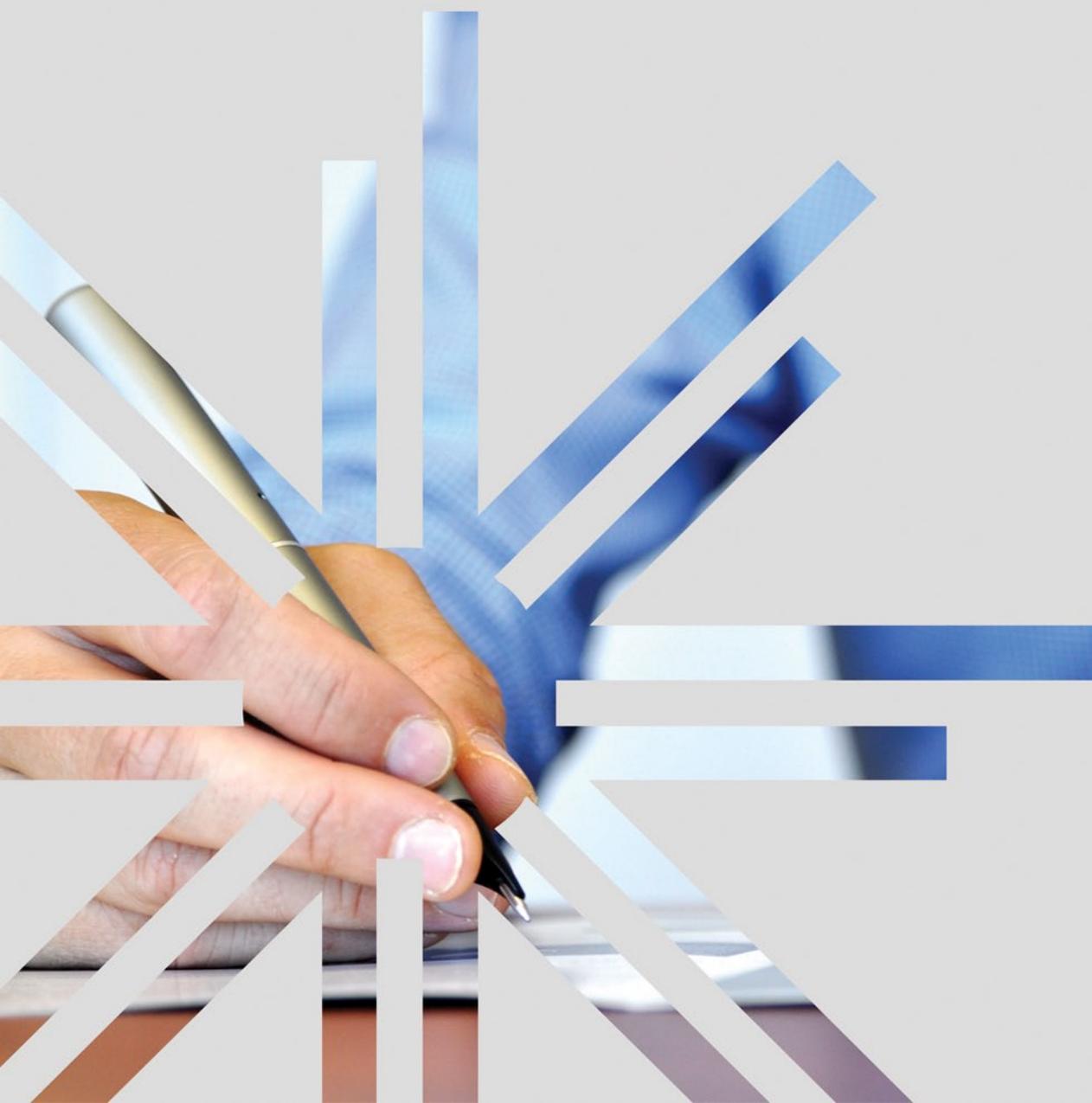


The 2011 Fuel Cell Patent Review



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Executive Summary

The 2011 Patent Review is the first in Fuel Cell Today's new series of annual reports on fuel cell patent activity. It analyses both granted patents and patent applications published in 2010, by comparison with publications in 2000 and 2005.

The fuel cell patent numbers reported here reflect the rapid technological progress in the industry from 2000 to 2010, and the advent of commercialisation in that period. The number of granted fuel cell patents increased by 347%, from 403 in 2000 to 1,801 in 2010, significantly outstripping underlying growth in overall patent activity. The increase is, however, generally in line with growth in clean technology intellectual property reported elsewhere.

The majority of patents in these three years, 2,067 out of a total of 3,065, were granted to assignees in the USA and Japan. Japan overtook the USA during the decade to become the largest source of fuel cell patents. In terms of regions, the number of patents originating from North America and Europe increased steadily over the decade, but more rapid growth occurred in Asia – in Japan as expected, and in South Korea, Taiwan and China. Little activity in the Rest of World region is evident.

Japanese corporations increasingly dominate the list of patent assignees and many automotive manufacturers are among the top patent holders, showing the extent of their commitment to fuel cell vehicle technology.

Looking ahead, the number of applications published in 2010 shows evidence of some effect from the economic downturn of 2008/9, which is known to have depressed general patent activity. As a result, it is probable that there will be somewhat more modest growth in the number of granted fuel cell patents from 2011 to 2014 than accelerating commercialisation may suggest, especially when compared to the spectacular growth in the 2000s.

However, we consider that the rapidity of this early growth partly reflected the function of patents as a measure of value in a pre-commercial industry and that the need for this particular function is declining. Patent activity remains a good proxy for sentiment in the industry and we expect it to settle into a pattern of steady and sustainable growth as the industry matures and moves towards full commercialisation.

1. Introduction

1.1 Scope

Since 2007, Fuel Cell Today has reported on developments in fuel cell patenting worldwide, first quarterly and then half-yearly. With this edition we are moving to an annual patent review, covering developments for each calendar year.

The 2011 report covers granted patents published between 1st January and 31st December 2010 by the United States Patent and Trademark Office (USPTO) and the European Patent Office (EPO). Data from 2000 and 2005 are shown alongside 2010 to provide some basis for comparison and to chart broad developments in this area over the last ten years. We also analyse applications for new patents published in 2010, including international patent applications, to forecast patent developments which may be seen from 2010 onwards.

As this is the first in our new series of patent reports, Sections 1.2 to 1.4 provide more detail on how we approached the analysis.

1.2 Search Protocol

Patent searching was conducted for Fuel Cell Today by Technology Forecasting and Information services (TFI) at the Johnson Matthey Technology Centre at Sonning Common in the UK. Patents and applications relating to fuel cells were located by searches carried out on Thomson Reuters' Aureka[®] IP analysis platform, using relevant keywords and the International Patent Classification (IPC) code H01M0008* for 'Fuel Cells, Manufacture Thereof.' Japanese patent results were cross-checked using the LexisNexis[®] TotalPatent[™] database.

