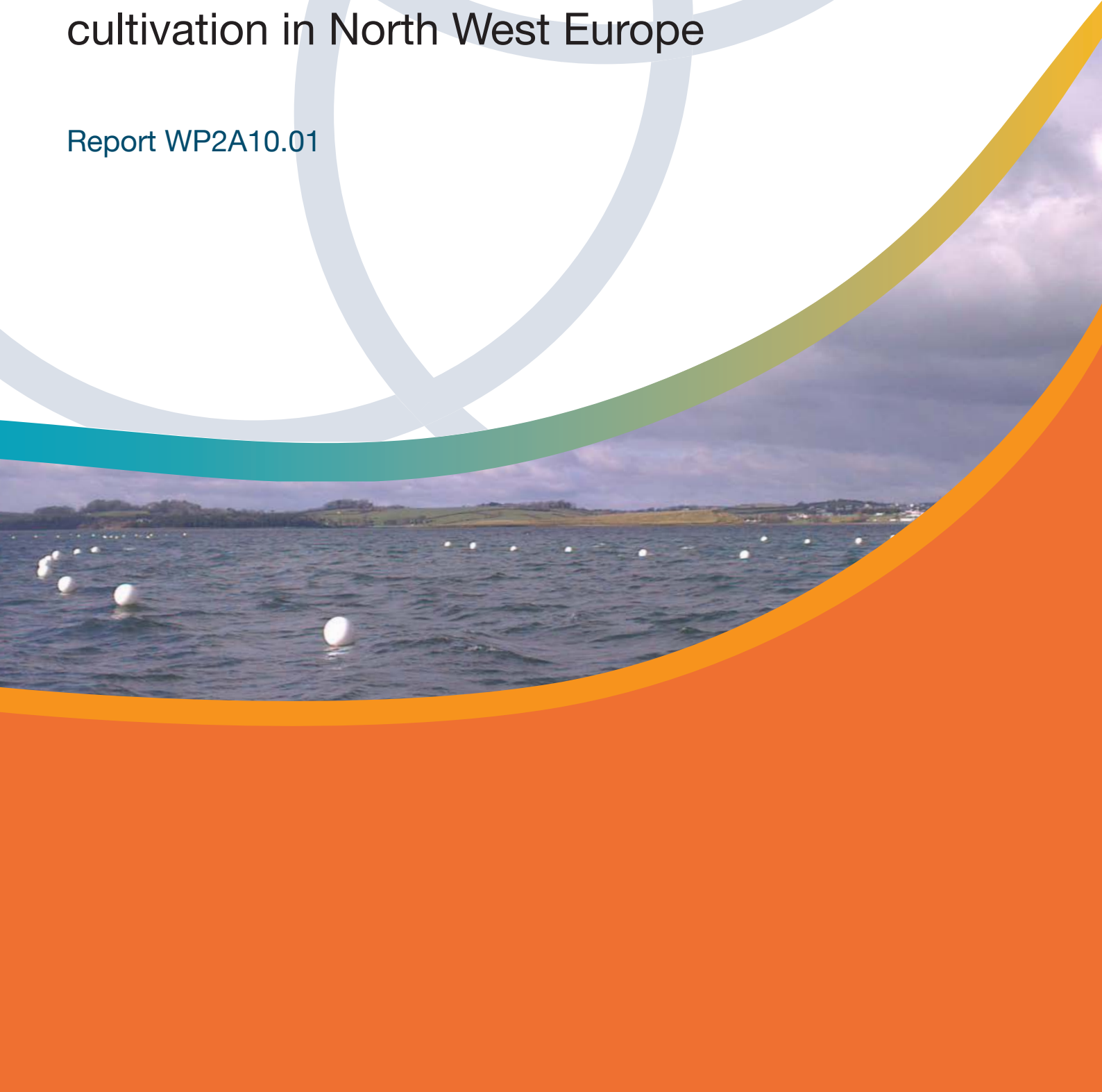


Regulations and Permitting concerning algal cultivation in North West Europe

Report WP2A10.01



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Regulations and Permitting concerning algal cultivation in North West Europe

1 Introduction and Aims

Currently only a small number of cultivation sites for micro- or macroalgae exist in North-West Europe. Environmental permits, planning and regulatory issues for those have been dealt with by the authorities responsible on a per-case basis in accordance with the requirements in their national legislation. This approach is likely to lead to considerable differences in requirements imposed on similar growth facilities not only between, but also within different EU member states. In addition, the de-novo approach prolongs the procedure of obtaining permits. Both constitute barriers to the more widespread adoption of algal production systems and/or “farms”.

Aims

This report fulfils WP2, Action 10, of the EnAlgae project to

1. Review the current landscape of environmental and planning permits as well as regulatory issues for the cultivation of both micro- and macroalgae in NW Europe (including genetic modification).
2. Provide an assessment of the strengths, weaknesses, opportunities and threats to algal production within this regulatory context.
3. Make the review's findings available to those interested in developing algal growth facilities, both through the decision support tool (WP 3), and through fact sheets ('how to-guide') and case studies.
4. Discuss findings with policy makers, planning and environmental authorities and regulators to seek opportunities to improve permitting processes as much as possible across NW Europe.
5. **Provide policy recommendations** with a particular emphasis placed on identifying lessons for both the EU and national governments for stimulating the development of micro and macro algal industries and whether an EU strategy is required for algal production to harmonise regulatory responses currently in place.

Scope

The following report outlines the regulatory frameworks of several European countries with regard to:

- Algal production processes
- Land use planning systems
- Constraints on end use of products*

*Although EnAlgae focuses on energy generation, short and medium term successful commercialisation of algae requires at least partial use of the biomass for markets such as feed, food and chemicals or as an ecosystem service. Regulations are reviewed with respect to this broader spectrum of end products.

2 Microalgae Permitting

2.1 Environmental Permitting in different European states

This section provides an overview of the permitting situation in the UK (England and Wales), The Netherlands, Ireland, Germany, France, Flanders/Belgium and Switzerland¹.

Although the licensing of emissions from industrial installations has a long history in countries such as the UK and France (OECD 1999), the context to environmental permitting in North-West European states is currently informed by European Union (EU) legislation. The primary legal instrument in this respect is the Integrated Pollution and Prevention Control Directive (IPPC) 2008 that mandates environmental permitting for multiple industrial sectors and emissions to air, water and land. Operators must also mitigate emissions by employing Best Available Techniques (BAT) solutions, implemented through the use of BREFs (BAT Reference guidance documents). Other significant EU measures for permitting include the Waste Framework Directive.

From 2013 onwards, the IPPC Directive will be replaced by the Industrial Emissions Directive (IED) which also incorporates the Large Combustion Plant, Waste Incineration, Titanium Dioxide and Solvent Emissions Directives. Although EU legislation provides a relatively harmonized framework for permitting, implementation of measures still varies between countries. These differences have implications for algal industrial processes. However, few up to date published studies exist on the implementation of industrial permitting in Europe - a comparative national analysis of the implications of permitting for the bioenergy industry generally was last completed in 2009 (European Parliament 2009). The following section provides an overview of current practice in different states by examining: national permitting regulations; permitting agencies; and, permit types and application procedures. Implications for algal production are then discussed.

2.2 Permitting in England and Wales

Industrial permitting was originally a British concept. Acting in response to the emergence of highly polluting alkali chemical industries, the British government established the Alkali Inspectorate in 1863 to help control the noxious fumes produced by these processes (Bell and McGillivray 2000). However, while the system of industrial permitting implemented by the Inspectorate helped reduce alkali fumes, it failed to limit other emissions such as smoke. A contradictory situation then evolved over the next century whereby local authorities became responsible for controlling industrial smoke emissions while the Inspectorate managed alkali pollution, and other bodies controlled health and safety and water pollution. An increasing demand emerged for a more joined-up approach in the 1970s, finally resulting in the creation of Her Majesty's Inspectorate of Pollution in 1987. This institutional change, which merged industrial control functions within one organisation, paved the way for the introduction of integrated pollution control (IPC) in the Environmental Protection Act in 1990. The concept was then adopted by the EU in developing the IPPC Directive in the late 1990s to provide some coherence to permitting between countries.

¹ Although not part of the European Union, Switzerland is a member of the European Free Trade Area (EFTA). As such, Switzerland is gradually aligning its legislation with some EU directives.

Current permitting in the UK is determined by slightly different regulations in England/Wales, Scotland and Northern Ireland. In the former context, the regulatory framework is determined by the **Environmental Permitting (England and Wales) Regulations (EPR) 2010** SI2010 No. 675, as amended. Known more commonly as the Environmental Permitting Regime, or **EPR** for short, the regulations oblige industrial operators to acquire a permit for certain specified activities or register an exemption from permitting. These activities are identified in Schedules to the regulations that also place specific requirements on operators. Several of the Schedules relate directly to EU Directives, most significantly the IPPC, Waste Framework and Landfill Directives. Others address water discharges, groundwater and radioactive substances. Where an industrial facility engages in an activity covered by one or more Schedules, it must comply with relevant requirements, stipulated in a permit. The regulations are implemented primarily by the Environment Agency², but also local authorities³, in England and Wales. Slightly different procedures exist in the devolved administrations of Scotland and Northern Ireland and are not described in detail here.

Several types of industrial activities are regulated under the regime through different permitting options. Schedule 1 of the Regulations lists seven classes of industrial installations covered by permitting, including installations (with activities listed in Schedule 1 of the EPR), mobile plant, waste operations, mining waste operations, radioactive substances activity, water discharge activity and groundwater activity. Operators of a regulated installation must apply for an environmental permit. Only the operator can be issued with the permit.

In general, there are three permitting options:

1. **Standard Permits** contain a set of fixed rules governing certain activities. If a facility complies with the standard scenarios then a permit can be issued by the EA. These permits have fixed charges.
2. **Bespoke Permits** are applicable where facilities do not meet standard requirements but need permitting. In these cases, a bespoke permit will have to be issued. As such permits must be written specially for the facility they can be more expensive than standard permits and require a higher investment in time and effort from the operator in supplying the requisite information to the EA.
3. **Permit Waiver or exemption.** It is a near no-cost option, but relies on local EA agreement for a waiver based on information supplied to the EA head office. This option also involves less on-going involvement for the EA in terms of audit, reporting, etc. but facilities must still be registered with the Agency.

R&D facilities are not required to have a permit (i.e. a permit waiver applies) unless waste is involved: the facility is then classed as an R&D waste operation. A time limited position statement can be issued for a R&D process that otherwise would require permitting, although these are usually only valid for a year, must involve genuine research activities and conform to certain specified criteria.

An application can only be made by the operator of the installation. Applications must contain certain information, specified on an official application form, in order to be considered. The issuing authority then assesses the application in consultation with the public. In granting the permit, the regulator considers several factors in the 'determination' process. One is whether the installation meets relevant environmental protection standards and whether the operator is capable of achieving the conditions stipulated in the permit, i.e. is 'competent'. Considerations here include the operator's past history of compliance with environmental permits, and whether they are technically and financially equipped to manage the installation to the specified requirements. In this respect, the regulator can attach conditions to the permit which must be met in full.

² The EA regulates so-called Part A(1) installations and mobile plant, in addition to waste operations.

³ Local authorities have responsibilities in the case of Part A(2) and B installations.

The EA is obliged to periodically review the permit, although no specific time limit is specified in the EPR. A review would be necessary where EU legislation changes or the installation is found in breach of permit conditions. Violation could result in revocation of the permit.

2.2.1 Microalgae case study: permitting in England

The EnAlgae case study is based on an anaerobic digester (AD) for energy production. Microalgal growth facilities are so uncommon in England and Wales that no general web-based advice is available on permitting. Therefore, the project managers contacted the Environment Agency for advice. In discussion with the EA regional office (in Ely) a number of issues were identified for further consideration, including:

- General considerations:
 - What is the size of the facility?
 - What services exist already on the site?
 - Is the site located close to dwellings / environmentally sensitive areas / sites of special scientific interest?
 - Are any discharges produced by the site?
- **Input sources / outputs:** An environmental permit (or exemption) was likely to be needed if anything that enters or leaves the site was classified as a **waste**. For example, if liquid digestate from Anaerobic Digestion (AD) was not produced on site, but imported into the site from a facility that is not PAS110 / ADQP compliant, it is classified as a waste, and would need either a permit or an exemption. This would not apply if the liquid digestate was either produced on site, or imported from a PAS110 / ADQP compliant producer, since it is then not classified as a waste. The volume of inputs and wastes entering and/or leaving the site is also of relevance and interest to the EA.
- **Growth conditions, harvesting, processing, storage:** For all these aspects of the work of a growth facility, it needed to be identified
 - how the algal biomass would be contained
 - what safeguards would be in place in case of a spillage
 - the potential impact on biodiversity (particularly if a non—native strain is used)
 - what levels of noise, odours and light pollution (if artificial illumination is included) would be generated.
- **Distribution / site traffic:** In addition to the above, appropriate access to the site needs to be demonstrated.

After an analysis of the AD process using these criteria, the only issue likely to render the facility liable for permitting was the intended end use of the algal biomass if it was classified as waste. However, since this was assessed as minimal, the facility was classed by the EA as an **R&D operation**, thereby not requiring a permit, i.e. a **permit waiver** was agreed.

The case study provides several lessons for those interested in setting up micro-algal growth facilities in England and Wales. Operators should in the first instance contact their local EA office to discuss their plans. Out of the discussion of the particular setting it can then be determined whether a standard permit is appropriate, a waiver can be granted or a bespoke permit will be needed. Issues of relevance to the Environment Agency, which those planning an algal growth facility need to consider, include the size and position of the development, what types of discharges it will produce (particularly to air, water and land), the types of inputs and outputs (particularly the use and production of waste material), production impacts and mitigation measures and also issues such as transport access.

2.3 Permitting in the Netherlands

In general, there is little experience in the Netherlands with commercial algae cultivation. Therefore, a great number of laws and regulations are not specifically designed for algae cultivation (or aquaculture in general) but may be applicable for algal production. Primarily, regulatory frameworks exist for industrial permitting that, as in England and Wales, implement EU directives within the context of Dutch environmental legislation. Separate permits are also required for water extraction activities that may be relevant for algal production.

According to implementation data from the European Commission (European Commission 2012), the Netherlands has followed an integrated licensing system for pollution control since 1993. The main legislative measures framing this system were the Environmental Management Act 1993 (Wet milieubeheer – or Wm) provisions on integrated permitting (implementing the IPPC Directive), the Pollution of Surface Waters Act on water permitting (Wvo), in addition to general requirements under the Environmental Protection Act. A new law, the **General Provisions Environmental Permitting Act** (Wet Algemene Bepalingen Omgevingsrecht or **Wabo**), was then introduced in 2010 to streamline permitting for businesses by integrating multiple permits under a single authorisation (omgevingsvergunning or APPA) – including a building/planning permit (see Section 3). However, the system is not fully integrated as, a separate water permit (**watervergunning**), may be required from the relevant water board or government authorities for abstraction and discharge activities.

Under the Dutch system, regional governments (Provincie) are responsible for implementing national environmental permitting law (under the Wabo) in conjunction with municipalities. Since the introduction of Wabo, a single environmental permit covering site-specific licences and authorisations can be issued by the Provincie. The permit covers IPPC, waste processing and potentially hazardous industrial processes⁴, although other less polluting businesses are now only subject to general environmental requirements under the 'Activities Decree' and do not require authorisation⁵.

Permits can be obtained from the regional government through an application procedure. Companies must first assess whether they require a permit or are covered by the Activities Decree. If a permit is needed, an application can be made online⁶ or in writing. Issues considered in granting the permit include air, soil, noise, safety, waste, energy efficiency and traffic impacts. The procedure is split into a consultation phase and a licensing procedure. Consultation initially takes place between the licensing authority and the company during which a draft permit is produced. The public are allowed to respond to permit application approvals in their draft form which are publicised by the Province. A final decision is then made and permit issued. Individuals can also appeal against a permitting decision.

⁴ These are identified in the BRZO: the Dutch regulations implementing the EU Seveso Directive II on industrial accidents.

⁵ The Activities Decree (Activiteitbesluit) covers three types of industry: Type A – where activities have negligible impacts and do not require a permit; Type B – which have some potential impacts and may require a permit; and Type C – which have extensive impacts and are subject to IPPC. The cultivation of algae is a Type C business, based on the AIM (Activiteitenbesluit Internet Module, <http://aim.vrom.nl>). This website gives an answer to which type is relevant based on a number of questions regarding the activities of the business. The agricultural sector is subjected to some exceptions/additions (amvb's – Algemene maatregelen van bestuur). The 'amvb's' are there, for example, for agriculture and environmental protection, greenhouses and environmental protection and manure storage. Agricultural businesses are all classified as Type C businesses.

⁶ Omgevingsloket online (www.omgevingsloket.nl)

Permits are usually issued for an unspecified length of time but can be reviewed if the production process or facility is changed. In some cases, where extensive changes are made, a new permit will have to be applied for. Permits are issued for the facility and not the operator, hence can be transferred if ownership changes.

Two types of permits may therefore be significant for algal production under this framework. An environmental permit could be required if facilities involve IPPC, BRZO or waste processing/production. The types of impacts that would require permitting are noise, vibrations, high energy use, waste production, odour, emissions to air, the draining of water, increases in traffic, discharges to soil and hazardous substances. A water permit (watervergunning) would also be required if the production process requires the extraction from, and emission to, a water body. Permits are issued under the 2009 Water Act⁷, which aims to control activities that could impact on the quality of surface and groundwater. In algae cultivation, a number of water related issues could therefore emerge in respect of permitting. Cultivation could require a water well and the disposal of water. As discussed below, these permits could be integrated into a planning permit to provide a fully integrated approach.

One other permit could be important for algal production. When employees are hired the employer is subjected to a number of laws and regulations. The rules regarding employees can be split up in the following laws and regulations that are relevant to businesses involving algae cultivation:

- All the hiring of personnel is subjected to the laws in the civil code of the Netherlands (Burgelijk wetboek), chapter 7. The contract and other legally binding agreements between employee and employer are regulated in the civil code of the Netherlands;
- The health and safety of workers is subject to the worker health and safety law (Arbeidsomstandighedenwet). Regarding algae cultivation a Risk Analysis is required.

2.3.1 Case Study: Wageningen UR

Figure 1: Indoor raceway at EnAlgae partners Wageningen UR. Credit: Marcel van der Voort.

The Wageningen UR facilities in Lelystad (four locations in total) all have one main permit granted by the municipality of Lelystad. The algae production facility is part of a larger project called “Energierijk”, (in English literally, “energy rich” or “energy kingdom”).

For each activity of the project a permit is granted, which in effect is an expansion of the main permit. The permitting of these activities follows the same legislation as that of regular



⁷ The competent authorities for issuing water permits vary according to context, with the local water board (Waterschap) responsible for the regional water system, the government department for Public Works and Water Management (Rijkswaterstaat) for the main water system, and the provincial government for water extraction and groundwater discharge.

businesses in the Netherlands. Since almost all activities fall in category C, all activities are subjected to the obligation for permits.

Exceptions are the temporary installations. Installations that are used no longer than 6 months do not require a permit. This allows Wageningen UR to test and research installations and/or techniques without having to undergo the permitting process. A permit process will take between six and twelve weeks minimum. This means that Wageningen UR does not lose time going through the application process and, if necessary, responding to the authorities. In turn, this saves time and costs on projects related to the testing of new techniques and installations. It should be noted that the exception for the temporary installations does require a detailed description for the authorities. Based on the detailed description the decision to allow the exception is made.

2.4 Permitting in Ireland

The Environmental Protection Agency (EPA) or local authorities are the bodies responsible for licensing industrial and agricultural activities in Ireland. Licencing is conducted under the regulatory regime established by the Protection of the Environment Act 2003⁸ which implements the EU IPPC Directive. The First Schedule of the Act lists those activities subject to IPPC licensing, including mining, energy production and chemical manufacturing. Schedules Three and Four list waste activities requiring a separate licence from the EPA.

Under this system **IPPC licences** issued by the Agency are designed to control emissions to multiple environmental media and encourage efficiency in energy and resource usage. As such, licences adopt a relatively integrated approach by controlling most emissions from a given production facility, while linking with other EPA licences relevant for its environmental management such as those for waste disposal and recovery.

Operators must demonstrate to the EPA that the facility does not present a significant environmental risk by following a staged licencing procedure (EPA 2012a,b). In **Stage 1** (Figure 1), the operator must comply with the public participation requirements of the Act by initially publishing details of the proposed activity, in the local newspaper and by notification on the site, and then notifying the requisite Local Planning Authority (see Section 3 below). After this phase is completed, the operator submits an application to the EPA for assessment (**Stage 2**). Application forms, available in hardcopy and in electronic format, contain several sections:

Section A requires a non-technical summary identifying 'all environmental impacts of significance associated with the undertaking of the activity, and describe mitigation measures proposed or existing to address these impacts' (EPA 2012b: 16);

Section B should contain: the applicant details; a map showing their ownership of the land; the location of the activity, three maps (a site plan, location map and services plan); the class of activity as defined in the EPA Act; the number of employees anticipated and the capital costs of development, the name of the relevant LPA; whether planning permission has been granted or is being sought; the name of the relevant Water Services Authority and regional Health Service Executive; a copy of the site notice, newspaper advert

⁸ This Act amends the **Environmental Protection Agency Act 1992** which introduced licensing under Integrated Pollution Control (IPC).

and notification letter to the LPA; a statement of whether the activity is covered by Seveso II or IPPC legislation. From 2013, a statement of whether the activity is encompassed by the IED will be required;

Section C concerns the management of the installation. Details of the production site management and controls, any Environmental Management System (EMS) and hours of operation should be included;

Section D requires information on the range of activities and processes that will be undertaken, and also relevant details on the historical development and operational history of the site;

Section E obliges applicants to list all emissions to the atmosphere, surface waters, sewers, ground (including landspreading) and noise. Emissions should be categorised according to BAT guidance limits;

Section F concerns controls and monitoring systems. Applicants must specify any treatment or abatement measures for emissions to surface water, sewers or ground, along monitoring points and data collection;

Section G requires information on raw materials use and energy efficiency;

Section H should cover all materials handling, transportation and storage. This section should also outline hazardous and non-hazardous waste arisings (as defined in the Waste Management act 1996, as amended) and waste disposal;

Section I requires applicants to include assessments of the existing environment and impacts resulting from the activity on the atmosphere, surface water, sewers and ground. Information should also be provided on the land spreading of agricultural and non-agricultural wastes, noise and groundwater impacts;

Section J should contain details of any emergency response and accident prevention measures;

Section K concerns any remediation, decommissioning, restoration and aftercare that will be undertaken after the cessation of the activity, primarily with regards to reducing environmental liability and risks.

The EPA has eight weeks to determine whether to grant a licence (known as a 'proposed determination') which is then made available for public comment (**Stage 3**). Objectors have 28 days to lodge a complaint. Any objections to the application are considered by the EPA in its final determination (**Stage 4**), which can include a verbal representation from objectors (**Stage 5**). The final determination is then made and communicated back to the applicant and made publicly available (**Stage 6**). Although the EPA is the competent authority for larger installations, local authorities may perform this role for smaller facilities.

If granted, licences can impose conditions on the operation of the facility. Licences are generally non-specific in terms of time but can include compliance conditions for IPPC, but waste licences can have a limited time span. Neither can they be transferred to another operator without EPA consent.

While the EPA system is relatively integrated, there are other permits that may be applicable to algal production. Some activities with minor impacts are not covered by IPPC/waste licensing but can require a permit from the local authority, e.g. discharge of effluent to drains⁹, limited air emissions, and the storage of small amounts of waste. Operators should therefore check with the EPA and local authorities on likely permitting requirements.

⁹ Local authority Effluent Discharge Licences.

