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In this issue:

Protecting your sustainability credentials	04
IP for a sustainable future	05
Green claims in the spotlight	06
Green patent filings	08
Smart grids	10
Green branding & regulated language	11
Marine microplastic detection	12
Greentech IP essentials	14
New ideas for old batteries	16
Sustainable spaceflight	17

Sustainable data centre patent strategy
Claims, supply and location



Full Story Page 02

Editorial

The conclusion to COP31 has underlined the complexity of reaching international consensus on climate action. While countries were unable to agree an overarching outcome, the practical challenges of addressing climate change, and the need for innovation and implementation, remain.

For those of us working in intellectual property, that makes the innovation taking place particularly relevant. New technologies raise questions about how ideas are protected and commercialised, while businesses must consider how they protect their brands and communicate environmental credentials responsibly.

In this special edition newsletter, colleagues from across D Young & Co have explored sustainability and climate technology through an IP lens, considering emerging technologies alongside practical patent, trade mark and wider intellectual property issues.

The international policy landscape may be uncertain, but research, innovation and commercial activity continue. We hope this collection is thought-provoking and useful, offering practical perspectives on the role intellectual property can play as businesses develop and bring forward new technologies and more sustainable solutions.

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Data centres

Sustainable data centre patent strategy
Claims, supply and location

The growth of artificial intelligence (AI) and cloud computing is increasing the importance of efficient data centre infrastructure. The notorious demands for water and electricity to operate these facilities presents opportunities for technical innovation. However, obtaining commercially useful patent protection requires more than identifying a technical solution to an environmental problem. It is also important to consider how an invention will be supplied, where it will be used, and whether infringement could be identified.

Where is innovation occurring?

Cooling is one important area. Evaporative cooling consumes water as part of the heat removal process, whereas closed-loop arrangements recirculate coolant. Developments intended to reduce water consumption include improved cooling loops and systems using fluids other than water. The way heat is ultimately rejected also matters, with some developments targeting efficient heat exchangers to extract the heat from the closed loop. From a patent perspective, room for inventions might lie in the arrangement of fluid pathways, the interaction of cooling components, or the way circulation is controlled, rather than in an entirely new component.

Electricity consumption presents a different set of challenges. A large facility supporting cloud-based AI workloads may have a substantial, relatively sustained power requirement, while a smaller edge data centre serving nearby users may experience greater fluctuations with demand. Improvements may therefore concern both the computer hardware used to process a workload and the techniques used to manage operation. For example, specialised processing hardware may reduce the energy needed for a given task, while a scheduling technique could defer non-critical workloads to quieter periods to smooth peaks in power demand.

Protecting the right part of the infrastructure

A data centre is not generally supplied as a single finished product. Equipment may be provided by several suppliers and connected on site by an operator or specialist installation contractor. A cooling invention might use otherwise conventional pumps, pipes and heat exchangers arranged in a new way. If a patent claim requires the entire installed arrangement, the claimed configuration may only come into existence at the data centre. Supplying an individual component would not necessarily directly infringe that claim. This can be disadvantageous where the inventive contribution lies in one or more sub-components, because those components may be manufactured, bought and sold without falling within the scope of a claim directed only to the complete installed system.

Enforcement may then depend on proving that the components have been combined and operated in the claimed arrangement, rather than addressing their manufacture or supply at an earlier stage. This can be particularly difficult once the data centre has been constructed, since the relevant equipment may be located in a secure or inaccessible facility, making it difficult to inspect the installation or determine whether the patented combination is present. These practical difficulties can reduce the commercial value of protection drafted solely around the completed data centre.

It is therefore worth considering whether the inventive concept can be protected at the level of individual subsystems, controllers or other separately supplied apparatus, which can be manufactured and protected independently. For a cooling-loop invention, for example, it may be possible to define the relevant fluid connections and control features without requiring the servers themselves to form part of the claimed apparatus. This can avoid making protection unnecessarily dependent on the particular computing equipment being assembled with the cooling system.

Applicants should bear in mind that this is not simply a matter of removing features to make a claim broader – the claim must still define a new and inventive technical contribution. Where a particular hardware component

Related article
Cross-border computer systems: patent infringement across multiple jurisdictions: dycip.com/computer-systems-cross-border

Sustainable data centre tech can create valuable opportunities for patent protection



provides that contribution, apparatus claims may offer a useful opportunity to address manufacture and supply before installation. Where the contribution lies only in the assembled arrangement, system or method claims may remain essential. We recommend discussing the intended supply chain with a patent attorney as early as possible.

Where should protection be sought?

Patents are territorial, so the physical location of a data centre can be particularly important for an invention implemented only after equipment has been installed. Protection in a supplier's home country may provide limited assistance if the claimed system is assembled and operated elsewhere. Conversely, a patent covering a separately supplied inventive apparatus may be relevant in a country where that apparatus is made, even if the eventual data centre is elsewhere. The relevant countries can therefore differ depending on what is claimed.

Country selection should reflect likely deployment locations as well as manufacturing and supply markets. Larger economies such as the United States may be an important candidate for many businesses, but it should not be the only location considered. There are some noticeable trends to deploy data centres to more remote high-latitude locations, such as the Nordics, due to more abundant renewable power and natural cooling possibilities. Location preferences and infrastructure investment can change, so filing decisions should be informed by the applicant's customers, competitors and expected markets rather than assumptions about where data centres, or the companies that operate them, are traditionally found.

In Europe, there are several ways of obtaining effective patent protection. Upon grant of a European patent, the applicant has a choice of validating the patent in whichever countries are most useful for a particular business strategy. Alternatively, with the introduction of unitary patents, applicants can obtain more cost-effective protection across all participating countries. This can be particularly useful, for example, where data centres could be situated in such a variety of locations. The appropriate combination of unitary protection and national rights will depend on the geographical coverage required and the applicant's wider strategy.

Cross-border operation raises a further issue where, for example, a customer's device is in one country and the data centre providing the service is in another. We discussed these considerations in our article "Cross-border computer systems: patent infringement across multiple jurisdictions": *dycip.com/computer-systems-cross-border*.

Practical advice

For inventions with an environmental benefit, the UK Intellectual Property Office's (UKIPO's) "Green Channel" offers a route for accelerated processing, which may help obtain an early patentability assessment during the priority year before major overseas filing decisions are made. More generally, a useful starting point is to identify the technical contribution, the equipment or process that embodies it, who supplies or operates that equipment, and where those activities will occur.

Sustainable data centre technology can create valuable opportunities for patent protection, but there is no single filing or claim strategy suitable for every development. We recommend seeking advice from a patent attorney familiar with the technology and explaining how the invention is intended to be commercialised to reach an appropriate claim scope and international filing strategy.

Authors:
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Protecting your sustainability credentials Registered trade marks, certification and collective marks

While it is very important to protect, where possible, a sustainable product or invention via patents or registered designs, it is becoming equally important for businesses to protect their sustainability credentials via registered trade marks, certification or collective marks. The commercial value of protecting verifiable environmental claims should not be ignored but how is it best for a business to do so?

Protecting sustainability credentials can bring real value to your business



Registered trade marks

It may be possible to protect green attributes and sustainability credentials via word or logo trade marks. However, for a trade mark to be inherently registrable in the UK it must be distinctive and not merely a commonplace promotional message or statement. For example, "SUSTAINABILITY IS OUR GOAL" would not be an inherently registrable trade mark. Trade marks which merely describe a characteristic of the specified goods or services will also be refused registration. Therefore, using words such as "green", "eco", "sustainable", "recycled" or "renewable" in a trade mark may invite an inherent registrability objection unless combined with distinctive trade mark matter such as a highly stylised logo.

