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# The ASLEE Project: Using intermittent energy to grow microalgae

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**Empowering Rural Industries Conference**

20th March 17, Glasgow

LOCAL ENERGY SCOTLAND

Greener Scotland
Scottish Government

THE CHALLENGE FUND

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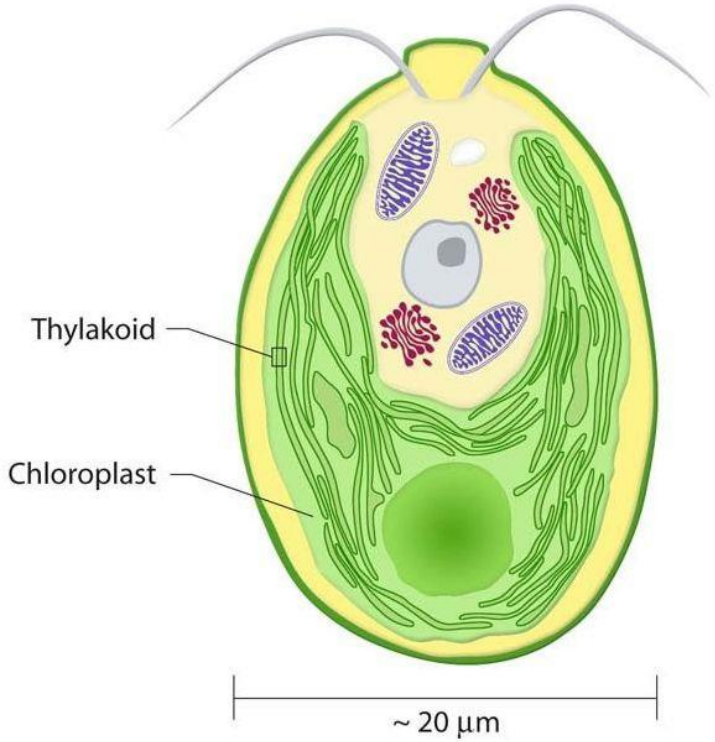
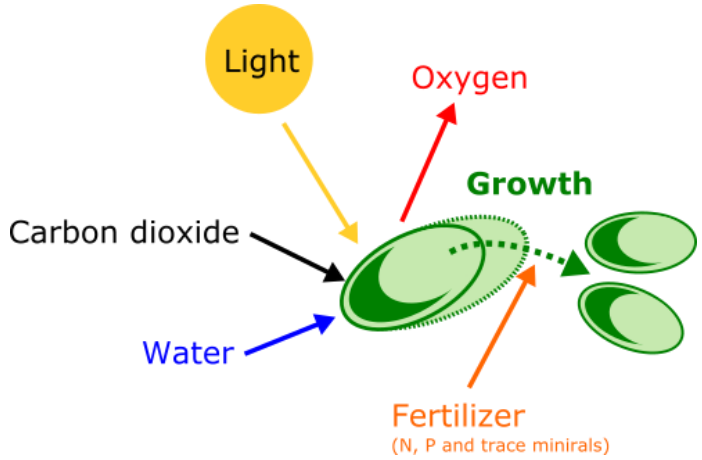
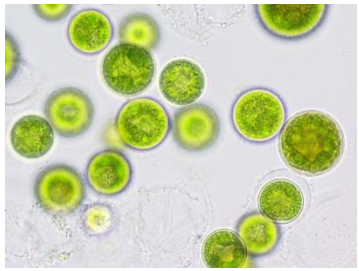
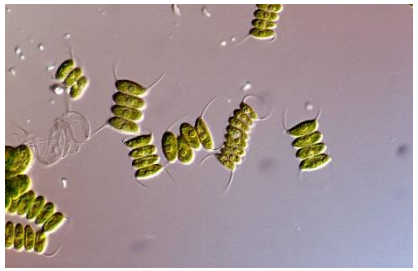
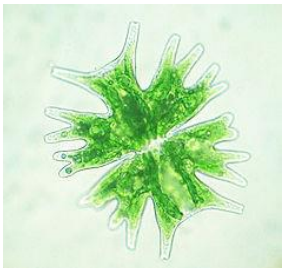
# Microalgae




