

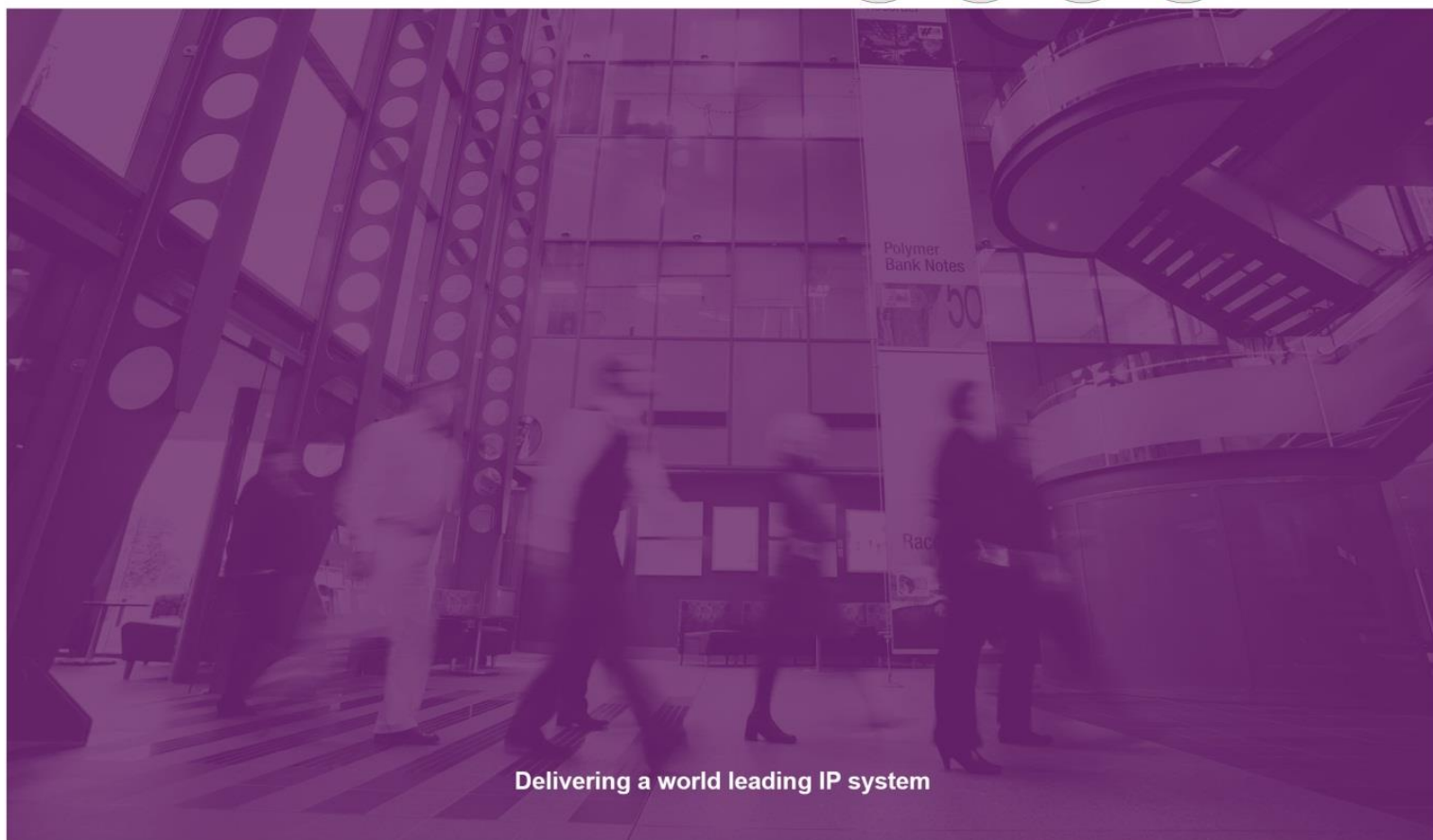


Australian Government

IP Australia

# Patent Analytics Report: Algal Technologies

December 2016



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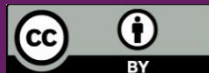
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## 1. Introduction

This report provides an analysis of technology relating to algae through the lens of intellectual property (IP). It uses the scale and intensity of patent activity to provide an overview of innovation in the area.

