Project title: Mediterranean Innovation Alliance for sustainable blue economy
Acronym: BLUE BIO MED

Priority Axis 4: Enhancing Mediterranean Governance
4.1: To support the process of strengthening and developing multilateral coordination frameworks in the Mediterranean for joint responses to common challenges

https://blue-bio-med.interreg-med.eu/

Deliverable 3.2.3	**Technology and market forecast**
Description	The report highlights the technology and market future trends for the different sectors pertaining the blue bioeconomy and their linkages with the Sustainable Development Goals. The deliverable is structured into different sections: 1. *Introduction* **2. *How to read this document*** 3. *Technology forecast and importance of SDGs in Blue Bioeconomy* 4. *Complete report on patent and NPL analysis* - *Part I: Fishery and Aquaculture* - *Part II: Blue Biotechnology* - *Part III: Blue Sustainable Development* 5. *Key points on Patent and NPL* 6. *Final remarks*
WP 3 Responsible Partner	AREA SCIENCE PARK
Authors	Francesca Furlan, Riccardo Priore and Noemi Tomasi Research Valorisation Unit | Innovation and Projects Institute Area Science Park www.areasciencepark.it
Acknowledgements	Mauro Celussi, Simone Libralato Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – OGS – www.inogs.it
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Index

2. How to read this document

Definition of the Sectors of BlueBioMed project

The "Conceptual Framework and Mapping Methodology" has identified three broad fields of interest which are further divided into sub-fields as follows:

1. Fishery and aquaculture

The fishing and aquaculture sector has been divided in the following four sub-sectors of interest:

a. Pelagic and Demersal Large-Scale Fisheries (LSF) and Distant Water Fleet (DWF) include fisheries and the quite diversified range of gears used, with some significant differences among countries and regions. Among the Mediterranean countries the industrial segment operates mainly for Bluefin tuna fishing and is practiced by large tuna seiners in certain countries such as Spain and Italy. The LSF in the Mediterranean area (highly dependent on a small number of species) is mainly made up of vessels using active gears, especially trawlers targeting demersal resources and purse seiners and pelagic trawlers targeting sardines and anchovies.

b. Small Scale Fisheries (SSF) targeting the local market for fresh fish, mainly sold directly to consumers, is widespread in the Mediterranean and generally operate in lagoons and the coastal area of the continental shelf, using small boats and not towed gears. If industrial fisheries are characterized by a general lack of sustainability, small scale fisheries are generally closer to blue growth principles (Pauly 2018) but it is also subjected to lesser control (Penca et al., 2021).

c. Marine Finfish aquaculture (MFA): Mediterranean fish farming focuses on the popular carnivorous finfish species with either a low production volume from capture fisheries or from over-fishing stocks; European sea bass (*Dicentrarchus labrax*) and Gilthead sea bream (*Sparus aurata*) are the main species grown

d. Shellfish aquaculture (SA) sector produced almost 550 ktons in 2012 at a value nearing EUR 900 million, accounting for roughly half of EU aquaculture output, one fifth of which produced in the Mediterranean with Mussels and Oyster production dominating the sector.

e. Seafood processing and trade converts the whole fish or shellfish harvested by fishermen or produced by aquaculture operations into the products that are sold at retail stores or restaurants. Primary processors generally convert whole fish into fish fillets, steaks or loins or shuck or cook raw shellfish or remove the edible meat. These edible portions are then packed in some way and distributed as fresh refrigerated products or are frozen prior to distribution to wholesalers or directly to retail stores or restaurants. Secondary processors convert fresh or frozen fish and shellfish products and other ingredients into the final products that are available in retail stores and restaurants.

2. Blue Biotechnologies

Blue (marine) biotechnology are defined as science and technology applications aimed at producing knowledge, goods and services from (marine) biological resources. Blue Biotechnology involves basic and applied research in the full value chain, from the marine habitat to biotechnology products and uses living organisms as source or outcome of biotechnology applications according to OECD definition.

Blue biotechnology has been subdivided into the following subsectors considering the application products:

a. Healthcare and Pharmaceutical applications: biotechnology has led to the discovery and development of advanced medicines, therapies, diagnostics, and vaccines. For example, biotechnological breakthroughs have created new medicines for patients suffering from growth diseases, metabolic diseases, multiple sclerosis, rheumatoid arthritis and cancer.

b. Agriculture, Livestock, Food processing: biotechnology has improved animal feed (food supplements to strengthen the immune systems of livestock and reduce the consumption of antibiotics), produced vaccines for

livestock, and improved diagnostics for detecting diseases such as BSE, foot and mouth disease, and salmonella. It has also enabled the use of enzymes for more efficient food processing and improved the breeding of plants to obtain desired characteristics.

c. Industrial Processes and Manufacturing: biotechnology has led to the use of enzymes in the production of detergents, pulp and paper, textiles, and biomass. By using fermentation and enzyme bio-catalysis instead of traditional chemical synthesis, higher process efficiency can be obtained, decreasing energy and water consumption. This leads to a reduction in toxic waste.

d. Biofuel: as using micro-algae technology a theoretical volume of 20 000-80 000 dm3 of oil per hectare per year could be produced.

e. Biomonitoring and Bioremediation: CO2bio-remediation using micro-algae cultures for the treatment of atmospheric emissions from industry.

3. Blue sustainable development

This sector includes cross-sectoral innovation drivers or enablers that are of interest for the project. The **blue sustainable development sector** allows to consider not only development trajectories aimed at reducing the negative impact of blue economy activities (i.e. fishery and aquaculture) but also broader trajectories addressing the negative impact of human pressure on marine living ecosystems (e.g transportation).

a. Monitoring and Observing systems for marine environment: the Mediterranean is characterized by an intense traffic of ships transporting hydrocarbons and chemical, toxic-harmful substances and by several offshore oil installations (platforms and pipelines) that represent a constant potential risk for the environment. In terms of prevention and identification of illegal activities that can potentially cause marine pollution, routinely oil spill detection monitoring of the sea basin has a deterrent action against those vessel owners who operate tankers' illegal washing. Monitoring and observing can also be used to track illegal fishery using extensively integrated maritime surveillance systems, databases management and information technologies tools.

b. Marine Environmental Technologies: this broad sector includes technologies applied to aquaculture (as valorization of by-products and waste), the exploitation of marine organisms and their commercial biomass applications as well as that one of enzymes. "Biomass organisms" comprise macroalgae (seaweeds), microorganisms (microalgae, bacteria and fungi) and invertebrates as sea stars, sea cucumbers, sea urchins. An important role is also played by new technologies to built environmental-friendly vessels (reduction of sulphur and nitrogen oxide emissions and noise pollution, for example), strictly linked to MRE.

c. Methods and tools for the preservation and management of marine ecosystem, reduction of anthropogenic pressure: economic activities can affect marine ecosystems in a wide range of ways, from fishing and its impacts on the benthos and marine populations, to oil spills, eutrophication, agriculture with nitrate pollution, marine pollution and plastics. These phenomena con be tackled with technological developments and improvements in monitoring systems, including new business models to combine economic, social and environmental values. In this context Marine spatial planning and Marine Protected Areas (MPAs) can play a growing role in the innovation ecosystem.

How to read this document

The deliverable of the DT3.2.3 "Technology and Market Forecast" is divided into 6 documents which addresses the complexity of the themes:

- Introduction
- **How to read this document**
- Technology forecast and importance of SDGs in Blue Bioeconomy
- Complete report on patent and NPL analysis

- *Part I: Fishery and Aquaculture*
- *Part II: Blue Biotechnology*
- *Part: Blue Sustainable Development*

- Key points on Patent and NPL
- Final remarks and recommendation

Methodology

Technology and Market Landscape

For the Technology and Market landscape two datasets where use which are reported as it follows:

1. © MarketsandMarkets (MnM) 2021. All rights reserved. The MnM Report represent data, research opinions, and/or viewpoints published as a part of a service by MnM and are not representations of fact. The MnM Reports are relevant only as to their original date of publication, and not of the date of this document, and the viewpoints and/or opinions expressed in the original MnM Report(s) are subject to change without notice.
2. BCC Research (https://www.bccresearch.com/)

The **Technology and Market Landscape** is an organized analysis to gather information about target markets and competitive landscape in a particular sector. This analysis provides relevant information to identify and analyse market needs, market size and competition in the fields of interest.