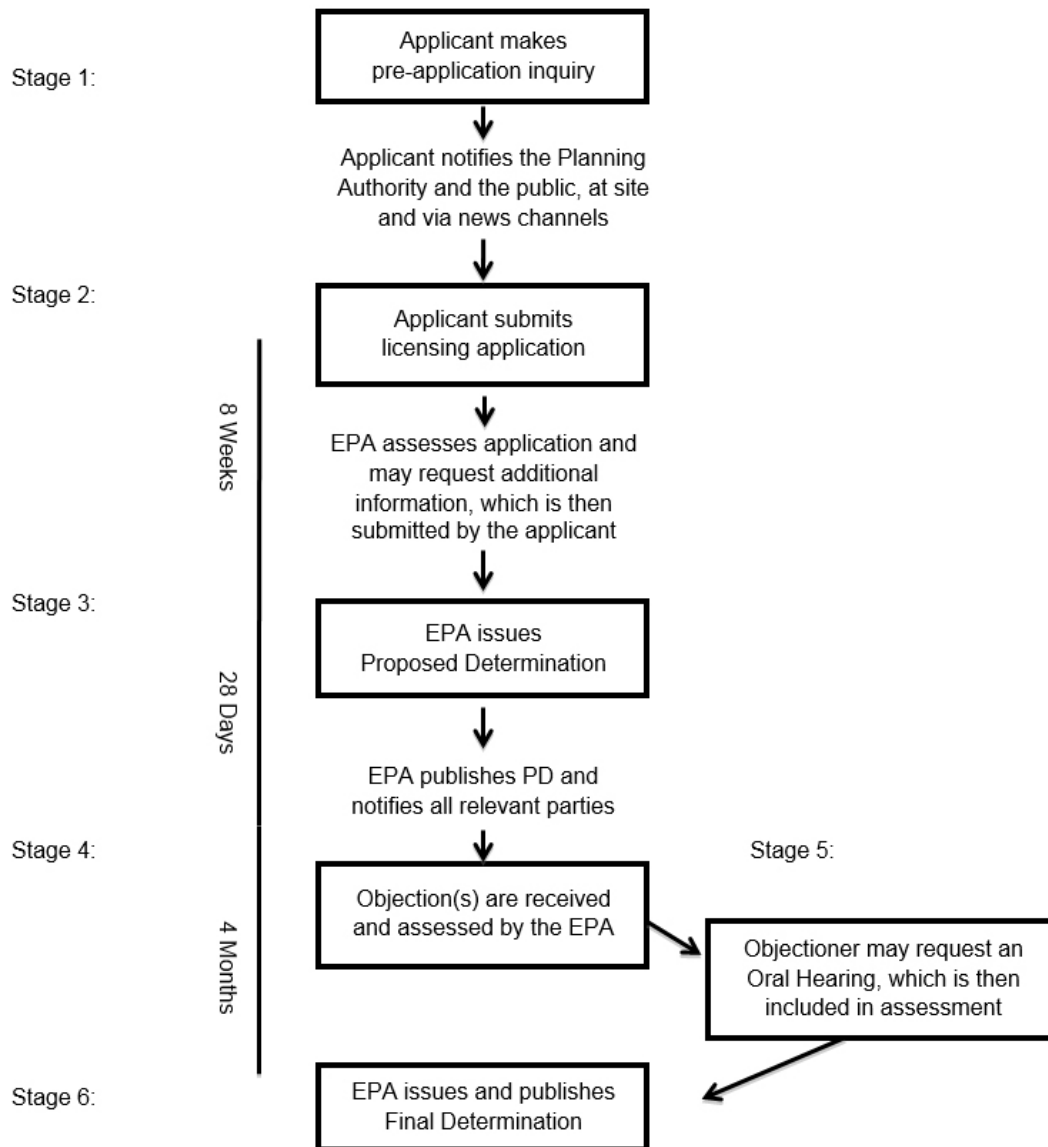


Figure 2: The IPPC licensing application process in the Republic of Ireland.

(adapted from Enterprise Ireland 2008:7)

2.5 Permitting in Germany

Germany is a federal country comprised of 16 semi-autonomous Länder. Competences are shared between the federal government and Länder in the area of the environment, with the federal level generally establishing framework legislation that is implemented at state level. The main federal law concerning industrial permitting is the **Federal Emission Control Act** (Bundesimmissionsschutzgesetz, BImSchG) and related ordinances¹⁰. The Act requires that large industrial facilities have an emission control permit which must be applied for before the construction of the facility. Germany is currently transposing the IE Directive via amendments to the BImSchG. The Federal Environmental Agency also publishes the guidelines (BREFs) for the best available techniques.

2.5.1 Länder implementation

Under the German federal system, the Länder are responsible for implementing the BImSchG in their Land. Because each Länder has some flexibility in implementing federal law, permitting differs between jurisdictions. The situation is complex. In some Länder, a state-level agency is responsible for the licensing, in some it is the local level environmental agencies of districts or towns (*Umweltämter der Land und Stadtkreise*).

Generally, however, the **environmental agency** of the respective federal state (Landesumweltamt) is the competent licensing authority responsible for the emission control permit procedure under the BImSchG and associated ordinances. Space and research time preclude an overview of practice in all 16 Länder but we can consider two examples.

Firstly, using the example of Land Brandenburg, it is the Ministry for the Environment, Health and Consumer Protection that is responsible for industrial permitting. The State Agency for the Environment, Health and Consumer Protection, under the control of the Ministry, is the competent authority for issuing permits. The permitting process in Brandenburg for one technology/technological plant under the Federal BImSchG takes approximately 6 to 12 months.

Secondly, the case of Saarland (EnAlgae project partner **Hochschule für Technik und Wirtschaft des Saarlandes**) is also instructive. In the Saarland, the Landesumweltamt manages the approval process for new plants. Facilities requiring licensing approval are listed in the Federal BImSchG (Section 4) and divided into ten main categories:

1. Power generation, mining and energy;
2. Quarrying, glass, ceramics, building material production;
3. Steelmaking, iron and other metal production and processing;

¹⁰ The implementation of the IPPC Directive 2008 in Germany is given effect by amendments to this legislation (Act on the protection against harmful effects of air pollution, noise, vibration and similar phenomena 2009 – or the Federal Pollution Control Act). Several Ordinances implementing the Federal Pollution Control Act are applicable, including those for installations subject to licensing (Fourth Ordinance - (*Verordnung über genehmigungsbedürftige Anlagen*), the approval process (Ninth Ordinance - *Verordnung über genehmigungsbedürftige Anlagen*), hazardous incidents (Twelfth Ordinance), large combustion plants (Thirteenth Ordinance), and incineration and co-incineration of waste (Seventeenth Ordinance). In addition, consideration may be needed of the General Administrative Provisions of the Act including those for technical instructions on air quality control (TA Luft - *Technische Anleitung zur Reinhaltung der Luft*) and noise. Related Laws on Environmental Impact Assessment and Greenhouse Gas Emissions Trading may be applicable for some industries.

4. Chemicals, pharmaceuticals, petroleum refining and processing;
5. Surface treatment with organic materials, manufacture of plastics, other processing of resins and plastics;
6. Wood, pulp;
7. Food, beverages and animal feed, agricultural products;
8. Recovery and disposal of waste and other waste materials;
9. Storage, loading and unloading of substances and preparations;
10. Other industries. (Saarland 2012a)

Under the federal Act, a **formal authorisation procedure** is conducted for specified installations that require an Environmental Impact Assessment (Umweltverträglichkeitsprüfung)¹¹. The approval process can be reduced (in a '**simplified procedure**') for facilities where environmental impacts are limited¹² and an EIA is not required.

In a pre-application phase, the agency recommends that the operator contacts it to discuss the development prior to any application. The agency can then provide advice on undertaking the application. One consideration will be the extent of the EIA, also known as 'scoping' (see Glasson *et al.* 2011). Here, the authority examines what potential environmental impacts should be 'scoped' into the EIA in conjunction with other stakeholders and the public.

The project developer then prepares and submits the permit application. The Saarland Ministry of Environment and Consumer Protection provides a form for the application process which requires several types of documents (Saarland 2012b):

- Data on the installation's operation;
- A list of all potential emissions;
- Data on operational emissions;
- The raw materials used;
- Noise;
- Waste production data;
- Information on safety measures;
- Information on the CO₂ emissions from the plant;
- Information on calculating and monitoring CO₂ emissions.

Upon its receipt, the agency checks the application to ensure all relevant information is provided. It then publishes the application in the government Official Journal and makes a copy available for public inspection for one month. Municipalities affected by the development are also given an opportunity to examine the development application. Any objections raised are included in a public hearing. The approval authority then has one month to reach a decision, taking into account any objections from the public and local municipalities, and an EIA if conducted. Overall, the procedure can take up to seven months although the simplified procedure takes three months.

¹¹ These requirements, under the federal Act on the Assessment of Environmental Impacts (Gesetz über die Umweltverträglichkeitsprüfung (UVPG)) (1990), implements the EU EIA Directive (85/337/EEC as amended by Directive 97/11/EC). Further information on EIA in Germany can be found on the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) website: <http://www.bmu.de>. Other details are available from: <http://www.gesetze-im-internet.de/bundesrecht/uvpg/gesamt.pdf>

¹² Installations falling into this category may include, for example, paint spray shops or small fuel storage facilities.

2.5.2 Permitting for algal production

Permitting for algal production will therefore depend on a number of factors, most notably the production process and its likely impacts as they could relate to different federal laws and ordinances.

The **Fertilisation Ordinance** (DüV), the **Ordinance on Fertiliser** (DüMV) and the **waste management law** could play an important role for stakeholders that plan to use the substrate from the algae production as fertiliser once the algae are harvested and remaining nutrients are partly recycled. According to the law and the definition of the Federal Ministry for Environment (BMU) the concerned phosphate and nitrate-rich water cannot be used as fertiliser, but must be treated as waste water (even if there is proof of its harmlessness and positive effects). If the remaining substrate is defined as waste water, it will create additional expenses for its disposal, which needs to be taken into account.

Of note to the establishment of algal research projects is the exemption for technologies under the BImSchG Technologies which are still in the pilot or research phase do not require a permit. As soon as the technology is used to generate a product for market production, it requires a permit.

Another factor that may be of significance is water management. In Germany, permits can be refused where impacts on water resources are anticipated. As Länder are allocated competence for water management under the German constitution, procedures can vary. Operators of algal facilities should therefore contact the relevant Länder agency to establish which procedures relate to their application where production impacts on water resources may be significant.

2.6 Permitting in France

Like the UK, France has had a national approach to permitting industrial activities for many decades. Certain specified industrial installations became subject to permitting of operational requirements, in the form of a prefectural order, under Law No. 76-663 in 1976¹³. Applicants had to apply to the regional Prefecture for a permit: a system that endures today. However, modifications to this approach became necessary with the implementation of IPPC in the 2000s, which has been achieved legally through amendments to the national **Environmental Code (Article L.511-1)**.

Under this system, a permit is required for certain industrial activities. Under French environmental law, an industrial or agricultural activity 'likely to create hazards or cause pollution or nuisance especially for the health and safety of residents' is a **classified activity** (Ministère de l'Écologie, du Développement Durable et de l'Énergie 2012a). Classified installations are categorised according to whether they require authorisation or a declaration according to their likely impacts or risks:

Statement: for activities with limited pollution or risk potential. Here, all that is required is a simple statement to this effect issued by the relevant Prefecture;

Registration: introduced in 2009, this mechanism is designed as a simple authorisation for industrial sectors where impacts are well established and technological solutions are available to reduce them;

¹³ The Law was implemented by Decree No. 77-1133 1977.

Authorisation: for installations that present high environmental and health risks. Operators must apply for permission from the relevant Prefecture (regional authority) Inspectorate of Classified Installations. Classified installations are categorised according to the substances involved (toxic, flammable, radioactive) and activities (for example, food processing, chemical manufacture)

The national Ministère de l'Écologie, du Développement Durable et de l'Énergie or Ministry for Ecology, Sustainable Development and Energy (2012b,c) provides a detailed description of the registration and authorisation application process, which are similar (Fig. 3). Firstly, applicants must assemble an application file (dossier) containing a letter specifying the installation location, the nature of the activities, manufacturing processes, and an assessment of the operator's financial and technical capacity. Supporting documents should include a location map, installation plan, an environmental impact assessment¹⁴, a risk assessment¹⁵ and a note describing how the facility will comply with health and safety regulations. If a building permit (see Section 3) is also requested for the installation, it must accompany the environmental permit application. The application file is then forwarded to the Prefecture and assessed by the Inspectorate of Classified Installations. A copy is also sent to the council of the municipality (conseils municipaux) concerned. Details are then published on the internet for four weeks. Several stakeholders are consulted including different government bodies, including CODERST¹⁶ and also the public in the form of an inquiry. The permitting process can take up to 5 months from the date of the application for a registration but up to 12 months for authorisation, due to the number of consultees.

Lengths of permits are not generally stipulated. However, they are subject to review by the regulator to assess compliance and to update conditions of the permit. The regulator can also revoke the permit if there are risks of pollution or its conditions are not adhered to.

¹⁴ The requirements of environmental assessment are specified by Article R512-6 of the national Environmental Code. Applicants should include an analysis of: the site and baseline environmental conditions, including material assets and cultural heritage; direct, indirect, temporary and permanent effects of the facility on the environment and human health; and the scale and magnitude of these impacts. Information on any mitigation and remediation measures for the impacts should be included, in addition to a justification of why the site was chosen with regards alternative sites.

¹⁵ Risk assessments should state that the project will achieve the lowest level of risk to the environment and human health as possible in respect of economically and technologically feasible solutions. Conditions for the assessment are contained in Articles L.211-1 and L.5.11-1 of the national Environmental Code.

¹⁶ Conseil de l'Environnement et des Risques Sanitaires et Technologiques.

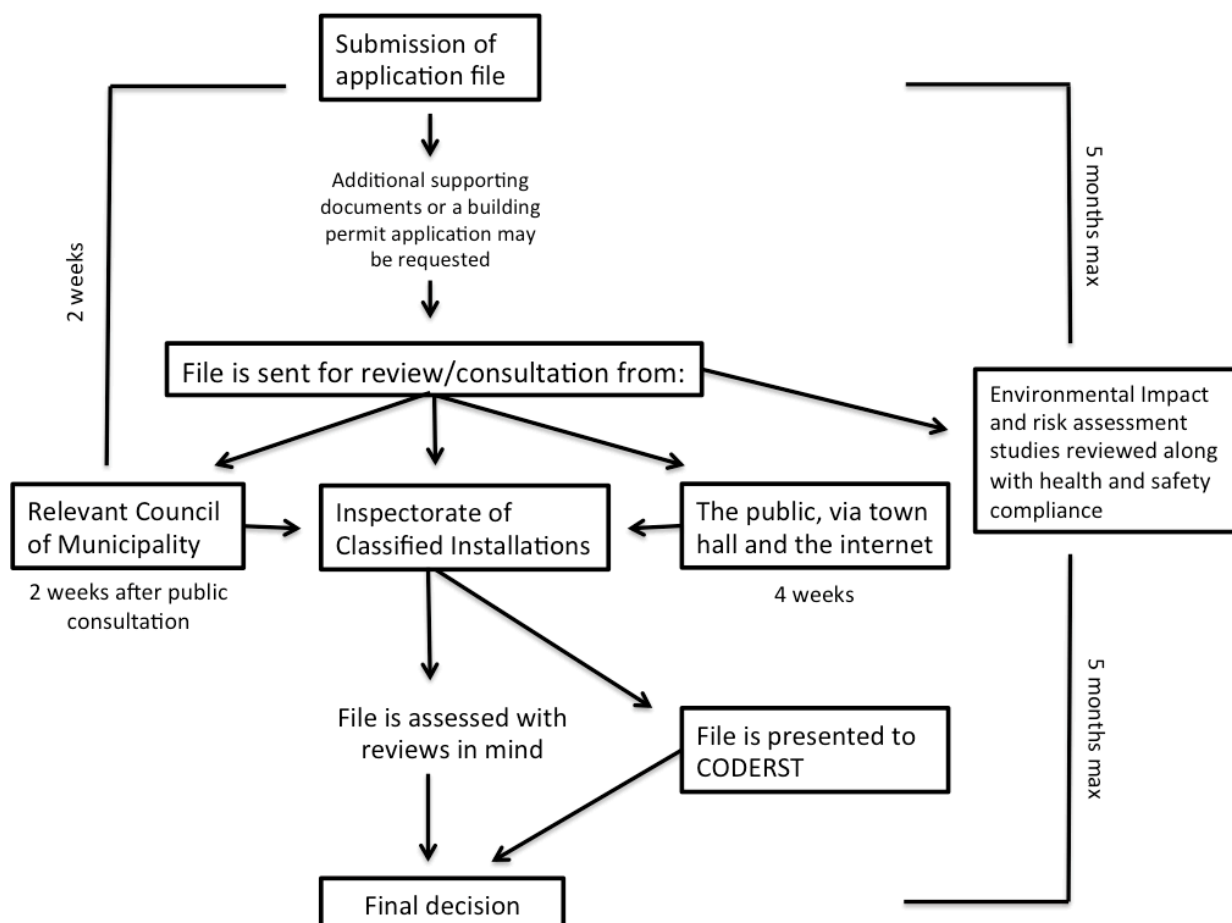


Figure 3: Procedure for a registration application.

(adapted from Ministère de l'Écologie, du Développement Durable et de l'Énergie 2012c)

2.7 Permitting in Flanders/Belgium

Permitting in Flanders reflects the division of powers in the Belgian federal political system (Bernaert 2009). Belgium is divided into three semi-autonomous regions: Brussels, Wallonia and Flanders (Vlaanderen). Responsibilities for environmental protection under this system are allocated to the regional level, so separate legal and permitting system exist in these jurisdictions. In Flanders, integrated permitting is administered by the Environmental Licences Division of the regional government Environment, Nature and Energy Department.

The current permitting system based on the Flemish Environmental Permitting Regulations (VLAREM) predates EU IPPC legislation (Bernaert 2009; Goris 2009). Flanders first introduced a system of integrated permitting in 1985 under the Flemish Environmental Permit Statute, to replace its existing fragmented sectoral permits. The Statute was enacted by the VLAREM I and II regulations (see Departement Leefmilieu, Natuur en Energie 2013). Under this system, a single permit was required for facilities emitting to air, water, land and producing waste. This system then incorporated EU IPPC legislation after 1996 through integrating environmental protection, pollution prevention and also pollution control within a single permit. It was

subsequently updated when the IPPC Directive was revised in 2008 and is in the process of further change in order to implement the IED Directive.

Currently three types of permits, based on an assessment of environmental risk, are employed in the Flanders region (Government of Flanders 2012). Firstly, for low risk facilities a **Class 3 permit** is issued. Typically, these permits only apply to small commercial facilities with negligible environmental impacts. **Class 2 permits** are appropriate for facilities that have some limited environmental impacts but do not constitute a major risk/nuisance. **Class 1 permits** incorporate installations covered by the IPPC Directive and cover higher risk, higher polluting activities such as chemicals processing and intensive animal rearing. These permits also integrate with the EU Environmental Impact Assessment (EIA) Directive, which obliges EIA for these industries, and the Seveso Directive II on the prevention of industrial accidents. Permits set out both general rules and specific operating conditions for the facility, with conditions for Class 1 activities set according to BAT. In addition, environmental permits can be integrated with building permits to avoid duplication (see Section 3 below).

Permitting occurs in respect of a set application procedure (Government of Flanders 2012). Operators must submit an application by first determining which category the facility is likely to fall under using the VLAREM regulations. For Class 1 installations, operators must apply to the Provincial Environmental Licences Division Committee, who are obliged to either grant or deny a permit within 4-5 months. Applications for Class 2 and 3 facilities should be directed to the municipal authorities where the development will take place. Permit applications for Class 1 must include several documents, including an Environmental Impact Assessment and safety report (where applicable), and information pertaining to IPPC (for example, a description of the installation, likely emissions, BAT), (Bernaert 2009). Measures for public participation include making the application publicly available and including any objections in its determination. If a permit is refused, an appeal can be made to either the Government of Flanders or the provincial committee depending on the permit Class.

Permits can be granted for a maximum of 20 years. They are transferable between operators but notification must be made to the provincial government. Penalties for non-compliance with permits can be high, with criminal sanctions possible of up to two years imprisonment or fines up to €1.5 million.

As microalgae culture is categorized as aquaculture, Flemish legislation on water is very important. In Flanders, all permits affecting the water system are subjected to the 'watertoets'. This is an online tool (<http://www.integraalwaterbeleid.be/watertoetsinstrument/>) by which the authorities who decide on a permit assess the impact of the facility on the water system. All persons applying for a permit can use this online tool for free. The 'watertoets' has been implemented since its publication in the Flemish Decree on Integrated Water Policy. The Decree was officially approved in July 2003 (Belgium Law Gazette, 14.11.03). This decree is the juridical implementation of the European Water Framework Directive (2000) and the Floods Directive (2007) in Flemish law. The online tool 'watertoets' was adjusted on March 1st 2012.

The outcome of the 'watertoets' assessment for algae production facilities depends on several factors such as whether it also involves the construction of a building (for example, a small lab or indoor harvesting facility), the depth of the algae pond, the presence of land surfaces which are not permeable for water, the change in vegetation and landscape, etc. The outcome of the watertoets is noted in the permit as a 'waterparagraaf'.

In July 2010, the Flemish Government published their new rules for the VLAREM regarding the discharge of wastewater effluent into water bodies in Flanders (Flemish Government, 2010. Besluit van de Vlaamse Regering tot wijziging van het besluit van de Vlaamse Regering van 6 februari 1991 houdende vaststelling van het Vlaams reglement betreffende de milieuvergunning en van het besluit van de Vlaamse Regering van

1 juni 1995 houdende algemene en sectorale bepalingen inzake milieuhygiëne, voor wat betreft de milieukwaliteitsnormen voor oppervlaktewateren, waterbodems en grondwater. 2010/35462; Belgisch Staatsblad). These rules will be implemented in Flanders by 2015. They will not only affect future algal pilot facilities but highlight the need for new biological wastewater treatments since certain standards, such as those for phosphorous, are extremely low and not feasible with the current available wastewater treatment technologies.

2.7.1 Microalgae case study: permitting in Flanders

As part of the EnAlgae research, Howest University has constructed a small scale pilot facility in Beitem, Flanders. It includes a 25m² open pond system with influent tank, effluent tank, gas tank, heating system, and container with PLC-steering and gas boiler and for material storage. In this facility, part of the wastewater effluent from the pike perch culture of the Inagro plant is being treated. It has been in operation since January 2013 and will be operated until the end of September 2013. In October 2013, this facility will be moved to another location. Since the amount of wastewater treated by the pilot facility is rather small compared to the total amount of wastewater produced by Inagro, no change to the environmental permit (milieuvergunning) for water discharge by Inagro was needed.

For this EnAlgae pilot facility, established by Howest, a Class 3 permit was issued for the gas tank by the municipal authorities (City of Roeselare) after a control audit was conducted by an authorized organisation (OCB). This gas tank was needed to fuel the heating system of the pilot facility. Only a Class 3 permit was needed for the pilot facility since it is non-permanent and will be moved after one year's operation to another location. The permit was requested by Howest and not by Inagro since Howest is the owner of the pilot facility and not Inagro.

2.8 Permitting in Switzerland

No microalgal growth facilities exist in Switzerland as yet, hence no procedure or guidelines for setting up such a facility are available. However, several environmental laws may need to be considered when acquiring an operating and building permit for such a facility (see also Section 3 below).

As in Germany and Belgium, responsibility for pollution control and environmental protection in Switzerland is divided between the federal government and Cantons (states). Federal laws and regulations for environmental protection provide the framework for implementation by the Cantons, who have the responsibility for ensuring compliance by local authorities (communes). This aspect of environmental protection is particularly important for industrial permitting as Cantons are responsible for environmental licensing while communes (municipalities) maintain powers for building control (see Section 3.8). A key mechanism in this respect is environmental assessment which ensures compatibility between national environmental objectives and local development.

At the federal level, the main legislative instrument for environmental permitting is the **Environmental Protection Act (Umweltschutzgesetz)** and its associated ordinances. It embodies several key principles, including the 'polluter pays', 'precautionary', stakeholder participation or 'cooperation' and 'reduction at source of pollution'. The Act also seeks to limit the environmental impacts of noise, air pollution, vibration, radiation and hazardous substances, with additional requirements for genetically modified organisms, waste management, soil protection and environmental taxation.

For existing plant, the permitting procedure involves the plant operator submitting an application file to the Cantonal permitting authority (OECD 1999). The file must contain details of any emissions to air, water and

land as well as noise levels, waste production and hazardous substances being used. Information on mitigation measures and safety precautions should also be included in the application. A review of the application is then conducted by the authority. Key considerations in the decision-making will be the standards provided in federal legislation – outlined in the next paragraph. Operators can appeal the decision to the administrative court where the authority stipulates higher standards than those contained in federal law or if proposals for abatement measures made by the applicant are refused by the canton. A permit can be issued for an indefinite period but can be recalled for reassessment where environmental standards are negatively affected during the plant operation.

For new plant, the Umweltschutzgesetz incorporates a requirement for environmental compatibility assessment under the **Verordnung über die Umweltverträglichkeitsprüfung** legislation. Proposers of certain new developments or significant modifications to existing developments are required to provide an assessment of the likely environmental impacts as part of the commune building permit procedure. Several industrial developments are subjected to a mandatory environmental compatibility assessment, namely: motorways, railways, shipping routes, energy production and storage facilities, large water infrastructure projects such as dams, waste disposal facilities, heavy industry, chemicals/pharmaceutical manufacturing, minerals extraction, large farming facilities, and also shopping centres. Cantons and communes are obliged to take into account other federal laws in the assessment process, including:

The **Noise Control Act** (Lärmschutzverordnung) that seeks to reduce the harmful effects of noise. As discussed in Section 3, noise is a particular consideration for planning when considering a building permit;
The **Clean Air Act** (Luftreinhalteverordnung) which defines Emission Limit Values (ELVs) for industry;
The **Water Bodies Protection Law** (Gewässerschutzgesetz) which regulates water use and water protection;
The **Energy Law** (Energiegesetz) which regulates the energy efficiency of new buildings and major alterations to existing buildings.

