Exploring bioluminescence as a light source

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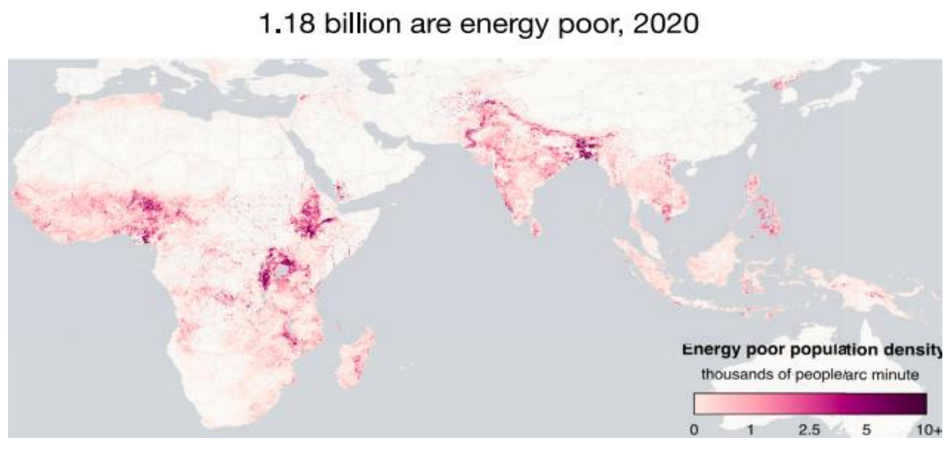
Priority topic area: Clean Energy and Climate Action

Objectives

At least **1.18 billion people suffer from energy poverty [1]** without access to reliable and affordable electricity, and so live in darkness.

We aim to create a **light source that runs independent of electricity using the emerging technology of bioluminescence**, creating numerous socioeconomic benefits and to boost residents' quality of life. To make the design sustainable and feasible to produce, we have chosen locally available recourses: bioluminescent bacteria that can be collected from the coast; and **upcycling single-use plastic drink bottles** for the main structure to reduce landfill, working towards creating a **circular economy.**

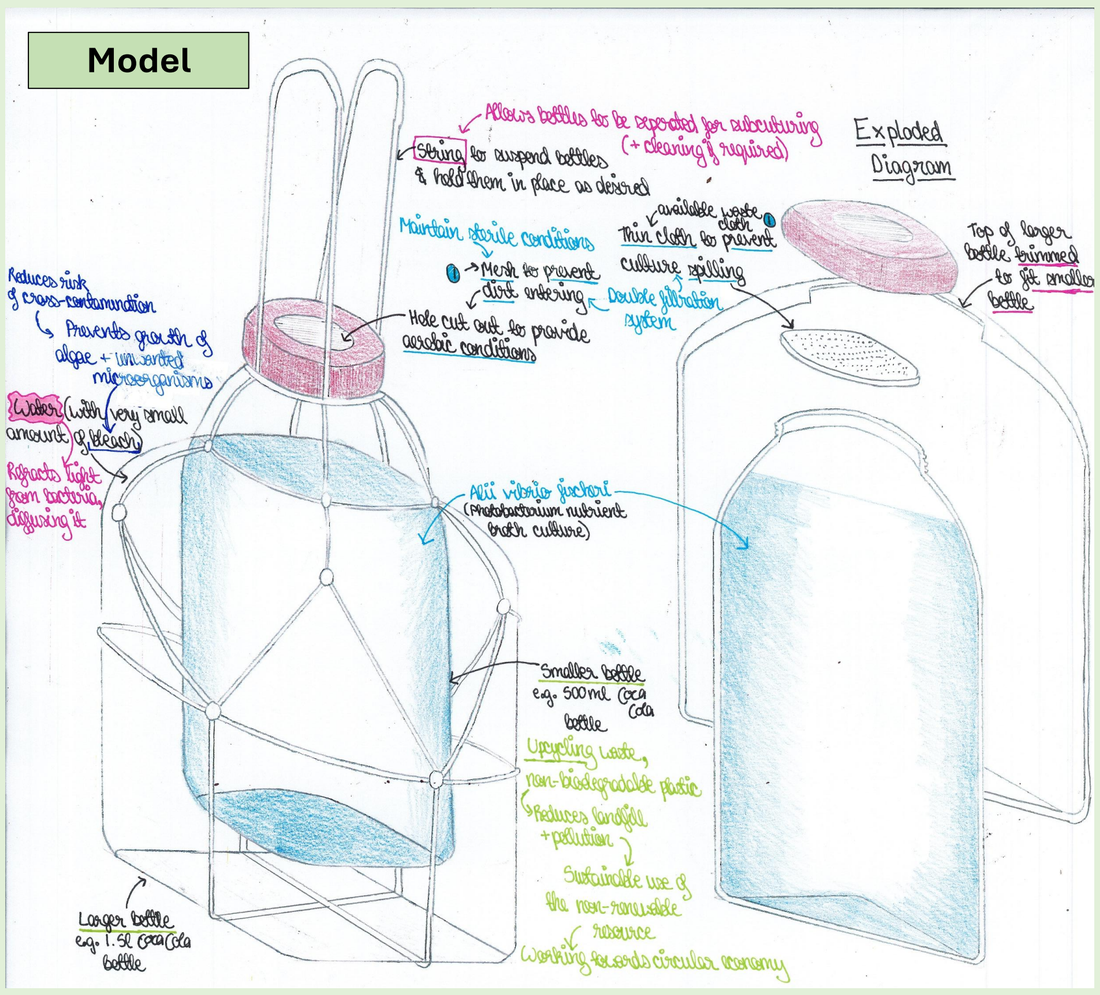


Methodology

A bioluminescent lamp using ***Alii vibrio fischeri*** bacteria **[2]**, found in subtropical salinity marine environments, **dissolved in a photobacterium broth**

