in Farads

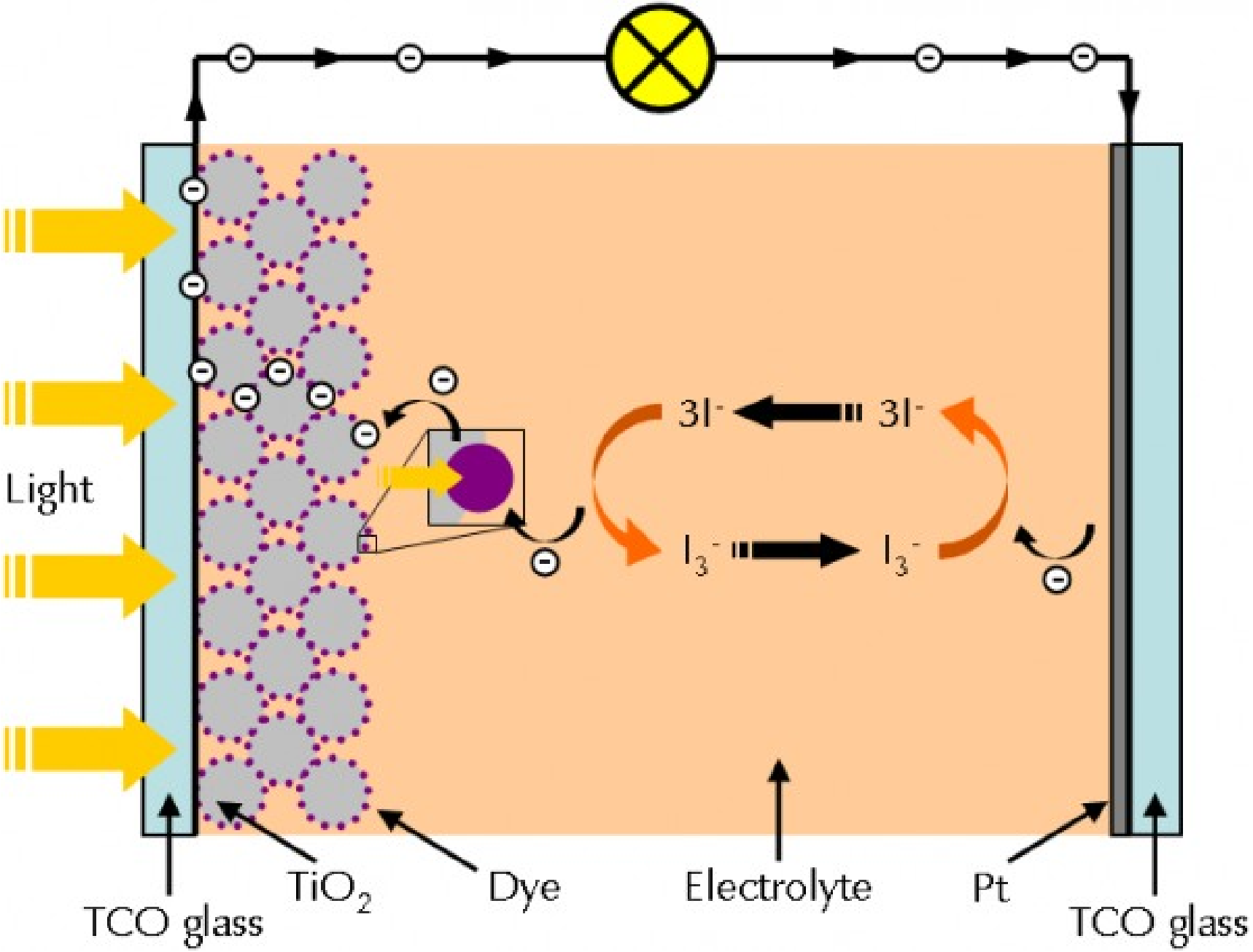
ε = Permittivity of dielectric (absolute, not relative)