The search and analysis of market and technology data in this project was performed with the application of the technology and business intelligence tools MarketsandMarkets and BCC Research.

MarketsandMarkets is a multisectoral database that collects market research reports in various technological fields and designed to process some information interactively. More than 1,200 market reports are published each year (https://www.mnmks.com/).

BCC Research (https://www.bccresearch.com/) is a collection of multi-sector reports, with main information and market data on the main technologies in the following areas: life sciences, materials, sensors (applications and technologies), production, energy and environment.

The research in the information providers was based on the use of keywords or by thematic area, according to the specific topics of interest of the project. The results of the assessment are data about the target or global market potential, market values and trends of the markets of interest. During the search particular reference was given to the **European** and to the **Mediterranean area markets**.

The Patent Landscape and NPL analysis

Guidelines for reading the data of the Ms_PowerBI dashboards

The criteria aimed at the screening of the patent documents lead to the selection of indexes that identify the **"patent families[1]"**. Such results may be selected following specific search strategies that are based on queries run on a patent

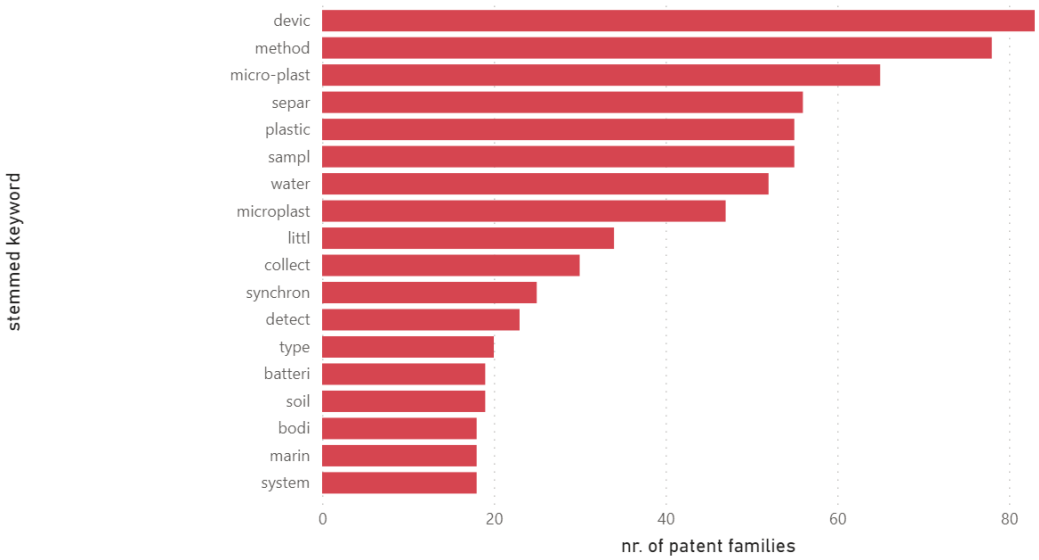
[1] "Patent family" refers to a pool of patent documents sharing the same priority date. Since the text of the original patent application may undergo amendments as consequence of the examination procedures diversified depending on each national patent office or regional/international authority where each application may be filed, the extent of the legal protection assured by each version belonging to the same family is not always identical, though in principle **the main technical features of the invention remain unaltered**.

database, in our analysis Orbit Intelligence has been consulted[2]. The technical context specificity can be preliminarily assessed upon analysing the results by means of two complementary methodologies:

a) It is possible to highlight the technical keywords from the patents' titles and to rank the "stemmed" keywords depending on the respective frequency in the patent documents' titles.
b) A complementary assessment relies on the selection of lists of technical concepts specific for each retrieved patent document. Such analysis is feasible thanks to the possibility of exporting lists of technical concepts specifically associated to each patent family, being such information gathered from the Orbit Intelligence database consultation. Data are subsequently elaborated with a dedicated IPython-notebook, with the aim of associating each patent family with nine representative "technical concepts". An example, restricted to few patent families is provided as in Figure 1, being there the possibility to further analyse those results sharing a specific technical concept.

From now on, the examples used to explain the meaning of the data of each MS Power BI dashboard are taken from the analysis regarding the patent documents dealing with the detection/treatment of the micro-plastic particles that might negatively affect the quality of the seawater.

Figure 1 "Technical keywords" cited in the patent documents' titles[3]



For customisable inspection of the data the reader is readdressed to the Power-BI dashboard entitled "PAT. Titles' keywords analysis".

[2] Orbit Intelligence: Patent database provided by Questel. Daily updated system that includes over 54 million patent families and 100 million patent documents with a worldwide coverage. Further details can be found at the following URL: https://www.questel.com/business-intelligence-software/orbit-intelligence/

[3] Assessment performed upon elaboration of the patents' titles by means of Python.

Figure 2 Sequences of technical concepts associated to each patent document (family)

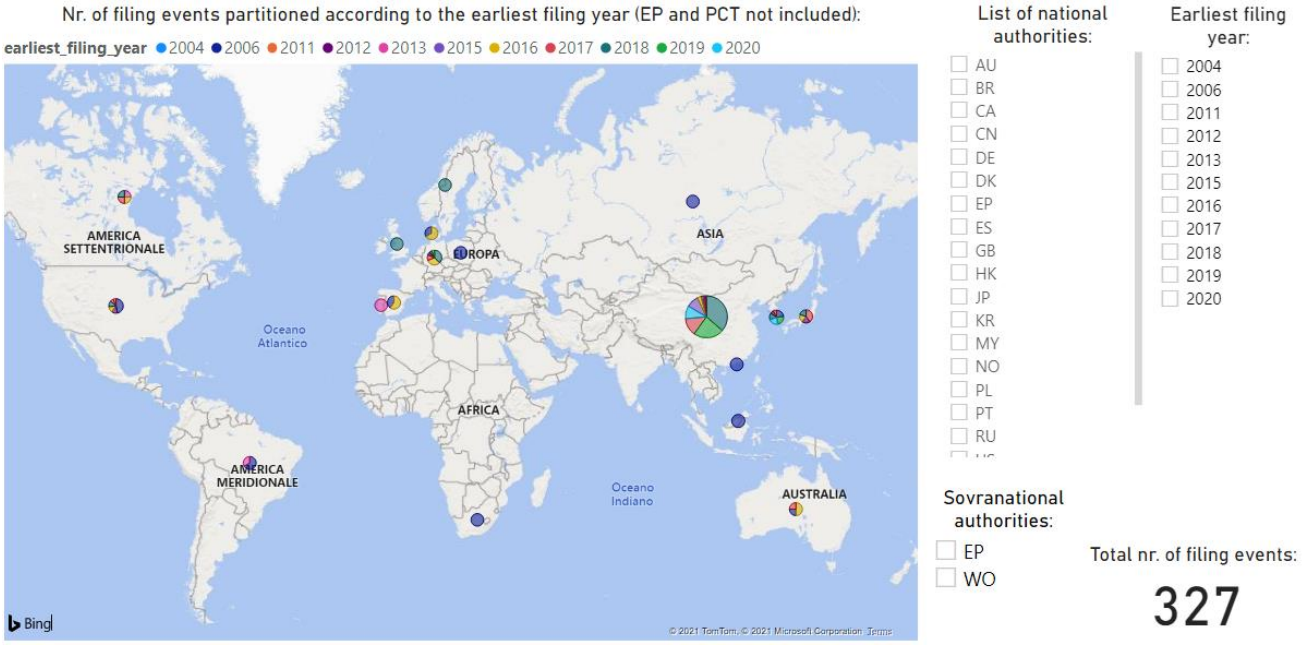
docdb_family_id	Tech_concept#1	Tech_concept#2	Tech_concept#3	Tech_concept#4	Tech_concept#5	Tech_concept#6	Tech_concept#7	Tech_concept#8	Tech_concept#9
60103535	FILTER CYLINDER	SEDIMENT	EXTRACTING MICROPLASTIC	ENDOCRINE DISRUPTOR	INORGANIC IMPURITY	ARGILLACEOUS SEDIMENT DISPERSION	MICROPLASTIC	SOLID PARTICLE	FLOATING SOLID M
61099262	LANDFILL LEACHATE	MICROPLASTIC	MAGNETIC MICROSPHERE	MAGNETIC SELECTIVE ADSORBENT	SELECTIVE ADSORBENT	TEMPLATE MOLECULE	DISSOLVE SEDIMENT	LANDFILL LEACHATE SAMPLE	LANDFILL LEACHAT
63338402	OYSTER	HYPERSPECTRAL TECHNOLOGY	RAPIDLY DETECTING MICROPLASTIC	RAPID DETECTION	OYSTER BODY MICROPLASTIC	MICROPLASTIC	MICROPLASTIC SHEARING PREPARATION	MICROPLASTIC SHEARING	OYSTER VISCERA R
65046277	MICROPLASTIC	ORGANIC MEMBRANE	WATER ENVIRONMENT	AUXILIARILY DETECTING MICROPLASTIC	FLUORESCENT SUBSTANCE	FLUORESCENCE MICROSCOPE	SUPER CLEAN BENCH	MEMBRANE FILTER	HYDROPHOBIC MI
65068434	MICROPLASTIC	WATER	WATER	DETECTING DENSITY	MICROPLASTIC	DENSITY	MICROSCOPIC	G	MICROSCOPIC FOU

The complete panel of technical concepts (Figure 2) can be visualized by means of Power BI, upon selecting the dashboard entitled “PAT. ORBIT technical_concepts”.