As the industrial licensing process in Switzerland is inter-linked with the land use planning/building permitting procedures of communes, it will be described in more detail in section 3 below.

2.9 Permitting in Luxembourg

As in Switzerland, no algal production facilities currently exist or are being planned in Luxembourg but the following section is included to guide any future development of the industry in this EU country. Luxembourg law requires that any industrial, commercial or craft facilities that present a danger or nuisance to public health, security or the environment obtain prior authorisation¹⁷. Several types of permits could be applicable to algal production, namely those for a classified activity (incorporating IPPC) but also for water abstraction and nature protection. A separate building permit is issued for construction of facilities (see Section 3 below). Classified activities must obtain an operating permit or ‘commodo/incommodo’ authorisation (guichet.lu 2013a). These authorisations specify the conditions of operation for building processes or fixed facilities and are categorised according to several classes – 1,2,3,3A, 3B or 4. The classes range from 1, covering industrial facilities with potentially high impacts, to 4 which relates to small scale facilities with negligible impacts. **Class 1** includes facilities that fall under the requirements of the IPPC Directive. Here,

¹⁷ Loi du 19 Novembre 2003 modifiant la loi du 10 juin 1999 relative aux établissements classés. Luxembourg has yet to transpose the IE Directive (2010) into national legislation.

establishments that are likely to produce significant discharges to the air, water and land¹⁸ must apply for a **Class 1 operating permit**.

Applications for operating permits must be submitted to the relevant authority. In the case of Class 1 activities, the application must be made to the **Environment Agency** (Administration de l'Environnement). The application procedure for these activities follows a number of steps (see guichet.lu 2013a). Firstly, applicants should consult with the relevant commune to ensure that the proposed activity coincides with the requisite development plans (the general development plan or plan d'aménagement général (PAG) and the corresponding special development plan or plan d'aménagement particulier (PAP)) – Section 3 below.

Secondly, previous activities on the site should be checked to ensure it does not require decontamination, is polluted or contains historical remains. Thirdly, applicants should draught a preliminary list of elements of the project that require authorisation and determine which class they fall under. Fourthly, a dossier must be prepared as part of the application. Dossiers must include the following information: a copy of the local land register showing the development relative to neighbouring plots within 200 metres; a topographical map of the area; a copy of the relevant part of the PAG showing the development; a certificate from the commune stating that the project is consistent with local development objectives; and, plans of the proposed facility. Thereafter, the Agency has 15 days to check the application is admissible and acknowledge receipt to the applicant. If the application is incomplete, the authority can request further information before proceeding further.

When complete, the application is sent to the relevant commune for consideration by public inquiry. Details of the proposal are made publicly available for 15 days, during which written submissions can be made to the local mayor. A public inquiry is then conducted by the mayor with the results communicated back to the Environment Agency for final decision-making. Where significant impacts are predicted for Class 1 facilities, the Agency can request an environmental impact assessment¹⁹, a risk assessment²⁰ or safety report to be produced. Slightly different application procedures exist for other Classes of facilities (see guichet.lu 2013a, for details). Application forms are available online and must be submitted to the relevant authority, depending on the specific Class of the project. Class 4 facilities only require notification to the Environment Agency.

As in the Netherlands, activities involving the abstraction of, and discharge to, ground or surface water resources may require a separate permit (see guichet.lu 2013b). A facility wishing to undertake these activities must apply for a **water permit** to the Water Management Authority (Administration de la gestion de l'eau). Permits are designed to control threats to water resources by protecting human and animal health, the aquatic environment, drinking supplies, countryside and land, and also reducing flood risks. As such, the

¹⁸ These include energy industries, metal production and processing, minerals production, chemicals manufacturing and waste management facilities.

¹⁹ Some classified establishments may be subject to an environmental impact assessment (EIA) or evaluation des incidences sur l'environnement – EIE) procedure. Certain Class 1 activities automatically require an EIA. These include extractive industries, energy production, sewage treatment, waste processing, metal smelting, chemical plants, paper mills and intensive livestock facilities. Other Classes of activities may require an EIA, particularly where waste processing and water treatment is undertaken. Operators of algal production facilities should therefore make enquiries with the Environment Agency prior to submitting a permit/planning application.

²⁰ A risk assessment (RA) of threats to the vicinity, general public and employees posed by the facility is required for most Class 1 developments. The risk assessment must be verified by an accredited organisation in conjunction with the Inspectorate of Health and Mines. It must then be added to the permit application dossier. Activities where risk assessments are mandatory include the manufacture of oils and chemicals. Other activities that may be subject to RA after a case by case determination include those where there is a risk of release of dangerous substances to the environment, fire, explosions and impacts on the health of workers and the public (guichet.lu 2013d). Again, algal operators should establish whether an RA is required as part of the permit application process.

permit relates to multiple activities that may have implications for the establishment of an algal production facility, including inter alia: ground and surface water extraction; water discharges to ground or surface water; pollution of water resources; and, any threats to water resources in protected areas.

Under Luxembourg legislation, a **nature protection permit** may also be required for algal production facilities. Permitting is designed to reduce risks to landscapes, flora and fauna, with authorisations issued by the Department of the Environment (Département de l'Environnement, part of the Ministère du Développement Durable et des Infrastructures (MDDI)). An application for a permit must be made if construction or renovation of a facility occurs within 30 metres of: woodland (of one hectare or more); watercourses without sewerage connection; or protected areas (with municipal, national or EU designations, for example a Natura 2000 site) (guichet.lu 2013c). A permit is also required if development of processes such as renewable energy production occurs within a designated 'green area', as specified in the PAG.

2.10 Comparing environmental permitting

The above analysis allows cross-national comparison of permitting practice which can be synthesised into a Table 1. All countries have at least one national legislative mechanism for environmental permitting. However, responsibility for permitting does not entirely reflect whether the country is a unitary/federal political system. Only in England/Wales, Luxembourg and Ireland is permitting conducted by national agencies, although the UK is now a devolved unitary state with Scotland and Northern Ireland government agencies also assuming these powers. While France and the Netherlands are also unitary states, both have devolved responsibilities to Prefectures and Provinces respectively. Federal states (Germany, Belgium and Switzerland) all enumerate these functions to lower levels within the context of national framework law. With regards to permit types, several countries have different classifications of permits, depending on the characteristics of the development.

In some countries permits are relatively 'integrated', including all environmental authorisations, while in others separate permits still exist alongside IPPC for some activities. In Ireland, for example, a separate waste permit must be obtained from the EPA, and a water permit is required in the Netherlands, Belgium and Luxembourg. Environmental permits are also integrated with the planning process in some countries such as the Netherlands, Germany and Switzerland. Yet, in the UK and Ireland these systems remain separate.

Table 1: A comparison of environmental permitting in the UK, Ireland, the Netherlands, Germany, France, Flanders/Belgium, Switzerland and Luxembourg.

Country	Main implementing legislation	Primary implementing agency	Permit types
UK (England and Wales)	Environmental Permitting (England and Wales) Regulations (EPR) 2010	Environment Agency	Standard Bespoke Permit waiver
The Netherlands	Environmental Management Act 1993 (Wm) on integrated permitting The Pollution of Surface Waters Act on water permitting (Wvo) General Provisions Environmental Permitting (Wabo)	Provincial governments	Environmental permit/ Integrated building permit Water permit
Republic of Ireland	Protection of the Environment Act 2003	Environmental Protection Agency	IPPC Licence
Germany	Federal Emission Control Act (Bundes-Immissionsschutzgesetz; BImSchG)	Länder Environment Agency (Landesumweltamt)	Emission Control Permit or Licence
France	Law 76-663, as integrated into the Environmental Code in 2000	Prefecture Inspectorate	Environmental Licence
Flanders/Belgium	Flemish Environmental Permitting Regulations (VLAREM)	Flanders Environment, Nature and Energy Department – Environmental Licences Division Municipal authorities	Class 1, 2, 3 Watertoets
Switzerland	Federal Environmental Protection Act (Umweltschutzgesetz) Environmental Compatibility Assessment Act	Canton government agency	Environmental/building permit
Luxembourg	Loi du 19 Novembre 2003 modifiant la loi du 10 juin 1999 relative aux établissements classés	Environment Agency – Class 1 permits	Class 1 – 4 permits (Class 1 for IPPC activities) Water permit Nature protection permit

3 Microalgae Planning

3.1 Planning Permission ²¹

For aspects of environmental regulation in the EU, such as environmental permitting, there is little European level legislation relating to land use planning apart from directives on environmental impact assessment (EIA) and strategic environmental assessment (SEA). Consequently, planning systems can vary significantly between countries. These differences can in turn influence the establishment of certain industries such as algal production, a feature we will examine in this section in the different European states.

3.2 Planning in England and Wales

Land use planning in the UK is governed by Town and Country Planning (T&CP) legislation. Therefore, the current planning framework in England and Wales relates primarily to the **Town and Country Planning Act 1990**, as amended. Separate T&CP legislation frames land use planning in Scotland and Northern Ireland. At the heart of the UK system is local authority planning control within a broader context of national strategic objectives setting. Local planning authorities prepare development plans in conjunction with local communities and are also responsible for development control through, for example, making and enforcing planning decisions. Government supports local authority planning through introducing national legislation and also providing guiding policy. In England and Wales, government Planning Policy Guidance and Statements guided the implementation of land use planning up until 2012 when they were replaced by a **National Planning Policy Framework**. Planning authorities are obliged to consider this framework in their decision-making. Appeals against refusal of planning permission in England can be directed to the Planning Inspectorate (an executive agency of the Department of Communities and Local Government) or the Welsh Assembly in Wales.

Several features characterise the planning system in England and Wales. Firstly, it is a 'plan-led' system. Each local planning authority is obliged to periodically produce a development plan or **Local Development Framework (LDF)** setting out long term development objectives. The LDF then forms the basis for subsequent planning decisions. Secondly, most developments must secure planning permission from the authority, with applications processed using a specific procedure (see 3.2.2 below). Finally, the T&CP approach makes provision for public participation. The public are consulted in the development of LDFs and also can comment on planning applications affecting their communities.

In general, the planning rules of local councils will apply for algal growth facilities just as they do to other industrial developments. However, large or controversial industrial developments can be referred to central government for a decision.

²¹ The input of Sheena McCallum from URS Scott Wilson into this section is gratefully acknowledged; parts of this section have been provided verbatim by URS Scott Wilson in a report on planning for the InCrops Algal Innovation Centre in Cambridge.

3.2.1 Overview of issues to consider

Issues of relevance to Planning Authorities which those wishing to set up an algal growth facility need to consider include:

General considerations:

- What is the size of the facility?
- What services exist already on the site?
- Is the site located close to dwellings / environmentally sensitive areas / sites of special scientific interest?
- Are any discharges produced by the site?
- Is the site likely to cause nuisance (e.g. noise above levels of agricultural machinery / odour / light above dense street lighting)?

Input sources / outputs:

Transport movements

Growth conditions, harvesting, processing, storage:

For all these aspects of the work of a growth facility, it needs to be identified

- what levels of noise, odours and light pollution (if artificial illumination is included) will be generated,
- if site security is appropriate.

Distribution / site traffic:

In addition to the above, appropriate access to the site needs to be demonstrated.

The intended end use of the algal biomass is only of relevance to planning permission if it influences e.g. transport movements and site security; the issues raised above are of relevance to use for energy, feed/food and chemicals.

The approach to achieving planning permission will vary according to the chosen site's characteristics and constraints. An appropriate strategy for obtaining permission can be based on assessing the key planning constraints and policies pertaining to the development (i.e. in LDFs and national policy). The following paragraphs give an overview of the steps and timelines involved in the application process.

3.2.2 Overview of the steps and timelines involved in the application process

Pre-application submission / Consultation (optional)²²

Depending on the characteristics of the chosen site, it may be advantageous to seek a pre application meeting with the Council. There is sometimes a fee associated with this meeting and the Council is likely to require details of the proposal together with some plans beforehand. The benefit of this approach is to gain support and seek to address any issues raised up front prior to submission. This often improves the planning application process. It may also be beneficial to contact key consultees such as the Environment Agency to gain their views prior to submission.

²² The following paragraphs have been adapted from a report by URS Scott Wilson on planning for the InCrops Algal Innovation Centre in Cambridge.

Community Engagement

As part of the application process, it is recommended that, where possible, support is gained from the local public. Given the national importance and relatively complex subject of algal growth facilities, depending on the site location, it may be useful to produce a brief letter to inform the local residents or businesses of the proposals and what it will mean to the area. Also, various techniques exist for facilitating public engagement through, for example, collaborative stakeholder workshops, exhibitions or publicity events, where information about the proposed development can be disseminated and community opinions assessed. Being upfront with information often helps to overcome any concerns and often reduces the number of objections received to the application.

Planning Application

The application submission will normally comprise (this list may vary slightly from one district to another):

- Completed Forms and notices
- Site location plan (1:1250 or 1:2500)
- Block plan of the site (1:100 or 1:200) showing any site boundaries
- Existing and proposed elevations (1:50 or 1:100)
- Existing and proposed floor plans (1:50 or 1:100)
- Existing and proposed site sections and finished floor and site levels (1:50 or 1:100)
- Roof plans (1:50 or 1:100)
- Design and Access Statement
- Appropriate fee (based on site area)

The preparation of the application involves completing the necessary forms, and coordinating and compiling all the relevant material (as listed above) including plans from the architect and information from the various specialists as required.

The application should also be accompanied by a supporting planning statement detailing how the proposals accord with current planning policy. We suggest this not only focuses upon local site specific policy but also draws upon the national importance of algal growth projects and their potential contribution towards the climate change agenda, and to developing a green economy. Given the scale and nature of the proposals outlined, information on the:

- transport impacts
- landscaping details
- ventilation/extraction
- site waste management
- noise
- lighting and
- sustainability

will be required, but it is likely that this information can all be included as part of the planning statement.

Other reports that may potentially be required, depending on the site chosen, include a:

- Travel Plan
- Biodiversity Survey and Report
- Flood Risk Assessment

- Land Contamination Assessment, and
- Environmental Impact Assessment (EIA) (especially for sites >0.5 ha)²³.

These documents are all site dependant, and confirmation of what statements the Local Authority will require prior to submission should be sought.

Application Process

The application is usually submitted in an electronic format, online, via a Planning Portal. Each application must be legally valid, contain clear plans and be accompanied by the correct fee in order to be registered by the Local Planning Authority. The planning application process is likely to take either 8 or 13 weeks from registration, depending on whether or not the authority classifies it as a major proposal.

Once the local authority receives the application it is then logged in the Planning Register, which is available for public inspection at the council offices²⁴. Parish Councils, neighbours and other relevant organisations are consulted on applications. Key statutory consultees such as the Highway Authority, Environmental Health and Environment Agency will also be contacted. To publicise the proposed development a site notice will be posted on site for a period of 21 days. If the site is in a conservation area press notices will also be published.

During the application process, a planning officer will inspect the site. From the examination of the site, site history, relevant development plan policies and the results of consultations, a recommendation is made.

Once the application is submitted it is important to remain in close contact with the planning case officer up to determination of the application, in order to address any concerns he or she may have received and overcome any obstacles.

The decision will either be made under delegated powers by the Development Manager and his/her senior officers, or by Planning Committee, which comprises a body of elected Councillors. The application will either be approved, with or without conditions, or refused. A written notice of the decision is sent to the applicant and this includes notes on the right to appeal.

Post Determination

It is likely that the planning authority will apply some planning conditions to the planning permission. The conditions may require information to be submitted prior to any development commencing. It will be important to monitor and coordinate the submission and discharge of these conditions to enable development to commence.

Estimate of Likely Costs

The cost of preparing a planning application (through an appropriate consultancy) will vary greatly depending on the nature of the site chosen and its specific characteristics; £5000 to £8000 excluding VAT and

²³ Some projects may be subject to an EIA due to their nature, location and potential impacts. The EU EIA Directive lists both mandatory projects (Annex I) which must be assessed and also discretionary projects (Annex II) where assessment is determined through indicative criteria and thresholds. The Directive is implemented in the UK under the T&CP Regulations with liable projects identified in Schedules I and II (for more details, see Glasson *et al.* 2011).

²⁴ Example Cambridge: <http://www.scambs.gov.uk/CouncilAndDemocracy/Howtofindus/default.htm>

expenses are a realistic estimate. This figure excludes the provision of architect's plans, but should be assumed to cover:

- Management of the planning application process and liaison with the client
- Identification of Pre Application issues
- Attendance at pre application meeting (Local Authority Fee not included)
- Completion of application form and certificates (Local Authority Application Fee not included)
- Production of a supporting planning statement
- Coordination and liaison with architect for plans
- Submission and monitoring of application during the 8 or 13 week process.

The above scope of work also assumes at this stage that no detailed risk assessments or environmental appraisals are required in relation to issues such as visual impact, noise, traffic, site drainage, contaminated land, flood risk etc. As a rough guide each of these individual pieces of work would tend to range in price from £1500 to £5000 if needed.

3.3 Planning in the Netherlands

General framework: Spatial planning

Spatial planning in the Netherlands reflects both the hierarchy of governance arrangements and the notion that every piece of land should have a designated function. At the national level, planning responsibilities are specified in the Spatial Planning Act (WRO) 2008. The central government produces the strategic '**planologische kernbeslissing**' that provides the general objectives for land use functions and the use of space for the whole country. At the regional/provincial level, authorities describe these objectives in more detail through the **Streekplan**. Finally, at local authority level, structure plans or '**structuurvisies**' and '**bestemmingsplans**', or local land use plans, provide more detailed descriptions of land use functions and spatial planning. While local authorities have to take account of higher level planning, the local municipal plan is legally binding and the most important determinant of planning decisions.

In this respect, under Dutch planning it is the function of the spatial use of the land that would determine where algal cultivation could occur. Certain areas may be designated for agriculture, industry and housing - so the main question for algal production would be whether the process is classified as agricultural or industrial.

3.3.1 Integrated environment planning permit (omgevingsvergunning)

In terms of the application procedure for planning permission, as discussed above a building permit can be combined with environmental permitting (omgevingsvergunning). The law on environmental permitting (**Wet algemene bepalingen omgevingsrecht – Wabo**), introduced in 2010, allows environmental permits to be integrated with building permits and other permissions. This system of integrated physical environmental planning should make applications considerably easier to make in the future as just one needs to be made to the authorities of the municipality. One general requirement, for this and other laws, is that all businesses are required to have a permit. However, an application for an integrated physical environmental planning permit could conflict with the designated function or use of the particular space. In some cases, exceptions can be made by the competent authority/government.

3.4 Planning in the Republic of Ireland

Land use planning in Ireland has similarities with the UK system. The overall framework for land use and planning control is set by the national **Planning and Developments Act 2000**, as amended. The Act is given effect by the **Planning and Development Regulations**. These require local planning authorities to consider national policy objectives in both development planning and their planning decisions. In this respect, the planning authorities of local governments are required to periodically produce strategic development plans according to specific criteria. As in the UK, applications for planning permission are then considered in light of these higher objectives.

In general, under planning legislation, the decision as to whether to grant a planning permission, with or without conditions, is a matter for the relevant local planning authority in the first instance. In making decisions on planning applications, planning authorities must consider the proper planning and sustainable development of the area having regard to the provisions of the development plan, any submissions or observations received from members of the public or the prescribed bodies, relevant Ministerial or Government policies, including any guidelines issued by Government Departments. Planning decisions may be appealed to An Bord Pleanála, the planning appeals board within 8 weeks of a decision being made by the local authority.

Planning exemptions exist for certain developments, including those connected with agricultural activity. Planning exemptions are set out in Section 4 of the Planning and Development Acts 2000-2011 and Article 6 of the Planning and Development Regulations 2001-2012. Schedule 2 - Part 3, of the Regulations sets out those developments connected with agriculture that are exempt. Included in this is Class 9 development which includes glasshouse-type structures with a gross floor space not exceeding 300 square metres. The exemption applies only with a number of conditions and limitations. Class 9 developments appear on page 193 of the Planning and Development Regulations 2001 (S.I. 600 of 2001). The Department of Agriculture should be consulted about what it considers to be agricultural activity as consent systems other than the planning system exist, including one which is within the remit of, and operated by the Dept. of Agriculture.

Some projects may require an EIA. The guiding legislative framework for assessment is determined by the EU EIA Directive. The planning authority will consult with prescribed statutory bodies including the Environmental Protection Agency with regard to developments which may impact upon the environment and may require that an Environmental Impact Assessment be carried out where it is of the view that the development would exceed the thresholds set out in legislation or where the cumulative effects of sub-threshold developments may adversely affect the environment.

Under section 247 of the Planning and Development Act 2000, a developer has the right to a pre-planning consultation with the planning authority to iron out any potential problems which may result in invalidation of the application or likely refusal of permission. It is recommended, therefore, that those seeking to establish algal production contact the relevant planning authority to discuss an application prior to submitting.

3.5 Planning in Germany

Land use planning in Germany reflects its federal system of governance with the federal, state (Länder), regional and municipality (Gemeinden) levels all playing an important role. A central federal steer on lower level development is provided through the **Federal Spatial Planning Act, Guidelines for Regional Planning** and the **Federal Building Code (Ordinance)**. This federal legislation provides the broad framework for planning at the Länder level. States interpret these requirements through their own legislative measures meaning that approaches to planning permission vary from state to state.

The Federal Building Code Ordinance determines, among other criteria, which building measures are free of permission. The federal building ordinance determines for each State what exactly needs to have a building permission and what does not, and what an application for building permission has to look like and what needs to be included. In the State of Lower Saxony, for example, an agricultural company (it is necessary to have/ obtain the so called agricultural privilege) is free of permission to build a greenhouse with a maximum ridge height of 4 m. This regulation could considerably facilitate the construction of the production site for algae (if it involves greenhouses). However, this might be regulated differently in other states of Germany and needs to be checked beforehand. Operators should therefore contact the relevant planning authority for guidance.

Apart from a few exemptions, a building permit is always needed for constructing a production facility, although research projects are generally exempted. What exactly needs to be included into the application documents depends on the building project and its location. Further ordinances and laws need to be considered for the building application. The following legislative rules could play a role in the application process:

- Biomass Ordinance (BiomasseV)
- Federal Emission control law (BImSchG); (incl. air pollution and noise)
- Law on Environmental Impact Assessment (UVPG)
- Waste management (Landesabfallgesetz) (regulated by the respective federal state)
- Bio-Waste Ordinance (BioabfallV)
- Fertilisation Ordinance (DüV)
- Ordinance on Fertiliser (DüMV)
- Law on Water Economy (Wasserhaushaltsgesetz)
- Regulations regarding safety at work

This list is not exhaustive and application depends on the specific project.

3.6 Planning in France

Land use planning in France represents the outcome of national level *aménagement du territoire* – regional planning determined by central government - and physical planning which are the responsibilities of local authorities. This relationship between higher level planning objectives and lower level discretion frames French approaches to land use planning.

At the national level, planning is shaped by central government planning objectives. Spatial development at the regional (prefecture) level is determined by the Schémas de coherence territoriale which is similar to a county structure plan in the UK or the Dutch Streekplan. These provide some context for local authority plans (Plan Local d'Urbanisme (PLU)) which employ zoning to determine where development should take place²⁵.

National planning rules are contained in the '**Code de l'Urbanisme**' or **Planning Code** and associated regulations. It establishes the general rules for planning, including industrial development and also the use of EIA. But while national planning rules regarding permission apply across France, their interpretation varies

²⁵ Land is divided into urban and agricultural areas.

between regions and municipalities/communes. In this respect, the local town hall and the mayor are highly influential in planning decisions.

The procedures for gaining planning permission in France can be complex. Before applying for a building permit, applicants should ensure that the proposed development can be undertaken through acquiring a '**Certificat d'Urbanisme**' (CDU). This document provides the rights to build on the land and should take account of relevant planning laws, plans and zoning. Once this right is established, developers can then apply for one of two types of building permit. Firstly, for small scale developments of less than 20m², a '**Déclaration de travaux**' (or declaration of works) is required. If the development is larger, then a full '**Permis de Construire**' (or building permit) must be acquired.

Applications for a CDU and building permit must be submitted to the local town hall or municipal planning office (DDE). In some cases, the application process will be managed by the prefecture (through the Direction Régionale de l'Environnement, de l'Aménagement et du Logement (DREAL)).

