

TECHNOLOGY
WATCH REPORT



Smart waste management: industrial symbiosis

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Smart waste management: industrial symbiosis

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Overview of innovation and tendencies in Smart waste management

The volume of **waste generated in the world continues to grow**. This year it is expected to reach 29.3 thousand million tons, with **Asia-Pacific and Europe** being the regions mainly responsible for these figures, followed by America and Middle East & African countries (MEA). But on a world-wide level the percentage of waste being dumped still remains close to 60%. Even though it is expected that the world recycling market will increase to about 320 thousand million tons in 2018, the **recycling rate grows much more slowly than waste production**.

More than half, 16,400 million tons, corresponds to **non-hazardous industrial waste**, followed by plastic waste, construction and demolition (C&D) waste, Municipal solid waste (MSW) and waste electrical and electronic equipment (WEEE).

The **economic diversification and legislative improvements** in developing countries such as India and China, as well as the recycling objectives of developed countries, such as North-America and Europe, are expected to drive the industrial waste recycling market, mainly in sectors related to energy, agriculture, metallurgy, textile, food/beverage and cement producing industries.

“In a context where resources are being exhausted and of unsustainable consumption, it is necessary to advance towards a circular economy, with a decided emphasis on remanufacturing, recycling and re-use”

The **collection rate** for industrial waste is expected to increase from 73.7% in 2017 to **76.8%** this year, mainly because of the strict environmental legislation imposed on manufacturers, the **growing interest in waste as a strategic resource**, and the **increased demand for secondary raw materials**. It is also important to note that developed European countries and North-America have made a considerable effort to reduce the amount of waste generated, as well as to improve the selective collection of industrial bio-waste.

The **Frost & Sullivan** report “Global Waste Recycling Market Outlook, 2018: principles of sustainability, innovative business models, and disruptive technologies to change the landscape of waste recycling market” indicates some innovations and **tendencies in industrial waste management**:

- There is a tendency to increase the traction for sustainable waste management in the industrial sector. Many industries not only advance by adapting the principle of reduction and recycling, but also make a commitment to **change in the consumption patterns of raw and other materials**.
- The recovery of materials and closed-loop supply chains provide **investment opportunities** for the application of new technologies.
- **Inverse logistics** progressively come to the fore, taking charge of the recuperation and recycling of containers, packaging and hazardous waste, as well as the processes for the return of excess inventory, obsolete products and customer returns.

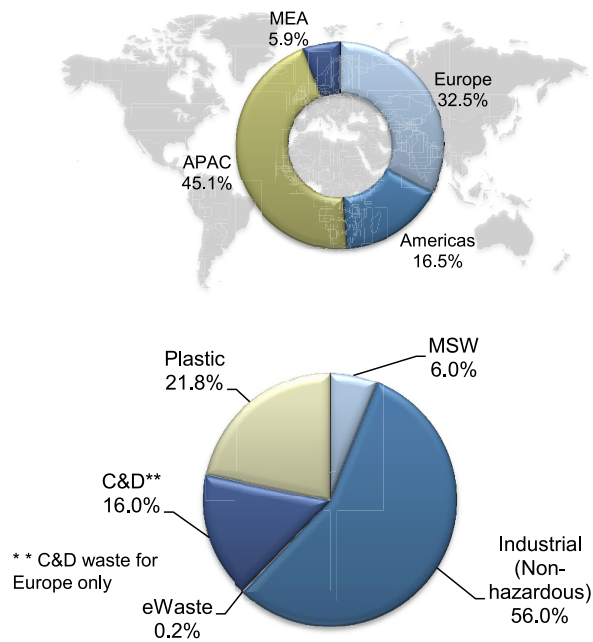
- Due to the approach of new methods for zero landfill policy advances are progressively being made in **bio-stabilizing** the mixed waste, anaerobic digestion and capture of **biogas for energy production**.
- The **use of technology** such as 3D printing is and will be decisive in the transformation of industrial operations and is already being used by many industries to achieve greater durability, extended product life and more efficient replacement of spare parts.
- Waste management companies are facing many challenges, and some experts suggest that **augmented reality can play a significant role in circular economy**, because it provides information about the environmental impact of raw materials and finished products, enhancing the decision-making skills of manufacturers.
- The **availability of data** on waste generation, collection and recycling is one of the most important problems of the waste management industry, thus opening up the need for **real-time monitoring** through the use of **smart devices** based on the Internet of Things. **Predictive analyses** will also improve and this will optimise waste collection, saving fuel, increasing the collection rate and preventing overflow.
- The electronics industry is progressing toward closed-loop supply chain, creating opportunities for **active disassembly of electronic products**, thereby significantly reducing waste electrical and electronic equipment.
- There is a significant pressure on **automakers** to reduce sending waste to landfill due to the lack of space and also by increasing landfill tax. This is likely to create economic opportunities by creating materials with less carbon footprint.
- Sustainable design or **eco-design** has become common in manufacturing industries. Many industries account for recycling and closed-loop supply chain while designing a product and considering environmental impacts during design phase simplifies recycling and reuse.
- The application of **project specific certifications** for zero waste classification systems help companies achieve zero waste objectives.
- **Upcycling or creative reinvention** of the use for products and materials, associated with the reduction of waste and contamination, is also a tendency, especially in the fashion industry.

