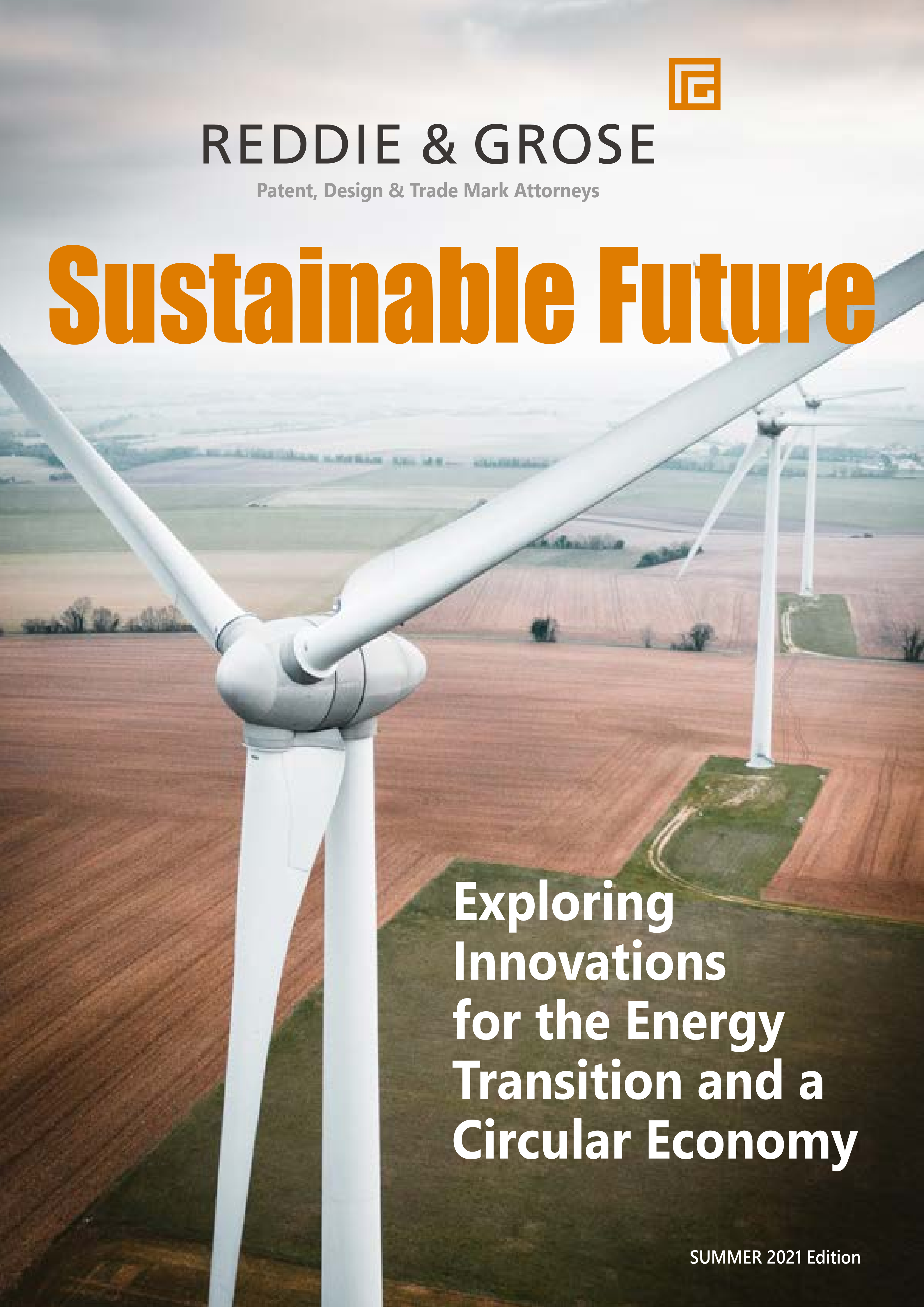
REDDIE & GROSE

Patent, Design & Trade Mark Attorneys

Sustainable Future



Exploring Innovations for the Energy Transition and a Circular Economy

SUMMER 2021 Edition

Contents

This issue at a glance

From the Editor

On 9 August, in a "code red for humanity", the UN's International Panel on Climate Change released the world's largest ever report into climate change, setting out the stark reality of the state of the planet. In the words of the report, "it is unequivocal that human influence has warmed the atmosphere, oceans and land". Since 1970, global surface temperatures have risen faster than in any other 50 year period over the past 2,000 years, and this warming is already affecting many weather and climate extremes in every region across the globe.

Almost every nation on Earth has signed the Paris Agreement, which aims to keep global temperature rises, this century, well below 2 degrees Celsius; and to pursue efforts to limit the temperature increase to 1.5 degrees Celsius. The report warns that both targets will be broken this century unless huge cuts in emissions take place. As the UK gears up to host COP26 in November, the message to global leaders has never been clearer – radical changes are needed to avoid climate catastrophe.

The report does sound a more hopeful note that if we can cut global emissions in half by 2030, and reach net zero by the mid-century, we can halt, or even reverse the rise in temperatures. With this comes an unprecedented need for innovation in the energy and cleantech sectors.

With recent discussions in the media about waiving patents on COVID-19 vaccines, it's easy to perceive patents as a block to rolling out innovation in the face of a global emergency. We argue the opposite. Used properly, patents encourage innovation, with the promise of return on investments in new and emerging technologies. According to the IEA's Energy Technology Perspectives 2020 report, more than a third of the emissions reductions required to achieve net-zero by 2050 will stem from technologies not commercially available today. But to meet that target, we need to be innovating now. The promise of patent protection can incentivise such much needed activity.

In this issue of Sustainable Future, we focus on a range of green technologies on track to play a part in the sustainable future of the planet, and how patents can support innovation in these areas. We look at increasing patent filings for hydrogen generation, the role that hydrogen has to play as a clean fuel, and its interaction with other green energy technologies such as wind and solar. We also look at the role of solar photovoltaics, biofuels, liquid air energy storage and electric propulsion in aviation in curbing emissions. Taking a deeper dive into patent law, we discuss the European Patent Office's recent decision on patenting computer simulations, and what this means for the renewable energy sector. We also look at space based solar - no longer the stuff of science fiction, but a potentially viable source of clean energy. Moving away from energy, we look at the circular plastics economy and how innovation can help to mitigate plastic pollution.

We also celebrate Reddie & Grose's participation in this year's London Climate Action Week, where we delivered a presentation on 'Innovations for a Sustainable Lifestyle'. Here, we highlight the changes that individuals can make in the own lives to be better ancestors to future generations, and focus on ways in which innovation can help us, as individuals, reduce our carbon footprint and impact on the planet.

At Reddie & Grose, our Energy & Natural Resources and Sustainability teams are dedicated to green innovation in all of its aspects. Our attorneys cover the full spectrum of technical disciplines, making us well placed to handle the diverse technologies underlying the energy transition and the circular economy. We have extensive experience advising on IP strategy, securing patent protection for innovation, managing global patent portfolios and defending crown jewel IP rights. We pride ourselves on listening to our clients and offering expert and pragmatic advice that is tailored to our clients' needs. Avoiding a 'one size fits all' approach has allowed us to build up many valued long-lasting client relationships.

Georgina Ainscow • Editor

Meet the Team

Contributing to this Edition

Georgina Ainscow • Editor

Georgina is a UK and European Patent Attorney who regularly reports in the media, providing an IP perspective on developments in renewable energy.
Email her at georgina.ainscow@reddie.co.uk, or click here for her full bio

Nick Reeve • Partner

Since studying climate change in his final year MSc Physics project more than 20 years ago, Nick has a huge interest in renewables and sustainability innovation. He primarily handling patents for electronics, electrical devices and computer implemented inventions.
Email him at nick.reeve@reddie.co.uk, or click here for his full bio.

Gillian Taylor • Partner

Gillian handles patent work in the chemical and mechanical fields, including food technology, manufacturing processes, wind turbines, building materials and packaging.
Email her at gillian.taylor@reddie.co.uk, or click here for her full bio.

Andrew Carridge • Partner

Andrew handles patents in areas including fractionating lignocellulosic biomass; production of biogenic activated carbon; producing fuels, electricity and raw materials using algal-derived biofuels; and catalytic conversion of alcohols to hydrocarbon blendstock.
Email him at andrew.carridge@reddie.co.uk, or click here for his full bio.

Zack Mummery • Senior Associate

Zack works with technologies spanning the chemistry and pharmaceutical fields and has particular experience in small molecule pharmaceuticals, polymers, specialist fibres, sustainable materials, food technology, semiconductors and synthetic chemistry.
Email him at zack.mummery@reddie.co.uk, or click here for his full bio.

Andy Williams • Senior Associate

Andy handles patent work in the engineering, materials and consumer products fields. Andy is also a Chartered Mechanical Engineer having worked as an engineer in the nuclear industry prior to becoming a patent attorney.
Email him at andy.williams@reddie.co.uk, or click here for his full bio.

Dr Alexander Frank • Associate

Alex handles cases in the life sciences sector, including biotech, pharma and medical devices. He has a keen interest in sustainability and chairs the R&G internal meetings of our social group "Sustainability Club".
Email him at alex.frank@reddie.eu, or click here for his full bio.

Adam Kelvey • Associate

Adam works in the engineering, materials and consumer products fields. He has a particular interest in sustainable innovation and is involved in a number of relevant technologies including biodegradable polymers, electric vehicle powertrains, and wind turbines.
Email him at adam.kelvey@reddie.co.uk, or click here for his full bio.

Dr Xiaoxi Zhu • Assistant

Xiaoxi handles patents in the electrical engineering and software fields. Her PhD focused on investigation of functional inks employing Graphene and related two-dimensional (2D) materials and their applications in printable and flexible electronic devices.
Email her at xiaoxi.zhu@reddie.co.uk, or click here for her full bio.

Olivia Buckingham • Assistant

Olivia has a master's degree in physics and specialises in filing and prosecuting patents in the electronics and software fields. She has a strong interest in renewables and has written a number of blogs in this area.
Email her at olivia.buckingham@reddie.co.uk, or click here for her full bio.

Dr Dongyoung Kim • Assistant

Dongyoung handles patents in the semiconductors, photonics, electronics, and electrical engineering fields. He has experience in high voltage power distribution and control systems. His PhD focused on terrestrial and extra-terrestrial photovoltaic applications.
Email him at dongyoung.kim@reddie.co.uk, or click here for his full bio.

Dr Dustin Bauer • Assistant

Dustin handles patent work in the engineering, materials and consumer products fields. He is a native German speaker who has a PhD in Materials Chemistry, focussed on the hydrothermal synthesis of nanoparticles for use in a range of energy storage devices.
Email him at dustin.bauer@reddie.co.uk, or click here for his full bio.

Joanne Pham • Assistant

Joanne handles patents in the chemical and mechanical fields, including packaging, polymer substrates and biodegradable products. Her research involved the development of a novel organic-inorganic hybrid polymer to improve the efficiency of solar cells.
Email her at joanne.pham@reddie.co.uk, or click here for her full bio.

Katie Smith • Assistant

Katie has a Master's degree in Chemical Engineering and handles patents in the chemical and mechanical fields. During her placement year, Katie worked as a Process Engineer implementing operational improvements within Industrial Gas facilities.
Email her at katie.smith@reddie.co.uk, or click here for her full bio.

Generating Hydrogen

A potential alternative, or supplement, to batteries?

We reported last year on a new [report](#) from the European Patent Office (EPO) on electricity storage, in particular using batteries. Excluded from the EPO's report was hydrogen and its use in electricity storage, which is seen by some as a very useful supplement to batteries, not just in electricity storage but also for applications where batteries may not be appropriate, such as heavy transport and industry.

For example, the first commercially-available hydrogen powered car was launched by Hyundai in 2013. In September 2020, HydroFLEX became the first hydrogen powered train to run on UK main line tracks. Recently, there have also been reports of the world's first liquid hydrogen powered ferry, JCB testing the world's first hydrogen powered digger, and the first passenger flight in a commercial-grade plane powered by a hydrogen fuel cell. Others have put claim to these, or similar, hydrogen-powered transportation milestones.

But while developments in better hydrogen fuel cells and hydrogen-powered vehicles are fascinating, this begs a question: where is all the hydrogen coming from?

For hydrogen-powered vehicles to be an environmentally-friendly alternative to vehicles powered by internal combustion engines, the hydrogen required to run them must be produced in environmentally-friendly ways. To do this, the UK government's recent ten point plan for a green Industrial Revolution set out building up hydrogen generation capacity as one of its ten aims. Clean hydrogen generation was also a topic at this year's CERAweek conference.

Currently, most hydrogen is produced from fossil fuel, most commonly via steam (methane) reforming, which is energy intensive. Hydrogen produced by steam reforming is often referred to as "grey hydrogen" because of the potential environmental impact of its production. This is because the chemical reaction of methane to carbon monoxide and hydrogen is strongly endothermic, i.e. it requires the absorption of energy:

$$CH_4 + H_2O_{steam} > CO + 3\ H_2$$

More hydrogen may then be generated using the, moderately exothermic, water-gas shift reaction:

$$CH_4 + H_2O_{steam} > CO + H_2$$

As such, production of "grey hydrogen" requires both, however, there are alternative, more environmentally-friendly, ways of producing hydrogen. Two of these have received particular attention: "blue hydrogen" and "green hydrogen".

"Blue hydrogen", like "grey hydrogen", is produced by steam reforming, however, the carbon dioxide is captured and stored rather than being released into the atmosphere. "Green hydrogen" is produced by electrolysis of water using renewable energy. As hydrogen can be stored, distributed, and used away from the site of production, ideally, "green hydrogen" may be generated using excess renewable energy when electricity demand is relatively low (e.g. at night) and renewable electricity generation is high (e.g. the sun is shining). "Green hydrogen" may then be used to supplement energy provision when electricity demand is relatively high, or where fossil fuels would traditionally be used.

Patents for hydrogen production

Research and development in hydrogen production has been ongoing for decades, but appears to have picked up recently. In the past ten years, the number of patent families related to hydrogen generation has increased, especially in the last couple of years, coinciding with a renewed push to mitigate the climate crisis, and a corresponding increase in funding.

Looking at three IPC classification codes relevant to grey and blue hydrogen, C01B3/00 (Hydrogen; separation of hydrogen from mixtures containing it); C01B3/02 (Production of hydrogen or of gaseous mixtures containing hydrogen); and C01B 3/38 (Production of hydrogen using catalysts), after a small dip in patent families being published in the middle of the last decade, new records for the number of patent families published were set for each of the IPC classes in 2020 (see Figure 1a).

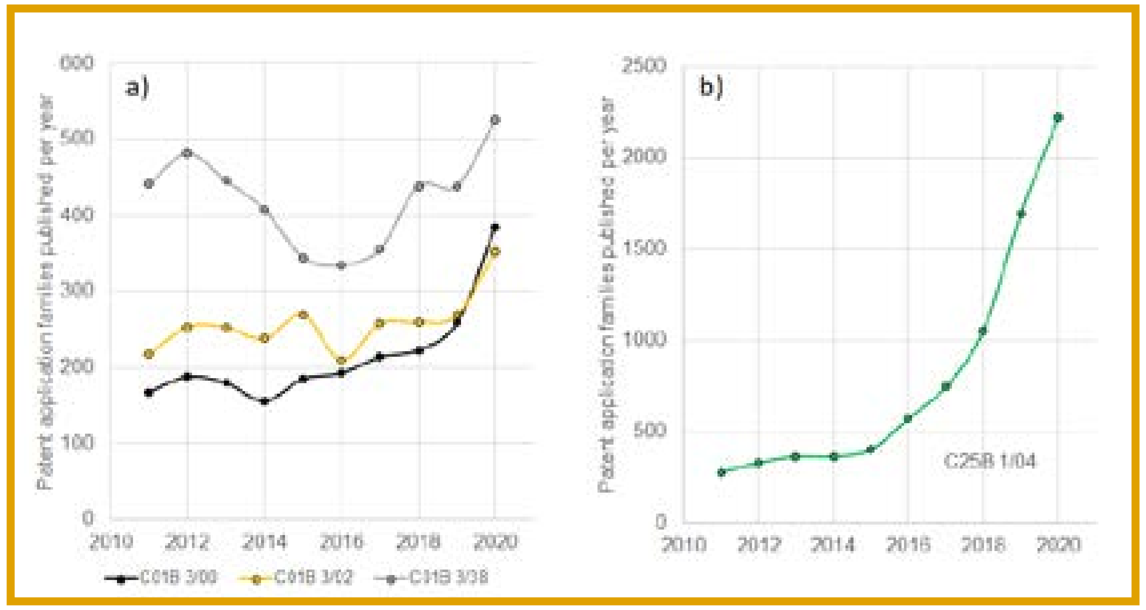


Figure 1: a) Patent application families published per year in three IPC classes related to hydrogen production. b) Patent application families published per year in IPC class C25B1/04, related to green hydrogen production.

More significantly, in IPC class C25B1/04 (electrolytic production of hydrogen or oxygen by electrolysis of water), which is relevant to the generation of green hydrogen, patent application families published per year have increased significantly and continually, from 279 in 2011, to 2218 in 2020 (see Figure 1b).

That is an eightfold increase in a decade – and most of the increase has come more recently from 2016 to 2020.

So who is filing all these patent applications?

Looking at patent filings in green hydrogen (IPC class C25B1/04) in more detail, six of the ten largest filers of patent application families in the past decade are Chinese universities, including the largest filers University Shaanxi Science & Technology and University Tianjin, indicating that a lot of the research and development (and related commercialisation and licensing) is based on academic research. Some other large filers include European and Japanese companies and research organisations with a well-established interest in sustainable technologies, including Toshiba, CEA, Siemens and Honda.

However, interestingly, when looking at the number of patent applications, i.e. counting each patent application in a patent family individually, the picture changes: the largest filers are mostly companies, not universities, including the Danish catalysis company Haldor Topsoe, Toshiba, and Siemens.

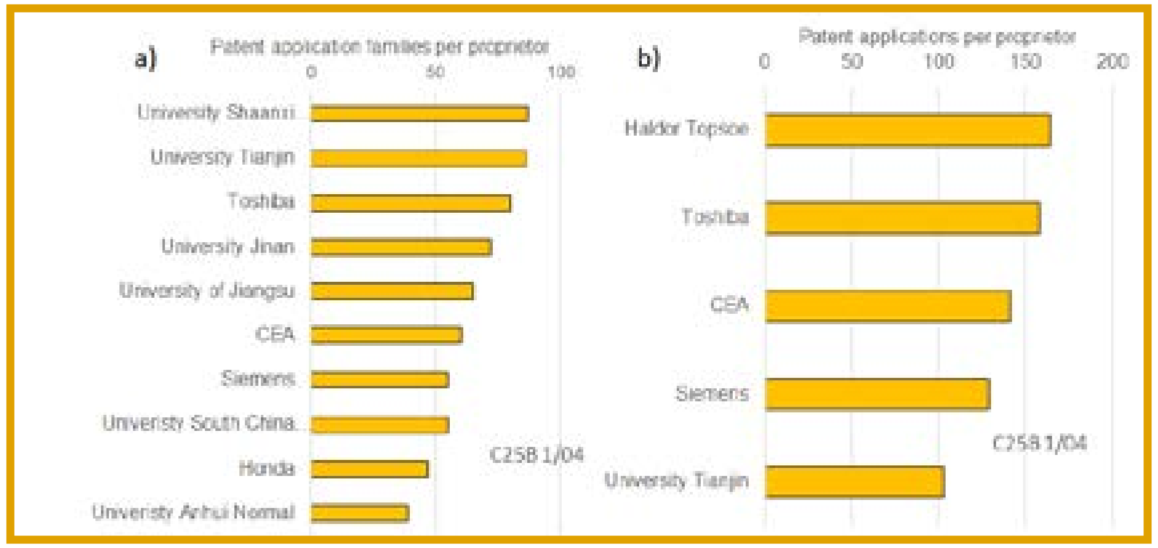


Figure 2: a) Patent application families published (2011-2020) per proprietor, and b) patent applications published (2011-2020) per proprietor, in IPC class C25B1/04, related to green hydrogen production.

