

Annex 1

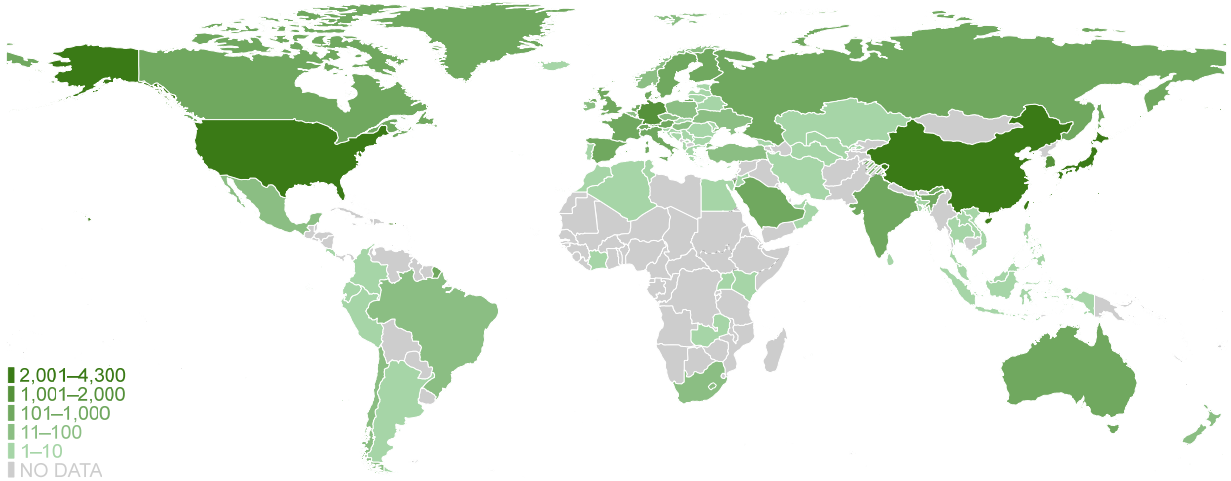
Figure 1 Trend in Green Energy patent applications filed under the PCT



Source: WIPO IP Statistics Database applying the WIPO International Patent Classification (IPC) Green Inventory.

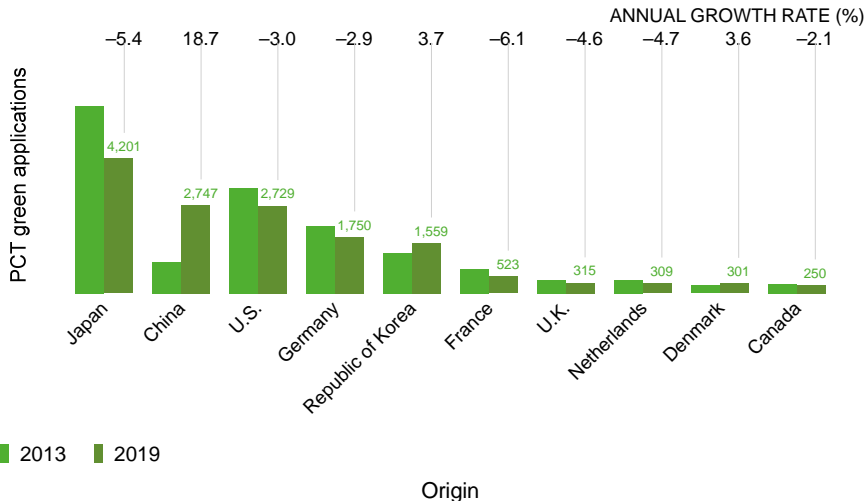
The PCT shows that green innovation is emerging from all over the world. However, as illustrated in Figure 2, a few countries, where international patent applications were originally filed, account for the vast majority of applications. The top five such countries in 2019 (Japan, China, U.S., Germany, and the Republic of Korea) accounted for over 76% of all green patent applications filed under the PCT. Of the top ten countries, all but China and the Republic of Korea experienced declined (see Figure 3). The growth of Chinese PCT filings in the field has been extraordinary in most green energy technologies. Notably, China has become a world leader in the patenting of green transportation technologies in recent years.

Figure 2: Green patent applications filed under the PCT, 2019



Source: WIPO IP Statistics Database applying the WIPO International Patent Classification (IPC) Green Inventory.

Figure 3: Green patent applications filed under the PCT by top origins, 2013 and 2019



Source: WIPO IP Statistics Database applying the WIPO International Patent Classification (IPC) Green Inventory.