In short, developed countries are expected to create new infrastructures to manage the increase of waste and its **recycling close to the place of generation**. Even more so after the ban put in place by China, **Europe** will take a firm stand related to **legislative improvements** to promote the **recuperation of value of secondary sources**. In Europe the waste management sector is entering a period of development as a result of strategic reference plans (*Thematic Strategy on the Urban Environment; Waste Framework Directive (WFD); Thematic Strategy on the Prevention and Recycling of Waste*) and, more specifically, the *European Strategy for Plastics, EU Bioeconomy Strategy 2012 and EU Circular Economy Package*.

It is undeniable that rapid industrialisation leads to an increase in the volume of industrial waste. In a context of unsustainable consumption where resources are being exhausted, **it is imperative to advance towards a circular economy**, with a decided emphasis on remanufacturing, recycling and re-use.

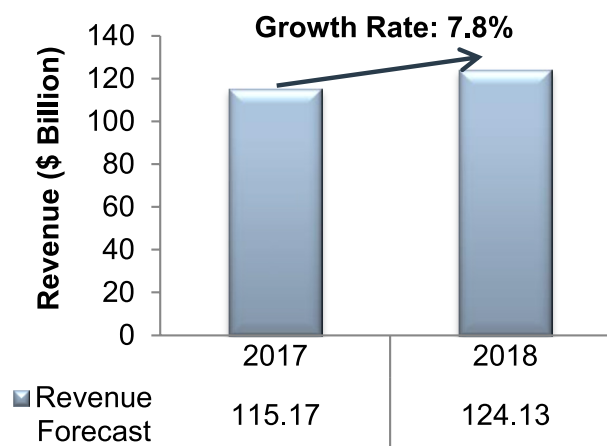
2 Industrial waste management: Key infographics on a dynamic market