Applications can be made for a CDU by completing an application form containing information on the intended use of the building and plans showing the location and property details. Requests for a building permit must contain a detailed file, again accompanied by plans of the development. For a property over 170m², a professional architect must draft the plans and make the application on behalf of the developer. If permission is granted, the developer must publicise the decision to local people, usually through a sign placed by the property. If permission is refused, the decision can be appealed through the administrative courts.

3.7 Planning in Belgium/Flanders

As with environmental permitting, land use planning in Belgium is devolved to the regional level with separate systems in Wallonia, Brussels and Flanders. Land use planning legislation, regulations and development plans therefore differ across Belgium. In Flanders, land use planning is determined by three main laws: the 1996 Decree on Spatial Planning; 1999 Decree on the Organisation of Spatial planning; and the 2006 Decree on land assets. Each region also produces its development plans, which in turn determine land use patterns. A 10 year strategic spatial development plan (the Ruimtelijk Structuurplan Vlaanderen – RSV) is produced for the whole of Flanders by the regional government to incorporate urban, rural, economic, and transport considerations through land zoning. The RSV provides the context for other sectoral and municipal plans produced in the region and hence all development.

All development requires a building permit. Four main types of permits are employed in the Flanders region: **environmental permits** (see Section 2.7); **subdivision permits** for dividing land for sale or building; and building **planning permission**. Environmental and planning permits can be combined into a **single permit** where appropriate, while minor permits can be issued for commercial installations that have limited impacts. As described in Section 2.7, under the VLAREM regulations environmental permits fall into one of three Categories (1, 2 and 3) depending on the anticipated impacts of the development on the environment.

Gaining planning permission is achieved through a set procedure. Developers must first assess whether planning permission is required by contacting the local planning authority in the region. The authority should give an assessment to this effect – in some cases, the project may be too small to need permission. However, in most cases permission should be sought necessitating an application. The first step of the application process is to contact the local planning office in order to assess the feasibility of the project in the form of a planning report or opinion. Applicants are then required to complete and submit a planning

permission application form. Planners then have a specified time frame in which to respond to the application.

3.7.1 Case study: wastewater treatment in Flanders

Figure 4: Microalgae pilot at Howest, Belgium.
Credit; Sofie Van Den Hende.



As described above in Section 2.1, a microalgal facility was established by Howest in Beitem, Flanders. This portable microalgal bacterial floc (MaB-floc) pilot reactor is currently being operated at Inagro treating wastewater from pike perch cultivation. Establishing the facility involved three steps: initially finding a location to construct and operate the MaB-floc reactor; culturing MaB-flocs to inoculate the pilot reactor; and constructing the reactor. Few issues were encountered with land use planning for the facility, primarily as Howest, in order to better involve local companies, decided to operate the mobile pilot reactor every year at a different location. However, the construction process is instructive for others seeking to successfully establish microalgae facilities in Flanders. One key factor, discussed also in Section 3, is the need to involve multiple stakeholders in setting up the production process. Critically, in this case, Howest collaborated with local companies, universities, local authorities and the community.

To find the location for the first year of pilot operation, Howest launched the First EnAlgae Pilot Call Flanders 2012 in March 2013. In total 19 Flemish companies/research institutions subscribed to this call, reflecting the large interest of Flemish industry in this MaB-floc technology. In April 2012, two participants were preselected for testing in a lab scale MaB-floc reactor: a manure treating SME, Innova Manure, and the Aquaculture Practice Center of Inagro. Based on these lab results amongst others, Inagro was selected as the site to construct and operate the pilot reactor. The contract was officially signed at an EnAlgae info-session in October 2012 which was attended by around 60 participants and the press. Alongside the presentation of Howest about their participation in the EnAlgae project and the first results on wastewater treatment with MaB-flocs, all other EnAlgae partners from Flanders and the Netherlands presented their tasks and first results within the EnAlgae project.

As a second step, MaB-flocs were cultured starting from local microalgae collected from the site of Inagro in 0.5 L photobioreactors (PBR) and transferred to a 2 L PBR in April, then to a 4L PBR in May, and then to a 40L PBR in July. This 40 L reactor was operated with pike perch wastewater until October in Howest. As part of the second investment, an indoor pre-pilot reactor of 400L was constructed to grow MaB-floc inoculum at Inagro. In this pre-pilot reactor, MaB-flocs were cultured and temporarily stored while treating pike perch wastewater from October 2012 till March 2013. The MaB-flocs of this reactor were used to inoculate the MaB-floc pilot reactor. Another function of this 400 L reactor, was to gradually introduce the MaB-flocs reactor concept to Inagro personnel. In this way, experience was gained by Inagro and Howest on the practical issues such as the collection of the wastewater and the reactor operation if wastewater was temporarily unavailable due to blocking of the drum filter or electrical breakdowns.

Before these MaB-flocs could be tested outdoors, a pilot scale MaB-floc reactor needed to be built. To find inspiration for the design and construction of this MaB-floc reactor, Howest organised an algal pilot study trip

to the Netherlands (June 2012) together with the Flemish Algae Platform. In the Netherlands, there is much more experience in algal technology compared to Flanders: over 30 pilot or demonstration scale algae project are being performed compared to only one outdoor photo-bioreactor in Belgium. Around 40 people participated in the visit to the EnAlgae pilot reactors of ACCRESS University Wageningen, next to AlgaeParc, and an algae producing farm Kelstein. In this way, multiple stakeholders were involved as part of the start-up of an algae economy in Flanders.

Thereafter, the MaB-floc pilot reactor was designed and a public procurement process started. Several companies initially showed interest but no proposals were received. Lack of experience in both industrial automation and pond construction were the main reasons. Therefore, the procurement was split into two separate parts, with details sent to several companies. Offers were subsequently received from three of them. The first one, for industrial automation/measuring devices/data logging/container, was commissioned from CATAEL bvba. The second offer, for the construction of the pond/tanks/pumps/flue gas injection/heating system, was commissioned from Bebouwen en Bewaren nv. Both are Belgian SMEs from the NWE region. Between November and January 2013, the pilot reactor was successfully constructed and test runs were performed with wastewater. As stated above in Section 2.7, no permits were needed, except for a permit of Class 3 for the gas tank. This gas tank (with propane) is needed to fuel the gas boiler to heat up the open pond facility.

At the end of January, the pilot reactor was inoculated with MaB-flocs from the pre-pilot reactor. At the end of February, the MaB-flocs density reached a concentration of 0.3 g TSS L^{-1} , indicating good growth. The MaB-floc had settled well. The investment also involved a MaB-floc harvesting system consisting of a hydropress and filter bags. Several samples of a technical textile to produce these bags were sourced from several Flemish SMEs. This was another way to involve local companies in the project. Harvesting tests were performed in March-May 2013. Temporary synthetic flue gas was also injected into the MaB-floc pond. Meanwhile, a system for the injection of flue gas from the gas boiler will be designed and later commissioned.

Besides Howest, who designed and managed all reactor construction and operations, a number of institutions, SMEs and the broader public were involved in several ways in establishing the project. This highlights the importance of wide collaboration for successful project implementation and application of microalgal technology in NWE – a feature encountered in the Strangford Lough macroalgal research conducted by Queens University Belfast (see case study in Section 4.3.2). This collaborative strategy took several forms, namely:

- Involving Inagro by providing wastewater and the pilot location and by being an external member of the procurement commission;
- The Flemish SMEs Bebouwen en Bewaren nv (a local SME specialised in systems for wastewater treatment and ponds) and CATAEL bvba (a local SME specialised in industrial automation), were involved in constructing the pilot. By doing so, these companies have gained experience in algal technology which they did not have before. On the other hand, Howest gained much experience from these companies on how to solve practical issues in a very efficient and fast way;
- Several SMEs/large companies were involved in providing samples of technical textile for the algae harvesting system of the pilot reactor;
- A small company, BMS Wijndepot, was contracted to provide the hydropress;
- Several SMEs were involved in providing parts of the prepilot reactor (pumps, stirring, tanks etc.);
- Ghent University (partner) was involved by being an external member of the Pilot Call Flanders 2013 selection commission and the pilot procurement commission;
- Wageningen University (partner) was involved by hosting the visit and explaining their system during the field trip and during the public EnAlgae info-session at Howest;
- Involving the local community of Roeselare (location of pilot), students of the art Academy have painted the effluent tank of the pilot reactor with algae-graffiti-art;

- Involving multiple stakeholders through organising pilot visits, including: the official pilot launch of the 26th March; the pilot show case on the Inagro open day (25th of August 2012), the visit of students from the University of Wageningen, the visit of students from Howest University, the visit of participants from the Aquaculture Symposium, the visit of international partners from Germany, and also the visit of other EnAlgae partners (KIT & UGent).

3.8 Planning in Switzerland

As specified above, no microalgal facilities have been established in Switzerland meaning that there is no precedent for a planning application. However, Swiss planning practice can be outlined for the purposes of future applications.

As in other federal states (e.g. Germany, Belgium), powers for land use planning are divided hierarchically between levels of governance. The general legal structure is determined by the federal **Raumplanungsgesetz** (Land Use Planning Law) which provides the overarching framework for lower levels to follow. Other important federal laws with relevance to planning applications include the Environmental Protection Law (**Umweltschutzgesetz**), Environmental Compatibility Assessment Act, Noise Control Act, Clean Air Act, Water Bodies Protection Law and the Energy Efficiency of buildings Law²⁶. Due to the devolved nature of Swiss federalism, many powers for land use planning are enumerated to Cantons. Each of the 26 Cantons has its own building laws and development plans that include landscape, residential areas, transport, public utility infrastructure and public buildings. Within each canton, regional level plans are produced that encompass the same issues but in more detail. Finally, local level plans must incorporate national, Cantonal and regional level objectives. Local planning includes the designation of building zones, including industrial, recreational and protected areas and public utilities.

Applications for a building permit are determined by Cantonal legislation but administered locally. Every Canton has its own separate building permit legislation although there are some commonalities. A permit is required for the construction or modification of a building exceeding a certain size, although minor alterations are generally exempt. Permit applications also require the submission of certain documentation, for example site plans. Applications are made to the requisite local authority in the Canton. The local planning authority then assesses the application and can request modifications to the plans. The application can then be approved provisionally, in which case the authority publishes details of the project in the official government gazette while granting the public the opportunity to view the submission for a specified time. On the basis of responses received, the authority will make its decision, either by granting a building permit or rejecting the application. Where the granting of a building permit is denied, the applicant can appeal the decision in court, with the Federal Court having the final determination. One significant consideration in the permitting process is the environmental compatibility assessment, as described above.

²⁶ The federal Environment Protection Law (Umweltschutzgesetz) can apply to aspects of new development. It seeks to protect the environment by reducing air, water, land, noise, vibration, radiation, waste and GMO pollution related to the construction and operation of developments. The Environmental Compatibility Assessment Act mandates that projects involving significant impacts such as power stations, waste treatment facilities and motorways should be assessed. It is therefore analogous to the EU EIA Directive.

3.9 Planning in Luxembourg

General framework: spatial planning

As in the Netherlands and Belgium, the context for land use in Luxembourg is determined by integrated spatial planning. At the national level, this framework is subject to the Law of 21 May 1999²⁷ that established the Programme Directeur d'Aménagement du Territoire, or planning programme, as the main instrument for spatial plan development in Luxembourg. Under this Law, the government is obligated to pursue sustainable development through coordinating sectoral programmes within spatial planning. In this respect, the Programme Directeur is subdivided into inter-related 'sectoriels', for housing, transport, landscape/forests and economic activity. Here, the responsible body is the Ministry of the Interior (Ministère de L'Intérieur et de l'Aménagement du territoire).

Although regional level plans exist in Luxembourg (plan directeur regional) that implement national spatial planning in six regions, it is the municipalities (communes) that largely determine development within this overarching national/regional framework. Local municipalities (communes) have constitutionally-enshrined powers for planning at the local scale. As mentioned in Section 2.9, at the operational level, two types of plans have significance for industrial developments in communes: the general development plan or plan d'aménagement général (PAG); and the corresponding special development plan or plan d'aménagement-particulier (PAP)). The PAG covers the whole of the commune area and establishes zoning for specific activities, including industry. The PAPS are for areas designated in the PAG. Although local authorities have power to determine these plans, nonetheless they are subject to Ministerial approval in conjunction with the Spatial Planning Commission (Commission d'Aménagement).

Building permits

Building permits (autorisation de construire, autorisation de bâtir or permis de construire) are issued on the basis of the PAG but in certain cases can be determined under the requisite PAP. A permit is required for all building activities, including construction and demolition. While application procedures vary according to the building regulations (règlement sur les bâtisses) of the specific commune, some commonalities are evident (guichet.lu 2013e). Applicants must first prepare a dossier comprising certain types of document, which will vary according to the local commune. For example, the submission will invariably require: details of the relevant designation under the PAP; a site plan; a more detailed layout plan; construction plans; and an energy performance certificate. All plans should be drafted by a registered architect or construction engineer. Once the dossier has been compiled, applications can be submitted using the standardised form provided by the commune. A decision by the Commune Mayor can take several months, during which time local people can inspect the application plans and make representations. As procedures can differ between communes, operators of algal facilities should ideally consult with the relevant local authority before compiling the dossier.

²⁷ Loi du 21 Mai 1999 concernant l'aménagement du territoire. Additional instruments were introduced in 2004 for urban planning – Loi du 19 juillet 2004 concernant l'aménagement communal et le développement urbain – and in 2005, modifying earlier planning laws – Loi du 19 juillet 2005.

3.10 Comparing land use planning

The above analysis allows cross-national comparison of land use planning practice that can be synthesised into a Table 2. All countries have one single national legal measure for planning, although it is the regional/state/local level that is overtly responsible for decision-making within the guiding context of national development objectives. The main planning mechanism employed across Europe is a building permit, although in the Netherlands and Germany this can be integrated with the environmental permitting process.

Table 2: Differences in land use planning in European countries.

Country	Main implementing legislation	Primary planning authority	Planning mechanism
UK (England and Wales)	Town and Country Planning Act 1990, as amended	Local planning authorities (LPAs)	Planning permission
The Netherlands	Spatial Planning Act (WRO) 2008	Local planning authorities (municipalities)	Integrated physical environment planning (omgevingsvergunning)
Republic of Ireland	National Planning and Developments Act 2000	Local Planning Authorities (LPAs)	Planning permission
Germany	Federal Zoning Law Building Regulations Law (Bauordnungsrecht)	Local building authority (Bauamt)	Building permit (Baugenehmigung)
France	Code de l'Urbanisme	Local municipality/commune	Permis de Construire
Flanders/Belgium	Flanders Planning Decrees	Local planning authority	Building permit
Switzerland	Federal Raumplanungsgesetz Cantonal legislation	Local authority/Commune	Building permit
Luxembourg	Loi du 21 Mai 1999 concernant l'aménagement du territoire	Local authority /commune	Building permit

4 Macroalgae – Permitting and Marine Planning

4.1 Introduction

Despite the Common Fisheries Policy (CFP), until recently there was no coherent EU policy for managing marine resources. However, a more 'joined-up' approach is now emerging with the introduction of the Marine Strategy Framework Directive (MSFD) in 2008, which will form the environmental component of an EU Integrated Maritime Policy. The MSFD requires Member States to produce regional marine plans that integrate economic, social and environmental priorities into strategic development objectives. Integrated coastal zone management (ICZM) has also been encouraged²⁸, although not compelled, by the EU to guide development in coastal areas. The EU is also committed to a 'blue growth' strategy that seeks to enhance the economic potential of marine resources, including providing opportunities for the biotechnology, food and energy production sectors (European Commission 2013).

That said, there appear few dedicated regulatory measures that affect algal production apart from Regulations introduced to support organic food production that cover some seaweed products designed for human consumption:

- Regulation (EC) No 834/2007 of 28 June 2007 on organic production and the labelling of organic products, repealing Regulation (EEC) No 2092/91;
- Regulation (EC) No 889/2008 of the Commission of 5 September 2008 on the measures on the application of Regulation (EC) No 834/2007 of the Council relating to organic production and the labelling of organic products with regard to organic production, the labelling and controls;
- Regulation (EC) No 710/2009 of the Commission of 5 August 2009 amending Regulations (EC) No 889/2008 on the measures for implementing Regulation (EC) No 834/2007 with regard to organic production of aquaculture animals and seaweed.

In this context, national measures are the most influential on the emerging macroalgal industry - but there is significant variance in approaches, with countries such as France and Ireland having long-established measures to regulate established small-scale seaweed industries. Other countries such as the UK, Netherlands, Germany and Belgium have only limited macroalgal industries while Switzerland and Luxembourg have no coastline. This section therefore compares how macroalgal production is licensed and subject to planning requirements. Regulation of end-products is not discussed as this is covered in detail in Section 5 later. Given the limited data available from several states, this section focuses primarily on the UK, Ireland and France.

4.2 Permitting, planning and regulatory situation in the UK

Seaweed has been harvested in the UK and the Channel Islands for centuries. In Wales, the seaweed purple larver (*Porphyra umbilicalis*) is a popular food in western counties such as Pembrokeshire. Seaweed has also been traditionally employed as a fertiliser by farmers in the Channel Islands and parts of Scotland such as the Hebrides. Despite its long history, seaweed production, mainly from wild harvesting, in the UK is currently quite small scale (6000 tonnes per annum) and limited mainly to parts of Scotland, Wales and

²⁸ <http://ec.europa.eu/environment/iczm/home.htm>. See also, EC Recommendation (2002) concerning the implementation of integrated coastal zone management in Europe.

Northern Ireland where biomass is used for food, agriculture and healthcare products (NetAlgae 2012). Individuals have also been recently granted rights to collect seaweed from beaches in England, primarily to service high-end Asian restaurants with edible species such as dulse and kelp (Daily Mail 2012). In addition, research has been conducted into the viability of kelp farming in areas of England (see Atkins Ltd 2010), Scotland (the Biomara Project)²⁹ and in Northern Ireland (see case study below).

No specific legislation exists to control seaweed production in the UK, meaning it is regulated through several general marine and environmental protection measures³⁰. As discussed above, differing regulatory systems exist between England and Wales, Scotland and Northern Ireland meaning licensing procedures vary.

4.3 Licensing/permitting

Licensing issues in the UK context have been discussed in some detail already in the NetAlgae project (e.g. NetAlgae 2012). Under the **Marine and Coastal Access Act (MCAA)** 2009, activities listed in Part 4, Chapter 1, must apply for a licence. Before applying for a licence, applicants must first determine ownership of the resource in order to gain permission for the activity. Land between mean high water (MHW) and mean low water (MLW) can be privately owned. Other land, amounting to around 50% of the UK foreshore and most of the seabed, from MHW to 12 nautical miles offshore is owned by the government and is managed by the **Crown Estate**. A lease must be obtained from the Crown Estate prior to undertaking the activity on this property.

The nature of any licensing then depends on the specific activity: the wild harvesting of seaweed or commercial aquaculture (NetAlgae 2012) – Table 3. Wild harvesting of seaweed in England is licensed by the **Marine Management Organisation (MMO)**, in Scotland by **Marine Scotland** and **Scottish Natural Heritage**, in Wales by the **Welsh Assembly** and the **Countryside Council for Wales**, and the **Department of Environment, Marine Division**. Licensing for wild harvesting follows much the same procedure in each country, whereby licences are issued after an application process that involves sending an application form and specified documents to the relevant agency.

Commercial aquaculture is licensed under provisions in the MCAA (Part 4, Chapter 1). In England, the **MMO** is responsible for licensing marine activities. Applications for licences are checked for compliance with the EU Habitats and Water Framework Directives. Depending on the nature of the development, they may also be subject to an EIA. In the future, applications will also be assessed with regards marine plans currently being prepared under the obligations of the MSFD. The MCAA is implemented in Scotland by the Marine (Scotland) Act 2010. Under its provisions, **Marine Scotland** is responsible for issuing and administering licences for the Scottish inshore region to a distance of 12 nautical miles from the coast. Marine activities in Wales are licensed by the **Welsh Assembly Marine Consents Unit (MCU)**, while in Northern Ireland this function is undertaken by the **Marine Division** (part of the Department of the Environment).

Although application procedures differ between these jurisdictions, the example of Scotland is instructive³¹. Applicants should first contact the licensing authority to request a meeting. Marine Scotland can then offer

²⁹ www.biomara.org

³⁰ The Environmental Protection Act, Town and Country Planning Act, Marine and Coastal Access Act 2009, The Marine Scotland Act 2010.

³¹ A detailed description of the application process in England is provided by the MMO (2011).

advice on the application process. A pre-application consultation may be relevant where the development could impact local communities as it also gives a chance for them to be involved in assessing the application. A pre-screening meeting may also be required if the project could be subject to an Environmental Impact Assessment (EIA). In this case, screening will be conducted by the authority to decide on whether an assessment is needed before a licence can be issued. Any decision will be taken in conjunction with statutory consultees, as determined by the Marine Licensing (Consultees) (Scotland) Order 2011³². Relevant nature conservation agencies are also consulted if the project may impact a Natura 2000 site, as designated under EU nature protection directives. In this case, a Habitats Regulations Appraisal will be needed. Public participation in the applications procedure is achieved by publication of any application and the invitation of representations from persons with an interest in the development. Decision-making should take any public submissions into account.

Table 3: Licensing authorities for wild harvesting and commercial aquaculture in UK countries (derived from NetAlgae 2012).

	Licensing authority England	Licensing authority Wales	Licensing authority Scotland	Licensing authority Northern Ireland
Wild Harvesting	Marine Management Organisation (MMO)	Welsh Assembly/Countryside Council for Wales	Scottish Government - Marine Scotland/Scottish Natural Heritage	Department of Environment, Marine Division
Commercial aquaculture	Marine Management Organisation (MMO)	Welsh Assembly Marine Consents Unit (MCU)	Marine Scotland	Department of Environment, Marine Division

4.3.1 Planning

Marine licensing is increasingly being integrated with marine spatial planning. The Marine and Coastal Access Act 2009 implements the EU MSFD by dividing the UK marine environment into ten regions, each with its own plan development process. In England, the MMO is the planning authority while separate arrangements exist in each of the devolved national administrations. While currently government Marine Policy Statements provide the planning framework for assessing licensing of projects, the marine plans will eventually form the basis of any licensing procedures. One key issue for deciding licensing of marine activities such as aquaculture/algal production will undoubtedly be proximity to protected areas, in particular Marine Protected Areas.

Marine plans are also designed to integrate with terrestrial land use planning (see Section 2). Some projects such as wind farms will require cables and shore based facilities, so marine plans will take account of such developments. This factor may have implications for offshore algal production as onshore processing facilities may be required. Here again, the proximity to conservation areas such as Special Protected Areas

³² These include the following organisations: SEPA; Scottish Natural Heritage; and the Maritime & Coastguard Agency.

(SPAs), Special Areas of Conservation (SACs) and Sites of Special Scientific Interest (SSSI) will be a key consideration (see, for Atkins 2010).

4.3.2 Case study: Strangford Lough, Northern Ireland

Queen's University Belfast (QUB) has established a macroalgal research facility at the Queen's Marine Laboratory at Portaferry, on Strangford Lough in Northern Ireland. A pilot site has been established, aimed at the future production of kelp (*Laminaria digitata*, *Saccharina latissima* and *Alaria esculenta*). The project, aimed at assessing the viability of using macroalgae for bioenergy gas production, has developed techniques for creating macroalgal cultures, established a hatchery facility and also an on-growing process based on transferring juvenile macroalgae to longlines in the Lough.

Production is complicated by the protected area status of Strangford Lough and the multiple users of this natural resource. Over 32 kilometres in length, the Lough is the largest feature of its kind in the UK and Ireland. Part of the Lough is an Area of Outstanding Natural Beauty (AONB), while a Marine Nature Reserve (MNR) encompassing the area was designated in 1995³³. The MNR obliges the Northern Ireland authorities to conserve marine fauna, flora or physical features and also provides opportunities for research into these resources. In addition, parts of the Lough are subject to designations as a Special Protection Area (EU Birds Directive), a Special Area of Conservation (EU Habitats Directive), a Ramsar Site for the protection of wildfowl, and as an Area of Special Scientific Interest (ASSI). Human activities must therefore coexist with these various protected areas. Multiple users of the waters include anglers, commercial aquaculture, boatowners, shellfish collectors, potfisheries, wildfowlers and also researchers. Indeed, as mentioned above, the MNR dictates that the Lough should be used for educational and research purposes.

However, the QUB research project raises some issues over the regulation of research activities. A licence for the site was obtained several years ago, with an environmental survey conducted as part of the application. Conditions of the licence provide permission to grow locally indigenous seaweed species on longlines in a 7-8 hectare area of the Lough, with activities monitored by the Marine Division and local councils. Yet it is uncertain precisely how plans by the researchers to cultivate selectively bred seaweeds in the future would be regulated. Enquiries made by the research team suggest that none of the regulatory agencies in Northern Ireland or England were aware of the exact regulatory context other than a Change of Use Licence would be required, which may entail a new EIA. This issue suggests that the novel nature of such algal production processes is running ahead of current regulatory frameworks.