PCT green energy technologies can be divided into two broad categories: Alternative energy production and efficient energy use/consumption. Alternative energy production includes all green technologies that go into the actual production of energy, e.g. solar photovoltaic or waste heat collection for electricity generation. Efficient energy use includes all technologies that apply to the final consumption of energy e.g. light bulbs that are more efficient or aerodynamic panels that reduce drag on trains.

Table 4 PCT green energy technology breakdown

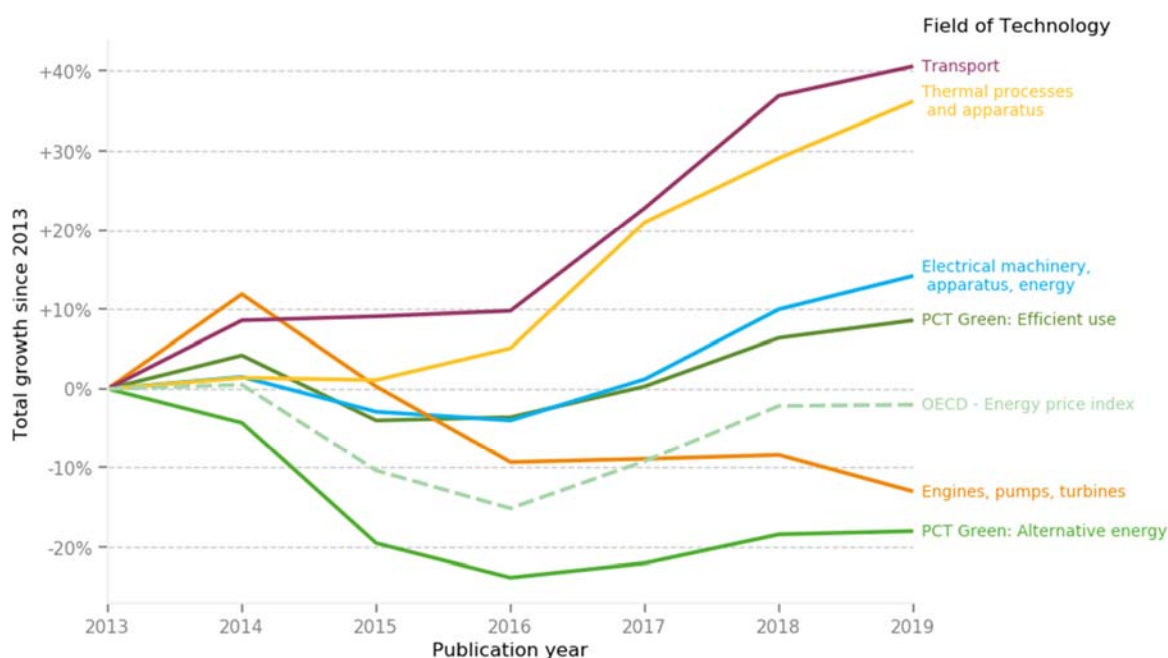
Green Technology	2013	2016	2019	Average Annual growth 2013 to 2019	Total Growth 2013 to 2019	Share of PCT Green appl. (2013 %)	Share of PCT Green appls. (2019 %)
Alternative Energy Production	9,322	7,099	7,646	-3%	-18%	52%	45%
Bio-fuels	2,088	1,852	1,866	-2%	-11%	12%	11%
Solar	2,842	1,604	1,766	-8%	-38%	16%	10%
Fuel cells	1,241	1,021	1,105	-2%	-11%	7%	7%
Wind	820	522	859	1%	5%	5%	5%
Manmade waste	761	680	716	-1%	-6%	4%	4%
Nuclear	543	510	468	-2%	-14%	3%	3%
Hydro energy	344	289	300	-2%	-13%	2%	2%
Geothermal energy	285	255	282	0%	-1%	2%	2%
Waste heat	253	260	203	-4%	-20%	1%	1%
Efficient Use/ Energy Consumption Total	8,558	8,248	9,294	1%	9%	48%	55%
Energy Conservation Total	6,210	6,101	6,800	2%	10%	35%	40%
Power supply circuitry	3,290	3,351	3,511	1%	7%	18%	21%
Low energy lighting	2,175	2,073	2,383	2%	10%	12%	14%
Storage of electrical energy	444	395	547	4%	23%	2%	3%
Thermal building insulation, in general	300	282	360	3%	20%	2%	2%
Transportation Total	2,260	2,066	2,321	0%	3%	13%	14%
Rail vehicles	523	518	734	6%	40%	3%	4%
Charging stations	268	283	383	6%	43%	1%	2%
Human-powered vehicle	193	285	324	9%	68%	1%	2%
Hybrids	613	385	304	-11%	-50%	3%	2%
Electric	456	313	285	-8%	-38%	3%	2%
Hydrogen	74	125	105	6%	42%	0%	1%
Vehicles in general	69	70	99	6%	45%	0%	1%
Heat – pumps	60	47	131	14%	120%	0%	1%
Total	17,880	15,347	16,940	-1%	-5%	100%	100%

Source: WIPO IP Statistics Database applying the WIPO International Patent Classification (IPC) Green Inventory.