Care must also be taken when using words associated with sustainability in a trade mark, as this could invite an inherent registrability objection based on the fact that the public could be deceived if the goods or services to be protected are not in fact "green" or made from "recycled" materials. This is a marketing tactic known as "greenwashing" where companies present their products as environmentally friendly when in fact they are not.

Certification marks

A certification mark indicates that the goods and/or services in connection with which it is used are certified by the proprietor of the mark in respect of origin, material, mode of manufacture of goods or performance of services, quality, accuracy or other characteristics.

The main feature of a certification mark is that it is used not by the proprietor of the mark but instead by their authorised users for the purpose of guaranteeing to the relevant public that goods or services possess a particular characteristic.

The proprietor's mark certifies the presence of the characteristic and they can authorise the use of the mark to anyone who can demonstrate that the goods and services for which it will be used have that characteristic. This may be particularly relevant to promoting a sustainability credential because it provides consumers with a clear indication of a product or service's adherence to a specific environmental standard.

It is a fairly complex procedure to obtain a certification mark as applications must be supported by a set of regulations, which include who is authorised to use the mark and on what basis, and how the proprietor tests those characteristics and supervises use of the mark. The UKIPO will examine these regulations to ensure that they are clear and easy to understand.

Collective marks

A collective mark is a mark distinguishing the goods or services of members of the association which is the proprietor of the mark from those of other undertakings.

The main feature of a collective mark is that it is used as an indication to the relevant public that goods or services originate from a member of a particular association. It is therefore a sign of membership.

Collective marks are often owned by trade associations, government departments or technical institutes to indicate that goods or services comply with certain practices. In the sustainability sector this could mean that they comply with certain environmental practices or sustainable manufacturing processes. By using collective marks, businesses can demonstrate their commitment to sustainability. This is helpful for consumers so that they can make informed choices based on the sustainability credentials of the provider.

Other legal considerations

"Sustainable" trade mark claims are primarily controlled through a combination of the Competition and Markets Authority's (CMA) Green Claims Code, ASA enforcement on misleading environmental advertising, alongside broader consumer protection rules and, for FCA-authorised firms, anti-greenwashing rules, and as discussed above, the Trade Marks Act 1994. In addition, the European Union Empowering Consumers Directive (EmpCo Directive) has now come into effect, and while this has not been implemented in the UK, UK businesses selling to or targeting consumers in the EU should be aware of these new rules.

Finding the right route to protection

Protecting your sustainability credentials can bring real value to your business, but choosing the right route - and avoiding potential pitfalls - is key. We can help you explore the options and develop a protection strategy that supports your business goals, so you can communicate your sustainability credentials with confidence.

Author:
Kate Cheney

Intellectual property for a sustainable future
Collaborating for change

Useful links

COP31 Priorities: dycip.com/cop31-priorities

LIQUID3: dycip.com/liquid30

Harnessing nature's power: collaborative effort explores algae for lower-carbon road construction: dycip.com/tarmac-algae-roads

ALGIECEL: dycip.com/algiecel

ENLIL: dycip.com/enlil

Alpha311: dycip.com/alpha-311

UKIPO Licensing IP: dycip.com/ukipo-licensing-ip

Highway-integrated vertical-axis wind turbines for harvesting induced wind for the generation of electricity: A critical review: dycip.com/ScienceDirect-highway-wind

At COP31 2026, the Presidency Priorities will focus on driving implementation through cooperation and collective action. Countries can trade internationally transferred mitigation outcomes (ITMOs), often called carbon credits, linked to financial and technical support for climate targets. This article looks at UK patent-system incentives for developing and sharing green technology, using hypothetical resilient-city examples relevant to this year's priorities: electrification, resilient cities and buildings, and green industrialisation.

The United Nations Emissions Gap Report 2026 emphasises that opportunities for improvements are greater than ever.

> With technology developing fast, the challenge is implementation. How can the IP system incentivise the development and implementation of greentech?

Development: innovation, investment and IP

Innovative technologies are likely to acquire patent protection for the companies and individuals behind the invention. Patents can help attract investors to fund development. This is part of the justification for the "patent bargain": a granted patent gives inventors a temporary monopoly, enabling them to recoup research and development costs through commercial exploitation of their IP.

One way the UK incentivises this research and development is the "Patent Box", a reduction in corporation tax which is given to companies that own and exploit patents. The UKIPO also offers a "Green Channel" for accelerating the processing of patent applications which pertain to environmentally friendly inventions. And indeed, there are some statutory provisions which provide exceptions (or defences) to patent infringement. Section 60(5)(b) of the Patents Act provides that acts done for "experimental purposes" do not infringe, so it is perfectly legitimate to undertake research relating to patented technologies.

Algae photobioreactor tanks offer an alternative for trees where urban conditions make planting unsuitable, with considerable potential to improve air quality in dense cities. Liquid3 uses a solar panel to capture and store daytime energy, powering artificial lighting for photosynthesis at night. However, low sunlight availability may limit its effectiveness. Other emerging uses include algae biomass as bio-bitumen, a lower carbon alternative for bitumen for more sustainable road construction, and algae-derived ingredients for food and cosmetics.

Another promising urban technology is the vertical axis wind turbine (VAWT). VAWTs may be deployed alongside roads to harvest energy from vehicle-induced turbulence. Proposed technologies such as Alpha 311 may retrofit turbines onto existing infrastructure such as streetlights. As transport electrification accelerates, infrastructure to meet road users' growing electricity demand is increasingly important.

You may already see potential for collaboration here; by replacing or supplementing photobioreactor solar panels with VAWTs on roads, this might potentially improve the effectiveness of the technology in regions with low sunlight availability. Perhaps the grown algae can be used for one of the described further purposes. But none of the individual entities would be likely to secure a patent by merely combining their own invention with someone else's, and a patent only protects against infringement and does not guarantee freedom to operate. There is an important balance between IP rights avoiding unnecessary restrictions on progress and offering a strong financial incentive, to help innovative green technology become widespread more quickly.

Implementation: commercialisation, co-operation, and competition

How else can the government incentivise the actual implementation of these novel solutions? It's important for governments to offer the right incentives and infrastructure for businesses to collaborate. Current "crown use" statutes authorise the government to utilise patented inventions without infringement. This is currently limited to foreign defence, drugs and medicines, and atomic energy. Green inventions therefore require the government to cooperate with rights holders.

Possible ways to encourage businesses to cooperate with each other and with the UK Government to implement green technology would be to use the "Licence of Right" declaration for patents, which is an endorsement you can register that entitles you to half the cost of renewal fees for maintaining your patent. It means that you must offer a licence to interested parties, but the terms and fees of such licences are still yours to determine. Alternatively, if a patent has been granted for more than three years and if it is not being commercially "worked" in the relevant territories, then anyone can apply to the comptroller for a "compulsory licence", subject to certain provisions.

IP rights are not the sole consideration when integrating technology with public infrastructure. Governmental requirements apply to public property, especially where public safety is affected. These technologies may also require significant green infrastructure investment from municipal authorities such as councils, whose budgets differ.