Another issue faced by the project has been how to engage with other users of the Lough to reduce operating problems. Several engagement techniques have been employed. Firstly, consultations have occurred since before the start of the project with local stakeholders via the Strangford Lough and Lecale Partnership (SLLP). Consultations initially focused on the re-installation of the longlines prior to any work being conducted, thereby allowing any objections to be voiced from the start. Secondly, as the SLLP does not include all stakeholders to the same extent, consultation has occurred on an individual basis with certain users. Thirdly, a highly successful programme of educational outreach, based on giving talks in local schools, has been undertaken in order to directly inform children, and thereby indirectly their parents, about the benefits of bioenergy research in the Lough. Further engagement will occur through a Marine Lab Open

³³ The MNR includes all waters, seabed and Lough shores below mean high water mark. The designation was made under Article 20 of the Nature and Conservation and Amenity Lands (NI) Order.

Day and the Turn of The Tide Festival, both of which will feature a substantial EnAlgae presence. Finally, a conscious decision was taken to work with local businesses as a means of securing stakeholder support and generating trust. For example, tenders for the longlines were placed with a Belfast company who then subcontracted work back to local fishermen. Engaging local fishermen in this way, to an extent, helped diffuse any potential objections to the research by demonstrating that it did not present a threat to their activities.

Another conclusion from the QUB research is consequently that effective stakeholder engagement can help avoid objections to the establishment of macroalgal production. The early inclusion of stakeholders could then also be seen as an important prerequisite in the initial planning application and permitting process: a lesson for future operators in the UK and elsewhere.

4.4 Permitting, planning and regulatory situation in The Netherlands

Few examples of macroalgal production were found in the Netherlands during this survey. Some research is being conducted into macroalgal production by Ecofys in conjunction with the Netherlands' Energy Research Centre (ECN), with a new facility established offshore from Texel in North Holland in 2012. The project seeks to combine wind power generation with macroalgal cultivation. A seaweed cultivation facility, measuring 20 by 20 metres, has been constructed within an existing wind farm to grow naturally occurring algal species, with biomass produced intended for research into biofuel and protein production (see Ecofys 2012).

Despite the limited development of this industrial sector in the Netherlands compared to other countries, some regulatory issues are nonetheless significant for its future growth. Marine permitting and planning is similar compared to onshore developments. Firstly, industrial developments such as wind farms and energy production facilities must be permitted. Secondly, in order to receive a permit, projects must also be assessed against the objectives of marine spatial planning and environmental concerns. As with onshore production (Section 2), permitting and planning are interlinked, therefore we can consider these two factors together in relation to any potential macroalgal production facility.

4.4.1 Licensing/permitting and planning issues

Offshore energy production is subject to marine spatial planning (MSP). Introduced as the Integrated Marine Plan for the North Sea 2015 (IMPNS) in 2005³⁴, marine planning sought to reconcile conflicts between recreational, transport, energy, conservation and resource exploitation demands (IDON 2005). The Plan was developed by collaboration between several ministries under the coordination of the Interdepartmental Directors' Consultative Committee North Sea (*Interdepartementaal Directeurenoverleg Noordzee* (IDON)). This system initially established 'use zones' for specific private sector activities such as shipping or gravel extraction (*ibid.*). A more strategic approach was adopted after the implementation of the EU MFSD³⁵. Marine spatial planning became incorporated into wider national objectives, in particular those for water quality, in the Policy Document of the North Sea 2009. In this respect, MSP became part of the National Water Plan (*Nationaal Waterplan*) 2009 and was implemented under the national Water Act, and not land-use planning legislation. The Dutch government then extended MSP across the full EEZ (national exclusive

³⁴ The IMPNS formed a new chapter in the National Spatial Planning Document published by VROM, the Dutch ministry for housing, spatial planning and the environment (UNESCO-ILO 2012).

³⁵ MSP also integrates with the EU Water Framework Directive 2000 which also applies to coastal waters.

economic zone) in 2010. Although technically only having advisory status for planning decisions, MSP nonetheless obliges the government to take decisions in accordance with it (UNESCO-ILO 2012).

As in the original IMPNS 2015, the approach of MSP involves dividing marine areas into sectoral zones. Areas within 1 km of the Dutch coast are subject to normal land use planning under the competent municipal authority (see Section 2). The MSP extends from this coastal area out to the limit of Dutch EEZ territorial waters. Specific zones are reserved for wind farms and energy production, shipping, gravel extraction and nature conservation (for example, Natura 2000 areas). The plan regulates the use of activities in these zones, which in turn are licensed through a permit system.

The permitting system was introduced by the IMPNS. According to IDON (2005: 65) 'providing permits has been and remains an important instrument for regulating activity in the North Sea'. One important feature of the permitting approach introduced is an integrated assessment framework that aims to 'consider the admissibility of the economic activity concerned for each permit application, on the basis of spatial aspects, ecological and environmental consequences and the conditions and constraints to be attached to the permit' (*ibid.*).

Meeting this aim involves initially examining the need and scope of the assessment (IDON 2005). A permit is only required for certain activities, with shipping, gravel extraction, fishing, military usage and recreation exempt. If significant environmental effects are anticipated from the development, an EIA as well as the integrated assessment may have to be undertaken. Of particular consideration here are any impacts on designated nature protection areas such as Special Areas of Conservation (SACs) under the EU Birds and Habitats Directives and nationally significant ecological resources. Once the need for an integrated assessment is established, along with its scope, five separate steps must be undertaken. Firstly, the spatial extent of the development must be established. The applicant describes the activity, any potential effects and the space required in writing as part of the application. Although not part of the assessment per se, the description forms an important part of the information used in the assessment. Secondly, the precautionary principle is considered. Applicants are required to show that preventative measures have been incorporated into project designs or production processes to avoid long term or irreversible damage to the environment. Where an EIA is requested, which is likely where the activity is novel to the North Sea, such measures should be described in the Environmental Impact Statement that accompanies the application. Thirdly, applicants have to demonstrate the usefulness and necessity of the activity, although with energy projects such as wind turbines this may relate to their promotion through national/EU policy. Fourthly, the choice of location and use of space must be justified. Activities are determined according to zones in the MSP and new development in or near areas of ecological value are not permitted unless there is an evident public interest or no alternatives exist. Finally, mitigation and compensation for ecological impacts must be provided for, with measures assessed by the competent authority. As the framework applies to all of the EEZ, any activity that could impact an SAC within it could require a licence even though it is exempt under other circumstances.

Offshore algal production would be restricted by the requirements of MSP, although the exact permitting and planning arrangements may vary according to the project type. According to IDON (2005: 74), new mariculture activities would likely require an EIA or integrated assessment although it is unclear precisely how the permitting obligations apply to macroalgal production. The Ecofys Texel research project did not require a permit since it is conducting research. However, the project is linked to a wind farm, which would require an assessment and EIA, and it would probably then be subject to permitting if scaled up to commercial production.

4.5 Permitting, planning and regulatory situation in the Republic of Ireland

Seaweed has been harvested for fertiliser and food for centuries in Ireland. The burning of kelp for the production of iodine was also an important export industry in the past (Walsh 2012). Although seaweed production peaked in the 1970s (*ibid.*), the macroalgae industry still remains an important economic sector. In 2011, the industry employed over 185 full-time equivalent people and generated around €18 million per year, with almost all seaweed harvested in the western coastal counties of Donegal, Sligo, Mayo, Galway, Kerry and Cork (Morrissey *et al.* 2011; see also Walsh 2012). Much of this production is still used to produce agricultural and horticultural products, in addition to smaller quantities of food and cosmetics (*ibid.*).

Two main types of production are evident. Harvesting from the foreshore occurs on land and the seabed between the high water mark and the twelve-mile limit, which is owned by the government. Commercial growing of macroalgae is classed as aquaculture and is subject to different regulations.

4.5.1 Licensing/permitting issues

Two main legislative acts determine macroalgal production in Ireland. Seaweed can be harvested from the foreshore (seabed or shoreline) according to the provisions of the **Foreshore Acts**. They require that a **foreshore consent (licence)**³⁶ must be obtained from the relevant Ministry (Foreshore Unit, Department of Environment, Community and Local Government DECLG) for activities such as seaweed collection conducted on the foreshore. Licences last five years and are subject to an annual fee payable to the government (Walsh 2012). Fees are decided on a case by case basis although are usually of a nominal amount.

The application process involves completing a form, available from the **Department of Environment, Community and Local Government** website³⁷. The form must be accompanied by a map showing the location of harvesting and plans of any facilities. Information requested on the form includes a description of the activities, a statement of reasons for the activity and details of any impacts on other uses of the marine area and whether an EIA is required.

The Department recommends that applicants first consult with them prior to any application. A key consideration is whether the project requires an Environmental Impact Statement to be generated under an EIA process. Thereafter, non-EIS plans are displayed for 21 days for public comment. Any objections to the application must be made to the Department within this period. The Department will then prepare a report containing its decision on whether to grant the licence and any conditions attached to it. The Minister then takes a decision on granting the licence. Walsh (2012) states that the process can take some time (1 - 1.5 years) as multiple agencies must be consulted.

The Department for Agriculture, Food and the Marine (DAFM) is the competent authority responsible for commercial aquaculture. Under the **Fisheries (Amendment) Act 1997**, the Aquaculture Licensing Section of the DAFM issues licences for commercial aquaculture activities, including the cultivation of seaweed. Applications for a licence should be made directly to the DAFM. Here, applicants must be able to demonstrate that they can undertake the proposed activity with a high degree of professionalism. Applications again must include maps, site plans and detailed descriptions of the activities and relevant measures for health and safety, waste management and marketing strategies. The Department must then

³⁶ A lease is required for the occupation of the foreshore with a facility, e.g. a jetty.

³⁷ <http://www.environ.ie/en/Foreshore/ApplyingforaForeshoreConsent/>

consider the suitability of the site for the proposed activity, other users of the waters (or land), the status of the waters regarding local development plans, and any likely economic, cultural or environmental effects. In respect of the latter, an EIA may be required for certain activities. Another factor for consideration is whether the activity involves discharges of trade or sewage effluent, since it will then require another licence³⁸. Under the old licensing system, two types of licence could be requested, namely:

- **Aquaculture Licence:** licensees are permitted to undertake a specified form of aquaculture for a pre-determined period, not normally in excess of 20 years;
- **Trial Licence:** licensees can undertake investigative or experimental aquaculture activities over a short period, generally not more than 3 years.

However, the system is currently being updated. A revised licensing system was first announced in December 2011 by the Minister, Simon Coveney TD (DAFM 2011). New aquaculture and foreshore licence templates are subsequently being phased in to account for technological, environmental and legal issues that emerged after the first licences were issued under the Fisheries (Amendment) Act 1997. The main changes include:

- a move to Standing Stock Biomass for finfish as the means of measuring production capacity at an aquaculture site;
- enhanced provisions on environmental monitoring;
- greater clarity on the requirements for operators in relation to operational conduct and monitoring;
- the possibility for the group-marking of sites for navigational purposes;
- specific provisions covering company registration/dissolution, tax certificates, payment of fees etc.(DAFM 2011)

A new aquaculture licensing system is also under implementation that introduces seven templates, as opposed to the one previously in use, where operators indicate which type of aquaculture is applicable:

- Marine based shellfish e.g. mussels, typically using longlines
- Marine based shellfish sea-bed bottom culture e.g. mussels, oysters, scallops - no structures are used
- Marine based shellfish inter/sub tidal e.g. oysters, typically using bags and trestles
- Marine based aquatic plants/fish food e.g. seaweed using longlines
- Marine finfish e.g. salmon, rainbow trout, cod - using cages
- Land based finfish (freshwater), mainly hatcheries for salmon farms
- Marine multi species - to provide for cases where multi method or multi species are used e.g. a combination of longlines and trestles, mussels and oysters etc. (DAFM 2011)

As these templates are still yet to be fully rolled out, operators must currently apply for the old template but are automatically issued with a new style of licence. However, this process can be extremely lengthy and a wait of up to three years is not unusual. One reason for this long delay is the large backlog of licences for all forms of aquaculture currently under consideration by the Department, thereby providing a major obstacle to developing a seaweed industry in Ireland. More positively, the new system allows the chance to apply for a multi-species licence, opening the door for Integrated Multi-Trophic Aquaculture (ITMA) – potentially an important tool in sustainable aquaculture practices.

Applicants primarily conducting activities such as harvesting seaweed from beaches or constructing facilities on the foreshore for this purpose should apply for a **foreshore licence or lease**.

³⁸ Under section 4 of the Local Government (Water Pollution) Act, 1977.

4.5.2 Land use planning

Engaging in aquaculture activities such as seaweed production could involve some planning considerations. Any development on the foreshore will require planning permission from the Local Planning Authority even if a license is granted by the government. It is advisable, therefore, that before an application is submitted for a license, the LPA is consulted on the viability of the proposed activity. In cases where certain developments are proposed, the applicant may be asked to prepare an environmental impact statement (EIS)³⁹ if the activity presents significant environmental effects. For example, an EIA will be required if the activity is located close to a Natura 2000 conservation site (under the EU Habitats Directive). Where an EIA is required, planning applications should be submitted directly to An Bord Pleanála (under Part XV, Planning and Development Act 2000). National regulations stipulate a public consultation period of 8 weeks as part of the EIA process, while a copy of the EIS must be submitted to statutory consultees⁴⁰. As mentioned above, if an outfall or discharge pipe will be laid on the foreshore, a water licence must be obtained from the EPA or local authority.

Ireland is also developing marine planning, although this is at a very early stage. The permitting and planning system is likely to change when these become operational. The **General Scheme of a Marine Planning Bill** was introduced in 2011, with the strategic objectives to:

‘Integrate the foreshore permitting process for major infrastructure projects within the strategic permitting process operated by An Bord Pleanála, and for non-strategic projects within the wider planning system operated by local authorities;

Provide for a plan-led approach to the foreshore through the development of integrated coastal management objectives within the existing planning hierarchy to manage the interface between terrestrial planning and foreshore development; and provide for a new statutory MSP framework.’ (UNESCO-ILO 2012).

4.5.3 Case study: Dingle Bay Seaweeds, County Kerry

Figure 5: Off shore cultivation of algae on longlines in Ireland. Credit: Benoit Queguineur.

Dingle Bay Seaweeds (DBS) is an Irish partnership, which was started in 2005 with the purpose of developing a seaweed aquaculture business, using algae native to Ireland. Products derived from the DBS cultivated seaweeds include a pet food supplement, and a racehorse dietary supplement.

The partners of DBS had no previous direct experience of growing seaweeds before starting the business, but collectively have many years related experience as



³⁹ The relevant categories of development are contained in the European Communities (Environmental Impact Assessment) Regulations, 1989 to 1999.

⁴⁰ The European Communities (Foreshore) Regulations 2009.

fishermen and chandlers. Through this work and their location in the southwest of Ireland, they were also involved in aquaculture development projects (e.g. gear design for salmon and mussel farms). At the time of doing their market research prior to setting up DBS, the partners investigated the potential of a variety of aquaculture scenarios. They identified that the mussel industry might be too much of a challenge for a new business, but that there was a potential for seaweed cultivation in Ireland. Therefore, approximately 7 years ago, DBS started the process of applying for an aquaculture licence to grow seaweed in Ventry Harbour, County Kerry.

Ventry Harbour is a sandy bay on the Dingle Peninsula on the west coast of Ireland, surrounded by farmland, interspersed by low-density housing and no industry. The bay is sheltered from most weather, exposed in the main to south easterly winds. It is not subject to any conservation protection (i.e. Special Area of Conservation/ Special Protected Area). Once this site was chosen for future seaweed cultivation, DBS informally contacted as many of the relevant agency and departmental representatives as possible to ascertain whether it was likely that a licence application in this area would be successful. Of particular assistance was the southwest Regional Development Officer of Bord Iascaigh Mhara (BIM; The Irish Sea Fisheries Board) who offered advice and practical assistance throughout the whole of the application procedure. Through general consensus, DBS were advised to apply for a trial licence (3 year duration), which was duly achieved in 2009 for an 18 ha. site in Ventry Harbour. In recent years, a considerable backlog of licence applications has developed at the Department of Agriculture, Food and the Marine. Therefore it must be noted that it is difficult to compare the success of this particular licence application with any others, because the vast majority of other aquaculture licences being sought were for salmon and shellfish aquaculture.

While the trial licence enabled DBS to deploy cultivation equipment as soon as it was granted, there were some delays and setbacks associated with the process. For example, the licence was granted in October 2009, but due to the seasonality of the species of seaweed cultivated, it was impossible to deploy the structures and seeded material during that same year. Therefore it was nearly 1.5 years later that the first harvest was achieved. There was also a financial setback associated with the trial licence, whereby DBS could not access financial assistance from BIM; funding was only concurrent with a full aquaculture licence. Conversely, the benefit of having a trial license enabled DBS to carry out gear behaviour and cultivation/growth trials at the site which then formed part of the report submitted with the application for a full license which was granted without delay in 2012.

Throughout the process of obtaining a trial and full licence to cultivate seaweed, DBS have been provided with assistance from BIM in the form of practical/technical assistance, application preparation and financial support. The National University of Ireland, Galway (NUIG) has also provided technical and advisory support to DBS. Within the EnAlgae project, NUIG has access to the DBS site at Ventry Harbour in order to gather data from the seaweeds cultivated at the macroalgal pilot facility installed as part of the project.

Since obtaining a licence in Ventry Harbour, DBS have steadily developed the 18 ha. site, experimenting with several different deployment structures. The first iteration (2010) included one horizontal longline (230 m) and one 30-m² horizontal grid. Vertical droppers were also trialled. In 2011, structures on the site were increased to include ten 220-m horizontal longlines and a 50-m² grid. The grid structures were relatively easy to deploy and held more seeded material per hectare than the horizontal longlines; however, deployment and harvesting of the seaweed was more difficult to accomplish, so the design was abandoned in favour of horizontal longlines. In 2012, the mooring system was adapted and expanded from those of the previous year to enable more longlines to be added to the site. Currently, the site is almost at capacity and holds forty-five 280-m horizontal longlines. Deployment and harvesting methodologies have also been developed during this time, which continually increase the efficiency of the macroalgal biomass production.

Looking to the future, DBS hope to increase their seaweed production, but are now reaching capacity at the Ventry Harbour site. They have identified a new site and have started the licence application process in a similar way to the Ventry Harbour site. This has been ongoing for two years, and despite regular communication and discussion with the licensing authorities (the Department of Agriculture, Food and the Marine), a confirmed result is outstanding.

4.6 Permitting, planning and regulatory situation in Germany

Only a few research establishments are conducting studies on macroalgal production in Germany. Consequently the industry is quite limited at present in both Baltic and North Sea coastal areas. Some federal regulation of aquaculture exists, although primarily this encompasses onshore fish farms and also mussel production. In addition, Germany has introduced marine spatial planning, which can be discussed in relation to potential offshore algal production. It is unclear, therefore, precisely how macroalgal production would be regulated.

4.6.1 Licensing/permitting and planning issues

Responsibilities for aquaculture, coastal and marine resources are highly complex in Germany, reflecting the multi-level federal nature of governance. Both federal and Länder legislation exist for aquaculture but while federal exclusive competences extend to waters beyond the 12 nautical mile zone, the Länder have concurrent powers over activities in inland coastal waters and onshore. According to the FAO the federal Seefischereigesetz (Fisheries Act) covers sea fishing and aquaculture but different state fisheries legislation (Fischereigesetz or FischereiG) exist in the sixteen Länder. However, these measures mostly relate to the permitting of onshore fish farming, primarily of trout and carp, with some limited mussel farming conducted in the North Sea Länder. In fact, Länder legislation generally only refers to the regulation of aquatic animals not seaweed (FAO 2012). Other federal and state laws may also be significant, including those on water and wastewater charges (*ibid.*). The federal body responsible for aquaculture is the Federal Ministry of Consumer Protection, Food and Agriculture (Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft – BMVEL).

For developments on land and in coastal zones, state regulations on land use planning (Section 3.5) apply. Aquaculture facilities require a building permit and may be subject to an EIA. However, for offshore developments, macroalgal production will be subject to marine planning. Introduced under amendments to the federal Land Use Planning Act 1997 (the Raumordnungsgesetz (ROG)) planning, the German system of planning extends from 12 nautical miles offshore to the limit of the EEZ in both the Baltic and North Sea. Three types of zones are designated: 'priority areas' for activities such as shipping; 'reservation areas' which privilege specific use functions; and 'marine protected areas' designated under EU and national nature protection measures. Activities generally require approval which differs according to use function. Energy production, mostly wind farms, and aquaculture/mariculture is subject to assessment by the competent authority. Research facilities do not require a licence.

4.7 Permitting, planning and regulatory situation in France

As in Ireland and the UK, seaweed has been harvested in some areas of France for centuries, mostly as a fertiliser but also for chemicals. Main areas of production are concentrated in Brittany where seaweed, primarily kelp, has been harvested since the 1600s by locals for fertiliser, feedstock, fuel and, more recently, for chemicals manufacture. Between the 1700 and 1900s, kelp was processed to extract nitrates for fertiliser, soda for glass production and also iodine for pharmaceuticals. Although these industries declined during the 20th Century, the manufacture of alginates has since become more economically significant. According to NetAlgae (2012), the French seaweed industry now produces nearly 60,000 tonnes annually; almost all from seaweed harvesting. Around 75% of this production is used in food processing, chemistry and microbiology, with smaller amounts utilised for agriculture, water treatment, health/cosmetics products and food (direct consumption) (*ibid.*).

The legal framework for aquaculture, including seaweed production, is set by national legislation, with regulations divided into land based and marine activities (European Parliament 2009). Land aquaculture is generally regulated by the Environmental Code (see Section 2). For marine aquaculture, the main national measures are Law No. 97-1051 (as amended) on Maritime Fisheries and Mariculture, in addition to the:

- Decree of January 9th, 1852 on Maritime Fisheries (as amended 2010 by **Ordinance no. 2010-462**), that regulates the farming of marine animals and plants;
- **Decree No. 90-719** 1990 that identifies the types of seaweed farming that can be engaged in⁴¹;
- Order No. 2009-0329 (23/04/09) on the sustainable harvesting of seaweed at sea. (see Mesnildrey *et al.* 2012)

According to the European Parliament (2009), under these laws aquaculture on private land or shoreline requires authorisation but in open waters a concession is needed, with different procedures applicable depending on the activity – as discussed below.

Although national measures apply uniformly across France, a number of local Departmental regulations apply in Brittany, where the majority of algae production occurs in France. These include **Deliberations** and **Orders** issued by the different administrative authorities in Brittany⁴² that specify the allocations for seaweed harvesting, the collection season and the conditions for sustainable seaweed gathering on the shoreline (see Mesnildrey *et al.* 2012, p.22)

National measures are implemented by a hierarchy of multiple levels and actors (*ibid.*). The Ministry for Ecology, Sustainable Development and Energy are responsible for regulation at the national level. At the inter-regional level, the Direction Interrégionale de la mer (DIRM) coordinates national maritime and coastal policy within its area. At district level, the Directions Départementale des Territoires et de la Mer (**DDTM**) implement national regulations. These organisations coordinate implementation with non-state fisheries organisations, including the Comité National des Pêches Maritimes et des Élevages Marins (**CNPMEM**), which is the national body representing fishermen and marine aquaculturalists, and regional committees for marine fishing and mariculture (or **CRPMEMs**). Local commissions represent the interests of seaweed farmers and gatherers on the regional CRPMEM in Brittany.

⁴¹ Three types of seaweed can be harvested, namely shore seaweed, requiring authorisation; marine seaweed farming of kelp, which requires a concession/licence; and 'wrecked' seaweed washed up on the shore in storms.

⁴² Cote D'Armor, Finistere and Ile-et-Vilaine.

4.7.1 Licensing/permitting issues

Maritime resources in France are subject to the concept of maritime public domain (DPM) whereby the beach, foreshore and sea are governed by the state. Individuals and organisations can access them if properly licensed by public authorities (Mesnildrey *et al.* 2012). As in the UK, different types of licence are required for seaweed cultivation and shoreline harvesting.

An authorisation to harvest algae from the shoreline must be sought from the relevant Department and regional fishing organisation for sea fishing (NetAlgae 2012). In Brittany, it is the **DDTM** in conjunction with the **Comité Régional des Pêches Maritimes et des Elvages Marins** that authorises the harvesting of algae from the shore. Specific Orders governing 'foot gathering' are also issued by the different local authorities in Brittany.

