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Executive Summary

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Investing in Opportunities

This project has received European Regional Development Funding through INTERREG IV B.

INTERREG IVB

Objectives

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1. to develop a network of pilot and demonstration sites and identify strategic factors for optimising the algae cultivation environment;
2. to undertake technical and economic feasibility analyses to determine if algae exploitation can provide added value to NW Europe;
3. to perform system analyses to identify political, economic, social & technological opportunities and barriers for producing energy from algae.

Outputs ....

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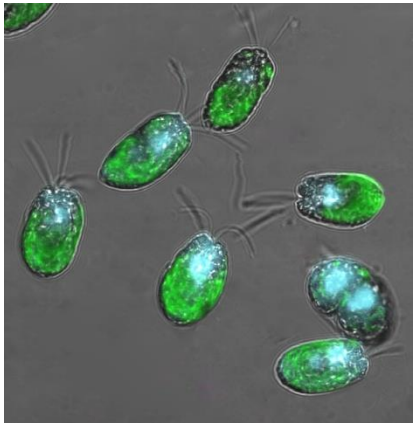
Standard Operating Procedures

- SOPs for the analysis of microalgal biomass – *well documented and detailed*
- SOPs for mass production of macroalgae – *far less mature, and clearly warrant further investment if they are to mirror the microalgae skill sets*



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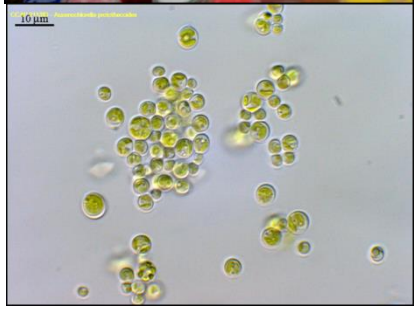
Environmental parameters
Temperature
pH
Salinity
Light (PFD/PAR)
Dissolved chemicals
Ammonia & Ammonium (NH3 NH4+)
Nitrate (NO3-)
Nitrite (NO2)
Total dissolved N
Soluble Reactive Phosphate (SRP; PO43-)
Total dissolved P
Silicon (Si)
Total dissolved inorganic and organic Carbon
Dissolved Oxygen
Biological Oxygen Debt (BOD)
Chemical Oxygen Debt (COD)
Iron (Fe)
Growth Parameters in Microalgal Culture
Biomass Weight (AFDW/DW/VSS/ TSS)
Absorbance (optical density, OD)
Cell count and biovolume
Chlorophyll & photosynthetic efficiency
Cellular composition
Proteins
Carbohydrates
Lipids
Chlorophyll a
Carotenoids
Elemental content (C,N,P)
Fatty Acids (FAME)
Heavy metals (B,Cu,Fe,Mn,Zn,Al,Ca,K, Mg)
Biogas outputs
Biochemical methane potential
Biogas analyses (CH4, CO2)
Biogas collection

Best practice for algal strain maintenance



- Vital resource and skill set for any commercial exploitation as each strain has its own unique physiology and potential
- Developed, trained and reported methods for maintaining strains of microalgae
- *There is a notable lack of coverage for macroalgae in this sector*