Algae are a diverse group of photosynthetic aquatic organisms. They range from unicellular genera, such as *Chlorella* and the diatoms, to multicellular forms, such as the giant kelp. Algae are used commercially across many fields including food, cosmetics, medicine, sewage treatment, and as sources of biofuel.<sup>1</sup>

Patents can be used as indicators of research output. A patent is a right that is granted for any device, substance, method or process that is new, inventive, and useful. Patent rights are legally enforceable and give the owner exclusive rights to commercially exploit the invention for a limited period of time.

It is a requirement of patent law that patent documents are published and that they fully disclose inventions. As a result of the disclosure requirement, patent literature reflects developments in science and technology. Patent documents include other useful information, such as international patent classifications and information about inventors and applicants.

Through the extraction and analysis of data associated with patent documents, it is possible to measure aspects of inventive activity such as scope, intensity, collaboration and impact. These metrics can be developed across technology sectors and by various units of measurement, such as individuals (inventors), institutions (applicants), regions and countries.

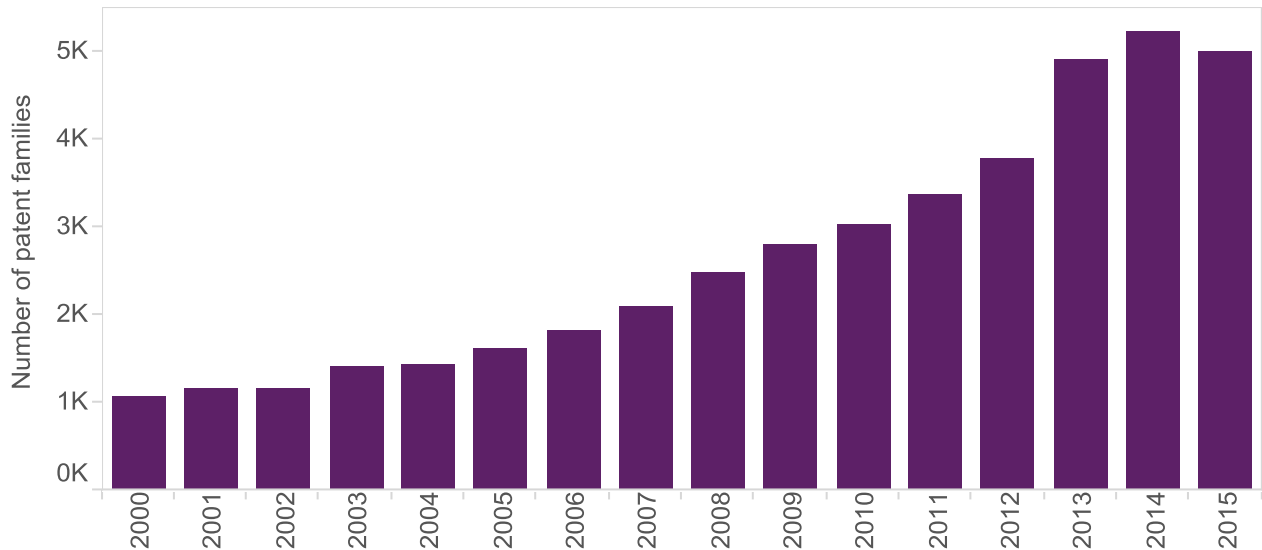
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<sup>1</sup> Priyadarshani, I. et al., "Commercial and industrial applications of micro algae – A review", J. Algal Biomass Utiln, 2012, Vol. 3(4), pages 89–100.