Although PCT green patent applications have declined overall since 2013, most of that decline is due to the drop in alternative energy technologies, which fell 18% (table 4). In contrast, patent applications for technologies that improve efficiency actually increased by 9% in that same time period. This rise was driven by energy conservation tech (10%) and to a lesser degree by Transportation (3%).

That efficient use technology has performed better than alternative energy may reflect activity in global energy markets. The price of energy and commodities took a large fall after 2014, which may have reduced the incentive to find sustainable green energy sources (see also the [WIPO Global Innovation Index 2018](#) on this point). This is reflected in Figure 5 where trends in energy markets correlate with the OECD energy price index (dashed line). Efficient-use technologies also fell slightly in conjunction with energy prices, but not to the same degree.

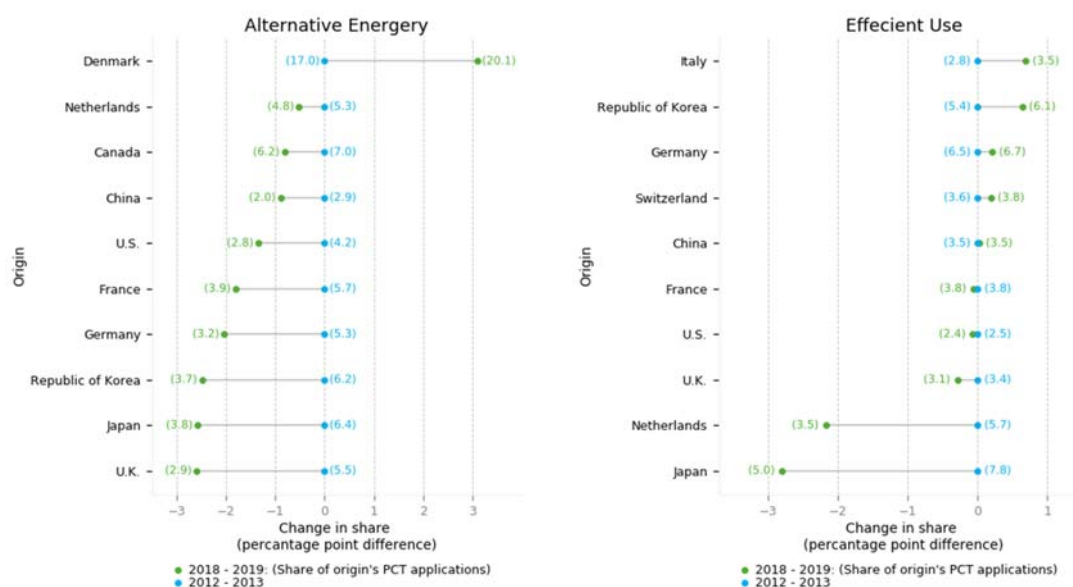
Figure 5 Technology Trends 2013 – 2019



Source: WIPO IP Statistics Database applying the WIPO International Patent Classification (IPC) Green Inventory, and OECD energy price index.

As can be seen in Figure 5, green technologies have not kept pace with their related technology fields. The recent drop in green technology is also reflected across countries. The share of alternative energy patents to total patents has fallen in the majority of the top origins (see Figure 6). China and the Republic of Korea, both of which have experienced overall growth in green technology in absolute terms, experienced a 0.9 and 2.5 percentage point decrease respectively in the share of alternative energy patents. Shares of efficient-use patent applications fair slightly better with 5 out of the top ten origins experiencing gains, although those gains are modest.

Figure 6 Green share of total PCT patent applications



Source: WIPO IP Statistics Database applying the WIPO International Patent Classification (IPC) Green Inventory.

About:

For the full methodology on the WIPO International Patent Classification (IPC) Green Inventory, and earlier analysis corroborating above findings, see:

Fushimi, K, Bergquist, K., Rivera León, L, Xu, N., and S. Wunsch-Vincent (2018) Measuring innovation in energy technologies: green patents as captured by WIPO's IPC green inventory, Economic Research Working Paper No. 44, Geneva: WIPO. <https://www.wipo.int/publications/en/series/index.jsp?id=138&sort=code>.

Dutta, S. et al. (2018). The Global Innovation Index 2018: Energizing the World with Innovation [Chapter1], Geneva: Cornell, INSEAD, and WIPO. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2018-chapter1.pdf.