This suggests that a lot of the patent applications from Chinese universities are not (or at least not yet) extended to further countries, and may be Chinese applications only. The Japanese and European companies and research organisations, on the other hand, appear to seek protection in at least a few jurisdictions for most of their patent families.

Looking at IPC class C01B3/00 as representative of research and development in grey and blue hydrogen, it is apparent that large Japanese, Korean, and European actors, such as Toyota, Panasonic, and CEA, are the largest filers of patent application families (see Figure 3). However, University Tianjin, which is the second largest filer related to green hydrogen, is also the second largest filer in this IPC class.

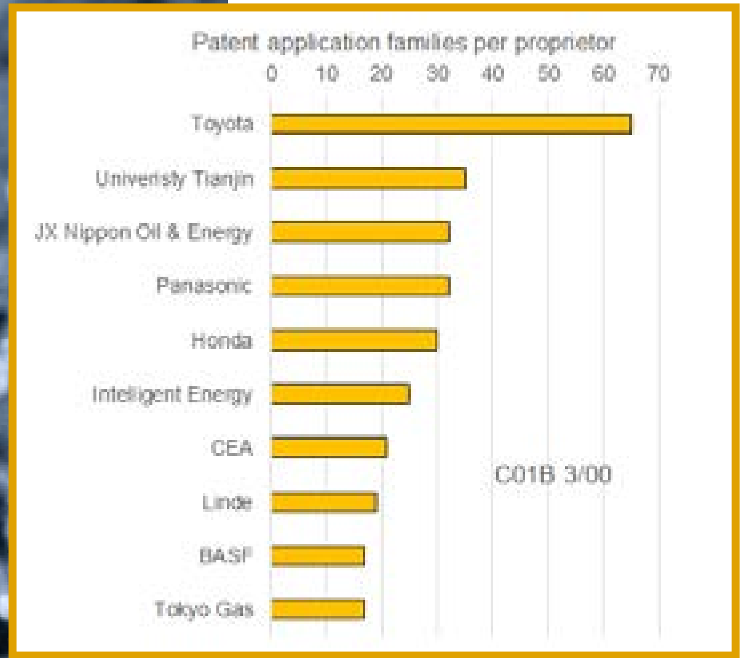


Figure 3: Patent application families published per proprietor in IPC class C01B 3/00, related to grey and blue hydrogen generation.

What does this tell us about the future of hydrogen generation?

It is clear that hydrogen production, and in particular green hydrogen production, is an area of significant, and increasing, research and development activity. While patent filing numbers can never tell the whole story, in particular considering the 18-month lag between filing of a patent application and its publication, it seems clear that Chinese universities, as well as Japanese and European companies and research organisations such as Toshiba, CEA, and Haldor Topsoe, are in a good position to take advantage of the desired switch to more, and greener, hydrogen.

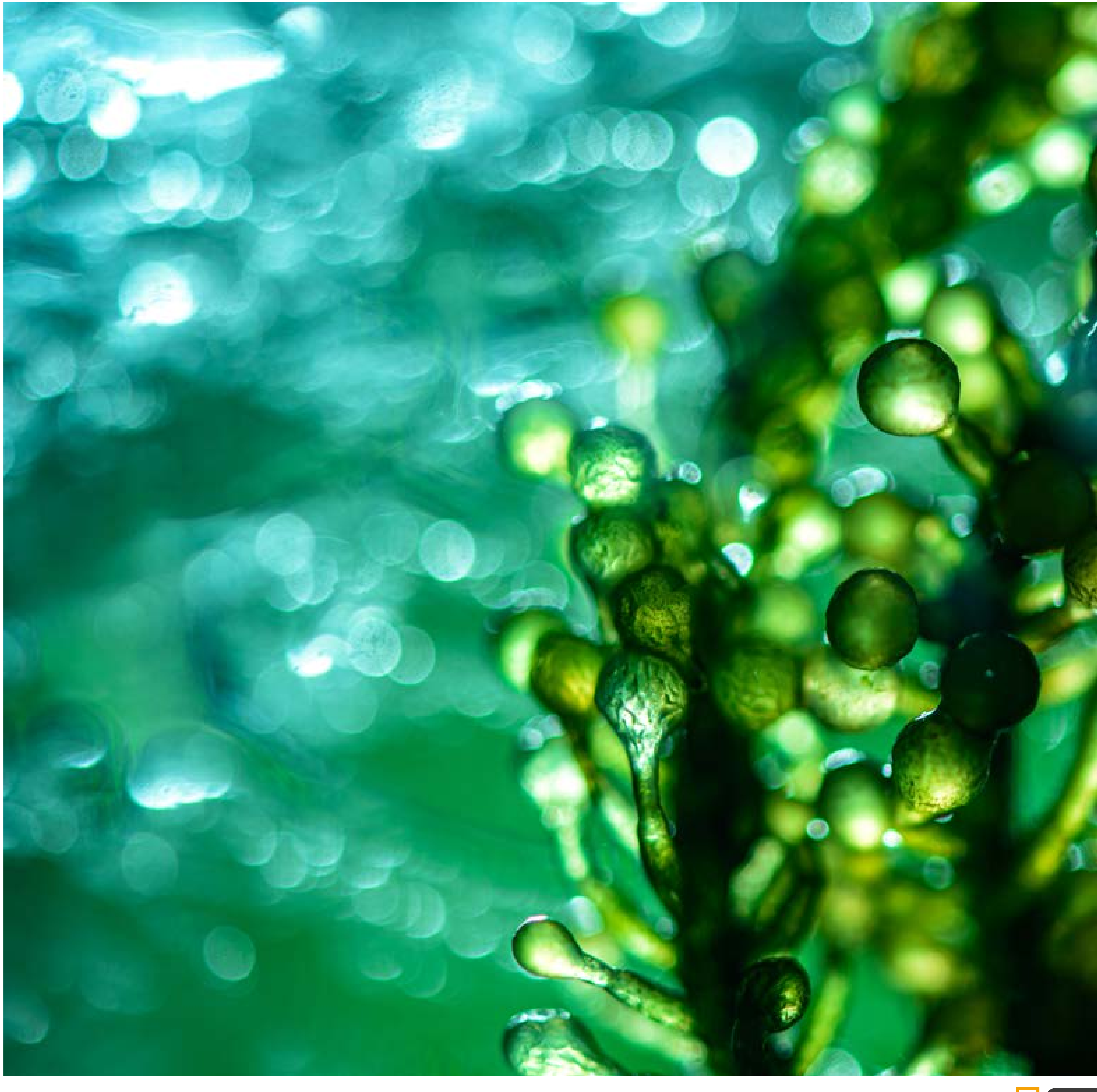
While hydrogen generation is only one aspect in the development of a hydrogen economy, it is important to consider that the hydrogen supply chain is complex. Protecting your intellectual property at various stages of this supply chain, be it related to the generation, storage, use, or transportation, is essential. Judging by the patent data shown above, Chinese universities, and Japanese and European companies and research organisations, seem to be leading the way, in particular when it comes to green hydrogen production.

In Europe, the European Clean Hydrogen Alliance is being used to kick-start research on renewable hydrogen production by streamlining investments of an estimated €430 billion until 2030. As stated above, the UK has recently named building up hydrogen generation capacity as one of the ten aims for a green Industrial Revolution, which will be supported by government funding.

At Reddie & Grose, our experts can advise you on the best ways to protect your intellectual property related to the hydrogen supply chain, whether you work on green, blue, or grey hydrogen.

Author: Dr Dustin Bauer

What is the future for biofuels?



The first long-haul flight powered by biofuels took off on 18th May 2021. An Air France-KLM flight from Paris to Montreal used a mix of conventional jet fuel and a sustainable aviation fuel (SAF) made from used cooking oils. Also, the UK Government has recently announced that it will mandate the introduction of E10 fuel (petrol containing up to 10% of sustainable bioethanol) from September this year.

Although this is positive news, there is more that can be done. According to the International Energy Agency (IEA), transport biofuel production expanded 6% year-on-year in 2019, and 3% annual production growth is expected up to 2024. However, this falls short of the sustained 10% output growth per year needed until 2030 to align with the IEA's Sustainable Development Scenario (SDS). The SDS outlines a major transformation of the global energy system, showing how the world can change course to achieve universal access to energy, reduce the severe health impacts of air pollution and to tackle climate change.

In addition to policy support, the IEA highlights the need for innovation to reduce costs in order to to scale up both advanced biofuel consumption and the adoption of biofuels.

Second generation biofuels

A focus of innovation is the transition from first generation biofuels to second generation biofuels. First generation biofuels are derived from food crops. Sugar or starch derived from feedstock such as corn, sugar cane and soybeans can be converted to bioethanol using yeast fermentation. Oils, such as virgin vegetable oils, can undergo transesterification to produce biodiesel. First generation biofuels are certainly useful, and represent the majority of biofuels available today, but their use can threaten food supplies and biodiversity.

Second generation biofuels, on the other hand, utilise feedstocks that are generally not food crops or are not suitable for human consumption. This can include straw, bagasse, perennial grasses and waste vegetable oil. Common second generation feedstocks may produce more biomass per unit area, because the entire crop is available as feedstock for conversion to fuel, and may be able to grow on land that is not suitable for food crops.

Use of second generation feedstocks to produce ethanol involves two steps: the cellulose and hemicellulose components of the biomass are first broken down into sugars; and the sugars are then fermented to obtain ethanol. The first step is technically challenging, with research focussing on developing efficient and cost-effective ways of carrying out the process. Up to now, the lack of commercial viability has limited the uptake of cellulose-based second-generation biofuels.

In the context of biofuels for transportation, current research is also focussing on 'drop-in' biofuels. In contrast to bioethanol and biodiesel, drop in biofuels are fuels that are functionally equivalent to petroleum fuels that have the potential to replace fossil petrol to reduce high amounts of greenhouse gas emissions from conventional petrol cars, without investing into new vehicles or modifying the old ones.

In May 2021, Neste reported that they are in the final phase of testing a drop-in biofuel that they hope will be suitable for commercial use in existing petrol and hybrid cars.

Drop-in fuels can be produced from oleochemical feedstocks such as vegetable oils and used cooking oils. They can also utilise thermochemical technologies such as gasification, pyrolysis or hydrothermal liquefaction based on lignocellulosic feedstocks.

Third generation biofuels

Third generation biofuels refers to those derived from algae. Microalgal biomass is versatile and can be used to produce bioethanol, by fermentation and biodiesel by transesterification. Algal fuels have very high yields and can be grown almost anywhere temperatures are warm enough. This means that no farm land need be threatened by algae. Algae can even be grown in waste water, so they can provide additional advantages by helping to waste while avoiding taking up any additional land. Algae could also potentially utilise waste carbon dioxide in their cultivation.

Although algae can be grown in open water, in order to optimise yield and control, research into third generation biofuels has at least partly focussed on closed systems such as photobioreactors. However, photobioreactors remain an active area of research in order to make them more cost-effective and scalable.

The future for biofuels in transport

In 2020, the UK government announced the end of the sale of new petrol and diesel cars in the UK by 2030. So, do biofuels have a part to play in future transport? It would appear so.

Biofuels may be particularly suited to sectors such as long distance trucking, shipping and aviation where electrification is not a suitable option. Also, one cannot ignore the role that biofuels can play in the production of electricity ("bioelectricity"). So, biofuels can supplement electric transport by reducing upstream emissions in electricity production.

CASE STUDIES

Reddie & Grose has assisted:

A multinational energy company developing enzymes with improved activity and stability, that are able to break down cellulose and hemi-cellulose.

A UK-based company that has developed a process for fractionating biomass to allow recovery and isolation of hemicellulosic and cellulosic sugars.

A US-based academic research institution using catalytic conversion of alcohols obtained from lignocellulosic biomass as feedstock, to produce higher hydrocarbons.

A US-based company in obtaining patent protection for novel photobioreactors.

A US-based company to obtain patent protection in Europe for technology which utilises solid biomass to produce activated carbon and energy.

Bioenergy for electricity and heat

According to the IEA, bioenergy accounts for about 10% of world total primary energy supply today. Its contribution to final energy demand across all sectors is five times higher than wind and solar combined. In 2019, bioenergy electricity generation increased by over 5%, but the heating sector remains the largest source.
Unlike biofuels for transport, biofuels for electricity and heat production are not limited to liquids. The Drax Power Station in North Yorkshire (UK) has been converting its coal-fired boilers to use biomass. The station uses a range of biomass feedstocks including wood pellets, sunflower pellets, olive, peanut shell husk and rape meal. The station also uses BECCS technology ("Bioenergy with carbon capture and storage") to make sure that no carbon is released into the atmosphere from its biomass boilers.

It is apparent that biofuels are an essential component of our future energy supply and in the reduction of greenhouse gas emissions. More innovation is key to unlocking the true potential of biofuels, particularly for transport, to scale-up and improve cost-effectiveness.

Biofuels are promising in many ways, not least because they rely on biomass resources that are more evenly distributed around the world, and because there is the potential to use waste products as raw materials.

Reddie and Grose is excited to be assisting innovative companies in the biofuels sector.

Author: Andrew Carridge

LIQUID-AIR ENERGY STORAGE

A COOL FUTURE FOR ENERGY STORAGE?

Last year construction started on a 250MWh liquid-air energy-storage system in Greater Manchester. Supported by a £10 million UK government grant, when completed the "CRYOBattery" will be the largest liquid-air energy-storage system in the world.

Energy Storage

Use of renewable energy to power the UK electricity grid has never been higher. Wind and solar are sustainable, but their output varies with environmental conditions. This makes balancing the grid a significant challenge. If the UK is to move away from a baseload of electricity generated by fossil fuels, the variable nature of renewable energy must be addressed. Energy storage is widely viewed as a potential solution.

In our article last year we discussed innovation in electricity storage, following a detailed report by the European Patent Office and the International Energy Agency on patenting activity in this field. The report suggested that battery storage is the main area of innovation, and in particular that lithium-ion batteries may be essential in meeting our future energy storage needs. Lithium-ion batteries are very useful for portable storage such as in electric vehicles.
For larger-scale storage they can be difficult and costly to scale up, but perhaps not impossible, as shown by Tesla's Hornsdale Power Reserve.
Another option is pumped-storage hydropower, which in 2019 accounted for 90% the world's energy storage for stationary applications.
Pumped storage offers large-scale energy storage, but it is geographically constrained, capital intensive and impactful on the environment.

Liquid Air Energy Storage (LAES)

The main benefit of LAES is to provide medium to long duration energy storage, believed by some to be crucial in complementing the short-duration storage provided by batteries.

Like other energy-storage solutions, the idea of LAES is that during periods of high electricity production (i.e. when there is a lot of wind), rather than curtailing production, the excess energy is stored, to be used later during periods of high demand.

LAES comprises three stages.

The first stage is charging. When excess energy is produced during periods of high production or low demand, the energy is used to form liquid air. This is achieved by compressing the air to form a high-pressure gas, the air is then cooled by heat exchange with a cold fluid. The cold compressed air is then expanded. This expansion further decreases the temperature of the air, condensing it to liquid form at around -196°C.

The second stage is storage. 700L of gaseous air can be stored as 1L of liquid air in insulated tanks at near ambient pressures.

Finally, when the demand for electricity increases, the energy is discharged. The liquid air is pumped to a high pressure and then heated, to produce a high pressure gas. The gas is then expanded across a turbine, driving the turbine to generate electricity.

Unfortunately, simply running the three-step process would be too inefficient to be economically viable; LAES needs to have efficiencies to rival battery storage.

To achieve this, LAES plants recycle the waste cold that results from the discharge stage, to help cool incoming air when charging. This reduces the amount of power used for cooling and increases overall efficiency.

> **"Although the fundamental technology is decades old, innovation is required to increase efficiency and make LAES commercially viable."**

The heat produced by initial compression of the gas during charging can also be recycled and used for expansion of the air during discharge. The key to the efficiency of LAES is heat integration of the entire process in the plant.

Innovation in LAES

A significant benefit of LAES is that much of the technology is old and well established. For years, components of LAES systems have been used in other processes across the industrial gas industry. But although the fundamental technology is decades old, innovation is required to increase efficiency and make LAES commercially viable.

A search of patent databases indicates that the patents in this field are directed towards the improvement of LAES system efficiency and heat recovery.

For example, EP2895810 is a patent application directed towards an improved version of the Claude cycle (a common process used for liquefying air). Using cold recovery the process provides more cooling to the gas prior to liquefaction. The improved cooling increases liquid production. As a result, the efficiency of the system is increased, and crucially the price per unit of power can be reduced. Other patents such as US9638068 propose liquid-air energy storage based on modifications to the Linde-Hampson cycle (another process for liquefying air) and heat integration.

So far most research into LAES has been limited to theory. To achieve commercially-viable efficiencies large-scale plants are required and therefore a high initial investment in equipment is needed. If the new "CRYOBattery" plant proves successful, it could be the turning point for industrial-scale developments of LAES systems in the future.

Author: Katie Smith

Photo: Traditional Liquid Air Plant

Are you going around in circles? You should be.

Plastic is great. It's cheap, strong, lightweight, durable, waterproof, doesn't break down easily... the list goes on. Its diverse range of properties lends itself to many applications. However, the exceptional durability of plastic is something of a double edged sword. In order to meet the high demand for plastic we produce over 300 million tonnes of it per year, much of which ends up in landfill, the oceans and even our bodies.

So, how can we mitigate this problem of plastic pollution when plastic has nestled itself so deep into our lives?

Many say we need to fundamentally rethink the way we design, use, and reuse plastic. This is what a circular plastics economy is all about.

Circular Plastics Economy

A circular plastics economy is an economic system with a regenerative approach. It aims to eliminate plastic waste through the circulation and continual use of plastic – a plastic loop. In other words, it's a system where plastic never becomes waste. It involves both limiting the amount of plastic that enters the loop, and keeping any plastic that has entered the loop in the loop. This is mostly through reusing and recycling.

Sounds simple enough. But, can we achieve a circular plastics economy? Not without awareness and innovation.

The New Plastics Economy is a global initiative, led by the Ellen MacArthur Foundation, with a commitment to unite key stakeholders to rethink and redesign the future of plastic. The initiative argues that the current "linear" economy of "take-make-waste" is unsustainable and sets out the action needed to shift to a circular plastics economy instead. The initiative has united over 850 organisations through its vision for a circular economy for plastic supported by three key actions: eliminate, innovate, circulate.

Eliminate – Designing out plastic

Limiting the amount of plastic that we generate is the best way to eliminate plastic waste, it's something of a no-brainer. To do so we need alternative materials that are able to perform the same function as plastic. As mentioned above, plastic is very versatile; therefore, innovation is key to designing alternative materials that can compete with plastic.

In our previous blog, we wrote about such materials: from algae water capsules that were handed out to runners at the London Marathon 2019 to packaging made from mushrooms which was nominated for the European Inventor Award 2019.

However, sometimes it is difficult to design out plastic, due to the material properties that are required for a certain product. Then, if we can't avoid plastic, we should at least design the product such that it is recyclable.

Innovate – Designing for recyclability

An example of an innovation designed for recyclability is the CORRETTO™ cups (see WO 2019/025274 A1) by UK based company Bockatech. The cups are both reusable and recyclable and are designed to replace single use plastic-lined paper coffee cups.

While plastic-lined paper coffee cups may sound environmentally friendly, since it contains paper, there are many issues with them when it comes to recycling. Paper coffee cups need a lining, typically plastic, to make it waterproof. While this does not render them non-recyclable, it does make recycling them very difficult. The plastic lining needs to be separated from the paper cup in order for them to be recycled. However, there are not many recycling facilities in the UK that are able to do this. As a result, most plastic-lined paper coffee cups end up in landfill.

The CORRETTO™ cups are made only from polypropylene, making them easily recyclable, since there is no need for any material separation. However, without the corrugated paper normally found in plastic-lined paper coffee cups, how are the CORRETTO™ cups adequately heatproof?

The CORRETTO™ cups feature walls comprising a foamed polypropylene layer. This not only provides the cups with good thermal insulation properties, it also provides the cups with a rigidity suitable for a coffee cup.

At first sight a wholly plastic product replacing a partially plastic product may seem counterproductive towards tackling the plastic problem, but sometimes this may be the solution to achieving a circular plastics economy where there is no plastic waste.

Circulate – Consumer behaviour

The benefits of any innovation will only be realised if they are readily adopted by the public. As such, with any innovation, consideration has to be given to consumer behaviour.

