

# UK-India Algae funding and opportunities

2014-2017

BBSRC and DBT Joint Bioenergy call on Algae (micro and macro)

Other, less directed funding through UK-India joint funding

- UK networks:
- 2015-2019 Phyconet (microalgae only)
- 2020 – 2024 Algae-UK (micro, macro and cyanobacteria)

<https://www.ukri.org/wp-content/uploads/2021/09/UKRI-300921-UKRI-India-Impact-Analysis-Report.pdf>

# Recently-funded UK macroalgae projects ( $\geq$ £100,000)

| Name of Project  | Recipient/s  | Funders                                 | Amount                        | Project Term        |
|--|--|---|-------------------------------|---------------------|
| GCRF GlobalSeaweed - Safeguarding the future of seaweed aquaculture in developing countries  | Scottish Association for Marine Science (lead research organisation)   | UKRI BBSRC<br>ESRC<br>NERC              | £5,419,058<br>(USD 7,483,903) | Oct 2012– Dec 2021  |
| Teleconnected SARGassum risks across the Atlantic: building capacity for Transformational Adaption in the Caribbean and West Africa (SARTRAC)                      | University of Southampton (lead research organisation)   | UKRI<br>ESRC                            | £876,346<br>(USD 1,210,263)   | Nov 2019– Oct 2022  |
| University of Exeter GCRF Global Research Translation Award: Sustainable solutions to food security challenges.  | The University of Exeter   | UKRI GCRF<br>Newton Fund<br>Innovate UK | £621,951<br>(USD 858,159)     | Oct 2019– Mar 2021  |
| SeaGas: Production of bio-methane from seaweed by Anaerobic Digestion (AD)   | Queen's University of Belfast (lead research organisation)   | UKRI BBSRC<br>EPSRC                     | £534,373<br>(USD 737,987)     | July 2015– Oct 2020 |
| Development of the automated Ooho! Machine – reducing single use plastic packaging for <100 mL liquids, condiments and cosmetics through seaweed alginate membrane | Skipping Rocks Lab Limited (lead participant)<br>Lucozade Ribena Suntory Limited, Vita Mojo International Ltd (participants) | UKRI<br>Innovate UK                     | £343,734<br>(USD 474,708)     | Feb 2019– Mar 2020  |
| Oceanium: Seaweed-based compostable, marine safe bio-packaging   | Oceanium Ltd   | UKRI<br>Innovate UK                     | £99,756<br>(USD 137,766)      | Aug 2019– Oct 2020  |

Kostas *et al.*, (2021)  
Renewable and Sustainable Energy Reviews 151 (2021) 111553

## Key Institutes in India working on micro/macro algae

| S.No. | Indian institutes working on micro/macro algae           | Area of research/ products   |
|-------|--|--|
| 1.    | DBT TERI Centre of Excellence                            | Advanced biofuels and biocommodities   |
| 2.    | NIT, Tiruchirapalli                                      | Biodiesel  |
| 3.    | NIIST, Trivendrum  | Harvesting of microalgae   |
| 4.    | Sardar Patel Renewable Energy Research Institute         | Biofuels, Industrial effluent remediation, value added products  |
| 5.    | CSIR- CSMCRI   | Marine algae research station, macroalgae  |
| 6.    | Institute of Chemical Technology-Engineers India Limited | Large scale cultivation, value added products  |
| 7.    | National Fisheries Development Board                     | Seaweed cultivation  |
| 8.    | DBT PAN IIT Centre for Bioenergy                         | Bioenergy from algae   |
| 9.    | DBT-ICT Centre for Energy Biosciences                    | Value added products from microalgae, genetic engineering of algae for drop in fuels and high value products |
| 10.   | DBT ICGEB Advanced Bioenergy Research                    | Algal Omics, Biofuels, Bio based chemicals   |