## 2. Scale of Patent Activity

Shown below in Figure 1 is a time series analysis of patent applications relating to algae between 1 January 2000 and 31 December 2015. We identified 42,282 unique INPADOC patent families. Applications have increased steadily from the early 2000's until 2014, which can be attributed to an increase in applications originating from Asia. Technologies that have driven the increase from 2011 onwards include inventions related to food, bioreactors and sewage treatment. The drop in patent families in 2015 is due to publication lag of applications.

**Figure 1: Patent families by priority year**



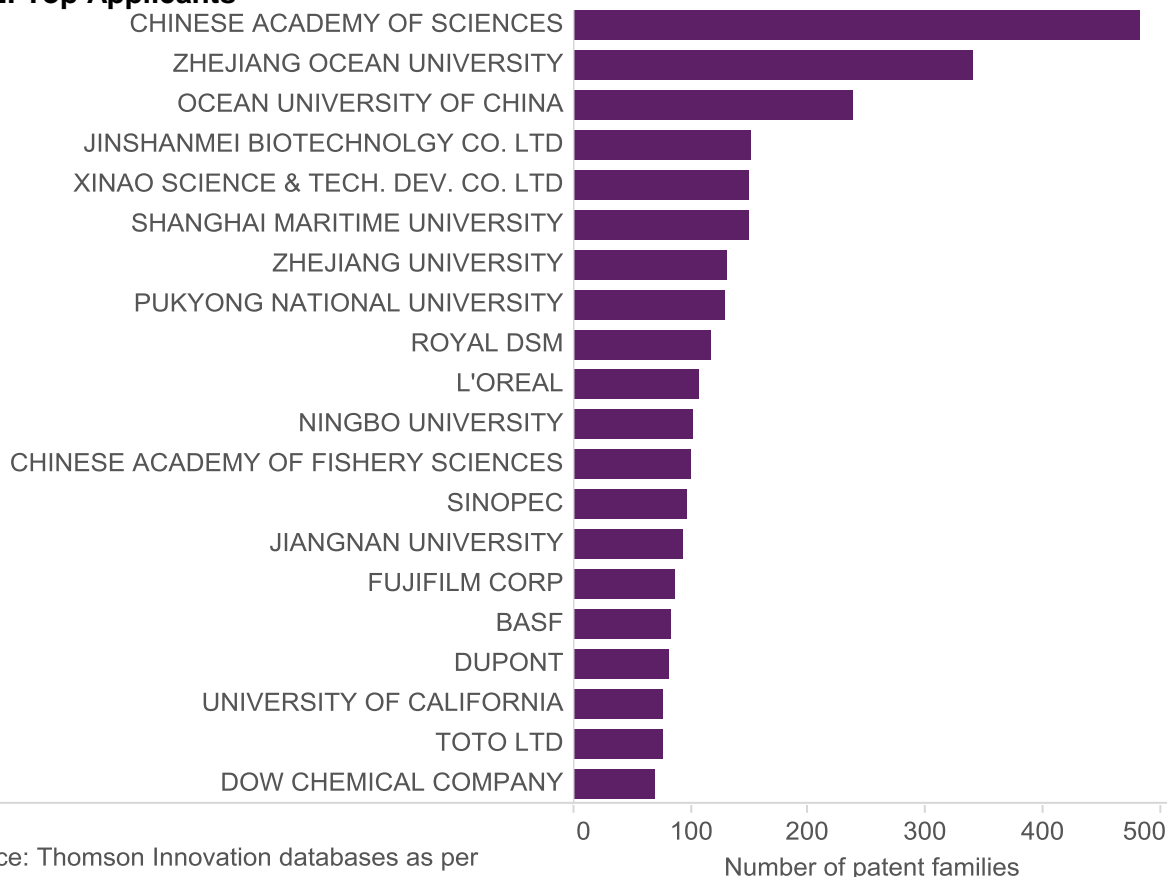
Source: Thomson Innovation databases as per Appendix B (accessed July 2016)

### 3. Applicants

#### 3.1. Top Applicants

Shown in Figure 2 are the top applicants. China features heavily through its universities and research institutes with nine of the top 20 applicants.