Even here, technology is being used to help encourage us to recycle. In the Italian Renaissance city of Lucca, the local waste collection company Sistema Ambiente SpA is using passive RFID tags on waste containers and even individual bin bags. The RFID tags are read by a reader on the garbage truck when the waste is collected. This allows the company to keep track of the amount of waste produced by each household and, critically, how much of it is recyclable. The households are then billed for the waste collection on this basis, thereby encouraging users to cut waste and spend time sorting their waste for recycling.

We also previously wrote about a recent funding competition for projects on sustainable plastic solutions with a particular emphasis on changing human behaviour. Click here to find out more.

Have you closed the loop? If you would like advice on protecting your innovation to help us move to a circular economy, or any other innovation, please get in touch.

Author: Joanne Pham

Innovations in Aviation

Electric Propulsion

The Paris Agreement on climate change entered into force in November 2016, with a goal of limiting global warming to below 2, preferably to 1.5 degrees Celsius – compared to pre-industrial levels. According to the International Energy Agency (IEA), CO2 emissions from aviation in 2019 equated to around 2.8% of global CO2 emissions from fossil fuel combustion. So, it's probably no great surprise that there has been much research in recent years on ways to reduce the carbon footprint of the aviation sector.

Clearly, there was a significant reduction in aviation-related emissions in 2020 due to the travel restrictions resulting from COVID-19. However, as the world slowly returns to a version of normality, airline travel and related emissions will increase. So, the need and desire for innovations to help reduce aviation's carbon footprint will remain.

Alternative fuels

Jet engines for civil aircraft have undergone improvements in efficiency over the years, but are largely still reliant on the use of kerosene as fuel. Work has been done on so-called "drop-in" fuels, being alternative fuels which can be used in place of kerosene without requiring extensive redesign of existing engines, and related aircraft systems.

Innovations in electric propulsion

However, another area that has seen innovation in recent years is that of electric propulsion systems for aircraft.

One example is E-Fan X, which was active between 2017 to April 2020. E-Fan X was a hybrid electric aircraft technology demonstrator programme. The programme used a BAe 146 aircraft as a platform, and replaced the core of one of the aircraft's four turbofan engines with a 2MW electric motor. Power for the electric motor was provided by a turboshaft engine and generator located in the rear of the aircraft fuselage, with an air intake provided in the fuselage to feed the turboshaft engine. Additionally, a 2MW battery was also provided in the fuselage to provide energy storage.

However, aircraft have also been developed solely employing electric power, without the need for conventionally powered engines to provide propulsion or to serve as means for generating electric power.

Much of the progress to date has been in the light aircraft sector. Aircraft are being developed which use a large number of electrically-powered engines arranged on the aircraft – known as distributed electric propulsion. One such example is the Lilium jet, which is intended to transport 4 passengers and a pilot over a short range, and have a 60 minute flying time. The aircraft employs a configuration of 36 electrically-powered ducted fans arranged in different groups to provide propulsion, and able to tilt to provide vertical take-off and landing (VTOL) capability.

The integration of the fans into the structure of the wings means that the housings/nacelles for the fans can also contribute to the generation of lift.

The International Civil Aviation Organisation (ICAO) provides a non-extensive list of various projects relating to the development of aircraft employing electric propulsion systems.

As you might imagine, research and development in electric propulsion has been accompanied by an increase in patent filings in this sector.

One example of such a filing is shown here, relating to a hybrid gas-electric propulsion system for an aircraft. For this hybrid system, power generated by two conventional jet engines is used to drive an electric motor provided in a boundary layer ingestion fan provided at the rear of the aircraft's fuselage. In-flight, the fan will ingest a boundary layer of air flowing over the fuselage of the aircraft, thereby reducing aircraft drag and enabling an increase in propulsive efficiency.

Another example relates to an aircraft having a propulsion system in which electrically powered ducted fans are integrated into the wings of the aircraft. This again is a hybrid design, employing a turboshaft engine for driving a generator, with the generator providing AC power to the ducted fans.

The upscaling of electric propulsion to larger civil aircraft with longer range will present significant challenges for the future, but will also provide opportunities for innovation and the development of valuable new intellectual property.

Author: Andy Williams

Space-Based Solar Power – a patent perspective

Transmitting solar energy generated in space back to Earth has long been the subject of science fiction, first appearing in Isaac Asimov's 1941 short story, 'Reason', where solar energy is converted to microwaves by a space station, and beamed back to nearby planets.

The science that underlies extra-terrestrial solar power is, in fact, highly plausible. Utilising solar energy in this way has a range of advantages over conventional terrestrial solar power generation. For example, unlike terrestrial solar power generation which can only generate power during daylight hours, extra-terrestrially-generated solar power will be available 24 hours a day as the energy collection is performed in the space where the sun never sets. This can obviate the need for large-scale energy storage facilities. Moreover, extra-terrestrial solar spectrum (AM0) is free from losses caused by the Earth's atmosphere. This can lead to higher power generation rate when compared with terrestrial solar power generation under the standard AM1.5G spectrum.

Technical and economic constraints have, until recently, prevented the solar technology from getting off the ground. However, recent technological advances in the field of lightweight solar panels, wireless power transmission, and lower cost commercial space launch, mean that the concept might actually be technically and economically viable.

The UK government recently commissioned their own research into space based solar power systems, and, earlier this year, Pentagon scientists successfully tested a solar panel in space, finding it to be capable of beaming electricity back to Earth.

Patents are an important tool for companies investing time and money into innovative technology. They provide an exclusive right for the owner of the patent to economically exploit an invention, as a return on their research and development costs. But patents are national rights. This means that a UK patent provides rights in the UK, whereas, for example, a US patent is needed to protect the invention in the US.

This makes inventions in space a complex area, as discussed in detail by Andy Attfield in our earlier article. Under international law, an object that is launched into space from a particular country is subject to the jurisdiction of that country. But this does not mean that the object is in that country. The US has specific provisions under which an object launched into space from the US that performs a patented process is deemed to be performed within the US. However, corresponding provisions do apply in other countries, meaning that the protection afforded by the US provisions could be easily circumvented by launching from a site outside the US.

In the UK, a patent covering an object would be infringed if a competitor were to both manufacture the object in the UK and launch it into space from the UK. This is probably also the case for objects imported into the UK. But what if the object is assembled in space? One of the biggest technical issues to overcome in establishing space-based solar power is assembling the satellites in orbit, which has not been done before on the scale required. Protection for innovations involving the assembly or interaction of parts only once they are in space, and thus outside the UK, is not so clear cut. The situation becomes yet more complicated if the solar power station involves a network of separate satellites, potentially launched at different times and from different jurisdictions.

The need to close this gap in international patent law and provide fair protection for innovators is recognised by organisations such as the World Intellectual Property Organisation (WIPO) and the European Space Agency (ESA), but it remains to be seen how, and when, the law might be modified.

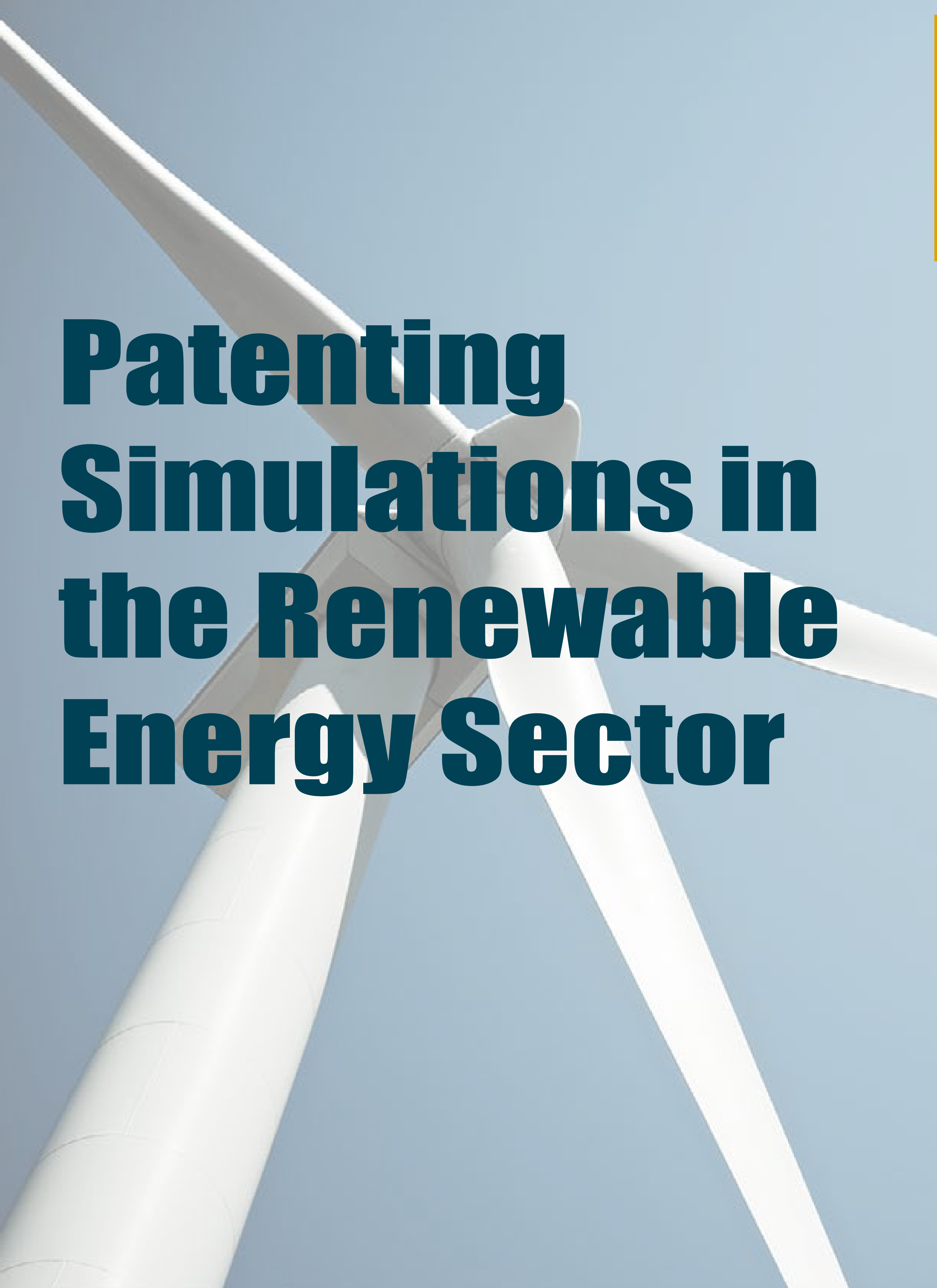
For now, the safest option is to draft patents to include claims that would be infringed on earth. If possible, the patent should include separate claims to individual elements that are assembled on earth, as well as the assembled product or network of satellites that is finally deployed in space. In principle, a properly drafted claim directed to the elements of a satellite could be infringed by a kit containing those elements launched from earth, even if the satellite is ultimately assembled in space. However, care must be taken where the invention lies in the configuration of the satellite once it is assembled and in use. In this case, thought should be given to whether a claim can be drafted to features which enable that configuration, rather than the configuration itself.

It is also important to be mindful of what can be protected in different countries. The specific provisions in the US, for example, regarding inventions in space, justify the inclusion of claims that would be infringed by an object in space, even if infringement under UK law seems questionable.

And of course, cooperating ground-based systems and operations on earth should not be forgotten. In the context of space solar, patent claims protecting aspects of the ground-based receivers and their integration into the grid may prove critical.

At Reddie & Grose LLP, we have the specialist knowledge and experience to draft meaningful and commercially useful patents for our clients, taking into account an understanding of how and where inventions are to be deployed, as well as a detailed understanding of the underlying technical concepts.

Authors: Georgina Ainscow & Dongyoung Kim



Patenting Simulations in the Renewable Energy Sector

Renewable energy is more affordable now than it has ever been. According to BloombergNEF, it is now cheaper to build a new solar or wind farm to meet rising electricity demand or replace a retiring generator, than it is to build a new fossil fuel-fired plant. Policy incentives, increased investment and technological advances are driving this strong growth in the renewables sector, leading to technological improvements in the structural hardware necessary for renewable energy generation, transmission and storage.

But innovation in these fields is not limited to improvements in the hardware; digitisation is key to maximising efficiency in the future energy system, and much innovation in the renewable energy space relates to software simulations and big data analytics that underpin this. Sophisticated simulations allow for component and system design optimisation before manufacture, driving down costs at the R&D stage. Simulations also allow the operation of a renewable energy plant to be modelled under different conditions, with a range of benefits, including the ability to assess the suitability of different sites, and controlling operation to optimise performance.

For example, the National Renewable Energy Laboratory (NREL) in the US have developed simulation software which allows users to investigate effects of weather patterns, turbulence, and complex terrain on the performance of wind turbines and plants. Through the use of the software, NREL found that optimising yaw control and the relative positioning of individual turbines improved the power performance of downstream turbines by mitigating the interference that wind turbines in an array have on each other.

Simulation and optimisation in component design and plant placement are equally vital in solar energy, and in both fields, forecasting has a significant role to play in allowing the grid to accommodate the inherent variability of the supply. Digitisation in the form of simulations and big data analytics will also facilitate the integration of microgrids and distributed energy resources – diverse energy resources including rooftop solar panels, battery storage, smart meters and controllable loads like electric vehicles, to promote efficiencies and help balance the grid.

Patenting Simulations in the UK and Europe

Patent protection for physical devices is well understood. If the device is new and inventive over what has gone before, a patent can generally be granted. However, patent protection for software is much more complicated, with the result that the use of patents to protect innovation in this field is often overlooked.

In the UK and Europe, simulations, and software in general, are not guaranteed to be eligible for patent protection, because a European patent can only be granted for an "invention" that provides a technical solution to a technical problem. This definition of an invention does not cover programs for computers, mathematical methods and mental acts (which cover simulations in their purest form), as these are not considered to be inherently technical. However, in practice, software innovations that are directly linked to a physical, technical effect in the real world, may be patented so long as they clear the usual hurdles of being new and involving an inventive step.

But what does this mean for simulations, where the innovation resides in modelling real world technical applications on a computer? Is it possible to protect such simulations via a European patent without a direct physical link to the real world?

A landmark decision on patenting simulations – G1/19

A few weeks ago, the Enlarged Board of Appeal of the European Patent Office (EPO) issued a landmark decision "G1/19", on the extent to which computer-implemented simulations are patentable in Europe (previously reported here). The patent application in question concerned a computer program for simulating the movement of a pedestrian through an environment, the main purpose of the simulation being its use in designing a venue such as a railway station or a stadium. The decision confirmed that computer-implemented simulations should be considered in the same way as any other computer-implemented process, but went on to clarify that the simulation does not need to have a direct link to physical reality, and there is no need for the simulated system to be inherently technical.

Before G1/19 there was doubt as to whether a simulation could fulfil the EPO's criteria of involving an inventive step without including a direct link to a physical process or system. This is because under European practice, a computer-implemented invention must produce a technical effect when run on a computer.

Generally, a technical effect could be found in anything that goes beyond the "normal" physical interactions between computer software and computer hardware. This leads to the suggestion that a simulation could only be patentable if it provided a technical effect on a physical entity in the real world: for example, when the simulation controls a technical process, such as yaw control for a wind turbine.

However, in G1/19 it is indicated that there is no strict requirement for the claim to explicitly link the output of the simulation with external physical reality (such as a step of controlling a device based on the output of the simulation), provided the claim implies the technical use of the simulation's output.

What does this mean for simulations in the renewable energy space?

Where patent protection for a computer simulation is sought, success is more likely if the scope of protection defined by the patent claims can be explicitly limited to a physical application in the real world. However, it is not always desirable to limit the scope of protection in this way. For example, where the simulation and the real world application would typically be performed or used by different parties or in different jurisdictions. G 1/19 may be helpful in these circumstances because it suggests that an implied technical use may be enough.

By way of example, in coming to their decision, the Enlarged Board in G 1/19 endorsed an earlier EPO decision (T 625/11) which concerned a software simulation for establishing a limit value for an operational parameter of a nuclear reactor. The calculation of the limit value based on a simulation of the reactor was held to contribute to the technical character of the claim, even though the use of the value in the operation of a real world nuclear reactor was not directly specified. Here, it seems that the reference to "an operational parameter of a nuclear reactor" was enough to imply physical control of a real would reactor, even though that physical control was not explicitly claimed.

G 1/19 also gives the example of weather forecasting. While improved weather forecasting is not patentable on its own, or when directed to the forecasting of a financial product, it "probably" would be patentable if the weather forecasting data is used, for example, to automatically open or close window shutters on a building.

By extension of these examples, it would seem that an improved weather forecasting simulation used to control the operation of a wind farm, for example, could be patentable. Moreover, it may be enough to specify the generation of a control signal or an operational parameter for controlling the wind farm, without explicitly claiming aspects of the wind farm, or the steps performed at the wind farm.

Conclusion

G1/19 represents a significant finding for any industry which utilises simulations, including the renewables sector, where it may not be desirable to limit patent protection for a simulation by specifying a direct link with a physical device in the real world. For simulations to be patentable, it appears that it may be sufficient in the future that the simulation is implicitly for a technical purpose. In practice, such arguments might be more persuasive if the intended further use of the simulation output data can be clearly signposted in the patent claims. Moreover, while a direct link to physical reality is not required to patent a computer-implemented simulation in Europe, it is still worth including such a feature as a fall-back position when drafting patent applications.

At Reddie & Grose, our attorneys have extensive experience drafting and prosecuting patent applications in the UK and Europe and around the world, and are well placed to advise on the IP challenges faced by innovators in the renewable sector.

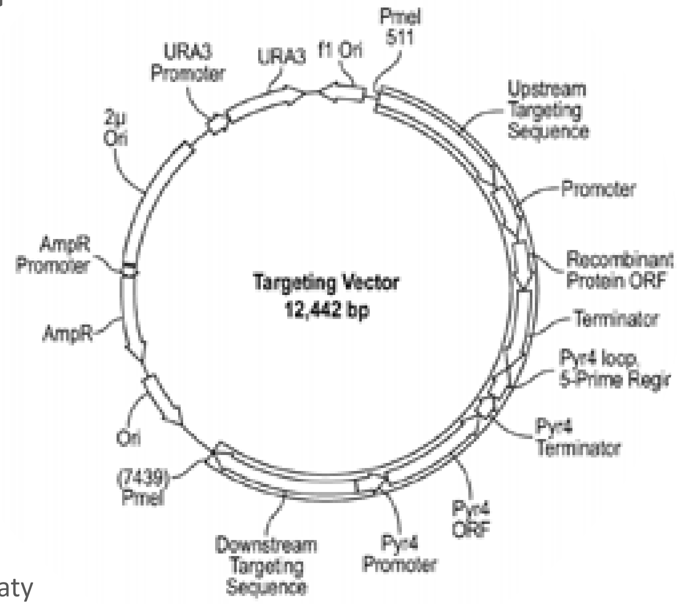
For more detailed commentary on the content of G1/19, see Christopher Smith's recent article here.

Author: Georgina Ainscow

Reddie & Grose LLP recently participated in London Climate Action Week, delivering a presentation entitled "Innovations for a Sustainable Lifestyle". Rather than focussing on large-scale global or societal technological fixes, we very much wanted to highlight the changes that individuals could make in their own lives to be better ancestors to future generations. The presentation focussed on innovation in four areas of our everyday lives – food, fashion, home and plastics – and discussed ways in which innovation can help us reduce our carbon footprint and impact on the planet.

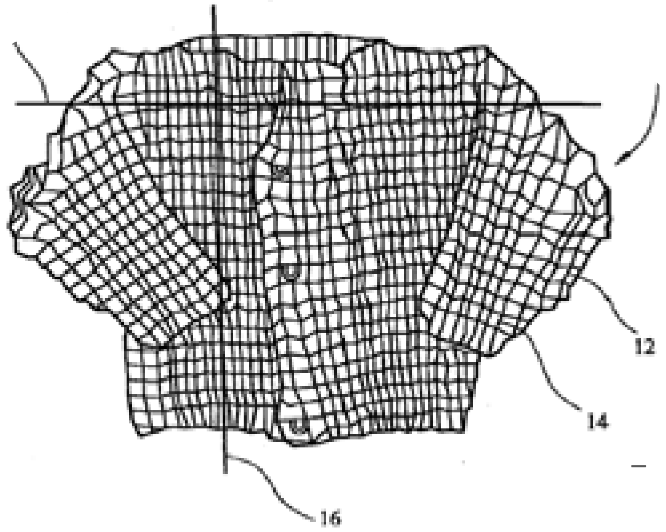
Food

As explained by Zack Mummery, a senior associate in our London office, food production currently accounts for 26% of anthropogenic GHG emissions . Production of beef and lamb is well known to be a large contributor of GHGs, though we were surprised to find dark chocolate also made a large contribution. We suspect many might find dark chocolate harder to reduce than meat consumption!