Cultivation and harvesting of algae offshore is practiced at a few sites in France, mainly in Brittany⁴³, subject to specific concessions under DPM. According to the Ministère de l'Écologie, du Développement Durable et de l'Énergie (2012d), seaweed is grown on various media to facilitate harvesting, mostly in the open ocean. The production is seasonal, with growth mainly occurring between the months of April and November. Production is labour intensive as algae generally must be inserted onto lines and then subsequently harvested by hand. Concessions for such production are issued by the local **Direction Départementale des Territoires et de la Mer (DDTM)**. As specified above, in Brittany licensed activities are also governed by specific Deliberations and Orders issued by local authorities. Applications for a concession are made under **Decree No. 83-228**, as amended. Applicants must include a plan of any installation, details of the cultivated/harvested species, the harvesting period and any production process. Concessions can include a number of conditions and can be revoked in the case of non-compliance. For example, applicants must be able to prove their professional capabilities (including academic qualifications) prior to the granting of the concession. Also, the hiring of workers for seaweed harvesting is subject to a number of strict rules regarding conditions of employment and social security arrangements (Mesnildrey *et al.* 2012: 24).

4.7.2 Land use planning

Development issues surrounding algae production are complex (Ministère de l'Écologie, du Développement Durable et de l'Énergie 2012d). National planning law aims to regulate coastal development to protect it from urbanisation and allow free access to the public. A set of measures are incorporated into the legislation relating to the protection and management of certain coastal and inland waters (Articles L.146-1 and L.146-9 of the Planning Code or **Code de l'Urbanisme**). A need must be shown for any development in protected coastal areas. In Brittany, where most algal production occurs, much of the coastal marine environment is protected under various designations (national parks, nature reserves and Natura 2000 sites). An activity can only be authorised in these areas after a study of the potential impacts on both the natural environment and human activities is conducted. As other actors, such as tourists, boat owners and fisherman, also have access to coastal resources under DPM, conflicts with algal production could be possible. One way of managing access in the past has been to form multi-actor committees to bring stakeholders together (CCM or Commissions des Cultures Marines). Establishing a dialogue with regulators and other resource users is therefore important for operators planning a production facility in France.

⁴³ In total, production amounts to around 20 hectares (Ministère de l'Écologie, du Développement Durable et de l'Énergie 2012d)

4.7.3 Regulatory concerns

This dense multi-level regulatory network of permitting and planning could be seen as an impediment to aquaculture generally and algal production specifically. The European Parliament, in a comparative study of the wider industry, argue that 'major issues' pertain to the establishment of new aquaculture facilities in France (European Parliament 2009). To this end, they state that:

'Anecdotal evidence indicates that it is effectively impossible to obtain authorization for new aquaculture facilities... because of the manner in which planning decisions... are made, and because of burdensome requirements for impact studies, waste control and monitoring... In effect, there appears to be an institutional barrier to new development caused by a reluctance to prioritise aquaculture meaningfully in the light of competing activities, particularly in areas where tourism is important.' (*ibid.*: 49)

The Commission also cites the lack of a joined-up approach to aquaculture, with regulatory requirements split between environmental and maritime legislation.

4.8 Permitting, planning and regulatory situation in Flanders/Belgium

4.8.1 Permitting

There is no specific legislation covering macroalgal production in Belgium. Aquaculture in Flanders is however regulated under the VLAREM regulations on permitting (see Section 1). According to the VLAREM, a Class 1 or 2 environmental licence is required depending on the degree of environmental impacts of the development. A Class 3 activity does not require a licence, only notification to the authorities, due to its limited impacts. Procedures for obtaining a licence depending on the specific Class of the licence, with Class 1 (the most environmentally significant) activities licensed by the Provincial Council and Class 2 by the local mayor. Factors that may also be considered are whether the development requires an EIA and if, conducted offshore, it conflicts with articles in the Belgian Marine Protection Law 1999. Here, a critical issue is whether non-indigenous species will be introduced as part of the production process as this requires authorization in order to protect local biota (Art. 11). Specific permitting arrangements pertain to activities covered by marine spatial planning (see below).

4.8.2 Land use planning

Two other questions are significant regarding aquaculture in the VLAREM. Firstly, does the facility require planning permission? For land based (terrestrial) facilities the answer to this question invariably rests on the individual project, although if ponds are constructed for the production of algae, planning permission will more than likely be required. In this case, the decision will be taken by the local planning authority in accordance with spatial planning (see Section 3.7 above).

Secondly, does the facility conflict with marine planning? Offshore facilities will have to comply with the marine plan. Belgium introduced a marine 'master plan' in 2003 to determine specific uses of its offshore resources. The plan is currently being further developed to account for marine protected areas. As in the Dutch MSP, the Belgian approach employs zoning as a means of allocating activities, which are then subject to permitting. Specific areas are designated for energy production, i.e. wind farms, and mariculture that could potentially be used for macroalgal production.

4.9 Permitting, planning and regulatory situation in Switzerland

Macroalgal production facilities are not applicable to Switzerland.

4.10 Permitting, planning and regulatory situation in Luxembourg

Macroalgal production facilities are not applicable to Luxembourg.

4.11 Comparing macroalgae production

Regulations covering macroalgal production are highly variable across Europe, reflecting the fact that seaweed industries have been established for centuries in some states such as Ireland, France and the UK compared to other countries where it is only just becoming evident. Consequently, in Ireland, for example, regulation of seaweed production is already incorporated into national legislation and licensing arrangements. France also has a highly developed industry that is largely regulated at local levels, within the context of national legal measures, through multi-level institutions. The survey, however, found little evidence of widespread commercial macroalgal production and its overt regulation in Belgium, The Netherlands and Germany, with only some small scale research projects currently engaged in seaweed cultivation. The overall impression given of regulatory measures is that they are uneven both between, and in some cases within, states. Limited guidance is provided by EU measures although the shift towards marine planning under national policy and the Marine Strategy Framework Directive is gradually integrating macroalgal production into strategic planning, for example under the MCAA in the UK.

Table 4: Main implementing legislation, implementing agencies and permit types in macroalgal production in the different countries.

Country	Main implementing legislation	Primary implementing agency	Permit types
UK	National marine and environmental legislation	Various agencies in England, Wales, Scotland and N. Ireland	Seaweed Harvesting Licence Aquaculture Licence
The Netherlands	National Water Act 2009	IDON	MSP permit
Republic of Ireland	The Foreshore Acts	Department of Environment, Community and Local Government	Foreshore Licence
	The Fisheries Act	Department of Agriculture, Food and the Marine	Trial Licence Aquaculture Licence
Germany	Raumordnungsgesetz (ROG) – marine planning	Bundesamt für Seeschifffahrt und Hydrographie (BSH)	Approval by competent authorities
	National and Lander fisheries laws	Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft – BMVEL	
		Lander fisheries agencies	Lander aquaculture licence
France	National maritime law and decrees	DDTM/CRPMEM	Harvesting Licence Concession
Flanders/Belgium	VLAREM	Flanders Environment, Nature and Energy Department – Environmental Licences Division	Environmental licence (Class 1 and 2)
	Master Plan – marine planning		
Switzerland	-	-	-
Luxembourg	-	-	-

5 Regulatory Issues

Unlike environmental and planning permissions (see sections 2, 3 and 4), which are largely independent of the end use of the biomass produced, regulatory issues are intimately linked with end use. Hence the regulatory landscape for each class of product will be considered separately.

Much of the regulatory context for biomass products is set by EU legislation, with two main instruments significant. Regulations have 'direct effect' in Member States national law, i.e. they must be applied directly. As such, they apply uniformly across the EU and establish a harmonised, single market for specific products in order to eliminate constraints to trade. Directives have to be transposed into national law and often provide for flexibility according to different national contexts. Some differences are therefore apparent between countries.

Three types of end use product will be considered. Firstly, the use of algae as an energy generation feedstock is examined and secondly, the use of algal chemical products. Finally, the use of algae as food or animal feed is considered. While energy feedstocks are generally governed by EU directives, chemicals and food products are primarily encompassed by regulations reflecting the transnational trade in these commodities.

5.1 Algae as Feedstock for Energy Generation

Different bioenergy products that could be derived from algal biomass include: liquid fuel (diesel, alcohols), gas (biogas/CH₄), dried biomass as solid fuel and thermochemical conversion products. The choice of inputs in the growth process may have implications on the fuel quality, as well as on waste streams, e.g. through contamination with heavy metals. In principle, any process or technology for growth, harvesting and processing can be chosen; however careful consideration needs to be given to Life Cycle Assessment (ensuring overall greenhouse gas savings), and on any impact on the parameters by which final fuel quality is judged. For each fuel type the producer will need to check with the buyers concerning current regulations for impurities in fuels, and any quality protocols, as these are subject to change across Europe.

5.1.1 The EU regulatory context

Despite the lack of dedicated standards for end-products, the main regulatory context for biofuels in European states is set by existing EU legislation. The **Biofuels Directive 2003/30/EC** seeks to promote the use of biofuels and other renewable fuels in the transport sector. Fuel quality generally is regulated by the **Directive 2009/30/EC** (The Fuel Quality Directive) amending Directive 98/70/EC⁴⁴. Physical properties of the final product are the main concern, rather than the production process. Concerning biofuels, the Directive enables the wider use of ethanol in petrol, incorporates sustainability criteria for greenhouse gas emissions by biofuels and stipulates biodiesel content for diesel fuels. Paragraph 31 of Directive 2009/30/EC also recommends new standards relating to fuel composition and contaminants:

"It is appropriate to adapt Annex IV to Directive 98/70/EC to enable the placing on the market of diesel fuels with a higher biofuel content (B7) than envisaged in standard EN 590:2004 (B5). This standard should be updated accordingly and should establish limits for technical parameters not included in that Annex, such as

⁴⁴ <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32009L0030>

oxidation stability, flash point, carbon residue, ash content, water content, total contamination, copper strip corrosion, lubricity, kinematic viscosity, cloud point, cold filter plugging point, phosphorous content, acid index, peroxides, acid index variation, injector fouling and addition of additives for stability.”

Other EU directives relate to the carbon sequestration potential of biofuels. In responding to past criticisms of EU biofuels policy in promoting unsustainable biofuels production, particularly in non-EU states, the **Renewable Energy Directive (RED) 2009/30/EC** contains sustainability criteria that relate to end-products⁴⁵. Most significantly, the RED states that total CO₂ emissions of biofuels produced should be 35% less than fossil fuel equivalents (rising to 50% from 2017, and 60% from 2017 for new installations). Of importance to algal biofuel production, therefore, is ensuring that fuel products do actually result in emissions reductions. Further regulations apply to fuel storage and transportation; at EU level this is regulated by **Directive 1999/92/EC (ATEX)**⁴⁶. **European standards (EN)** have also been established for different transport fuels (for example, EN 14214 for biodiesel fuels). The European Commission is currently working with CEN (the European Committee for Standardisation) and other countries to develop internationally harmonised biofuel standards⁴⁷. A White Paper on internationally compatible standards has also been produced by the Commission (CEC 2007). A discussion on the impacts for multi-level governance can be found in Benson *et al.* (2014)

5.1.2 Implications for European states

This European policy context strongly influences practice across the EU, although some national variations are apparent. In the **UK**, the Renewable Transport Fuel Obligation Order (RTFO) (as amended 2011) requires suppliers of fossil based road transport fuels to produce evidence that a specified percentage of their fuels intended for road transport in the UK comes from renewable sources, or that an equivalent substitutable amount of money is paid in compensation (UK Government 2013a). Any supplier producing over 450,000 litres of fuel per year, including biofuels, is included in the scheme. The Obligation was amended in 2011 to implement the RED, thereby making mandatory its sustainability criteria.

The UK RTFO operates via a certification scheme. For each litre of biofuel (or kilogram of biomethane) produced, suppliers are awarded one certificate, although some fuels produced from wastes and residues, such as ligno-cellulosic and non-edible cellulosic material, can count double. At the end of each year, suppliers must have accrued enough certificates to show that they have met the obligations of the scheme, i.e. a certain percentage of fuel production is of biofuel origin. Suppliers can also purchase certificates in order to meet this obligation when they have not produced enough biofuel, with the buy-out price set in the RTFO order. Certificates can be traded with members of the scheme and can be carried over into the following year under some circumstances. Guidance is issued by the UK Government covering the operation of the RTFO (see UK Government 2013b for details).

As the RTFO only covers transport fuels, separate policy exists for bioliquids or biomass used in to generate heat or electricity (see Ofgem 2013). Since 2011, operators of biomass fuelled generation must show how they meet the RED sustainability criteria in the fuel that they use. Three obligations are made on operators in terms of provisions: an annual sustainability report; information on land use and emissions for biofuels employed; and a Bioliquid Sustainability Audit Report. Further changes to this system will be introduced in late 2013.

⁴⁵ For a comparative overview of the implementation of the RED sustainability criteria see Ecofys (2012).

⁴⁶ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:023:0057:0064:en:PDF>

⁴⁷ http://ec.europa.eu/energy/renewables/biofuels/standards_en.htm

In the **Netherlands**, the production of biofuels from algae is subject to a number of laws and regulations. The following may be relevant for algal biofuels production:

- EU Directive 2003/30/EC on stimulation the use of biofuels for transportation;
- Governmental decision on biofuels in transport fuels 2007. The policy document on mandatory incorporation of biofuels in transport fuels. A Dutch incorporation of the EU Directive 2003/30/EC;
- EU Directive 2003/96/EC and 92/12/EC on tariffs for energy products and electricity;
- Law on tariffs (Wet op de Accijns) for *inter alia* energy products;
- EU directive 70/220/EC on emission demands on transport fuels;
- Quality standard: EN 14214 FAME on diesel engines;
- Quality standard: EN 15376 (proposed) on ethanol for petrol.

An independent audit body, established and organised by industry, monitors compliance with EU and national obligations for biofuels (EBB 2013). The government is supporting their development of a certification system that ensures the sustainability requirements and ensures the RED is fully implemented. The Ministry of the Environment is responsible for transport biofuels. For biomass intended for electricity and heating, the Ministry of economic affairs assumes responsibility.

Biofuels use is well established in **Germany** and the standardisation of products such as biodiesel first occurred in the 1990s⁴⁸. Consequently it is 'a pioneer in the implementation of the European Fuel Quality Directive (2009/30/EC) and therewith the amended fuel standards of EN 590 (B7) and EN 228 (E10) as well as in national implementation as per the Renewable Energy Directive's (2009/28/EC) specified sustainability requirements' (BMU 2012)⁴⁹. Currently, the production and marketing of biofuels are regulated by Section 37 of the Federal Emissions Control Act (the Bundesimmissionsschutzgesetz, BImSchG). Other federal laws important for biofuels include the Renewables Energy Sources Act (EEG) 2012 and its associated ordinances, which help support renewable energy through mechanisms such as tariffs. For example, the Biomass Ordinance (BiomasseV) identifies which substances are recognised as biomass for energy (i.e. electricity) production. Biokraft-NachV (Biofuels Sustainability Ordinance) also implements RED requirements for sustainability in fuel production. According to the BMU, German unions, industry and farmers established a REDcert certification system in 2010 to ensure compliance.

In **Ireland** technical specifications for gas oils, petrol and diesel are administered by the Department for Environment, Community and Local Government. National regulations implement EU measures (including sustainability criteria under Directive 2009/30/EC). Ireland also implements a Biofuel Obligation Scheme (2010) as part of the national Energy Policy Framework, Bioenergy Action Plan and Programme for Government. The aim is to increase biofuel use from 4% to 6% of transport fuels in the next year in response to EU Directive 2003/30/EC. The Obligation Scheme operates on the basis of redeemable certificates granted to those bringing biofuel to the market. These certificates are then redeemed by Obligated Parties against their obligations.

In **Flanders**, biofuel regulation is determined by Belgian federal legislation. Under the Royal Decree of 22 November 2006, producers are permitted to introduce these fuels on to the Belgian market, including those

⁴⁸ The first German standard for biodiesel produced from plants was established in 1994 by the German Institute for Standardisation.

⁴⁹ The BMU provides detailed information on its website regarding the commercial status of biofuels in Germany. Important fuels in the German market are bioethanol, manufactured from agricultural feedstocks, biodiesel and biomethane.

with a biofuel content higher than that authorised by the EU for petrol and diesel. They are also allowed to sell rapeseed oil to transport businesses and individual drivers. A range of tax incentives and support measures have been introduced since 2006 for promoting bioethanol and biodiesel use at both federal and provincial levels. Sustainability criteria under EU legislation will be implemented via a Royal Decree under the Law on Product Standards (Law of 21/12/1998) and the National Action plan on Renewable Energy. Independent bodies monitor the sustainability criteria and may be accredited in Belgium (BELC procedure). The independent bodies report regularly to the Directorate General for the Environment, Federal Public Service for Public Health, Food Chain Safety and the Environment. In the Flemish region, VREG is responsible for monitoring the compliance of sustainability criteria for solid and liquid biomass used for power generation.

France has actively promoted biofuel use since the early 1990s. Two main types are produced: biodiesel derived from vegetable oil (or VOME) and bioethanol (ETBE). These are blended with conventional fossil fuel for sale, with diesel permitted to contain up to 7% biodiesel and petrol 15% of ethanol. An accreditation system allows biofuel companies to sell a certain amount of their product on to the market without tax liability, while taxes are imposed on fuels not containing biofuels. Implementation of EU sustainability criteria is achieved by the Grenelle I Act (article 21). The French government also determines the procedures for granting tax exemptions for biofuels producers and fuel producers.

Switzerland also has a long history of supporting biofuels, although is not a major producer when compared to its neighbours Germany, France and Austria. Beginning in 1996, the Swiss Federal Government introduced three laws to stimulate production: an exemption from mineral oil tax for biofuel pilot/demonstration plants; amendments to existing legislation allowing the production of ethanol from agricultural crops; and the introduction of a federal ordinance⁵⁰ creating a new subsidy support for oilseed processing. Two main types of biofuels are currently produced nationally, namely biodiesel/vegetable oils and ethanol. The main legislative instrument is the Mineral Oil Tax Law (MinOTL) (2007) and its associated ordinances. Under the MinOTL, biofuels are tax exempt if they can demonstrate a 'positive global ecological balance' and be 'produced in a socially acceptable way'. The Mineral Oil Tax Ordinance (MinOTO) sets out the minimum requirements for these sustainability criteria. Fuels produced from agricultural or forestry waste do not generally have to demonstrate a positive environmental balance but all other types of biofuel must provide evidence of their wider sustainability. Another ordinance, the Biofuels Life Cycle Assessment Ordinance (OEcobiC), sets out how such proof should be determined. Fuel manufacturers should assess two aspects: impacts across the entire life-cycle of production; and whether biodiversity worldwide is impacted. Producers of algal biofuels should therefore consult the Ordinance⁵¹ for specific details of the assessment.

Biofuels production in **Luxembourg** is determined primarily by EU legislation. The Grand-Ducal Regulation of 27 February 2011 fixes the sustainability criteria for biofuels and bioliquids, which transposes the EU RED and other related fuel directives. Tax exemptions are available for biofuels for transport (see national implementation plans - EBB (2013)). Reduced taxes have also been introduced for biofuels blended with petrol and diesel. The Luxembourg Government has also established a database of biofuels businesses with the objective of providing a comprehensive list of those involved in producing or importing biofuels in order to demonstrate their compliance with the RED sustainability criteria. Operators must register for the database online.⁵²

⁵⁰ Article 56 and 59 of the Law on Agriculture relating to support to oilseeds production and transformation of renewable raw materials.

⁵¹ Information available from the Department of the Environment, Transport, Energy and Communications (DETEC).

⁵² See http://www.environnement.public.lu/guichet_virtuel/biocarburants/index.html

5.2 Algae as Feedstock for Chemicals

Chemicals are highly regulated in Europe. As shown above, chemicals manufacturing is subject to environmental permitting and strict controls by the EU. End-products are also heavily regulated, with measures controlling the registration, evaluation, authorisation, classification, labelling, packaging, storage and transport. As most of these requirements are implemented under EU Regulations, they apply uniformly within the Union. Even so, some countries have their own approaches to regulating aspects of chemicals production and marketing.

5.2.1 Registration and evaluation of chemicals

In the EU Chemicals are regulated by Regulation (EC) No 1907/2006⁵³ (concerning the **Registration, Evaluation, Authorisation & restriction of CHemicals: REACH**⁵⁴). The legislation evolved out of earlier EU restrictions on the marketing of new chemicals until they were evaluated. REACH introduces a single system of evaluation for all chemicals, both 'new' (i.e. introduced into the market since 1981) and 'existing' chemicals (as listed in the European inventory of commercial chemical substances before 1981). The legislation places the 'burden of proof' on industry rather than public authorities to provide information on substances and demonstrate that products do not present a risk to the environment or public health. One other major feature is its requirement for dangerous chemicals to be progressively phased out when safer alternatives are found.

REACH is one of the most extensive EU environmental laws and it places several main requirements on producers, users and importers of chemicals (IEEP 2012):

- Any chemical substance of a 1 tonne or more that is manufactured or imported into the EU requires registering with the European Chemicals Agency (ECHA) in Finland;
- As part of the registration process, a dossier containing information on the safe use of the substance must be submitted;
- High risk substances cannot be used until an authorisation is granted;
- Where substances present a risk, manufacturers should seek to replace them with lower risk alternatives;
- The legislation can also restrict certain chemicals where they are seen as presenting too high a risk.

The REACH legislation (Titles II-VIII) provides: lists of substances exempt from registration; registration requirements; data sharing obligations; supply chain and downstream user information; evaluation and authorisation procedures; restrictions on dangerous substances;

These regulations have implications for algal-based chemicals producers. Authorisation for chemicals may have to be sought under REACH, so producers should contact relevant national authorities as early as possible to discuss any planned manufacturing.

5.2.2 Chemicals classification, labelling and packaging

All chemicals produced and marketed in the EU must be classified, labelled and packaged according to rules established by the **CLP Regulation (EC) No 1272/2008**. The Regulation repeals and amends three earlier EU measures: The Dangerous Substances Directive 67/548/EEC; the Dangerous Preparations Directive

⁵³ <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32006R1907>

⁵⁴ http://ec.europa.eu/environment/chemicals/reach/reach_en.htm

1999/45/EC; and Regulation (EC) No 1272/2008 on the classification, labelling and packaging of chemical substances and mixtures. This legislation aims to protect human and health and the environment while maintaining a single market for chemicals. In this respect, the Regulation stipulates EU-wide criteria for chemicals manufactured or imported into the Union that potentially could harm the environment or humans.

The CLP Regulation differs from REACH in that it compels that manufacturers and importers of certain chemicals must notify the ECHA about their classification and labelling. Details are then entered into an ECHA Classification and Labelling Inventory. Two types of chemicals must be registered with the Inventory: hazardous substances and non-hazardous substances already registered under REACH. Procedures for registration are available from the ECHA⁵⁵.

For producers of algal derived chemicals, this requirement – as with REACH – could add additional constraints to operations. Depending on the chemicals being produced, notification with ECHA may be necessary.

One other source of information that may be relevant to producers is the Biodiesel REACH Consortium (EBB 2013). The European Biodiesel Board (EBB) has established the Consortium 'to facilitate the EU biodiesel industry to meet the requirements under REACH and ensure proper registration of biodiesel and related substances' (*ibid.*). The Consortium aims at facilitating cost-effective preparation of REACH dossiers for its membership through *inter alia* information sharing, providing legal and technical guidance and helping with data evaluation.

5.2.3 The storage and transportation of chemicals

The EU has several legislative measures that may be applicable to the storage and transportation of chemicals. For example, the **Seveso II Directive**⁵⁶ provides obligations on EU national governments to prevent major industrial accidents through introducing pre-emptive measures. Industries involving 'handling dangerous substances above certain thresholds must regularly inform the public likely to be affected by an accident, providing safety reports, a safety management system and an internal emergency plan. Member States must ensure that emergency plans are in place for the surrounding areas and that mitigation actions are planned. Account must also be taken of these objectives in land-use planning' (CEC 2012). If production installations involve flammable materials or chemicals in any way classified as hazardous, their storage is subject to further regulation at the EU level through **Directive 1999/92/EC (ATEX)**⁵⁷. Finally, the international trade in hazardous chemicals is controlled under **Regulation (EC) 689/2008** which implements the Rotterdam Convention and obliges Prior Informed Consent (PIC) for exports, meaning that operators exporting to non-EU states should check relevant requirements.

5.2.4 Implications for European state practice

As EU Regulations, REACH and the CLP have 'direct effect' in Member State law, i.e. they do not require transposition and must be implemented directly. Technically, therefore, there is no difference in how they are applied in the different member states, an important factor in the production, marketing and transportation of

⁵⁵ ECHA (2010) Practical Guide 7: How to notify Substances in the Classification and Labelling Inventory, European Chemicals Agency.

⁵⁶ <http://ec.europa.eu/environment/seveso/index.htm>

⁵⁷ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:023:0057:0064:en:PDF>

algal products. However, other national laws are significant, with some minor differences in approaches to chemicals regulation apparent.