**Figure 2: Top Applicants**



Source: Thomson Innovation databases as per Appendix B (accessed July 2016)

The Chinese Academy of sciences<sup>2</sup> and Zhejiang Ocean University<sup>3</sup> are the top two applicants, among other research institutions focussed on algae. The applications by the Chinese Academy of Sciences are spread across the spectrum of algal technologies. This includes food; separation technologies for proteins and chemicals of interest, bioreactors, sewage/water treatment, potential therapeutics and biofuels. This is in contrast to the second top applicant Zhejiang Ocean University, which is focussed on food technology. Ningbo University and the Chinese Academy of Fishery Sciences also have patent filings across all the categories. Another major Chinese applicant is SINOPEC, a state-owned petroleum and petrochemical company. They have an interest in algal technology for the production of biodiesel.<sup>4</sup>

<sup>2</sup> Chinese Academy Of Sciences, [Homepage](#)

<sup>3</sup> Zhejiang Ocean University, [Homepage](#)

<sup>4</sup> SINOPEC, [New energy](#)

Royal DSM, is a Dutch multi-national company that works across a number of areas including nutrition, materials and energy production.<sup>5</sup> DSM produces its own synthetic astaxanthin nutritional product, AstaSana™, which has received a ‘Generally Recognised as Safe’ certification from the United States Food and Drug Administration.<sup>6</sup>

French cosmetics company L’Oreal, uses algal extracts in a range of cosmetics. Fujifilm, more well-known for producing film and camera equipment, is also active in the use of cosmetics. Astaxanthin, as a natural antioxidant, was already used by the company to preserve colours in printed photographs, and they currently use astaxanthin in their Astalift® range of cosmetics.<sup>7</sup>

Kao Group<sup>8</sup> is a Japanese company with a broad product base including cosmetics, human health, home care and chemicals. Their interest in algae relates to the extraction of fatty acids and oils as sustainable ingredients in their products.

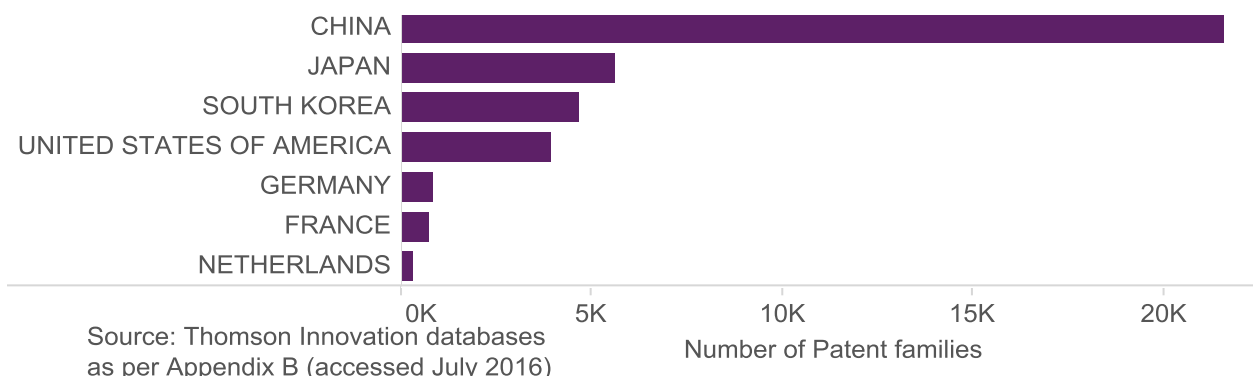
Korean-based Pukyong National University<sup>9</sup> has applications predominantly in the food and medicine categories. Toto Ltd,<sup>10</sup> a Japanese sanitary products manufacturer, is focussed on the chemistry/biochemistry of aglae.

Dow, DuPont and the University of California are the top USA-based applicants. German based BASF<sup>11</sup> have used algal extracts for a range of commercial applications.