Lessons for businesses

Incentives exist in the patent system for investing in green technology, and once patents exist, provisions are available for both collaboration and earning a return on investment. This may lead to collaboration with competitors, by licensing the technology or cross-licensing on favourable terms. If a patented technology isn't actively being exploited, businesses can investigate the potential for a compulsory licence. Opportunities exist to utilise green technology for both the good of the planet and mutual commercial gain, and the patent system can support that effort.

Author:
Kara Richards

Green claims in the spotlight at COP31
Germany's new rules on green claims now in force

Environmental claims have become a staple of modern marketing, but the legal framework governing them in Germany has now tightened. Since 27 September 2026, Germany's reformed Act Against Unfair Competition (UWG), which implements the EU Empowering Consumers for the Green Transition Directive (EmpCo Directive), has imposed targeted restrictions on green claims. Generic environmental statements, advertising premised on greenhouse gas offsetting, and sustainability labels without recognised certification are now prohibited. Importantly for brand owners, the rules reach beyond advertising: brand, company and product names can themselves amount to environmental claims.

> The EmpCo Directive applies to other member states in the EU and does not directly apply in the UK; however, UK businesses selling to or targeting consumers in the EU should be aware that these rules are now in effect.

Why this matters

As governments and stakeholders gather in Antalya for COP31, climate pledges and sustainability messaging will be everywhere. Every such claim made to consumers in Germany is now tested against the new rules, including net-zero and carbon-reduction targets announced around the conference. Enforcement is also immediate: in Germany, competitors, consumer associations and competition associations can send warning letters (Abmahnungen) and seek injunctions, so a single campaign can quickly lead to costly proceedings.

German courts had already set a high bar

In a decision of the German Regional Court of Bochum (19 O 24/25) concerning green claims in online advertising, the court held that advertising "CO2-neutral shipping" is misleading where the underlying shipping service is in fact only CO2-reduced. While "CO2-reduced" suggests a decrease in emissions, "CO2-neutral" conveys a significantly stronger environmental claim. The court also emphasised that what matters is the specific statement used in the advertising, not whether consumers may generally understand that transport services are not entirely emission-free. The decision is in line with the German Federal Court of Justice's case law on claims such as "climate neutral", confirming that environmental claims must be accurate, clear and sufficiently explained in the advertising itself.

The Regional Court applied the same approach to the broader claim "sustainable & regional". The court held that such wording is too vague and open-ended unless the advertisement itself clearly explains what aspects of the product or business are considered sustainable and in what sense they are regional. General references to the circular economy, sustainable processes or local operations were considered insufficient, particularly where the business operated a nationwide online shop. According to the court, consumers must be able to understand directly from the advertising itself what specific environmental or regional qualities are being claimed and what factual basis these claims rely on.

Therefore, German courts were already applying a strict standard to green claims under the existing rules on misleading commercial practices. Businesses should nevertheless check their marketing communications are compliant with the UWG, as the new rules build on the existing approach with a more specific regulatory framework for environmental claims and sustainability labels.

What the UWG requires

The reform is based on the recognition that environmental messaging can significantly influence consumer choices. Where green claims are broad or unsubstantiated, they risk creating misleading impressions. The rules therefore aim to enhance transparency and support better-informed purchasing decisions.

In substance, the reform focuses on environmental claims and sustainability labels. General environmental claims such as "green", "environmentally friendly" or "sustainable" are now subject to stricter scrutiny. Such broad statements are generally permissible where they can be substantiated by recognised excellent environmental performance or where the relevant explanation is clearly provided in the same medium. The same applies to claims regarding future environmental performance. In particular, forward-looking claims, such as net-zero pledges or carbon-reduction targets, require a sufficiently detailed, realistic and verifiable implementation plan, including measurable and time-bound commitments.

In addition, the blacklist of prohibited commercial practices has been expanded. The rules now strictly ban generic environmental claims without substantiation; outlaw product advertising based solely on the offsetting of greenhouse gas emissions; and prohibit the use of sustainability labels that are not based on a recognised certification scheme or established by a public authority. Companies should therefore review their product communication, packaging, labels and marketing materials as a matter of priority. Green claims remain possible, but they must be concrete, substantiated and supported by a sound factual and legal basis.

When your brand name is a green claim

For brand owners, the rules do not stop at advertising slogans. Brand, company and product names containing terms such as "eco", "green" or "climate neutral" can themselves be environmental claims and must meet the same requirements. A trade mark registration does not shield a business from an unfair competition claim: a registered mark can still be used in a misleading way.

Green terms also create risks at the registry. At the EUIPO and the UKIPO, such terms may be refused as descriptive or non-distinctive, or as deceptive where they suggest environmental qualities the goods or services do not have. Registered marks can also be challenged later in invalidity or revocation proceedings if they are, or have become, misleading. Clearance searches and

Useful link

European Commission, Directorate-General for Justice and Consumers, Questions & Answers on Directive (EU) 2024/825 as regards empowering consumers for the green transition (Brussels, September 2026), Question 3: dycip.com/ec-green-directive-questions

Businesses should comply with the new green claims framework as an immediate priority



filing strategies for new sustainability brands should therefore take account of both trade mark law and the new advertising rules.

Sustainability labels raise a separate question of ownership and control. In Germany, a label may now only be used if it is based on a certification scheme with independent third-party verification or established by a public authority. Businesses that run their own schemes should check whether they meet these requirements and whether the label is protected, for example as an EU or UK certification mark. According to the European Commission, ordinary individual trade marks will generally not be treated as sustainability labels, but in-house badges, icons and logos with an environmental message are high risk.

Finally, where a claim rests on a green innovation, the underlying technical evidence matters. Technical documentation, test data and life-cycle assessments, often generated alongside patent filings, can help substantiate specific environmental claims and show that they are accurate. Generic claims, by contrast, generally require recognised excellent environmental performance, such as the EU Ecolabel. IP and marketing teams should therefore agree together what is said and how it is supported.

What businesses should do now

Now that the rules are in effect, businesses should treat compliance with the new green claims framework as an immediate priority rather than a future planning exercise.

In practical terms, this means auditing existing green claims and sustainability labels to ensure they are specific, accurate and substantiated. Generic terms like “green”, “eco-friendly” or “sustainable” should either be dropped or accompanied by a clear, factual explanation in the same medium. Forward-looking claims such as net-zero targets or carbon-reduction pledges must be backed by a concrete and verifiable plan. Sustainability labels should only be used where they are based on a recognised certification scheme or established by a public authority. Trade mark portfolios should form part of this review: existing and planned marks, logos and badges containing environmental terms or imagery should be checked, and the evidence supporting them kept on file.

Outside of Germany

Companies operating across the EU should also be aware that similar rules should now apply in all member states under the same Directive, although national implementation can vary, making a consistent EU-wide review of marketing materials advisable.

From a UK perspective, “green” claims, including green trade marks, continue to be regulated through, in particular, the Competition and Markets Authority’s (CMA) Green Claims Code, Advertising Standards Authority (ASA) enforcement against misleading environmental advertising, and the application of the Trade Marks Act 1994 (including the examination of “green” terms and whether they are descriptive or deceptive), alongside broader consumer protection rules and, for FCA-authorised firms, anti-greenwashing rules. The CMA, for example, has the power to fine businesses directly for misleading green claims under the Digital Markets, Competition and Consumers Act 2024, with penalties of up to 10% of global turnover or £300,000 (whichever is greater).

> The bottom line: green claims are not off the table, but the bar for using them in the EU has risen.