## Key industries in India working on micro/macro algae

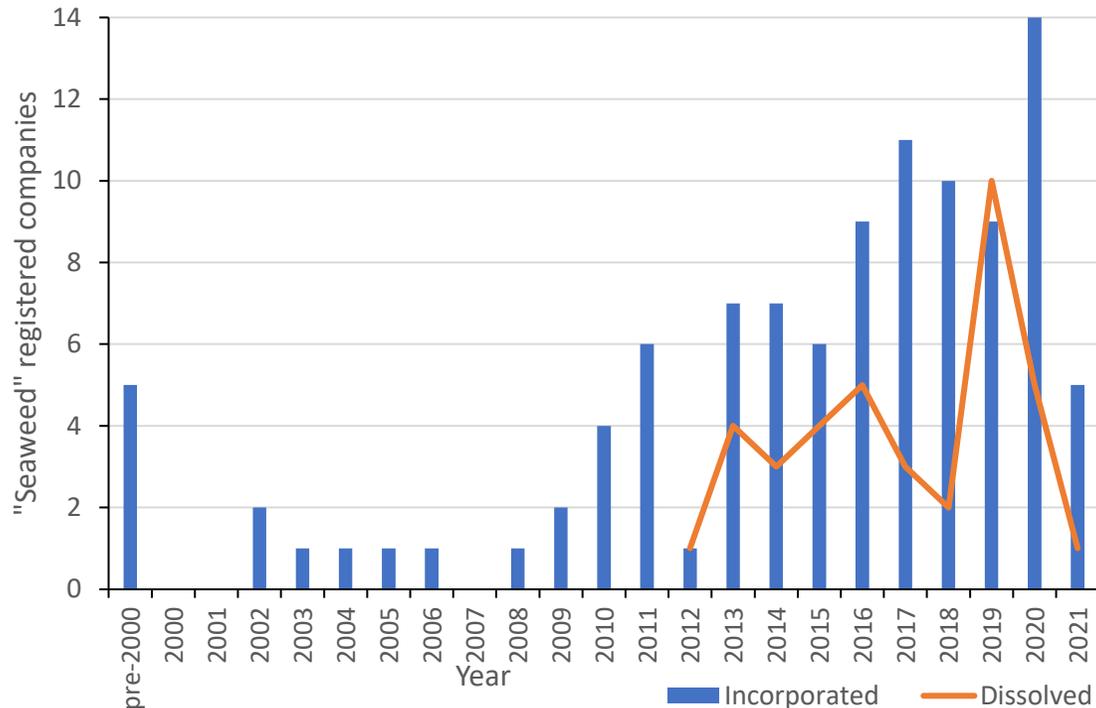
| <b>S.No.</b> | <b>Indian companies/startups working on micro/macro algae</b> | <b>Area of research/ products</b>  |
|--------------|---|--|
| 1.           | Reliance Industries   | Carbon dioxide sequestration, HTL of algae for biofuels                            |
| 2.           | Phycospectrum   | Bioremediation, Spirulina for nutrition  |
| 3.           | Zaara Biotech   | Algae as alternative food source   |
| 4.           | Green Bubble Algalworks Pvt. Ltd.                             | Nutrition derivatives viz. vitamins, minerals, antioxidants, omega oil supplements |
| 5.           | Sea6 Energy   | Sea weed cultivation   |
| 6.           | Indian Oil Corporation  | Biofuels from algae  |
| 7.           | Hindustan Petroleum Corporation Ltd.                          | Biofuels from algae  |

# UK seaweed companies



Companies House

Search: "Seaweed". n=105

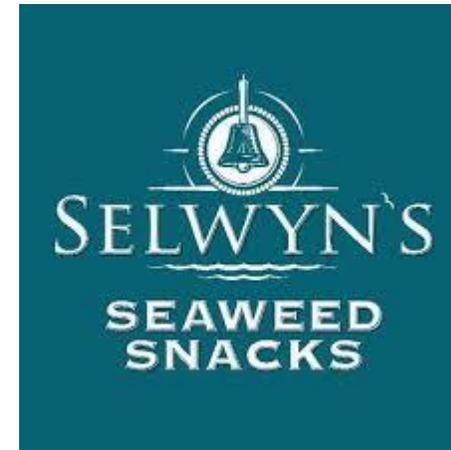


- Trend, not comprehensive
- Includes e.g. Seaweed Close Ltd.
  - 68320 - Management of real estate on a fee or contract basis
- Excludes e.g. GreenSeas Resources
  - 03210 - Marine aquaculture
- 5x "seaweed" companies in Wales
  - business support services;
  - manufacture of food products;
  - manufacture of soap/detergents;
  - licensed restaurants;
  - tourist guides;
  - marine aquaculture;