### 3.2. Applicant Origin

Figure 3 shows the number of patent families by applicant country. Applicants are primarily from Asia, with China, Japan and South Korea ranking first, second and third respectively. The United States is in fourth, whilst Australia (not shown) ranks 16<sup>th</sup> with 143 patent families.

**Figure 3: Applicant Origin**



<sup>5</sup> 'DSM Bright Science. Brighter Living', [About DSM](#)

<sup>6</sup> DSM Media, [DSM's AstaSana Astaxanthin receives new safety backing](#)

<sup>7</sup> Nippon, [Fujifilm Finds New Life in Cosmetics](#)

<sup>8</sup> Kao Group, [Annual Report 2014](#)

<sup>9</sup> Pukyong National University, [Homepage](#)

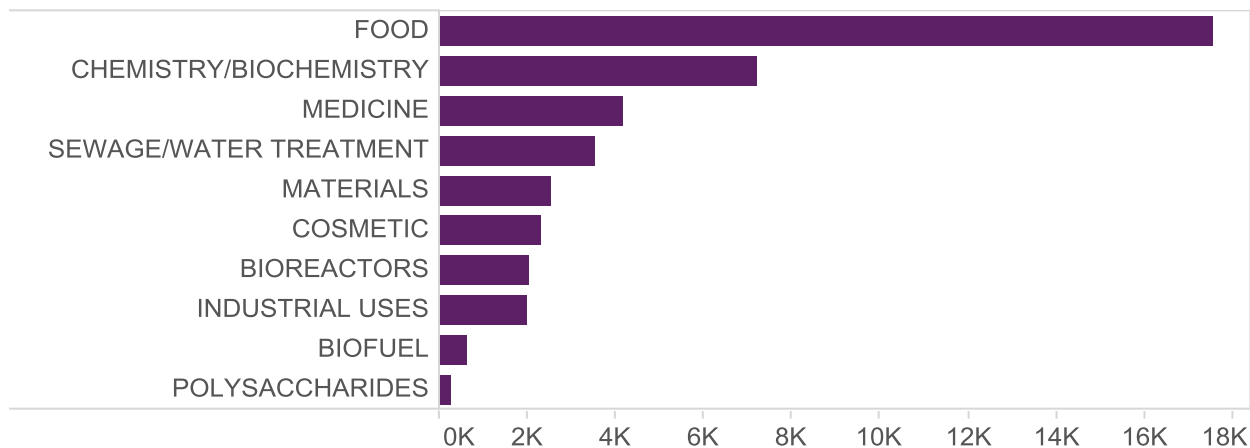
<sup>10</sup> Toto Ltd, [Homepage](#)

<sup>11</sup> BASF, [BASF and Solazyme launch the first commercial microalgae-derived betaine surfactant](#)

## 4. Technology Breakdown

Figure 4 shows a breakdown of the technology into 10 broad categories (see Appendix B: Search strategy and Technology Breakdown for a detailed explanation).

Figure 4: Technology Breakdown



Source: Thomson Innovation databases as per Appendix B (accessed July 2016)

