Algae in the Marine Environment

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Red Tide, La Jolla, California

- *Karenia brevis* algae blooms red tides
- Red tides, like this one in La Jolla, California, can form as a result of nutrient pollution

. **Photo Credit**: P. Alejandro Díaz | English Wikipedia

Mail Online- **Slimewatch UK: 8inch-thick carpet of algae is clogging South Coast**

- **UK- Portsmouth mud flats**
- **France- Brittany 60,000 tonnes**
- Read more: http://www.dailymail.co.uk/sciencetech/article-1207817/Coastal-wildlife-threatened-vast-seaweed-blooms-caused-hot-rainy

Seaweed to biofuel: not a new idea, but time to revisit the technology……

- As long ago as 1974, Americans looked for a renewable source of methane (natural gas) from the seas
- Their data showed that high levels of methane could be readily produced from seaweed
- However then, off-shore seaweed farms were a failure
- Since then seaweed aquaculture has developed on a massive scale

Sources of seaweed for biofuels

Kelp aquaculture?

Subtidal kelp?

Beach-cast kelp? (wrack)

Seaweed fermented to make bioethanol
or
anaerobically digested to make biogas (methane)

447 TJ of energy to be generated from macroalgae by 2020.
~0.2% of current national road-fuel demands.

Hughes et al (2012) Biotechnology for Biofuels

What is the bioenergy potential?

Example of beach cast kelp washed ashore after storms, November 2011, North Uist, Scotland

TOTAL biomass of beach cast estimated in the entire Outer Hebrides:

210 000 tons/year (Walker 1954)[1]

= 4.62 x 10^6 m^3 methane

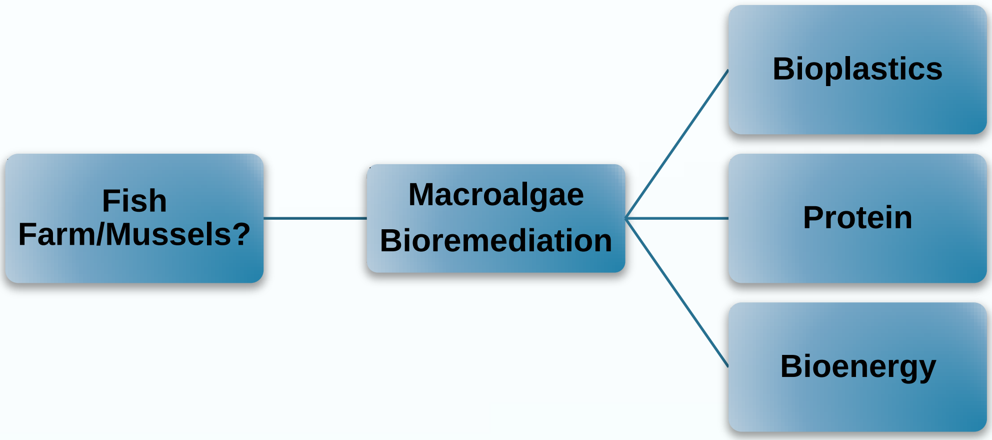
- enough methane to heat 2874 houses (24% of total households)

- Equivalent to ~ 5 000 000 liters petrol

Where: [2]One wet ton of seaweed yields 22 m^3 of methane with a gross calorific value of 39.8 MJ/m.
[3]One m^3 biogas is equivalent to 1.1 liters petrol[2]

Walker, F. T. (1954). "Distribution of Laminariaceae around Scotland." Journal du Conseil 20(2): 160-166. [2]Bruton, T., H. Lyons, et al. (2009). A Review of the Potential of Marine Algae as a Source of Biofuel in Ireland, Sustainable Energy Ireland., [3]http://www.balticbiogasbus.eu/web/about-biogas.aspx

Integrated Multi-Trophic Aquaculture (IMTA)?



Bioremediation

- Palmaria palmata (growth rate 48% and biomass 63%)
- Saccharina latissima (growth rate 61% and biomass 27%)

Placement of seaweed- nitrogen content increases as you get closer to the fish cages

Potential to remove 5% to 12% of waste nitrogen from 500 tonnes salmon farm over 2 yrs

(ref. Sanderson et al (2012) Aquaculture)