Mapping of the patent applications’ filing events

The proxy aimed at quantifying the patent applications filed to different national patent offices, as well as to regional/international offices (a.k.a. authorities), allows to detect the territories most likely relevant if considering the strategies aimed at an adequate commercial exploitation of the know-how. Such information allows in part to foresee potential hurdles or, alternatively, to envisage the opportunities that may influence the strategy aimed at legally protecting an innovative product/service in one or more countries of interest. Therefore, such map highlights potential market areas. Of course, there may be several patent applications filed to supranational authorities, such as the EPO or the WIPO (PCT applications) the identification of whom is not feasible on the geographic chart, therefore the number of patent applications filed to the supranational patent authorities appears framed in a box. Assuming subsequent nationalization of EP and/or PCT patent applications the number of countries corresponding to potential markets may be very large. In the dashboard accessible from the MS Power BI file and entitled “PAT. filings”, the world map cited above is reproduced (Figure 3) so that patent applications may be further selected depending on the earliest_filing_year.

Figure 3 Example of the territories hosting the national patent authorities and quantification of the patent applications

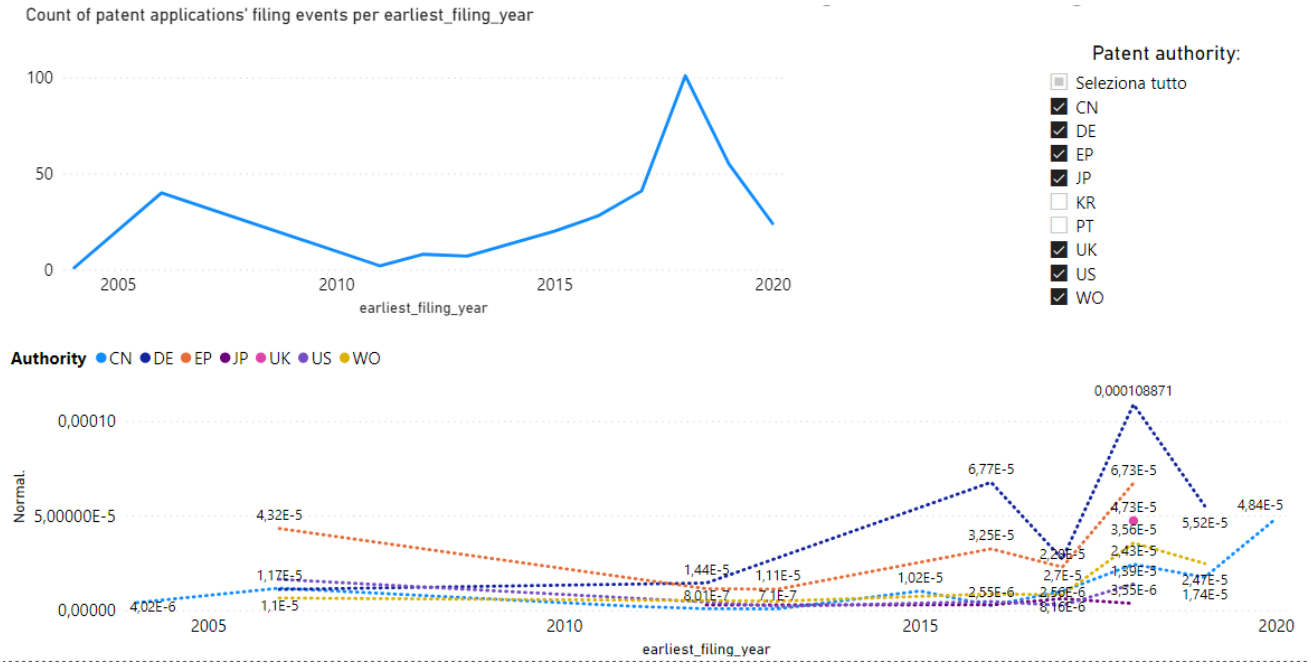


By means of circles characterised by variable dimension, each being proportional to the number of patent applications filed, several countries are identified corresponding to the local patent authorities to whom the patent applications have been filed during a given time-frame[4]. Such data can be analysed at greater detail, for example upon focussing on one specific national authority, or, rather, considering the distribution of the applications filed to a multiplicity of authorities selected by the user allowed to select also a specific value of the earliest filing year.

Normalization of the filing events

The data shown in the Power BI dashboard entitled "PAT. Normaliz" are in part those shown in Figure 4, although the present step of the analysis just focuses on some of the most relevant national and on the supranational authorities. Each trend represents **the ratio obtained dividing the number of patent applications filed to a selected authority and regarding the specific objective of our investigation** (i.e., **the implementations of technical solutions regarding the microplastics' detection/purification**) **by the whole number of patent applications, i.e., detected irrespectively of the technical field but filed to the same authority during the very same time frame**. This alternative visualization of the patent applications allows to detect possible bias, for example linked to demographic factors, being not surprising that in densely populated countries the "absolute" number of patent applications dealing with a specific topic may be higher than in smaller countries. Moreover, some authors claim that the normalisation of the data would allow to control for institutional characteristics that affect the raw patent count, such as the strength of patent protection, the level of fees and other aspects of the design of patent systems (such as the fact that patent systems in some countries favour numerous but narrow patent applications—as in Japan and Korea—or that some patent offices do not publish all patent applications—such as the USPTO—which lowers the patent count).

Figure 4 Normalization of the filing data considering national/supranational authorities



[4] *Supranational authorities such as EPO or WIPO cannot be visualised in the geographical map, yet the Power BI dashboard allows to determine the number of patent applications filed to each authority in the considered time frame.*

From such kind of diagram evidence supporting the assumption that the legal protection may be often sought for by initially filing the patent application(s) to the WIPO or to the EPO supranational authorities and only later effectively achieved upon "nationalizing" the patent or patent application in the countries of interest may emerge.

The patents' grant rate

In Figure 5 an ordered list of assignees/applicants is shown, based on the decreasing number of the respective patent families owned.

Figure 5 Ranking of the applicants/assignees based on the corresponding number of patent families

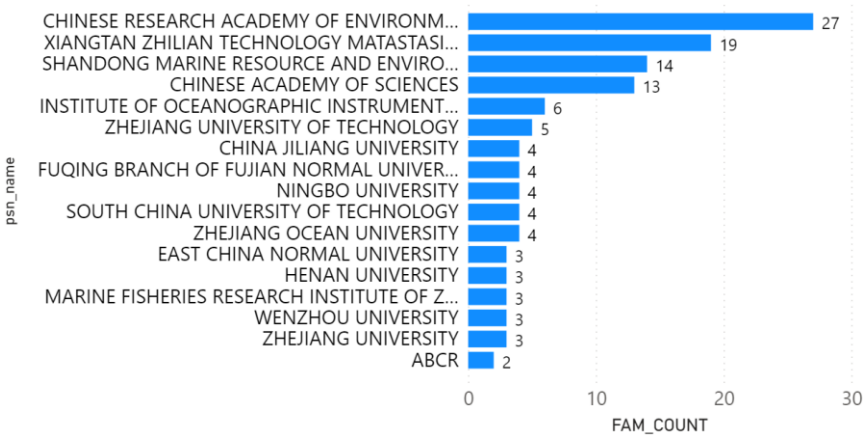
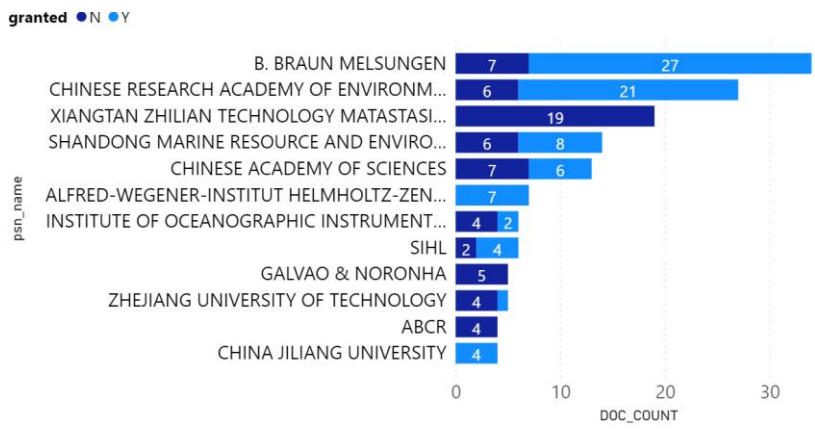