2.1. Forecast waste generation, by continents and type of waste (2018)



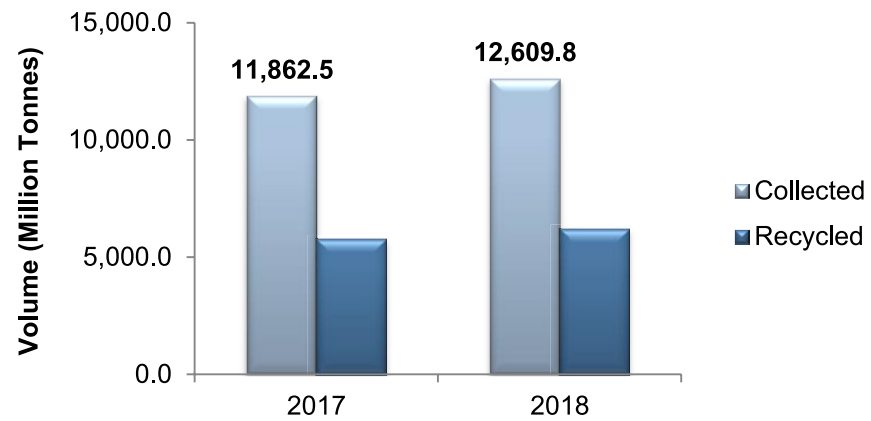
Source: Frost & Sullivan (2018). Global Waste Recycling Market Outlook, 2018

2.2. Evolution of the industrial non-hazardous waste recycling market (2017-2018)



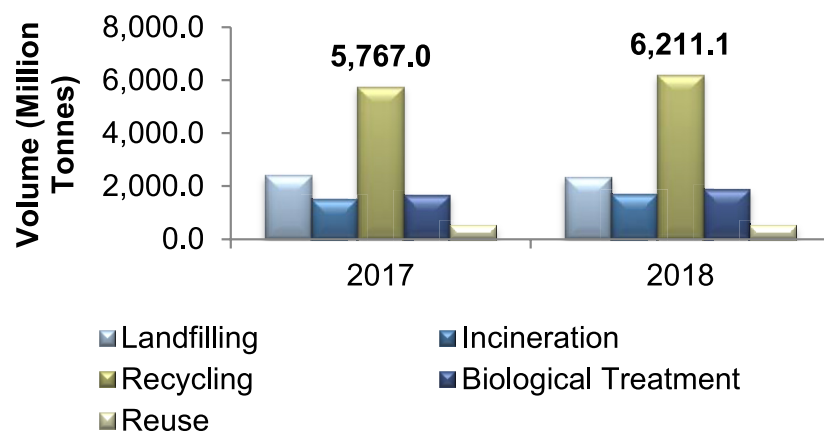
Source: Frost & Sullivan (2018). Global Waste Recycling Market Outlook, 2018

2.3. Volume of non-hazardous industrial waste recycled (2017 and 2018)



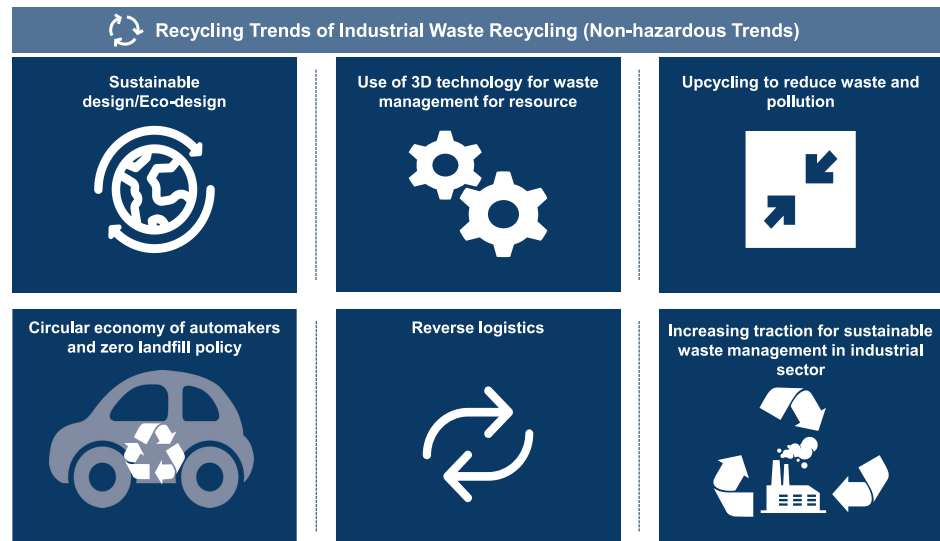
Source: Frost & Sullivan (2018). Global Waste Recycling Market Outlook, 2018