The dataset has been de-duplicated so that each patent family is only counted once, regardless of how many iterations of the patenting process it has been through or how many of the selected authorities it has been lodged with in each year.

1.3 Selected Patent Offices

An application for a patent can be filed with a number of patent authorities, either at the same time or in succession as the assignee decides to protect the invention in other locations. There are many national patent offices worldwide, publishing in a range of languages, and it is difficult to search them all in a meaningful way. We have thus selected those authorities that handle significant volumes of applications we consider to be international, i.e. made in a territory other than the country of origin. Our selection is explained below.

We excluded all patent-granting authorities except the five largest. These five patent offices (the 'IP5') account for 90% of all patent applications filed worldwide¹ and therefore most patent activity is captured through these.

¹ The Five IP Offices (IP5): www.fiveipoffices.org/about-us.html

The IP5 comprises:

- The European Patent Office (EPO);
- The Japanese Patent Office (JPO);
- The Korean Intellectual Property Office (KIPO);
- The Chinese State Intellectual Property Office (SIPO);
- The United States Patent and Trademark Office (USPTO).

We then excluded the JPO, KIPO and SIPO from our analysis as the great majority of applications made to these authorities are domestic^{2,3}. By contrast, just under half the applications received by the USPTO originate from within the USA. Similarly, only around 50% of the applications filed with the EPO are domestic, but it should be noted that 'domestic' within this context means from within the EPO's member states, rather than a specific nation, hence these applications are already on an international footing. The remainder of applications to the EPO are non-European.

Our assumption is that an analysis of publications by the EPO and USPTO allows us to capture an accurate picture of trends in international fuel cell patenting activity, albeit with some bias towards the USA and Europe.

To test this assumption, a separate search of all fuel cell patents granted in 2010 by the JPO was carried out and compared to our results. This search identified only four granted patents that had been applied for only in Japan and nowhere else. Given Japan's prominence in fuel cell technology and the strength of its domestic market, this gives us good reason to believe that we are not missing any significant patent numbers.

1.4 The Patent Cooperation Treaty

There is at present no such thing as a truly international patent. The nearest equivalent is the Patent Cooperation Treaty (PCT), administered by the World Intellectual Property Organization (WIPO). The PCT makes it possible to file a single 'international' patent application to all 142 of the contracting states simultaneously⁴. The filing of the application establishes a date from which priority for the invention can be claimed, but granting of the patent in each state remains the responsibility of the individual national patent offices. Publications by WIPO have been included in our analysis of patent applications.

² EPO, JPO, KIPO, USPTO, 'Four Office Statistics Report', 2009 Edition, October 2010, p40: www.trilateral.net/statistics/tsr/fosr2009.html

³ WIPO, 'World Intellectual Property Indicators 2010', p40: www.wipo.int/freepublications/en/intproperty/941/wipo_pub_941_2010.pdf

⁴ WIPO, PCT Applicant's Guide, 9th June 2011: www.wipo.int/pct/en/appguide/index.jsp

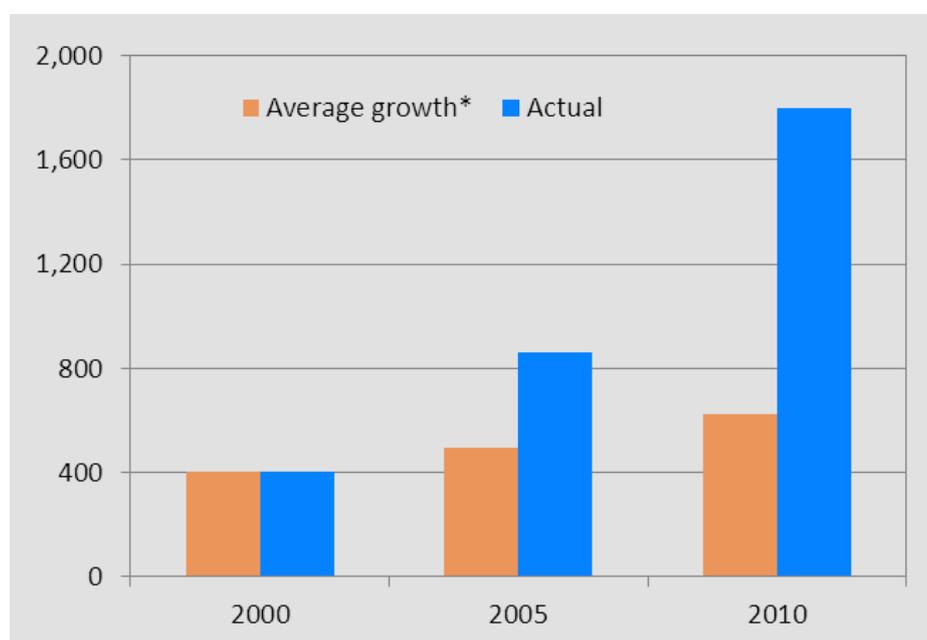
2. Granted Patents

2.1 Number of Patents

In 2010, the US and European patent offices published a combined total of 1,801 granted fuel cell patents. A comparison of this number to the total number of granted patents published in 2000 and 2005 (Figure 1) shows significant growth in intellectual property between 2000 and 2005, and again from 2005 to 2010. The increase equates to 347% growth in annual patent numbers over the decade.

To determine to what extent the increase in fuel cell patents exceeded underlying growth in general patent activity, we have estimated the number of fuel cell patents that would have resulted from no more than average growth. These have been calculated from a 2000 baseline using overall patent growth rates from WIPO (see Appendix) and are shown in orange in Figure 1. Had fuel cell patenting grown in line with general patenting, the number of fuel cell patents in 2005 would have been just 494 (compared to 861 actual) and in 2010 almost three times fewer at 627.

Since applications for patents are only granted if they satisfy the requirement for novelty, the growth in granted patents reflects substantial levels of innovation in fuel cell technology. It also underscores the rapid progress of the industry towards commercialisation in the first decade of this millennium, as granted patents are only pursued and maintained by the assignee if a profit is expected from the invention.



*Figure 1: Total annual patents granted in fuel cell technology
* From 2000 baseline (= 403)*

2.2 Filing Date

It takes some years for a patent application to be granted, so the number of granted patents reflects the level of research and development activity that took place some years previously. To illustrate this, Figure 2 charts the filing year of the 1,801 patents granted in 2010, indicating how many of these patents were applied for in each preceding year.

Note that filing date differs from publication date: the USPTO and EPO typically publish applications around eighteen months after filing. The date of filing of the first application will be the priority date of the patent.