Best Practice dissemination for mass production of microalgae

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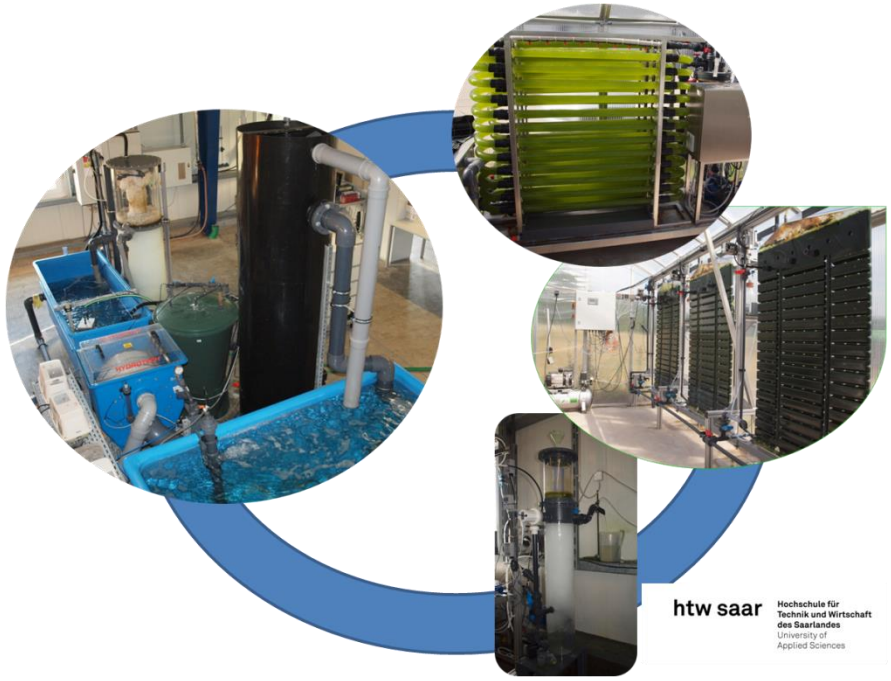
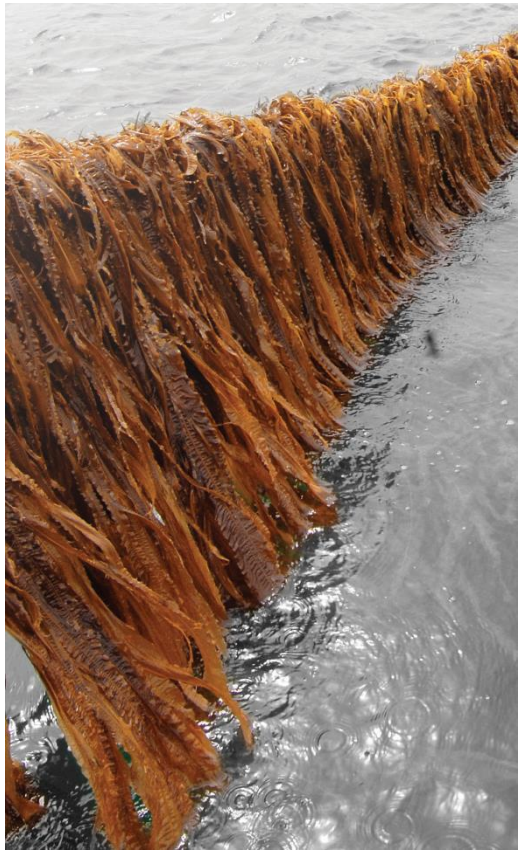
- Video Q&A
- Best Practice Report, on microalgae cultivation at pilot operation scale.
- Different nutrient streams
- Different systems (ponds, PBRs)
- Simple platforms through to ...
- fully integrated systems using nutrients from marine fish production, with microalgae for sustainable food **and** biomass production



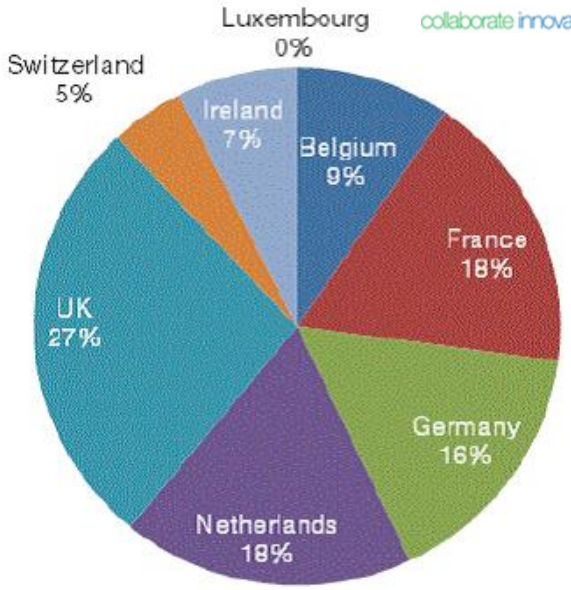
Best Practice dissemination for mass production of macroalgae