2.4. Volume of non-hazardous industrial waste recycled, by type of treatment



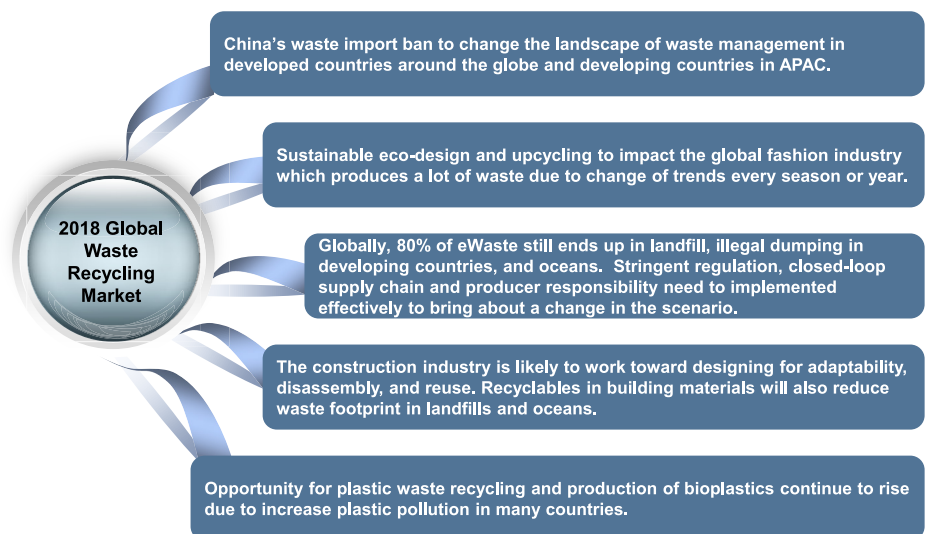
Source: Frost & Sullivan (2018). Global Waste Recycling Market Outlook, 2018

2.5. Forecast industrial waste recycling (non-hazardous)



Source: Frost & Sullivan (2018). Global Waste Recycling Market Outlook, 2018

2.6. Global waste recycling market: conclusions



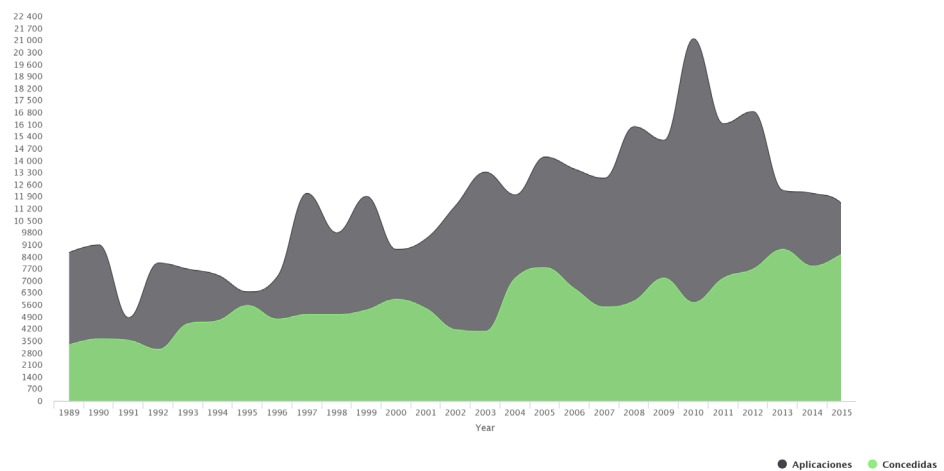
Source: Frost & Sullivan (2018). Global Waste Recycling Market Outlook, 2018