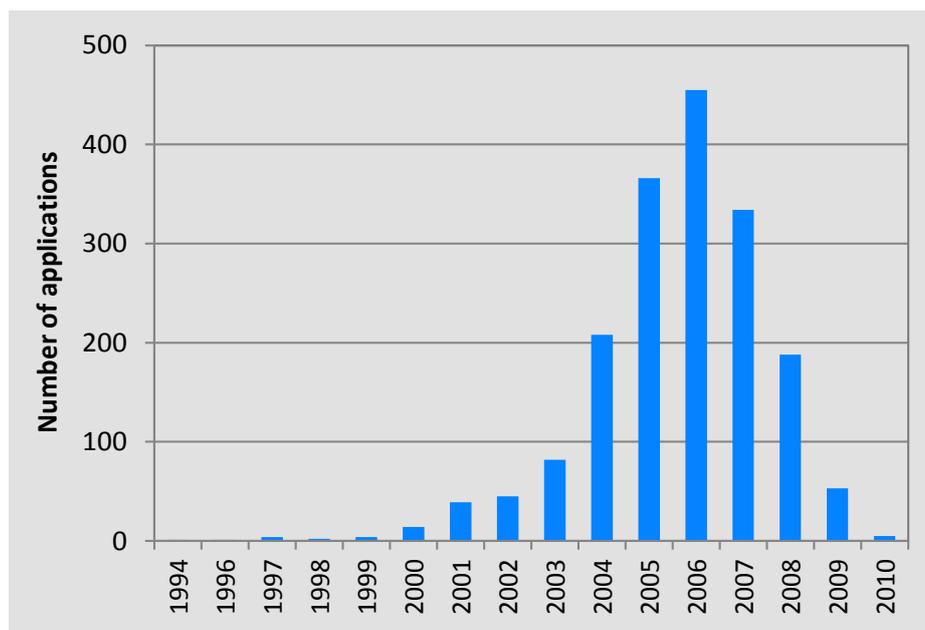


Figure 2: Application filing date for fuel cell patents granted in 2010

The majority of applications (almost 65%) were filed between 2005 and 2007 and therefore took from three to five years to be granted. (Figure 2 only shows those applications that were subsequently granted in 2010, and not all fuel cell related applications that were filed in those years.)

The 2010 numbers shown in Figure 1 do not appear to have suffered any impact from the recent global economic crisis. An analysis of filing year indicates why this is the case: the peak filing year was 2006, before the effects of the crisis began to be felt.

2.3 Country of Origin

We have assigned a 'country of origin' to each patent in our dataset. This is the designated country of residence of the patent assignee, or the country in which the relevant company is headquartered (in the case of more than one assignee, we have used the country of the first assignee). We have done this in order to give a true reflection of where the innovation has originated and where the intellectual property resides. Note that this differs from a patent's priority country. The priority country of a patent is the country in which the first filing of the application is claimed. This is often – but not necessarily – the country of origin of the patent assignee.

The number of patents granted to each country by the US and European patent offices, collectively, is shown in Figure 3 (top ten countries) and Figure 4 (countries with fewer than 100 patents in each year).

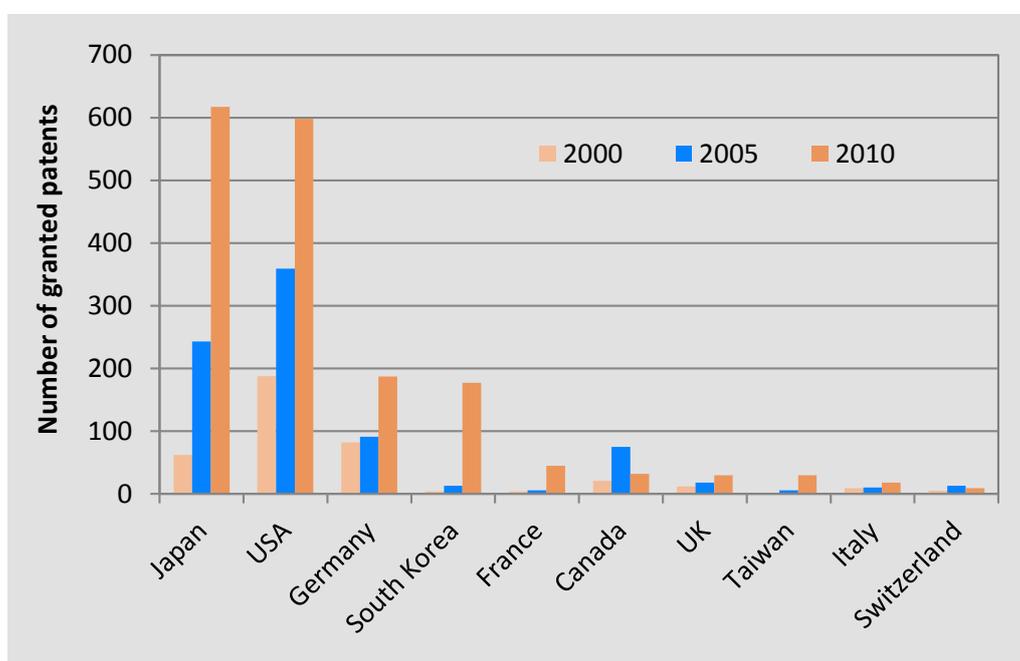


Figure 3: Annual granted fuel cell patents per country of origin (top ten)

Figure 3 shows Japan and the USA leading the field, as we would expect. There have been significant increases in absolute terms for both these countries, but fuel cell patenting in Japan accelerated sufficiently during the decade to put Japan ahead of the USA by 2010.

We believe this may be ascribed in part to a more widespread acceptance of fuel cells as commercial technology in Japan, aided by government support for the Ene-Farm project (amongst others). After the demonstration phase, which ran from 2005 to 2009, this support took the form of a 'pull' subsidy, with the Japanese Government providing a significant percentage of the purchase cost of the Ene-Farm system. The result has been thousands of fuel cell units sold to residential customers in Tokyo and elsewhere in Japan.

The number of patents from South Korea has also increased markedly from 2005 to 2010 – almost putting it on a par with Germany, which has been active in this area for some time. Large Korean corporations are responsible for pushing it to prominence, particularly Samsung and to a lesser extent Hyundai and LG, but again significant support from the South Korean authorities for fuel cell technology should be counted as a spur to innovation.

Figure 3 largely accords with the results of a recent patent-based study on clean energy technology, jointly conducted by the EPO, the United Nations Environment Programme (UNEP) and the International Centre for Trade and Sustainable Development (ICTSD)⁵. The study found that almost 80% of innovation in clean energy technology originates in just six countries: Japan, the USA, Germany, the Republic of Korea, France and the UK.