Fortunately, a revolution in food technology is underway with many innovators and entrepreneurs bringing products to the market that are more sustainable, and that taste increasingly like the products they replace. The well-known brand Oatly for example has patented its technique for producing oat milk in European patent EP2953482B, while Perfect Day Inc, has developed a recombinant milk protein (WO2020081789A) that is made without animals and can be used to make a host of dairy products including milk, cheese and ice cream. Impossible Foods has developed ground meat and beef burger alternatives using soy and a recombinant Heme protein made using yeast cells. Heme naturally occurs in meat and imparts a meaty flavour. Impossible Foods have set about protecting a variety of their technologies and have successfully patented a "meat replica composition" in EP3125699B, securing claims that relate to a 5% to 88% "meat dough" comprising an isolated plant protein, and a 0.01% to 4% heme containing protein.

Fashion



As discussed by Gillian Taylor, a partner in our London office, the fashion industry has a huge environmental impact. The statistics are surprising: the fashion industry currently produces a tenth of the world's carbon emissions; in Britain alone, 1.5 million tonnes of unwanted clothes are discarded every year ending up in landfill, not to mention the increasing amount of pollution to rivers and oceans resulting from microfibers run-off, and on average Britons wear clothes only seven times before throwing them away currently only 10% of clothing is recycled.

In addition, many of the materials used by the fashion industry, both synthetic and natural, are not sustainable. Again, technical solutions are available in the form of alternative, more sustainable materials. "Pineapple Leather" patented by Ananas Anam Limited under EP2576881B, and marketed under the trade mark Pinatex is an artificial leather material comprising cellulose fibres extracted from waste pineapple leaves, which are an agricultural by-product that would otherwise be burnt or dumped. The resultant material is already widely available and is surprisingly similar to real leather in terms of appearance and texture. Bolt Threads have patent protection in the US (US11015059) for another artificial leather material based on mushroom "mycelium" and marketed under the trade mark Mylo.

Lastly, Petit Pli have relied on old-fashioned creativity to come up with their "garment pleating" technology to develop clothing for babies and children that can "grow" with the child (GB patent application GB2566250).

Home

Nick Reeve a partner in the London office discussed innovations and practices we can adopt at home to reduce our carbon footprint. Figures from the Climate Change Committee, the independent advisory body to the government, for example, show that the UK has reduced its carbon emissions by almost 50% compared with the 1990 baseline, largely due to decarbonisation of our electricity supply and reduced contributions from manufacturing, but that the UK still has a lot of work to do to reach its net zero target of 2050. Very little progress has been made so far in areas such as heating of homes and offices, and transport, which now account for nearly 20% and 25% of the UK's GHG emissions respectively.

Solutions for decarbonising our homes exist already, and many are based on well-established technologies, such as solar panels and heat pumps. Heat pumps and underfloor heating will be crucial in the coming years to replace gas boilers, which currently emit around 2 tonnes of CO_2 per household per year and which are due to be phased out from 2025. One of the first patents relating to a heat pump was issued in 1912 to the Swiss inventor Heinrich Zoelly, CH59350, and in the past century or so the technology has not changed significantly. Even without heat pumps, innovations exist that reduce gas usage, such as intelligent thermostats (for example NEST's self-learning thermostat patented as EP2769279B relating to a "Energy Efficiency Promoting Schedule Learning Algorithms For Intelligent Thermostat"), and water saving shower heads (US2006219821).

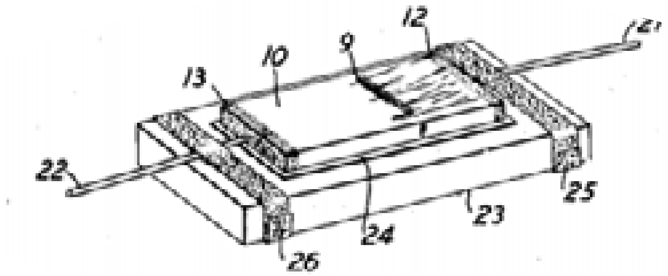
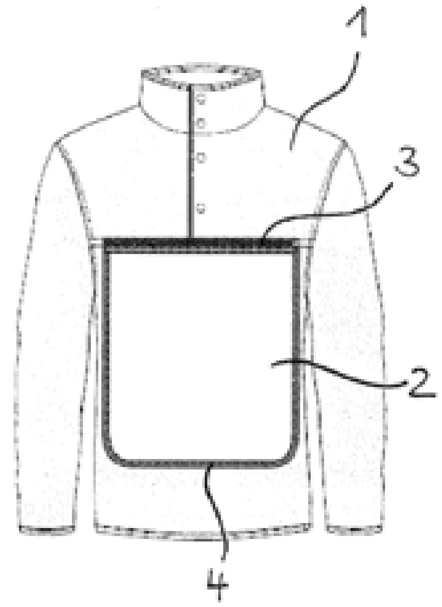


FIG. 5

Photovoltaic technology on the other hand has seen a dramatic change over the past century or so. Initial technologies involved Selenium covered with a thin layer of gold, and had a limited efficiency of just 1% (US389124 in the name of Charles Fritt possibly covers the first solar panel patent and dates back to 1887). These were replaced by silicon single crystal PV cells patented by Bell Labs in 1941 providing efficiencies of up to 6% or so (US2402662 for example). Typically efficiencies are now in the 20% to 30% range, with multi-junction technologies giving values of nearly 50% . Exciting innovations also include solar fabrics (such as EP2625703 relating to "Powerfoyle" by Exeger, who have been voted SME inventors of the year at the EPO for 2021) and Building Integrated PVs.

Plastics



Alex Frank, an associate in our Munich Office, discussed innovation aiming to end the curse of plastic pollution. Plastic is a "Wunderstoff" – light, durable, and versatile, and with a pedigree stretching back to early patenting in 1909, US942699 in the name of Leo Baekeland of New York.

However, plastic's ubiquity means that current recycling and refuse collection systems fail to capture plastic waste well enough, leading to huge problems of plastic pollution clogging up the sea, waterways, shores and landfill. In the UK alone, almost 250,000 kg of microplastics run-off from laundry and clothing each year. A product called Guppyfriend made the headlines a few years ago when this problem hit public attention. Essentially a washing bag for your washing machine, Guppyfriend was designed as a fine mesh to capture microfibers from clothing, especially fleeces which are more likely to be made with synthetic materials. The inventors of Guppyfriend have been looking into a new product in the form of a reversible fleece with its own laundry bag included.

Elsewhere technologies exist to capture waste that has already entered rivers and streams, such as air or bubble barriers like those initially discussed in US3744254 from 1973, or to replace it all together. A different approach to reduce single-use plastic altogether is pursued by Mater-Bi, which is a biodegradable plastic made from plant starches discussed in WO2009/135921. Likewise, in 2019 at the London Marathon 30,000 edible drink capsules were handed out made from seaweed (WO2018172781).

Summary

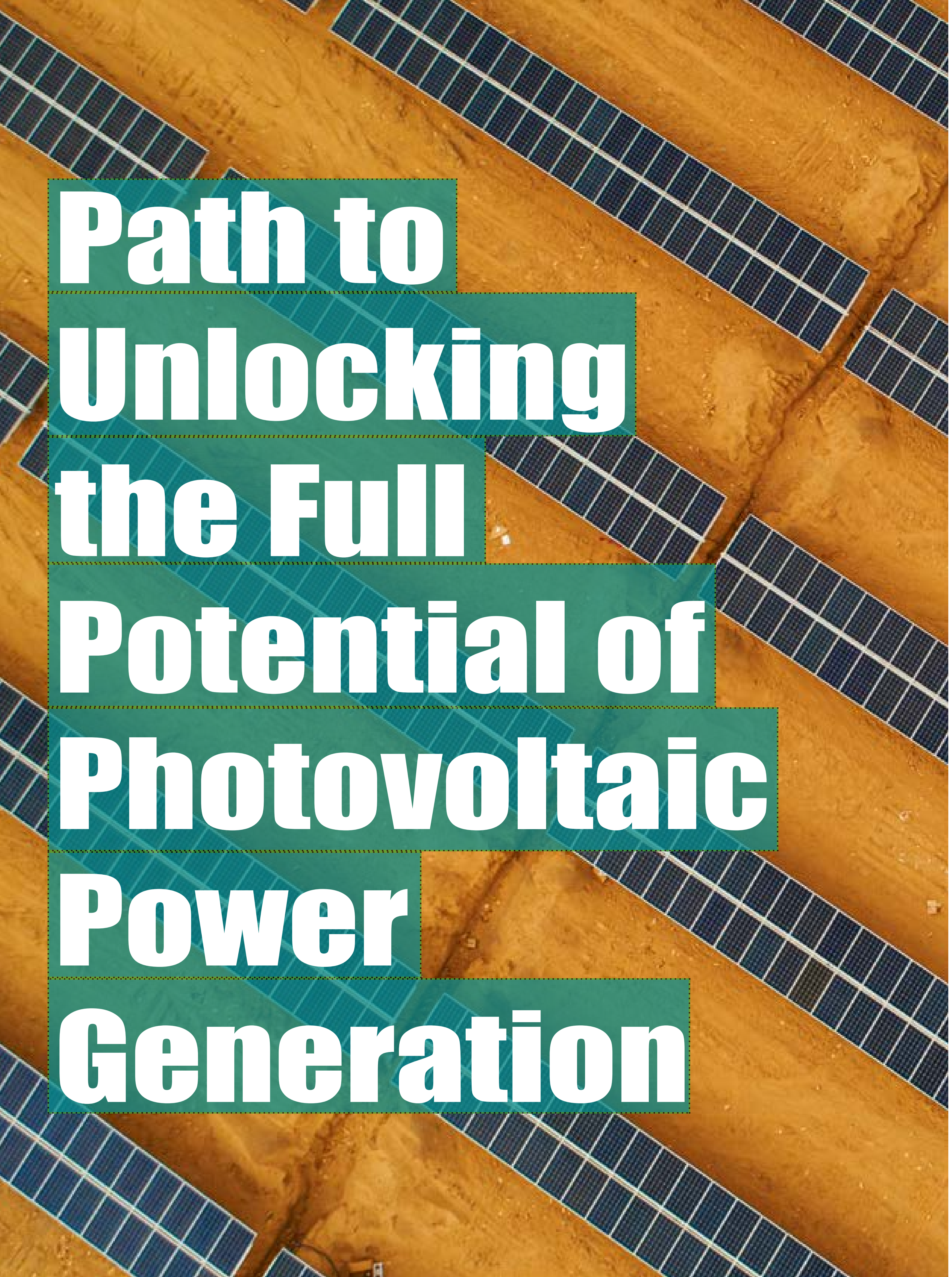
Individuals actions are part of the climate problem and therefore also part of the climate solution. Leading a sustainable lifestyle is about the choices we make, reducing consumption of carbon intensive or polluting products and practices, while looking out for more sustainable alternatives. The technologies highlighted above show that many of the innovations needed to reduce our impact on the planet exist already. As they become more established in the market, it should be easier to include them in our lifestyles so we can be better ancestors to future generations.

This article is for general information relating to sustainable innovations, and nothing in the article above should be taken as an endorsement or recommendation of a particular product or solution.

Reddie & Grose LLP has an active sustainability interest group, initially established during the pandemic to maintain social contact, but still meeting regularly to share tips and information on how to lead a more sustainable lifestyle.

Professionally, Reddie & Grose also have a cleantech group and a sustainable materials group providing professional advice and support to innovators in the renewable and solar fields, as well as in packaging and sustainability sectors.

Authors: Nick Reeve, Zack Mummery, Gillian Taylor & Dr Alexander Frank



Path to Unlocking the Full Potential of Photovoltaic Power Generation

The solar energy industry has seen an extremely rapid development in the past decade. In 2020 alone, we saw over 127 GW of new photovoltaic (PV) power generation capacity installed, leading to the total global PV power generation capacity of 707.5 GW (702.9 GW on-grid and 4.584 MW of off-grid) at the end of 2020, according to IRENA's Renewable Capacity Statistics for 2021.

This means more than one fifth of renewable energy in the world today is generated by PV technology.

However, whilst it is only in recent years that we have witnessed a dramatic improvement of the technical and economic feasibilities of PV power generation, it should be remembered that such improvement is an achievement enabled by nearly two centuries of technical and commercial development.

Development of solar cell technology

Discovery of photovoltaic effect and early devices

PV cells in early days looked very different from the advanced solar panels we know today. The first device Edmond Becquerrel used to discover the photovoltaic effect in 1839 (working in his father's laboratory as a nineteen-year-old) comprised a tank filled with acidic solution, a thin membrane dividing the tank into two sections, and one electrode submerged in the acidic solution in each section. The first advance in the material used in the PV cell was reported by Adams and Days in 1877. Based on the earlier discovery of the photo-sensitivity of selenium by Smith, Adams and Days created the first semiconductor-based (selenium based) PV cell. However, although Adams and Days' PV device comprised a semiconductor material just like modern solar cells (which are typically made of silicon or III-V semiconductor materials), their device, encased in a glass tube, still had a very different shape from modern solar panels.

First solar panel

The origin of today's solar panel is the device Charles Fritts made in 1883 which had a small selenium surface coated with a thin transparent layer of gold, thus forming a Schottky junction. This effect was then confirmed by Werner von Siemens, the founder of Siemens. Although his device at the time had a low efficiency of 1-2%, Fritts already envisioned the possibilities of replacing fossil fuels with the power produced by solar panels in industrial scale.

First silicon solar cell patents

Solar cells, alongside many other semiconductor devices, benefited from the semiconductor industry boom in the mid-20th century. The p-n junction, which is the foundation of many modern semiconductor devices, was invented at Bell Labs by Russell Ohl in 1939. He also demonstrated the photovoltaic properties of p-n junction, and filed the first silicon solar cell patents in 1941 [US Patents No. 2,402,662 and 2,443,542]. Silicon still remains as the dominant material used in PV technology today, currently accounting for almost all of the PV market, despite the emergence of a few promising new materials.

Solar cells for space applications

Despite the semiconductor industry boom, the costs of silicon purification and semiconductor fabrication mid-20th century still remained high. In view of this, PV power generation for terrestrial was considered impractical. However, the rise of the space industry opened up new uses of PV cells. Many extraterrestrial projects required an autonomous and lightweight power source, such as solar cells, for long-term operations. For critical applications such as powering spacecrafts, the benefits of using PV power outweighed the cost issue.

The first spacecraft powered by solar panels was the Vanguard 1 satellite, launched in 1958. It was equipped with 6 silicon solar cells on top of traditional electrochemical batteries. The electrochemical batteries ran out of power within the first few weeks, yet the satellite continued its operation for more than 6 years solely relying on the power generated by the solar cells.

Thanks to technological advances, the economic feasibility of silicon-based solar cells, even for terrestrial uses, is no longer a question today. However, due to various physical constraints, including Shockley-Queisser limit and indirect bandgap, the theoretical maximum solar conversion efficiency for silicon solar cells is capped at 29% (under unconcentrated AM 1.5 solar spectrum).

Given that the state-of-art monocrystalline silicon solar cells already have efficiencies of 26%, there is not a huge room for future improvement. Overcoming such intrinsic limits of conventional silicon-based solar cells is the main motivation of ongoing novel space PV materials and nanostructures today.

Reducing losses in solar cells

As PV technologies mature, a significant part of recent R&D activities has been dedicated to improving power conversion efficiencies by tackling losses in solar cells. Figure 1 shows various loss mechanisms in solar cells. Two of the main losses in conventional solar cells are the sub-bandgap losses and lattice thermalisation. The former leads to lower current output and the latter results in lower voltage output. These two optical losses account for more than 50% of the losses in single bandgap solar cells. To this end, there are ongoing studies on multi-junction solar cells (MJSCs, also known as tandem cells) and novel material-based bandgap-engineered solar cells, such as quantum dot (QD) intermediate band solar cells (IBSC). So far, the highest performing class of solar cells in terms of efficiency has been MJSC. The 6-junction III-V solar cells by scientists at the National Renewable Energy Laboratory (NREL) hold the world record for the highest solar conversion efficiency of 47.1% (under concentrated illumination).

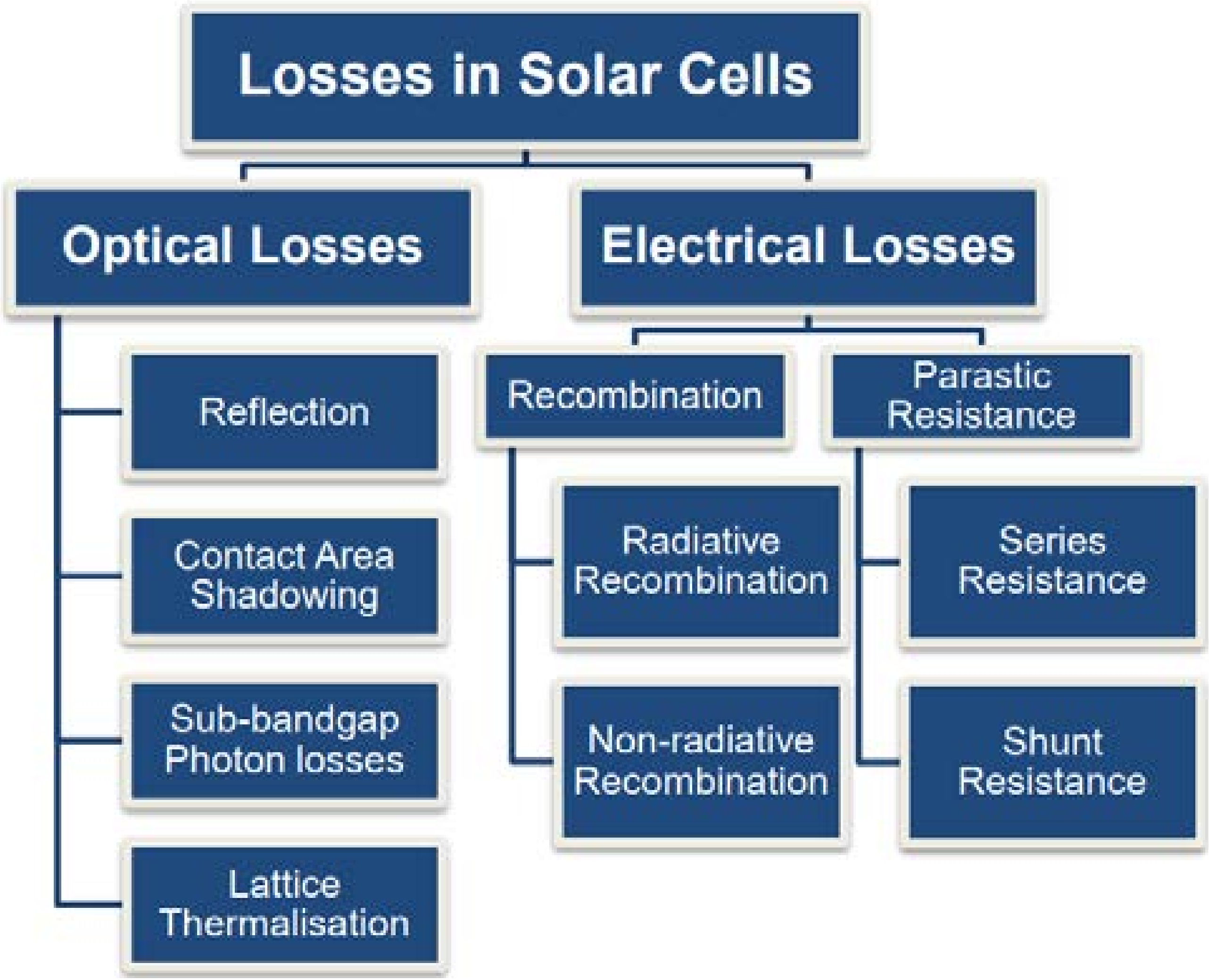
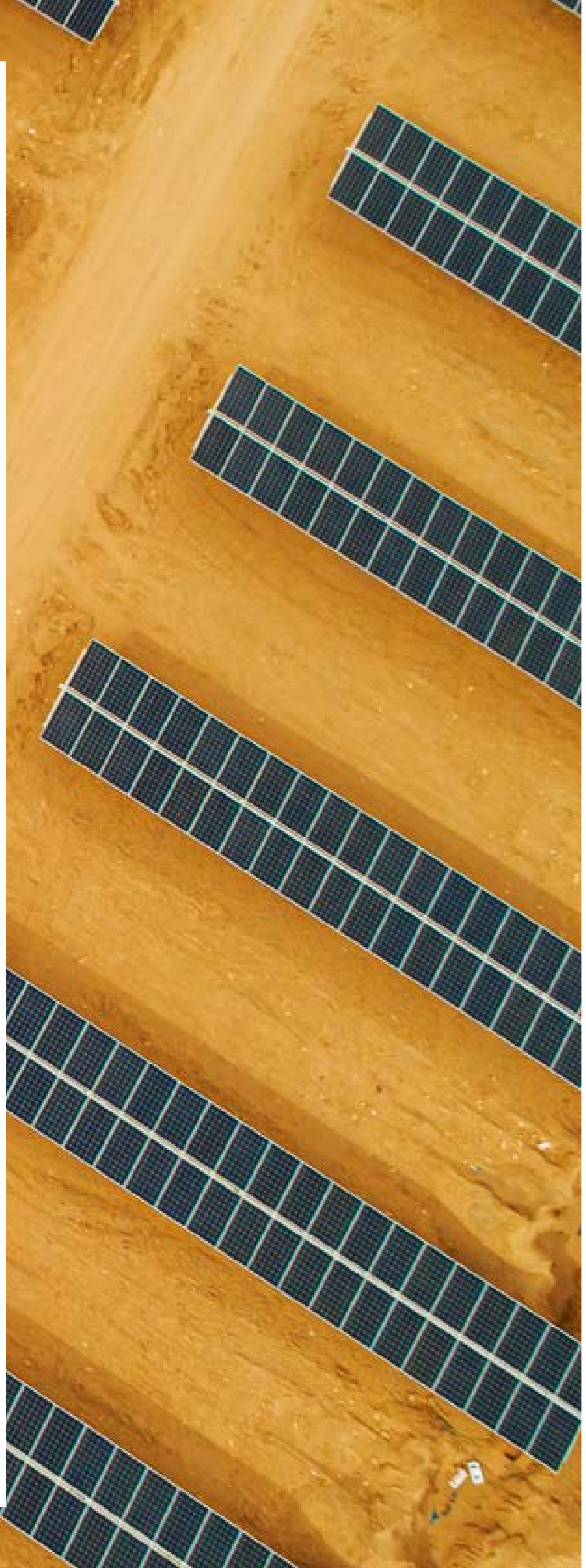