- Microscopic
- Unicellular
- Freshwater and marine
- Photosynthetic

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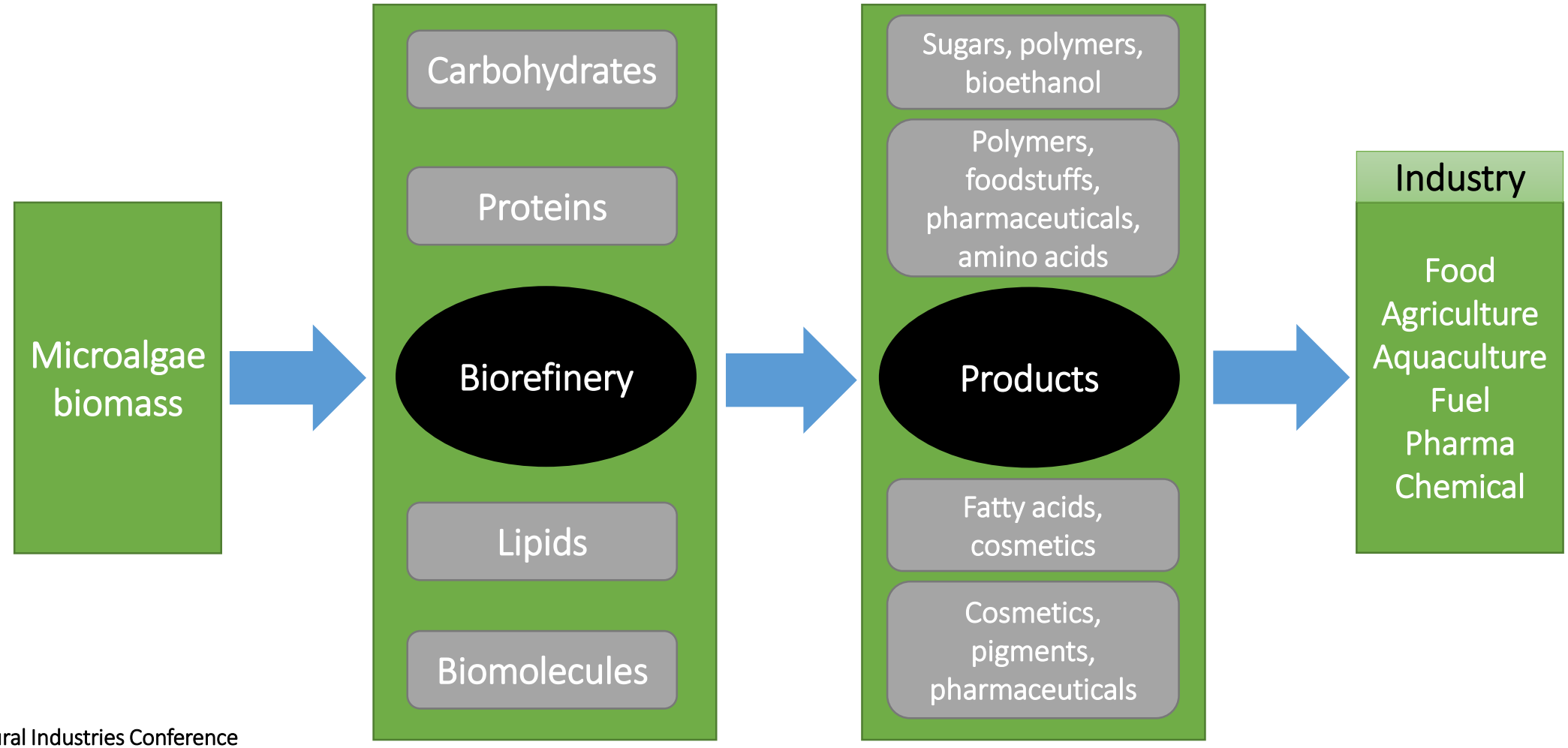
# High-value products and applications



