2022

Patent Information Analysis Based on GXTI
(Abstract)

March.2023

Japan Patent Office

Index

Chapter 1 Survey Overview

Section 1 Aims and Overview of the Survey

1. Aims of the Survey

The JPO created the Green Transformation Technologies Inventory (GXTI), which gives a bird's-eye view of technologies related to Green Transformation (GX), and published it in June 2022, along with the patent search formulae to search patent documents included in each technology category.

In order to increase their value, companies advance efforts to disclose how their products and services can contribute to the GX. Also, the revised Corporate Governance Code (June 2021) has added a Supplementary Principle stating that "companies listed on the Prime Market should collect and analyze the necessary data on the impact of climate change-related risks and earning opportunities on their business activities and profits, and enhance the quality and quantity of disclosure based on the TCFD (Task Force on Climate-related Financial Disclosure) recommendations, which are an internationally well-established disclosure framework, or an equivalent framework".

Patent information analysis is considered to be one of the most effective methods of highlighting the GX-related efforts of individual companies and objectively showing the impact of climate change upon business and other aspects of their operations.

This survey is intended to provide an overview of application trends in each country/region for each technology category, etc. in the GXTI, in order to serve as a reference for companies and others when considering disclosures relating to responses to climate change issues based on patent information.

2. Overview of the Survey

The 2022 "Patent Information Analysis Based on GXTI" is summarized as follows.

(1) For overall GX technologies and for each GX technology, research and analysis are carried out on patent trends, such as annual trend in the number of patent families[1] and the number of IPFs[2]; the number of patent families by country/region of applicant and the number of IPFs; the revealed technological advantage index (RTA index; indicates the degree of focus on a particular technology); and patent values.

(2) Key market/policy trends, and R&D trends are researched for each GX technology.

(3) Expert hearings on the results of the patent trend survey are held to analyze Japan's strengths and challenges in comparison with other countries/regions for overall GX technologies and

[1] It refers to a "group consisting of multiple applications" where an application for an invention is filed in a country/region and then an application is filed in another country/region abroad claiming priority on the basis of the earlier application. Normally, patents with the same content and filed in multiple countries/regions belong to the same patent family, and the "number of patent families" is considered to be approximately equal to the "number of inventions".

[2] IPF (International Patent Family) means a patent family that includes applications to multiple countries/regions or a patent family that includes applications to the European Patent Office (EPO) or PCT applications (applications presumed to be based on an intention to obtain rights in multiple countries/regions).

for each GX technology.

The survey targets are patent applications filed in the following 13 countries/regions and PCT applications. For the definition of Europe, see subsection 1.2.3.

Japan, USA, Europe, Germany, France, UK, China, Taiwan, South Korea, Canada, India, ASEAN, Australia

Section 2 Survey/Analysis Method

1. Green Transformation Technologies Inventory (GXTI)

The "Green Transformation Technologies Inventory (GXTI)" is a technology inventory created by the JPO in June 2022 to provide an overview of technologies related to Green Transformation (GX) and is also published with patent search formulae for searching patent documents included in each technology category[3].

The GXTI has a three-level hierarchical structure, with 6 large categories (gxA, gxB, gxC, gxD, gxE, gxY), 32 medium categories, and 86 small categories. Large category is the union of medium category, medium categories is the union of small category, and each small categories is associated with a patent search formula. However, since gxY is a technical category of "cross-tabulation," and it is a technology category that further limits the categories gxA to gxE from a cross-cutting perspective (control/adjustment related technology, etc.), the properties are different from gxA to gxE.

2. Databases and Notes for Obtaining Patent Information

In the survey on application trends, etc. in Chapters 2 to 7, Derwent™ Innovation[4,5] , provided by Clarivate Analytics Japan Co., Ltd., was used as the database for obtaining patent information, and "value-added patent data (DWPI[6] and DPCI[7])" was used for the patent collection.

The DWPI is a database for recording information over 59 global patent issuing authorities and two journals and in the DWPI, a patent family (DWPI family) that is a collection of all publication information related to one invention is registered as one record. Since the DWPI scrutinizes technical content and classifies families, it can be used to ascertain the number of patent families from a technical point of view when conducting a survey for each DWPI family. In addition, the DPCI is also a citation database for collecting corrected citation information items on a per DWPI family basis.

In this survey, we created a patent search formula for Derwent™ Innovation for each technology

[3] https://www.jpo.go.jp/resources/statistics/gxti.html
[4] Derwent is a registered trademark of Camelot UK Bidco Limited.
[5] Derwent™ Innovation is a registered trademark of Camelot UK Bidco Limited.
[6] DWPI stands for Derwent World Patents Index and is a registered trademark of Camelot UK Bidco Limited.
[7] DPCI stands for Derwent Patents Citation Index is a registered trademark of Camelot UK Bidco Limited.

category, counted the number of patent families using the created search formula, and conducted a survey of application trends. The search formula was created using the Green Transformation Technologies Inventory Version 1.03 (published on September 2, 2022).

3. Target Countries/Regions

In this survey, we set the target countries/regions for the survey as Japan, the USA, Europe, Germany, France, the UK, China, Taiwan, South Korea, Canada, India, ASEAN, Australia, and PCT applications (international applications).

European applications in this search include applications of Ireland, Italy, Austria, the Netherlands, Switzerland, Sweden, Spain, Slovakia, the Czech Republic, Denmark, Germany, Turkey, Norway, Hungary, Finland, France, Belgium, Poland, Portugal, Romania, Luxembourg, the UK, and European Patent Convention (EPC).

In addition, the European applications in this survey are applications whose earliest priority claim countries are Iceland, Ireland, Albania, Italy, Estonia, Austria, the Netherlands, Cyprus, Greece, Croatia, San Marino, Switzerland, Sweden, Spain, Slovakia, Slovenia, Serbia, the Czech Republic, Denmark, Germany, Turkey, Norway, Hungary, Finland, France , Bulgaria, Belgium, Poland, Portugal, the Republic of North Macedonia, Malta, Monaco, Latvia, Lithuania, Liechtenstein, Romania, Luxembourg, and the UK, and EPC applications.

In this survey, the country/region of the applicant was set as the country/region in which the patent application with the earliest filing date among the patent applications claiming priority in the DWPI family was filed. However, in a case where the earliest application claiming priority is a PCT application, the country/region of the country/region number (application number first registered in the database) included in the basic application number of the DWPI family was set as the destination country/region.

4. Survey Period

The survey period for this survey was set from 2010 to 2021, based on the filing years (priority years)[8]. It should be noted that Derwent™ Innovation may not have had enough recorded data the filing year (priority year) of 2019 and onward when conducting this survey.

5. Survey of Number of the Patent Applications

In this survey, we surveyed the trends of all patent applications regardless of GXTI technology classification (Chapter 2), patent applications for overall GX technologies (Chapter 3), patent applications for large categories in the GXTI (Chapter 4), patent applications for medium categories in the GXTI (Chapter 5), patent applications for 10 small categories in the GXTI (Chapter 6), and

[8] The year of priority claim is the filing year of the patent application that is the basis of the priority claim in the application based on the priority claim (in a case where there are a plurality of the patent applications that serve as the basis, the filing year of the earliest patent application).

patent applications for 8 notable technologies related to climate trend, which are not included in the GXTI categories (Chapter 7).

The number of the patent applications was factored by the number of families using the DWPI family aggregated by invention unit and the number of international patent families (IPFs, inventions filed in multiple countries/regions, inventions filed at the EPO, or patent families filed for PCT) focused on patents filed in multiple countries/regions.

In addition, the number of searched patent families and IPFs was analyzed in terms of the growth rate and a revealed technological advantage index (RTA index). The growth rate and the revealed technology advantage index were obtained by the following formulae.

$$Growth\ rate(\%) = \frac{Annual\ average\ (2015-2019) - Annual\ average\ (2010-2014)}{Annual\ average\ \ (2010-2014)} \times 100$$

$$RTA\ index(\%) = \frac{A_B}{A_{All}} \div \frac{S_B}{S_{All}} \times 100$$

A_B: $Number\ of\ patent\ applications\ in\ category\ B\ filed\ by\ applicants\ in\ country\ A$

A_{All}: $Number\ of\ all\ patent\ applications\ by\ applicant\ in\ country\ A$

S_B: $Number\ of\ all\ patent\ applications\ in\ category\ B\ filed$

S_{All}: $Number\ of\ all\ patent\ applications$

In addition, the IPF active rate, which is the ratio of IPFs that were legally valid at the time of the survey, was calculated based on Derwent™ Innovation's DWPI patent status judgment results.

In the DWPI patent status determination, it is determined whether a patent is still valid or invalid reconciling legal status information (adverse litigation, extension of time, non-payment of fees, etc.), status of relevant registered patents, the expiry date, and filing date data with the applicable law of the patent issuing authority. In addition, families for which expiry dates, filing dates, and relevant legal status data are not available are determined to be indeterminate.

In this survey, the number of IPF of the active patent applications was calculated by first extracting active patent applications using the "patent collections of each country/region/patent agency with DWPI" recorded by patent publication unit and then excluding the active patent applications with the same IPF. As a result, regardless of the filed country/region of the patent application, if at least one of the patent applications included in the IPF is active, the family will be deemed valid.

IPF active rate was conducted a survey by the following formula.

$$IPF\ active\ rate(\%) = \frac{number\ of\ active\ IPF}{number\ of\ IPF} \times 100$$

The number of IPF with 28 or more examiner citations is a rare number of IPFs whose number of citations by examiners is within the top 1% of all inventions, and such inventions are considered to have great impact and value on subsequent patent applications. In order to analyze international influence and to eliminate bias due to differences in language, the analysis was performed on the

number of IPFs rather than the number of families. IPFs with 28 or more examiner citations were judged by using the search tag "DGCE" of Derwent™ Innovation by adding the condition of DGCE>=28 to the search formula.

6. Survey for Top Applicants

In this survey, we extracted the top 20 applicants for each technology category.

When extracting applicants, we performed the work "name-based aggregation" of correcting and standardizing applicant names for inconsistencies and typographical errors or the work "unification" of unifying applicants who should be treated as the same. The following rules were used for this "unification" processing.

(1) As for corporate groups, all the companies under their affiliation are grouped into one applicant.
However, if a major company is affiliated with another corporate group due to M&A, it will be treated as a separate applicant.
Example: LG Chemical, LG Display, etc. of LG CORPORATION are counted as the same applicant
SHARP CORP. is affiliated with HON HAI PRECISION INDUSTRY CO., LTD., but is counted as a separate applicant from HON HAI PRECISION INDUSTRY CO., LTD.

(2) Applications of the same applicant which were filed prior to the M&A (corporate absorption/merger) and no application is seen after the announcement of the M&A shall be treated as those of the surviving applicant.
Example: The applications of Glaxo and SmithKline Beecham are counted as GlaxoSmithKline plc.

(3) Overseas subsidiaries of a corporate group are treated as those of the main company.
Example: SONY UK is counted as Sony, IBM Japan is counted as IBM Corporation

7. Survey Implementation Date

Data for this survey were collected from October 24 to December 16, 2022.

Chapter 2 Overall Trend Survey

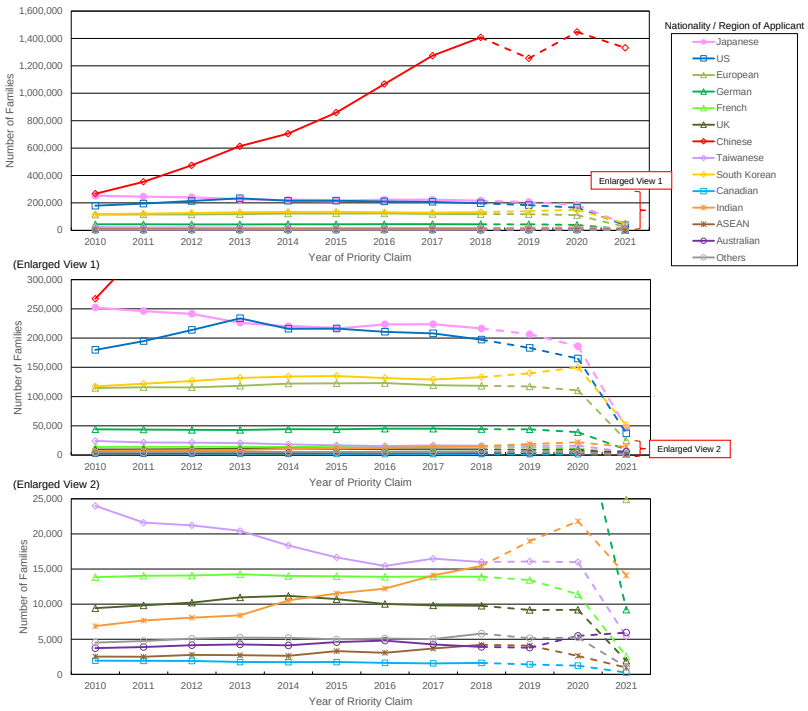
This chapter presents survey results on all patent application trends, regardless of the Green Transformation Technologies. In order to understand the trend of the patent applications related to the Green Transformation Technologies described in Chapter 3 and later, it is meaningful to understand the overall trend of the patent applications.

Section 1 Annual Trend in Number of Patent Families and Number of Patent Families Rate

Fig. 2-1 illustrates the annual trends in the number of patent families by the country/region of the applicant.

At the time at which 2010 was the filing year (priority year), the number of patent families by Japanese and Chinese applicants was almost the same, but after that, the number of patent families by Chinese applicants increased rapidly, and by 2018, there was a difference of about seven times. In addition, the number of patent families by Indian applicants has doubled from 2010 to 2018. The number of patent families by Japanese and Taiwanese applicants is gradually decreasing, while the number of patent families for applicants of other countries/regions remains at the same level.

Fig. 2-1 Annual trend in the number of patent families by country/region of the applicant
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)



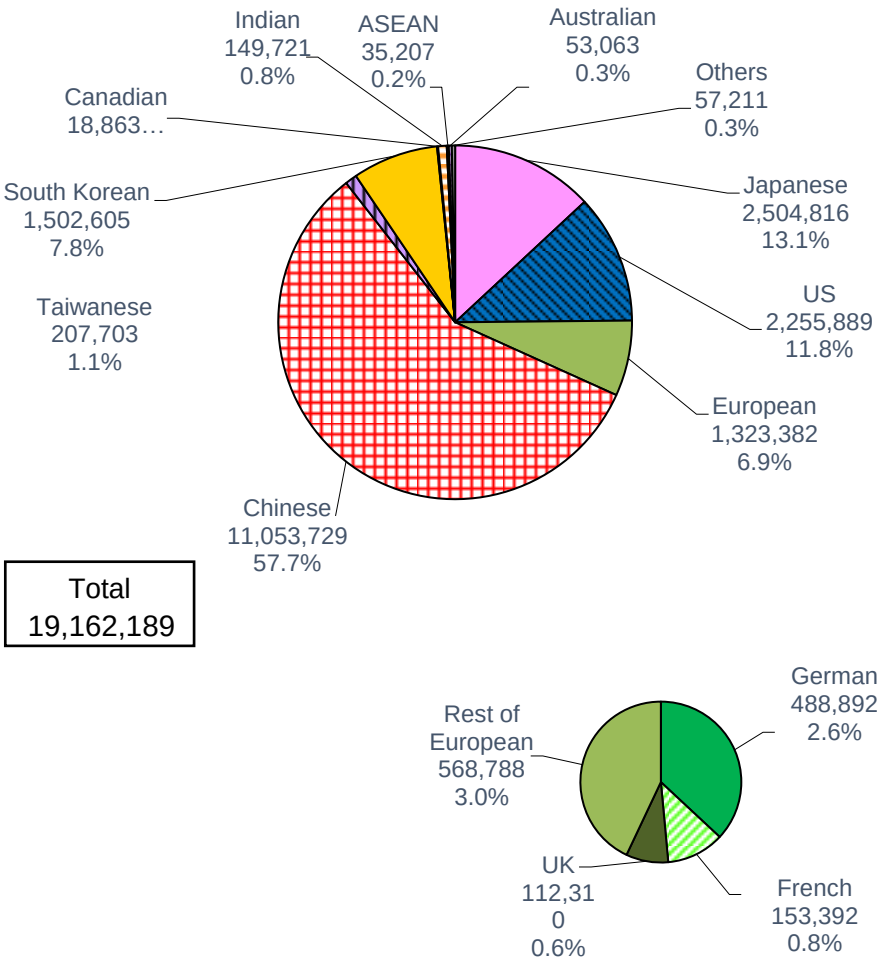
Database: Derwent™ Innovation

Note: Please note that Derwent™ Innovation may not have had sufficient recorded data from the filing year (priority year) of 2019 onward when conducting this survey. Therefore, data from 2019 onwards are illustrated with dotted lines.

Fig. 2-2 illustrates the ratio of the number of patent families by the country/region of the applicant. The graph on the lower right illustrates the details of the number of patent families by European applicants.

In terms of the ratio of the number of patent families, Chinese applicants accounted for the largest share at 57.7%, followed by Japanese, US, South Korean, and European applicants, in that order. Of the patent families filed in the countries/regions surveyed in this survey, 97.3% were filed by Japanese, US, European, Chinese, and South Korean applicants.

Fig. 2-2 Ratio of the number of patent families by country/region of the applicant
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)



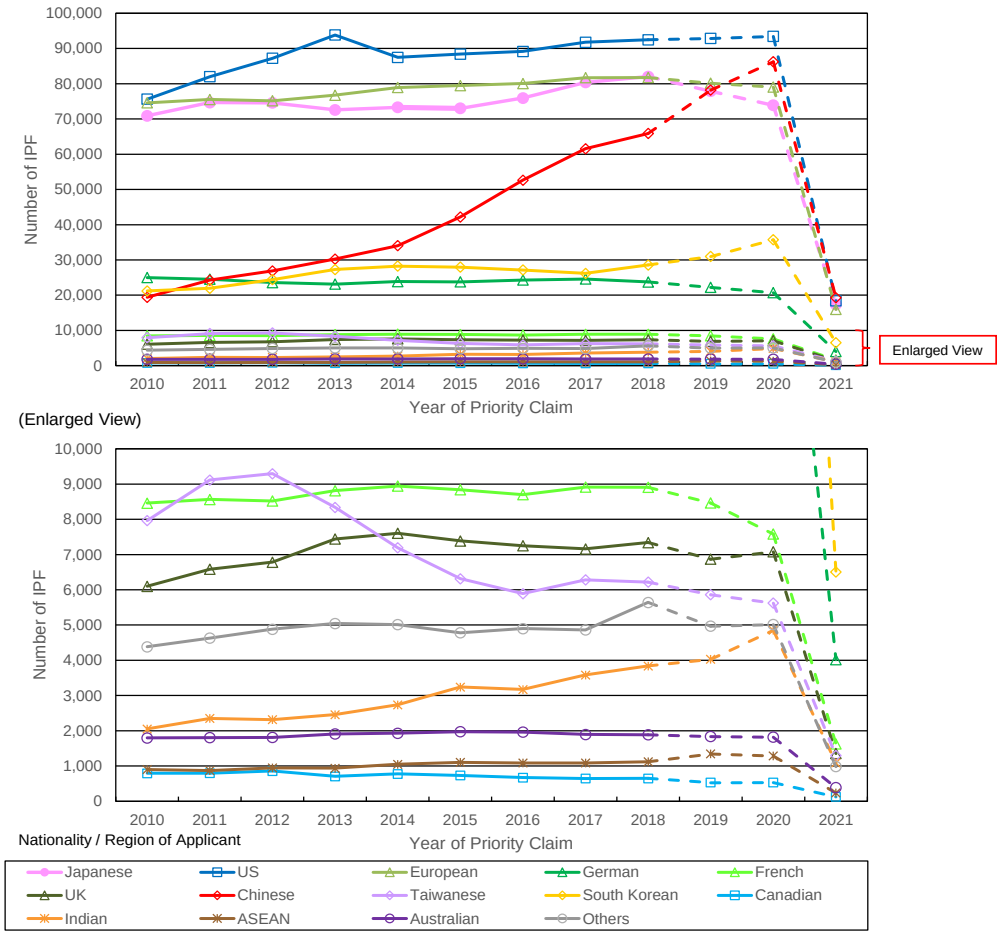
Database: Derwent™ Innovation

Section 2 Annual Trend in Number of IPFs and Number of IPFs Rate

Fig. 2-3 illustrates the annual trends in the number of IPFs by the country/region of the applicant. In this survey, IPFs where set as patent families for those applications filed under the PCT, with the EPO, and in at least two countries/regions. Refer to Chapter 1 for details.

At the time at which 2010 was the filing year (priority year), the number of IPFs by Japanese, US, and European applicants exceeded 70,000, while the number of IPFs by Chinese applicants was around 20,000. Thereafter, the number of IPFs by Chinese applicants increased, and by 2019, was about the same as that of Japanese and European applicants. The number of IPFs by US applicants increased from 2010 to 2013, and then remained at the same level. The number of IPFs by Japanese applicants remained at the same level after 2010, but has been on the rise since 2015. The number of IPF for Indian applicants has been increasing, and has doubled from 2010 to 2019.

Fig. 2-3 Annual trend in the number of IPFs by country/region of the applicant
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)



Database: Derwent™ Innovation

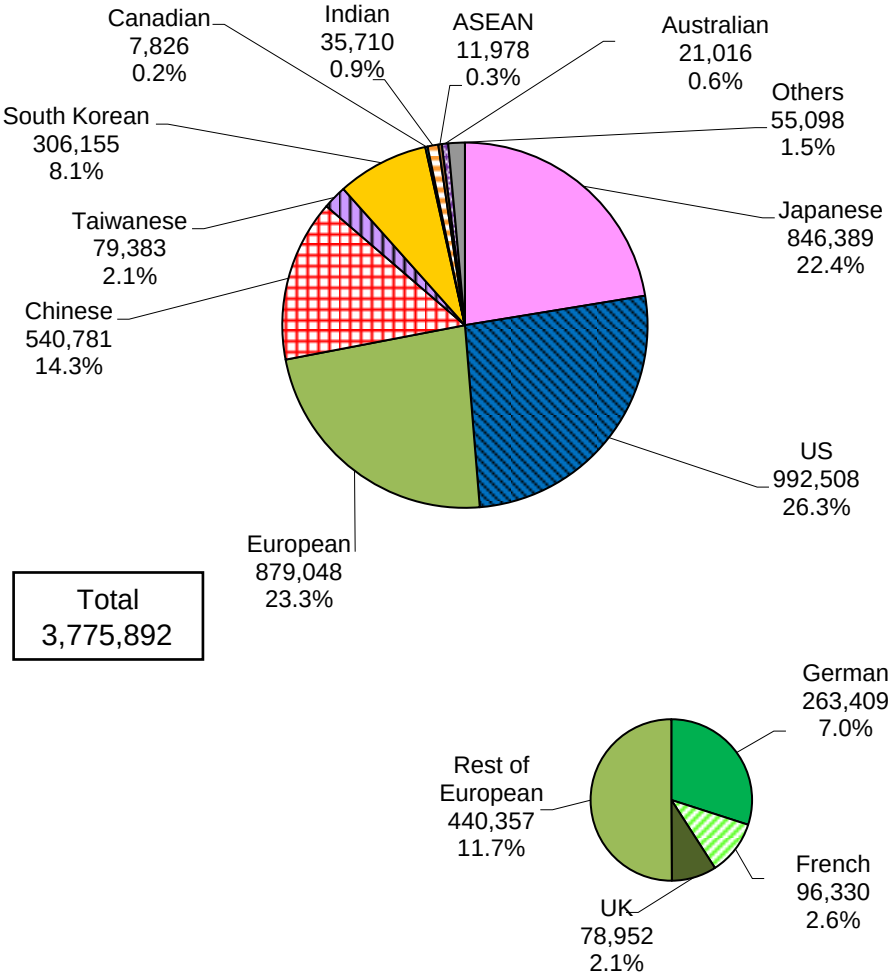
Note: Please note that Derwent™ Innovation may not have had sufficient recorded data from the filing year (priority year) of 2019 onward when conducting this survey. Therefore, data from 2019 onwards are illustrated with dotted

lines.

Fig. 2-4 illustrates the ratio of the number of IPFs by the country/region of the applicant. The graph on the lower right illustrates the details of the number of European applicants. In terms of the ratio of the number of IPF, US applicants accounted for the largest share at 26.3%, followed by European, Japanese, and Chinese applicants, in that order.

Fig. 2-4 Ratio of the number of IPF by country/region of the applicant

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)



Database: Derwent™ Innovation

Section 3 Summary

Regarding trends in patent applications of 14 countries/regions and organizations, we conducted a survey on the number of patent families and the number of IPFs by the country/region of the applicant. In addition, regarding the patent application trends in Japan, the US, Europe, China, and South Korea, we conducted a survey on the number of applications by the filed country/region of the patent application and by the country/region of the applicant. In terms of trends in the number of patent families, at the time at which 2010 was the filing year (priority year), the numbers of patent families by Japanese applicants and Chinese applicants were about the same, but after that, the number of patent families by Chinese applicants increased rapidly, and in 2018, there was a difference of about seven times. In addition, the number of patent families by Indian applicants has doubled from 2010 to 2018.

In terms of trends in the number of IPFs, at the time at which 2010 was the filing year (priority year), the number of IPFs by Japanese, US, and European applicants exceeded 70,000, while the number of IPFs by Chinese applicants was around 20,000. Thereafter, the number of IPFs by Chinese applicants increased, and in 2019, it was about the same as that of Japanese and European applicants. The number of IPFs by Japanese applicants remained at the same level after 2010, but has been on the rise since 2015. The number of IPFs by Indian applicants has been increasing, and has doubled from 2010 to 2019.

Chapter 3 Trend Survey of Overall GX Technologies

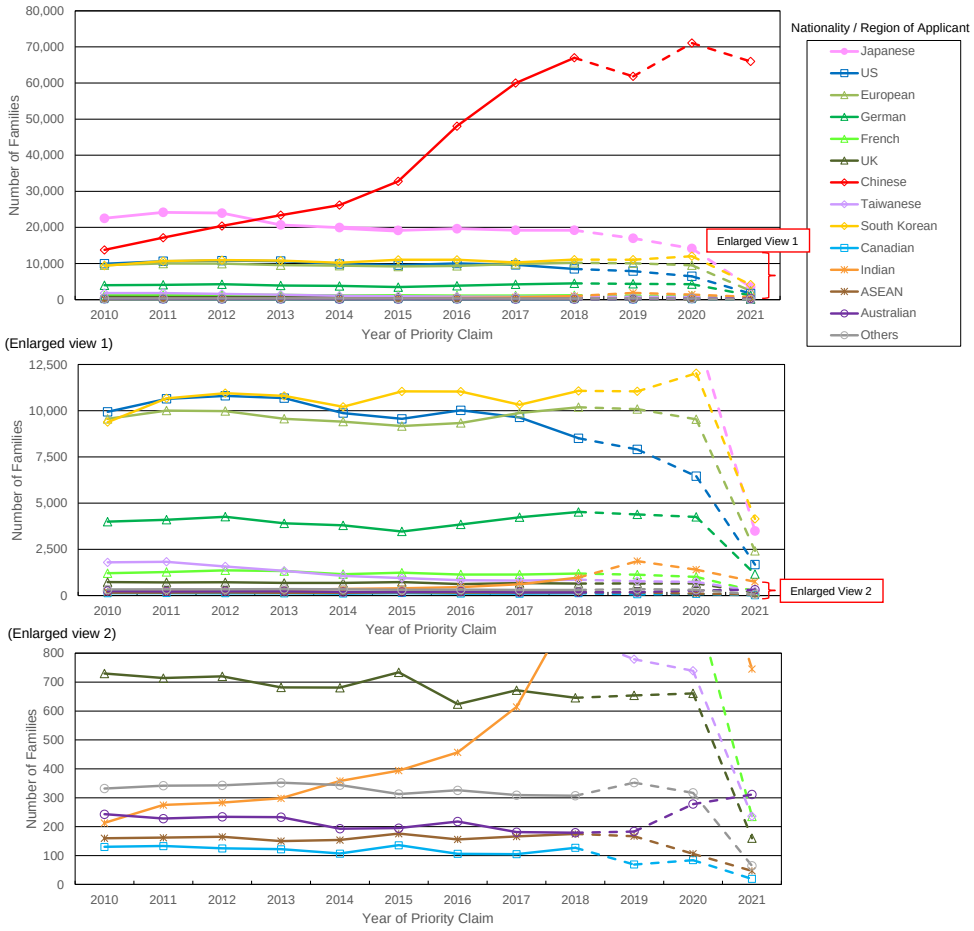
This part presents survey results on trends in patent applications for overall of the green transformation (GX) technologies. The overall of the GX technologies are the sum of small categories listed in the GXTI, and the survey was conducted using the union of search formulae for small (level 3) categories in the GXTI.

Section 1 Annual trends in the Number of Patent Families and IPFs and Ratio of the Number of Patent Families and IPFs

Fig. 3-1 illustrates the annual trends in the number of patent families by the country/region of the applicant of overall of the GX technologies.

At the time at which 2010 was the filing year (priority year), the number of patent families by Japanese applicants was the largest. However, after that, while the number of patent families by Japanese applicants decreased slightly, the number of patent families by Chinese applicants increased, surpassing the number of patent families by Japanese applicants in 2013 to become the largest number. Although the number of families by applicants from most countries/regions has remained at almost the same level, the number of patent families by Indian applicants has been increasing since around 2015. On the other hand, the number of patent families by Taiwanese applicants is on the decline.

Fig. 3-1　Annual trend in the number of patent families by country/region of the applicant
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)



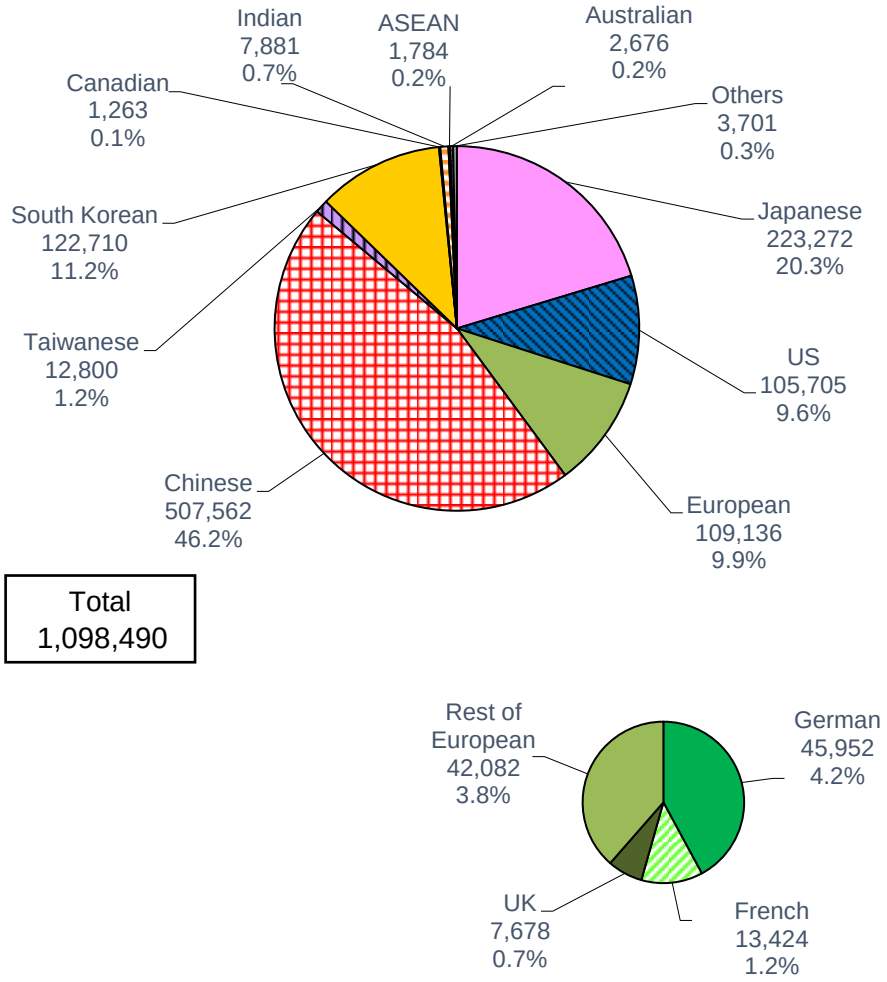
Database: Derwent™ Innovation

Note: Please note that Derwent™ Innovation may not have had sufficient recorded data from the filing year (priority year) of 2019 onward when conducting this survey.　Therefore, data from 2019 onwards are illustrated with dotted lines.

Fig. 3-2 illustrates the ratio of the number of patent families by the country/region of the applicant of overall of the green transformation technologies. The graph on the lower right illustrates the details of the number of European applicants.

In terms of the ratio of the number of patent families, Chinese applicants accounted for the largest share at 46.2%, followed by Japanese, South Korean, European, US applicants, in that order. Of the patent families of overall of the green transformation technologies filed in the countries/regions surveyed in this survey, 97.3% were filed by Japanese, US, European, Chinese and South Korean applicants.

Fig. 3-2 Ratio of the number of patent families by country/region of the applicant
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

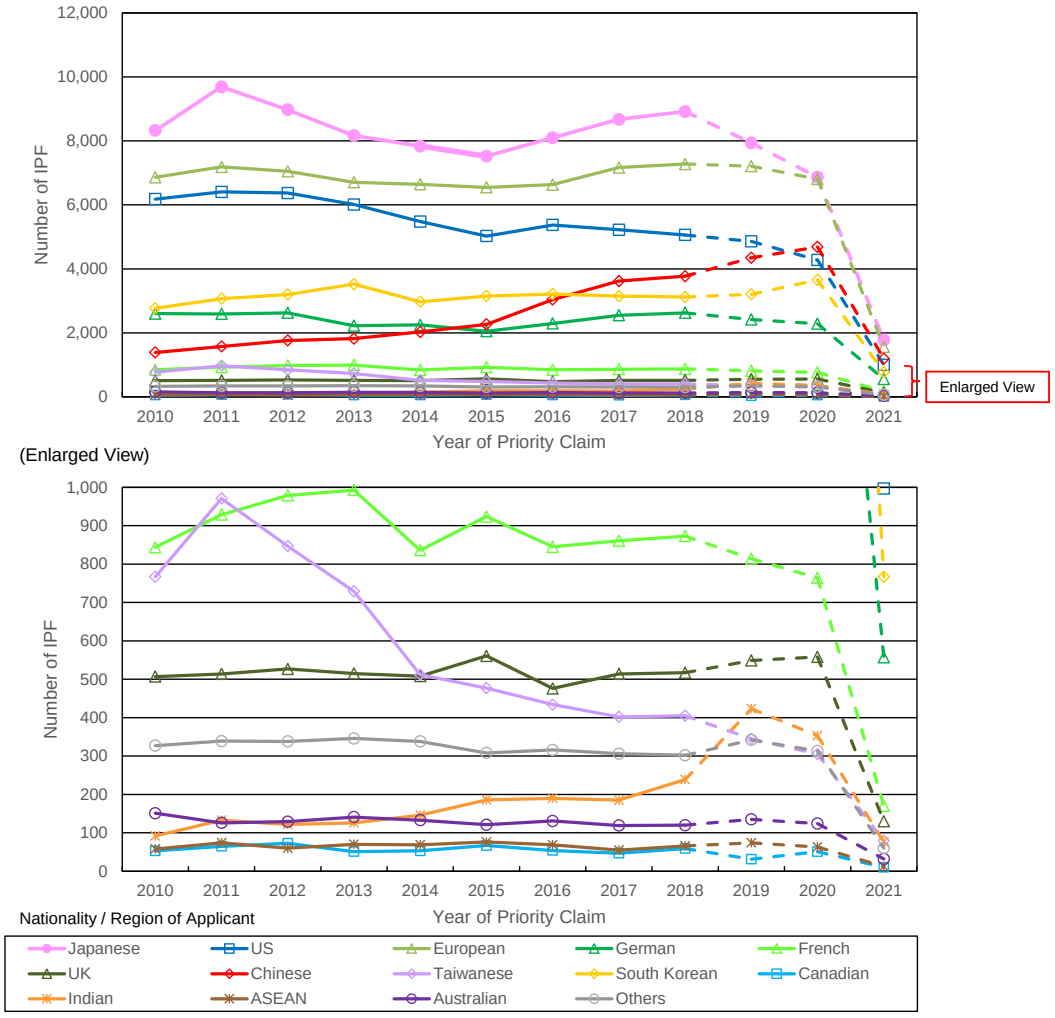


Database: Derwent™ Innovation

Fig. 3-3 illustrates the annual trends in the number of IPFs by the country/region of the applicant of overall of the green transformation technologies. In this survey, IPFs were set as the patent families of those applications filed under the PCT, with the PCT, the EPO, and at least two countries/regions. Refer to Part 1 for details.

The number of IPFs by Japanese applicants is the largest in all of the filing years (priority years) during the survey period. The number of IPFs started to decrease from 2012, but started to increase again from 2016. The number of IPFs by Chinese applicants has been gradually increasing, but as of 2019, it is about half that of Japanese applicants. The number of IPF by Indian applicants began to increase around 2014, and has surged from 2018 to 2019. On the other hand, the numbers of IPFs by US, Taiwanese, and French applicants are on the decline.

Fig. 3-3 Annual trend in the number of IPF by country/region of the applicant
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

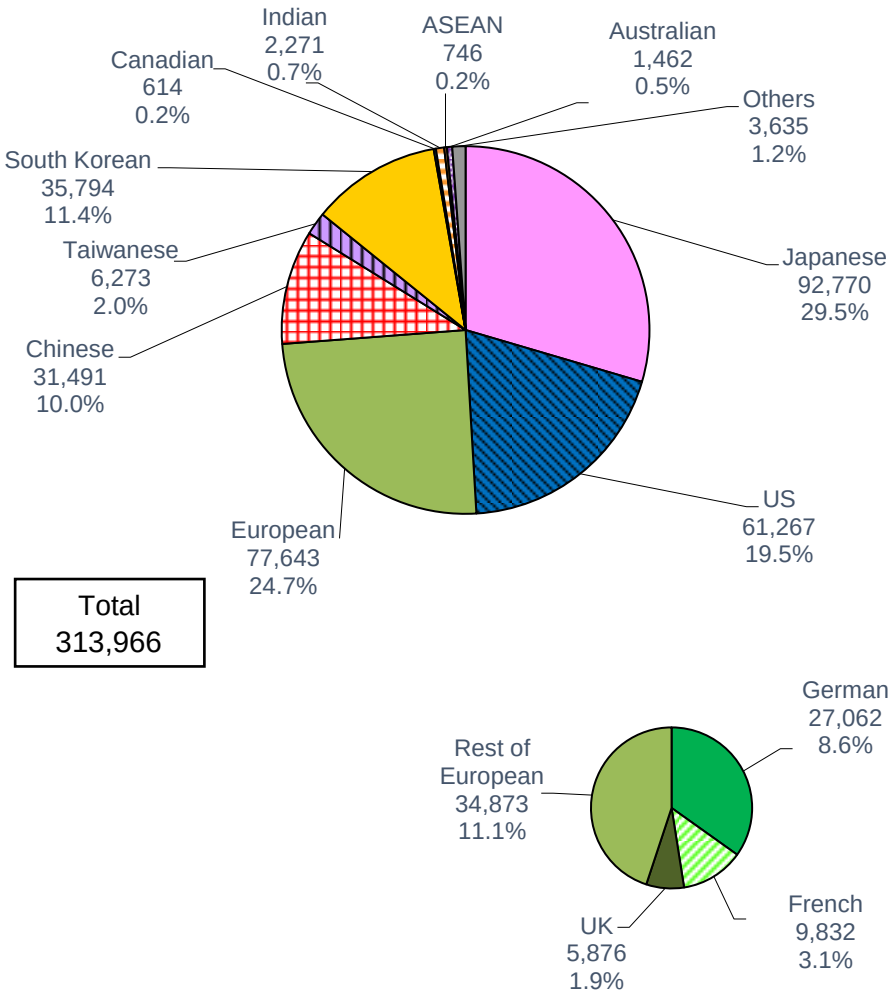


Database: Derwent™ Innovation

Note: Please note that Derwent™ Innovation may not have had sufficient recorded data from the filing year (priority year) of 2019 onward when conducting this survey. Therefore, data from 2019 onwards are illustrated with dotted lines.

Fig. 3-4 illustrates the ratio of the number of IPFs by the country/region of the applicant of overall of the green transformation technologies. The graph on the lower right illustrates the details of the number of IPFs by European applicants. In terms of the ratio of the number of IPF, Japanese applicants accounted for the largest share at 29.5%, followed by European, US, South Korean, and Chinese applicants, in that order. Of the number of IPF filed in the countries/regions surveyed in this survey, 95.2 of the numbers of IPF of overall of the green transformation technologies were filed by Japanese, US, European, Chinese, and South Korean applicants.

Fig. 3-4 Ratio of the number of IPFs by country/region of the applicant
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)



Database: Derwent™ Innovation

Section 2 Growth Rate of IPFs

The growth rates of IPFs for overall GX technologies are shown in Table 3-1 by country/region of applicant.

There are large growth rates of IPFs for Indian and Chinese applicants, both exceeding 10% per year. On the other hand, the number of IPFs by Taiwanese applicants decreases significantly, and the numbers of IPFs for US and Canadian applicants also decrease by more than 2% per year. In terms of Japanese applicants, unlike the number of patent families, the number of IPFs only decreases by 1% or less per year.

Table 3-1 Growth rates of IPFs by country/region of applicant (the Filing Years (Priority Years) 2010-2019)

		Country / Region of Applicant												Total
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	
gx	Overall GX Technologies	−0.86%	−3.22%	0.22%	−0.58%	−1.15%	0.36%	19.78%	−9.22%	0.40%	−2.51%	19.52%	0.54%	−1.59%	0.15%

Database: Derwent™ Innovation

Section 3 Revealed Technological Advantage Index of IPFs

The revealed technological advantage indices (RTA Indices) of IPFs for overall GX technologies are shown in Table 3-2 by country/region of applicant.

The RTA indices for Japanese, European and South Korean applicants are large, with a particularly large RTA index of 140.6% for Korean applicants, suggesting that they are filing applications quite specifically in GX technology. Conversely, the RTA indices for US, Chinese, Indian and ASEAN applicants are low and in the 70% range, suggesting that they are not filing applications without much specialization in GX technology.

Table 3-2 The revealed technological advantage indices (RTA Indices) of IPFs by country/region of applicant (the Filing Years (Priority Years) 2010-2021)

		Country / Region of Applicant											
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian
gx	Overall GX Technologies	131.8%	74.2%	106.2%	123.6%	122.7%	89.5%	70.0%	95.0%	140.6%	94.4%	76.5%	74.9%	83.7%

Database: Derwent™ Innovation

Section 4 Top Ranking

Table 3-1 illustrates the top 20 applicants with the number of patent families for overall of the green transformation technologies, and Table 3-2 illustrates the top 20 applicants with the number of IPF.

The top applicants in terms of the number of patent families are TOYOTA MOTOR CORPORATION ranked first, LG CORPORATION (South Korea) ranked second, and PANASONIC CORP. CORP. ranked third. Japanese applicants account for 11 out of 20 applicants.

The top applicants in terms of the number of IPF are SAMSUNG GROUP (South Korea) ranked first, LG CORPORATION (South Korea) ranked second, TOYOTA MOTOR CORPORATION ranked third, and PANASONIC CORP. ranked fourth. There were 10 Japanese applicants, 4 South Korean applicants, 3 US and European applicants, and no Chinese applicants.

Table 3-1 Top 20 applicants with the number of patent families

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of Families	Name of Applicant	Nationality / Region
1	22,469	TOYOTA MOTOR CORPORATION	Japan
2	20,442	LG CORPORATION	Korea
3	14,600	PANASONIC CORP.	Japan
4	12,594	SAMSUNG GROUP	Korea
5	8,271	STATE GRID CORP. OF CHINA	China
6	8,140	MITSUBISHI ELECTRIC CORP.	Japan
7	7,918	HYUNDAI MOTOR CORP.	Korea
8	7,665	TOSHIBA CORP.	Japan
9	7,113	ROBERT BOSCH GMBH	Germany
10	5,968	HONDA MOTOR CO., LTD.	Japan
11	5,455	HITACHI, LTD.	Japan
12	4,872	TOYOTA INDUSTRIES CORPORATION	Japan
13	4,781	SHARP CORP.	Japan
14	4,660	DENSO CORP.	Japan
15	4,557	GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI	China
16	4,399	GENERAL ELECTRIC CO.	USA
17	4,144	NISSAN MOTOR CO., LTD.	Japan
18	4,011	KIA CORP.	Korea
19	3,946	MIDEA HOLDING CO., LTD.	China
20	3,686	MITSUBISHI HEAVY IND, LTD.	Japan

Table 3-2 Top 20 applicants with the number of IPF

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	9,971	SAMSUNG GROUP	Korea
2	9,858	LG CORPORATION	Korea
3	8,252	TOYOTA MOTOR CORPORATION	Japan
4	7,446	PANASONIC CORP.	Japan
5	4,764	ROBERT BOSCH GMBH	Germany
6	4,448	HYUNDAI MOTOR CORP.	Korea
7	3,831	MITSUBISHI ELECTRIC CORP.	Japan
8	3,640	HONDA MOTOR CO., LTD.	Japan
9	3,521	GENERAL ELECTRIC CO.	USA
10	3,109	FORD MOTOR CO.	USA
11	3,105	TOSHIBA CORP.	Japan
12	3,051	SIEMENS A.G.	Germany
13	2,854	SHARP CORP.	Japan
14	2,743	KONINKLIJKE PHILIPS N.V.	Netherlands
15	2,700	KIA CORP.	Korea
16	2,687	HITACHI, LTD.	Japan
17	2,199	GENERAL MOTORS CORP.	USA
18	2,127	DENSO CORP.	Japan
19	2,021	SANYO ELECTRIC CO.,LTD.	Japan
20	1,909	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan

Database: Derwent™ Innovation

Table 3-3 illustrates the trends in the ranking of the top 20 patent families notably cited by examiners for overall of the green transformation technologies, and Table 3-4 illustrates the top 10 Japanese applicants. In this survey, patent families notably cited by examiners are defined as patent families with 28 or more examiner citations. A patent family with 28 citations by examiners is less than 1% of the total number of patent families and is a rare patent family, and the applicant who owns it can be said to be a notable applicant in this technology. Refer to Chapter 1 for the extraction method.

In terms of ranking trends, from the filing years (priority years) of 2010 to 2013, there were 12 Japanese applicants, 3 US and South Korean applicants, and 2 European applicants. However, from 2014 to 2017, there were 8 Chinese applicants, 5 Japanese and US applicants, 3 South Korean applicants, and 1 Indian applicant, and no European applicants were ranked. From the filing years (priority years) of 2018 to 2021, only 14 patent families could be extracted, including 7 Chinese applicants who had applied for 2 patent families.

The top Japanese applicants were TOYOTA MOTOR CORPORATION with 239 cases, followed by PANASONIC CORP. with 197 cases and SEMICONDUCTOR ENERGY LABORATORY CO., LTD. with 179 cases.

Since the number of citations by examiners tends to increase over time from the filing year and it is possible that the filing year of the patent family cited by the examiner of the filing country/region may differ, caution is required.

Table 3-3 Trends in the ranking of the top 20 patent families notably cited by examiners
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

2010 to 2013				2014 to 2017				2018 to 2021			
Order	Number of Families	Name of Applicant	Nationality / Region	Order	Number of Families	Name of Applicant	Nationality / Region	Order	Number of Families	Name of Applicant	Nationality / Region
1	511	SAMSUNG GROUP	Korea	1	77	SAMSUNG GROUP	Korea	1	2	BYD COMPANY LIMITED	China
2	312	LG CORPORATION	Korea	2	68	LG CORPORATION	Korea	1	2	TCL TECHNOLOGY	China
3	227	GENERAL ELECTRIC CO.	USA	3	33	PHILIP MORRIS INTERNATIONAL INC.	USA	1	2	CENTRAL SOUTH UNIVERSITY	China
4	222	TOYOTA MOTOR CORPORATION	Japan	4	26	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan	1	2	DALIAN UNIVERSITY OF TECHNOLOGY	China
5	182	PANASONIC CORP.	Japan	5	22	FORD MOTOR CO.	USA	1	2	TSINGHUA UNIVERSITY	China
6	162	SONY GROUP CORP.	Japan	5	22	MIDEA HOLDING CO., LTD.	China	1	2	SHAANXI LIGHTE OPTOELECTRONICS MATERIAL CO., LTD.	China
7	153	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan	7	21	STATE GRID CORP OF CHINA	China	1	2	AMBRIS (WUXI) CO., LTD.	China
8	108	HITACHI, LTD.	Japan	8	19	TSINGHUA UNIVERSITY	China				
9	105	KONINKLIJKE PHILIPS N.V.	Netherlands	9	17	TOYOTA MOTOR CORPORATION	Japan				
10	100	FORD MOTOR CO.	USA	10	15	PANASONIC CORP.	Japan				
11	94	ROBERT BOSCH GMBH	Germany	10	15	JAPAN DISPLAY INC.	Japan				
12	93	DENSO CORP.	Japan	12	14	APPLE INC.	USA				
13	87	GENERAL MOTORS CORP.	USA	12	14	BOE TECHNOLOGY GROUP CO., LTD.	China				
14	82	SHARP CORP.	Japan	12	14	HYUNDAI MOTOR CORP.	Korea				
15	81	HONDA MOTOR CO., LTD.	Japan	15	13	AGC INC.	Japan				
16	80	MITSUBISHI ELECTRIC CORP.	Japan	15	13	BYD COMPANY LIMITED	China				
17	78	SANYO ELECTRIC CO.,LTD.	Japan	15	13	BAIC MOTOR CORP. LTD.	China				
18	72	TOSHIBA CORPORATION	Japan	18	12	GENERAL ELECTRIC CO.	USA				
19	67	SB LIMOTIVE CO. LTD.	Korea	18	12	QUALCOMM INC.	USA				
20	66	NISSAN MOTOR CO., LTD.	Japan	18	12	HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY	China				
				18	12	CONTEMPORARY AMPEREX TECHNOLOGY CO., LTD.	China				
				18	12	NANOTEK INSTRUMENTS, INC.	India				

Database: Derwent™ Innovation

Table 3-4　Top 10 patent families of Japanese applicants notably cited by examiners
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of Families	Name of Applicant
1	239	TOYOTA MOTOR CORPORATION
2	197	PANASONIC CORP.
3	179	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.
4	164	SONY GROUP CORP.
5	114	HITACHI, LTD.
6	100	DENSO CORP.
7	87	MITSUBISHI ELECTRIC CORP.
8	85	SHARP CORP.
9	85	HONDA MOTOR CO., LTD.
10	80	SANYO ELECTRIC CO.,LTD.

Database: Derwent™ Innovation

Section 5 Summary

Regarding trends in patent applications for overall of the green transformation technologies, we conducted a survey on the number of patent families, the number of IPF, or the like targeting 14 countries/regions and institutions.　In addition, the top 20 applicants with the largest number of patent families, IPF, and patent families notably cited by examiners were extracted.

In terms of trends in the number of patent families, at the time at which 2010 was the filing year (priority year), the number of patent families for Japanese applicants was the largest.　However, after that, while the number of patent families for Japanese applicants decreased slightly, the number of patent families for Chinese applicants increased, surpassing the number of patent families for Japanese applicants in 2013 to become the largest number.　In addition, although the number of families of applicants from most countries/regions has remained at almost the same level, the number of patent families for Indian applicants has been increasing since around 2015. On the other hand, the number of patent families for Taiwanese applicants is on the decline.

In terms of annual trends in the number of IPF, the number of Japanese applicants was large throughout the survey period.　The number of IPF for Chinese applicants is gradually increasing, but as of 2019, it is about half that of Japanese applicants.　In addition, the number of IPF for Indian applicants began to increase around 2014, and has surged from 2018 to 2019.

In the top rankings, TOYOTA MOTOR CORPORATION, LG CORPORATION, PANASONIC CORP., and SAMSUNG GROUP are all ranked high in the number of patent families, the number of IPF, and the number of patent families notably cited by examiners.

Chapter 4 Trend Survey by Large (Level 1) Category in the GXTI

This chapter presents survey results on patent application trends for large (level 1) categories in the GXTI. Large (level 1) categories in the GXTI consists of 5 categories of "gxA: Energy Supply," "gxB: Energy Saving, Electrification, Demand-Supply Flexibility," "gxC: Batteries, Energy Storage," "gxD: CO2 Reduction in Non-Energy Sector," and "gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas," and the survey was conducted using the union of search formulae for small (level 3) categories included in each large (level 1) categories listed in the GXTI.

Section 1 Annual Trends in the Number of Patent Families and IPF

Table 4-1 illustrates the annual trends in the number of patent families for large (level 1) categories.

In total, gxB has the largest number of patent families, followed by gxA, gxC, gxD, and gxE. In addition, all categories are on the rise. In the filing year (priority year) of 2010, gxB had the largest number of patent families, but in 2021, the number of gxA patent families exceeded that of gxB.

Table 4-1 Annual trend in the number of patent families

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Level 1		Year of Priority Claim												Total
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
gxA	Energy Supply	26,108	27,526	27,007	24,477	24,213	25,106	29,250	32,418	36,110	33,277	36,986	28,513	350,991
gxB	Energy Saving, Electrification, Demand-Supply Flexibility	27,933	31,609	33,347	34,403	33,926	36,845	43,637	47,359	48,175	43,167	41,946	24,149	446,496
gxC	Batteries, Energy Storage	11,680	13,936	15,421	15,536	16,169	18,240	23,153	27,454	30,839	30,903	33,048	22,099	258,478
gxD	CO2 Reduction in Non-Energy Sector	3,644	3,987	4,503	4,443	4,748	5,157	6,356	6,654	7,077	7,324	7,847	5,907	67,647
gxE	Capture, Storage, Utilization and Removal of Greenhouse	1,578	1,659	1,725	1,595	1,785	1,736	2,054	2,218	2,186	2,289	2,369	1,888	23,082

Database: Derwent™ Innovation

Table 4-2 illustrates the Annual trends in the number of IPF for large (level 1) categories.

In total, gxB has the largest number of patent families, followed by gxA, gxC, gxD, and gxE. The number of patent families in

Table 4-1 showed an increasing trend at all categories. However, in IPF, gxB and gxC are on the increase, gxD and gxE have remained at the same level, and gxA is on the decline.

Table 4-2 Annual trend in the number of IPF

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Level 1		Year of Priority Claim												Total
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
gxA	Energy Supply	10,067	10,102	9,018	7,857	7,224	6,919	6,957	7,088	7,096	6,894	6,889	1,604	87,715
gxB	Energy Saving, Electrification, Demand-Supply Flexibility	11,358	13,201	13,341	13,364	12,788	12,507	13,775	14,329	14,294	13,266	11,349	2,649	146,221
gxC	Batteries, Energy Storage	5,208	5,978	6,117	5,902	5,839	5,950	6,765	7,650	8,173	8,651	8,905	2,240	77,378
gxD	CO2 Reduction in Non-Energy Sector	1,351	1,382	1,424	1,398	1,234	1,262	1,255	1,199	1,317	1,541	1,507	332	15,202
gxE	Capture, Storage, Utilization and Removal of Greenhouse	779	812	826	751	740	714	708	753	733	758	690	136	8,400

Database: Derwent™ Innovation

Note: Please note that Derwent™ Innovation may not have had sufficient recorded data from the filing year

(priority year) of 2019 onward when conducting this survey.

Section 2 Number of Patent Families and IPFs by Country/Region of the Applicant

Table 4-3 illustrates the number of patent families by country/region of the applicant in the filing years (priority years) of 2010 to 2021, for large (level 1) categories. In the table, the cells of the top three countries/regions are grayed out, with the red frame indicating the first place and the blue frame indicating the second place.

At every category, there are many patent families by Chinese applicants. Japanese applicants are ranked within the top three in the four categories of gxA, gxB, gxC and gxE. South Korean applicants are ranked within the top three in three categories of gxA, gxB and gxC. In addition, the number of gxC patent families exceeded that of gxA only for Japanese applicants.

Table 4-3 The number of patent families by country/region of the applicant

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Level 1		Nationality/region of applicant														Total
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	Others	
gxA	Energy Supply	58,596	33,725	38,942	13,381	4,768	3,156	165,940	4,430	41,762	575	3,292	848	1,194	1,687	350,991
gxB	Energy Saving, Electrification, Demand-Supply Flexibility	106,592	48,112	49,554	23,773	5,949	3,124	181,429	6,242	49,192	518	2,144	441	1,013	1,259	446,496
gxC	Batteries, Energy Storage	61,934	19,662	19,131	10,817	2,540	1,134	122,081	1,869	30,872	128	1,904	198	308	391	258,478
gxD	CO2 Reduction in Non-Energy Sector	4,955	6,905	5,553	765	585	429	43,881	462	3,981	79	849	291	247	444	67,647
gxE	Capture, Storage, Utilization and Removal of Greenhouse	3,432	4,190	2,806	565	450	315	9,810	122	2,176	52	167	82	137	108	23,082

Database: Derwent™ Innovation

Table 4- illustrates the number of IPFs by the country/region of the applicant in the filing years (priority years) of 2010 to 2021 for large (level 1) categories.

Among applicants of all countries/regions, Japanese applicants had the largest number of IPF for gxB and gxC, European applicants for gxA, and US applicants for gxD and gxE. In addition, among Japanese applicants, the number of IPF for gxB is remarkably large, followed by gxC, gxA, gxD, and gxE.

Table 4-4 The number of IPF by country/region of the applicant

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Level 1		Nationality/region of applicant														Total
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	Others	
gxA	Energy Supply	19,705	19,674	27,550	7,826	3,478	2,353	6,717	1,623	8,697	238	853	290	703	1,665	87,715
gxB	Energy Saving, Electrification, Demand-Supply Flexibility	48,009	26,090	35,286	14,443	4,224	2,350	15,573	3,658	14,758	260	664	233	462	1,228	146,221
gxC	Batteries, Energy Storage	28,065	12,185	13,079	6,062	1,992	938	8,618	954	13,154	82	522	119	212	388	77,378
gxD	CO2 Reduction in Non-Energy Sector	1,802	5,152	4,679	563	502	386	1,502	195	804	49	326	110	148	435	15,202
gxE	Capture, Storage, Utilization and Removal of Greenhouse	1,741	2,930	2,445	447	374	279	344	56	509	32	90	52	95	106	8,400

Database: Derwent™ Innovation

Section 3 Growth Rates of Patent Families and IPFs

The growth rates of patent families in each Large (Level 1) category are shown in Table 4-5 by country/region of applicant.

In total, gxC has the largest growth rate at 15.9%, followed by gxD, gxB, gxE and gxA, with patent families increasing in all categories. The growth rate of gxC is negative only for Japanese applicants and positive for other applicants. The growth rates of patent families for Chinese and Indian applicants are positive in all categories, in particular the growth rate of gxC for Chinese applicants and the growth rates of gxB and gxC for Indian applicants are significantly large.

Table 4-5 Growth rates of patent families by country/region of applicant
(the Filing Years (Priority Years) 2010-2019)

Level 1		Country / Region of Applicant												Total
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	
gxA	Energy Supply	−6.90%	−6.34%	−3.71%	−3.61%	−5.43%	−6.11%	31.34%	−9.53%	−3.37%	−4.55%	25.78%	0.10%	−2.80%	4.15%
gxB	Energy Saving, Electrification, Demand-Supply Flexibility	−1.05%	−0.32%	2.82%	4.00%	0.66%	0.82%	28.07%	−10.62%	2.02%	−1.69%	39.04%	−0.48%	−6.83%	7.19%
gxC	Batteries, Energy Storage	−1.44%	3.25%	4.63%	1.61%	4.07%	14.81%	63.62%	0.02%	8.55%	0.36%	265.93%	37.27%	18.63%	15.90%
gxD	CO2 Reduction in Non-Energy Sector	−1.95%	−5.40%	−0.88%	−6.83%	−5.59%	0.33%	23.06%	4.86%	3.81%	3.87%	11.59%	−2.41%	7.89%	10.54%
gxE	Capture, Storage, Utilization and Removal of Greenhouse	−0.01%	−2.96%	−2.48%	−4.69%	−5.93%	1.31%	23.28%	2.59%	0.11%	2.61%	13.04%	−2.63%	−1.85%	5.13%

Database: Derwent™ Innovation

The growth rates of IPFs in each Large (Level 1) category is shown in Table 4-6 by country/region of applicant.

In total, the growth rates of gxB and gxC are positive, while the growth rates of gxA, gxD and gxE are negative, showing a different trend from the growth rates of patent families. The growth rates of IPFs for Chinese and Indian applicants are positive in all categories, in particular the growth rate of gxC for Chinese applicants and the growth rates of gxB and gxC for Indian applicants are significantly large.

For Japanese applicants, the growth rates of gxC and gxE are positive, the growth rate of gxA is negative and the growth rates of gxB and gxD are around 0%.

Table 4-6 Growth rates of IPFs by country/region of applicant
(the Filing Years (Priority Years) 2010-2019)

Level 1		Country / Region of Applicant												Total
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	
gxA	Energy Supply	−5.47%	−7.61%	−3.38%	−4.15%	−5.19%	−5.84%	14.21%	−10.27%	−3.36%	−5.08%	6.60%	0.93%	−2.16%	−4.21%
gxB	Energy Saving, Electrification, Demand-Supply Flexibility	0.35%	−0.68%	2.66%	2.56%	1.25%	3.59%	16.23%	−10.69%	−1.44%	0.17%	26.45%	−2.39%	−3.40%	1.29%
gxC	Batteries, Energy Storage	1.50%	2.65%	4.71%	0.00%	4.38%	16.09%	39.18%	0.76%	7.98%	0.00%	112.08%	22.58%	21.38%	5.61%
gxD	CO2 Reduction in Non-Energy Sector	0.40%	−4.71%	−0.65%	−7.15%	−5.08%	0.48%	17.06%	14.48%	1.92%	0.00%	7.39%	−3.08%	−0.94%	−0.63%
gxE	Capture, Storage, Utilization and Removal of Greenhouse	3.02%	−3.69%	−2.42%	−4.77%	−5.00%	2.20%	18.99%	0.77%	−3.03%	−2.35%	6.88%	−0.91%	−3.18%	−1.24%

Database: Derwent™ Innovation

Section 4 Revealed Technological Advantage Indices of Patent Families and IPFs

The revealed technological advantage indices (RTA indices) of patent families in each Large (Level 1) category are shown in Table 4-7 by country/region of applicant. In the table, the red box indicates first place, the light blue box indicates second place and the orange box indicates third place.

The RTA indices of gxB for German applicants, gxD for ASEAN applicants, and gxE for French, UK, Canadian and Australian applicants exceed 200%, suggesting that they are filing applications quite specifically in this category. For Japanese applicants, the RTA indices for gxB and gxC are large, in the range of 180%, while the RTA index for gxD is low at 56.0%.

Table 4-7 The revealed technological advantage indices (RTA indices) of patent families by country/region of applicant (the Filing Years (Priority Years) 2010-2021)

Level 1		Country / Region of Applicant												
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian
gxA	Energy Supply	127.7%	81.6%	160.7%	149.4%	169.7%	153.4%	82.0%	116.4%	151.7%	166.4%	120.0%	131.5%	122.8%
gxB	Energy Saving, Electrification, Demand-Supply Flexibility	182.6%	91.5%	160.7%	208.7%	166.4%	119.4%	70.4%	129.0%	140.5%	117.9%	61.5%	53.8%	81.9%
gxC	Batteries, Energy Storage	183.3%	64.6%	107.2%	164.0%	122.8%	74.9%	81.9%	66.7%	152.3%	50.3%	94.3%	41.7%	43.0%
gxD	CO2 Reduction in Non-Energy Sector	56.0%	86.7%	118.9%	44.3%	108.0%	108.2%	112.5%	63.0%	75.0%	118.6%	160.6%	234.1%	131.9%
gxE	Capture, Storage, Utilization and Removal of Greenhouse	113.7%	154.2%	176.0%	95.9%	243.5%	232.8%	73.7%	48.8%	120.2%	228.9%	92.6%	193.4%	214.3%

Database: Derwent™ Innovation

The revealed technological advantage indices (RTA indices) of IPFs in each Large (Level 1) category are shown in Table 4-8 by country/region of applicant.

The RTA indices of gxC for South Korean applicants, gxD for Indian applicants and ASEAN applicants, and gxE for Australian applicants exceed 200%, suggesting that they are filing applications quite specifically in this category. For Japanese applicants, the RTA index for gxC is large at 161.8%, while the RTA index for gxD is low at 52.9%.

Table 4-8 The revealed technological advantage indices (RTA indices) of IPFs by country/region of applicant (the Filing Years (Priority Years) 2010-2021)

Level 1		Country / Region of Applicant												
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian
gxA	Energy Supply	100.2%	85.3%	134.9%	127.9%	155.4%	128.3%	53.5%	88.0%	122.3%	130.9%	102.8%	104.2%	144.0%
gxB	Energy Saving, Electrification, Demand-Supply Flexibility	146.5%	67.9%	103.7%	141.6%	113.2%	76.9%	74.4%	119.0%	124.5%	85.8%	48.0%	50.2%	56.8%
gxC	Batteries, Energy Storage	161.8%	59.9%	72.6%	112.3%	100.9%	58.0%	77.8%	58.6%	209.7%	51.1%	71.3%	48.5%	49.2%
gxD	CO2 Reduction in Non-Energy Sector	52.9%	128.9%	132.2%	53.1%	129.4%	121.4%	69.0%	61.0%	65.2%	155.5%	226.7%	228.1%	174.9%
gxE	Capture, Storage, Utilization and Removal of Greenhouse	92.5%	132.7%	125.0%	76.3%	174.5%	158.8%	28.6%	31.7%	74.7%	183.8%	113.3%	195.1%	203.2%

Database: Derwent™ Innovation

Section 5 Top-Ranking with the Number of Patent Families and IPFs

1. gxA: Energy Supply

The top 20 applicants with the number of patent families in “gxA: Energy Supply” are shown in Table 4-9 and the top 20 applicants with the number of IPFs are shown in Table 4-10.

The top-ranking applicants with the number of patent families are TOYOTA MOTOR CORPORATION in first place, followed by PANASONIC CORP. in second place and LG CORPORATION (South Korea) in third place. There are seven Japanese applicants, five Chinese applicants, four South Korean applicants, three European applicants, and one US applicant in the ranking.

The top-ranking applicants with the number of IPFs are GENERAL ELECTRIC CO. (USA) in first place, followed by TOYOTA MOTOR CORPORATION in second place and SIEMENS A.G. (Germany) in third place. There are nine Japanese applicants, five European applicants, four South Korean applicants, two US applicants, and no Chinese applicants in the ranking.

Table 4-9 The top 20 applicants with the number of patent families in “gxA: Energy Supply” (the Filing Years (Priority Years) 2010-2021)

Order	Number of Families	Name of Applicant	Country / Region
1	5,538	TOYOTA MOTOR CORPORATION	Japan
2	3,117	PANASONIC CORP.	Japan
3	3,009	LG CORPORATION	Korea
4	2,485	NUCLEAR POWER INSTITUTE OF CHINA	China
5	2,420	STATE GRID CORP. OF CHINA	China
6	2,412	HYUNDAI MOTOR CORP.	Korea
7	2,390	SAMSUNG GROUP	Korea
8	2,389	GENERAL ELECTRIC CO.	USA
9	2,363	TOSHIBA CORP.	Japan
10	2,239	MITSUBISHI HEAVY IND, LTD.	Japan
11	2,085	HONDA MOTOR CO., LTD.	Japan
12	1,992	CHINA GENERAL NUCLEAR POWER CORP.	China
13	1,825	ROBERT BOSCH GMBH	Germany
14	1,642	DALIAN INSTITUTE OF CHEMICAL PHYSICS, CHINESE ACADEMY OF SCIENCES	China
15	1,615	SIEMENS A.G.	Germany
16	1,598	CHINA HUANENG GROUP CO., LTD.	China
17	1,536	KOREA ELECTRIC POWER CORP.	Korea
18	1,505	KYOCERA CORP.	Japan
19	1,436	VESTAS WIND SYSTEMS A/S	Denmark
20	1,418	SHARP CORP.	Japan

Database: Derwent™ Innovation

Table 4-10 The top 20 applicants with the number of IPFs in “gxA: Energy Supply”
(the Filing Years (Priority Years) 2010-2021)

Order	Number of IPF	Name of Applicant	Country / Region
1	2,015	GENERAL ELECTRIC CO.	USA
2	1,861	TOYOTA MOTOR CORPORATION	Japan
3	1,476	SIEMENS A.G.	Germany
4	1,468	PANASONIC CORP.	Japan
5	1,307	VESTAS WIND SYSTEMS A/S	Denmark
6	1,295	SAMSUNG GROUP	Korea
7	1,287	HYUNDAI MOTOR CORP.	Korea
8	1,242	LG CORPORATION	Korea
9	1,140	ROBERT BOSCH GMBH	Germany
10	1,014	HONDA MOTOR CO., LTD.	Japan
11	1,010	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
12	972	MITSUBISHI HEAVY IND, LTD.	Japan
13	752	KIA CORP.	Korea
14	695	TOSHIBA CORP.	Japan
15	600	SHARP CORP.	Japan
16	585	FUJIFILM CORP.	Japan
17	545	WOBBEN PROPERTIES GMBH	Germany
18	536	HITACHI, LTD.	Japan
19	519	SANYO ELECTRIC CO.,LTD.	Japan
20	462	GENERAL MOTORS CORP.	USA

Database: Derwent™ Innovation

2. gxB: Energy Saving, Electrification, Demand-Supply Flexibility

The top 20 applicants with the number of patent families in “gxB: Energy Saving, Electrification, Demand-Supply Flexibility” are shown in Table 4-11 and the top 20 applicants with the number of IPFs are shown in Table 4-12.

The top-ranking applicants with the number of patent families are TOYOTA MOTOR CORPORATION in first place, followed by PANASONIC CORP. in second place and MITSUBISHI ELECTRIC CORP. in third place. There are eight Japanese applicants, four Chinese applicants, four South Korean applicants, three European applicants, and one US applicant in the ranking.

The top-ranking applicants with the number of IPFs are TOYOTA MOTOR CORPORATION in first place, followed by SAMSUNG GROUP (South Korea) in second place and PANASONIC CORP. in third place. There are nine Japanese applicants, five European applicants, four South Korean applicants, two US applicants, and no Chinese applicants in the ranking.

Table 4-11 The top 20 applicants with the number of patent families in “gxB: Energy Saving, Electrification, Demand-Supply Flexibility”
(the Filing Years (Priority Years) 2010-2021)

Order	Number of Families	Name of Applicant	Country / Region
1	10,117	TOYOTA MOTOR CORPORATION	Japan
2	8,422	PANASONIC CORP.	Japan
3	6,831	MITSUBISHI ELECTRIC CORP.	Japan
4	6,676	LG CORPORATION	Korea
5	4,888	SAMSUNG GROUP	Korea
6	4,885	STATE GRID CORP. OF CHINA	China
7	4,563	HYUNDAI MOTOR CORP.	Korea
8	3,875	GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI	China
9	3,844	TOSHIBA CORP.	Japan
10	3,810	MIDEA HOLDING CO., LTD.	China
11	2,991	HONDA MOTOR CO., LTD.	Japan
12	2,960	HITACHI, LTD.	Japan
13	2,940	SHARP CORP.	Japan
14	2,923	KONINKLIJKE PHILIPS N.V.	Netherlands
15	2,809	DENSO CORP.	Japan
16	2,777	FORD MOTOR CO.	USA
17	2,444	KIA CORP.	Korea
18	2,408	ROBERT BOSCH GMBH	Germany
19	2,183	OSRAM GMBH	Germany
20	2,162	HAIER GROUP	China

Database: Derwent™ Innovation

Table 4-12 The top 20 applicants with the number of IPFs in “gxB: Energy Saving, Electrification, Demand-Supply Flexibility”
(the Filing Years (Priority Years) 2010-2021)

Order	Number of IPF	Name of Applicant	Country / Region
1	4,381	TOYOTA MOTOR CORPORATION	Japan
2	4,058	SAMSUNG GROUP	Korea
3	3,886	PANASONIC CORP.	Japan
4	3,662	LG CORPORATION	Korea
5	3,398	MITSUBISHI ELECTRIC CORP.	Japan
6	2,747	HYUNDAI MOTOR CORP.	Korea
7	2,675	KONINKLIJKE PHILIPS N.V.	Netherlands
8	2,480	FORD MOTOR CO.	USA
9	2,078	SHARP CORP.	Japan
10	2,036	HONDA MOTOR CO., LTD.	Japan
11	1,717	KIA CORP.	Korea
12	1,691	OSRAM GMBH	Germany
13	1,590	ROBERT BOSCH GMBH	Germany
14	1,564	TOSHIBA CORP.	Japan
15	1,495	DENSO CORP.	Japan
16	1,427	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan
17	1,368	GENERAL ELECTRIC CO.	USA
18	1,309	HITACHI, LTD.	Japan
19	1,270	SIEMENS A.G.	Germany
20	1,260	VALEO S.A.	France

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3. gxC: Batteries, Energy Storage

The top 20 applicants with the number of patent families in “gxC: Batteries, Energy Storage” are shown in Table 4-13and the top 20 applicants with the number of IPFs are shown in Table 4-14.

The top-ranking applicants with the number of patent families are LG CORPORATION (South Korea) in first place, followed by TOYOTA MOTOR CORPORATION in second place and SAMSUNG GROUP (South Korea) in third place. There are twelve Japanese applicants, four Chinese applicants, three South Korean applicants, one European applicant, and no US applicants in the ranking.

The top-ranking applicants with the number of IPFs are LG CORPORATION (South Korea) in first place, followed by SAMSUNG GROUP (South Korea) in second place and TOYOTA MOTOR CORPORATION in third place. There are thirteen Japanese applicants, three South Korean applicants, two US applicants, one European applicant, and one Chinese applicant in the ranking.

Table 4-13 The top 20 applicants with the number of Patent Families in “gxC: Batteries, Energy Storage” (the Filing Years (Priority Years) 2010-2021)

Order	Number of Families	Name of Applicant	Country / Region
1	11,252	LG CORPORATION	Korea
2	8,770	TOYOTA MOTOR CORPORATION	Japan
3	5,825	SAMSUNG GROUP	Korea
4	3,967	TOYOTA INDUSTRIES CORPORATION	Japan
5	3,519	PANASONIC CORP.	Japan
6	3,384	ROBERT BOSCH GMBH	Germany
7	2,513	GS YUASA CORPORATION	Japan
8	2,472	TDK CORP.	Japan
9	2,192	SANYO ELECTRIC CO.,LTD.	Japan
10	2,153	CONTEMPORARY AMPEREX TECHNOLOGY CO., LTD.	China
11	1,600	DENSO CORP.	Japan
12	1,589	HITACHI, LTD.	Japan
13	1,585	HONDA MOTOR CO., LTD.	Japan
14	1,571	HYUNDAI MOTOR CORP.	Korea
15	1,528	TOSHIBA CORP.	Japan
16	1,506	NISSAN MOTOR CO., LTD.	Japan
17	1,495	HEFEI GUOXUAN HIGH-TECH POWER ENERGY CO., LTD.	China
18	1,477	SUMITOMO ELECTRIC INDUSTRIES, LTD.	Japan
19	1,362	BYD COMPANY LIMITED	China
20	1,347	CENTRAL SOUTH UNIVERSITY	China

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Table 4-14 The top 20 applicants with the number of IPFs in “gxC: Batteries, Energy Storage” (the Filing Years (Priority Years) 2010-2021)

Order	Number of IPF	Name of Applicant	Country / Region
1	5,360	LG CORPORATION	Korea
2	5,046	SAMSUNG GROUP	Korea
3	3,094	TOYOTA MOTOR CORPORATION	Japan
4	2,426	ROBERT BOSCH GMBH	Germany
5	2,399	PANASONIC CORP.	Japan
6	1,500	SANYO ELECTRIC CO.,LTD.	Japan
7	1,286	CONTEMPORARY AMPEREX TECHNOLOGY CO., LTD.	China
8	1,182	HONDA MOTOR CO., LTD.	Japan
9	1,064	GS YUASA CORPORATION	Japan
10	1,059	MURATA MFG CO., LTD.	Japan
11	1,039	TDK CORP.	Japan
12	950	HITACHI, LTD.	Japan
13	922	HYUNDAI MOTOR CORP.	Korea
14	888	TOSHIBA CORP.	Japan
15	812	FORD MOTOR CO.	USA
16	802	GENERAL MOTORS CORP.	USA
17	776	SUMITOMO ELECTRIC INDUSTRIES, LTD.	Japan
18	704	NISSAN MOTOR CO., LTD.	Japan
19	698	NEC CORP.	Japan
20	671	DENSO CORP.	Japan

Database: Derwent™ Innovation

4. gxD: CO_2 Reduction in Non-Energy Sector

The top 20 applicants with the number of patent families in “gxD: CO_2 Reduction in Non-Energy Sector” are shown in Table 4-15 and the top 20 applicants with the number of IPFs are shown in Table 4-16.

The top-ranking applicants of the number of patent families are dominated by Chinese applicants, with JIANGNAN UNIVERSITY (China) in first place, CHINA PETROCHEMICAL CORP (China) in second place, and ZHEJIANG UNIVERSITY OF TECHNOLOGY (China) in third place. There are fifteen Chinese applicants, three European applicants, one US applicant, one South Korean applicant, and no Japanese applicants in the ranking.

The top-ranking applicants with the number of IPFs are DUPONT DE NEMOURS, INC. (USA) in first place, followed by NOVO NORDISK AS (Denmark) in second place and KONINKLIJKE DSM N.V. (the Netherlands) in third place. There are seven European applicants, five US applicants, three Japanese applicants, two South Korean applicants, one Chinese applicant, one Saudi Arabian applicant, and one New Zealand applicant in the ranking.

Table 4-15 The top 20 applicants with the number of Patent Families in "gxD: CO_2 Reduction in Non-Energy Sector"
(the Filing Years (Priority Years) 2010-2021)

Order	Number of Families	Name of Applicant	Country / Region
1	1,394	JIANGNAN UNIVERSITY	China
2	1,088	CHINA PETROCHEMICAL CORP.	China
3	560	ZHEJIANG UNIVERSITY OF TECHNOLOGY	China
4	461	NANJING TECH UNIVERSITY	China
5	446	TIANJIN UNIVERSITY OF SCIENCE AND TECHNOLOGY	China
6	405	SHENWU TECHNOLOGY GROUP CORPORATION	China
6	405	SOUTH CHINA UNIVERSITY OF TECHNOLOGY	China
8	365	DUPONT DE NEMOURS, INC.	USA
9	311	NOVO NORDISK AS	Denmark
10	283	ZHEJIANG UNIVERSITY	China
11	282	TIANJIN UNIVERSITY	China
12	276	TIANJIN INSTITUTE OF INDUSTRIAL BIOTECHNOLOGY, CHINESE ACADEMY OF SCIENCES	China
13	262	POSCO CORP.	Korea
14	253	COFCO CORP.	China
15	241	EAST CHINA UNIVERSITY OF SCIENCE AND TECHNOLOGY	China
16	237	SHANGHAI JIAO TONG UNIVERSITY	China
17	235	KONINKLIJKE DSM N.V.	Netherlands
17	235	BEIJING UNIVERSITY OF CHEMICAL TECHNOLOGY	China
19	229	CHINESE ACADEMY OF AGRICULTURAL SCIENCES	China
20	223	BASF SE	Germany

Database: Derwent™ Innovation

Table 4-16 The top 20 applicants with the number of IPFs in "gxD: CO_2 Reduction in Non-Energy Sector"
(the Filing Years (Priority Years) 2010-2021)

Order	Number of IPF	Name of Applicant	Country / Region
1	318	DUPONT DE NEMOURS, INC.	USA
2	290	NOVO NORDISK AS	Denmark
3	229	KONINKLIJKE DSM N.V.	Netherlands
4	211	BASF SE	Germany
5	127	EVONIK IND A.G.	Germany
6	111	JIANGNAN UNIVERSITY	China
7	104	IFP ENERGIES NOUVELLES S.A.	France
8	102	TORAY INDUSTRIES, INC.	Japan
9	100	EASTMAN CHEMICAL COMPANY	USA
10	99	SAUDI BASIC IND CORP.	Saudi Arabia
11	96	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	France
12	88	MITSUBISHI CHEMICAL HOLDINGS CORP.	Japan
13	86	POSCO CORP.	Korea
14	85	KOBE STEEL LTD	Japan
14	85	UNIVERSITY OF CALIFORNIA	USA
16	79	INVISTA NORTH AMERICA S.A.R.L.	USA
17	78	CJ CHEILJEDANG CORP.	Korea
18	75	UPM KYMMENE CORP.	Finland
19	69	DOW INC.	USA
20	63	LANZATECH NEW ZEALAND LTD	New Zealand

Database: Derwent™ Innovation

5. gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas

The top 20 applicants with the number of patent families in “gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas” are shown in Table 4-17 and the top 20 applicants with the number of IPFs are shown in Table 4-18.

The top-ranking applicants with the number of patent families are CHINA PETROCHEMICAL CORP (China) in first place, followed by MITSUBISHI HEAVY IND, LTD. in second place and AIR LIQUIDE S.A. (France) in third place. There are five European applicants, five Chinese applicants, three Japanese applicants, three US applicants, three South Korean applicant, and one Saudi Arabian applicant in the ranking.

The top-ranking applicants with the number of IPFs are MITSUBISHI HEAVY IND, LTD. in first place, followed by AIR LIQUIDE S.A. (France) in second place and DAIKIN INDUSTRIES, LTD. in third place. There are nine European applicants, five Japanese applicants, five US applicants, one Saudi Arabian applicant, and no Chinese and South Korean applicants in the ranking.

Table 4-17 The top 20 applicants with the number of Patent Families in “gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas”
(the Filing Years (Priority Years) 2010-2021)

Order	Number of Families	Name of Applicant	Country / Region
1	449	CHINA PETROCHEMICAL CORP.	China
2	271	MITSUBISHI HEAVY IND, LTD.	Japan
3	258	AIR LIQUIDE S.A.	France
4	228	EXXONMOBIL CORP.	USA
5	225	KOREA INSTITUTE OF ENERGY RESEARCH	Korea
6	219	TOSHIBA CORP.	Japan
7	197	DALIAN INSTITUTE OF CHEMICAL PHYSICS, CHINESE ACADEMY OF SCIENCES	China
8	196	DAIKIN INDUSTRIES, LTD.	Japan
9	166	ZHEJIANG UNIVERSITY	China
10	159	TIANJIN UNIVERSITY	China
11	154	GENERAL ELECTRIC CO.	USA
12	152	LINDE A.G.	UK
13	151	SIEMENS A.G.	Germany
14	150	KOREA ELECTRIC POWER CORP.	Korea
15	149	HONEYWELL INTERNATIONAL INC.	USA
16	140	SAUDI ARABIAN OIL CO.	Saudi Arabia
17	131	BASF SE	Germany
18	127	DAEWOO SHIPBUILDING & MARINE ENGINEERING CO., LTD.	Korea
19	126	CHINA HUANENG GROUP CO., LTD.	China
20	121	ALSTOM S.A.	France

Database: Derwent™ Innovation

Table 4-18 The top 20 applicants with the number of IPFs in “gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas”
(the Filing Years (Priority Years) 2010-2021)

Order	Number of IPF	Name of Applicant	Country / Region
1	209	MITSUBISHI HEAVY IND, LTD.	Japan
2	205	AIR LIQUIDE S.A.	France
3	175	DAIKIN INDUSTRIES, LTD.	Japan
4	172	EXXONMOBIL CORP.	USA
5	140	TOSHIBA CORP.	Japan
6	132	SIEMENS A.G.	Germany
7	126	GENERAL ELECTRIC CO.	USA
7	126	LINDE A.G.	UK
9	113	ALSTOM S.A.	France
10	112	BASF SE	Germany
10	112	SAUDI ARABIAN OIL CO.	Saudi Arabia
12	105	ARKEMA S.A.	France
13	95	HONEYWELL INTERNATIONAL INC.	USA
13	95	THE CHEMOURS COMPANY	USA
15	93	UOP LLC	USA
16	91	AGC INC.	Japan
17	89	COVESTRO DEUTSCHLAND AG	Germany
17	89	ROYAL DUTCH SHELL PLC.	Netherlands
19	84	IFP ENERGIES NOUVELLES S.A.	France
20	77	FUJIFILM CORP.	Japan

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Section 6 Summary

Regarding trends in patent applications for large (Level 1) categories in the GXTI, we conducted a survey on the number of patent families, the number of IPF, and the like targeting 14 countries/regions and institutions.

In terms of the total number of patent families for all survey years, "gxB: Energy Saving, Electrification, Demand-Supply Flexibility" was the largest, followed by "gxA: Energy Supply," "gxC: Batteries, Energy Storage," "gxD: CO2 Reduction in Non-Energy Sector," and "gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas." In addition, all categories are on the rise. By country/region of the applicant, Chinese applicants have the largest number of patent families in any level, but Japanese applicants are also ranked within the top three in four categories: gxA, gxB, gxC, and gxE.

The annual trends in the number of IPF differ from the trends in the number of patent families, which tended to increase in all categories. Although gxB and gxC are on the rise, gxD and gxE have remained at the same level, and gxA is on the decline. By country/region of the applicant, Japanese applicants had the largest number of IPF for gxB and gxC, US applicants for gxD and gxE, and European applicants for gxA.

The growth rates of patent families (Table 4-5) are positive for all categories, with the gxC category being the largest, followed by the gxD, gxB, gxE and gxA categories. On the other hand, the growth rates of IPFs (Table 4-6) are positive for the gxB and gxC categories, but negative for the gxA, gxD and gxE categories. In terms of the growth rates of IPFs for Japanese applicants,

gxC and gxE are positive, gxA is negative, and gxB and gxD are around 0%.

In the revealed technological advantage index (RTA index) (Table 4-7) of patent families, the RTA indices of gxB for German applicants, gxE for UK, French and Australian applicants, and gxD for ASEAN applicants exceed 200%, suggesting that these countries/regions are filing applications quite specifically in this category. For Japanese applicants, the RTA indices of patent families for gxB and gxC are large, in the range of 180%, while the RTA index for gxD is low at 56.0%. In the revealed technological advantage index (RTA index) (Table 4-8) of IPFs, the RTA indices of gxC for South Korean applicants, gxD for Indian applicants and ASEAN applicants, and gxE for Australian applicants exceed 200%, suggesting that they are filing applications quite specifically in this category. For Japanese applicants, the RTA index of IPFs for gxC is large, in the range of 150%, while the RTA index for gxD is low at 52.9%.

In the top-ranking with the number of patent families, seven Japanese applicants are ranked in the gxA (Table 4-9) category, eight in the gxB (Table 4-11) category, twelve in the gxC (Table 4-13) category, three in the gxE (Table 4-17) category, and none in the gxD (Table 4-15) category.

Chapter 5 Trend Survey by Medium (Level 2) Category in the GXTI

This chapter presents survey results on patent application trends for medium (level 2) categories in the GXTI. Medium (level 2) categories in the GXTI consists 32 categories included in six large (level 1) categories of "gxA: Energy Supply," "gxB: Energy Saving, Electrification, Demand-Supply Flexibility," "gxC: Batteries, Energy Storage," "gxD: CO2 Reduction in Non-Energy Sector," "gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas," and "gxY: Cross-Tabulation (×Control, ×Measuring, ×Business, ×ICT)" and we conducted a survey using the union of search formulae for small (level 3) categories included in each medium (level 2) category listed in the Green Transformation Technologies Inventory.

Section 1 Annual Trends in the Number of Patent Families and IPFs

Table 5-1 illustrates the annual trends in the number of patent families for medium (level 2) categories.

In the total excluding cross-tabulation, gxB01 was the largest, followed by gxC01, gxA01, gxB05, and gxA09, but gxC01 increased significantly. Most Medium categories are on the increase, but gxB04, gxC03, and gxC04 show a remarkable increase, although the number of cases is small.

For medium categories, in terms of energy supply, the order is gxA01, xA09, gxA03, gxA10, gxA02, gxA07, gxA08, gxA05, gxA06, gxA11, and gxA04. Each medium category is trending at about the same level, but gx02, gxA10, and gxA11 are on the rise.

In terms of energy saving, electrification, demand-supply flexibility, the order is gxB01, gxB05, gxB06, gxB07, gxB02, gxB04, gxB03, and gxB08. The gxB03 is remained at the same level, but other medium categories is on the rise.

In terms of batteries and energy storage, the order is gxC01, gxC04, gxC03, and gxC02, and all medium categories are on an increasing trend.

In terms of CO2 reduction in non-energy sector, the order is gxD01, gxD03, and gxD02. gxD01 and gxD03 are on the increase, but gxD02 is trending at almost the same level.

In terms of capture, storage, utilization and removal of greenhouse gas, the order is gxE01 and gxE02, and both are increasing.

The total of the cross-tabulations, gxY04 has the most, followed by gxY02, gxY01, and gxY03. gxY02 and gxY03 tend to increase, but gxY04 tends to decrease.

Table 5-1 Annual trends in the number of patent families

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Level 1	Level 2		Year of Priority Claim												Total
			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
Energy Supply	gxA01	Solar Photovoltaic Power Generation	10,125	10,803	9,865	8,392	8,291	8,805	10,753	12,583	14,049	11,322	12,703	10,160	127,851
	gxA02	Solar Thermal Energy Utilization	1,751	1,697	1,662	1,643	1,387	1,533	1,980	2,584	3,347	2,600	3,137	2,157	25,478
	gxA03	Wind Power Generation	3,865	4,272	3,831	3,360	3,242	3,168	3,756	4,364	4,577	4,242	5,177	4,480	48,334
	gxA04	Geothermal Utilization	44	82	95	78	72	99	174	344	435	403	491	374	2,691
	gxA05	Hydro-Power Generation	1,316	1,489	1,416	1,343	1,271	1,444	1,576	1,684	1,796	1,553	1,935	1,629	18,452
	gxA06	Ocean Energy Power Generation	735	765	729	776	829	735	832	795	868	759	977	680	9,480
	gxA07	Biomass	1,699	1,756	1,754	1,638	1,751	2,047	2,176	2,128	2,202	1,848	1,709	1,138	21,846
	gxA08	Nuclear Power Generation	1,281	1,420	1,772	1,501	1,550	1,482	1,542	1,670	1,669	1,789	2,038	1,416	19,130
	gxA09	Fuel Cells	4,795	4,627	4,923	4,747	4,682	4,859	5,544	5,581	6,458	6,971	7,298	4,982	65,467
	gxA10	Hydrogen Technology	2,089	2,108	2,161	2,135	2,330	2,467	2,828	2,925	3,603	4,015	4,402	3,822	34,885
	gxA11	Ammonia Technology	270	247	333	331	314	297	334	416	441	482	635	551	4,651
Energy Saving, Electrification, Demand-Supply Flexibility	gxB01	Energy Saving in Buildings (ZEB, ZEH, etc.)	17,068	19,104	20,473	21,328	20,147	22,169	26,033	27,503	25,551	21,177	19,702	10,938	251,193
	gxB02	High-Efficiency Motors and Inverters	1,062	1,305	1,431	1,370	1,462	1,413	1,751	1,794	1,990	1,992	2,252	1,556	19,378
	gxB03	Combined Heat and Power (CHP)	761	837	940	874	911	904	960	965	1,000	843	785	565	10,345
	gxB04	Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge	556	560	635	757	844	947	1,285	1,621	2,022	1,720	1,878	1,495	14,320
	gxB05	Electromobilities	4,384	5,248	5,110	4,985	5,303	5,775	7,307	8,917	10,734	10,605	10,166	5,227	83,761
	gxB06	Electrification of Industrial Heat	2,846	2,912	2,878	3,097	3,137	3,838	4,687	4,704	4,937	4,571	4,491	2,221	44,319
	gxB07	Power Transmission and Distribution, Smart Grids	1,690	2,137	2,410	2,530	2,652	2,359	2,248	2,569	2,695	2,960	3,295	2,752	30,297
	gxB08	Demand-Supply Flexibility of Power Systems	3	2	3	2	1	2	5	10	9	30	25	37	129
Batteries, Energy Storage	gxC01	Secondary Batteries	10,601	12,663	13,693	13,553	13,953	15,706	19,710	23,945	27,054	27,029	29,409	19,539	226,855
	gxC02	Mechanical Energy Storage	72	99	103	101	105	91	126	166	191	171	174	269	1,668
	gxC03	Thermal Energy Storage	592	776	864	969	1,115	1,195	1,538	1,699	1,829	2,021	2,031	1,514	16,143
	gxC04	Electric Double Layer Capacitors, Hybrid Capacitors	890	939	1,467	1,565	1,878	2,122	2,748	2,698	2,809	2,613	2,136	1,297	23,162
CO2 Reduction in Non-Energy Sector	gxD01	Chemical Production from Biomass	2,620	2,827	3,286	3,191	3,591	3,882	4,512	4,423	4,753	4,874	4,819	3,816	46,594
	gxD02	Reduction of CO2 Emission in Steelmaking Process	191	200	246	226	201	181	325	402	199	275	286	272	3,004
	gxD03	Recycling	858	983	998	1,050	975	1,110	1,539	1,855	2,164	2,226	2,802	1,899	18,459
Capture, Storage, Utilization and Removal of Greenhouse Gas	gxE01	CCS, CCUS, Negative Emission	1,379	1,493	1,539	1,423	1,556	1,546	1,814	1,939	1,955	2,022	2,180	1,805	20,651
	gxE02	Measures Against Non-CO2 Greenhouse Gases	202	167	191	176	235	194	248	282	238	276	196	115	2,520
Cross-Tabulation	gxY01	GXTI×Control-Related Technology	1,163	1,309	1,221	1,128	1,145	1,139	1,442	1,648	1,577	1,390	1,276	595	15,033
	gxY02	GXTI×Measuring-Related Technology	2,416	2,691	2,715	2,770	2,802	3,053	3,696	4,067	4,452	4,588	4,996	2,738	40,984
	gxY03	GXTI×Business-Related Technology (Including Authentication and Payment)	311	450	348	410	477	536	642	815	972	1,209	1,363	1,176	8,709
	gxY04	GXTI×ICT-Related Technology (Excluding Business-Related Technology)	16,251	17,557	16,463	14,342	11,528	11,431	12,589	12,774	13,654	12,416	11,117	7,009	157,131

Database: Derwent™ Innovation

Note: Please note that Derwent™ Innovation may not have had sufficient recorded data from the filing year (priority year) of 2019 onward when conducting this survey.