Figure 1 Types of losses in a solar cell.



Development of PV industry in recent years

The development of the PV industry in the 20th century had mainly been fuelled by technological advances and the needs of a few niche markets, such as space applications. On the other hand, the development and expansion of the PV industry since the beginning of 21st century are heavily attributed to cost reductions through economies of scale and public policy support.

One of the main outcomes of this is the increasing importance of improving other components of PV power generation system, not just the solar cell. Alongside the solar cell, PV system comprises many other components, including battery, mounting, AC isolator, inverter, charge controller, and tracking system. Evolution in designs and technologies of such components will further reduce the cost and improve the yield. For example, Capital expenditures (CAPEX) can be reduced by using module trackers comprising torsion locks that can manage heavy bifacial PV panels (for example, as disclosed in the US Patent No. 10,174,970), operating expenditures (OPEX) can be minimised by automating the operation and maintenance, and the yield can be further improved by using reflective and high-albedo foundation and preventing under-module vegetation growths.

The increasing demand for innovations in the non-cell parts of PV systems will be good news for new businesses that wish to step into solar power industry. Perhaps the rapid increase in the number PV-related patent filings in recent years is not only a reflection of technological advances of PV cells, but also a sign of a wider range of innovations to come.

At Reddie & Grose we have extensive experience drafting and prosecuting patent applications covering cutting edge technological developments, ensuring that our clients are provided with high quality patents, which adequately protect their inventions. If you have a solar power-based invention, or would like more information, please contact one of our team.

Author: Dr Dongyoung Kim

Net Zero by 2050 – A new IEA report highlighting a roadmap reliant on improvements in traditional, and development of disruptive, technologies

In May this year, amid unseasonably windy and wet weather in the UK, National Grid reported a new record share of electricity demand being produced by wind turbines (62.5 %) throughout Great Britain. In a timely coincidence, in the same week, the International Energy Agency (IEA) released a fascinating report on how a net zero (emissions) energy system may be achieved globally by 2050.

The report provides a roadmap providing a narrow but achievable path to a global "net zero" energy system based on technologies including renewable such as solar and wind, bioenergy, and carbon capture, and behaviour changes.

In the following, we concentrate on the technological aspects of the report. At Reddie & Grose, we have experience helping inventors and developers in sustainable energy technologies. In particular, we have experts who specialise in improved combustion engines, electric engines, future transport systems including batteries and fuel cells, and renewables such as solar, wind, and biofuels as well as improved oil and gas extraction.

Over the next 30 years, disruptive technologies must make an increasing contribution to the net-zero effort.

Over the next 30 years, disruptive technologies must make an increasing contribution

While the IEA assumes that most of the reduction in CO2 emissions until 2030 must come from significant investment into current technologies, such as renewables, electric vehicles and energy efficient buildings, by 2050, they expect nearly half the emission savings to be achieved by technologies currently in the prototype phase.

This signals that to achieve net zero by 2050, which is a goal of an increasing number of governments around the world and looks set to be a key topic at COP2026 in Glasgow, significant investments will have to be made into products at various levels of development.

This opens opportunities for inventive companies both in more mature technologies (looking for incremental improvements) and areas where technologies are currently at the prototype stage (looking for disruptive development).

By 2040, the IEA figures that renewable electricity generation should cover about half of the total global energy consumption. This requires significant research and development in some "ancillary" technologies to provide flexibility to the electricity system – the report mentions batteries, hydrogen fuels, and hydropower.

By 2045, the IEA report assumes that new, currently underdeveloped, technologies will be widespread and contribute to reducing net carbon dioxide emissions. According to the roadmap, by 2045, almost all cars will be running on batteries or fuel cells, planes will rely on advanced biofuels, and carbon capture and storage or hydrogen fuels will reduce emissions from industrial plants.

Key solutions

According to the IEA, a few key solutions will be particularly important for achieving net zero. While most of the solutions highlighted by the report will not come as a surprise to interested parties, we expect to see increasing patenting activity in these fields as proliferation of each of these key technologies increases.

•**Renewables:** by 2050, solar and wind are predicted to grow to providing 70% of global electricity, making the single largest source of CO2 emissions more sustainable;

•**Energy efficiency:** reducing carbon emissions in existing technologies by making them more energy efficient is set to significantly reduce CO2 emissions in the near term – the IEA focuses on reduced fuel consumption of heavy trucks and improved buildings, appliances, and industrial production;

•**Electrification:** electrification of sectors and technologies currently using fossil fuels will contribute significantly to net-zero by 2050, in particular by increasing the share of electric buses, cars, and trucks (resulting in massive increases in annual battery demand) and increasing use of heat pumps;

•**Bioenergy:** sustainable bioenergy will reduce emissions from planes and ships (where batteries are unlikely to be a workable alternative), and replace fossil fuels in heating, electricity generation, and cooking.

•**CCUS:** Carbon capture, utilisation, and storage will be essential in the production of products such as cement and aluminium, where emissions are difficult to reduce;

•**Hydrogen and hydrogen based fuels:** some sectors, including shipping and planes, are unlikely to become electrified by 2050, and bioenergy supply is unlikely to be sufficient to supply these sectors. As such, low carbon fuels such as hydrogen and hydrogen based fuels may have to contribute significantly to reaching net zero by 2050.

The technologies that the IEA believe to hold the biggest opportunities

While the IEA highlights some broad key solutions, they also point to a set of three key technology areas which they believe will make some of the most significant contributions to the reduction in CO2 emissions between 2030 and 2050, i.e. once the currently available technologies have been more broadly deployed.

•Advanced batteries
•Hydrogen electrolysers
•Direct air capture and storage

Hydrogen electrolysers, are discussed earlier in this newsletter.

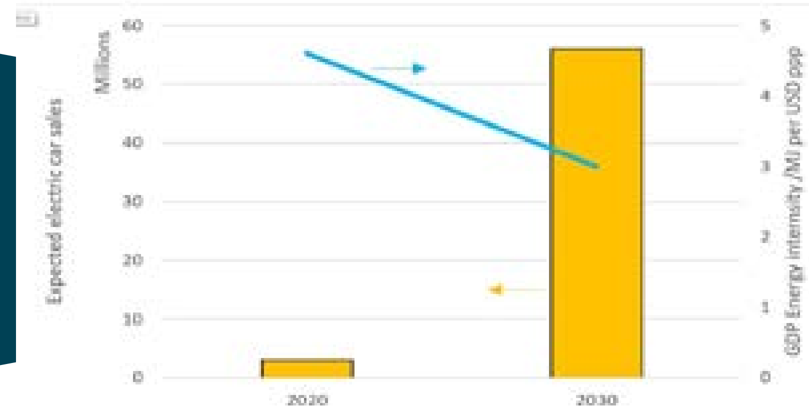
Some of the most striking numbers

The IEA report contains many interesting and thought-provoking statistics, and we recommend anyone interested to look at the full 224 page report. Some of the most striking numbers are highlighted below.

Figure 1 shows the massive predicted growth in electric car sales between 2020 (3 million) and 2030 (56 million). This growth will come with significant further investment and development in electric vehicle technology, and all associated technologies (including batteries, charging infrastructure, etc.). At the same time, it is predicted that the energy intensity of GDP, long believed to require energy demand to increase for GDP to grow, to decrease between 2020 and 2030.

Figure 2 highlights the different factors that will contribute to the reduction in CO2 emissions in 2030 and in 2050. While behaviour change is expected to make only modest contributions, technologies currently on the market are expected to contribute about 82 % of CO2 savings in 2030. However, by 2050, the more disruptive, current prototype technologies, are expected to contribute more significantly (46 %) to CO2 saving by 2050.

Figure 1: Expected electric car sales in millions on the left (orange) in 2020 and 2030; Energy intensity in MJ required per USD ppp of GDP generated



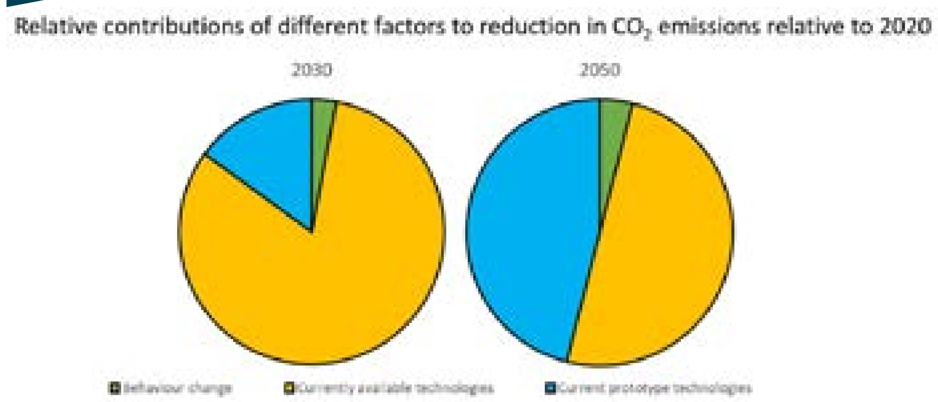


Figure 2: Relative contributions to CO2 savings in 2030 and 2050 by behaviour change, technologies currently on the marked, and technologies currently at prototype stage.

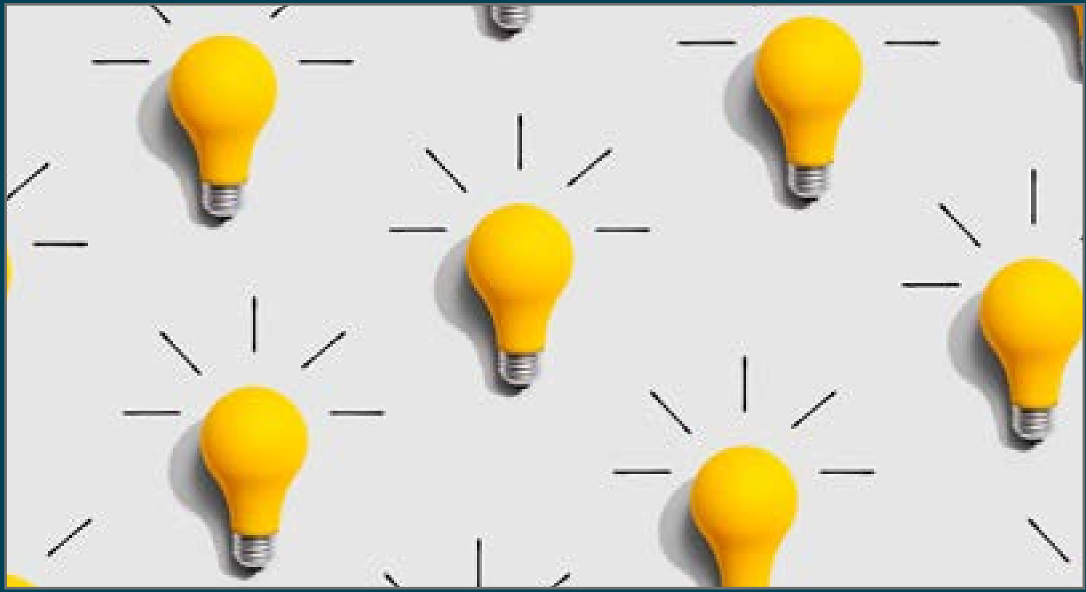
Summary

This new IEA report highlights that there is a narrow but realistic path to a global net zero emissions energy system by 2050. Achieving net zero will require significant investment, and innovation, in technologies currently on the market and disruptive technologies currently in the various stages of prototyping.

The IEA report points out a few key solutions for CO2 savings, including renewables, energy efficiency, electrification, bioenergy, carbon capture, and hydrogen. It further defines three key technology areas which will underscore some of these key solutions, including advanced batteries, hydrogen electrolysers, and direct air capture.

As patent attorneys, we are always fascinated by innovation, and we will therefore continue to follow any new developments in these technologies closely. We are experienced at supporting our clients protect their inventions in these planet-friendly technologies, so please do not hesitate to contact us if you would like help patenting your inventions.

Author: Dr Dustin Bauer



TECHNOLOGY AND INNOVATION ON THE PATH TO NET ZERO

As climate change and the energy transition drive fundamental shifts in technology, industry, investment and regulatory policy, innovation and technology have never played a more important role. In this article, we discuss how climate change and the energy transition are driving these shifts, the technologies needed to meet net-zero and how this is reflected by patent filings in renewable energy field. We gather the perspectives of leaders and decision makers in the fields of energy, technology, business and government, presenting at the recent CERAWeek 2021 conference.

Energy transition & climate change

We are now in the middle of a profound shift in the global economy away from fossil fuels. 9 out of 10 countries have renewable energy targets, almost four times the number just 10 years ago. At the end of last year, almost every country submitted more ambitious national plans for decarbonisation into the COP process. Global recognition of the risks associated with climate change, provides great incentive to deploy lower carbon options, but economic considerations also apply.

Bill Gates, in his role as founder of Breakthrough Energy, introduced the idea of 'the Green Premium' – the additional cost of choosing a clean technology over one that emits a greater amount of greenhouse gases. The Green Premium is useful because it helps to measure progress made toward addressing climate change and understand where there are still barriers to overcome. Technologies with low Green Premiums should be the priority right now. When the Green Premium is too high, that is an indicator of where we need to focus R&D investment. To drive the Green Premium down, governments can use policies to make higher carbon solutions more expensive and cleaner solutions cheaper. They can also make rules about how much carbon can be emitted, implement regulations that shape the financial markets, and invest in R&D. Companies and investors also have a role to play by committing to cleaner alternatives, investing in R&D, supporting clean-energy start-ups, and advocating for government policies.

Achieving low-carbon objectives requires partnerships and new ways of thinking. Energy and digitalisation technology players are teaming up to deliver lower-carbon solutions. A good example is the collaboration between BP and Amazon Web Services (AWS). BP has agreed to supply an additional 404 MW of wind power to Amazon while, AWS provides data and cloud services to BP. This has not only allowed BP to be more energy efficient, because running infrastructure in the cloud is much more energy efficient than running on premises, but has also freed up resources to work on renewable initiatives.

Innovation & technology for Net Zero

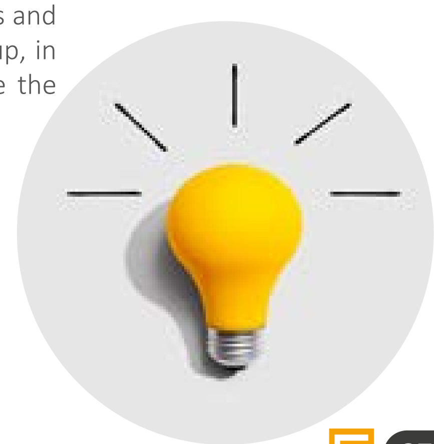
Analysis by the International Energy Agency (IEA) found that 75% of the emissions reductions necessary to achieve net-zero scenarios depend on technologies that have not yet reached commercial maturity. These targets depend on major acceleration of innovation in four key areas – electrifying heat and transport, carbon capture, utilisation and storage (CCUS), green hydrogen and bioenergy.

The electrification of energy is recognised as one of the most potent forces driving the energy transition, but faces challenges due to the high costs of implementing new infrastructure, and because many of the necessary technologies are not yet mature.

Reduction in emissions from existing oil and gas industry is also important, at least in the short term, and CCUS plays an important role in offsetting emissions in hard-to-decarbonise sectors. Encouragingly, the global Carbon Capture and Storage (CCS) institute last year witnessed a 33% combined average growth rate in CCUS projects.

David Eyton, EVP in Innovation & Engineering of BP, pointed out four challenging areas: 1. intermittency of renewable power supply; 2. replacing fossil fuels in 'hard-to-abate' sectors (e.g. heavy duty transport, high heat application in industry); 3. retrofitting low carbon heating and cooling into the built environment; and 4. enhancing carbon removal from the atmosphere through either natural or human actions. There is always a balance to strike – investment in improving existing infrastructure versus creating new infrastructure and new consumption devices such as Tesla. David also emphasised the importance of modularity – making small modules of solar PV cells, wind turbines and electrolysers that may then be scaled up, in order to improve flexibility and reduce the cost.

"As climate change and the energy transition drive fundamental shifts in technology, industry, investment and regulatory policy, innovation and technology have never played a more important role."



Ahmad O. Al-Khowaiter, CTO of Saudi Aramco, discussed three steps to reduce emission from the existing oil and gas industry. First is to achieve zero routine flaring. Flaring of gas emits CO_2, black carbon and other pollutants.

About 22% of the emission from the production of oil comes from flaring. Second is to introduce more renewable energy into the production of energy intensive processes, such as in heavy oil and tar sands. Third is the optimisation of reservoir production, minimising the energy of production and minimising fluid production. There are a variety of technologies that could be applied and incorporated in these steps.

Trends in renewable energy

Developments in wind and solar energy have rapidly increased in the past ten years. In the wind sector, bigger turbine blades, better and cheaper materials and better use of data have driven multiple efficiencies and cut costs. In the solar sector, huge increases in scale along with steady improvements and quality control have pushed prices down at an exponential rate.

Despite this, continuous demand for cost reduction, higher efficiency and political support are still driving a rapid growth in these sectors.