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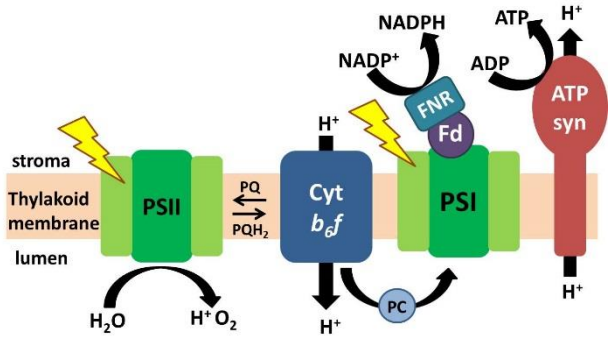
# Cultivation

- Closed systems and ponds

- Nutrients
- pH ($CO_2$)
- Temperature
- Mixing

- Light energy – limiting factor

# Some concepts on light

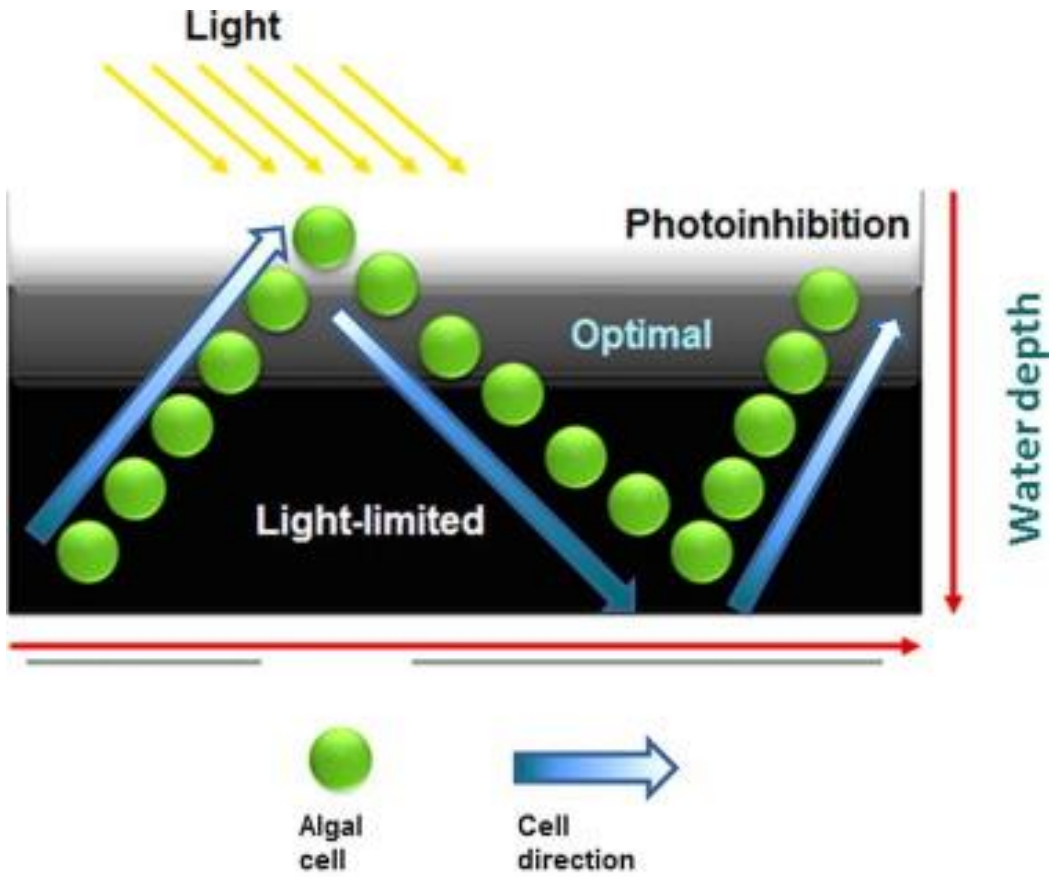



- Light harvesting organelles are continuously damaged during constant exposure to light
  Capacity of repair is limited and excessive light may cause the overall rate of photosynthesis to drop – **photoinhibition**