Table 5-2 illustrates the annual trends in the number of IPFs for Medium categories.

In the total excluding cross-tabulation, gxB01 was the largest, followed by gxC01, gxB05, gxA01, and gxA09, with gxC01 clearly increasing compared to other Medium categories. In addition, an increasing trend is observed in gxB05 and gxA09. Other gxA01 and gxB01 are on the decline.

For medium categories in energy supply, the order is gxA01, gxA09, gxA03, gxA10, gxA07, gxA02, gxA08, gxA05, gxA06, gxA11, and gxA04. In the number of patent families in Table 5-1, an increasing trend was observed for gxA04, gxA09, gxA10 and gxA11, but no increasing trend was observed for any Medium categories in the IPF, and a slight increasing trend was observed for gxA04.

In terms of Energy Saving, Electrification, Demand-Supply Flexibility, the order is gxB01, gxB05, gxB06, gxB07, gxB02, gxB03, gxB04, and gxB08. In the number of patent families in Table 5-1, an increasing trend was observed for gxB02, gxB05 and gxB06, but an increasing trend was observed for gxB05 and gxB06 in IPF.

In terms of batteries and energy storage, the order is gxC01, gxC04, gxC03, and gxC02. In the number of patent families in Table 5-1, although there was an increasing trend at all categories, an increasing trend was observed in gxC01 and gxC04 in IPF.

In terms of CO2 reduction in non-energy sector, the order is gxD01, gxD03, and gxD02. In the number of patent families in Table 5-1, gxD03 showed an increasing trend, and the IPF also shows an increasing trend in gxD03.

In terms of capture, storage, utilization and removal of greenhouse gas, the order is gxE01 and gxE02. The number of patent families in Table 5-1 showed a slightly increasing trend for gxE01, but remained almost the same for IPF.

At each Medium category of the cross-tabulation, gxY04 has the largest, followed by gxY02, gxY01, and gxY03. In the number of patent families in Table 5-1, gxY02 and gxY03 showed an increasing trend, but in IPF, gxY03 showed an increasing trend, but gxY03 showed an increasing trend from 2017 onwards. The number of gxY01 and gxY04 remained almost the same, showing the same trend as the number of patent families in Table 5-1.

Table 5-2　Annual trends in the number of IPFs

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Level 1	Level 2		Year of Priority Claim												Total
			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
Energy Supply	gxA01	Solar Photovoltaic Power Generation	4,021	3,972	3,290	2,688	2,323	2,356	2,225	2,170	2,131	1,949	1,796	391	29,312
	gxA02	Solar Thermal Energy Utilization	641	631	541	455	397	399	353	405	387	354	357	86	5,006
	gxA03	Wind Power Generation	1,651	1,703	1,361	1,168	1,117	1,005	1,128	1,325	1,294	1,255	1,144	268	14,419
	gxA04	Geothermal Utilization	21	32	44	29	22	34	42	71	63	59	60	20	497
	gxA05	Hydro-Power Generation	449	490	395	341	264	303	267	259	267	248	188	44	3,515
	gxA06	Ocean Energy Power Generation	234	271	192	227	204	198	169	178	146	133	137	36	2,125
	gxA07	Biomass	685	709	644	568	440	400	328	332	283	321	285	47	5,042
	gxA08	Nuclear Power Generation	437	412	519	438	439	398	354	376	331	345	340	90	4,479
	gxA09	Fuel Cells	1,734	1,730	1,734	1,614	1,616	1,508	1,713	1,641	1,844	1,809	1,902	480	19,325
	gxA10	Hydrogen Technology	848	883	893	907	866	857	912	855	906	975	1,156	279	10,337
	gxA11	Ammonia Technology	112	110	118	103	107	99	95	126	108	131	115	26	1,250
Energy Saving, Electrification, Demand-Supply Flexibility	gxB01	Energy Saving in Buildings (ZEB, ZEH, etc.)	6,603	7,613	7,713	7,690	7,049	6,918	7,383	7,357	6,748	5,979	4,932	1,095	77,080
	gxB02	High-Efficiency Motors and Inverters	467	581	632	571	646	588	641	678	749	740	696	179	7,168
	gxB03	Combined Heat and Power (CHP)	274	287	290	263	262	263	238	214	160	148	95	20	2,514
	gxB04	Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge	88	65	64	58	53	57	60	74	60	94	87	21	781
	gxB05	Electromobilities	2,016	2,475	2,433	2,415	2,416	2,463	3,214	3,656	4,290	4,146	3,582	888	33,994
	gxB06	Electrification of Industrial Heat	1,087	1,098	1,102	1,214	1,278	1,418	1,662	1,709	1,837	1,712	1,483	330	15,930
	gxB07	Power Transmission and Distribution, Smart Grids	1,038	1,349	1,370	1,428	1,344	1,031	875	936	793	766	707	175	11,812
	gxB08	Demand-Supply Flexibility of Power Systems	3	1	3	2	0	0	0	0	0	4	1	4	18
Batteries, Energy Storage	gxC01	Secondary Batteries	4,780	5,490	5,537	5,358	5,251	5,351	6,086	7,025	7,647	8,097	8,355	2,113	71,090
	gxC02	Mechanical Energy Storage	30	41	51	40	37	44	43	52	45	36	31	10	460
	gxC03	Thermal Energy Storage	223	305	318	309	375	352	391	349	322	352	310	85	3,691
	gxC04	Electric Double Layer Capacitors, Hybrid Capacitors	443	502	591	564	643	646	722	718	638	608	563	125	6,763
CO2 Reduction in Non-Energy Sector	gxD01	Chemical Production from Biomass	1,033	1,028	1,085	1,048	949	980	919	897	995	975	873	185	10,967
	gxD02	Reduction of CO2 Emission in Steelmaking Process	69	63	69	64	40	52	59	45	37	65	54	21	638
	gxD03	Recycling	263	301	283	294	253	235	281	266	295	516	598	131	3,716
Capture, Storage, Utilization and Removal of Greenhouse Gas	gxE01	CCS, CCUS, Negative Emission	669	735	709	642	613	591	585	599	600	606	592	123	7,064
	gxE02	Measures Against Non-CO2 Greenhouse Gases	112	78	118	112	129	125	128	154	135	154	99	14	1,358
Cross-Tabulation	gxY01	GXTI×Control-Related Technology	802	820	775	750	774	713	835	848	838	734	451	120	8,460
	gxY02	GXTI×Measuring-Related Technology	1,438	1,584	1,575	1,578	1,607	1,620	1,832	1,980	2,137	1,997	1,678	419	19,445
	gxY03	GXTI×Business-Related Technology (Including Authentication and Payment)	185	214	160	179	189	206	217	285	299	371	284	66	2,655
	gxY04	GXTI×ICT-Related Technology (Excluding Business-Related Technology)	8,381	8,792	7,957	7,105	6,111	5,856	6,082	6,195	6,222	5,380	3,975	893	72,949

Database: Derwent™ Innovation

Note: Please note that Derwent™ Innovation may not have had sufficient recorded data from the filing year (priority year) of 2019 onward when conducting this survey.

Section 2 Number of Patent Families and IPF by Country/Region of the Applicant

Table 5-3 illustrates the number of patent families by the country/region of the applicant in the filing years (priority years) of 2010 to 2021, according in medium categories.

The top three countries/regions in medium (level 2) categories are Chinese applicants, Japanese applicants, US applicants, European applicants, and South Korean applicants. Of these, Chinese applicants are ranked within the top three in all medium categories and ranked first in many medium categories. The other two countries/regions are Japanese, US, European, or South Korean applicants. The trends in the top three countries/regions other than China for each medium (level 2) category are summarized below. For medium (level 2) categories in terms of energy supply, Japanese applicants ranked in the top three in gxA01, gxA04, gxA08, gxA09, and gxA10. In addition, European applicants ranked in the top three in gxA02, gxA03, gxA05, gxA06, gxA07, gxA10 and gxA11. Furthermore, South Korean applicants ranked in the top three in gxA01, gxA03, gxA04, gxA05, gxA06, gxA08 and gxA09. In addition, US applicants ranked in the top three in gxA02 and gxA07.

In terms of the energy saving, electrification, demand-supply flexibility, Japanese applicants ranked in the top three in gxB01, gxB02, gxB03, gxB05, gxB06, gxB07, and gxB08. In addition, European applicants ranked in the top three with gxB02, gxB03, gxB05 and gxB06. South Korean applicants ranked in the top three with gxB01, gxB04, and gxB08. Furthermore, US applicants ranked in the top three with gxB04 and gxB07.

In terms of batteries and energy storage, Japanese applicants ranked in the top three in gxC01, gxC03, and gxC04. In addition, European applicants ranked in the top three in gxC02 and gxC03. US applicants ranked in the top three in gxC02 and gxC04. Furthermore, South Korean applicants ranked in the top three in gxC01.

In terms of CO2 reduction in non-energy sector, European applicants ranked in the top three in gxD01 and gxD03. In addition, South Korean applicants ranked in the top three in gxD02 and gxD03. Japanese applicants ranked in the top three in gxD02. Furthermore, US applicants ranked in the top three in gxD01.

In terms of capture, storage, utilization and removal of greenhouse gas, among the top three countries/regions, Japanese and US applicants ranked in the top three.

At medium (level 2) categories of the cross-tabulation, Japanese applicants ranked in the top three in all cross-tabulations, US applicants ranked in the top three in gxY01 and gxY02, and South Korean applicants ranked in the top three in gxY03 and gxY04.

Table 5-3 The number of patent families by country/region of the applicant

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Level 1	Level 2		Nationality/region of applicant														Total
			Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	Others	
Energy Supply	gxA01	Solar Photovoltaic Power Generation	22,137	12,075	8,168	2,647	1,390	593	62,764	2,467	18,406	117	820	152	450	295	127,851
	gxA02	Solar Thermal Energy Utilization	1,285	2,491	2,946	879	333	199	16,197	301	1,296	58	494	31	168	211	25,478
	gxA03	Wind Power Generation	2,683	4,437	11,051	3,285	506	782	23,345	517	4,599	114	850	196	172	370	48,334
	gxA04	Geothermal Utilization	303	259	267	64	16	18	1,514	8	282	16	14	2	11	15	2,691
	gxA05	Hydro-Power Generation	1,542	1,527	2,348	654	267	293	10,153	236	1,921	76	263	122	89	175	18,452
	gxA06	Ocean Energy Power Generation	623	752	1,498	203	202	413	4,860	179	1,143	50	115	50	77	133	9,480
	gxA07	Biomass	1,516	2,869	2,355	397	351	150	12,346	117	1,946	62	248	128	108	151	21,846
	gxA08	Nuclear Power Generation	4,021	2,296	1,506	298	598	195	7,963	32	2,920	36	83	12	16	245	19,130
	gxA09	Fuel Cells	21,096	5,755	6,972	4,137	781	559	21,612	539	8,604	48	514	110	109	108	65,467
	gxA10	Hydrogen Technology	6,376	4,210	4,463	1,444	694	368	15,740	276	3,029	81	248	121	160	181	34,885
	gxA11	Ammonia Technology	540	503	582	163	87	49	2,650	29	195	9	16	6	27	94	4,651
Energy Saving, Electrification, Demand-Supply Flexibility	gxB01	Energy Saving in Buildings (ZEB, ZEH, etc.)	61,120	26,057	19,300	6,884	2,516	1,330	106,950	4,890	30,226	347	817	258	618	610	251,193
	gxB02	High-Efficiency Motors and Inverters	4,431	1,904	2,716	1,420	197	189	8,461	213	1,408	14	116	13	33	69	19,378
	gxB03	Combined Heat and Power (CHP)	1,971	830	1,580	875	121	111	4,642	27	1,144	26	37	10	19	59	10,345
	gxB04	Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge	262	321	245	58	45	22	12,943	56	332	5	74	21	26	35	14,320
	gxB05	Electromobilities	25,968	9,005	16,103	10,766	2,085	775	23,819	356	7,385	45	689	68	114	209	83,761
	gxB06	Electrification of Industrial Heat	9,123	5,631	7,258	2,789	746	501	14,252	343	7,069	59	216	45	118	205	44,319
	gxB07	Power Transmission and Distribution, Smart Grids	5,635	5,411	3,717	1,682	384	297	12,072	411	2,521	36	245	30	109	110	30,297
	gxB08	Demand-Supply Flexibility of Power Systems	34	8	3	0	0	0	71	1	9	0	1	0	2	0	129
Batteries, Energy Storage	gxC01	Secondary Batteries	56,888	17,599	16,349	9,825	2,098	851	103,337	1,685	28,645	84	1,643	135	212	278	226,855
	gxC02	Mechanical Energy Storage	163	175	276	110	14	44	839	29	128	11	15	7	14	11	1,668
	gxC03	Thermal Energy Storage	2,028	1,153	2,227	827	401	203	9,360	66	974	21	164	24	60	66	16,143
	gxC04	Electric Double Layer Capacitors, Hybrid Capacitors	8,893	1,797	909	289	161	99	9,571	125	1,605	16	114	37	42	53	23,162
CO2 Reduction in Non-Energy Sector	gxD01	Chemical Production from Biomass	3,188	5,345	3,454	354	413	259	31,194	286	1,912	40	568	210	132	265	46,594
	gxD02	Reduction of CO2 Emission in Steelmaking Process	303	145	196	39	3	10	1,965	6	252	4	60	7	30	36	3,004
	gxD03	Recycling	1,498	1,476	1,941	375	174	166	10,955	174	1,844	37	226	74	87	147	18,459
Capture, Storage, Utilization and Removal of Greenhouse Gas	gxE01	CCS, CCUS, Negative Emission	2,757	3,679	2,472	514	338	242	9,114	112	2,050	50	139	74	117	87	20,651
	gxE02	Measures Against Non-CO2 Greenhouse Gases	694	533	352	54	116	76	718	11	130	2	28	9	21	22	2,520
Cross-Tabulation	gxY01	GXTI×Control-Related Technology	2,725	4,430	2,184	854	253	164	3,651	297	1,315	22	199	28	113	69	15,033
	gxY02	GXTI×Measuring-Related Technology	10,522	6,890	6,075	3,090	775	384	9,640	405	6,576	46	523	51	114	142	40,984
	gxY03	GXTI×Business-Related Technology (Including Authentication and Payment)	1,949	1,293	417	155	65	34	3,092	89	1,594	9	200	7	52	7	8,709
	gxY04	GXTI×ICT-Related Technology (Excluding Business-Related Technology)	51,695	22,327	13,020	4,439	1,972	1,035	38,307	4,167	24,584	132	1,932	160	442	365	157,131

Database: Derwent™ Innovation

Table 5-4 illustrates the number of patent families by the country/region of the applicant in the filing year (priority year) of 2019, for medium (level 2) categories.

The top three countries/regions in the filing year (priority year) of 2019, are almost the same as the top three countries/regions in the filing years (priority years) of 2010 to 2021, but differ in the following points.

In terms of the energy supply, South Korean applicants fell out of the top three in gxA03, while US applicants ranked in the top three. In addition, Japanese applicants fell out of the top three in gxA04, and European applicants ranked in the top three. Furthermore, US applicants fell out of the top three in gxA07, and South Korean applicants ranked in the top three. In addition, European applicants fell out of the top three in gxA11, and US applicants ranked in the top three.

In terms of the energy saving, electrification, demand-supply flexibility, US applicants fell out of the top three in gxB04, and European applicants ranked in the top three. In addition, Japanese applicants fell out of the top three in gxB06, and South Korean applicants ranked in the top three. Furthermore, US applicants fell out of the top three in gxB07, and European applicants ranked in the top three. Finally, South Korean applicants fell out of the top three in gxB08, and US applicants ranked in the top three.

In terms of batteries and energy storage, European applicants fell out of the top three in gxC04, and South Korean applicants ranked in the top three.

In terms of CO2 reduction in non-energy sector, European applicants fell out of the top three in gxD01, and Japanese applicants ranked in the top three.

In terms of the cross-tabulations, US applicants fell out of the top three in gxY02, and South Korean applicants ranked in the top three.

Table 5-4 The number of patent families by country/region of the applicant

(Application to the country/region to be surveyed, 2019, the filing year (priority year))

Level 1	Level 2		Nationality/region of applicant														Total
			Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	Others	
Energy Supply	gxA01	Solar Photovoltaic Power Generation	937	733	566	146	95	37	7,129	118	1,594	12	150	17	31	35	11,322
	gxA02	Solar Thermal Energy Utilization	34	144	224	58	34	17	1,944	21	75	6	119	5	13	15	2,600
	gxA03	Wind Power Generation	138	296	916	221	29	47	2,445	35	238	6	115	16	4	33	4,242
	gxA04	Geothermal Utilization	22	18	38	8	4	2	265	1	54	1	3	0	0	1	403
	gxA05	Hydro-Power Generation	97	74	124	39	10	20	1,050	23	139	3	24	5	3	11	1,553
	gxA06	Ocean Energy Power Generation	29	43	65	5	9	18	528	5	60	1	13	4	1	10	759
	gxA07	Biomass	91	112	159	23	26	11	1,267	7	152	0	33	10	5	12	1,848
	gxA08	Nuclear Power Generation	241	180	97	18	21	19	967	2	264	1	9	1	2	25	1,789
	gxA09	Fuel Cells	1,581	402	731	459	57	42	3,340	35	740	1	109	9	12	11	6,971
	gxA10	Hydrogen Technology	519	312	436	138	62	34	2,288	20	370	3	34	4	22	7	4,015
	gxA11	Ammonia Technology	60	51	45	12	1	3	294	4	15	0	4	4	4	1	482
Energy Saving, Electrification, Demand-Supply Flexibility	gxB01	Energy Saving in Buildings (ZEB, ZEH, etc.)	4,573	1,801	1,323	427	142	76	10,654	224	2,329	13	160	27	25	48	21,177
	gxB02	High-Efficiency Motors and Inverters	432	146	322	192	32	21	889	12	167	1	13	2	1	7	1,992
	gxB03	Combined Heat and Power (CHP)	91	47	75	36	4	2	570	3	46	2	6	0	0	3	843
	gxB04	Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge	18	19	21	4	3	3	1,627	3	21	0	6	0	2	3	1,720
	gxB05	Electromobilities	2,636	1,022	2,229	1,576	267	78	3,672	28	825	6	120	10	11	46	10,605
	gxB06	Electrification of Industrial Heat	769	400	806	315	88	76	1,726	35	772	1	33	4	6	19	4,571
	gxB07	Power Transmission and Distribution, Smart Grids	415	217	306	140	33	19	1,774	17	179	2	31	2	10	7	2,960
	gxB08	Demand-Supply Flexibility of Power Systems	13	2	0	0	0	0	13	1	1	0	0	0	0	0	30
Batteries, Energy Storage	gxC01	Secondary Batteries	4,738	1,820	1,840	980	248	132	14,550	153	3,008	4	828	24	27	37	27,029
	gxC02	Mechanical Energy Storage	11	13	21	12	0	2	108	4	11	0	0	1	2	0	171
	gxC03	Thermal Energy Storage	169	94	182	69	19	14	1,421	9	89	0	41	1	7	8	2,021
	gxC04	Electric Double Layer Capacitors, Hybrid Capacitors	737	139	83	20	16	8	1,447	9	159	3	17	10	6	3	2,613
CO2 Reduction in Non-Energy Sector	gxD01	Chemical Production from Biomass	293	363	279	21	21	19	3,555	39	195	3	105	13	8	21	4,874
	gxD02	Reduction of CO2 Emission in Steelmaking Process	16	9	32	2	0	0	202	0	10	0	3	0	1	2	275
	gxD03	Recycling	123	198	229	35	18	15	1,330	20	235	4	53	7	10	17	2,226
Capture, Storage, Utilization and Removal of Greenhouse Gas	gxE01	CCS, CCUS, Negative Emission	245	260	218	41	22	22	1,066	12	179	3	19	8	5	7	2,022
	gxE02	Measures Against Non-CO2 Greenhouse Gases	88	40	34	7	4	8	93	0	12	0	6	0	1	2	276
Cross-Tabulation	gxY01	GXTI×Control-Related Technology	234	331	172	54	26	13	450	20	105	1	51	5	8	13	1,390
	gxY02	GXTI×Measuring-Related Technology	898	511	601	297	70	45	1,561	32	809	4	143	3	9	17	4,588
	gxY03	GXTI×Business-Related Technology (Including Authentication and Payment)	233	110	54	21	9	3	444	12	280	2	68	2	2	2	1,209
	gxY04	GXTI×ICT-Related Technology (Excluding Business-Related Technology)	2,974	1,398	884	252	131	71	4,484	185	1,518	9	888	15	23	38	12,416

Database: Derwent™ Innovation

Table 5-5 illustrates the number of IPFs by the country/region of the applicant in the filing years (priority years) of 2010 to 2021 for medium (level 2) categories.

In the filing years (priority years) of 2010 to 2021, almost all medium (level 2) categories applicants with Japanese, US, and European applicants ranked first to third in the number of IPFs, but in some medium (level 2) categories, applicants of countries/regions, including Chinese applicants, ranked in the top three.

Chinese applicants ranked in the top three in gxA06 and gxB04. In addition, South Korean applicants ranked in the top three in gxC01, and German applicants ranked in the top three in gxA03 and gxC02.

Table 5-5 The number of IPFs by country/region of the applicant

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Level 1	Level 2		Nationality/region of applicant														Total
			Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	Others	
Energy Supply	gxA01	Solar Photovoltaic Power Generation	8,346	6,204	6,158	1,815	999	461	3,024	998	3,716	52	187	88	249	290	29,312
	gxA02	Solar Thermal Energy Utilization	528	1,219	1,967	520	242	126	520	115	215	32	87	14	104	205	5,006
	gxA03	Wind Power Generation	1,116	2,622	8,262	2,092	284	542	1,086	139	483	34	207	35	67	368	14,419
	gxA04	Geothermal Utilization	53	168	177	39	12	12	43	4	20	8	3	1	5	15	497
	gxA05	Hydro-Power Generation	353	820	1,336	342	176	201	329	89	249	19	69	20	60	171	3,515
	gxA06	Ocean Energy Power Generation	122	392	900	112	108	252	256	49	169	18	37	15	37	130	2,125
	gxA07	Biomass	381	1,957	1,712	244	278	120	305	31	288	24	90	36	67	151	5,042
	gxA08	Nuclear Power Generation	741	1,498	1,096	195	457	144	358	9	478	20	27	0	9	243	4,479
	gxA09	Fuel Cells	6,877	3,744	4,484	2,032	664	497	839	215	2,776	21	131	51	84	103	19,325
	gxA10	Hydrogen Technology	2,242	2,709	3,474	887	575	318	488	125	757	49	120	75	120	178	10,337
	gxA11	Ammonia Technology	241	346	495	124	74	43	61	10	48	5	8	1	21	14	1,250
Energy Saving, Electrification, Demand-Supply Flexibility	gxB01	Energy Saving in Buildings (ZEB, ZEH, etc.)	27,037	12,049	14,714	4,903	1,806	875	10,378	2,860	8,641	180	239	141	250	591	77,080
	gxB02	High-Efficiency Motors and Inverters	2,439	1,224	2,018	864	141	155	726	136	498	5	36	3	14	69	7,168
	gxB03	Combined Heat and Power (CHP)	536	578	977	434	82	71	134	11	183	13	8	5	10	59	2,514
	gxB04	Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge	60	166	173	29	25	18	248	15	45	1	19	9	10	35	781
	gxB05	Electromobilities	12,218	6,204	9,837	5,686	1,400	624	1,964	193	3,037	23	216	36	63	203	33,994
	gxB06	Electrification of Industrial Heat	3,538	3,242	5,678	1,901	573	423	1,333	189	1,559	31	56	25	80	199	15,930
	gxB07	Power Transmission and Distribution, Smart Grids	2,952	3,284	2,932	1,120	326	263	994	284	1,062	19	110	16	50	109	11,812
	gxB08	Demand-Supply Flexibility of Power Systems	6	6	3	0	0	0	1	0	2	0	0	0	0	0	18
Batteries, Energy Storage	gxC01	Secondary Batteries	26,409	10,918	11,074	5,490	1,637	705	8,068	878	12,704	60	465	85	153	276	71,090
	gxC02	Mechanical Energy Storage	54	114	204	65	12	35	30	8	22	1	6	4	6	11	460
	gxC03	Thermal Energy Storage	745	708	1,563	449	323	158	307	25	176	17	29	17	39	65	3,691
	gxC04	Electric Double Layer Capacitors, Hybrid Capacitors	3,678	1,164	782	238	149	91	399	69	527	6	34	18	33	53	6,763
CO2 Reduction in Non-Energy Sector	gxD01	Chemical Production from Biomass	1,272	4,094	3,055	258	356	245	1,192	124	554	23	248	79	66	260	10,967
	gxD02	Reduction of CO2 Emission in Steelmaking Process	128	111	179	31	3	8	58	3	84	3	8	1	28	35	638
	gxD03	Recycling	416	993	1,471	276	146	137	268	68	176	24	72	30	55	143	3,716
Capture, Storage, Utilization and Removal of Greenhouse Gas	gxE01	CCS, CCUS, Negative Emission	1,221	2,525	2,150	410	275	212	299	53	483	31	80	48	89	85	7,064
	gxE02	Measures Against Non-CO2 Greenhouse Gases	523	413	304	39	101	69	46	3	26	1	10	4	6	22	1,358
Cross-Tabulation	gxY01	GXTI×Control-Related Technology	1,998	2,749	1,910	730	214	151	656	236	625	17	104	25	72	68	8,460
	gxY02	GXTI×Measuring-Related Technology	5,598	4,746	4,837	2,187	669	340	1,186	286	2,301	36	204	36	73	142	19,445
	gxY03	GXTI×Business-Related Technology (Including Authentication and Payment)	862	773	363	125	56	31	166	46	318	6	82	6	26	7	2,655
	gxY04	GXTI×ICT-Related Technology (Excluding Business-Related Technology)	27,837	13,866	11,047	3,511	1,615	896	6,041	2,610	10,164	87	548	108	280	361	72,949

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Table 5-6 illustrates the number of IPF by the country/region of the applicant in the filing year (priority year) of 2019 in medium (level 2) categories.

In the filing year (priority year) of 2019, as in the filing years (priority years) of 2010 to 2021, almost all medium (level 2) categories as well as 2010 to 2021, the number of IPFs by Japanese, US, and European applicants ranked the top one to three. However, the number of items in which Chinese applicants are ranked in the top three is increasing.

Chinese applicants ranked the top three in gxA02, gxA04, gxA05, gxA05, gxA06, gxA07, gxB01, gxB04, gxC01, gxC03, gxC04, gxD01 and gxD02. In addition, German applicants ranked in the top three in gxA03, gxB02, gxB05 and gxC02, and South Korean applicants ranked in the top three in gxA08, gxB08 and gxC01.

Table 5-6 The number of IPF by country/region of the applicant
(Application to the country/region to be surveyed, 2019, the filing year (priority year))

Level 1	Level 2		Nationality/region of applicant														Total
			Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	Others	
Energy Supply	gxA01	Solar Photovoltaic Power Generation	433	377	426	95	71	27	360	37	230	5	17	7	24	33	1,949
	gxA02	Solar Thermal Energy Utilization	14	77	160	36	22	14	52	10	9	3	8	1	6	14	354
	gxA03	Wind Power Generation	53	186	762	156	14	34	142	10	42	3	20	1	3	33	1,255
	gxA04	Geothermal Utilization	2	14	26	6	2	2	12	0	4	0	0	0	0	1	59
	gxA05	Hydro-Power Generation	24	47	79	25	8	15	51	7	19	2	5	1	2	11	248
	gxA06	Ocean Energy Power Generation	9	24	45	3	7	13	38	0	3	1	2	0	1	10	133
	gxA07	Biomass	31	75	123	17	22	9	42	1	18	0	10	4	5	12	321
	gxA08	Nuclear Power Generation	30	129	77	13	17	17	33	0	48	0	1	0	2	25	345
	gxA09	Fuel Cells	585	272	466	217	52	38	163	12	266	1	17	4	12	11	1,809
	gxA10	Hydrogen Technology	204	218	342	78	51	27	71	6	94	0	9	4	20	7	975
	gxA11	Ammonia Technology	33	36	39	9	1	3	10	1	4	0	2	1	4	1	131
Energy Saving, Electrification, Demand-Supply Flexibility	gxB01	Energy Saving in Buildings (ZEB, ZEH, etc.)	2,138	883	1,027	285	96	52	1,156	124	533	7	37	17	11	46	5,979
	gxB02	High-Efficiency Motors and Inverters	242	109	228	112	25	19	96	9	47	0	1	0	1	7	740
	gxB03	Combined Heat and Power (CHP)	29	35	49	17	3	2	15	1	13	2	1	0	0	3	148
	gxB04	Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge	6	13	15	2	2	2	49	2	3	0	1	0	2	3	94
	gxB05	Electromobilities	1,365	673	1,317	789	188	65	312	18	369	2	34	5	7	44	4,146
	gxB06	Electrification of Industrial Heat	359	271	642	197	64	74	219	20	164	0	9	3	6	19	1,712
	gxB07	Power Transmission and Distribution, Smart Grids	170	166	234	87	23	18	127	8	38	1	7	1	7	7	766
	gxB08	Demand-Supply Flexibility of Power Systems	2	1	0	0	0	0	0	0	1	0	0	0	0	0	4
Batteries, Energy Storage	gxC01	Secondary Batteries	2,524	1,170	1,249	513	179	117	1,345	78	1,442	2	210	15	26	36	8,097
	gxC02	Mechanical Energy Storage	3	9	14	8	0	1	3	2	2	0	0	1	2	0	36
	gxC03	Thermal Energy Storage	75	59	123	33	14	12	64	2	13	0	2	1	5	8	352
	gxC04	Electric Double Layer Capacitors, Hybrid Capacitors	306	99	70	15	14	7	70	3	43	0	6	2	6	3	608
CO2 Reduction in Non-Energy Sector	gxD01	Chemical Production from Biomass	110	292	248	16	19	19	180	13	56	1	43	6	6	20	975
	gxD02	Reduction of CO2 Emission in Steelmaking Process	9	7	31	2	0	0	13	0	3	0	0	0	0	2	65
	gxD03	Recycling	43	159	198	30	16	14	38	8	22	3	16	5	7	17	516
Capture, Storage, Utilization and Removal of Greenhouse Gas	gxE01	CCS, CCUS, Negative Emission	130	178	187	29	18	20	45	6	36	1	6	7	4	6	606
	gxE02	Measures Against Non-CO2 Greenhouse Gases	72	37	33	6	4	8	5	0	4	0	1	0	0	2	154
Cross-Tabulation	gxY01	GXTI×Control-Related Technology	175	222	152	45	24	13	71	15	57	1	18	4	6	13	734
	gxY02	GXTI×Measuring-Related Technology	519	382	487	199	62	44	212	22	298	3	46	2	9	17	1,997
	gxY03	GXTI×Business-Related Technology (Including Authentication and Payment)	123	81	49	18	7	3	33	8	39	1	32	1	2	2	371
	gxY04	GXTI×ICT-Related Technology (Excluding Business-Related Technology)	1,997	980	781	197	117	63	616	116	598	5	219	10	21	37	5,380

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Section 3 IPF Growth Rate

Table 5-7 illustrates the IPF growth rate by the country/region of the applicant for medium (level 2) categories.

In total, gxA04, gxB05, gxB06, gxC01, gxE02 and gxY03 have a positive growth rate of equal to or more than 5%. On the other hand, other totals gxA01, gxA02, gxA05, gxA06, gxA07, gxB03, gxB07 and gxB08 have a negative growth rate of equal to or more than 5%. It showed a different trend from the growth rate of patent families. The growth rate of patent families by Chinese and Indian applicants is positive in almost all categories. In particular, gxA04 for Chinese applicants and gxC01 and gxY03 for Indian applicants are remarkably high. Among other countries/regions, the growth rate of gxA04 for French applicants is remarkably high.

Among Japanese applicants, the growth rates of gxC02, gxB08, gxY03, gxE02, gxA04, gxB06, gxB05, gxA11, gxC03, gxY02, gxA10, gxC04, gxB02, gxC01, gxA09, gxD01 and gxE01 was positive, and the growth rate of gxA06 was around 0, and the growth rate of other medium items was negative.

Table 5-7　IPF growth rate by the country/region of the applicant

(Application to the country/region to be surveyed, 2010 to 2019, the filing years (priority years))

Level 1	Level 2		Nationality/region of applicant													Total
			Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	
Energy Supply	gxA01	Solar Photovoltaic Power Generation	-10.05%	-8.19%	-6.13%	-10.39%	-5.49%	-3.09%	20.91%	-12.69%	-7.16%	-3.57%	9.84%	-1.00%	3.05%	-6.71%
	gxA02	Solar Thermal Energy Utilization	-11.17%	-6.75%	-6.16%	-9.17%	-4.25%	-2.46%	8.30%	-7.83%	-9.10%	-9.00%	14.62%	8.00%	-4.07%	-5.76%
	gxA03	Wind Power Generation	-6.28%	-7.34%	-1.17%	1.54%	-4.52%	-8.33%	6.86%	-5.75%	-6.56%	1.43%	8.70%	9.23%	-14.04%	-2.84%
	gxA04	Geothermal Utilization	8.57%	5.57%	23.83%	10.77%	140.00%	10.00%	84.00%	-	36.00%	20.00%	-	-	-20.00%	16.35%
	gxA05	Hydro-Power Generation	4.80%	-10.70%	-8.81%	-10.28%	-7.80%	-11.97%	7.86%	1.50%	-0.50%	8.57%	1.29%	40.00%	-9.74%	-6.14%
	gxA06	Ocean Energy Power Generation	0.00%	-6.00%	-9.42%	-16.09%	-8.66%	-11.04%	13.16%	-8.57%	-1.38%	-7.27%	5.71%	20.00%	-6.00%	-5.39%
	gxA07	Biomass	-3.71%	-14.27%	-5.62%	-11.43%	-5.10%	-5.16%	4.24%	0.00%	-2.92%	-6.15%	6.29%	-9.57%	-10.23%	-9.07%
	gxA08	Nuclear Power Generation	-9.19%	-4.28%	-5.12%	-10.56%	-9.25%	12.56%	8.26%	-10.00%	0.18%	-15.00%	15.56%	-	5.00%	-3.93%
	gxA09	Fuel Cells	0.98%	-4.31%	0.65%	4.50%	-2.75%	-7.69%	20.29%	-6.78%	1.07%	16.67%	15.56%	7.78%	12.14%	0.21%
	gxA10	Hydrogen Technology	4.32%	-4.48%	0.73%	-1.86%	-1.69%	-1.45%	11.29%	-4.38%	9.80%	-6.92%	3.04%	-0.59%	9.50%	0.49%
	gxA11	Ammonia Technology	4.79%	-6.46%	2.45%	8.00%	-8.29%	32.73%	29.23%	-10.00%	2.67%	-6.67%	-10.00%	-	66.67%	0.33%
Energy Saving, Electrification, Demand-Supply Flexibility	gxB01	Energy Saving in Buildings (ZEB, ZEH, etc.)	-0.81%	-2.41%	-1.10%	-4.01%	-2.02%	-2.33%	11.31%	-12.08%	-6.02%	-0.48%	19.14%	-1.18%	-6.00%	-1.25%
	gxB02	High-Efficiency Motors and Inverters	1.60%	3.16%	2.96%	4.35%	28.82%	7.74%	20.21%	4.14%	-0.37%	40.00%	27.50%	-20.00%	-11.11%	3.44%
	gxB03	Combined Heat and Power (CHP)	-7.23%	-5.38%	-4.57%	-8.83%	-5.65%	-2.63%	5.00%	-12.50%	-2.44%	-13.33%	-5.00%	-6.67%	-20.00%	-5.13%
	gxB04	Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge	-7.74%	-10.00%	-6.36%	-10.00%	-14.44%	-10.00%	46.09%	10.00%	5.88%	-	-6.00%	-4.00%	13.33%	1.04%
	gxB05	Electromobilities	5.45%	6.78%	12.05%	15.71%	3.72%	7.26%	70.04%	5.60%	19.36%	-1.82%	55.86%	-3.33%	15.24%	10.23%
	gxB06	Electrification of Industrial Heat	5.89%	7.14%	6.88%	3.83%	8.68%	17.85%	27.61%	0.47%	22.73%	0.00%	62.50%	5.45%	-2.63%	8.86%
	gxB07	Power Transmission and Distribution, Smart Grids	-8.29%	-8.20%	-3.74%	-4.59%	-3.40%	-0.82%	6.65%	-12.04%	-9.49%	14.29%	20.00%	-10.00%	-1.67%	-6.52%
	gxB08	Demand-Supply Flexibility of Power Systems	20.00%	-16.00%	-20.00%	-	-	-	-	-	0.00%	-	-	-	-	-11.11%
Batteries, Energy Storage	gxC01	Secondary Batteries	1.35%	3.02%	5.85%	0.78%	4.43%	25.22%	39.40%	1.25%	8.25%	-0.77%	155.14%	30.53%	21.00%	5.90%
	gxC02	Mechanical Energy Storage	22.50%	-2.22%	-2.60%	-9.00%	8.00%	0.00%	25.00%	13.33%	4.00%	-	10.00%	-	80.00%	2.11%
	gxC03	Thermal Energy Storage	4.44%	2.48%	-0.53%	-6.59%	8.39%	-1.74%	35.56%	-10.00%	4.93%	-2.50%	33.33%	13.33%	12.86%	3.08%
	gxC04	Electric Double Layer Capacitors, Hybrid Capacitors	3.92%	2.86%	2.08%	-5.12%	-2.34%	17.33%	32.09%	1.48%	2.65%	10.00%	8.00%	-2.50%	45.71%	4.29%
CO2 Reduction in Non-Energy Sector	gxD01	Chemical Production from Biomass	0.78%	-6.16%	-1.48%	-10.43%	-6.36%	2.06%	19.56%	16.92%	2.69%	-1.82%	7.47%	-1.11%	7.20%	-1.47%
	gxD02	Reduction of CO2 Emission in Steelmaking Process	-5.22%	-8.62%	3.71%	-2.67%	0.00%	0.00%	6.00%	20.00%	-5.53%	-	-5.00%	-	-11.43%	-3.08%
	gxD03	Recycling	1.69%	5.21%	0.81%	-3.75%	-0.73%	-2.50%	10.60%	8.89%	2.12%	-6.00%	6.92%	-8.75%	-2.40%	2.86%
Capture, Storage, Utilization and Removal of Greenhouse Gas	gxE01	CCS, CCUS, Negative Emission	0.60%	-4.40%	-2.90%	-5.14%	-6.00%	0.87%	18.39%	0.00%	-3.79%	-3.53%	4.83%	1.05%	-3.81%	-2.30%
	gxE02	Measures Against Non-CO2 Greenhouse Gases	9.43%	1.41%	1.91%	0.00%	-2.35%	8.46%	25.00%	20.00%	20.00%	-	26.67%	-13.33%	10.00%	5.36%
Cross-Tabulation	gxY01	GXTI×Control-Related Technology	-0.46%	0.38%	-1.45%	-3.41%	3.74%	-5.88%	13.48%	-7.29%	-2.65%	24.00%	20.69%	1.82%	7.33%	0.24%
	gxY02	GXTI×Measuring-Related Technology	4.41%	-0.77%	1.98%	-0.12%	-2.77%	3.92%	36.76%	2.20%	18.67%	13.33%	34.15%	16.67%	-3.33%	4.58%
	gxY03	GXTI×Business-Related Technology (Including Authentication and Payment)	10.17%	0.85%	11.11%	15.00%	3.64%	0.00%	47.59%	28.33%	13.94%	-	166.67%	20.00%	6.00%	9.73%
	gxY04	GXTI×ICT-Related Technology (Excluding Business-Related Technology)	-4.27%	-6.03%	-4.74%	-7.85%	-4.00%	-4.18%	8.78%	-11.85%	-6.65%	-6.40%	56.81%	-3.64%	-1.63%	-4.49%

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Section 4 Revealed Technology Advantage Index of IPF

Table 5-8 illustrates a revealed technology advantage index (RTA Index) of the IPF by the country/region of the applicant for Medium categories.　In the table, the red frame indicates first place, the light blue frame indicates second place, and the orange frame indicates third place.

Japanese gxC04, European gxA03, German gxB05, French gxA08, gxC03, and gxE02, the UK gxA06 and gxC02, South Korean gxC01, Canadian gxA04, gxB03, and gxD03, Indian gxD01 and gxY03, ASEAN gxA10 and gxB04, and Australian nationals gxA02, gxA05, gxA07, gxA11, gxD02 and gxE01 are ranked first in the RTA index at each category, the RTA index exceeded 200%, and applications are being made specifically for each category.

Table 5-8 Revealed technology advantage index (RTA Index) of IPF by country/region of the applicant (Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Level 1	Level 2		Nationality/region of applicant												
			Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian
Energy Supply	gxA01	Solar Photovoltaic Power Generation	127.0%	80.5%	90.2%	88.8%	133.6%	75.2%	72.0%	161.9%	156.4%	85.6%	67.5%	94.6%	152.6%
	gxA02	Solar Thermal Energy Utilization	47.1%	92.6%	168.8%	148.9%	189.5%	120.4%	72.5%	109.3%	53.0%	308.4%	183.8%	88.2%	373.3%
	gxA03	Wind Power Generation	34.5%	69.2%	246.1%	208.0%	77.2%	179.8%	52.6%	45.9%	41.3%	113.8%	151.8%	76.5%	83.5%
	gxA04	Geothermal Utilization	47.6%	128.6%	153.0%	112.5%	94.6%	115.5%	60.4%	38.3%	49.6%	776.6%	63.8%	63.4%	180.8%
	gxA05	Hydro-Power Generation	44.8%	88.8%	163.3%	139.5%	196.3%	273.5%	65.4%	120.4%	87.4%	260.8%	207.6%	179.4%	306.7%
	gxA06	Ocean Energy Power Generation	25.6%	70.2%	181.9%	75.6%	199.2%	567.2%	84.1%	109.7%	98.1%	408.7%	184.1%	222.5%	312.8%
	gxA07	Biomass	33.7%	147.7%	145.9%	69.4%	216.1%	113.8%	42.2%	29.2%	70.4%	229.7%	188.7%	225.1%	238.7%
	gxA08	Nuclear Power Generation	73.8%	127.2%	105.1%	62.4%	399.9%	153.8%	55.8%	9.6%	131.6%	215.4%	63.7%	0.0%	36.1%
	gxA09	Fuel Cells	158.8%	73.7%	99.7%	150.7%	134.7%	123.0%	30.3%	52.9%	177.2%	52.4%	71.7%	83.2%	78.1%
	gxA10	Hydrogen Technology	96.8%	99.7%	144.4%	123.0%	218.0%	147.1%	33.0%	57.5%	90.3%	228.7%	122.7%	228.7%	208.6%
	gxA11	Ammonia Technology	86.0%	105.3%	170.1%	142.2%	232.0%	164.5%	34.1%	38.1%	47.4%	193.0%	67.7%	25.2%	301.8%
Energy Saving, Electrification, Demand-Supply Flexibility	gxB01	Energy Saving in Buildings (ZEB, ZEH, etc.)	156.5%	59.5%	82.0%	91.2%	91.8%	54.3%	94.0%	176.5%	138.3%	112.7%	32.8%	57.7%	58.3%
	gxB02	High-Efficiency Motors and Inverters	151.8%	65.0%	120.9%	172.8%	77.1%	103.4%	70.7%	90.2%	85.7%	33.7%	53.1%	13.2%	35.1%
	gxB03	Combined Heat and Power (CHP)	95.1%	87.5%	166.9%	247.5%	127.9%	135.1%	37.2%	20.8%	89.8%	249.5%	33.6%	62.7%	71.5%
	gxB04	Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge	34.3%	80.9%	95.1%	53.2%	125.5%	110.2%	221.7%	91.4%	71.1%	61.8%	257.2%	363.3%	230.0%
	gxB05	Electromobilities	160.3%	69.4%	124.3%	239.8%	161.4%	87.8%	40.3%	27.0%	110.2%	32.6%	67.2%	33.4%	33.3%
	gxB06	Electrification of Industrial Heat	99.1%	77.4%	153.1%	171.1%	141.0%	127.0%	58.4%	56.4%	120.7%	93.9%	37.2%	49.5%	90.2%
	gxB07	Power Transmission and Distribution, Smart Grids	111.5%	105.8%	106.6%	135.9%	108.2%	106.5%	58.8%	114.4%	110.9%	77.6%	98.5%	42.7%	76.1%
	gxB08	Demand-Supply Flexibility of Power Systems	148.7%	126.8%	71.6%	0.0%	0.0%	0.0%	38.8%	0.0%	137.0%	0.0%	0.0%	0.0%	0.0%
Batteries, Energy Storage	gxC01	Secondary Batteries	165.7%	58.4%	66.9%	110.7%	90.3%	47.4%	79.2%	58.7%	220.4%	40.7%	69.2%	37.7%	38.7%
	gxC02	Mechanical Energy Storage	52.4%	94.3%	190.5%	202.6%	102.3%	363.9%	45.5%	82.7%	59.0%	104.9%	137.9%	274.1%	234.3%
	gxC03	Thermal Energy Storage	90.0%	73.0%	181.9%	174.4%	343.0%	204.7%	58.1%	32.2%	58.8%	222.2%	83.1%	145.2%	189.8%
	gxC04	Electric Double Layer Capacitors, Hybrid Capacitors	242.6%	65.5%	49.7%	50.4%	86.4%	64.4%	41.2%	48.5%	96.1%	42.8%	53.2%	83.9%	87.7%
CO2 Reduction in Non-Energy Sector	gxD01	Chemical Production from Biomass	51.7%	142.0%	119.7%	33.7%	127.2%	106.8%	75.9%	53.8%	62.3%	101.2%	239.1%	227.1%	108.1%
	gxD02	Reduction of CO2 Emission in Steelmaking Process	89.5%	66.2%	120.5%	69.7%	18.4%	60.0%	63.5%	22.4%	162.4%	226.9%	132.6%	49.4%	788.5%
	gxD03	Recycling	49.9%	101.7%	170.0%	106.5%	154.0%	176.3%	50.4%	87.0%	58.4%	311.6%	204.9%	254.5%	265.9%
Capture, Storage, Utilization and Removal of Greenhouse Gas	gxE01	CCS, CCUS, Negative Emission	77.1%	136.0%	130.7%	83.2%	152.6%	143.5%	29.6%	35.7%	84.3%	211.7%	119.7%	214.2%	226.4%
	gxE02	Measures Against Non-CO2 Greenhouse Gases	171.8%	115.7%	96.2%	41.2%	291.5%	243.0%	23.7%	10.5%	23.6%	35.5%	77.9%	92.9%	79.4%
Cross-Tabulation	gxY01	GXTI×Control-Related Technology	105.4%	123.6%	97.0%	123.7%	99.2%	85.4%	54.1%	132.7%	91.1%	97.0%	130.0%	93.2%	152.9%
	gxY02	GXTI×Measuring-Related Technology	128.4%	92.9%	106.9%	161.2%	134.9%	83.6%	42.6%	70.0%	145.9%	89.3%	110.9%	58.4%	67.5%
	gxY03	GXTI×Business-Related Technology (Including Authentication and Payment)	144.8%	110.8%	58.7%	67.5%	82.7%	55.8%	43.7%	82.4%	147.7%	109.0%	326.6%	71.2%	175.9%
	gxY04	GXTI×ICT-Related Technology (Excluding Business-Related Technology)	170.2%	72.3%	65.0%	69.0%	86.8%	58.7%	57.8%	170.2%	171.8%	57.5%	79.4%	46.7%	69.0%

Database: Derwent™ Innovation

Section 5 IPF Active Rate

Table 5-9 illustrates an IPF active rate by the country/region of the applicant for Medium categories.

In the table, the cells of the top three countries/regions by category are filled with gray, with the red frame indicating the first place and the blue frame indicating the second place.

The IPF active rate for Japanese, US, European and South Korean applicants is consistently high at over 50% in all categories. In addition, although the rate of patent family registration for Indian applicants was high in all categories, there is also medium categories where the IPF active rate is as low as equal to or less than 35%.

Table 5-9　Active rate of the IPF by the country/region of the applicant

(Application to the country/region to be surveyed, 2014, the filing year (priority year))

Level 1	Level 2		Nationality/region of applicant													Total
			Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	
Energy Supply	gxA01	Solar Photovoltaic Power Generation	73.1%	70.5%	73.3%	73.6%	87.3%	65.2%	62.5%	58.6%	81.3%	16.7%	50.0%	55.6%	61.5%	73.5%
	gxA02	Solar Thermal Energy Utilization	59.4%	69.4%	63.6%	73.7%	52.6%	47.1%	45.8%	60.0%	92.9%	0.0%	50.0%	100.0%	45.5%	63.1%
	gxA03	Wind Power Generation	80.7%	72.1%	69.1%	72.0%	64.3%	53.5%	53.1%	58.3%	81.0%	0.0%	52.2%	50.0%	33.3%	71.0%
	gxA04	Geothermal Utilization	71.4%	100.0%	88.9%	100.0%	-	-	-	-	-	-	-	-	-	91.3%
	gxA05	Hydro-Power Generation	88.9%	72.6%	58.2%	46.2%	75.0%	58.3%	66.7%	80.0%	75.0%	-	55.6%	100.0%	66.7%	66.0%
	gxA06	Ocean Energy Power Generation	80.0%	65.6%	53.4%	40.0%	75.0%	61.3%	50.0%	80.0%	70.8%	0.0%	60.0%	-	0.0%	61.5%
	gxA07	Biomass	83.8%	59.4%	66.7%	60.7%	78.3%	41.7%	79.2%	0.0%	75.9%	50.0%	76.9%	60.0%	44.4%	66.0%
	gxA08	Nuclear Power Generation	83.9%	81.6%	73.5%	71.4%	90.2%	78.6%	86.1%	-	88.9%	100.0%	66.7%	-	100.0%	82.8%
	gxA09	Fuel Cells	84.0%	74.4%	76.5%	80.4%	88.1%	71.7%	68.4%	64.3%	88.3%	100.0%	85.7%	100.0%	87.5%	83.8%
	gxA10	Hydrogen Technology	83.1%	69.9%	69.4%	60.5%	78.6%	68.4%	79.5%	75.0%	80.0%	0.0%	58.3%	100.0%	42.9%	73.7%
	gxA11	Ammonia Technology	70.8%	89.3%	73.9%	70.0%	50.0%	0.0%	66.7%	-	50.0%	-	0.0%	-	-	75.9%
Energy Saving, Electrification, Demand-Supply Flexibility	gxB01	Energy Saving in Buildings (ZEB, ZEH, etc.)	75.3%	76.9%	78.2%	82.9%	84.6%	80.0%	57.6%	60.5%	84.4%	64.0%	75.0%	68.8%	56.4%	78.2%
	gxB02	High-Efficiency Motors and Inverters	73.5%	82.9%	60.8%	65.1%	87.5%	81.3%	70.1%	84.6%	87.5%	-	100.0%	-	100.0%	78.8%
	gxB03	Combined Heat and Power (CHP)	84.6%	74.1%	68.5%	69.0%	71.4%	87.5%	42.9%	100.0%	87.5%	100.0%	100.0%	0.0%	0.0%	76.9%
	gxB04	Energy Saving and Supply/Demand Flexibility in	100.0%	68.8%	68.8%	0.0%	100.0%	66.7%	71.4%	0.0%	100.0%	-	33.3%	0.0%	0.0%	70.4%
	gxB05	Electromobilities	87.0%	89.1%	85.0%	87.1%	92.9%	83.3%	81.7%	73.3%	91.8%	50.0%	50.0%	100.0%	33.3%	90.0%
	gxB06	Electrification of Industrial Heat	88.4%	80.2%	84.1%	81.5%	90.2%	91.2%	43.8%	56.3%	87.7%	25.0%	25.0%	50.0%	85.7%	82.8%
	gxB07	Power Transmission and Distribution, Smart Grids	79.9%	86.6%	76.0%	88.0%	86.7%	68.2%	77.0%	63.0%	83.2%	-	62.5%	0.0%	50.0%	85.1%
	gxB08	Demand-Supply Flexibility of Power Systems	100.0%	-	-	-	-	-	-	-	100.0%	-	-	-	-	100.0%
Batteries, Energy Storage	gxC01	Secondary Batteries	81.5%	80.3%	83.0%	85.7%	91.9%	73.5%	62.2%	75.8%	85.8%	80.0%	85.7%	40.0%	80.0%	83.7%
	gxC02	Mechanical Energy Storage	100.0%	72.7%	75.0%	100.0%	100.0%	0.0%	0.0%	50.0%	100.0%	-	100.0%	-	-	73.7%
	gxC03	Thermal Energy Storage	61.2%	68.2%	75.0%	63.0%	83.3%	100.0%	64.3%	100.0%	76.5%	-	-	0.0%	80.0%	71.7%
	gxC04	Electric Double Layer Capacitors, Hybrid Capacitors	84.0%	75.0%	74.4%	73.9%	71.4%	87.5%	75.7%	100.0%	86.8%	-	-	80.0%	100.0%	83.5%
CO2 Reduction in Non-Energy Sector	gxD01	Chemical Production from Biomass	76.4%	67.4%	76.9%	76.7%	81.1%	65.2%	74.6%	90.0%	74.4%	100.0%	94.1%	18.2%	60.0%	73.5%
	gxD02	Reduction of CO2 Emission in Steelmaking Process	83.3%	69.2%	60.0%	50.0%	-	-	-	-	88.9%	-	100.0%	-	-	78.0%
	gxD03	Recycling	83.8%	68.2%	80.3%	73.7%	88.9%	64.3%	66.7%	80.0%	81.8%	-	100.0%	0.0%	100.0%	77.5%
Capture, Storage, Utilization and Removal of Greenhouse Gas	gxE01	CCS, CCUS, Negative Emission	82.3%	77.2%	77.5%	60.0%	91.4%	73.9%	43.8%	100.0%	86.0%	100.0%	66.7%	50.0%	100.0%	78.4%
	gxE02	Measures Against Non-CO2 Greenhouse Gases	79.0%	74.2%	75.0%	-	0.0%	100.0%	-	-	100.0%	-	-	100.0%	100.0%	86.8%
Cross-Tabulation	gxY01	GXTI×Control-Related Technology	82.9%	89.6%	81.3%	84.8%	95.2%	80.0%	76.0%	61.1%	84.9%	100.0%	92.9%	75.0%	69.2%	87.9%
	gxY02	GXTI×Measuring-Related Technology	80.9%	87.0%	83.8%	84.3%	93.5%	76.3%	72.5%	76.9%	84.2%	66.7%	70.0%	66.7%	77.8%	86.9%
	gxY03	GXTI×Business-Related Technology (Including	81.5%	76.5%	80.0%	85.7%	85.7%	50.0%	62.5%	50.0%	70.8%	-	100.0%	50.0%	75.0%	82.0%
	gxY04	GXTI×ICT-Related Technology (Excluding Business-Related	78.6%	80.9%	77.8%	79.1%	87.4%	77.5%	74.8%	67.3%	87.3%	42.9%	66.7%	50.0%	58.1%	81.5%

Database: Derwent™ Innovation

Section 6 Number of IPFs with 28 or more Examiner Citations

The number of IPFs with 28 or more examiner citations in each medium (Level 2) category are shown in Table 5-10 by country/region of applicant. In the table, the cells for the top 3 countries/regions by each category are filled in gray, with red frames referring the first and blue frames referring the second.

In general, US applicants have the largest number of IPFs with 28 or more examiner citations, followed by Japanese applicants and European applicants. US applicants have the largest number of IPFs with 28 or more examiner citations in all medium (Level 2) categories except gxB01, gxB02, gxC01, and gxE02, while Japanese applicants have the largest number in the medium (Level 2) categories gxB01, gxB02, gxC01, and gxE02, which means that they may hold important IPFs often cited by an examiner. Japanese applicants are in second place in the medium (Level 2) categories gxA01, gxA08 to gxA11, gxB03, gxB07, gxC04, gxY01, gxY02 and gxY04; US applicants are in second place in the medium (Level 2) categories gxB01, gxB02, gxC01 and gxE02; European applicants are in second place in the medium (Level 2) categories gxA02 to gxA08, gxB06, gxC02, gxC03, gxD01 to gxD03 and gxE01; Chinese applicants are in second place in the medium (Level 2) category gxB04; and UK applicants are in second place in the medium (Level 2) category gxA04.

Table 5-10 The number of IPFs with 28 or more examiner citations by country/region of applicant (the Filing Years (Priority Years) 2010-2021)

Level 1	Level 2		Country / Region of Applicant														Total
			Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	Others	
Energy Supply	gxA01	Solar Photovoltaic Power Generation	182	359	102	17	11	25	59	11	97	2	0	0	10	6	828
	gxA02	Solar Thermal Energy Utilization	5	66	12	2	2	1	9	1	6	0	1	0	1	2	103
	gxA03	Wind Power Generation	32	210	165	35	3	22	21	1	5	1	3	1	5	3	447
	gxA04	Geothermal Utilization	0	8	1	0	0	1	0	0	0	0	0	0	0	0	9
	gxA05	Hydro-Power Generation	8	43	12	2	3	5	3	1	3	0	0	0	1	0	71
	gxA06	Ocean Energy Power Generation	3	14	7	1	1	3	4	0	2	1	0	0	0	0	31
	gxA07	Biomass	1	102	15	1	3	2	8	0	3	3	0	0	2	2	136
	gxA08	Nuclear Power Generation	8	35	8	2	2	2	4	0	5	0	0	0	0	1	61
	gxA09	Fuel Cells	78	121	30	6	3	12	12	0	37	0	2	1	1	1	283
	gxA10	Hydrogen Technology	25	84	18	3	2	4	17	1	4	3	2	0	1	1	156
	gxA11	Ammonia Technology	5	23	4	2	0	0	2	0	0	1	0	0	0	0	35
Energy Saving, Electrification, Demand-Supply Flexibility	gxB01	Energy Saving in Buildings (ZEB, ZEH, etc.)	980	759	258	67	34	25	254	60	587	2	5	2	0	6	2,913
	gxB02	High-Efficiency Motors and Inverters	67	46	39	12	1	8	14	2	11	0	0	0	1	0	180
	gxB03	Combined Heat and Power (CHP)	9	51	8	3	2	0	6	0	2	0	0	0	0	0	76
	gxB04	Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge	1	13	1	0	0	1	2	0	1	0	0	0	0	0	18
	gxB05	Electromobilities	549	401	179	84	27	28	79	3	92	5	1	2	4	7	1,322
	gxB06	Electrification of Industrial Heat	52	151	127	13	5	17	60	3	14	0	0	0	3	4	414
	gxB07	Power Transmission and Distribution, Smart Grids	197	431	85	13	5	16	56	6	107	2	5	1	1	12	903
	gxB08	Demand-Supply Flexibility of Power Systems	0	3	1	0	0	0	0	0	0	0	0	0	0	0	4
Batteries, Energy Storage	gxC01	Secondary Batteries	959	703	130	51	25	23	225	16	384	4	2	1	4	4	2,432
	gxC02	Mechanical Energy Storage	1	8	7	2	0	3	1	0	0	0	0	0	0	0	17
	gxC03	Thermal Energy Storage	7	27	13	3	2	3	9	0	2	0	0	0	0	0	58
	gxC04	Electric Double Layer Capacitors, Hybrid Capacitors	85	89	12	5	2	2	16	0	18	1	1	2	1	1	226
CO2 Reduction in Non-Energy Sector	gxD01	Chemical Production from Biomass	19	148	37	5	3	5	20	0	4	0	2	0	2	3	235
	gxD02	Reduction of CO2 Emission in Steelmaking Process	1	3	2	0	0	1	1	0	0	0	0	0	0	0	7
	gxD03	Recycling	3	24	14	1	4	0	8	0	0	2	2	0	0	0	53
Capture, Storage, Utilization and Removal of Greenhouse Gas	gxE01	CCS, CCUS, Negative Emission	18	106	28	5	0	8	14	0	5	1	3	1	0	0	176
	gxE02	Measures Against Non-CO2 Greenhouse Gases	30	14	9	0	6	2	0	0	1	0	0	0	0	1	55
Cross-Tabulation	gxY01	Control-Related Technology	95	276	76	17	2	21	42	9	28	1	7	1	1	3	539
	gxY02	Measuring-Related Technology	236	376	87	22	7	16	42	6	75	3	4	0	2	6	837
	gxY03	Business-Related Technology (Including Authentication and Payment)	38	118	15	3	1	5	16	0	12	0	2	0	1	1	203
	gxY04	ICT-Related Technology (Excluding Business-Related Technology)	1,041	1,199	280	53	29	48	212	51	691	8	7	2	10	18	3,519

Database: Derwent™ Innovation

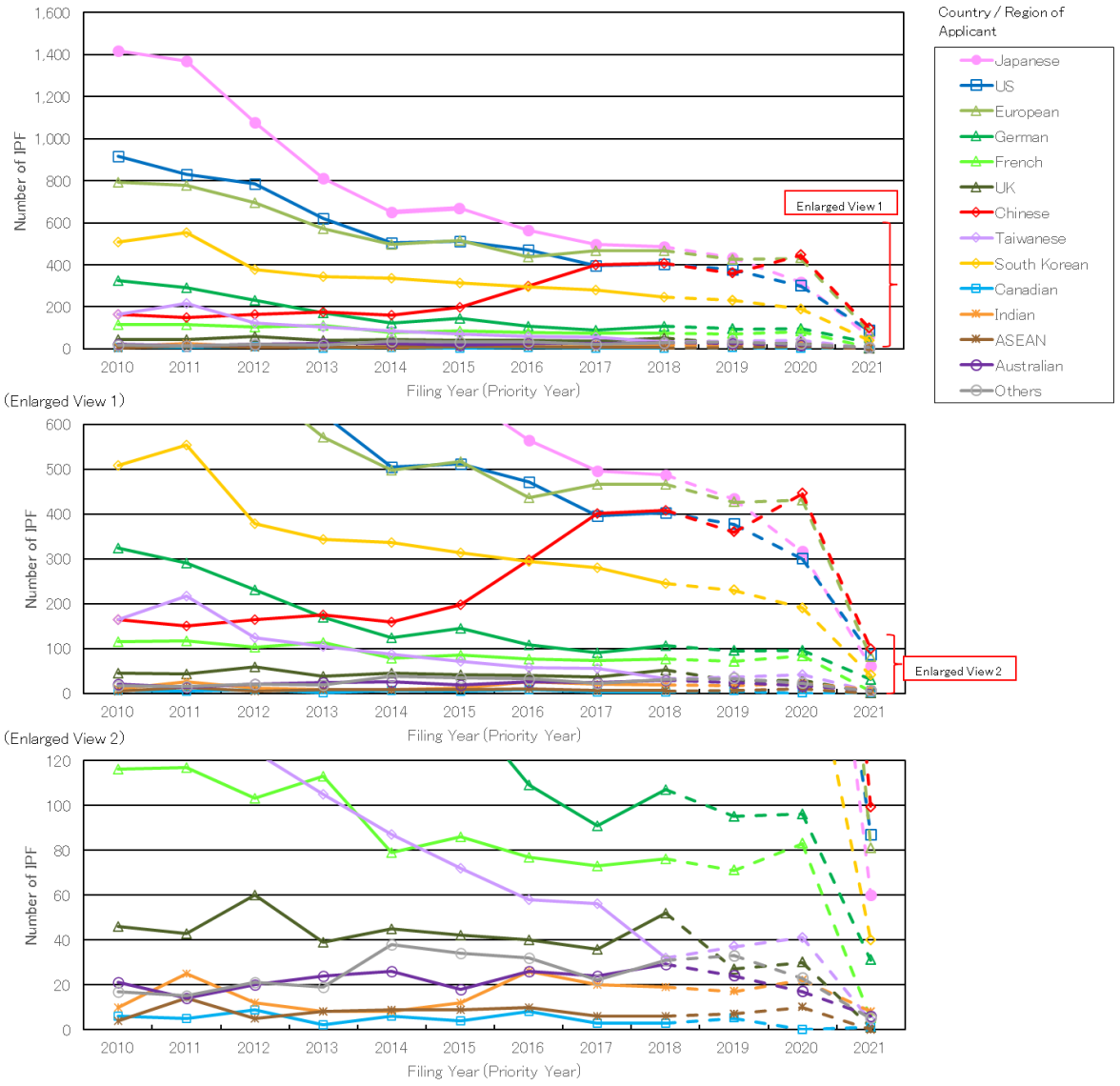
Section 7 Annual Change in Number of IPFs and Number of IPFs Rate by Country/Region of Applicant

1. gxA01: Solar Photovoltaic Power Generation

Annual trend in number of IPFs in “gxA01: Solar Photovoltaic Power Generation” is shown in Figure 5-1 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by Japanese applicants is the largest and remains in the same ranking until 2019, although the number of IPFs by Japanese applicants decreases since then. While the numbers of IPFs by applicants of most countries/regions tend to be almost flat or to decrease slightly, the number of IPFs by Chinese applicants is on an increasing trend since 2014 and is almost equal to the number of IPFs by US applicants in 2017.

Figure 5-1 Annual trend in the number of IPFs in “gxA01: Solar Photovoltaic Power Generation” by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



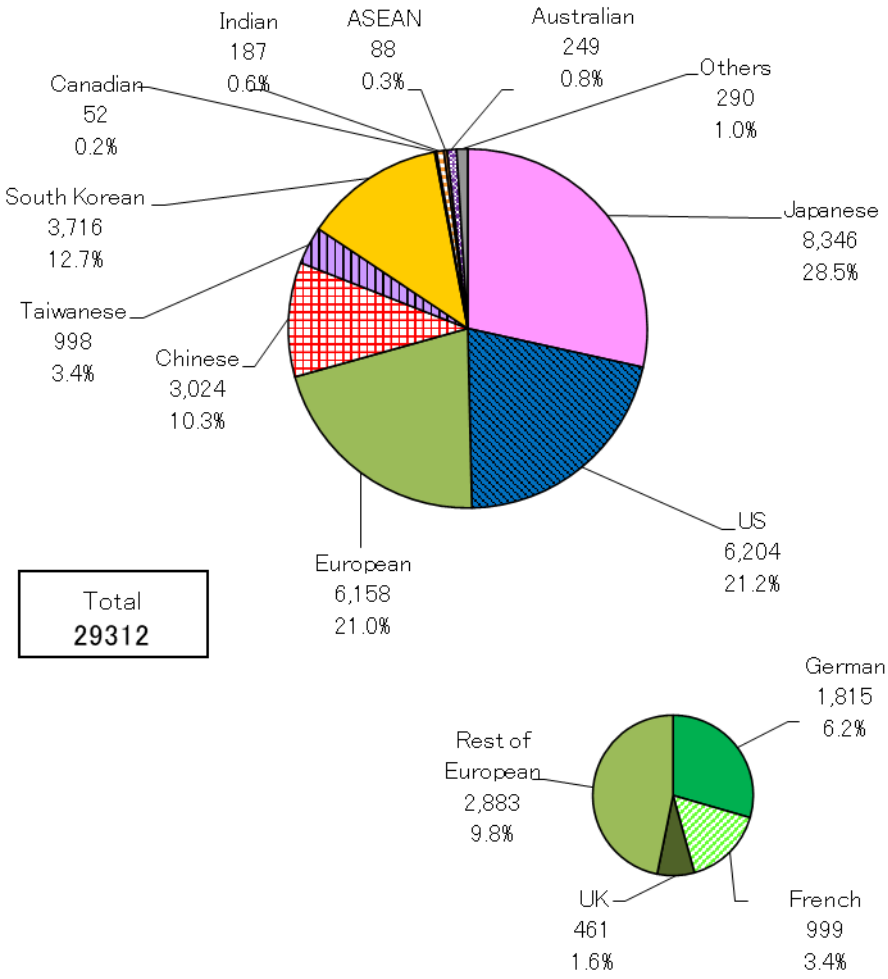
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-2 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, Japanese applicants account for the largest rate with 28.5%, followed by US, European, South Korean, and Chinese applicants. 93.6% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-2 Number of IPFs rates in “gxA01: Solar Photovoltaic Power Generation” by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



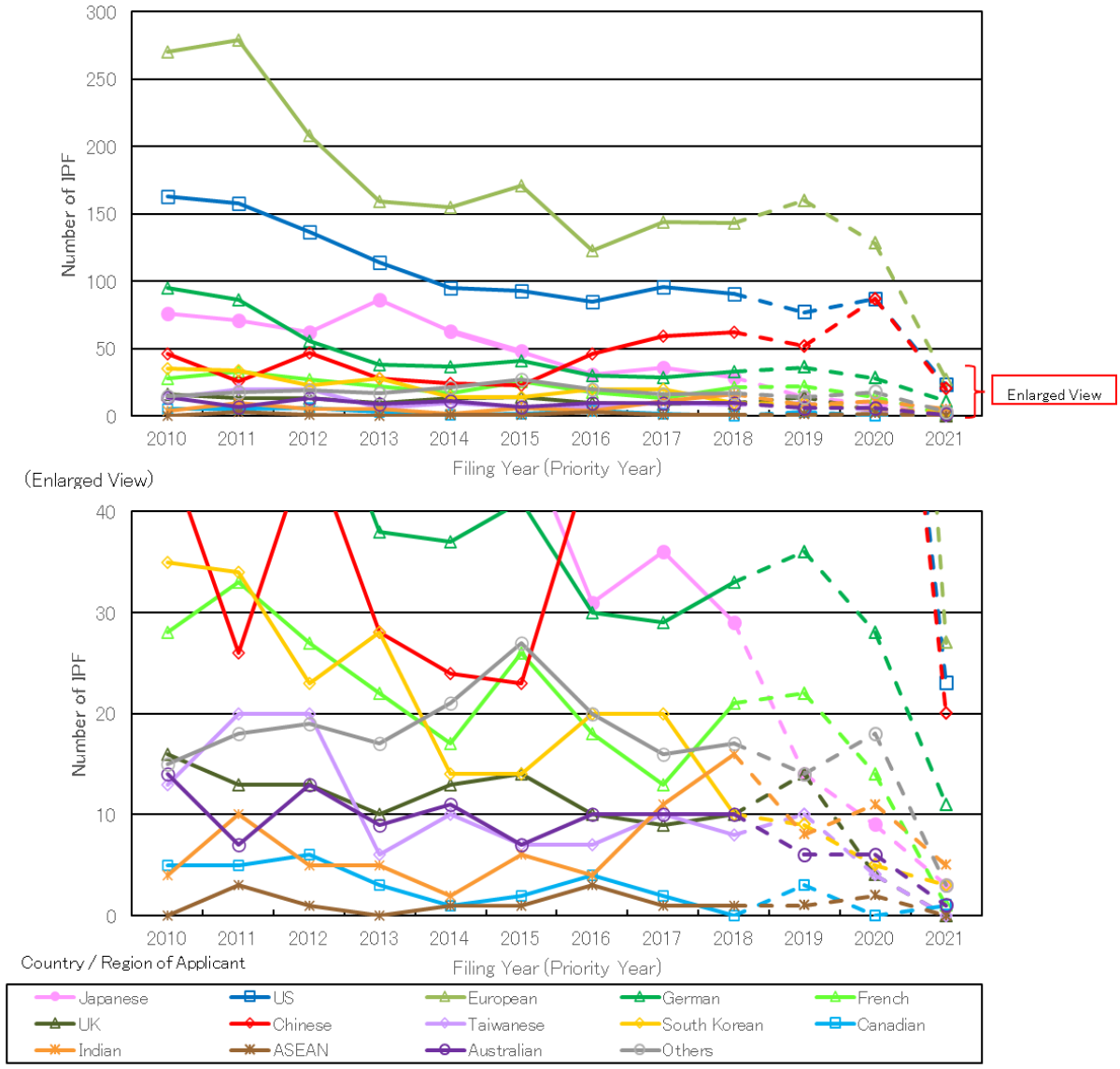
Database: Derwent™ Innovation

2. gxA02: Solar Thermal Energy Utilization

Annual trend in number of IPFs in “gxA02: Solar Thermal Energy Utilization” is shown in Figure 5-3 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by European applicants is the largest and then remains unchanged in the same ranking, although the number of IPFs by European applicants decreases since then. The number of IPFs by US applicants, like the number of IPFs by European applicants, also remains unchanged in the same ranking, although it decreases since 2010. While the numbers of IPFs by applicants of most countries/regions are on a slightly decreasing trend since 2010, the number of IPFs by Chinese applicants is on a similar or increasing trend, exceeding the number of IPFs by Japanese applicants in 2016 and becoming second only to the number of IPFs by US applicants.

Figure 5-3 Annual trend in the number of IPFs in "gxA02: Solar Thermal Energy Utilization" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



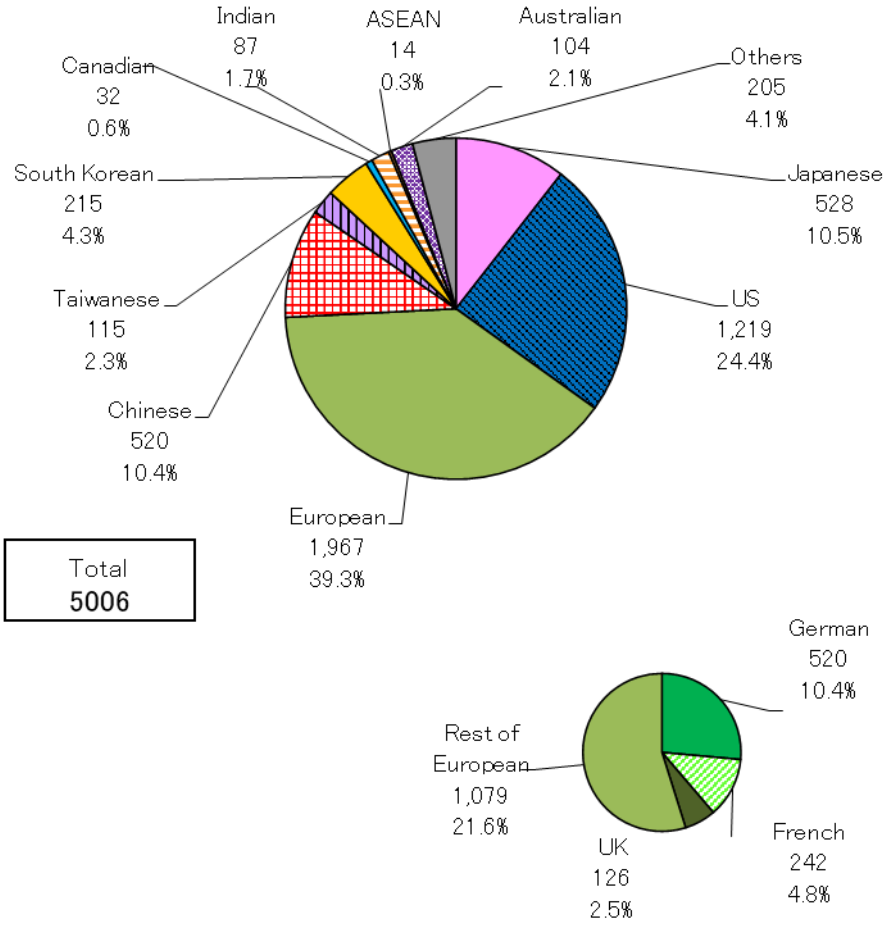
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-4 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of IPFs by European applicants.

In terms of the number of IPFs rates, European applicants account for the largest rate with 39.3%, followed by US, Japanese, Chinese, and South Korean applicants. 88.9% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-4 Number of IPFs rates in “gxA02: Solar Thermal Energy Utilization” by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



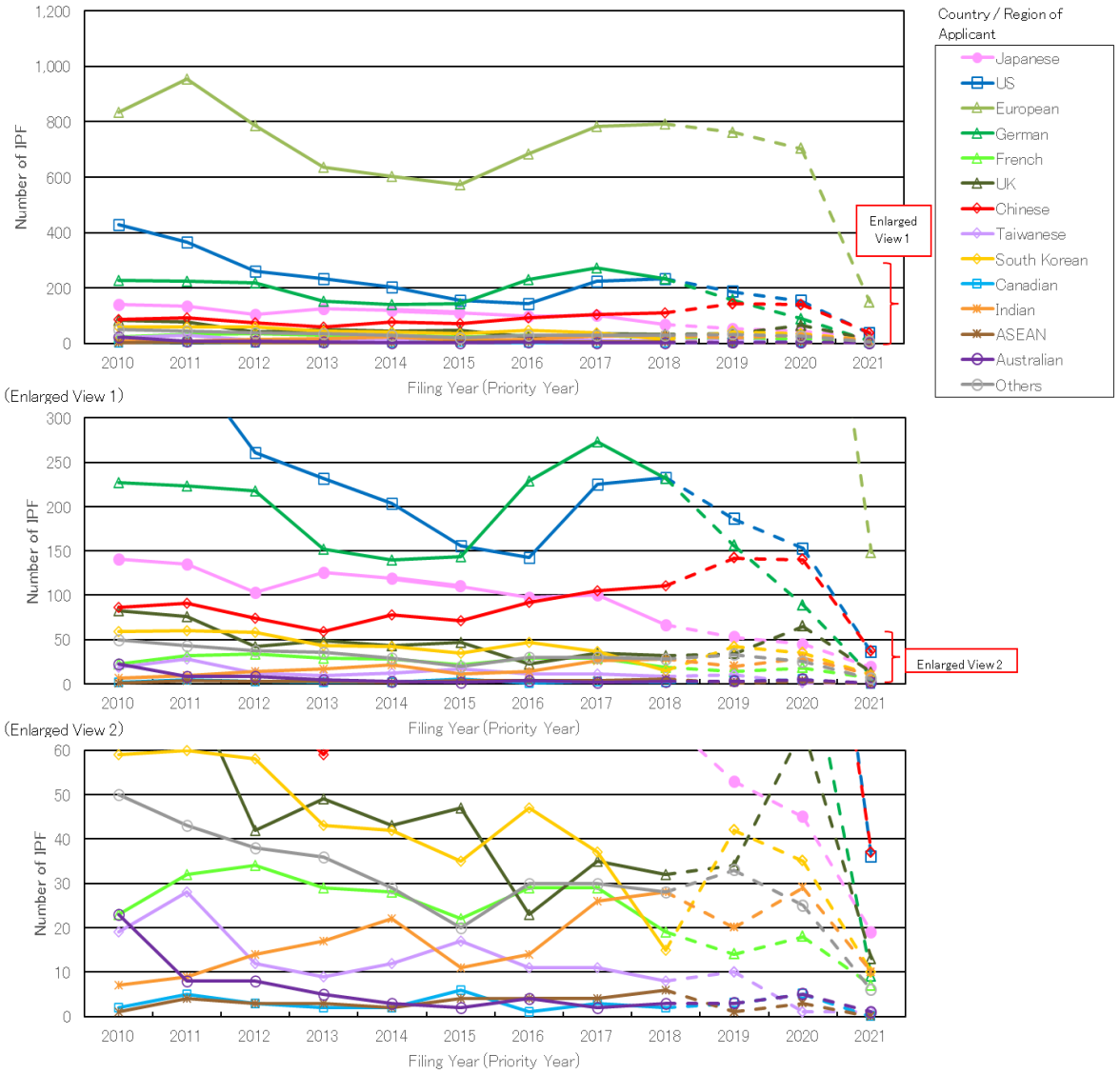
Database: Derwent™ Innovation

3. gxA03: Wind Power Generation

Annual trend in number of IPFs in “gxA03: Wind Power Generation” is shown in Figure 5-5 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by European applicants is the largest, decreasing from 2012 to 2015, increasing from 2016 to 2018 and remaining unchanged in the same ranking. While the numbers of IPFs by US and Japanese applicants increase and decrease, the number of IPFs by Chinese applicants increases since 2015, exceeding the number of IPFs by Japanese applicants in 2017 and becoming second only to the number of IPFs by US applicants. The number of IPFs by German applicants is the largest among European applicants, fluctuating at almost the same number of IPFs as the number of IPFs by US applicants. In addition, the number of IPFs by Indian applicants increases slightly since around 2012.

Figure 5-5 Annual trend in number of IPFs in “gxA03: Wind Power Generation” by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



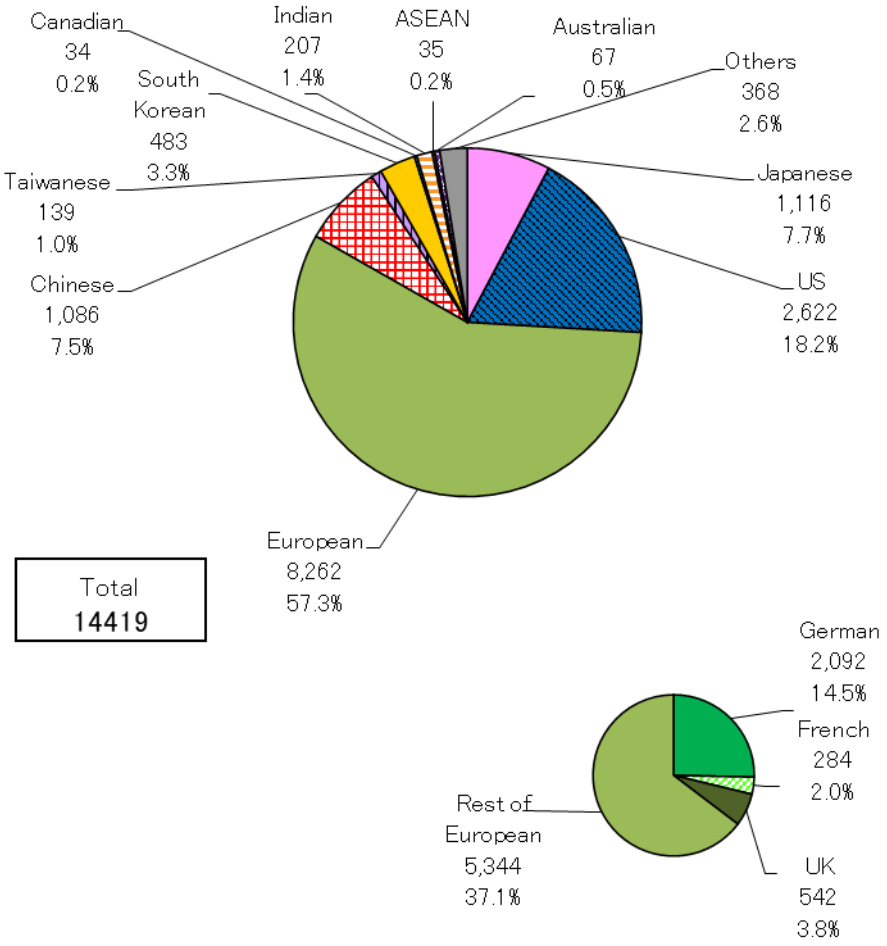
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-6 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of IPFs by European applicants.

In terms of the number of IPFs rates, European applicants account for the largest rate with 57.3%, followed by US, Japanese, Chinese, and South Korean applicants. 94.1% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-6 Number of IPFs rates in “gxA03: Wind Power Generation” by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



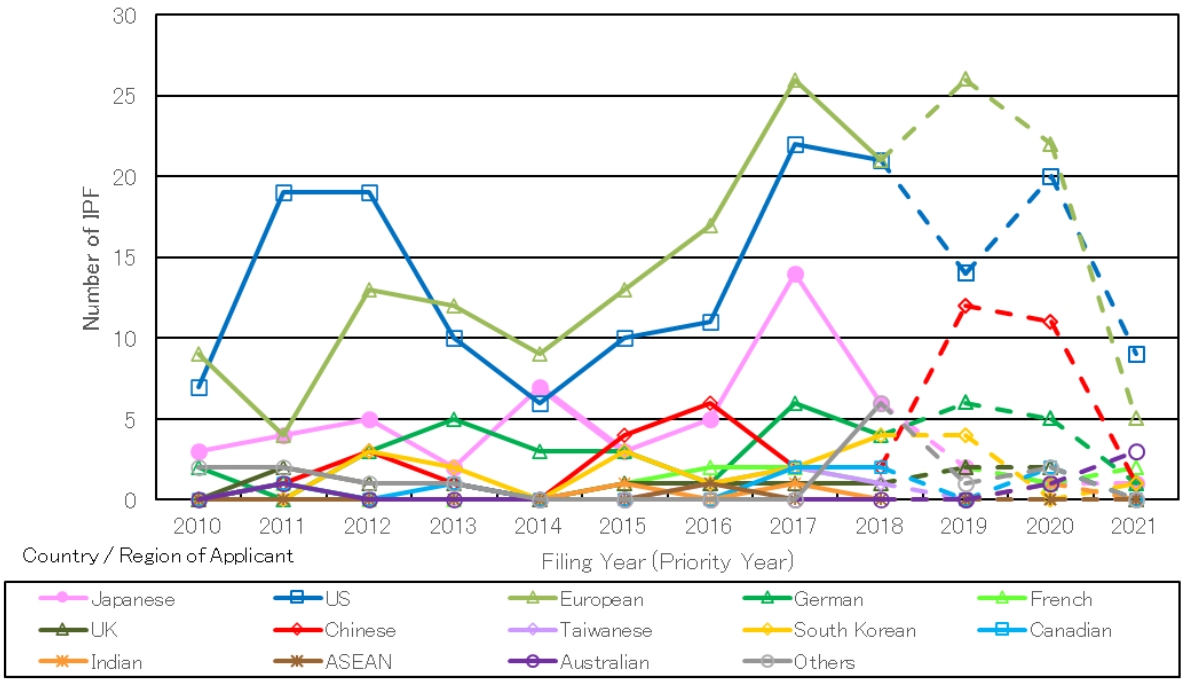
Database: Derwent™ Innovation

4. gxA04: Geothermal Utilization

Annual trend in number of IPFs in "gxA04: Geothermal Utilization" is shown in Figure 5-7 by country/region of applicant.

In the filing year (priority year) 2010, the number of IPFs by European applicants is the largest, but thereafter the number of IPFs by US applicants exceeds the number of IPFs by European applicants from 2011 to 2012, while the number of IPFs by European applicants remains at the same level. Furthermore, since 2013, the number of IPFs by European applicants again exceeds the number of IPFs by US applicants, becoming the largest. The number of IPFs by Japanese applicants is third only to those for US and European applicants, but the number of IPFs by Chinese applicants increases since 2014 and is on track to exceed the number of IPFs by Japanese applicants from 2018. The numbers of IPFs for applicants of most countries/regions tend to be almost flat.