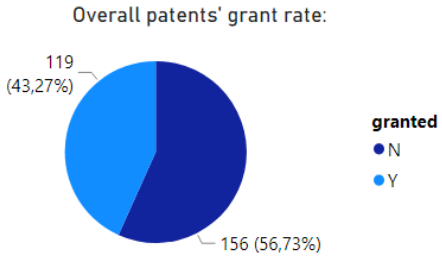
Figure 6 (the data are extracted from the same Power BI dashboard) is instead referring to the number of filed patent applications. Moreover, from such diagram it is possible to evaluate the proportion of the granted patents (to this aim pls. refer to the light blue sector of each bar of the diagram), so that the assignees can be ranked evidencing those ones that most likely benefit from the competitive advantage offered by a valid patent.

Figure 6 Assignees/applicants and the corresponding proportion of the granted patents



The cumulative information regarding the overall patents' grant rate is shown in Figure 7, from which it is usually arguable that **on average, for about 1/3 ÷ 1/2 of the filed patent applications the pre-grant patent prosecution ends up with the decision to grant the patent**.

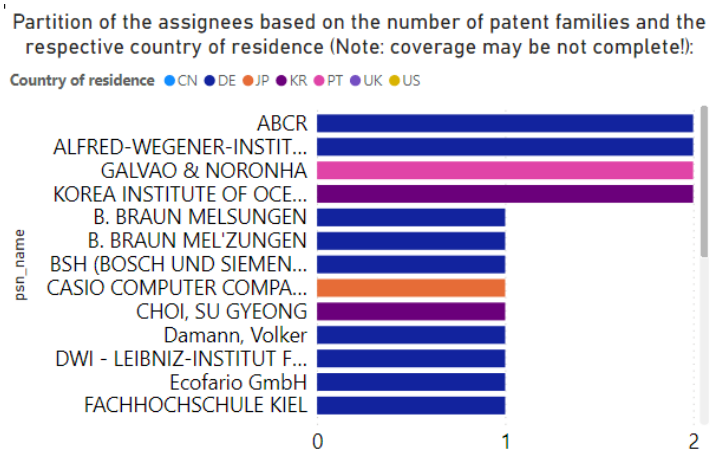
Figure 7 Overall patents' grant rate



Countries of residence of the assignees/applicants

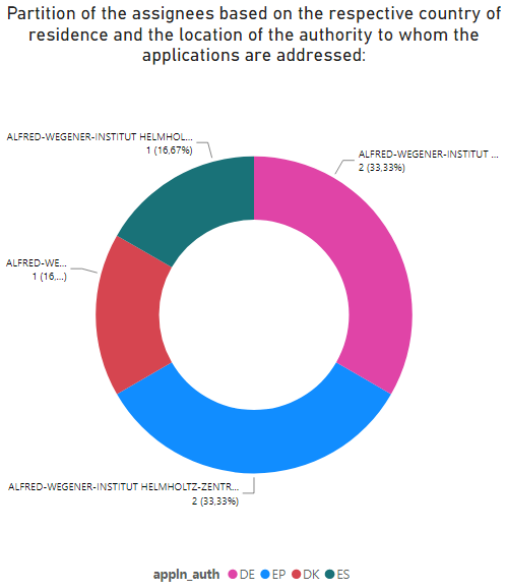
In the present section, as well as in the corresponding dashboard of the Power BI file, the analysis is focused on the country of residence of the most representative patent assignees (Figure 8), being such information as well useful to identify the most appealing market territories. It is nevertheless necessary to consider the possibility that such information may be not always complete, the reason being that, as in the case of several national authorities, for example some hosted within certain Asian countries, the information regarding the country of residence of the assignee is not always acquired and/or transmitted to the EPO. Even if partial, these data can complement the information arguable from those of Figure 3, the latter data facilitating the identification and subsequent quantification of the patent applications' filing procedures, either in case the patent prosecution implicates the filing to one or more national authorities or in case a supranational authority (EPO or WIPO) is addressed.

Figure 8 Ranking of the patent assignees based on the number of patent families owned and on the respective country of residence



The visualization of the aggregated information is of course an option provided by the dashboard, but the detail shown in Figure 9 specifically refers to the case of the "top assignee" ALFRED WEGENER INSTITUT, corroborating the idea that, although several national authorities have been addressed by this specific players, several PCT/EP applications have been filed, such harmonised procedures subsequently enabling one or more nationalization procedures aimed at achieving the legal protection for the same object in several countries considered of utmost importance for the business.

Figure 9 Example regarding the analysis of the patenting strategies based on the applications filed by ALFRED WEGENER INSTITUT



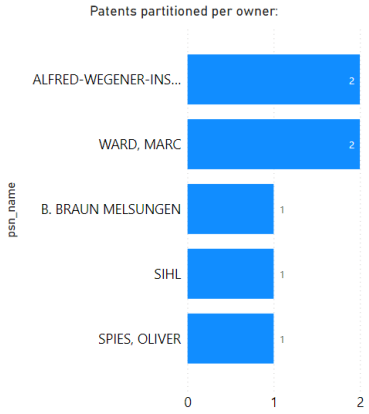
Evaluation of the technologies' innovativeness level (residual validity of patents and fee payments)

The *dashboard* providing information useful for an estimation of the innovativeness/obsolescence of a claimed product/methodology is based on the analysis of data extracted from the database EPRegister (https://register.epo.org/regviewer) of EPO and available for consultation free of charge. Even if such evaluation may be not strictly depending on the technical content of the patent document, the margin of implementation of a specific technical field can be indirectly foreseen considering the residual validity of granted patents included within the pool of documents dealing with the technical field of interest, as well as from the evaluation of the trend regarding the annual maintenance fees paid for each granted patent. The fee payments may be discontinued due to the patent expiration[5], or even before such event, for example in case the owner considers that his protected know-how is out of date and/or might not be worth implementing in the future. Such kind of information can be argued from the sample of data shown in Figure 10. **In case of patents already expired negative values might be assigned to the residual validity. Positive, yet small numbers might refer to a technology closed to the obsolescence, whereas positive numbers, as high as those displayed in Figure 10, would implicate that the claimed technologies may be still susceptible of implementation**. However this information is just indicative, being necessary to analyse more deeply the legal status of the patent(s) of interest, for example in case a 'freedom to operate' analysis would be required.

[5] *Usually after 20 years calculated starting from the priority date.*

Figure 10 A sample of the data referring to the patent owners partitioned according to the residual validity of the respective patent(s) and to the number of annual fees paid

psn_name	Publication_Nr	EXPIRY_days	fee_renewal_year
ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FUR POLAR- UND MEERESFORSCHUNG	EP3329994	5858	3
ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FUR POLAR- UND MEERESFORSCHUNG	EP3272421	5726	4
SPIES, OLIVER	EP3402921	5534	4
WARD, MARC	US2014138288	4386	4
WARD, MARC	US8944253	4386	4
SIHL	EP2805366	4079	8
B. BRAUN MELSUNGEN	EP2083898	2176	13



Whenever possible, the reader is recommended to integrate such information with that arguable from the so called "triadic" families' analysis. Such patent family definition represents one of several proxies useful to qualitatively estimate the know-how claimed in the patent documents.