A = Area of plate overlap in square meters

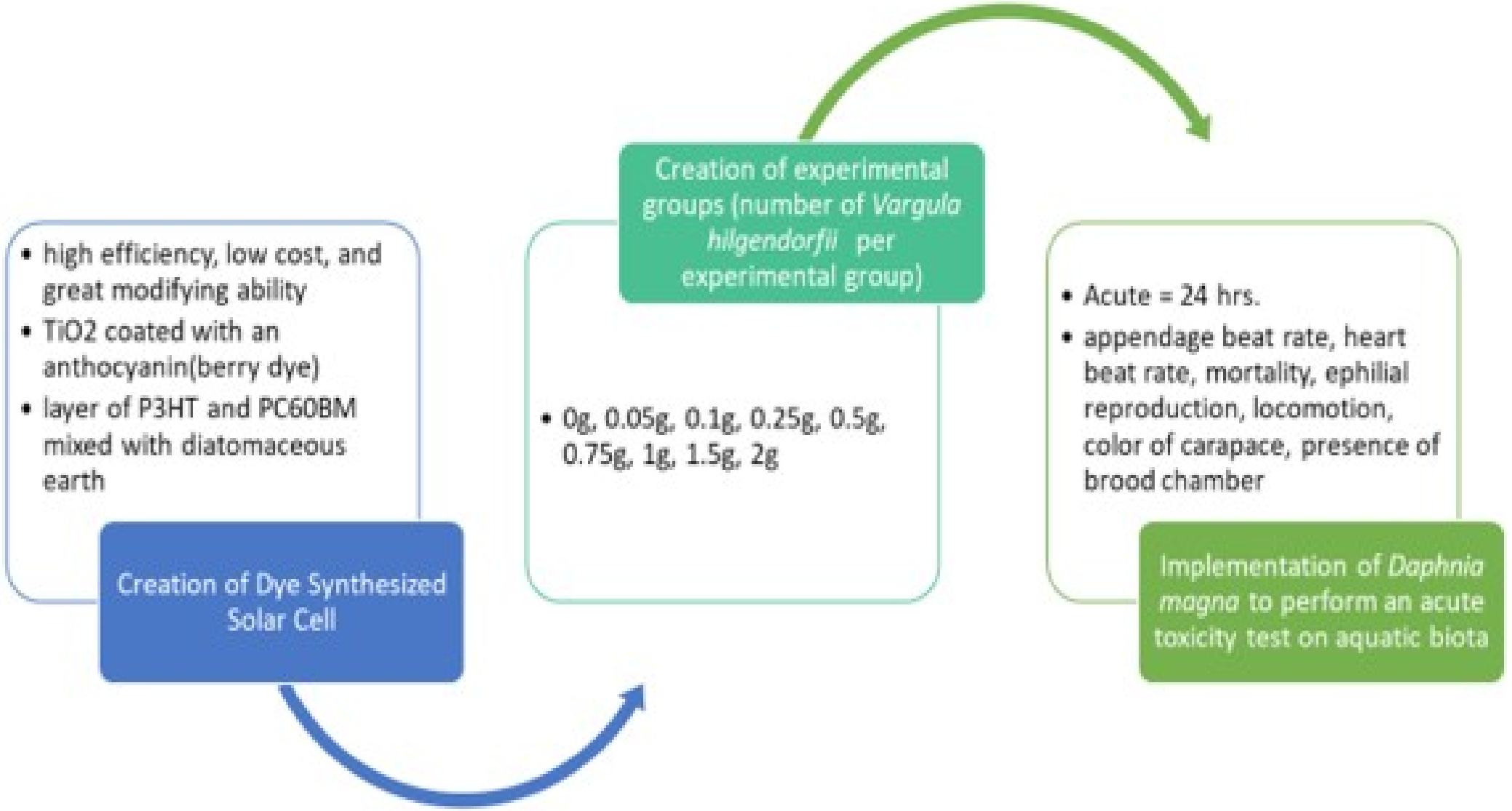
d = Distance between plates in meters

Methodology

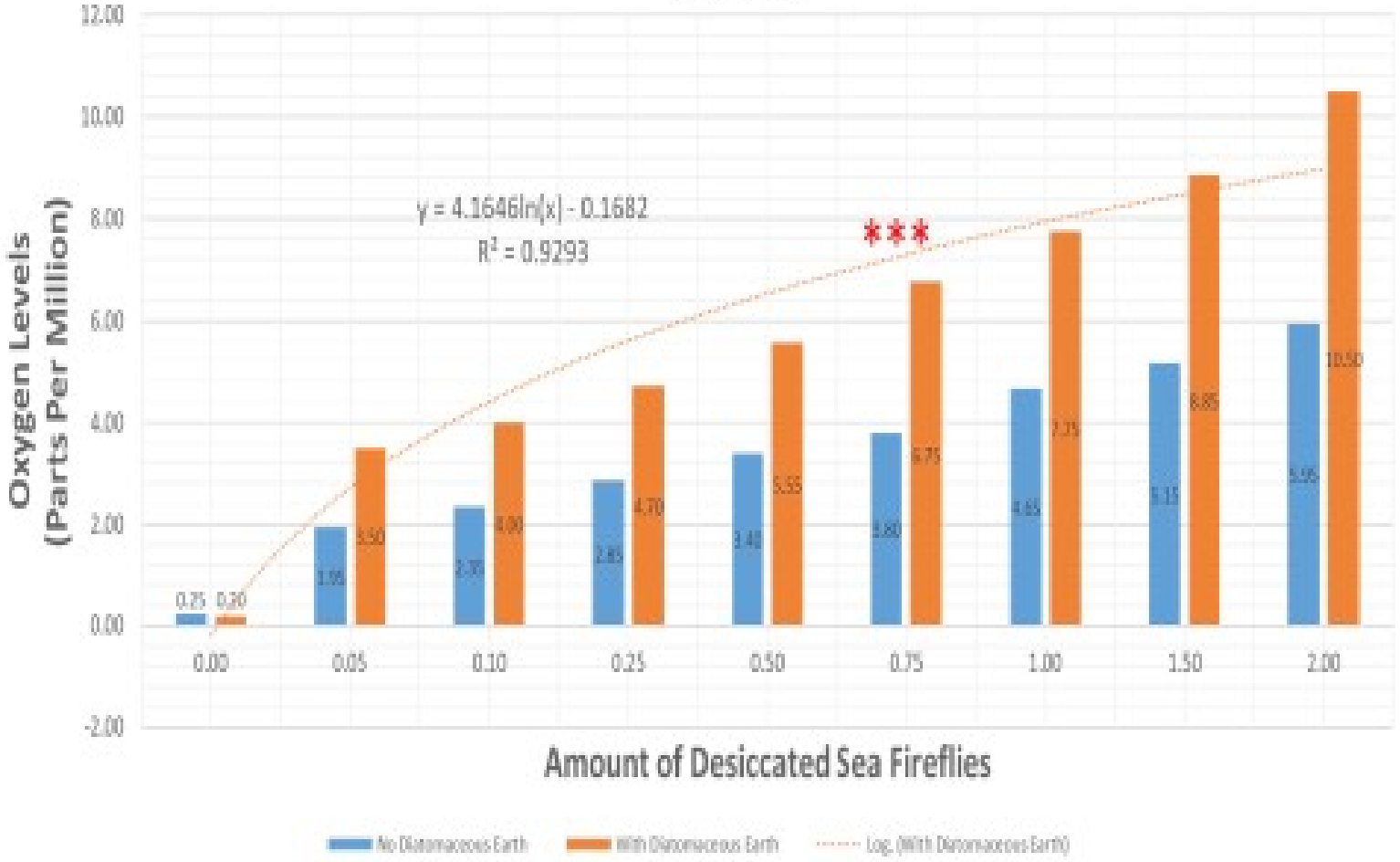



Light
$3I^-$
$3I^-$
I_3^-
I_3^-
TCO glass
TiO_2
Dye
Electrolyte
Pt
TCO glass

Methodology

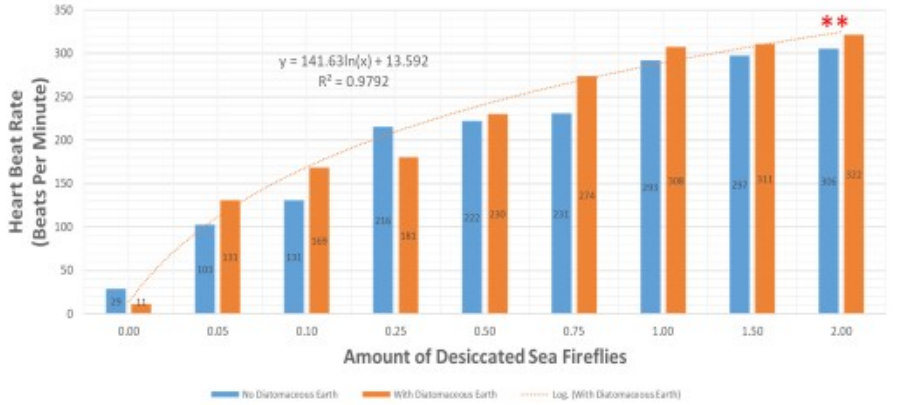


