

# Patenting trends in renewable energy

By James Nurton, freelance writer

From 2002 to 2012, a decade in which innovation was being promoted in the renewables sector, the number of patent applications published under the Patent Cooperation Treaty for renewables increased by 547 percent. Although this figure has declined, in 2019, it was still 3.5 times higher than in 2002.





Photo: alexsi / iStock / Getty Images Plus

The most notable trend since 2002 is the growth of solar technology. In 2002, solar accounted for just over a quarter of published PCT applications for renewables, while in 2019 they accounted for over half of them.

The development of renewal sources of energy (such as solar, wind and tidal) is essential to tackling the climate crisis. What can we learn about them from looking at patent data?

The past decade has seen unprecedented investment in renewable energy, as well as significant development of new technologies. You can see the evidence of this with the proliferation of solar cells and wind turbines dotted across the landscape. But it can also be measured by looking at trends in the number of published patent applications.

Patents are widely used as an indicator of how much innovation is taking place, where and in which fields. Taking a deeper look at the data can therefore provide a range of insights into innovation in this sector.

#### **THE BIG PICTURE**

According to the Global Trends in Renewable Energy Investment 2019 report, published by the UN Environment Programme and BloombergNEF, investment in renewables capacity exceeded USD 250 billion each year from 2014 to 2018. Taking the decade as a whole, the report estimates that a total of USD 2.6 trillion was invested worldwide. By 2019, renewables in total (including large hydro) represent 26.3 percent of total electricity produced worldwide.

However, the investment picture varies from year to year. While investment in 2018 was high, it was actually lower than in 2017, as the authors of the Global Trends report

explain: “Yes, the 2018 global investment figures were 12 percent down on the previous year, but this is not a step backwards. Renewable energy, particularly solar photovoltaics, is getting cheaper.”

As Yongping Zhai and Yoonah Lee explained in an article for the World Economic Forum, investment in renewable energy is slowing down, but this is not necessarily bad news. “The slower growth in renewable energy investment can be attributed mainly to falling costs in solar and wind globally, and to the change in market conditions with reduced subsidies in many countries ... In other words, the needed investment is lower for installing the same level of solar or wind power capacity,” the authors note.

It is worth bearing these factors in mind as we take a look at trends in patenting in the renewable energy sector.

#### **PATENTS AND RENEWABLE ENERGY**

The WIPO-administered Patent Cooperation Treaty (PCT) is widely used by inventors seeking patents internationally. By filing a single PCT application, applicants can seek patent protection for an invention in more than 150 countries that have signed up to the pact. The granting of patents, however, remains under the control of national or regional patent Offices.

Under the PCT system, a patent applicant can file an international application, which triggers the process of seeking to acquire rights in multiple jurisdictions. Importantly, the application is normally published 18 months after the earliest filing date, meaning that the invention is publicly disclosed at that point. After this, the patent is examined and (if it fulfills relevant patentability criteria) granted by each national or regional patent office in which protection is sought. If granted, patents are normally valid for up to 20 years from the filing date, subject to the payment of maintenance fees. When patent rights lapse, the technology in question enters the public domain meaning the public is free to use it without risking a lawsuit.

Studying trends in the number of international applications published under the PCT can provide a valuable insight into technology trends worldwide, as long as a couple of limitations are kept in mind. First, the PCT figures do not represent all inventive activity worldwide: some inventors may choose to file individual patent applications nationally or regionally instead of using the PCT system or may opt not to file patents at all. Second, the publication data provides a snapshot of trends at the time of publication, which is normally 18 months after a patent is filed, and many years before the patent expires; it does not tell us how long a patent remains valid for, or how the patent is commercialized or licensed in the market.

“Increasing the use of renewable energy is key to limiting global warming to 1.5°C.”

## OVERALL TRENDS

As Figure 1 shows, the total number of international applications filed and published under the PCT for renewable technologies increased each year from 2002 to 2012, when it peaked at 4,541. Since then, the number of applications declined each year from 2013 to 2018, although figures increased slightly in 2019.

To put these data in context, 237,378 PCT applications were published by WIPO across all technologies in 2018, meaning the proportion of patents for renewables was just over 1 percent. This is small compared to areas such as computer technology, digital communication, medical technology and pharmaceuticals, each of which accounts for at least 6 percent of international applications.

However, the growth rate in renewables is impressive: from 2002 to 2012, the number of PCT patent applications published for renewables increased by 547 percent. This corresponds to the decade in which most investment was being made in the sector, and innovation was being promoted. And, although the total number of PCT publications has declined since the peak of 2012, in 2019 it was still 3.5 times higher than in 2002.

Another way to measure trends is to look at patent families. A patent family includes all the national/regional patents with the same priority date; in other words, it helps to measure both the number of innovations and the number of markets in which they are filed. Using this measure, the total number of patent applications relating to renewables, based on the filing year of the first listed application, increased from 10,463 in 2002 to a peak of 27,089 in 2011. In 2017 (the most recent year for which data is available) the number was 24,027.

What can we deduce from all these figures? It is important to remember that patents are a long-term investment. For example, a patent applied for in 2012 could still be valid in 2032. The patent applicant can commercialize the invention at any point during that time, either through developing products or services incorporating the patented technology, or by licensing it to others.

The inventions relating to renewable energy that were being patented during the 2002–2012 boom are therefore likely to be seen in commercially available products and services today and in the coming decade. The evidence from these statistics is that a lot of innovation has taken place in this sector since 2002 and now we are just

beginning to see the benefits of these inventive efforts. Moreover, by breaking down the statistics by type of technology we can identify trends in the renewable sector.