# UK recent developments



Since 2012



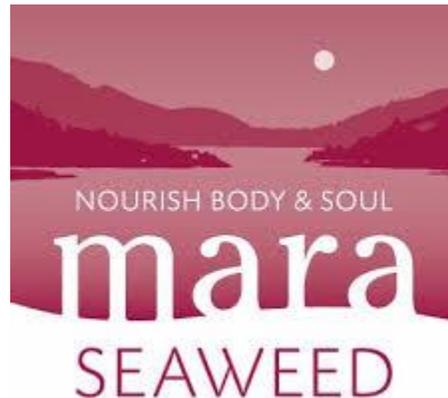
Since 2014



Animal feed supplement,  
soil enhancer, alginate,  
nutraceuticals  
Since 2006



Since 2010



Since 2010



Main focus alginates  
Set-up 2009



Seaweed & Co. advise on, supply and accredit superior seaweed

Since 2014

# Gaps in the field 1

- **CO<sub>2</sub> uptake is a key component** to develop for use of algae (micro & macro) towards bioenergy generation, as biomass feedstock (for thermo- and biochemical productions) or for direct production of energy vectors.
- Greater focus on cultivating microalgae using industrial effluent and CO<sub>2</sub> reduces costs, water footprint of microalgae production.
- Need efficient pathways for maximizing CO<sub>2</sub> fixation and routing to energy vectors or algal biomass with qualities amenable for energy generation.
- **Generation of biomass with appropriate characteristics** for energy generation and high enough productivities needed. Current productivities do not allow for an economic translation of technology.
- High value products needed in product profiles for move away from raceway ponds, popular for large scale cultivations, due to economic reasons, but offer little control.

## Gaps in the field 2

- Most past effort has been in the development of microalgae for biodiesel production. There is much scope to examine the development of algal (micro and macro) biomass for production of other energy vectors including alcohols, biomethane, biohydrogen, in addition to bio-oil and biodiesel (which are more energy dense).
- PBRs not currently viable in the UK, high opex. Raceway ponds also unviable
- Product diversification - in a **biorefinery concept** to additionally produce high value products might help deal with process economics (a general consensus in the community).
- Energy efficient and sustainable harvesting of biomass/processes that minimise DSP requirements.
- Biomass pretreatment strategies (mainly when used as feedstock for biochemical or thermochemical conversions).

# Areas to focus (UK- India) 1

- The key attraction of including algae in the energy mix is its ability to photosynthesise and capture CO<sub>2</sub> (not only from air but also from point source emitters) – A key enabler would be to understand and **maximise CO<sub>2</sub> uptake** by algae (macro or micro) and carbon routing to relevant products of interest.
- Past efforts have predominantly focused on biodiesel production from microalgae. With the move to electrification, biofuels for transportation is more of a transitory requirement – **ethanol or butanol** for blending with petrol can be a transitory target.
- Might be more useful to aim for biohydrogen, jet fuels, hydrocarbons, bio-oil in **net-zero or net-carbon negative processes**, which is a challenge to jointly address.
- Whichever energy vector is aimed for the **TEA and LCA** of the process need to be favourable, which is a challenge to address. To make meaningful contributions high volume productions will be needed of what is essentially a low value product, which is a challenge.
- In this regard, **product diversification** with the inclusion of **high value** products as well as materials via the development of **algal biorefineries** could be aimed for – we might need to identify specific industries in India and the UK where we can perhaps establish algal biorefineries.

# Areas to focus (UK- India) 2

- Technologies that enable **high biomass productivities** of algae biomass is used as feedstock and high product yields for energy products needed to compete with alternatives.
- Innovative and energy efficient approaches to harvest biomass and downstream processing needed (including processes that minimise DSP requirements).
- **Synthetic biology** interventions to expand on natural capacity as well as those that enable innovative downstream processing will be areas to build collaborative capacity.
- The use of **machine learning/computational** approaches and process modelling might help accelerate process related innovations and will need developing collaborative capacity.
- Sustainable processes that **minimise recourse to resources** (water, N, P) and are circular need to be aimed for.
- Might need to identify specific industries in India and UK where we can establish algal biorefineries.
- Aquafeed / animal feed
- Biohydrogen and an electrified future – not just about making liquid fuels

# Sustainable algae based products for biorefinery model

