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Report on the state of algae related research and industrial activities in Ireland

Report WP2A9.07



Energetic Algae ('EnAlgae')

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1 Introduction

In 2012-2014 an inventory of North-West European algae initiatives was carried out to provide an impression of research and commercial activities connected to algae production and utilization. The collected data has been reviewed in country specific reports and collated and summarised in an overview report covering the whole North-West-Europe region (including Ireland, Great Britain, Germany Belgium, France, Switzerland, Luxemburg and the Netherlands).

Data was obtained via a comprehensive questionnaire distributed among stakeholders identified in a preliminary scoping exercise. Although not unexpected, not all questionnaires were returned. In these cases, publically available information was used for the landscaping study and some additional information was collected through personal interviews with the respective stakeholders. The questionnaire aimed to gather more information on focus, expertise and applied technology of the addressed institutions. It was also designed in a way that allows its use as an information sheet in EnAlgae's web-based information portal.

This report summarises the results of the analysis of data collected for Ireland, where 21% of the sent-out questionnaires were returned by the stakeholders.

In this context it must be emphasized that this report cannot claim to reflect an exhaustive list of all stakeholders active in algae research and business. The reasons behind this are that it is a rather broad area and in some cases only very limited information is available about respective activities. In addition, there is lots of movement in this sector with regard to new start-ups and the closing down of business operations, making it difficult to give an up-to-date overview. If too little information could be found about certain institutions they were not included in this survey.

However, this study nevertheless represents the most important institutions active in this area, allowing conclusions to be drawn about the main fields of interests, technology and market opportunities for algal research in Ireland.

2 Irish stakeholders

In total 11 institutions working with algae could be identified in Ireland. The majority of these stakeholders (91%) are research institutes and the remaining 9% industrial organisations. The following table (Table 1) gives an overview about the identified stakeholders.

The following pages present the results of survey results for Irish research institutions and major industrial organizations.

Table 1: Overview of Irish stakeholders active in the broader algae area.

Research institutions	
Irish seaweed group, The Ryan Institute, National University of Ireland, Galway	Expertise includes cultivation of native brown kelps, and red and green seaweed, Multi-Trophic Aquaculture (IMTA), seaweed ingredients and as food and feed products, sustainability aspects of harvesting (and use of) macroalgae for the production of 2nd generation biofuels.
University College Dublin	Expertise includes harvesting and processing of microalgae via pyrolysis, use of microalgae as soil fertilizer, integration of microalgae production with flue gas and wastewater bioremediation, LCA analysis and environment modelling for microalgae systems, bioprospecting of seaweed, use of seaweed oligosaccharides for sow and piglets gut microflora.
University of Limerick	Expertise includes microalgae and cyanobacteria cultivation in brackish and fresh water, metabolic engineering and protein engineering of converting enzymes of cells, ethanol fermentation, downstream processing, upscaling of technologies to pilot.
Daithi O'Mhurchu Marine Research Station, Cork/ Indigo Rock.	Expertise includes microalgae cultivation in plastic bags and tubular bioreactors, reactor design, macroalgae cultivation in hatchery and in long lines, fermentation of macroalgae and production of biopolymers and fish feed, LCA and environmental modelling for macroalgae cultivation, taxonomy studies for both macro and micro algae.
Teagasc	Expertise includes cultivation of macroalgae, production of nutraceuticals, food, and feed, biotic and abiotic interactions of seaweed, thermal extraction of ingredients.
Marine Institute	Expertise includes marine Harmful Algal Blooms (HABs), biotic and abiotic interaction of algal blooms (micro and macro), diseases and toxicology, wastewater open ponds, interaction of algal and bacterial biomasses.
Sustainable energy research group - University college cork	Expertise includes macroalgal cultivation, processing technologies for production of biopolymers and edible/biodegradable films/coatings, and food ingredients.
Dundalk Institute of Technology	Expertise includes Production of ethanol and biogas from seaweed, extraction of oils and biogas production from microalgae.