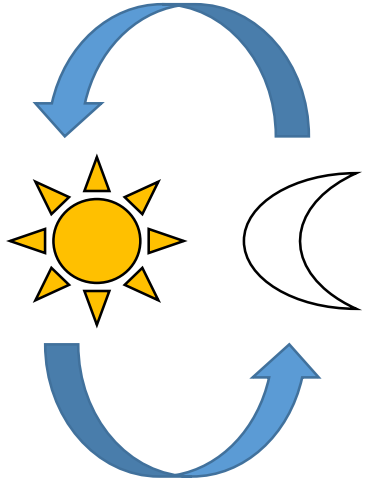
- Too low light levels may hinder growth – **light-limitation**

- Intermittent lighting, which also allows for periods of only darkness, should result in an optimal integrated light supply for photosynthesis and growth

# Light/dark gradients




Optimal mixing



in “Flashing light in microalgae biotechnology”, Abu-Ghosh *et al*. 2015

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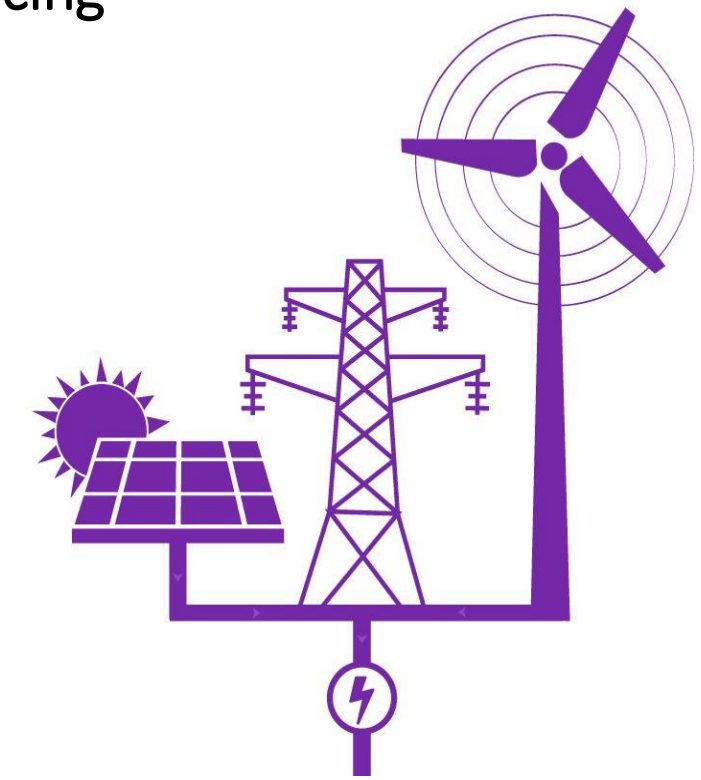
# ASLEE PROJECT

## WP Operations: Integration with renewables and grid balancing

- Investigate the effect of intermittent lighting on the growth of microalgal cultures in photobioreactors by mimicking intermittency patterns as experienced with different renewable energy scenarios