The Dissolved Oxygen Levels Logarithmically Increased by the 20 Hour Period



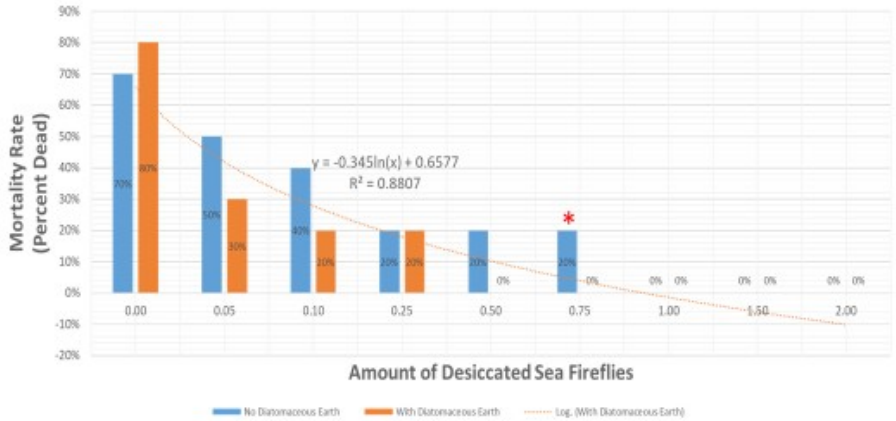
p test: *(p value) < 0.05 **(p value) < 0.01 ***(p value) < 0.005

The Heart Beat Rate Increased Logarithmically by the 20 Hour Period



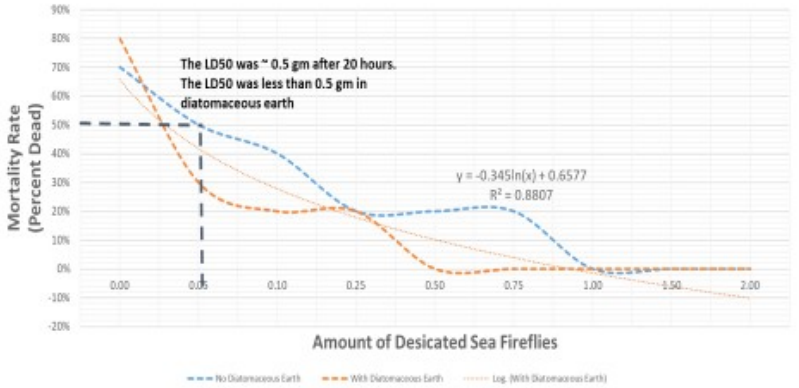