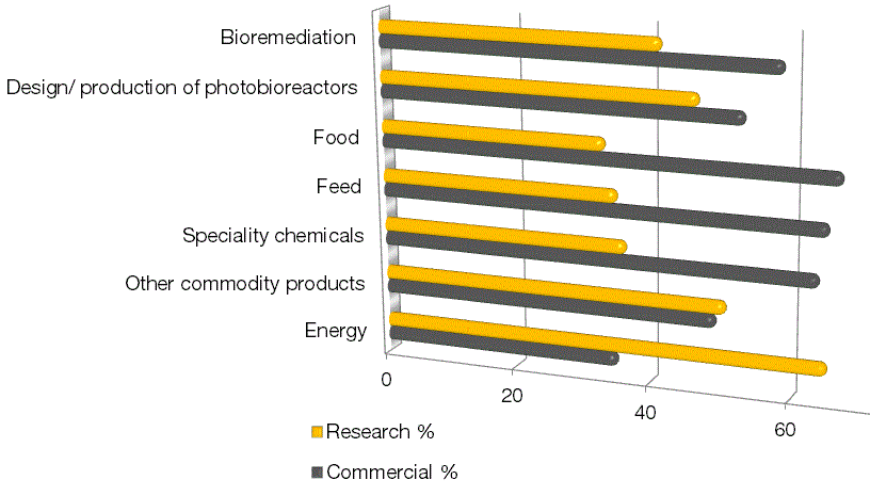
- standardised sampling and cultivation practices
- reflects the various individual ways macroalgal production is achieved at different geographic locations
- *noteworthy is the sharp contrast with microalgal approaches, which involve hitech designed systems*

Identifying Academic and Industrial Stakeholders

- Identification of 283 scientific and commercial algae stakeholders in a NW-European landscaping study
- Data served as basis for an interactive database profiling academic and industrial stakeholders
- Country reports summarise the findings and provide information on national funding options for algae related R&D activities

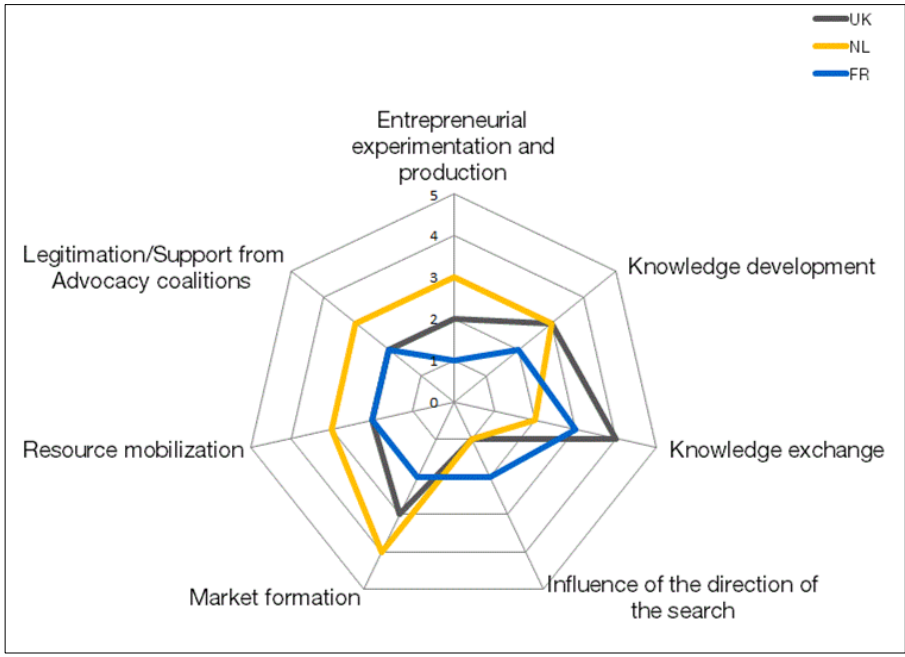


Distribution of algae stakeholders in NW-Europe



Removing barriers; optimising policies

- Landscaping strategies, and economic incentives schemes for NW European versus algae policies outside this region
- Developed recommendations to remove barriers to exploitation ...
- (Re)-prioritise funding R&D for handling, biorefining (etc) algae away from energy products to non-energy products
- Clarify status of algae-from-waste and their downstream products