In the **UK**, the Competent Authority is hosted by the Health and Safety Executive, working with the Environment Agency and other government departments.⁵⁸ The HSE provides useful advice on adhering to the requirements of REACH via its website⁵⁹. It can also help in the evaluation of substances identified for potential regulatory action under the Directive. The HSE is also responsible for the UK Control of Substances Hazardous to Health (COSHH) regulations. Employers are legally obliged to ensure the safety of employees by controlling substances presenting hazards to human health. Several measures are recommended, including the use of risk assessments⁶⁰ and control measures. Separate measures exist in the UK covering the storage and transportation of dangerous goods that may be applicable to chemicals production. The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 ("CDG 2009"), came into force in 2009. The storage of flammable or hazardous chemicals is also subject to further regulation through the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR⁶¹)).

In the **Netherlands**, for example, a number of regulations may apply to algal chemical and pharmaceutical production. European REACH requirements are incorporated into the Dutch Environmental Management Act (the Wm), while EU regulations on the classification, labelling and packaging of chemicals are also implemented. However, national laws exist for animal medicine (the Animal Drug Law - Diergeneesmiddelenwet), pesticides (the Pesticides Law - Bestrijdingsmiddelenwet) and pharmaceuticals (the Medicines Act or Geneesmiddelenwet on medicine for application on humans, and the Food and Drug Act, or Warenwet, on cosmetics).

France also directly implements the REACH and CLP Regulations in its national measures ensuring a harmonised approach with other EU states. There is some variation evident in both industrial risk prevention and transportation of dangerous materials policy. Industrial facilities that exhibit risks are subject to specific laws where they are Classified Installations for the Protection of the Environment (ICPE). Several regulations also cover the transport of such goods, with an Inter-ministerial Committee on the Transport of Dangerous Goods (CITMD) established.

The other EU states – Germany, Ireland and Belgium - also fully implement REACH and the CLP through national legislation. In Ireland, for example, the EPA, the Health and Safety Authority and the Minister for Agriculture, Fisheries and Food, are designated as the competent authorities for REACH implementation under the national Chemicals Act 2008 (as amended 2010). The Act also implements the EU Detergents Regulation, the Regulation on the Import and Export of Dangerous Chemicals, the CLP Regulation and the Seveso Directive. Further details on the Chemicals Act can be found on the relevant Department of Jobs, Enterprise and Innovation website (<http://www.djei.ie/employment/chemicalspolicy/chemicalsbill.htm>). In Germany, the REACH and CLP regulations are supplemented by provisions under the federal Chemicals Act. A REACH-CLP helpdesk has been established by The Federal Institute for Occupational Safety and Health (Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA)) in Dortmund in order to help with business enquiries⁶². Like biofuel regulation, chemicals in Belgium are regulated at the federal level. Both REACH and the CLP are administered across the country by the Federal Public Service (FPS) for Health, Food Chain Safety and Environment.

⁵⁸ <http://www.hse.gov.uk>

⁵⁹ <http://www.hse.gov.uk/reach/compauth.htm>

⁶⁰ <http://www.hse.gov.uk/coshh/riskassess/index.htm>

⁶¹ <http://www.hse.gov.uk/fireandexplosion/dsear.htm>

⁶² <http://www.reach-clp-helpdesk.de/en/Homepage.html>

Switzerland, meanwhile, maintains its own approach to chemicals regulation that relates primarily to the federal Protection Against Dangerous Substances Act (ChemA) 2000, Environmental Protection Act, Landwirtschaftsgesetz and related ordinances. The ChemA (and its associated ordinance, the ChemO 2005) refers to the ‘handling’ of chemical substances and preparations, and covers aspects of the classification, evaluation, notification, labelling, packaging and marketing of chemicals. Other relevant measures may include the Chemical Risk Reduction Ordinance (ORRChem) and the Prior Informed Consent Ordinance (ChemPICO) for exported products. Separate ordinances relate to GMO release and export. As with other Swiss environmental laws, chemicals regulation is formulated by the federal government and implemented by the Cantons.

In **Luxembourg**, REACH and CLP are implemented by the so-called Paquet REACH⁶³ (Helpdesk Reach 2013). This piece of legislation, introduced in 2011, replaced the previous law⁶⁴ by extending its provisions for official controls and infringement penalties to the CLP and well as REACH obligations under EU law. In this respect, the Paquet REACH incorporates a law covering enforcement and a regulation relating to the production of data sheets. Under the legislation, the competent implementing authority is the environment ministry (Ministère du Développement Durable et des Infrastructures (MDDI), supported by the Administration de l’environnement (AEV) and several other agencies. Implementation is coordinated between these institutions by the Comité REACH-CLP, comprised of representatives from several government ministries. The committee collaborates with the Resource Centre for Environmental Technologies (CRTE) which provides implementation advice to businesses and supports the ministry. In addition, obligations under the Seveso Directive means that operators of Class 1 industries (see Section 2) in Luxembourg must attach a notification of any dangerous substances to their operating permit application. The competent authority for implementing the Directive is the Inspectorate of Labour and Mines (Inspection du Travail et des Mines – ITM).

5.3 Algae as Feedstock for Food or Feed

As with chemicals governance, the need to establish harmonised Europe-wide markets for products means that feedstock for food and animal feed is subject to tight EU regulation, but other influences such as international norms and national regulatory approaches are also apparent. Consequently, there is some variance between countries in regulation, particularly in food production and marketing.

The general principles and requirements of EU food law are contained in **Regulation (EC) 178/2002**. It aims to provide a framework for food standards and is primarily concerned with harmonising rules across the EU in this area by ensuring the functioning of the internal market. This Regulation is supported by many other measures covering food production and marketing, animal nutrition and food safety. In this respect, significant measures for algal production include: Regulation (EC) 258/97 (on novel foods and ingredients); Regulation (EC) 767/2009 (the marketing of feed materials and compound feed); Directive 89/107/EEC (food additives); Regulation (EC) 1831/2003 (on the authorisation, supervision and labelling of feed additives); Regulation (EC) No 852/2004 (food hygiene); Regulation 1831/2005 (feed hygiene regulation); and Regulation 1829/2003 (on GMOs for food and feed). A number of other EU regulations and directives cover the production and distribution of animal feedstuffs, although **Regulation 183/2005** is the key measure for algal production. This Regulation, requiring registration and approval of all feedstuff operators, is the critical

⁶³ See http://www.reach.lu/mmp/online/website/menu_hori/homepage/index_EN.html

⁶⁴ Paquet REACH of 27 April 2009.

measure within the EU's overall 'Hygiene Package' that came into force in 2006⁶⁵. Together with international food norms⁶⁶, this regulatory context largely shapes food and feedstuff practice in Member States.

5.3.1 Food regulation in European states

There is some variation in approaches to regulating food and feedstock in Member States, although within the wider context of EU regulation. In the **UK**, businesses that intend to produce algae for food or feed must be approved by the appropriate enforcement agency (in the UK the Environmental Health department at the local authority) at least 28 days before trading. The entire process is subject to HACCP (Hazard Analysis and Critical Control Point) assessment; a system adopted by the World Health Organisation⁶⁷ and the Codex Alimentarius Commission as recommended international code of practice for general principles of food hygiene (CAC/RCP 1-1969 Rev 4)⁶⁸. "The HACCP system, which is science based and systematic, identifies specific hazards and measures for their control to ensure the safety of food. HACCP is a tool to assess hazards and establish control systems that focus on prevention rather than relying mainly on end-product testing. Any HACCP system is capable of accommodating change, such as advances in equipment design, processing procedures or technological developments. HACCP can be applied throughout the food chain from primary production to final consumption and its implementation should be guided by scientific evidence of risks to human health."⁶⁹

If the algal biomass is to enter the food / feed chain, nothing that is labelled as 'waste' can be an input (e.g. liquid digestate has to be PAS110 / ADQP compliant; flue gas has to be part of HACCP assessment to identify and mitigate possible hazards and risks). The entire process, including growth, harvesting, processing, storage and transport, needs to be covered by HACCP assessment. If the biomass is grown outdoors, especially in open systems, the HACCP assessment needs to include contamination risk, hazards of potential contaminants, and appropriate mitigation⁷⁰. For feed products in the UK, FEMAS (FEED Materials Assurance Scheme⁷¹) certification, a product-based certification, should be sought. Food products in the UK need to comply with British Retail Consortium Standards⁷² (e.g. through ISO22000⁷³, a system-based certification).

Companies in the UK who are currently producing algal biomass for the food and feed chain have invested substantial work into developing appropriate HACCP protocols for their systems; this is an important and valuable aspect of their Intellectual Property.

⁶⁵ http://europa.eu/legislation_summaries/food_safety/veterinary_checks_and_food_hygiene/f84005_en.htm

⁶⁶ Primarily the UN *Codex Alimentarius* – endorsed by the WHO, FAO and WTO.

⁶⁷ <http://www.who.int/foodsafety/publications/haccp-principles/en/>

⁶⁸ Available from http://www.who.int/foodsafety/areas_work/food-standard/en/ and in several languages at http://www.codexalimentarius.net/web/more_info.jsp?id_sta=23

⁶⁹ P. 21, CAC/RCP 1-1969, Rev. 4-2003 – Annex: www.codexalimentarius.net/download/standards/23/CXP_001e.pdf

⁷⁰ for principles see: www.codexalimentarius.net/web/standard_list.do?lang=en

⁷¹ UK-based international quality & safety standard for feed products (private standard), cf

www.agindustries.org.uk/content/output/95/95/Trade%20Assurance/Trade%20Assurance%20Schemes/FEMAS.msp

⁷² UK-based international food safety standard (private standard), cf

http://www.brcglobalstandards.com/KnowledgeCentre/Publications/FoodSafetyAGlobalView.aspx#_VA84u_mwLYg

⁷³ http://www.iso.org/iso/specific-applications_food-safety and http://www.iso.org/iso/catalogue_detail?csnumber=35466

In the **Netherlands**, food and feedstock derived from algae would be subject to regulation depending on the type of product. Most regulation results from the direct translation of EU measures in Dutch law, with the Netherlands implementing *inter alia*:

- European General Food Law regulation 178/2002 on food safety;
- EU regulation 258/97 on Novel Foods regarding the marketing of new food stuffs and food ingredients;
- EU regulations on the hygiene of food (products) 2074/2005, 852/2004 and 853/2004;
- EU regulation on hygiene of animal feed 183/2005;
- EU directive on pet feed 82/475/EEG;
- EU directive on unwanted substances in animal feed 2002/32/EG.

The Dutch Food and Drug act (Warenwet) will also influence food and feedstuffs derived from algae. It specifies the treatment and processing of food, labelling, food hygiene, additives and ingredients. The Dutch Food and Drug Act incorporates a number of European regulations.

German food regulation is also heavily determined by EU legislation. If the targeted market for algae is the supply of feedstuff for livestock, attention needs to be paid to the certain regulations. As response to Mad-cow disease (BSE) the European Commission adopted a "Regulation on the catalogue of feed materials (EU No 575) in 2001. The catalogue is regularly updated (9th edition in 2011) and now includes one chapter named "Other plants, algae and products derived thereof". However, in Germany, an additional list of "straight feedstuff" for feeding livestock was drawn up, in order to reduce the possibility of unhealthy or harmful substances entering the food chain (e.g. the dioxin scandal in 2011). The list is based on a clear definition of the origin and characteristics of the feedstuffs. For this purpose, it is necessary to describe the manufacturing process, including processing aids, and distribution.⁷⁴ In order to get new animal feedstuff accredited (and with it marketable status) it needs to be on the "**Positive List of Straight Feedstuffs**". Algae are relatively new in this market and they were not listed before August 2011 when a couple of algae stakeholders successfully applied for the inclusion of at least Chlorella and Spirulina. Since August 2011, it is officially permissible to use these two algae species to feed livestock in Germany. A company needs to apply to the Central Committee of German Agriculture if it wants to include a certain feedstuff in the positive list. Primary criteria for the inclusion of a straight feeding stuff in the positive list comprise⁷⁵:

- a) a substantial feed value (including safety for animals and humans, energy supply, absence of negative effects on the quality of the animal products, absence of hazards to the ecological balance due to undesirable substances);
- b) a recognisable importance in the market;
- c) the legal admissible use as a straight feedstuff.

If the application is successful, the feedstuff will be put on the list in form of a data sheet which includes⁷⁶:

- 1) Name of the feeding stuff or product;
- 2) Product description;
- 3) Information about the production process;
- 4) Processing aids (including all added substances);

⁷⁴ Positive List of Straight Feeding Stuffs, 9th edition, 2011:

http://statictypo3.dlg.org/fileadmin/downloads/fachinfos/futtermittel/positivliste/positivlist_en_9.pdf

⁷⁵ Staudacher, W.: Microalgae have hurdled the German Positive List for Straight Feeding Stuffs – Why?; presentation on the 5th International Algae Congress

⁷⁶ Staudacher, W.: Microalgae have hurdled the German Positive List for Straight Feeding Stuffs – Why?; presentation on the 5th International Algae Congress

- 5) Information about the composition;
- 6) Information about relevant non-desirable substances during the risk-oriented self-inspection (e.g. HACCP);
- 7) Details about shelf life, storage and transport;
- 8) Safety information;
- 9) Information of critical constituents;
- 10) Information about specific analytical problems.

The Positive List of Straight Feedstuff is only relevant for feeding livestock, i.e. animals that are possibly used for human food. The list is not binding for feeding pets. It is therefore easier for algae stakeholders to enter the pet food market.

The last amendment of the German Feeding Stuff Ordinance (Futtermittelverordnung⁷⁷) in 2011 especially influences the production and further processing of fats, oils or fatty acids from plants and animals for feeding purposes which might also effect the processing of algae. The oils and fats can only be produced in factories that are solely used for the production of food or feed and must be separated from any substances that are not used for food or feed. This regulation could, for example, influence the design of a biorefinery that could be used to process algae for combined energetic and material use, when one of the targeted products is a feed stuff. Furthermore the amendment of the German Feeding Stuff Ordinance determines that there need to be extensive analysis of the produced fats, oils or fatty acids for undesirable substances like dioxins, furans and PCB before they can be used as feed or feed additives. The German Feeding Stuff Ordinance determines limiting values for certain substances in feeding stuff. It thereby differentiates between different animal species the feedstuff is intended for. The restrictions for pets are less extensive than for animals used for human food (e.g. no tests for myko-toxins in pet food).

In order to obtain a marketable product in the food as well as in the feed sector it needs to be certified. There are different certification systems (e.g. ISO, QS, HACCP) that can be used. On this basis, accredited institutions can examine and certify the product as well as the entire production process. This is particularly important since algae or algae based products are fairly new on the European Food and Feed market and certificates will create the necessary confidence on the consumer side.

If the targeted end use for algae is food or food ingredients, yet another regulation needs to be considered: the Novel Foods Regulation. "Novel Foods" are foods and food ingredients that were not yet used on a significant scale for human consumption before the "Regulation (EC) No 258/97 78 concerning novel foods and novel food ingredients" came into force on 15 May 1997 in the European Community and are classified in different categories including food and food ingredients consisting of or isolated from micro-organisms, fungi or algae (e.g. oil made from microalgae)⁷⁹. Before novel foods can be placed on the market, they must go through a notification or authorisation procedure. Applications are to be submitted to the Federal Institute for Consumer Protection and Food Safety (BVL).⁸⁰ If the characteristics of the novel foods differ from those of conventional products, the consumers must be informed of this by means of corresponding labelling.⁸¹ The products covered by the scope of the Novel Foods Regulation may only be placed on the market if, within the framework of the notification or authorisation procedure, it has been proved that they do not:

⁷⁷ Gesetze im Internet: Futtermittelverordnung: http://www.gesetze-im-internet.de/bundesrecht/futtmv_1981/gesamt.pdf

⁷⁸ Novel Food Regulation: <http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31997R0258:EN:HTML>

⁷⁹ BfR: Health Assessment of Novel Food: http://www.bfr.bund.de/en/health_assessment_of_novel_foods-1809.html

⁸⁰ BfR: Health Assessment of Novel Food: http://www.bfr.bund.de/en/health_assessment_of_novel_foods-1809.html

⁸¹ BfR: Health Assessment of Novel Food: http://www.bfr.bund.de/en/health_assessment_of_novel_foods-1809.html

- present a danger for the consumer,
- mislead the consumer or
- differ from the conventional products which they are intended to replace to such an extent that their normal consumption would be nutritionally disadvantageous for the consumer.⁸²

The notification and authorisation procedure is relatively time-consuming and expensive and might not be feasible for small enterprises. This needs to be taken into account if it is planned to use a new algae species for entering the food or feed market.

Food and feed production in **Ireland** also is governed by EU and national measures. Food safety is covered by a range of different laws⁸³. Primarily, these instruments implement EU legislation and are administered by the Food Safety Authority of Ireland (FSIA). Of potential relevance to algal production includes Regulation 258/97/EC concerning novel foods and novel food ingredients (as amended), which is currently being incorporated into Irish legislation, and EU regulations on food additives. Ireland bases its practice for the manufacture, distribution and use of animal feed products on the obligations of Regulation (EC) 1831/2003. Under national regulations⁸⁴, so-called FBOs (Feed Business Operators) must be approved by the relevant authority, namely the Department of Agriculture, Food and the Marine (DAFM 2013). In Ireland, to gain approval an establishment must apply to the Ministry and pay an inspection fee. In accordance with the Regulation, FBOs must ensure all stages of production meet relevant EU and national standards, including introducing a system based on HACCP principles.

French food laws are amongst the strictest in Europe. Producers and retailers must be able to provide traceability of foods through the provision of information over product origins. Multiple laws exist to ensure consumer protection. Responsibility for food regulation in **France** is similarly complex and split between government ministries. The General Directorate for Food (part of the Ministry of Agriculture), or DGAL/MINAG, is the principal regulator for food production. Food safety is regulated by the Directorate General for Competition, Consumption and Repression of Fraud (DGCCRF) (Ministry of Economy and Finance). The Association Française de Normalisation also performs a regulatory function through developing national standards in conjunction with the European Standardization System (CEN) and International Organization for Standardization (ISO).

While it is not possible within the context of this report to detail all potentially significant measures for algal food and feed production in France, some can be highlighted. Additives derived from algal production such as thickeners would be regulated under EU standards and French national regulations (e.g. Regulation 1333/2008, 1331/2008). Labelling of food products is also highly regulated through implementation of EU Directive 2000/13/EC. French implementing regulations determine that labels should contain strictly defined information, including the ingredients, date marking and manufacturer details. Algal products would also likely be regulated under the Novel Food/Feed Regulation. Use of GMOs in such products is highly regulated. Manufacturers are compelled to label any material containing an EU approved GMO as a biotech product. Organic products, such as seaweeds (see Section 3 below), are regulated under EU Regulation (EC) No 834/2007, as amended. An AB (Agriculture Biologique) designation must be applied to labels.

Animal feedstuffs in France are regulated by the Ministry of Agriculture, Food and Forestry. Regulations for the animal feed sector are published on the Ministry website (Ministère de l'Agriculture, de l'Agroalimentaire et de la Forêt 2013). These regulations cover health institutions, and the marketing and labelling of feed

⁸² BfR: Health Assessment of Novel Food: http://www.bfr.bund.de/en/health_assessment_of_novel_foods-1809.html

⁸³ An overview can be found on the FSAl website: http://www.fsai.ie/legislation/food_legislation.html

⁸⁴ The European Communities (Food and Feed Hygiene) Regulations, 2009 (S.I. 432 of 2009).

products. Compliance is ensured by two departmental divisions, namely directorates for the protection of the population (HADD) and for social cohesion and public protection (DDCSPP). The national regulations relate primarily to EU measures, namely for feed additives (Regulation EC No 1831/2003), undesirable substances and residues (Directive 2002/32/EC), the placing of feed on the market as raw materials, additives of food compounds (Regulations EC No 767/2009 and Regulation EU No 575/2011), the approval and registration of establishments (Regulation EC No 183/2005 – part of the EU ‘Hygiene Package’, see above), import authorisation to third countries (Regulation EC No 183/2005) and food control (Regulation EC No 882/2004). Both the HADD and DDCSPP conduct inspections in order to issue licences or registrations for animal feed establishments. They also undertake regular inspections to ensure on-going compliance.

Food safety in **Belgium**, unlike permitting and planning, is a federal government competence. Consequently the responsibility for food regulation is vested with the Federal Public Service for Health, Food Chain Safety and Environment (FASFC) which is a federal executive agency with authority over all Belgian territory, including Flanders. Established by the Federal Law of 2000, the FASFC is responsible for formulating, implementing and enforcing laws relating to food risks to human health. Most federal standards for food safety, including novel foods and food labelling, is derived from EU legislation and is therefore relatively harmonised with practice in other European states. The main national legislation – the Belgian Food and Drugs Law (de Wet betreffende de bescherming van de gezondheid van de gebruikers op het stuk van de voedingsmiddelen en andere producten 1977) applies to all domestic and imported products. In the near future (2014), the food legislation will be changed to take into account some current issues for algae production for food and feed.

Food and feed regulation in **Switzerland**, in contrast, is largely determined by the Federal Act on Foodstuffs and Utility Articles (**FSA**) 1992. The Act has several aims, namely:

- ‘to protect consumers from foodstuffs and utility articles that may present a risk to their health;
- to ensure that foodstuffs are handled hygienically;
- to protect consumers from deception relating to foodstuffs.’ (Article 1)

These aims apply to a wide range of activities, including the manufacture, processing, storage, transport and selling of foodstuffs and ‘utility’ articles such as food packaging and cosmetics. Provisions also apply to the labelling, advertising, importation and export of foodstuffs, and also agricultural production if intended for foodstuff manufacturing.

Swiss federal law would therefore have implications for algal food and feed manufacturers, although there is no specific legislation relating to these products. The Act provides for authorities to authorise food types, manufacturing processes and marketing of products. In particular, the federal government can restrict or prohibit ‘microbiological and biotechnological processes for the manufacture or processing of foodstuffs or utility articles’ if they present a risk to health (Article 9). Manufacturers should then consult with federal authorities and Cantonal governments on relevant regulations and how they relate to the proposed manufacturing process.

National legislative measures relating to food and feedstuff regulation is divided by the **Luxembourg** government into feedstuffs (législation sur les aliments pour animaux) and food products (législation sur les denrées alimentaires d’origine animale and législation alimentaire) (Grand-Duché de Luxembourg 2009a,b). Regarding animal feedstuffs, practice is framed in the context of EU Regulation 183/2005 on the hygiene of food. All facilities involved in the production, processing, storage, transport or distribution of feed must be registered with the competent authority. Operators are obliged to implement recognised standards of

hygiene and employ HACCP principles. Several national regulations also pertain to feed production, published online by the Division of Laboratories and Test Control Administration of Technical Services of the Agriculture Ministry (Grand-Duché de Luxembourg 2011)⁸⁵. Food products for human consumption, as in other EU countries, are regulated by European and national measures: for an overview, the Government food security service lists all relevant legal instruments in a compendium (Grand-Duché de Luxembourg 2009b).

5.4 Comparing product regulation

Since the product categories described above are largely dealt with by global industries, in most cases international industry standards and EU regulations and directives apply, so differences between EU member states are comparatively small. With regards to algal feedstocks for fuels, the main determining legislation in EU states are the Fuel Quality Directive and RED, in addition to other fuel standards. Although there is some variance in national approaches, a harmonised market largely exists in the EU for such products. Similarly, chemicals regulation is mainly set at the EU level with REACH the most important measure for producers to consider. Food and animal feed is also heavily regulated by the EU, with several significant regulations covering food production and safety. Nonetheless, some national variance is evident. Switzerland, as a non-EU state, implements its own standards.

⁸⁵ http://www.securite-alimentaire.public.lu/professionnel/aliments_animaux/recueil_legislation_aliments_animaux.pdf

Table 5: The main regulatory framework for algal energy, chemicals, food and animal feed end-products.