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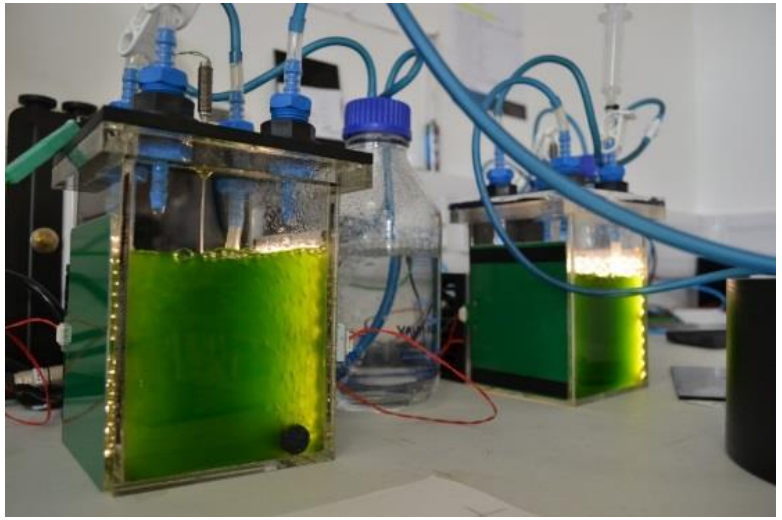
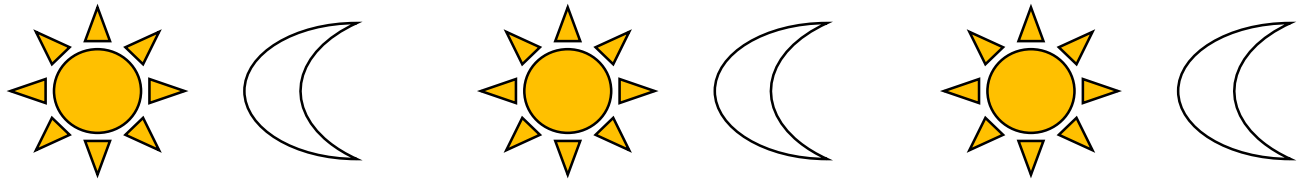
# Influence of intermittency on the growth of *Chlorella sorokiniana*



1L microPharos™ photobioreactor, Xanthella Ltd

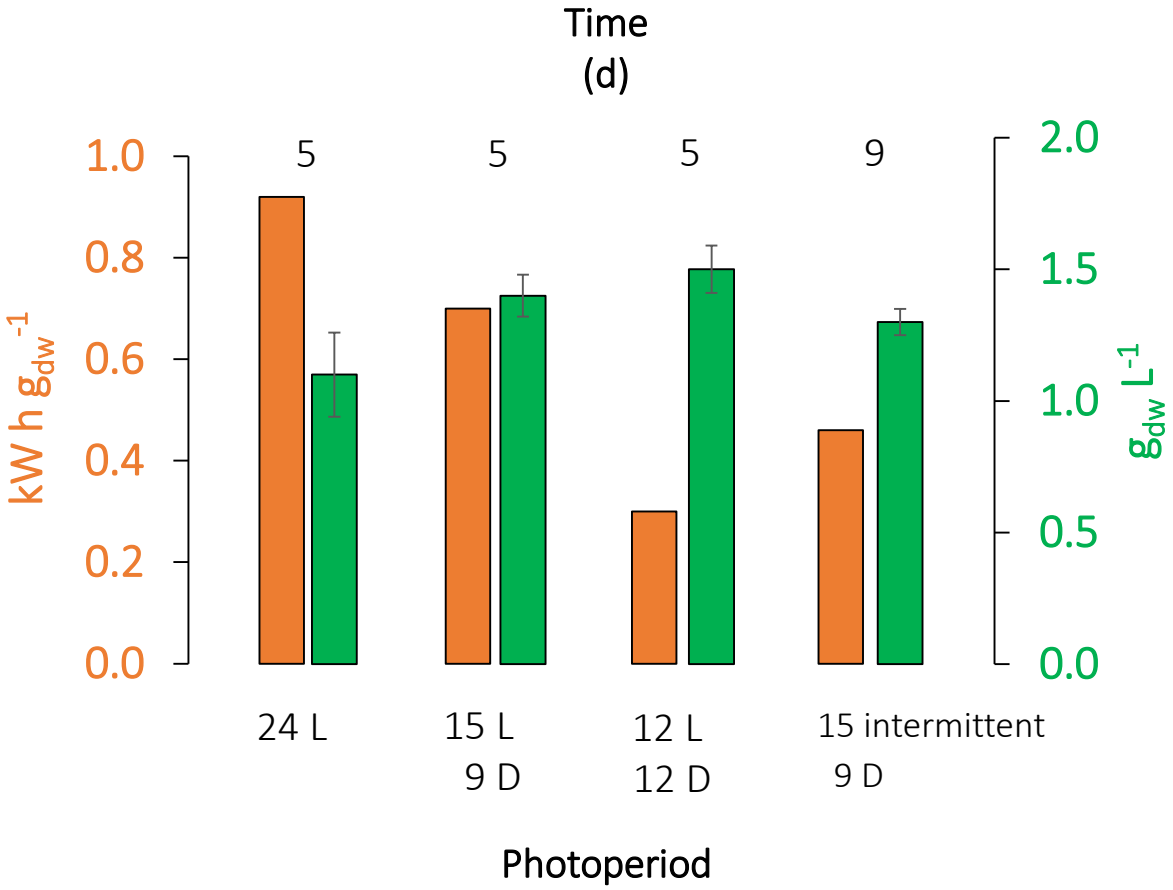
| Photoperiod | Duty cycle |
|---|---|
| 24h light | 1.0 |
| 15h light : 9h dark | 0.6 |
| 12h light : 12h dark | 0.5 |
| 15h intermittent illumination : 9h dark | 0.3 |