Figure 5-7 Annual trend in number of IPFs in "gxA04: Geothermal Utilization" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



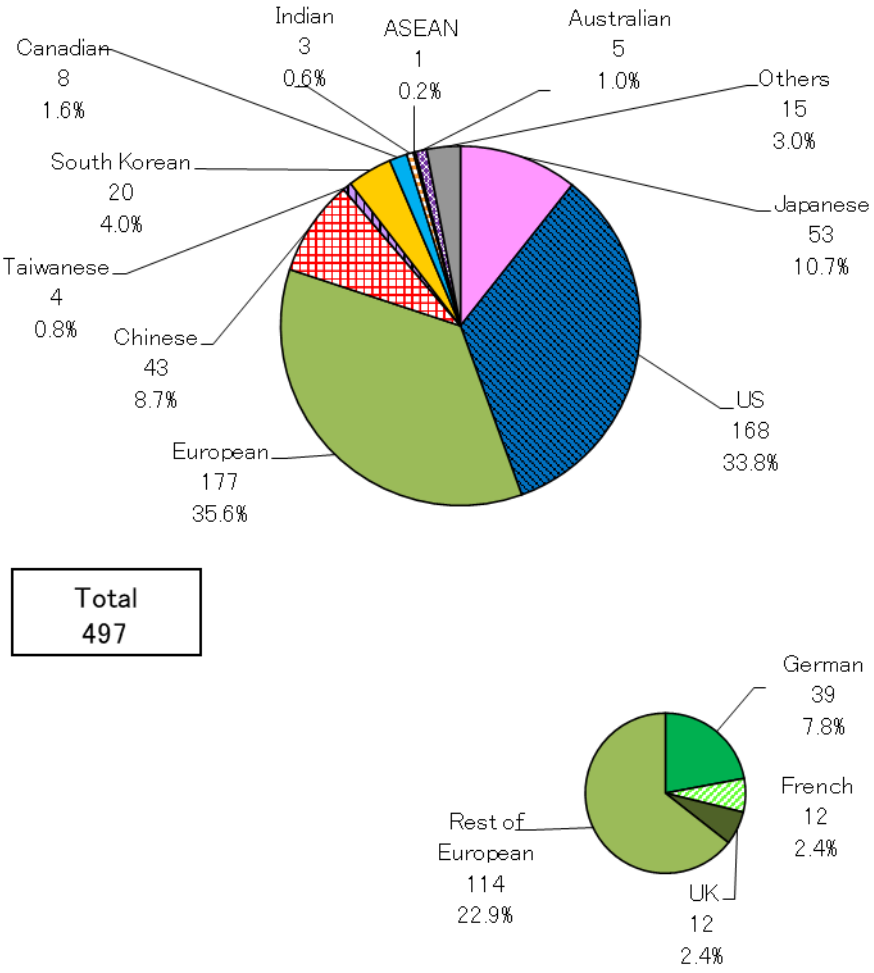
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-8 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, European applicants account for the largest rate with 35.6%, followed by US, Japanese, Chinese, and South Korean applicants. 92.8% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-8 Number of IPFs rates in "gxA04: Geothermal Utilization" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



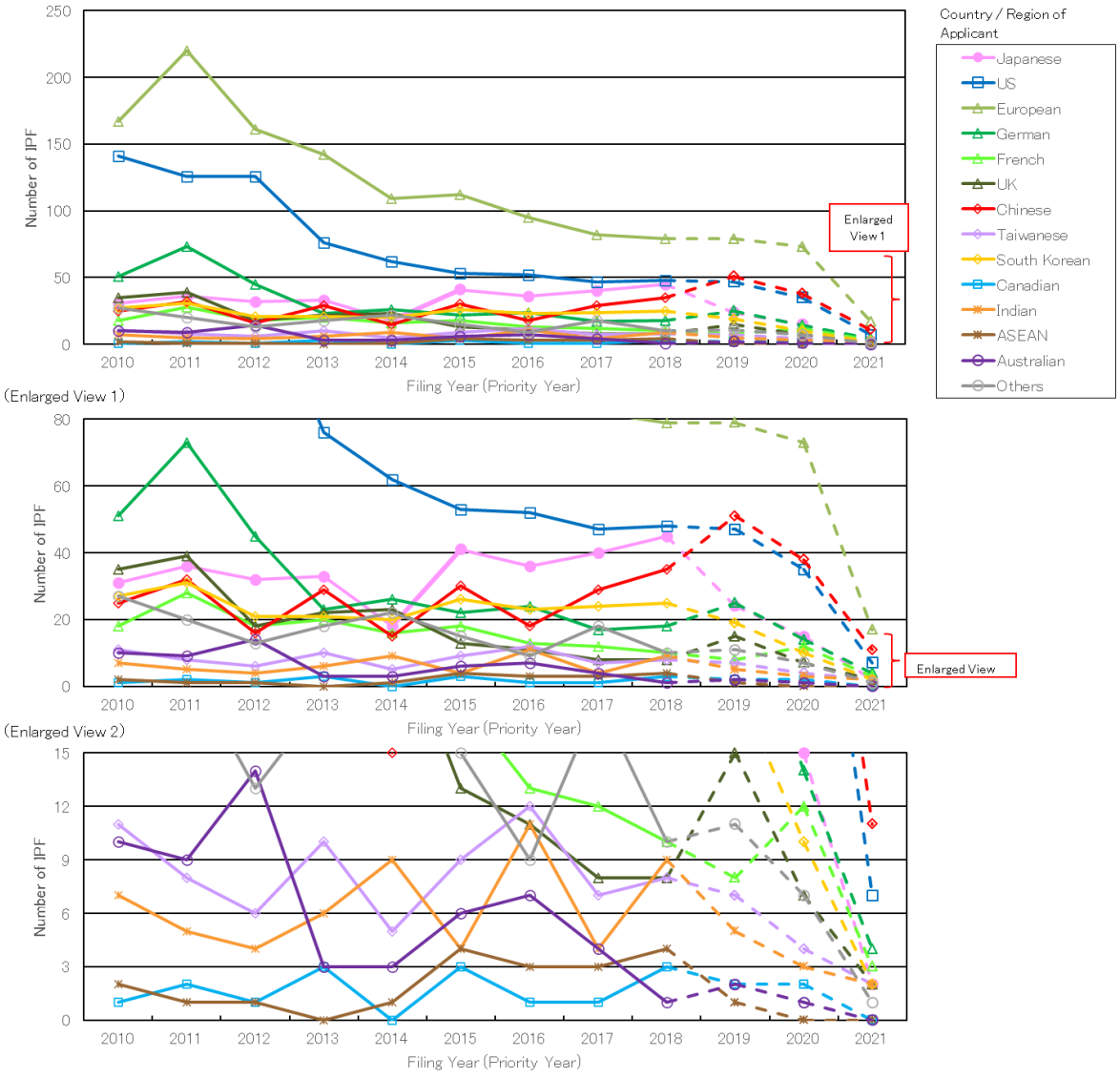
Database: Derwent™ Innovation

5. gxA05: Hydro-Power Generation

Annual trend in number of IPFs in "gxA05: Hydro-Power Generation" is shown in Figure 5-9 by country/region of applicant.

In the filing year (priority year) 2010, the number of IPFs by European applicants is the largest, followed by US applicants. Since then, the numbers of IPFs for European and US applicants decrease slightly, but remain unchanged in the same ranking. While the numbers of IPFs for applicants of most countries/regions tend to be almost flat, increasing and decreasing from year to year, the number of IPFs by Chinese applicants increases since 2017 and is almost equal to the number of IPFs by US applicants in 2019.

Figure 5-9 Annual trend in number of IPFs in "gxA05: Hydro-Power Generation" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



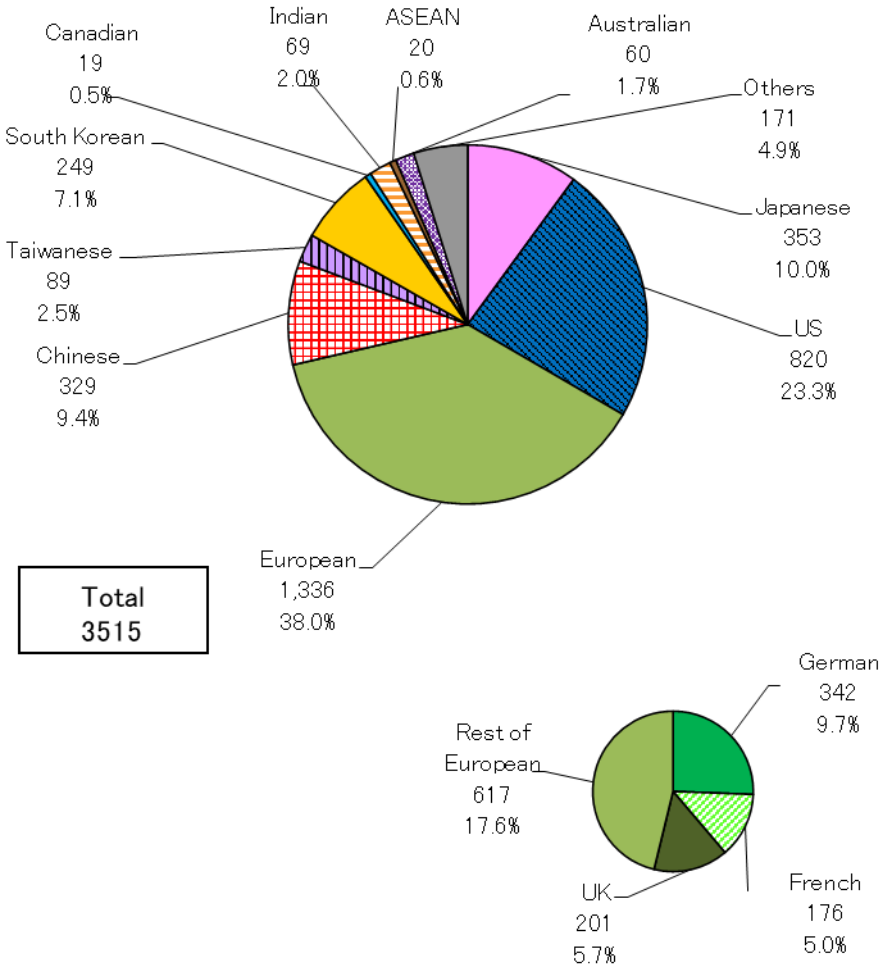
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-10 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, European applicants account for the largest rate with 38.0%, followed by US, Japanese, Chinese, and South Korean applicants. 87.8% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-10 Number of IPFs rates in "gxA05: Hydro-Power Generation" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



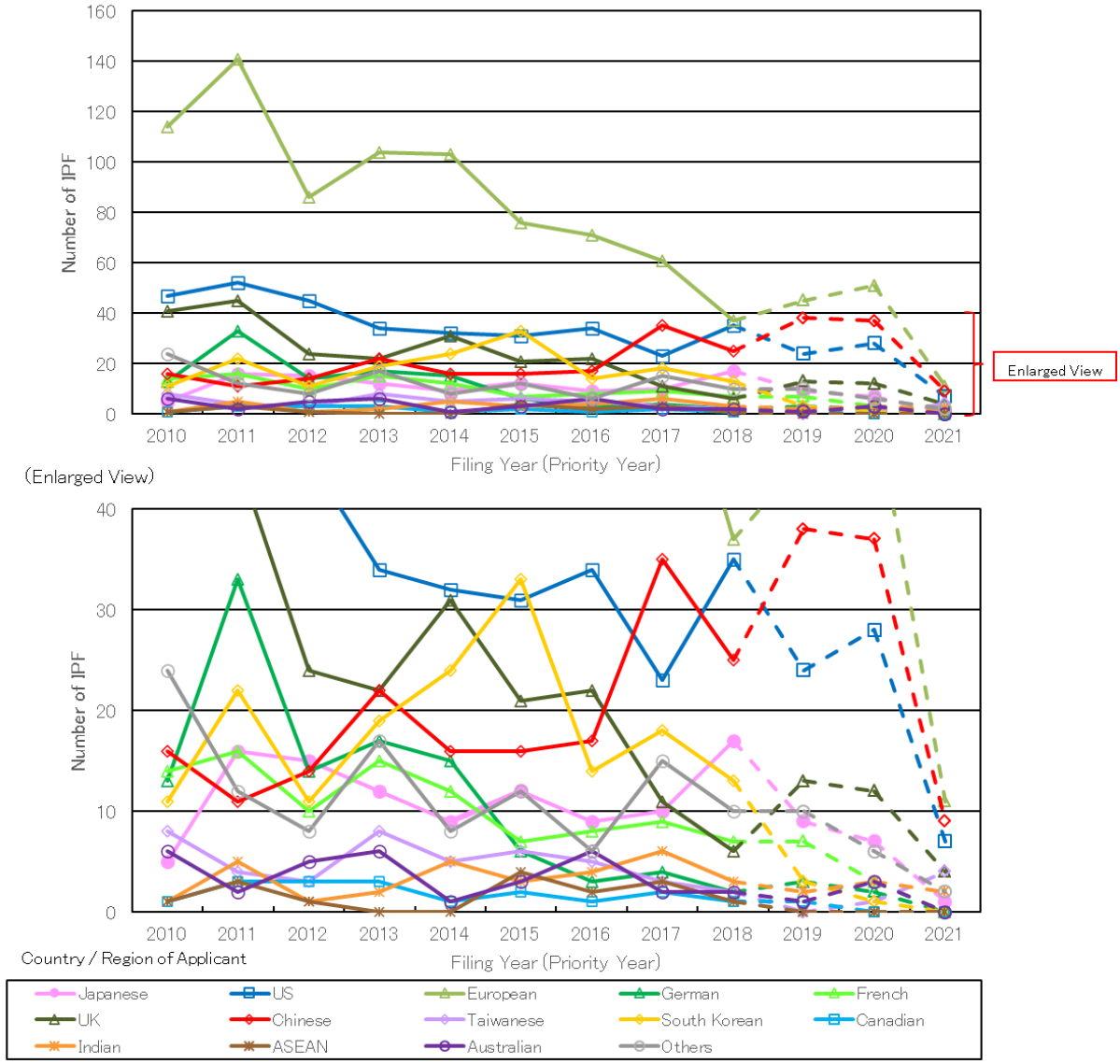
Database: Derwent™ Innovation

6. gxA06: Ocean Energy Power Generation

Annual trend in number of IPFs in "gxA06: Ocean Energy Power Generation" is shown in Figure 5-11 by country/region of applicant.

In the filing year (priority year) 2010, the number of IPFs by European applicants is the largest and remains unchanged in the same ranking, although the number of IPFs by European applicants decreases thereafter. While the number of IPFs by applicants of most countries/regions tend to be almost flat, increasing and decreasing from year to year, the number of IPFs by Chinese applicants is on an increasing trend since 2016.

Figure 5-11 Annual trend in number of IPFs in "gxA06: Ocean Energy Power Generation" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



Database: Derwent™ Innovation

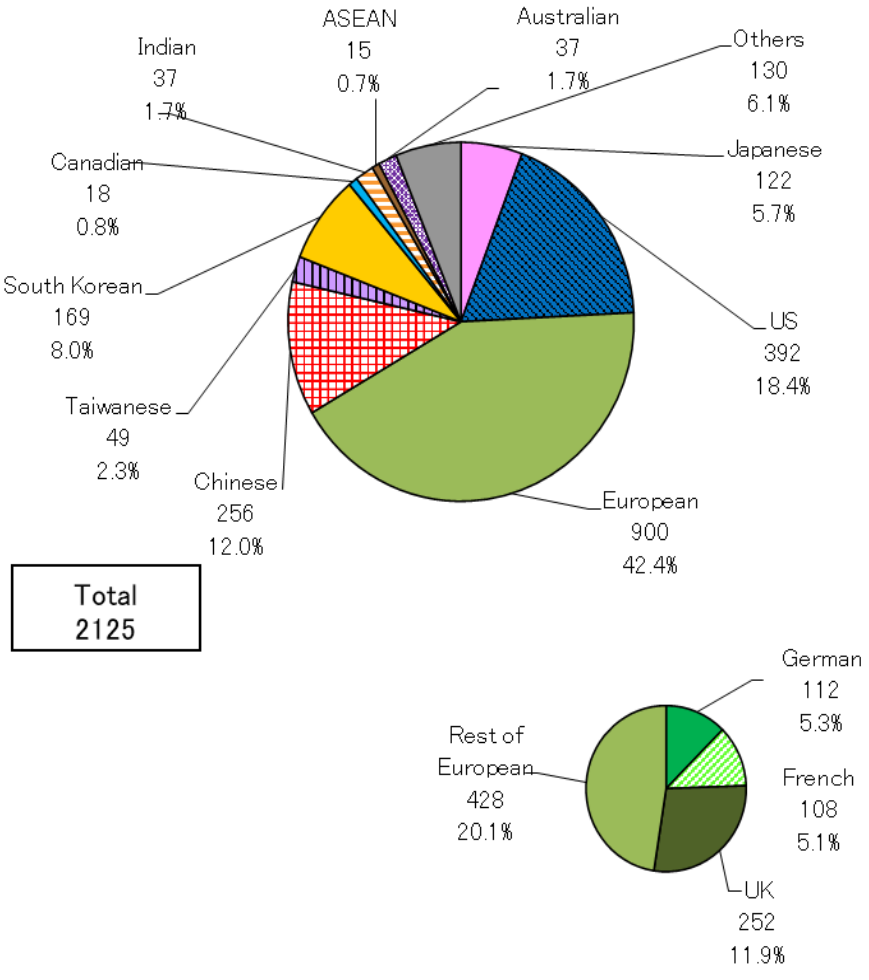
Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in

Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-12 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, European applicants account for the largest rate with 42.4%, followed by US, Chinese, South Korean, and Japanese applicants. 86.5% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-12 Number of IPFs rates in "gxA06: Ocean Energy Power Generation" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



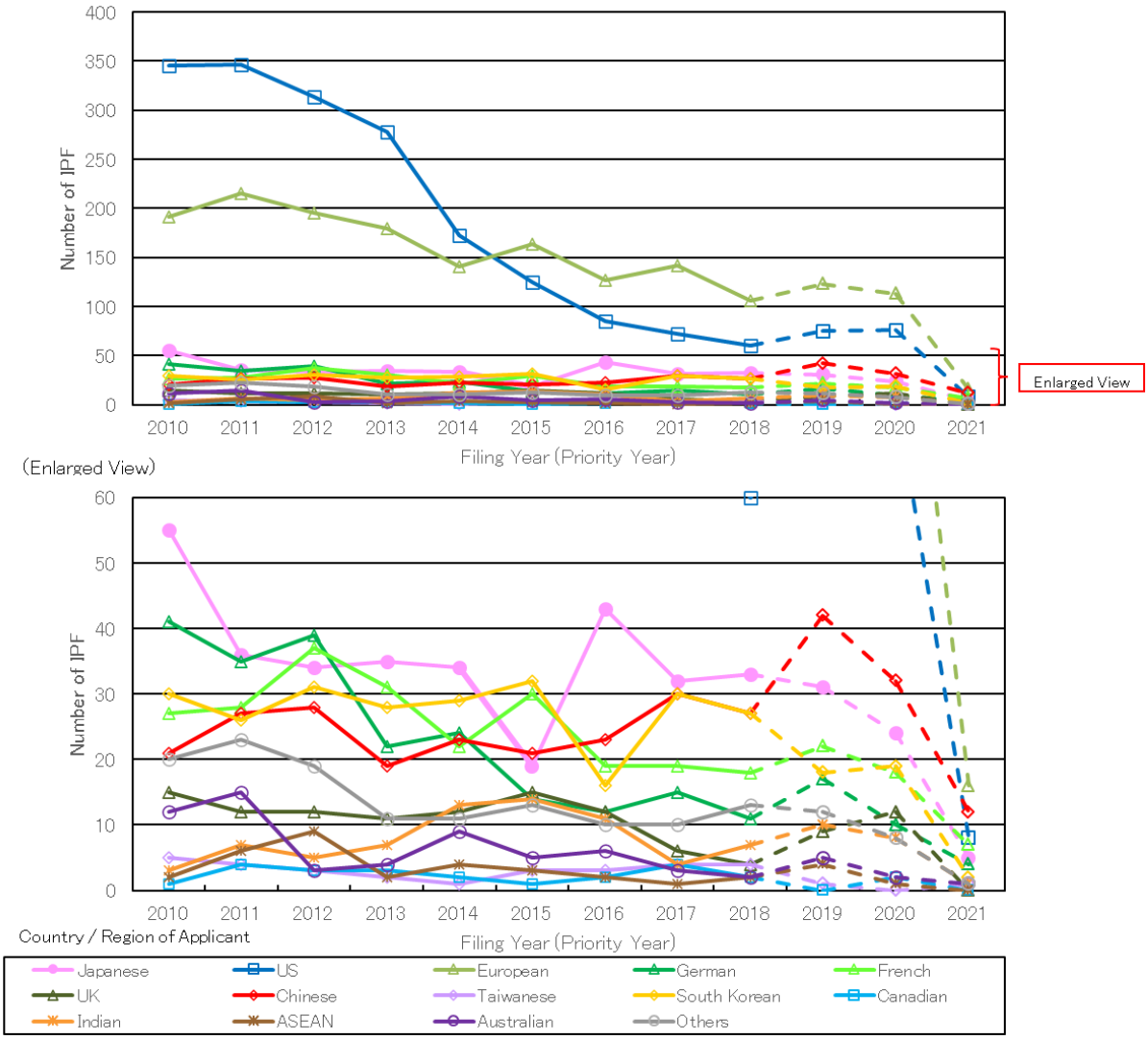
Database: Derwent™ Innovation

7. gxA07: Biomass

Annual trend in number of IPFs in "gxA07: Biomass" is shown in Figure 5-13 by country/region of applicant.

In the filing year (priority year) 2010, the number of IPFs by US applicants is the largest, but while there is a decreasing trend from 2012 to 2018 and the number of IPFs by European applicants decreases only slightly, the number of IPFs by European applicants becomes the largest in 2015. While the numbers of IPFs for applicants of most countries/regions tend to decrease slightly, increasing or decreasing from year to year, the number of IPFs by Chinese applicants is on an increasing trend since 2015.

Figure 5-13 Annual trend in number of IPFs in "gxA07: Biomass" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



Database: Derwent™ Innovation

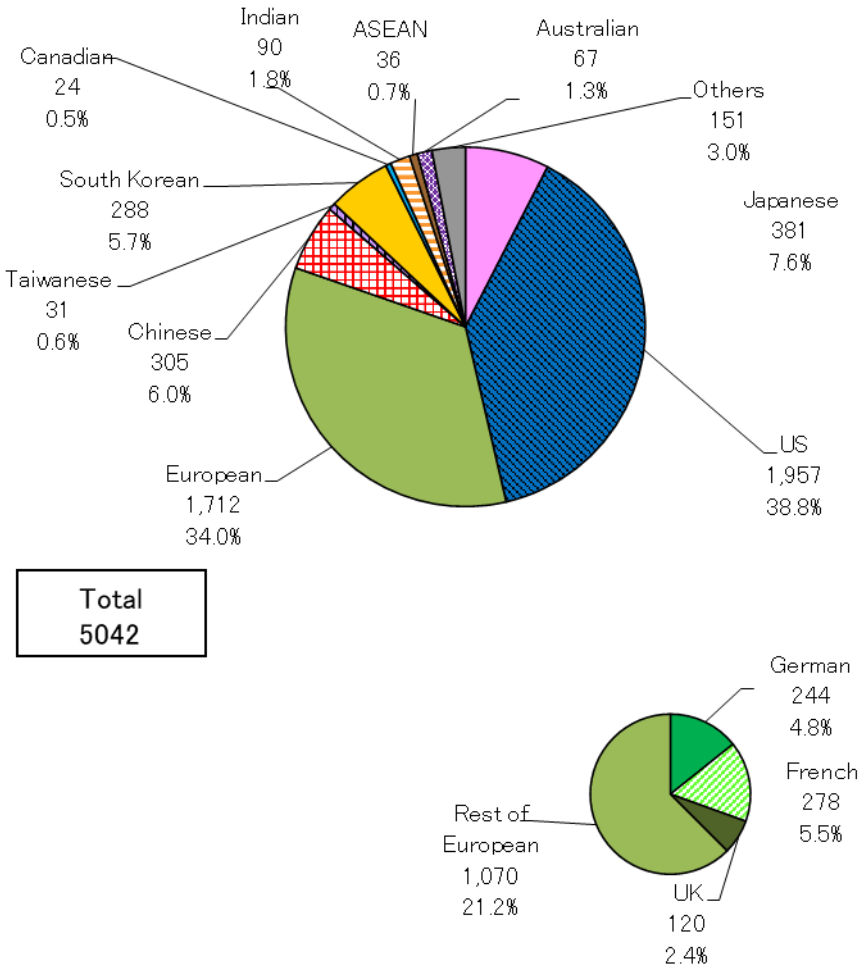
Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line

from 2019.

Number of IPFs rates are shown in Figure 5-14 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, US applicants account for the largest rate with 38.8%, followed by European, Japanese, Chinese, and South Korean applicants. 92.1% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-14 Number of IPFs rates in "gxA07: Biomass" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



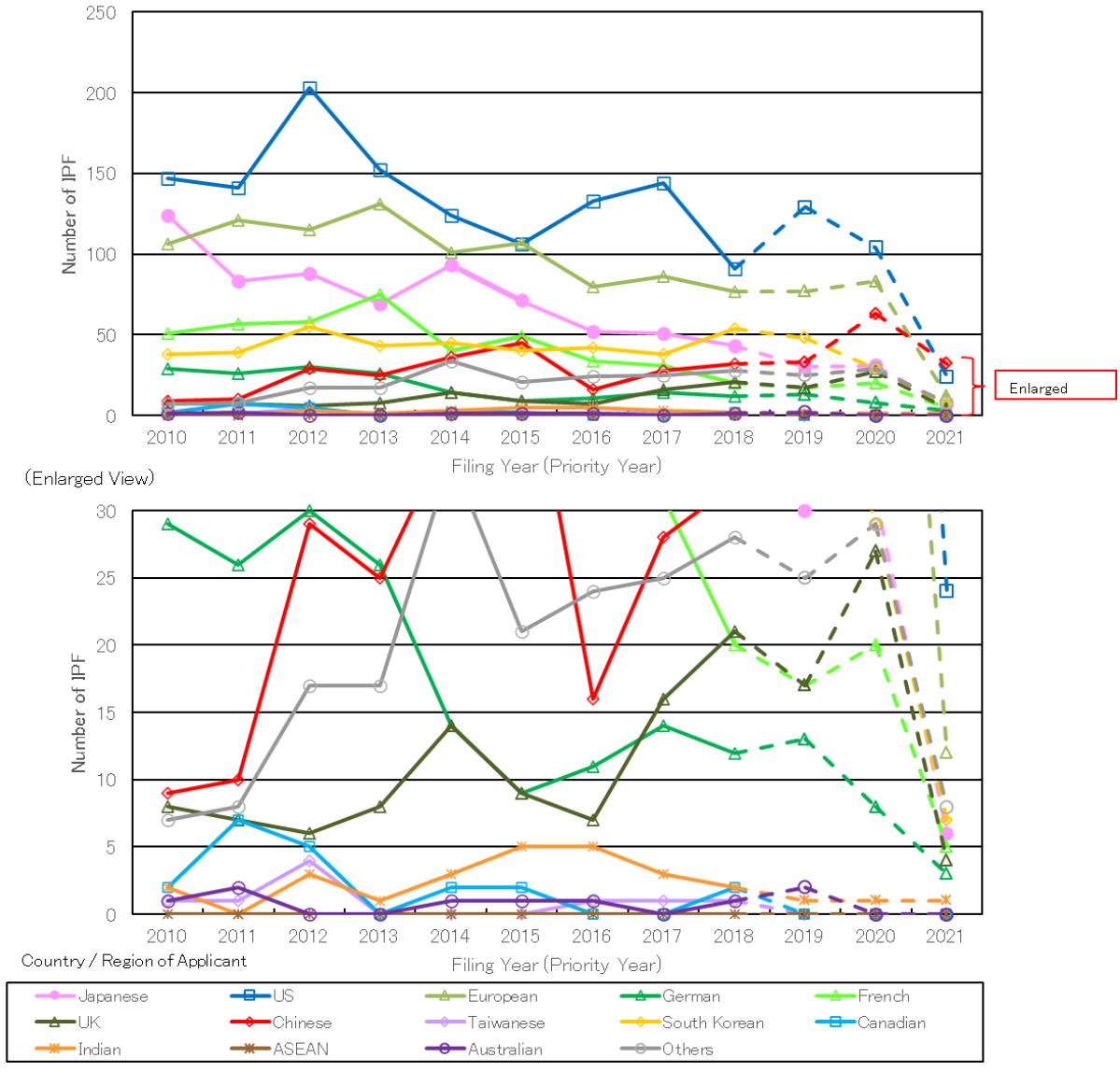
Database: Derwent™ Innovation

8. gxA08: Nuclear Power Generation

Annual trend in number of IPFs in "gxA08: Nuclear Power Generation" is shown in Figure 5-15 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by US applicants is the largest and then remains unchanged in the same ranking, although the number of IPFs by US applicants decreases since then. The number of IPFs by Japanese applicants is second only to that for US applicants in 2010, but since 2011, the number of IPFs is on a decreasing trend, falling below the number of IPFs by European applicants in 2011 and the number of IPFs by South Korean applicants in 2018. While the numbers of IPFs for applicants of most countries/regions tend to be almost flat, the number of IPFs by Chinese applicants continues to increase slightly.

Figure 5-15 Annual trend in number of IPFs in "gxA08: Nuclear Power Generation" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



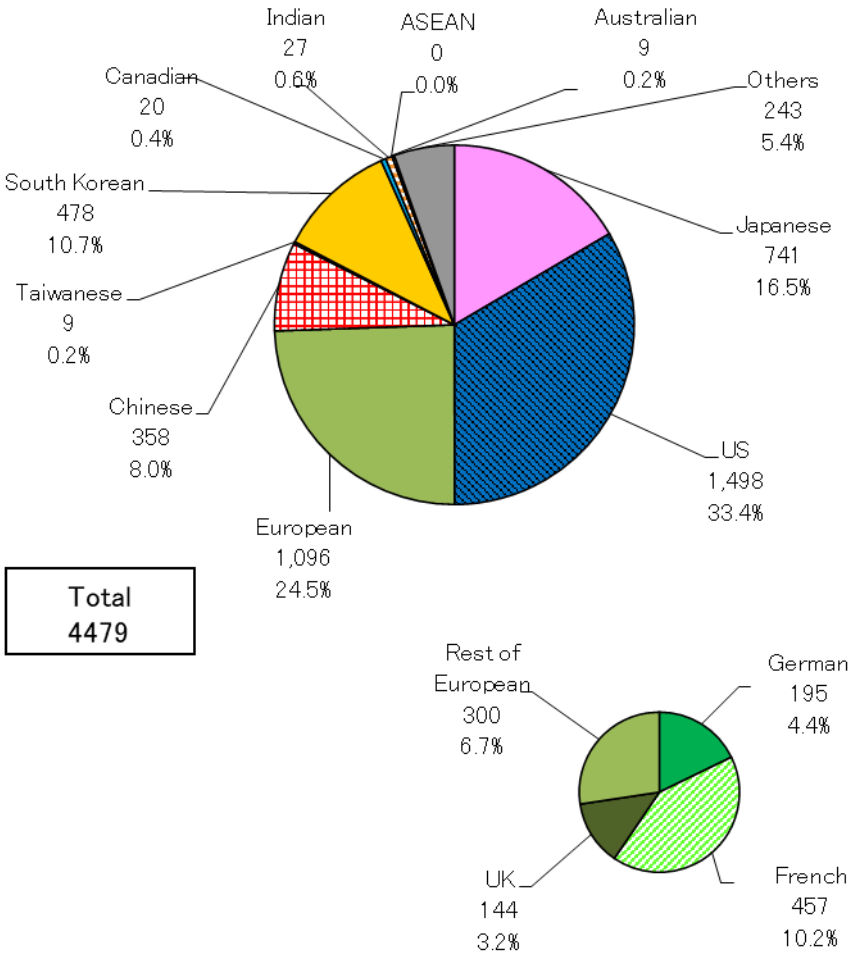
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-16 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, US applicants account for the largest rate with 33.4%, followed by European, Japanese, South Korean, and Chinese applicants. 93.1% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-16 Number of IPFs rates in "gxA08: Nuclear Power Generation" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



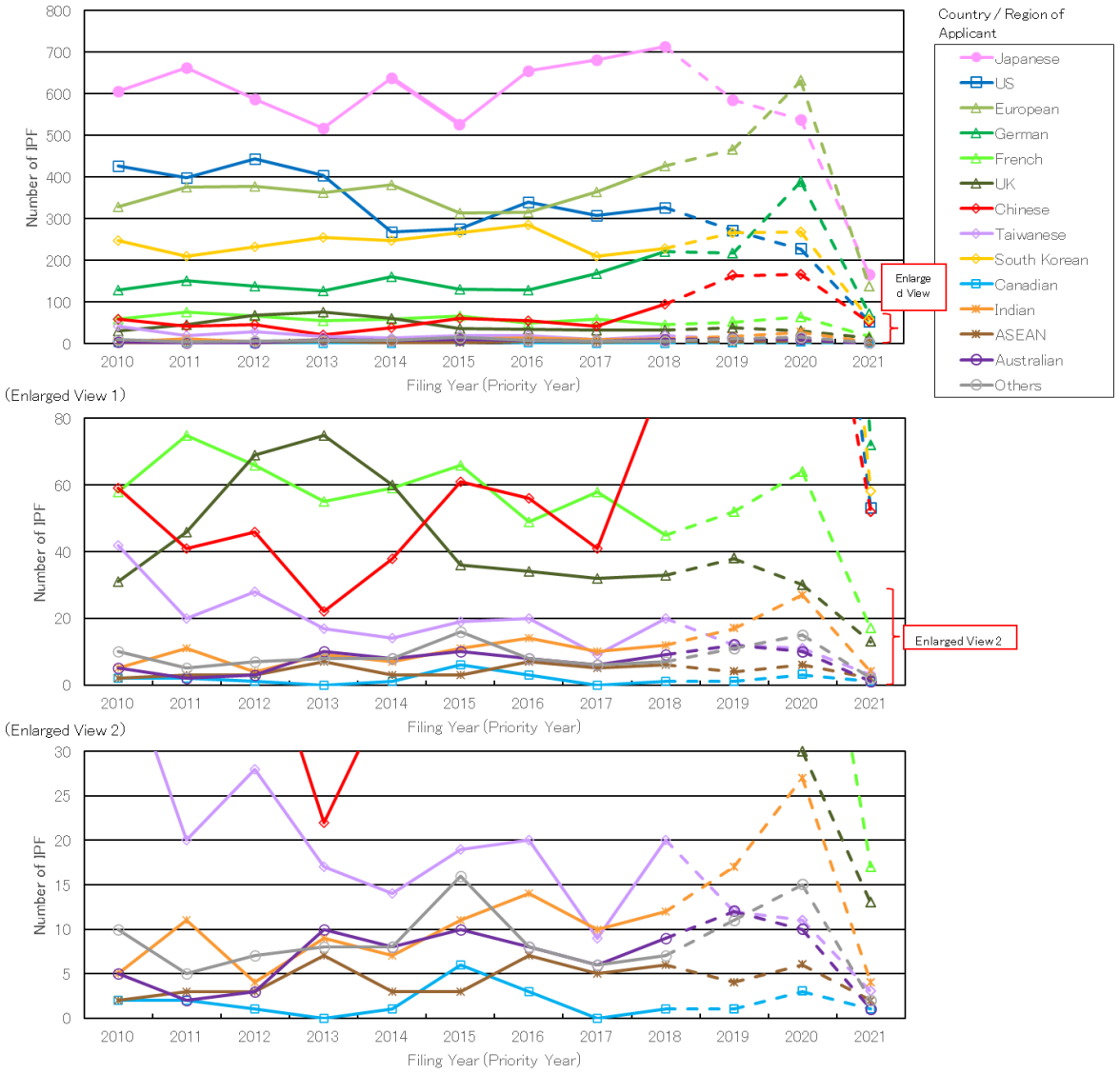
Database: Derwent™ Innovation

9. gxA09: Fuel Cells

Annual trend in number of IPFs in “gxA09: Fuel Cells” is shown in Figure 5-17 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by Japanese applicants is the largest, then fluctuates but increases and remains unchanged in the same ranking. While the number of IPFs by US applicants, which is second place in 2010, decreases slightly, the number of IPFs by European applicants, which is on a slightly increasing trend, exceeds that for US applicants in 2014 and is on an increasing trend since 2017. Among European applicants, the number of IPFs of German applicants stands out, with an increasing trend since 2017, and is expected to exceed the number of IPFs by US applicants from 2020. The numbers of IPFs for applicants of most countries/regions increase and decrease from year to year, but tend to be almost flat. Only the number of IPFs by Chinese applicants is on an increasing trend since 2017.

Figure 5-17 Annual trend in number of IPFs in “gxA09: Fuel Cells” by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



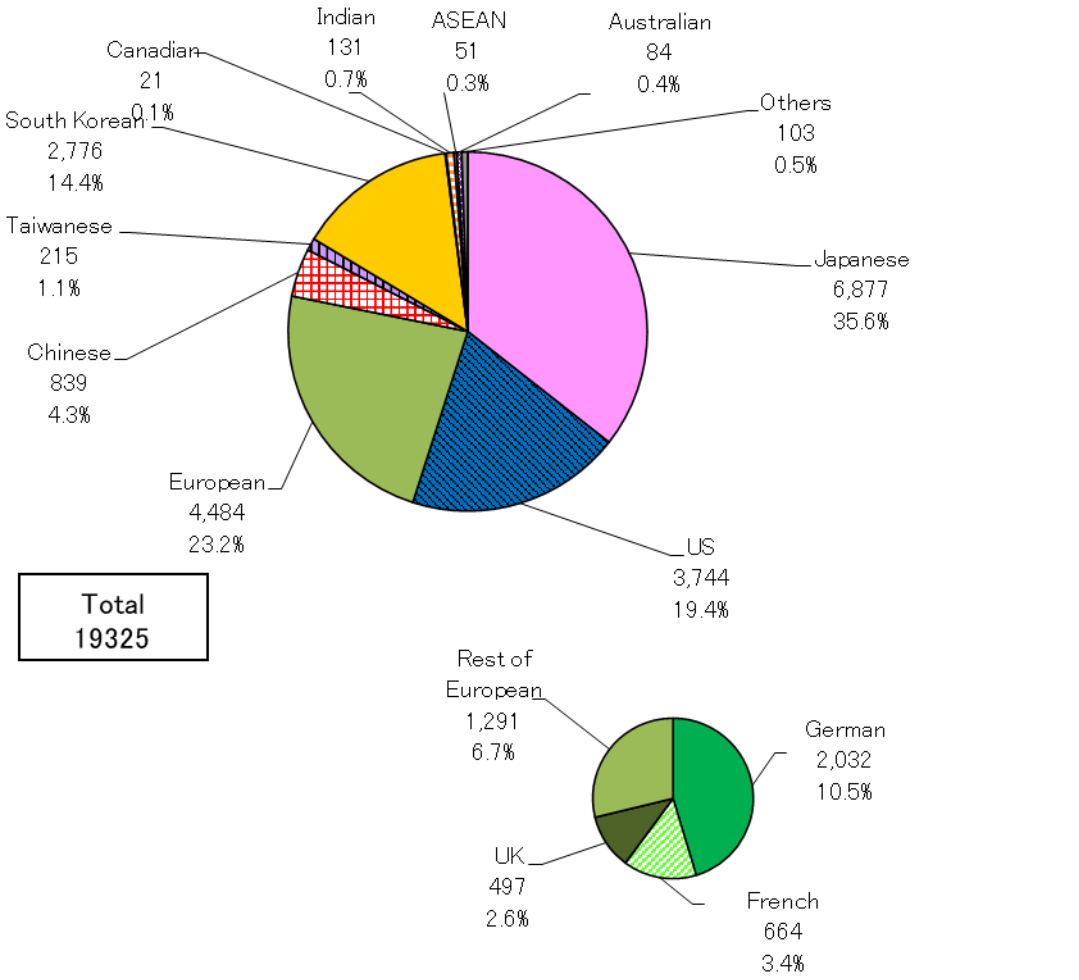
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-18 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, Japanese applicants account for the largest rate with 35.6%, followed by European, US, South Korean, and Chinese applicants. 96.9% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-18 Number of IPFs rates in “gxA09: Fuel Cells” by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



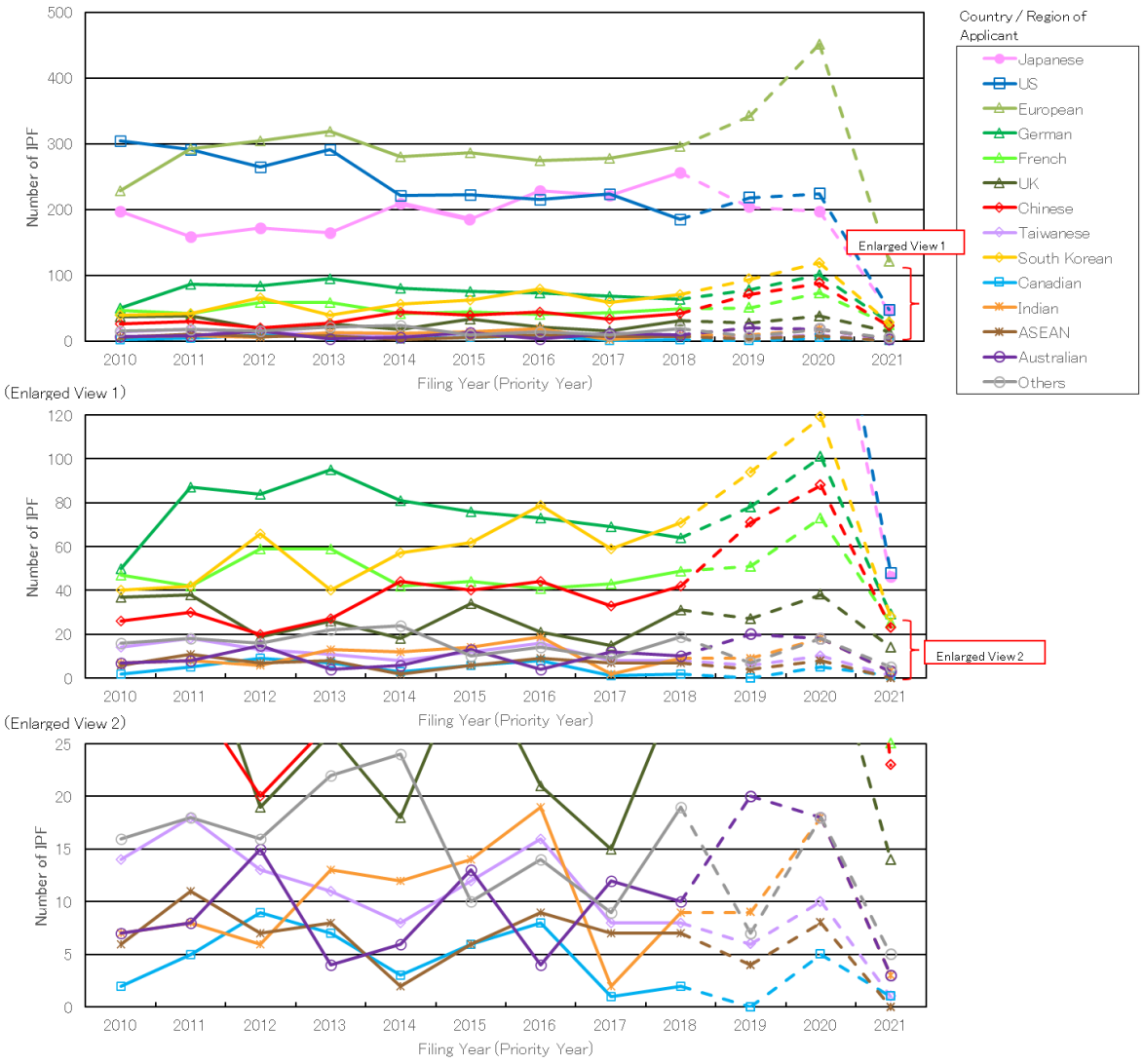
Database: Derwent™ Innovation

10. gxA10: Hydrogen Technology

Annual trend in number of IPFs in “gxA10: Hydrogen Technology” is shown in Figure 5-19 by country/region of applicant.

In the filing year (priority year) 2010, the number of IPFs by US applicants is the largest, but since 2011, the number of IPFs by European applicants is the largest and remains unchanged in the same ranking with some increases and decreases since then. The number of IPFs by Japanese applicants maintains a slight increase, exceeding the number of IPFs by US applicants in 2016 and 2018 and maintaining the trend. While the numbers of IPFs for applicants of most countries/regions are almost flat, the numbers of IPFs for South Korean and Chinese applicants increase steadily since around 2013.

Figure 5-19 Annual trend in number of IPFs in “gxA10: Hydrogen Technology” by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



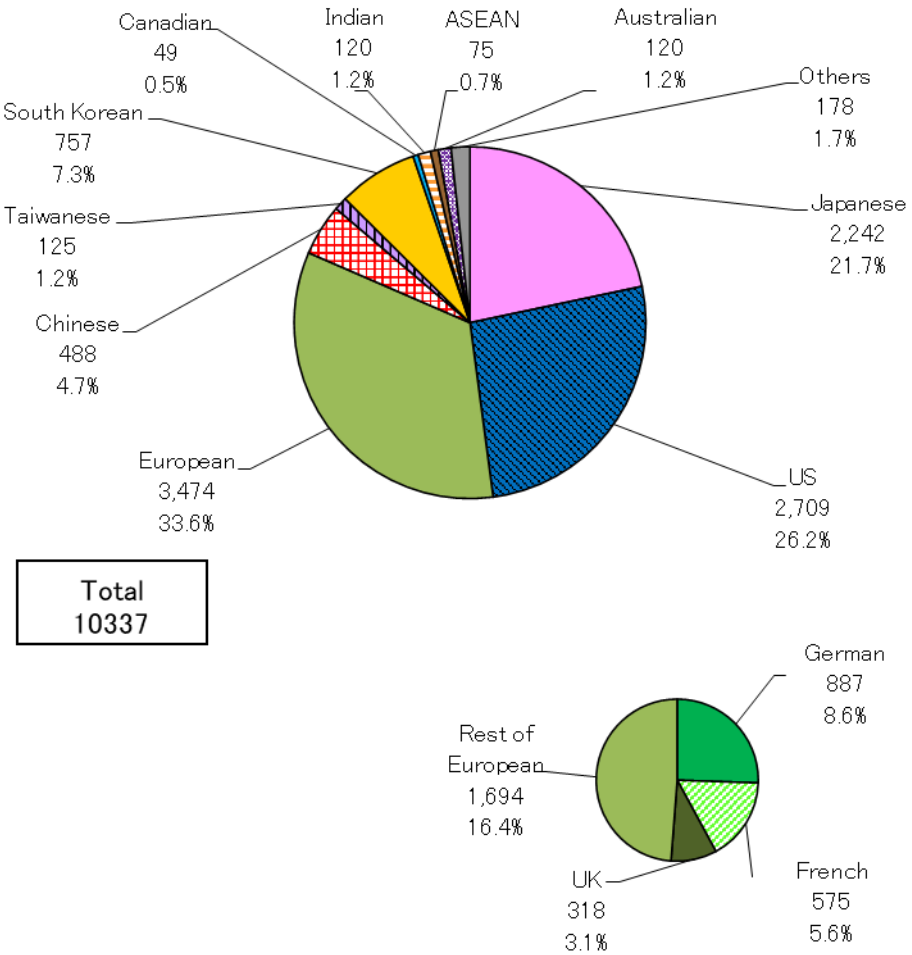
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-20 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, European applicants account for the largest rate with 33.6%, followed by US, Japanese, South Korean, and Chinese applicants. 93.5% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-20 Number of IPFs rates in "gxA10: Hydrogen Technology" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



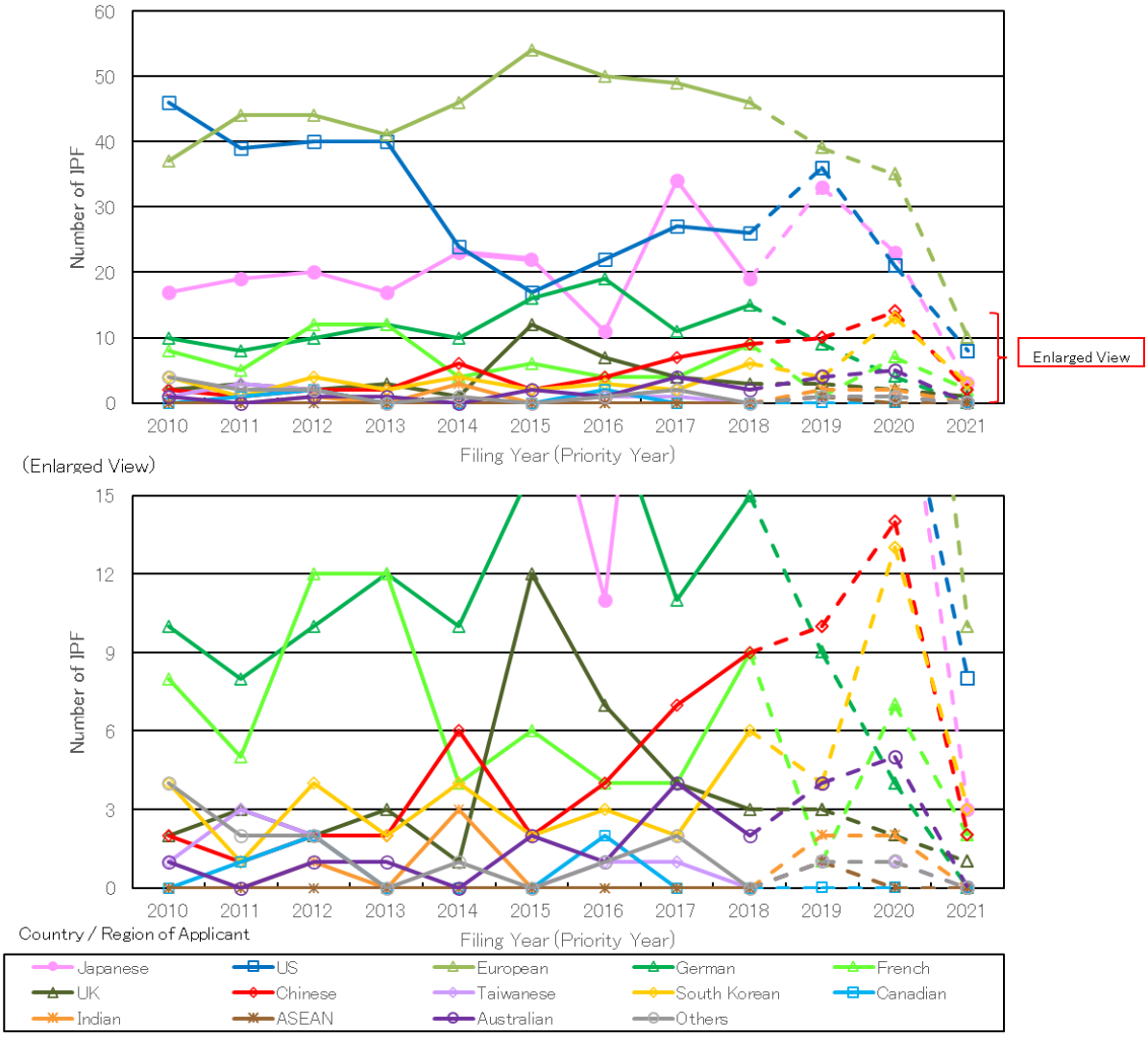
Database: Derwent™ Innovation

11. gxA11: Ammonia Technology

Annual trend in number of IPFs in "gxA11: Ammonia Technology" is shown in Figure 5-21 by country/region of applicant.

In the filing year (priority year) 2010, the number of IPFs by US applicants is the largest, but the number of IPFs by European applicants exceeds the number of IPFs by US applicants in 2011, and since then the number of IPFs by European applicants is the largest. The number of IPFs by US applicants is on a decreasing trend from 2011 to 2015, with a slightly increasing trend since then. While the numbers of IPFs for applicants of most countries/regions tend to be almost flat, the numbers of IPFs for Japanese and Chinese applicants are on a slightly increasing trend since around 2014.

Figure 5-21 Annual trend in number of IPFs in "gxA11: Ammonia Technology" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



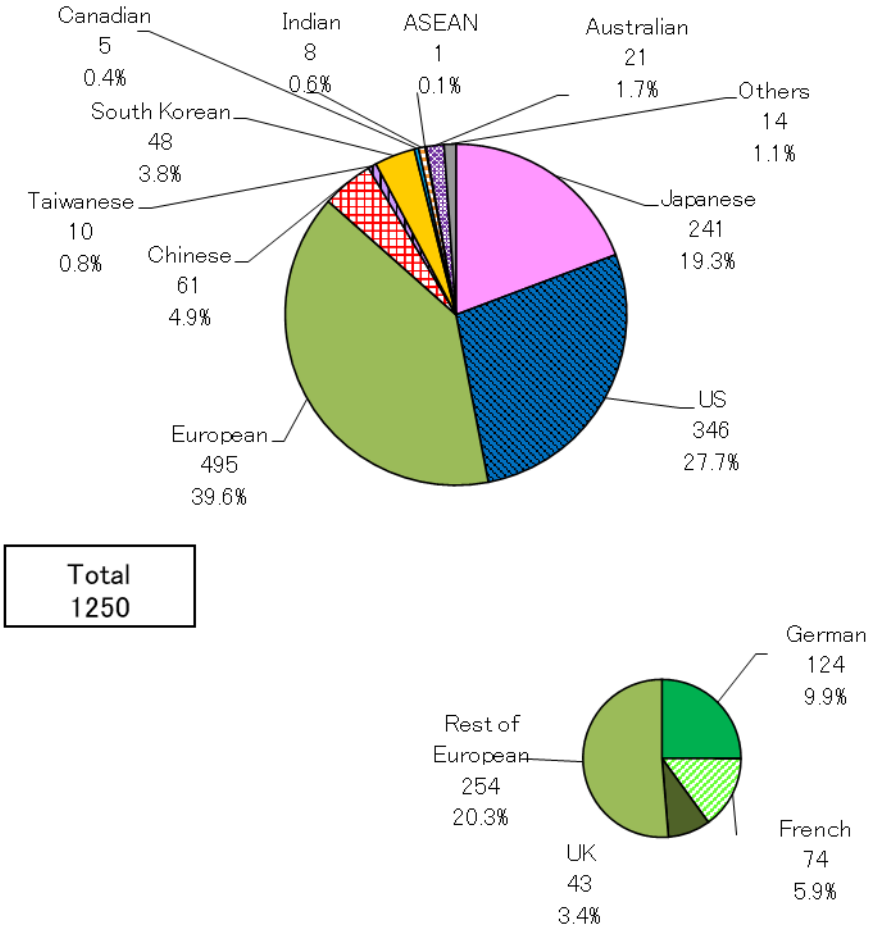
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-22 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, European applicants account for the largest rate with 39.6%, followed by US, Japanese, Chinese, and South Korean applicants. 95.3% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-22 Number of IPFs rates in "gxA11: Ammonia Technology" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



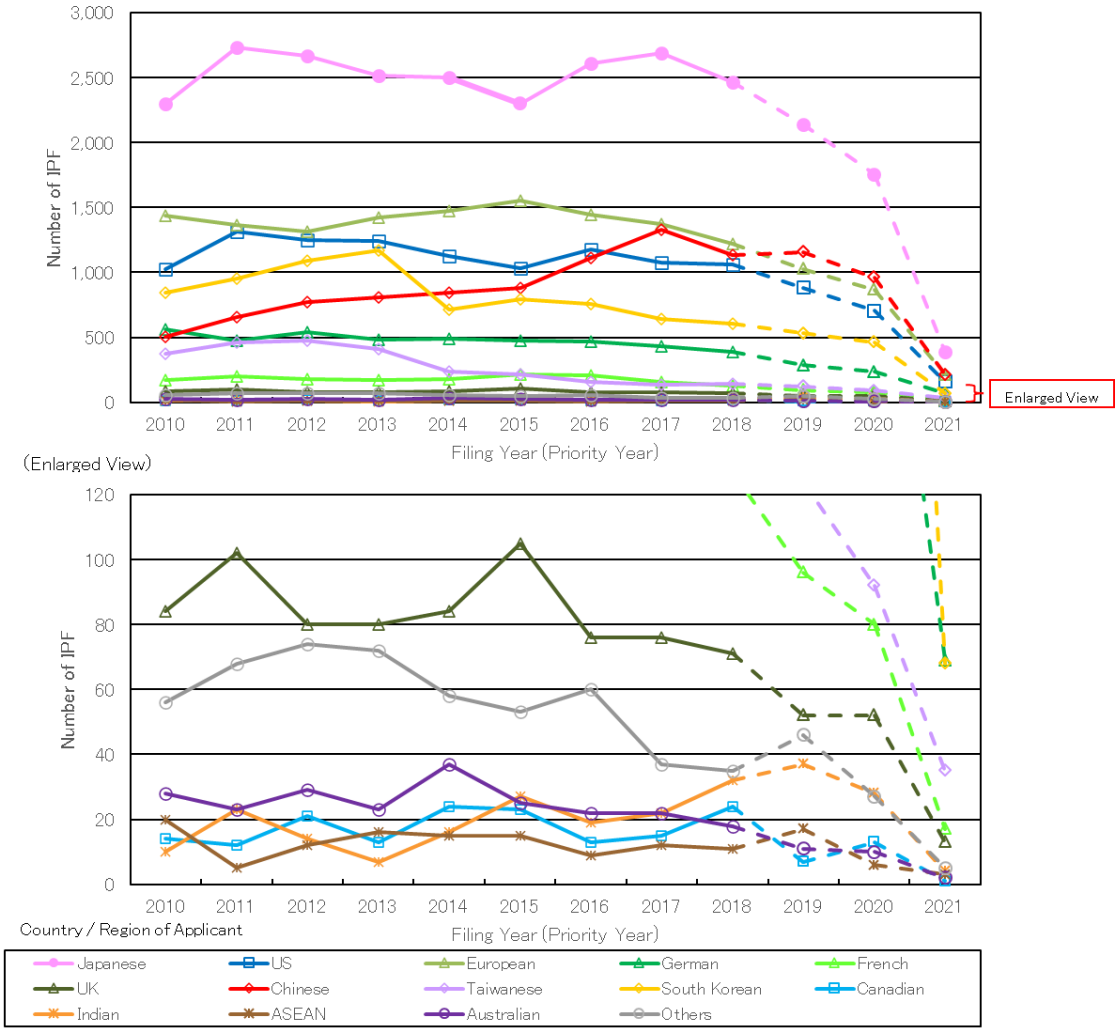
Database: Derwent™ Innovation

12. gxB01: Energy Saving in Buildings (ZEB, ZEH, etc.)

Annual trend in number of IPFs in "gxB01: Energy Saving in Buildings (ZEB, ZEH, etc.)" is shown in Figure 5-23 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by Japanese applicants is the largest. The number of IPFs by European applicants, which is the next largest, decreases slightly, but remains in second place until 2018. Meanwhile, the number of IPFs by Chinese applicants steadily increases since 2010, and is expected to exceed the number of IPFs by US applicants in 2017 and exceed the number of IPFs by European applicants from 2019. While the numbers of IPFs for applicants of most countries/regions tend to be almost flat, the number of IPFs by Indian applicants is on an increasing trend since around 2014.

Figure 5-23 Annual trend in number of IPFs in "gxB01: Energy Saving in Buildings (ZEB, ZEH, etc.)" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



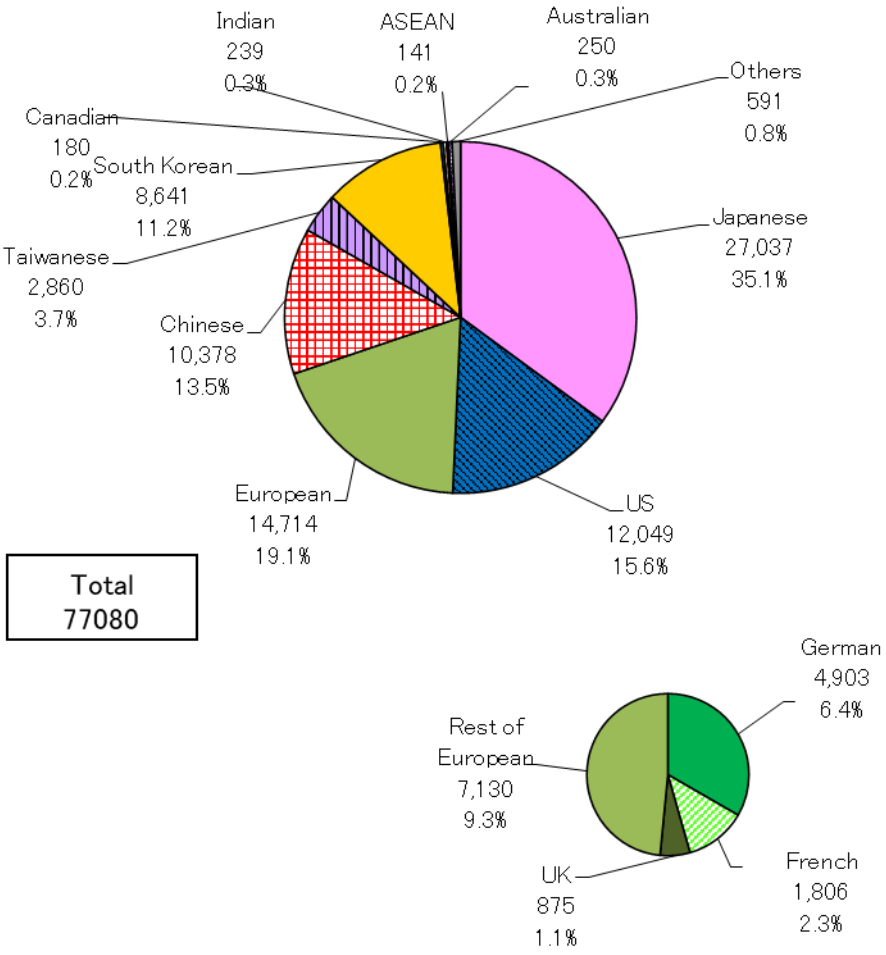
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-24 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, Japanese applicants account for the largest rate with 35.1%, followed by European, US, Chinese, and South Korean applicants. 94.5% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-24 Number of IPFs rates in "gxB01: Energy Saving in Buildings (ZEB, ZEH, etc.)" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



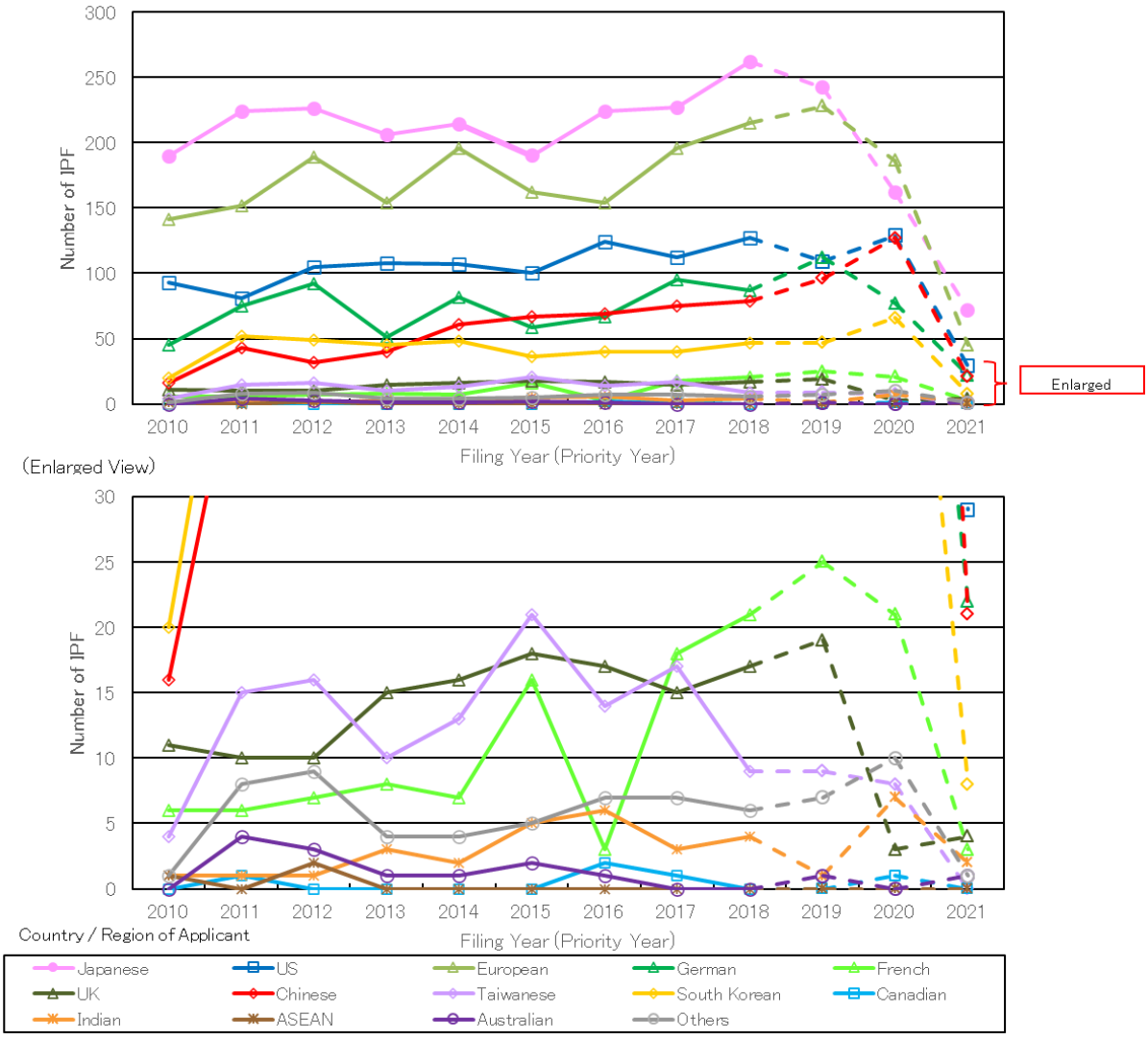
Database: Derwent™ Innovation

13. gxB02: High-Efficiency Motors and Inverters

Annual trend in number of IPFs in "gxB02: High-Efficiency Motors and Inverters" is shown in Figure 5-25 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by Japanese applicants is the largest, followed by European and US applicants. In addition, the number of IPFs by Chinese applicants steadily increases since 2010, approaches the number of IPFs by German applicants in 2018, and is on track to exceed the numbers of IPFs for German and US applicants from 2019.

Figure 5-25 Annual trend with the number of IPFs in "gxB02: High-Efficiency Motors and Inverters" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



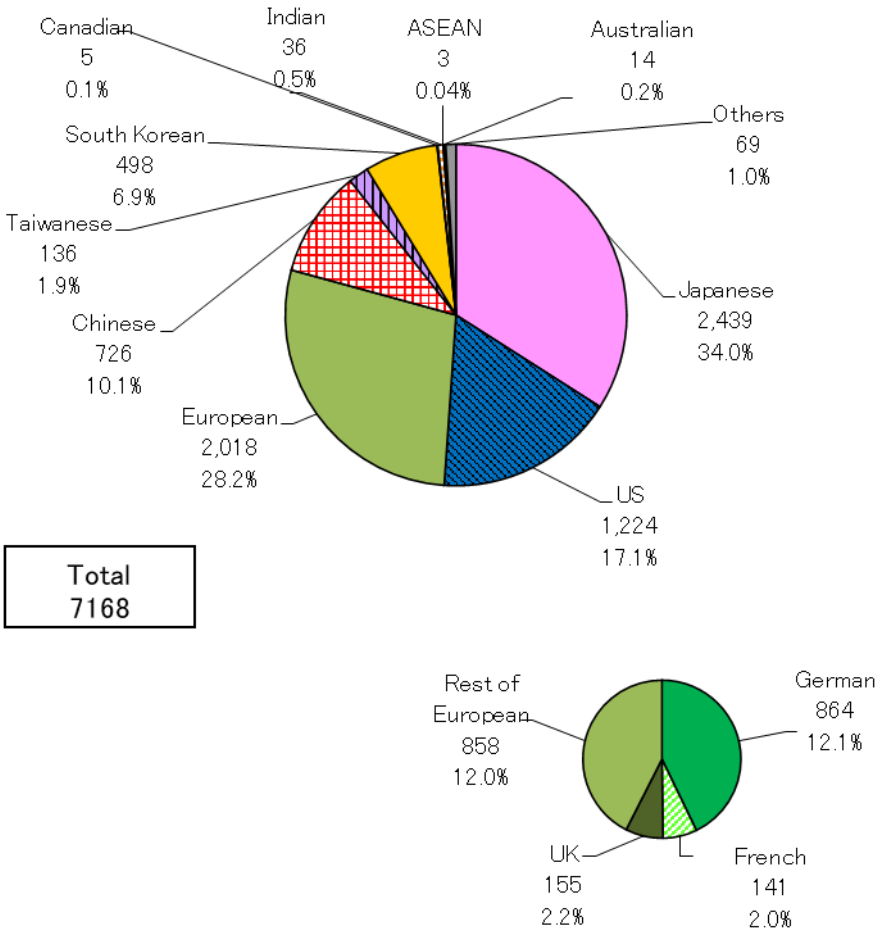
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-26 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, Japanese applicants account for the largest rate with 34.0%, followed by European, US, Chinese, and South Korean applicants. 96.3% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-26 Number of IPFs rates in "gxB02: High-Efficiency Motors and Inverters" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



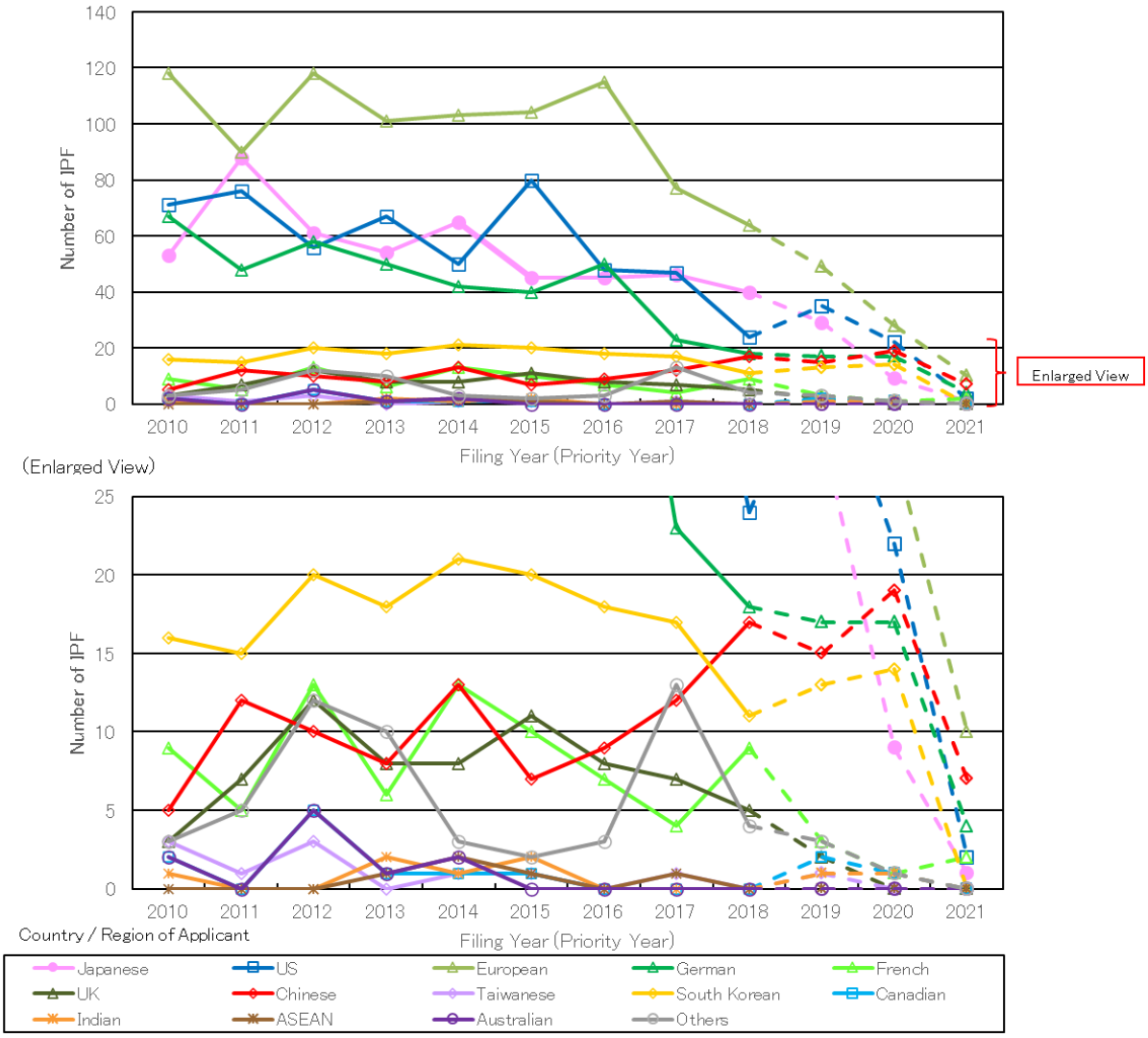
Database: Derwent™ Innovation

14. gxB03: Combined Heat and Power (CHP)

Annual trend in number of IPFs in "gxB03: Combined Heat and Power (CHP)" is shown in Figure 5-27 by country/region of applicant.

In the filing year (priority year) 2010, the number of IPFs by European applicants is the largest, followed by US, German, and Japanese applicants. Since then, the number of IPFs by European applicants decreases slightly, but remains unchanged in the same ranking. The number of IPFs by German applicants is on a decreasing trend, as is the number of IPFs by European applicants, and falls below the number of IPFs by Japanese applicants since 2017. Meanwhile, the number of IPFs by US applicants and the number of IPFs by Japanese applicants fluctuate almost equally. While the numbers of IPFs for applicants of most countries/regions tend to be almost flat or to decrease slightly, the number of IPFs by Chinese applicants increases slightly since 2011.

Figure 5-27 Annual trend with the number of IPFs in "gxB03: Combined Heat and Power (CHP)" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



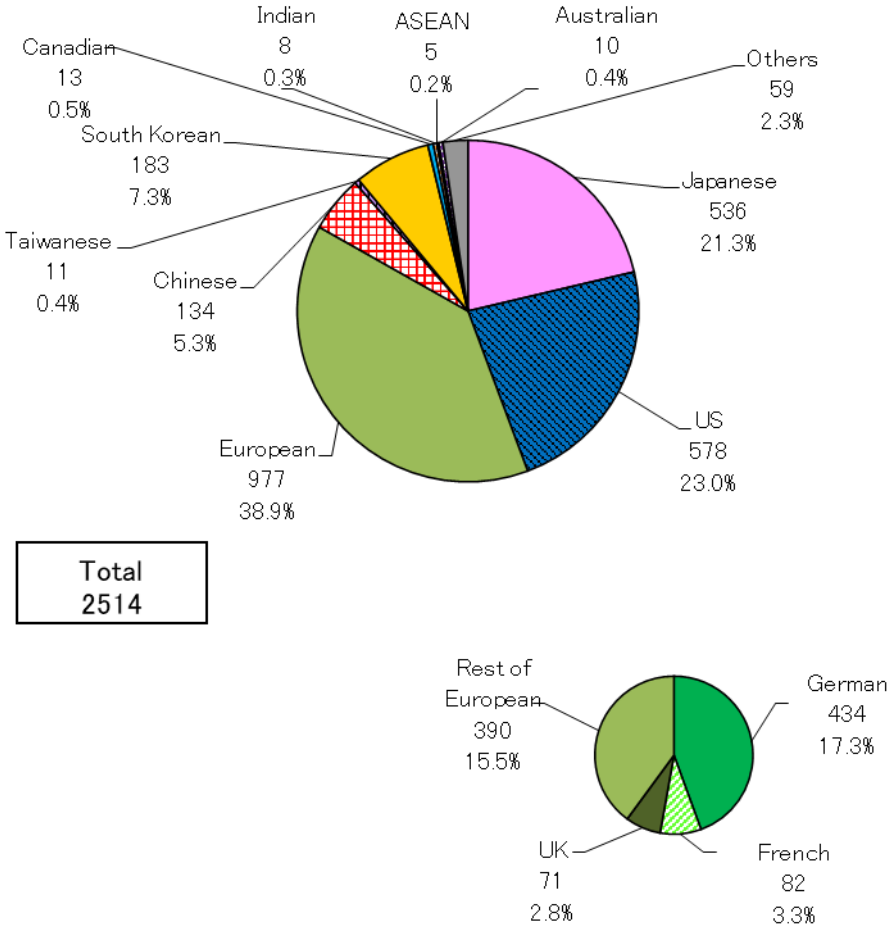
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-28 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, European applicants account for the largest rate with 38.9%, followed by US, Japanese, South Korean, and Chinese applicants. 95.8% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-28 Number of IPFs rates in "gxB03: Combined Heat and Power (CHP)" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



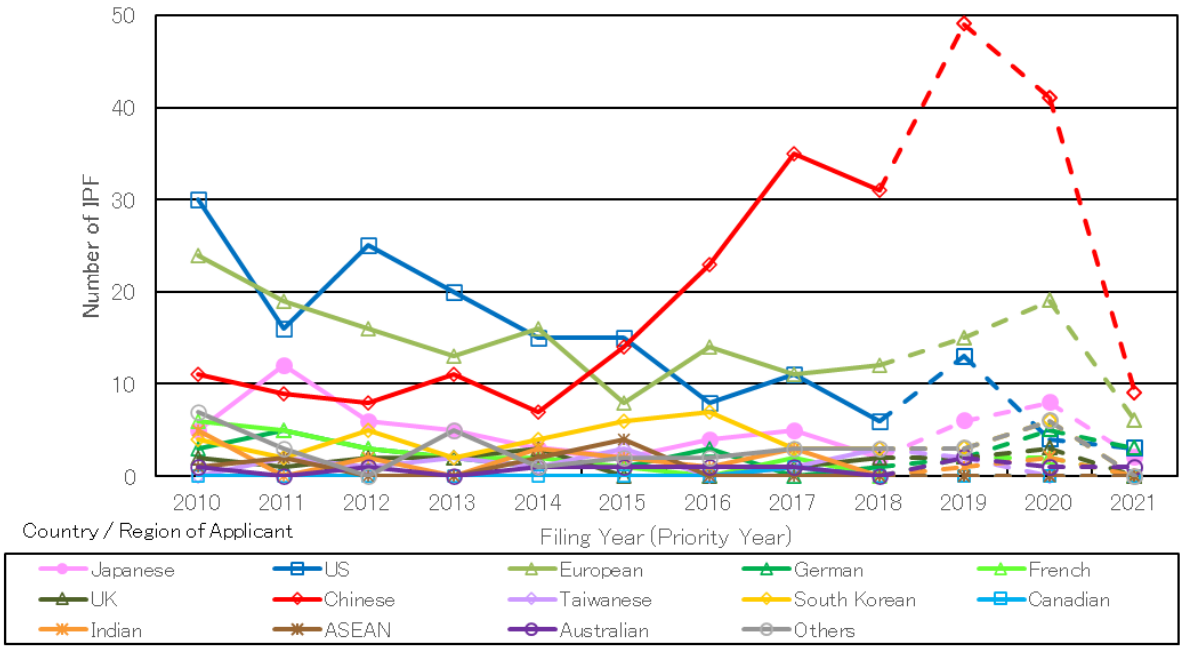
Database: Derwent™ Innovation

15. gxB04: Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge

Annual trend in number of IPFs in "gxB04: Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge" is shown in Figure 5-29 by country/region of applicant.

In the filing year (priority year) 2010, the numbers of IPFs for US and European applicants are first and second, fluctuating with a slight decrease, and the number of IPFs by European applicants is the largest in 2011 and 2014. Since 2015, the number of IPFs by Chinese applicants increases rapidly, and since 2016, it exceeds the numbers of IPFs for US and European applicants to become the largest. The numbers of IPFs for applicants of most countries/regions tend to be almost flat since 2015.

Figure 5-29 Annual trend in number of IPFs in "gxB04: Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



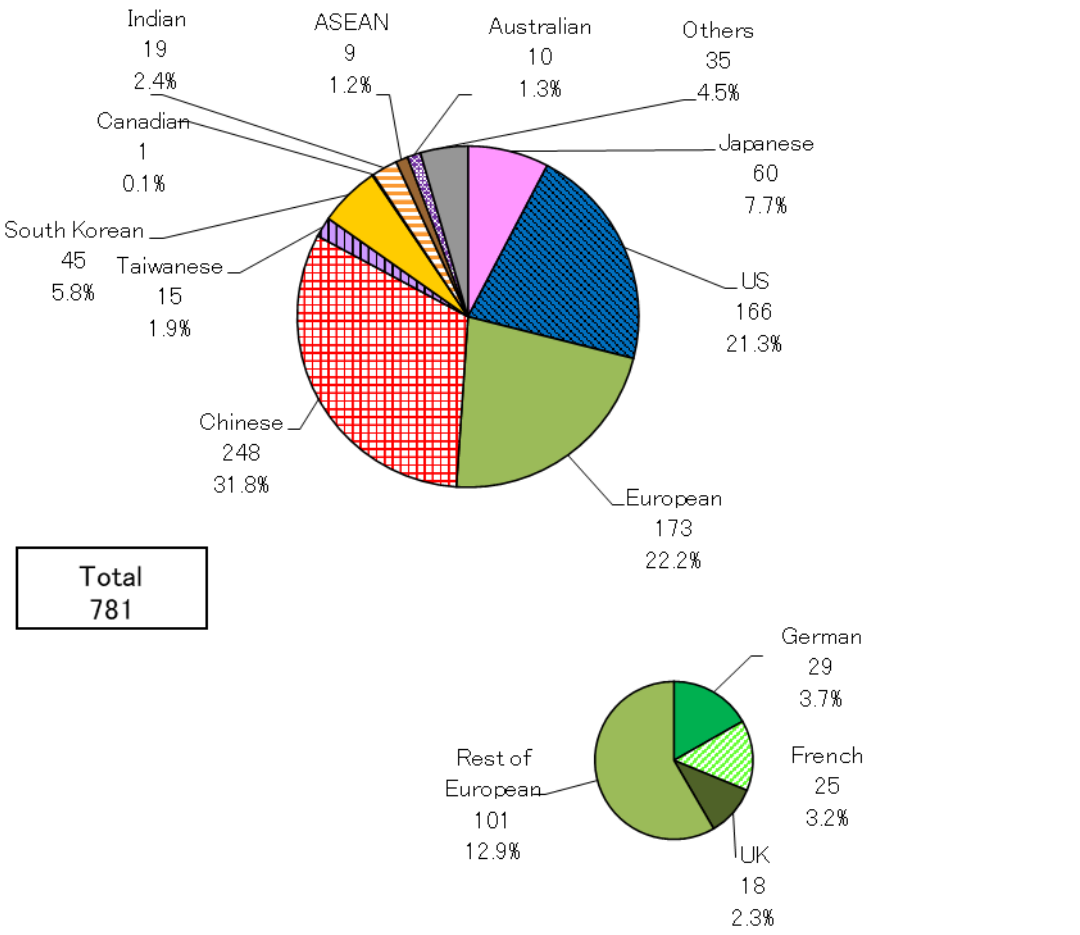
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-30 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, Chinese applicants account for the largest rate with 31.8%, followed by European, US, Japanese, and South Korean applicants. 88.6% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-30 Number of IPFs rates in "gxB04: Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



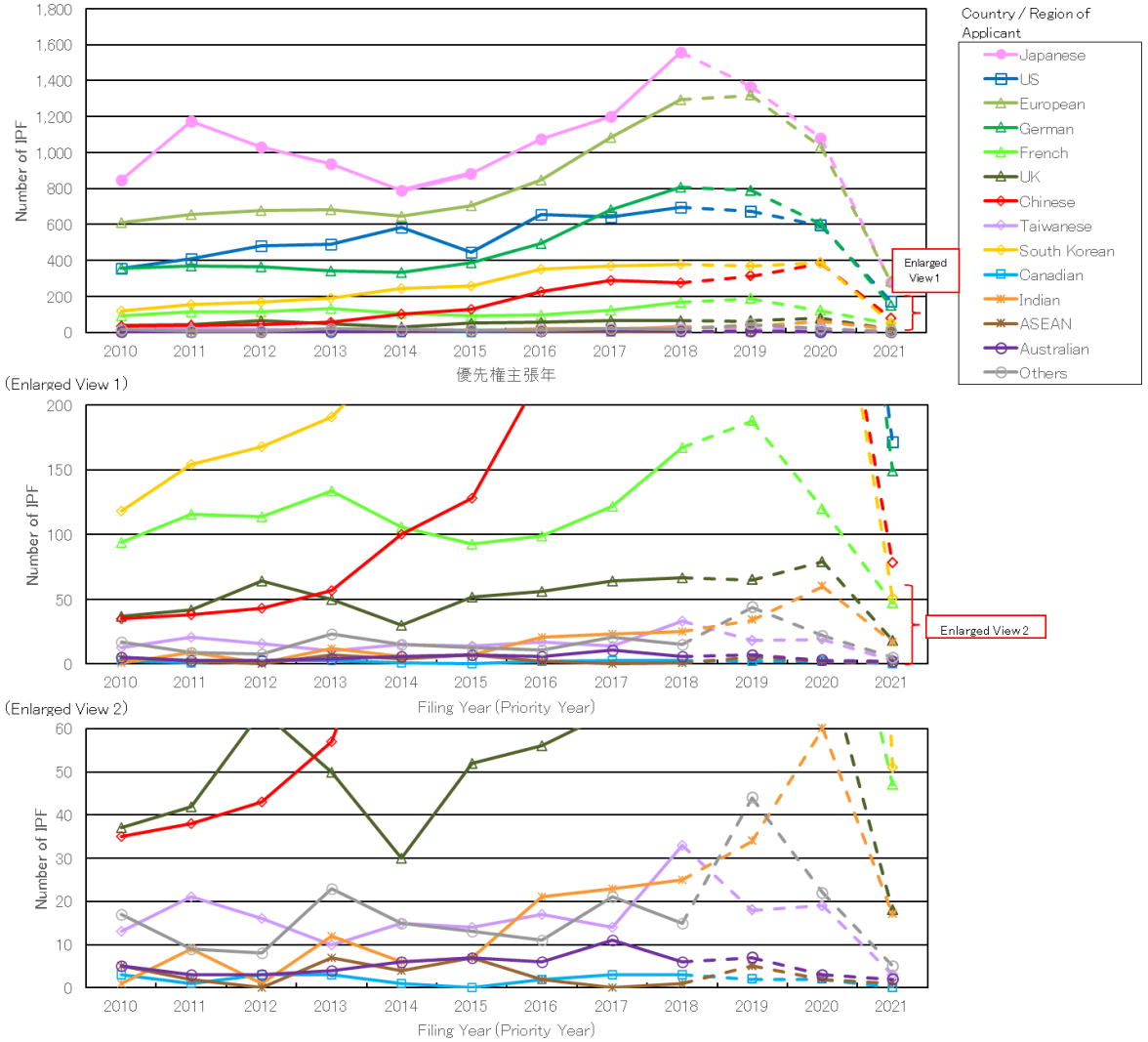
Database: Derwent™ Innovation

16. gxB05: Electromobilities

Annual trend in number of IPFs in "gxB05: Electromobilities" is shown in Figure 5-31 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by Japanese applicants is the largest, decreasing slightly from 2011 to 2014, after which the number of IPFs increases. The numbers of IPFs for European and US applicants continue to increase since 2010. The number of IPFs by Chinese applicants is on an increasing trend, but is lower than the number of IPFs by South Korean applicants. The number of IPFs by Indian applicants is on an increasing trend since 2015.

Figure 5-31 Annual trend in number of IPFs in "gxB05: Electromobilities" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



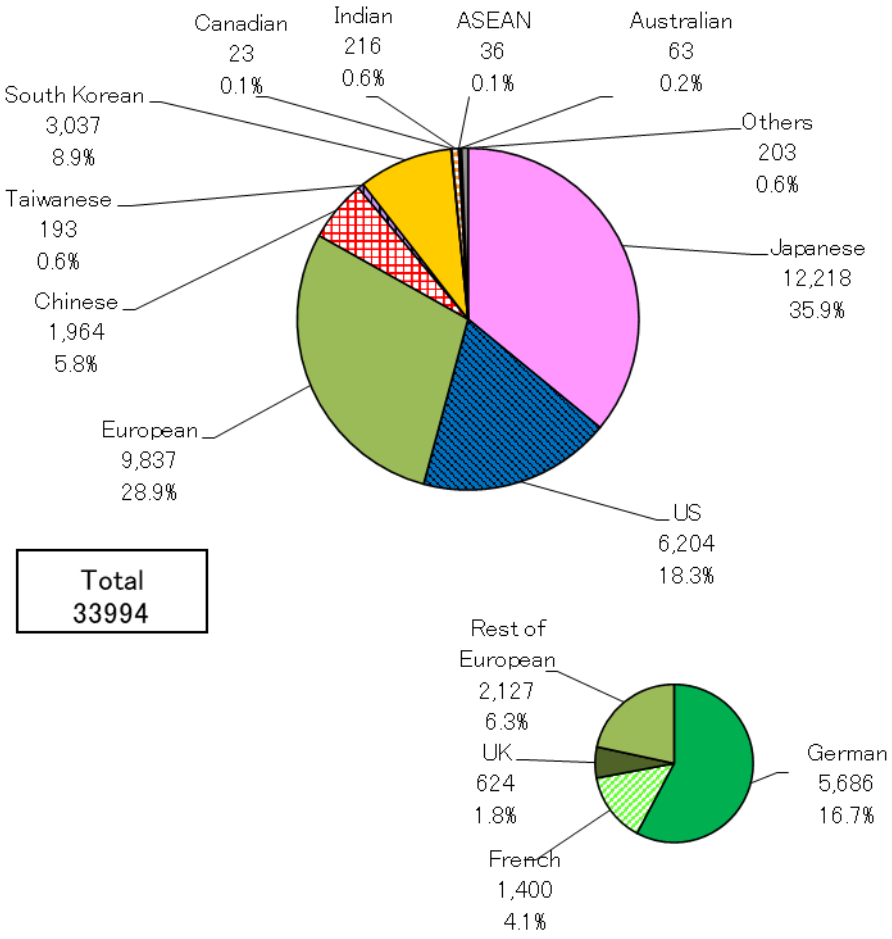
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-32 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, Japanese applicants account for the largest rate with 35.9%, followed by European, US, South Korean, and Chinese applicants. 97.8% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-32 Number of IPFs rates in "gxB05: Electromobilities" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



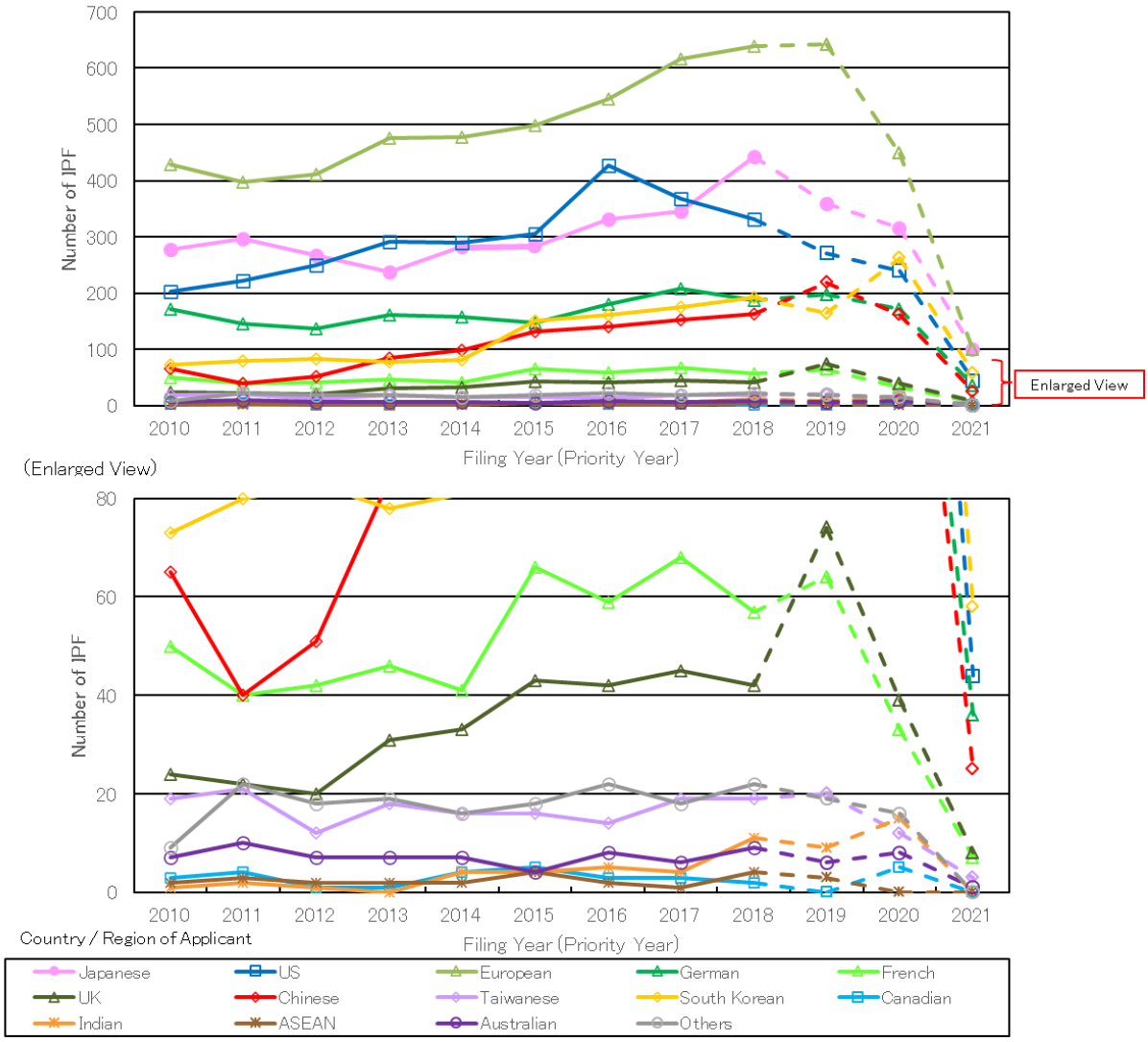
Database: Derwent™ Innovation

17. gxB06: Electrification of Industrial Heat

Annual trend in number of IPFs in “gxB06: Electrification of Industrial Heat” is shown in Figure 5-33 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by European applicants is the largest, then decreases slightly in 2011, but the number of IPFs is on an increasing trend since 2012. The numbers of IPFs for Japanese and US applicants increase in a similar manner to the number of IPFs by European applicants until 2016, with the ranking shifting in each year. The number of IPFs by Chinese applicants increases, and is expected to exceed the number of IPFs by South Korean applicants in 2019. The number of IPFs by Indian applicants is on an increasing trend since 2014.

