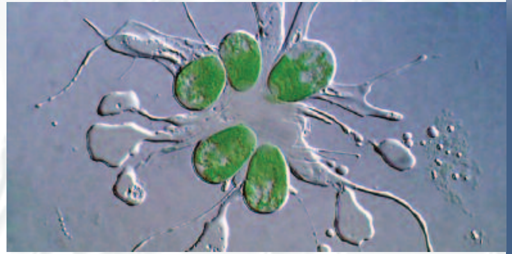
The BioMara Project

BioMara is a four year UK and Irish joint project examining the feasibility and viability of producing third generation biofuels from marine biomass. It is investigating the use of algae as an alternative to terrestrial agri-fuel, examining the practicality of using these aquatic plants as a competitive, sustainable biofuel source. BioMara is engaging widely with stakeholders and incorporating environmental impacts of algal cultivation and extraction as core considerations of the project.

High rainfall and poor agricultural land in areas of western Scotland, Northern Ireland and Ireland restrict the production of terrestrial biofuels. BioMara aims to provide the region with locally produced, renewable, relatively cheap and low-impact fuel to help support traditional ways of life.



Biofuels From Algae

Aquatic plants are highly efficient converters of sunlight energy into biomass and some produce valuable oils, providing a potential solution to the global problems associated with growing agri-fuel.

Microalgae are single-celled plants that convert light into biomass more efficiently than terrestrial plants. They can grow under a wide range of conditions and many naturally produce oils, which can be converted to biodiesel.

Large brown macroalgae (seaweeds) grow very fast in easily accessible coastal locations and are readily used as biofuel.

Macroalgae and microalgae can be anaerobically digested to produce methane and/or fermented to produce ethanol. They lack lignin and have a low cellulose content, which makes them better than land plants for complete biological degradation to methane.

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THE CROWN ESTATE

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Partners

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- The Centre for Renewable Energy at Dundalk Institute of Technology (CREDIT)
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Sustainable fuels from Marine Biomass

Project coordination office
BioMara
Scottish Association for Marine Science
Scottish Marine Institute
Oban, Argyll
PA37 1QA
Scotland, UK

Tel +44 (0)1631 559000
Fax +44 (0)1631 559001
Email biomara@sams.ac.uk
www.biomara.org

BioMara

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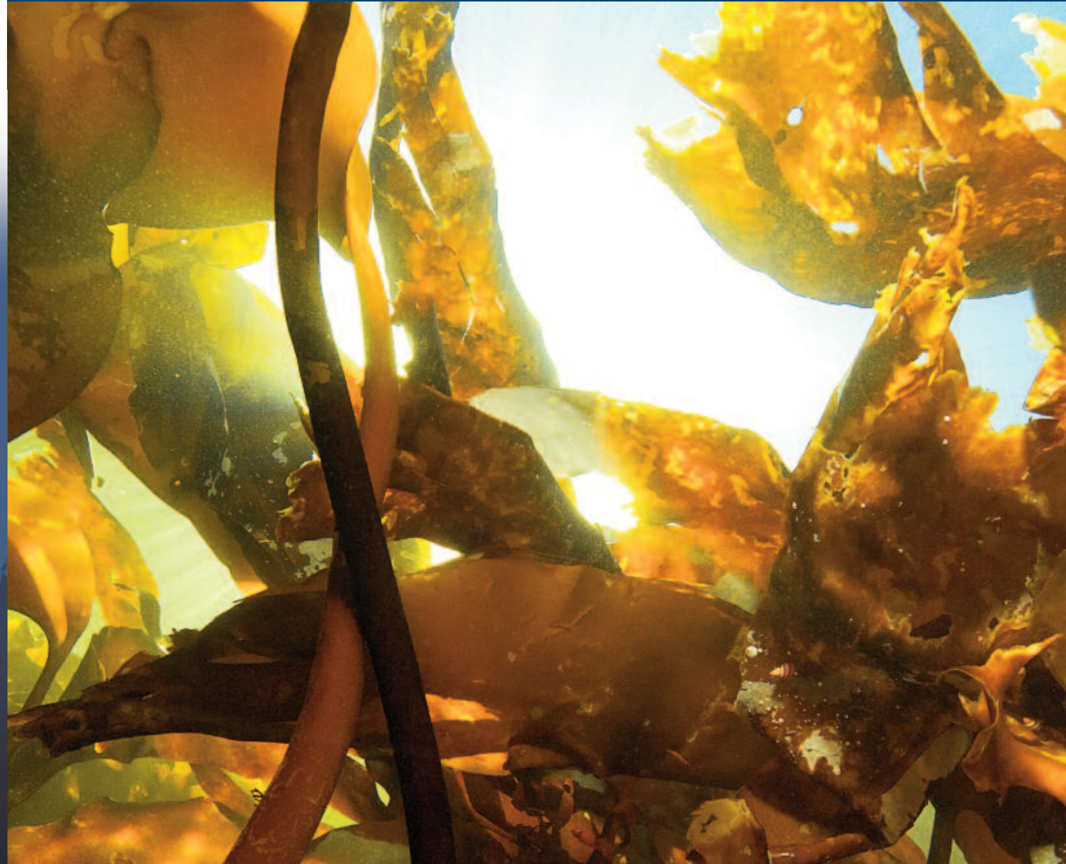
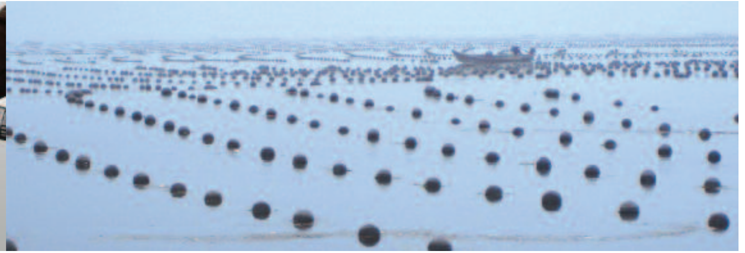