Clear, honest and well-documented environmental communication is now essential for businesses seeking to avoid legal and regulatory risk, and it is increasingly what consumers and regulators expect. Looking ahead, the proposed EU Green Claims Directive, which would have required claims to be verified in advance, has stalled since the European Commission announced its intention to withdraw it in June 2025. For now, the EmpCo rules and national unfair competition law set the standard, and the climate pledges made around COP31 to consumers in the EU will need to meet it.

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With thanks to Chartered Trade Mark Attorney Jennifer Heath for the provision of UK-related content in this article.

Green patent filings
Growth hides a shifting global picture

The United States Patent and Trademark Office (USPTO) closed its Climate Change Mitigation Pilot program in 2025. We previously asked whether this closure signalled a global loss of appetite for green technology. In this article, we revisit that question using a new methodology from WIPO and recent first-filing data.

A new definition for green patenting

There has not been a universally adopted approach to identify "green" filings. In our December 2025 article, *Is the appetite for green technology waning? Insights from worldwide patent office statistics*, we used Cooperative Patent Classification (CPC) Y02 tags to identify green innovation. However, these tags are harder to search and not as widely used as others.

In August 2026, WIPO published a paper which compared these existing classification systems and methodologies whilst introducing its own new methodology for classifying green technologies: The World Intellectual Property Organization's Green Technology Inventory for Statistical Use (WIPO–GTIS).

When comparing three established methodologies, WIPO's paper found that together they identified around 2.4 million green patent families in 2021-2023, but only 11.3% of these families were identified by all three methodologies.

WIPO-GTIS uses international patent classification (IPC) codes, which are more widely used than CPC, to group 36 fields of green technology into five sectors:

- Clean energy
- Energy efficiency, conversion and storage
- Sustainable mobility
- Pollution control, recycling, water treatment
- Agriculture, forestry and industry

Using an AI-assisted review of samples of patents and by refining the lists of IPC codes for each field, WIPO produced its concordance workbook, which can be used as a methodology for generating custom insights into green filings.

Total number of green patent families by first-filing year



Filing trends using WIPO-GTIS

WIPO's report uses first filing data until the end of 2023. We used the WIPO-GTIS to extend the analysis to include first filings to the end of 2024; since patent applications typically publish around 18 months after their filing date, this is the last full year of data that is presently available.

Globally, the number of new green patent families increased 7.7% from 2023, to 406,022 in 2024. This also represents an increase of 16.5% since 2020 and 74.1% since 2015. As seen in the chart above, however, first filings in China accounted for 75.6% of new green patent filings in 2024, whilst combined first filings at the other IP5 offices (Japan, South Korea, European Patent Office, USA) fell 7% from 2023 to 2024 due, in the most part, to a 14% reduction in new green patent filings in the USA. This is a stark change from the average decrease of 5.5% each year since 2021. In 2024 the USPTO Climate Change Mitigation Pilot program was still open and Joe Biden was the president, so the continual downturn in green first filings in the USA since 2021 is likely to continue as data from 2025 and 2026 becomes available due to the closure of the USPTO Climate Change Mitigation Pilot program in 2025 and the second Trump administration cutting green technology funding.

The largest increases in green first filings in China came in smart energy, grid and transmission (23%) and carbon capture and storage (19%), although increases were seen across all the WIPO-GTIS energy sectors. In contrast, the only area where first filings increased in the USA was smart energy, grid and transmission (0.8%).

Japan has also seen a continuous downturn in green patent filings since 2015, but not to the same scale as the USA; green first filings reduced by 2.4% in 2024, although this is less than the 3.1% reduction in 2023. More generally, green first filings in Japan have decreased 9% since 2020 and 25% since 2015, although Japan has now overtaken the USA as the second largest patent office for carbon capture and storage filings, after China.

Related article

Is the appetite for green technology waning? Insights from worldwide patent office statistics, December 2025: dycip.com/patents-greentech-2025

Useful link

WIPO IPC-Green Technology Concordance – A Harmonized Classification Methodology, published 2026: dycip.com/wipo-gtis

Whilst we previously reported that green first filings at the European Patent Office (EPO) were still increasing year on year, this is no longer the case. 2024 saw a 7% reduction in new green first filings compared to 2023, with even larger reductions in filings in solar energy (-35%), wind energy (-19%) and hydrogen and fuel cells (-12%). In contrast, smart energy, grid and transmission saw a 19% increase in first filings at the EPO, indicating a change in emphasis of green filings at the EPO. The EPO does still have the highest share of green filings compared to all filings at the office at 18%, down from 20% in 2020, compared to 17.5% for China and South Korea, 12% for Japan and 11.3% for the USA. This data, however, is for first filings at the EPO rather than individual national offices. A similar reduction has been seen across the larger national offices in Europe in 2024, with a 4% reduction in the UK, 2% in Germany, 11% in France and 4% in the Netherlands.

With the exception of a 1.2% reduction in 2022, South Korea has seen growth in first green patent filings since 2020, with a 5.1% growth in 2024, with increases in first filings in smart energy, grid and transmission (16%) and hydrogen and fuel cells (9%) countering reductions in first filings in solar energy (-33%) and wind energy (-17%). Korea now has more first green patent filings per year than Japan.

Trends within technologies

Smart energy, grid and transmission has consistently seen the largest increase in first filings since 2020; filings have nearly doubled worldwide in the same period. China now accounts for 87% of all smart energy, grid and transmission first filings, but there are a large number of filings in the USA compared to the other areas analysed and this is one of the few areas to still see a growth in new filings in the USA. 61% of this worldwide increase came from two IPC groups; data processing for energy or water supply (G06Q 50/06) and electrical testing and fault location (G01R 31/00). With the rapid increase in renewable energy generation, particularly in China, managing variable power flows and fault detection becomes vital, hence an increase in filings in this area. In wind energy, the wind-motor subclass (F03D) accounts for around 80% of the growth in filings since 2020; in the same period China's installed wind capacity nearly doubled, with China now accounting for 76% of all new wind energy filings.

In Korea and Japan, the largest growth in first filings since 2020 has been in carbon capture and storage, where the largest contributor to global growth has been from filings in carbon-oxide separation (B01D 53/62). The largest growth in first filings at the EPO in the same period, however, has been in hydrogen and fuel cells, where water electrolysis was the largest contributor to global growth. This shows differing strengths of industry and research focus in the different jurisdictions analysed; many green first filings come from universities and SMEs, so the changes in first-filing data are a good indicator of where universities are targeting their research.

Although the number of new filings in solar power only rose 3.6% in China in 2024, at the other four offices it fell 33%, resulting in a 9% reduction globally in 2024. It is worth noting, however, that the WIPO-GTIS omits some of the newer photovoltaic IPC groups from its methodology, such as inorganic photovoltaic cells and module groups. With these IPC groups included the reduction in filings in 2024 was only 4%, which is indicative of a shift in the subject matter of the filings.

Outlook

Although the global outlook for green patents is still buoyant thanks to continued growth in China, there are geographic pockets of strength for particular technology areas outside of China. This analysis also looks at first filings to see where innovation is originating, not where the target market is. As described in our December 2025 article, the number of PCT applications for Chinese first filings is still increasing, so there is a growing global outlook for green patent families. Equally, developments in green technology benefit the whole globe, regardless of where the innovation originated.