1. The **photobacterium nutrient broth culture** under sterile conditions **[3],** is **inoculated and incubated f**or a period of 18-24 hours to achieve maximum bioluminescence. Optimal growth occurs between 20°C to 30°C. To maintain the bioluminescence of the culture, the bacteria must be sub-cultured twice a week, although sub-culturing thrice is more effective. **[4]**
2. The culture will be **encased in water which refracts and diffusing the light.** A small amount of bleach added to the water to prevent the growth of algae and unwanted microorganisms. **[5]**

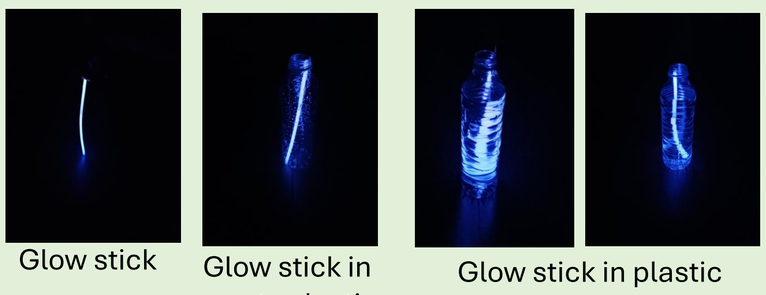
Model



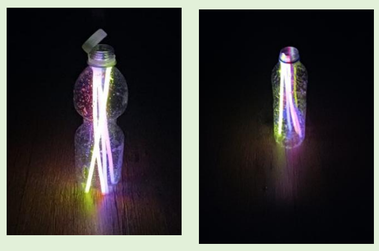
Developments and Issues

Experiment:

To test the use of water as a **reflector,** we used a blue glow stick to mimic the bioluminescent bacteria. Objectively, its light intensity remained the same, however, **it did diffuse the light as hypothesized.**



Glow stick | Glow stick in empty plastic bottle | Glow stick in plastic bottle with water



Mixed colour glow sticks (in empty bottle)

We also mixed different coloured glow sticks, creating **whiter lighting that helps improve sight**. However, this does not offer an accurate comparison to the blue glow stick as using numerous glow sticks has greatly increased light intensity. We did not have enough blue glow sticks available to fully compare.

Potential applications: streetlights, night lights, lamps, general house lights (dim)

Issues include:

- ✓ **Only produce 15 lumens**/square meter **[7]**, whereas LEDs produce over 100 lumens. However, can be sufficient to illuminate indoors and outdoors
- ✓ **Only produces blue light**. White light is ideal for clear sight.
- ✓ *Alii vibrio fischeri* is **found in subtropical marine environments**, i.e. in coastal areas, and has an **optimum temperature of 20°C - 30°C**, greatly **limiting the regions** that can benefit

Benefits to society

Several areas face frequent power outages, such as Chile **[6]**, which suffered a major blackout this year - left millions without electricity, impacting business, hospitals and government offices. To tackle this, our product is:

- ✓ **Reliable** and **accessible** (for off-grid areas) as no electricity is required
- ✓ **Environmentally sustainable** due to repurposing of non-biodegradable single-use plastic to help reduce landfill and using a renewable resource that is carbon-neutral
- ✓ **Easy to maintain and replicate** as the cyclic culturing process means bacteria will not have to be re-collected

It could further create local jobs, improve quality of life, and set off a **multiplier effect**.

Next Steps

Source *Alii vibrio fischeri* bacteria to produce an accurate model of product to test if it functions as required. We wish to measure its luminescence to deduce if it is a sufficient light source, and its maximum life-span. We can also compare how luminescence changes with age of the bacteria.

References/Acknowledgements

[1] Lost in the dark: A survey of energy poverty from space : *'sun.connect.org', Accessed 20/03/25 at 23:06*
[2] Bioluminescent bacteria will soon light up this French street: '*www.freethink.com*' *Accessed 20/03/25 at 23:10*
[3] Sterile Technique - StatPearls - NCBI Bookshelf: 'www.ncbi.nlm.nih.gov' *Accessed 20/03/25 at 23: 33*
[4]Care Guide: Vibrio fischeri | Carolina Biological Supply: 'www.carolina.com' Accessed 20/03/25 at 23:19
[5] (227) How to make Solar bottle bulbs project | DIY Liter of Light | Science Project - YouTube 'www.youtube.com' *Accessed 20/03/25 at 23:35*
[6] 2025 Chile blackout - Wikipedia *: 'www.wikipedia.com' Accessed 25/03/25 23:39*
[7] How Bright Is 15 Lumens and Is It Enough? - Setick *'www.setick.com' Accessed 21/03/35*

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