Factors influencing development of algal production technologies in 3 case-studies:
1= development barrier;
5= development driver

- Noteworthy that Biofuel regulation harmonised in NW Europe, but food/feed differs

Sustainability Assessment of Algal Exploitation

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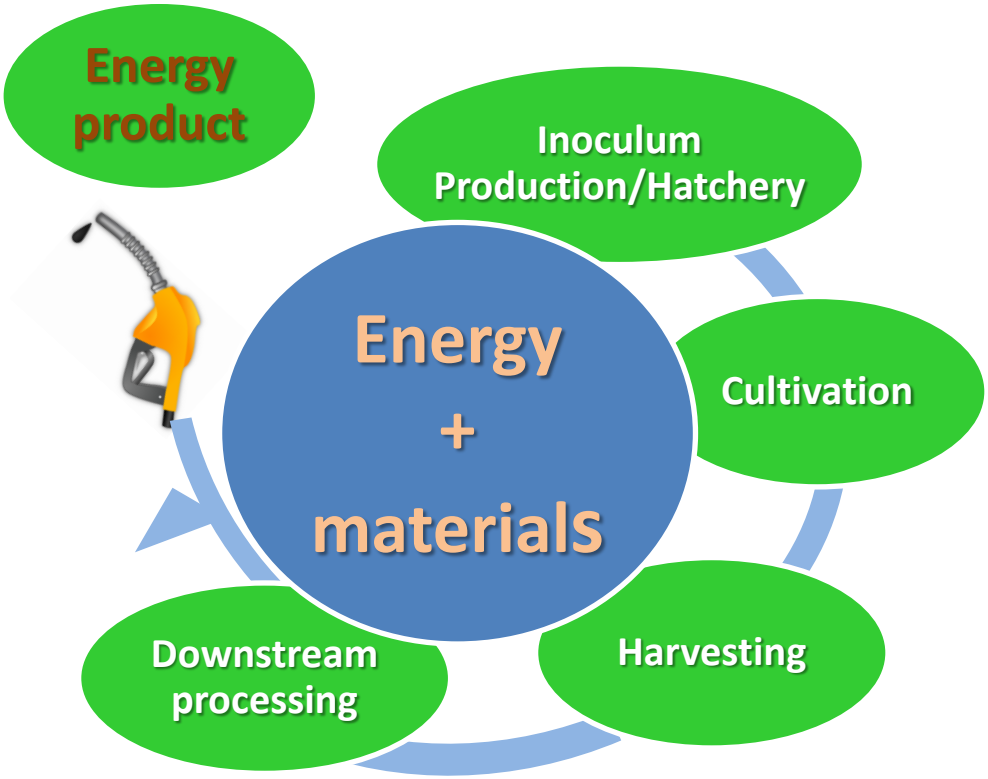
<u>Quantitative</u> Approach: environmental Life-cycle Assessment (LCA)
→ for energy consumption



<u>Qualitative</u> Approach: Perceptions assessed in two Stakeholder Workshops (Frankfurt + London)