The global outlook for green patents is still buoyant



Author:
Andrew Cockerell

Smart grids
Innovation and IP in a changing energy landscape

Useful links

ElectronicsForU.com, 140,000 Home Batteries Supply 580 MW To California Grid: dycip.com/california-home-battery-grid

UCL Discovery, assessing the benefits of demand-side flexibility in residential and transport sectors from an integrated energy systems perspective: dycip.com/ucl-demand-flexibility

University of Oxford Research Archive, how much do smart appliances reduce CO2 emissions? Assessing the environmental impact of domestic demand response technologies: dycip.com/oxford-smart-apps-co2

In September 2026, more than 140,000 home batteries across California, USA were coordinated to deliver around 580 MW to the grid in a single evening, more than many individual gas-fired plants can produce. That is the smart grid at work, and its origins lie in a much older problem.

Before the national grid, towns were powered from a local generating station. Big, relatively efficient boilers ran continuously, while smaller units were fired up for heavy usage periods. A human operator would watch the load and (literally) open the steam valves or bring reserve units in and out of operation to match output to demand.

From the 1930s the UK National Grid allowed demand to be pooled amongst different regions, which smoothed the peaks and troughs but increased the scale and magnitude of the balancing operation. Early attempts to influence users included government control of factory working hours and consumer incentives such as cheaper overnight tariffs.

Today, renewables can provide much of the UK's electricity needs. Their output is roughly predictable by weather forecasting but cannot be controlled, so balancing demand against capacity matters more than ever. Done well, it reduces the amount of temporary, higher carbon generation, such as gas-fired capacity, brought into operation. Part of that balancing is now handled by the "smart grid".

What is a smart grid?

The concept is not new; the term and the software-driven approach date from the early 2000s. Software and connectivity have since improved so that individual devices can adapt their load according to received price and carbon data, with so-called "aggregators" coordinating large fleets of them. The controlled devices tend to be relatively large electricity consumers such as electric vehicle (EV) chargers, heat pumps and domestic batteries. External control gives a more reliable response than simple tariff incentives. For example, an EV charger needed at 3am is far more likely to switch on if externally controlled than if a user must do it manually.

Cybersecurity is also central; an aggregator that can switch a fleet of heat pumps on or off is as much a potential risk to the grid as a benefit. The UK Government is consulting on a licensing regime for organisations that control domestic load, reflecting this.

IP aspects

In terms of the IP landscape, other than brand protection for the aggregators, activity falls into various areas.

- Regarding the devices themselves, patentable inventions can relate to controller circuitry, sensing techniques and device adaptations (for example, a heat pump that pre-heats a building, or a power consuming device with improved tolerance for externally controlled interruptions).
- Algorithm-related inventions might involve scheduling logic to predict grid carbon emissions and capacity changes, to forecast domestic consumption and its reaction to control, and to reduce net power consumption when needed without adversely affecting comfort and operation. Virtual power plant technology, similar to the California example mentioned earlier, is attracting particularly heavy patent activity.
- Standards inevitably become involved when devices from multiple manufacturers must respond to signals from many aggregators. Standard essential patents (SEPs), fair, reasonable and non-discriminatory (FRAND) conditions and open protocols may determine where the value in these systems is captured.
- Finally, smart grid use generates a huge amount of data (for example, switching histories, household load profiles) which could itself be valuable. Here, data protection laws, trade secrets and database rights become relevant.

What comes next?

We can expect at least three main areas of development. Machine learning (ML) will play an increasing part in controlling devices and predicting grid loading. Vehicle-to-grid technology will allow EV batteries to store and return energy, having the advantage that EV batteries are often much higher capacity than domestic units. Peer-to-peer and local grid technology will allow local pooling of load and stored power, for example within a single residential street.

Will it make a difference?

Smart grid technology will not itself decarbonise the grid, but it can help the grid move towards decarbonisation by improving the usage of wind and solar while aiding the retirement of high-carbon peak-duty power plants. The scale of the benefit is debated. UCL modelling suggests smart appliances and EVs could cut UK peak load by around 9% by 2050, but other research warns that the carbon benefit can be negligible unless the way generation is dispatched also changes.

Where does intellectual property fit into smarter energy networks?



Author:
James Turner

When green branding meets regulated language Lessons from Oatly's "POST MILK GENERATION" trade mark

Case details at a glance
Jurisdiction: England & Wales
Decision level: Supreme Court
Parties: Oatly AB (appellant) and Dairy UK Ltd (respondent)
Date: 11 February 2026
Citation: [2026] UKSC 4
Decision (PDF): dycip.com/2026-uksc-4

Sustainable businesses understandably want their brands to say something meaningful about the greener choices they offer. Plant-based food and drink alternatives are an example. But clever, campaign-ready slogans can run into hard legal limits if they use protected or regulated terminology, or if their trade marks are deemed deceptive.

The Oatly decision may bring closer scrutiny of regulated terms in the UK



Sustainability messaging still needs trade mark discipline

Oatly registered and used the trade mark "POST MILK GENERATION" for oat-based food and drinks. From a marketing perspective, it is easy to see the appeal. The phrase is memorable, provocative and neatly aligned with a shift away from traditional dairy consumption.

However, in considering a regulation controlling the use of dairy terms, the Supreme Court found that the word "milk" cannot be used in a trade mark (or otherwise) for plant-based food and drink goods, unless the use clearly describes a characteristic quality of the goods, such as being "milk-free". The key point was that the relevant rules do not only catch product names but also apply to broader use of protected dairy designations in relation to relevant products. In this respect, the term "milk" cannot be used even as part of a slogan for an oat-based drink.

Oatly tried to argue that the phrase fell into the exception and clearly described a characteristic quality of the goods: that the goods were milk-free. The court was not persuaded. It regarded the slogan as a reference to the intended consumers rather than a clear description of the goods' milk-free characteristics. That description of the product characteristic was too indirect to satisfy the exception. The trade mark was therefore declared invalid on the basis that it was prohibited by an enactment other than law relating to trade marks.

Interestingly, whilst not an issue before the Supreme Court, the POST MILK GENERATION mark was also initially attacked on the basis that it was deceptive; a ground arising specifically under trade mark law which states that a trade mark cannot be registered if it deceives the relevant public with regard to the nature, quality or origin of the goods or services in question.

The UKIPO had rejected this basis, finding there was neither actual deceit nor a sufficiently serious risk of deception occurring. It was found that the average consumer would view the mark as an ironic way of saying Oatly's goods had moved on from conventional milk and were for consumers of a "post-milk generation"; that is, those who no longer consume dairy milk. It was considered that this message was not difficult to receive. In any event, this finding did not prevent invalidity on the grounds that the inclusion of the term MILK was a protected term.

Why this matters for green and clean brands

Sustainability-led brands often want to draw attention to their environmental benefits and distinguish their products from conventional alternatives. However, whilst effective branding often depends on a sharp, simple message, it is important to check whether any part of that messaging is constrained by rules and regulations regarding terminology or could otherwise be perceived as deceptive.

These issues are not limited to dairy terminology. For sustainability-led businesses across the food and drink, cleantech and greentech sectors, similar issues may arise when brand names or slogans include claims about carbon neutrality, recyclability or renewable energy. No matter how catchy the slogan, it must be accurate and comply with the relevant legal requirements. Brand owners should therefore ask two distinct questions: could the wording deceive consumers, and is its use permitted in the first place?