Number of Patent Families

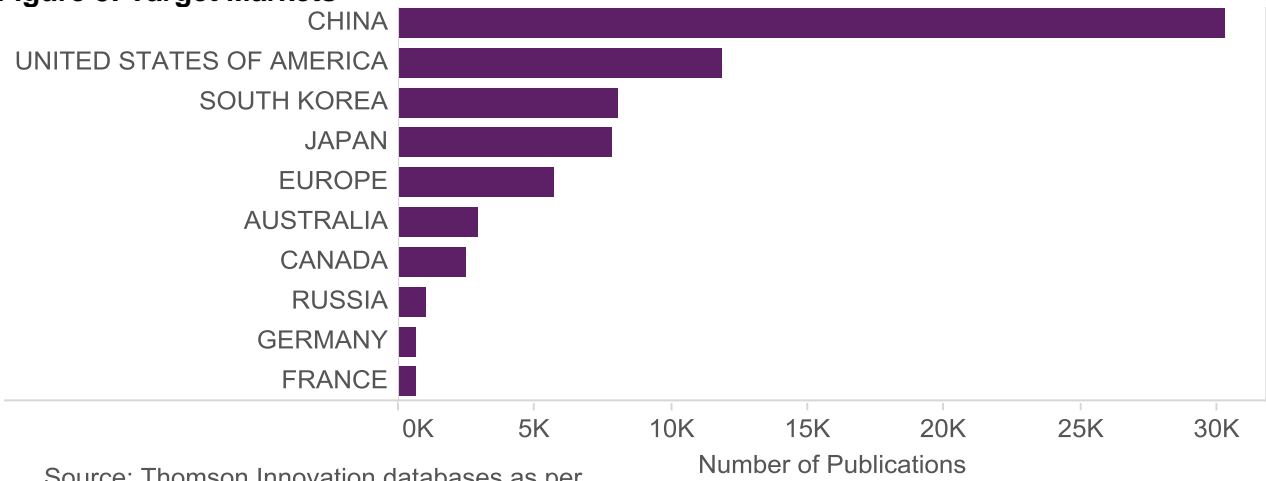
Food, with almost 42 per cent of patent families, is the largest category in algae technology, with all the top applicants highlighted in Figure 2 having at least one patent application in this category. The majority of Chinese applicants are active in this field, specifically in the nutritional supplements. Jinshanmei Biotechnology, appearing as one of the top applicants, has all its applications in the food category. Chemistry/Biochemistry, which covers reactions and physico-chemical processes of algae under different conditions, is the next biggest category followed by medicinal applications of algal products and sewage/water treatment. Despite algal products being used commercially in cosmetics the category ranks sixth. Perhaps surprisingly there is only a small amount of comparative activity in the biofuels area.

## 5. Target Markets

In order to determine the target markets of algal technologies, we can look at the countries where applicants elected to enter national phase. Figure 5 shows the countries where applicants choose to file their applications relating to algal technologies. It is clear from this figure that Asia is where the majority of patenting activity is occurring, specifically China, Japan and South Korea who all appear at the top. This finding is in line with applicant origin indicating that applicants are seeking to protect their inventions locally.



**Figure 5: Target Markets**



Source: Thomson Innovation databases as per Appendix B (accessed July 2016)

## 6. Conclusion

This patent analytics study aimed to provide a board overview of technologies involving algae.

Applications have increased steadily from the early 2000's until 2014, which can be attributed to a rise in applications originating from Asia. Nine of the top 20 applicants are Chinese universities and research institutes, with the Chinese Academy of Sciences and Zhejiang Ocean University being the top two applicants. Non-research institutions in the top 20 applicants include Royal DSM, Fujifilm and L'Oreal. In line with the top applicants, China, Japan and South Korea are the top three countries of origin.

China clearly leads the way as a target market. However, this is likely a reflection of the large number of Chinese applicants only filing in China, rather than foreign applicants seeking to access the Chinese market. The United States is second, followed by South Korea and Japan.

Food, with almost 42 per cent of patent families, is the largest category in algae technology, with all the top applicants highlighted having at least one patent application in this category. The majority of Chinese applicants are active in this field, specifically in the nutritional supplements. Other major areas of technological focus include the chemistry/biochemistry of algae, medicine and water treatment.

## Appendix A: Definitions

### Patents, applications and publications

A patent is a right that is granted for any device, substance, method or process that is new, inventive and useful. Australian patent rights are legally enforceable and give the owner, or patentee, exclusive rights to commercially exploit the invention in Australia for a period of up to 20 years. In this report, an application refers to a single patent filing. A patent application is usually published within 18 months of its earliest filing date (also known as the priority date). We consider that the priority date is most relevant for our analysis as it is the closest date to that when the invention occurred.