p test: *(p value) < 0.05 **(p value) < 0.01 ***(p value) < 0.005

The Mortality Decreased Logarithmically by the 20 Hour Period

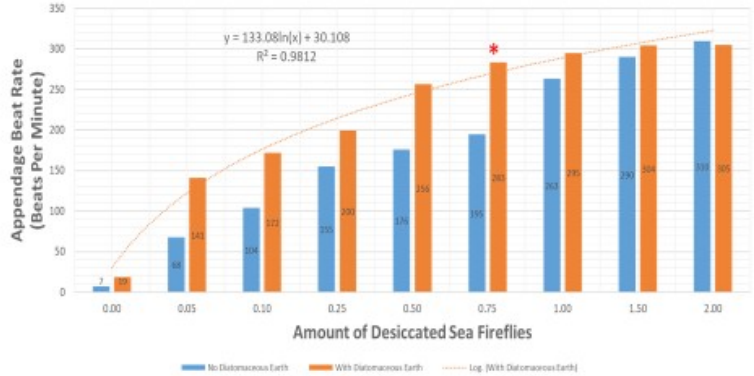


p test: *(p value) < 0.05 **(p value) < 0.01 ***(p value) < 0.005

The LD50 Significantly Decreased after the Inclusion of Diatomaceous Earth Solar Cells