Intermittent illumination = 30min light : 30min dark



# Energy usage to build-up biomass

- Energy used more efficiently with intermittent lighting?
  - more for growth, less for cell repair
- Energy load reduced with increasing dark periods
  - but too long dark periods result in lower growth rates



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# Take home message

- Cultivation of microalgae is possible over a range of light energy levels that do not significantly affect productivity

**Grid Balancing**

- Allows to use cheaper electricity

ENERGY & MONEY SAVING

- Photobioreactors can be used as transactive loads

VCHARGE
Turn It On

- Allows to use surplus energy

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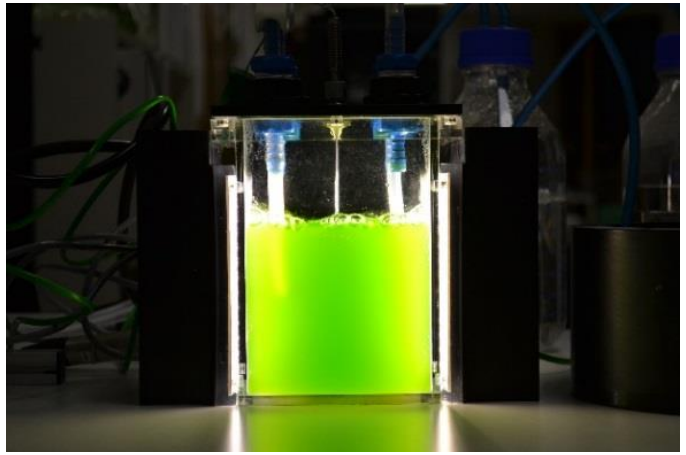
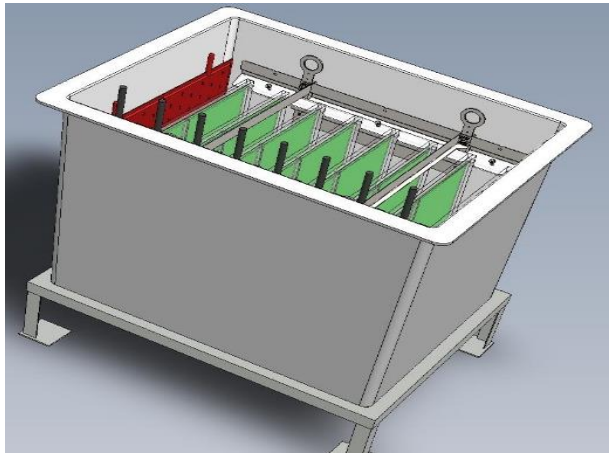
# Future work



1L microPharos™ photobioreactor, Xanthella Ltd

Bag cultures at Ardtoe facilities, fai



600L Pandora™ photobioreactor, Xanthella Ltd

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# Thank you