The market for clean hydrogen solutions has gained serious momentum over the last year, and global industries are eager to learn how to make hydrogen a part of their sustainability and operational efficiency plans. Hydrogen production, storage and utilisation are still challenging, leading to exciting opportunities in this field.

Offshore wind – moving wind turbines offshore brings with it the advantages of higher capacity and higher efficiency. Unlike onshore wind, which consumes land, offshore wind has a breadth of resources around the world. Felipe Arbelaez from BP expressed his confidence in the offshore wind industry. Although it comes to an inflection point of growth, the long term development of offshore wind is still promising, and is becoming more competitive. He foresees continuous growth in double digits by 2030. Steve Dayney from Siemens Gamesa pointed out the sustainability that needs to be realised by the technology as it heads towards industry maturity and supply chain growth. The logistics of wind turbine including transport and storage remains challenging. Siemens Gamesa plans to make further investment in technology and innovation relating to sustainable turbine installation and transportation across the globe.

Solar – The solar supply chain continues to invest in hardware and software to allow their products to remain cutting edge. Nathanael Esposito from RWE Renewables Americas and Jeff Krantz from Array Technologies both discussed the development of solar trackers. Constantly evolving core technologies are used to remove points of failure of components within solar trackers. Array Technologies is largely working on reducing installation costs using a clamping mechanism, and working on risk mitigation especially during different weather conditions. They also developed a machine learning software that improves the output of the plant which are more efficient and more related to data. Michael Irwin from Hunt Perovskite Technologies LLC, emphasised the advances in research relating to printable, high efficiency and low cost metal halide perovskite.

Hydrogen – Interest in low-carbon hydrogen as a decarbonisation tool reached unprecedented levels in 2020, driven by favourable policies and funding as well as the expectation of continuing cost reduction of low-carbon hydrogen, including green hydrogen produced by electrolysis powered by renewables.

Air Products & Chemicals plans to invest $7 billion in green hydrogen, aiming to produce 650 tons a day of green hydrogen in 2025. Siemens Energy, alongside several international companies, is carrying out the Haru Oni project in Chile to produce green fuels from wind energy and water. In this project, Siemens Gamesa delivers the key equipment such as 3.4 MW wind turbine and PEM Si-lyzer 200 based on a power rating of 1.5MW. This project aims to achieve 130,000 liters in pilot phase and then scale up output to about 55 million liters e-fuel by 2024 and 550 million liters by 2026. Mitsubishi Power Americas introduced the Delta Utah project to repower the power plant, capable of using 30% hydrogen. Another ground breaking project introduced is the underground hydrogen storage in a huge salt dome, aiming for commercial operation in 2025.

Patent filing trends

To add our own perspective, we have seen patent filings in renewable energy sectors such as wind and solar energy peak in 2018. However, there are still many new technology areas within the sector that are producing increasing number of patents. In offshore wind, patent trends suggest growth in areas relating to floating structures reflecting increasing interest in the developing floating offshore wind sector. In the solar sector, research on PV cells based on novel materials or structures such as perovskite solar cells is still very active. As for hydrogen, a promising increase in the number of patent filings can be seen in energy storage, hydrogen production by water electrolysis, and the use of hydrogen technology in transportation (e.g. using fuel cells), etc.

In the progress of reshaping the global energy system, technology and innovation are critical tools for navigating the energy transition and achieving Net Zero. There are a huge number of challenges, but also opportunities for companies and investors to play a role. We foresee a rapid and sustainable growth in renewable energies and big potential for technology developers and investors in the next 10-20 years.

"In offshore wind, patent trends suggest growth in areas relating to floating structures reflecting increasing interest in the developing floating offshore wind sector. In the solar sector, research on PV cells based on novel materials or structures such as perovskite solar cells is still very active. As for hydrogen, a promising increase in the number of patent filings can be seen in energy storage, hydrogen production by water electrolysis, and the use of hydrogen technology in transportation"

Author: Dr Xiaoxi Zhu

THE FUTURE OF RENEWABLE ENERGY

TRACKING THE PATENT TRENDS

In our regular patent tracker feature, we look at patent filing trends in the renewable energy sector.

Patents are, of necessity, filed at an early stage in the development of new technology, which means that patent filing trends can provide good insights of today's R&D and tomorrow's leading technologies.

Climate change targets are a major driver of innovation in today's world. There is little doubt that innovative solutions are needed across the board if we are to achieve net-zero by 2050, and limit the rise in average global temperate to below 2°C, as set out in the Paris Agreement.

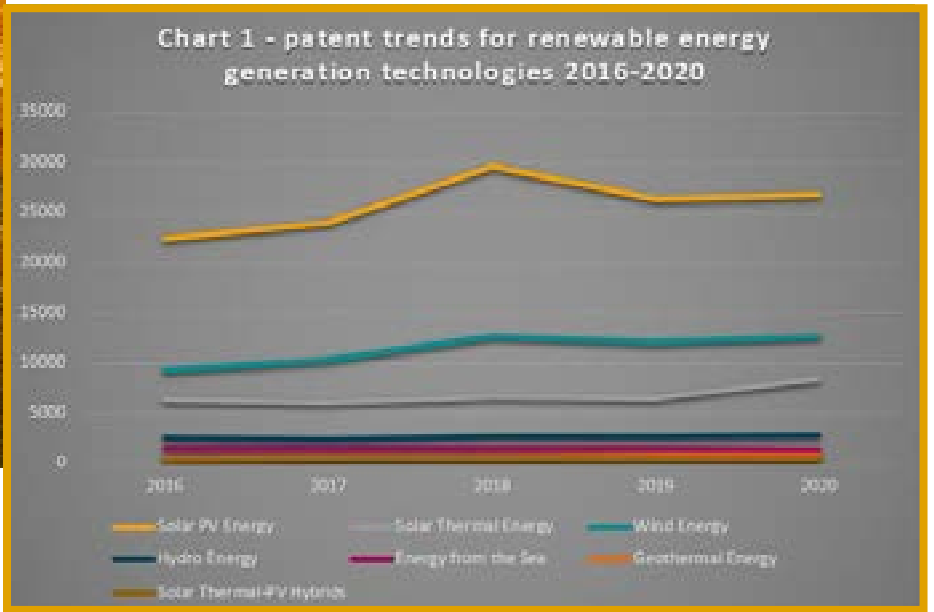
Climate change mitigation technologies, however, cut across many fields, and can be difficult to track using traditional technology-specific classification codes. In response, the European Patent Office developed the Y02 classification scheme which allows patents for sustainable technologies to be retrieved quickly and accurately, and allows patent trends in this area to be extracted and analysed. Interpreted correctly, the data affords useful insights into technology trends and competitor activity within the green economy, informing strategic decision making in industry, and allowing for evidence based discussion by policymakers.

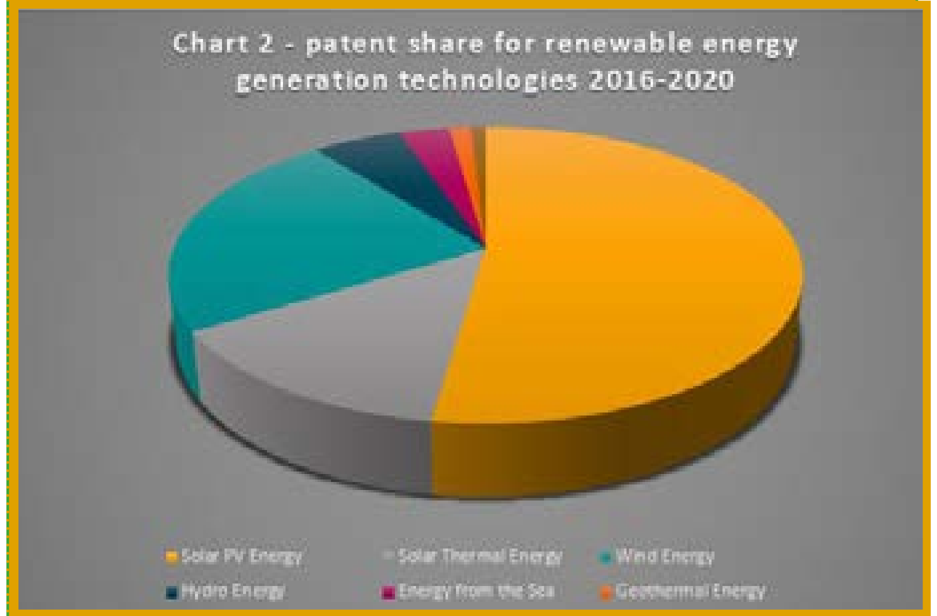
The Y02 classification scheme covers all climate change mitigation technologies, with categories for energy generation, transportation, buildings, waste, carbon capture and storage, and smart grids.

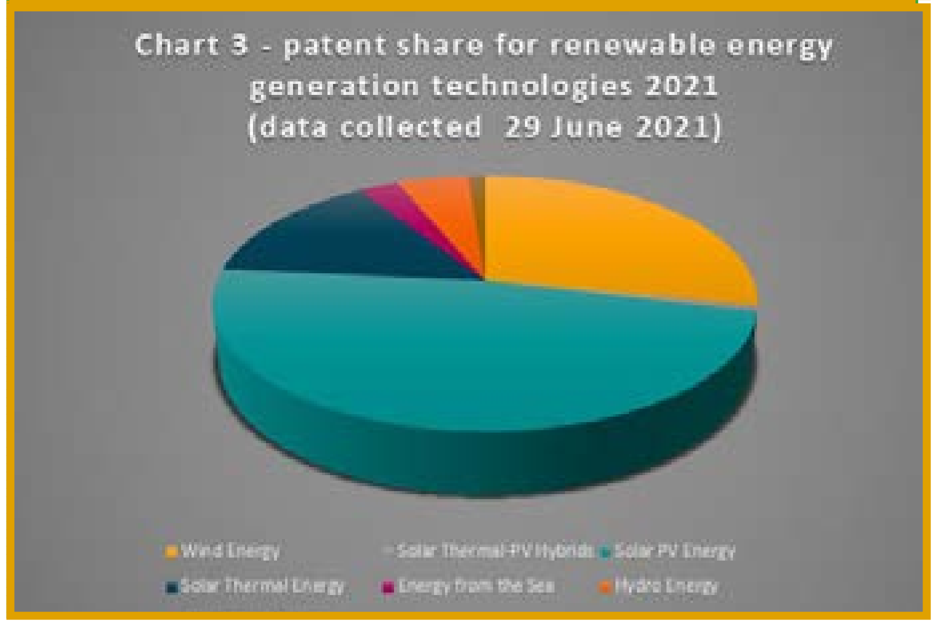
In this feature, we focus on renewable energy generation. This means solar energy – both thermal and PV, wind energy, geothermal energy, hydro energy, and energy from the sea, e.g. wave energy or salinity gradient.

Number of patents by field

Charts 1 and 2 show patent applications published in the different renewable energy fields during the 10 years to the end of 2020. This is a particularly interesting period which covers the lead up to the Paris Agreement and its entry into force in 2016. Solar PV energy emerges as the clear leader, with the number of patent publications far exceeding those in other areas, representing more than half the total number.







The data for solar PV energy does, however, show a sharp drop in numbers during 2019 following a peak in 2018, from which the figures have not yet recovered. Noting that there is typically an 18 month delay between patent filing and publication, this suggests a peak in innovative activity during 2016-2017. The trend should not be taken as an indication of any lessening of interest in solar PV energy, but does suggest that the industry may have reached a mature stage where patent filings have levelled off.

Wind energy, solar thermal energy and hydro energy, by contrast, all saw their highest ever number of patent publications during 2020, with the upward trend most marked for solar thermal energy, which had previously seen a steady decline from 2013. The upward trends for in these areas indicates a recent increase in innovation in these areas.

Chart 3 displays the share of publications associated with the same industries for the first few months of 2021. Notably, the proportion of solar PV publications, which remained above 50% from 2014 to 2020, now sits below half. In contrast, the share of publications related to wind energy generation is currently higher than it has been for the last 10 years, supporting the hypothesis of increased innovation in this area. The figures for solar thermal energy and the remaining fields remain relatively consistent with those in Chart 2, indicating sustained interest.

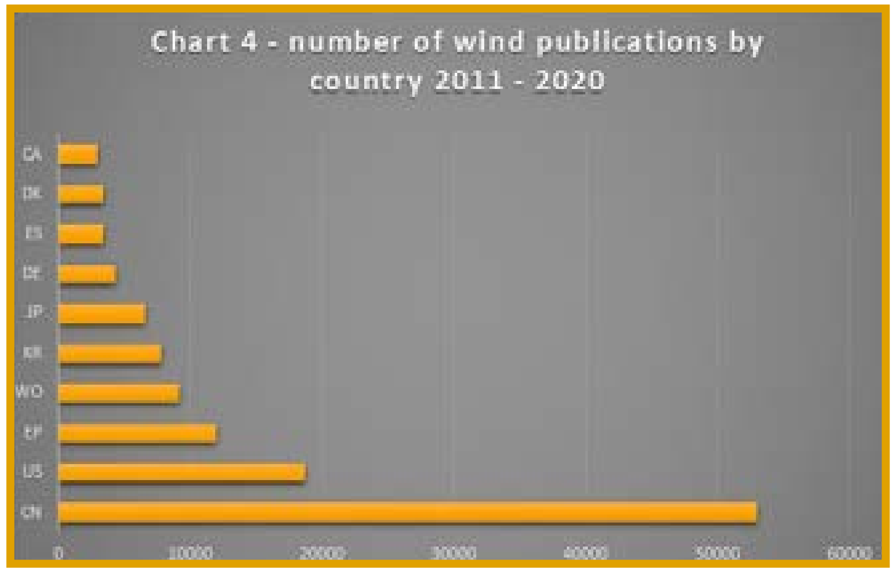
Such recent data does, however, have to be viewed with caution. Some patent offices may take longer to provide details of published patent applications than others. This has the potential to skew the data, especially where filings for the different technology areas are being made in different areas around the world.

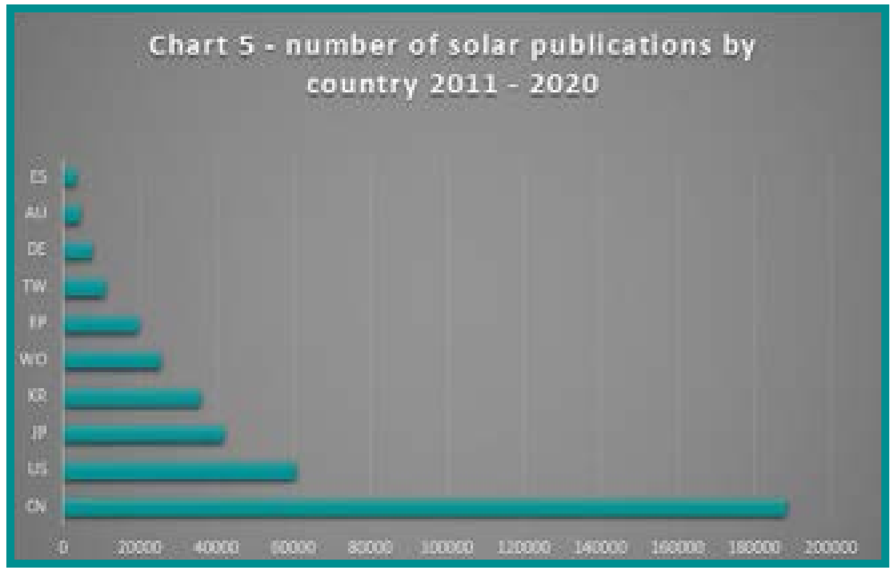
Numbers of patents by country

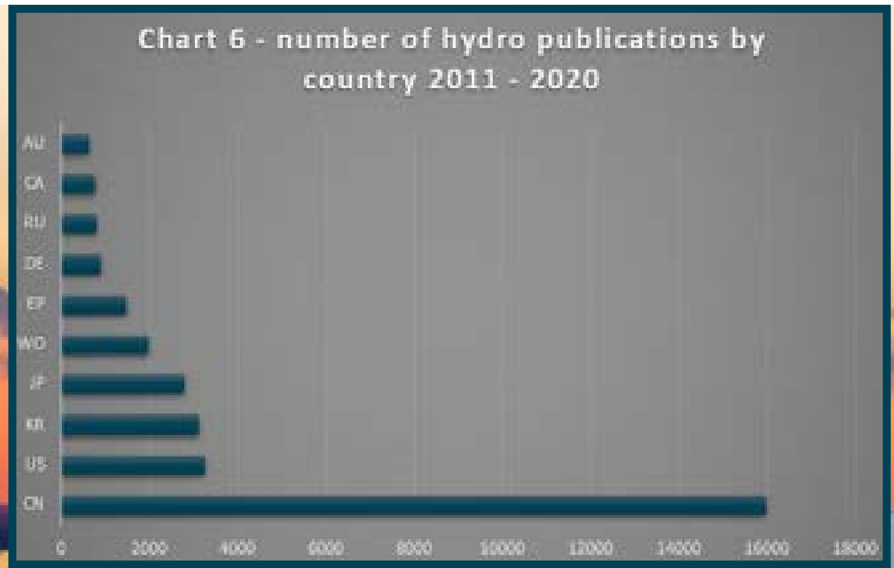
Charts 4, 5 and 6 respectively illustrate the number of publications related to wind, solar and hydro renewable energy generation from 2011 to 2020 by country of publication.

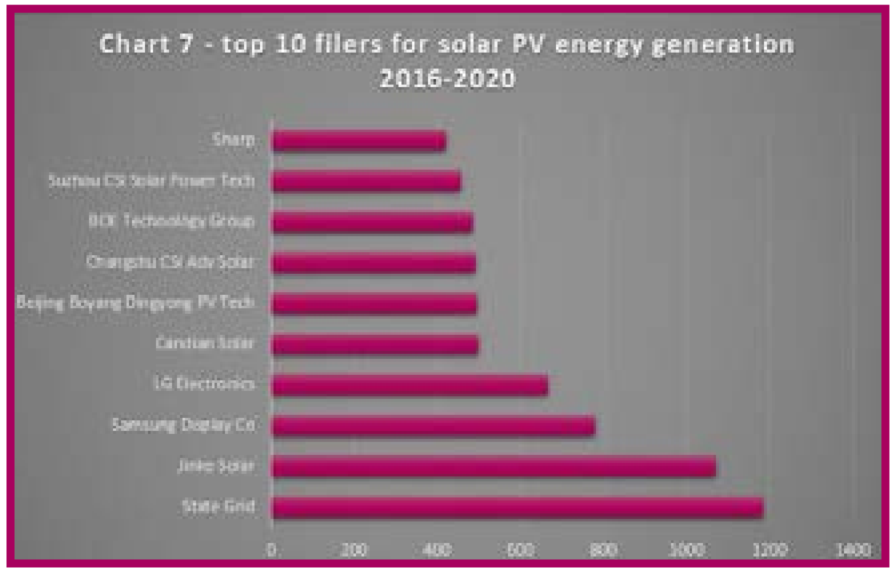
Perhaps unsurprisingly, China dominates all three charts. Taking data published by the International Renewable Energy Agency, China has produced the most electricity from renewable sources every year between 2011 and 2018. A 2019 UN report on Global Trends in Renewable Energy Investment also named China as 'by far' the biggest investor in renewable energy since 2012.

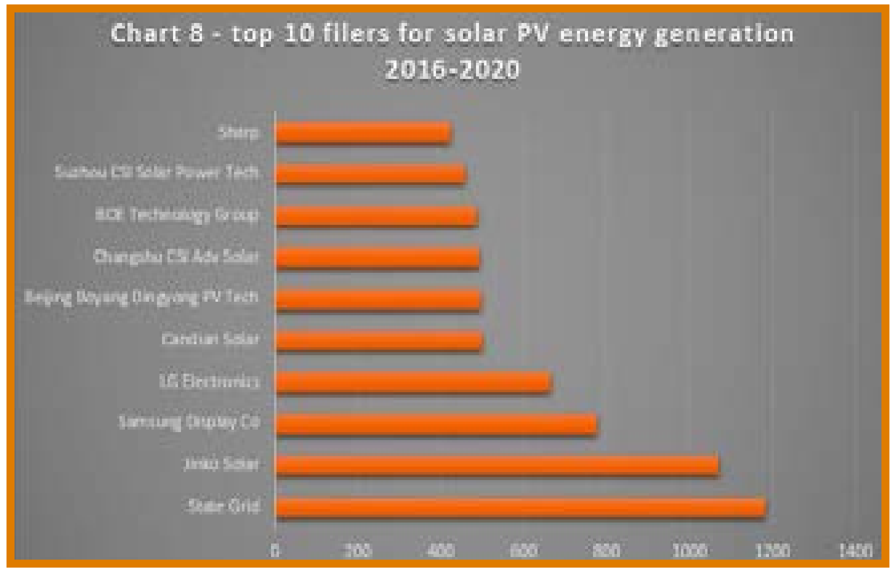
From the above charts, the margin by which China leads the way for publications related to hydro energy is larger than that for wind and solar. This may be attributed to the fact that renewable hydropower is currently China's largest source of renewable energy, accounting for an incredible 66% of electricity generated from renewable sources in China in 2018, for example. For the purpose of comparison, renewable hydropower only accounted for 40% in the United States.