The "triadic" families

As said above, the "triadic" families represent a proxy that may be used, for example, to corroborate certain conclusions arguable from the patent validity information, being such metric matching the OECD definition[6]. Such kind of patent family implicates a commitment which should be substantially higher than in case the applicant would address only one national authority for filing the patent application, thus legitimating the assumption that, a multiple protection **likely concerns technical solutions characterised by a consistent margin of implementation and exploitation**.

Figure 11 One example of the "triadic" families

psn_name	person_ctry_code	PUB	Conteggio di families
SIHL	DE	EP2805366	1
Totale			**1**

As can be argued from Figure 11, in specific contexts, for example niche sectors, a small number of patent documents corresponding to the triadic families might be explained assuming that, as far as specific technical fields are concerned, the predominating assignees may be individuals rather than companies or academic institutions, therefore with limited availability of resources to be invested in multiple filing procedures. This seems indeed the case for the applications dealing with the microplastic detection/removal from the sea-water.

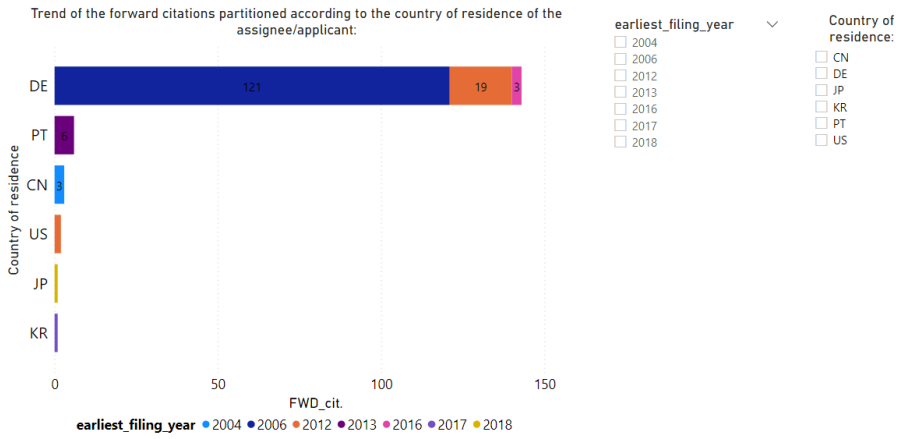
Trend of the forward citations

The information presented by means of a graphic format in Figure 12 is referred to as the quantification of the "forward" patent documents, differently said, the patent documents citing earlier filed patent applications. Likewise, the ranking of the scientific journals is based on the so-called citation index. Each patent document may be ranked considering the respective number of forward citations. Such proxy allows for the identification of those patent documents most likely characterised by a significant know-how, since they are frequently recalled in patent applications

[6] *The "triadic" family includes patent documents referring to the same invention and consists of at least one patent application filed to the EPO, one patent application filed to the Japanese Patent Office (JPO), and one patent granted by the USPTO (OECD, 2009, "Patent Statistics Manual).*

filed subsequently. According to the diagram of Figure 12, the countries where the applicants of the patent documents pooled in the present dataset are resident can be identified and ranked depending on the average number of the forward citations. Clues may be based on the identification of **those countries in which the most influent inventors/applicants are located**.

Figure 12 The quantitative evaluation of the forward citations is based on of the average number of documents citing prior patent documents filed by applicants resident in a specific country (indicated on the 'Y' axis)

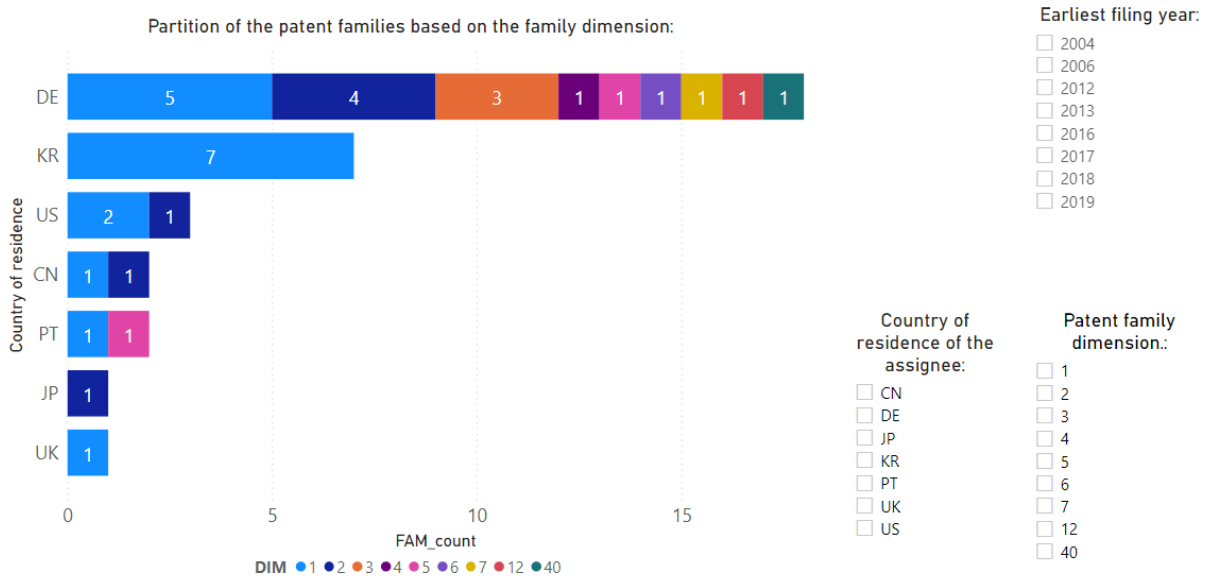


Dimension of the patent families

To properly evaluate the extent of the legal protection determined by multiple patent prosecutions regarding one specific invention, the integration of the information so far gathered with additional data based on the patent family dimension may be considered. The underlying principle is that, similarly to the case of the triadic families, it is plausible that the payoff for the consistent investments required to translate and file to each national authority applications belonging to the same patent family implies the maximization of the competitive advantage conferred by the protected know-how, thus impacting on the production, marketing, export, as well as on the possibility of engaging collaborators in a wide area.

The results of such analysis can be seen in Figure 13. The Power BI dashboard allows either to extract aggregate information, or to focus on specific values of the earliest filing year, rather than ranking the results according to a specific family dimension.

Figure 13 The distribution of the patent families permits the differentiation of the patent family dimensions (indicated in the legend with colored dots). The numbers on each bar quantify the patent families sharing a specific dimension



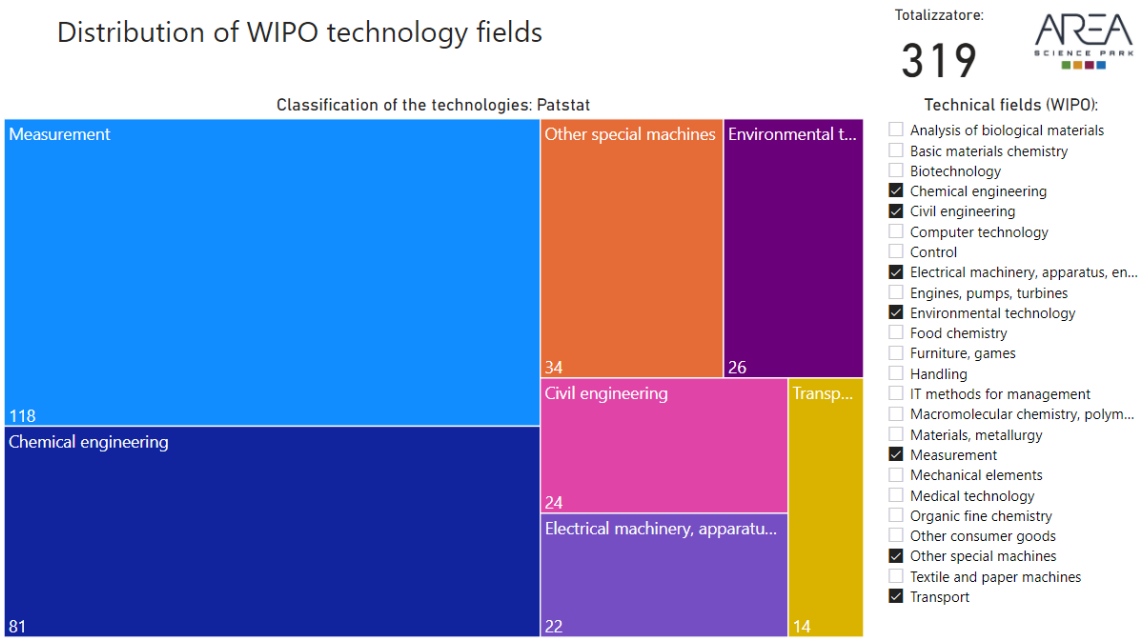
The data regarding the worldwide filing of patent applications shown in Figure 3 may be better interpreted taking in due consideration also the distribution of the patent families' dimensions shown in Figure 13, the latter parameter appearing especially remarkable for the Germany residents in the specific example concerning the 'microplastics' sector. From such data it might be argued that a consistent fraction of the filing events documented in Figure 3 could be ascribed to several procedures of nationalization likely conforming to the strategy adopted by some German applicants, for example the Alfred-Wegener-Institute. This assumption, although suggestive, should be corroborated by further investigation based on individual patent documents' examination.