To expand the fine detail in Figure 3, Figure 4 excludes the USA, Japan, Germany and South Korea, and shows those countries from which fewer than 100 patents but more than five patents originated in 2010. (There are a further sixteen countries which were granted fuel cell patents in one or more of the three years, with a total of 49 patents between them; they are not included in this figure but a full list is given in the Appendix.)

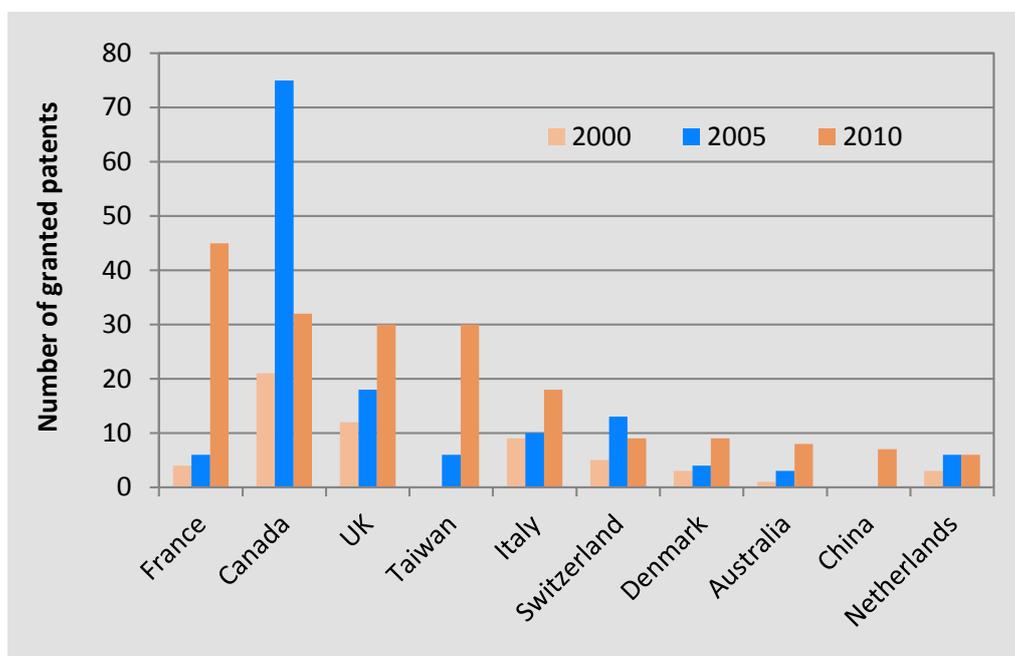


Figure 4: Annual granted fuel cell patents per country of origin (>5 and <100 in 2010)

Steady growth from year to year is seen for the UK, Italy, Denmark and Australia, with progress in these countries driven almost entirely by a handful of familiar names in the fuel cell industry. Significant growth in France has seen increases in patents granted to a number of parties, significantly automakers Peugeot and Renault, and the CEA (Commissariat à l'énergie atomique et aux énergies alternatives; the French Alternative Energies and Atomic Energy Commission).

⁵ UNEP, 'Pioneering study examines the role of patents in combating climate change', 30th September 2010: <http://www.unep.org/climatechange/News/PressRelease/tabid/416/language/en-US/Default.aspx?DocumentId=647&ArticleId=6763>

Canada is interesting for having a substantial spike in 2005, although it is not possible to say how much of an anomaly this is without looking at data from the intervening years. The spike is due almost entirely to Ballard Power Systems: from 48 patents in 2005, constituting almost two-thirds of the Canadian total for that year, the number of patents awarded to Ballard has declined to two in 2010 – just over 6% of the total.

Part of the reason for this may be a change in Ballard's strategy, leading it to withdraw from developing end-use systems to focus on its core strength: fuel cell stack production. Ballard cited this as the reason for selling its electric drive business in 2007, and it may also have influenced the decision to sell its automotive assets to Daimler in 2008 and to dissolve Ebara Ballard in 2009.

However, reduction of patent activity can also be due to technology maturing – particularly in a country such as Canada that has been active in this field for some time. This is likely to be the case for both Ballard and Hydrogenics, another well-established Canadian company: Hydrogenics' granted patents dropped from eight in 2005 to just the one in 2010, while its commercial activity ramped up during the same period.

Maturation also appears to be behind the tailing off of patent activity in Switzerland. Major contributors in 2000 and 2005 were Sulzer Hexis (now Hexis) and Vaillant, but in 2010 the number of Hexis' granted patents has halved and Vaillant is absent. Both these companies have moved on to demonstration and commercialisation of their fuel cell products for residential heat and power.

China and Taiwan have both entered the field in the last decade, and significant growth in patenting from these countries can be expected – particularly as China has recently announced an ambitious strategy to boost innovation, specifically as measured by patent numbers⁶. However, it may take a few years for the full effect of this to be felt in the international intellectual property arena.

⁶ 'National Patent Development Strategy (2011-2020)', State Intellectual Property Office of China, trans. USPTO, New York Times, 1st January 2011: <http://graphics8.nytimes.com/packages/pdf/business/SIPONatPatentDevStrategy.pdf>

2.4 Geographic Region of Origin

Fuel Cell Today analyses the global fuel cell market in terms of four geographic regions: Asia, Europe, North America, and Rest of World. The extent of each region is shown on a world map included in the Appendix.

We have sorted the granted patents into these regions and the result is shown in Figure 5. It confirms that healthy growth in patenting in North America and Europe is being outstripped by the rate of growth in Asia. Japan is of course dominant here but there is also significant growth in the rest of Asia, specifically in South Korea, Taiwan and China. Bear in mind that domestic patenting in these countries has not been included, as it has been for the USA and to some extent for the European nations by searching the USPTO and EPO.

Based on this dataset, there appears to be limited fuel cell research and development taking place in the international arena for the Rest of World region. We would hope to see activity in the rest of the world increasing markedly in the coming decade, but this analysis suggests there is substantial catching up to do.