Registration is not the end of the matter

It is important to remember that registration does not put trade marks beyond challenge: as the case discussed here illustrates, a registered mark may subsequently be declared invalid if it falls foul of the trade mark requirements or is otherwise prohibited by law. Brand owners should therefore not treat registration as confirmation that their chosen trade mark meets all relevant legal requirements.

Practical takeaways for brand owners

This decision may prompt increased scrutiny in the UK marketplace regarding the use of regulated terms. For brand owners, it is important to build legal checks into the creative process early enough so that the best ideas can be shaped, protected and used with confidence.

- Check whether any words in your proposed mark are protected, regulated or reserved for particular products or sectors.
- Consider whether environmental language could be challenged as deceptive.
- Treat slogans and campaign lines as carefully as product names.
- Run trade mark availability and regulatory checks before investing heavily in packaging, advertising and campaign assets.

In short

Oatly's case is a useful reminder that a phrase can be distinctive, engaging and commercially attractive, yet still be unavailable if it uses protected language in the wrong way. For **sustainability-led** businesses, the best approach is not to choose between creativity and compliance. It is to make sure they are working together from the start.

Author:
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Microplastic detection in marine environments

Protecting microplastic monitoring technologies

Microplastic pollution is an increasing focus of research, industry and environmental monitoring. Microplastics are plastic particles smaller than 5mm. Particularly in marine environments, detection of microplastics is important for providing a detailed picture of what the microplastic pollution landscape looks like. Quantification of microplastics in a sample can provide information relevant to assessing its potential effects on marine life, and subsequently the impact on humans through consumption. Detection may also involve identifying the type of plastic, which may in turn help trace the source of pollution, and therefore assist in preventing further contamination.

For businesses developing new detection technologies, however, technical innovation is only half the challenge. Commercialisation of the technology may depend on attracting investment. Once a technique is out in the open, it may be easy to copy, so securing patent protection may help protect revenue from the new technology.

> The way in which microplastics are collected, detected and analysed can have important consequences for patent strategy.

A patent which protects an invention in principle may be less commercially valuable if the protected method is difficult to enforce in the locations the technology is actually being used in.

The challenge of detecting microplastics

One of the fundamental problems with microplastic detection is, perhaps unsurprisingly, size. Smaller particles can be particularly difficult to detect, with greater levels of difficulty being found when detecting particles smaller than 10µm. Additionally, many existing detection methods require extensive sample preparation, including dissection or chemical treatment. Such processes can be slow and time-consuming and, where destructive analysis is required, may be unsuitable for assessing plastic contamination in products which are subsequently intended for sale. This, in combination with the increasing number of emerging AI models directed towards the detection process, leaves considerable scope for technological development.

Small particles, big challenges: detecting plastics in seawater



Who is interested in the technology?

Users of such detection technologies may include researchers and conservation organisations investigating the abundance and distribution of microplastics, along with industry players who may have a commercial interest in measuring microplastics in preparation for likely upcoming regulatory standards, and as a defensive mechanism against public perception and concerns about microplastic pollution in consumer goods (for example, in the fishing industry, and the cosmetics industry).

Those markets may place quite different requirements on the technology. A technique intended for specialist researchers, for example, may accommodate laboratory equipment or a relatively involved workflow. A commercial user testing large numbers of samples may instead place greater value on speed, automation and integration into existing processes.

Considering the requirements of the relevant interested sectors and where the relevance of a given technological advancement lies can be key for determining patent coverage. A patent may be more valuable if it covers

actions more likely to be performed by a commercial entity rather than merely techniques performed by academic researchers or conservation charities.

Considerations for patent protection

Areas of technical innovation for which patent protection may be sought may concern the physical detection of microplastics, or alternatively may lie further downstream in the workflow, for example in subsequent laboratory analysis or in algorithms and software used to interpret detection data.

A microplastic detection system may involve several distinct stages: collecting a sample, preparing it, physically detecting particles and analysing the resulting data. It is worth considering that different stages in the process may also be supplied or performed by entirely different entities, and in different locations. Some stages may take place in the field, others in a laboratory, while software analysis might be supplied by a third-party provider.

> When seeking patent protection, it may be inadvisable to treat the complete workflow as a single indivisible invention.

While a claim requiring every stage to be performed may provide apparently comprehensive protection, infringement may be more difficult to establish if no single commercial party performs the complete claimed method, or if the process is performed across different territories. Claim protection should be sought around products which are manufactured and distributed together, rather than relying solely on protection for the eventual assembled system.

For a microplastic-detection-related invention, it can therefore be valuable to ask at an early stage: where does the inventive concept really lie, and who will commercially exploit it? Where possible, it may be beneficial to direct alternative sets of claims towards commercially useful parts of the technology individually, rather than protecting only the complete end-to-end process.

If the innovation is principally a physical detector or another product, the territorial filing strategy may concentrate on countries in which the product is likely to be manufactured and sold, and where competitors are likely to manufacture or sell competing products. Protection may also be desirable in important territories where the invention is likely to be used. It is worth noting that, even where the commercial focus is the physical product, associated method claims can still provide a useful additional layer of protection.

A primarily method-based invention can present challenges for patent protection, particularly for those relating to marine environments. Due to the territorial nature of patent rights, the location at which the claimed technique (particularly if it is a method or process) is carried out is commercially significant when seeking protection.

Collection or analysis performed in remote marine locations raises a potential challenge as territorial waters, wherein patent protection is extended, only extend 12 nautical miles from land. Consequently, it may be worth considering whether useful patent claims can be drafted around steps performed on land, around the operation of a protected detector or other physical product, or around other commercially relevant parts of the process which occur within important patent territories (e.g. on post-processing steps performed at a land-based facility), so as to obtain claims capable of being enforced against meaningful commercial activity.

Scope of protection

While in some cases the marine environment may provide the original motivation for an invention, this environment may not necessarily define the limits of the underlying technology. As microplastics can also be found in air, soil and commercial products, a detector initially developed to analyse seawater could therefore potentially have applications outside marine environments.

If the inventive detection principle operates equally well on an atmospheric, soil, food or manufactured-product sample, unnecessarily defining the claimed technology by reference to a marine environment could surrender commercially useful protection. Broader claims, supported by an appropriately drafted description, may leave open markets which were not the immediate focus when the technology was first developed.

Strategic tips

For developers of microplastic detection technology, a good patent strategy should therefore start with the commercial workflow rather than with the patent claim itself.

Before filing, it is worth mapping out:

- which part of the detection process contains the inventive contribution;
- whether protection can be obtained for a physical product as well as a method;
- who is expected to make, sell and use each part of the technology;
- where those activities are likely to take place;
- whether different stages will be performed by different organisations; and
- whether the underlying invention has useful applications outside marine environments.

Such an analysis can help ensure that claims protect commercially meaningful activity rather than merely describing the complete scientific process.

Microplastic detection presents a particularly good example of why patent strategy needs to follow both the technology and the market. As detection moves from research towards wider commercial use, considering these questions early can make the difference between simply obtaining a patent and obtaining patent protection that is genuinely useful to the business.

Authors:
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Quick guide

Greentech IP essentials
A quick guide for sustainable businesses

Innovation across the cleantech and green technology sectors is moving quickly. From cleaner energy generation and storage to more efficient transport, buildings and industrial processes, businesses are developing technologies that can make a real contribution to the transition to a lower-carbon economy. For those businesses, intellectual property is often more than a legal asset: it can be central to attracting investment, securing commercial partnerships and maintaining a competitive position in a fast-developing market.