Institute of Technology Sligo	Expertise includes developing and scaling up of processes in the areas of AD and fermentation technologies for micro and macro algae, use of wastewater for production of seaweed, toxicology and algal competition, advanced pre-treatment and co-digestion technologies for biogas production.
Waterford Institute of Technology	Expertise includes mining of seaweeds for pharmaceutical activity, bioactives for feed, remediation of heavy metal and chemical contamination.
Industrial Organisations	
Arramara Teoranta	Expertise includes process and product development of plant hormones, soil enrichers from macroalgae, vitamin and trace elements source, protein, polysaccharides for feed and fish feed.
Consortiums, Networks & Multi partner projects	
Biomara	<p>The Sustainable Fuels from Marine Biomass project, BioMara, was a joint UK and Irish project that aimed to demonstrate the feasibility and viability of producing third generation biofuels from marine biomass.</p> <p>Project partners: Scottish Association for Marine Science (SAMS), Centre for Renewable Energy at Dundalk Institute of Technology, Fraser of Allander Institute at University of Strathclyde, University of Ulster, Institute of Technology Sligo, Queens University Belfast.</p>
Technology Centre for Biorefining and Bioenergy	<p>The TCBB is established and led by Irish industry, and initially funded by Enterprise Ireland and the IDA Ireland.</p> <p>The centres to demonstrate and demonstrate technologies relevant to 2G feedstocks, such as algae to bioenergy and biorefinery applications. Also, centre is developing processing technologies via biological and thermochemical pathways for production of energy and other products.</p> <p>The Centre is co-hosted by 3 Irish universities, NUI Galway, University of Limerick, and University College Dublin. The Centre engages with other Irish Universities such as Trinity College Dublin, to enable it to expand its expertise and resources to serve the greatest possible audience.</p>
DEMA	The Direct ethanol from microalgae, DEMO, is an EU Framework project that aimed at use of cyanobacteria for direct ethanol production via metabolic engineering for biofuel application. Project partners: Imperial College London, University of Amsterdam, A4F Portugal, University of Cambridge, Pervatech, The Netherlands.
IDREEM	<p>The €5.7 million project is coordinated by the Scottish Association for Marine Science (SAMS) and delivered in collaboration with fourteen industrial and research partners from across Europe.</p> <p>The project demonstrates the benefits of IMTA through pilot commercial-scale testing, field research and modelling. Interdisciplinary research within IDREEM will examine the obstacles and risks to the use of IMTA systems and develop tools to overcome these constraints, whether they are economic, environmental, technical, social or regulatory.</p> <p>Project partners: Scottish Association for Marine Science (SAMS), Daithi O'Murchu Marine Research Station, Loch Fyne Oysters, Viking Fish Farm, Norwegian Institute for Agricultural and Environmental Research, Scottish Salmon Company, Longline Environment Ltd, University of Haifa, Suf Fish Mariculture Ltd, GIFAS Ltd, Seawave Fisheries Ltd, Marine & Environmental Research Lab Ltd, Aqua Soc. Agr. s.r.l., Università degli Studi di Genova, Universiteit Leiden, ETA-Florence Renewable Energies.</p>

SEABIOPLAS	<p>Seabioplas proposes the use of seaweeds to produce bioplastics. PolyLactic Acid (PLA) is a bio-based, biodegradable polymer which, along with other biopolymers, is demonstrating impressive growth rates. The seaweed fermentation procedures for lactic acid production will generate seaweed residues. These by-products have potential market value in the animal feed sector. The scientific approach comprises a technical phase followed by the validation and dissemination phases.</p> <p>Project partners: Daithi O'Murchu Marine Research Station, Algaplus Producao e Comercializacao De Algas e Seus Derivados LDA, Stichting Dienst Landbouwkundig Onderzoek, Centro Interdisciplinar de Investigaçao Marinha e Ambiental, Instituto de Ciências e Tecnologias Agrárias e Agro-Alimentares, Centre d'Etude et de Valorisation des Algues (CEVA), Herfst en Helder bv, Nordbiochem Ou, Sleever Technologies, Agrolabo S.p.A., Cartron Point Shellfish.</p>
ACCLIPHOT	<p>AccliPhot is a Marie Curie Initial Training Network funded by the European Commission. The main research aim of AccliPhot is to investigate and understand short-term acclimation mechanisms to changes in light conditions in photosynthetic organisms. Our aim is to employ this understanding to optimise and upscale biotechnological exploitation of photosynthetic microalgae for the production of biofuels and high-value commodities.</p> <p>Project partners: Heinrich Heine University Düsseldorf, Università degli Studi di Verona, Université de Genève, Centre national de la recherche scientifique (CNRS). Université Pierre et Marie Curie, Martin Luther Universität Halle-Wittenberg, Eidgenössische Technische Hochschule (ETH) Zürich, Switzerland, Oxford Brookes University, Daithi O'Murchu Marine Research Station (DOMMRS), University of Nantes, Fermentalg.</p>
NutraMara	<p>NutraMara aims to explore natural marine bioresources for novel bioactive substances with the potential to be used as ingredients in functional foods. Marine natural bioresources include a diversity of under-explored and under-exploited materials derived from macroalgal and microalgal sources as well as marine byproducts such as fish skins and viscera, shellfish waste and crab/prawn shells.</p> <p>Project partners: Teagasc Food Research Center, NUI Galway, Univeristy College Dublin, Univeristy College Cork, Univeristy of Limerick, Univeristy of Ulster.</p>

3 Types of algae

The majority of research institutions are working with both micro and macroalgae (67%), with a minority working solely with macroalgae (22%) and the remainder working with micro algae.