The Biofuel Challenge

As global fossil fuel supplies dwindle and atmospheric carbon concentrations rise, pressure is on to find viable biofuel alternatives to petroleum products. The European Parliament is calling for 10% of road transport fuel to come from renewable sources by 2020, making this an urgent challenge.

90% of the world's biofuel production is currently bioethanol. Made largely from sugar cane and maize, it is used as a petrol additive. The remaining 10% of biofuel comes from plant oils such as rapeseed, soya and palm and is turned into biodiesel. These “first generation”



biofuels or agri-fuels are a long way from meeting the world's need for energy security and reductions in CO_2 emissions, and their cultivation raises environmental and food security concerns.

The oceans cover more than 70% of the world's surface and their extensive coastal regions are more efficient for growing biomass than the land. The marine environment therefore offers the planet's largest area for mass cultivation of biomass and opportunities are already being realised in countries like China.

BioMara Research So Far

Macroalgae

Seaweed cultivation and harvest is an established process in Scotland. Macroalgal spores are collected, seeded onto strings where they germinate into tiny plants, then transferred to sea to be harvested after six to eight months. Mature macroalgae can be used to generate methane via anaerobic digestion (AD) or to produce ethanol by fermentation. Seaweed for both AD and fermentation is harvested in spring and early summer, physic-chemically characterised, processed and stored for future trials. To examine the potential geographical variation in chemical composition of the seaweeds, the plants are collected around Scotland and Ireland.

Anaerobic digestion and fermentation

One of the biggest stumbling blocks for the commercialization of the seaweed to biogas process is the resistance of the algal cell wall to hydrolysis. Pre-treatment of algal biomass to enhance its biodigestibility is key, so the efficiency of various pre-treatments is being assessed by monitoring the release of biomolecules from the algal biomass. The most suitable pre-treatments are selected for anaerobic digestion trials. Investigations include the use of environmentally friendly pre-treatment.

In the area of bioethanol, initial work is focusing on the breakdown of seaweed by bacteria, producing simple sugars which can then be fermented to ethanol.

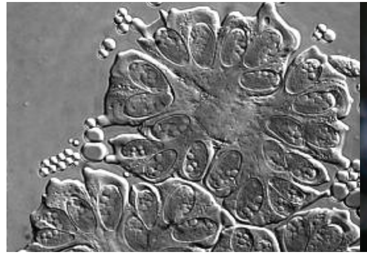
Techno-economics

Development of an Anaerobic Digestion Techno-Economic Model is underway and this will be validated and the effect of homogenising the feed stock examined. Although the macroalgae to gasification route is also promising, high ash content of macroalgae is one of the major disadvantages associated with this technology. Ash chemistry restricts the use of macroalgae for direct combustion and gasification and reduces the calorific value of the feedstock.

Microalgae

Wild strains of microalgae characterised by high oil content and high stress resistance are being screened to identify those capable of sustained growth in outdoor conditions. Initially these will be grown on a small scale in enclosed systems.

200 strains have been selected based on their potential to produce fatty acids required for biodiesel production. Differences in oil content have been found between strains and gas chromatography is carried out to identify the oils present. Gene probe development will help develop tests to confirm when an organism is switching to oil production mode. The effects of varying nutrient and temperature levels on oil content and growth rates are also being tested.



Socio-economics

Multi-sectoral economic models have been developed for each of the geographic regions forming the focus of our study, probing the potential impacts of biofuels from marine algae in these areas. A model of the Scottish Western Isles examines the potential economic impacts of macroalgae production, and is being expanded to examine alternative impacts from different uses of macroalgae, and alternative scales of macroalgae production in the area. The supply chain for biofuels production and algae will be an important factor for the wider economic impacts, and work has begun to identify the key areas for the regional economies in securing economic developments from macroalgae production.