Figure 1

Publication year	Total renewables
2002	831
2003	1,084
2004	1,123
2005	1,464
2006	1,701
2007	2,048
2008	2,575
2009	3,090
2010	3,662
2011	4,272
2012	4,541
2013	4,308
2014	3,556
2015	2,752
2016	2,477
2017	2,606
2018	2,689
2019	2,863

Source: Economics and Statistics Division, WIPO.

## TECHNOLOGY BREAKDOWN

The total number of published PCT applications for renewable energy can be divided into the four main sectors: solar power, fuel cells (which generate electricity through chemical reactions), wind energy and geothermal (using heat from under the earth).

The most notable trend since 2002 is the growth of solar technology (see Figure 2). In 2002, solar accounted for just over a quarter of published PCT applications for renewables, while in 2019 they accounted for over half of them.

Over the past 17 years, the number of published PCT applications relating to solar power increased by 678 percent. Solar has been the leading technology every year since 2009. It peaked in 2012, when 2,691 international patent applications were published. This investment in innovation reflects the growth of solar power generation around the world: the Global Trends report referred to above found that there was only 25 Gigawatts (GW) of solar capacity at the end of 2009. In the period 2010 to 2019, an additional 638 GW were available.

The data for solar contrasts with that for fuel cell technology, which peaked earlier in 2008, when it was the leading technology category. Since then, the number of published patent applications has dropped by about one half. In 2019, international patent applications for fuel cell technology accounted for just 19 percent of renewables.

The number of published international patent applications for wind energy has fluctuated considerably, although the overall trend is one of growth. In 2019, they accounted for 28 percent of publications in the renewables sector. However, international patent applications relating to geothermal energy accounted for just 1.4 percent of those published in the sector.

Figure 2

Publication year	Solar	Fuel cell	Wind energy	Geothermal
2002	218	488	120	5
2003	239	640	194	11
2004	252	696	170	5
2005	403	902	148	11
2006	526	971	193	11
2007	722	1,045	263	18
2008	997	1,173	385	20
2009	1,536	976	530	48
2010	2,026	834	767	35
2011	2,522	854	848	48
2012	2,691	883	914	53
2013	2,465	921	875	47
2014	1,846	949	714	47
2015	1,290	819	608	35
2016	1,296	647	508	26
2017	1,374	577	619	36
2018	1,363	571	713	42
2019	1,479	537	807	40

Source: Economics and Statistics Division, WIPO.

## REGIONAL BREAKDOWN

Another way to analyze patent trends is to look at where the patent comes from. The country of origin of the applicant must be stated in the application and where there is more than one applicant, the data is based on the first one listed.

Based on this analysis, over the decade 2010 to 2019, we can see that Japan tops the leader board with respect to the total number of patent applications for renewables in general, and for both solar and fuel cell technologies. The United States ranks highest for geothermal technology (see Figure 3) and in wind energy, Denmark is top ranked, followed by Germany.

However, if we look at the second half of the decade, the picture is somewhat different. While Japan still leads the way with a total of 3,114 published international patent applications for renewables, and the United States remains second with 2,247, China has risen to third place with 1,522. Of the total number of published applications from China, 1,115 are in the field of solar technology, where China has made great advances in recent years: in 2017, China became the first country to pass 100 GW of solar capacity. Its aim is to reach 1,330 GW by 2050.

China is also comfortably ranked number one when we look at patent families. In the period 2013 to 2017, for example, counting entire patent families, 45,472 patents originated from China, more than twice the number originating from Japan, which is ranked second (21,386). The trend is driven by solar technology, where Chinese applicants have three times the number of patents compared to those in Japan.

The contrast between the data on published patents and patent families is interesting as it indicates that applicants from China are applying for patents in more jurisdictions compared to those from other regions. This in turn suggests that the inventions being patented may have greater potential for commercialization around the world.

Figure 3

Top origins	Top renewables	2010-2019			
		Solar	Fuel Cell	Wind energy	Geothermal
Japan	9,394	5,360	3,292	702	40
U.S.	6,300	3,876	1,391	927	106
Germany	3,684	1,534	813	1,309	28
Republic of Korea	2,695	1,803	506	360	26
China	2,659	1,892	189	555	23
Denmark	1,495	52	81	1,358	4
France	1,226	660	348	184	34
U.K.	709	208	271	218	12
Spain	678	341	29	300	8
Italy	509	316	57	123	13

Source: Economics and Statistics Division, WIPO.

## IMPROVING TECHNOLOGIES

Increasing the use of renewable energy is key to limiting global warming to 1.5°C above pre-industrial levels, one of the goals set by the Paris Agreement. A 2018 report by the UN Intergovernmental Panel on Climate Change (IPCC) looked at various scenarios and projected that, to meet the 1.5°C target, renewables need to supply between 70 percent and 85 percent of electricity by 2050. It added: “While acknowledging the challenges and differences between the options and national circumstances, political, economic, social and technical feasibility of solar energy, wind energy and electricity storage technologies have substantially improved over the past few years ... These improvements signal a potential system transition in electricity generation.”

The evidence from the publication of patent data supports this finding and suggests that innovation in the renewables sector took off in the decade up to 2012, particularly in solar technologies. Over the next few years, we will see how that innovation helps to tackle global warming in practice.