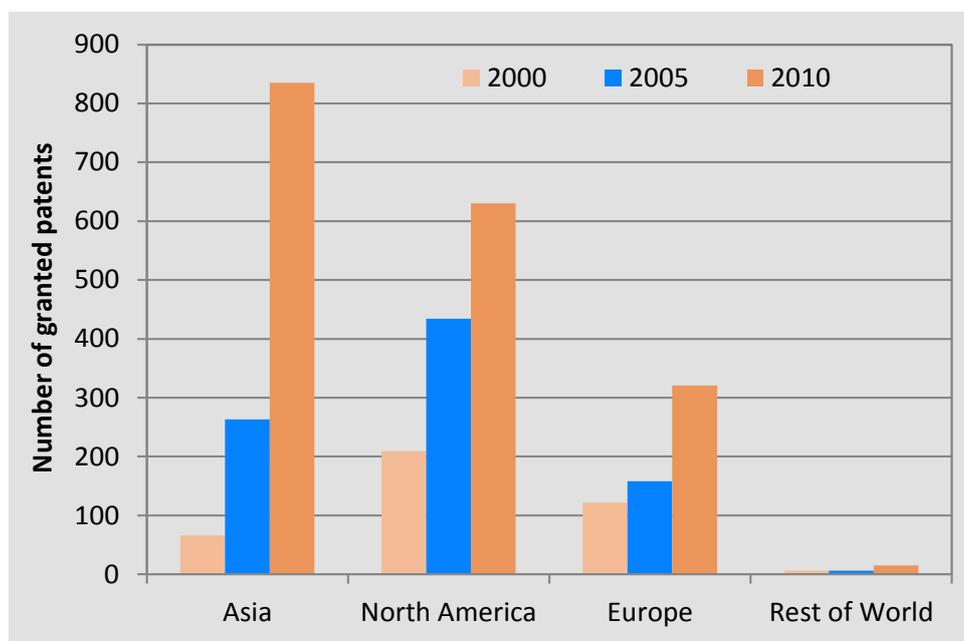


Figure 5: Annual granted fuel cell patents per region of origin

2.5 Assignee

Table I gives the top ten companies in terms of granted patents in each of the three years and the number of patents they were assigned. It confirms the growing dominance of Japan in this area: 20% of the top ten assignees in 2000 were Japanese corporations; this proportion increased to 50% in 2005 and to 70% in 2010.

Samsung has had a meteoric rise, from no presence in the top ranks in either 2000 or 2005, to number one on the list in 2010. It accounts for the bulk of Korea's 177 granted patents in 2010 and has been almost solely responsible for pushing that country into the top ten (Figure 3).

The presence of so many automotive manufacturers in the list for each year is particularly encouraging, and underlines the determined effort by these companies to push fuel cell electric vehicles to commercialisation by 2015.

Table I: Top ten assignees of fuel cell patents granted in each year

Rank	2000		2005		2010	
1	IFC ^a	29	Honda	68	Samsung	140
2	Siemens	23	General Motors	50	Honda	135
3	Ballard	19	Ballard	48	General Motors	130
4	DBB ^b	12	Nissan	26	Toyota	90
5	Du Pont	10	UTC Fuel Cells	24	Panasonic	58
6	Honda	10	Matsushita ^e	22	Nissan	46
7	Plug Power	10	Toyota	22	Hitachi	26
8	General Motors	9	Delphi Tech.	17	Delphi Tech.	24
9	FZ Jülich ^c	8	Hewlett Packard	16	Toshiba	21
10	De Nora / Toyota ^d	7	Daimler Chrysler	12	Canon	20

Notes:

^a International Fuel Cells, a division of United Technologies Corp.; renamed UTC Fuel Cells in 2001

^b Daimler-Benz-Ballard Fuel Cell Engines, a forerunner of the AFCC collaboration

^c Forschungszentrum Jülich GmbH (Jülich Research Centre)

^d De Nora and Toyota each had 7 patents granted in 2000 and are therefore both ranked 10th

^e Matsushita Electric Industrial Co. was renamed Panasonic Corporation in 2008

3. Patent Applications

3.1 Applications as a Preview

To get an idea of current patent activity, we have looked at the number of new patent applications published in 2010 by the US and European patent offices, as well as applications published by WIPO under the Patent Cooperation Treaty in 2010.

Applications to the EPO and USPTO are published eighteen months after filing so these applications were made between mid-2008 and mid-2009. Based on Figure 2, it can be assumed that the bulk of these applications will result in granted patents from about mid-2011 through to 2015. These applications are thus a preview of developments in the near future.

Of course, an application does not necessarily result in a patent being granted, even if a grant is pursued by the assignee. This is discussed further in Section 3.6.

3.2 Number of Applications

We have compared the number of applications made to the three authorities in 2010 to the number of applications made in 2000⁷ and 2005 (Figure 6).

As an indication of activity in this area, Figure 6 shows a striking increase from 2000 to 2005, with the number of applications almost tripling. Patent activity then appears to falter in the second half of the decade, with around 500 fewer applications in 2010 than in 2005, but we propose possible reasons for this below.

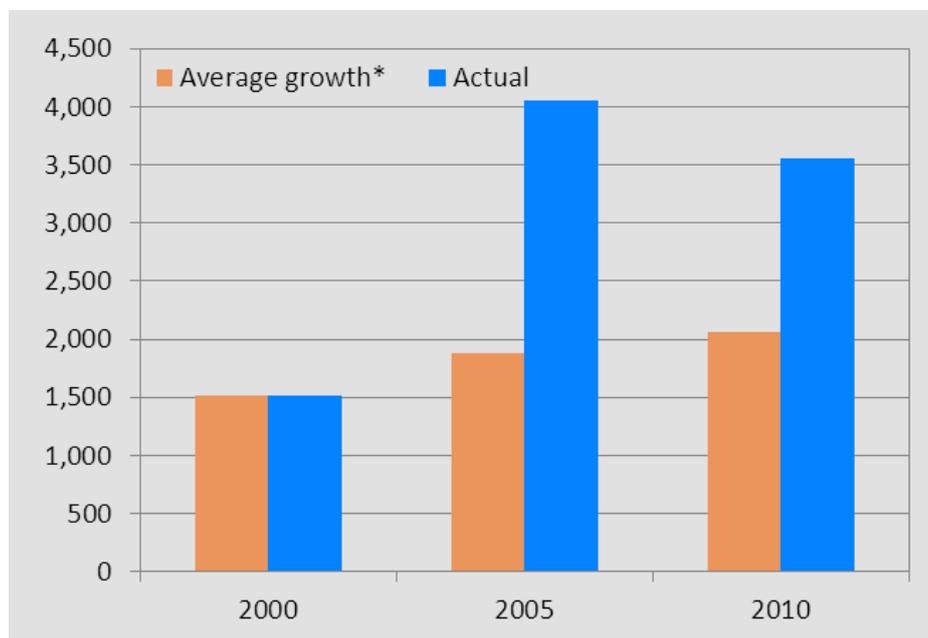
Again, we have projected the numbers we could have expected to see for fuel cell applications had they been subject to no more than average growth (shown in orange in Figure 6). Starting with 1,516 applications in 2000 and applying annual growth rates from WIPO gives us a figure of 1,881 for 2005, compared to 4,051 actual, and 2,064 for 2010, against 3,561 actual.