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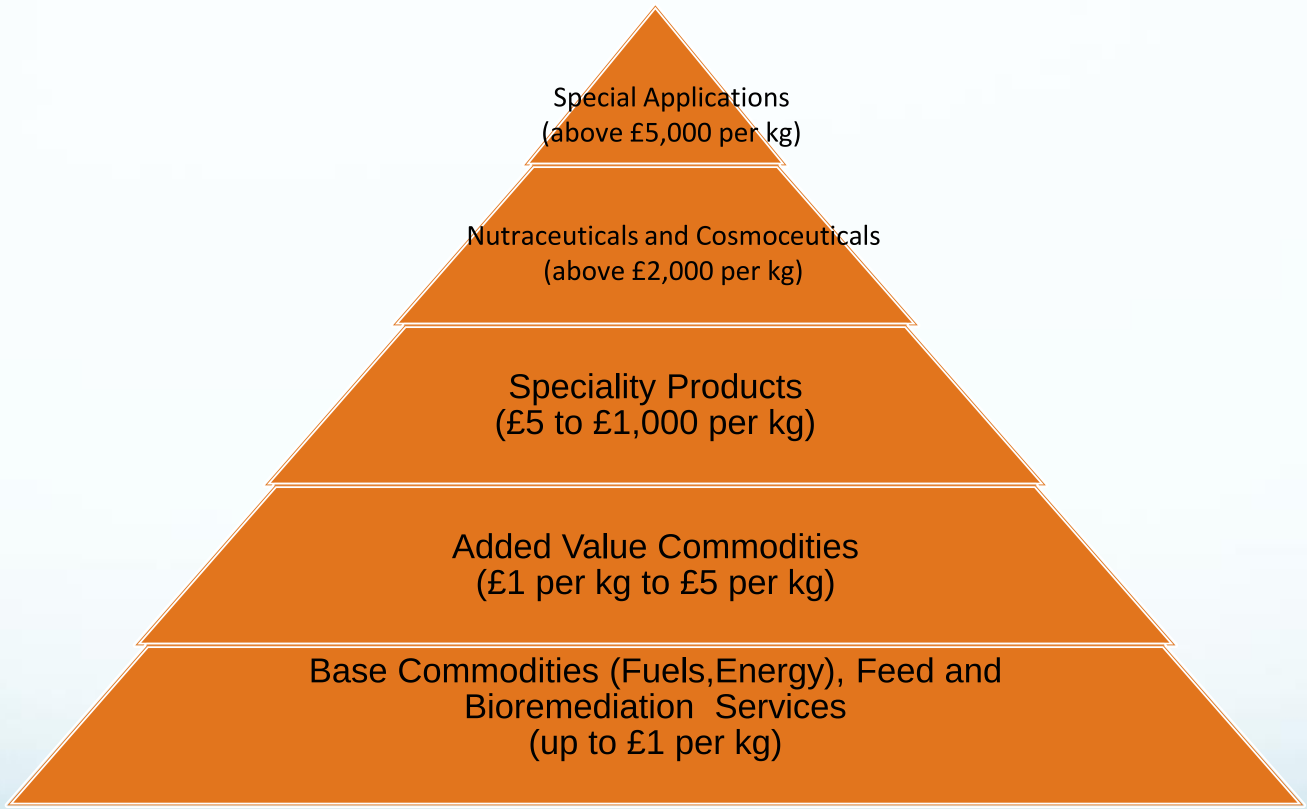

Value Pyramid for Algal Derived Products (modified from Subitec Value Pyramid for Algae Product Markets in Bruton et al, 2009)

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Research Needs in Ecosystem Services to Support Algal Biofuels, Bioenergy and Commodity Chemicals Production in the UK

February 2012

A Project for the Algal Bioenergy Special Interest Group

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Research Councils UK Energy For a Low Carbon Future