Figure 5-33 Annual trend in number of IPFs in “gxB06: Electrification of Industrial Heat” by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



Database: Derwent™ Innovation

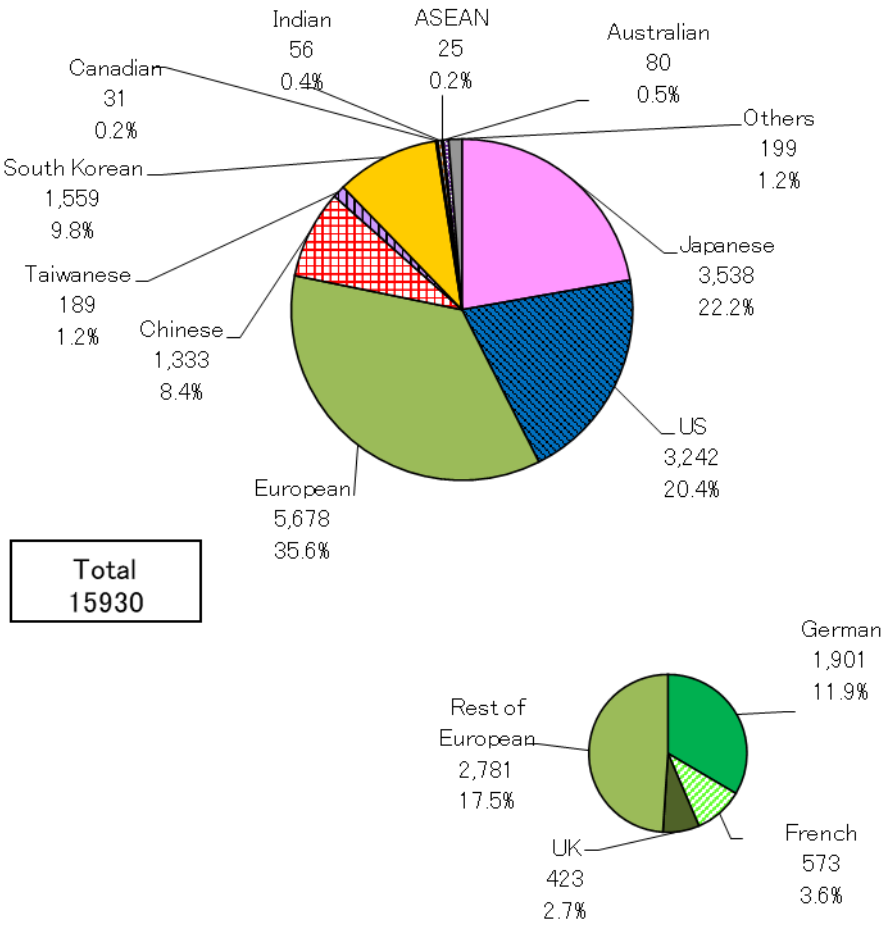
Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in

Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-34 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, European applicants account for the largest rate with 35.6%, followed by Japanese, US, South Korean, and Chinese applicants. 96.4% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-34 Number of IPFs rates in "gxB06: Electrification of Industrial Heat" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



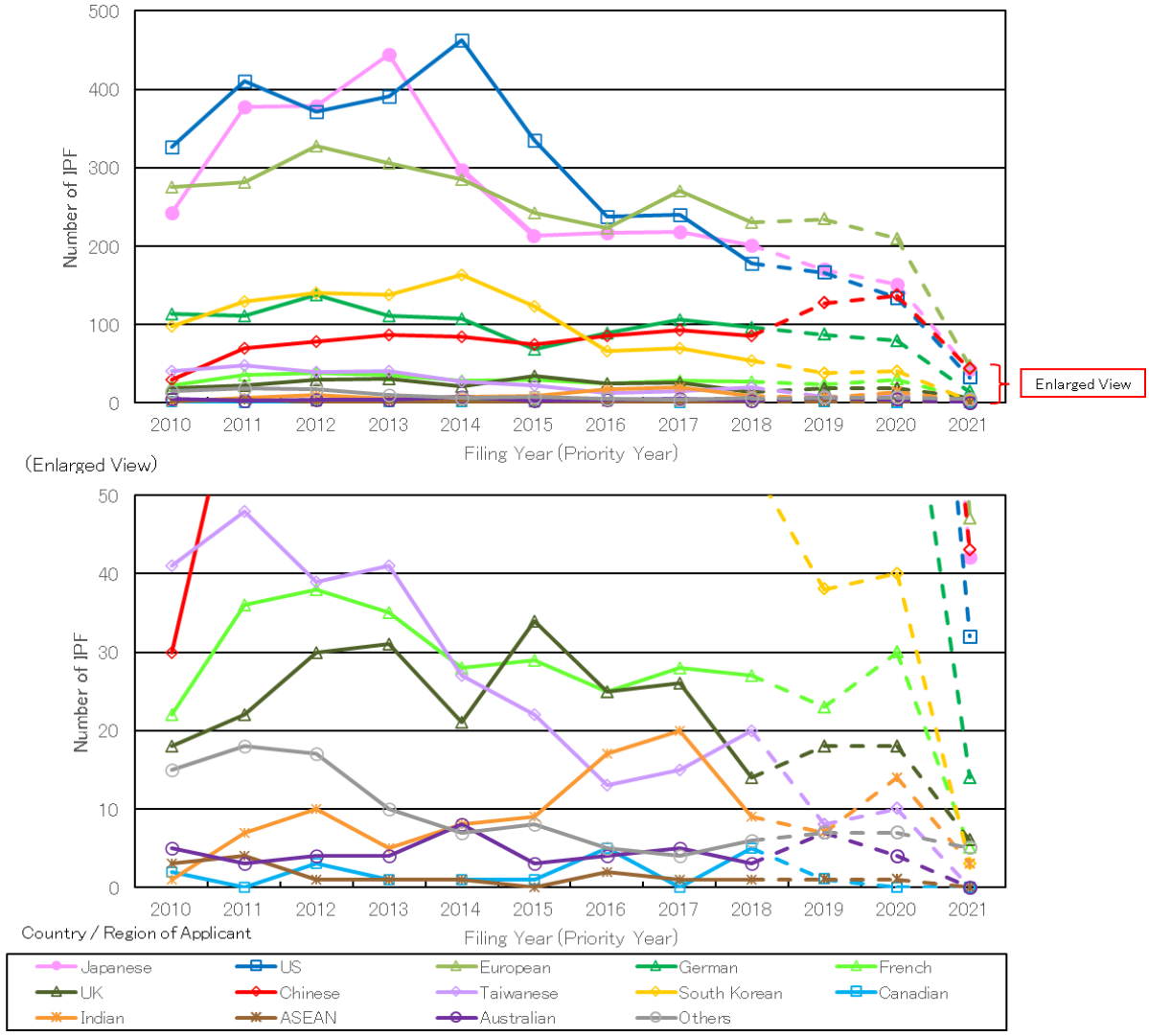
Database: Derwent™ Innovation

18. gxB07: Power Transmission and Distribution, Smart Grids

Annual trend in number of IPFs in “gxB07: Power Transmission and Distribution, Smart Grids” is shown in Figure 5-35 by country/region of applicant.

In the filing year (priority year) 2010, the number of IPFs by US applicants is the largest, followed by European, and Japanese applicants. Since 2011, the numbers of IPFs for US and Japanese applicants increase and decrease in a similar trend, with an increasing trend from around 2011 to 2013, and since 2014, the number of IPFs by US applicants fluctuates, exceeding the number of IPFs by Japanese applicants. Meanwhile, the number of IPFs by European applicants is almost flat, despite slight increases and decreases, and is the largest since 2017. The number of IPFs by Chinese applicants is on an increasing trend since 2010, exceeding the number of IPFs by South Korean applicants in 2016, and is expected to approach the numbers of IPFs for Japanese, US and European applicants from 2019. While the numbers of IPFs for applicants of most countries/regions tend to be almost flat, the number of IPFs by Indian applicants is on an increasing trend since around 2014.

Figure 5-35 Annual trend with the number of IPFs in "gxB07: Power Transmission and Distribution, Smart Grids" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



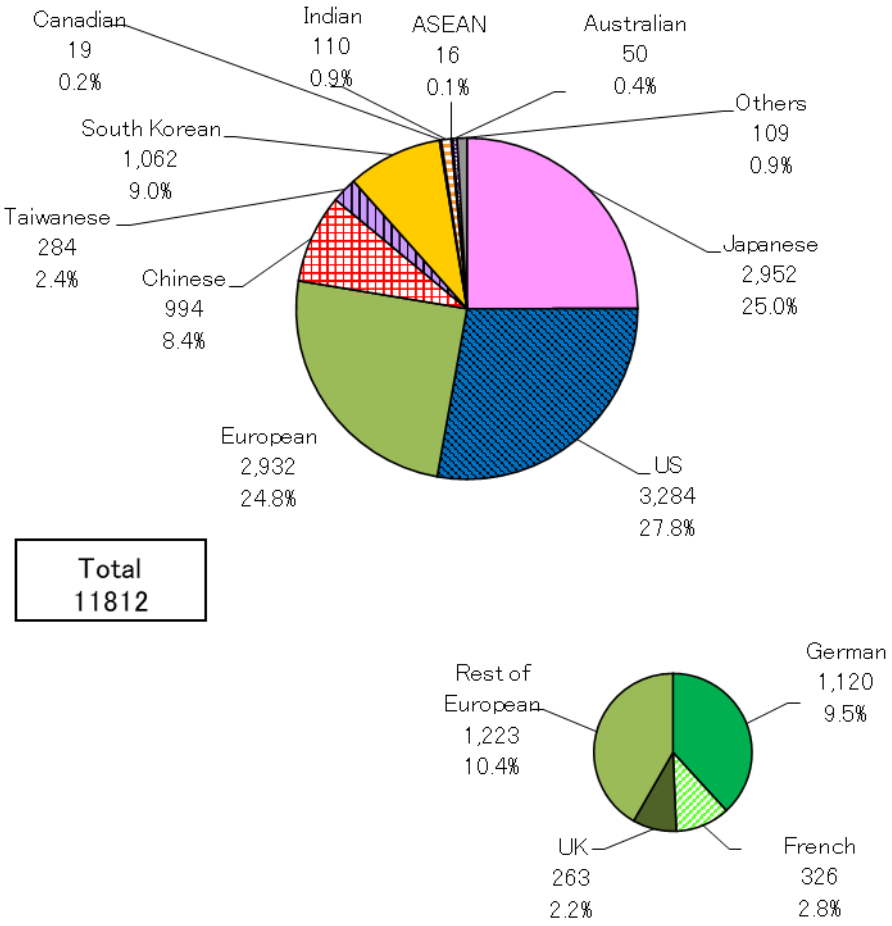
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-36 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, US applicants account for the largest rate with 27.8%, followed by Japanese, European, South Korean, and Chinese applicants. 95.0% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-36 Number of IPFs rates in “gxB07: Power Transmission and Distribution, Smart Grids” by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



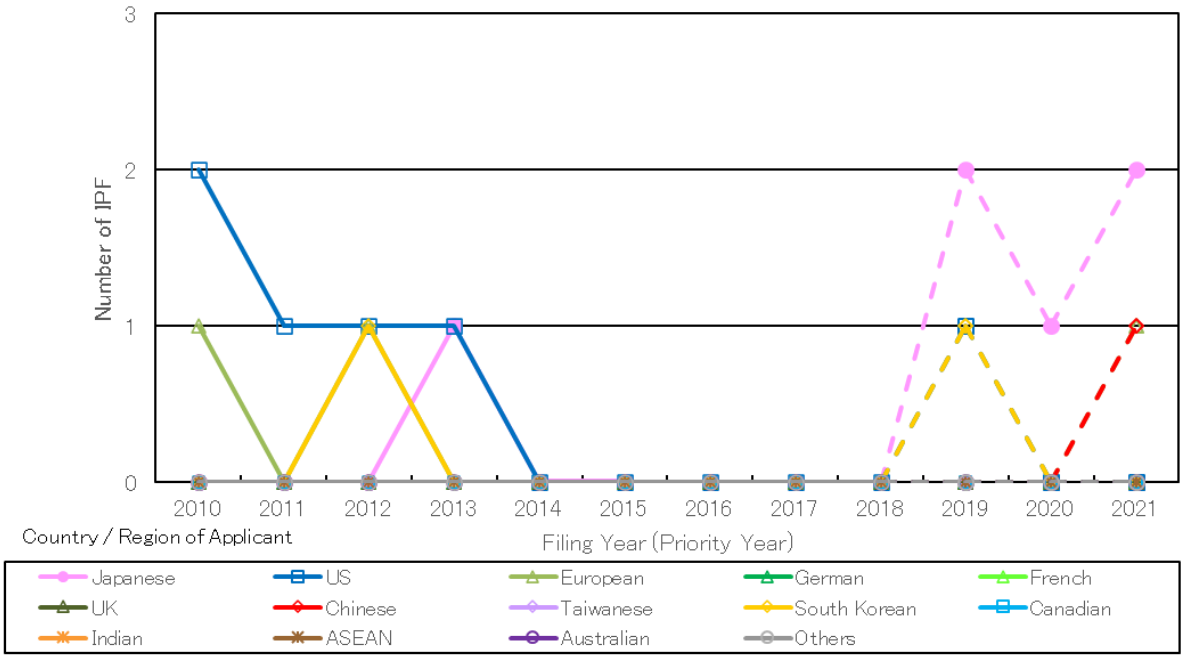
Database: Derwent™ Innovation

19. gxB08: Demand-Supply Flexibility of Power Systems

Annual trend in number of IPFs in "gxB08: Demand-Supply Flexibility of Power Systems" is shown in Figure 5-37 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by US, European, Japanese, and South Korean applicants fluctuate between 0 and 2 cases. Regarding the number of IPFs by applicants of other countries/regions, there is only one IPF by Chinese applicants in 2021.

Figure 5-37 Annual trend in number of IPFs in "gxB08: Demand-Supply Flexibility of Power Systems" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



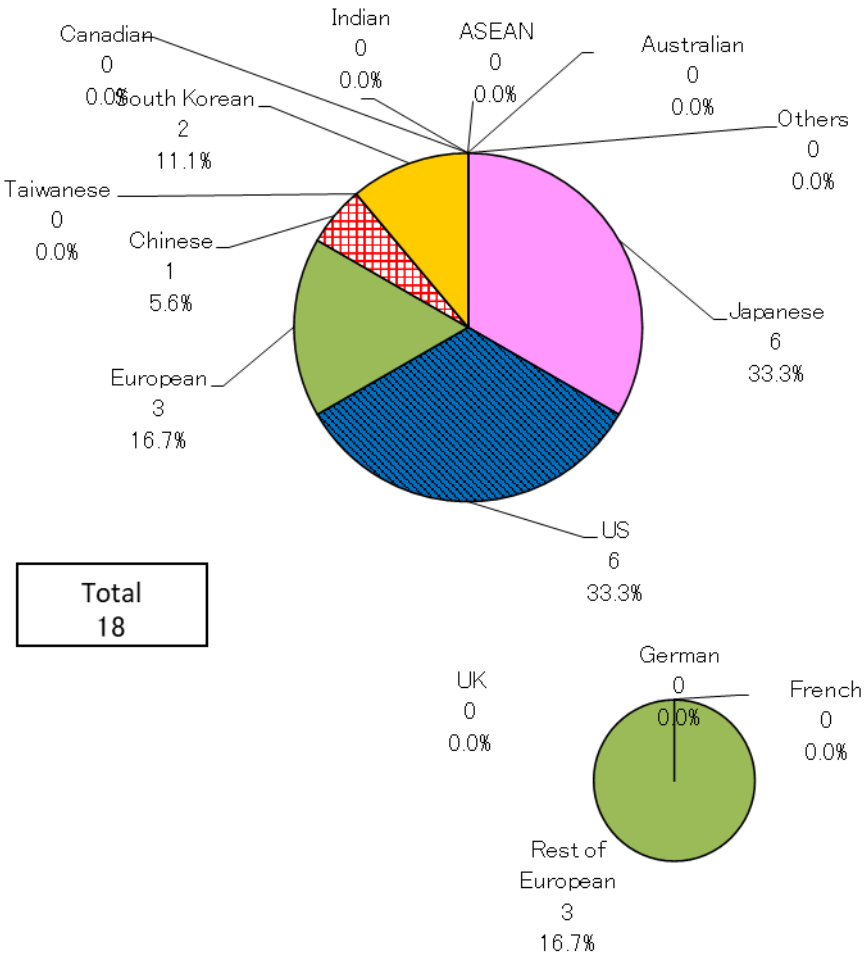
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-38 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, Japanese and US applicants account for the largest rate with 33.3%, followed by European, South Korean, and Chinese applicants. 100.0% of the IPFs filed in the countries/region surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-38 Number of IPFs rates in "gxB08: Demand-Supply Flexibility of Power Systems" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



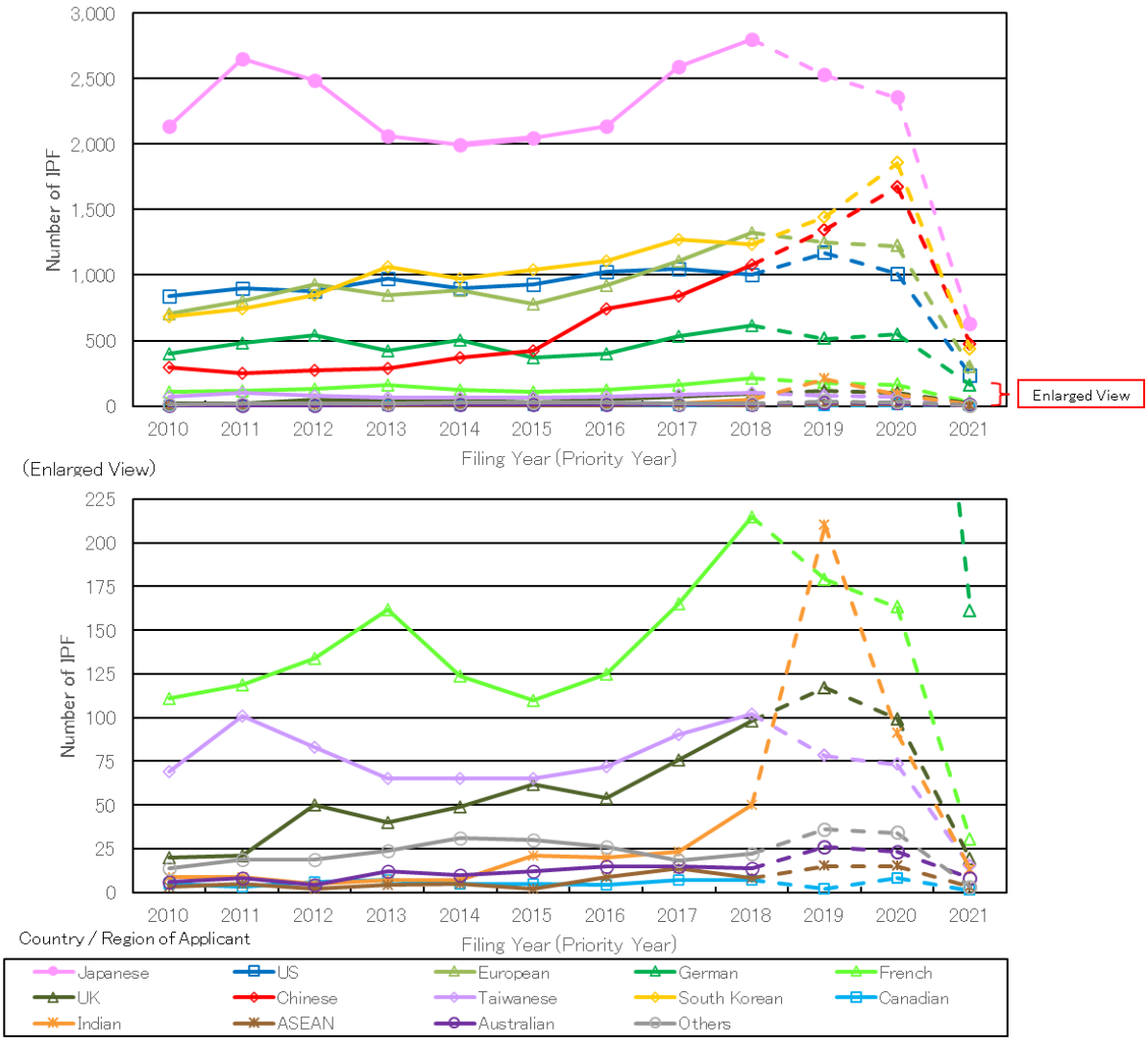
Database: Derwent™ Innovation

20. gxC01: Secondary Batteries

Annual trend in number of IPFs in "gxC01: Secondary Batteries" is shown in Figure 5-39 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by Japanese applicants is the largest and remains unchanged in the same ranking, but the number of IPFs by Japanese applicants decreases from 2012 to 2014 and shows an increasing trend again since 2015. The numbers of IPFs by US, European and South Korean applicants increase slowly in the second to fourth place. While the numbers of IPFs by applicants of most countries/regions are on a slowly increasing trend, the number of IPFs by Chinese applicants is on an increasing trend since 2014 and the number of IPFs by Indian applicants is on an increasing trend since 2017.

Figure 5-39 Annual trend in number of IPFs in "gxC01: Secondary Batteries" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



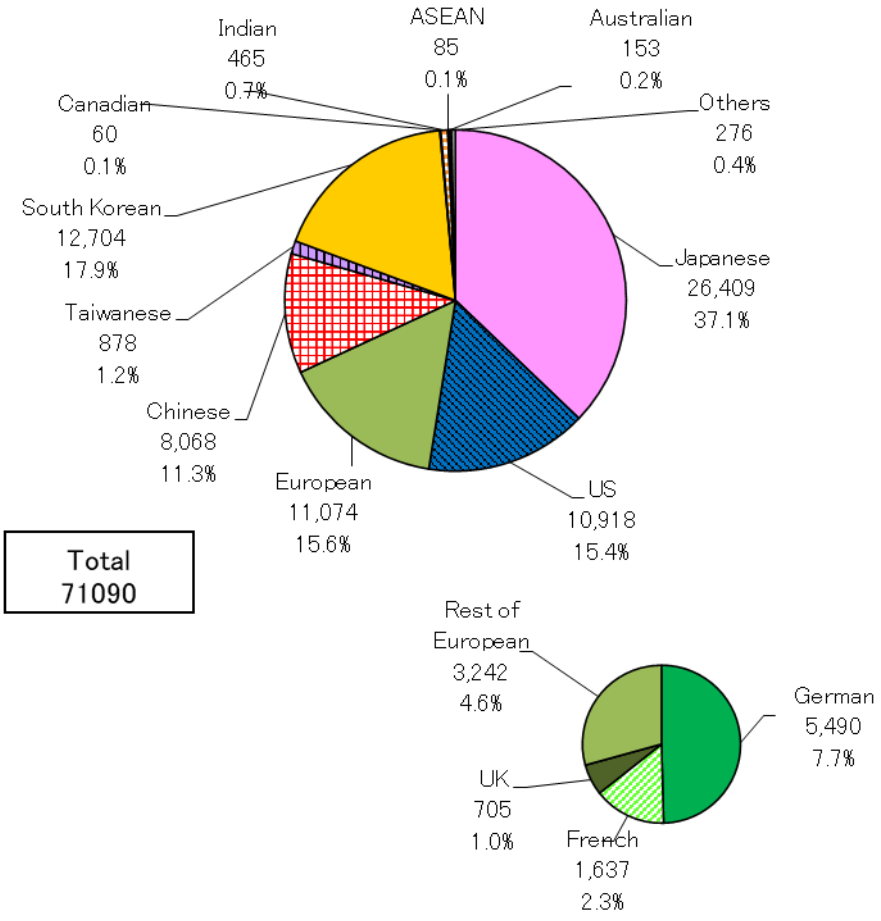
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-40 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, Japanese applicants account for the largest rate with 37.1%, followed by South Korean, European, US, and Chinese applicants. 97.3% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-40 Number of IPFs rates in "gxC01: Secondary Batteries" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



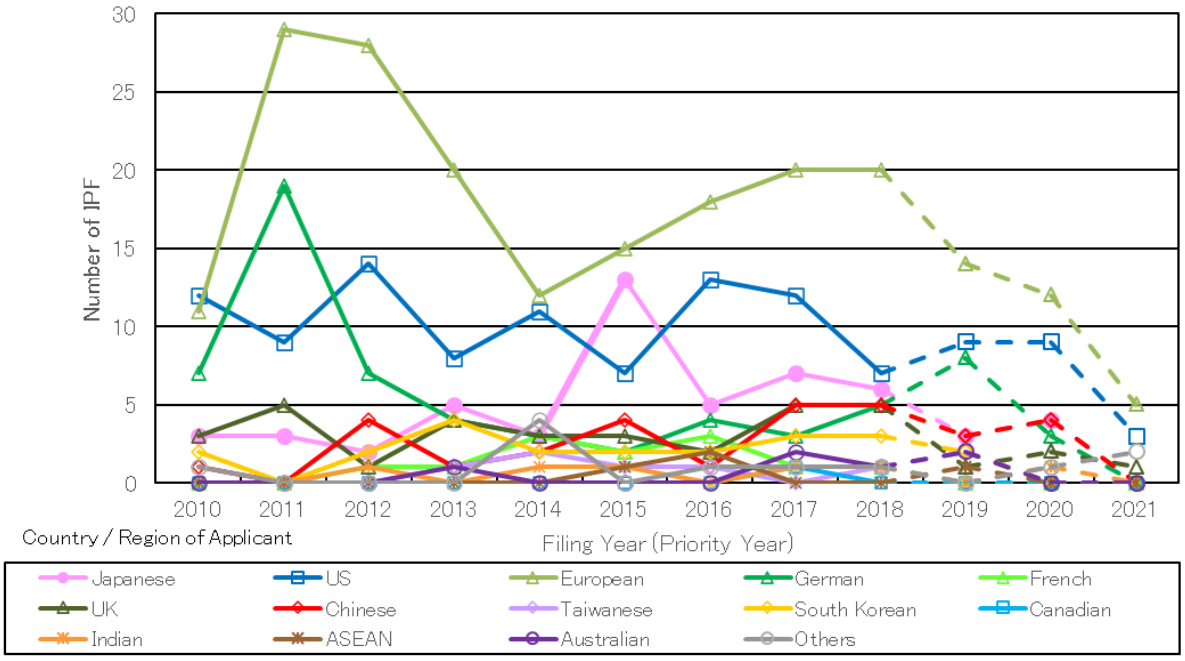
Database: Derwent™ Innovation

21. gxC02: Mechanical Energy Storage

Annual trend in number of IPFs in "gxC02: Mechanical Energy Storage" is shown in Figure 5-41 by country/region of applicant.

In the filing year (priority year) 2010, the number of IPFs by US applicants is the largest, but since 2011, the number of IPFs by European applicants exceeds it, repeatedly increasing and decreasing, but remaining unchanged in the same ranking. Meanwhile, the number of IPFs by US applicants fluctuates at almost the same level since 2011 as in 2010. The number of IPFs by Japanese applicants increases through repeated increases and decreases, temporarily exceeding the number of IPFs by US applicants in 2015 and becoming second only to the number of IPFs by European applicants. While the numbers of IPFs for applicants of most countries/regions tend to be almost flat, increasing and decreasing, the number of IPFs by Chinese applicants is on a slightly increasing trend since 2012.

Figure 5-41 Annual trend with the number of IPFs in "gxC02: Mechanical Energy Storage" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



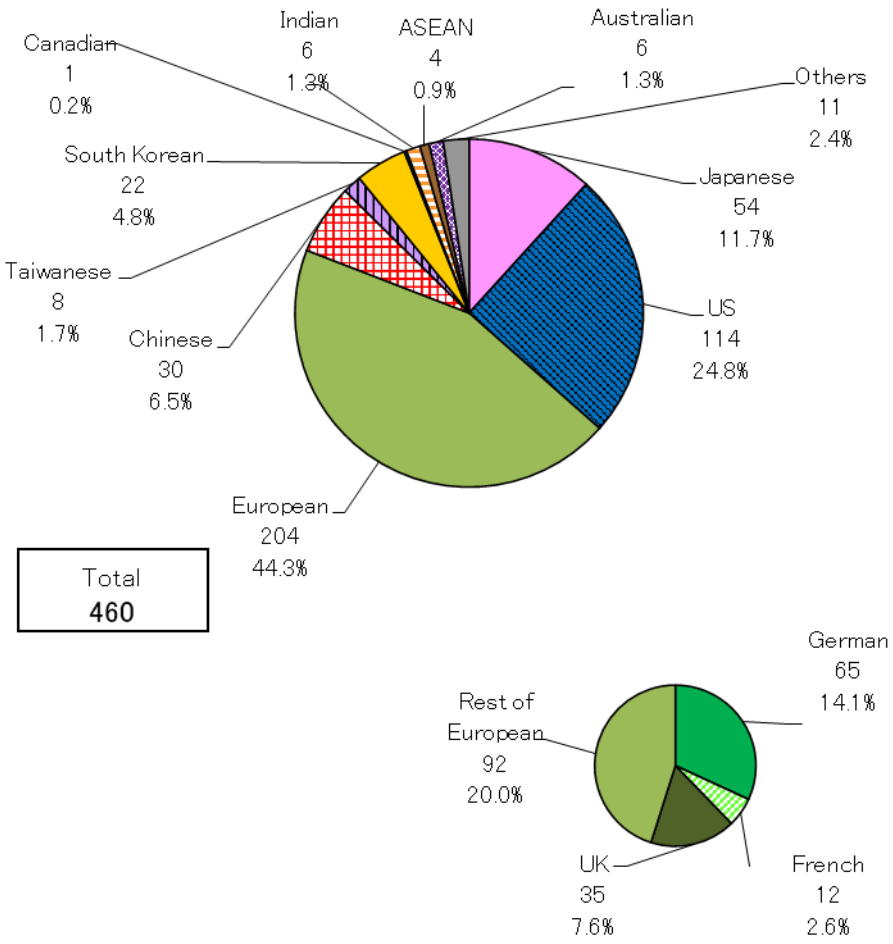
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-42 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers by European applicants.

In terms of the number of IPFs rates, European applicants account for the largest rate with 44.3%, followed by US, Japanese, Chinese, and South Korean applicants. 92.2% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-42 Number of IPFs rates in "gxC02: Mechanical Energy Storage" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



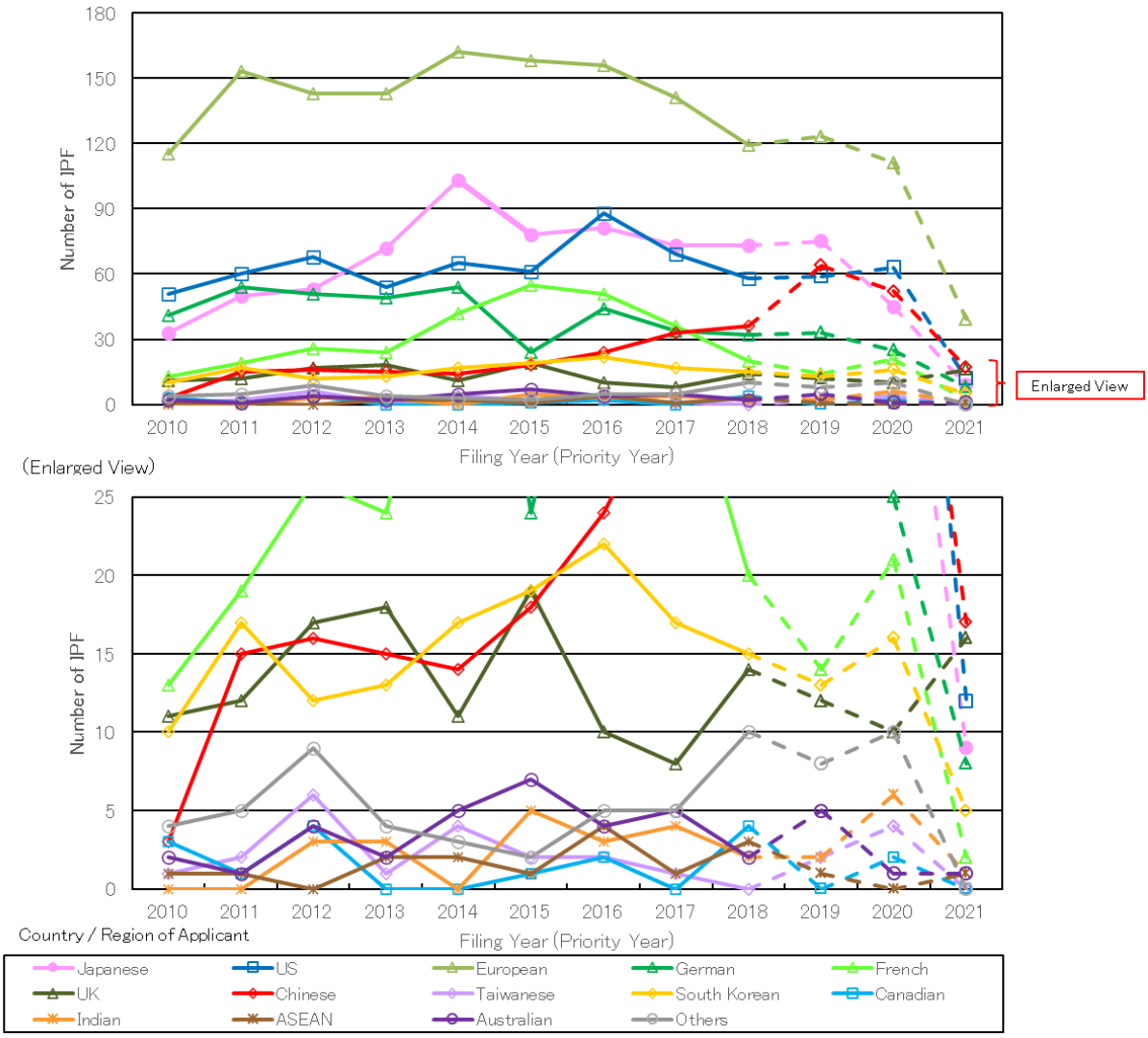
Database: Derwent™ Innovation

22. gxC03: Thermal Energy Storage

Annual trend in number of IPFs in "gxC03: Thermal Energy Storage" is shown in Figure 5-43 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by European applicants is the largest, with an increasing trend from 2011 to 2016, followed by a decreasing trend from 2017, remaining unchanged in the same ranking. The numbers of IPFs by US and Japanese applicants are on an increasing trend, with the ranking shifting from 2011 to 2016, and the number of IPFs remains stable since 2017. In addition, the number of IPFs by Chinese applicants increases since 2015 and exceeds the number of IPFs by German applicants in 2018, ranking fourth behind those for European, Japanese and US applicants. The numbers of IPFs by applicants of most countries/regions tend to be almost flat or to increase slightly.

Figure 5-43 Annual trend in number of IPFs in "gxC03: Thermal Energy Storage" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



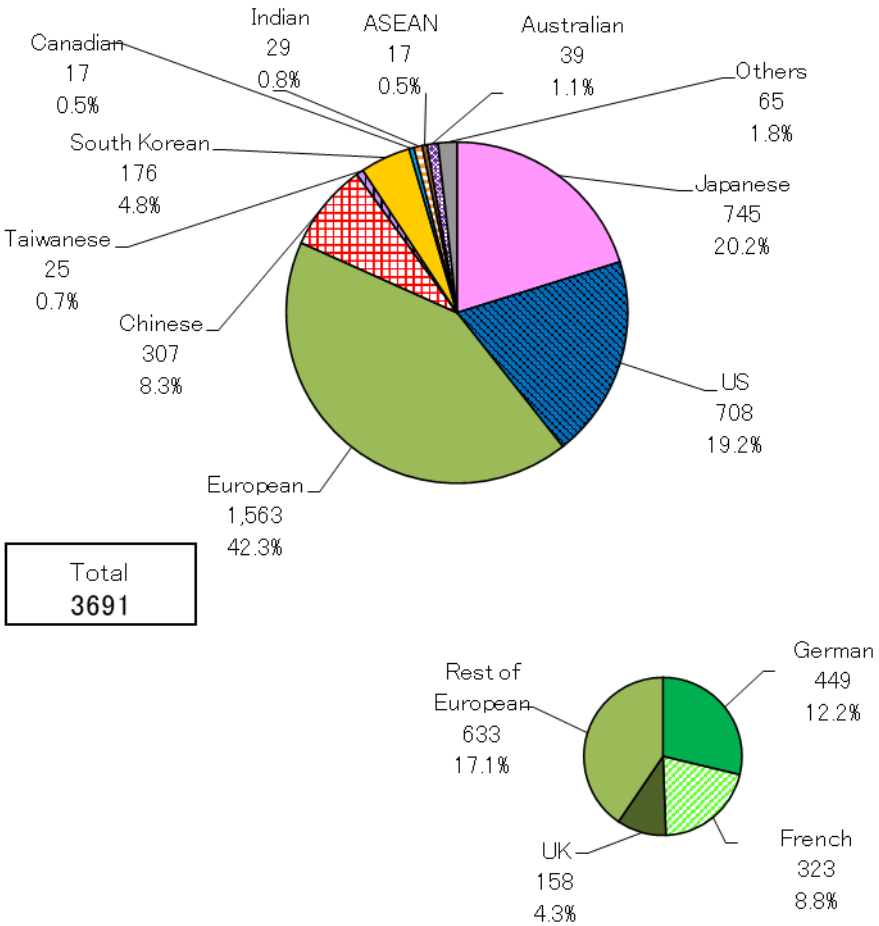
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-44 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of IPFs by European applicants.

In terms of the number of IPFs rates, European applicants account for the largest rate with 42.3%, followed by Japanese, US, Chinese, and South Korean applicants. 94.8% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-44 Number of IPFs rates in "gxC03: Thermal Energy Storage" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



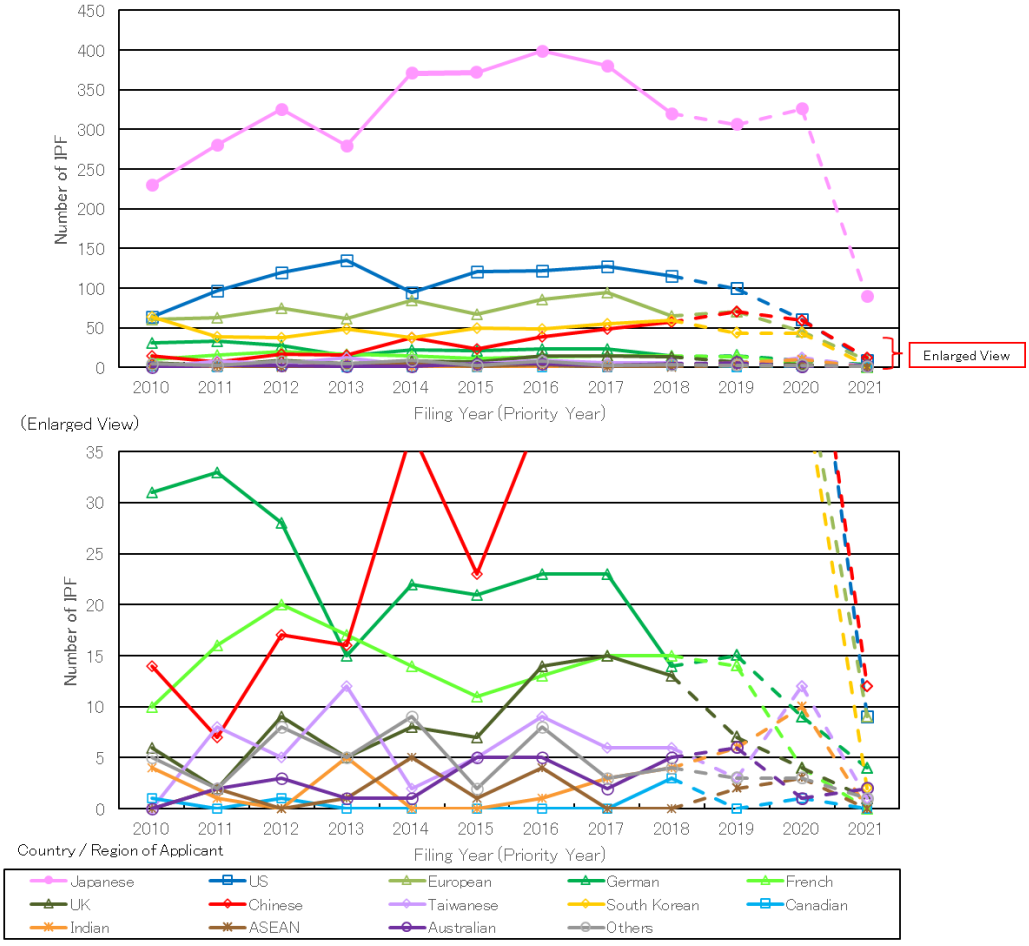
Database: Derwent™ Innovation

23. gxC04: Electric Double Layer Capacitors, Hybrid Capacitors

Annual trend in number of IPFs in "gxC04: Electric Double Layer Capacitors, Hybrid Capacitors" is shown in Figure 5-45 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by Japanese applicants is the largest and on an increasing trend from 2010 to 2016, but remains unchanged in the same ranking, although it starts to decrease since 2017. The numbers of IPFs by US and European applicants follow a similar trend to the number of IPFs by Japanese applicants, with an increasing trend from 2010 to 2016 and a decreasing trend from around 2017. While the numbers of IPFs by applicants of most countries/regions peak around 2016 and tend to increase and decrease slightly, the number of IPFs by Chinese applicants tends to increase since around 2012 and almost reaches the number of IPFs by European applicants around 2018.

Figure 5-45 Annual trend in number of IPFs in "gxC04: Electric Double Layer Capacitors, Hybrid Capacitors" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



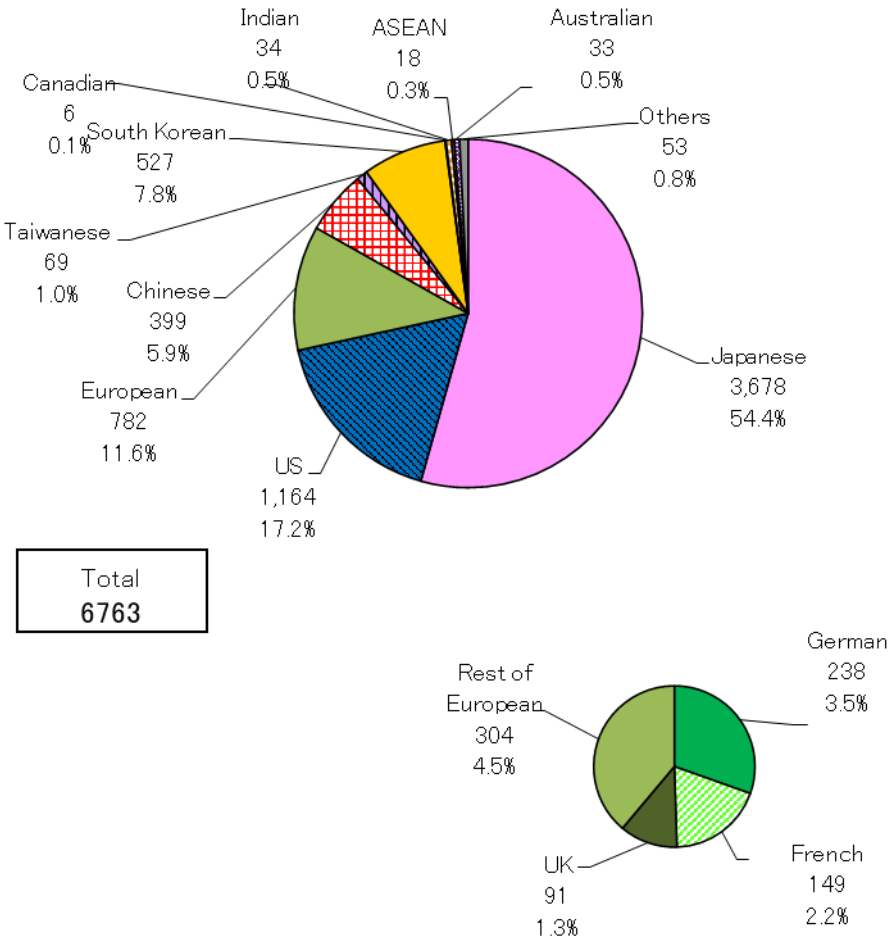
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-46 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of IPFs by European applicants.

In terms of the number of IPFs rates, Japanese applicants account for the largest rate with 54.4%, followed by US, European, South Korean, and Chinese applicants. 96.9% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-46 Number of IPFs rates in "gxC04: Electric Double Layer Capacitors, Hybrid Capacitors" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



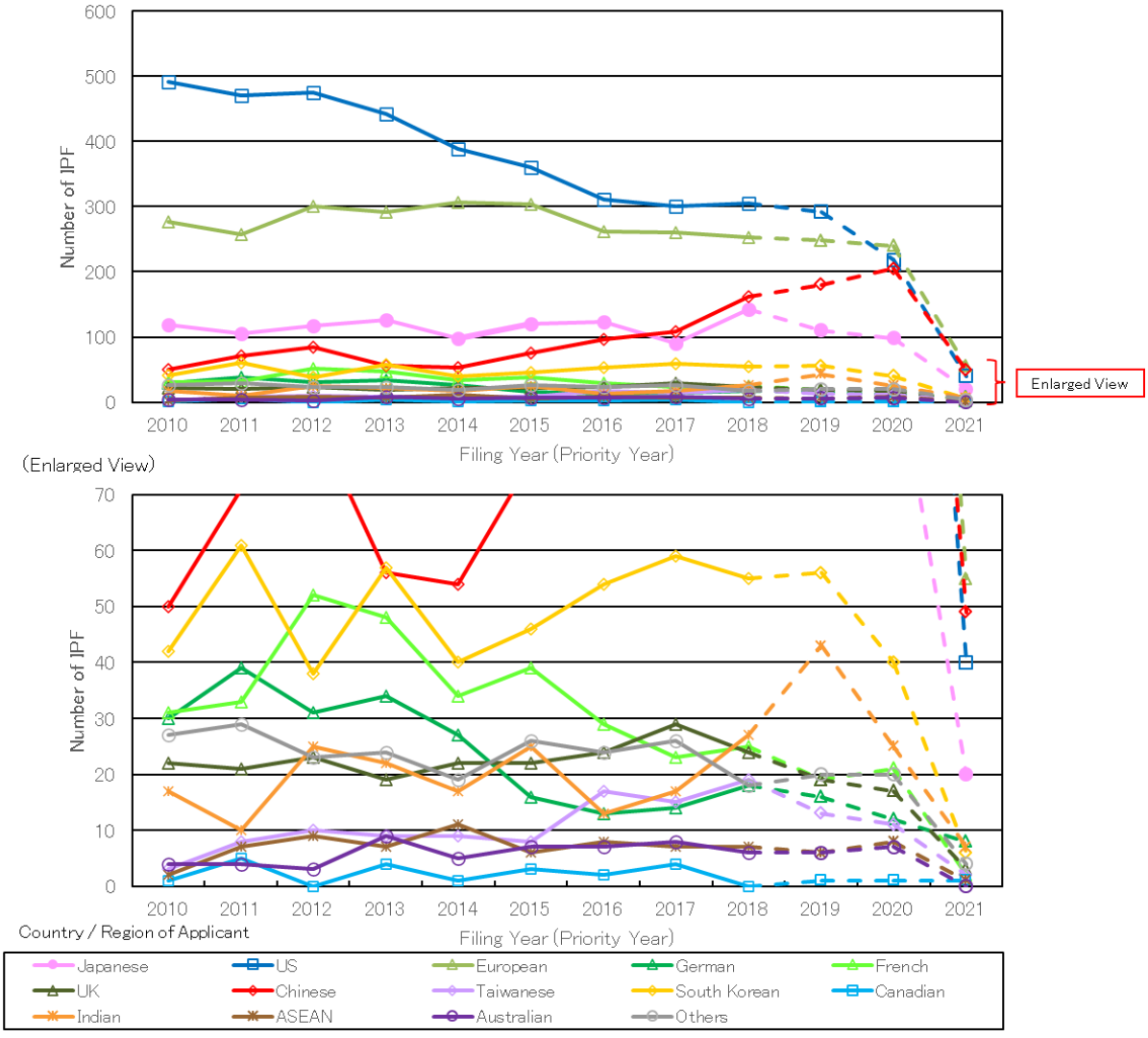
Database: Derwent™ Innovation

24. gxD01: Chemical Production from Biomass

Annual trend in number of IPFs in "gxD01: Chemical Production from Biomass" is shown in Figure 5-47 by country/region of applicant.

Since the filing year (priority year) 2010, while the number of IPFs by US applicants is the largest and then decreases slightly, the number of IPFs by European applicants tends to be close to the number of IPFs by US applicants. While the numbers of IPFs by applicants of most countries/regions tend to be almost flat, the number of IPFs by Chinese applicants is on an increasing trend since 2014, exceeding the number of IPFs by Japanese applicants in 2017, and is expected to approach the number of IPFs by European applicants in 2020. The number of IPFs by Indian applicants is on an increasing trend since 2017.

Figure 5-47 Annual trend with the number of IPFs in "gxD01: Chemical Production from Biomass" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



Database: Derwent™ Innovation

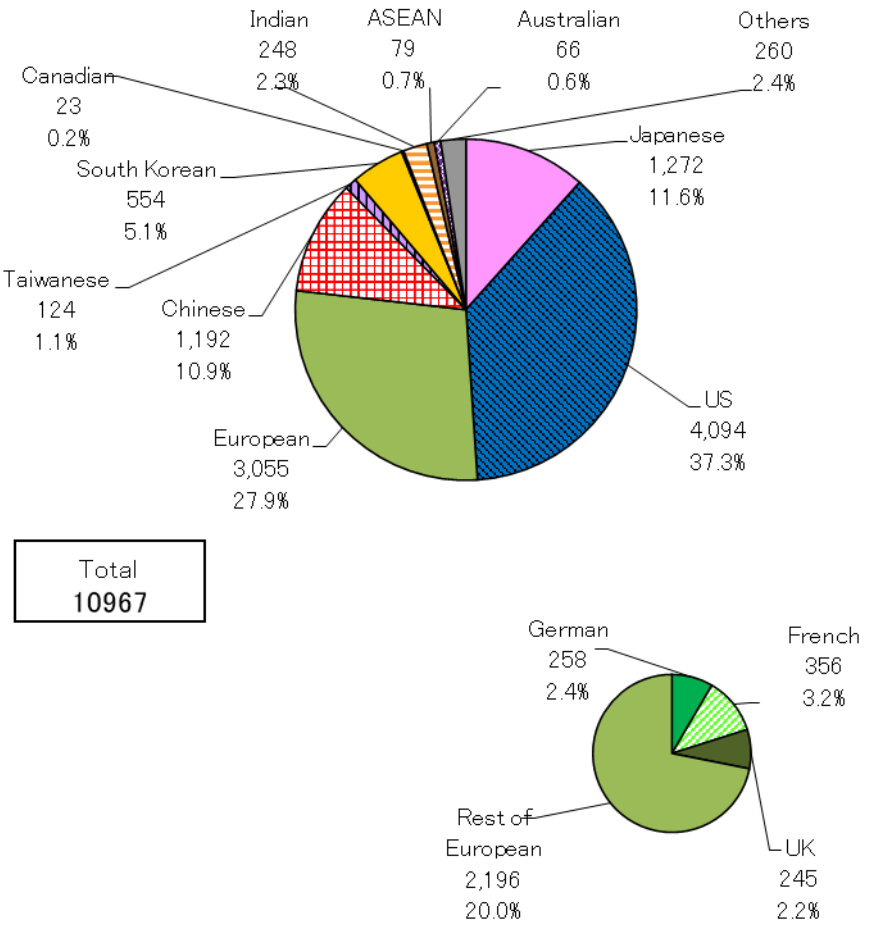
Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in

Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-48 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates by the numbers of European applicants.

In terms of the number of IPFs rates, US applicants account for the largest rate with 37.3%, followed by European, Japanese, Chinese, and South Korean applicants. 92.7% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-48 Number of IPFs rates in "gxD01: Chemical Production from Biomass" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



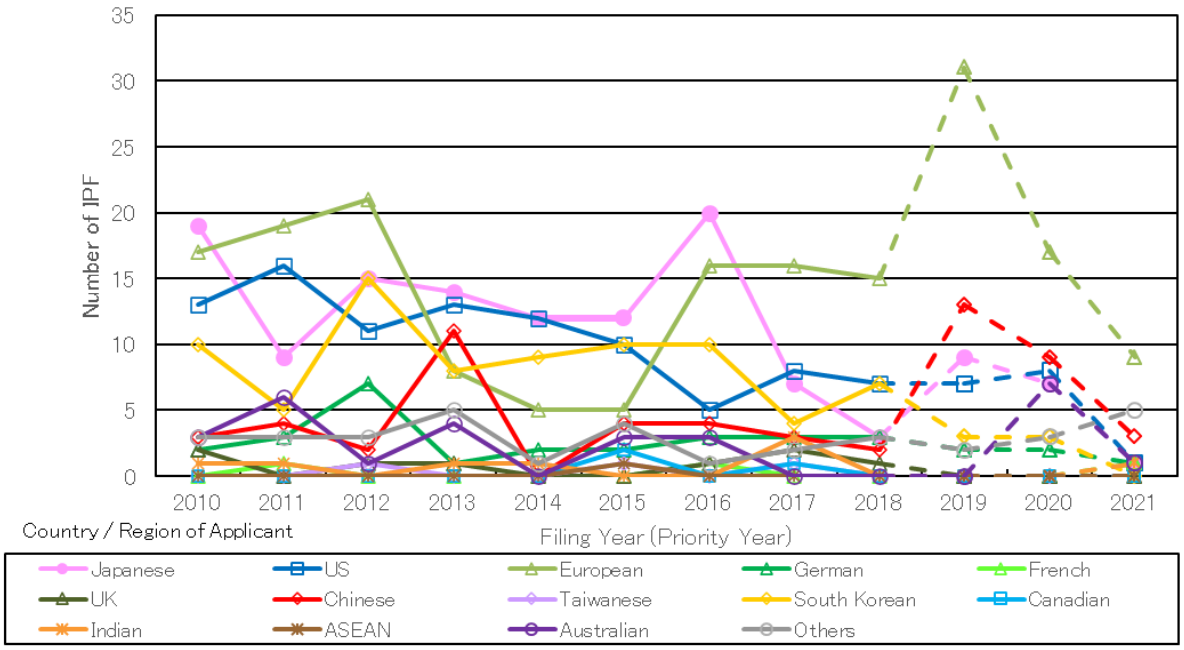
Database: Derwent™ Innovation

25. gxD02: Reduction of CO_2 Emission in Steelmaking Process

Annual trend in number of IPFs in "gxD02: Reduction of CO_2 Emission in Steelmaking Process" is shown in Figure 5-49 by country/region of applicant.

In the filing year (priority year) 2010, the number of IPFs by Japanese applicants is the largest, followed by European, US, and South Korean applicants. Since then, the ranking changes from year to year, but the numbers of IPFs by Japanese, European, US and Korean applicants still tend to be large. The numbers of IPFs by applicants of most countries/regions increase and decrease from year to year, but tend to be almost flat.

Figure 5-49 Annual trend with the number of IPFs in "gxD02: Reduction of CO_2 Emission in Steelmaking Process" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



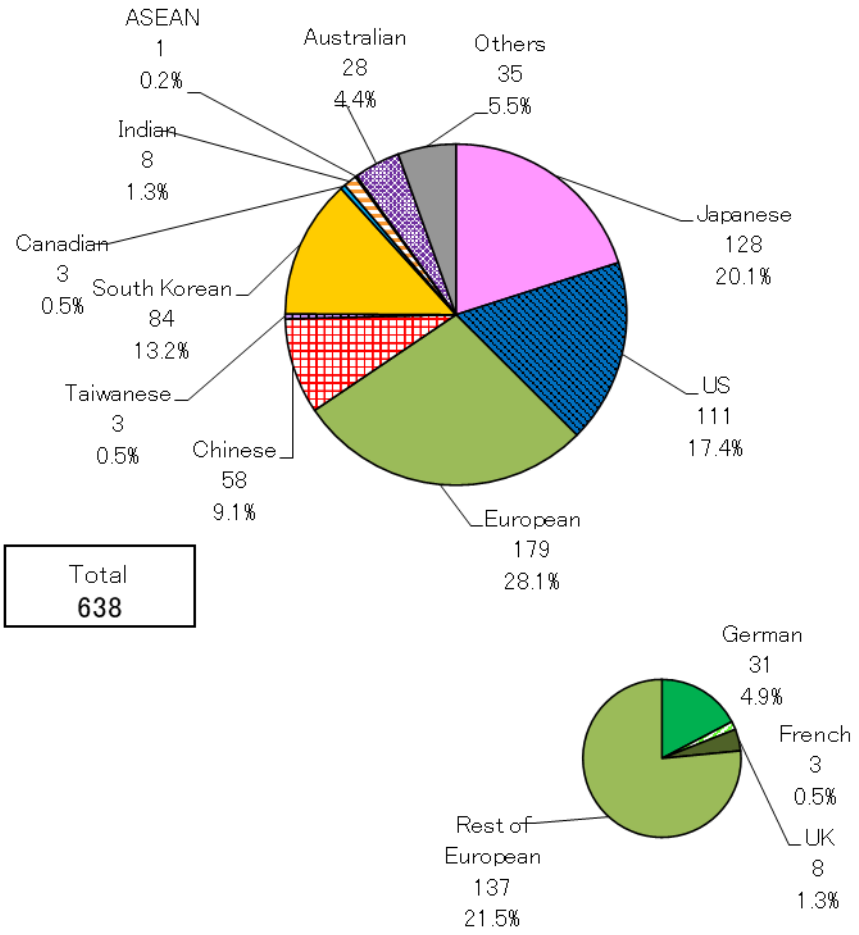
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-50 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of IPFs by European applicants.

In terms of the number of IPFs rates, European applicants account for the largest rate with 28.1%, followed by Japanese, US, South Korean, and Chinese applicants. 87.8% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-50 Number of IPFs rates in "gxD02: Reduction of CO_2 Emission in Steelmaking Process" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



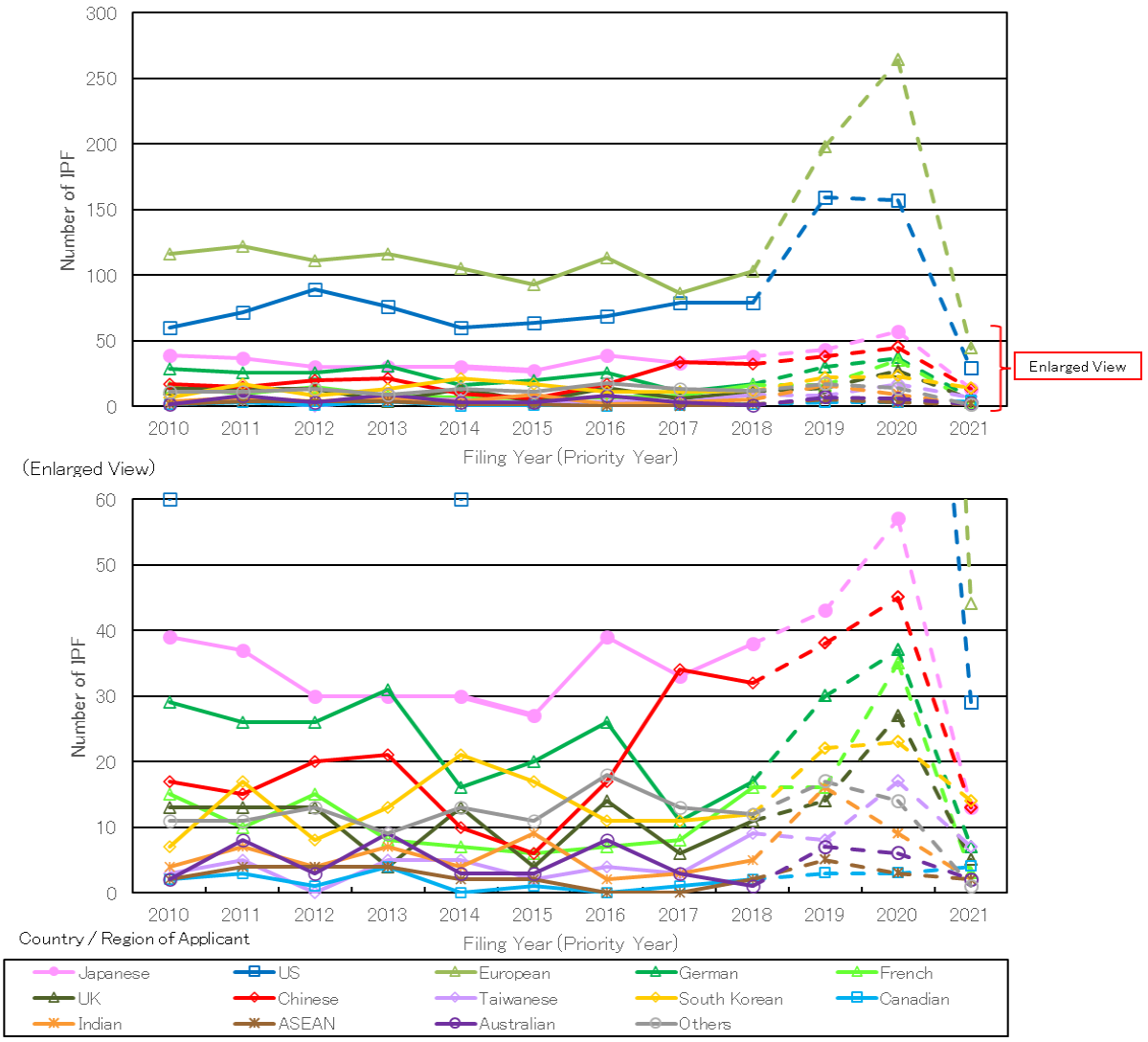
Database: Derwent™ Innovation

26. gxD03: Recycling

Annual trend in number of IPFs in "gxD03: Recycling" is shown in Figure 5-51 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by European applicants is the largest, followed by US and Japanese applicants. In addition, the number of IPFs by Chinese applicants increases since 2010, and by 2017 the number of IPFs by Chinese applicants is almost equal to that for Japanese applicants. The numbers of families for applicants of most countries/regions tend to be almost flat or to increase slightly.

Figure 5-51 Annual trend in number of IPFs in "gxD03: Recycling" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



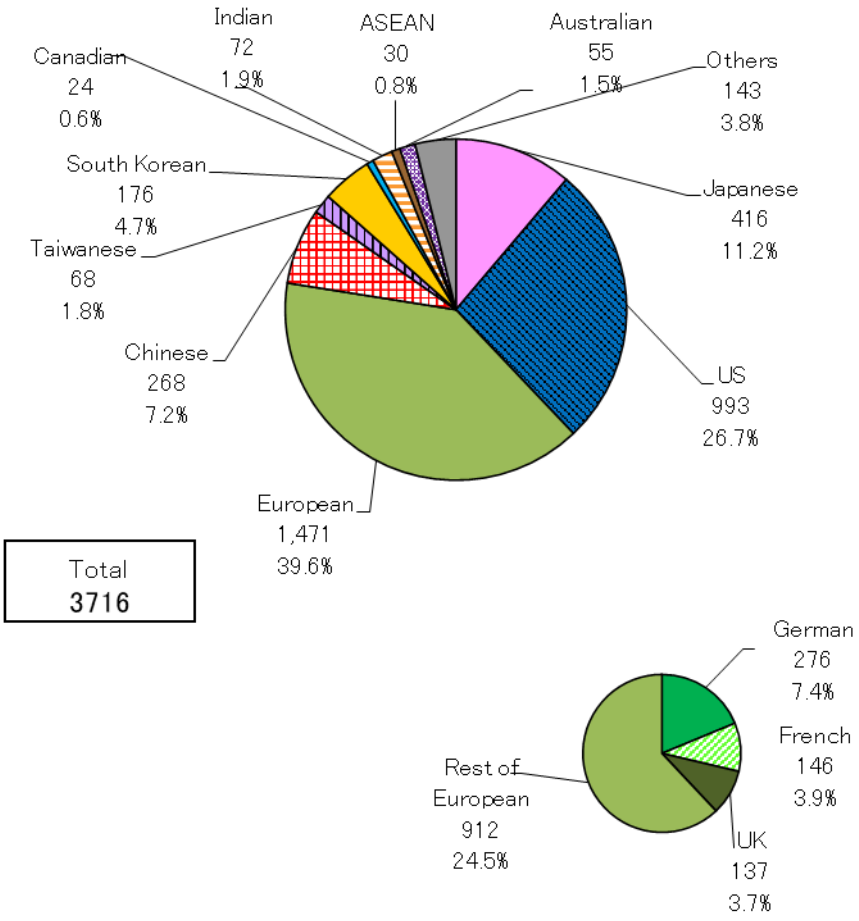
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-52 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of IPFs by European applicants.

In terms of the number of IPFs rates, European applicants account for the largest rate with 39.6%, followed by US, Japanese, Chinese, and South Korean applicants. 89.5% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-52 Number of IPFs rates in "gxD03: Recycling" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



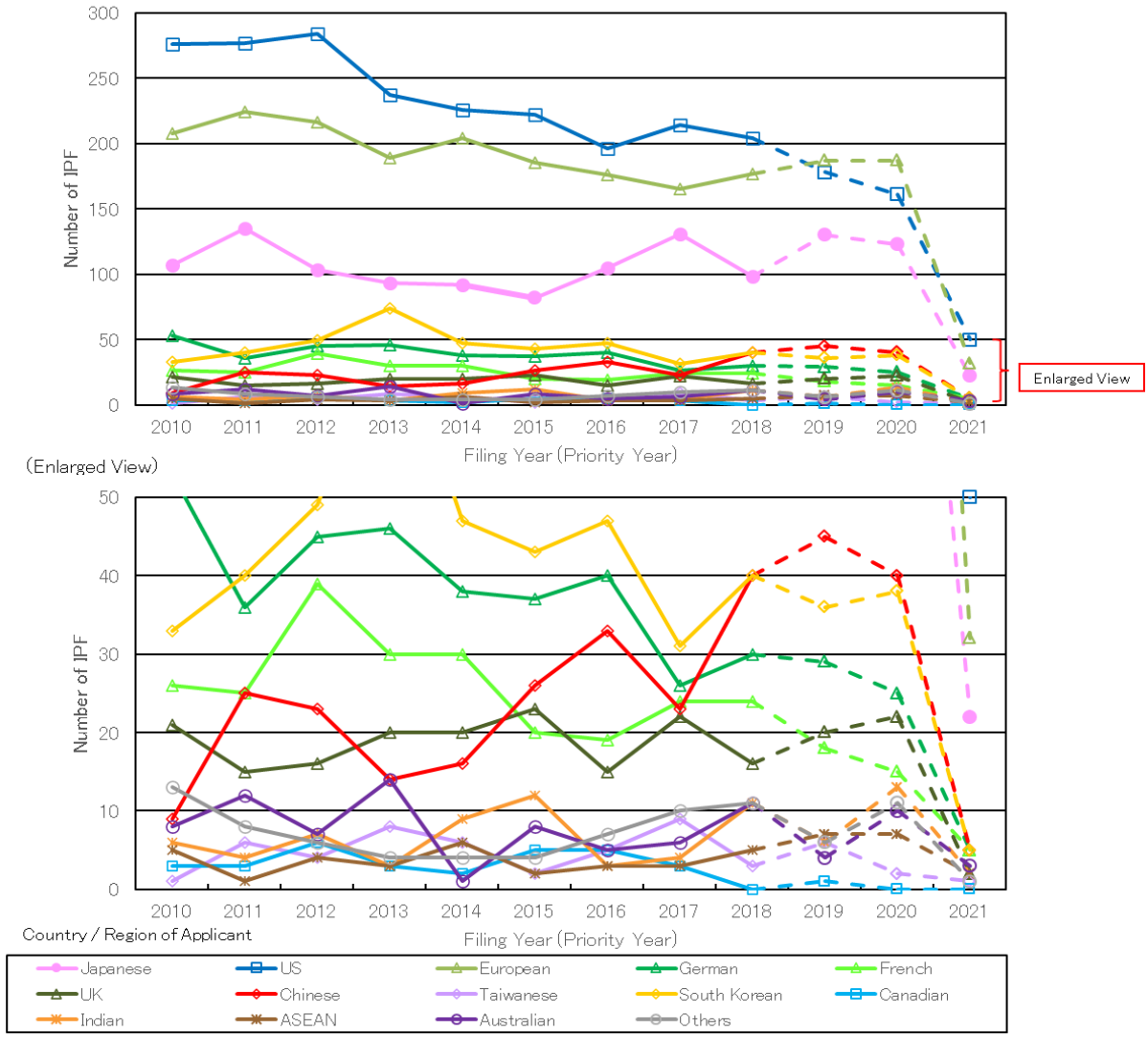
Database: Derwent™ Innovation

27. gxE01: CCS, CCUS, Negative Emission

Annual trend in number of IPFs in “gxE01: CCS, CCUS, Negative Emission” is shown in Figure 5-53 by country/region of applicant.

Since the filing year (priority year) 2010, until 2018, the number of IPFs by US applicants is the largest, followed by European and Japanese applicants. Since 2019, the number of IPFs by European applicants is on track to exceed the number of IPFs by US applicants. While the numbers of IPFs by applicants of most countries/regions are almost flat, the number of IPFs by Chinese applicants increases since around 2014 and is expected to exceed the number of IPFs by South Korean applicants in 2019, following the number of IPFs by Japanese applicants.

Figure 5-53 Annual trend with the number of IPFs in “gxE01: CCS, CCUS, Negative Emission” by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



Database: Derwent™ Innovation

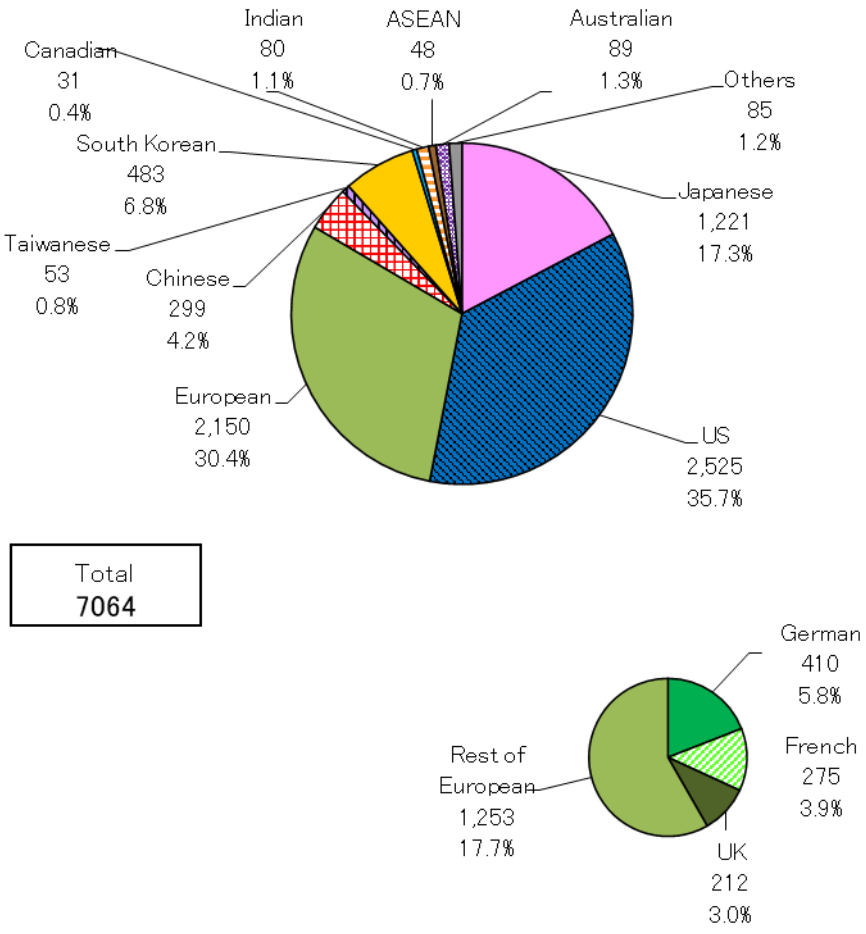
Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in

Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-54 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of IPFs by European applicants.

In terms of the number of IPFs rates, US applicants account for the largest rate with 35.7%, followed by European, Japanese, South Korean, and Chinese applicants. 94.5% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-54 Number of IPFs rates in "gxE01: CCS, CCUS, Negative Emission" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



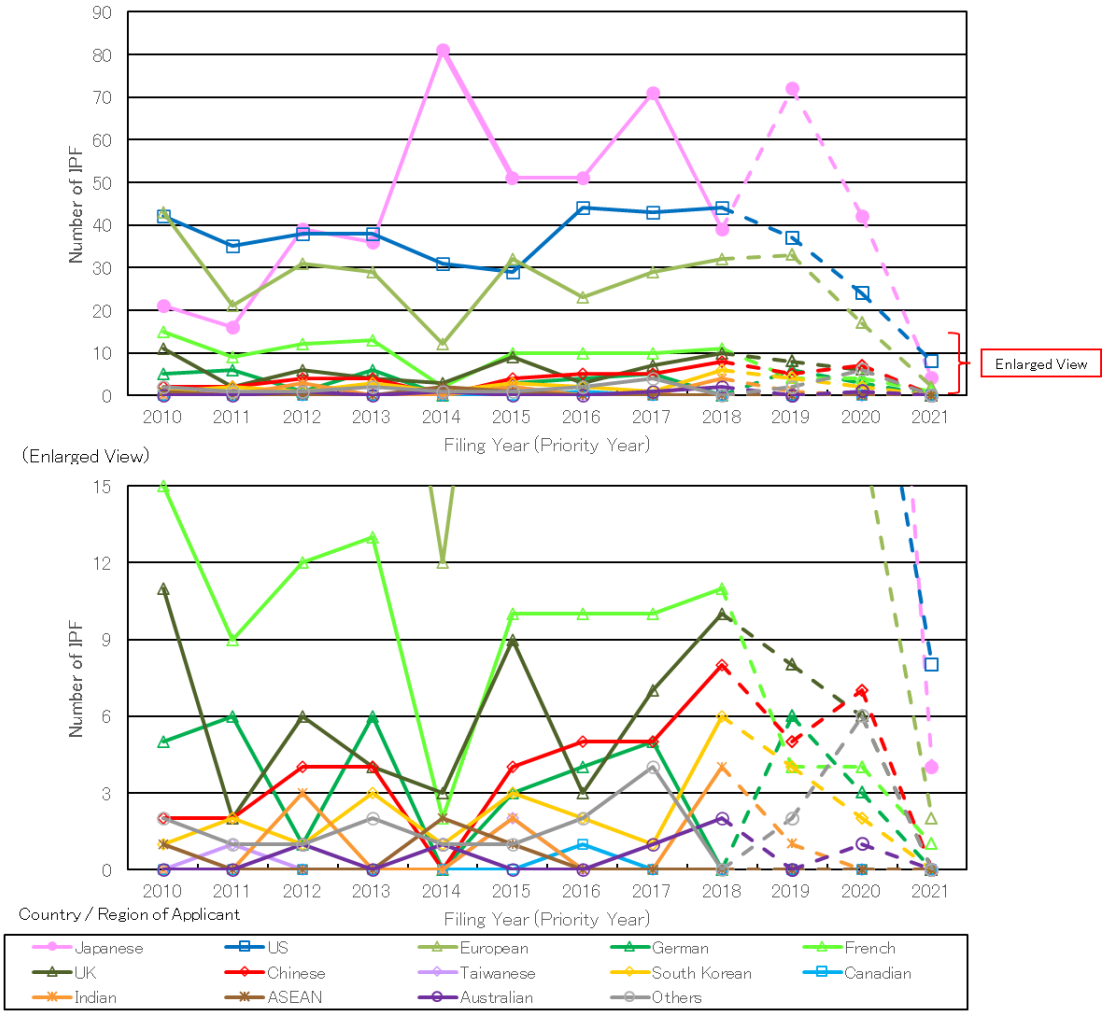
Database: Derwent™ Innovation

28. gxE02: Measures Against Non-CO_2 Greenhouse Gases

Annual trend in number of IPFs in "gxE02: Measures Against Non-CO_2 Greenhouse Gases" is shown in Figure 5-55 by country/region of applicant.

In the filing year (priority year) 2010, the numbers of IPFs by US and European applicants are almost equal and the largest, followed by the number of IPFs by Japanese applicants, thereafter, the number of IPFs by Japanese applicants increases and reaches the number of IPFs by US applicants in 2012 and 2013, and since then the number of IPFs by Japanese applicants becomes the largest. The number of IPFs by applicants of most countries/regions tends to be almost flat, but the number of IPFs by Chinese applicants increases since around 2015 and is expected to be almost equal to the number of IPFs by French applicants in 2018.

Figure 5-55 Annual trend with the number of IPFs in "gxE02: Measures Against Non-CO_2 Greenhouse Gases" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



Database: Derwent™ Innovation

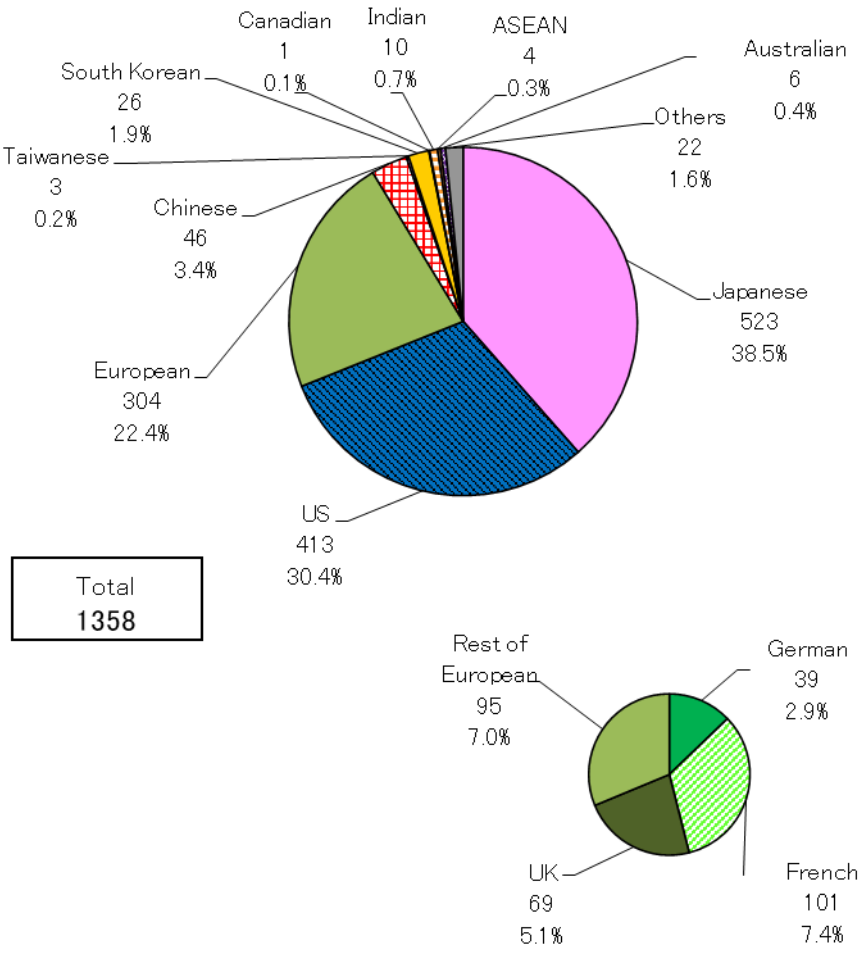
Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line

from 2019.

Number of IPFs rates are shown in Figure 5-56 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of IPFs by European applicants.

In terms of the number of IPFs rates, Japanese applicants account for the largest rate with 38.5%, followed by US, European, Chinese, and South Korean applicants. 96.6% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-56 Number of IPFs rates in "gxE02: Measures Against Non-CO_2 Greenhouse Gases" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



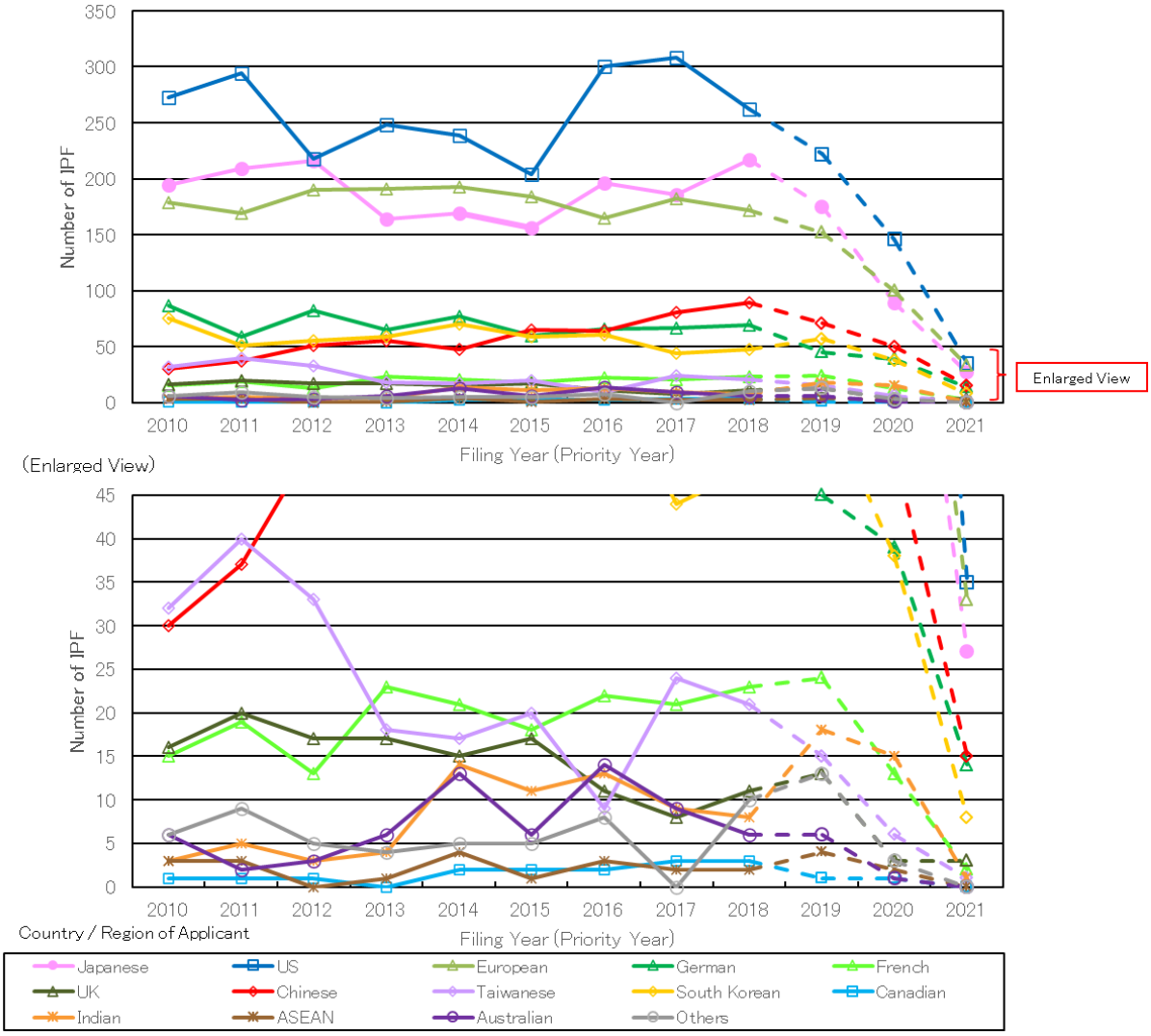
Database: Derwent™ Innovation

29. gxY01: GXTI×Control-Related Technology

Annual trend in number of IPFs in “gxY01: GXTI×Control-Related Technology” is shown in Figure 5-57 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by US applicants is the largest, and although there are some increases and decreases since then, the number increases again since 2015 and remains unchanged in the same ranking. The number of IPFs by Japanese applicants is second only to the number of IPFs by US applicants in 2010, but falls below the number of IPFs by European applicants from 2013 to 2015. Since then, the number of IPFs by Japanese applicants increases again from 2016, becoming second only to the number of IPFs by US applicants and remaining unchanged in the same ranking. While the numbers of IPFs by applicants of most countries/regions tend to be almost flat or to increase slightly, the number of IPFs by Chinese applicants increases since 2015 and is on track to exceed the number of IPFs by German applicants in 2017.

Figure 5-57 Annual trend with the number of IPFs in "gxY01: GXTI×Control-Related Technology" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



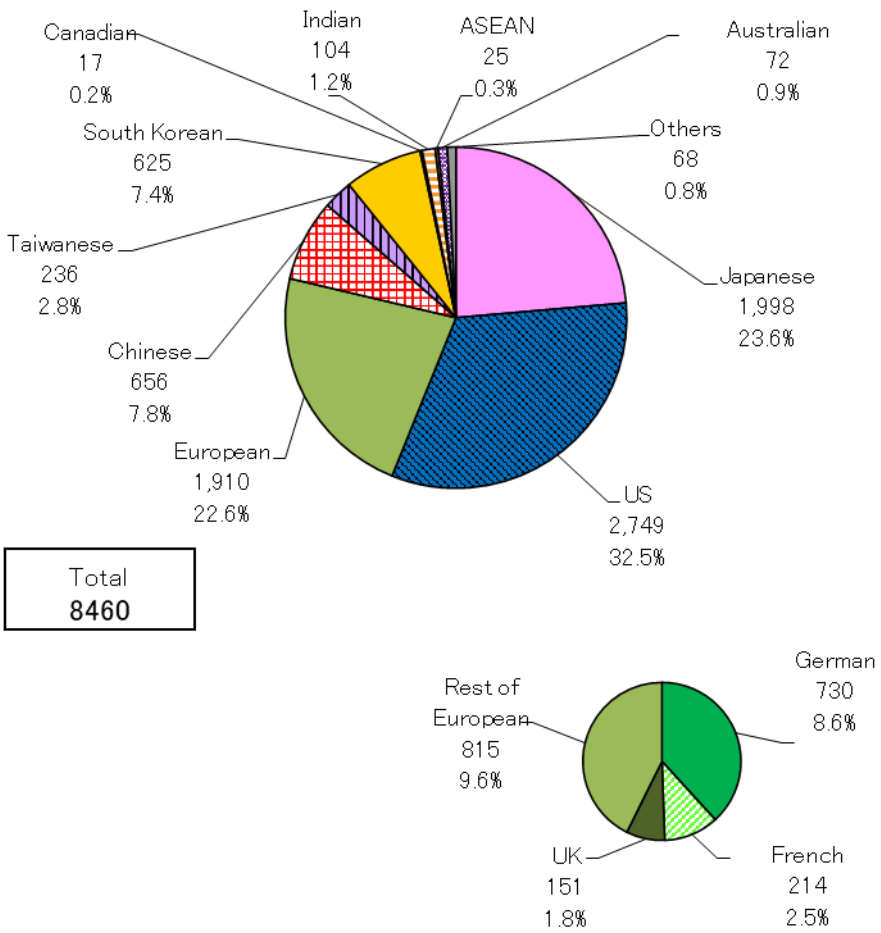
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-58 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, US applicants account for the largest rate with 32.5%, followed by Japanese, European, Chinese, and South Korean applicants. 93.8% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-58 Number of IPFs rates in “gxY01: GXTI×Control-Related Technology” by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



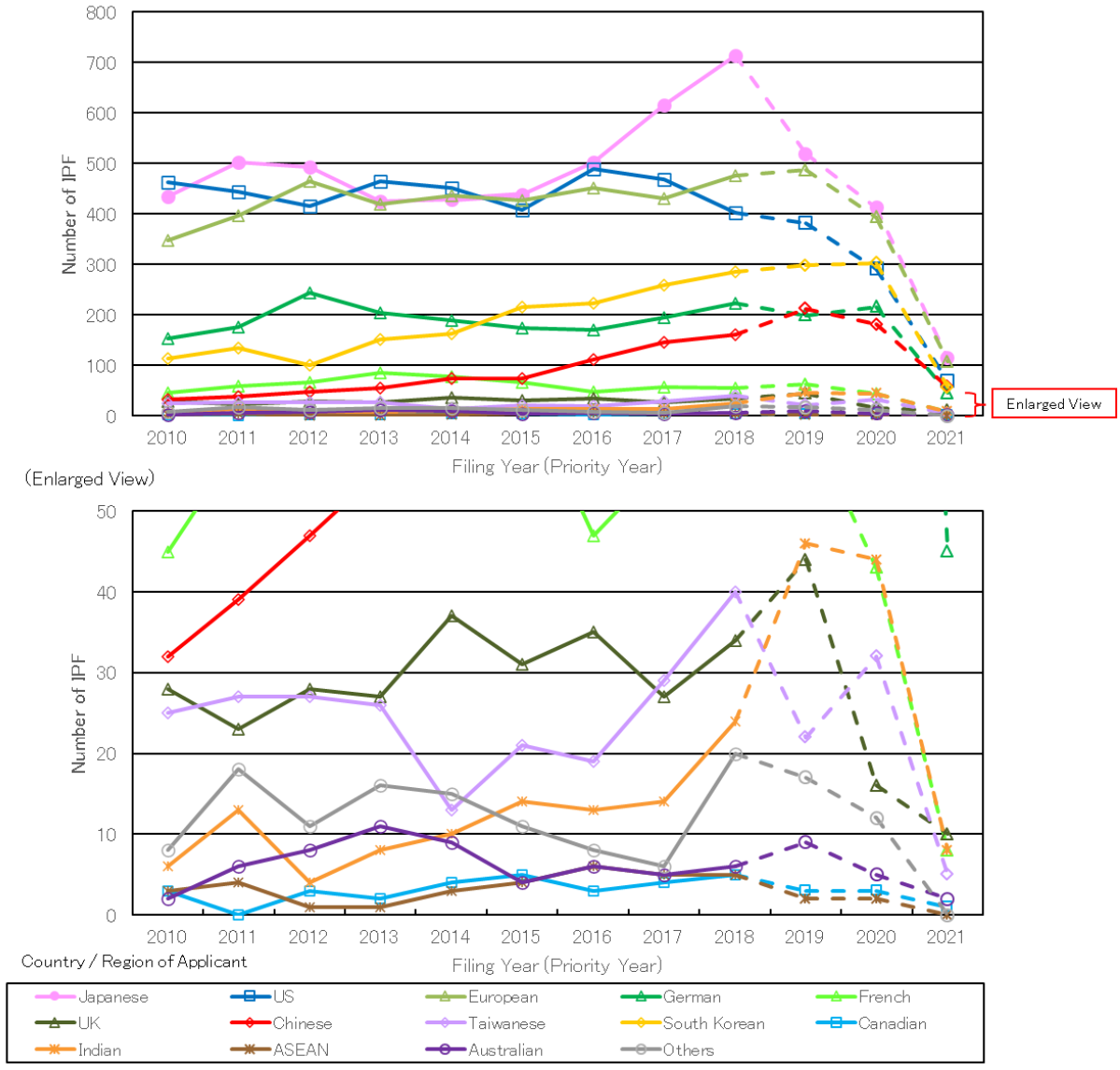
Database: Derwent™ Innovation

30. gxY02: GXTI×Measuring-Related Technology

Annual trend in number of IPFs in “gxY02: GXTI×Measuring-Related Technology” is shown in Figure 5-59 by country/region of applicant.

In the filing year (priority year) 2010, the number of IPFs by US applicants is the largest, followed by Japanese and European applicants, but the number of IPFs by Japanese applicants is the largest in 2011 and 2012, the number of IPFs by US applicants is the largest again in 2013 and 2014, the number of IPFs by Japanese applicants is largest again in 2015, and the trend continues since then. Meanwhile, the number of IPFs by US applicants and the number of IPFs by European applicants fluctuate almost equally since 2016. The numbers of IPFs by South Korean and Chinese applicants steadily increase since 2010. While the numbers of IPFs by applicants of most other countries/regions tend to be almost flat, the number of IPFs by Indian applicants is on an increasing trend since 2017.