Analysis of the technology fields

The WIPO classification system7 relying on the identification of 35 technology fields covering the whole collection of IPC/CPC classification codes facilitates the partition of the patent families by means of a tree diagram. A simplified scheme can be obtained, allowing to assess whether the most representative fields do match the technical concepts in which the reader of the report might be really interested in. The outcome of such assessment, as evident from Figure 14, appears consistent with the results obtained from the preliminary examination of the distribution of the technical concepts and of the keywords, respectively characterizing the patent documents' contents and titles, (shown in Figure 1 and in Figure 2). In particular, the most relevant share is associated to the technical field 'Measurement', being plausible that a complementary, yet relevant role can be ascribed to the field 'Chemical Engineering'.

[7] https://www.prh.fi/en/patentit/Tilastoja/patent_applications_per_field_of_technology.html

Figure 14 The quantification of the patent families classified by one or more "Technical fields" defined by WIPO. Pls. note that in principle one patent family may be associated to more than one technical field. To identify the patent families sharing two or more technical fields a further analysis, based on clustering of patent families, is required



Higher granularity regarding the identification of the technologies may be achieved considering that several thousands of IPC/CPC classification codes are available. While the ranking of single classification codes is not precluded from our methodology, additional information can be gathered from the dashboard showing **the co-occurrence of the most frequently assigned classification codes (IPC and CPC, respectively – see also** Espacenet https://worldwide.espacenet.com/patent/cpc-browser). The presence of recurrent associations may be helpful to better define the technical principles underlying the protected know-how or to identify technological innovations for which no individual classification code exists at present.

The frequency may be evaluated from the number of patent families sharing a specific combination of classification codes (Figure 15).

Figure 15 Co-occurrence of the IPC and CPC classification codes

NumberOfFamilies	ipc_class_symbol_1	ipc_class_symbol_2
10	G01N 1/34	G01N 1/10
9	E02B 15/10	B63B 35/32
9	G01N 1/34	G01N 1/28
8	B29B 17/02	B29B 17/00
7	G01N 1/40	G01N 1/34
6	B01D 29/58	B01D 29/01
6	G01N 1/10	B01D 35/02
6	G01N 1/34	B01D 35/02
5	B01D 29/56	B01D 29/01
5	B07B 1/46	B07B 1/04
5	B07B 9/00	B07B 1/04
5	B07B 9/00	B07B 1/46
5	B29B 17/00	B01D 35/02
5	B29B 17/02	B01D 35/02
5	G01N 1/10	B29B 17/00
5	G01N 1/10	B29B 17/02
5	G01N 1/34	B29B 17/00

NumberOfFamilies	cpc_class_symbol_1	cpc_class_symbol_2
11	Y02W 30/62	B29B 17/02
11	Y02W 30/62	Y02W 30/52
7	Y02E 60/10	H01M 4/16
7	Y02E 60/10	H01M2220/20
6	G01N 1/34	G01N 1/28
6	Y02E 60/10	H01M 4/57
6	Y02W 30/52	B29B 17/02
5	B29B2017/0244	B29B 17/02
5	Y02E 60/10	H01M 10/0566
5	Y02W 30/62	B29B2017/0244
4	E02B 15/10	B63B 35/32
4	G01N 21/84	G01N 1/34
4	G01N2001/1006	G01N 1/10
4	H01M 4/16	H01M 4/14
4	H01M 4/57	H01M 4/14
4	H01M 4/57	H01M 4/16
4	Y02E 60/10	H01M 4/14

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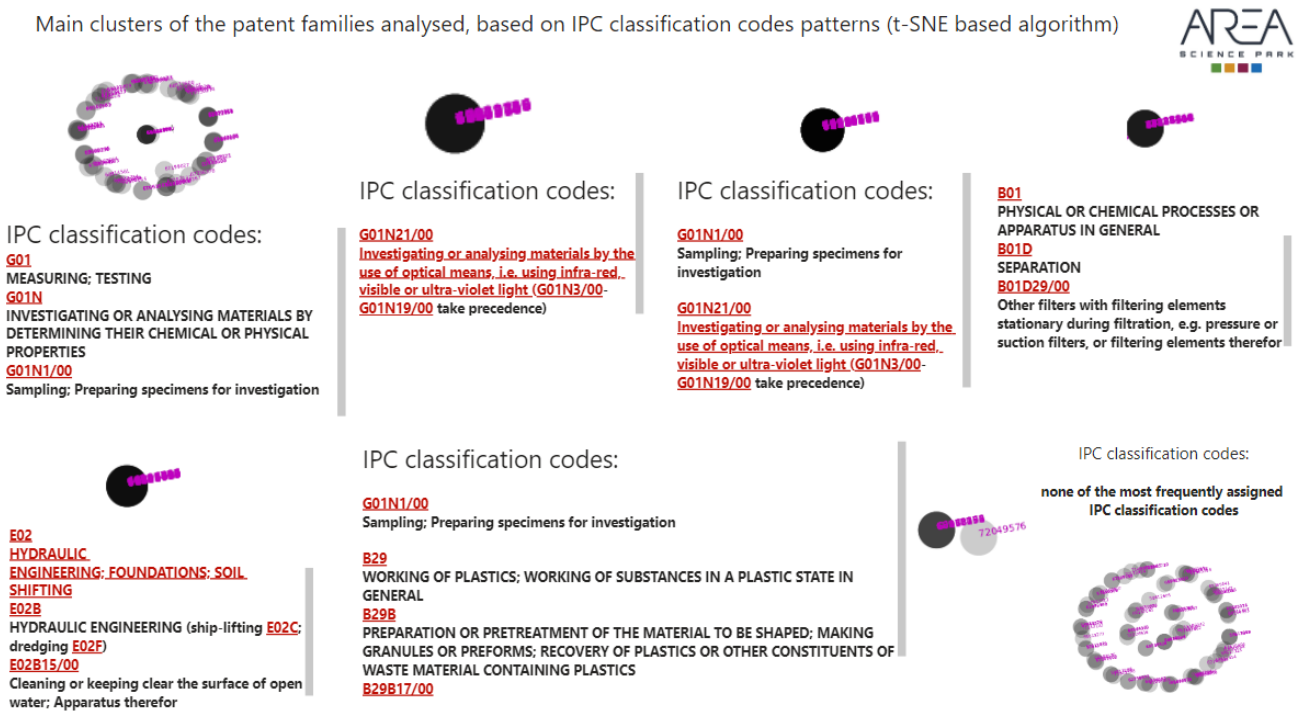
A more sophisticated analysis concerns the identification of IPC/CPC classification codes or WIPO technologies patterns. The relevant concept refers to clusters of patent documents characterised by a pattern of 1, 2, …., n of classification codes (or WIPO technologies). This visualization is not dynamic however it is still possible to associate single patent documents with a pattern of classification codes, being plausible that the patents characterised by the same pattern might share some relevant technical aspects. It is also important to remind that classification codes have been not created with the precise purpose of performing a statistical analysis based on the technical content of each patent document. As in the example of the "microplastics" analysis, three dashboards of MS PowerBI concern the IPC classification codes (PAT. Clustering IPC codes), the CPC classification codes (PAT. Clustering CPC codes) and the WIPO technologies (PAT. Clustering Techn.fields). Figure 16 specifically refers to the analysis based on the IPC codes' patterns:

Figure 16 Clustering of the patent families (identified by means of numbers in purple) depending on the IPC classification codes shared by the patent families. Identification of patterns formed by 1,…,n IPC classification codes is feasible upon analysing the dataset with Patstat online. Subsequently the t-SNE algorithm is applied to the Patstat data



The results above are achieved through a basic approach, however further investigation is feasible, for example to ascertain whether smaller clusters might appear when considering patterns formed by additional classification codes, not identifiable at first glance from the graphical representation of the t-SNE based analysis. Likewise, there might be interest toward specific patterns, rather based on IPC subgroups than on more generical IPC main groups. This deeper analysis may be performed upon request.