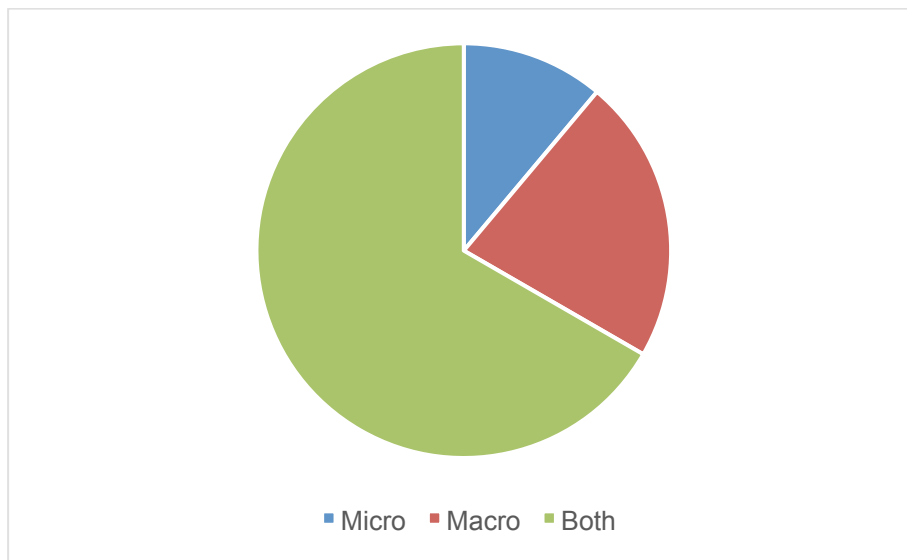


Figure 1: Broad types of algae utilized by Ireland's algae stakeholders.

A small number of respondents provided details of the precise algae species they are working with, those identified are listed in Table 2.

Table 2: Types of algae listed in survey results.

<i>Laminaria digitata</i>	<i>Cyanobacteria Synechocystis</i>
<i>L. hyperborea</i>	<i>Palmaria palmata</i>
<i>Saccharina latissima</i>	<i>Tetraselmis suecica</i>
<i>Saccorhiza polyschides</i>	<i>Isochrysis galbana</i>
<i>Alaria esculenta</i>	<i>Chaetocerus muelleri</i>
<i>Phaeodactylum tricornutum</i>	<i>Isochrysis galbana</i>
<i>Tetraselmis suecica</i>	<i>Chaetocerus muelleri</i>

4 Cultivation facilities

Very few responders provided details of the facilities they used. Tubular photobioreactors are the most common system for cultivating microalgae in Ireland, followed by plastics bags. For macroalgae 2 institutes are engaged with cultivation in longlines. Little information was provided on the scale of cultivation facilities, the largest reported scale was 50m³.



Figure 2: The cultivation facilities used by Irish research institutions: number of institutions.

5 Growth conditions

Many of the responders provided no details of the growth conditions, neither the water or light sources used. The results of those that did are illustrated below in Figure 3. From the responses, the majority used salt water to cultivate algae, some used fresh, but also 1 respondent is doing research with wastewater.