Living With Environmental Change

Knowledge Transfer Network Biosciences

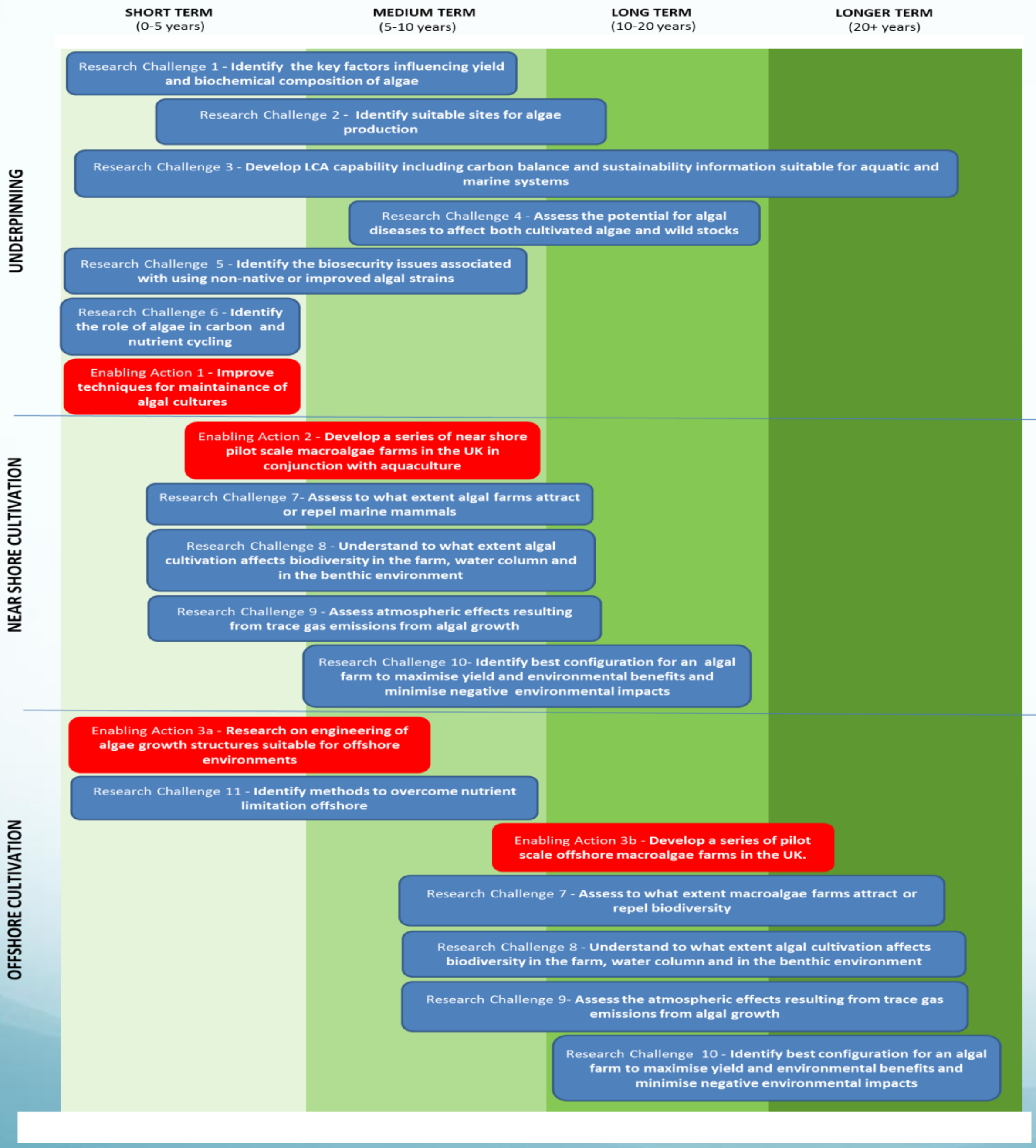
Knowledge Transfer Network Energy Generation and Supply

Knowledge Transfer Network Environmental Sustainability

https://connect.innovateuk.org/web/algal-biotechnology-special-interest-group/document-library

Technology	Availability / Potential	Environmental Risks	Environmental Benefits	UK Capability	UK Potential
Inputs					
Wastewater treatment					
Industrial CO_2 use					
Biomass Production					
Photobioreactors					
Open Ponds					
Macroalgae in Sea					
Microalgae in Open Sea					
Microalgae in enclosed membranes in Sea					
Driftweed/Wrack					
On Land Tanks					
Standing Stocks					
Conversion Processes					
Heterotrophic					
Anaerobic Digestion					
Sugar Fermentation					
Hydrothermal Processes					
Extraction					

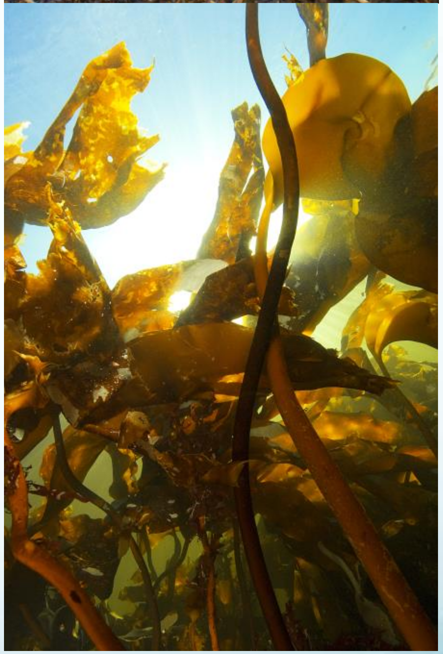
Key: low availability/high or detrimental impact, high availability/low impact, intermediate availability / intermediate impact.



From the SRA- 11 Research challenges (highlighted in blue) associated with the large-scale use of macro and microalgal feedstocks for biofuel and commodity chemicals production. The realisation of these research areas will also be dependent upon a specific enabling action (highlighted in red)

Key Questions

- Key environmental factors influencing yield and biochemical composition.
- Site selection.
- Develop life cycle assessment
  - Carbon balance
  - Sustainability information suitable for aquatic and marine systems.
- Identify the role of algae in carbon and nutrient cycling.
- Understand to what extent algal cultivation affects biodiversity in the farm, the water column and benthic environment.



Thank You

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