The rapid growth in applications in the first half of the decade obviously corresponds to real underlying growth in intellectual property. But we believe the extent of the growth also shows the effects of a 'patent rush', stimulated by incipient commercialisation of the industry. In a favourable economic climate, and with expectations of eventual profits, inventors are more likely to file patent applications and to do so as soon as possible in order to establish priority dates for their inventions and to attract further investment.

The prospect of licensing fees also provides more reason to file a defensive application to block the use of technology by someone else, even if the company itself does not immediately intend to put it into production.

⁷ No applications for patents were published in the USA prior to 2001, when there was a change in US patent law. To get our 2000 number, patents granted by the USPTO after 2000 were searched to determine how many had been applied for in 2000. The number was corrected using the proportion of queried patents in 2000 to account for applications in 2000 that were not granted.

However, not all these applications will necessarily be pursued through to grant, as companies tend to apply more stringent selection criteria in this part of the process due to the costs involved.



*Figure 6: Total annual patent applications in fuel cell technology
* From 2000 baseline (= 1516)*

Commercialisation of the industry really got underway in the latter part of the decade, and the drop in applications from 2005 to 2010 therefore appears contradictory. At the time of writing some 2010 publications were yet to be released and this figure is therefore likely to be revised upwards before being finalised, but even so the rapid increase in application numbers does not appear to have been sustained through to 2010. In this reduction we are seeing the lingering effects of the global economic crisis of 2008/9, which is known to have caused a pronounced dip in patent applications to WIPO⁸ and in patent activity generally.

While patent activity will recover, we believe a return to the rapid pace of growth in applications seen in the first half of the decade should not be expected. Our expectations are discussed further in Section 4.

⁸ WIPO, 'World Intellectual Property Indicators 2010', p21: www.wipo.int/freepublications/en/intproperty/941/wipo_pub_941_2010.pdf

3.3 Country of Origin

Figure 7 gives the countries of origin for 2010 fuel cell patent applications. Only countries with more than 30 applications each are shown; 'Others' is the sum of applications from the remainder (see the Appendix for a full list).

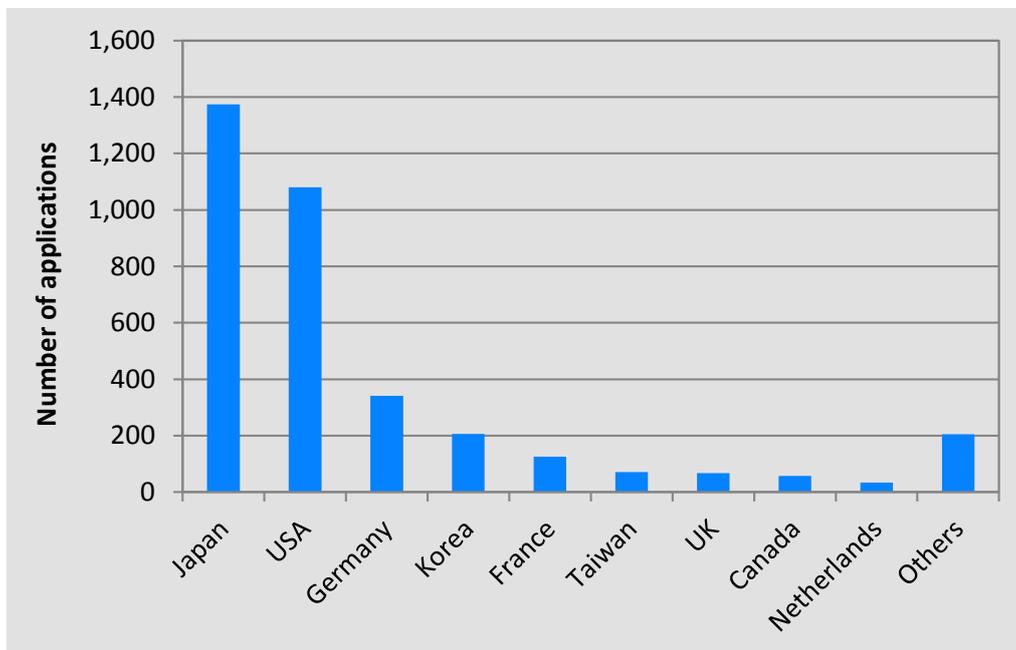


Figure 7: Applications for fuel cell patents in 2010 per country of origin

Japan and the USA continue to dominate and Japan has pulled further ahead of the USA, suggesting a continuation of the trend seen in the numbers of granted patents. However, we need to consider if this is a bias introduced by the inclusion of WIPO publications. A closer look at the data shows this is not the case: applications to WIPO have a similar Japanese proportion to applications made to the USPTO or EPO. Of the 2010 applications, 38% of applications to WIPO were Japanese, as were 35% of applications to the USPTO and 44% of applications to the EPO.

Germany, South Korea and France fill out the rest of the 'top five', indicating that the high level of investment and interest in fuel cell technology in those countries is set to continue into the foreseeable future.

Taiwan has moved up the list, confirming that it is likely to be an increasingly important contributor in this area. It is only four applications ahead of the UK, which continues to be a steady performer. The number of applications from Canada is comparable to the numbers for Taiwan and the UK and there are no signs of a further decline, indicating that it has probably stabilised at or near the 2010 level.

The presence of the Netherlands here suggests that the apparent plateau seen in the number of granted patents from this country is misleading. The number of applications from the Netherlands is also exceptional for another reason. A comparison shows that the

number of applications in 2010 for each country included in Figure 7 is typically about double the number of granted patents for each of those countries in 2010 (Figure 4). However, the number of applications from the Netherlands is almost six times higher, implying a recent surge in development and deployment of fuel cell technology by that country. The comparison is shown in the Appendix.

3.4 Geographic Region of Origin

Looking at the 2010 applications sorted by geographical region of origin (Figure 8), we can infer that Asia will maintain a significant lead in granted patents in the next few years. There is also an indication here that Europe is gaining ground on North America.

Once again, only minimal activity is evident for the Rest of World region, despite the inclusion of WIPO publications, suggesting that we will see little 'catching up' before 2015. In the near future, any demonstrations or commercial fuel cell sales in much of the Rest of World region are likely to be imports or manufactured locally under licence from companies established elsewhere. Of course, there may be domestic developments that are not captured in our data, but we believe the number of purely domestic fuel cell patents in these countries is unlikely to be significant when compared with the rest of our dataset.