There are two major routes for filing a patent application: international route and direct filing. The international route involves filing a Patent Cooperation Treaty (PCT) application, which establishes a filing date in all 148 contracting states. Subsequent prosecution at national patent offices, referred to as national-phase entry (NPE), is made at the discretion of the applicant. A patent can only be enforced once it has been granted and a PCT application must enter the national phase to proceed towards grant. Alternatively, applications can be filed directly in the countries of interest.

### Patent families

Applications generally relating to the same invention but filed in different countries are collectively known as a patent family. Patent families enable us to analyse inventive activity regardless of the number of countries in which protection is sought. Patent families are commonly used in analytics as they generally represent a single invention. We determine patent families based on INPADOC classification. INPADOC patent families give a unique family ID to patents that have a least one priority document in common.<sup>12,13</sup> For metrics, the number of patent families is typically used. There are some exceptions where individual applications are reported on, as each application represents a legal right in an individual country. When analysing the number of applications or families per applicant, related commercial entities have been grouped under a single, harmonised applicant name.

When individual publication numbers are quoted, we have chosen a representative publication from the respective patent family. These are usually WO documents which are publications of PCT applications. These are useful as representatives and they are usually in English.

### Classification

Patents are initially classified by technology into a hierarchical system known as the International Patent Classification (IPC). A further classification system referenced in this report is the Cooperative Patent Classification (CPC). The CPC began in 2013 and is a bilateral system which developed by the EPO and the USPTO which provides more in depth classifications.<sup>14</sup>

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<sup>12</sup> Espacenet, [Patent families](#)

<sup>13</sup> Martinez, 'Insight into Different Type of Patent Families', OECD Science, Technology and Industry Working Papers, No. 2010/2, OECD Publishing, Paris; see section 3.2, 'Extended families'.

<sup>14</sup> European and United States Patent Offices, [Cooperative Patent Classification System](#)

## Appendix B: Search strategy and Technology Breakdown

### Data extraction and analysis

We used four stages of data extraction and analysis.

- Phase 1: Development of an appropriate search strategy based on the aims of the project. The detailed search strategy is shown below.
- Phase 2: Data mining using data extracted from Thomson Innovation (accessed in Thomson Innovation, 6 July 2016). This covers data from the following worldwide database(s); DWPI, WIPO, United States patent and trademark office, European patent office, IP Australia, Canadian patent office, German patent office, British patent office, French patent office, Chinese patent office, Indian patent office, Indonesian patent office, Japanese patent office, Korean patent office, Malaysian patent office, Singaporean patent office and bibliographic details provided by other authorities. It includes bibliographic and abstract data for current publications. The unique INPADOC family members relating to algae were identified and used as the basis of the analysis. INPADOC extended families are patent families that relate to one or more inventions, each member of which has for the basis of its priority right, at least one application in common with at least one other member of the family.
- Phase 3: Data cleaning removed data duplication and ensured the return of the correct records. Data was also filtered according to the technological focus of the patent families.
- Phase 4: Data analysis used Tableau 10.0 for calculation and visual presentation of patent metrics.

### Search Strategy

IPCAny=( C12N1/12 or C12N1/13 or A61K36/02 or A61K36/03 or A61K36/04 or A61K36/05 or A01G33/00 or A01N65/03 ) OR ABD=( macroalga\* or macro-alga\* or microalga\* or micro-alga or Diatom or red algae or green algae or brown algae or Chlorophyta or *Acetabularia* or Charophyceae or Desmidiaceae or Charales or *Chlamydomonas* or *Chlorella* or *Cladophora* or *Codium* or *Hydrodictyon* or *Oedogonium* or *Pediastrum* or *Pleurococcus* or *Scenedesmus* or *Spirogyra* or *Ulothrix* or *Ulva* or *Volvox* or Chromophyta or Phaeophyceae or *Fucus* or *Laminaria* or *Macrocystis* or *Pelagophycus* or *Sargassum* or Bacillariophyceae or Batrachospermum or Callophyllis or *Chondrus crispus* or *Palmaria palmata* or phyra or Nitophyllum) AND (PRD>=(19990101) AND PRD<=(20151231))