Figure 5-59 Annual trend with the number of IPFs in "gxY02: GXTI×Measuring-Related Technology" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



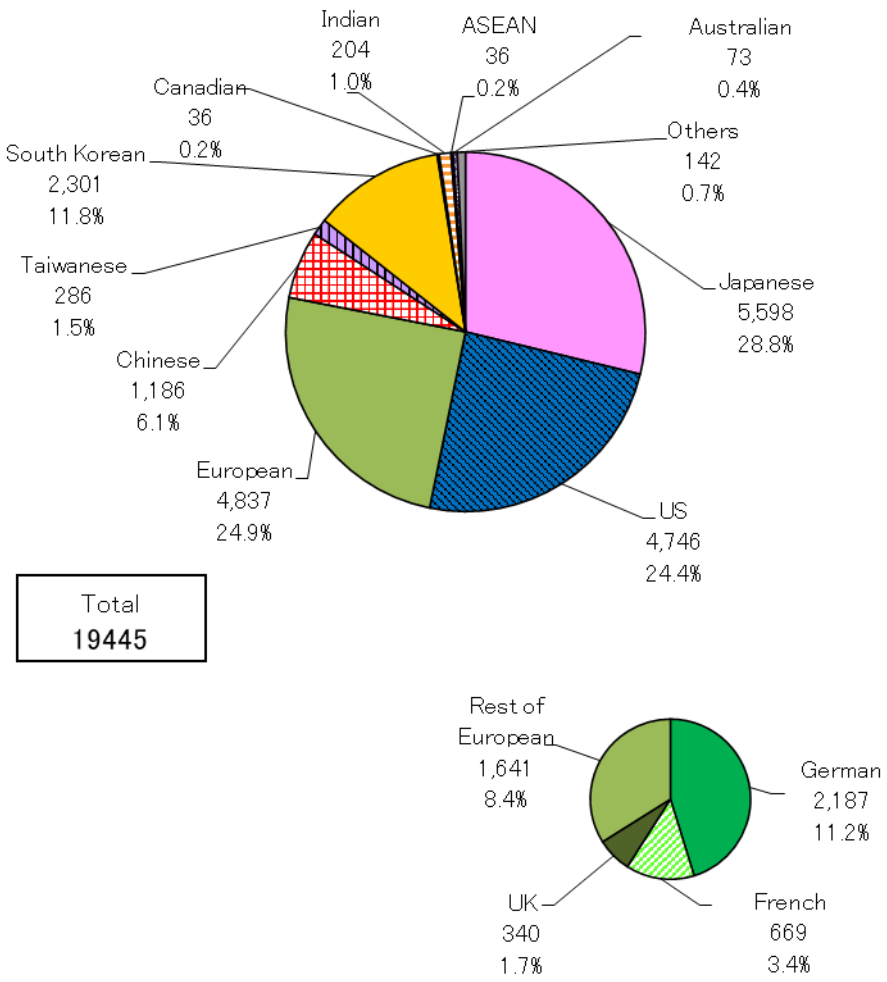
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-60 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, Japanese applicants account for the largest rate with 28.8%, followed by European, US, South Korean, and Chinese applicants. 96.0% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-60 Number of IPFs rates in “gxY02: GXTI×Measuring-Related Technology” by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



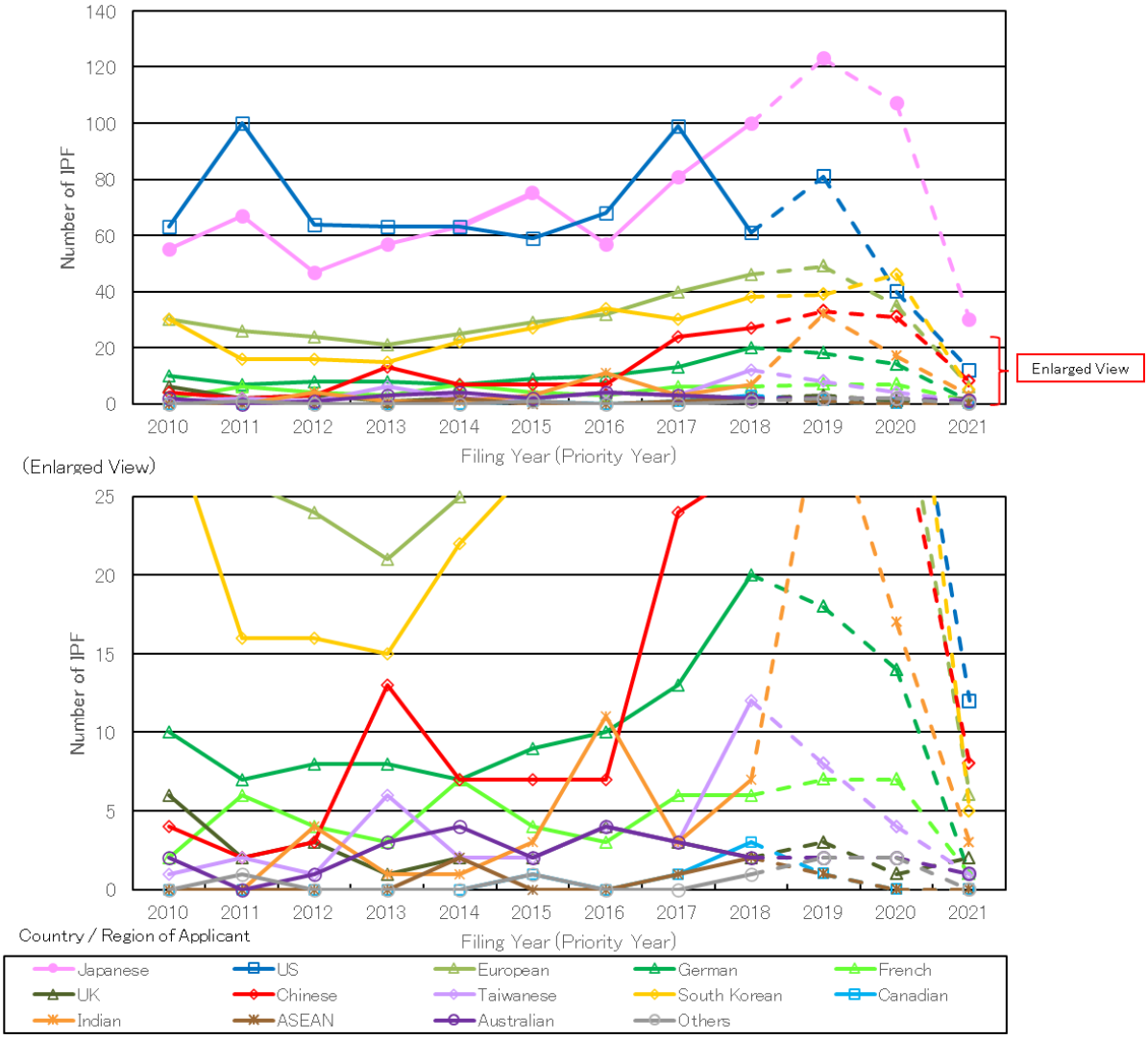
Database: Derwent™ Innovation

31. gxY03: GXTI×Business-Related Technology (Including Authentication and Payment)

Annual trend in number of IPFs in "gxY03: GXTI×Business-Related Technology (Including Authentication and Payment)" is shown in Figure 5-61 by country/region of applicant.

In the filing year (priority year) 2010, the number of IPFs by US applicants is the largest, but in 2014 and 2015, the number of IPFs by Japanese applicants is the largest. Thereafter, while the number of IPFs by US applicants tends to be flat, the number of IPFs by Japanese applicants is on a slightly increasing trend, becoming the largest in 2018 and remaining in the same ranking since then. While the numbers of IPFs by applicants of most countries/regions tend to be almost flat, the number of IPFs by Chinese applicants is on an increasing trend since 2012, approaching the number of IPFs by South Korean applicants from 2017.

Figure 5-61 Annual trend with the number of IPFs in "gxY03: GXTI×Business-Related Technology (Including Authentication and Payment)" by country/region of applicant (the Filing Years (Priority Years) 2010-2021)



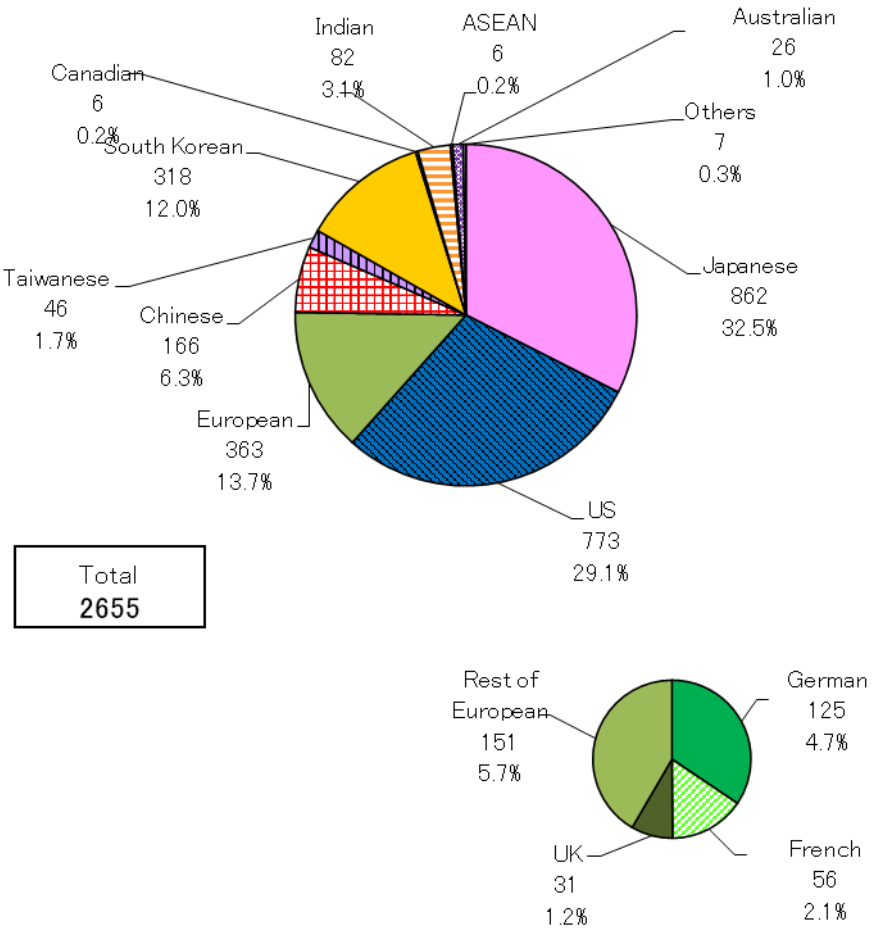
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-62 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of IPFs by European applicants.

In terms of the number of IPFs rates, Japanese applicants account for the largest rate with 32.5%, followed by US, European, South Korean, and Chinese applicants. 93.5% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-62 Number of IPFs rates in "gxY03: GXTI×Business-Related Technology (Including Authentication and Payment)" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



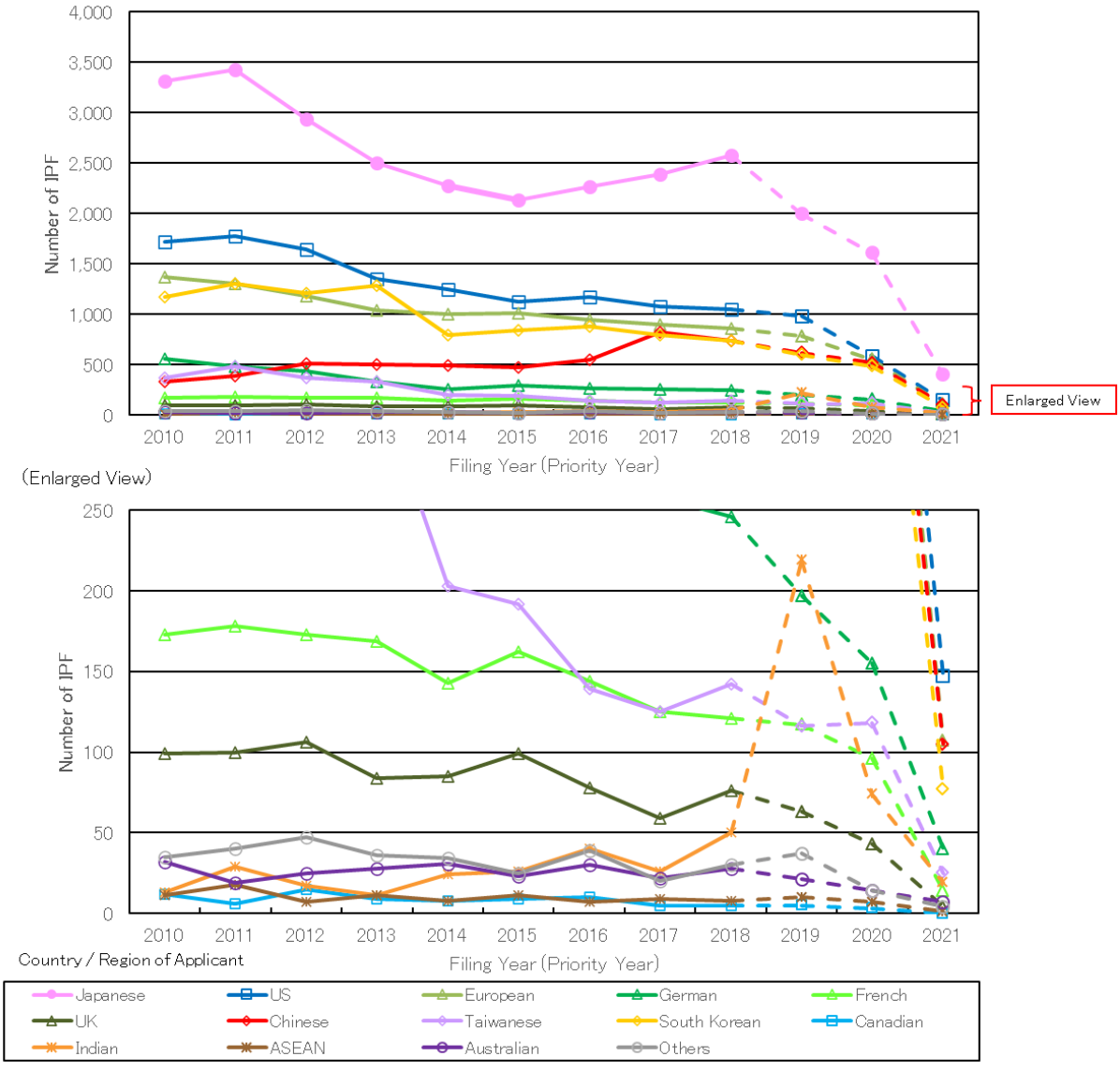
Database: Derwent™ Innovation

32. gxY04: GXTI×ICT-Related Technology (Excluding Business-Related Technology)

Annual trend in number of IPFs in "gxY04: GXTI×ICT-Related Technology (Excluding Business-Related Technology)" is shown in Figure 5-63 by country/region of applicant.

Since the filing year (priority year) 2010, the number of IPFs by Japanese applicants is the largest, with a decreasing trend since 2012 and an increasing trend again from 2016 to 2018. In 2010, the number of IPFs by US applicants is second only to the number of IPFs by Japanese applicants, but is on a decreasing trend since 2012. The number of IPFs by European and South Korean applicants are also on a decreasing trend since 2010. The number of IPFs by Chinese applicants increases since 2010 and exceeds the number of IPFs by South Korean applicants in 2017. The number of IPFs by applicants of most countries/regions tend to be almost flat.

Figure 5-63 Annual trend in number of IPFs in "gxY04: GXTI×ICT-Related Technology (Excluding Business-Related Technology)" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



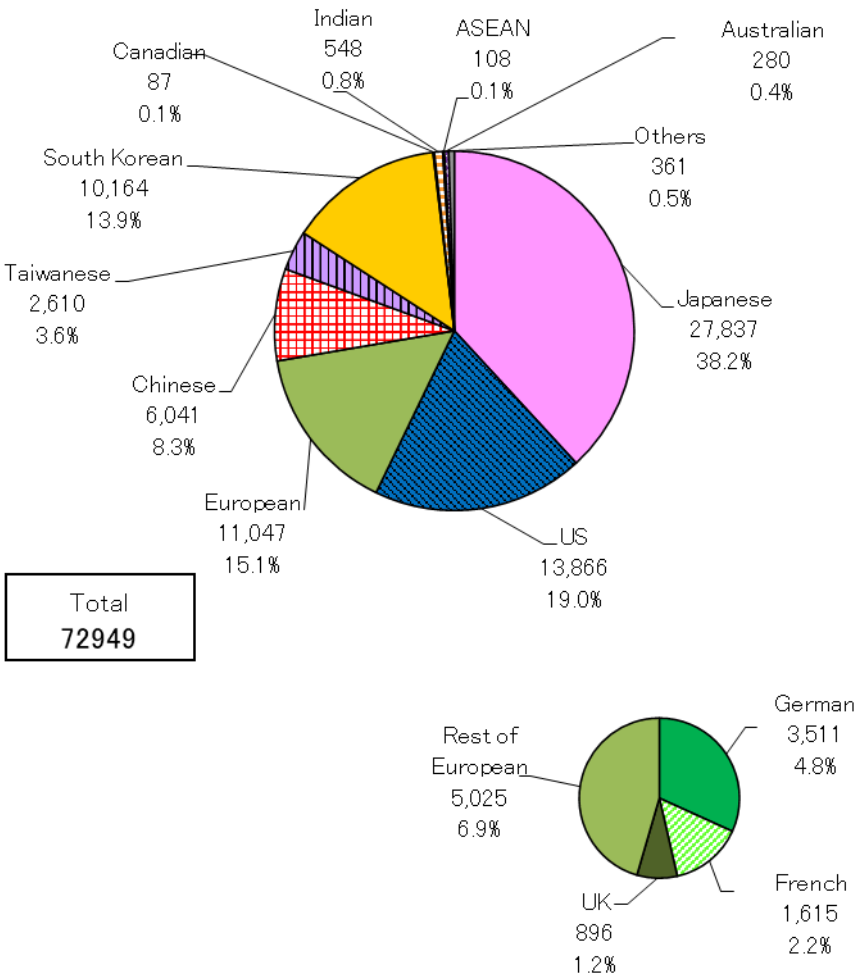
Database: Derwent™ Innovation

Note: It should be noted that at the time of conducting this survey, there may not be sufficient data recorded in Derwent™ Innovation after the filing year (priority year) 2019. Therefore, they are shown with a dotted line from 2019.

Number of IPFs rates are shown in Figure 5-64 by country/region of applicant. The graph at the bottom right shows the breakdown of the rates of the numbers of European applicants.

In terms of the number of IPFs rates, Japanese applicants account for the largest rate with 38.2%, followed by US, European, South Korean, and Chinese applicants. 94.5% of the IPFs filed in the countries/regions surveyed in this survey are filed by Japanese, US, European, Chinese and South Korean applicants.

Figure 5-64Number of IPFs rates in "gxY04: GXTI×ICT-Related Technology (Excluding Business-Related Technology)" by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)



Database: Derwent™ Innovation

Section 8 Top-Ranking with the Number of IPFs

1. gxA01: Solar Photovoltaic Power Generation

Table 5-11 illustrates the top 20 IPF applicants in "gxA01: Solar Photovoltaic Power Generation."

Among the top applicants, LG CORPORATION (South Korea) ranked first, PANASONIC CORP. ranked second, and SAMSUNG GROUP (South Korea) ranked third. 10 Japanese applicants, 3 European applicants, 2 South Korean and US applicants, and 1 Chinese applicant were ranked.

Table 5-11 Top 20 IPF applicants in "gxA01: Solar Photovoltaic Power Generation"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	909	LG CORPORATION	Korea
2	808	PANASONIC CORP.	Japan
3	799	SAMSUNG GROUP	Korea
4	553	SHARP CORP.	Japan
5	482	FUJIFILM CORP.	Japan
6	476	SANYO ELECTRIC CO.,LTD.	Japan
7	402	SONY GROUP CORP.	Japan
8	380	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
9	352	TOTAL S.A.	France
10	322	TOSHIBA CORP.	Japan
11	263	MITSUBISHI ELECTRIC CORP.	Japan
12	247	KYOCERA CORP.	Japan
13	242	MERCK KGAA	Germany
14	228	KANEKA CORPORATION	Japan
15	213	SUMITOMO CHEMICAL CO., LTD.	Japan
16	199	HANERGY HOLDING GROUP LTD.	China
17	178	FIRST SOLAR, INC.	USA
18	167	DUPONT DE NEMOURS, INC.	USA
19	158	AU OPTRONICS CORP.	Taiwan
20	154	TAIWAN SEMICONDUCTOR MFG CO., LTD.	Taiwan

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 11 Japanese applicants, four European applicants, three US applicants, and two South Korean applicants in the filing years (priority years) 2010-2013, while there are 10 Japanese applicants, five Chinese applicants, three South Korean applicants, and two European applicants in 2018-2021.

Table 5-12 Trend of top-ranking applicants with the number of IPFs in “gxA01: Solar Photovoltaic Power Generation”

(the Filing Years (Priority Years) 2010-2021)

2010–2013				2014–2017				2018–2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	501	LG CORPORATION	Korea	1	299	LG CORPORATION	Korea	1	148	SAMSUNG GROUP	Korea
2	475	SANYO ELECTRIC CO.,LTD.	Japan	2	275	PANASONIC CORP.	Japan	2	130	PANASONIC CORP.	Japan
3	429	SAMSUNG GROUP	Korea	3	222	SAMSUNG GROUP	Korea	3	113	KANEKA CORPORATION	Japan
4	403	PANASONIC CORP.	Japan	4	148	SHARP CORP.	Japan	4	109	LG CORPORATION	Korea
5	379	SHARP CORP.	Japan	5	145	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	5	89	SONY GROUP CORP.	Japan
6	335	FUJIFILM CORP.	Japan	6	139	TOTAL S.A.	France	6	84	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
7	198	SONY GROUP CORP.	Japan	7	115	SONY GROUP CORP.	Japan	7	81	HANERGY HOLDING GROUP LTD.	China
8	151	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	7	115	TOSHIBA CORP.	Japan	8	75	TOSHIBA CORP.	Japan
9	149	TOTAL S.A.	France	9	105	MITSUBISHI ELECTRIC CORP.	Japan	9	69	HUAWEI TECHNOLOGIES CO., LTD.	China
10	143	FIRST SOLAR, INC.	USA	10	101	FUJIFILM CORP.	Japan	10	64	TOTAL S.A.	France
11	142	MERCK KGAA	Germany	10	101	HANERGY HOLDING GROUP LTD.	China	11	57	SUMITOMO ELECTRIC INDUSTRIES, LTD.	Japan
12	133	DUPONT DE NEMOURS, INC.	USA	12	86	KYOCERA CORP.	Japan	11	57	LONGI SOLAR TECHNOLOGY CO., LTD.	China
13	132	TOSHIBA CORP.	Japan	13	84	MERCK KGAA	Germany	13	53	SUMITOMO CHEMICAL COMPANY, LIMITED	Japan
14	131	KYOCERA CORP.	Japan	14	77	KANEKA CORPORATION	Japan	14	46	FUJIFILM CORP.	Japan
15	129	MITSUBISHI ELECTRIC CORP.	Japan	15	64	SEKISUI CHEMICAL CO., LTD.	Japan	15	43	SUNGROW POWER SUPPLY CO., LTD.	China
16	121	RESONAC HOLDINGS CORPORATION	Japan	16	61	BOE TECHNOLOGY GROUP CO., LTD.	China	15	43	HANWHA GROUP	Korea
17	113	AU OPTRONICS CORP.	Taiwan	17	58	SUMITOMO CHEMICAL COMPANY, LIMITED	Japan	17	39	TOYOTA MOTOR CORPORATION	Japan
18	111	KONICA MINOLTA, INC.	Japan	18	57	TOYOTA MOTOR CORPORATION	Japan	18	38	RICOH COMPANY,LTD.	Japan
19	110	ROBERT BOSCH GMBH	Germany	19	56	SUMITOMO ELECTRIC INDUSTRIES, LTD	Japan	19	36	JINKOSOLAR HOLDING CO., LTD.	China
20	102	SUMITOMO CHEMICAL COMPANY, LIMITED	Japan	19	56	OSRAM GMBH	Germany	20	34	HONDA MOTOR CO.,LTD.	Japan
20	102	DOW INC.	USA								

Database: Derwent™ Innovation

2. gxA02: Solar Thermal Energy Utilization

Table 5-13illustrates the top 22 IPF applicants in "gxA02: Solar Thermal Energy Utilization."

Among the top applicants, SIEMENS A.G. (Germany) ranked first, followed by Abengoa (Spain) and the Atomic Energy and FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION (France). 8 European and Japanese applicants, 5 US applicants, 1 South Korean applicant ranked, and no Chinese applicant were ranked.

Table 5-13 Top 22 IPF applicants in "gxA02: Solar Thermal Energy Utilization"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	104	SIEMENS A.G.	Germany
2	69	ABENGOA SA	Spain
2	69	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
4	52	FUJIFILM CORP.	Japan
5	51	KONICA MINOLTA, INC.	Japan
6	49	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
7	44	GENERAL ELECTRIC CO.	USA
8	40	TOTAL S.A.	France
9	37	HITACHI, LTD.	Japan
9	37	LG CORPORATION	Korea
11	35	DEUTSCHE ZENTRUM LUFT & RAUMFAHRT EV	Germany
12	32	ALSTOM S.A.	France
12	32	ROBERT BOSCH GMBH	Germany
14	26	YAZAKI CORP.	Japan
15	25	TOYOTA INDUSTRIES CORP.	Japan
16	24	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	USA
17	19	3M CO.	USA
17	19	NEXTRACKER INC.	USA
19	18	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG E.V.	Germany
20	17	CHIYODA CORPORATION	Japan
20	17	IBIDEN CO.,LTD.	Japan
20	17	BOLY INC.	USA

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are nine European applicants, six Japanese applicants, four US applicants, three South Korean applicants, and one Chinese applicant in the filing years (priority years) 2010-2013, while there are six European applicants, six Chinese applicants, four US applicants, and one Japanese applicant in 2018-2021.

Table 5-14 Trend of top-ranking applicants with the number of IPFs in “gxA02: Solar Thermal Energy Utilization”

(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	90	SIEMENS A.G.	Germany	1	31	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	1	15	GERMAN AEROSPACE CENTER	Germany
2	57	ABENGOA SA	Spain	2	16	YAZAKI CORP.	Japan	2	14	NEXTRACKER INC.	USA
3	42	KONICA MINOLTA, INC.	Japan	3	15	CHIYODA CORPORATION	Japan	2	14	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
4	40	FUJIFILM CORP.	Japan	4	14	TOYOTA INDUSTRIES CORPORATION	Japan	4	12	SOLTEC INNOVATIONS SL	Spain
5	39	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	4	14	BOLY INC.	USA	5	10	ARRAY TECHNOLOGIES INC.	USA
6	33	HITACHI, LTD.	Japan	4	14	BOLYMEDIA HOLDINGS CO. LTD.	USA	5	10	OJJO INC.	USA
7	32	GENERAL ELECTRIC CO.	USA	7	13	GERMAN AEROSPACE CENTER	Germany	7	7	ARCTECH SOLAR HOLDING CO. LTD	China
8	28	ALSTOM S.A.	France	7	13	TOTAL S.A.	France	7	7	XIAN JIAOTONG UNIVERSITY	China
8	28	LG CORPORATION	Korea	9	12	FUJIFILM CORP.	Japan	9	6	SUMITOMO ELECTRIC INDUSTRIES, LTD	Japan
10	25	TOTAL S.A.	France	9	12	ABENGOA SA	Spain	9	6	ABSOLICON SOLAR COLLECTOR AB	Sweden
11	24	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	9	12	SIEMENS A.G.	Germany	9	6	ARAYMOND NETWORK	France
12	20	ROBERT BOSCH GMBH	Germany	12	11	ROBERT BOSCH GMBH	Germany	9	6	SYNHELION	Switzerland
13	16	BRIGHTSOURCE INDUSTRIES (ISRAEL) LTD.	Israel	12	11	ZIBO ENVIRONMENTAL PROTECTION TECHNOLOGY CO., LTD.	China	9	6	BOLY MEDIA COMMUNICATIONS (SHENZHEN) CO. LTD.	China
14	13	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	USA	14	9	KONICA MINOLTA, INC.	Japan	9	6	HANERGY HOLDING GROUP LTD.	China
15	12	AGC INC.	Japan	14	9	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	9	6	LI JIAN-FENG (Individual)	China
15	12	3M	USA	16	8	GENERAL ELECTRIC CO.	USA	16	5	3M	USA
17	11	SAMSUNG GROUP	Korea	16	8	UNIVERSITY OF CALIFORNIA	USA	16	5	SHENZHEN BROADWELL ENVIRONMENTAL TECHNOLOGY CO., LTD.	China
18	10	IBIDEN CO.,LTD.	Japan	16	8	LG CORPORATION	Korea				
18	10	GUARDIAN INDUSTRIES	USA	16	8	SAUDI ARABIAN OIL CO.	Saudi Arabia				
18	10	FRENCH NATIONAL CENTRE FOR SCIENTIFIC RESEARCH	France	20	7	IBIDEN CO.,LTD.	Japan				
18	10	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG E.V.	Germany	20	7	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	USA				
18	10	SUNPARTNER TECHNOLOGIES	France	20	7	Tesla, Inc.	USA				
18	10	XIANGTAN ELECTRIC MANUFACTURING CO., LTD.	China	20	7	BASF SE	Germany				
18	10	KOREA INSTITUTE OF ENERGY RESEARCH	Korea	20	7	SHENZHEN ENESOON SCIENCE & TECHNOLOGY CO. LTD.	China				

Database: Derwent™ Innovation

3. gxA03: Wind Power Generation

Table 5-15 illustrates the top 20 IPF applicants in "gxA03: Wind Power Generation."

Among the top applicants, GENERAL ELECTRIC CO. (USA) ranked first, VESTAS WIND SYSTEMS A/S (Denmark) ranked second, and SIEMENS GAMESA RENEWABLE ENERGY S.A (Spain) ranked third. 13 European applicants, 3 US and Japanese applicants, 1 Chinese applicant, and no South Korean applicants were ranked.

Table 5-15　Top 20 IPF applicants in "gxA03: Wind Power Generation"

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	1,554	GENERAL ELECTRIC CO.	USA
2	1,308	VESTAS WIND SYSTEMS A/S	Denmark
3	1,018	SIEMENS GAMESA RENEWABLE ENERGY S.A.	Spain
4	996	SIEMENS A.G.	Germany
5	545	WOBBEN PROPERTIES GMBH	Germany
6	471	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
7	305	SENVION S.A.	Germany
8	235	NORDEX SE	Germany
9	208	ALSTOM S.A.	France
10	189	BEIJING GOLDWIND SCIENCE & CREATION WINDPOWER EQUIPMENT CO., LTD.	China
11	187	HITACHI, LTD.	Japan
12	100	NTN CORP.	Japan
13	93	SVENSKA KULLAGERFABRIKEN AB	Finland
14	81	ZF FRIEDRICHSHAFEN A.G.	Germany
15	77	E.ON SE	Germany
16	74	ROBERT BOSCH GMBH	Germany
17	50	ABB AB	Switzerland
18	46	UNITED TECHNOLOGIES CORP.	USA
19	45	THYSSENKRUPP A.G.	Germany
20	43	X(GOOGLE X)	USA

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 12 European applicants, five Japanese applicants, three US applicants, and one Chinese applicant in the filing years (priority years) 2010-2013, while there are 12 European applicants, three Japanese applicants, two US applicants, two Chinese applicants, and one South Korean applicant in 2018-2021.

Table 5-16 Trend of top-ranking applicants with the number of IPFs in “gxA03: Wind Power Generation”

(the Filing Years (Priority Years) 2010-2021)

2010–2013				2014–2017				2018–2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	668	GENERAL ELECTRIC CO.	USA	1	468	VESTAS WIND SYSTEMS A/S	Denmark	1	442	GENERAL ELECTRIC CO.	USA
2	580	SIEMENS A.G.	Germany	2	444	GENERAL ELECTRIC CO.	USA	2	414	VESTAS WIND SYSTEMS A/S	Denmark
3	426	VESTAS WIND SYSTEMS A/S	Denmark	3	365	SIEMENS A.G.	Germany	3	194	WOBBEN PROPERTIES GMBH	Germany
4	292	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	4	272	SIEMENS GAMESA RENEWABLE ENERGY S.A.	Spain	4	97	BEIJING GOLDWIND SCIENCE & CREATION WINDPOWER EQUIPMENT CO., LTD.	China
5	169	ALSTOM S.A.	France	5	212	WOBBEN PROPERTIES GMBH	Germany	5	70	SENVION S.A.	Germany
6	139	WOBBEN PROPERTIES GMBH	Germany	6	127	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	6	66	NORDEX SE	Germany
7	134	SIEMENS GAMESA RENEWABLE ENERGY S.A.	Spain	7	126	SENVION S.A.	Germany	7	52	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
8	109	SENVION S.A.	Germany	8	98	NORDEX SE	Germany	8	51	SIEMENS A.G.	Germany
9	71	NORDEX SE	Germany	9	92	HITACHI, LTD.	Japan	9	34	E.ON SE	Germany
10	64	HITACHI, LTD.	Japan	10	87	BEIJING GOLDWIND SCIENCE & CREATION WINDPOWER EQUIPMENT CO., LTD.	China	10	31	HITACHI, LTD.	Japan
11	59	ROBERT BOSCH GMBH	Germany	11	57	NTN CORPORATION	Japan	11	30	NTN CORPORATION	Japan
12	56	SVENSKA KULLAGERFABRIKEN AB	Finland	12	39	ALSTOM S.A.	France	12	21	MIBA AG	Austria
13	43	ZF FRIEDRICHSHAFEN A.G.	Germany	13	31	E.ON SE	Germany	13	20	TPI COMPOSITES INC	USA
14	32	UNITED TECHNOLOGIES CORP.	USA	14	27	SVENSKA KULLAGERFABRIKEN AB	Finland	13	20	CHINA HUANENG GROUP CO., LTD.	China
15	30	WINDFIN B.V.	Netherlands	15	24	ZF FRIEDRICHSHAFEN A.G.	Germany	15	18	DEME GROUP	Belgium
16	23	AREVA NP	France	16	23	HAMILTON SUNDSTRAND CORPORATION	USA	16	16	ITREC B. V.	Netherlands
17	22	JTEKT CORPORATION	Japan	16	23	X	USA	17	14	FOS4X GMBH	Germany
17	22	GOOGLE LLC	USA	18	20	NABTESCO CORPORATION	Japan	17	14	THYSSENKRUPP A.G.	Germany
19	21	SUMITOMO HEAVY INDUSTRIES, LTD.	Japan	18	20	ABB	Switzerland	17	14	ZF FRIEDRICHSHAFEN A.G.	Germany
20	20	YASKAWA ELECTRIC CORPORATION	Japan	18	20	THYSSENKRUPP A.G.	Germany	17	14	ENVISION CO. LTD.	Korea
20	20	SINOVEL WIND GROUP CO. LTD	China								

Database: Derwent™ Innovation

4. gxA04: Geothermal Utilization

Table 5-17 illustrates the top 15 IPF applicants in "gxA04: Geothermal Utilization."

Among the top applicants, MITSUBISHI HEAVY INDUSTRIES, LTD. ranked first, EAVOR TECHNOLOGIES INC. (Canada) ranked second, and CHINA UNIVERSITY OF MINING & TECHNOLOGY (China) and HOHAI UNIVERSITY (China) ranked third. 4 US applicants, 3 Japanese and European applicants, 2 Chinese applicants, and no South Korean applicants were ranked.

Table 5-17 Top 15 IPF applicants in "gxA04: Geothermal Utilization"

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	21	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
2	13	EAVOR TECHNOLOGIES INC.	Canada
3	7	CHINA UNIVERSITY OF MINING & TECHNOLOGY	China
3	7	HOHAI UNIVERSITY	China
5	6	GENERAL ELECTRIC CO.	USA
5	6	ORMAT TECHNOLOGIES INC.	USA
5	6	SIEMENS A.G.	Germany
8	5	TOSHIBA CORP.	Japan
8	5	JANSEN AG	Switzerland
8	5	YANG TAI-HER (Individual)	Taiwan
11	4	OSAKA UNIVERSITY	Japan
11	4	BAKER HUGHES CO.	USA
11	4	ECOLAB INC.	USA
11	4	E.ON SE	Germany
11	4	GOOD WATER ENERGY LTD	Australia

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 11 US applicants, four European applicants, two Japanese applicants, and one South Korean applicant in the filing years (priority years) 2010-2013, while there are four Chinese applicants, four European applicants, three Japanese applicants, and two US applicants in 2018-2021.

Table 5-18 Trend of top-ranking applicants with the number of IPFs in “gxA04: Geothermal Utilization” (the Filing Years (Priority Years) 2010-2021)

2010–2013				2014–2017				2018–2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	6	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	1	7	HOHAI UNIVERSITY	China	1	10	EAVOR TECHNOLOGIES INC.	Canada
1	6	GENERAL ELECTRIC CO.	USA	2	6	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	2	9	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
3	5	TOSHIBA CORP.	Japan	3	3	MITSUBISHI ELECTRIC CORP.	Japan	3	5	CHINA UNIVERSITY OF MINING & TECHNOLOGY	China
3	5	ORMAT TECHNOLOGIES INC.	USA	3	3	JANSEN AG	Switzerland	4	4	BAKER HUGHES CO.	USA
3	5	YANG TAI-HER(Individual)	Taiwan	3	3	EAVOR TECHNOLOGIES INC.	Canada	4	4	GOOD WATER ENERGY LTD	Australia
6	4	SIEMENS A.G.	Germany	6	2	ECO-PLANNER CO., LTD.	Japan	6	3	SANOH INDUSTRIAL CO., LTD.	Japan
7	3	KALEX LLC	USA	6	2	EST CORPORATION, LTD	Japan	6	3	UNIVERSITY PUBLIC CORPORATION OSAKA	Japan
7	3	ALSTOM S.A.	France	6	2	EST CORPORATION, LTDJAPAN NEW ENERGY	Japan	6	3	ICE THERMAL HARVESTING LLC	USA
9	2	BOSTON SCIENTIFIC CORP	USA	6	2	KOBE STEEL, LTD.	Japan	6	3	ENVOLA GMBH	Germany
9	2	FRIESTH KEVIN LEE(Individual)	USA	6	2	NEWJEC INC.	Japan	6	3	QUANTITATIVE HEAT OY	Finland
9	2	INTERNATIONAL MERGER & ACQUISITION CORPORATION	USA	6	2	OSAKA UNIVERSITY	Japan	6	3	SENERA OY	Finland
9	2	KAPAUN STEVE(Individual)	USA	6	2	TAWARA SHUNICHI	Japan	6	3	STEINHÄUSER GMBH & CO. KG	Germany
9	2	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	USA	6	2	THE KANSAI ELECTRIC POWER CO., INC.	Japan	6	3	GUANGZHOU INSTITUTE OF ENERGY CONVERSION, CHINESE ACADEMY OF SCIENCES	China
9	2	RILEY WILLIAM(Individual)	USA	6	2	TOYOTA MOTOR CORPORATION	Japan	6	3	JIANGSU CIFU TECHNOLOGY CO. LTD.	China
9	2	TAS ENERGY INC.	USA	6	2	ECOLAB INC.	USA	6	3	SHENZHEN UNIVERSITY	China
9	2	UNITED TECHNOLOGIES CORP.	USA	6	2	GREENFIRE ENERGY INC.	USA	6	3	SAUDI ARABIAN OIL CO.	Saudi Arabia
9	2	EQUINOR ASA	Norway	6	2	OHNS HOPKINS UNIVERSITY	USA				
9	2	GREENFIELD MASTER IPCO LIMITED	Germany	6	2	E.ON SE	Germany				
9	2	KOREA INSTITUTE OF GEOSCIENCE AND MINERAL RESOURCES	Korea	6	2	E-TUBE SWEDEN AB	Sweden				
				6	2	G.H.P.- E.K. GEOTHERMIE-HANDEL- UND PRODUKTION E.K.	Germany				
				6	2	SENS GEOENERGY STORAGE AB	Sweden				
				6	2	TRIAS V&M GMBH	Germany				
				6	2	CHINA UNIVERSITY OF MINING & TECHNOLOGY	China				
				6	2	NANJING CANATAL AIR-CONDITIONING ELECTRICAL & MECHANICAL CO. LTD.	China				
				6	2	WISE INTERVENTION SERVICES INC	Canada				

Database: Derwent™ Innovation

5. gxA05: Hydro-Power Generation

Table 5-19illustrates the top 20 IPF applicants in "gxA05: Hydro-Power Generation."

Among the top applicants, GENERAL ELECTRIC CO. (USA) ranked first, VOITH GMBH (Germany) ranked second, and ALSTOM S.A. (France) ranked third. 9 European applicants, 6 Japanese applicants, 3 US applicants, 2 Chinese applicants, and no South Korean applicants were ranked.

Table 5-19 Top 20 IPF applicants in "gxA05: Hydro-Power Generation"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	166	GENERAL ELECTRIC CO.	USA
2	105	VOITH GMBH	Germany
3	59	ALSTOM S.A.	France
4	45	UNITED TECHNOLOGIES CORP.	USA
5	41	NTN CORP.	Japan
6	37	TOSHIBA CORP.	Japan
7	35	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
8	26	ROBERT BOSCH GMBH	Germany
9	24	SIEMENS A.G.	Germany
10	23	SVENSKA KULLAGERFABRIKEN AB	Finland
11	20	S.A.FRAN S.A.	France
12	19	HALLIBURTON CO.	USA
12	19	ROLLS ROYCE PLC.	UK
14	18	HITACHI, LTD.	Japan
14	18	ANDRITZ A.G.	Austria
14	18	OPENHYDRO GROUP	Ireland
17	17	THE CHUGOKU ELECTRIC POWER COMPANY, INCORPORATED	Japan
18	16	BELLSION KK	Japan
19	15	HUANG GUI-YING (Individual)	China
20	14	DALIAN UNIVERSITY OF TECHNOLOGY	China

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 10 European applicants, seven US applicants, four Japanese applicants in the filing years (priority years) 2010-2013, while there are six European applicants, six Chinese applicants, four US applicants, four Japanese applicants, and one South Korean applicant in 2018-2021.

Table 5-20 Trend of top-ranking applicants with the number of IPFs in “gxA05: Hydro-Power Generation” (the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	110	GENERAL ELECTRIC CO.	USA	1	38	GENERAL ELECTRIC CO.	USA	1	21	VOITH GMBH	Germany
2	54	VOITH GMBH	Germany	2	30	VOITH GMBH	Germany	2	18	GENERAL ELECTRIC CO.	USA
3	42	UNITED TECHNOLOGIES CORP.	USA	3	26	NTN CORPORATION	Japan	3	14	NTN CORPORATION	Japan
4	33	ALSTOM S.A.	France	4	24	ALSTOM S.A.	France	4	8	GUDESEN HANS GUDE (Individual)	Norway
5	23	ROBERT BOSCH GMBH	Germany	5	16	BELLSION:KK	Japan	5	7	THE CHUGOKU ELECTRIC POWER COMPANY, INCORPORATED.	Japan
6	22	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	5	16	TOSHIBA CORP.	Japan	5	7	DALIAN UNIVERSITY OF TECHNOLOGY	China
7	17	SIEMENS A.G.	Germany	7	15	HUANG GUI-YING(Individual)	China	5	7	INGINE INC.	Korea
8	15	TOSHIBA CORP.	Japan	8	13	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	8	6	TOSHIBA CORP.	Japan
9	14	ROLLS ROYCE PLC.	UK	8	13	HUANG KE-JUN(Individual)	China	8	6	SVENSKA KULLAGERFABRIKEN AB	Finland
10	13	OPENHYDRO GROUP	Ireland	10	11	BELLSION:KK	Japan	8	6	GUANGZHOU YATU NEW ENERGY TECHNOLOGY CO. LTD.	China
11	10	SCHLUMBERGER LTD.	USA	11	10	HUANG KUO-CHANG (Individual)	Taiwan	11	5	SUPERGRID INSTITUTE	France
11	10	SLB LIMITED	USA	12	9	SAFRAN S.A.	France	11	5	CHINA UNIVERSITY OF MINING & TECHNOLOGY	China
11	10	SVENSKA KULLAGERFABRIKEN AB	Finland	13	8	HALLIBURTON CO.	USA	11	5	HANGZHOU LHD INSTITUTE OF NEW ENERGY LLC	China
14	9	HITACHI, LTD.	Japan	14	7	HITACHI, LTD.	Japan	14	4	MITSUBISHI ELECTRIC CORP.	Japan
14	9	HALLIBURTON CO.	USA	14	7	THE CHUGOKU ELECTRIC POWER COMPANY, INCORPORATED.	Japan	14	4	CUMMINS INC.	USA
14	9	HAMILTON SUNDSTRAND CORPORATION	USA	14	7	ANDRITZ A.G.	Austria	14	4	LONE GULL HOLDINGS LTD	USA
17	8	ANDRITZ A.G.	Austria	14	7	SIEMENS A.G.	Germany	14	4	OCEANA ENERGY COMPANY	USA
18	7	KAWASAKI HEAVY INDUSTRIES, LTD.	Japan	14	7	SVENSKA KULLAGERFABRIKEN AB	Finland	14	4	SAFRAN S.A.	France
18	7	RAYTHEON TECHNOLOGIES CORPORATION	USA	14	7	KOREA INSTITUTE OF OCEAN SCIENCE AND TECHNOLOGY	Korea	14	4	SUBSEA 7 NORWAY AS	Norway
18	7	ABB	Switzerland	20	6	DAIKIN INDUSTRIES, LTD	Japan	14	4	GANZHOU HUANGJIN WOTE POWER GENERATION EQUIPMENT CO. LTD.	China
18	7	SAFRAN S.A.	France					14	4	JIANGXI UNIVERSITY OF SCIENCE AND TECHNOLOGY	China

Database: Derwent™ Innovation

6. gxA06: Ocean Energy Power Generation

Table 5-21 illustrates the top 22 IPF applicants in "gxA06: Ocean Energy Power Generation."

Among the top applicants, GENERAL ELECTRIC CO. (USA) ranked first, ROBERT BOSCH GMBH (Germany) ranked second, and VOITH GMBH (Germany) ranked third. 11 European applicants, 5 US applicants, and 2 Chinese, Japanese, and South Korean applicants were ranked.

Table 5-21 Top 22 IPF applicants in "gxA06: Ocean Energy Power Generation"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	43	GENERAL ELECTRIC CO.	USA
2	36	ROBERT BOSCH GMBH	Germany
3	30	VOITH GMBH	Germany
4	24	DALIAN UNIVERSITY OF TECHNOLOGY	China
5	22	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
6	21	OPENHYDRO GROUP	Ireland
7	20	AW-ENERGY OY	Finland
8	18	INGINE INC.	Korea
8	18	KOREA INSTITUTE OF OCEAN SCIENCE AND TECHNOLOGY	Korea
10	17	NAVAL GROUP	France
11	16	LONE GULL HOLDINGS LTD	USA
11	16	OSCILLA POWER INC.	USA
13	15	IFP ENERGIES NOUVELLES S.A.	France
14	14	LOCKHEED MARTIN CORP	USA
14	14	SVENSKA KULLAGERFABRIKEN AB	Finland
16	11	THE ABELL FOUNDATION INC.	USA
16	11	ALSTOM S.A.	France
16	11	OCEAN HARVESTING TECHNOLOGIES AB	Sweden
19	10	NTN CORP.	Japan
19	10	MINESTO AB	Sweden
19	10	ROLLS ROYCE PLC.	UK
19	10	HANGZHOU LHD INSTITUTE OF NEW ENERGY LLC	China

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 12 European applicants, six US applicants, one Japanese applicant, one Chinese applicant, and one South Korean applicant in the filing years (priority years) 2010-2013, while there are nine European applicants, eight Chinese applicants, five US applicants, four Japanese applicants, and one South Korean applicant in 2018-2021.

Table 5-22 Trend of top-ranking applicants with the number of IPFs in “gxA06: Ocean Energy Power Generation”

(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	29	ROBERT BOSCH GMBH	Germany	1	17	GENERAL ELECTRIC CO.	USA	1	13	DALIAN UNIVERSITY OF TECHNOLOGY	China
2	26	GENERAL ELECTRIC CO.	USA	2	11	KOREA INSTITUTE OF OCEAN SCIENCE AND TECHNOLOGY	Korea	2	12	LONE GULL HOLDINGS LTD	USA
3	25	VOITH GMBH	Germany	3	9	OPENHYDRO GROUP	Ireland	3	7	OCEAN UNIVERSITY OF CHINA	China
4	13	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	4	8	KYB CORPORATION	Japan	3	7	INGINE INC.	Korea
5	12	OPENHYDRO GROUP	Ireland	4	8	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	5	6	UNIVERSITY OF TOKYO	Japan
6	10	OSCILLA POWER INC.	USA	4	8	AW-ENERGY OY	Finland	5	6	NAVAL GROUP	France
7	9	THE ABELL FOUNDATION INC.	USA	4	8	DALIAN UNIVERSITY OF TECHNOLOGY	China	5	6	JIANGSU UNIVERSITY OF SCIENCE AND TECHNOLOGY	China
7	9	ROLLS ROYCE PLC.	UK	4	8	INGINE INC.	Korea	8	5	OSCILLA POWER INC.	USA
9	8	AW-ENERGY OY	Finland	9	7	NTN CORPORATION	Japan	8	5	MARINE POWER SYSTEMS LIMITED	Germany
10	7	TIDALSTREAM LIMITED	UK	9	7	LOCKHEED MARTIN CORP	USA	8	5	SHANGHAI OCEAN UNIVERSITY	China
11	6	LOCKHEED MARTIN CORP	USA	9	7	OCEAN CURRENT ENERGY LLC	USA	11	4	KAWASAKI HEAVY INDUSTRIES, LTD.	Japan
11	6	MINESTO AB	Sweden	9	7	ALSTOM S.A.	France	11	4	THE CHUGOKU ELECTRIC POWER COMPANY, INCORPORATED.	Japan
11	6	NAVAL GROUP	France	9	7	IFP ENERGIES NOUVELLES S.A.	France	11	4	AW-ENERGY OY	Finland
11	6	WELLO OY	Finland	14	6	ROBERT BOSCH GMBH	Germany	11	4	OCEAN HARVESTING TECHNOLOGIES AB	Sweden
15	5	RESOLUTE MARINE ENERGY INC.	USA	14	6	SVENSKA KULLAGERFABRIKEN AB	Finland	11	4	SVENSKA KULLAGERFABRIKEN AB	Finland
15	5	ROHRER JOHN W (Individual)	USA	14	6	JUNG MIN SI (Individual)	Korea	11	4	HANGZHOU LHD INSTITUTE OF NEW ENERGY LLC	China
15	5	IFP ENERGIES NOUVELLES S.A.	France	14	6	UNIVERSITY OF ULSAN	Korea	17	3	DOBASHI YOSHIHIDE	Japan
15	5	SABELLA	France	18	5	NAVAL GROUP	France	17	3	INNOVATOR ENERGY LLC.	USA
15	5	SEABASED AB	Sweden	18	5	OCEAN HARVESTING TECHNOLOGIES AB	Sweden	17	3	SUDDABY LOUBERT S (Individual)	USA
15	5	HANGZHOU LHD INSTITUTE OF NEW ENERGY LLC	China	18	5	VOITH GMBH	Germany	17	3	UNIVERSITY OF NORTH FLORIDA	USA
15	5	KOREA INSTITUTE OF OCEAN SCIENCE AND TECHNOLOGY	Korea	18	5	W4P WAVES4POWER AB	Sweden	17	3	BOMBORA WAVE POWER EUROPE LTD	Germany
15	5	INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE	Taiwan	18	5	HUANG GUI-YING (Individual)	China	17	3	IFP ENERGIES NOUVELLES S.A.	France
				18	5	HUANG KE-JUN (Individual)	China	17	3	KABOODVANDY RAD MODJTABA (Individual)	Ireland
								17	3	MURPHY STUART FRANK (Individual)	Germany
								17	3	GUANGZHOU INSTITUTE OF ENERGY CONVERSION, CHINESE ACADEMY OF SCIENCES	China
								17	3	HANGZHOU JIANGHE HYDRO-ELECTRIC SCIENCE & TECHNOLOGY CO. LTD.	China
								17	3	ZHEJIANG ZHOUSHAN LHD ENERGY DEVELOPMENT CO. LTD.	China

Database: Derwent™ Innovation

7. gxA07: Biomass

Table 5-23illustrates the top 20 IPF applicants in "gxA07: Biomass."

Among the top applicants, ROYAL DUTCH SHELL PLC. PLC. (Netherlands) ranked first, IFP ENERGIES NOUVELLES S.A. (France) ranked second, and NESTE OYJ (Finland) ranked third. 10 European applicants, 8 US applicants, 1 Japanese applicant, and no Chinese and South Korean applicant were ranked.

Table 5-23　Top 20 IPF applicants in "gxA07: Biomass"

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	185	ROYAL DUTCH SHELL PLC.	Netherlands
2	91	IFP ENERGIES NOUVELLES S.A.	France
3	72	NESTE OYJ	Finland
4	68	NOVO NORDISK AS	Denmark
5	64	CELANESE CORPORATION	USA
6	54	UOP LLC	USA
7	48	KIOR, INC.	USA
8	41	UNIVERSITY OF CALIFORNIA	USA
8	41	TOTAL S.A.	France
10	40	EXXONMOBIL CORP.	USA
11	39	DUPONT DE NEMOURS, INC.	USA
12	38	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
12	38	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	France
12	38	KONINKLIJKE DSM N.V.	Netherlands
12	38	UPM KYMMENE CORP.	Finland
16	35	XYLECO, INC.	USA
17	32	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
18	30	BP PLC.	UK
18	30	LANZATECH NEW ZEALAND LTD	New Zealand
20	28	BUTAMAX ADVANCED BIOFUELS, LLC	USA

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 11 US applicants, 10 European applicants, and one Japanese applicant in the filing years (priority years) 2010-2013, while there are 11 European applicants, three Japanese applicants, two US applicants, and one Chinese applicant in 2018-2021.

Table 5-24 Trend of top-ranking applicants with the number of IPFs in “gxA07: Biomass”

(the Filing Years (Priority Years) 2010-2021)

2010–2013				2014–2017				2018–2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	126	ROYAL DUTCH SHELL PLC.	Netherlands	1	48	ROYAL DUTCH SHELL PLC.	Netherlands	1	17	NESTE OYJ	Finland
2	64	CELANESE	USA	2	28	IFP ENERGIES NOUVELLES S.A.	France	2	14	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
3	51	IFP ENERGIES NOUVELLES S.A.	France	3	26	NESTE OYJ	Finland	2	14	TONGJI UNIVERSITY	China
4	45	UOP LLC	USA	4	19	NOVO NORDISK AS	Denmark	4	12	EASTMAN CHEMICAL COMPANY	USA
5	44	KIOR, INC.	USA	5	14	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	4	12	EXXONMOBIL CORP.	USA
6	42	NOVO NORDISK AS	Denmark	6	13	SK GROUP	Korea	4	12	IFP ENERGIES NOUVELLES S.A.	France
7	29	UNIVERSITY OF CALIFORNIA	USA	7	11	BASF SE	Germany	4	12	TOTAL S.A.	France
7	29	NESTE OYJ	Finland	7	11	FRENCH NATIONAL CENTRE FOR SCIENTIFIC RESEARCH	France	4	12	LANZATECH NEW ZEALAND LTD	New Zealand
9	28	BUTAMAX ADVANCED BIOFUELS, LLC	USA	7	11	SUEZ S.A.	France	9	11	AIR LIQUIDE S.A.	France
9	28	XYLECO, INC.	USA	7	11	TOTAL S.A.	France	9	11	EUROPEENNE DE BIOMASSE	France
11	27	DUPONT DE NEMOURS, INC.	USA	11	10	REN FUEL K2B AB	Sweden	9	11	ROYAL DUTCH SHELL PLC.	Netherlands
11	27	KONINKLIJKE DSM N.V.	Netherlands	11	10	VEOLIA ENVIRONNEMENT S.A.	France	12	10	UPM KYMMENE CORP.	Finland
13	23	EXXONMOBIL CORP.	USA	11	10	ANAERGIA INC.	Canada	13	9	SABIC	Saudi Arabia
13	23	PHILLIPS 66	USA	11	10	IOGEN CORPORATION	Canada	14	8	SEKISUI CHEMICAL CO.,LTD	Japan
13	23	FRENCH NATIONAL CENTRE FOR SCIENTIFIC RESEARCH	France	15	9	IHI CORPORATION	Japan	14	8	TAIHEIYO CEMENT CORPORATION	Japan
13	23	UPM KYMMENE CORP.	Finland	15	9	BIOMASS ENERGY ENHANCEMENTS LLC	USA	14	8	SUEZ S.A.	France
17	22	BP PLC.	UK	15	9	UNIVERSITY OF CALIFORNIA	USA	14	8	IOGEN CORPORATION	Canada
18	21	INAERIS TECHNOLOGIES LLC	USA	15	9	INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE	France	18	7	NOVO NORDISK AS	Denmark
19	18	TOTAL S.A.	France	15	9	RELIANCE INDUSTRIES LIMITED	India	18	7	SIEMENS A.G.	Germany
20	17	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	20	8	ANELLOTECH INC	USA	18	7	VALMET	Finland
20	17	CONOCOPHILLIPS COMPANY	USA	20	8	DUPONT DE NEMOURS, INC.	USA	18	7	INDIAN OIL CORP.	India
20	17	BIOCHEMTEX S.P.A.	Italy	20	8	EMERSON ELECTRIC CO.	USA				
				20	8	ENI	Italy				
				20	8	LANZATECH NEW ZEALAND LTD	New Zealand				

Database: Derwent™ Innovation

8. gxA08: Nuclear Power Generation

Table 5-25 illustrates the top 20 IPF applicants in "gxA08: Nuclear Power Generation."

Among the top applicants, GENERAL ELECTRIC CO. (USA) ranked first, WESTINGHOUSE ELECTRIC CORPORATION (USA) ranked second, and KOREA ELECTRIC POWER CORP. (South Korea) ranked third. 8 US applicants, 5 European applicants, 3 Japanese applicants, and 2 South Korean and Chinese applicants were ranked.

Table 5-25 Top 20 IPF applicants in "gxA08: Nuclear Power Generation"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	363	GENERAL ELECTRIC CO.	USA
2	361	WESTINGHOUSE ELECTRIC CORPORATION	USA
3	249	KOREA ELECTRIC POWER CORP.	Korea
4	230	AREVA NP	France
5	208	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
6	192	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
7	186	CHINA GENERAL NUCLEAR POWER CORP.	China
8	176	FRAMATOME CONNECTORS INTERNATIONAL	France
9	136	KOREA ATOMIC ENERGY RESEARCH INSTITUTE	Korea
10	121	TOSHIBA CORP.	Japan
11	89	WESTINGHOUSE ELECTRIC COMPANY LLC	USA
12	84	BABCOCK & WILCOX ENTERPRISES, INC.	USA
13	71	HITACHI, LTD.	Japan
14	70	JOINT-STOCK COMPANY ASE ENGINEERING COMPANY	Russia
15	68	TERRAPOWER LLC	USA
16	51	FLUOR CORPORATION	USA
17	49	BWXT MPOWER INC.	USA
18	45	HOLTEC INTERNATIONAL	USA
18	45	NUCLEAR POWER INSTITUTE OF CHINA	China
20	44	TOKAMAK ENERGY LTD	Germany

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are nine US applicants, four European applicants, three Japanese applicants, two South Korean applicants, and two Chinese applicants in the filing years (priority years) 2010-2013, while there are eight European applicants, five US applicants, four Chinese applicants, two South Korean applicants, and one Japanese applicant in 2018-2021.

Table 5-26 Trend of top-ranking applicants with the number of IPFs in “gxA08: Nuclear Power Generation”

(the Filing Years (Priority Years) 2010-2021)

2010–2013				2014–2017				2018–2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	168	GENERAL ELECTRIC CO.	USA	1	125	WESTINGHOUSE ELECTRIC COMPANY LLC	USA	1	91	WESTINGHOUSE ELECTRIC COMPANY LLC	USA
2	145	WESTINGHOUSE ELECTRIC COMPANY LLC	USA	2	114	GENERAL ELECTRIC CO.	USA	2	90	CHINA GENERAL NUCLEAR POWER CORP.	China
3	140	AREVA NP	France	3	89	AREVA NP	France	3	81	GENERAL ELECTRIC CO.	USA
4	129	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	4	77	KOREA ELECTRIC POWER CORP.	Korea	4	77	KOREA ELECTRIC POWER CORP.	Korea
5	111	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	5	70	CHINA GENERAL NUCLEAR POWER CORP.	China	5	76	FRAMATOME CONNECTORS INTERNATIONAL	France
6	95	KOREA ELECTRIC POWER CORP.	Korea	6	67	FRAMATOME CONNECTORS INTERNATIONAL	France	6	30	KOREA ATOMIC ENERGY RESEARCH INSTITUTE	Korea
7	75	TOSHIBA CORP.	Japan	7	61	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	7	25	TOKAMAK ENERGY LTD	Germany
8	72	BABCOCK & WILCOX ENTERPRISES, INC.	USA	8	57	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	8	23	ROLLS ROYCE PLC.	UK
9	69	KOREA ATOMIC ENERGY RESEARCH INSTITUTE	Korea	9	42	TOSHIBA CORP.	Japan	9	22	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
10	61	WESTINGHOUSE ELECTRIC COMPANY LLC	USA	10	37	HITACHI, LTD.	Japan	9	22	JOINT-STOCK COMPANY ASE ENGINEERING COMPANY	Russia
11	39	BWXT MPOWER INC.	USA	10	37	KOREA ATOMIC ENERGY RESEARCH INSTITUTE	Korea	11	20	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
12	33	FRAMATOME CONNECTORS INTERNATIONAL	France	12	35	JOINT-STOCK COMPANY ASE ENGINEERING COMPANY	Russia	12	19	BWX TECHNOLOGIES, INC.	USA
13	29	HITACHI, LTD.	Japan	13	33	TERRAPOWER LLC	USA	13	18	TERRAPOWER LLC	USA
14	26	CHINA GENERAL NUCLEAR POWER CORP.	China	14	28	WESTINGHOUSE ELECTRIC COMPANY LLC	USA	14	15	JOINT-STOCK COMPANY "ATOMENERGOPROEKT"	Russia
14	26	NUCLEAR POWER INSTITUTE OF CHINA	China	15	27	FLUOR CORPORATION	USA	15	12	JOINT-STOCK COMPANY "TVEL"	Russia
16	24	ATOMIC ENERGY OF CANADA LTD	Canada	16	21	JOINT STOCK COMPANY "SCIENCE AND INNOVATIONS"	Russia	15	12	SCIENCE AND INNOVATIONS - NUCLEAR INDUSTRY SCIENTIFIC DEVELOPMENT PRIVATE ENTERPRISE	Russia
17	22	HOLTEC INTERNATIONAL	USA	17	20	ELECTRICITY OF FRANCE	France	17	11	HOLTEC INTERNATIONAL	USA
18	19	FEDERAL GOVERNMENT OF THE UNITED STATES	USA	18	18	MITSUBISHI ELECTRIC CORP.	Japan	17	11	SHANGHAI NUCLEAR ENGINEERING RESEARCH AND DESIGN INSTITUTE	China
19	18	ELECTRICITY OF FRANCE	France	19	17	TOKAMAK ENERGY LTD	Germany	19	10	NUCLEAR POWER INSTITUTE OF CHINA	China
20	17	SEARETE LLC	USA	20	16	ROSATOM CORP.	Russia	19	10	XIAN JIAOTONG UNIVERSITY	China
20	17	TERRAPOWER LLC	USA								

Database: Derwent™ Innovation

9. gxA09: Fuel Cells

Table 5-27 illustrates the top 20 IPF applicants in "gxA09: Fuel Cells."

Among the top applicants, TOYOTA MOTOR CORPORATION ranked first, HYUNDAI MOTOR CORP. (South Korea) ranked second, and HONDA MOTOR CO., LTD. Ranked third. 7 European applicants, 6 Japanese applicants, 4 South Korean applicants, 3 US applicants, and no Chinese applicants were ranked.

Table 5-27 Top 20 IPF applicants in "gxA09: Fuel Cells"

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	1,535	TOYOTA MOTOR CORPORATION	Japan
2	1,065	HYUNDAI MOTOR CORP.	Korea
3	862	HONDA MOTOR CO., LTD.	Japan
4	772	ROBERT BOSCH GMBH	Germany
5	637	KIA CORP.	Korea
6	588	PANASONIC CORP.	Japan
7	444	SAMSUNG GROUP	Korea
8	443	NISSAN MOTOR CO., LTD.	Japan
9	420	GENERAL MOTORS CORP.	USA
10	315	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
11	298	LG CORPORATION	Korea
12	294	AUDI A.G.	Germany
13	239	SUMITOMO ELECTRIC INDUSTRIES, LTD.	Japan
14	198	DAIMLER A.G.	Germany
15	193	INTELLIGENT ENERGY	UK
16	191	KYOCERA CORP.	Japan
17	171	VOLKSWA.G.EN A.G.	Germany
18	163	SIEMENS A.G.	Germany
19	152	UNITED TECHNOLOGIES CORP.	USA
20	140	FORD MOTOR CO.	USA

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are six Japanese applicants, six European applicants, five South Korean applicants, and three US applicants in the filing years (priority years) 2010-2013, while there are eight Japanese applicants, six European applicants, five South Korean applicants, and one Chinese applicant in 2018-2021.

Table 5-28 Trend of top-ranking applicants with the number of IPFs in “gxA09: Fuel Cells” (the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	361	TOYOTA MOTOR CORPORATION	Japan	1	598	TOYOTA MOTOR CORPORATION	Japan	1	576	TOYOTA MOTOR CORPORATION	Japan
2	314	SAMSUNG GROUP	Korea	2	410	HYUNDAI MOTOR CORP.	Korea	2	481	ROBERT BOSCH GMBH	Germany
3	291	GENERAL MOTORS CORP.	USA	3	235	HONDA MOTOR CO.,LTD.	Japan	3	397	HYUNDAI MOTOR CORP.	Korea
4	271	HONDA MOTOR CO.,LTD.	Japan	4	197	PANASONIC CORP.	Japan	4	371	KIA CORP.	Korea
5	258	HYUNDAI MOTOR CORP.	Korea	5	192	KIA CORP.	Korea	5	356	HONDA MOTOR CO.,LTD.	Japan
6	247	PANASONIC CORP.	Japan	6	186	ROBERT BOSCH GMBH	Germany	6	144	PANASONIC CORP.	Japan
7	227	NISSAN MOTOR CO., LTD.	Japan	7	184	NISSAN MOTOR CO., LTD.	Japan	7	108	AUDI A.G.	Germany
8	139	UNITED TECHNOLOGIES CORP.	USA	8	166	LG CORPORATION	Korea	8	84	KOLON INDUSTRIES, INC.	Korea
9	132	DAIMLER A.G.	Germany	9	127	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	9	74	AVL LIST GMBH	Austria
10	119	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	10	121	SUMITOMO ELECTRIC INDUSTRIES, LTD	Japan	10	71	SUMITOMO ELECTRIC INDUSTRIES, LTD	Japan
10	119	INTELLIGENT ENERGY	UK	11	109	VOLKSWA.G.EN A.G.	Germany	11	69	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
12	106	ENEOS HOLDINGS, INC.	Japan	12	101	GENERAL MOTORS CORP.	USA	12	60	CERES INTELLECTUAL PROPERTY COMPANY LIMITED	UK
13	105	ROBERT BOSCH GMBH	Germany	13	97	AUDI A.G.	Germany	13	49	VOLKSWA.G.EN A.G.	Germany
14	89	AUDI A.G.	Germany	14	81	SAMSUNG GROUP	Korea	13	49	LG CORPORATION	Korea
15	85	SIEMENS A.G.	Germany	15	79	KYOCERA CORP.	Japan	13	49	SAMSUNG GROUP	Korea
16	83	LG CORPORATION	Korea	16	64	INTELLIGENT ENERGY	UK	16	48	TOSHIBA CORP.	Japan
17	74	KIA CORP.	Korea	17	63	TOSHIBA CORP.	Japan	17	47	WEICHAI POWER CO.,LTD.	China
18	67	KYOCERA CORP.	Japan	18	62	FORD MOTOR CO.	USA	18	45	KYOCERA CORP.	Japan
19	58	FORD MOTOR CO.	USA	19	53	TORAY INDUSTRIES, INC.	Japan	19	44	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
20	52	KOREA INSTITUTE OF ENERGY RESEARCH	Korea	20	52	DAIMLER A.G.	Germany	20	41	DENSO CORP.	Japan

Database: Derwent™ Innovation

10. gxA10: Hydrogen Technology

Table 5-29 illustrates the top 20 IPF applicants in "gxA10: Hydrogen Technology."

Among the top applicants, AIR LIQUIDE S.A (France) ranked first, PANASONIC CORP. ranked second, and LINDE A.G. (UK) ranked third. 9 European applicants, 5 Japanese applicants, 2 South Korean and US applicants, and no Chinese applicants were ranked.

Table 5-29 Top 20 IPF applicants in "gxA10: Hydrogen Technology"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	355	AIR LIQUIDE S.A.	France
2	264	PANASONIC CORP.	Japan
3	228	LINDE A.G.	UK
4	218	TOYOTA MOTOR CORPORATION	Japan
5	201	HYUNDAI MOTOR CORP.	Korea
6	188	HONDA MOTOR CO., LTD.	Japan
7	177	SAUDI BASIC IND CORP.	Saudi Arabia
8	175	HALDOR TOPSOE A/S	Denmark
9	135	KIA CORP.	Korea
10	129	ROBERT BOSCH GMBH	Germany
11	122	AIR PRODUCTS AND CHEMICALS, INC.	USA
12	111	SAUDI ARABIAN OIL CO.	Saudi Arabia
13	107	SIEMENS A.G.	Germany
14	105	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
15	97	ROYAL DUTCH SHELL PLC.	Netherlands
16	96	BASF SE	Germany
17	91	ENEOS HOLDINGS, INC.	Japan
17	91	GENERAL ELECTRIC CO.	USA
17	91	THYSSENKRUPP A.G.	Germany
20	86	TOSHIBA CORP.	Japan

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 10 European applicants, five Japanese applicants, three US applicants, and two South Korean applicants in the filing years (priority years) 2010-2013, while there are seven European applicants, seven Japanese applicants, three South Korean applicants, and three US applicants in 2018-2021.

Table 5-30 Trend of top-ranking applicants with the number of IPFs in “gxA10: Hydrogen Technology”
(the Filing Years (Priority Years) 2010-2021)

2010–2013				2014–2017				2018–2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	102	AIR LIQUIDE S.A.	France	1	115	AIR LIQUIDE S.A.	France	1	138	AIR LIQUIDE S.A.	France
2	97	PANASONIC CORP.	Japan	2	103	SABIC	Saudi Arabia	2	95	HYUNDAI MOTOR CORP.	Korea
3	81	DENSO CORP.LINDE A.G.	UK	3	95	DENSO CORP.LINDE A.G.	UK	3	87	KIA CORP.	Korea
4	72	TOYOTA MOTOR CORPORATION	Japan	4	92	PANASONIC CORP.	Japan	4	86	ROBERT BOSCH GMBH	Germany
5	68	HONDA MOTOR CO.,LTD.	Japan	5	81	HYUNDAI MOTOR CORP.	Korea	5	75	PANASONIC CORP.	Japan
6	66	GENERAL ELECTRIC CO.	USA	6	71	TOYOTA MOTOR CORPORATION	Japan	5	75	TOYOTA MOTOR CORPORATION	Japan
7	58	ENEOS HOLDINGS, INC.	Japan	7	61	HALDOR TOPSOE A/S	Denmark	7	74	HONDA MOTOR CO.,LTD.	Japan
8	56	AIR PRODUCTS AND CHEMICALS, INC.	USA	8	54	TOSHIBA CORP.	Japan	8	72	HALDOR TOPSOE A/S	Denmark
9	50	ROYAL DUTCH SHELL PLC.	Netherlands	9	46	HONDA MOTOR CO.,LTD.	Japan	9	62	SAUDI ARABIAN OIL CO.	Saudi Arabia
10	43	IFP ENERGIES NOUVELLES S.A.	France	10	43	AIR PRODUCTS AND CHEMICALS, INC.	USA	10	52	DENSO CORP.LINDE A.G.	UK
11	42	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	10	43	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	11	43	SABIC	Saudi Arabia
11	42	HALDOR TOPSOE A/S	Denmark	12	37	BASF SE	Germany	12	38	SIEMENS A.G.	Germany
11	42	INTELLIGENT ENERGY	UK	12	37	KIA CORP.	Korea	13	34	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
11	42	SIEMENS A.G.	Germany	14	33	ROBERT BOSCH GMBH	Germany	14	33	THYSSENKRUPP A.G.	Germany
15	35	BASF SE	Germany	15	32	PRAXAIR TECHNOLOGY INC.	USA	15	28	ENEOS HOLDINGS, INC.	Japan
16	32	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	16	30	ROYAL DUTCH SHELL PLC.	Netherlands	15	28	TOSHIBA CORP.	Japan
16	32	GENERAL MOTORS CORP.	USA	17	29	EXXONMOBIL CORP.	USA	17	24	EXXONMOBIL CORP.	USA
18	31	SABIC	Saudi Arabia	18	28	THYSSENKRUPP A.G.	Germany	17	24	BASF SE	Germany
19	30	THYSSENKRUPP A.G.	Germany	18	28	SAUDI ARABIAN OIL CO.	Saudi Arabia	19	23	AIR PRODUCTS AND CHEMICALS, INC.	USA
19	30	KOREA INSTITUTE OF ENERGY RESEARCH	Korea	20	27	SIEMENS A.G.	Germany	20	22	KAWASAKI HEAVY INDUSTRIES, LTD.	Japan
19	30	SAMSUNG GROUP	Korea					20	22	PRAXAIR TECHNOLOGY INC.	USA
								20	22	KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY	Korea

Database: Derwent™ Innovation

11. gxA11: Ammonia Technology

Table 5-31 illustrates the top 20 IPF applicants in "gxA11: Ammonia Technology."

Among the top applicants, HALDOR TOPSOE A/S (Denmark) ranked first, CAS.A.LE S.A. (Switzerland) ranked second, and THYSSENKRUPP A.G. (Germany) ranked third. 10 European applicants, 6 Japanese applicants, 3 US applicants, and no Chinese or South Korean applicants were ranked.

Table 5-31 Top 20 IPF applicants in "gxA11: Ammonia Technology"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	51	HALDOR TOPSOE A/S	Denmark
2	50	CAS.A.LE S.A.	Switzerland
3	46	THYSSENKRUPP A.G.	Germany
4	39	TOYOTA MOTOR CORPORATION	Japan
5	34	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
6	23	SIEMENS A.G.	Germany
7	20	JAPAN SCIENCE AND TECHNOLOGY AGENCY	Japan
8	17	TOKYO INSTITUTE OF TECHNOLOGY	Japan
9	16	GENERAL ELECTRIC CO.	USA
9	16	COMPAGNIE PLASTIC OMNIUM S.A.	France
9	16	SAUDI BASIC IND CORP.	Saudi Arabia
12	15	NISSAN CHEMICAL CORPORATION	Japan
12	15	UNIVERSITY OF TOKYO	Japan
12	15	JOHNSON MATTHEY PLC.	UK
15	13	INERGY AUTOMOTIVE SYSTEMS SAS	France
16	12	EXXONMOBIL CORP.	USA
17	11	AIR PRODUCTS AND CHEMICALS, INC.	USA
17	11	AIR LIQUIDE S.A.	France
17	11	IFP ENERGIES NOUVELLES S.A.	France
17	11	YARA INTERNATIONAL ASA	Norway

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 11 European applicants, seven US applicants, five Japanese applicants, and one Chinese applicant in the filing years (priority years) 2010-2013, while there are 10 European applicants, nine Japanese applicants, four South Korean applicants, and three US applicants in 2018-2021.

Table 5-32 Trend of top-ranking applicants with the number of IPFs in “gxA11: Ammonia Technology” (the Filing Years (Priority Years) 2010-2021)

2010–2013				2014–2017				2018–2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	20	TOYOTA MOTOR CORPORATION	Japan	1	27	THYSSENKRUPP A.G.	Germany	1	21	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
2	18	CAS.A.LE S.A.	Switzerland	2	26	HALDOR TOPSOE A/S	Denmark	2	15	NISSAN CHEMICAL CORPORATION	Japan
3	10	HALDOR TOPSOE A/S	Denmark	3	22	CAS.A.LE S.A.	Switzerland	2	15	HALDOR TOPSOE A/S	Denmark
3	10	AAQIUS & AAQIUS SA	China	4	16	SIEMENS A.G.	Germany	4	14	UNIVERSITY OF TOKYO	Japan
5	9	GENERAL ELECTRIC CO.	USA	5	15	TOYOTA MOTOR CORPORATION	Japan	5	13	SABIC	Saudi Arabia
5	9	AMMINEX EMISSIONS TECHNOLOGY A/S	Denmark	6	11	JAPAN SCIENCE AND TECHNOLOGY AGENCY	Japan	6	10	CAS.A.LE S.A.	Switzerland
5	9	INERGY AUTOMOTIVE SYSTEMS SAS	France	6	11	TOKYO INSTITUTE OF TECHNOLOGY	Japan	6	10	THYSSENKRUPP A.G.	Germany
5	9	THYSSENKRUPP A.G.	Germany	6	11	JOHNSON MATTHEY PLC.	UK	8	8	YARA INTERNATIONAL ASA	Norway
9	8	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	9	9	PLASTIC OMNIUM	France	9	7	JAPAN SCIENCE AND TECHNOLOGY AGENCY	Japan
9	8	STELLANTIS N.V.	France	10	7	DENSO CORP.LINDE A.G.	UK	9	7	TOYOTA INDUSTRIES CORPORATION	Japan
11	7	KURARAY CO.,LTD	Japan	11	5	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	9	7	AIR PRODUCTS AND CHEMICALS, INC.	USA
11	7	SUMITOMO SEIKA CHEMICALS CO.,LTD.	Japan	11	5	THE CHUGOKU ELECTRIC POWER COMPANY, INCORPORATED.	Japan	12	5	NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY	Japan
11	7	FORD MOTOR CO.	USA	11	5	EXXONMOBIL CORP.	USA	12	5	EXXONMOBIL CORP.	USA
11	7	INTERNATIONAL TRUCKS	USA	11	5	GENERAL ELECTRIC CO.	USA	12	5	SAUDI ARABIAN OIL CO.	Saudi Arabia
11	7	MCALISTER TECHNOLOGIES, LLC	USA	11	5	AIR LIQUIDE S.A.	France	15	4	TOKYO INSTITUTE OF TECHNOLOGY	Japan
16	6	GENERAL MOTORS CORP.	USA	11	5	ROBERT BOSCH GMBH	Germany	15	4	TOYOTA MOTOR CORPORATION	Japan
16	6	KBR, INC.	USA	17	4	IHI CORPORATION	Japan	15	4	TSUBAME BHB CO., LTD.	Japan
16	6	BLUE WAVE CO S.A.	Luxembourg	17	4	JGC HOLDINGS CORPORATION	Japan	15	4	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	USA
19	5	HITACHI ZOSEN CORPORATION	Japan	17	4	ORGANO CORPORATION	Japan	15	4	AIR LIQUIDE S.A.	France
19	5	INVISTA	USA	17	4	ENTEGRIS, INC.	USA	15	4	GAZTRANSPORT ET TECHNIGAZ SA	France
19	5	ALSTOM S.A.	France	17	4	PRAXAIR TECHNOLOGY INC.	USA	15	4	IFP ENERGIES NOUVELLES S.A.	France
19	5	COLDWAY	France	17	4	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG E.V.	Germany	15	4	NETHERLANDS ORGANIZATION FOR APPLIED SCIENTIFIC RESEARCH	Netherlands
19	5	PLASTIC OMNIUM	France	17	4	IFP ENERGIES NOUVELLES S.A.	France	15	4	TOPSOE A/S	Denmark
19	5	MAN SE.	Germany	17	4	INERGY AUTOMOTIVE SYSTEMS SAS	France	15	4	TOTAL S.A.	France
								15	4	DAEWOO SHIPBUILDING & MARINE ENGINEERING CO., LTD	Korea
								15	4	HYUNDAI MOTOR CORP.	Korea
								15	4	KIA CORP.	Korea
								15	4	KOREA INSTITUTE OF SCIENCE AND TECHNOLOGY	Korea

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12. gxB01: Energy Saving in Buildings (ZEB, ZEH, etc.)

Table 5-33 illustrates the top 20 IPF applicants in "gxB01: Energy Saving in Buildings (ZEB, ZEH, etc.)."

Among the top applicants, SAMSUNG GROUP (South Korea) ranked first, PANASONIC CORP. ranked second, and LG CORPORATION (South Korea) ranked third. 12 Japanese applicants, 5 European applicants, 2 South Korean applicants, 1 Chinese applicant, and no US applicants were ranked.

Table 5-33 Top 20 IPF applicants in "gxB01: Energy Saving in Buildings (ZEB, ZEH, etc.)" (Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	3,106	SAMSUNG GROUP	Korea
2	2,827	PANASONIC CORP.	Japan
3	2,563	LG CORPORATION	Korea
4	2,342	MITSUBISHI ELECTRIC CORP.	Japan
5	1,969	KONINKLIJKE PHILIPS N.V.	Netherlands
6	1,953	SHARP CORP.	Japan
7	1,686	OSRAM GMBH	Germany
8	1,418	SIGNIFY N.V.	Netherlands
9	1,404	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan
10	1,053	JAPAN DISPLAY INC.	Japan
11	1,005	TOSHIBA CORP.	Japan
12	945	DAIKIN INDUSTRIES, LTD.	Japan
13	833	ZUMTOBEL AG	Austria
14	799	KOITO MANUFACTURING CO., LTD.	Japan
15	793	VALEO S.A.	France
16	767	SUMITOMO CHEMICAL CO., LTD.	Japan
17	753	FUJIFILM CORP.	Japan
18	721	KONICA MINOLTA, INC.	Japan
19	674	SONY GROUP CORP.	Japan
20	663	BOE TECHNOLOGY GROUP CO., LTD.	China

As shown in trend of top-ranking applicants with the number of IPFs below, there are 11 Japanese applicants, four European applicants, two South Korean applicants, and one Chinese applicant in the filing years (priority years) 2010-2013, while there are 12 Japanese applicants, four European applicants, two South Korean applicants, and two Chinese applicants in 2018-2021.

Table 5-34 Trend of top-ranking applicants with the number of IPFs in “gxB01: Energy Saving in Buildings (ZEB, ZEH, etc.)”(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	1,867	SAMSUNG GROUP	Korea	1	1,119	MITSUBISHI ELECTRIC CORP.	Japan	1	637	MITSUBISHI ELECTRIC CORP.	Japan
2	1,392	PANASONIC CORP.	Japan	2	1,017	PANASONIC CORP.	Japan	2	557	SHARP CORP.	Japan
3	1,019	LG CORPORATION	Korea	3	992	LG CORPORATION	Korea	3	552	LG CORPORATION	Korea
4	889	SHARP CORP.	Japan	4	895	KONINKLIJKE PHILIPS N.V.	Netherlands	4	526	SIGNIFY N.V.	Netherlands
5	888	KONINKLIJKE PHILIPS N.V.	Netherlands	5	806	SAMSUNG GROUP	Korea	5	433	SAMSUNG GROUP	Korea
6	863	OSRAM GMBH	Germany	6	630	OSRAM GMBH	Germany	6	418	PANASONIC CORP.	Japan
7	643	TOSHIBA CORP.	Japan	7	627	JAPAN DISPLAY INC.	Japan	7	349	DAIKIN INDUSTRIES, LTD	Japan
8	586	MITSUBISHI ELECTRIC CORP.	Japan	8	583	SIGNIFY N.V.	Netherlands	8	321	KOITO MANUFACTURING CO., LTD.	Japan
9	579	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan	9	527	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan	9	298	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan
10	428	HON HAI PRECISION IND CO., LTD.	Taiwan	10	507	SHARP CORP.	Japan	10	294	SUMITOMO CHEMICAL COMPANY, LIMITED	Japan
11	395	KONICA MINOLTA, INC.	Japan	11	398	VALEO S.A.	France	11	267	JAPAN DISPLAY INC.	Japan
12	362	ZUMTOBEL AG	Austria	12	375	BOE TECHNOLOGY GROUP CO., LTD.	China	12	258	CANON INC.	Japan
13	323	AU OPTRONICS CORP.	Taiwan	13	352	DAIKIN INDUSTRIES, LTD	Japan	13	248	NITTO DENKO CORP.	Japan
14	309	SIGNIFY N.V.	Netherlands	14	299	ZUMTOBEL AG	Austria	14	229	NICHIA CORPORATION	Japan
15	300	SONY GROUP CORP.	Japan	15	276	KONICA MINOLTA, INC.	Japan	15	222	FUJIFILM CORP.	Japan
16	289	TCL TECHNOLOGY	China	16	263	KOITO MANUFACTURING CO., LTD.	Japan	16	221	LEEDARSON IoT TECHNOLOGY INC.	China
17	278	FUJIFILM CORP.	Japan	17	253	FUJIFILM CORP.	Japan	17	193	OSRAM GMBH	Germany
18	270	JOLED INC.	Japan	17	253	SUMITOMO CHEMICAL COMPANY, LIMITED	Japan	18	190	BOE TECHNOLOGY GROUP CO., LTD.	China
19	256	HITACHI, LTD.	Japan	19	244	TOSHIBA CORP.	Japan	19	186	KONINKLIJKE PHILIPS N.V.	Netherlands
20	245	CANON INC.	Japan	20	227	TCL TECHNOLOGY	China	20	182	VALEO S.A.	France

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13. gxB02: High-Efficiency Motors and Inverters

Table 5-35 illustrates the top 21 IPF applicants in "gxB02: High-Efficiency Motors and Inverters."

Among the top applicants, MITSUBISHI ELECTRIC CORP. ranked first, SIEMENS A.G. (Germany) ranked second, and NIPPON DENSAN CO., LTD. ranked third. 8 Japanese applicants, 5 European applicants, 4 US applicants, and 2 South Korean and Chinese applicants were ranked.

Table 5-35 Top 21 IPF applicants in "gxB02: High-Efficiency Motors and Inverters"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	427	MITSUBISHI ELECTRIC CORP.	Japan
2	375	SIEMENS A.G.	Germany
3	255	NIPPON DENSAN CO., LTD.	Japan
4	234	HITACHI, LTD.	Japan
5	181	GENERAL ELECTRIC CO.	USA
6	158	HONDA MOTOR CO., LTD.	Japan
7	151	TOYOTA MOTOR CORPORATION	Japan
8	146	DENSO CORP.	Japan
9	143	ROBERT BOSCH GMBH	Germany
10	115	PANASONIC CORP.	Japan
11	107	ABB AB	Switzerland
11	107	HYUNDAI MOTOR CORP.	Korea
13	103	LG CORPORATION	Korea
14	97	TOSHIBA CORP.	Japan
15	95	HAMILTON SUNDSTRAND CORPORATION	USA
16	85	BORGWARNER INC.	USA
17	76	JOHNSON ELECTRIC HOLDINGS LIMITED	Hong Kong
18	72	SCHAEFFLER A.G.	Germany
19	71	FORD MOTOR CO.	USA
20	58	ROLLS ROYCE PLC.	UK
20	58	MIDEA HOLDING CO., LTD.	China

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As shown in trend of top-ranking applicants with the number of IPFs below, there are 10 Japanese applicants, five US applicants, four European applicants, and two South Korean applicants in the filing years (priority years) 2010-2013, while there are seven Japanese applicants, five European applicants, three US applicants, three South Korean applicants, and two Chinese applicants in 2018-2021.

Table 5-36 Trend of top-ranking applicants with the number of IPFs in “gxB02: High-Efficiency Motors and Inverters”(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	158	SIEMENS A.G.	Germany	1	157	MITSUBISHI ELECTRIC CORP.	Japan	1	155	MITSUBISHI ELECTRIC CORP.	Japan
2	115	MITSUBISHI ELECTRIC CORP.	Japan	2	149	SIEMENS A.G.	Germany	2	127	NIPPON DENSAN CO., LTD.	Japan
3	97	HITACHI, LTD.	Japan	3	97	NIPPON DENSAN CO., LTD.	Japan	3	90	HONDA MOTOR CO.,LTD.	Japan
4	77	GENERAL ELECTRIC CO.	USA	4	87	HITACHI, LTD.	Japan	4	68	SIEMENS A.G.	Germany
5	63	TOYOTA MOTOR CORPORATION	Japan	5	57	DENSO CORP.	Japan	5	56	SCHAEFFLER A.G.	Germany
6	58	ROBERT BOSCH GMBH	Germany	6	55	GENERAL ELECTRIC CO.	USA	6	51	FORD MOTOR CO.	USA
7	55	BORGWARNER INC.	USA	7	54	JOHNSON ELECTRIC HOLDINGS LIMITED	Hong Kong	6	51	LG CORPORATION	Korea
8	51	PANASONIC CORP.	Japan	8	51	ROBERT BOSCH GMBH	Germany	8	50	HITACHI, LTD.	Japan
9	48	YASKAWA ELECTRIC CORPORATION	Japan	9	46	TOSHIBA CORP.	Japan	9	49	GENERAL ELECTRIC CO.	USA
10	47	DENSO CORP.	Japan	10	43	TOYOTA MOTOR CORPORATION	Japan	10	45	TOYOTA MOTOR CORPORATION	Japan
11	44	ABB	Switzerland	11	39	ABB	Switzerland	11	42	DENSO CORP.	Japan
12	39	AISIN CORPORATION	Japan	12	37	PANASONIC CORP.	Japan	12	40	HYUNDAI MOTOR CORP.	Korea
13	36	HYUNDAI MOTOR CORP.	Korea	13	36	HAMILTON SUNDSTRAND CORPORATION	USA	13	36	HAMILTON SUNDSTRAND CORPORATION	USA
14	35	SAMSUNG GROUP	Korea	14	35	HONDA MOTOR CO.,LTD.	Japan	14	34	ROBERT BOSCH GMBH	Germany
15	33	HONDA MOTOR CO.,LTD.	Japan	15	31	HYUNDAI MOTOR CORP.	Korea	15	31	MIDEA HOLDING CO., LTD.	China
16	32	TOSHIBA CORP.	Japan	16	30	LG CORPORATION	Korea	16	27	PANASONIC CORP.	Japan
17	31	NIPPON DENSAN CO., LTD.	Japan	17	27	MIDEA HOLDING CO., LTD.	China	16	27	ROLLS ROYCE PLC.	UK
18	27	ALSTOM S.A.	France	18	23	ROLLS ROYCE PLC.	UK	16	27	KIA CORP.	Korea
19	23	GENERAL MOTORS CORP.	USA	19	20	FANUC CORPORATION	Japan	19	26	GREE ELECTRIC APPLIANCES INC.	China
19	23	HAMILTON SUNDSTRAND CORPORATION	USA	20	19	BORGWARNER INC.	USA	20	24	ABB	Switzerland
19	23	RHEEM MANUFACTURING COMPANY	USA	20	19	VALEO S.A.	France				
				20	19	HYOSUNG CORPORATION	Korea				

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14. gxB03: Combined Heat and Power (CHP)

Table 5-37 illustrates the top 20 IPF applicants in "gxB03: Combined Heat and Power (CHP)."

Among the top applicants, GENERAL ELECTRIC CO. (USA) ranked first, MITSUBISHI HEAVY INDUSTRIES, LTD. (MHI) ranked second, and ROBERT BOSCH GMBH (Germany) ranked third. 8 Japanese applicants, 6 European applicants, 3 US applicants, 2 South Korean applicants, and no Chinese applicants were ranked.