Decision Support Toolset for microalgal growth

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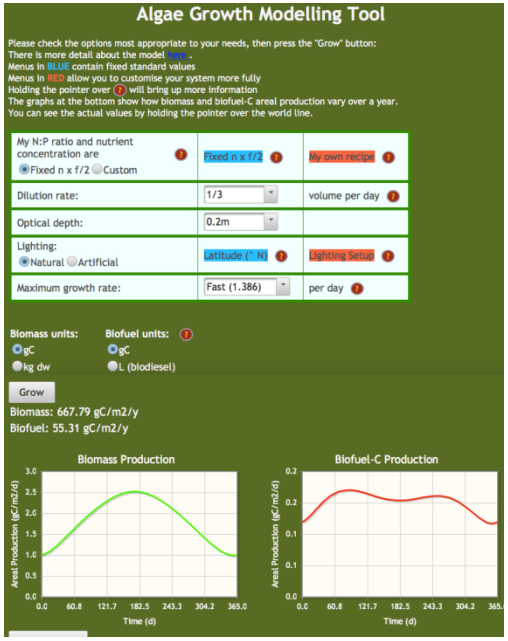
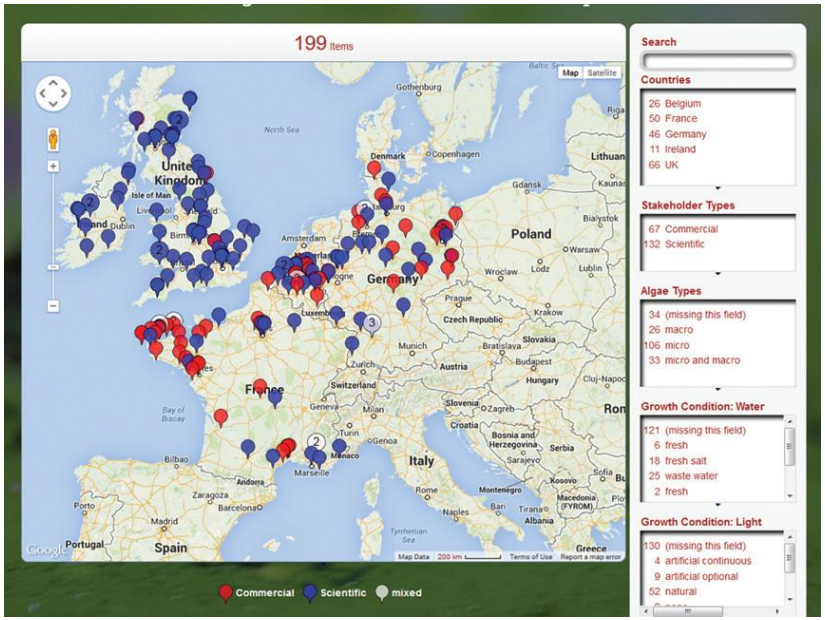
- To aid commercial sector
- Economic dashboards
- Stakeholder map
- 3D visualisation tool for virtual algae platform
- Growth modelling tool
- GIS tool locating potential algae cultivation sites





Legacy and Added Value

- Algal Information Network (AIN)
- Regional Algae Support Centres (ASCs)
- *Decision Support Toolset*
- *Algae Sector Open Database*
- *International and national projects dissemination*
- *Expert network and training*

and finally ....

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Is there a significant future exploiting "energetic algae" for energy?

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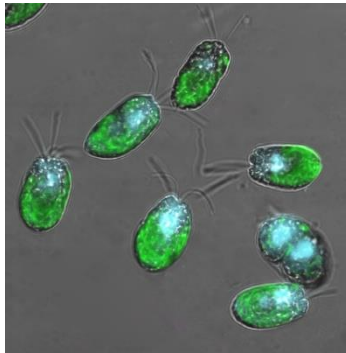
- Our projects indicate that this is unlikely
- Productivity rates (Kg/hectare/yr) are too low
- Demands for space and nutrients are too high
- The net value of the product (biofuel) is too low compared with extracted fossil fuels
- The value of the product is too high to justify burning it rather than exploiting its nutraceutical potential



EU Algal Biofuels Potential

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For algal biofuels to replace just 10% of the 350 billion L/yr of EU demand needs ..

- 10 million hectares (= 3 x Belgium; =6% EU agriculture land; =20 x EU brownfield area)
- 5 million tonnes N fertilizer /yr
- 0.5 millions tonnes P fertilizer /yr (=50% of that used for EU agriculture)

BUT .....

- A future for algal biotechnologies is most certainly there,
- and the technologies, approaches and policies developed by Enalgae have a clear value for Europe, notably for food security and allied spheres

Algal exploitation is certainly set to have an energetic future in Europe

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EnAlgae is a Strategic Initiative of the INTERREG IVB NWE Programme

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