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Patent analysis

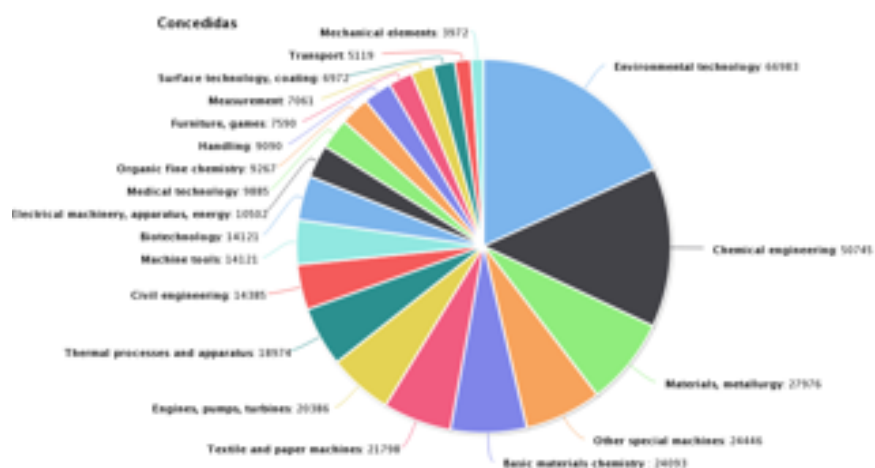
3.1. Evolution of the patents applied for and granted over the last 30 years

There is a growing tendency for both applications and granting of patents in the field analysed, probably due to combination of various factors: (1) the strong correlation between the performance of industrial processes and waste management parameters leads to an increase in the volume of “base applications”; (2) the influence of a dynamic regulatory framework, and (3) the tendency to protect the industrial secrets of companies innovating processes as a competitive strategy.



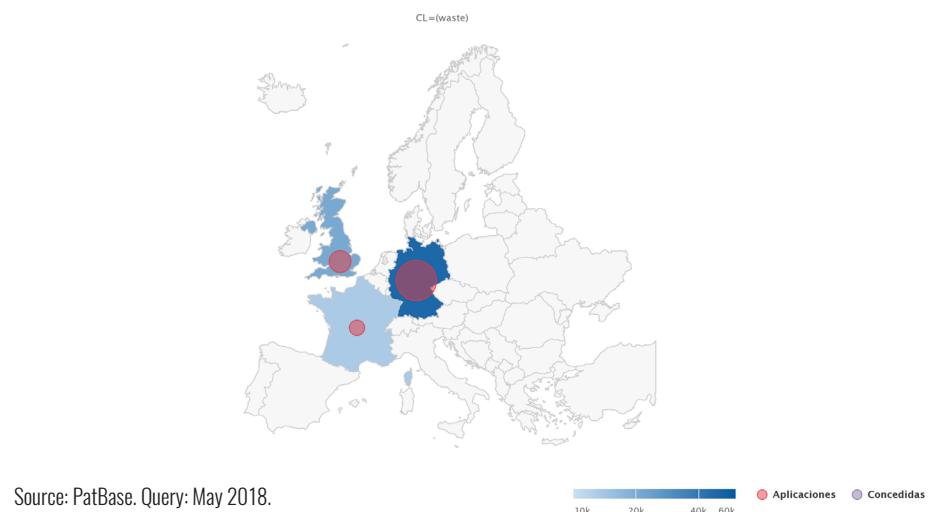
3.2. Technological sector of the patents analysed

The graph emphasises the important multidisciplinary character of the innovation associated with waste management, integrating areas of knowledge related, among others, with chemistry, biology, materials and machinery, with mechanic and electronic components.