Table 5-37 Top 20 IPF applicants in "gxB03: Combined Heat and Power (CHP)"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	99	GENERAL ELECTRIC CO.	USA
2	95	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
3	85	ROBERT BOSCH GMBH	Germany
4	68	SIEMENS A.G.	Germany
5	66	HYUNDAI MOTOR CORP.	Korea
6	61	SCANIA CV ABP	Sweden
7	57	FORD MOTOR CO.	USA
8	50	MAHLE GMBH	Germany
9	46	TOYOTA MOTOR CORPORATION	Japan
10	38	KOBE STEEL LTD	Japan
11	35	TOYOTA INDUSTRIES CORP.	Japan
12	31	PANASONIC CORP.	Japan
13	30	SAUDI ARABIAN OIL CO.	Saudi Arabia
14	27	CUMMINS INC.	USA
14	27	KIA CORP.	Korea
16	26	SANDEN CORPORATION	Japan
16	26	MAN SE	Germany
18	24	HONDA MOTOR CO., LTD.	Japan
18	24	NISSAN MOTOR CO., LTD.	Japan
18	24	VOLVO GROUP	Sweden

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are nine Japanese applicants, six European applicants, five US applicants, and two South Korean applicants in the filing years (priority years) 2010-2013, while there are eight European applicants, six US applicants, five Japanese applicants, four South Korean applicants, and two Chinese applicants in 2018-2021.

Table 5-38 Trend of top-ranking applicants with the number of IPFs in “gxB03: Combined Heat and Power (CHP)”
(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	62	GENERAL ELECTRIC CO.	USA	1	39	ROBERT BOSCH GMBH	Germany	1	29	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
2	43	ROBERT BOSCH GMBH	Germany	1	39	SCANIA CV ABP	Sweden	2	14	SCANIA CV ABP	Sweden
3	37	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	3	32	GENERAL ELECTRIC CO.	USA	3	13	HYUNDAI MOTOR CORP.	Korea
3	37	SIEMENS A.G.	Germany	4	31	HYUNDAI MOTOR CORP.	Korea	3	13	KIA CORP.	Korea
5	34	TOYOTA INDUSTRIES CORPORATION	Japan	5	29	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	5	9	RINNAI CORPORATION	Japan
6	27	FORD MOTOR CO.	USA	6	28	SAUDI ARABIAN OIL CO.	Saudi Arabia	6	8	UNITED TECHNOLOGIES CORP.	USA
7	22	HYUNDAI MOTOR CORP.	Korea	7	27	TOYOTA MOTOR CORPORATION	Japan	6	8	SIEMENS A.G.	Germany
8	19	NISSAN MOTOR CO., LTD.	Japan	7	27	MAHLE GMBH	Germany	8	7	NORITZ CORPORATION	Japan
9	18	PANASONIC CORP.	Japan	9	25	KOBE STEEL, LTD.	Japan	8	7	MAHLE GMBH	Germany
10	17	SANDEN CORPORATION	Japan	9	25	FORD MOTOR CO.	USA	10	6	KOBE STEEL, LTD.	Japan
10	17	TOYOTA MOTOR CORPORATION	Japan	11	23	SIEMENS A.G.	Germany	10	6	RAYTHEON TECHNOLOGIES CORPORATION	USA
12	16	HITACHI, LTD.	Japan	12	17	BORGWARNER INC.	USA	10	6	VOLKSWAGEN A.G.	Germany
12	16	ECHOGEN POWER SYSTEMS L.L.C.	USA	13	13	MIURA CO.,LTD.	Japan	13	5	HONDA MOTOR CO.,LTD.	Japan
12	16	GENERAL MOTORS CORP.	USA	13	13	DOOSAN CORP.	Korea	13	5	CUMMINS INC.	USA
12	16	MAHLE GMBH	Germany	15	12	VALEO S.A.	France	13	5	FORD MOTOR CO.	USA
16	15	VOLVO GROUP	Sweden	16	11	NORITZ CORPORATION	Japan	13	5	GENERAL ELECTRIC CO.	USA
17	14	CUMMINS INC.	USA	16	11	AVL LIST GMBH	Austria	13	5	FAURECIA SE	France
18	13	HONDA MOTOR CO.,LTD.	Japan	16	11	FIAT S.p.A.	Italy	13	5	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
18	13	KAWASAKI HEAVY INDUSTRIES, LTD.	Japan	16	11	ASSOCIAÇÃO PARANAENSE DE CULTURA	Brazil	13	5	DAEWOO SHIPBUILDING & MARINE ENGINEERING CO., LTD	Korea
18	13	ALSTOM S.A.	France	20	10	PANASONIC CORP.	Japan	20	4	RHEEM MANUFACTURING COMPANY	USA
18	13	DAIMLER A.G.	Germany	20	10	RINNAI CORPORATION	Japan	20	4	IFP ENERGIES NOUVELLES S.A.	France
18	13	KYUNGDONG NAVIEN CO., LTD	Korea	20	10	MAN SE	Germany	20	4	MAN SE	Germany
								20	4	JIANGSU DONGJIU HEAVY INDUSTRY CO. LTD.	China
								20	4	SHENZHEN BROADWELL ENVIRONMENTAL TECHNOLOGY CO. LTD.	China
								20	4	LG CORPORATION	Korea

Database: Derwent™ Innovation

15. gxB04: Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge

Table 5-39 illustrates the top 19 IPF applicants in "gxB04: Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge."

Among the top applicants, SIEMENS A.G. (Germany) ranked first, followed by VEOLIA ENVIRONNEMENT S.A. (France) ranked second, and GENERAL ELECTRIC CO. (USA) ranked third. 5 Chinese applicants, 4 European and Japanese applicants, 3 US applicants, and 1 South Korean applicant were ranked.

Table 5-39 Top 19 IPF applicants in "gxB04: Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	9	SIEMENS A.G.	Germany
2	7	VEOLIA ENVIRONNEMENT S.A.	France
3	6	GENERAL ELECTRIC CO.	USA
3	6	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	USA
3	6	NANJING UNIVERSITY	China
6	5	MIDEA HOLDING CO., LTD.	China
6	5	NANJING YANCHANG REACTION TECHNOLOGY RESEARCH INSTITUTE CO. LTD	China
6	5	DOOSAN CORP.	Korea
9	4	HITACHI, LTD.	Japan
9	4	KURITA WATER INDUSTRIES LTD.	Japan
9	4	MATSUI MFG. CO., LTD.	Japan
9	4	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
9	4	UNIVERSITY OF CALIFORNIA	USA
9	4	DEGRÉMONT, S.A.	France
9	4	SUEZ S.A.	France
9	4	GUANGDONG UNIVERSITY OF TECHNOLOGY	China
9	4	JIMEI UNIVERSITY	China
9	4	KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY	Saudi Arabia
9	4	SAUDI ARABIAN OIL CO.	Saudi Arabia

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are seven European applicants, seven Japanese applicants, six US applicants, and two Chinese applicants in the filing years (priority years) 2010-2013, while there are 19 Chinese applicants, three Japanese applicants, two US applicants, one South Korean applicant, and one European applicant in 2018-2021.

Table 5-40 Trend of top-ranking applicants with the number of IPFs in “gxB04: Energy Saving and Supply/Demand Flexibility in Treatment of Water, Wastewater, Sewage, and Sludge” (the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	7	SIEMENS A.G.	Germany	1	4	MIDEA HOLDING CO., LTD.	China	1	5	NANJING YANCHANG REACTION TECHNOLOGY RESEARCH INSTITUTE CO. LTD	China
2	5	VEOLIA ENVIRONNEMENT S.A.	France	1	4	DOOSAN CORP.	Korea	2	4	GUANGDONG UNIVERSITY OF TECHNOLOGY	China
3	4	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	USA	3	3	MATSUI MFG. CO., LTD.	Japan	2	4	JIMEI UNIVERSITY	China
4	3	METAWATER CO., LTD.	Japan	3	3	GENERAL ELECTRIC CO.	USA	2	4	NANJING UNIVERSITY	China
4	3	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	3	3	OMYA AG	Switzerland	5	3	ORGANO CORPORATION	Japan
4	3	TOMOE ENGINEERING CO., LTD.	Japan	3	3	PAQUES BV	Netherlands	5	3	BEIJING UNIVERSITY OF TECHNOLOGY	China
4	3	DEGRÉMONT	France	3	3	TIANJIN XIDUN JINYANG ENVIRONMENTAL PROTECTION TECHNOLOGY CO. LTD.	China	5	3	CHINA HUANENG GROUP CO., LTD.	China
4	3	ZHANG YU (Individual)	China	3	3	WESDON-TIENDA ENVIRONMENTAL SCIENCES CO. LTD.	China	5	3	JIANGNAN UNIVERSITY	China
4	3	ANAERGIA INC.	Canada	3	3	XI'AN WESTPEACE FIRE TECHNOLOGY CO. LTD.	China	5	3	SOUTHEAST UNIVERSITY	China
10	2	FUJI ELECTRIC CO., LTD.	Japan	3	3	SAUDI ARABIAN OIL CO.	Saudi Arabia	10	2	KURITA WATER INDUSTRIES LTD.	Japan
10	2	HITACHI, LTD.	Japan	11	2	HITACHI, LTD.	Japan	10	2	UTSUNOMIYA INDUSTRIES CO.,LTD	Japan
10	2	KAWASAKI HEAVY INDUSTRIES, LTD.	Japan	11	2	TOYOBO CO., LTD.	Japan	10	2	COLUMBIA UNIVERSITY	USA
10	2	TORAY INDUSTRIES, INC.	Japan	11	2	UNIVERSITY OF CALIFORNIA	USA	10	2	PALO ALTO RESEARCH CENTER	USA
10	2	AQUATECH INTERNATIONAL CORPORATION	USA	11	2	CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.	China	10	2	SUEZ S.A.	France
10	2	GENERAL ELECTRIC CO.	USA	11	2	DALIAN UNIVERSITY OF TECHNOLOGY	China	10	2	CENERTECH TIANJIN CHEMICAL RESEARCH AND DESIGN INSTITUTE CO. LTD.	China
10	2	JAEGER CLAUDIUS (Individual)	USA	11	2	GUANGZHOU INSTITUTE OF ENERGY CONVERSION, CHINESE ACADEMY OF SCIENCES	China	10	2	CHANGCHUN UNIVERSITY OF SCIENCE AND TECHNOLOGY	China
10	2	UNIVERSITY OF MICHIGAN	USA	11	2	HAIER GROUP	China	10	2	CHINA NATIONAL OFFSHORE OIL CORPORATION	China
10	2	XYLECO, INC.	USA	11	2	LIU NA-LIN (Individual)	China	10	2	HUNAN SHIKELANG ENVIRONMENTAL TECHNOLOGY CO. LTD.	China
10	2	ABB	Switzerland	11	2	SHENYANG VYCON NEW ENERGY TECHNOLOGY CO. LTD.	China	10	2	NANFANG CHUANGYE (TIANJIN) TECHNOLOGY DEVELOPMENT CO. LTD.	China
10	2	AREVA NP	France	11	2	LG CORPORATION	Korea	10	2	NANJING HAN'ERSI BIOLOGICAL TECHNOLOGY CO. LTD.	China
10	2	CRYSTAL LAGOONS (CURACAO) B.V	Netherlands	11	2	FOREVERTRUST INTERNATIONAL (S) PTE. LTD.	Singapore	10	2	SHANDONG UNIVERSITY	China
10	2	SOLVAY	Belgium	11	2	INDUSTRIAL ADVANCED SERVICES FZ-LLC	UAE	10	2	SUZHOU RONG NENG ENVIRONMENTAL PROTECTION TECHNOLOGY CO LTD	China
10	2	ZHEJIANG ZOKSEN ENVIRO-ENERGY EQUIPMENT CO. LTD.	China	11	2	KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY	Saudi Arabia	10	2	TONGJI UNIVERSITY	China
10	2	COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH	India	11	2	SEMB-ECO R&D PTE LTD	Singapore	10	2	TSINGHUA UNIVERSITY	China
10	2	KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS	Saudi Arabia					10	2	ZIBO ENVIRONMENTAL PROTECTION TECHNOLOGY CO. LTD.	China
								10	2	SIONTECH CO. LTD.	Korea
								10	2	INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE	Taiwan

Database: Derwent™ Innovation

16. gxB05: Electromobilities

Table 5-41 illustrates the top 20 IPF applicants in "gxB05: Electromobilities."

Among the top applicants, TOYOTA MOTOR CORPORATION ranked first, HYUNDAI MOTOR CORP. (South Korea) ranked second, and FORD MOTOR CO. (USA) ranked third. 9 Japanese applicants, 7 European applicants, 2 South Korean and US applicants, and no Chinese applicants were ranked.

Table 5-41 Top 20 IPF applicants in "gxB05: Electromobilities"

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	3,881	TOYOTA MOTOR CORPORATION	Japan
2	2,193	HYUNDAI MOTOR CORP.	Korea
3	2,024	FORD MOTOR CO.	USA
4	1,682	HONDA MOTOR CO., LTD.	Japan
5	1,476	KIA CORP.	Korea
6	911	GENERAL MOTORS CORP.	USA
7	884	ROBERT BOSCH GMBH	Germany
8	780	NISSAN MOTOR CO., LTD.	Japan
9	765	SCHAEFFLER A.G.	Germany
10	677	ZF FRIEDRICHSHAFEN A.G.	Germany
11	658	DENSO CORP.	Japan
12	532	AUDI A.G.	Germany
13	529	AISIN CORP.	Japan
14	487	SUZUKI MOTOR CORP.	Japan
15	481	HITACHI, LTD.	Japan
16	448	BAYERISCHE MOTOREN WERKE A.G.	Germany
17	426	RENAULT S.A.S.	France
18	382	SUBARU CORPORATION	Japan
19	351	MITSUBISHI ELECTRIC CORP.	Japan
20	343	VOLKSWA.G.EN A.G.	Germany

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are nine Japanese applicants, seven European applicants, two US applicants, and two South Korean applicants in the filing years (priority years) 2010-2013, while there are nine European applicants, seven Japanese applicants, two South Korean applicants, and two US applicants in 2018-2021.

Table 5-42 Trend of top-ranking applicants with the number of IPFs in “gxB05: Electromobilities”

(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	1,264	TOYOTA MOTOR CORPORATION	Japan	1	1,296	TOYOTA MOTOR CORPORATION	Japan	1	1,321	TOYOTA MOTOR CORPORATION	Japan
2	446	GENERAL MOTORS CORP.	USA	2	916	FORD MOTOR CO.	USA	2	895	HYUNDAI MOTOR CORP.	Korea
3	419	FORD MOTOR CO.	USA	3	884	HYUNDAI MOTOR CORP.	Korea	3	820	KIA CORP.	Korea
4	414	HYUNDAI MOTOR CORP.	Korea	4	480	KIA CORP.	Korea	4	817	HONDA MOTOR CO.,LTD.	Japan
5	401	HONDA MOTOR CO.,LTD.	Japan	5	464	HONDA MOTOR CO.,LTD.	Japan	5	689	FORD MOTOR CO.	USA
6	399	NISSAN MOTOR CO., LTD.	Japan	6	272	ROBERT BOSCH GMBH	Germany	6	380	SCHAEFFLER A.G.	Germany
7	282	ROBERT BOSCH GMBH	Germany	7	261	DENSO CORP.	Japan	7	330	ROBERT BOSCH GMBH	Germany
8	274	AISIN CORPORATION	Japan	8	257	SCHAEFFLER A.G.	Germany	8	303	ZF FRIEDRICHSHAFEN A.G.	Germany
9	182	DENSO CORP.	Japan	9	244	GENERAL MOTORS CORP.	USA	9	240	SUBARU CORPORATION	Japan
10	176	KIA CORP.	Korea	10	239	NISSAN MOTOR CO., LTD.	Japan	10	238	SUZUKI MOTOR CORP.	Japan
11	174	HITACHI, LTD.	Japan	11	222	AUDI A.G.	Germany	11	221	GENERAL MOTORS CORP.	USA
11	174	RENAULT S.A.S.	France	12	206	ZF FRIEDRICHSHAFEN A.G.	Germany	12	215	DENSO CORP.	Japan
13	168	ZF FRIEDRICHSHAFEN A.G.	Germany	13	173	BYD COMPANY LIMITED	China	13	203	AUDI A.G.	Germany
14	153	SUZUKI MOTOR CORP.	Japan	14	169	BMW	Germany	14	184	BMW	Germany
15	144	MITSUBISHI ELECTRIC CORP.	Japan	15	153	HITACHI, LTD.	Japan	15	152	VOLKSWA.G.EN A.G.	Germany
16	128	SCHAEFFLER A.G.	Germany	16	133	MITSUBISHI ELECTRIC CORP.	Japan	16	142	NISSAN MOTOR CO., LTD.	Japan
17	120	PORSCHE AG	Germany	16	133	RENAULT S.A.S.	France	17	140	AISIN CORPORATION	Japan
18	109	MITSUBISHI MOTORS CORPORATION	Japan	16	133	LG CORPORATION	Korea	18	126	VALEO S.A.	France
19	107	AUDI A.G.	Germany	19	119	VOLKSWA.G.EN A.G.	Germany	19	123	VOLVO GROUP	Sweden
20	104	SIEMENS A.G.	Germany	20	115	AISIN CORPORATION	Japan	20	119	RENAULT S.A.S.	France

Database: Derwent™ Innovation

17. gxB06: Electrification of Industrial Heat

Table 5-43 illustrates the top 20 IPF applicants in "gxB06: Electrification of Industrial Heat."

Among the top applicants, BSH HAUSGERATE GMBH (Germany) ranked first, LG CORPORATION (South Korea) ranked second, and PANASONIC CORP. ranked third. 8 Japanese applicants, 6 European applicants, 3 US applicants, 2 South Korean applicants, and 1 Chinese applicant were ranked.

Table 5-43 Top 20 IPF applicants in "gxB06: Electrification of Industrial Heat"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Country / Region
1	582	BSH HAUSGERATE GMBH	Germany
2	517	LG CORPORATION	Korea
3	475	PANASONIC CORP.	Japan
4	352	PHILIP MORRIS INTERNATIONAL INC.	USA
5	263	SAMSUNG GROUP	Korea
6	233	AKTIEBOLAGET ELECTROLUX	Sweden
7	197	CANON INC.	Japan
8	185	NGK INSULATORS, LTD.	Japan
9	172	MIDEA HOLDING CO., LTD.	China
10	165	KYOCERA CORP.	Japan
11	163	S.A.INT GOBAIN S.A.	France
12	162	VALEO S.A.	France
13	149	WHIRLPOOL CORPORATION	USA
14	146	JAPAN TOBACCO INC.	Japan
15	144	APPLIED MATERIALS, INC.	USA
16	143	NICOVENTURES HOLDINGS, LTD.	UK
17	138	MITSUBISHI ELECTRIC CORP.	Japan
18	129	E.G.O.-GRUPPE	Germany
19	123	DENSO CORP.	Japan
20	122	TOKYO ELECTRON LTD.	Japan

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are seven European applicants, seven Japanese applicants, three US applicants, two South Korean applicants, and one Chinese applicant in the filing years (priority years) 2010-2013, while there are eight European applicants, seven Japanese applicants, three South Korean applicants, one US applicant, and one Chinese applicant in 2018-2021.

Table 5-44 Trend of top-ranking applicants with the number of IPFs in “gxB06: Electrification of Industrial Heat”

(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	233	BSH HAUSGERATE GMBH	Germany	1	182	PHILIP MORRIS INTERNATIONAL INC.	USA	1	309	LG CORPORATION	Korea
2	196	PANASONIC CORP.	Japan	2	177	BSH HAUSGERATE GMBH	Germany	2	172	BSH HAUSGERATE GMBH	Germany
3	74	ELECTROLUX GROUP	Sweden	3	175	PANASONIC CORP.	Japan	3	145	PHILIP MORRIS INTERNATIONAL INC.	USA
4	70	SAMSUNG GROUP	Korea	4	160	LG CORPORATION	Korea	4	112	NGK INSULATORS, LTD.	Japan
5	62	MITSUBISHI ELECTRIC CORP.	Japan	5	101	MIDEA HOLDING CO., LTD.	China	5	104	PANASONIC CORP.	Japan
6	61	CANON INC.	Japan	6	93	ELECTROLUX GROUP	Sweden	6	102	SAMSUNG GROUP	Korea
7	55	SAINT-GOBAIN S.A.	France	7	91	SAMSUNG GROUP	Korea	7	96	JAPAN TOBACCO INC.	Japan
8	52	APPLIED MATERIALS, INC.	USA	8	86	ALTRIA GROUP	USA	8	77	NICOVENTURES HOLDINGS, LTD.	UK
9	48	LG CORPORATION	Korea	9	71	VALEO S.A.	France	9	73	CANON INC.	Japan
10	46	KYOCERA CORP.	Japan	10	69	ILLINOIS TOOL WORKS INC.	USA	10	66	KYOCERA CORP.	Japan
10	46	TOKYO ELECTRON LTD.	Japan	10	69	WHIRLPOOL CORPORATION	USA	10	66	ELECTROLUX GROUP	Sweden
12	39	WHIRLPOOL CORPORATION	USA	12	63	CANON INC.	Japan	10	66	KT&G CORPORATION	Korea
12	39	ARCELIK A.S.	Turkey	13	59	SAINT-GOBAIN S.A.	France	13	60	MIDEA HOLDING CO., LTD.	China
12	39	SIEMENS A.G.	Germany	14	58	E.G.O.-GRUPPE	Germany	14	54	EBERSPACHER GROUP	Germany
15	38	VALEO S.A.	France	15	56	ARCELIK A.S.	Turkey	15	53	VALEO S.A.	France
16	35	NGK INSULATORS, LTD.	Japan	16	55	DENSO CORP.	Japan	16	49	SAINT-GOBAIN S.A.	France
17	34	CHINA BOTON GROUP	China	16	55	NICOVENTURES HOLDINGS, LTD.	UK	17	48	DENSO CORP.	Japan
18	32	RICOH COMPANY,LTD.	Japan	18	53	KYOCERA CORP.	Japan	17	48	TOKYO ELECTRON LTD.	Japan
18	32	GENERAL ELECTRIC CO.	USA	18	53	MITSUBISHI ELECTRIC CORP.	Japan	19	46	MAHLE GMBH	Germany
20	31	E.G.O.-GRUPPE	Germany	20	50	APPLIED MATERIALS, INC.	USA	19	46	MIELE & CIE. KG	Germany

Database: Derwent™ Innovation

18. gxB07: Power Transmission and Distribution, Smart Grids

Table 5-45 illustrates the top 20 IPF applicants in "gxB07: Power Transmission and Distribution, Smart Grids."

Among the top applicants, SAMSUNG GROUP (South Korea) ranked first, GENERAL ELECTRIC CO. (USA) ranked second, and SIEMENS A.G. (Germany) ranked third. 9 Japanese applicants, 4 European applicants, 3 South Korean applicants, 2 US applicants, and 1 Chinese applicant were ranked.

Table 5-45Top 20 IPF applicants in "gxB07: Power Transmission and Distribution, Smart Grids"

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	479	SAMSUNG GROUP	Korea
2	472	GENERAL ELECTRIC CO.	USA
3	336	SIEMENS A.G.	Germany
4	301	ABB AB	Switzerland
5	286	ROBERT BOSCH GMBH	Germany
6	282	PANASONIC CORP.	Japan
7	258	TOYOTA MOTOR CORPORATION	Japan
8	226	MITSUBISHI ELECTRIC CORP.	Japan
9	217	LG CORPORATION	Korea
10	204	QUALCOMM INC.	USA
11	198	STATE GRID CORP. OF CHINA	China
12	182	TOSHIBA CORP.	Japan
13	148	SONY GROUP CORP.	Japan
14	129	KONINKLIJKE PHILIPS N.V.	Netherlands
15	120	CANON INC.	Japan
16	116	DENSO CORP.	Japan
17	115	HITACHI, LTD.	Japan
17	115	LS ELECTRIC CO., LTD.	Korea
19	103	DELTA ELECTRONICS INC	Taiwan
20	97	FUJITSU LTD.	Japan

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 10 Japanese applicants, five European applicants, two South Korean applicants, and two US applicants in the filing years (priority years) 2010-2013, while there are 10 Japanese applicants, four European applicants, three US applicants, two Chinese applicants, and one South Korean applicant in 2018-2021.

Table 5-46 Trend of top-ranking applicants with the number of IPFs in "gxB07: Power Transmission and Distribution, Smart Grids"
(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	318	SAMSUNG GROUP	Korea	1	197	GENERAL ELECTRIC CO.	USA	1	96	STATE GRID CORP. OF CHINA	China
2	224	GENERAL ELECTRIC CO.	USA	2	126	SAMSUNG GROUP	Korea	2	92	SIEMENS A.G.	Germany
3	176	PANASONIC CORP.	Japan	3	124	SIEMENS A.G.	Germany	3	73	TOYOTA MOTOR CORPORATION	Japan
4	143	ROBERT BOSCH GMBH	Germany	4	112	QUALCOMM INC.	USA	4	67	ABB	Switzerland
5	134	ABB	Switzerland	5	100	ABB	Switzerland	5	58	MITSUBISHI ELECTRIC CORP.	Japan
6	120	SIEMENS A.G.	Germany	5	100	LG CORPORATION	Korea	6	51	GENERAL ELECTRIC CO.	USA
7	110	SONY GROUP CORP.	Japan	7	98	MITSUBISHI ELECTRIC CORP.	Japan	7	48	ROBERT BOSCH GMBH	Germany
8	103	TOYOTA MOTOR CORPORATION	Japan	8	95	ROBERT BOSCH GMBH	Germany	8	39	HUAWEI TECHNOLOGIES CO., LTD.	China
9	96	LG CORPORATION	Korea	9	82	TOYOTA MOTOR CORPORATION	Japan	9	36	DENSO CORP.	Japan
10	94	TOSHIBA CORP.	Japan	9	82	LS ELECTRIC CO., LTD.	Korea	10	35	SUMITOMO ELECTRIC INDUSTRIES, LTD	Japan
11	88	QUALCOMM INC.	USA	11	80	PANASONIC CORP.	Japan	10	35	SAMSUNG GROUP	Korea
12	77	HON HAI PRECISION IND CO., LTD.	Taiwan	12	65	STATE GRID CORP. OF CHINA	China	10	35	DELTA ELECTRONICS INC	Taiwan
13	75	KONINKLIJKE PHILIPS N.V.	Netherlands	13	63	TOSHIBA CORP.	Japan	13	26	HITACHI, LTD.	Japan
14	70	MITSUBISHI ELECTRIC CORP.	Japan	14	52	INTEL CORP.	USA	13	26	PANASONIC CORP.	Japan
15	62	FUJITSU LTD.	Japan	15	49	KONINKLIJKE PHILIPS N.V.	Netherlands	15	25	CANON INC.	Japan
16	58	ALSTOM S.A.	France	16	42	SUMITOMO ELECTRIC INDUSTRIES, LTD	Japan	15	25	HONDA MOTOR CO.,LTD.	Japan
17	57	CANON INC.	Japan	17	39	DENSO CORP.	Japan	15	25	TOSHIBA CORP.	Japan
18	53	KYOCERA CORP.	Japan	17	39	HITACHI, LTD.	Japan	15	25	FORD MOTOR CO.	USA
18	53	MURATA MFG CO., LTD.	Japan	19	38	CANON INC.	Japan	19	23	YAZAKI CORP.	Japan
20	52	NEC CORPORATION	Japan	19	38	WITRICITY	USA	19	23	HAMILTON SUNDSTRAND CORPORATION	USA
								19	23	ROLLS ROYCE PLC.	UK

Database: Derwent™ Innovation

19. gxB08: Demand-Supply Flexibility of Power Systems

Table 5-47 illustrates the top three IPF applicants in "gxB08: Demand-Supply Flexibility of Power Systems."

Table 5-47 Top 3 IPF applicants in "gxB08: Demand-Supply Flexibility of Power Systems" (Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	2	HONDA MOTOR CO., LTD.	Japan
1	2	TOYOTA MOTOR CORPORATION	Japan
1	2	TERAFERO BVBA	Belgium

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below.

Table 5-48 Trend of top-ranking applicants with the number of IPFs in “g gxB08: Demand-Supply Flexibility of Power Systems”(the Filing Years (Priority Years) 2010-2021)

2010–2013				2014–2017				2018–2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	2	TERAFERO BVBA	Belgium	–	–	–	–	1	2	HONDA MOTOR CO.,LTD.	Japan
								1	2	TOYOTA MOTOR CORPORATION	Japan

20. gxC01: Secondary Batteries

Table 5-49 illustrates the top 20 IPF applicants in "gxC01: Secondary Batteries."

Among the top applicants, LG CORPORATION (South Korea) ranked first, SAMSUNG GROUP (South Korea) ranked second, and TOYOTA MOTOR CORPORATION ranked third. 12 Japanese applicants, 4 South Korean applicants, 2 US applicants, and 1 European and Chinese applicants were ranked.

Table 5-49 Top 20 IPF applicants in "gxC01: Secondary Batteries"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	5,355	LG CORPORATION	Korea
2	4,976	SAMSUNG GROUP	Korea
3	3,064	TOYOTA MOTOR CORPORATION	Japan
4	2,376	ROBERT BOSCH GMBH	Germany
5	2,307	PANASONIC CORP.	Japan
6	1,500	SANYO ELECTRIC CO.,LTD.	Japan
7	1,306	CONTEMPORARY AMPEREX TECHNOLOGY CO., LTD.	China
8	1,181	HONDA MOTOR CO., LTD.	Japan
9	1,033	TDK CORP.	Japan
10	1,029	GS YUASA CORPORATION	Japan
11	1,007	MURATA MFG CO., LTD.	Japan
12	934	HITACHI, LTD.	Japan
13	916	HYUNDAI MOTOR CORP.	Korea
14	872	TOSHIBA CORP.	Japan
15	804	GENERAL MOTORS CORP.	USA
16	794	FORD MOTOR CO.	USA
17	732	SUMITOMO ELECTRIC INDUSTRIES, LTD.	Japan
18	696	NISSAN MOTOR CO., LTD.	Japan
19	688	NEC CORP.	Japan
20	628	KIA CORP.	Korea

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 13 Japanese applicants, three South Korean applicants, two European applicants, and one US applicant in the filing years (priority years) 2010-2013, while there are 10 Japanese applicants, five South Korean applicants, two European applicants, two US applicants, and one Chinese applicant in 2018-2021.

Table 5-50 Trend of top-ranking applicants with the number of IPFs in “gxC01: Secondary Batteries”
(the Filing Years (Priority Years) 2010-2021)

2010–2013				2014–2017				2018–2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	2,264	SAMSUNG GROUP	Korea	1	1,699	LG CORPORATION	Korea	1	2,675	LG CORPORATION	Korea
2	1,131	ROBERT BOSCH GMBH	Germany	2	1,683	SAMSUNG GROUP	Korea	2	1,080	TOYOTA MOTOR CORPORATION	Japan
3	981	LG CORPORATION	Korea	3	1,039	TOYOTA MOTOR CORPORATION	Japan	3	1,052	CONTEMPORARY AMPEREX TECHNOLOGY CO., LTD.	China
4	945	TOYOTA MOTOR CORPORATION	Japan	4	812	ROBERT BOSCH GMBH	Germany	4	1,029	SAMSUNG GROUP	Korea
5	761	SANYO ELECTRIC CO.,LTD.	Japan	5	665	PANASONIC CORP.	Japan	5	1,014	PANASONIC CORP.	Japan
6	628	PANASONIC CORP.	Japan	6	427	FORD MOTOR CO.	USA	6	756	TDK CORP.	Japan
7	510	HITACHI, LTD.	Japan	7	398	GS YUASA CORPORATION	Japan	7	667	HONDA MOTOR CO.,LTD.	Japan
8	468	NISSAN MOTOR CO., LTD.	Japan	8	377	MURATA MFG CO., LTD.	Japan	8	433	ROBERT BOSCH GMBH	Germany
9	386	SB LIMOTIVE CO. LTD.	Korea	9	351	TOSHIBA CORP.	Japan	9	424	HYUNDAI MOTOR CORP.	Korea
10	351	NEC CORPORATION	Japan	10	336	SANYO ELECTRIC CO.,LTD.	Japan	10	403	SANYO ELECTRIC CO.,LTD.	Japan
11	340	SONY GROUP CORP.	Japan	11	313	NEC CORPORATION	Japan	11	395	KIA CORP.	Korea
12	296	GENERAL MOTORS CORP.	USA	12	303	HITACHI, LTD.	Japan	12	389	MURATA MFG CO., LTD.	Japan
13	284	TOSHIBA CORP.	Japan	12	303	SUMITOMO ELECTRIC INDUSTRIES, LTD	Japan	13	352	GS YUASA CORPORATION	Japan
14	279	GS YUASA CORPORATION	Japan	14	300	HYUNDAI MOTOR CORP.	Korea	14	305	GENERAL MOTORS CORP.	USA
15	266	TOYOTA INDUSTRIES CORPORATION	Japan	15	284	HONDA MOTOR CO.,LTD.	Japan	15	302	SK GROUP	Korea
16	241	MURATA MFG CO., LTD.	Japan	16	249	CONTEMPORARY AMPEREX TECHNOLOGY CO., LTD.	China	16	253	FORD MOTOR CO.	USA
17	230	HONDA MOTOR CO.,LTD.	Japan	17	230	SUMITOMO CHEMICAL COMPANY, LIMITED	Japan	17	239	VOLKSWAGEN A.G.	Germany
18	211	SUMITOMO ELECTRIC INDUSTRIES, LTD	Japan	18	226	TOYOTA INDUSTRIES CORPORATION	Japan	18	237	DENSO CORP.	Japan
19	205	HON HAI PRECISION IND CO., LTD.	Taiwan	19	203	TDK CORP.	Japan	18	237	TOSHIBA CORP.	Japan
20	196	DAIMLER A.G.	Germany	19	203	GENERAL MOTORS CORP.	USA	20	218	SUMITOMO ELECTRIC INDUSTRIES, LTD	Japan

Database: Derwent™ Innovation

21. gxC02: Mechanical Energy Storage

Table 5-51 illustrates the top 21 IPF applicants in "gxC02: Mechanical Energy Storage."

Among the top applicants, SIEMENS A.G. (Germany) ranked first, ENRICHMENT TECHNOLOGY COMPANY LTD. (Germany) ranked second, and KOBE STEEL, LTD. ranked third. 10 European applicants, 6 US applicants, 5 Japanese applicants, and no Chinese or South Korean applicants were ranked.

Table 5-51 Top 21 IPF applicants in "gxC02: Mechanical Energy Storage"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	18	SIEMENS A.G.	Germany
2	15	ENRICHMENT TECHNOLOGY COMPANY LTD.	Germany
3	14	KOBE STEEL LTD	Japan
4	11	HITACHI, LTD.	Japan
4	11	VOITH GMBH	Germany
6	10	ABB AB	Switzerland
7	8	TOSHIBA CORP.	Japan
7	8	GENERAL ELECTRIC CO.	USA
9	7	RAYTHEON TECHNOLOGIES CORP.	USA
9	7	IFP ENERGIES NOUVELLES S.A.	France
11	6	FANUC CORP.	Japan
11	6	DRESSER INDUSTRIES, INC.	USA
11	6	GENERAL COMPRESSION INC.	USA
11	6	ENERGY TECHNOLOGIES INSTITUTE LLP	Germany
15	5	AMBER KINETICS INC	USA
15	5	MAERSK DRILLING A/S	Denmark
15	5	NUOVO PIGNONE INTERNATIONAL, LTD.	Italy
15	5	SIEMENS GAMESA RENEWABLE ENERGY S.A.	Spain
19	4	NABTESCO CORPORATION	Japan
19	4	THE BOEING CO.	USA
19	4	ISENTROPIC LTD	Germany

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 11 European applicants, four US applicants, two Japanese applicants, and one South Korean applicant in the filing years (priority years) 2010-2013, while there are six European applicants, four Japanese applicants, one US applicant, and one Chinese applicant in 2018-2021.

Table 5-52 Trend of top-ranking applicants with the number of IPFs in “gxC02: Mechanical Energy Storage”

(the Filing Years (Priority Years) 2010-2021)

2010–2013				2014–2017				2018–2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	10	ENRICHMENT TECHNOLOGY COMPANY LTD.	Germany	1	11	KOBE STEEL, LTD.	Japan	1	7	SIEMENS A.G.	Germany
2	8	VOITH GMBH	Germany	2	6	IFP ENERGIES NOUVELLES S.A.	France	2	5	SIEMENS GAMESA RENEWABLE ENERGY S.A.	Spain
3	6	GENERAL COMPRESSION INC.	USA	2	6	SIEMENS A.G.	Germany	3	4	RAYTHEON TECHNOLOGIES CORPORATION	USA
3	6	ABB	Switzerland	4	5	GENERAL ELECTRIC CO.	USA	4	3	FANUC CORPORATION	Japan
5	5	SIEMENS A.G.	Germany	4	5	ENRICHMENT TECHNOLOGY COMPANY LTD.	Germany	4	3	HITACHI, LTD.	Japan
6	4	HITACHI, LTD.	Japan	6	4	HITACHI, LTD.	Japan	4	3	SCHMIDT-BÖCKING HORST (Individual)	Germany
6	4	TOSHIBA CORP.	Japan	6	4	NABTESCO CORPORATION	Japan	4	3	VOITH GMBH	Germany
6	4	DRESSER INDUSTRIES, INC.	USA	6	4	AMBER KINETICS INC	USA	8	2	KOBE STEEL, LTD.	Japan
6	4	THE BOEING CO.	USA	6	4	MAERSK DRILLING A/S	Denmark	8	2	TOSHIBA CORP.	Japan
6	4	NUOVO PIGNONE INTERNATIONAL, LTD.	Italy	10	3	RAYTHEON TECHNOLOGIES CORPORATION	USA	8	2	ABB	Switzerland
11	3	GENERAL ELECTRIC CO.	USA	10	3	ENERGY TECHNOLOGIES INSTITUTE LLP	Germany	8	2	LUTHER GERHARD (Individual)	Germany
11	3	ALSTOM S.A.	France	10	3	TERALOOP OY	Finland	8	2	TSINGHUA UNIVERSITY	China
11	3	ED. ZÜBLIN AG	Germany	13	2	FANUC CORPORATION	Japan	8	2	HYDROSTOR INC.	Canada
11	3	ENERGY TECHNOLOGIES INSTITUTE LLP	Germany	13	2	TOSHIBA CORP.	Japan	8	2	INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE	Taiwan
11	3	EVONIK IND A.G.	Germany	13	2	FORD MOTOR CO.	USA	8	2	STORAGE DROP LTD	Israel
11	3	ISENTROPIC LTD	Germany	13	2	OBERMEYER HENRY K. (Individual)	USA				
11	3	STEAG GMBH	Germany	13	2	ABB	Switzerland				
11	3	DAEWOO SHIPBUILDING & MARINE ENGINEERING CO., LTD	Korea	13	2	DEMETAIR SYSTEMS	Germany				
11	3	MORAVSKY VYZKUM S.R.O.	Israel	13	2	ELEMENT POWER IRELAND LIMITED	Ireland				
				13	2	KS RESEARCH SOCIÉTÉ ANONYME	Belgium				
				13	2	S4 ENERGY B.V.	Netherlands				
				13	2	SEW-EURODRIVE GMBH & CO KG	Germany				
				13	2	BROSHY YUVAL (Individual)	China				
				13	2	NASCHEM CO. LTD.	Korea				
				13	2	SUMRITVANITCHA SUPOT (Individual)	Thailand				

Database: Derwent™ Innovation

22. gxC03: Thermal Energy Storage

Table 5-53 illustrates the top 22 IPF applicants in "gxC03: Thermal Energy Storage."

Among the top applicants, SIEMENS A.G. (Germany) ranked first, VALEO S.A. (France) ranked second, and FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION (France) ranked third. 11 Japanese applicants, 9 European applicants, 1 US and Chinese applicants, and no South Korean applicants were ranked.

Table 5-53 Top 22 IPF applicants in "gxC03: Thermal Energy Storage"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	89	SIEMENS A.G.	Germany
2	85	VALEO S.A.	France
3	69	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
4	67	DENSO CORP.	Japan
5	55	PANASONIC CORP.	Japan
6	50	SHARP CORP.	Japan
7	48	TOYOTA INDUSTRIES CORP.	Japan
8	45	TOYOTA MOTOR CORPORATION	Japan
9	38	MITSUBISHI ELECTRIC CORP.	Japan
10	29	GENERAL ELECTRIC CO.	USA
10	29	ROBERT BOSCH GMBH	Germany
12	24	SHOWA DENKO MATERIALS CO., LTD.	Japan
12	24	BASF SE	Germany
12	24	IFP ENERGIES NOUVELLES S.A.	France
15	23	YAZAKI CORP.	Japan
16	22	HITACHI ASTEMO, LTD.	Japan
16	22	HUTCHINSON S.A.	France
16	22	MAHLE GMBH	Germany
19	21	DEUTSCHE ZENTRUM LUFT & RAUMFAHRT EV	Germany
20	19	DAIKIN INDUSTRIES, LTD.	Japan
20	19	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
20	19	SHENZHEN ENESOON SCIENCE & TECHNOLOGY CO. LTD.	China

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 11 European applicants, seven Japanese applicants, and two US applicants in the filing years (priority years) 2010-2013, while there are nine Japanese applicants, nine European applicants, three Chinese applicants, and one US applicant in 2018-2021.

Table 5-54 Trend of top-ranking applicants with the number of IPFs in “gxC03: Thermal Energy Storage” (the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	40	SIEMENS A.G.	Germany	1	60	VALEO S.A.	France	1	20	MITSUBISHI ELECTRIC CORP.	Japan
2	25	PANASONIC CORP.	Japan	2	42	SIEMENS A.G.	Germany	2	17	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
3	22	DENSO CORP.	Japan	3	38	DENSO CORP.	Japan	3	16	RESONAC HOLDINGS CORPORATION	Japan
4	19	TOYOTA MOTOR CORPORATION	Japan	4	36	TOYOTA INDUSTRIES CORPORATION	Japan	3	16	GERMAN AEROSPACE CENTER	Germany
5	18	SHARP CORP.	Japan	5	34	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	5	15	OCTOPUS ENERGY GROUP LIMITED	Germany
5	18	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	6	21	TOYOTA MOTOR CORPORATION	Japan	5	15	SIEMENS GAMESA RENEWABLE ENERGY S.A.	Spain
5	18	VALEO S.A.	France	7	20	SHARP CORP.	Japan	7	14	FUJIFILM CORP.	Japan
8	17	GENERAL ELECTRIC CO.	USA	8	16	PANASONIC CORP.	Japan	7	14	PANASONIC CORP.	Japan
9	16	ROBERT BOSCH GMBH	Germany	9	15	HUTCHINSON S.A.	France	9	12	SHARP CORP.	Japan
10	14	BASF SE	Germany	10	14	IFP ENERGIES NOUVELLES S.A.	France	9	12	YAZAKI CORP.	Japan
11	12	TOYOTA INDUSTRIES CORPORATION	Japan	11	13	MITSUBISHI ELECTRIC CORP.	Japan	9	12	MIDEA HOLDING CO., LTD.	China
12	11	HITACHI ASTEMO, LTD.	Japan	11	13	KYUNGDONG NAVIEN CO., LTD	Korea	12	11	ZHANG LE-PING(Individual)	China
12	11	MAHLE GMBH	Germany	13	12	ROBERT BOSCH GMBH	Germany	13	9	NETHERLANDS ORGANIZATION FOR APPLIED SCIENTIFIC RESEARCH	Netherlands
14	10	DOW INC.	USA	14	10	HITACHI ASTEMO, LTD.	Japan	13	9	SHENZHEN ENESOON SCIENCE & TECHNOLOGY CO. LTD.	China
14	10	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG E.V.	Germany	14	10	YAZAKI CORP.	Japan	15	8	DAIKIN INDUSTRIES, LTD	Japan
16	9	BSH HAUSGERATE GMBH	Germany	14	10	GENERAL ELECTRIC CO.	USA	15	8	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
17	8	HITACHI, LTD.	Japan	14	10	BASF SE	Germany	15	8	IFP ENERGIES NOUVELLES S.A.	France
17	8	ABENGOA SA	Spain	18	9	FORD MOTOR CO.	USA	18	7	DENSO CORP.	Japan
17	8	ALSTOM S.A.	France	19	8	KOBE STEEL, LTD.	Japan	18	7	MALTA INC	USA
17	8	ISENTROPIC LTD	Germany	19	8	MURATA MFG CO., LTD.	Japan	18	7	ROLLS ROYCE PLC.	UK
				19	8	RESONAC HOLDINGS CORPORATION	Japan	18	7	SIEMENS A.G.	Germany
				19	8	DUPONT DE NEMOURS, INC.	USA	18	7	VALEO S.A.	France
				19	8	HONEYWELL INTERNATIONAL INC.	USA				
				19	8	MAHLE GMBH	Germany				
				19	8	SHENZHEN ENESOON SCIENCE & TECHNOLOGY CO. LTD.	China				

Database: Derwent™ Innovation

23. gxC04: Electric Double Layer Capacitors, Hybrid Capacitors

Table 5-55 illustrates the top 20 IPF applicants in "gxC04: Electric Double Layer Capacitors, Hybrid Capacitors."

Among the top applicants, GS Yuasa CORPORATION ranked first, SUMITOMO ELECTRIC INDUSTRIES, LTD. Ranked second, and TOYOTA INDUSTRIES CORP. ranked third, and Japanese applicants dominate the top ranks. 17 Japanese applicants, 2 South Korean applicants, 1 European applicant, and no US and Chinese applicants were ranked.

Table 5-55 Top 20 IPF applicants in "gxC04: Electric Double Layer Capacitors, Hybrid Capacitors" (Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	421	GS YUASA CORPORATION	Japan
2	197	SUMITOMO ELECTRIC INDUSTRIES, LTD.	Japan
3	190	TOYOTA INDUSTRIES CORP.	Japan
4	185	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan
5	184	TOYOTA MOTOR CORPORATION	Japan
6	178	PANASONIC CORP.	Japan
7	150	LG CORPORATION	Korea
8	145	SAMSUNG GROUP	Korea
9	139	MURATA MFG CO., LTD.	Japan
10	129	DAI NIPPON PRINTING CO., LTD.	Japan
11	110	ZEON CORPORATION	Japan
12	105	RESONAC HOLDINGS CORPORATION	Japan
13	99	SUMITOMO WIRING SYSTEMS, LTD.	Japan
14	98	DAIKIN INDUSTRIES, LTD.	Japan
15	87	ROBERT BOSCH GMBH	Germany
16	80	NIPPON CHEMI-CON CORPORATION	Japan
17	76	UBE CORPORATION	Japan
18	75	ASAHI KASEI CORP.	Japan
19	73	HONDA MOTOR CO., LTD.	Japan
19	73	TAIYO YUDEN CO., LTD.	Japan

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, in the filing years (priority years) 2010-2013, there are 17 Japanese applicants, two South Korean applicants, and one US applicant, while in 2018-2021, there are 17 Japanese applicants, two South Korean applicants, and one US applicant.

Table 5-56 Trend of top-ranking applicants with the number of IPFs in “gxC04: Electric Double Layer Capacitors, Hybrid Capacitors”(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	96	SAMSUNG GROUP	Korea	1	185	GS YUASA CORPORATION	Japan	1	144	GS YUASA CORPORATION	Japan
2	92	GS YUASA CORPORATION	Japan	2	102	TOYOTA INDUSTRIES CORPORATION	Japan	2	88	PANASONIC CORP.	Japan
3	90	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan	3	96	SUMITOMO ELECTRIC INDUSTRIES, LTD	Japan	3	85	TOYOTA MOTOR CORPORATION	Japan
4	65	SUMITOMO ELECTRIC INDUSTRIES, LTD	Japan	4	68	SUMITOMO WIRING SYSTEMS, LTD.	Japan	4	77	DAI NIPPON PRINTING CO., LTD.	Japan
5	46	TOYOTA INDUSTRIES CORPORATION	Japan	4	68	TOYOTA MOTOR CORPORATION	Japan	5	71	PRIME PLANET ENERGY & SOLUTIONS, INC.	Japan
6	43	CORNING INC.	USA	6	66	RESONAC HOLDINGS CORPORATION	Japan	6	55	LG CORPORATION	Korea
7	40	NISSAN MOTOR CO., LTD.	Japan	7	64	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan	7	48	ZEON CORPORATION	Japan
7	40	LG CORPORATION	Korea	7	64	ROBERT BOSCH GMBH	Germany	8	44	MURATA MFG CO., LTD.	Japan
9	37	JSR CORPORATION	Japan	9	61	MURATA MFG CO., LTD.	Japan	9	42	TOYOTA INDUSTRIES CORPORATION	Japan
10	36	UBE CORPORATION	Japan	10	55	PANASONIC CORP.	Japan	10	41	DAIKIN INDUSTRIES, LTD	Japan
11	35	PANASONIC CORP.	Japan	10	55	LG CORPORATION	Korea	11	40	TDK CORP.	Japan
12	34	MURATA MFG CO., LTD.	Japan	12	43	DAI NIPPON PRINTING CO., LTD.	Japan	12	36	SUMITOMO ELECTRIC INDUSTRIES, LTD	Japan
13	32	NIPPON CHEMI-CON CORPORATION	Japan	13	38	ZEON CORPORATION	Japan	13	31	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan
14	31	HONDA MOTOR CO.,LTD.	Japan	14	36	DAIKIN INDUSTRIES, LTD	Japan	14	30	ASAHI KASEI CORPORATION	Japan
14	31	TOYOTA MOTOR CORPORATION	Japan	15	34	TAIYO YUDEN CO.,LTD.	Japan	15	29	SAMSUNG GROUP	Korea
16	29	FURUKAWA ELECTRIC CO., LTD.	Japan	16	33	HONDA MOTOR CO.,LTD.	Japan	16	25	GENERAL MOTORS CORP.	USA
17	28	TAIYO YUDEN CO.,LTD.	Japan	16	33	UBE CORPORATION	Japan	17	24	SUMITOMO WIRING SYSTEMS, LTD.	Japan
18	26	TORAY INDUSTRIES, INC.	Japan	18	31	TORAY INDUSTRIES, INC.	Japan	18	21	RICOH COMPANY,LTD.	Japan
19	25	NEC CORPORATION	Japan	19	30	ASAHI KASEI CORPORATION	Japan	19	20	KURARAY CO.,LTD	Japan
19	25	UACJ CORPORATION	Japan	19	30	NIPPON CHEMI-CON CORPORATION	Japan	19	20	RESONAC HOLDINGS CORPORATION	Japan

Database: Derwent™ Innovation

24. gxD01: Chemical Production from Biomass

Table 5-57 illustrates the top 20 IPF applicants in "gxD01: Chemical Production from Biomass."

Among the top applicants, DUPONT DE NEMOURS, INC. (USA) ranked first, NOVO NORDISK AS (Denmark) ranked second, and KONINKLIJKE DSM N.V. (Netherlands) ranked third. 8 European applicants, 5 US applicants, 4 Japanese applicants, and 1 Chinese and 1 South Korean applicant were ranked.

Table 5-57 Top 20 IPF applicants in "gxD01: Chemical Production from Biomass"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	313	DUPONT DE NEMOURS, INC.	USA
2	290	NOVO NORDISK AS	Denmark
3	226	KONINKLIJKE DSM N.V.	Netherlands
4	193	BASF SE	Germany
5	120	EVONIK IND A.G.	Germany
6	112	JIANGNAN UNIVERSITY	China
7	95	TORAY INDUSTRIES, INC.	Japan
8	83	UNIVERSITY OF CALIFORNIA	USA
9	81	IFP ENERGIES NOUVELLES S.A.	France
10	80	MITSUBISHI CHEMICAL HOLDINGS CORP.	Japan
10	80	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	France
12	77	CJ CHEILJEDANG CORP.	Korea
13	75	INVISTA NORTH AMERICA S.A.R.L.	USA
14	66	UPM KYMMENE CORP.	Finland
15	64	LANZATECH NEW ZEALAND LTD	New Zealand
16	57	NIPPON PAPER INDUSTRIES CO., LTD.	Japan
17	56	STORA ENSO OYJ	Finland
18	53	OJI HOLDINGS CORP.	Japan
18	53	CARGILL INCORPORATED	USA
18	53	DOW INC.	USA

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 10 European applicants, six US applicants, two Japanese applicants, and one South Korean applicant in the filing years (priority years) 2010-2013, while there are nine European applicants, three Chinese applicants, three Japanese applicants, two US applicants, and two South Korean applicants in 2018-2021.

Table 5-58 Trend of the top 20 applicants with the number of IPFs in “gxD01: Chemical Production from Biomass”(the Filing Years (Priority Years) 2010-2021)

2010–2013				2014–2017				2018–2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	169	DUPONT DE NEMOURS, INC.	USA	1	97	KONINKLIJKE DSM N.V.	Netherlands	1	68	JIANGNAN UNIVERSITY	China
2	166	NOVO NORDISK AS	Denmark	1	97	NOVO NORDISK AS	Denmark	2	58	BASF SE	Germany
3	83	KONINKLIJKE DSM N.V.	Netherlands	3	96	DUPONT DE NEMOURS, INC.	USA	3	48	DUPONT DE NEMOURS, INC.	USA
4	62	BASF SE	Germany	4	73	BASF SE	Germany	4	46	KONINKLIJKE DSM N.V.	Netherlands
5	51	TORAY INDUSTRIES, INC.	Japan	5	50	EVONIK IND A.G.	Germany	5	35	EVONIK IND A.G.	Germany
6	41	IFP ENERGIES NOUVELLES S.A.	France	6	37	MITSUBISHI CHEMICAL CORPORATION	Japan	6	28	OJI HOLDINGS CORP.	Japan
7	37	DOW INC.	USA	6	37	INVISTA	USA	7	27	NOVO NORDISK AS	Denmark
8	35	EVONIK IND A.G.	Germany	6	37	JIANGNAN UNIVERSITY	China	7	27	斉魯工業大学	China
9	33	MITSUBISHI CHEMICAL CORPORATION	Japan	9	35	EVOLVA HOLDING SA	Switzerland	9	26	NIPPON PAPER INDUSTRIES CO., LTD.	Japan
9	33	UPM KYMMENE CORP.	Finland	10	33	UNIVERSITY OF CALIFORNIA	USA	9	26	INBIOSE N.V.	Belgium
11	32	FRENCH NATIONAL CENTRE FOR SCIENTIFIC RESEARCH	France	11	32	CJ CHEILJEDANG CORP.	Korea	11	24	BRASKEM S.A.	Brazil
11	32	ROQUETTE FRÈRES	France	12	31	FRENCH NATIONAL CENTRE FOR SCIENTIFIC RESEARCH	France	12	22	TORAY INDUSTRIES, INC.	Japan
11	32	LANZATECH NEW ZEALAND LTD	New Zealand	13	26	UPM KYMMENE CORP.	Finland	13	20	UNIVERSITY OF CALIFORNIA	USA
14	31	GENOMATICA	USA	14	25	HONDA MOTOR CO.,LTD.	Japan	13	20	IFP ENERGIES NOUVELLES S.A.	France
15	30	UNIVERSITY OF CALIFORNIA	USA	15	23	HALDOR TOPSOE A/S	Denmark	13	20	CJ CHEILJEDANG CORP.	Korea
15	30	STORA ENSO OYJ	Finland	15	23	PURAC BIOCHEM B.V.	Netherlands	13	20	KOREA UNIVERSITY	Korea
17	27	CODEXIS, INC.	USA	17	22	TORAY INDUSTRIES, INC.	Japan	17	18	CHR. HANSEN HOLDING A/S	Denmark
18	25	CJ CHEILJEDANG CORP.	Korea	17	22	CARGILL INCORPORATED	USA	18	17	FRENCH NATIONAL CENTRE FOR SCIENTIFIC RESEARCH	France
19	24	XEROX CORPORATION	USA	19	21	NIPPON PAPER INDUSTRIES CO., LTD.	Japan	18	17	HALDOR TOPSOE A/S	Denmark
19	24	PURAC BIOCHEM B.V.	Netherlands	20	20	IFP ENERGIES NOUVELLES S.A.	France	18	17	TIANJIN INSTITUTE OF INDUSTRIAL BIOTECHNOLOGY, CHINESE ACADEMY OF SCIENCES	China
								18	17	LANZATECH NEW ZEALAND LTD	New Zealand

Database: Derwent™ Innovation

25. gxD02: Reduction of CO_2 Emission in Steelmaking Process

Table 5-59 illustrates the top 20 IPF applicants in "gxD02: Reduction of CO2 Emission in Steelmaking Process."

Among the top applicants, KOBE STEEL, LTD. ranked first, POSCO CORP. (South Korea) ranked second, and PRIMETALS TECHNOLOGIES LTD. ranked third. 7 European applicants, 6 Japanese applicants, and 1 South Korean, US, and Chinese applicant were ranked.

Table 5-59 Top 20 IPF applicants in "gxD02: Reduction of CO2 Emission in Steelmaking Process" (Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	81	KOBE STEEL LTD	Japan
2	76	POSCO CORP.	Korea
3	49	PRIMETALS TECHNOLOGIES LTD.	Japan
4	40	SIEMENS A.G.	Germany
5	28	JFE STEEL CORP.	Japan
6	23	TECHNOLOGICAL RESOURCES PTY. LIMITED	Australia
7	20	NIPPON STEEL CORP.	Japan
8	14	DANIELI GROUP	Italy
9	13	NORTHEASTERN UNIVERSITY	USA
9	13	HYL TECHNOLOGIES S.A.	Mexico
9	13	TATA STEEL LIMITED	India
12	12	ARCELORMITTAL S.A.	Luxembourg
13	11	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
13	11	TATA STEEL NEDERLAND B.V.	Netherlands
13	11	THYSSENKRUPP A.G.	Germany
13	11	SAUDI BASIC IND CORP.	Saudi Arabia
17	10	ADOLF WURTH GMBH & CO. KG	Germany
18	9	METSO CORP.	Finland
18	9	SHENWU TECHNOLOGY GROUP CORPORATION	China
20	8	SUMITOMO METAL MINING CO., LTD.	Japan

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are six Japanese applicants, five European applicants, two Chinese applicants, two US applicants, and one South Korean applicant in the filing years (priority years) 2010-2013, while there are seven European applicants, four Japanese applicants, three Chinese applicants, two US applicants, and two South Korean applicants in 2018-2021.

Table 5-60 Trend of top-ranking applicants with the number of IPFs in “gxD02: Reduction of CO2 Emission in Steelmaking Process”(the Filing Years (Priority Years) 2010-2021)

2010–2013				2014–2017				2018–2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	40	KOBE STEEL, LTD.	Japan	1	31	POSCO CORP.	Korea	1	14	KOBE STEEL, LTD.	Japan
2	39	SIEMENS A.G.	Germany	2	27	KOBE STEEL, LTD.	Japan	2	12	Northeastern University	USA
3	37	POSCO CORP.	Korea	3	9	JFE STEEL CORP.	Japan	3	10	PRIMETALS TECHNOLOGIES LTD.	Japan
4	30	PRIMETALS TECHNOLOGIES LTD.	Japan	3	9	PRIMETALS TECHNOLOGIES LTD.	Japan	3	10	ARCELORMITTAL, S.A.	Luxembourg
5	12	TECHNOLOGICAL RESOURCES PTY. LIMITED	Australia	5	8	SABIC	Saudi Arabia	5	9	JFE STEEL CORP.	Japan
6	11	TATA STEEL LIMITED	India	6	7	SUMITOMO METAL MINING CO., LTD.	Japan	5	9	TATA STEEL NEDERLAND B.V.	Netherlands
7	10	JFE STEEL CORP.	Japan	7	5	NIPPON STEEL CORP.	Japan	7	8	WUERTH GROUP	Germany
7	10	NIPPON STEEL CORP.	Japan	7	5	TECHNOLOGICAL RESOURCES PTY. LIMITED	Australia	7	8	POSCO CORP.	Korea
9	7	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	9	4	DENSO CORP.LINDE A.G.	UK	9	7	THYSSENKRUPP A.G.	Germany
9	7	SHENWU TECHNOLOGY GROUP CORPORATION	China	10	3	NIPPON SANSO HOLDINGS CORPORATION	Japan	10	6	DANIELI GROUP	Italy
11	5	DANIELI GROUP	Italy	10	3	AIR LIQUIDE S.A.	France	10	6	GREENIRON H2 AB	Sweden
11	5	HYL TECHNOLOGIES S.A.	Mexico	10	3	DANIELI GROUP	Italy	10	6	TECHNOLOGICAL RESOURCES PTY. LIMITED	Australia
13	4	MITSUBISHI STEEL MFG. CO., LTD.	Japan	10	3	METSO CORP.	Finland	13	5	NIPPON STEEL CORP.	Japan
13	4	BIOGENIC REAGENTS LLC	USA	10	3	CHINA METALLURGICAL GROUP CORPORATION	China	13	5	HYBRIT DEVELOPMENT AB	Sweden
13	4	CARBON TECHNOLOGY HOLDINGS LLC	USA	10	3	HYL TECHNOLOGIES S.A.	Mexico	13	5	HYL TECHNOLOGIES S.A.	Mexico
13	4	METSO CORP.	Finland	16	2	DAIDO STEEL CO., LTD.	Japan	16	4	NEU NONFERROUS SOLID WASTE TECHNOLOGY RESEARCH INSTITUTE (LIAONING) CO. LTD.	China
13	4	VALE S.A.	Brazil	16	2	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	17	3	EASTMAN CHEMICAL COMPANY	USA
18	3	AIR LIQUIDE S.A.	France	16	2	VULETIC VLADAN (Individual)	USA	17	3	SHANDONG MOLONG PETROLEUM MACHINERY CO. LTD.	China
18	3	VOESTALPINE AG	Austria	16	2	WUERTH GROUP	Germany	17	3	SHANDONG UNIVERSITY	China
18	3	INSTITUTE OF PROCESS ENGINEERING OF CHINESE ACADEMY OF SCIENCES	China	16	2	ARCELORMITTAL, S.A.	Luxembourg	17	3	JEIL MACHINERY CO LTD	Korea
				16	2	SMS GROUP GMBH	Germany				
				16	2	THYSSENKRUPP A.G.	Germany				
				16	2	VULETIC BOGDAN (Individual)	Germany				
				16	2	WARNER NOEL A (Individual)	Germany				
				16	2	SHENWU TECHNOLOGY GROUP CORPORATION	China				
				16	2	AGRICULTURE AND AGRI-FOOD CANADA	Canada				
				16	2	TATA STEEL LIMITED	India				

Database: Derwent™ Innovation

26. gxD03: Recycling

Table 5-61 illustrates the top 21 IPF applicants in "gxD03: Recycling."

Among the top applicants, EASTMAN CHEMICAL COMPANY (USA) ranked first, SAUDI BASIC IND CORP. (Saudi Arabia) ranked second, and THE PROCTER & GAMBLE CO. (USA) ranked third. 10 European applicants, 6 US applicants, 2 Japanese applicants, 1 South Korean applicant, and no Chinese applicant were ranked.

Table 5-61 gxD03: Recycling

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	88	EASTMAN CHEMICAL COMPANY	USA
2	73	SAUDI BASIC IND CORP.	Saudi Arabia
3	42	THE PROCTER & GAMBLE CO.	USA
4	40	UNICHARM CORP.	Japan
5	27	BOREALIS A.G.	Austria
6	26	EREMA GROUP GMBH	Austria
7	24	IFP ENERGIES NOUVELLES S.A.	France
8	23	SOLVAY S.A.	Belgium
9	22	HEWLETT PACKARD ENTERPRISE CO.	USA
9	22	NAN YA PLASTICS CORP.	Taiwan
11	21	ROYAL DUTCH SHELL PLC.	Netherlands
12	20	BASF SE	Germany
13	19	PANASONIC CORP.	Japan
13	19	NORTHEASTERN UNIVERSITY	USA
15	18	EXXONMOBIL CORP.	USA
15	18	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	France
15	18	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG E.V.	Germany
15	18	POSCO CORP.	Korea
19	17	DOW INC.	USA
19	17	ARKEMA S.A.	France
19	17	CONTINENTAL A.G.	Germany

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 10 European applicants, seven Japanese applicants, four US applicants, and one South Korean applicant in the filing years (priority years) 2010-2013, while there are 11 European applicants, five US applicants, one South Korean applicant, and one Japanese applicant in 2018-2021.

Table 5-62 Trend of top-ranking applicants with the number of IPFs in “gxD03: Recycling” (the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	22	EREMA GROUP GMBH	Austria	1	24	SABIC	Saudi Arabia	1	83	EASTMAN CHEMICAL COMPANY	USA
2	18	SABIC	Saudi Arabia	2	23	UNICHARM CORP.	Japan	2	31	SABIC	Saudi Arabia
3	12	KRONES AG	Germany	3	17	SOLVAY	Belgium	3	23	BOREALIS A.G.	Austria
4	11	POSCO CORP.	Korea	4	13	Northeastern University	USA	4	22	NAN YA PLASTICS CORP.	Taiwan
5	10	FRENCH NATIONAL CENTRE FOR SCIENTIFIC RESEARCH	France	5	12	THE PROCTER & GAMBLE COMPANY	USA	5	21	THE PROCTER & GAMBLE COMPANY	USA
6	9	THE PROCTER & GAMBLE COMPANY	USA	6	11	HEWLETT PACKARD ENTERPRISE CO.	USA	6	19	IFP ENERGIES NOUVELLES S.A.	France
6	9	SIEMENS A.G.	Germany	7	9	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG E.V.	Germany	7	15	EXXONMOBIL CORP.	USA
8	8	DAIHEN CORPORATION	Japan	8	7	PANASONIC CORP.	Japan	8	13	ROYAL DUTCH SHELL PLC.	Netherlands
8	8	UNICHARM CORP.	Japan	8	7	GOLDEN RENEWABLE ENERGY LLC	USA	9	12	COVESTRO AG	Germany
10	7	BRIDGESTONE CORPORATION	Japan	8	7	THE BOEING CO.	USA	9	12	SK GROUP	Korea
10	7	PANASONIC CORP.	Japan	11	6	JFE STEEL CORP.	Japan	11	11	DOW INC.	USA
10	7	MBA POLYMERS INC.	USA	11	6	RESONAC HOLDINGS CORPORATION	Japan	11	11	HEWLETT PACKARD ENTERPRISE CO.	USA
10	7	MOHAWK INDUSTRIES, INC.	USA	11	6	DOW INC.	USA	11	11	NESTE OYJ	Finland
10	7	NIKE, INC	USA	11	6	GEO-TECH POLYMERS LLC	USA	14	10	ARKEMA S.A.	France
10	7	ARKEMA S.A.	France	11	6	CARBIOS	France	14	10	BASF SE	Germany
10	7	HEIDELBERGCEMENT AG	Germany	11	6	PREVIERO N. S.R.L.	Italy	14	10	CONTINENTAL A.G.	Germany
17	6	DAIKIN INDUSTRIES, LTD	Japan	11	6	LOTTE CHEMICAL CORPORATION	Korea	14	10	TOTAL S.A.	France
17	6	JFE STEEL CORP.	Japan	18	5	FURUKAWA ELECTRIC CO., LTD.	Japan	14	10	VTT TECHNICAL RESEARCH CENTRE OF FINLAND	Finland
17	6	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	18	5	ANELLOTECH INC	USA	19	9	UNICHARM CORP.	Japan
17	6	BASF SE	Germany	18	5	BRAVEN ENVIRONMENTAL LLC	USA	19	9	LYONDELLBASELL INDUSTRIES N.V.	Netherlands
17	6	HOLCIM LTD.	Switzerland	18	5	HEIDELBERGCEMENT AG	Germany				
17	6	INEOS GROUP LIMITED	UK	18	5	ROYAL DUTCH SHELL PLC.	Netherlands				
17	6	STEEPER ENERGY APS	Denmark	18	5	HYUNDAI MOTOR CORP.	Korea				
				18	5	KOREA INSTITUTE OF SCIENCE AND TECHNOLOGY	Korea				
				18	5	POSCO CORP.	Korea				

Database: Derwent™ Innovation

27. gxE01: CCS, CCUS, Negative Emission

Table 5-63 illustrates the top 20 IPF applicants in "gxE01: CCS, CCUS, Negative Emission."

Among the top applicants, MITSUBISHI HEAVY INDUSTRIES, LTD. ranked first, Air Liquide S.A (France) ranked second and EXXONMOBIL CORP. (USA) ranked third. 9 European applicants, 5 US applicants, 3 Japanese applicants, 1 South Korean applicant, and no Chinese applicant were ranked.

Table 5-63　Top 20 IPF applicants in "gxE01: CCS, CCUS, Negative Emission"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	212	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
2	203	AIR LIQUIDE S.A.	France
3	169	EXXONMOBIL CORP.	USA
4	136	TOSHIBA CORP.	Japan
5	130	SIEMENS A.G.	Germany
6	123	GENERAL ELECTRIC CO.	USA
7	122	LINDE A.G.	UK
8	112	ALSTOM S.A.	France
8	112	SAUDI ARABIAN OIL CO.	Saudi Arabia
10	110	BASF SE	Germany
11	93	UOP LLC	USA
12	89	COVESTRO DEUTSCHLAND AG	Germany
13	88	ROYAL DUTCH SHELL PLC.	Netherlands
14	81	IFP ENERGIES NOUVELLES S.A.	France
15	78	FUJIFILM CORP.	Japan
16	74	KOREA INSTITUTE OF ENERGY RESEARCH	Korea
17	67	AIR PRODUCTS AND CHEMICALS, INC.	USA
18	56	SAUDI BASIC IND CORP.	Saudi Arabia
19	50	PRAXAIR TECHNOLOGY INC.	USA
19	50	BAYER A.G.	Germany

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are nine European applicants, four Japanese applicants, four US applicants, and two South Korean applicants in the filing years (priority years) 2010-2013, while there are nine European applicants, seven Japanese applicants, and four US applicants in 2018-2021.

Table 5-64 Trend of the top 20 applicants with the number of IPFs in “gxE01: CCS, CCUS, Negative Emission”(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	108	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	1	62	EXXONMOBIL CORP.	USA	1	60	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
2	100	ALSTOM S.A.	France	2	60	TOSHIBA CORP.	Japan	2	58	AIR LIQUIDE S.A.	France
3	91	GENERAL ELECTRIC CO.	USA	2	60	AIR LIQUIDE S.A.	France	3	45	SAUDI ARABIAN OIL CO.	Saudi Arabia
4	85	AIR LIQUIDE S.A.	France	4	56	BASF SE	Germany	4	40	TOSHIBA CORP.	Japan
5	75	EXXONMOBIL CORP.	USA	5	48	DENSO CORP,LINDE A.G.	UK	5	32	EXXONMOBIL CORP.	USA
6	59	SIEMENS A.G.	Germany	6	44	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	6	27	SIEMENS A.G.	Germany
7	52	ROYAL DUTCH SHELL PLC.	Netherlands	6	44	SIEMENS A.G.	Germany	7	26	COVESTRO AG	Germany
8	48	DENSO CORP,LINDE A.G.	UK	8	38	SABIC	Saudi Arabia	7	26	DENSO CORP,LINDE A.G.	UK
8	48	KOREA INSTITUTE OF ENERGY RESEARCH	Korea	9	37	SAUDI ARABIAN OIL CO.	Saudi Arabia	9	20	NITTO DENKO CORP.	Japan
10	45	UOP LLC	USA	10	34	COVESTRO AG	Germany	10	18	TOYOTA MOTOR CORPORATION	Japan
10	45	IFP ENERGIES NOUVELLES S.A.	France	11	33	UOP LLC	USA	10	18	BASF SE	Germany
12	44	BAYER A.G.	Germany	12	32	FUJIFILM CORP.	Japan	10	18	FRENCH NATIONAL CENTRE FOR SCIENTIFIC RESEARCH	France
13	41	AIR PRODUCTS AND CHEMICALS, INC.	USA	13	27	GENERAL ELECTRIC CO.	USA	10	18	TOTAL S.A.	France
14	37	FUJIFILM CORP.	Japan	13	27	CAS.A.LE S.A.	Switzerland	14	17	HONDA MOTOR CO.,LTD.	Japan
15	36	TOSHIBA CORP.	Japan	13	27	IFP ENERGIES NOUVELLES S.A.	France	14	17	PRAXAIR TECHNOLOGY INC.	USA
15	36	BASF SE	Germany	16	25	ROYAL DUTCH SHELL PLC.	Netherlands	16	16	SUMITOMO SEIKA CHEMICALS CO.,LTD.	Japan
17	31	SK GROUP	Korea	17	24	KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY	Saudi Arabia	16	16	ARIZONA STATE UNIVERSITY	USA
18	30	SAUDI ARABIAN OIL CO.	Saudi Arabia	18	21	DOW INC.	USA	18	15	NGK INSULATORS, LTD.	Japan
19	29	PANASONIC CORP.	Japan	18	21	UNIVERSITY OF CALIFORNIA	USA	18	15	UOP LLC	USA
19	29	COVESTRO AG	Germany	20	20	LG CORPORATION	Korea	18	15	EVONIK IND A.G.	Germany
								18	15	HALDOR TOPSOE A/S	Denmark

Database: Derwent™ Innovation

28. gxE02: Measures Against Non-CO2 Greenhouse Gases

Table 5-65 illustrates the top 20 IPF applicants in "gxE02: Measures Against Non-CO2 Greenhouse Gases."

Among the top applicants, DAIKIN INDUSTRIES, LTD. ranked first, THE CHEMOURS COMPANY (USA) ranked second, and ARKEMA S.A. (France) ranked third. 10 Japanese applicants, 5 US applicants, 4 European applicants, and no Chinese or South Korean applicants were ranked.

Table 5-65 Top 20 IPF applicants in "gxE02: Measures Against Non-CO2 Greenhouse Gases"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	164	DAIKIN INDUSTRIES, LTD.	Japan
2	95	THE CHEMOURS COMPANY	USA
3	91	ARKEMA S.A.	France
4	88	AGC INC.	Japan
5	84	HONEYWELL INTERNATIONAL INC.	USA
6	66	ENEOS HOLDINGS, INC.	Japan
7	52	DUPONT DE NEMOURS, INC.	USA
8	50	IDEMITSU KOSAN CO.,LTD.	Japan
9	45	MITSUBISHI ELECTRIC CORP.	Japan
10	43	ORBIA ADVANCE CORPORATION, S.A.B. DE C.V.	Mexico
11	28	3M CO.	USA
12	22	PANASONIC CORP.	Japan
13	21	CENTRAL GLASS CO., LTD.	Japan
13	21	KONINKLIJKE DSM N.V.	Netherlands
15	20	HITACHI, LTD.	Japan
16	15	EVONIK IND A.G.	Germany
17	13	JOHNSON CONTROLS–HITACHI AIR CONDITIONING	Japan
17	13	WEISS UMWELTTECHNIK GMBH	Germany
19	10	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
19	10	INGERSOLL RAND INC.	USA

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 11 Japanese applicants, seven US applicants, and six European applicants in the filing years (priority years) 2010-2013, while there are 10 Japanese applicants, six European applicants, three US applicants, three Chinese applicants, and one South Korean applicant in 2018-2021.

Table 5-66 Trend of top-ranking applicants with the number of IPFs in “gxE02: Measures Against Non-CO2 Greenhouse Gases”
(the Filing Years (Priority Years) 2010-2021)

2010–2013				2014–2017				2018–2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	48	DUPONT DE NEMOURS, INC.	USA	1	70	DAIKIN INDUSTRIES, LTD	Japan	1	87	DAIKIN INDUSTRIES, LTD	Japan
1	48	ARKEMA S.A.	France	2	67	AGC INC.	Japan	2	45	THE CHEMOURS COMPANY	USA
3	36	HONEYWELL INTERNATIONAL INC.	USA	3	27	MITSUBISHI ELECTRIC CORP.	Japan	3	24	HONEYWELL INTERNATIONAL INC.	USA
4	25	ENEOS HOLDINGS, INC.	Japan	4	26	IDEMITSU KOSAN CO.,LTD.	Japan	4	20	ARKEMA S.A.	France
5	24	THE CHEMOURS COMPANY	USA	4	26	THE CHEMOURS COMPANY	USA	5	16	ENEOS HOLDINGS, INC.	Japan
6	18	ORBIA ADVANCE CORPORATION, S.A.B. DE C.V.	Mexico	6	25	ENEOS HOLDINGS, INC.	Japan	6	13	KONINKLIJKE DSM N.V.	Netherlands
7	14	IDEMITSU KOSAN CO.,LTD.	Japan	7	24	HONEYWELL INTERNATIONAL INC.	USA	6	13	ORBIA ADVANCE CORPORATION, S.A.B. DE C.V.	Mexico
8	13	AGC INC.	Japan	8	23	ARKEMA S.A.	France	8	10	IDEMITSU KOSAN CO.,LTD.	Japan
9	12	PANASONIC CORP.	Japan	9	15	3M	USA	8	10	WEISS UMWELTTECHNIK GMBH	Germany
10	10	CENTRAL GLASS CO., LTD.	Japan	10	12	ORBIA ADVANCE CORPORATION, S.A.B. DE C.V.	Mexico	10	9	3M	USA
10	10	MITSUBISHI ELECTRIC CORP.	Japan	11	8	HITACHI, LTD.	Japan	11	8	AGC INC.	Japan
12	8	HITACHI, LTD.	Japan	12	7	CENTRAL GLASS CO., LTD.	Japan	11	8	MITSUBISHI ELECTRIC CORP.	Japan
12	8	EVONIK IND A.G.	Germany	12	7	DENSO CORP.	Japan	13	7	JOHNSON CONTROLS–HITACHI AIR CONDITIONING	Japan
14	7	DAIKIN INDUSTRIES, LTD	Japan	12	7	INGERSOLL RAND INC.	USA	14	5	SRF LIMITED	India
15	6	KH NEOCHEM CO., LTD.	Japan	15	6	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	15	4	CENTRAL GLASS CO., LTD.	Japan
16	5	KYOWA KIRIN CO., LTD.	Japan	15	6	PANASONIC CORP.	Japan	15	4	FUJITSU LTD.	Japan
16	5	TAZZETTI S.P.A.	Italy	17	5	JOHNSON CONTROLS–HITACHI AIR CONDITIONING	Japan	15	4	HITACHI, LTD.	Japan
18	4	TOYOTA INDUSTRIES CORPORATION	Japan	18	4	FUJITSU LTD.	Japan	15	4	PANASONIC CORP.	Japan
18	4	3M	USA	18	4	DUPONT DE NEMOURS, INC.	USA	15	4	SINOCHEM GROUP	China
18	4	BIOSYNTHETIC TECHNOLOGIES	USA	18	4	EVONIK IND A.G.	Germany	20	3	BP PLC.	UK
18	4	CHEMTURA CORPORATION	USA	18	4	KONINKLIJKE DSM N.V.	Netherlands	20	3	EVONIK IND A.G.	Germany
18	4	LUBRIGREEN BIOSYNTHETICS LLC	USA	18	4	DENSO CORP.LINDE A.G.	UK	20	3	SOLVAY	Belgium
18	4	IFP ENERGIES NOUVELLES S.A.	France	18	4	TOTAL S.A.	France	20	3	GREE ELECTRIC APPLIANCES INC.	China
18	4	KONINKLIJKE DSM N.V.	Netherlands					20	3	ZHEJIANG QUHUA FLUORINE CHEMICALS CO. LTD.	China
18	4	LANXESS AG	Germany					20	3	LG CORPORATION	Korea

Database: Derwent™ Innovation

29. gxY01: GXTI×Control-Related Technology

Table 5-67 illustrates the top 21 IPF applicants in "gxY01: GXTI X Control-Related Technology."

Among the top applicants, TOYOTA MOTOR CORPORATION ranked first, GENERAL ELECTRIC CO. (USA) ranked second, and PANASONIC CORP. ranked third. 8 Japanese applicants, 5 European applicants, 4 US and South Korean applicants, and no Chinese applicants were ranked.

Table 5-67　Top 21 IPF applicants in "gxY01: GXTI X Control-Related Technology"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	274	TOYOTA MOTOR CORPORATION	Japan
2	225	GENERAL ELECTRIC CO.	USA
3	202	PANASONIC CORP.	Japan
4	170	MITSUBISHI ELECTRIC CORP.	Japan
5	156	SAMSUNG GROUP	Korea
6	152	FORD MOTOR CO.	USA
7	151	SIEMENS A.G.	Germany
8	144	HYUNDAI MOTOR CORP.	Korea
9	108	ROBERT BOSCH GMBH	Germany
10	107	LG CORPORATION	Korea
11	106	HONDA MOTOR CO., LTD.	Japan
12	98	TOSHIBA CORP.	Japan
13	95	KIA CORP.	Korea
14	90	GENERAL MOTORS CORP.	USA
14	90	VESTAS WIND SYSTEMS A/S	Denmark
16	89	ABB AB	Switzerland
17	87	HITACHI, LTD.	Japan
18	85	OSRAM GMBH	Germany
19	68	DENSO CORP.	Japan
20	66	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
20	66	JOHNSON CONTROLS, INC.	USA

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are nine Japanese applicants, five European applicants, three US applicants, and two South Korean applicants in the filing years (priority years) 2010-2013, while there are eight Japanese applicants, five US applicants, four Korean applicants, and four European applicants in 2018-2021.

Table 5-68 Trend of top-ranking applicants with the number of IPFs in “gxY01: GXTI×Control-Related Technology”(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	107	GENERAL ELECTRIC CO.	USA	1	93	TOYOTA MOTOR CORPORATION	Japan	1	118	TOYOTA MOTOR CORPORATION	Japan
2	91	SAMSUNG GROUP	Korea	2	85	GENERAL ELECTRIC CO.	USA	2	48	HONDA MOTOR CO.,LTD.	Japan
3	88	PANASONIC CORP.	Japan	3	76	MITSUBISHI ELECTRIC CORP.	Japan	3	41	PANASONIC CORP.	Japan
4	74	SIEMENS A.G.	Germany	3	76	FORD MOTOR CO.	USA	4	39	LG CORPORATION	Korea
5	67	MITSUBISHI ELECTRIC CORP.	Japan	5	73	PANASONIC CORP.	Japan	5	34	FORD MOTOR CO.	USA
6	63	TOYOTA MOTOR CORPORATION	Japan	6	60	SIEMENS A.G.	Germany	5	34	HYUNDAI MOTOR CORP.	Korea
7	58	HYUNDAI MOTOR CORP.	Korea	7	52	HYUNDAI MOTOR CORP.	Korea	5	34	KIA CORP.	Korea
8	52	GENERAL MOTORS CORP.	USA	8	46	JOHNSON CONTROLS, INC.	USA	8	33	GENERAL ELECTRIC CO.	USA
9	50	TOSHIBA CORP.	Japan	8	46	VESTAS WIND SYSTEMS A/S	Denmark	9	28	ROBERT BOSCH GMBH	Germany
10	49	ROBERT BOSCH GMBH	Germany	10	43	ABB	Switzerland	10	27	MITSUBISHI ELECTRIC CORP.	Japan
11	42	FORD MOTOR CO.	USA	11	42	LG CORPORATION	Korea	11	26	SAMSUNG GROUP	Korea
11	42	OSRAM GMBH	Germany	12	39	SAMSUNG GROUP	Korea	12	22	GENERAL MOTORS CORP.	USA
13	41	HITACHI, LTD.	Japan	13	32	KIA CORP.	Korea	12	22	ABB	Switzerland
14	37	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	14	31	ROBERT BOSCH GMBH	Germany	14	20	DENSO CORP.	Japan
14	37	KONINKLIJKE PHILIPS N.V.	Netherlands	15	30	HITACHI, LTD.	Japan	15	19	DAIKIN INDUSTRIES, LTD	Japan
16	33	KYOCERA CORP.	Japan	16	29	TOSHIBA CORP.	Japan	15	19	TOSHIBA CORP.	Japan
16	33	SONY GROUP CORP.	Japan	17	27	HONDA MOTOR CO.,LTD.	Japan	15	19	OSRAM GMBH	Germany
18	31	HONDA MOTOR CO.,LTD.	Japan	18	26	ZUMTOBEL AG	Austria	18	17	SIEMENS A.G.	Germany
18	31	ZUMTOBEL AG	Austria	19	24	DENSO CORP.	Japan	19	16	HITACHI, LTD.	Japan
18	31	HON HAI PRECISION IND CO., LTD.	Taiwan	19	24	KONINKLIJKE PHILIPS N.V.	Netherlands	20	15	JOHNSON CONTROLS, INC.	USA
				19	24	OSRAM GMBH	Germany	20	15	LENNOX INTERNATIONAL INC.	USA

Database: Derwent™ Innovation

30. gxY02: GXTI×Measuring-Related Technology

Table 5-69 illustrates the top 20 IPF applicants in "gxY02: GXTI X Measuring-Related Technology."

Among the top applicants, LG CORPORATION (South Korea) ranked first, TOYOTA MOTOR CORPORATION ranked second, and ROBERT BOSCH GMBH (Germany) ranked third. 10 Japanese applicants, 4 South Korean applicants, 3 European and US applicants, and no Chinese applicants were ranked.

Table 5-69 Top 20 IPF applicants in "gxY02: GXTI X Measuring-Related Technology"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	853	LG CORPORATION	Korea
2	749	TOYOTA MOTOR CORPORATION	Japan
3	644	ROBERT BOSCH GMBH	Germany
4	618	SAMSUNG GROUP	Korea
5	411	HYUNDAI MOTOR CORP.	Korea
6	363	PANASONIC CORP.	Japan
7	330	GENERAL ELECTRIC CO.	USA
8	316	FORD MOTOR CO.	USA
9	300	HITACHI, LTD.	Japan
10	299	GENERAL MOTORS CORP.	USA
11	293	HONDA MOTOR CO., LTD.	Japan
12	267	DENSO CORP.	Japan
13	261	KIA CORP.	Korea
14	259	SIEMENS A.G.	Germany
15	255	TOSHIBA CORP.	Japan
16	247	MITSUBISHI ELECTRIC CORP.	Japan
17	194	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
18	163	GS YUASA CORPORATION	Japan
19	127	SONY GROUP CORP.	Japan
20	121	YAZAKI CORP.	Japan

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 10 Japanese applicants, four European applicants, three South Korean applicants, and three US applicants in the filing years (priority years) 2010-2013, while there are nine Japanese applicants, four South Korean applicants, three European applicants, three US applicants, and one Chinese applicant in 2018-2021.

Table 5-70 Trend of top-ranking applicants with the number of IPFs in “gxY02: GXTI×Measuring-Related Technology”(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	288	SAMSUNG GROUP	Korea	1	258	LG CORPORATION	Korea	1	482	LG CORPORATION	Korea
2	276	ROBERT BOSCH GMBH	Germany	2	244	TOYOTA MOTOR CORPORATION	Japan	2	333	TOYOTA MOTOR CORPORATION	Japan
3	172	TOYOTA MOTOR CORPORATION	Japan	3	192	ROBERT BOSCH GMBH	Germany	3	201	HONDA MOTOR CO.,LTD.	Japan
4	170	GENERAL ELECTRIC CO.	USA	4	190	SAMSUNG GROUP	Korea	4	176	ROBERT BOSCH GMBH	Germany
5	162	GENERAL MOTORS CORP.	USA	5	178	HYUNDAI MOTOR CORP.	Korea	5	145	HYUNDAI MOTOR CORP.	Korea
6	132	HITACHI, LTD.	Japan	6	163	FORD MOTOR CO.	USA	6	140	SAMSUNG GROUP	Korea
7	118	PANASONIC CORP.	Japan	7	147	PANASONIC CORP.	Japan	7	128	KIA CORP.	Korea
8	115	SIEMENS A.G.	Germany	8	112	MITSUBISHI ELECTRIC CORP.	Japan	8	109	DENSO CORP.	Japan
9	113	LG CORPORATION	Korea	9	108	GENERAL ELECTRIC CO.	USA	9	98	PANASONIC CORP.	Japan
10	88	SANYO ELECTRIC CO.,LTD.	Japan	10	106	TOSHIBA CORP.	Japan	10	93	FORD MOTOR CO.	USA
10	88	TOSHIBA CORP.	Japan	11	96	KIA CORP.	Korea	11	74	HITACHI, LTD.	Japan
10	88	HYUNDAI MOTOR CORP.	Korea	12	94	HITACHI, LTD.	Japan	12	71	GS YUASA CORPORATION	Japan
13	86	SONY GROUP CORP.	Japan	13	86	DENSO CORP.	Japan	13	66	MITSUBISHI ELECTRIC CORP.	Japan
14	85	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	13	86	SIEMENS A.G.	Germany	14	62	CONTEMPORARY AMPEREX TECHNOLOGY CO., LTD.	China
15	72	DENSO CORP.	Japan	15	76	GENERAL MOTORS CORP.	USA	15	61	TOSHIBA CORP.	Japan
16	69	MITSUBISHI ELECTRIC CORP.	Japan	16	72	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France	15	61	GENERAL MOTORS CORP.	USA
16	69	NISSAN MOTOR CO., LTD.	Japan	17	65	GS YUASA CORPORATION	Japan	17	58	SIEMENS A.G.	Germany
18	60	FORD MOTOR CO.	USA	18	57	LS ELECTRIC CO., LTD.	Korea	18	56	VOLKSWAGEN A.G.	Germany
19	57	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	19	52	HONDA MOTOR CO.,LTD.	Japan	19	52	GENERAL ELECTRIC CO.	USA
20	53	KONINKLIJKE PHILIPS N.V.	Netherlands	20	45	JOHNSON CONTROLS, INC.	USA	20	45	YAZAKI CORP.	Japan

Database: Derwent™ Innovation

31. gxY03: GXTI×Business-Related Technology (Including Authentication and Payment)

Table 5-71 illustrates the top 20 IPF applicants in “gxY03: GXTI X Business-Related Technology (Including Authentication and Payment).”

Among the top applicants, TOYOTA MOTOR CORPORATION ranked first, HONDA MOTOR CO., LTD. Ranked second, and PANASONIC CORP. ranked third and Japan applicants dominated the top ranks. 10 Japanese applicants, 6 South Korean applicants, 2 European applicants, and 1 US and Chinese applicants were ranked.

Table 5-71 Top 20 IPF applicants in "gxY03: GXTI X Business-Related Technology (Including Authentication and Payment)"

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	135	TOYOTA MOTOR CORPORATION	Japan
2	127	HONDA MOTOR CO., LTD.	Japan
3	103	PANASONIC CORP.	Japan
4	90	GENERAL ELECTRIC CO.	USA
5	89	TOSHIBA CORP.	Japan
6	67	HITACHI, LTD.	Japan
7	51	MITSUBISHI ELECTRIC CORP.	Japan
8	49	SIEMENS A.G.	Germany
9	44	NEC CORP.	Japan
10	43	SAMSUNG GROUP	Korea
11	38	LS ELECTRIC CO., LTD.	Korea
12	30	STATE GRID CORP. OF CHINA	China
12	30	HYUNDAI MOTOR CORP.	Korea
12	30	LG CORPORATION	Korea
15	29	KYOCERA CORP.	Japan
16	27	KONINKLIJKE PHILIPS N.V.	Netherlands
17	26	DAIKIN INDUSTRIES, LTD.	Japan
17	26	SONY GROUP CORP.	Japan
19	23	KIA CORP.	Korea
20	21	KOREA ELECTRONICS & TELECOMMUNICATIONS RESEARCH INSTITUTE	Korea

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are nine Japanese applicants, four South Korean applicants, four European applicants, two US applicants, and one Chinese applicant in the filing years (priority years) 2010-2013, while there are eight Japanese applicants, five South Korean applicants, three European applicants, three US applicants, and two Chinese applicants in 2018-2021.

