

What can patent data tell us about the state of progress in the development of green technologies?

The 2022 edition of Appleyard Lees' annual *Inside Green Innovation: Progress Report* examines patent data, in industry context, as a barometer of green innovation activity.

The data-driven report gets behind the rhetoric, to shed light on the state of progress in the development of green technologies. How close are we to finding the technological solutions that will be so important for achieving sustainability? Where, and by whom, are these innovations being developed?

This article highlights some of the report's key findings related to chemistry-focussed innovation.

2020 spike in biodegradable plastics innovation ends two decades of decline in patent applications

After almost two decades of decline, there has been a sharp spike in biodegradable plastics-related patent applications. Technology innovation in this area peaked in 2020, when 423 priority patent applications were filed – an almost 130% increase on 2018 (186) and the most prolific patent filing year since 2000 (294).

The largest sub-group within biodegradable plastics patent applications was related to butylene-based bioplastics. Many of these applications focused on improvements to biodegradable packaging and single-use items. Butylene-based polymers are biodegradable and as such, are anticipated to become more important in the global transition to bioplastics because they have properties that are parallel to conventional plastics.

In the case of monomers, patent data research reveals that pyrolysis – a process for decomposing plastic feedstock into smaller hydrocarbons – is currently taking the top spot among regeneration recycling technologies. In 2020, this technology accounted for about 70% of patent filings among the four most common decomposition recycling approaches.

Innovation activity is dominated by Eastman Chem Co., with more than 70 patent applications for plastics recycling technologies in 2019-20 alone, followed by Sabic Global Technologies, whose applications include technology to process plastic waste by hydrotreatment and pyrolysis.

Increasing innovation in hydrogen fuel cells for use in transportation

According to the report, innovation in the priority energy technology of green hydrogen is reaching record highs. While the patent filing rate for green hydrogen production via electrolysis of water has increased steadily since the 1990s, it leapt by 160% in the second half of the 2010s.

In recent years there has been a notable upsurge in patent filings for the use of blue and green hydrogen in fuel cells to power transport, particularly for trains, buses, trucking and lightweight aircraft. Increased innovation in hydrogen fuel cells is being driven by improvements in electrical and mechanical engineering and focused on safety and function – such as gas detection – diagnosis of faults in pressure and control of valves and machinery, important for commercial transport.

However, for widespread application in cars, for example, the distribution and storage of hydrogen, as well as the re-fuelling of hydrogen tanks, are major challenges to be met before this energy source can realistically find mass application outside of the heavy-transport sector.

Innovation in carbon capture utilisation and storage (CCUS) has reached highest peak since 2012

The report points to a steady upturn in CCUS patent filing numbers in recent years, with more than 140 in 2020 – approximately 60% higher than 2015 – and an ongoing increase expected from 2021-22. Half of the new, priority patents filed in 2020 relate to direct air capture, where innovation is needed to address this emerging technology's current challenges.

Innovation in direct air capture has shown considerable growth over the past decade. For CCUS, it is expected to be a necessary part of meeting climate goals, though it comes with challenges such as the lower concentration of carbon dioxide in air compared to gas power stations. Further technology advances will be required to reduce the cost of large-scale adoption.

Innovation in this area of CCUS is currently led by companies such as Climeworks AG in Switzerland, which uses filters containing amines which bind carbon dioxide from the air. The company launched "Orca", the world's largest direct air capture and storage plant, in 2021, while its "Mammoth" plant project – expected to capture 36 kilo-tonnes of carbon per annum when operational – was announced in June this year.

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