3.3. Territorial location of patents: Europe in the top-10 jurisdictions

L'anàlisi dels països amb més sol·licituds indica on convé protegir el sector analitzat. A les raons relacionades amb les diverses aplicacions de la tecnologia se solen afegir consideracions al voltant del producte interior brut i l'existència de clústers, però en el cas específic de la gestió de residus, el marc regulador dels països resulta un factor clau a considerar. Un cas clar és el d'Alemanya, al capdavant d'Europa en sol·licitud de patents, i a nivell mundial només superat pels Estats Units. Segons les darreres dades difoses per l'Agència Europea de Medi Ambient (AEMA), el país germànic es posiciona com el segon que més recicla a Europa (taxa de 62%, només superada per un punt per Àustria) després de la implantació de mesures incentivadores, com que tot envàs sigui retornable, cobrar per les bosses de plàstic o vetar la compra de màquines de cafè amb càpsules en edificis institucionals.



3.4. Who are among the most committed? The 20 most active applicants

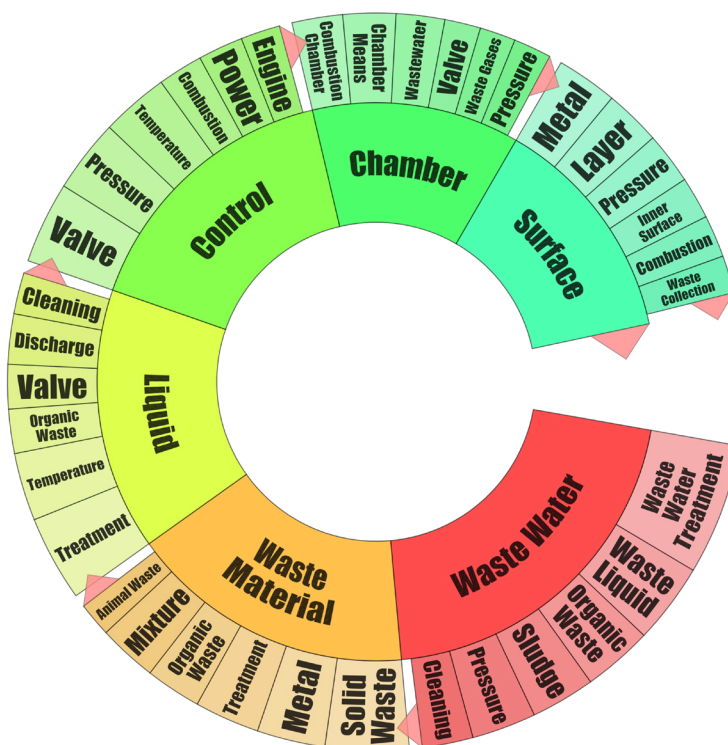
The table offers information about the twenty most active organisations in the waste management sector, which in turn are classified in function of specific fields of action, thus allowing a better understanding of the strategic lines of research and innovation to implement solutions, and whether there is a focus on concentration or diversification within the wide range of technology analysed.

Environmental Technology (54893)	0	1677	530	177	89	0	1766	89	89	0	0	89	265	0	442	177	0	0	0	89
Chemical Engineering (44199)	89	1148	89	0	177	442	1942	265	0	89	177	0	354	0	0	442	89	0	0	0
Materials, Metallurgy (25917)	0	0	89	89	177	0	1854	265	0	0	0	89	0	1324	265	442	0	0	0	0
Basic Materials Chemistry (20064)	0	795	0	0	177	0	1942	89	0	89	0	177	0	0	0	0	354	707	0	0
Other Special Machines (20060)	0	530	530	0	0	1589	0	0	0	0	0	0	0	354	0	0	0	0	0	0
Textile And Paper Machines (19525)	0	0	0	0	0	1589	1766	0	0	0	0	0	0	0	0	0	0	707	0	0
Engines, Pumps, Turbines (17234)	0	0	0	0	177	0	0	89	530	0	0	0	265	0	0	0	0	0	89	0
Thermal Processes And Apparatus (15734)	1236	0	0	0	177	0	1766	0	0	0	0	0	0	0	0	0	0	0	89	0
Biotechnology (13348)	0	0	530	0	0	0	0	0	0	0	265	0	0	0	0	971	707	0	0	0
Machine Tools (11492)	0	0	0	0	0	0	0	0	0	0	0	0	89	0	442	0	0	0	0	0
Samsung Electronics Co Ltd (10)																				
Bayer Ag (9)																				
Bayer Ag (7)																				
Siemens Ag (7)																				
Honeywell Int Inc (6)																				
Mitsubishi Chemical Corp (6)																				
Korea Int Of Energy Research (6)																				
Toshiba Katsushika R&D (5)																				
Shakee Corp (5)																				
Shanghai Kunshan Technology Co Ltd (5)																				
Equitech Int Llc (5)																				
Un Energy (5)																				
Avastia Corp (5)																				
Hoechst Ag (5)																				
Aquatech Corp (5)																				
Tissue Control Llc (5)																				
Melip Sankha Pharma Co Ltd (5)																				
Bax Llc (5)																				
Thomson D (5)																				