Table 5-72 Trend of top-ranking applicants with the number of IPFs in "gxY03: GXTI×Business-Related Technology (Including Authentication and Payment)"(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	61	GENERAL ELECTRIC CO.	USA	1	45	TOYOTA MOTOR CORPORATION	Japan	1	111	HONDA MOTOR CO.,LTD.	Japan
2	46	TOSHIBA CORP.	Japan	2	29	PANASONIC CORP.	Japan	2	86	TOYOTA MOTOR CORPORATION	Japan
3	36	PANASONIC CORP.	Japan	2	29	TOSHIBA CORP.	Japan	3	38	PANASONIC CORP.	Japan
4	22	HITACHI, LTD.	Japan	4	28	MITSUBISHI ELECTRIC CORP.	Japan	4	21	HITACHI, LTD.	Japan
5	20	SONY GROUP CORP.	Japan	5	24	HITACHI, LTD.	Japan	4	21	HYUNDAI MOTOR CORP.	Korea
6	17	NEC CORPORATION	Japan	6	21	NEC CORPORATION	Japan	6	20	KIA CORP.	Korea
6	17	LS ELECTRIC CO., LTD.	Korea	6	21	GENERAL ELECTRIC CO.	USA	7	16	SIEMENS A.G.	Germany
6	17	SAMSUNG GROUP	Korea	6	21	LS ELECTRIC CO., LTD.	Korea	7	16	TATA MOTORS LIMITED	India
9	15	SIEMENS A.G.	Germany	9	18	SIEMENS A.G.	Germany	9	15	SAMSUNG GROUP	Korea
10	14	KONINKLIJKE PHILIPS N.V.	Netherlands	10	14	HONDA MOTOR CO.,LTD.	Japan	10	14	TOSHIBA CORP.	Japan
11	11	KYOCERA CORP.	Japan	10	14	JOHNSON CONTROLS, INC.	USA	10	14	STATE GRID CORP. OF CHINA	China
11	11	MITSUBISHI ELECTRIC CORP.	Japan	12	13	FUJITSU LTD.	Japan	12	13	DAIKIN INDUSTRIES, LTD	Japan
11	11	ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE	Korea	13	12	KYOCERA CORP.	Japan	13	12	MITSUBISHI ELECTRIC CORP.	Japan
11	11	LG CORPORATION	Korea	13	12	KONINKLIJKE PHILIPS N.V.	Netherlands	14	11	LG CORPORATION	Korea
15	10	IBM	USA	15	11	SAMSUNG GROUP	Korea	15	10	ENVISION CO. LTD.	Korea
16	9	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan	16	10	OMRON CORPORATION	Japan	16	9	FORD MOTOR CO.	USA
16	9	STATE GRID CORP. OF CHINA	China	16	10	SIGNIFY N.V.	Netherlands	16	9	SHANGHAI ENVISION KECHUANG INTELLIGENT TECHNOLOGY CO. LTD.	China
18	8	ABB	Switzerland	18	9	FORD MOTOR CO.	USA	16	9	KWANG YANG MOTOR CO.,LTD.	Taiwan
18	8	GOGORO INC.	Taiwan	18	9	NIO INC.	China	19	8	GENERAL ELECTRIC CO.	USA
20	7	DENSO CORP.	Japan	20	8	SHARP CORP.	Japan	20	7	DENSO CORP.	Japan
20	7	SCHNEIDER ELECTRIC SE	France	20	8	HYUNDAI MOTOR CORP.	Korea	20	7	CARRIER GLOBAL CORPORATION	USA
				20	8	ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE	Korea	20	7	ABB	Switzerland
				20	8	LG CORPORATION	Korea	20	7	ROBERT BOSCH GMBH	Germany

Database: Derwent™ Innovation

32. gxY04: GXTI×ICT-Related Technology (Excluding Business-Related Technology)

Table 5-73 illustrates the top 20 IPF applicants in "gxY04: GXTI X ICT-Related Technology (Excluding Business-Related Technology)."

Among the top applicants, SAMSUNG GROUP (South Korea) ranked first, LG CORPORATION (South Korea) ranked second, and PANASONIC CORP. ranked third. 13 Japanese applicants, 2 South Korean, European and Chinese applicants, and 1 US applicant were ranked.

Table 5-73 Top 20 IPF applicants in "gxY04: GXTI X ICT-Related Technology (Excluding Business-Related Technology)"

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	4,006	SAMSUNG GROUP	Korea
2	2,992	LG CORPORATION	Korea
3	2,310	PANASONIC CORP.	Japan
4	2,236	SHARP CORP.	Japan
5	1,556	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan
6	1,197	FUJIFILM CORP.	Japan
7	1,121	SONY GROUP CORP.	Japan
8	1,066	JAPAN DISPLAY INC.	Japan
9	995	KONINKLIJKE PHILIPS N.V.	Netherlands
10	938	TOSHIBA CORP.	Japan
11	934	SUMITOMO CHEMICAL CO., LTD.	Japan
12	843	CANON INC.	Japan
13	821	OSRAM GMBH	Germany
14	774	KONICA MINOLTA, INC.	Japan
15	720	BOE TECHNOLOGY GROUP CO., LTD.	China
16	709	TOYOTA MOTOR CORPORATION	Japan
17	624	TCL TECHNOLOGY	China
18	600	NITTO DENKO CORP.	Japan
19	553	JOLED INC.	Japan
20	533	GENERAL ELECTRIC CO.	USA

Database: Derwent™ Innovation

As shown in trend of top-ranking applicants with the number of IPFs below, there are 11 Japanese applicants, three European applicants, two South Korean applicants, one US applicant, and one Chinese applicant in the filing years (priority years) 2010-2013, while there are 15 Japanese applicants, two South Korean applicants, two European applicants, and one Chinese applicant in 2018-2021.

Table 5-74 Trend of top-ranking applicants with the number of IPFs in “gxY04: GXTI×ICT-Related Technology (Excluding Business-Related Technology)”(the Filing Years (Priority Years) 2010-2021)

2010-2013				2014-2017				2018-2021			
Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region	Order	Number of IPF	Name of Applicant	Country / Region
1	2,316	SAMSUNG GROUP	Korea	1	1,132	LG CORPORATION	Korea	1	642	SAMSUNG GROUP	Korea
2	1,287	LG CORPORATION	Korea	2	1,048	SAMSUNG GROUP	Korea	2	573	LG CORPORATION	Korea
3	1,241	PANASONIC CORP.	Japan	3	758	PANASONIC CORP.	Japan	3	533	SHARP CORP.	Japan
4	1,114	SHARP CORP.	Japan	4	628	JAPAN DISPLAY INC.	Japan	4	339	SUMITOMO CHEMICAL COMPANY, LIMITED	Japan
5	673	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan	5	589	SHARP CORP.	Japan	5	329	TOYOTA MOTOR CORPORATION	Japan
6	586	FUJIFILM CORP.	Japan	6	559	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan	6	324	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan
7	555	TOSHIBA CORP.	Japan	7	438	KONINKLIJKE PHILIPS N.V.	Netherlands	7	311	PANASONIC CORP.	Japan
8	543	SONY GROUP CORP.	Japan	8	398	BOE TECHNOLOGY GROUP CO., LTD.	China	8	307	CANON INC.	Japan
9	448	KONICA MINOLTA, INC.	Japan	9	347	FUJIFILM CORP.	Japan	9	279	JAPAN DISPLAY INC.	Japan
10	444	KONINKLIJKE PHILIPS N.V.	Netherlands	10	321	SONY GROUP CORP.	Japan	10	264	FUJIFILM CORP.	Japan
11	428	OSRAM GMBH	Germany	11	298	SUMITOMO CHEMICAL COMPANY, LIMITED	Japan	11	257	SONY GROUP CORP.	Japan
12	422	SANYO ELECTRIC CO.,LTD.	Japan	12	292	OSRAM GMBH	Germany	12	251	NITTO DENKO CORP.	Japan
13	362	HON HAI PRECISION IND CO., LTD.	Taiwan	13	273	KONICA MINOLTA, INC.	Japan	13	211	BOE TECHNOLOGY GROUP CO., LTD.	China
14	322	CANON INC.	Japan	14	248	TCL TECHNOLOGY	China	14	207	NICHIA CORPORATION	Japan
14	322	AU OPTRONICS CORP.	Taiwan	15	238	SIGNIFY N.V.	Netherlands	15	190	HONDA MOTOR CO.,LTD.	Japan
16	297	SUMITOMO CHEMICAL COMPANY, LIMITED	Japan	16	233	TOSHIBA CORP.	Japan	16	162	SEIKO EPSON CORP.	Japan
17	289	GENERAL ELECTRIC CO.	USA	17	214	CANON INC.	Japan	17	159	SIGNIFY N.V.	Netherlands
18	288	TCL TECHNOLOGY	China	18	209	MERCK KGAA	Germany	18	150	TOSHIBA CORP.	Japan
19	270	JOLED INC.	Japan	19	199	JOLED INC.	Japan	19	113	KONINKLIJKE PHILIPS N.V.	Netherlands
20	263	MERCK KGAA	Germany	20	192	MITSUBISHI ELECTRIC CORP.	Japan	20	108	KANEKA CORPORATION	Japan

Database: Derwent™ Innovation

Section 9 Summary

Regarding patent application trends for Medium categories in the GXTI, we subjected on a survey on the number of patent families, the number of IPF, etc. in 14 countries/regions. We also extracted the top 20 applicants with the largest number of IPF.

In terms of the annual trends in the number of patent families, most Medium categories patent families tend to increase year by year. In terms of the number of patent families by the country/region of the applicant in the filing years (priority years) of 2010 to 2021 for medium categories., Chinese applicants ranked in the top three in all Medium categories, and in many cases, they ranked first. The other top three applicants are Japanese, US, European, and South Korean. The above trend is the same for the number of patent families by the country/region of the applicant in the filing year (priority year) of 2019, and the tendency for Chinese applicants to rank first is the same.

The annual trends in the number of IPF are different from the trends in the number of patent families, which tended to increase in all categories. Although gxC01, gxB05, and gxA09 increased or tended to increase, Medium categories tends to increase or decrease, such as gxA01 and gxB01 tend to decrease. In terms of the number of IPF by the country/region of the applicant for Medium categories in the filing years (priority years) of 2010 to 2021, is almost all Medium categories, and Japanese, US, and European applicants are the top three countries/regions. On the other hand, in the filing year (priority year) of 2019, the number of IPF of Japanese, US, and European applicants are the top three countries/regions in Medium categories. However, in some Medium categories, the number of applicants has decreased slightly, and instead, Chinese applicants ranked in the top three countries/regions.

In terms of the revealed technology advantage index (RTA Index) of the IPF by the country/region of the applicant, Japanese gxC04, European gxA03, German gxB05, French gxA08, gxC03, and gxE02, the UK gxA06 and gxC02, South Korean gxC01, Canadian gxA04, gxB03, and gxD03, Indian gxD01 and gxY03, ASEAN gxA10 and gxB04, and Australian applicants gxA02, gxA05, gxA07, gxA11, gxD02 and gxE01 are ranked first in the RTA index at each category, the RTA index exceeded 200%, and applications are being made specifically for each category.

According to the IPF active rate in the filing year (priority year) of 2014, the IPF active rate for Japanese, US, European and South Korean applicants is consistently high at equal to or higher than 50% in all categories.

The number of IPFs with 28 or more examiner citations (Table 5-10) is the largest for US applicants, followed by Japanese and European applicants. US applicants have the largest number in all Medium (Level 2) categories except for gxB01, gxB02, gxC01 and gxE02, while Japanese applicants have the largest number in gxB01, gxB02, gxC01, and gxE02, which suggests that they may hold important IPFs often cited by an examiner.

Chapter 6 Trend Survey by Small (Level 3) Categories in the GXTI

This chapter presents the results of a survey on patent application trends for small categories in the GXTI. Small (level 3) categories in the GXTI consists 66 categories included in five large (level 1) categories of "gxA: Energy Supply," "gxB: Energy Saving, Electrification, Demand-Supply Flexibility," "gxC: Batteries, Energy Storage," "gxD: CO2 Reduction in Non-Energy Sector," and "gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas," and among these, the following 10 small (level 3) categories were subjected to a survey using search formulae linked to each small category.

- gxA07b: Liquid Biofuels
- gxB01d: High-Efficiency Lighting (LEDs, OLEDs)
- gxB05a: Electric Vehicles, Hybrid Vehicles
- gxB06b: Induction Heating
- gxC01a: Secondary Batteries
- gxD01b: Cellulose Nanofibers
- gxD03a: Plastic Recycling
- gxE01c: CO2 Separation by Membranes
- gxE01i: CO2 Conversion into Hydrocarbons and Derivatives by Reduction (Methanation, Electrosynthesis, Carboxylation, Artificial Photosynthesis, etc.)
- gxE02b: Green Refrigerants (Low GWP Refrigerant)

Section 1 Annual Trends in the Numbers of IPF

1 illustrates the annual trends in the number of IPFs for small (level 3) categories.

In total, gxC01a had the largest number of IPF, followed by gxB01d, gxB05a, gxB06b, gxD03a, gxA07b, gxE01c, gxE02b, gxE01i, and gxD01b.

Table 6-1 Annual trends in the numbers of IPF

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Level 1	Level 2	Level 3		Year of Priority Claim												Total
				2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
Energy Supply	Biomass	gxA07b	Liquid Biofuels	489	498	432	374	259	238	180	152	142	141	145	21	3,071
Energy Saving, Electrification, Demand-Supply Flexibility	Energy Saving in Buildings (ZEB, ZEH, etc.)	gxB01d	High-Efficiency Lighting (LEDs, OLEDs)	5,303	6,157	6,224	6,141	5,460	5,291	5,554	5,404	5,019	4,304	3,533	856	59,246
	Electromobilities	gxB05a	Electric Vehicles, Hybrid Vehicles	1,969	2,428	2,375	2,349	2,318	2,363	3,026	3,494	4,058	3,891	3,322	899	32,492
	Electrification of Industrial Heat	gxB06b	Induction Heating	353	337	323	370	368	358	425	514	524	549	463	98	4,682
Batteries, Energy Storage	Secondary Batteries	gxC01a	Secondary Batteries	4,371	5,060	5,112	4,904	4,882	4,996	5,599	6,416	6,935	7,325	7,451	1,986	65,037
CO2 Reduction in Non-Energy Sector	Chemical Production from Biomass	gxD01b	Cellulose Nanofibers	24	22	46	48	37	50	58	49	73	51	47	8	513
	Recycling	gxD03a	Plastic Recycling	253	287	260	277	236	219	267	242	279	488	577	127	3,512
Capture, Storage, Utilization and Removal of Greenhouse Gas	CCS, CCUS, Negative Emission	gxE01c	CO2 Separation by Membranes	106	125	129	119	129	118	132	139	151	117	115	20	1,400
		gxE01i	CO2 Conversion into Hydrocarbons and Derivatives by Reduction (Methanation, Electrosynthesis, Carboxylation, Artificial Photosynthesis, etc.)	56	54	72	76	65	75	87	98	101	83	98	30	895
	Measures Against Non-CO2	gxE02b	Green Refrigerants (Low GWP Refrigerant)	105	71	110	101	122	117	113	139	121	139	86	12	1,236

Database: Derwent™ Innovation

Note: Please note that Derwent™ Innovation may not have had sufficient recorded data from the filing year (priority year) of 2019 onward when conducting this survey.

Section 2 Numbers of IPFs by Country/Region of the Applicant

Table 6-2 illustrates the number of IPFs by the country/region of the applicant in the filing years (priority years) of 2010 to 2021 for small (level 3) categories. In the table, the cells of the top three countries/regions in each category are filled with gray, with the red frame indicating the first place and the blue frame indicating the second place.

Among applicants of all countries/regions, Japanese applicants had the largest number of IPF for gxB01d, gxB05a, gxC01a and gxE02b, US applicants for gxA07b and gxE01c, and European applicants for gxB06b, gxD01b, gxD03a and gxE01i. In addition, at small (level 3) categories other than gxC01a, Japanese, US, and European applicants ranked in the top three. However, only for gxC01a, European applicants are out of the top three, and South Korean applicants ranked second.

Table 6-2 The number of IPFs by country/region of the applicant

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Level 1	Level 2	Level 3		Nationality/region of applicant														Total
				Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	Others	
Energy Supply	Biomass	gxA07b	Liquid Biofuels	151	1,524	874	48	143	65	149	19	142	15	64	20	34	79	3,071
Energy Saving, Electrification, Demand-Supply Flexibility	Energy Saving in Buildings (ZEB, ZEH, etc.)	gxB01d	High-Efficiency Lighting (LEDs, OLEDs)	20,552	9,067	10,414	3,607	1,084	551	8,513	2,710	7,183	98	160	62	139	348	59,246
	Electromobilities	gxB05a	Electric Vehicles, Hybrid Vehicles	11,982	5,786	9,349	5,539	1,318	563	1,757	180	2,935	19	209	34	54	187	32,492
	Electrification of Industrial Heat	gxB06b	Induction Heating	923	746	2,009	469	165	146	276	40	585	3	19	9	26	46	4,682
Batteries, Energy Storage	Secondary Batteries	gxC01a	Secondary Batteries	24,423	10,109	9,889	4,810	1,511	644	7,088	761	11,800	54	441	82	138	252	65,037
CO2 Reduction in Non-Energy Sector	Chemical Production from Biomass	gxD01b	Cellulose Nanofibers	182	74	192	7	11	6	39	1	6	0	6	4	5	4	513
	Recycling	gxD03a	Plastic Recycling	396	958	1,432	271	143	134	197	62	163	23	69	28	52	132	3,512
Capture, Storage, Utilization and Removal of Greenhouse Gas	CCS, CCUS, Negative Emission	gxE01c	CO2 Separation by Membranes	315	610	307	48	55	39	25	6	87	5	4	14	14	13	1,400
		gxE01i	CO2 Conversion into Hydrocarbons and Derivatives by Reduction (Methanation, Electrosynthesis, Carboxylation, Artificial Photosynthesis, etc.)	190	283	297	107	35	12	42	3	48	1	13	4	9	5	895
	Measures Against Non-CO2	gxE02b	Green Refrigerants (Low GWP Refrigerant)	514	384	254	36	96	59	44	2	17	1	8	4	2	6	1,236

Database: Derwent™ Innovation

Section 3 IPF Growth Rate

Table 6-3 illustrates the IPF growth rate by the country/region of the applicant for small categories.

In total, the growth rate of gxD01b was the highest, and the growth rates of gxB05a, gxE01i, gxB06b, gxC01a, gxE02b, gxD03a and gxE01c were positive, while gxB01d and gxA07b were negative. The growth rates of patent families by Chinese and Indian applicants are positive in most categories. In particular, gxD01b for Chinese applicants and gxC01a, gxE02b and gxB06b for Indian applicants are remarkably high.

Among Japanese applicants, gxD01b has the highest growth rate and gxA07b has the lowest growth rate.

Table 6-3 IPF growth rate by the country/region of the applicant

(Application to the country/region to be surveyed, 2010 to 2019, the filing years (priority years))

Level 1	Level 2	Level 3		Nationality/region of applicant													Total
				Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	
Energy Supply	Biomass	gxA07b	Liquid Biofuels	-9.25%	-15.42%	-6.64%	-6.43%	-8.60%	-3.87%	-1.14%	-2.00%	-7.56%	2.86%	0.67%	-11.43%	-11.67%	-11.69%
Energy Saving, Electrification, Demand-Supply Flexibility	Energy Saving in Buildings (ZEB, ZEH, etc.)	gxB01d	High-Efficiency Lighting (LEDs, OLEDs)	-2.48%	-3.63%	-0.83%	-4.96%	0.83%	-1.82%	8.92%	-12.43%	-7.36%	-0.43%	17.50%	-5.00%	-7.80%	-2.54%
	Electromobilities	gxB05a	Electric Vehicles, Hybrid Vehicles	4.97%	5.48%	11.74%	15.52%	2.81%	4.39%	64.26%	5.07%	18.88%	-7.27%	53.10%	-5.56%	12.63%	9.43%
	Electrification of Industrial Heat	gxB06b	Induction Heating	-3.25%	4.14%	6.70%	2.02%	-3.06%	43.57%	37.29%	-10.77%	57.38%	20.00%	100.00%	5.00%	5.45%	7.07%
Batteries, Energy Storage	Secondary Batteries	gxC01a	Secondary Batteries	1.19%	2.68%	5.31%	-0.19%	4.43%	24.61%	39.80%	2.29%	8.88%	-2.50%	162.94%	29.47%	21.67%	5.71%
CO2 Reduction in Non-Energy Sector	Chemical Production from Biomass	gxD01b	Cellulose Nanofibers	39.51%	9.29%	-4.65%	60.00%	-6.67%	0.00%	80.00%	-	40.00%	-	80.00%	-	40.00%	11.75%
	Recycling	gxD03a	Plastic Recycling	1.66%	5.10%	1.32%	-3.81%	0.00%	-2.22%	3.66%	20.00%	2.00%	-4.44%	8.33%	-9.33%	-2.50%	2.77%
Capture, Storage, Utilization and Removal of Greenhouse Gas	CCS, CCUS, Negative Emission	gxE01c	CO2 Separation by Membranes	5.57%	-1.82%	3.39%	-2.50%	12.94%	-8.57%	75.00%	-6.67%	8.13%	10.00%	-10.00%	-3.33%	-12.00%	1.61%
		gxE01i	CO2 Conversion into Hydrocarbons and Derivatives by Reduction (Methanation, Electrosynthesis, Carboxylation, Artificial Photosynthesis, etc.)	13.70%	3.03%	4.70%	16.00%	-5.26%	-8.57%	10.77%	20.00%	35.00%	-	33.33%	0.00%	120.00%	7.49%
	Measures Against Non-CO2	gxE02b	Green Refrigerants (Low GWP Refrigerant)	10.05%	0.22%	0.00%	4.00%	-2.80%	4.17%	21.67%	-	20.00%	-	120.00%	-13.33%	0.00%	4.72%

Database: Derwent^{TM} Innovation

Section 4 Revealed Technology Advantage Index of IPF

Table 6-4 illustrates a revealed technology advantage index (RTA Index) of the IPF by the country/region of the applicant for small categories. In the table, the red frame indicates first place, the light blue frame indicates second place, and the orange frame indicates third place.

The RTA index of gxB05a for German applicants, gxE02b for French applicants, gxB01d for Taiwanese applicants, gxC01a for South Korean applicants, gxA07b and gxD03a for Canadian applicants and gxD01b and gxE01c for ASEAN applicants exceeded 200%. The RTA index is also the highest in each small category compared to other applicant countries/regions, and it is considered that the applications are quite specialized in this technology field. Among the Japanese applicants, the gxE02b has a high RTA index of 185.5%, while the gxA07b has a low RTA index of 21.9%.

Table 6-4　Revealed technology advantage index (RTA Index) of IPF by country/region of the applicant(Application to the country/region to be surveyed, 2010 to 2021, the filing years (priority years))

Level 1	Level 2	Level 3		Nationality/region of applicant												
				Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian
Energy Supply	Biomass	gxA07b	Liquid Biofuels	21.9%	188.8%	122.2%	22.4%	182.5%	101.2%	33.9%	29.4%	57.0%	235.7%	220.4%	205.3%	198.9%
Energy Saving, Electrification, Demand-Supply Flexibility	Energy Saving in Buildings (ZEB, ZEH, etc.)	gxB01d	High-Efficiency Lighting (LEDs, OLEDs)	154.8%	58.2%	75.5%	87.3%	71.7%	44.5%	100.3%	217.6%	149.5%	79.8%	28.6%	33.0%	42.2%
	Electromobilities	gxB05a	Electric Vehicles, Hybrid Vehicles	164.5%	67.7%	123.6%	244.4%	159.0%	82.9%	37.8%	26.4%	111.4%	28.2%	68.0%	33.0%	29.9%
	Electrification of Industrial Heat	gxB06b	Induction Heating	87.9%	60.6%	184.3%	143.6%	138.1%	149.1%	41.2%	40.6%	154.1%	30.9%	42.9%	60.6%	99.8%
Batteries, Energy Storage	Secondary Batteries	gxC01a	Secondary Batteries	167.5%	59.1%	65.3%	106.0%	91.1%	47.4%	76.1%	55.7%	223.8%	40.1%	71.7%	39.7%	38.1%
CO2 Reduction in Non-Energy Sector	Chemical Production from Biomass	gxD01b	Cellulose Nanofibers	158.3%	54.9%	160.8%	19.6%	84.0%	55.9%	53.1%	9.3%	14.4%	0.0%	123.7%	245.8%	175.1%
	Recycling	gxD03a	Plastic Recycling	50.3%	103.8%	175.1%	110.6%	159.6%	182.5%	39.2%	84.0%	57.2%	316.0%	207.7%	251.3%	266.0%
Capture, Storage, Utilization and Removal of Greenhouse Gas	CCS, CCUS, Negative Emission	gxE01c	CO2 Separation by Membranes	100.4%	165.8%	94.2%	49.1%	154.0%	133.2%	12.5%	20.4%	76.6%	172.3%	30.2%	315.2%	179.7%
		gxE01i	CO2 Conversion into Hydrocarbons and Derivatives by Reduction (Methanation, Electrosynthesis, Carboxylation, Artificial Photosynthesis, etc.)	94.7%	120.3%	142.5%	171.4%	153.3%	64.1%	32.8%	15.9%	66.1%	53.9%	153.6%	140.9%	180.7%
	Measures Against Non-CO2	gxE02b	Green Refrigerants (Low GWP Refrigerant)	185.5%	118.2%	88.3%	41.8%	304.4%	228.3%	24.9%	7.7%	17.0%	39.0%	68.4%	102.0%	29.1%

Database: Derwent™ Innovation

Section 5 IPF Active Rate

Table 6-5 illustrates an IPF active rate by the country/region of the applicant for small categories. In the table, the cells of the top three countries/regions by category are filled with gray, with the red frame indicating the first place and the blue frame indicating the second place.

Except for gxE02b, the IPF active rate for French applicants is consistently high at equal to or higher than 85% in all categories, and the IPF active rates in gxB01d, gxB06b, gxC01a, gxE01c and gxE01i ranked first.　The IPF active rates for ASEAN applicants in gxA07b, gxB05a, gxB08b, and gxE02b ranked first.　In addition, the IPF active rate for Indian applicants in gxD01b, gxD03a, and gxE01c ranked first.

Table 6-5　Active rate of the IPF by the country/region of the applicant (Application to the country/region to be surveyed, 2014, the filing year (priority year))

Level 1	Level 2	Level 3		Nationality/region of applicant												Total
				Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	
Energy Supply	Biomass	gxA07b	Liquid Biofuels	76.5%	62.6%	66.7%	57.1%	88.9%	50.0%	63.6%	0.0%	81.8%	0.0%	75.0%	100.0%	80.0%	66.9%
Energy Saving, Electrification, Demand-Supply Flexibility	Energy Saving in Buildings (ZEB, ZEH, etc.)	gxB01d	High-Efficiency Lighting (LEDs, OLEDs)	78.5%	76.9%	77.8%	83.1%	85.6%	82.3%	57.5%	60.4%	83.2%	56.3%	83.3%	66.7%	52.2%	77.1%
	Electromobilities	gxB05a	Electric Vehicles, Hybrid Vehicles	86.7%	89.5%	84.6%	87.1%	92.2%	83.3%	81.7%	73.3%	91.7%	0.0%	50.0%	100.0%	20.0%	89.9%
	Electrification of Industrial Heat	gxB06b	Induction Heating	88.5%	85.9%	85.6%	87.1%	100.0%	83.3%	38.9%	100.0%	89.5%	0.0%	0.0%	100.0%	100.0%	86.8%
Batteries, Energy Storage	Secondary Batteries	gxC01a	Secondary Batteries	82.0%	80.0%	82.8%	85.0%	91.7%	73.9%	65.5%	75.8%	86.4%	75.0%	85.7%	40.0%	70.0%	84.2%
CO2 Reduction in Non-Energy Sector	Chemical Production from Biomass	gxD01b	Cellulose Nanofibers	84.6%	62.5%	95.2%	-	-	-	100.0%	-	-	-	100.0%	-	-	84.8%
	Recycling	gxD03a	Plastic Recycling	84.4%	68.3%	79.8%	72.2%	87.5%	61.5%	66.7%	75.0%	85.7%	-	100.0%	0.0%	100.0%	78.1%
Capture, Storage, Utilization and Removal of Greenhouse Gas	CCS, CCUS, Negative Emission	gxE01c	CO2 Separation by Membranes	71.4%	84.7%	75.0%	62.5%	100.0%	66.7%	-	100.0%	100.0%	-	100.0%	33.3%	100.0%	79.4%
		gxE01i	CO2 Conversion into Hydrocarbons and Derivatives by Reduction (Methanation, Electrosynthesis, Carboxylation, Artificial Photosynthesis, etc.)	88.9%	74.1%	79.2%	66.7%	100.0%	100.0%	100.0%	-	66.7%	-	0.0%	-	-	78.8%
	Measures Against Non-CO2	gxE02b	Green Refrigerants (Low GWP Refrigerant)	78.8%	73.3%	70.0%	-	0.0%	100.0%	-	-	-	-	-	100.0%	-	86.1%

Database: Derwent™ Innovation

Section 6 Number of IPFs with 28 or more Examiner Citations

The number of IPFs with 28 or more examiner citations in each Small (Level 3) category is shown Table 6-6 by country/region of applicant. In the table, the cells for the top 3 countries/regions by each category are filled in gray, with red frames referring the first and blue frames referring the second.

In general, the number of IPFs with 28 or more examiner citations is large for Japanese, US, and European applicants, and these applicants hold the first and second places in all Small (Level 3) categories. Japanese applicants have the largest number in gxB01d, gxB05a, gxC01a, gxD01b and gxE02b, US applicants have the largest number in gxA07b, gxD01b, gxD03a, gxE01c, and gxE01i, as well as European applicants have the largest number in gxB06b and gxD01b, which suggests that they may hold important IPFs often cited by an examiner. As a side note, Chinese applicants rank third in gxA07b, gxD03a and gxE01i, while South Korean applicants rank third in gxB01d and gxC01a.

Table 6-6 The number of IPFs with 28 or more examiner citations
by country/region of applicant(the Filing Years (Priority Years) 2010-2021)

Level 1	Level 2	Level 3		Country / Region of Applicant														Total
				Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	Others	
Energy Supply	Biomass	gxA07b	Liquid Biofuels	1	83	7	1	3	0	4	0	2	1	0	0	2	2	102
Energy Saving, Electrification, Demand-Supply Flexibility	Energy Saving in Buildings (ZEB, ZEH, etc.)	gxB01d	High-Efficiency Lighting (LEDs, OLEDs)	792	651	218	54	22	19	214	58	551	1	4	1	0	5	2,495
	Electromobilities	gxB05a	Electric Vehicles, Hybrid Vehicles	546	366	155	77	22	24	71	3	92	4	1	1	3	6	1,248
	Electrification of Industrial Heat	gxB06b	Induction Heating	16	30	49	3	3	6	10	0	4	0	0	0	1	0	110
Batteries, Energy Storage	Secondary Batteries	gxC01a	Secondary Batteries	886	675	127	50	23	23	215	15	364	4	2	1	4	4	2,297
CO2 Reduction in Non-Energy Sector	Chemical Production from Biomass	gxD01b	Cellulose Nanofibers	8	6	8	0	1	1	0	0	0	0	0	0	1	0	23
	Recycling	gxD03a	Plastic Recycling	3	22	13	1	4	0	5	0	0	1	2	0	0	0	46
Capture, Storage, Utilization and Removal of Greenhouse Gas	CCS, CCUS, Negative Emission	gxE01c	CO2 Separation by Membranes	4	27	4	0	0	2	0	0	1	0	0	0	0	0	36
		gxE01i	CO2 Conversion into Hydrocarbons and Derivatives by Reduction (Methanation, Electrosynthesis, Carboxylation, Artificial Photosynthesis, etc.)	1	21	5	1	0	2	2	0	0	0	0	0	0	0	29
	Measures Against Non-CO2 Greenhouse Gases	gxE02b	Green Refrigerants (Low GWP Refrigerant)	30	14	8	0	6	2	0	0	1	0	0	0	0	0	53

Database: Derwent™ Innovation

Section 7 Top Ranking of the Number of IPF

1. gxA07b: Liquid Biofuels

Table 6-7 illustrates the top 20 IPF applicants in "gxA07b: Liquid Biofuels."

Among the top applicants, ROYAL DUTCH SHELL PLC. (Netherlands) ranked first, IFP ENERGIES NOUVELLES S.A. (France) ranked second, and NESTE OYJ (Finland) ranked third and the European applicants dominated the top ranks. 10 European and US applicants, and no Japanese, Chinese, and South Korean applicants were ranked.

Table 6-7　Top 20 IPF applicants in "gxA07b：Liquid Biofuels"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	185	ROYAL DUTCH SHELL PLC.	Netherlands
2	75	IFP ENERGIES NOUVELLES S.A.	France
3	71	NESTE OYJ	Finland
4	63	CELANESE CORPORATION	USA
5	56	NOVO NORDISK AS	Denmark
6	54	UOP LLC	USA
7	48	KIOR, INC.	USA
8	39	EXXONMOBIL CORP.	USA
8	39	UNIVERSITY OF CALIFORNIA	USA
10	38	TOTAL S.A.	France
11	36	DUPONT DE NEMOURS, INC.	USA
12	34	UPM KYMMENE CORP.	Finland
13	32	XYLECO, INC.	USA
14	31	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	France
14	31	KONINKLIJKE DSM N.V.	Netherlands
16	30	BP PLC.	UK
17	28	BUTAMAX ADVANCED BIOFUELS, LLC	USA
18	26	INAERIS TECHNOLOGIES LLC	USA
19	24	PHILLIPS 66	USA
19	24	BASF SE	Germany

Database: Derwent™ Innovation

2. gxB01d: High-Efficiency Lighting (LEDs, OLEDs)

Table 6-8 illustrates the top 20 IPF applicants in "gxB01d: High-Efficiency Lighting (LEDs, OLEDs)."

Among the top applicants, SAMSUNG GROUP (South Korea) ranked first, PANASONIC CORP. ranked second, and LG CORPORATION (South Korea) ranked third.　12 Japanese applicants, 4 European applicants, 2 South Korean and Chinese applicants, and no US applicants were ranked.

Table 6-8　Top 20 IPF applicants in "gxB01d: High-Efficiency Lighting (LEDs, OLEDs)"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	2,918	SAMSUNG GROUP	Korea
2	2,306	PANASONIC CORP.	Japan
3	2,054	LG CORPORATION	Korea
4	1,953	KONINKLIJKE PHILIPS N.V.	Netherlands
5	1,872	SHARP CORP.	Japan
6	1,685	OSRAM GMBH	Germany
7	1,415	SIGNIFY N.V.	Netherlands
8	1,404	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan
9	1,053	JAPAN DISPLAY INC.	Japan
10	863	TOSHIBA CORP.	Japan
11	833	ZUMTOBEL AG	Austria
12	799	KOITO MANUFACTURING CO., LTD.	Japan
13	764	SUMITOMO CHEMICAL CO., LTD.	Japan
14	735	FUJIFILM CORP.	Japan
15	716	KONICA MINOLTA, INC.	Japan
16	670	SONY GROUP CORP.	Japan
17	662	BOE TECHNOLOGY GROUP CO., LTD.	China
18	614	CANON INC.	Japan
19	586	TCL TECHNOLOGY	China
20	553	JOLED INC.	Japan

Database: Derwent™ Innovation

3. gxB05a: Electric Vehicles, Hybrid Vehicles

Table 6-9 illustrates the top 20 IPF applicants in "gxB05a: Electric Vehicles, Hybrid Vehicles."

Among the top applicants, TOYOTA MOTOR CORPORATION ranked first, HYUNDAI MOTOR CORP. (South Korea) ranked second, and FORD MOTOR CO. (USA) ranked second third. 9 Japanese applicants, 7 European applicants, 2 South Korean and US applicants, and no Chinese applicants were ranked.

Table 6-9 Top 20 IPF applicants in "gxB05a: Electric Vehicles, Hybrid Vehicles"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	3,876	TOYOTA MOTOR CORPORATION	Japan
2	2,182	HYUNDAI MOTOR CORP.	Korea
3	2,024	FORD MOTOR CO.	USA
4	1,657	HONDA MOTOR CO., LTD.	Japan
5	1,465	KIA CORP.	Korea
6	908	GENERAL MOTORS CORP.	USA
7	883	ROBERT BOSCH GMBH	Germany
8	780	NISSAN MOTOR CO., LTD.	Japan
9	765	SCHAEFFLER A.G.	Germany
10	676	ZF FRIEDRICHSHAFEN A.G.	Germany
11	651	DENSO CORP.	Japan
12	531	AUDI A.G.	Germany
13	529	AISIN CORP.	Japan
14	480	HITACHI, LTD.	Japan
15	474	SUZUKI MOTOR CORP.	Japan
16	448	BAYERISCHE MOTOREN WERKE A.G.	Germany
17	426	RENAULT S.A.S.	France
18	378	SUBARU CORPORATION	Japan
19	348	MITSUBISHI ELECTRIC CORP.	Japan
20	342	VOLKSWA.G.EN A.G.	Germany

Database: Derwent™ Innovation

4. gxB06b: Induction Heating

Table 6-10 illustrates the top 20 IPF applicants in "gxB06b: Induction Heating."

Among the top applicants, BSH HAUSGERATE GMBH (Germany) ranked first, LG CORPORATION (South Korea) ranked second, and PANASONIC CORP. ranked third. 8 European applicants, 4 Japanese and US applicants, 3 South Korean applicants, and 1 Chinese applicant were ranked.

Table 6-10 Top 20 IPF applicants in "gxB06b: Induction Heating"

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	432	BSH HAUSGERATE GMBH	Germany
2	324	LG CORPORATION	Korea
3	192	PANASONIC CORP.	Japan
4	183	PHILIP MORRIS INTERNATIONAL INC.	USA
5	157	AKTIEBOLAGET ELECTROLUX	Sweden
6	108	MITSUBISHI ELECTRIC CORP.	Japan
7	104	NICOVENTURES HOLDINGS, LTD.	UK
8	85	SAMSUNG GROUP	Korea
9	83	E.G.O.-GRUPPE	Germany
10	71	MIDEA HOLDING CO., LTD.	China
11	66	ARCELIK A.S.	Turkey
12	63	JAPAN TOBACCO INC.	Japan
12	63	MIELE & CIE. KG	Germany
12	63	KT&G CORPORATION	Korea
15	51	THE BOEING CO.	USA
16	47	ILLINOIS TOOL WORKS INC.	USA
17	46	WHIRLPOOL CORPORATION	USA
18	42	CANON INC.	Japan
19	41	CARL ZEISS MEDITEC A.G.	Germany
19	41	EUROKERA S.N.C.	France

Database: Derwent™ Innovation

5. gxC01a: Secondary Batteries

Table 6-11 illustrates the top 20 IPF applicants in "gxC01a: Secondary Batteries."

Among the top applicants, LG CORPORATION (South Korea) ranked first, SAMSUNG GROUP (South Korea) ranked second, and TOYOTA MOTOR CORPORATION ranked third. 12 Japanese applicants, 4 South Korean applicants, 2 US applicants, and 1 European and Chinese applicants were ranked.

Table 6-11 Top 20 IPF applicants in "gxC01a: Secondary Batteries"

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	4,937	LG CORPORATION	Korea
2	4,613	SAMSUNG GROUP	Korea
3	2,855	TOYOTA MOTOR CORPORATION	Japan
4	2,168	ROBERT BOSCH GMBH	Germany
5	2,154	PANASONIC CORP.	Japan
6	1,327	SANYO ELECTRIC CO.,LTD.	Japan
7	1,110	CONTEMPORARY AMPEREX TECHNOLOGY CO., LTD.	China
8	1,003	TDK CORP.	Japan
9	974	HONDA MOTOR CO., LTD.	Japan
10	970	MURATA MFG CO., LTD.	Japan
11	910	GS YUASA CORPORATION	Japan
12	877	HITACHI, LTD.	Japan
13	829	TOSHIBA CORP.	Japan
14	826	HYUNDAI MOTOR CORP.	Korea
15	750	GENERAL MOTORS CORP.	USA
16	653	NISSAN MOTOR CO., LTD.	Japan
17	647	NEC CORP.	Japan
18	646	FORD MOTOR CO.	USA
19	589	DENSO CORP.	Japan
20	562	KIA CORP.	Korea

Database: Derwent™ Innovation

6. gxD01b: Cellulose Nanofibers

Table 6-12 illustrates the top 25 IPF applicants in "gxD01b: Cellulose Nanofibers."

Among the top applicants, NIPPON PAPER INDUSTRIES CO., LTD. ranked first, and OJI HOLDINGS CORP. and UPM KYMMENE CORP. (Finland) were ranked second. 10 Japanese applicants, 9 European applicants, 3 US and Chinese applicants, and no South Korean applicants were ranked.

Table 6-12 Top 25 IPF applicants in "gxD01b: Cellulose Nanofibers"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	52	NIPPON PAPER INDUSTRIES CO., LTD.	Japan
2	46	OJI HOLDINGS CORP.	Japan
2	46	UPM KYMMENE CORP.	Finland
4	37	STORA ENSO OYJ	Finland
5	18	DAIO PAPER CORPORATION	Japan
6	14	VTT TECHNICAL RESEARCH CENTRE OF FINLAND, LTD.	Finland
7	12	MITSUBISHI CHEMICAL HOLDINGS CORP.	Japan
8	10	GRANBIO INTELLECTUAL PROPERTY HOLDINGS LLC	USA
8	10	UNIVERSITY OF MAINE	USA
10	7	KEMIRA OYJ	Finland
10	7	QILU UNIVERSITY OF TECHNOLOGY	China
12	6	ASAHI KASEI CORP.	Japan
12	6	TOPPAN INC.	Japan
12	6	GEORGIA-PACIFIC LLC	USA
15	5	UNICHARM CORP.	Japan
15	5	SAPPI NETHERLANDS SERVICES B.V.	Netherlands
17	4	DIC CORPORATION	Japan
17	4	HOKUETSU CORPORATION	Japan
17	4	UNIVERSITY OF TOKYO	Japan
17	4	FIBERLEAN TECHNOLOGIES LIMITED	UK
17	4	INNVENTIA AB	Sweden
17	4	INSTITUT POLYTECHNIQUE DE GRENOBLE	France
17	4	VALMET CORP.	Finland
17	4	GOLD EAST PAPER(JIANGSU)CO.,LTD.	China
17	4	GOLDEAST PAPER (JIANGSU) CO. LTD	China

Database: Derwent™ Innovation

7. gxD03a: Plastic Recycling

Table 6-13 illustrates the top 21 IPF applicants in "gxD03a: Plastic Recycling."

Among the top applicants, EASTMAN CHEMICAL COMPANY (USA) ranked first, SAUDI BASIC IND CORP. (Saudi Arabia) ranked second, and THE PROCTER & GAMBLE CO. (USA) ranked third. 12 European applicants, 5 US applicants, 2 Japanese applicants, and no Chinese or South Korean applicants were ranked.

Table 6-13 Top 21 IPF applicants in "gxD03a: Plastic Recycling"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	88	EASTMAN CHEMICAL COMPANY	USA
2	72	SAUDI BASIC IND CORP.	Saudi Arabia
3	42	THE PROCTER & GAMBLE CO.	USA
4	40	UNICHARM CORP.	Japan
5	27	BOREALIS A.G.	Austria
6	26	EREMA GROUP GMBH	Austria
7	24	IFP ENERGIES NOUVELLES S.A.	France
8	23	SOLVAY S.A.	Belgium
9	22	HEWLETT PACKARD ENTERPRISE CO.	USA
9	22	NAN YA PLASTICS CORP.	Taiwan
11	21	ROYAL DUTCH SHELL PLC.	Netherlands
12	20	BASF SE	Germany
13	19	PANASONIC CORP.	Japan
14	18	EXXONMOBIL CORP.	USA
14	18	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG E.V.	Germany
16	17	DOW INC.	USA
16	17	ARKEMA S.A.	France
16	17	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	France
16	17	CONTINENTAL A.G.	Germany
20	16	KRONES AG	Germany
20	16	TOTAL S.A.	France

Database: Derwent™ Innovation

8. gxE01c: CO2 Separation by Membranes

Table 6-14 illustrates the top 21 IPF applicants in "gxE01c: CO2 Separation by Membranes."

Among the top applicants, FUJIFILM CORP. ranked first, Air Liquide S.A (France) ranked second and UOP LLC (USA) ranked third. 8 US applicants, 7 Japanese applicants, 4 European applicants, and no Chinese or South Korean applicants were ranked.

Table 6-14 Top 21 IPF applicants in "gxE01c: CO2 Separation by Membranes"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	78	FUJIFILM CORP.	Japan
2	61	AIR LIQUIDE S.A.	France
3	48	UOP LLC	USA
4	38	SAUDI ARABIAN OIL CO.	Saudi Arabia
5	32	GEORGIA INSTITUTE OF TECHNOLOGY	USA
6	26	LINDE A.G.	UK
7	24	TORAY INDUSTRIES, INC.	Japan
8	23	NGK INSULATORS, LTD.	Japan
9	22	NITTO DENKO CORP.	Japan
10	21	SUMITOMO CHEMICAL CO., LTD.	Japan
10	21	DOW INC.	USA
10	21	MEMBRANE TECHNOLOGY AND RESEARCH INC	USA
13	20	KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY	Saudi Arabia
14	19	GENERAL ELECTRIC CO.	USA
15	18	CHEVRON CORPORATION	USA
15	18	EVONIK IND A.G.	Germany
17	17	RENAISSANCE ENERGY RESEARCH CO., LTD.	Japan
18	15	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
18	15	EXXONMOBIL CORP.	USA
18	15	UNIVERSITY OF CALIFORNIA	USA
18	15	ROYAL DUTCH SHELL PLC.	Netherlands

Database: Derwent™ Innovation

9. gxE01i: CO2 Conversion into Hydrocarbons and Derivatives by Reduction (Methanation, Electrosynthesis, Carboxylation, Artificial Photosynthesis, etc.)

Table 6-15 illustrates the top 20 IPF applicants in "gxE01i: CO2 Conversion into Hydrocarbons and Derivatives by Reduction (Methanation, Electrosynthesis, Carboxylation, Artificial Photosynthesis, etc.)."

Among the top applicants, TOSHIBA CORP. ranked first, SIEMENS A.G. (Germany) ranked second, and BASF SE (Germany) ranked third. 8 European applicants, 6 Japanese applicants, 3 US applicants, and no Chinese or South Korean applicants were ranked.

Table 6-15 Top 20 IPF applicants in "gxE01i: CO2 Conversion into Hydrocarbons and Derivatives by Reduction (Methanation, Electrosynthesis, Carboxylation, Artificial Photosynthesis, etc.)"

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	59	TOSHIBA CORP.	Japan
2	57	SIEMENS A.G.	Germany
3	30	BASF SE	Germany
4	24	PANASONIC CORP.	Japan
5	22	LIQUID LIGHT INC.	USA
6	19	HONDA MOTOR CO., LTD.	Japan
6	19	VANTIUM KNOWLEDGE CENTRE B.V.	Netherlands
8	17	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	France
9	16	SAUDI BASIC IND CORP.	Saudi Arabia
10	14	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan
10	14	HALDOR TOPSOE A/S	Denmark
12	13	HITACHI ZOSEN CORPORATION	Japan
12	13	TOYOTA MOTOR CORPORATION	Japan
12	13	UNIVERSITY OF TORONTO	Canada
15	10	OPUS 12 INCORPORATED	USA
15	10	TOTAL S.A.	France
15	10	SAUDI ARABIAN OIL CO.	Saudi Arabia
18	9	DIOXIDE MATERIALS INC	USA
18	9	EVONIK IND A.G.	Germany
18	9	IFP ENERGIES NOUVELLES S.A.	France

Database: Derwent™ Innovation

10. gxE02b: Green Refrigerants (Low GWP Refrigerant)

Table 6-16 illustrates the top 22 IPF applicants in "gxE02b: Green Refrigerants (Low GWP Refrigerant)."

Among the top applicants, DAIKIN INDUSTRIES, LTD. ranked first, THE CHEMOURS COMPANY (USA) ranked second, and AGC INC. ranked third. 13 Japanese applicants, 5 US applicants, 3 European applicants, and no Chinese or South Korean applicants were ranked.

Table 6-16 Top 22 IPF applicants in "gxE02b: Green Refrigerants (Low GWP Refrigerant)" (Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	163	DAIKIN INDUSTRIES, LTD.	Japan
2	95	THE CHEMOURS COMPANY	USA
3	88	AGC INC.	Japan
4	86	ARKEMA S.A.	France
5	84	HONEYWELL INTERNATIONAL INC.	USA
6	66	ENEOS HOLDINGS, INC.	Japan
7	50	IDEMITSU KOSAN CO.,LTD.	Japan
7	50	DUPONT DE NEMOURS, INC.	USA
9	44	MITSUBISHI ELECTRIC CORP.	Japan
10	43	ORBIA ADVANCE CORPORATION, S.A.B. DE C.V.	Mexico
11	28	3M CO.	USA
12	21	CENTRAL GLASS CO., LTD.	Japan
12	21	PANASONIC CORP.	Japan
14	20	HITACHI, LTD.	Japan
15	15	EVONIK IND A.G.	Germany
16	13	JOHNSON CONTROLS–HITACHI AIR CONDITIONING	Japan
16	13	WEISS UMWELTTECHNIK GMBH	Germany
18	10	INGERSOLL RAND INC.	USA
19	9	DENSO CORP.	Japan
19	9	FUJITSU LTD.	Japan
19	9	KH NEOCHEM CO., LTD.	Japan
19	9	MITSUBISHI HEAVY INDUSTRIES, LTD.	Japan

Database: Derwent™ Innovation

Section 8 Summary

Regarding patent application trends for small categories in the GXTI, we conducted a survey on the number of IPF, or the like targeting 14 countries/regions. In addition, the top 20 applicants with the largest number of IPF were extracted.

The annual trends in the number of IPF differ from the trends in the number of patent families, which tended to increase in 9 categories. Although the 6 small categories are on the increase, gxB01d, gxE01c and gxE02b are remained at the same level, while gxA07b is on the decline. Among applicants by the country/region, Japanese applicants had the largest number of IPF for gxB01d, gxB05a, gxC01a, and gxE02b, US applicants for gxA07b and gxE01c, and European applicants for gxB06b, gxD01b, gxD03a and gxE01i.

In terms of the IPF growth rate by the country/region of the applicant, the growth rates of patent families for Chinese and Indian applicants are positive in almost all categories. In particular, the growth rate of gxD01b for Chinese applicants and gxC01a, gxE02b, and gxB06b for Indian applicants are remarkably high.

In terms of revealed technology advantage index (RTA Index) of the IPF by the country/region of the applicant, the RTA index of gxB05a for German applicants, gxE02b for French applicants, gxB01d for Taiwanese applicants, gxC01a for South Korean applicants, gxA07b and gxD03a for Canadian applicants and gxD01b and gxE01c for ASEAN applicants exceeded 200%. The RTA index is also the highest in each small category compared to other applicant countries/regions, and it is considered that the applications are quite specialized in this category.

In terms of IPF active rate by the country/region of the applicant, the IPF active rate for French applicants is consistently high at equal to or higher than 85% in all categories.

In general, the numbers of IPFs with 28 or more examiner citations (Table 6-6) is large for Japanese, US, and European applicants, and these applicants hold the first and second places in all Small (Level 3) categories. Japanese applicants have the largest number in gxB01d, gxB05a, gxC01a, gxD01b and gxE02b, US applicants have the largest number in gxA07b, gxD01b, gxD03a, gxE01c and gxE01i, as well as European applicants have the largest number in gxB06b and gxD01b, which suggests that they may hold important IPFs often cited by an examiner.

Chapter 7 Trend Survey of Notable Technologies outside GXTI

In this chapter, we define featured technologies related to climate change, which are not included in GXTI, as notable technologies outside GXTI, and we conducted a survey on following eight notable technologies outside GXTI.

- Perovskite Solar Cell
- Data Center Energy Saving
  - Photonics Convergence Technology
  - Power Semiconductor
  - Energy Saving for Entire Facility
- Optimization of Delivery Routes
- Sharing of Goods
- Room Temperature Storage of Food
- CO2 Emission Trading

Section 1 Annual Trends in the Number of Patent Families and IPF

Table 7-1 illustrates the annual trends in the number of patent families by notable technologies outside GXTI.

In total, the number of cases of "Room Temperature Storage of Food" was the largest, followed by "Sharing of Goods," "Photonics Convergence Technology," "Optimization of Delivery Routes," "Perovskite Solar Cell," "Energy Saving for Entire Facility," "Power Semiconductor," and "CO2 Emission Trading" and there is a big difference in the number of families depending on the technology.

Considering the annual trends, the number of families of "Photonics Convergence Technology" is gradually decreasing and other technologies are on the rise. However, "Room Temperature Storage of Food" peaked in the filing year (priority year) of 2016, and "Energy Saving for Entire Facility" peaked in the filing year (priority year) of 2017 and have turned to a downward trend.

Table 7-1 Annual trends in the number of patent families

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Featured Technologies outside GXTI		Year of Priority Claim												Total
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
Perovskite Solar Cell		4	20	23	70	269	465	543	643	837	863	835	745	5,317
Data Center Energy Saving	Photonics Convergence Technology	613	679	564	454	483	517	475	474	500	437	375	248	5,819
	Power Semiconductor	17	33	37	33	29	44	48	49	54	45	32	5	426
	Energy Saving for Entire Facility	372	379	484	450	374	407	360	452	391	356	373	270	4,668
Optimization of Delivery Routes		36	53	87	116	141	191	409	608	736	920	1,105	941	5,343
Sharing of Goods		930	1,282	1,627	1,764	1,704	1,775	2,323	3,453	3,603	3,555	4,170	2,793	28,979
Room Temperature Storage of Food		2,399	2,673	3,524	4,658	6,567	8,553	11,128	10,945	9,800	6,931	6,560	4,897	78,635
CO2 Emission Trading		9	11	6	10	1	2	11	10	23	31	30	60	204

Database: Derwent™ Innovation

Note: Please note that Derwent™ Innovation may not have had sufficient recorded data from the filing year (priority year) of 2019 onward when conducting this survey.

Table 7-2 illustrates the annual trends in the number of IPF by notable technologies outside GXTI.

In total, the number of cases of "Sharing of Goods, was the largest, followed by "Room Temperature Storage of Food," "Photonics Convergence Technology," "Energy Saving for Entire Facility," "Optimization of Delivery Routes," "Perovskite Solar Cell," "Power Semiconductor," and "CO2 Emission Trading." In terms of the number of patent families of Table 7-1, there was an order of magnitude difference in the number of cases depending on the technology. However, in IPF, although the number of cases of "Power Semiconductor" and in particular, "CO2 Emission Trading" is extremely small, there is no significant difference in other technologies. Considering the annual trends, the number of IPF for "Photonics Convergence Technology" and "Energy Saving for Entire Facility" is gradually decreasing, but other technologies are on the rise. The patent family of "Room Temperature Storage of Food" peaked in the filing year (priority year) of 2016, and has turned to a downward trend. However, no such trend is seen in IPF, and the trend is gradual increase throughout the survey period.

Table 7-2 Annual trends in the number of IPF

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Featured Technologies outside GXTI		Year of Priority Claim												Total
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
Perovskite Solar Cell		1	2	12	38	105	143	131	149	148	148	163	30	1,070
Data Center Energy Saving	Photonics Convergence Technology	393	414	292	247	222	241	191	226	184	182	150	41	2,783
	Power Semiconductor	7	30	20	22	26	41	42	33	32	37	30	0	320
	Energy Saving for Entire Facility	176	182	223	195	154	166	161	157	136	144	129	35	1,858
Optimization of Delivery Routes		18	30	43	48	48	63	114	154	157	171	206	37	1,089
Sharing of Goods		286	409	529	507	451	401	404	577	642	564	628	133	5,531
Room Temperature Storage of Food		306	299	304	340	326	347	399	444	470	458	558	118	4,369
CO2 Emission Trading		2	3	2	3	0	0	0	1	2	2	3	0	18

Database: Derwent™ Innovation

Note: Please note that Derwent™ Innovation may not have had sufficient recorded data from the filing year (priority year) of 2019 onward when conducting this survey.

Section 2 Numbers of Patent Families and IPF by Country/Region of the Applicant

Table 7-3 illustrates the number of patent families by country/region of the applicant in the filing years (priority years) of 2010 to 2021, by notable technologies outside GXTI. In the table, the cells of the top three countries/regions for Category are filled with gray, with the red frame indicating the first place and the blue frame indicating the second place.

Chinese applicants have entered the top three patent families in 7 out of 8 technologies, with 5 of them ranked first. In addition, South Korean applicants have entered the top 3 ranks in 7 technologies, with 3 of them ranked second. Japanese applicants have entered the top 3 ranks in 6 technologies, "Photonics Convergence Technology" ranked first, and "Perovskite Solar Cell" ranked second. US applicant entered the top 3 ranks in 4 technologies, and 4 countries of Chinese, South Korean, Japanese, and the US occupy the top 3 rank.

Table 7-3 The number of patent families by country/region of the applicant
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Featured Technologies outside GXTI		Nationality/region of applicant														Total
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	Others	
Perovskite Solar Cell		522	367	263	23	28	51	3,532	41	520	1	23	13	20	15	5,317
Data Center Energy Saving	Photonics Convergence Technology	2,835	113	21	4	1	6	1,964	205	677	0	3	0	0	1	5,819
	Power Semiconductor	35	327	1	0	0	0	21	0	41	0	0	1	0	0	426
	Energy Saving for Entire Facility	592	1,986	133	25	20	29	1,426	146	305	2	52	6	7	13	4,668
Optimization of Delivery Routes		249	787	265	69	36	22	3,481	18	439	5	42	17	31	9	5,343
Sharing of Goods		2,312	7,861	485	74	74	56	11,286	264	6,031	55	382	42	206	55	28,979
Room Temperature Storage of Food		2,695	1,227	1,709	101	167	89	62,214	297	9,796	16	174	243	97	167	78,635
CO2 Emission Trading		18	10	2	1	0	0	137	1	31	2	1	0	2	0	204

Database: Derwent™ Innovation

Table 7-4 illustrates the number of IPF by country/region of the applicant in the filing years (priority years) of 2010 to 2021, by notable technologies outside GXTI.

Japanese applicants have entered the top 3 ranks in the number of IPF in all technologies, among them, the perovskite solar cell and photonics convergence technology ranked first. US applicants have entered the top three in the number of IPF in 7 out of 8 technologies, with 5 of them ranked first. In the number of patent families of Table 7-3, Chinese applicant have entered the top 3 ranks in 7 technologies. However, in the number of patent families of Table 7-3, Chinese applicant entered the top 3 tanks in only 3 technologies and no technology ranked first. European and South Korean applicants are also in the top three in the number of IPF for the three technologies.

Table 7-4　The number of IPF by country/region of the applicant

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Featured Technologies outside GXTI		Nationality/region of applicant														Total
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	Others	
Perovskite Solar Cell		273	217	245	18	27	46	111	19	166	0	2	6	17	14	1,070
Data Center Energy Saving	Photonics Convergence Technology	2,039	61	17	0	1	6	201	130	332	0	2	0	0	1	2,783
	Power Semiconductor	24	245	1	0	0	0	14	0	35	0	0	1	0	0	320
	Energy Saving for Entire Facility	326	829	109	19	14	25	257	103	173	1	38	6	4	12	1,858
Optimization of Delivery Routes		155	424	221	42	32	20	146	5	67	3	24	16	19	9	1,089
Sharing of Goods		808	2,529	355	37	50	43	517	53	905	17	184	34	75	54	5,531
Room Temperature Storage of Food		726	897	1,371	57	134	73	474	72	549	9	35	31	40	165	4,369
CO2 Emission Trading		3	7	2	1	0	0	4	0	1	0	1	0	0	0	18

Database: Derwent™ Innovation

Section 3 Patent Families and IPF Growth Rate

Table 7-5 illustrates the growth rate of the patent families by the country/region of the applicant by notable technologies outside GXTI.

Since the growth rate cannot be calculated for items with 0 patent families in the filing years (priority years) of 2010 to 2015, the items are marked with "-". In addition, since the total numbers of patent families for "Power Semiconductor" and "CO2 Emission Trading" in the filing years (priority years) of 2010 to 2014, is less than 10 for most countries/regions of the applicant, it is excluded from the analysis. Furthermore, the applicants were analyzed by excluding the applicants from countries/regions with a small number of cases. "Perovskite Solar Cell" and "Optimization of Delivery Routes" will be analyzed for Japanese, US, European, Chinese, and South Korean applicants. "Photonics Convergence Technology" and "Energy Saving for Entire Facility" will be analyzed for Japanese, US, European, Chinese, Taiwanese, and South Korean applicants. The growth rate in patent families for "Perovskite Solar Cell" is high, and in particular, the number of patent families of Chinese applicants is increasing at an annual rate of 336.3% (French applicants are excluded due to the small number of applicants). In addition, the growth rate for "Optimization of Delivery Routes" is also high, with the growth rate for South Korean applicants being particularly high at 338.8% and that for Chinese applicants being 252.2%. On the other hand, the growth rate for "Photonics Convergence Technology" is low, and the growth rate of a negative value (decrease) except for European and Chinese applicants. In addition, the growth rate for "Energy Saving for Entire Facility" is also low, and the growth rate is negative (decrease) except for Chinese and South Korean applicants (German, French, Indian, and ASEAN applicants are excluded due to the small number of applicants). Among Japanese applicants, "Perovskite Solar Cell" had the highest growth rate of 78.7%, followed by "Optimization of Delivery Routes," "Sharing of Goods," and "Room Temperature Storage of Food." "Energy Saving for Entire Facility" and "Photonics Convergence Technology" had negative values (decrease) ("Power Semiconductor" and "CO2 Emission Trading" are excluded due to the small number of applications).

Table 7-5　Patent families growth rate by the country/region of the applicant

(Application to the country/region to be surveyed, 2010 to 2019, the filing years (priority years))

Featured Technologies outside GXTI		Nationality/region of applicant													Total
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	
Perovskite Solar Cell		78.70%	48.73%	48.40%	140.00%	340.00%	13.33%	336.33%	52.50%	116.08%	-	-	160.00%	13.33%	153.63%
Data Center Energy Saving	Photonics Convergence Technology	-7.26%	-7.69%	20.00%	-13.33%	-20.00%	-	13.84%	-12.70%	-4.63%	-	-	-	-	-2.79%
	Power Semiconductor	24.44%	23.83%	-	-	-	-	-12.31%	-	-14.38%	-	-	-20.00%	-	12.21%
	Energy Saving for Entire Facility	-10.29%	-3.39%	-0.65%	0.00%	11.43%	-5.00%	18.37%	-13.89%	6.33%	-20.00%	8.24%	0.00%	-13.33%	-0.90%
Optimization of Delivery Routes		66.67%	35.38%	27.94%	32.86%	45.00%	14.29%	252.19%	100.00%	338.75%	10.00%	28.57%	200.00%	20.00%	112.29%
Sharing of Goods		9.82%	-2.74%	9.70%	86.67%	7.14%	-1.54%	180.30%	16.10%	16.36%	-8.00%	26.08%	10.00%	5.43%	20.26%
Room Temperature Storage of Food		3.97%	3.26%	4.51%	-3.18%	-1.58%	1.05%	37.67%	10.00%	6.73%	2.86%	15.69%	20.00%	7.37%	27.78%
CO2 Emission Trading		-9.09%	-16.67%	-20.00%	-20.00%	-	-	280.00%	-	-5.45%	-20.00%	-20.00%	-	0.00%	21.62%

Database: Derwent™ Innovation

Table 7-6 illustrates the IPF growth rate by the country/region of the applicant by notable technologies outside GXTI.

Since the growth rate cannot be calculated for items with 0 IPF in the filing years (priority years) of 2010 to 2015, the items are marked with "-". In addition, since the total numbers of IPF for "Power Semiconductor" and "CO2 Emission Trading" in the filing years (priority years) of 2010 to 2014, is less than 10 for most countries/regions of the applicant, it is excluded from the analysis. Furthermore, the applicants were analyzed by excluding the applicants from countries/regions with a small number of cases. "Optimization of Delivery Routes" will be analyzed for Japanese, US, and European, "Perovskite Solar Cell" will be analyzed for Japanese, US, European, and South Korean applicants, and "Photonics Convergence Technology" and "Energy Saving for Entire Facility" will be analyzed for Japanese, US, European, Chinese, Taiwanese, and South Korean applicants.

The IPF growth rate for "Perovskite Solar Cell" is high, and in particular the IPF for Japanese applicants is increasing at an annual rate of 120.0% (French and Chinese applicants are excluded due to the small number of applicants). On the other in addition, the growth rate for "Optimization of Delivery Routes" is also high, and the growth rate for Japanese applicants is particularly high at 80.0% (Chinese, South Korean and ASEAN applicants are excluded due to the small number of applicants). In addition, the growth rate for "Energy Saving for Entire Facility" is also low, and the growth rate is a negative value (decrease) except for South Korean applicants (Indian and ASEAN applicants are excluded due to the small number of applicants). Among Japanese applicants, "Perovskite Solar Cell" had the highest growth rate of 120.0%, followed by "Optimization of Delivery Routes," "Sharing of Goods," and "Room Temperature Storage of Food." "Energy Saving for Entire Facility" and "Photonics Convergence Technology" had negative values (decrease) ("Power Semiconductor" and "CO2 Emission Trading" are excluded due to the small number of applications).

Table 7-6　IPF growth rate by the country/region of the applicant

(Application to the country/region to be surveyed, 2010 to 2019, the filing years (priority years))

Featured Technologies outside GXTI		Nationality/region of applicant													Total
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	
Perovskite Solar Cell		120.00%	49.50%	48.94%	110.00%	320.00%	16.25%	272.00%	23.33%	71.30%	-	-	-	10.00%	71.01%
Data Center Energy Saving	Photonics Convergence Technology	-7.31%	-8.89%	45.00%	-	-20.00%	-	14.52%	-14.14%	-8.51%	-	0.00%	-	-	-6.94%
	Power Semiconductor	8.89%	35.17%	-	-	-	-	-12.00%	-	-14.07%	-	-	-20.00%	-	15.24%
	Energy Saving for Entire Facility	-9.61%	-1.53%	-2.64%	-4.44%	-2.86%	-3.08%	-3.00%	-13.33%	14.48%	-20.00%	2.67%	0.00%	-10.00%	-3.57%
Optimization of Delivery Routes		80.00%	36.18%	27.92%	45.71%	35.00%	16.67%	545.00%	60.00%	120.00%	20.00%	5.71%	200.00%	16.67%	50.48%
Sharing of Goods		27.37%	-4.20%	6.00%	110.00%	8.89%	-3.64%	51.55%	4.55%	3.54%	-16.92%	16.73%	5.00%	1.71%	3.72%
Room Temperature Storage of Food		6.49%	4.23%	3.05%	3.16%	-1.64%	-2.35%	35.70%	22.00%	11.93%	-8.00%	13.33%	46.67%	7.69%	6.90%
CO2 Emission Trading		-10.00%	-15.00%	-20.00%	-20.00%	-	-	40.00%	-	-	-	-20.00%	-	-	-10.00%

Database: Derwent™ Innovation

Section 4 Revealed Technology Advantage Index of Patent Families and IPF

Table 7-7 illustrates the revealed technology advantage index (RTA Index) of the patent families by the country/region of the applicant by notable technologies outside GXTI.

Applicants with a patent family RTA index of exceeding 200% are Japanese and Taiwanese applicants for "Photonics Convergence Technology," US applicants for "Power Semiconductor," US and Taiwanese applicants for "Energy Saving for Entire Facility," Australian applicants for "Optimization of Delivery Routes," South Korean, Australian, and US applicants for "Sharing of Goods," and Canadian and Australian applicants for "CO2 Emission Trading." The RTA index of Japanese applicants is less than 100% except for "Photonics Convergence Technology." In particular, the RTA index for "Room Temperature Storage of Food" is 26.2%, and the RTA index for "Optimization of Delivery Routes" is low at 35.7%.

Table 7-7　Revealed technology advantage index (RTA Index) of patent families by country/region of the applicant

(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Featured Technologies outside GXTI		Nationality/region of applicant												
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian
Perovskite Solar Cell		75.1%	58.6%	71.6%	17.0%	65.8%	163.7%	115.2%	71.1%	124.7%	19.1%	55.4%	133.1%	135.8%
Data Center Energy Saving	Photonics Convergence Technology	372.7%	16.5%	5.2%	2.7%	2.1%	17.6%	58.5%	325.0%	148.4%	0.0%	6.6%	0.0%	0.0%
	Power Semiconductor	62.9%	652.0%	3.4%	0.0%	0.0%	0.0%	8.5%	0.0%	122.7%	0.0%	0.0%	127.8%	0.0%
	Energy Saving for Entire Facility	97.0%	361.4%	41.3%	21.0%	53.5%	106.0%	53.0%	288.6%	83.3%	43.5%	142.6%	70.0%	54.2%
Optimization of Delivery Routes		35.7%	125.1%	71.8%	50.6%	84.2%	70.3%	112.9%	31.1%	104.8%	95.1%	100.6%	173.2%	209.5%
Sharing of Goods		61.0%	230.4%	24.2%	10.0%	31.9%	33.0%	67.5%	84.0%	265.4%	192.8%	168.7%	78.9%	256.7%
Room Temperature Storage of Food		26.2%	13.3%	31.5%	5.0%	26.5%	19.3%	137.2%	34.8%	158.9%	20.7%	28.3%	168.2%	44.5%
CO2 Emission Trading		67.5%	41.6%	14.2%	19.2%	0.0%	0.0%	116.4%	45.2%	193.8%	995.9%	62.7%	0.0%	354.0%

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Table 7-8 illustrates the revealed technology advantage index (RTA Index) of the IPF by the country/region of the applicant by notable technologies outside GXTI.

Applicants with the RTA index of the IPF of exceeding 200% are Australian and the UK applicants for "Perovskite Solar Cell," Japanese and Taiwanese applicants for "Photonics

Convergence Technology," US applicants for "Power Semiconductor," Taiwanese and Indian applicants for "Energy Saving for Entire Facility," ASEAN, Australian, and Indian applicants for "Optimization of Delivery Routes," Indian, Australian, and South Korean applicants for "Sharing of Goods," ASEAN applicants for "Room Temperature Storage of Food," and Indian applicants for "CO2 Emission Trading." The RTA index of Japanese applicants is less than 100% except for "Photonics Convergence Technology" and "Perovskite Solar Cell." In particular, the RTA index for "Power Semiconductor" is low at 33.5%.

Table 7-8 Revealed technology advantage index (RTA Index) of IPF by country/region of the applicant (Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Featured Technologies outside GXTI		Nationality/region of applicant												
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian
Perovskite Solar Cell		113.8%	77.2%	98.4%	24.1%	98.9%	205.6%	72.4%	84.5%	191.3%	0.0%	19.8%	176.8%	285.5%
Data Center Energy Saving	Photonics Convergence Technology	326.9%	8.3%	2.6%	0.0%	1.4%	10.3%	50.4%	222.2%	147.1%	0.0%	7.6%	0.0%	0.0%
	Power Semiconductor	33.5%	291.3%	1.3%	0.0%	0.0%	0.0%	30.5%	0.0%	134.9%	0.0%	0.0%	98.5%	0.0%
	Energy Saving for Entire Facility	78.3%	169.7%	25.2%	14.7%	29.5%	64.4%	96.6%	263.7%	114.8%	26.0%	216.3%	101.8%	38.7%
Optimization of Delivery Routes		63.5%	148.1%	87.2%	55.3%	115.2%	87.8%	93.6%	21.8%	75.9%	132.9%	233.0%	463.2%	313.5%
Sharing of Goods		65.2%	174.0%	27.6%	9.6%	35.4%	37.2%	65.3%	45.6%	201.8%	148.3%	351.8%	193.8%	243.6%
Room Temperature Storage of Food		74.1%	78.1%	134.8%	18.7%	120.2%	79.9%	75.8%	78.4%	155.0%	99.4%	84.7%	223.7%	164.5%
CO2 Emission Trading		74.4%	147.9%	47.7%	79.6%	0.0%	0.0%	155.2%	0.0%	68.5%	0.0%	587.4%	0.0%	0.0%

Database: Derwent™ Innovation

Section 5 IPF Active Rate

Table 7-9 illustrates an IPF active rate by the country/region of the applicant by notable technologies outside GXTI.

The number of IPF for "Power Semiconductor," "CO2 Emission Trading, " and "Optimization of Delivery Routes" is less than 10 cases for applicants from most countries/regions. Since German, French, the UK, Canadian, Indian, ASEAN, and Australian applicants have less than 10 IPFs for most technologies, these applicants are excluded from the analysis. In addition, since the number of IPF for "Photonics Convergence Technology" of US and European applicants and the number of IPF "Perovskite Solar Cell" of Chinese applicant are less than 10, these applicants are also excluded from the analysis.

The IPF active rate for South Korean applicants is higher than that for applicants from other countries/regions. In addition, the IPF active rate for Japanese applicants is relatively high, and in particular, the IPF active rates for "Sharing of Goods" and "Room Temperature Storage of Food" are in the 80% range.

Table 7-9　Active rate of the IPF by the country/region of the applicant
(Application to the country/region to be surveyed, 2014, the filing year (priority year))

Featured Technologies outside GXTI		Nationality/region of applicant													Total
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	
Perovskite Solar Cell		72.7%	63.0%	60.7%	100.0%	100.0%	57.1%	100.0%	75.0%	100.0%	-	-	-	75.0%	73.6%
Data Center Energy Saving	Photonics Convergence Technology	77.5%	57.1%	100.0%	-	100.0%	-	85.7%	25.0%	92.0%	-	-	-	-	78.5%
	Power Semiconductor	100.0%	11.8%	-	-	-	-	100.0%	-	100.0%	-	-	100.0%	-	100.0%
	Energy Saving for Entire Facility	71.0%	69.4%	66.7%	66.7%	100.0%	75.0%	60.0%	72.7%	85.7%	-	83.3%	0.0%	0.0%	79.4%
Optimization of Delivery Routes		83.3%	75.0%	58.8%	50.0%	66.7%	75.0%	100.0%	-	100.0%	0.0%	-	100.0%	0.0%	75.8%
Sharing of Goods		84.6%	67.7%	50.0%	0.0%	60.0%	42.9%	67.6%	50.0%	73.0%	33.3%	42.9%	0.0%	50.0%	68.0%
Room Temperature Storage of Food		84.2%	62.2%	68.5%	57.1%	100.0%	54.5%	86.7%	33.3%	68.1%	0.0%	-	0.0%	60.0%	68.8%
CO2 Emission Trading		-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Section 6 Number of IPFs with 28 or more Examiner Citation

The number of IPFs with 28 or more examiner citations for each notable technology outside GXTI is shown in Table 7-10 by country/region of applicant. As with Table 7-9, technologies or countries/regions of applicants, of which number of IPFs is small, are excluded from the analysis.

In general, the number of IPFs with 28 or more examiner citations is large for US applicants. US applicants have the largest number in all technologies other than “Perovskite Solar Cells” and “Optoelectronic Fusion Technology”, Japanese applicants have the largest number in “Optoelectronic Fusion Technology”, and European applicants have the largest number in “Perovskite Solar Cells”, which suggests that they may hold important IPFs often cited by an examiner.

Table 7-10 The number of IPFs with 28 or more examiner citations by country/region of applicant
(the Filing Years (Priority Years) 2010-2021)

Featured Technologies outside GXTI		Country / Region of Applicant														Total
		Japanese	US	European	German	French	UK	Chinese	Taiwanese	South Korean	Canadian	Indian	ASEAN	Australian	Others	
Perovskite Solar Cell		2	5	12	0	0	9	5	4	6	0	0	0	5	1	40
Data Center Energy Saving	Photonics Convergence Technology	71	0	0	0	0	0	4	1	7	0	0	0	0	0	83
	Power Semiconductor	2	16	0	0	0	0	6	0	3	0	0	0	0	0	27
	Energy Saving for Entire Facility	6	83	3	0	0	2	9	2	5	0	0	0	0	0	108
Optimization of Delivery Routes		0	43	4	1	0	2	12	1	1	0	0	0	0	0	61
Shairing of Goods		7	301	13	0	1	4	26	1	21	2	6	1	3	3	384
Room Temperature Storage of Food		0	20	7	0	0	1	13	0	1	1	0	0	0	2	44
CO2 Emission Trading		0	1	1	0	0	0	1	0	0	0	0	0	0	0	3

Database: Derwent^{TM} Innovation

Section 7 Top Ranking of the Number of Patent Families and IPF

1. Perovskite Solar Cell

Table 7-11 illustrates the top 20 applicants with the number of patent families in "Perovskite Solar Cell" and Table 7-12 illustrates the top 21 applicants with the number of IPF in "Perovskite Solar Cell".

The top applicants in terms of the number of patent families are HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY (China) ranked first, SEKISUI CHEMICAL CO., LTD. ranked second, and CHINA HUANENG GROUP CO., LTD. (China) and SOOCHOW UNIVERSITY (China) ranked third. 15 Chinese applicants, 2 Japanese and South Korean applicants, 1 European applicant, and no US applicants were ranked.

The top applicants in terms of the number of IPF are PANASONIC CORP. ranked first, MERCK KGAA (Germany) ranked second, and SEKISUI CHEMICAL CO., LTD. ranked third. 8 Japanese applicants, 5 European applicants, 4 South Korean applicants, and 2 US and Chinese applicants were ranked.

Table 7-11 Top 20 patent families applicants in "Perovskite Solar Cell"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of Families	Name of Applicant	Nationality / Region
1	89	HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY	China
2	86	SEKISUI CHEMICAL CO., LTD.	Japan
3	75	CHINA HUANENG GROUP CO., LTD.	China
3	75	SOOCHOW UNIVERSITY	China
5	71	UNIVERSITY OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA	China
6	65	HANGZHOU XIANNA OPTOELECTRONIC TECHNOLOGY CO. LTD.	China
7	64	NANJING UNIVERSITY OF POSTS AND TELECOMMUNICATIONS	China
8	62	WUHAN UNIVERSITY OF TECHNOLOGY	China
8	62	XI'AN JIAOTONG UNIVERSITY	China
10	61	LG CORPORATION	Korea
11	54	PEKING UNIVERSITY	China
12	53	HANERGY HOLDING GROUP LTD.	China
13	52	PANASONIC CORP.	Japan
14	50	DALIAN INSTITUTE OF CHEMICAL PHYSICS, CHINESE ACADEMY OF SCIENCES	China
15	47	NANJING TECH UNIVERSITY	China
15	47	KOREA RESEARCH INSTITUTE OF CHEMICAL TECHNOLOGY	Korea
17	46	NANKAI UNIVERSITY	China
18	45	SHANGHAI INSTITUTE OF CERAMICS, CHINESE ACADEMY OF SCIENCES	China
19	44	MERCK KGAA	Germany
19	44	SHAANXI NORMAL UNIVERSITY	China

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Table 7-12　Top 21 IPF applicants in "Perovskite Solar Cell"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	46	PANASONIC CORP.	Japan
2	44	MERCK KGAA	Germany
3	32	SEKISUI CHEMICAL CO., LTD.	Japan
4	30	LG CORPORATION	Korea
5	29	FUJIFILM CORP.	Japan
6	26	SWISS FEDERAL INSTITUTE OF TECHNOLOGY IN LAUSANNE	Switzerland
7	25	TOSHIBA CORP.	Japan
8	23	ALLIANCE FOR SUSTAINABLE ENERGY, LLC	USA
9	22	KOREA RESEARCH INSTITUTE OF CHEMICAL TECHNOLOGY	Korea
10	20	FRENCH ALTERNATIVE ENERGIES AND ATOMIC ENERGY COMMISSION	France
10	20	OXFORD UNIVERSITY INNOVATION LIMITED	UK
10	20	GLOBAL FRONTIER CENTER FOR MULTISCALE ENERGY SYSTEMS	Korea
13	19	SUMITOMO CHEMICAL CO., LTD.	Japan
14	17	TCL TECHNOLOGY	China
15	16	HANGZHOU MICROQUANTA SEMICONDUCTOR CO. LTD	China
15	16	SUNGKYUNKWAN UNIVERSITY	Korea
17	13	KAO CORP.	Japan
17	13	SHARP CORP.	Japan
19	12	NISSAN CHEMICAL CORPORATION	Japan
19	12	UNIVERSITY OF NORTH CAROLINA	USA
19	12	SIEMENS A.G.	Germany

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2. Data Center Energy Saving

(1) Photonics Convergence Technology

Table 7-13 illustrates top 20 applicants with the number of patent families and Table 7-14 illustrates top 21 applicants in terms of the number of IPF in the "Photonics Convergence Technology".

The top applicants in terms of the number of IPF are Sony Group ranked first, CANON INC. ranked second, PANASONIC CORP. ranked third, and Japanese applicants dominate the top ranks.　15 Japanese applicants, two South Korean and Chinese applicants, and no US or European applicants were ranked.

The top applicants in terms of the number of IPF are Sony Group ranked first, CANON INC. ranked second, and PANASONIC CORP. ranked third, and Japanese applicants dominate the top ranks.　15 Japanese applicants, 2 South Korean applicants, and 1 Chinese applicant were ranked, and no US or European applicants were ranked.

Table 7-13 Top 20 patent families applicants in "Photonics Convergence Technology" (Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of Families	Name of Applicant	Nationality / Region
1	448	SONY GROUP CORP.	Japan
2	241	CANON INC.	Japan
3	224	PANASONIC CORP.	Japan
4	161	SHARP CORP.	Japan
4	161	LG CORPORATION	Korea
6	159	FUJIFILM CORP.	Japan
7	151	KYOCERA CORP.	Japan
8	140	TOSHIBA CORP.	Japan
9	134	SAMSUNG GROUP	Korea
10	107	KANEKA CORPORATION	Japan
11	101	SANYO ELECTRIC CO.,LTD.	Japan
12	95	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan
13	79	MITSUBISHI ELECTRIC CORP.	Japan
14	75	SHANGHAI AIKO SOLAR ENERGY CO.,LTD.	China
15	61	BYD COMPANY LIMITED	China
16	59	SEIKO EPSON CORP.	Japan
16	59	SUMITOMO CHEMICAL CO., LTD.	Japan
18	46	SUMITOMO ELECTRIC INDUSTRIES, LTD.	Japan
19	42	JAPAN BROADCASTING CORPORATION	Japan
20	39	MOTECH INDUSTRIES INC.	Taiwan

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Table 7-14 Top 21 IPF applicants in "Photonics Convergence Technology"(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	407	SONY GROUP CORP.	Japan
2	204	CANON INC.	Japan
3	184	PANASONIC CORP.	Japan
4	141	FUJIFILM CORP.	Japan
5	128	SHARP CORP.	Japan
6	125	SAMSUNG GROUP	Korea
7	123	TOSHIBA CORP.	Japan
8	106	LG CORPORATION	Korea
9	97	SANYO ELECTRIC CO.,LTD.	Japan
10	75	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan
11	69	KANEKA CORPORATION	Japan
12	68	KYOCERA CORP.	Japan
13	47	MITSUBISHI ELECTRIC CORP.	Japan
14	45	SUMITOMO CHEMICAL CO., LTD.	Japan
15	25	SEIKO EPSON CORP.	Japan
15	25	SEKISUI CHEMICAL CO., LTD.	Japan
17	24	RICOH CO., LTD.	Japan
17	24	BOE TECHNOLOGY GROUP CO., LTD.	China
17	24	AU OPTRONICS CORP.	Taiwan
20	23	HON HAI PRECISION IND CO., LTD.	Taiwan
20	23	INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE	Taiwan

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(2) Power Semiconductor

Table 7-15 illustrates top 22 applicants with the number of patent families and Table 7-16 illustrates top 15 applicants in terms of the number of IPF in the "Power Semiconductor".

The top applicants in terms of the number of patent families are INTEL CORP. (USA) ranked first, SK GROUP (South Korea) ranked second, and QUALCOMM INC (USA) ranked third. 10 Japanese applicants, 7 US applicants, 2 South Korean and European applicants, and 1 Chinese applicant were ranked.

The top applicants in terms of the number of IPF are INTEL CORP. (USA) ranked first, SK GROUP (South Korea) ranked second, and SAMSUNG GROUP (South Korea) ranked third. 9 Japanese applicants, 4 US applicants, 2 South Korean applicants, and no European or Chinese applicants were ranked.

Table 7-15 Top 22 patent families applicants in "Power Semiconductor"(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of Families	Name of Applicant	Nationality / Region
1	287	INTEL CORP.	USA
2	25	SK GROUP	Korea
3	22	QUALCOMM INC.	USA
4	18	SAMSUNG GROUP	Korea
5	11	MICRON TECHNOLOGY, INC.	USA
6	10	FUJITSU LTD.	Japan
7	7	SONY GROUP CORP.	Japan
8	3	TOYOTA MOTOR CORPORATION	Japan
8	3	INTERNATIONAL BUSINESS MACHINES CORP.	USA
8	3	SEMICONDUCTOR MANUFACTURING INTERNATIONAL CORPORATION	China
11	2	HAJIME WATANABE (Individual)	Japan
11	2	HIROSHI WATANABE (Individual)	Japan
11	2	NIPPON TELEGRAPH AND TELEPHONE CORP.	Japan
11	2	PANASONIC CORP.	Japan
11	2	RENESAS ELECTRONICS CORPORATION	Japan
11	2	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan
11	2	TOSHIBA CORP.	Japan
11	2	MONOLITHIC POWER SYSTEMS, INC	USA
11	2	SANDISK CORPORATION	USA
11	2	SYNOPSYS, INC.	USA
11	2	ICEMOS TECHNOLOGY LTD.	UK
11	2	STMICROELECTRONICS N.V.	Switzerland

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Table 7-16 Top 15 IPF applicants in "Power Semiconductor"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	230	INTEL CORP.	USA
2	22	SK GROUP	Korea
3	14	SAMSUNG GROUP	Korea
4	13	QUALCOMM INC.	USA
5	7	FUJITSU LTD.	Japan
6	6	MICRON TECHNOLOGY, INC.	USA
7	4	SONY GROUP CORP.	Japan
8	3	TOYOTA MOTOR CORPORATION	Japan
9	2	HAJIME WATANABE (Individual)	Japan
9	2	HIROSHI WATANABE (Individual)	Japan
9	2	NIPPON TELEGRAPH AND TELEPHONE CORP.	Japan
9	2	RENESAS ELECTRONICS CORPORATION	Japan
9	2	SEMICONDUCTOR ENERGY LABORATORY CO., LTD.	Japan
9	2	TOSHIBA CORP.	Japan
9	2	MONOLITHIC POWER SYSTEMS, INC	USA

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(3) Energy Saving for Entire Facility

Table 7-17 illustrates top 20 applicants with the number of patent families and Table 7-18 illustrates top 20 applicants in terms of the number of IPF in the "Energy Saving for Entire Facility".

The top applicants in terms of the number of IPF are ranked INSPUR GROUP CO., LTD.

(Chinese) ranked first, INTEL CORP. (USA) ranked second, and INTERNATIONAL BUSINESS MACHINES CORP. (USA) ranked third. 8 US applicants, 4 Japanese applicants, 3 Chinese applicants, 1 South Korean applicant, and no European applicants were ranked.

The top applicants in terms of the number of IPF are INTEL CORP. (USA) ranked first, SAMSUNG GROUP (South Korea) ranked second, and FUJITSU LTD. ranked third. 8 US applicants, 5 Japanese applicants, 2 Chinese applicants, 1 South Korean applicant, and no European applicants were ranked.

Table 7-17 Top 20 patent families applicants in "Energy Saving for Entire Facility"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of Families	Name of Applicant	Nationality / Region
1	358	INSPUR GROUP CO., LTD.	China
2	342	INTEL CORP.	USA
3	234	INTERNATIONAL BUSINESS MACHINES CORP.	USA
4	177	DELL TECHNOLOGIES INC.	USA
5	171	SAMSUNG GROUP	Korea
6	151	FUJITSU LTD.	Japan
7	119	MICROSOFT CORP.	USA
8	116	HEWLETT PACKARD ENTERPRISE CO.	USA
9	113	HON HAI PRECISION IND CO., LTD.	Taiwan
10	87	INVENTEC CORP.	Taiwan
11	76	NEC CORP.	Japan
12	71	FOXCONN TECHNOLOGY GROUP	Taiwan
13	68	GOOGLE LLC	USA
14	64	LENOVO CORP.	China
15	58	HUAWEI TECHNOLOGIES CO., LTD.	China
16	56	QUANTA GROUP LIMITED	Taiwan
17	55	AMAZON.COM, INC.	USA
18	54	CANON INC.	Japan
19	38	APPLE INC.	USA
20	37	HITACHI, LTD.	Japan

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Table 7-18 Top 20 IPF applicants in "Energy Saving for Entire Facility"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	199	INTEL CORP.	USA
2	151	SAMSUNG GROUP	Korea
3	103	FUJITSU LTD.	Japan
4	85	HON HAI PRECISION IND CO., LTD.	Taiwan
5	79	HEWLETT PACKARD ENTERPRISE CO.	USA
6	71	MICROSOFT CORP.	USA
7	54	INVENTEC CORP.	Taiwan
8	52	FOXCONN TECHNOLOGY GROUP	Taiwan
9	49	QUANTA GROUP LIMITED	Taiwan
10	41	HUAWEI TECHNOLOGIES CO., LTD.	China
11	40	NEC CORP.	Japan
12	39	INTERNATIONAL BUSINESS MACHINES CORP.	USA
13	30	CANON INC.	Japan
14	29	QUALCOMM INC.	USA
15	28	BAIDU, INC.	China
16	27	GOOGLE LLC	USA
17	25	TOSHIBA CORP.	Japan
18	22	HITACHI, LTD.	Japan
19	18	WISTRON CORPORATION	Taiwan
20	17	APPLE INC.	USA

Database: Derwent™ Innovation

3. Optimization of Delivery Routes

Table 7-19 illustrates top 20 applicants with the number of patent families and Table 7-20 illustrates top 21 applicants in terms of the number of patent families in the "Optimization of Delivery Routes".

The top applicants in terms of the number of IPF are STATE GRID CORP. OF CHINA (China) ranked first, BEIJING JINGDONG CENTURY TRADING CO., LTD. (China) ranked second, and SOUTHEAST UNIVERSITY (China) ranked third and Chinese applicants dominate the top ranks. 14 Chinese applicants, 3 US applicants, 2 Japanese applicants, 1 South Korean applicant, and no European applicants were ranked.

The top applicants in terms of the number of IPF are DIDI GLOBAL (China) ranked first, FORD MOTOR CO. (USA) ranked second, and COUPANG CORP. (South Korea) ranked third. 6 US applicants, 5 Japanese applicants, and 3 European, Chinese and South Korean applicants were ranked.

Table 7-19 Top 20 patent families applicants in "Optimization of Delivery Routes"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of Families	Name of Applicant	Nationality / Region
1	133	STATE GRID CORP. OF CHINA	China
2	129	BEIJING JINGDONG CENTURY TRADING CO., LTD.	China
3	71	SOUTHEAST UNIVERSITY	China
4	63	BEIJING SANKUAI ONLINE TECHNOLOGY CO LTD	China
5	59	ALIBABA GROUP HOLDING, LTD.	China
5	59	SF EXPRESS	China
7	55	COUPANG CORP.	Korea
8	54	DIDI GLOBAL	China
9	53	HITACHI, LTD.	Japan
9	53	UBER TECHNOLOGIES, INC.	USA
11	49	INTERNATIONAL BUSINESS MACHINES CORP.	USA
12	43	FORD MOTOR CO.	USA
13	41	ZHEJIANG UNIVERSITY OF TECHNOLOGY	China
14	36	BEIJING JIAOTONG UNIVERSITY	China
14	36	HEFEI UNIVERSITY OF TECHNOLOGY	China
16	33	TOYOTA MOTOR CORPORATION	Japan
17	31	SOUTHWEST JIAOTONG UNIVERSITY	China
18	30	CHINA SOUTHERN POWER GRID CO., LTD.	China
19	27	BEIHANG UNIVERSITY	China
19	27	GUANGDONG UNIVERSITY OF TECHNOLOGY	China

Database: Derwent™ Innovation

Table 7-20 Top 21 IPF applicants in "Optimization of Delivery Routes"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	41	DIDI GLOBAL	China
2	40	FORD MOTOR CO.	USA
3	36	COUPANG CORP.	Korea
4	32	HITACHI, LTD.	Japan
5	31	TOYOTA MOTOR CORPORATION	Japan
6	28	UBER TECHNOLOGIES, INC.	USA
7	22	SIEMENS A.G.	Germany
8	15	GENERAL ELECTRIC CO.	USA
9	14	ACCENTURE GLOBAL SERVICES GMBH	Ireland
9	14	GRABTAXI HOLDINGS PTE. LTD	Singapore
11	12	NEC CORP.	Japan
11	12	PANASONIC CORP.	Japan
11	12	ROBERT BOSCH GMBH	Germany
11	12	BEIJING JINGDONG CENTURY TRADING CO., LTD.	China
15	11	FUJITSU LTD.	Japan
15	11	GOOGLE LLC	USA
15	11	WALMART INC.	USA
18	10	INTERNATIONAL BUSINESS MACHINES CORP.	USA
18	10	HYUNDAI MOTOR CORP.	Korea
20	9	ALIBABA GROUP HOLDING, LTD.	China
20	9	KIA CORP.	Korea

Database: Derwent™ Innovation

4. Sharing of Goods

Table 7-21 illustrates top 20 applicants with the number of patent families and Table 7-22 illustrates top 20 applicants in terms of the number of IPF in the "Sharing of Goods".