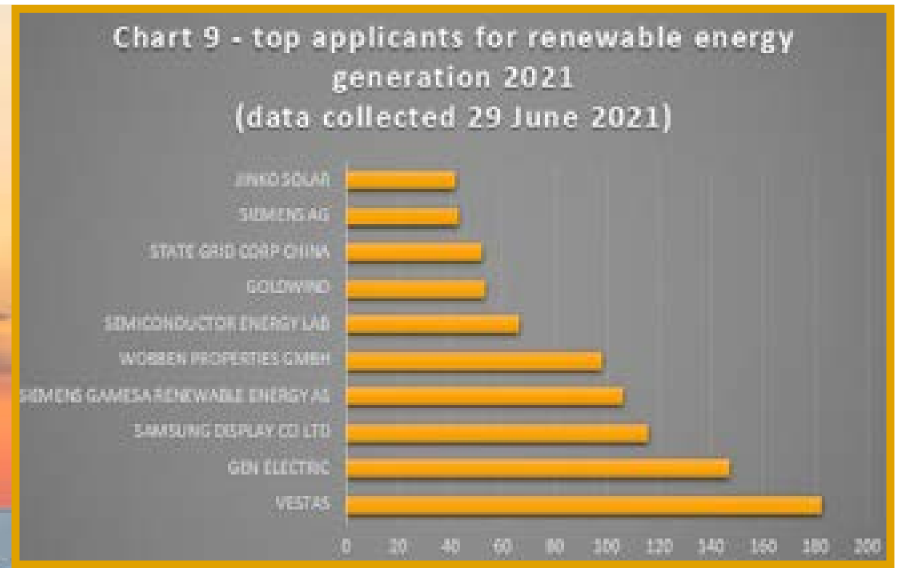












Top Filers

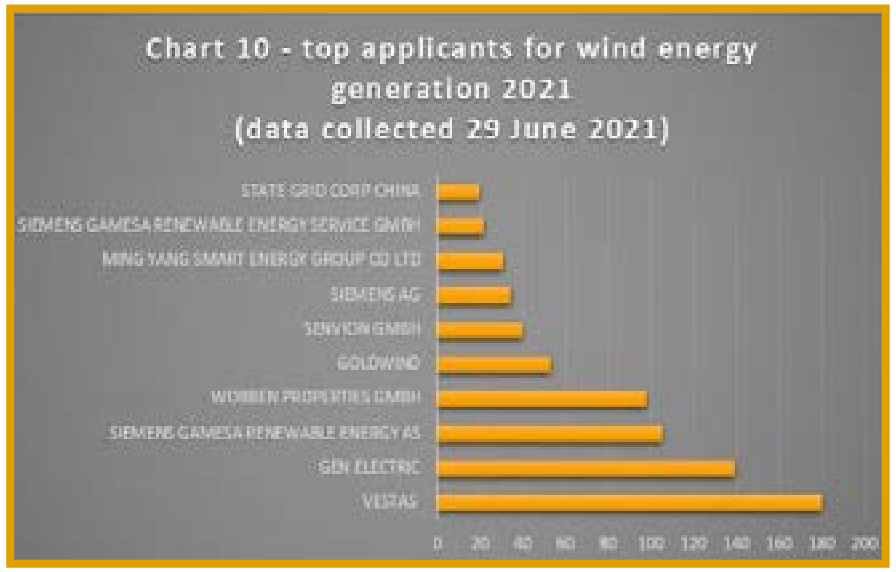
Chart 7 shows the top 10 filers for the 5 years from the beginning of 2016 to the end of 2020. China's State Grid are the leaders by a long way. This is unsurprising, and mirrors the significant increase in Chinese originating patent applications seen across all technologies in recent years.

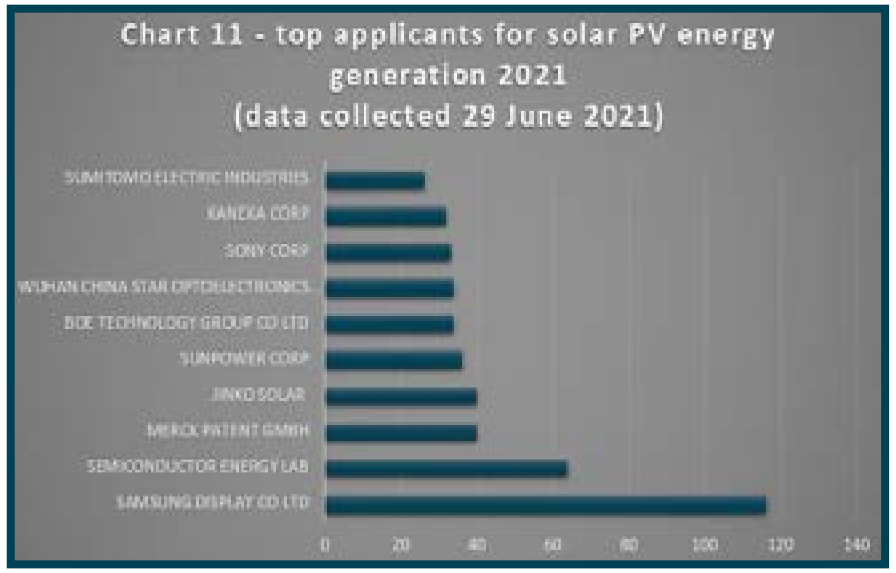
Chart 8 looks at solar PV energy field in particular. Unsurprisingly, given the dominance of solar PV related filings, the top 5 filers here are also seen in the overall top 10. Looking to wind energy in chart 6, however, we see more of a change, with Vestas and Goldwind in the top spots, narrowly ahead of State Grid and General Electric. Notably, Siemens and Siemens Gamesa both make individual appearances in the top 10 filers.

Chart 9 displays the top filers for renewable energy publications in 2021 so far, and Charts 10 and 11 rank the top filers for publications related respectively to wind energy and solar PV.

Although we are yet to obtain the full picture, when comparing the 2021 top filers published in our March feature with this month's, eight of the same applicants are replicated for publications related to solar PV energy and seven of the same for wind energy.

State Grid, which dominated both solar PV publications from 2016 to 2020 and renewable energy publications in general, is now only the eighth top applicant for renewable energy publications in 2021 so far. Vestas Wind Systems, which filed the second highest number of wind related patents published between 2016 and 2020, currently occupies the top spot for wind energy and, indeed, for renewable energy in general for 2021. General Electric, another top wind filer, follows closely, supporting other indications of increased innovation in the wind sector. It will be interesting to see how these rankings develop over the remainder of this year, and whether State Grid returns to the top as the data for 2021 matures.





What new technology are we seeing?

Clearly, renewable energy generation is a diverse field, and the patent publications seen so far in 2021 reflect this. However, to give a flavour, we can pick on the top filer under the wind energy classification codes. General Electric's patents published in January and February 2021 include several cases relating to the manufacture of wind turbine blades and their components, a modular gearbox for a wind turbine, a superconducting magnet for increasing the power and efficiency of a wind turbine, a control system for improving tolerance to grid voltage fluctuations, a DFIG converter, and an additively manufactured tower structure for a wind turbine.

In the field of solar PV renewable energy generation, US based solar energy company SunPower, is a top filer, ranking fifth place in Chart 11. Their 2021 publications so far cover a diverse range of solar PV related technology, ranging from a method of modelling solar energy production data, to another for mapping the location of PV modules, to a device for fabricating a string of solar cells conductively connected by metal ribbons. US 2021/0104643 A1 in particular provides an example of the circular economy in action, adding further to SunPower's green credentials. This application relates to recycling silicon swarf (particles produced when sawing silicon ingots to produce wafers) into electronic grade polysilicon or metallurgical-grade silicon, and thereby bringing silicon by-products back into the PV value stream.

We intend to make this renewable energy patent tracker a regular feature.

Are there other areas of interest, or areas we could cover in more detail? Please get in contact with your feedback and questions.

Authors: Georgina Ainscow & Olivia Buckingham

AND THE WINNER IS...

The annual European Inventor Awards 2021 were presented by the European Patent Office at a virtual event last month. While the inventions recognised were as diverse as ever, renewable energy and other sustainable technologies were well represented by the following winners and finalists:

WINNERT

SMALL AND MEDIUM-SIZED ENTERPRISES CATEGORY

Henrik Lindström and Giovanni Fili

Flexible solar cells for portable devices

The winners in the SME category have developed a revolutionary printed photo voltaic (PV) cell. Dye-sensitised solar cells (DSSCs) are particularly advantageous as they are thin and more flexible than other types of PV cell. However, DSSCs typically require a layer of indium tin oxide (ITO) which can be prohibitively expensive for many applications. Henrik and Giovanni wondered if this ITO layer could be dispensed with altogether. As described in EP2625703, they rearranged the layers usually found in a DSSC and introduced a new conductive layer of their own design. Since there is no expensive ITO, the resulting PV cell can be used in low cost appliances including bicycle head lights.

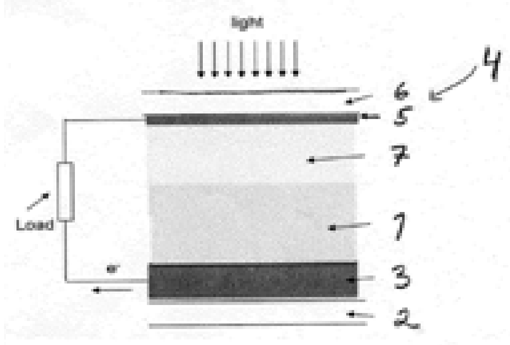


Fig. 2

FINALIST

SMALL AND MEDIUM-SIZED ENTERPRISES CATEGORY

Dr Carmen Hijosa

Turning pineapple leaves into a sustainable alternative to leather

Narrowly missing out to Henrik and Giovanni, Dr Carmen Hijosa recognised the high environmental cost of traditional leather goods. The damage comes not just from the rearing of livestock, but also from the chemical intensive tanning processes. As described in EP2576881, her new process uses pineapple leaves, which would otherwise be burnt, to produce a "fluff-like" material. This "fluff" is then mechanically formed in to a non-woven high density leather-like material. The process also provides a welcome additional revenue source for pineapple farmers. The material can already be found in a number of fashion brands including Hugo Boss and Paul Smith.

FINALIST

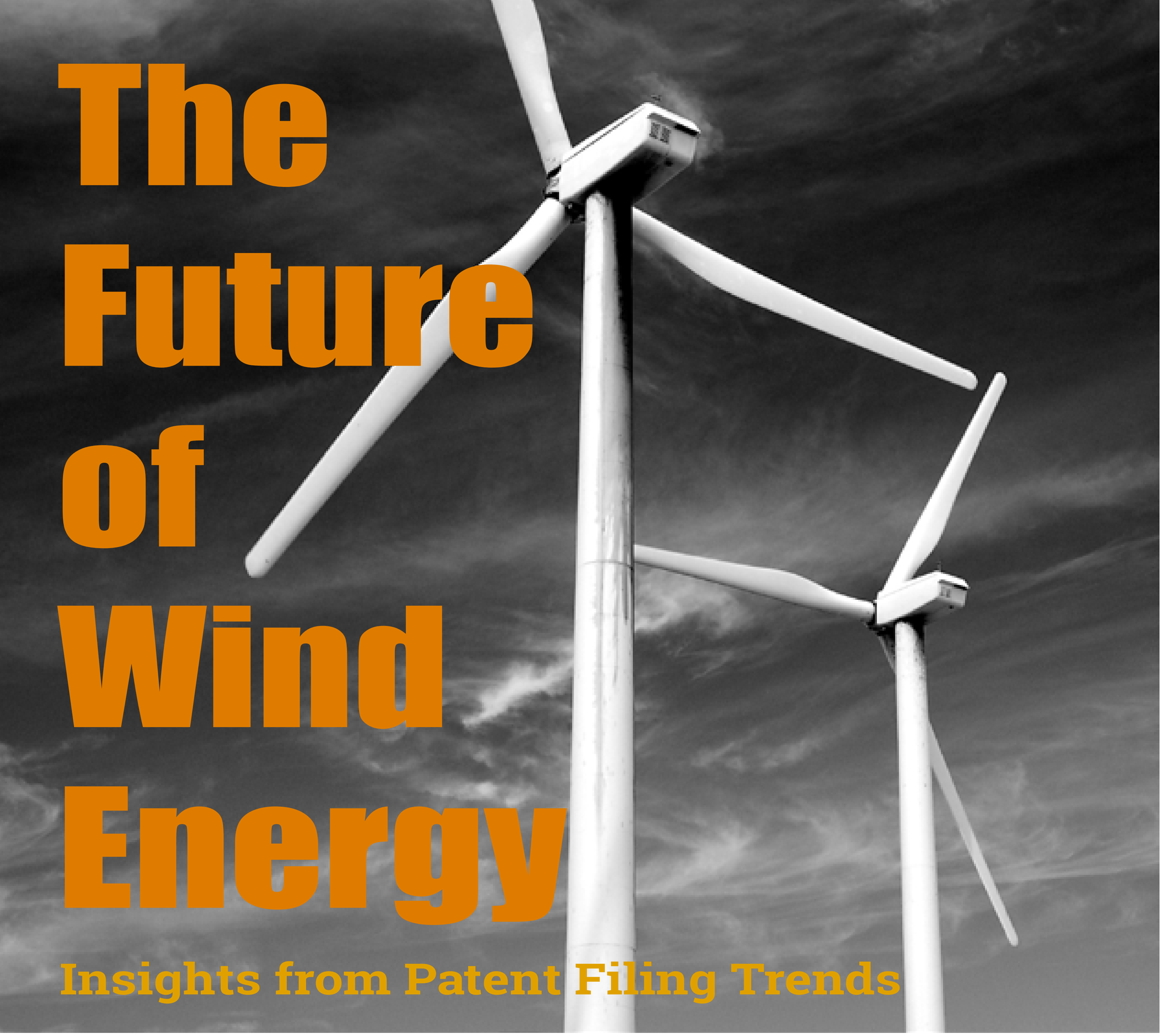
INDUSTRY CATEGORY

Christoph Gürtler, Walter Leitner and Team

Using carbon dioxide to make greener plastics

Christoph and Walter have developed a ground-breaking system for using carbon dioxide to make polyurethane. The relevant patents EP3041883, EP3008100 describe the process which uses alkylene oxides and carbon dioxide produce useful polyethercarbonate polyols, a precursor to polyurethane. Their technique reduces the amount of fossil feedstock needed to produce a given amount of polyol by up to 20%, and further provides a use for waste carbon dioxide which would otherwise find its way into the atmosphere.

Author: Adam Kelvey



The Future of Wind Energy

Insights from Patent Filing Trends

As awareness of the devastating consequences of climate change grows, technology that harnesses renewable energy has seen significant investment in recent years. Wind energy is no exception. With increased investment, there comes a need for protection by way of patents.

Patents are typically filed at an early stage of development, due to the requirement for the technology they cover to be new and inventive. This in turn means that patent filing statistics can provide a good insight into where R&D is being carried out, and into potential future technologies. In this article we ask, what areas are the core technologies where patent filings are being made, where are these filings being made, and who is filing them?

Statistics from IRENA's INSPIRE platform show that in the renewables field, wind energy patent filings come second only to those in the solar energy field, reflecting the critical importance of innovation in these fields to meet climate change goals.

The figures do, however, suggest that renewable energy patent filings may have plateaued. This plateau can be seen for wind energy patent filings in Fig. 1. The trend should not be taken as an indication of any lessening of interest in wind energy technologies, but does suggest that the industry have reached a mature stage where patent filings have levelled off.

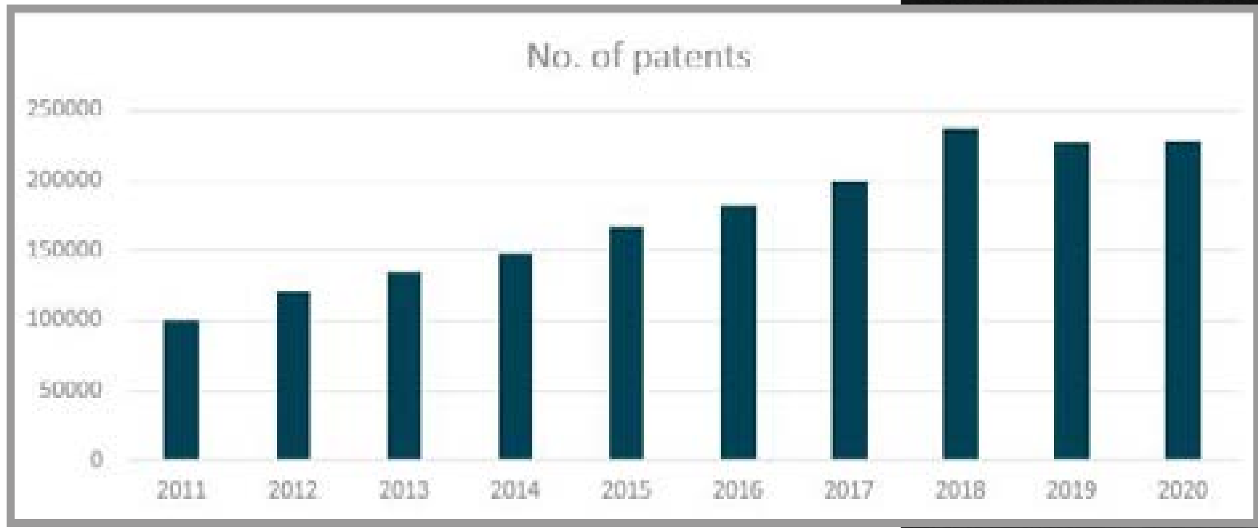


Fig. 1 No. of Wind Energy Patent Filings (by publication year)

Offshore wind, however, bucks the trend, as can be seen from Fig. 2. In the offshore wind field, filings continue to rise year on year, suggesting increasing development in this field. One explanation for this is increased R&D at low TRL by universities and companies who may have been less active in conventional wind energy, where the technology is more mature, and the market is already occupied by large companies with an established presence. Indeed, looking at the top 10 filers in this area, we notice two Chinese universities (Fig. 5).