Identification of the patent attorneys and the co-occurrence of competitor applicants/assignees

The dashboard entitled "PAT. Attorney" deals with a restricted pool of data referring to the patent documents collection of the EPO database EPRegister. The possibility exists for either identifying the European attorneys providing support to the applicants/assignees resident in Europe or those located outside Europe. In both situations the support of the patent attorney is specifically regarding an EP patent prosecution. Such analysis, although covering part of the dataset results, permit to highlight the situations in which the same attorney is engaged by two different applicants/competitors. Such piece of information can be respectively gathered from the data of Figure 17 and the data of Figure 18.

As anticipated above, the information arguable from such kind of analysis concerns the identification of players who might be dealing with similar technical implementations, though excluding the possibility of selecting the co-assignees. Therefore, the co-occurrence of players rather refers to competitors. In case both would engage the same patent attorney some information leakage cannot be excluded, such events likely conferring a competitive advantage to one player. It may be then useful to detect in due advance the association between a patent attorney and a potential competitor if the aim is that of protecting a new product/methodology limiting the likelihood of conflicts/oppositions in the future.

Figure 17 Extract from the list showing the relationship between a patent attorney and the applicant/assignee supported by that specific attorney

Attorney name	Assignee
f & e patent	SIHL
Grättinger Möhring von Poschinger Patentanwälte Partnerschaft	SPIES, OLIVER
Grättinger Möhring von Poschinger Patentanwälte Partnerschaft mbB	Nolte, Alexander
Grättinger Möhring von Poschinger Patentanwälte Partnerschaft mbB	SPIES, OLIVER
Hauck Patentanwaltspartnerschaft mbB	DAMANN, ROLAND
Hauck Patentanwaltspartnerschaft mbB	Damann, Volker
Kinkeldey, Daniela	B. BRAUN MELSUNGEN
Kinkeldey, Daniela, et al	B. BRAUN MELSUNGEN
Klingseisen, Franz	B. BRAUN MELSUNGEN
Klingseisen, Franz, et al	B. BRAUN MELSUNGEN
Nunes, Maria Margarida Gomes Sanches	GALVAO & NORONHA
Wallinger, Michael	FACHHOCHSCHULE KIEL
Withers & Rogers	Ecofario GmbH
Wittmann, Ernst-Ulrich	Ecofario GmbH

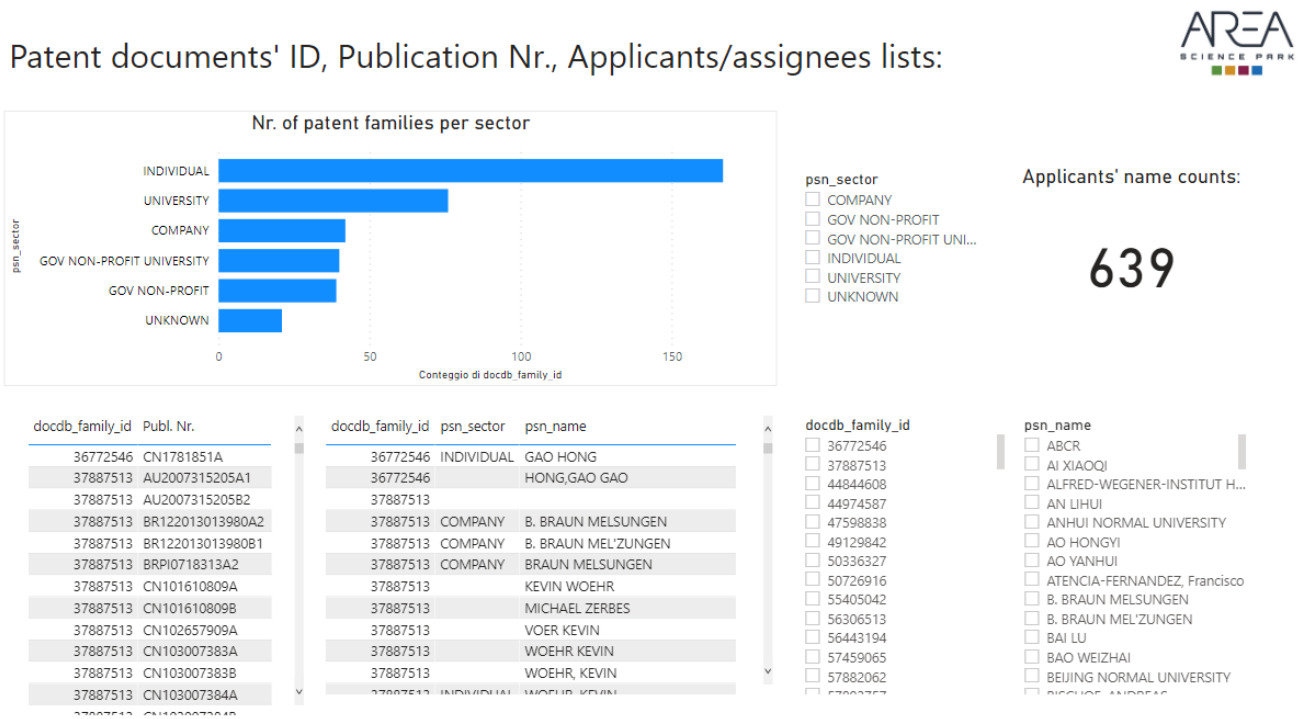
Figure 18 Extract from the list including the relationship between a patent attorney and two applicants/assignees NOT coassignees, yet assisted by the same attorney

Attorney name	Assignee_1	Assignee_2
Grättinger Möhring von Poschinger Patentanwälte Partnerschaft mbB	Spies, Oliver	Nolte, Alexander

Additional information regarding the patent dataset

Since each component of the dataset may be identified by a patent family identification code, assignees or co-assignees associated to the same patent family may be identified. Moreover, each patent family might correspond to a multiplicity of patent publication numbers. This kind of data might be retrieved/selected upon consulting the MS PowerBI dashboard entitled PAT. Documents' ID, shown in Figure 19.

Figure 19 Additional bibliographic data permitting the identification of the patent publication numbers corresponding to each patent family and permitting to rank the players depending on the affiliation (information might be not complete in the latter case)

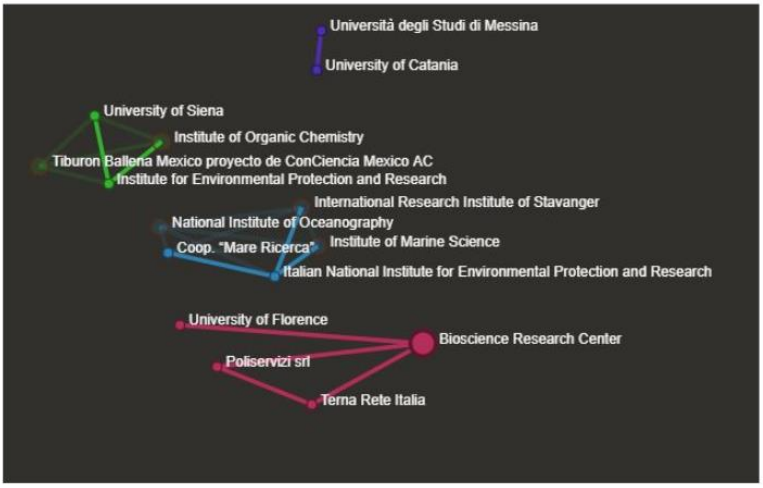


Additional information includes the applicant's affiliation, being possible that the applicant is an individual, a company, a university, a hospital or a non-profit institution.