### Technology Breakdown

We used a hierarchical technology breakdown based on the following IPC marks:

IF CONTAINS ([Ipc], "A21") OR CONTAINS ([Ipc], "A23") OR CONTAINS ([Ipc], "A22") OR CONTAINS ([Ipc], "C13") OR CONTAINS ([Ipc], "A01") OR CONTAINS ([Ipc], "C05F001108") THEN FOOD

ELSEIF CONTAINS ([Ipc], "A61K0008") OR CONTAINS ([Ipc], "A61K0006") OR CONTAINS ([Ipc], "A61K0007") OR CONTAINS ([Ipc], "A61Q") OR CONTAINS ([Ipc], "A61K0000") THEN COSMETIC

ELSEIF CONTAINS ([Ipc], "A61K0003") OR CONTAINS ([Ipc], "A61K0009") THEN MEDICINE

ELSEIF CONTAINS ([Ipc], "C07") OR CONTAINS ([Ipc], "C12C") OR CONTAINS ([Ipc], "C12F") OR CONTAINS ([Ipc], "C12G") OR CONTAINS ([Ipc], "C12H") OR CONTAINS ([Ipc], "C12J") OR CONTAINS ([Ipc], "C12L") OR CONTAINS ([Ipc], "C12P") OR CONTAINS ([Ipc], "C12Q") OR CONTAINS ([Ipc], "C12R") OR CONTAINS ([Ipc], "C12Y") OR CONTAINS ([Ipc], "B01") OR CONTAINS ([Ipc], "A01G") OR CONTAINS ([Ipc], "C01") THEN CHEMISTRY/BIOCHEMISTRY

ELSEIF CONTAINS ([Ipc], "C08B") THEN POLYSACCHARIDES

ELSEIF CONTAINS ([Ipc], "A61L") OR CONTAINS ([Ipc], "C09D") OR CONTAINS ([Ipc], "C08L") OR CONTAINS ([Ipc], "B81") OR CONTAINS ([Ipc], "G03") OR CONTAINS ([Ipc], "B32B") OR

CONTAINS ([ipc], "B05") OR CONTAINS ([ipc], "B82") OR CONTAINS ([ipc], "D06") OR CONTAINS ([ipc], "D02G") OR CONTAINS ([ipc], "G02") THEN MATERIALS

ELSEIF CONTAINS ([ipc], "C02F") OR CONTAINS ([ipc], "C02C000102") OR CONTAINS ([ipc], "E02D001720") THEN SEWAGE/WATER TREATMENT

ELSEIF CONTAINS ([ipc], "C12N") OR CONTAINS ([ipc], "C12M") OR CONTAINS ([ipc], "A01N0006503") OR CONTAINS ([ipc], "F26B002106") THEN BIOREACTORS

ELSEIF CONTAINS ([ipc], "C10") OR CONTAINS ([ipc], "C11") THEN BIOFUEL

ELSEIF CONTAINS ([ipc], "A61M") OR CONTAINS ([ipc], "A61F") OR CONTAINS ([ipc], "A61K004") OR CONTAINS ([ipc], "C11D") OR CONTAINS ([ipc], "G01N") OR CONTAINS ([ipc], "H01G") OR CONTAINS ([ipc], "C25B") OR CONTAINS ([ipc], "A24B") OR CONTAINS ([ipc], "A47C") OR CONTAINS ([ipc], "C08F") OR CONTAINS ([ipc], "C05G") OR CONTAINS ([ipc], "A47K") OR CONTAINS ([ipc], "A61H") OR CONTAINS ([ipc], "C08J") OR CONTAINS ([ipc], "C09K") OR CONTAINS ([ipc], "D04H") OR CONTAINS ([ipc], "F01K002310") OR CONTAINS ([ipc], "F02C000105") OR CONTAINS ([ipc], "F02G000500") OR CONTAINS ([ipc], "F03G000700") THEN INDUSTRIAL USES

END