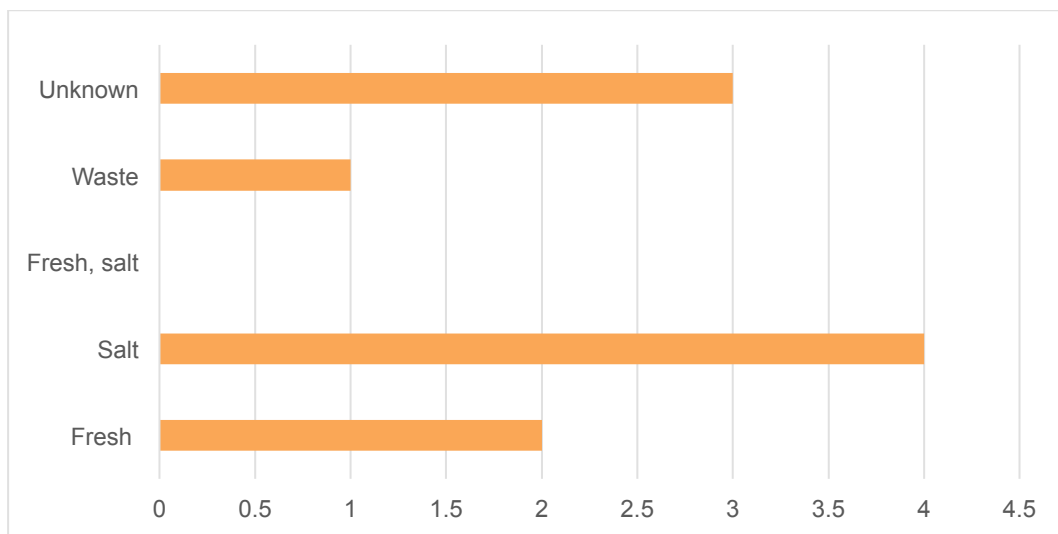


Figure 3: Number of research institutions employing each water source.

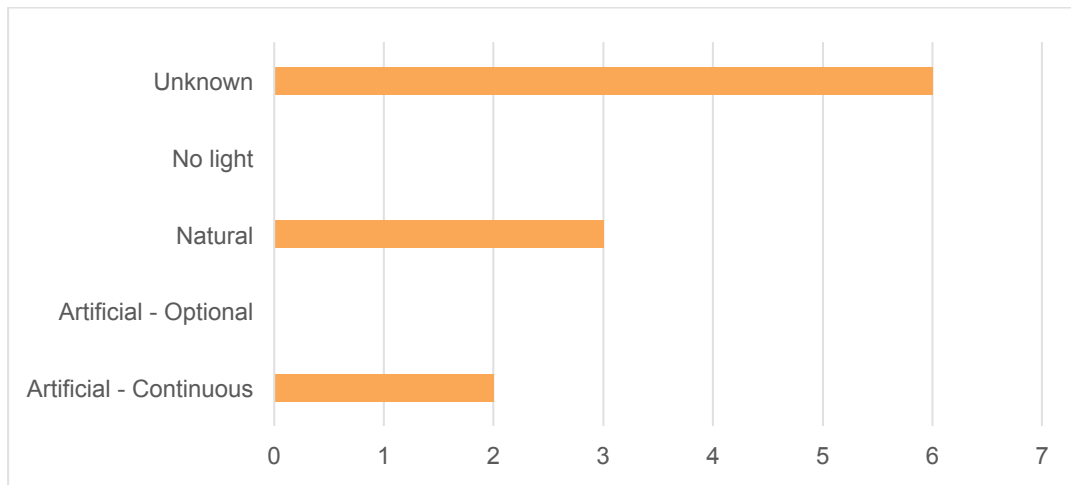


Figure 4: Number of research institutes employing each light source.

6 Markets

There is a spread market interest for research in bioenergy, bioremediation, and food and feed products. Also, there many institutions that are interested in commodity and speciality products (Figure 5).

For macroalgae the research interest is mainly on development of nutraceutical, but also production of food and feed, also bioremediation of wastewater. Production of biogas, and commodity products are also high on the list (Figure 6).

For microalgae major product development is research on production of oils (15 respondents), but also biogas and biodiesel production and other speciality products are of research interest. Also with microalgae bioremediation is combined. Finally some of the respondents (6) have been development reactor and other technology developments for growing microalgae as well as product recovery (Figure 7).