At the same time, cleantech companies often operate in a space where collaboration, public demonstration and sustainability claims are part of the route to market. That makes it particularly important to think about patents, trade marks, designs, copyright and confidential information together, and at an early stage. The following points highlight some of the key IP considerations for businesses developing, branding or commercialising clean and sustainable technologies.

The main types of IP at a glance

Different rights protect different aspects of a business. In broad terms, patents protect inventions, including new products and processes; trade marks protect brand names, logos and other signs used to distinguish goods or services; designs protect the visual appearance of products and their components; and copyright protects original written, artistic and other creative material, including software code and marketing content. Confidential information and trade secrets can also be important where know-how, data or technical detail is best kept out of the public domain.

For greentech businesses, these rights often work best together. A sustainable product may involve patentable technology, a distinctive brand, a recognisable product shape and copyright-protected software or promotional materials. Thinking about the full IP picture early can help identify what should be registered, what should remain confidential and where third-party rights or contractual issues may need to be checked.

1. Patents and trade secrets: protecting the technology at the heart of the business

For many sustainability-led businesses, the most valuable intellectual property sits in the underlying technology. That may be a new piece of hardware, such as carbon capture equipment, solar technology or mechanical components, or software-led innovation, such as AI-assisted grid optimisation or energy management systems. A clear protection strategy at the outset can make a material difference to value, investment readiness and freedom to collaborate.

- **Consider accelerated examination routes:** where an invention has an environmental benefit, applicants may be able to use schemes such as the UKIPO Green Channel to accelerate search, examination or publication. This can be particularly useful where a granted right would support fundraising, commercial discussions or enforcement planning. Quickly granted patents can also enable access to tax relief schemes such as the "patent box".
- **Decide what to keep proprietary and what to share:** businesses in the clean technology space often work in collaborative ecosystems, and some may wish to publish, license or make certain technology available on open terms. That can be entirely compatible with a strong IP strategy, provided the core proprietary technology is identified and protected before disclosure, and any open access position is supported by appropriate licensing terms.
- **Manage public testing carefully:** field trials and demonstrations are often commercially necessary, but they can create patentability risks if the invention is made available to the public before a patent application has been filed. Where outdoor or third-party testing is unavoidable, confidentiality arrangements, controlled access and careful handling of prototypes should be agreed in advance.

2. Trade marks and branding: building trust without overclaiming

A strong brand is especially important in the sustainability sector, where customers, investors and partners are looking for credible environmental claims. At the same time, names, logos and slogans can themselves be treated as environmental claims, so brand selection should be considered alongside advertising, consumer protection and greenwashing rules.

- **Choose distinctive brand names:** terms such as "eco", "green" and "sustainable" may be attractive from a marketing perspective, but they are often difficult to monopolise as trade marks if used descriptively. A more distinctive name is usually easier to protect and enforce, while still allowing supporting messaging to explain the environmental credentials of the product or service.
- **Take care with certification-style imagery:** icons, leaves, globes and badge-style logos can imply official approval or independent verification. Businesses should ensure that any sustainability label or signpost is accurate, substantiated and not liable to give the impression of a certification scheme where none exists.
- **Substantiate carbon-related claims:** claims such as "carbon neutral", "net zero" or similar should be approached with care, particularly where the claim depends on offsetting rather than emissions reductions within the business or supply chain. The safest approach is to ensure that brand language is precise, evidence-based and capable of standing up to regulatory scrutiny.

3. Designs: protecting the look and feel of green products

For consumer-facing cleantech products, appearance can be a significant differentiator. EV chargers, heat pumps, smart thermostats and other connected devices are increasingly designed to sit visibly in homes, workplaces and public spaces. Design protection can therefore be an important complement to patent and trade mark rights.

- **Protect the product appearance:** patents protect technical function, whereas registered designs protect visual features such as shape, contours, surface decoration and overall appearance. Registration is generally quick and relatively cost-effective, and can be a practical way to deter lookalike products.

A well-considered IP strategy can create stronger foundations for growth



- **Don't delay:** it is best practice to seek registered design protection before the product is publicly disclosed, but any application must be filed within 12 months of disclosure otherwise it may no longer be considered novel.

- **Keep a clear design record:** unregistered rights may arise automatically, but they are much easier to rely on where there is a reliable evidence trail. Time-stamped CAD files, design iterations, prototype records and records of first disclosure can all be valuable if a dispute arises.

4. Copyright and software: securing ownership of the code

Many clean and sustainable technologies rely on software, data processing and connectivity.

Copyright will often protect the written source code, while patents may also be relevant where the software contributes to a technical effect. In either case, ownership and documentation should not be left to chance.

- **Recognise the role of copyright:** copyright arises automatically in original software code, and can be useful when addressing copying of code or particular implementation details. It does not, however, protect every underlying idea or functionality, so it should be considered as part of a wider IP strategy. In particular, recent advances in artificial intelligence are making "vibe-coded" reproductions of software, without direct copying, ever easier to make; therefore consider whether there are any patentable aspects to the solutions your software addresses to provide more robust protection.

- **Check ownership where contractors are involved:** where external developers, consultants or agencies contribute to software, firmware or app development, the commissioning business should confirm that appropriate IP assignment provisions are in place. A written agreement dealing expressly with ownership can avoid difficult questions later, particularly during investment, acquisition or enforcement discussions.

- **Beyond software:** copyright does not just protect the software used in greentech, it would also protect other valuable materials such as engineer/CAD drawings, technical specifications, product manuals, website content, databases and marketing materials. It is therefore an important tool in the IP armoury.

Conclusion

A well-considered intellectual property strategy can help cleantech and sustainability-focused businesses protect what makes them different, communicate their environmental credentials with confidence and create stronger foundations for growth.

> There is rarely a one-size-fits-all approach: the right strategy will depend on the technology, the brand, the route to market and the business's wider commercial objectives.

By identifying protectable rights early, managing disclosures carefully and ensuring that sustainability messaging is clear and substantiated, companies can reduce avoidable risk while making the most of the value they are creating. For many innovators in the clean technology sector, that balance between protection, collaboration and credibility will be key.

If you are developing, launching or scaling a cleantech or sustainability-focused product, our patent and trade mark attorneys can help you identify the right IP strategy for your business.

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New ideas for old batteries
Growing innovations in recycling and re-use

Useful link
Battery circularity, Innovation trends for a future source of critical materials (PDF): dycip.com/epo-battery-circularity

The European Patent Office (EPO) and International Energy Agency (IEA) released a joint report on Battery Circularity in April 2026 assessing long-term commercial and patent trends relating to recycling and reusing batteries. This article comments on some of the interesting trends identified in the report.

State of health of the industry

Electric vehicles (EVs) are identified in the report as the primary driver for increasing deployment of lithium-ion batteries, with battery capacity considered to triple by 2030 in comparison to 2024. Accompanying this increase in capacity is a consequential increase in the number of batteries reaching their intended end-of-life in the coming decades. This has created a predictable need for solutions to recycle or reuse batteries that have reached the end of their lifetime.

In an assessment of patent developments relating to battery circularity, the report identifies a significant period of growth in the total number of patent families published from 2017, with a compound annual growth rate of 42% of international patent families between 2017 and 2023. This growth is repeated, and even preceded, in Chinese national applications with a significant uptick in Chinese patent publications relating to battery circularity from 2015.