	Feedstock for energy generation	Chemicals	Food and animal feed
UK	<ul style="list-style-type: none"> • RED • Fuel Quality Directive • National regulations 	<ul style="list-style-type: none"> • REACH • Regulation (EC) No 1272/2008 	<ul style="list-style-type: none"> • EU Regulations/Directives • National regulations
The Netherlands	<ul style="list-style-type: none"> • RED • Fuel Quality Directive • National regulations 	<ul style="list-style-type: none"> • REACH • Regulation (EC) No 1272/2008 • National laws on animal medicine, cosmetics and human medicine 	<ul style="list-style-type: none"> • EU Regulations/Directives • National regulations
Republic of Ireland	<ul style="list-style-type: none"> • RED • Fuel Quality Directive • National regulations 	<ul style="list-style-type: none"> • REACH • Regulation (EC) No 1272/2008 	<ul style="list-style-type: none"> • EU Regulations/Directives • National regulations
Germany	<ul style="list-style-type: none"> • RED • Fuel Quality Directive • National regulations 	<ul style="list-style-type: none"> • REACH • Regulation (EC) No 1272/2008 • Chemicals Act 	<ul style="list-style-type: none"> • EU Regulations/Directives • National regulations
France	<ul style="list-style-type: none"> • RED • Fuel Quality Directive • National regulations 	<ul style="list-style-type: none"> • REACH • Regulation (EC) No 1272/2008 	<ul style="list-style-type: none"> • EU Regulations/Directives • National regulations
Flanders/Belgium	<ul style="list-style-type: none"> • RED • Fuel Quality Directive • National regulations 	<ul style="list-style-type: none"> • REACH • Regulation (EC) No 1272/2008 	<ul style="list-style-type: none"> • EU Regulations/Directives • National regulations
Switzerland	<ul style="list-style-type: none"> • National biofuels legislation and ordinances (MinOTL) 	<ul style="list-style-type: none"> • Protection Against Dangerous Substances Act (ChemA) 2000 	<ul style="list-style-type: none"> • Federal Act on Foodstuffs and Utility Articles 1992
Luxembourg	<ul style="list-style-type: none"> • RED • Fuel Quality Directive • National regulations 	<ul style="list-style-type: none"> • REACH • Regulation (EC) No 1272/2008 • Pacquet REACH 	<ul style="list-style-type: none"> • EU Regulations/Directives • National regulations

6 Conclusions and policy recommendations

6.1 Conclusions: SWOT

Strengths

Several conclusions can be derived from the above research in terms of the strength of the current governance system. Firstly, on the whole, permitting, planning and product regulations across Europe do not significantly inhibit algal production, for both micro and macroalgal processes. Project facilities were able to secure environmental permitting in all the countries, with few problems encountered, although approaches to permitting did vary - despite an overarching EU regulatory context. Secondly, land use planning systems were similarly amenable to establishing facilities, which is encouraging given the wide diversity in planning cultures and approaches within European states. Finally, algal end-products are, to an extent, regulated by existing measures in European countries. Many products, such as chemicals and fuels, are subject to harmonised EU standards meaning, in theory, little variability in approaches is visible between countries. In view of the above conclusions, it could be argued that Europe provides a positive environment for the future growth of the industry, allowing it to contribute to the development of the wider green economy and low carbon objectives of the EU.

Weaknesses

However, one significant weakness is apparent. The EnAlgae project only involves R&D facilities. While EU policy, in particular regional funding, is highly supportive of this nascent research, it is less obvious how European and national level policies will help future growth of the industry once processes are 'scaled up' towards full production. At the moment, permitting and planning constraints that would be applicable to large scale industrial facilities are not evident with the mainly small scale research projects in the EnAlgae network. For example, research conducted in 2008 by the European Commission on the issues surrounding the permitting of commercial bioenergy facilities in the EU identifies 'several prejudices' including:

- Too many process steps and permits issued by separate authorities
- Permits... subject to a wide range of legislative acts
- Lack of clear timetables
- Lack of local knowledge and capacity to analyse complex bio-energy permit applications
- Lack of clear procedure to obtain grid access
- Local resistance to bio-energy projects (European Commission 2013a)

The Commission argues that these problems 'must be addressed and overcome to help the EU reach its bio-energy potentials and its renewable energy objectives' (*ibid.*). Given the wide diversity in such procedures across Europe, it is likely, therefore, that similar constraints will apply to future algal production. Indeed, many of the problems identified by the Commission in 2009 are still evident in 2013. As such, the above analysis suggests that industrial scale production and marketing of algal end-products could potentially be subject to a variety of existing EU and national regulations that could inhibit the development of the industry. At the moment, to borrow a phrase from Heritier (1996), the governance of algal production in Europe is a 'patchwork' of different and often conflicting regulations, rather than a unified response. Permitting in particular is variable, despite EU 'harmonising' IPPC legislation, with some countries implementing highly integrated regimes, that often incorporate building permits within 'one stop shop' environmental permitting, while others still issuing different permits for emission media, e.g. the water permits in the Netherlands.

The overall impression remains that few dedicated policy measures, either in the EU or in national contexts, are supporting the transition from laboratory research to marketable end-products. Biofuels production in the EU is being driven by several policy instruments, although there are evident 'gaps' and 'mismatches' regarding algal production. The main context for biofuels, for example, is set by Directive 2009/28/EC. However, along with earlier EU measures, this directive is primarily focused on first generation (crop based) biofuels and does not explicitly address advanced processes such as those based on algae. Sustainability criteria such as the RED requirement for significant reductions in CO₂ emissions vis-à-vis conventional fossil fuels could limit algal production without some form of 'phase in' period.

There is also little evident policy framework governing or supporting macroalgal production across Europe. Some limited national measures are evident in the UK, France and Ireland but EU marine and coastal policy, in the form of the Marine Strategy Framework Directive and Integrated Coastal Zone Management (ICZM) guidance, does not mention macroalgal production. Many countries have already introduced marine spatial planning but this issue is not generally being addressed as part of plan development.

Opportunities

The growth in low carbon technology demand and the green economy would provide the EU with opportunities to establish itself as a market leader in algal production, with attendant potential for technology export to emerging economies worldwide. Currently, the market for seaweed production alone is worth approximately \$7billion per year (with the food sector worth \$5-6 billion, hydrocolloids \$0.6 – 0.7 billion, and fertiliser \$10 – 20 billion) (Crown Estate 2012). Yet, the EU's share of this market is negligible, with countries such as China dominating both cultivated and natural seaweed production (*ibid.*). Macroalgal production could then form an important part of both an emerging EU marine policy and so-called 'Blue Growth' (European Commission 2013b,c). Microalgae could also contribute significantly to future biofuel, chemicals and food/feedstock production. Both production types could help invigorate 'green' economies in marginal regions of the EU, particularly economically depressed coastal areas and former areas of heavy industry. However, the potential economic, social and environmental impacts of production, such as biodiversity effects and employment opportunities, require further research.

Threats

One danger therefore is that governance in the EU and in national contexts fails to support the growth of the industry from the R&D phase. Significant threats would then exist to the future economic viability of the industry. In addition, European states would lose competitive advantage to global competitors such as the USA where many of these technologies are being developed and scaled-up to industrial production. Compared to other countries, most notably the USA, European states and the EU could do more to facilitate this industrial sector through more 'joined-up' regulatory responses: an issue that we discuss in the next section.

7 Regulations and Permitting for Genetically Modified (GM) Algae

While cultivation on the EnAlgae project has focussed on wild-type strains, there is growing academic and commercial interest in genetic manipulation of algae to improve growth characteristics or expression of molecules. This section of the report will outline the relevant legislation for the growth and subsequent sale of GM algae and products.

In October 1990 all EU nations adopted two European Council Directives governing the 'contained use' and 'deliberate release' of genetically-modified organisms (GMOs) into the environment. The two Directives cover the two scenarios relevant to algal cultivation. Firstly, genetically modified microalgae grown in 'containment' e.g., in a laboratory or in closed PBR systems in glasshouses falls under **Directive 2009/41/EC**. Secondly, GM algae 'deliberately released' into the environment, either through macroalgae cultivation at sea or via growth of microalgae in open ponds would be considered under **Directive 2001/18/EC**.

Prior to considering cultivation and precautionary procedures, it must be established whether the organism in question is defined as a GMO. The criteria and techniques included in Directive 2009/41/EC are summarized below⁸⁶. For instance, mutagenesis is considered to be a process which could occur in nature, hence techniques such as UV mutagenesis and selection for desired traits would not be considered as genetic modification under the Directive.

The adoption of these Directives is relatively harmonized between member states, hence this report will present the procedures outlined at Directive level, and signpost to the “competent authorities” who are responsible for dealing with applications (Table 6: List of competent authorities in EnAlgae member states for contained and uncontained growth of GM material.).

⁸⁶ Directive 2009/41/EC – **Techniques of genetic modification are**, inter alia: 1. *Recombinant nucleic acid techniques* involving the formation of new combinations of genetic material by the insertion of nucleic acid molecules produced by whatever means outside an organism, into any virus, bacterial plasmid or other vector system and their incorporation into a host organism in which they do not naturally occur but in which they are capable of continued propagation. 2. *Techniques involving the direct introduction into a micro-organism of heritable material* prepared outside the micro-organism, including micro-injection, macro-injection and micro-encapsulation. 3. *Cell fusion or hybridisation techniques* where live cells with new combinations of heritable genetic material are formed through the fusion of two or more cells by means of methods that do not occur naturally.

The following **techniques are not considered as genetic modification** for the regulatory purpose: 1. *in vitro fertilisation*; 2. *natural processes such as: conjugation, transduction, transformation*. 3. *polyploidy induction*. Techniques or methods of genetic modification yielding micro-organisms to be excluded from this Directive on condition that they do not involve the use of recombinant-nucleic acid molecules or GMMs other than those produced by one or more of the techniques/methods listed below: 1. *Mutagenesis*; 2. *Cell fusion* (including protoplast fusion) of prokaryotic species that exchange genetic material by known physiological processes; 3. *Cell fusion* (including protoplast fusion); 4. *Self-cloning*.

Table 6: List of competent authorities in EnAlgae member states for contained and uncontained growth of GM material.

Country	Competent authority to notify regarding uncontained growth of GM algae	Competent Authority to notify regarding contained growth of GM algae
UK	Department of the Environment, Food and Rural Affairs (DEFRA) https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs	Health and Safety Executive (HSE)* *can circulate to devolved administrations where appropriate http://www.hse.gov.uk/biosafety/GMO/index.htm
Republic of Ireland	Environmental Protection Agency (EPA) http://www.epa.ie/	Environmental Protection Agency (EPA) http://www.epa.ie/
Germany	The Federal Office of Consumer Protection and Food Safety (BVL) http://www.bvl.bund.de/EN/06_Genetic_Engineering/genetic_engineering_node.html	The Federal Office of Consumer Protection and Food Safety (BVL) http://www.bvl.bund.de/EN/06_Genetic_Engineering/genetic_engineering_node.html
France	Ministry of Food, Agriculture and Fisheries http://agriculture.gouv.fr/	Ministry of Research http://www.enseignementsup-recherche.gouv.fr/
Netherlands	Ministry of Infrastructure and Environment http://www.government.nl/ministries/ienm	Ministry of Infrastructure and Environment http://www.government.nl/ministries/ienm The GMO Office – part of the Expertise Centre for Substances (SEC) of the National Institute for Public Health and the Environment (RIVM) – supports the CA in administrative and technical/scientific aspects by handling the applications and supporting policy development. http://bggo.rivm.nl/Index.htm http://www.ggo-vergunningverlening.nl/
Belgium/ Flanders	The three regions (Brussels, Walloon and Flemish Region) each have their own CA for deliberate release of GMOs. More information can be found on the Belgian Biosafety Server: http://www.biosafety.be/gmcropff/EN/CADREN.html	The three regions (Brussels, Walloon and Flemish Region) each have their own CA for contained use of GMOs. There are no regular meetings between these CAs. Detailed information about the Belgian regulatory framework can be found on the Belgian Biosafety Server http://www.biosafety.be/Menu/BiosBelg.html
Switzerland		The Federal Coordination Centre for Biotechnology (FCCB) is the entry and exit point for all notifications and licence applications for authorisation http://www.bafu.admin.ch/biotechnologie/01744/01745/index.html?lang=en Federal Office for the Environment (FOEN) http://www.bafu.admin.ch/index.html?lang=en
Luxembourg	Ministère du Développement Durable et des Infrastructures http://www.dat.public.lu	Ministère du Développement Durable et des Infrastructures http://www.dat.public.lu

7.1 Cultivation of GM Macroalgae

The cultivation of GM macroalgae on longlines is considered here under the regulations for “deliberate release” (Directive 2001/18/EC). This Directive covers the procedure for authorising deliberate release and marketing of GMOs, establishes a common methodology for assessing environment risks throughout the EU and sets common EU-wide objectives for monitoring GMOs. It also specifies the mechanism for modifying, suspending or ending authorisation when new information on risks becomes available.

As mentioned previously, the adoption of Directive 2001/18/EC is relatively harmonized between member states; an outline of the procedure is listed here:

1. A notification must be submitted to the competent authority (see Table 6: List of competent authorities in EnAlgae member states for contained and uncontained growth of GM material.). The notification should include
 - a. A technical dossier⁸⁷
 - b. a statement evaluating the impacts and risks posed by the GMO(s) to human health or the environment
 - c. The number of sites/locations
 - d. Any data from cultivation of the GMO from inside or outside the region
2. The authority has 90 days to respond to the initial notification, indicating their decision.
3. The authority can also request that the notifier gives public notice (e.g. via newspaper) of the proposed activities. Written responses to the GM notification are invited over a period defined by the competent authority.

Member States can authorise GMO use but the criteria are stringent, and a number of countries have adopted a blanket no-GMO stance. At present only one commercial product, a variety of maize, has been licensed for use, and then in only a handful of states. There have been some important recent changes to the approval regime recently which enable member states to restrict GMO cultivation⁸⁸. Firstly, prior to authorisation of a GMO, a member state can request the applicant company, via the Commission, to specify in the application that the GMO cannot be cultivated on all or part of its territory. Secondly, the Member State in question will be able, by adopting an opt-out measure, to have the final say not to cultivate an EU authorised GMO on its territory. Furthermore, the Member States have the possibility to reinstate the process during the 10 year time of the GMO authorisation, should new objective circumstances appear.

Upon closer examination, a more complex picture emerges within member states themselves. The United Kingdom has permitted GM crop trials in England but the devolved administrations in Scotland and Wales are opposed to this activity. While the deadlines for decisions on deliberate release are defined in the Directive, in practice GM crops are often left in deadlock for long periods of time due to resistance from member states. GM crop trials have been controversial in the past, with sites being subject to protests.

The same Directive also covers how GMOs are placed on the market. For example, in the Netherlands GM carnations are authorised for import. This example is interesting because the risk assessment hinged on the facts that the flowers do not wind-pollinate. Therefore, there is a reduced probability for gene transfer into wild-type strains. For macroalgae, establishing the likelihood and consequences of GM gametophytes combining with wild-type would be integral to establishing the risk associated with deployment in open waters.

⁸⁷ (i) general information including information on personnel and training,
 (ii) information relating to the GMO(s),
 (iii) information relating to the conditions of release and the receiving environment,
 (iv) information on the interactions between the GMO(s) and the environment,
 (v) information on monitoring, control, waste treatment and emergency response plans

⁸⁸ See http://ec.europa.eu/food/plant/gmo/legislation/future_rules_en.htm

Cultivation of GM Microalgae

In NW Europe, the approach within member states to cultivation and containment of GM microorganisms adheres closely to Directive 2009/41/EC. In this report, the growth of GM microalgae within closed PBRs housed inside glasshouses will be considered under this framework. Outdoor, open ponds or raceways are considered under Directive 2001/18/EC as deliberate release.

Given that microalgae are readily aerosolized and dispersed, and many can remain dormant for extended periods under unfavourable conditions, the approach of the risk assessment by Henley et al. (2013) was to assume that release would be inevitable for both GM and non-GM strains cultivated at large scale. It is important to note the distinction of issues relating to Horizontal Gene Transfer (HGT) for cyanobacteria are slightly different to those pertaining to eukaryotic cells. This is covered in more detail in the publication. The authors suggest that HGT events are more common with cyanobacteria, meaning the risk of propagating introduced genetic material in the wild is higher, hence they suggest that GM eukaryotic cells may be more appropriate for biofuel production. Their definition of high risk was if the GM strain possessed characteristics that would enable them to outcompete other organisms inhabiting a particular ecological niche. The authors suggest that biocontainment strategies (such as reduced growth fitness, or conditional lethality) should be engineered into strains to limit uncontrolled growth in the wild.

Containment Levels

Where activities fall between classes (see

Table 7), the higher of the two containment levels are required. Details of the specific control and containment measures for each class are beyond the scope of this particular report, however, each competent authority will have guidelines on the specification of buildings and laboratories. Microalgae may be classified under GMMs (Genetically Modified Microorganisms) or under GM Plants. For example, in the UK the HSE compendium of guidance on genetic modification of plants also includes algae but suggests that for closed growth e.g. in fermenters, that the guidelines on GMMs might offer more pertinent advice.

Table 7: Description of Containment Levels relating to risk from GM material.

Organism class	Description	Containment Level required
Class 1	Unlikely to cause human disease or have any untoward environmental effects.	Containment Level 1
Class 2	May cause human disease or be a hazard to employees but it is unlikely to spread to the community and there is usually effective prophylaxis or effective treatment available. Unlikely to cause significant environmental damage.	Containment Level 2
Class 3	May cause severe human disease and presents a serious hazard to employees and it may present a risk of spreading to the community but there is usually effective prophylaxis or treatment available. Possibility of significant environmental damage, or economic loss if accidentally released.	Containment Level 3
Class 4	May cause severe human disease and presents a serious hazard to employees and it is likely to spread to the community and there is usually no effective prophylaxis or treatment available. Likely to cause severe environmental damage or economic loss if accidentally released.	Containment Level 4

7.2 Contained Growth of GM microalgae

When contained growth of GM microalgae is to be carried out in premises for the first time, the user is required to submit to the competent authorities a notification before starting work. Following notification to the competent authorities of a class 1 contained use, subsequent class 1 contained use may proceed without further notification. If a facility wishes to carry out Class 2 activities where they have not had previous notification, the competent authority must make a decision within 45 days of receiving a notification from the applicant. This period increases to 90 days for premises that would like to carry out Class 3 activities and have not previously been the subject of a notification.

The Annexes to the Directive detail the criteria for assessing the risks of GMMs to health and the environment, as well as the protective measures for each of the four levels of containment. If they so wish, Member States may provide for groups or the public to be consulted on any aspect of proposed contained use.

Before a contained use commences, Member States are required to ensure that an emergency plan is drawn up in order to react effectively in the case of an accident and persons at risk of being affected by an accident are informed of all aspects related to their safety. Facilities are obliged to report any accidents to the competent authority, and the Commission compiles these every three years⁸⁹.

An overview of activities for organisations wishing to carry out contained cultivation of GM microalgae for the first time is summarised here⁹⁰:

1. Notification of the appropriate competent authorities if GM material has not been cultivated on the premises before.
2. Conduct a risk assessment of any potential environmental or health effects of the GM organism.
3. Establish a GM safety committee to consider the risk.
4. Classify activities under the system shown in
5. Table 7
6. Apply necessary containment and control (including waste disposal) measures set out by the Directive for the particular classification.
7. For high risk activities, draw up emergency response plans.

The growth of GM microalgae in open ponds (uncontained use) follows a similar procedure as outlined for GM macroalgae cultivation. Given the volumes involved with large scale pond culture, a thorough assessment of the environmental and ecological risk involved may be needed. Interestingly, in the Netherlands, growth of microalgae outside may be considered under the regulation of contained use when it meets the following criteria⁹¹:

1. the system has a long history of safe use under conditions known as GILSP (Good Industrial Large Scale Practice) for cultivation of the particular host organism;

⁸⁹ See COMMISSION WORKING DOCUMENT Report on the experience of Member States with Directive 2009/41/EC of the European Parliament and of the Council of 6 May 2009 on the contained use of genetically modified micro-organisms (recast) for the period 2006 – 2009 <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52012DC0398>

⁹⁰ Variations within member states is summarised in the COGEM report “Survey on the implementation of Directive 2009/41/EC” <http://www.cogem.net/index.cfm/en/publications/publicatie/survey-on-the-implementation-of-directive-2009-41-ec>

⁹¹ Algae and genetic modification : research, production and risks Enzing, C.; Nooijen, A.; Eggink, G.; Springer, J.; Wijffels, R.H.: Technopolis Group, 2012 - 59 p. Wageningen UR Food & Biobased Research - Biobased Products

2. the particular GMO is composed of a non-pathogenic host organism, a 'safe' vector and insert, and the resulting GMO has a lower fitness in the environment than the host organism, in agreement with the criteria for organisms acceptable for use under GILSP (MI-I, in Netherlands regulation).

Cultivation of GM-algae and GM-cyanobacteria not meeting the criteria of GILSP in outdoor closed systems and open pond systems will be subject to an environmental risk assessment in accordance with directive 2001/18/EC.

7.3 Products from GM Algae

Under Regulation (EC) No 1829/2003 – The products resulting from GMOs are considered in the following groups:

Category 1: Chemically defined purified compounds and their mixtures in which both GMMs and newly introduced genes have been removed (e.g. amino acids, vitamins, oil extracts);

Category 2: Complex products in which both GMMs and newly introduced genes are no longer present (e.g. cell extracts, most enzyme preparations);

Category 3: Products derived from GMMs in which GMMs capable of multiplication or of transferring genes are not present, but in which newly introduced genes are still present (e.g. heat-inactivated starter cultures);

Category 4: Products consisting of or containing GMMs capable of multiplication or of transferring genes (e.g. live starter cultures for fermented foods and feed).

7.3.1 Risk Assessments and Guidance Documents

The European Food Safety Authority (EFSA) is responsible for approving GMOs and placing them on the market. Approved GMOs have passed specific tests proving that they do not affect human or animal health. Details of the risk assessment for genetically modified microorganisms and their products intended for food and feed use is described in the EFSA Journal 2011; 9(6): 2193 32⁹². This document provides detailed guidance to assist in the preparation and presentation of applications to market GMMs and their products for food and/or feed use, according to Articles 5(8) and 17(8) of Regulation (EC) No 1829/2003.

In addition, there are seven main guidance documents that should be used by applicants when compiling technical dossiers in support of GMO applications to be submitted to EFSA:

1. Risk assessment of food and feed from GM plants (2011)
2. Environmental risk assessment of GM plants (2010)
3. Guidance on the submission of applications for authorisation of GM food and feed and GM plants for food and feed (2011)
4. Risk assessment of GM microorganisms and their products intended for food and feed use (2011)
5. Risk assessment of GM plants used for non-food or non-feed purposes (2009)
6. Renewal of authorisations of existing GMO products (2006)
7. Risk assessment of food and feed from GM animals and on animal health and welfare aspects (2012)

In light of these classifications, the legislation surrounding the following GM biorefinery products are considered in this report: biofuels and chemicals, animal feed and human food.

⁹² <http://www.efsa.europa.eu/de/efsajournal/doc/2193.pdf>

7.3.2 Biofuel Products and Chemicals

Biofuel products, such as biodiesel derived from algal lipids, or ethanol from fermentation would fall under Category 1, as they are chemically defined simple molecules. Environmental Risk Assessment (ERA) of Categories 1 and 2 concerns demonstration of absence of viable GMMs or their recombinant DNA in the products. Guidance to demonstrate absence of viable GMMs and recombinant DNA is provided in the EFSA Guidelines. Environmental exposure of the GMM is negligible provided that no viable GMMs and recombinant genes originating from them are present.

7.3.3 Animal Feed / Human Food

Genetically modified organisms (GMOs), for both human food and animal feed, are listed under European legislation, which has harmonised their authorisation procedure, labelling and traceability. Since 2003, GMOs must be labelled GMO, however products containing extracts (for example Category 1 chemicals such as amino acids) do not have to be labelled as GM, providing they are free from any genetic material.

Food additives belonging to Categories 1 or 2 fall under the scope of Regulation (EC) No 1333/2008 and Regulation (EC) No 1331/2008. For these applications, Chapter III, Sections B.2.2. and B.4.1. of this guidance will apply. Applications should follow the Guidance on Submissions for Food additive Evaluations by the Scientific Committee on Food (EC, 2001).

Amino acids and enzymes used as feed additives belonging to Categories 1 and 2 respectively, and microbial feed additives belonging to Category 4 are assessed according to the Commission Regulation (EC) No 429/2008 on detailed rules for the implementation of Regulation (EC) No 1831/2003 as regards the preparation and the presentation of applications and the assessment and the authorisation of feed additives. According to the nature and use of the product, relevant guidance document(s) of the EFSA Panel on Additives and Products or Substances used in Animal Feed (FEEDAP) are also applicable (EFSA, online). Biomasses used as feed materials belonging to Category 3 are assessed according to the Regulation (EC) No 1829/2003. Applicants should also follow the Guidance on the assessment of microbial biomasses for use in animal nutrition (EFSA Panel on Additives and Products or Substances used in Animal Feed (FEEDAP), 2011).

7.4 Movement of GM Algae

If harvested GM material required transportation across country borders, then another additional set of regulations will apply. The Cartagena Protocol to the UN Convention on Biological Diversity seeks to regulate transboundary movements of GMOs. The EU introduced a regulation to transpose the Protocol into EU Law. This is detailed in Regulation EC 1946/2003⁹³.

It establishes the procedures for the trans-boundary movement of GMOs including:

- notification to importing parties
- information to the Biosafety Clearing House;
- requirements on identification and accompanying documentation.

⁹³ See here: <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32003R1946>

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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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