The top applicants in terms of the number of patent families are STATE GRID CORP. OF CHINA (China) ranked first, INTERNATIONAL BUSINESS MACHINES CORP. (USA) ranked second, and META PLATFORMS, INC. (USA) ranked third. 7 US applicants, 6 Chinese applicants, 4 South Korean applicants, 3 Japanese applicants, and no European applicants were ranked.

The top applicants in terms of the number of IPF are SAMSUNG GROUP (South Korea) ranked first, TOYOTA MOTOR CORPORATION ranked second, and MICROSOFT CORP. (USA) ranked third. 8 US applicants, 6 South Korean applicants, 4 Japanese applicants, 3 Chinese applicants, and no European applicants were ranked.

Table 7-21 Top 20 patent families applicants in "Sharing of Goods"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of Families	Name of Applicant	Nationality / Region
1	842	STATE GRID CORP. OF CHINA	China
2	761	INTERNATIONAL BUSINESS MACHINES CORP.	USA
3	354	META PLATFORMS, INC.	USA
4	343	MICROSOFT CORP.	USA
5	314	GOOGLE LLC	USA
6	281	TOYOTA MOTOR CORPORATION	Japan
7	238	CHINA SOUTHERN POWER GRID CO., LTD.	China
8	235	SAMSUNG GROUP	Korea
9	162	ALIBABA GROUP HOLDING, LTD.	China
10	140	HONDA MOTOR CO., LTD.	Japan
11	134	EBAY INC.	USA
12	124	TENCENT HOLDINGS, LTD.	China
13	116	WALMART INC.	USA
14	112	LG CORPORATION	Korea
15	107	SK GROUP	Korea
16	97	KOREA ELECTRONICS & TELECOMMUNICATIONS RESEARCH INSTITUTE	Korea
17	94	AMAZON.COM, INC.	USA
18	88	SONY GROUP CORP.	Japan
19	86	DIDI GLOBAL	China
20	85	SOUTHEAST UNIVERSITY	China

Database: Derwent™ Innovation

Table 7-22 Top 20 IPF applicants in "Sharing of Goods"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	198	SAMSUNG GROUP	Korea
2	197	TOYOTA MOTOR CORPORATION	Japan
3	154	MICROSOFT CORP.	USA
4	151	GOOGLE LLC	USA
5	84	HONDA MOTOR CO., LTD.	Japan
6	81	ALIBABA GROUP HOLDING, LTD.	China
7	77	META PLATFORMS, INC.	USA
8	72	SONY GROUP CORP.	Japan
9	56	TENCENT HOLDINGS, LTD.	China
10	51	INTERNATIONAL BUSINESS MACHINES CORP.	USA
11	50	KOREA ELECTRONICS & TELECOMMUNICATIONS RESEARCH INSTITUTE	Korea
12	46	FORD MOTOR CO.	USA
13	41	HEWLETT PACKARD ENTERPRISE CO.	USA
13	41	ANT GROUP	China
13	41	HYUNDAI MOTOR CORP.	Korea
16	39	KIA CORP.	Korea
17	38	LG CORPORATION	Korea
18	34	PANASONIC CORP.	Japan
19	33	INTEL CORP.	USA
19	33	WALMART INC.	USA

Database: Derwent™ Innovation

5. Room Temperature Storage of Food

Table 7-23 illustrates top 20 applicants with the number of patent families and Table 7-24 illustrates top 20 applicants in terms of the number of patent families in the "Room Temperature Storage of Food".

The top applicants in terms of the number of IPF are JIANGNAN UNIVERSITY (China) ranked first, BRIGHT DAIRY & FOOD CO LTD. (China) ranked second, and CHINESE ACADEMY OF AGRICULTURAL SCIENCES (China) ranked third and Chinese applicants dominate the top ranks. 16 Chinese applicants, 2 Japanese and South Korean applicants, and no US or European applicants

were ranked.

The top applicants in terms of the number of IPF are NESTLE S.A. (Switzerland) ranked first, MEIJI HOLDINGS CO., LTD. ranked second, and Chr. CHR HANSEN HOLDING A/S (Denmark) ranked third. 10 European applicants, 5 Japanese applicants, 2 US and South Korean applicants, and 1 Chinese applicant were ranked.

Table 7-23 Top 20 patent families applicants in "Room Temperature Storage of Food"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of Families	Name of Applicant	Nationality / Region
1	672	JIANGNAN UNIVERSITY	China
2	505	BRIGHT DAIRY & FOOD CO., LTD.	China
3	375	CHINESE ACADEMY OF AGRICULTURAL SCIENCES	China
4	341	INNER MONGOLIA YILI INDUSTRIAL GROUP CO., LTD.	China
5	290	CHINA MENGNIU DAIRY COMPANY LIMITED.	China
6	228	TIANJIN UNIVERSITY OF SCIENCE AND TECHNOLOGY	China
7	207	KOREA INSTITUTE OF ORIENTAL MEDICINE	Korea
8	204	RURAL DEVELOPMENT ADMINISTRATION	Korea
9	193	MEIJI HOLDINGS CO.,LTD.	Japan
10	187	HUNAN AGRICULTURAL UNIVERSITY	China
11	174	ZHEJIANG UNIVERSITY	China
12	164	CHINA AGRICULTURAL UNIVERSITY	China
13	160	ASAHI GROUP HOLDINGS, LTD	Japan
14	158	NORTHEAST AGRICULTURAL UNIVERSITY	China
15	154	NANCHANG UNIVERSITY	China
16	149	COFCO CORP.	China
17	143	GUANGXI ZHUANG AUTONOMOUS REGION	China
18	141	SOUTH CHINA UNIVERSITY OF TECHNOLOGY	China
19	139	HARBIN WEIPING TECHNOLOGY DEVELOPMENT CO. LTD.	China
19	139	SOUTH CHINA AGRICULTURAL UNIVERSITY	China

Database: Derwent™ Innovation

Table 7-24 Top 20 IPF applicants in "Room Temperature Storage of Food"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	134	NESTLE S.A.	Switzerland
2	133	MEIJI HOLDINGS CO.,LTD.	Japan
3	128	CHR. HANSEN HOLDING A/S	Denmark
4	120	NUTRICIA NV	Netherlands
5	119	DUPONT DE NEMOURS, INC.	USA
6	116	KONINKLIJKE DSM N.V.	Netherlands
7	79	ASAHI GROUP HOLDINGS, LTD	Japan
8	62	SUNTORY HOLDINGS LTD.	Japan
9	59	CJ CHEILJEDANG CORP.	Korea
10	54	JIANGNAN UNIVERSITY	China
11	42	NOVO NORDISK AS	Denmark
12	40	ROQUETTE FRERES	France
13	34	UNILEVER N.V.	UK
14	33	AT&T INC.	USA
15	29	EVONIK IND A.G.	Germany
16	26	JENNEWEIN BIOTECHNOLOGIE GMBH	Germany
17	25	YAKULT HONSHA CO.,LTD.	Japan
17	25	AMOREPACIFIC CORP.	Korea
19	24	PURAC BIOCHEM B.V.	Netherlands
20	21	AJINOMOTO CO.,INC.	Japan

Database: Derwent™ Innovation

6. CO2 Emission Trading

Table 7-25 illustrates top 26 applicants with the number of patent families and Table 7-26 illustrates top 23 applicants in terms of the number of patent families in the "CO2 Emission Trading".

The top applicants in terms of the number of IPF are STATE GRID CORP. OF CHINA (China) ranked first, CHINA SOUTHERN POWER GRID CO., LTD. (China) ranked second, and SOUTHEAST UNIVERSITY (China) ranked third and Chinese applicants dominate the top ranks. 20 Chinese applicants, 3 South Korean applicants, 2 Japanese applicants, 1 European applicant, and no US applicants were ranked.

The top applicants in terms of the number of IPF are VECHAIN GLOBAL TECHNOLOGY S.AR.L (Romania) ranked first and 22 applicants ranked second. 8 US applicants, 5 European applicants, 4 Japanese and Chinese applicants, and 2 South Korean applicants were ranked.

Table 7-25 Top 26 patent families applicants in "CO2 Emission Trading"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of Families	Name of Applicant	Nationality / Region
1	51	STATE GRID CORP. OF CHINA	China
2	9	CHINA SOUTHERN POWER GRID CO., LTD.	China
3	6	SOUTHEAST UNIVERSITY	China
4	5	YOO JAE SOO (Individual)	Korea
5	4	NORTHEAST DIANLI UNIVERSITY	China
6	3	TOMOO YOSHIMASA (Individual)	Japan
6	3	KUNMING UNIVERSITY OF SCIENCE AND TECHNOLOGY	China
6	3	TSINGHUA UNIVERSITY	China
6	3	XI'AN JIAOTONG UNIVERSITY	China
6	3	YANSHAN UNIVERSITY	China
11	2	MATSUI MFG. CO., LTD.	Japan
11	2	VECHAIN GLOBAL TECHNOLOGY S.AR.L	Romania
11	2	ACADEMY OF MILITARY MEDICAL SCIENCES	China
11	2	CHINA HUBEI EMISSION EXCHANGE CO. LTD.	China
11	2	HEFEI UNIVERSITY OF TECHNOLOGY	China
11	2	HEPU ENERGY ENVIRONMENT TECHNOLOGY CO. LTD.	China
11	2	HEPU TECHNOLOGY DEVELOPMENT (BEIJING) CO. LTD.	China
11	2	HOHAI UNIVERSITY	China
11	2	HUADIAN ELECTRIC POWER RESEARCH INSTITUTE	China
11	2	HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY	China
11	2	JIANGXI SIJI ZHIYUN DIGITAL TECHNOLOGY CO. LTD.	China
11	2	SHANGHAI CHUANGNENG GUORUI NEW ENERGY TECHNOLOGY CO. LTD.	China
11	2	TIANJIN UNIVERSITY	China
11	2	ZHEJIANG ZHEDA ENERGY TECHNOLOGY CO. LTD.	China
11	2	KF E&E CO. LTD.	Korea
11	2	RT CO. LTD.	Korea

Database: Derwent™ Innovation

Table 7-26 Top 23 IPF applicants in "CO2 Emission Trading"
(Application to the country/region to be surveyed, the filing years (priority years): 2010 to 2021)

Order	Number of IPF	Name of Applicant	Nationality / Region
1	2	VECHAIN GLOBAL TECHNOLOGY S.AR.L	Romania
2	1	MATSUI MFG. CO., LTD.	Japan
2	1	SHARP CORP.	Japan
2	1	THE JAPAN RESEARCH INSTITUTE, LIMITED	Japan
2	1	WEST HOLDINGS CORPORATION	Japan
2	1	BARTON BENNY (Individual)	USA
2	1	DEARBORN FINANCIAL INC.	USA
2	1	MOLEX INCORPORATED	USA
2	1	OPEN ACCESS TECHNOLOGY INTERNATIONAL, INC.	USA
2	1	REDFORD RYAN (Individual)	USA
2	1	ROCKWELL AUTOMATION, INC.	USA
2	1	SOLOWAY NORMAN P. (Individual)	USA
2	1	VAUGHN-FLAM ERIC (Individual)	USA
2	1	BUILDING RESEARCH ESTABLISHMENT LIMITED	UK
2	1	FEIERSTEIN MITCHELL BRUCE (Individual)	UK
2	1	NOKIA CORPORATION	Finland
2	1	STUCKMANN INGO (Individual)	Germany
2	1	HEPU TECHNOLOGY DEVELOPMENT (BEIJING) CO. LTD.	China
2	1	LEI JU-HUA (Individual)	China
2	1	LEI XUE-JUN (Individual)	China
2	1	ZHU JING (Individual)	China
2	1	CHONBUK NATIONAL UNIVERSITY	Korea
2	1	TNT RESEARCH CO., LTD.	Korea

Database: Derwent™ Innovation

Section 8 Summary

"Regarding the patent application trend of 8 featured technologies related to climate change, which are not included in GXTI, a survey was conducted on the number of patent families, the number of IPFs, etc. in 14 countries/regions. In addition, the top 20 applicants with the most number of patent families and IPF were extracted. Among the featured technologies, "Photonics Convergence Technology," "Power Semiconductor," and "Energy Saving for Entire Facility" where surveyed by limiting to technologies related to "Data Center Energy Saving."

In terms of the total number of patent families for all survey years, "Room Temperature Storage of Food" was the largest, followed by "Sharing of Goods," "Photonics Convergence Technology," "Optimization of Delivery Routes," "Perovskite Solar Cell," "Energy Saving for Entire Facility," "Power Semiconductor," and "CO2 Emission Trading" and there is a big difference in the number of families depending on the technology. It should be noted that the number of patent families for "Photonics Convergence Technology," "Power Semiconductor," and "Energy Saving for Entire Facility" is limited to technologies related to "Data Center Energy Saving." Considering the annual trends, the number of families of "Photonics Convergence Technology" is gradually decreasing and other technologies are on the rise. However, "Room Temperature Storage of Food" peaked in the filing year (priority year) of 2016, and "Energy Saving for Entire Facility" peaked in the filing year (priority year) of 2017 and have turned to a downward trend.

In terms of the total number of IPF for all surveyed years, "sharing of Goods" was the largest, followed by "Room Temperature Storage of Food," "Photonics Convergence Technology," "Energy Saving for Entire Facility," "Optimization of Delivery Routes," "Perovskite Solar Cell," "Power Semiconductor," and "CO2 Emission Trading." In terms of the number of patent families, there was an order of magnitude difference in the number of cases depending on the technology.

However, in IPF, although the number of cases of "Power Semiconductor" and in particular, "CO2 Emission Trading" is extremely small, there is no significant difference in other technologies. Considering the annual trends, the number of IPF for "Photonics Convergence Technology" and "Energy Saving for Entire Facility" is gradually decreasing, but other technologies are on the rise. The patent family of "Room Temperature Storage of Food" peaked in the filing year (priority year) of 2016, and has turned to a downward trend. However, no such trend is seen in IPF, and the trend is gradual increase throughout the survey period.

As for the growth rate of patent families, the growth rate of the patent family of "Perovskite Solar Cell" is high, and in particular, the patent family of Chinese applicants is increasing at an annual rate of 336.3%. In addition, the growth rate for "Optimization of Delivery Routes" is also high, with the rate of increase for South Korean applicants particularly high at 338.8% and for Chinese applicants at 252.2%. Among Japanese applicants, "Perovskite Solar Cell" had the highest growth rate of 120.0%, followed by "Optimization of Delivery Routes," "Sharing of Goods," and "Room Temperature Storage of Food." "Energy Saving for Entire Facility" and "Photonics Convergence Technology" had negative values (decrease).

Applicants with a revealed technology advantage index (RTA Index) of the patent family of exceeding 200% are Australian and the UK applicants for "Perovskite Solar Cell," Japanese and Taiwanese applicants for "Photonics Convergence Technology," US applicants for "Power Semiconductor," Taiwanese and Indian applicants for "Energy Saving for Entire Facility," ASEAN, Australian and Indian applicants for "Optimization of Delivery Routes," Indian, Australian, and South Korean applicants for "Sharing of Goods," ASEAN applicants for "Room Temperature Storage of Food, " and Indian applicants for "CO2 Emission Trading." The RTA index of Japanese applicants is less than 100% except for "Photonics Convergence Technology" and "Perovskite Solar Cell." In particular, the RTA index for "Power Semiconductor" is low at 33.5%.

In general, the number of IPFs with 28 or more examiner citations (Table 7-1) is large for US applicants. US applicants have the largest number in all technologies other than “Perovskite Solar Cells” and “Optoelectronic Fusion Technology”, Japanese applicants have the largest number in “Optoelectronic Fusion Technology”, and European applicants have the largest number in “Perovskite Solar Cells”, which suggests that they may hold important IPFs often cited by an examiner.

In the top ranking of the number of patent families, Chinese applicants ranked the most in "Perovskite Solar Cell" "Optimization of Delivery Routes," "Room Temperature Storage of Food," and "CO2 Emission Trading" and Japanese applicants ranked most in "Photonics Convergence Technology" and "Power Semiconductor," while U.S. applicants ranked most in "Energy Saving for Entire Facility" and "Sharing of Goods." In terms of the number of rankings of Japanese applicants, 15 Japanese applicants were ranked in "Photonics Convergence Technology," followed 10 Japanese applicants were ranked in "Power Semiconductor," 4 Japanese applicants were ranked in "Energy Saving for Entire Facility," 3 Japanese applicants were ranked in "Sharing of Goods," and 2 Japanese applicants were ranked in "Perovskite Solar Cell," "Optimization of Delivery Routes," "Room Temperature Storage of Food," and "CO2 Emission Trading.

Chapter 8 Trend Surveys of Market/Policy and R&D

In this survey, we conducted a survey of the Green Transformation (Green Transformation, and carbon-neutral related) market trends, including major countries/regions, national/regional policy trends, and research and development trends, in light of the new Technologies Inventory (GXTI).

Section 1 Featured Technologies

1. New catalyst development technology

Kyoto University has developed a new catalyst using an 8-element precious metal alloy, and has confirmed that the activity is more than 10 times higher than that of conventional platinum catalysts. On the other hand, Tokyo Institute of Technology has developed a new catalyst that does not use precious metals and confirmed sufficient activity and durability. It is considered that Japanese catalyst technology will contribute to chemical reaction processes around the world.

2. Technologies related to next-generation floating offshore wind power generation facilities

In Japan, core parts that are suitable for severe weather and sea conditions such as typhoons in Asian waters and have good maintainability have been developed. Daido Metal Co., Ltd. is developing sliding bearings for wind turbine main shafts that can be disassembled into individual parts[9]. MODEC, Inc. is working on the development of a floating offshore wind power generation facility that has excellent stability and can be installed in a small mooring installation area, which is about 1/1,000 of the area below the sea surface compared to other mooring methods[10].

3. Solar power generation that can be deployed in sheets

Perovskite solar cells are manufactured by coating and printing processes, exceed 25% conversion efficiency, are about one-tenth the weight of silicon solar cells, and are sheet-like, making them resistant to bending strain and easy to post-process. They are expected to contribute to countries/regions with small land areas that want to utilize the roofs and walls of buildings.

4. Bioplastic with fast biodegradation rate

In Japan, marine-degradable plastics with a switching function such that they do not decompose when exposed to light during normal use, but are discarded and sink to the seabed, and decompose when no longer exposed to light have been developed[11].

Osaka University has established a development platform with more than 20 participating companies to develop and commercialize highly biodegradable materials from inexpensive starch and cellulose[12].

[9] https://www.daidometal.com/jp/wind-power/
[10] https://www.modec.com/jp/news/2022/20220121_pr_TLP_OffshoreWindTurbines.html
[11] https://www.nedo.go.jp/content/100943647.pdf
[12] https://www.c.u-tokyo.ac.jp/info/news/topics/20220712140000.html

5. Technologies related to marine transport of hydrogen

In Japan, the world's first liquefied hydrogen carrier is being built. Since the liquefying temperature of hydrogen is minus 253 degrees, and the insulation is better than that of LNG carriers, it is necessary to have a design that can deal with deformation due to the temperature difference between the inside and outside of the tank[13]. The world's first ship-to-land transfer loading arm system for liquefied hydrogen has also been developed for loading and unloading of liquefied hydrogen from a hydrogen carrier. Safety has also been improved by introducing a hose coupling swivel joint[14] that has a rotation mechanism with a special high insulation structure. A method of converting gaseous hydrogen into a liquid called methylcyclohexane (MCH) and transporting the converted liquid by compressing its volume at normal temperature and pressure is also being investigated[15].

6. Artificial photosynthesis

In Japan, many artificial photosynthesis technologies have been developed. A photocatalytic panel reaction system that connects a water splitting panel reactor and a hydrogen/oxygen gas separation module has been developed and demonstrated[16]. A large CO2 electrolysis cell stack module has been developed to electrolyze CO2 and water to produce carbon monoxide and oxygen[17].

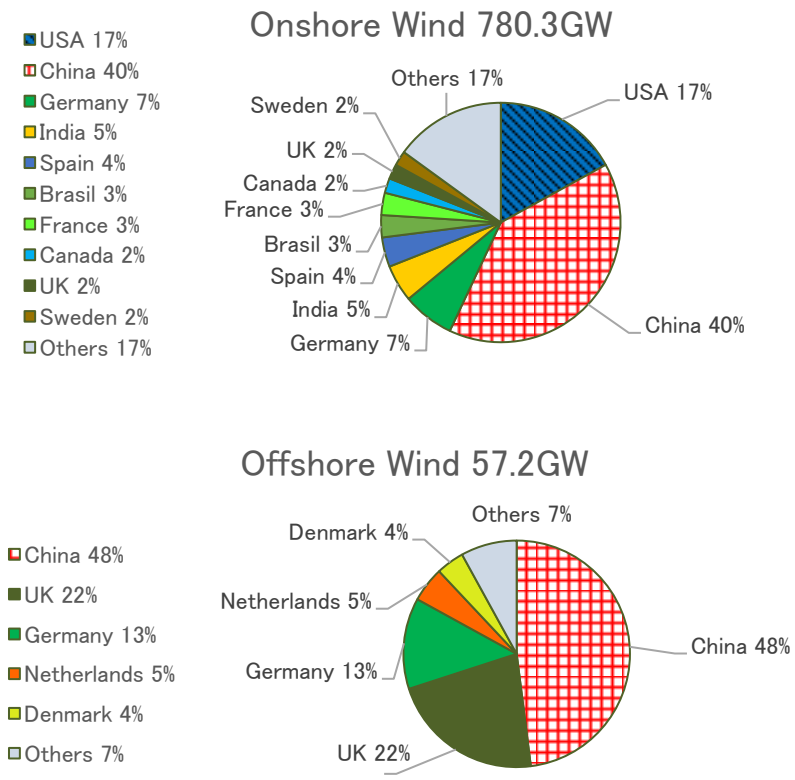
Section 2 Trends by Technology category

1. gxA: Energy Supply

China accounts for more than 40% of both onshore and offshore installed wind power generation facility capacity. Countries/regions with small land areas such as Japan, South Korea, Taiwan, and UK and countries/regions with a strong nature conservation movement such as Germany and Australia have a strong tendency to seek suitable offshore sites for wind power generation, and have high expectations for offshore wind power generation.

[13] https://biznova.nikkan.co.jp/article/feature/00000233
[14] AIST: Developed the world's first "ship-to-shore transfer loading arm for liquefied hydrogen"
[15] https://xtech.nikkei.com/atcl/nxt/column/18/01513/00003/
[16] https://www.nedo.go.jp/news/press/AA5_101473.html
[17] https://xtech.nikkei.com/atcl/nxt/column/18/02227/102000012/

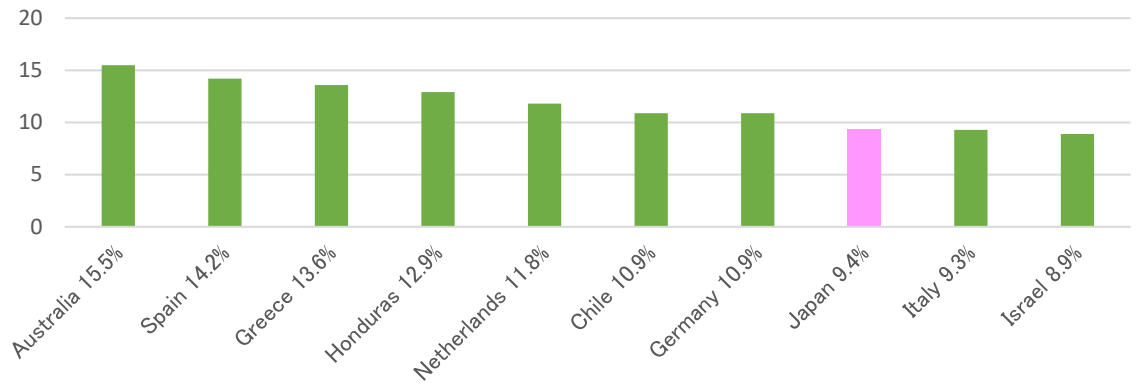
Fig. 8-1　In 2021, Global installed wind capacity, Onshore and Offshore



The chart is Created based on “GWEC　Global Wind Report 2022[18] “

Solar photovoltaic power generation is considered to continue to have high potential in the USA, Australia, etc., which have vast wastelands and dry areas that are unsuitable for farmland, housing, and commercial and industrial facilities.

Fig. 8-2　Top countries/regions for solar photovoltaic power generation in power demand in 2021



The table is created based on “IEA　Snapshot of Global PV Markets 2022[19]"

[18] GWEC　Global Wind Report 2022
https://gwec.net/wp-content/uploads/2022/03/GWEC-GLOBAL-WIND-REPORT-2022.pdf
[19] IEA　Snapshot of Global PV Markets 2022

As for hydrogen energy (hydrogen production, hydrogen supply), six countries/regions: Japan, the EU, China, South Korea, Canada, and Australia, are envisioning a comprehensive strategy for building a hydrogen society and fostering the hydrogen industry.

2. gxB: Energy Saving, Electrification, Demand-Supply Flexibility

Three countries/regions Japan, South Korea, and Germany have a policy of increasing the ratio of net zero energy building (ZEB) construction by improving insulation performance and utilizing solar panels.

Regarding electromobilities, while common EV promotion policies are being demonstrated, the USA, China, and South Korea stand out for having set higher goals.

USA: 50% of all new passenger cars and light trucks will be zero-emission vehicles (including FCVs) by 2030.

China: EVs already exceeded 5 million units by 2020, and more than 20% of production/sales will be new energy vehicles by 2025.

South Korea: EVs and hydrogen-powered vehicles will account for one-third of all new car sales in 2030 and 3 million EVs and 850,000 hydrogen-powered vehicles are expected to spread by 2030[20].

3. gxC: Batteries, Energy Storage

Production capacity (GWh/year) of China is particularly large compared to major countries/regions.

Table 8-1 In 2020, Storage battery production capacity

	Japan	Europe	USA	China	South Korea
Production capacity GWh/year	8	55	49	148	15

The table is created based on METI's report

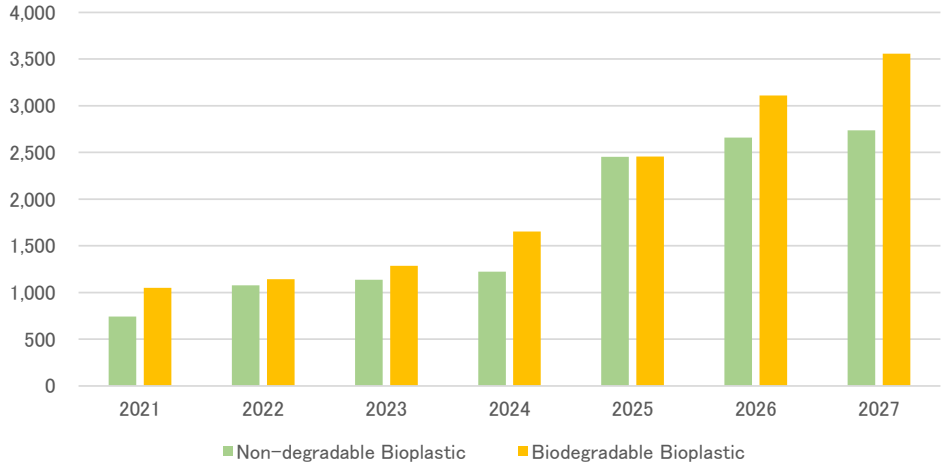
https://www.researchgate.net/publication/360562245_Snapshot_of_Global_PV_Markets_2022_Task_1_Strategic_PV_Analysis_and_Outreach_PVPS

[20] IEA Global EV Outlook 2022
https://iea.blob.core.windows.net/assets/ad8fb04c-4f75-42fc-973a-6e54c8a4449a/GlobalElectricVehicleOutlook2022.pdf

4. gxD: CO2 Reduction in Non-Energy Sector

The global bioplastic production capacity is approximately 2.21 million tons. Production capacity will continue to expand, and is expected to more than double to approximately 4.9 million tons by 2025.

Fig. 8-3 Bioplastic production prediction 2021-2027



The table is created based on "European Bioplastics UPDATE 2022[21]"

Regarding the iron-making process, the introduction of the hydrogen direct reduction method is a common goal. With the European Steel Federation (EUROFER), the EU has already set a goal of practical implementation of hydrogen direct reduction and electric furnace steelmaking by 2050, and in Germany, ArcelorMittal will start a 100,000-ton/year demonstration reactor in 2023 using hydrogen direct reduction and electric furnace iron-making.

[21] European Bioplastics UPDATE 2022
https://docs.european-bioplastics.org/publications/market_data/2022/Report_Bioplastics_Market_Data_2022_short_version.pdf

5. gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas

The total CO2 storage facility capacity of CO2 capture and storage (CCS) facilities including facilities currently under construction or planned will reach 240 million tons per year[22].

Table 8-2 Number of CCS facilities and annual storage capacity

	In operation	Under construction	Main consideration	Initial consideration	Stop	total
Main consideration	30	11	78	75	2	196
Annual storage capacity (unit: million tons)	42.5	9.6	97.6	91.8	2.3	243.9

The table is created based on "Global CCS Institute(GCCSI) "GLOBAL STATUS OF CCS 2022"

6. gxE02: Measures Against Non-CO2 Greenhouse Gases

Australia is promoting the development of feed supplements that use specific seaweed to reduce methane emissions by an average of 75% and research into genetic traits that suppress methane production.

7. CCU using CO2

In countries/regions that implement CCU as policy, the technology to synthesize CO2 and hydrogen to produce methane is becoming mainstream. The EU and China have placed importance on building CCU bases and developing green hydrogen raw material gas transportation systems based on the current technologies.

In Japan, CO2 filters are being developed with the aim of streamlining a series of processes and new catalysts are being developed with the aim of improving reaction efficiency and reducing costs. In addition, research and development is also progressing on the synthesis of naphtha by artificial photosynthesis, the synthesis of aviation fuel, and the synthesis of plastic materials[23].

[22] Global CCS Institute(GCCSI) GLOBAL STATUS OF CCS 2022 https://status22.globalccsinstitute.com/wp-content/uploads/2022/12/Global-Status-of-CCS-2022_Download_1222.pdf

[23] https://green-innovation.nedo.go.jp/project/development-plastic-raw-material-manufacturing/

8. Notable technologies outside GXTI

Photonics convergence technology is positioned as an important technology for reducing energy consumption in data centers[24]. The aim is to accelerate specific arithmetic processing by entrusting light-friendly processing to optical circuits[25].

Regarding the cooling of data centers, attention is being paid to the movement to replace some electrical signals with optical signals and change the mechanism of heat generation, attempt to replace high-density magnetic tape by reviewing power consumption of HDD that requires constant power supply, server immersion cooling, or the like[26].

Regarding the optimization of delivery routes, new attempts are being made, such as types (Loogia, GoNOW, etc.) that dynamically correspond to delivery order and route.

Regarding the sharing of goods, IoT, AI, and blockchain technology are utilized for the approach from de-carbonization of physical transportation and the process from information matching to payment and various business models are being considered to contribute to the sharing economy in a comprehensive manner.

Regarding the room temperature storage of foods, aiming to reduce food loss, container packaging technologies and food filling technologies are becoming more sophisticated, such as "Long-life milk" that can be stored for a long time at room temperature, "KATAMENO OISHII TOFU (Firm and delicious tofu)" that can be stored at room temperature for a long time, or "AJIMAIL" that allows customers to eat fish as it is without cooking.

Regarding the CO2 emission trading, efforts such as demonstration examinations of the domestic emissions trading market in which more than 40 companies and local governments nationwide including IHI Corporation, Tohoku Electric Power Co., Inc., and OSAKA GAS CO., LTD participate, CO2/greenhouse gas emissions automatic calculation/output software, and environmental data visualization/output systems that collect and calculate CO2 emissions and other environmental data from multiple corporate bases in Japan and overseas, output data, and create reports are being carried out.

[24]https://www.meti.go.jp/shingikai/sankoshin/green_innovation/industrial_restructuring/pdf/004_03_00.pdf
[25] https://journal.ntt.co.jp/article/5995
[26] https://japan.zdnet.com/article/35169181/

Section 3 Trends by Country/Region

1. Japan

In "the Basic Policy for the realization of Green Transformation (GX)" [27], approved by the Japanese Cabinet in February 2023, it was stated that "in order to realize Green Transformation (GX) investment exceeding 15 trillion JPY by public and private sectors, the government will execute bold pre-investment support on the scale of 2 trillion JPY."

In terms of technological trends, we are working on the design, manufacture, and operation technology development of floating offshore wind power generation facilities that can adapt to the weather peculiar to the Asian region and achieve power generation at a low cost that matches the market.

Japan is leading the world in hydrogen transportation technology with the world's first construction of a liquefied hydrogen carrier, and is ahead of other countries/regions with the world's highest combustion efficiency technology behind hydrogen power generation. It is promoting the development and introduction of hydrogen reduction ironmaking technology and is promoting development such as heat compensation in the furnace necessary for iron ore reduction, ensuring ventilation as the amount of coal used decreases, and upgrading electric furnaces essential for melting reduced iron in addition to improving combustion efficiency. Regarding the capture and utilization of CO2, there are advanced initiatives such as artificial photosynthesis using highly efficient photocatalysts and production of aviation fuel by synthesizing CO2 and hydrogen with new catalysts.

2. USA

The “Inflation Control Law” investing 369 billion dollars in climate change measures was established in August 2022, and by 2030 it will be possible to install 95 million solar panels and 120,000 wind turbines.

Technology trends show that utility-scale wind power generation plants in the USA nearly doubled in 2020 compared to 2019, and cumulative installed capacity has tripled over the past decade[28]. As a unique initiative of New York City, there is a plan to make offshore wind power generation the maximum proportion of the city’s power supply by 2030[29]. Regarding hydrogen energy, research and development and demonstration of hydrogen production with carbon management, hydrogen storage, reversible SOFC, pure hydrogen combustion turbines, etc. are in

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[27] https://www.cas.go.jp/jp/seisaku/gx_jikkou_kaigi/pdf/kihon.pdf

[28] Forbes, Renewable Energy Prices Hit Record Lows: How Can Utilities Benefit From Unstoppable Solar And Wind?, 2020/1/21
https://www.forbes.com/sites/energyinnovation/2020/01/21/renewable-energy-prices-hit-record-lows-how-can-utilities-benefit-from-unstoppable-solar-and-wind

[29] The Official Website of the City of New York, Mayor de Blasio Signs Landmark Bill to Ban Combustion of Fossil Fuels in New Buildings, 2021/12/22
https://www.nyc.gov/office-of-the-mayor/news/852-21/mayor-de-blasio-signs-landmark-bill-ban-combustion-fossil-fuels-new-buildings

progress[30]. In addition, as of 2020, the number of battery energy storage facilities in the USA has increased by 200% compared to 2019, and the future focus will be on the development and introduction of fuel cells for heavy-duty vehicles and their domestic manufacturing equipment[31] Regarding the biomass fuel, technological development is proceeding from two directions, a "biochemical approach" and a "thermochemical approach.[32]"

3. China

In 2021, the State Council of the People's Republic of China has proposed a comprehensive "10 actions to peak out CO2 emissions[33]." Furthermore, in 2022, the National Development and Reform Commission announced plans to position hydrogen energy as a strategic emerging industry[34].

For technology trends, the main technology for hydrogen production in 2030 is expected to be electrolysis using the conventional chlor-alkali method. Hydrogen transport will connect hydrogen production bases and coastal cities and industrial areas that consume hydrogen through dedicated hydrogen pipelines. Regarding the storage batteries, various technologies[35,36] such as sodium-ion batteries, redox flow batteries, high-performance lead-carbon batteries, and the like in addition to the lithium batteries (Li-B) are being developed and energy storage technology is also being developed under the policy of diversification of energy storage technology[37].

The production capacity of biodegradable plastics is 7,469,000 tons, including plants that are currently planned[38]. For the CO2 recovery and utilization, about 150,000 tons of CO2 is already used annually for the synthesis of chemical substances and materials. By 2050, there are plans to build an industrial CCUS hub and pipelines with a total CO2 transport capacity of 1 billion tons/year and a total length of more than 20,000 km nationwide. For CO2 absorption and fixation, planting of trees has been going on for decades and the forest coverage has continuously risen from 12% in 1979 to 22.96% in 2019[39].

4. EU

In 2020, the EU Hydrogen Strategy was launched to flexibly exchange energy reserves by generating hydrogen with offshore wind power and generating methane through the hydrogen,

[30] Office of Fossil Energy and Carbon Management, Strategic Vision, Outlining Priorities That Will Support The U.S. Government In Achieving Net-Zero Emissions By 2050, 2022/4/5 https://www.energy.gov/fecm/articles/fecm-releases-strategic-vision-outlining-priorities-will-support-us-government

[31] Center for Climate and Energy Solutions (C2ES), Federal Vehicle Standards, https://www.c2es.org/content/regulating-transportation-sector-carbon-emissions/

[32] Innovation for Cool Earth Forum (ICEF), Biomass Carbon Removal and Storage (BiCRS) Roadmap, Jan. 2021 https://www.icef.go.jp/pdf/summary/roadmap/icef2020_roadmap.pdf

[33] http://j.people.com.cn/n3/2021/1109/c94476-9917224.html

[34] https://www.ndrc.gov.cn/xxgk/zcfb/ghwb/202203/t20220323_1320038.html?code=&state=123

[35] https://www.jri.co.jp/page.jsp?id=102484

[36] https://www.nedo.go.jp/content/100938545.pdf

[37] https://spap.jst.go.jp/investigation/downloads/2021_rr_06.pdf

[38] https://www.takaroku.jp/h62gxu4u/wp-content/uploads/2022/01/202201_プラスチックエージ.pdf

[39] http://j.people.com.cn/n3/2019/0528/c94475-9582270.html

making it possible to convert electricity and methane bi-directionally[40].

Technological trends are focusing on offshore wind power generation and there are plans to increase the amount of offshore wind power generation from 65 GW to 85 GW by 2030. Solar photovoltaic power generation was already 160 GW in 2020, and the aim is to install 600 GW of solar power generation panels by 2030. For hydrogen energy, "IPCEI Hy2Tech," a group of value chain R&D and commercialization projects jointly applied for by 15 member countries/regions, is being developed. For biomethane, there are issues such as advanced pretreatment of raw materials used in anaerobic digestion and practical application of the hydrothermal gasification process[41].In the industrial field, the European Iron and Steel Federation (EUROFER) is promoting the practical application of diversified advanced ironmaking process technology and hydrogen reduction DRI-based electric furnace method (gas reduction DRI equipment)[42]. For the CO2 storage, about 2.5 million tons of CO2 are already collected annually.

Section 4 Summary

1. Policy trends

Policy trends are roughly divided into four.

(1) Group with CCS suitable sites and advantages in promoting carbon neutrality

The USA has a track record of combining and diverting its vast national land, underground resources, and domestic shale oil and gas fields for CCS, and this will continue to be recognized as an advantage in the future.

The EU needs time to shift from natural gas to hydrogen and China needs time to shift from coal to hydrogen. On the other hand, Australia is blessed with sites suitable for CCS, as well as solar photovoltaic power generation and wind power generation, and has the potential to become a green energy powerhouse. Canada is also blessed with abundant hydro-power generation and is well positioned to grow wind, hydro and biomass.

(2) Group that compensates for the disadvantages in promoting carbon neutrality with policies and technological capabilities

Germany, the UK, Japan, South Korea, and Taiwan are all investing comprehensively in policy and technology to expand renewable energy. CCS has small national groups in countries/regions like Germany, which has a deep-rooted opposition movement, and the UK and Japan, which have no choice but to seek the possibility of CO2 storage on the seabed.

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[40] International Energy Agency (IEA), Wind Electricity, Sept. 2022
https://www.iea.org/reports/wind-electricity

[41] European Biogas Association, Commission announces groundbreaking biomethane target: 'REPowerEU to cut dependence on Russian gas,' 2022/3/8
https://www.europeanbiogas.eu/commission-announces-groundbreaking-biomethane-target-repowereu-to-cut-dependence-on-russian-gas/

[42] EUROOFER, Successful implementation of bold new 2030 climate target urgently needs tangible framework, 2020/9/17
https://www.eurofer.eu/press-releases/successful-implementation-of-bold-new-2030-climate-target-urgently-needs-tangible-framework/

(3) Groups relying on international support

India and major ASEAN countries/regions are also expected to have high potential for renewable energy development and CCS development and expected to advance their development with international support through the introduction of funds from abroad and joint projects with overseas companies. In addition, the countries/regions present unique policies that do not fall under any of the above categories.

(4) Other countries/regions not covered by any of the above

Since Singapore is a small city-state with a land area of about 720 km2, it is difficult for them to secure land. Singapore is considering transporting CO2 to appropriate reservoir injection in other countries/regions and has formed a CCUS consortium[43].

[43] https://www.jetro.go.jp/biznews/2022/09/5959c1e4b4fec65c.html

2. Technological trends

Trends are roughly divided into four

(1) Technological trend 1

Currently in the stage of "Introduction of existing technologies and products"

Table 8-3 Technological trend 1. Introduction of existing technologies and products

Category	Product, system	Conventional technology, existing technology
gxA	Solar photovoltaic power generation	Silicon single crystal/amorphous silicon thin film solar cell
	Wind power generation	A land-mounted wind power generator that transmits the rotational energy of a rotor that combines three blades to a generator
	Hydrogen production	Electrolyzer to electrolyze water to obtain hydrogen (EU, China)
	Biofuel production	Methyl esterification treatment or hydrogenation treatment of waste cooking oil Fermenting grains to get ethanol
gxB	Mobility	Electric powered vehicles (EV), engine-motor hybrid vehicles (HV), and rechargeable hybrid vehicles (FCV)
gxC	Secondary battery	Lithium-ion battery (Li-B)
gxD	Bio plastic	Produced by fermentation and chemical synthesis using plant-based organic matter as raw materials Non-degradable (Bio PA, PE, PP, PET, PC, etc.) Biodegradable (PLA, PHA, PBS, PBAT, etc.)
gxE	CO2 storage CCS	Injecting CO2 into geological formations suitable for storage (U.S. shale oil/gas fields combined, diverted)
	Forest expansion	Expanding forests by planting trees (USA, China, Vietnam, etc.)

The table is created based on information collected through this survey

(2) Technological trend 2

「Currently in the stage of "Introduction and planning of new technologies and products for specific circumstances"

Table 8-4　Technological trend 2. Introduction and planning of new technologies and products for specific circumstances

Category	Product, system	Introduction of new technologies and products for specific circumstances
gxA	Solar Photovoltaic Power Generation	Solar panels floating on the surface of inland water such as lakes (Taiwan, Japan, etc.) There is a demand for lightweight solar cell sheets that can be installed on the walls of buildings (Singapore).　A perovskite solar cell technology of Japan seems to be the most promising candidate for lightweight sheet solar photovoltaic power generation systems.
	Wind power generation	Design and construction technology for floating offshore wind power generation Design and construction technology for bottom-mounted offshore wind power generation facilities with a base on the seabed (EU, UK, Japan, Taiwan, Philippines, etc.)
	Small modular reactor (SMR)	Hydrogen production facilities are installed in the SMR, and there are plans for the design and construction technology of two methods, electrolysis and thermal decomposition using the heat of the nuclear reactor (USA, France, South Korea, Japan, etc.)
gxB	Building	Efficient cooling of tropical region data centers is required, obtaining architectural design that utilizes the natural environment and cools autonomously (Singapore).
	Mobility	Hydrogen fuel cell vehicles (EU) are planned for long-distance transportation and high-power construction machinery, and hydrogen combustion and ammonia combustion are planned for ships (EU, Japan)
		There are measures and plans for electric vertical take-off and landing (VTOL) as a small flying car (UK, USA, Japan, etc.)
gxC	Secondary battery	Research and development is progressing on an all-solid-state lithium-ion battery with high Li-B energy density and high safety (Japan)
		Secondary batteries that do not use rare and expensive lithium, sodium ion batteries (China, Japan, etc.), zinc bromide batteries (Australia), redox flow stationary large storage batteries (China)

		Research and development is progressing on secondary batteries, lithium-sulfur batteries with large capacity that are cheaper than Li-B (Japan)
gxD	Bio plastic	Development of advanced pretreatment technology for raw materials used in anaerobic digestion and technology for practical use of hydrothermal gasification processes (EU)
gxE	CO2 storage CCS	Studies and plans to inject and store CO2 on the seabed (UK, Japan, etc.)
	CO2 absorption CCS	Absorption of CO2 in cement (EU, Germany, France, Japan, etc.)
	CO2 long-term fixation	Examination of using wood in building construction (Japan)

The table is created based on information collected through this survey

(3) Technological trend 3

Currently in the stage of "Technology in research and development"

Table 8-5 Technological trends 3. Technologies under the research and development

Category	Products, systems	Technologies under research and development	
gxA	Solar Photovoltaic Power Generation	Solar Photovoltaic Power Generation is generated in outer space, and the power is converted to radio waves such as microwaves, and sent to the ground. Space Solar Power Systems SSPS (Japan)	
	Nuclear fusion	Deuterium/tritium fusion and hydrogen/boron fusion, magnetic confinement method, laser fusion (USA, EU, China, Japan, etc.)	
gxB	Mobility	There are plans for electric vertical take-off and landing (VTOL) as a small flying car (UK, France, Germany, USA, China, Japan, etc.)	
gxC	Secondary battery	Zinc-air battery, redox flow stationary large storage battery (Japan)	
gxD	Bio plastic	None in particular	
gxE	CO2 storage CCS	Studies and plans to inject CO2 into the seabed (UK, Japan, etc.)	
	CO2 long-term fixation	Examination of laminated timber and architectural design using laminated timber for building construction (Japan)	
	Using a lead complex as a photocatalyst	Reducing CO2 and combine with hydrogen	Using Photocatalyst for hydrogen production. Synthesize plastic material naphtha (Japan)
		Using a lead complex as a photocatalyst	Photocatalyst of coordination polymer structure with photoconductivity (Tokyo Institute of Technology)
		Synthetic method using biocatalyst	Biomass-derived pyruvic acid is combined with CO2 to synthesize fumaric acid with an enzyme (Osaka Metropolitan University)
		CO2 absorption and power generation using algae	A combination of a panel filled with water and algae and a thermoelectric generator (Greenfluidics)
		Synthesis and power generation by algae and enzymes	Power Generation and Synthesis with Spirulina Fixed Electrode and Enzyme Fixed Electrode (Osaka City University)
		Reduction of CO2 by plasma and new alloy catalyst	Non-equilibrium plasma technology (Tokyo Institute of Technology)

The table is created based on information collected through this survey

(4) Technological trend 4

Currently in the stage of "Examination of climate change countermeasure technology from a different perspective"

Table 8-6 Technological trend 4, Examination of climate change countermeasure technology from a different perspective

Category	Product and System	Examination of climate change countermeasure technology from a different perspective
Outside GXTI	Marine city/Offshore city	Busan, South Korea, UN-Habitat, OCEANIX USA INC. will start the offshore city project from 2023.
		Shimizu Corporation's Green Float, a floating structure, is under consideration between the Singapore government and Shimizu Corporation.

The table is created based on the information below [44] [45] [46]

[44] https://www.busan.go.kr/jpn/bsnews01/1512896

[45] https://unhabitat.org/news/18-nov-2021/busan-un-habitat-and-oceanix-set-to-build-the-worlds-first-sustainable-floating

[46] Singapore government publicity website "Could this be the trump card for solving the world's environmental problems?" 2022/09/30 https://www.edb.gov.sg/ja/newsroom/news-library/singapore-shimizu-corporation-future-city-concept-greenfloat.html

Chapter 9 Comprehensive Analysis

This chapter provides comprehensive analysis based on the survey results in Chapters 2 to 8. Section 1 presents analysis results on the strengths of applicants in each country/region based on the trend of patent applications shown in Chapters 2 to 7. Section 2 presents important points etc. for future technology development based on the results in Section 1 and the trend of market/policy in Chapter 8.

Section 1 Analysis based on Trend of Patent Applications

This section presents the results of comparing overall trend of patent applications (including non-GX technology) shown in Chapter 2 and trend of overall GX technologies shown in Chapter 3, in "1. Overall Trend of Patent Applications and Trend of the Applications in all GXTI Categories". And furthermore, it presents the changes in the number of applications and the trend of each country/region by technology category, based on the results in Chapter 4 to 7, in "2. Trend of GXTI Large (Level 1) Categories", "3. Trend of GXTI medium (Level 2) and small (Level 3) categories", and "4. Trend of Notable Technologies outside GXTI".

1. Overall Trend of Patent Applications and Trend of the Applications in all GXTI Categories

The trend of the number of patent families in 2010-2019 in the countries/regions surveyed, with regard to the overall trend of patent applications by Japanese, US, European, Chinese, and South Korean applicants, shows a sharp increase in Chinese applicants, staying flats in US, European, and South Korean applicants, as well as a gradual decrease in Japanese applicants (Table 2-1). Looking at number of patent families in 2019 alone, Chinese applicants have a overwhelmingly larger number than other country/region applicants with about 1.2 million, following US and Japanese applicants with about 200,000 each, South Korean applicants with about 150,000, and European applicants with about 100,000. On the other hand, looking at number of IPFs during the same period, Chinese applicants increase it rapidly again, but US, European, Japanese, and South Korean applicants also increase it (Table 2-3). Looking at number of IPFs in 2019 alone, US applicants have a large number with about 90,000, following Europe, Japanese, Chinese applicants with about 80,000 each, and South Korean applicants with about 30,000.

IPFs are the inventions for which applicant intends to file an application in multiple countries/regions even if it spends a lot of money and time for it, and they are considered as valuable and important inventions. In general, such IPFs are often filed in the home country/region before the other countries/regions to allow sufficient time for translation. Alternatively, countries/regions with a first-filing requirement are obliged to file applications in the home country/region before other countries/regions. Considering this, the fact that although the number of patent families by Chinese applicants is about 1.2 million, the number of IPFs is only about 80,000 suggests that the majority of applications are filed only in the home country/region. On the other hand, the fact that although the numbers of inventions by Japanese, US, European, and South Korean applicants are

flat or slightly decreasing, the number of IPFs by them is increasing suggests that those countries/regions applicants are focusing on filing applications with an eye on international development.

2. Trend of GXTI Large (Level 1) categories

Among GXTI Large (Level 1) categories, Large (Level 1) categories, in which the number of IPFs is increasing, are “gxB: Energy Saving, Electrification, Demand-Supply Flexibility” and “gxC: Batteries, Energy Storage”, Large (Level 1) categories, in which the number of IPFs is flat, are “gxD: CO2 Reduction in Non-Energy Sector” and “gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas”, as well as Large (Level 1) category, in which the number of IPFs is decreasing, is “gxA: Energy Supply” (Table 4-2).

Among GXTI Large (Level 1) categories, Large (Level 1) categories, in which the number of IPFs by Japanese applicants ranks first, are “gxB: Energy Saving, Electrification, Demand-Supply Flexibility” and “gxC: Batteries, Energy Storage”, and furthermore Japanese applicants rank within the top three in other Large (Level 1) categories. Large (Level 1) categories, in which the number of IPFs by US applicants ranks first, are “gxD: CO2 Reduction in Non-Energy Sector” and “gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas”, and furthermore the US applicants rank within top three in other Large (Level 1) categories except for “gxC: Batteries, Energy Storage”. Large (Level 1) category, in which the number of IPFs by European applicants ranks first, is “gxA: Energy Supply”, and furthermore European applicants rank within top three in other Large (Level 1) categories. Among Large (Level 1) categories, the number of IPFs by South Korean applicants ranks third in “gxC: Batteries, Energy Storage”, following Japanese and European applicants (Table 4-4).

Looking at the degree of focus on each technology with RTA index (Table 4-8), the RTA index of South Korean applicants exceeds 200% in “gxC: Batteries, Energy Storage”, which suggests that they are focusing on it. RTA index of Japanese applicants exceeds 150% in “gxC: Batteries, Energy Storage”, RTA index of French applicants exceeds 150% in “gxA: Energy Supply” and “gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas”, as well as RTA index of England applicants exceeds 150% in “gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas”, which suggests they are focusing on these fields each.

3. Trends in Medium (Level 2) Categories and Small (Level 3) Categories of GXTI

(1) gxA: Energy Supply

Regarding the technology category of "**gxA01: Solar Photovoltaic Power Generation**," from the annual trends in the number of IPFs (Table 5-2), the number of IPFs exceeded 4,000 as of 2010, but has decreased to around 2,000 as of 2018, and experts suggest that the phase may have shifted to the diffusion of existing technologies rather than the development of new technologies.

From the annual trends in the number of IPFs by the country/region of the applicant (Fig. 5-1), while Japanese applicants maintains the top position with the number of IPFs for all periods up to 2018, the number of IPFs by Japanese, the US, European and Korean applicants has decreased. On the other hand, the number of IPFs by Chinese applicants has increased to the same level as Japanese, the US, and European applicants in recent years. In terms of the number of IPFs with 28 or more examiner citations (Table 5-10), that are considered to have a large impact on subsequent patent applications and are considered to be of high value, the US applicants accounted for 359, followed by Japanese applicants with 182, European applicants with 102, Korean applicants with 97, and Chinese applicants with 59. These results imply that Japan has strengths in terms of the number of IPFs and the impact on subsequent patent applications, that Europe and the US have a certain degree of presence, and that the recent developments of China are worth noticing in the field of "solar photovoltaic power generation."

Regarding the technology category of "**gxA03: Wind Power Generation**," from the annual trends in the number of IPFs (Table 5-2), the number of IPFs decreased from about 1,600 in 2010 to about 1,000 in 2015, and slightly increased to about 1,300 in 2018. From the annual trends in the number of IPFs by applicant country/region (Fig. 5-5), the number of IPFs by European applicants has remained in first place at around 600 to 1,000, and the number of IPFs by European applicants is about 2 to 4 times large than the number of IPFs by the US applicants in second place in all periods. (Since 2012, the number of German applicants alone has been about the same as the number of IPFs by the US applicants.) In terms of the number of IPFs with 28 or more examiner citations (Table 5-10), the US applicants accounted for 210, followed by European applicants with 165, far exceeding other countries/regions (for example, 32 Japanese applicants and 21 Chinese applicants), and therefore the US and European applicants can be considered to have applied for many high-value patents. From the trend of the top-ranking with the number of IPFs (Table 5-16), many European applicants continue to rank, suggesting their strong presence. Mitsubishi Heavy Industries, Ltd. and Hitachi, Ltd. are ranked within the top 10 in each period, which implies Japan have a certain presence on an applicant basis.

Regarding the technology category of "**gxA07: Biomass**," from the annual trends in the number of IPFs (Table 5-2), the number of IPFs decreased from around 700 to around 300 each year from 2010 to 2018. From the annual trends in the number of IPFs by the country/region of the applicant (Fig. 5-13), from 2010 to 2012, the number of IPFs by US applicants was over 300 each year, but since 2012, it has decreased significantly, and the number of IPFs by European applicants was also declining from around 200 each year from 2010 to 2012. However, the number of IPFs by other countries/regions is less than 50 in almost all year ranges, so it can be inferred that Europe and the US have a large accumulation of technology in the technology category of "Biomass." In terms of the number of IPFs with 28 or more examiner citations (Table 5-10), the US applicants accounted for 102, far exceeding European applicants with 15, implying the US's strengths in this technology category.

Regarding the technology category of "**gxA09: Fuel Cells**," from the annual trends in the number of IPFs (Table 5-2), the number of IPFs fluctuated between 1,500 and 1,700 from 2010 to 2017, but has increased to more than 1,800 since 2018, indicating that this technology has

attracted renewed attention in recent years. From the annual trends in the number of IPFs by the country/region of the applicant (Fig 5-17), from 2010 to 2018, the number of IPFs by Japanese applicants fluctuated between 500 and 700, and Japanese applicants maintain their top-position with a gap of more than 100 from US and European applicants. In terms of the number of IPFs with 28 or more examiner citations (Table 5-10), following 121 US applicants, Japanese applicants had the second highest number of IPFs with 78, suggesting that Japan is filing high-value IPFs. From the trend of the top-ranking with the number of IPFs (Table 5-28), among the top 20 applicants, 6 Japanese applicants were in 2010-2013, and 8 in 2014-2017 and 2018-2021, showing Japan's strengths in the technology category of "Fuel Cells." On the other hand, the number of US applicants who ranked first in the number of IPFs with 28 or more examiner citations is decreasing in the number of top 20 applicants in the ranking of the number of IPFs, no US applicants ranked in the top 20 from 2018 to 2021.

Regarding the technology category of "**gxA10: Hydrogen Technology**," from the annual trends in the number of IPFs (Table 5-2), from 2010 to 2018, the number of IPFs remained at the same level at around 850 to 900, but is expected to increase to over 1,000 from 2019 onwards, indicating that this technology is attracting increasing attention. From the annual trends in the number of IPFs by the country/region of the applicants (Fig. 5-19), from 2010 to 2018, the number of IPFs by European applicants remained at the same level around 300, the number of IPFs by US applicants slightly decreased from about 300 to about 200, and the number of IPFs by Japanese applicants slightly increased from less than 200 to about 250. However, the number of IPFs by European applicants has been increasing since 2019, showing that research and development in Europe can be considered to be becoming active again. In terms of the number of IPFs with 28 or more examiner citations (Table 5-10), US applicants accounted for 84, followed by Japanese applicants with 25, and European applicants with 18, suggesting that US applicants are one step ahead in terms of the number of high-value patent applications. In addition, from the trends in the top-ranking with the number of IPFs (Table 5-29), Air Liquide, a French applicant, has maintained the first position for the entire period, while Japanese applicants (Panasonic Corporation, Toyota Motor Corporation, Honda Motor Co., Ltd., etc.) have maintained the top 10 positions, implying the presence of these applicants. The fact that Saudi Arabian applicants also ranked 7th and 12th can be said to be notable in this technology category.

(2) gxB: Energy Saving, Electrification, Demand-Supply Flexibility

Regarding the technology category of "**gxB01: Energy Saving in Buildings (ZEB, ZEH, etc.)**," from the annual trends in the number of IPFs (Table 5-2), the number of IPFs remained at around 6,600 to 7,700 from 2010 to 2018, and although it is expected to decrease slightly to less than 6,000 in 2019. From the annual trends in the number of IPFs by the country/region of the applicants (Fig. 5-23), from 2010 to 2018, the number of IPFs by top-ranking Japanese applicants remained at around 2,500 each year, while the number of IPFs by European applicants, ranking second, remained at around 1,500 each year, with Japan surpassing them in the number of IPFs. From 2010 to 2017, the number of IPFs by Chinese applicants has increased, surpassing US

applicants in 2017, and in 2017 and 2018, their ranking in number of IPFs followed Japanese applicants and European applicants. In terms of the number of IPFs with 28 or more examiner citations (Table 5-10), top-ranking Japanese applicants accounted for 1,000, followed by US applicants with 800, Korean applicants with 600, and European applicants and Chinese applicants with about 300 each. In addition, from the trend of the top-ranking with the number of IPFs (Table 5-34), more than 10 Japanese applicants continue to rank. These results imply that Japanese applicants with the highest number of IPFs, patent value in terms of the number of examiner citations, and the number of applicants ranked in the top ranks of IPFs, have a strong presence in the field of “energy saving in buildings (ZEB, ZEH, etc.).”

Regarding the technology category of "**gxB02: High-Efficiency Motors and Inverters**," from the annual trends in the number of IPFs (Table 5-2), the number of IPFs has generally increased from 2010 to 2018, from about 460 in 2010 to about 750 in 2018. From the annual trends in the number of IPFs by the country/region of the applicants (Fig. 5-25), from 2010 to 2018, Japanese applicants took the lead, filing about 200 to 250 applications each year. During the same period, European applicants ranked second, filing approximately 150 to 200 applications each year, and US applicants ranked third, filing approximately 100 applications each year. In terms of the number of IPFs with 28 or more examiner citations (Table 5-10), top-ranking Japanese applicants accounted for 67, followed by US applicants with 46, and European applicants with 39. In addition, from the trend of the top-ranking with the number of IPFs (Table 5-36), more than 5 Japanese applicants are ranked among the top 10 applicants with the highest number of IPFs over the entire period. These results imply that Japanese applicants with the highest number of IPFs, patent value in terms of the number of examiner citations, and continuous rank-in with five or more in the top 10 in terms of the number of IPFs, have a strong presence in the field of “high-efficiency motors and inverters.”

Regarding the technology category of "**gxB03: Combined Heat and Power (CHP)**," from the annual trends in the number of IPFs (Table 5-2), the number of IPFs has generally been on a downward trend from 2010 to 2018, from approximately 270 in 2010 to 160 in 2018. From the annual trends in the number of IPFs by the country/region of the applicants (Fig. 5-27), from 2010 to 2018, European applicants ranked first, and from 2010 to 2016, there were about 100 IPFs each year, declined to about 80 in 2017 and about 60 in 2016. During the same period, the number of IPFs by US, Japanese, and German applicants has been on a downward trend, with roughly 80 to 40 IPFs being filed each year. In terms of the number of IPFs with 28 or more examiner citations (Table 5-10), US applicants accounted for 51, followed by Japanese applicants with 9, and European applicants with 8, and many US patent applications have been cited. From the top-ranking with the number of IPFs (Table 5-37), of the 20 respondents, 8 were Japanese, 6 were European, and 3 were US applicants, and automobile-related applicants were ranked regardless of country/region. These results imply that European applicants with a large number of IPFs, US applicants with high patent value, and Japanese applicants with the highest number of IPFs rankings have accumulated more technology than other countries/regions in the field of “combined heat and power (CHP).”

Regarding the technology category of "**gxB05: Electromobilities**," from the annual trends in

the number of IPFs (Table 5-2), the number of IPFs has generally increased from 2010 to 2018, from about 2,000 in 2010 to about 4,000 in 2018. From the annual trends in the number of IPFs by the country/region of the applicants (Fig. 5-31), from 2010 to 2018, Japanese applicants have remained at the top. During the same period, European applicants have remained in second place. In addition, the number of IPFs by Japanese, European, and German applicants have increased rapidly since 2015. In terms of the number of IPFs with 28 or more examiner citations (Table 5-10), Japanese applicants accounted for about 550, followed by US applicants with about 400, and European applicants with about 180. In addition, from the trend of the top-ranking with the number of IPFs (Table 5-42), many Japanese and European applicants ranked well. These results imply that, in terms of the number of IPFs, patent value, and the number of applicants ranked in the top ranks of IPFs, Japanese applicants are in a superior position compared to other countries/regions in the field of “electromobilities.”

Regarding the technology category of "**gxB06: Electrification of Industrial Heat**," from the annual trends in the number of IPFs (Table 5-2), the number of IPFs has generally increased from 2010 to 2018, from about 1,100 in 2010 to about 1,800 in 2018. From the annual trends in the number of IPFs by the country/region of the applicants (Fig. 5-33), from 2010 to 2018, European applicants remained at the top, increasing their IPFs from about 400 in 2010 to about 600 in 2018. During the same period, after European applicants, Japanese and US applicants filed about the same number of IPFs, with about 200 to 400 each year. In terms of the number of IPFs with 28 or more examiner citations (Table 5-10), US applicants accounted for about 160, followed by European applicants with about 130, Chinese applicants with about 60, and Japanese applicants with about 50. In terms of the top-ranking with the number of IPFs (Table 5-43), 8 Japanese applicants, 6 European applicants, 3 US applicants, 2 Korean applicants, and 1 Chinese applicant ranked. These results imply that European applicants with large number of IPFs, US applicants with high patent value, and Japanese applicants with the highest number of IPFs rankings have accumulated more technology than other countries/regions in the field of “electrification of industrial heat.”

Regarding the technology category of "**gxB07: Power Transmission and Distribution, Smart Grids**," from the annual trends in the number of IPFs (Table 5-2), after increasing from 2010 to around 2013, the number of IPFs has been decreasing since 2014. The number of IPFs, which was approximately 1,000 in 2010, has decreased to approximately 800 in 2018. From the annual trends in the number of IPFs by the country/region of the applicants (Fig. 5-35), from 2010 to 2018, the top three applicants with US, Japanese, and European applicants filed about the same number of IPFs about 200 to 400 applications each year. In terms of the number of IPFs with 28 or more examiner citations (Table 5-10), US applicants accounted for about 430, followed by Japanese applicants with about 200, Korean applicants with about 100, European applicants with about 90. In terms of the top-ranking with the number of IPFs (Table 5-45), 9 Japanese applicants, 4 European applicants, 3 Korean applicants, 2 US applicants ranked. These results imply that US applicants with large number of IPFs and high patent value, and Japanese applicants with large number of IPFs after that of US applicants, and the highest number of IPFs rankings, have accumulated technology in the field of “power transmission and distribution,

smart grids.”

(3) gxC: Batteries, Energy Storage

Regarding the technology category of "**gxC01: Secondary Batteries**," from the annual trends in the number of IPFs (Table 5-2), the number of IPFs has increased significantly from just under 5,000 in 2010 to more than 8,000 in 2019 and 2020, suggesting that research and development have been active. From the annual trends in the number of IPFs by the country/region of the applicants (Fig. 5-39), the number of IPFs by Japanese applicants has remained over 2,000 throughout the period, greatly exceeding second place (by around 1,000). In addition, in terms of the number of IPFs with 28 or more examiner citations (Table 5-10), Japanese applicants accounted for about 959, followed by US applicants with about 703, greatly exceeding Korean applicants in third place with 384. In terms of the top-ranking with the number of IPFs (Table 5-49), 12 Japanese applicants ranked. These results imply that Japan has strengths in the technology category of "secondary batteries." It should be noted that the 2 applicants with the highest number of IPFs are both Korean applicants.

Regarding the technology category of "**gxC04: Electric Double Layer Capacitors, Hybrid Capacitors**," from the annual trends in the number of IPFs by the country/region of the applicants (Fig. 5-45), the number of IPFs by Japanese applicants ranked first with two to three times as many as the second-ranking US applicants throughout the period. In addition, in terms of the number of IPFs with 28 or more examiner citations (Table 5-10), Japanese applicants accounted for 85, and US applicants with 89 greatly exceeded South Korean applicants with 18. In terms of the top-ranking with the number of IPFs (Table 5-55), 17 Japanese applicants ranked, implying that Japan has strengths in the field of “electric double layer capacitors, hybrid capacitors.”

(4) gxD: CO2 Reduction in Non-Energy Sector

Regarding the technology category of "**gxD01: Chemical Production from Biomass**,” from the annual trends in the number of IPFs (Table 5-2), the number of IPFs has remained at around 1,000. In terms of the annual trends in the number of IPFs by the country/region of the applicants (Fig. 5-47), between 2010 and 2012, the number of IPFs by US applicants in first place was just under 500, followed by European applicants in second place with just under 300 IPFs, and since 2016, the number of IPFs by US applicants has been about 300, close to the number of IPFs by European applicants. On the other hand, the number of IPFs by Japanese applicants remains at around 100, while the number of IPFs by Chinese applicants is gradually increasing, and is expected to match the number of cases of European and US applicants by around 2020. In addition, in terms of the number of IPFs with 28 or more examiner citations (Table 5-10), US applicants accounted for about 148, greatly exceeding European applicants with 37, as mentioned above, and it is important to note that the number of IPFs by US applicants has been on the decline in recent years. In addition, from the trend of the top-ranking with the number of IPFs (Table 5-58), from 2010 to 2013, 6 US applicants ranked, but from 2018 to 2021, this number

decreased to two. On the other hand, from 2010 to 2013, no Chinese applicants were listed, but from 2018 to 2021, 3 Chinese applicants ranked. “Chemical production from biomass” is a field in which the position of Europe has been relatively high in recent years, but China is expected to grow rapidly.

Regarding the small category of "**gxD01b: Cellulose Nanofibers**,” included in "gxD01: Chemical Production from Biomass," from the annual trends in the number of IPFs (Table 6-1), the number of IPFs was 24 in 2010, and increased to 73 in 2018. In terms of the number of IPFs by the country/region of the applicants (Table 6-2), European applicants accounted for 192, followed by Japanese applicants with 182, greatly exceeding US applicants with 74. In addition, in terms of the top-ranking with the number of IPFs (Table 6-12), 10 Japanese applicants, 9 European applicants, 3 US applicants and 3 Chinese applicants ranked. Europe and the US stood out in the medium category of "gxD01: Chemical Production from Biomass" as a whole, but in the small category of "gxD01b: Cellulose Nanofibers," Japan can be considered to have strengths along with Europe.

Regarding the technology category of "**gxD03: Recycling**,” from the annual trends in the number of IPFs (Table 5-2), the number of IPFs remained at just under 300 from 2010 to 2018, but is expected to surpass 500 from 2019 onwards. In terms of the annual trends in the number of IPFs by the country/region of the applicants (Fig. 5-51), until 2018, the number of IPFs by European applicants was about 100, and the number of IPFs by US applicants remained between 50 and 100, but the number of IPFs is expected to increase after 2019 in all countries/regions, including Europe and the US. In terms of the trend of the top-ranking with the number of IPFs (Table 5-62), among the top 20 applicants, 7 Japanese applicants were ranked in 2010-2013, and 5 applicants in 2014-2017, but only 1 applicant in 2018-2021. These results imply that Europe and the US are leading in the field of "recycling" from the perspective of countries/regions, and when viewed by applicant, Japanese applicants used to have a strong presence, but have weakened in recent years.

Regarding the small category of "**gxD03a: Plastic Recycling**,” included in "gxD03: Recycling," from the annual trends in the number of IPFs (Table 6-1), the number of IPFs increased from 253 in 2010 to around 500 in 2019. From the scale of the number of IPFs, it can be seen that most of the IPFs in the medium category of "gxD03: Recycling" are occupied by the small category of "gxD03a: Plastic Recycling". In terms of the number of IPFs by the country/region of the applicants (Table 6-2), the number of IPFs by European and US applicants far exceeds the number of IPFs by other countries/regions. In terms of the top-ranking with the number of IPFs (Table 6-13), European and US applicants account for 17 applicants. These results imply that “plastic recycling” is a field in which Europe and the US have strengths.

(5) gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas

Regarding the technology category of "**gxE01: CCS, CCUS, Negative Emission**,” from the annual trends in the number of IPFs (Table 5-2), the number of IPFs has nearly stagnated at around 600 to 700. In terms of the annual trends in the number of IPFs by the country/region of

the applicants (Fig. 5-53), from 2010 to 2018, the number of IPF by US applicants decreased from less than 300 to around 200, while the number of IPFs by European applicants decreased from over 200 to less than 200. On the other hand, the number of IPFs by Japanese applicants has remained between 100 and 150, narrowing the gaps between Europe, the US and Japan. In terms of the number of IPFs with 28 or more examiner citations (Table 5-10), the number of IPFs by US applicants is 106, which greatly exceeds the 28 IPFs for European applicants in second place. In terms of the trend of the top-ranking with the number of IPFs (Table 5-64), among the top 20 applicants, the number of Japanese applicants increased from 4 in 2010 to 2013 and 3 in 2014 to 2017 to 7 in 2018 to 2021. These results imply that Japan's position is relatively rising in the field of “CCS, CCUS, negative emission.”

In addition, Regarding the small category of "**gxE01c: CO2 Separation by Membranes**,” included in "gxE01: CCS, CCUS, Negative Emission," from the annual trends in the number of IPFs (Table 6-2), the number of IPFs by US applicants is 610, which is about twice as many as the number of IPFs by Japanese applicants (315 IPFs) and the number for European applicants (307 IPFs). In terms of the top-ranking with the number of IPFs (Table 6-14), 8 US applicants and 7 Japanese applicants ranked. 2 Saudi Arabian applicants also ranked. These results imply that "CO2 separation by membranes” is a field where the US has a large presence from the perspective of countries/regions, and when viewed by applicant, Japan is in a similar position to the US.

Moreover, regarding the small category of "**gxE01i: CO2 Conversion into Hydrocarbons and Derivatives by Reduction (Methanation, Electrosynthesis, Carboxylation, Artificial Photosynthesis, etc.)**,” included in "gxE01: CCS, CCUS, Negative Emission," from the annual trends in the number of IPFs (Table 6-1), the number of IPFs has increased from 56 in 2010 to around 100 since 2017. In terms of the annual trends in the number of IPFs (Table 6-2), European applicants (297 IPFs), US applicants (283 IPFs), and Japanese applicants (190 IPFs) have a large gap with other countries/regions. In terms of the top-ranking with the number of IPFs (Table 6-15), 8 European applicants, 6 Japanese applicants and 3 US applicants ranked, and no Chinese or Korean applicants ranked. 2 Saudi Arabian applicants also ranked. These results imply that "CO2 conversion into hydrocarbons and derivatives by reduction (methanation, electrosynthesis, carboxylation, artificial photosynthesis, etc.)" is a field where Japan, the US and Europe have a large presence.

Regarding the technology category of "**gxE02: Measures Against Non-CO2 Greenhouse Gases**,” from the annual trends in the number of IPFs (Table 5-2), the number of IPFs was around 100 from 2010 to 2013, but exceeded 150 in 2017 and 2019, showing a slight upward trend. In terms of the annual trends in the number of IPFs by the country/region of the applicants (Fig. 5-55), since 2014, the number of IPFs by Japanese applicants has been around 50 to 80, ranking first for many years, far ahead of Europe and the US, and since 2010, the number for US applicants has been stable at around 40, while the number for European applicants has been hovering around 30. In terms of the number of IPFs with 28 or more examiner citations (Table 5-10), the number of IPFs by Japanese applicants is 30, which is higher than that of US applicants (14 IPFs) and European applicants (9 IPFs). In terms of the trends of the top-ranking with the

number of IPFs (Table 5-66), of the top 20 applicants, more than 10 Japanese applicants ranked in each period. In addition, 3 Chinese applicants, none of whom were included in the list from 2010 to 2017, ranked from 2018 to 2021. These results imply that Japan has strengths in the field of “measures against non-CO2 greenhouse gases.”

Regarding the small category of "**gxE02b: Green Refrigerants (Low GWP Refrigerant)**," included in "gxE02: Measures Against Non-CO2 Greenhouse Gases," from the annual trends in the number of IPFs (Table 6-1), the number of IPFs increased from 105 in 2010 to 139 (or more) in 2019. From the scale of the number of IPFs, it can be seen that most of the IPFs in the medium category of "gxE02: Measures Against Non-CO2 Greenhouse Gases” are occupied by the small category of "gxE02b: Green Refrigerants (Low GWP Refrigerant).” In terms of the annual trends in the number of IPFs by the country/region of the applicants (Table 6-2), the number of IPFs by Japanese applicants, 514, ranks first, far ahead of US applicants (384 IPFs) and European applicants (254 IPFs). In addition, in terms of the top-ranking with the number of IPFs (Table 6-16), 13 Japanese applicants ranked. These results imply that Japan has strengths in the field of "green refrigerants (low GWP refrigerant).”

4. Notable Technologies outside GXTI

Regarding the technology category of "**Perovskite Solar Cells**," from the annual trends in the number of IPFs (Table 7-2), the number of IPFs surged from 2010 (1 IPF) to 2015 (143 IPFs), and has remained constant since then. In terms of the number of IPFs by the country/region of the applicants (Table 7-4), the number of IPFs by Japanese applicants (273 IPFs), European applicants (245 cases), and US applicants (217 IPFs) greatly exceeds the number of IPFs by other countries/regions. In addition, in terms of the top-ranking with the number of IPFs (Table 7-12), 8 Japanese applicants ranked, implying that "perovskite solar cells” is a technology category in which Japan has strengths.

Regarding the technology category of "**Photonics Convergence Technology**," from the annual trends in the number of IPFs (Table 7-2), the number of IPFs has been on a downward trend from 2010 (393 IPFs) to 2018 (184 IPFs). In terms of the number of IPFs by the country/region of the applicants (Table 7-4), the number of IPFs by Japanese applicants (2,039 IPFs) greatly exceeds the number for Korean applicants (332 IPFs) in second place. In addition, in terms of the top-ranking with the number of IPFs (Table 7-14), 15 Japanese applicants ranked, implying that "photonics convergence technology” is a technology category in which Japan has strengths.

Regarding the technology category of "**Optimization of Delivery Routes**," from the annual trends in the number of IPFs (Table 7-2), the number of IPFs increased sharply from 2010 (18 IPFs) to 2020 (206 IPFs). In terms of the number of IPFs by the country/region of the applicants (Table 7-4), the number of IPFs by US applicants (424 IPFs) far exceeds the number of IPFs by European applicants (221 IPFs) and Japanese applicants (155 IPFs). In terms of the top-ranking with the number of IPFs (Table 7-22), 15 US applicants and 5 Japanese applicants ranked. These results imply that the US has an advantage from the perspective of countries/regions, and when viewed by applicant, Japan and the US are considered to be in competition with each other in the

field of "optimization of delivery routes."

Regarding the technology category of "**Sharing of Goods**," from the annual trends in the number of IPFs (Table 7-2), the number of IPFs increased from 2010 (286 IPFs) to 2018 (642 IPFs). In terms of the number of IPFs by the country/region of the applicants (Table 7-4), the number of IPFs by US applicants (2,529 IPFs) far exceeds the number of IPFs by Korean applicants (905 IPFs) and Japanese applicants (808 IPFs). On the other hand, in terms of the top-ranking with the number of IPFs (Table 7-22), 8 US applicants, 4 Japanese applicants and 3 Chinese applicants ranked. These results imply that US has strengths in the field of "sharing goods."

Regarding the technology category of "**Room Temperature Storage of Food**," from the annual trends (Table 7-2), the number of IPFs increased sharply from 2010 (306 IPFs) to 2020 (558 IPFs). In terms of the number of IPFs by the country/region of the applicants (Table 7-4), the number of IPFs by European applicants was the largest (1,371 IPFs), followed by US applicants (897 IPFs) and Japanese applicants (726 IPFs). In addition, in terms of the top-ranking with the number of IPFs (Table 7-24), 10 European applicants, 5 Japanese applicants ranked, implying that Europe has strengths in the field of "room temperature storage of food."

Section 2 Analysis based on Trend of Market/Policy as well

This section presents important points etc. for future technology development, especially based on "Basic Policy for the Realization of GX[47]" approved by the Cabinet in February 2023, of the results in Section 1 and the trends of market/policy in Chapter 8.

1. General Statement

As shown in the analysis results of the trend of patent applications in Section1, Japanese applicants has a significant presence in many GX technology fields in terms of the number of IPFs, while there are also technology fields in which Europe and US applicants have a significant presence, as well as technology fields in which the number of IPFs by Chinese applicants has been increasing in recent years.

In addition, according to an IEA report, global renewable energy capacity is predicted to increase by about 2,400 GW in 2022-2027. The increase in new renewable energy capacity indicates that the market in the GX technology field is on expanding.

"Basic Policy for the Realization of GX" sets forth a variety of measures to achieve GX investment of over 150 trillion yen over the next 10 years through public-private cooperation, in which the acceleration of GX technology R&D is included, for achievement of the international commitment to reduce greenhouse gas emissions by 46% in 2030 and to realize carbon neutrality in 2050, while simultaneously realization of Japan's industrial competitiveness strengthening and economic growth. Such direct investment in R&D is highly likely to affect future trends of patent applications in GX technology field of Japan.

Furthermore, considering the expansion of ESG investment worldwide, it is highly likely that each country/region will accelerate R&D in fields in which they have strengths, therefore it may be necessary to keep an eye on these trends.

2. Analysis of Notable Technologies in Medium Categories and outside GXTI

(1) gxA: Energy Supply

Regarding the technology category of **"gxA01: Solar Photovoltaic Power Generation"**, Japanese applicants ranks first in the number of IPFs, and ranks second in the number of IPFs with 28 or more examiner citations after US applicants. It suggests that this is the field in which Japanese applicants has strengths while Europe and US applicants also have a presence, as well as it has been developing in China in recent years. As for the decreasing trend in the annual trends of the number of IPFs (Table5-2), experts suggest a possibility of shifting to a phase of dissemination of existing technologies rather than development of new technologies.

[47] https: //www.cas.go.jp/jp/seisaku/gx_jikkou_kaigi/pdf/kihon.pdf

"Basic Policy for the Realization of GX" approved by the Cabinet in February 2023 states that the installation of solar panels is to be expanded.

In expanding the installation of solar panels, it is beneficial to continue to examine policies for technology development and dissemination, on the basis of the above patent trend showing the presence of Japanese applicants, and it may be necessary to keep an eye on US, European, and Chinese applicants.

Regarding the technology category of **"gxA03: Wind Power Generation"**, the number of IPFs by European applicants ranks first in this field, which is 2 to 4 times that of US applicants ranks second in each year, and also the number of IPFs with 28 or more examiner citations ranks second after US applicants. However, in terms of applicants, Japanese applicants is also within the top 10 of the number of IPFs, indicating a certain presence.

"Basic Policy for the Realization of GX" states that "The goal of introducing floating offshore wind power generation is to be set, and technology development and large-scale demonstration are to be conducted to achieve this goal."

In developing technology in the field of wind power generation, it may be necessary to keep an eye on trends of Europe which has strengths in this field.

Regarding the technology category of **"gxA07: Biomass"**, the number of IPFs by Japanese applicants is 50 or less except for 2010, and this is smaller scale than the number fluctuating between 100 and 200 by European applicants or the number fluctuating between 50 and 350 by US applicants.

The reference material[48] for the "Basic Policy for the Realization of GX" state that public-private investments are to be made in the development of biomass-derived sustainable aviation fuel manufacturing technology development.

In technology development in the field of biomass, it may be necessary to pay attention to the technological trend of US, which has strengths in the number of IPFs and the number of IPFs with 28 or more examiner citations.

Regarding the technology category of **"gxA09: Fuel Cells"**, annual trend suggests that the number of IPFs by Japanese applicants changes in the range of 500 to 700 in 2010-2018, but have maintained the first place with a huge lead of more than 100 over European and US applicants throughout this period. Furthermore, the number of IPFs with 28 or more examiner citations by Japanese applicants ranks second with 78, following US applicants with 121, suggesting that this is the field in which Japan has strengths.

"Basic Policy for the Realization of GX" states that disseminating and expanding the fuel cells for automobiles, railroads, households, etc.to be addressed.

In disseminating and expanding the fuel cells, it should be noted that it is beneficial to continue to examine policies for technology development and dissemination on the basis of the fact that

[48] https: //www.cas.go.jp/jp/seisaku/gx_jikkou_kaigi/pdf/kihon_sankou.pdf

the number of IPFs by Japanese applicants ranks first with a huge lead over other countries/regions. And it should be noted that US applicants may have filed high-value patent applications in the terms of the number of IPFs with 28 or more examiner citations.

Regarding the technology category of **"gxA10: Hydrogen technology",** the numbers of IPFs were almost the same among Japanese, US, and European applicants, but it is expected that the number of IPFs by European applicants will increase significantly from 2019. In terms with the number of IPFs with 28 or more examiner citations, US applicants ranks first with 84, followed by Japanese applicants with 25 and European applicants with 18.

"Basic Policy for the Realization of GX" states that "the R&D and introduction support for the production and use of hydrogen from surplus renewable energy are to be accelerated", and "the R&D and practical use to make it possible to store surplus electricity in hydrogen are to be promoted".

In the R&D and practical use of hydrogen technology, it may be necessary to keep an eye on trends of Europe and US, which have strengths in hydrogen technology.

(2) gxB: Energy Saving, Electrification, Demand-Supply Flexibility

Regarding the technology category of **"gxB01: Energy Saving in Buildings (ZEB, ZEH, etc.)"**, Japanese applicants rank first in the number of IPFs, the number of IPFs with 28 or more examiner citations, and the number of applicants in top-ranking of the number of IPFs, suggesting that this is the field in which Japanese applicants have a significant presence.

The reference material for the "Basic Policy for the Realization of GX" state that by 2030, new houses and buildings are to ensure energy saving performance at the ZEH/ZEB level (houses are to reduce by 20% from the current energy saving standards excluding renewable energy, and buildings are to reduce by 30-40% (20% for small-scale buildings) from the current energy conservation standards excluding renewable energy).

In aiming to improve energy saving performance, it may be beneficial to continue to examine policies for technology development and dissemination, on the basis of the above patent trend indicating the presence of Japanese applicants.

Regarding the technology category of **"gxB05: Electromobilities"**, Japanese applicants have more advantageous position in this field than other countries/regions, in the number of IPFs, the number of IPFs with 28 or more examiner citations, and the number of applicants in top-ranking of the number of IPFs.

The reference material for the "Basic Policy for the Realization of GX" state that it is to be aimed for 100% electrified vehicles in new passenger car sales in the 2030s.

In disseminating and expanding the electrical vehicles, it may be beneficial to continue to examine policies for technology development and dissemination, on the basis of the above patent trend showing that Japanese applicants have an advantage position.

(3) gxC: Batteries, Energy Storage

Regarding the technology category of **"gxC01: Secondary Batteries"**, Japanese applicants rank first in the number of IPFs, the number of IPFs with 28 or more examiner citations, and the number of applicants in top-ranking of the number of IPFs, which suggests this is the field in which Japan has strengths. Looking at the number of applicants, both of the tops of the number of IPFs and the number of IPFs with 28 or more examiner citations are South Korean.

"Basic Policy for the Realization of GX" states that regarding the storage battery industry, it is to improve the international competitiveness of storage battery manufacturing by supporting the establishment and enhancing of advanced manufacturing technology, etc.

In improving the international competitiveness of secondary batteries (storage batteries), it is beneficial to continue to examine policies for technology development and dissemination, on the basis of the fact that Japan has strengths in the above patent trend. And it should be necessary to pay attention to trend of South Korean applicants within top-ranking in the number of IPFs.

(4) gxD: CO_2 Reduction in Non-Energy Sector

Regarding the technology category of **"gxD01: Chemical Production from Biomass"**, the numbers of IPFs by European and US applicants are large (about 250 or more per year), and the number of IPFs by Chinese applicants also slightly increasing, which is expected to be along with European and US applicants around 2020. On the other hand, the number of IPFs by Japanese applicants is about 100 per year.

The reference material for the "Basic Policy for the Realization of GX" refers to bio-manufacturing in "Case 13", and states that it is to disseminate and expand biomass plastic, etc.

In disseminating and expanding biomass plastic, it may be necessary to keep an eye on trends of Europe and US, which have an advantage position in the number of IPFs.

(5) gxE: Capture, Storage, Utilization and Removal of Greenhouse Gas

Regarding the technology category of **"gxE01: CCS, CCUS, Negative Emission"**, the numbers of IPFs by European and US applicants are on the decrease, while the number of IPFs by Japanese applicants is flat, indicating that the gap between the number by Europe and US applicants and the number by Japanese applicants is on the close. In addition, looking at the number of applicants, Japanese applicants which rank within the top 20 applicants of the number of IPFs is on the increase, CCS, CCUS, negative emission is the field which the position on Japan is relatively rising.

"Basic Policy for the Realization of GX" states that regarding CCS, it is to support for the development of advanced projects.

In supporting the development of projects such as CCS, it is beneficial to continue to examine policies for technology development and dissemination, on the basis of the above patent trend indicating that the difference of the annual number of IPFs is smaller between Japanese and

European applicants. And it should be noted that Europe and US have accumulated technology developments so far.

(6) Notable Technologies outside GXTI

Regarding the technology category of **"Perovskite Solar Cells"**, based on the number of IPFs and the number of top-ranking applicants the number of IPFs, it can be said that this is the field in which Japan has strengths while Europe and US have a certain presence.

"Basic Policy for the Realization of GX" states that "for the early social implementation of next-generation solar cells (perovskite), it is to accelerate R&D, introduction support, and demonstration in collaboration with users".

In the early social implementation of perovskite solar cells, it is beneficial to continue to examine policies for technology development and dissemination, on the basis of the above patent trend indicating that Japan has strengths, and it may be also necessary to take note of the trends of Europe and US which have a certain presence.

Regarding the technology category of **"Optimization of Delivery Routes"**, the number of IPFs by US applicants (424 IPFs) greatly exceeds European applicants (221 IPFs) and Japanese applicants (155 IPFs). However, looking at the number of top-ranking applicants in the number of IPFs, it is suggested that Japan and US may be almost the same.

The reference material for the "Basic Policy for the Realization of GX" state about "Promotion of Logistics Efficiency, etc." as the field of GX investment.

In technology development for logistics efficiency, it may be necessary to keep an eye on trend of US, which have an advantage position in the number of IPFs.

Regarding the technology category of **"Share of Items"**, the number of IPFs by US applicants (2,529 IPFs) greatly exceeds South Korean applicants (905 IPFs) and Japanese applicants (808 IPFs). Furthermore, 8 US applicants rank within the top 20 applicants of the number of IPFs.

The reference material for the "Basic Policy for Realization of GX" state that investment is to be made for "introduction of equipment for servitization of such as leasing and sharing".

In servitization of sharing, it may be necessary to keep an eye on trend of US which has strengths in this field.

Conclusion

From the perspective of achieving sustainable growth, companies and others are required responses to climate change issues. The revised Corporate Governance Code (June 2021) has added a Supplementary Principle stating that “companies listed on the Prime Market should collect and analyze the necessary data on the impact of climate change-related risks and earning opportunities on their business activities and profits, and enhance the quality and quantity of disclosure based on the TCFD (Task Force on Climate-related Financial Disclosure) recommendations, which are an internationally well-established disclosure framework, or an equivalent framework”.

In addition, the report of the Financial System Council Disclosure Working Group released in June 2022 has recommended that a new section is to be created for sustainability information, including responses to climate change, in securities reports. Furthermore, it states that it is considered appropriate to disclose information in said section with an equivalent framework to the TCFD, from the point of view of international comparability. Given this recommendation, the Cabinet Office Ordinance (Cabinet Office Ordinance on Disclosure of Corporate Information, etc.) and others has been revised in January 2023.

In relation to this TCFD framework, the “Practical Guide for Scenario Analysis in line with the TCFD Recommendations 3rd edition” created by the Ministry of the Environment in March 2021, explains that the TCFD recommendations request “all companies to (i) use climate-related scenarios (e.g., 2˚C scenario), to (ii) assess their climate-related risks and opportunities, to (iii) incorporate such risks and opportunities in their business strategies and risk management, and to (iv) understand and disclose their financial impacts”, while it also explains that one of the difficulties companies face in implementing scenario analysis is “utilizable external data for scenario analysis is lacking”.

On the other hand, regarding patents, a large amount of machine-processable data called “patent information” exists worldwide, and there are also many commercial databases that incorporate such data. And such patent information is considered one of the best candidates for utilizable data to analyze the effects of climate change. In this regard, IEA Energy Technology Perspectives (ETP) 2020, which is introduced as a material for scenario analysis in the Appendix of the Practical Guide created by the Ministry of the Environment, states that “Issuance of patents for low-carbon energy technologies in selected countries/regions” as one of the parameters related to the technology.

In this report, the trends of GX technology has surveyed and analyzed based on patent information, using the GXTI published by the Japan Patent Office in June 2022. In this report, Chapters 2 to 7 present the results of surveys on the patent applications trend in each country/region, Chapter 8 presents the results of surveys on market/policy, and Chapter 9 presents an example of comprehensive analysis using the results of surveys through Chapter 2 to 8. In comprehensive analysis, the number of patent families and the number of IPFs by applicants in each country/region, on the overall trend of patent applications shown in Chapter 2, have confirmed. In particular, it has explained that the number of IPFs is regarded as one indicator of the international influence by applicants in each country/region. And based on the results of various surveys on the number of IPFs for each GXTI technology category shown in Chapters 3 to 7, the analysis results relating to the strengths of applicants in each country/region has presented.

We would like it if the results of the survey and analysis presented in this report will be of help not only in planning R&D strategies for GX technology, but also in planning patent strategies and business strategies for each company by referring together with their own management information, etc., as well as in considering disclosure regarding responses to climate change issues based on patent information.

2022
Patent Information Analysis Based on GXTI

Published in March 2023

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