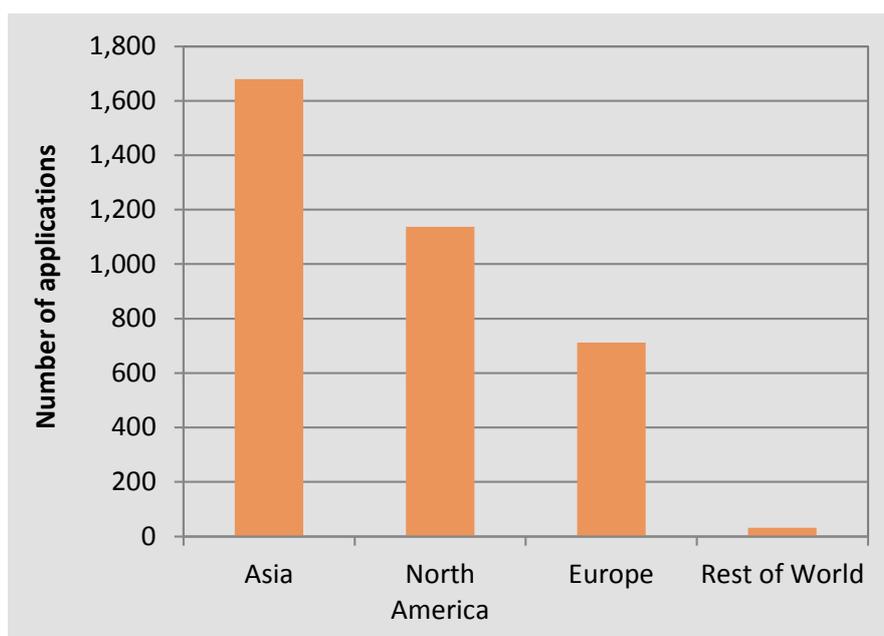


Figure 8: Applications for fuel cell patents in 2010 per region of origin

3.5 Assignees

The top ten assignees for applications published in 2010 are shown in Table II. Comparing this to Table I, it is clear that certain trends are continuing: automotive manufacturers are still very active and Japanese corporations dominate. Samsung continues to be prominent, although it has dropped down the list; this is probably because it is now heading into the production and commercialisation phase.

Table II: Top ten assignees of patent applications in 2010

Rank	2010 Applications
1	Toyota 381
2	Panasonic 141
3	UTC ^a 118
4	Honda 103
5	General Motors 103
6	Samsung 79
7	Daimler 75
8	Toshiba 61
9	Nissan 52
10	Sony 52

Note:

^a Including applications from both UTC Power Corp. and UTC Fuel Cells

Toyota's position at the top of this list is the outcome of a steady ascent, from 10th on the list for granted patents in 2000, to 7th place in 2005 and 4th place in 2010. Not only does Toyota head the list for applications published in 2010, it has a significant and quite astonishing lead – 240 applications more than Panasonic, next on the list. These are likely to keep Toyota in the top ten for granted patents around 2011 to 2013.

There is strong evidence here that Toyota's approach to the development of fuel cell vehicles (FCVs) is much the same as the aggressive patenting strategy it followed in the development of its flagship hybrid vehicle, the Prius. Toyota is intending to position itself to lead commercialisation of FCVs, as it did with gasoline–electric hybrids, and perhaps aiming to profit from licensing its intellectual property to other fuel cell vehicle manufacturers.

It is too soon to tell from patent data to what extent the earthquake and tsunami of March 2011 have affected research and development at Toyota and other Japanese automakers working on FCVs. For this, we would need to wait for the tally of applications filed in 2011.

3.6 Novelty

Not all applications for patents are granted, and even when a grant is being pursued the application may need to be modified and resubmitted. The most stringent requirement is for 'inventiveness' or novelty: the invention must be deemed to be sufficiently different from the technology that preceded it (the prior art) and it must be non-obvious.

In some cases, after a search of the prior art, the patent examiner may decide there is not sufficient novelty embodied in the invention and will then place a query on the patent application. These applications are usually coded with an X or a Y and there is a high probability that they will not be granted as they stand.

The percentage of applications queried in each year is shown in Figure 9.

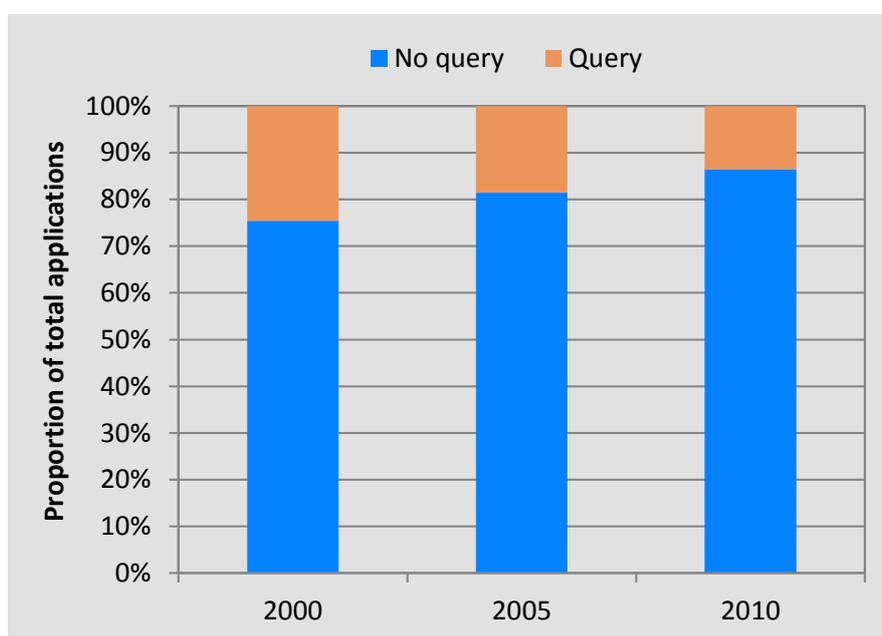


Figure 9: Proportion of total applications with novelty queried

In 2010, out of 3,561 total applications, 483 were rated as either X or Y after the search report. This equates to 13.6% of total applications and is a reduction in comparison to both 2005 (18.5%) and 2000 (24.5%). This shrinking proportion probably reflects two factors: increasing innovation and diversification in the inventions, and better knowledge of fuel cell technology in the patent offices.

The result is that, not only are more fuel cell applications being made each year, a greater majority of these are likely to result in granted patents in the coming years.

4. Conclusions and Outlook

The fuel cell patent numbers in this report reflect the rapid technological progress in the industry from 2000 to 2010, and the advent of commercialisation in that period. The extent of the growth we have reported, while extraordinary, is supported by statistics on clean energy patents reported elsewhere. The Organisation for Economic Co-operation and Development (OECD) has documented a significant rise in 'green' intellectual property from 1999 to 2008, with patents in renewable energy showing the largest increase⁹. The WIPO 2010 indicators similarly show growth in the number of PCT applications in four clean energy technologies: fuel cells, solar, wind and geothermal energy. From 584 applications in 2000, this had increased to 3,424 applications in 2009¹⁰.