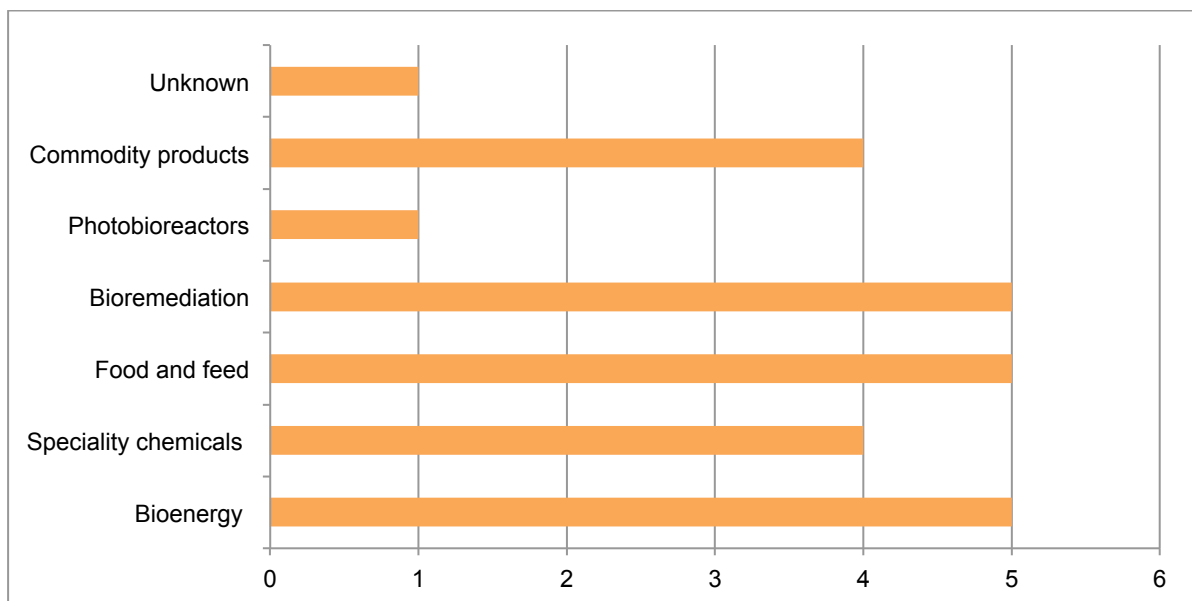


Figure 5: Target markets for research institutions using algae in Ireland (multiple answers permitted).

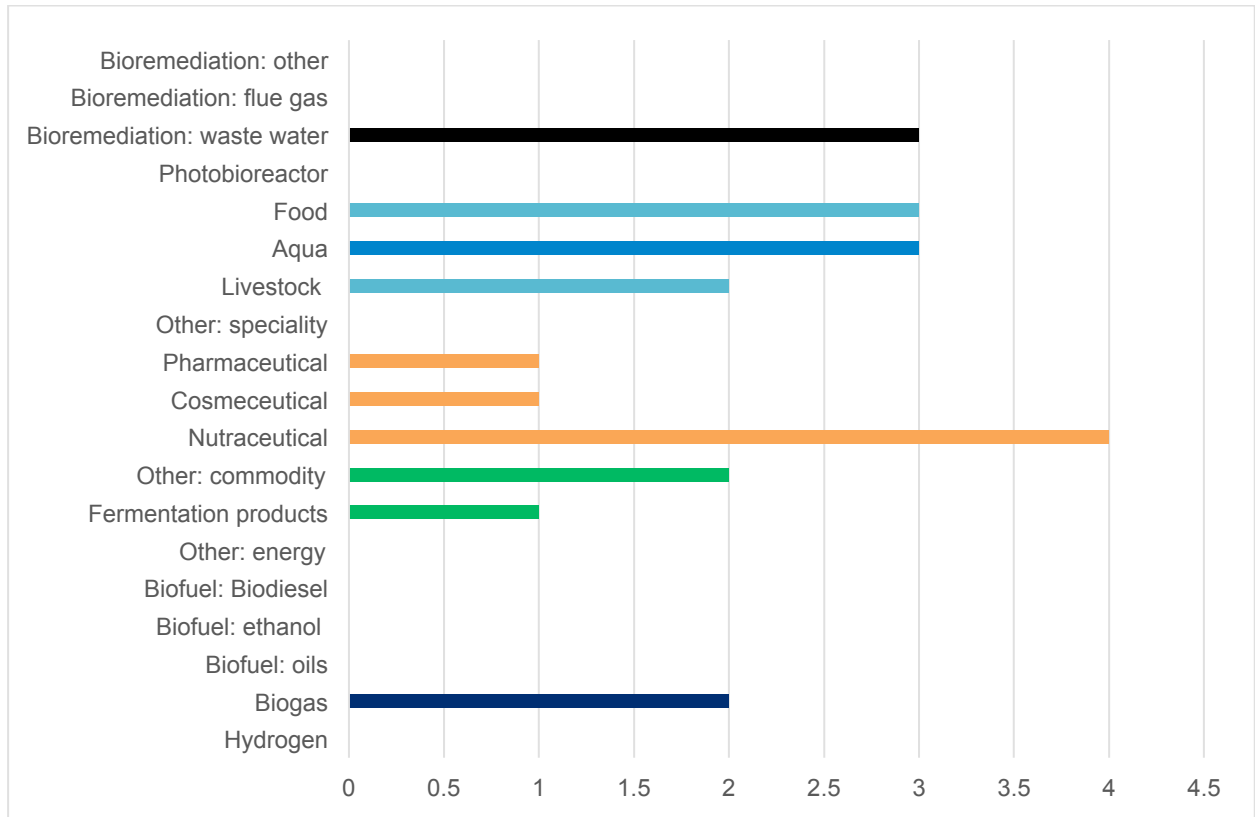


Figure 6: Target market products for research institutions using macroalgae in Ireland.