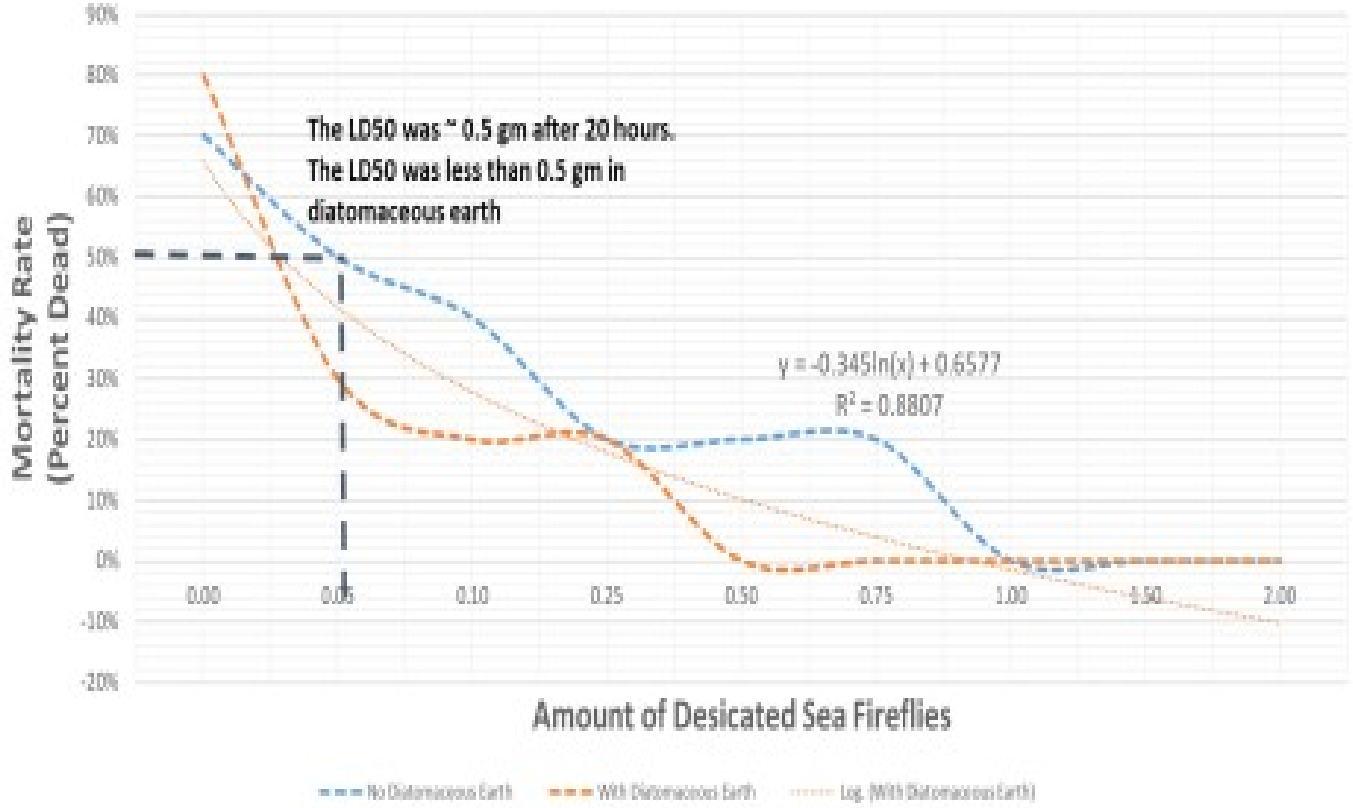


The Appendage Beat Rate Increased Logarithmically by the 20 Hour Period



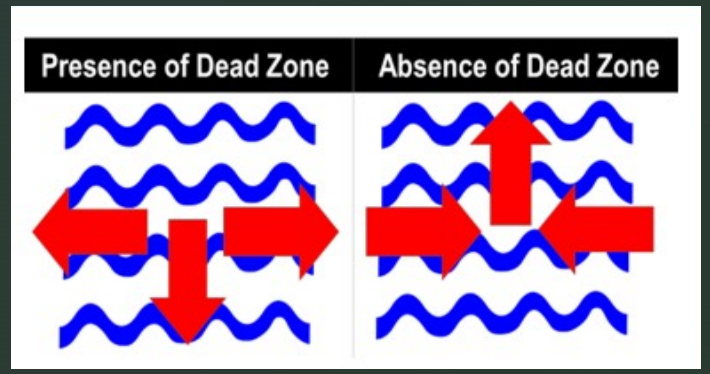
p test: *(p value) < 0.05 **(p value) < 0.01 ***(p value) < 0.005

The LD50 Significantly Decreased after the Inclusion of Diatomaceous Earth Solar Cells