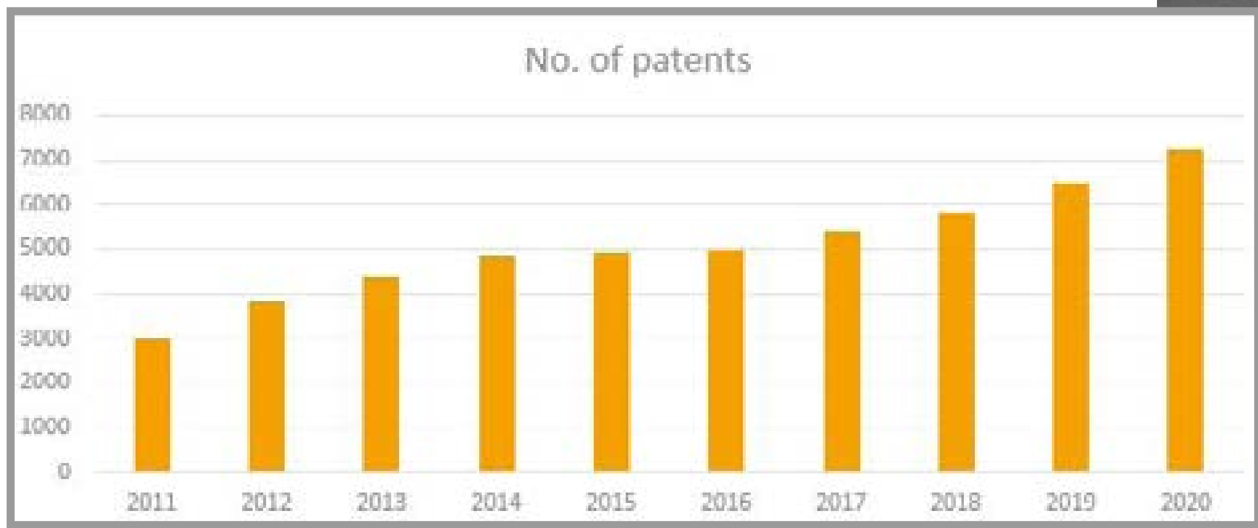


Fig. 2 No. of Offshore Wind Patent Filings (by publication year)

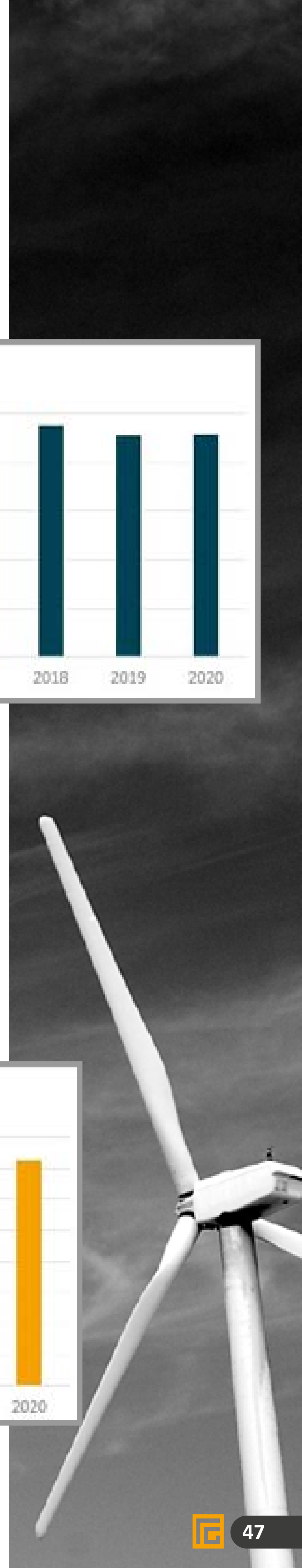


Fig. 3 shows the top 10 filers of wind energy patents. We found that Chinese state-owned utility corporation State Grid has filed the largest number of wind energy related patent applications, followed by Mitsubishi Electric, and then GE. By contrast, Fig. 4, which looks at offshore wind in particular, shows Siemens, followed by Samsung Heavy Industries, and then Vestas represent the top patent filers. Indeed, only 5 of the top wind energy patent filers are in the top 10 offshore wind energy patent filers list, and, as mentioned above, two Chinese universities appear among the top 10 filers.

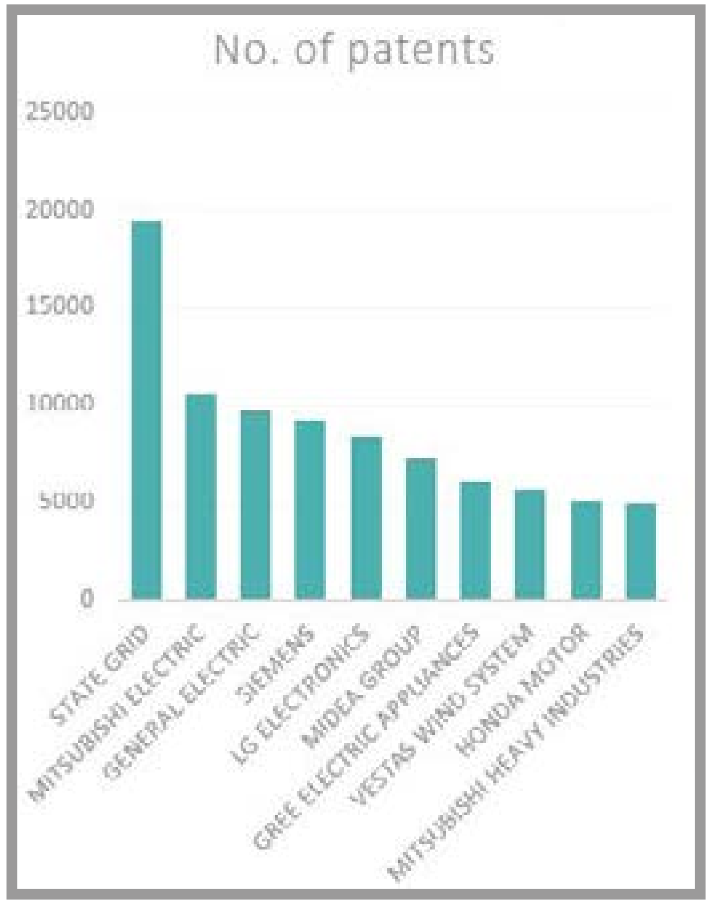


Fig. 3 No. of Wind Energy Patent Filers (2011-2020)

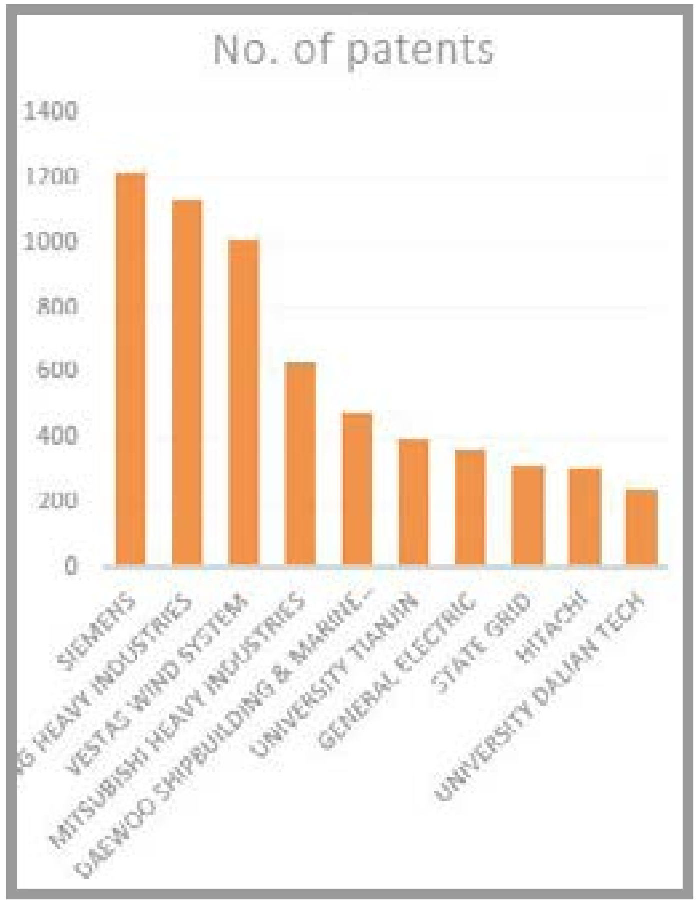
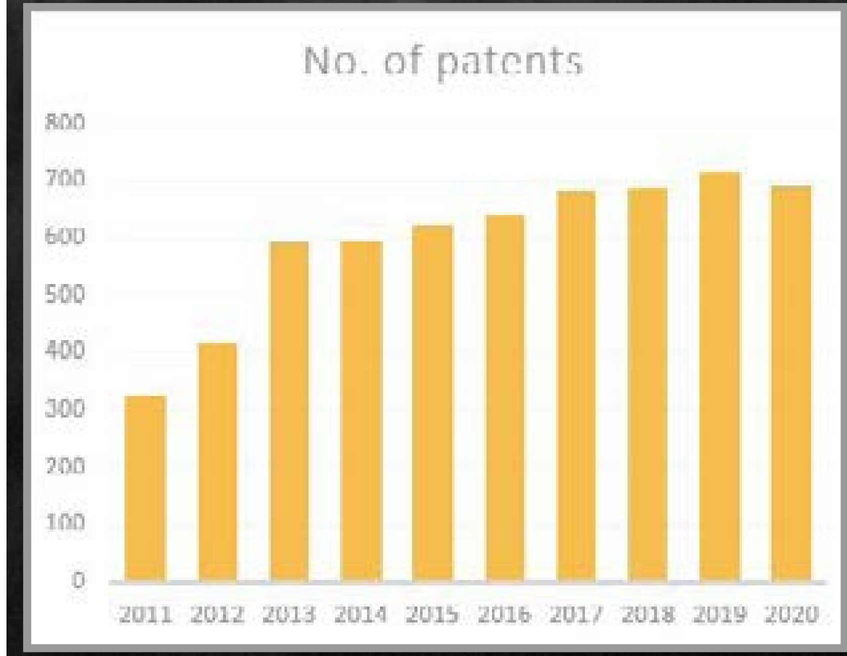
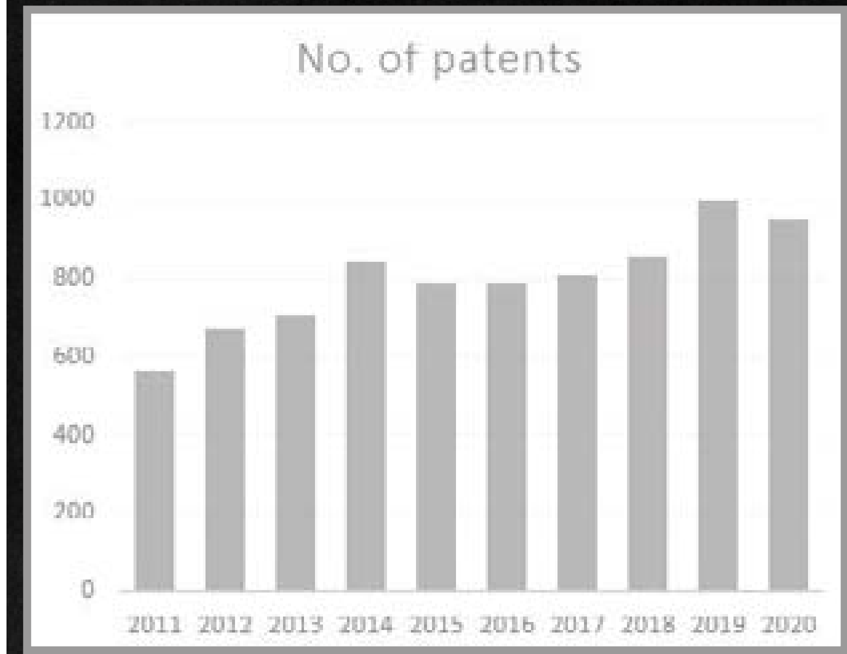
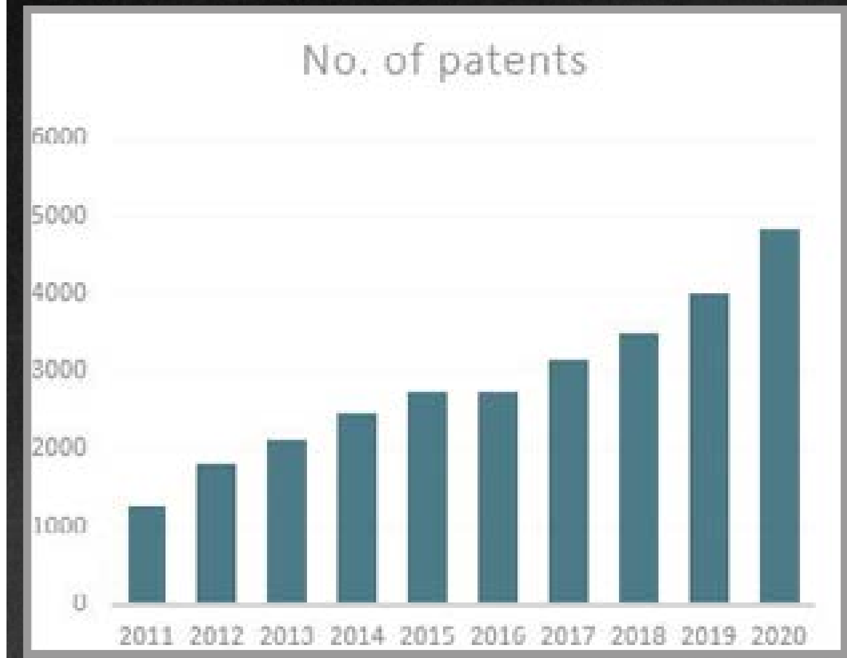


Fig. 4 No. of Wind Energy Patent Filers (2011-2020)

Patents are territorial rights, which means that applicants are required to pursue separate patents in each territory where they seek a monopoly. Patents published by the European Patent Office (EPO) show a rapid increase relating to offshore wind towards the beginning of the last decade, although that increase has slowed in recent years (Fig. 5a). In the US and Canada (Fig. 5b), yearly numbers of publications have, on average, been 1/3 higher than those of European applications, although this may be partly attributed to filings made directly at the national offices of European countries, which are not included in the EPO figures. Looking to East Asia (Fig. 5c), however, patent filings in China, Japan and Korea show significantly higher numbers than Europe and North America, and continue to increase at a high rate, with the past 5 years showing a 75% increase. The high number of patent filings in east Asia may be largely attributable to high numbers of filings for home grown technology, particularly in China, and mirrors a general trend in China across all technology areas.

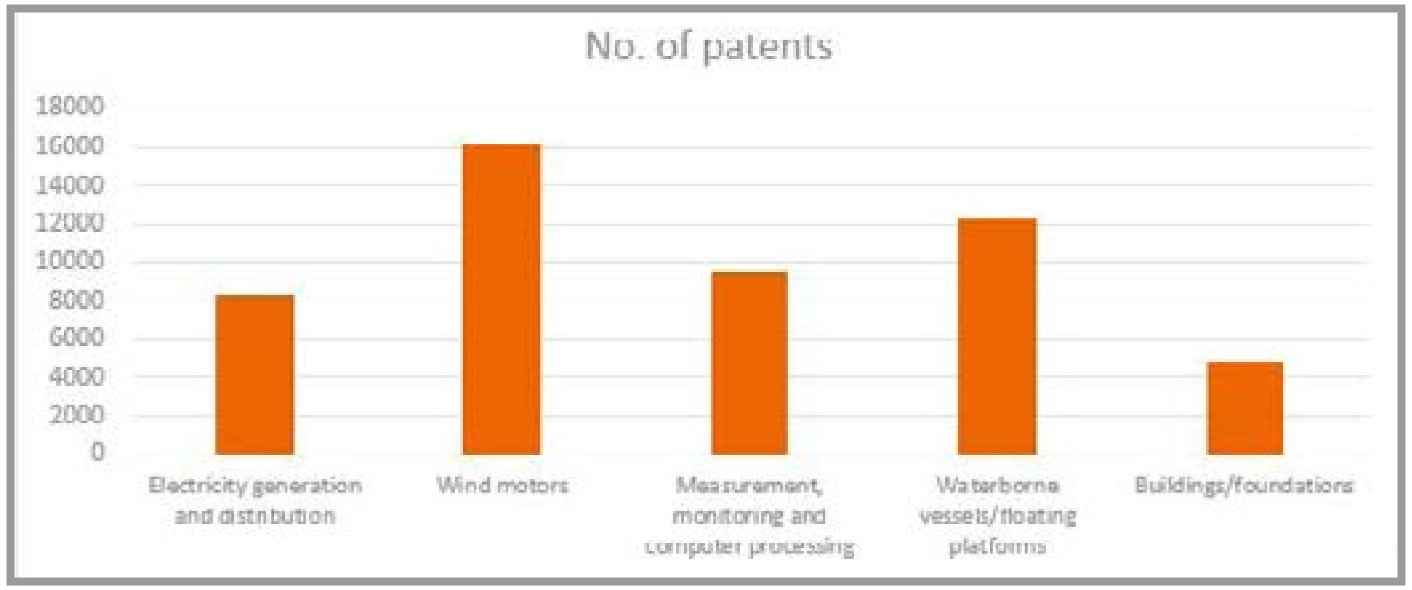






"The statistics reflect the current buzz surrounding the wind industry, and the field of offshore wind in particular. They also demonstrate that innovation in the sector is flourishing around the world, and extends into diverse technology areas."

Patent filings can also give us an insight into the core technology areas of interest to the offshore wind sector. Fig. 6 shows that the largest number of offshore wind related patent filings relate, at least in part, to aspects of the wind motors themselves – rotor blade design, nacelle covers, methods of control, and so on. After that, we see a large number of filings relating to waterborne vessels, and offshore platforms in particular, compared to a smaller proportion of filings relating to buildings and foundations, suggesting a trend towards floating wind. That said, filings in both areas continue to increase into 2020 supporting the interpretation of increased R&D in the field of offshore wind in general. Technology relating to measurement, monitoring and computer processing also accounts for a significant proportion of filings, suggesting developments in the field of digitalisation. Given the buzz around digitalisation in the wind industry, it is perhaps surprising that these filings do not represent a higher proportion of total filings, possibly suggesting higher numbers to come, or perhaps a perception that patents may be difficult in this area. A high number of patent filings also relate to electricity generation and distribution, reflecting the challenge of effectively utilizing the energy generated by wind turbines.



In general, the statistics reflect the current buzz surrounding the wind industry, and the field of offshore wind in particular. They also demonstrate that innovation in the sector is flourishing around the world, and extends into diverse technology areas. At Reddie & Grose, our multidisciplinary team, including specialists in the difficult digitalisation field, are well placed to file and prosecute patent applications in the diverse technology areas of interest to the wind industry.

Authors: Georgina Ainscow & Dr Dongyoung Kim

FROM Carbon Capture TO Yoga Pants

In July 2021, LanzaTech announced a partnership with the athletic clothing retailer Lululemon to create a fabric using recycled carbon emissions.

LanzaTech's process can use carbon dioxide from industrial emissions that are captured before it is released into the atmosphere. Carbon dioxide is fermented by LanzaTech's innovative microorganism-based technology into ethanol.

Although ethanol can be used as a biofuel, but it can also be used as an intermediate in the manufacture of useful materials.

Along with partners India Glycols Limited (IGL) and Far Eastern New Century (FENC), the ethanol can be used to produce polyester. Firstly, IGL converts the ethanol to monoethylene glycol, before FENG converts the monoethylene glycol to polyester.

A great example of how innovation and collaboration can help create a circular economy, and generate materials in a sustainable manner.

Author: Andrew Carridge

HERE TO HELP

At Reddie & Grose, our Energy & Natural Resources and Sustainability teams are dedicated to green innovation in all of its aspects. Our patent and design attorneys have extensive experience of advising research and development departments and a deep understanding of the key issues in an often complex legal and business environment. We help businesses in their due diligence and analysis of whether they are free to launch their products. We protect their innovations by preparing and prosecuting patent applications – building portfolios of rights to protect their commercial interests. We are also skilled in assisting clients to enforce their patents and designs, filing oppositions and cancellation/ revocation proceedings against third party rights, helping to defend our clients' position in infringement proceedings and defending clients' rights in oppositions and cancellation proceedings brought by third parties.

Our support of multinational clients is more than just managing their global patent portfolio and defending crown jewel IP rights. We understand that every stage of a product's development offers a unique challenge and our experience of working in established and emerging markets enables us to think beyond the law and devise patent strategies tailored to the commercial objectives of our clients.

In our support of start-ups and SMEs we have the commercial expertise to protect their innovation, ensure that their businesses are attractive to investors, ready for an IPO or perfectly placed to bring the next blockbuster to market.

We pride ourselves on listening to our clients and offering expert and pragmatic advice that is tailored to our clients' needs. Avoiding a 'one size fits all' approach has allowed us to build up many valued long-lasting client relationships.

We would be delighted to provide you with further information about our services and to organise a free initial consultation.

The contact details for the Energy and Natural Resources and Sustainability team leads are as follows:

Georgina Ainscow	georgina.ainscow@reddie.co.uk
Andy Carridge	andrew.carridge@reddie.co.uk
Duncan Nevett	duncan.nevett@reddie.co.uk
Gillian Taylor	gillian.taylor@reddie.co.uk