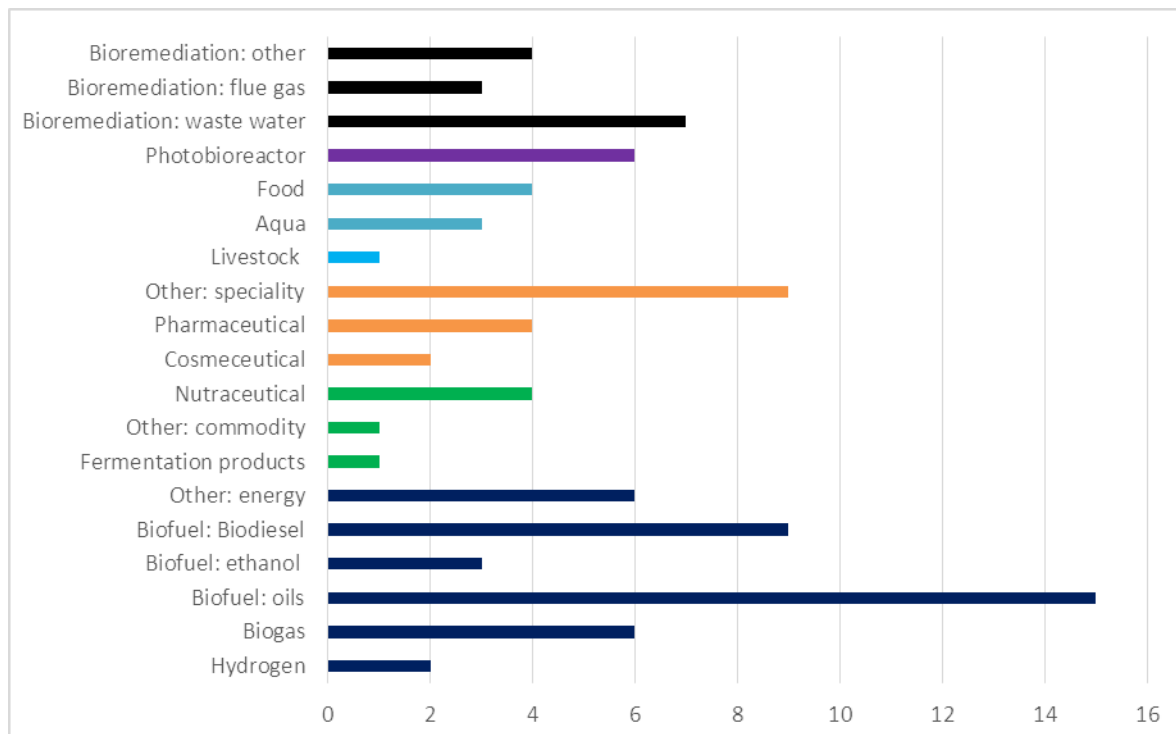


Figure 7: Target market products for research institutions using microalgae in Ireland.

7 Research

The focus of research carried out in Irish research organizations includes biotic and abiotic interactions, disease, modelling and life cycle analysis (Figure 8). However, unfortunately no information was supplied by a large number of surveyed parties.