For obvious reasons, growth in clean energy technology can be expected to continue outstripping underlying economic growth and its indicators, such as overall patent numbers. Once the dip in applications resulting from the global economic downturn of 2008-9 has worked its way through the system, we expect fuel cell patent numbers to quickly recover and resume growth from 2011 onwards.

Whether there will be a return to the very rapid growth in applications between 2000 and 2005 remains to be seen; our feeling is that this rate of increase is both unsustainable and unnecessary in the longer term. As we have noted, more modest growth in patent numbers is a positive indicator if it reflects a progression from research and development, and the intensive fund-raising phase, to commercial implementation within a maturing industry.

Some predictions for the next five years we can make confidently: Japan will retain its position of prominence in fuel cell patents, followed by the USA and Europe. These regions have built up a solid base of intellectual property over the last decade and are well positioned to reap the benefits of that as commercialisation gains momentum. The most rapid growth in intellectual property will likely be in South Korea, China and Taiwan, and we expect these to become powerhouses in the industry over the next decade.

What this analysis has also confirmed is the extent of the commitment to fuel cell technology by automotive OEMs. The patent numbers in this report show that major manufacturers such as Toyota, Honda and General Motors have sunk significant resources into this area. For fuel cell vehicles, and for the wide range of other applications for fuel cells, the rapid increase in patent activity in the decade 2000 to 2010 reflects growing confidence in fuel cell technology.

⁹ OECD, 'Towards Green Growth: Monitoring Progress: OECD Indicators', OECD Publishing, 2011, p112: <http://dx.doi.org/10.1787/9789264111356-en>

¹⁰ WIPO, 'World Intellectual Property Indicators 2010', p10: www.wipo.int/freepublications/en/intproperty/941/wipo_pub_941_2010.pdf

Appendix

Average Growth Projections

Granted Patents: Annual growth rates in all granted patents were taken from the World Intellectual Property Indicators, 2010 Edition, published by WIPO¹¹. Growth rates were available up to 2008. Estimated growth rates for granted patents in 2009 and 2010 were calculated by taking the average of the previous years (2001 to 2008) but excluding 2003 and 2006. This is because the high rates seen in 2003 and 2006 were atypical for the decade and WIPO states that low growth in 2009 and 2010 is most probable. Results are shown in Table III below.

Patent Applications: Annual growth rates in all applications were also taken from the World Intellectual Property Indicators, 2010 Edition, published by WIPO¹². Growth rates were available up to 2009. The estimated rate for 2010 is an average of the preceding two years' rates. This is rounded to zero and accords with expectations of little to no growth in 2010. Results are shown in Table III below and plotted in Figure 1 and Figure 6.

Table III: Projected granted patents and applications using average annual growth

Year	% Overall Growth in Grants	Estimated Fuel Cell Grants	Actual Fuel Cell Grants	% Overall Growth in Applications	Estimated Fuel Cell Applications	Actual Fuel Cell Applications
2000	-	-	403	-	-	1,516
2001	4.0	419	-	5.9	1,605	-
2002	3.8	435	-	-0.1	1,604	-
2003	10.6	481	-	3.0	1,652	-
2004	1.6	489	-	5.3	1,740	-
2005	1.1	494	861	8.1	1,881	4,051
2006	19.5	591	-	5.7	1,988	-
2007	2.5	605	-	4.0	2,068	-
2008	0.6	609	-	2.6	2,121	-
2009	1.5	618	-	-2.7	2,065	-
2010	1.5	627	1,801	0	2,065	3,561

¹¹ WIPO, 'World Intellectual Property Indicators 2010', pp 33, 34

¹² WIPO, 'World Intellectual Property Indicators 2010', pp 22, 23, 33
www.wipo.int/freepublications/en/intproperty/941/wipo_pub_941_2010.pdf

Country of Origin

The number of granted fuel cell patents published in 2000, 2005 and 2010 for each country of origin (as determined by Fuel Cell Today) is shown in Table IV. These are listed in descending order of number of patents granted in 2010.

The number of fuel cell patent applications published in 2010 for each country is shown in Table V, listed in descending order.

Table IV: Number of granted patents per country of origin

Country	2000	2005	2010	Total
Japan	62	243	617	922
USA	188	359	598	1,145
Germany	82	91	187	360
South Korea	4	13	177	194
France	4	6	45	55
Canada	21	75	32	128
UK	12	18	30	60
Taiwan	0	6	30	36
Italy	9	10	18	37
Switzerland	5	13	9	27
Denmark	3	4	9	16
Australia	1	3	8	12
China	0	0	7	7
Netherlands	3	6	6	15
Austria	0	1	4	5
Greece	0	0	4	4
Israel	4	1	3	8
Sweden	0	1	3	4
Belgium	2	1	2	5
Finland	0	1	2	3
Saudi Arabia	0	1	2	3
Singapore	0	1	2	3
Cayman Islands	0	0	2	2
India	0	0	2	2
Norway	1	2	1	4
Ireland	0	0	1	1
Russia	0	2	0	2
Spain	0	2	0	2
Costa Rica	0	1	0	1
Liechtenstein	1	0	0	1
South Africa	1	0	0	1
Total	403	861	1,801	3,065

Table V: Number of patent applications per country of origin

Country	2010
Japan	1,374
USA	1,080
Germany	341
South Korea	206
France	126
Taiwan	71
UK	67
Canada	57
Netherlands	34
Denmark	29
Italy	25
Switzerland	24
Sweden	22
Finland	17
China	15
Israel	13
Singapore	10
Australia	8
Austria	7
Norway	4
Spain	4
Brazil	3
Cayman Islands	3
India	3
Russia	3
South Africa	3
Greece	2
Ireland	2
Turkey	2
Belgium	1
Czech Republic	1
Estonia	1
Hong Kong	1
New Zealand	1
Saudi Arabia	1
Total	3,561

Ratio of 2010 Applications to 2010 Grants

Although there is no direct relationship between the number of granted patents and patent applications in a given year, a comparison allows us to detect an unusual change in the level of patent activity in a given country relative to the others. The ratios in Table VI show that most countries on this list had 1.2 to 2.8 times more fuel cell applications than grants in 2010. The Netherlands, on the other hand, had 5.7 times more applications than grants. This suggests that a substantial increase in fuel cell development activity occurred in that country, between 2005 and 2008–9 (when the applications published in 2010 were filed).

Table VI: Ratio of 2010 applications to grants

Country	Applications	Grants	Ratio
Japan	1,374	617	2.2
USA	1,080	598	1.8
Germany	341	187	1.8
South Korea	206	177	1.2
France	126	45	2.8
Taiwan	71	30	2.4
UK	67	30	2.2
Canada	57	32	1.8
Netherlands	34	6	5.7

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