Areas of innovation

Five broad areas are defined in the report relating to different aspects of battery circularity including:

1. "Collecting" of used and damaged batteries, including transport;
2. "Sorting and separating" of mixed battery waste into separate streams;
3. "Conditioning" battery components to restore or upgrade them for re-use;
4. "Transformation" of battery waste into purified raw materials; and
5. "Enabling technologies" that make collection, separation and recycling safer and more efficient.

Of these areas, collecting and transformation have consistently been associated with high levels of new international patent families between 2000 and 2023, with the largest grouping of international patent families (over 1,000) categorised as "hydrometallurgy" which covers transforming battery waste using liquid chemicals to dissolve metals from shredded battery materials.

Other significant hotspots of increasing patent activity include "battery stabilisation and discharge" to eliminate safety risks posed by used batteries, "comminution" involving shredding, milling or crushing batteries into smaller pieces, "electrochemical extraction" to recover metals using electrodes, and "pyrometallurgy" to melt battery waste.

To a lesser extent, further growth areas for patent activity are identified as "state of health analytics" for estimating the remaining useful life of a battery to steer whether it should be reused, repaired or fully recycled, "current collector" conditioning to remove contaminants, "relithiation and crystal repair" aiming to restore the original properties of cathode crystals, and "repackaging for stationary applications" to give batteries used in electric vehicles a second life.

Key innovators

The Chinese recycler Brunp is identified as the leading applicant in battery circularity with more than double the number of international patent families compared to the next largest applicant. Emphasising the emerging nature of this field, Brunp is also a relatively new entrant with virtually all of Brunp's patent publications being since 2020, and a broad patent portfolio with activity relating to pre-processing, mechanical sorting and separation, and chemical transformation.

Outside of China, Asia also contains the next four leading applicants in the period of 2000 to 2023 including in order LG, Sumitomo Metal Mining, Toyota, and JX Nippon Mining & Metals. Following Asia, European entities provide the sixth to eighth largest applicants while no US applicant features in the top fifteen for this period.

The report makes special mention that the German multinational BASF is now the largest European filer having more than doubled its total number of international patent filings since the end of 2023. Additionally, in Europe a distinction is drawn between filers such as Umicore and CEA which have filings over many decades that indicate mature R&D programs and emerging players such as Johnson Matthey, Duesenfield, Cilag International and Northvolt which have had strong growth in patent numbers in recent years and few older filings, if any.

The report further identifies that more than sixty European startups and universities have sought protection for inventions relating to battery circularity since 2001 with clusters in France, Germany, the UK and the Nordic countries.

Conclusion

With ever-increasing numbers of batteries predicted to reach the end of their lifetime each year, the EPO and IEA report identifies a strong need for the continued development of techniques and tools to enable recycling to reduce potential waste or re-use to provide batteries with a second life.

Patents provide an important tool for protecting innovation which can keep critical materials in circulation, as can be seen from the increasing patent activity in the last ten years.

Importantly, while Asia provides the largest filers, significant numbers of patent filings have been made by European applicants, principally by established companies and research institutes but also by startups.

We consider that these trends will continue over the coming years with patenting likely to be dominated by large companies having substantial infrastructure relating to chemical processing and recycling. However, we may also see new entrants innovating in niches which are relatively unexplored and unpatented.

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Sustainable spaceflight
Designing for a cleaner space sector

The environmental impact of a spacecraft is felt from the moment of its manufacture on Earth to the end of its life in outer space. Improving the sustainability of launches and orbital operations is therefore critical to protect the environment on Earth, but also to protect and preserve outer space for future generations.

There are three main areas of focus when it comes to improving the sustainability of spacecraft: eco design, zero debris, and the circular economy.

Eco-design

Eco-design aims to reduce the environmental impact of a spacecraft from the beginning of the design process. The mass of the spacecraft can be reduced by using lightweight materials and by designing the components such that materials are used efficiently. Lighter spacecrafts require a lower payload or launch capacity and generally use less propellant for manoeuvres in space.

Lightweight components can be produced using additive manufacturing, such as 3D printing, which allows materials to be used efficiently. Additive manufacturing processes can reduce manufacturing waste, as the components are built up layer by layer, as opposed to machining a component from a block and removing excess material. Additive manufacturing also can allow complex shapes to be formed with improved strength-to-mass ratios.

Spacecraft can also be designed to use resources more efficiently during operation. High-efficiency solar panels provide renewable electrical energy and efficient electronic components reduce the amount of power required to run the spacecraft. Electric propulsion systems, such as ion or Hall-effect thrusters, can also be used to significantly reduce the amount of propellant required for manoeuvres in comparison to chemical propulsion.

Towards zero debris

Another area in which spacecraft can be made more sustainable is in the debris produced by spacecraft. Defunct satellites and discarded spacecraft components can remain in orbit and potentially collide with operational spacecraft. Collisions can produce additional fragments, increasing the amount of debris and making useful orbital regions more difficult and risky to operate in.

One way in which debris produced by spacecraft can be reduced is through reliable and safe end-of-life disposal. Satellites should carry sufficient fuel and propulsion capability to leave operational orbits once their missions finish, either by controlled re-entry or movement to an appropriate disposal orbit.

Another aspect is “design for demise”, which aims to reduce the impact of debris on Earth. Spacecraft components can be designed from materials that are more likely to burn up during atmospheric re-entry, reducing the chance that hazardous fragments reach the ground.

Preventing collisions with existing debris is equally important. Accurate observation and tracking of spacecraft and debris enable operators to predict close approaches, and telecommunication systems allow collision warnings and orbital information to be shared quickly and avoidance manoeuvres to be coordinated. Together, these measures help preserve space as a safe operating environment for spacecraft.

Circular economy

A circular economy goes further by treating spacecraft and their components as resources rather than disposable products. Traditionally, spacecraft are designed for a single operational life, with limited opportunities for repair, refurbishment or reuse. A more circular approach involves designing spacecraft for reuse, repair, refurbishment and recycling.

Modular spacecraft are particularly useful in a circular economy. Instead of replacing an entire satellite following the failure of one component, future servicing spacecraft could potentially replace individual modules, upgrade instruments or replenish consumables.

Materials from old spacecraft could also be recovered and reused in orbit. This reduces the requirement to manufacture replacement hardware on Earth and launch every new component from the ground.

Conclusion

Improving the sustainability of spacecraft requires a whole-life approach that considers environmental impact from manufacture and launch through to operation and eventual end of life. Eco-design, zero-debris measures and circular-economy principles are therefore complementary rather than separate solutions.

Ultimately, sustainable spaceflight means moving away from treating spacecraft as disposable assets and instead considering their environmental consequences throughout their entire life cycle. As reliance on space-based infrastructure increases, incorporating sustainability into spacecraft design and operation will become increasingly important. By making better use of materials, preventing avoidable debris and enabling future reuse, the space sector can continue to develop while reducing its environmental impact on both the Earth and the space environment for future generations.

The journey towards more sustainable spaceflight inevitably gives rise to exciting innovations, from lightweight materials and manufacturing processes to propulsion systems and modular spacecraft.

For businesses developing these technologies, considering intellectual property early should form part of the wider commercial strategy, alongside plans for collaboration, licensing and deployment.

A well-considered IP strategy can help businesses protect these innovations and realise their commercial value.

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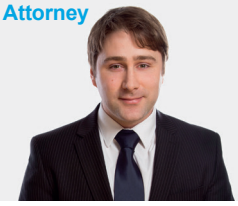
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