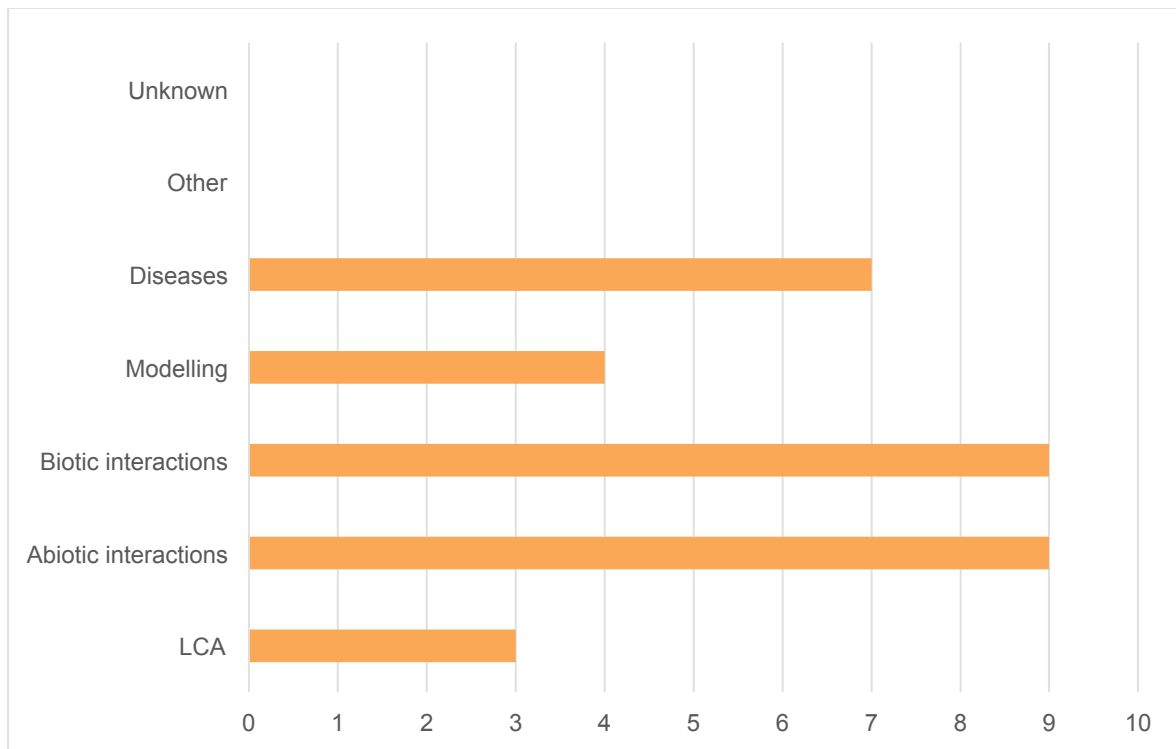


Figure 8: The algae research interests of Irish research institutions: number of universities.

8 Underpinning activities

A large number of surveyed parties did not provide detail of the underpinning technologies relating to their research in algae. However 9 research institutions had underpinning expertise processing technology, 5 institutions in culture collection, 4 in bioprospecting, and few others practice research in taxonomy and harvesting technologies (Figure 9).