Qualitative Observations

Locomotion



Brood Chamber

Color of the Carapace

Conclusion

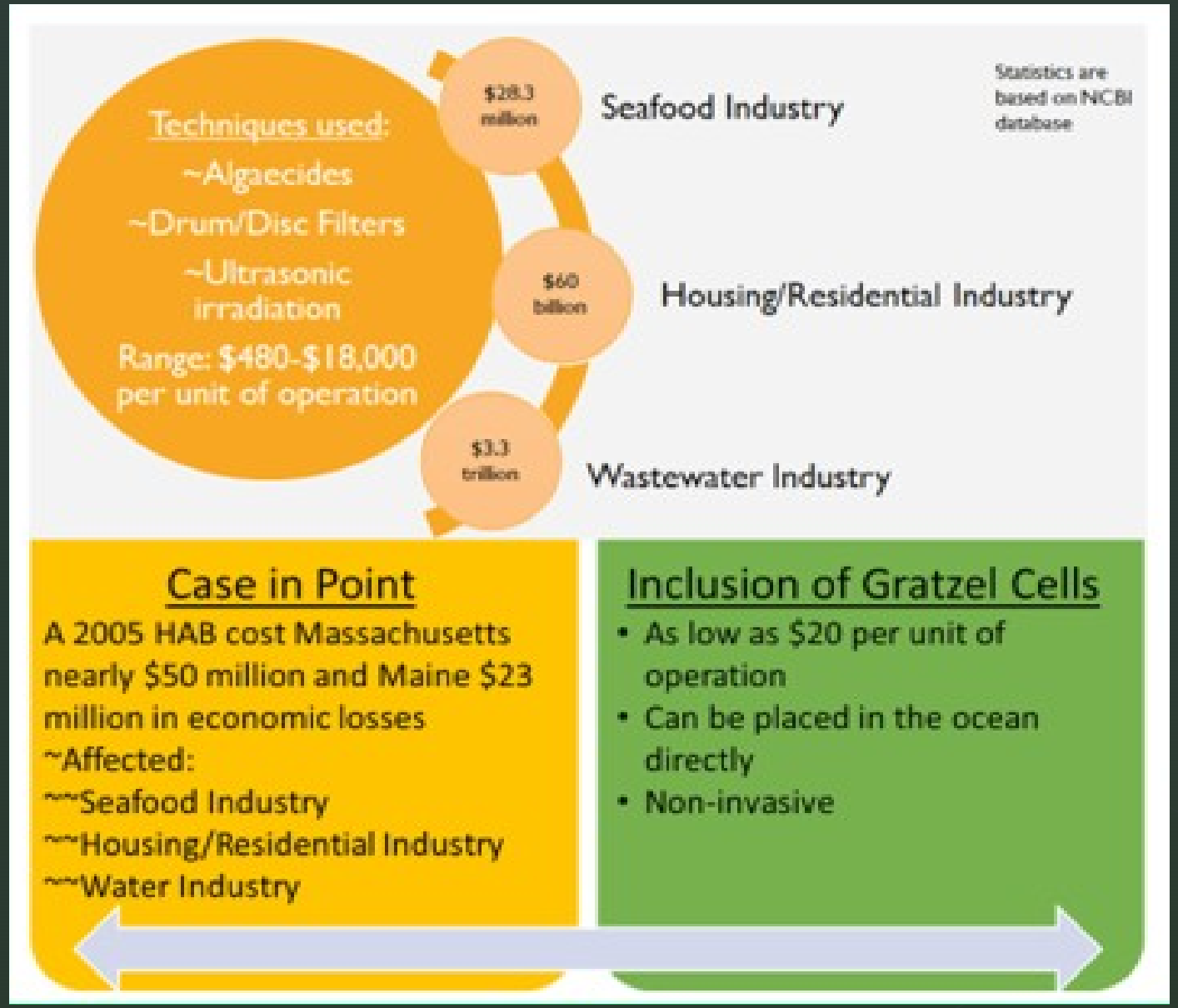
Sea fireflies **increase**, dissolved oxygen levels **increase**

Gratzel cells with diatomaceous earth require **less amount of light** to produce the **same amount of dissolved oxygen levels**

Presence of cells **remediates** heart beat, appendage beat rate, and reproduction

Gratzel cells show a remediated **carapace**, **phototactic** taxis, and **sight of brood chamber** was distinguishable

Cost Analysis



Future Applications and Research