Source: PatBase. Query: May 2018.

3.5. Keywords attributed to patents in this field

An analysis of the keywords most often repeated in the patent sample, as well as the relationship between them enables us to determine which facilitating applications and technologies are involved in the innovation of waste management material.



Source: PatBase. Query: May 2018.

3.6. METHODOLOGICAL APPENDIX

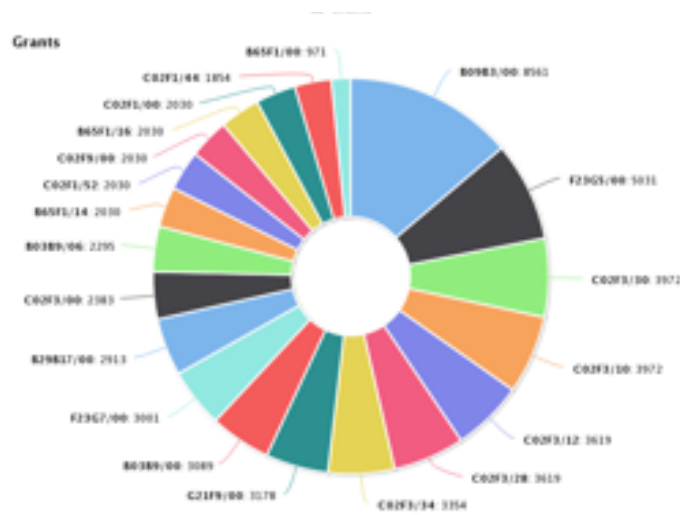
The information contained in the “Patent analysis” section refers to a statistical study performed on a sample of 454,403 patent applications in the field of waste management, with special emphasis on the last 20 years.

134,230	99,282	454,403	613,784
Patent family	Family of patents granted	Applications	Publications
Total number of families in this set of results	Total number of families with publications granted with this set of results	Applications within this result	Publications within this result

Source: PatBase. Query: May 2018.

Waste management is a field with a strong multidisciplinary character involving many industrial sectors. This places extreme importance on the criterion used to determine the application sample to be analysed, requiring a careful selection of keywords, fields of knowledge and technological applications. With this in mind, this patent analysis required adjusting the query in accordance with the inclusion of the word “waste” -and its derivatives- in the object of protection formulated on the patent application to obtain a sample which, a priori, does not ignore any technological field.

The sample obtained therefore includes various fields, as shown on the graph, in accordance with International Patent Classification (IPC) nomenclature:



Source: PatBase. Query: May 2018.

The following fields are especially outstanding:

- B09B3/00: destroying solid waste or transforming solid waste into something useful or harmless
- F23G5/00: methods or apparatus, e.g. incinerators, specially adapted for combustion of waste or low grade fuels
- C02F3/30: aerobic and anaerobic processes
- C02F3/10: packings; fillings; grids.
- C02F3/12: activated sludge processes
- C02F3/28: anaerobic digestion processes
- C02F3/34: characterised by the microorganisms used

Note that the five last fields belong to the general family of the biological treatment of water (C02F3/00: biological treatment of water, waste water, or sewage), which represents one third of the whole sample.

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