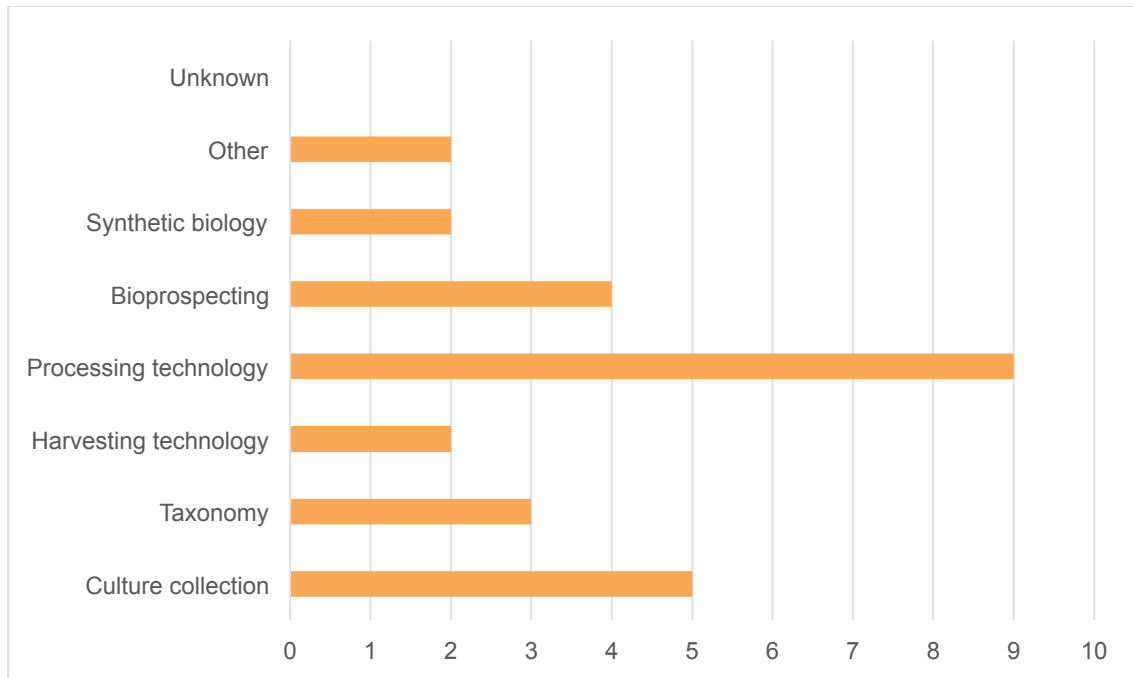
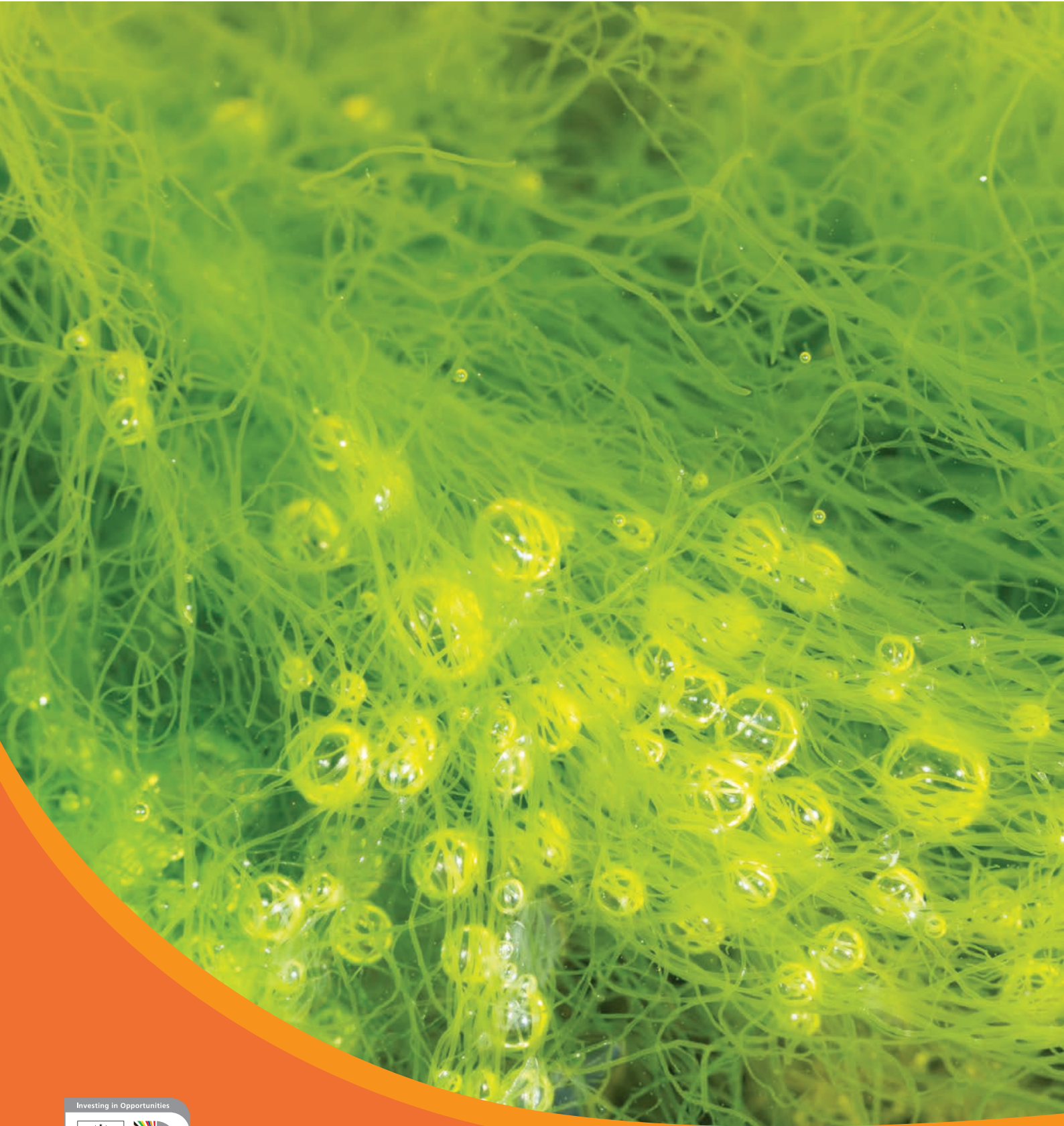


Figure 9: Number of Irish research institution involved in various algae related activities.



EnAlgae is a four-year Strategic Initiative of the INTERREG IVB North West Europe programme. It brings together 19 partners and 14 observers across 7 EU Member States with the aim of developing sustainable technologies for algal biomass production.

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This report has been produced by Swansea University, lead partner of the EnAlgae project.
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