The NPL datasets

As far as the 'Non-patent literature' (NPL) is concerned, the same topic (microplastics) may be analysed using the TIM database. In this case the data displayed on each MS PowerBI dashboard cannot be visualised in a dynamic format, however the main scope of the NPL investigation concerns the highlighting of potential collaborations between players located in the territories of the Mediterranean coast being the data often shown in aggregated form, although further detail can be argued when analysing the original source (TIM). Usually, this kind of survey concerns countries such as Italy, France, Spain, Greece, Slovenia, Croatia, Turkey, Israel and Egypt depending on the availability of meaningful information for each of the territories mentioned. Not only the collaborations between the players resident in a specific country may be identified but also cross-collaboration involving players of different countries, as shown in Figure 20, referring to the players located in Italy:

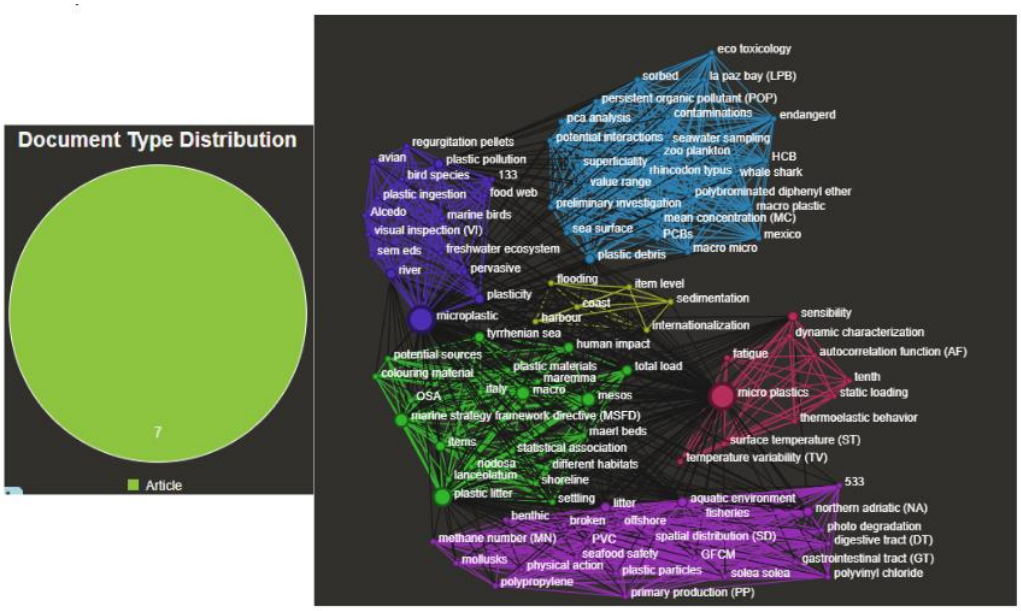
Figure 20 The players identified upon analysing the NPL data



TIM uses network visualizations extensively to display data. These network visualizations consist of nodes and edges. The size of each node corresponds to the number of documents associated with that node. Documents are not contained exclusively in one or the other node. It might very well be that e.g., a scientific paper was written by two authors from two institutions, one based in city A and one based in city B. In that case, that document would be counted twice, once for node A and once for node B. The edges generally correspond to documents that the two nodes have in common. For example, if a document has three institutions from three different countries, then there will be an edge among all those three countries, showing that these three countries have a document in common (Further information is available at the URL: http://tech.timanalytics.eu/html/index.html).

Additional information concerns the quantification of different modalities of divulgation (articles, reviews, books, conference proceedings, etc.) and the identification of the main technical topics identified by the most recurrent keywords of the publications (Figure 21).

Figure 21 The collection of NPL divulgation forms is schematically visualized by means of a pie-diagram (in this case only articles have been detected). The panel on the right highlights clusters of keywords.



Automatic keywords are computed by TIM for each type of document. Autokeywords or Automatic keywords are computed by text mining techniques using the text of the documents available in title, description and author keywords (if any). For a concept to be selected as automatic keyword, it has to have been used as an author keyword in a document. A variable number of words (10-15) are attributed by TIM to each document. This field is attributed to all types of documents in the system, including those that do not have author keywords (Further information is available at the URL: http://tech.timanalytics.eu/html/index.html).

Online visualisation

For each sector analysed in this report, you can access to the online dashboards realized by means of the MS software Power BI at the following links:

	Sub-Sector	Link
Fishery and Aquaculture	AQUACULTURE	https://app.powerbi.com/view?r=eyJrIjoiNGM3OWUzN2MtMmY1OC00YWQ5LWFmYTctNjQwOWU3N2QwMzdlIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	FISH MEAL	https://app.powerbi.com/view?r=eyJrIjoiMDA2ZWNmZTEtZjY2My00ODM5LThkYjYtMzVmYmM0Mzc4OGMzIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	SEAFOOD DERIVATE AND PROCESSING	https://app.powerbi.com/view?r=eyJrIjoiNDFkYmFkZDMtNDg5MC00NWE4LThlYzEtMWU1YmZhZWMyOGQ4IiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	FISHERY	https://app.powerbi.com/view?r=eyJrIjoiYjUxMzliNzMtNTQ2ZC00ZDJlLTkzNzctYzkwMmNlODYxYTgwIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9

Blue Biotechnology	BIOFUELS	https://app.powerbi.com/view?r=eyJrIjoiNTE5MDYwNzEtNDk4MS00MTQ5LTg4YTctZmIyNmMyZjY3MTdjIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	COSMETICS	https://app.powerbi.com/view?r=eyJrIjoiY2NjZDUzZTctZjJmNi00ODE5LTliNDUtZDAyNTY5OTU2ZDRjIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	NUTRACEUTICALS	https://app.powerbi.com/view?r=eyJrIjoiM2ZiZGQ0MjctZDM1NC00NDVlLTgzZjMtNzI0NzEyZmM1Y2M4IiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	PHARMACEUTICS	https://app.powerbi.com/view?r=eyJrIjoiMmYxNzYxMzQtMzA3ZC00ZGU0LTlhZmMtNzU5NWVjNzZhY2E4IiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	ENVIRONMENTAL REMEDIATION	https://app.powerbi.com/view?r=eyJrIjoiNThmMDg4MzMtZDcxMy00MjNlLTg1OWYtZTE3YWIwN2EwODhlIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	SEA ORGANISMS' GENETICS	https://app.powerbi.com/view?r=eyJrIjoiYWYyZmQ1NGItZTNiZC00ZTcyLWJhYzAtNDViNWRkMjJjZWRhIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	SEAWATER PURIFICATION	https://app.powerbi.com/view?r=eyJrIjoiMzdkNjZjNWItMzg2OS00YzQxLWFiNzItOTRhYmFjODM3YzJlIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	SOIL FERTILIZATION	https://app.powerbi.com/view?r=eyJrIjoiY2Y5MWNiMmQtYWM0MS00YTQ3LWJiNGUtOTkxZWNkNjgyOTI5IiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
Blue Sustainable Development	BIOPLASTICS	https://app.powerbi.com/view?r=eyJrIjoiNTMwNDc1YmEtZTdjMC00MGVmLThjMzMtNjlkYTkyN2IxNjNiIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	MARINE MAPPING	https://app.powerbi.com/view?r=eyJrIjoiOTI0MDljYjAtYTM0Ny00OTIyLWIyN2ItMGVmNDcxYTA1NGRiIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	MARITIME SURVEILLANCE	https://app.powerbi.com/view?r=eyJrIjoiMzg5ZDg3MGItNjgzMy00MjBmLTk0YzQtZWVlZDBhNjUxNDBjIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	MICROPLASTICS	https://app.powerbi.com/view?r=eyJrIjoiYzhmMGM3ZTktNWE1ZC00OTEzLTgzMjctOTZlMjVkZDk2ODQ2IiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	PRECISION AQUACULTURE	https://app.powerbi.com/view?r=eyJrIjoiMGY5MGU4NDItNGI0Mi00ODU5LWEwYWUtYjA1N2NkM2Q1Y2Q2IiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9

	SEAWATER SENSORS	https://app.powerbi.com/view?r=eyJrIjoiNjQzMGYwMTItYTBhYS00MTZhLWE1ZjQtZjlhYTc3OGMyNGIzIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9
	UUV	https://app.powerbi.com/view?r=eyJrIjoiZjAwZWQ2OWItMzM3OC00YTY4LTk3MjgtZjNlZDg1ZmEyODZkIiwidCI6ImQ0YWFmY2E2LWJmMzUtNDUxNS1iMDZhLTQ5NzNjZGZiYmVkMyIsImMiOjh9