

# WIPO MAGAZINE

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Carving a pathway to a green future is a modern-day imperative. We all share in this challenge and each have a role in building a green future. It is a complex and multi-faceted endeavor, but we have the collective wisdom, ingenuity and creativity to come up with new, more effective ways to shape a low-carbon future.

The 2020 World Intellectual Property Day campaign puts innovation – and the intellectual property (IP) rights that support it – at the heart of efforts to create a green future. Why? Because the choices we make today will shape our tomorrow.

This special focus issue of the *WIPO Magazine* explores the central role that innovation and IP rights play in opening a pathway to a green future, and offers a glimpse of some of the many inspiring ways individuals, companies and policymakers are coming up with solutions to tackle climate-related challenges and support our journey to a green future.

For more on World Intellectual Property Day, see [www.wipo.int/ip-outreach/en/ipday](http://www.wipo.int/ip-outreach/en/ipday). Join us on Twitter ([#worldipday](https://twitter.com/worldipday)) and Facebook ([www.facebook.com/worldipday](https://www.facebook.com/worldipday)).

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Editor: **Catherine Jewell**

Layout: **Ewa Przybyłowicz**

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# Climate change: now is the time to act

By **Cecelia Thirlway**, freelance writer

Climate change is one of the most urgent and complex challenges of our time. Can humanity's capacity for creativity and innovation really save the world?



Climate change is one of the most urgent and complex challenges of our time. To preserve our planet's ecosystem, we must dramatically reduce our net carbon dioxide (CO<sub>2</sub>) emissions, while continuing to sustain an expanding population.

That the problem is real is now mostly unchallenged: but how to tackle it remains a source of debate. Some believe we must learn simply to consume less. Others believe technological innovation alone can resolve the problem.

But can humanity's capacity for creativity and innovation really save the world?

### **IMPROVING OUR EFFICIENCY**

Meeting emissions targets to limit global warming to 1.5°C is a significant challenge and "would require rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems," according to a report by the Intergovernmental Committee on Climate Change (IPCC).

As consumers, we can play our part in reducing carbon-intensive activity: turn our thermostats down, buy local food, fly less, walk and cycle more. But such behavioral change, especially on a global scale, takes time and relies on a complex interplay of factors.

Our own efforts can feel like a drop in the ocean. Even the most well-intentioned consumer finds it difficult to make the best choices in a complex and opaque system. And besides, not all of the world's consumers have the luxury of interrogating their personal supply chain.

So how do we ensure our emissions decline as our consumption continues to rise? Is innovation the answer? Professor Steve Evans of the Institute for Manufacturing at Cambridge University takes a nuanced view.

"I'm a bit worried that we're so desperate to invent our way out of the problem, we're not going to change the way we see the world. We're just going to wait for renewable energy, for carbon capture, for people in laboratories to solve the problem rather than for CEOs, politicians and citizens to get involved."

Professor Evans' work involves identifying areas of waste to improve the efficiency – of resources, time, energy, materials – in manufacturing systems. Before a product such as a car ever reaches the buyer, the process of producing it has already had a significant environmental impact. His research shows there is huge scope to reduce that impact.

"Many may think, logically, that we should be close to best possible efficiency," says Professor Evans. "Remember, we're talking about energy, water, materials, pollution – which cost businesses money. Economics 101 would suggest that they would not be doing this very wastefully, but my data show otherwise."

“Innovation is always risky, and the complexity of the landscape makes these markets tricky to predict, so intellectual property (IP) remains a powerful business asset when it comes to addressing some of our biggest challenges.”

Professor Steve Evans, Institute for Manufacturing, Cambridge University, United Kingdom.

### Did you know?

Every time you wash fleeces and other synthetic garments, up to 700,000 tiny plastic microfibers are released into the world's rivers, lakes and oceans and are entering the food chain. The good news is that innovative filtration systems can stop this from happening.



Photo: pixedeli / iStock / Getty Images Plus



Photo: Courtesy of Xeros Technology Group

Xeros Technology's X-Filtra™ is inexpensive and easily incorporated into standard washing machines and aims to capture over 99 percent of microfibers generated in a load of laundry. '

He points to the most efficient car factory in Europe, which, over the last 14 years, has reduced the energy used to make a car by 8 percent every year. This means they can now make four cars with the energy it used to take to make one. With a cost-saving attainable on this scale, one might expect the entire industry to have followed suit, but according to Professor Evans, this hasn't happened.

"If the rest of the market moved halfway to where the best is now – just halfway – we'd have 12 percent more profit, 15 percent more jobs, and 5 percent fewer greenhouse gases."

So, should we be looking to reduce waste and improve efficiency in manufacturing and industry, rather than inventing new technology to deal with the climate crisis? Not necessarily, according to Professor Evans: it's about balance, and about speeding up and de-risking the process of bringing new knowledge to market.

"We have enough technology to be sustainable today – we've got to learn how to bring those things into daily operation."

To that end, as Chairman of Project X Global, an ambitious accelerator, he is working to help scientists commercialize their inventions quickly.

"If you're a scientist in a university research lab [and] you patent something, it takes about 10 to 15 years for that technology to scale. I'm interested in doing it in 10 to 15 months."

Project X focuses its efforts on the conundrum of the first big order: investors often want startups to have secured a large order before they commit, but most companies won't work with small, high-risk startups at that scale. This means organic growth typically happens over a long timescale. Project X aims to leapfrog that process.

"We work with a big company to help them define the problems they have, and then we seek out inventions that will help them solve that problem. But most importantly, before we do so, the company promises to make large orders for any technology that passes the test that they set. They dictate the tests, but if something passes, they buy 1,000 tonnes or 10,000 units or something along those lines."



To de-risk the initiative for the company, Project X Global employs a robust research methodology, combined with peer review, to ensure only the most effective and sustainable solutions are selected.

Innovation is always risky, and the complexity of the landscape makes these markets tricky to predict, so intellectual property (IP) remains a powerful business asset when it comes to addressing some of our biggest challenges.

Xeros Technology Group is a prime example: its technologies are helping garment manufacturing and cleaning industries to reduce water consumption and energy use in processes such as dyeing or washing. The company, which is built entirely on IP, licenses its technologies to manufacturers across the world.

“Our business model is to derive license income from our IP, we do not participate in markets directly,” explains Mark Nichols, CEO at Xeros. “Therefore, it is vital that we protect our patents and trademarks to secure and protect our revenues and generate a return on the investment we have made in developing our innovations into commercial products. Quite simply, without robust patents and extensive geographic coverage, we would not have a business.”

As an example, the company’s XOrb™ technologies, which are spheroidal polymers, only need low levels of water and chemistry to remove dirt and stray dyes when washing textiles. They also make cloth-dyeing processes (e.g. penetration and fixation) more efficient, dramatically reducing the time, water and energy required.

With over 40 patent families across a wide range of technologies, Xeros takes a focused and strategic approach to its IP and attracts investors who understand the value of the technologies it develops, and the need to protect them.

“We see an increasing number of funds being created to make ‘green’ investments, with the London Stock Exchange now also affording a Green Economy Mark to companies that generate at least 50 percent of their revenues from products and services that contribute to the global green economy.”

**“Our climate is an interconnected system that depends on a multitude of factors. This means that even defining the right problems to solve – the normal first step to innovation – is in many ways harder than coming up with a solution.”**

Photos: Courtesy of Climeworks



Climeworks, a Swiss-based company, has developed the world's first commercial direct air capture technology that removes carbon dioxide from the air. Each collector is the size of a small car and can be stacked to create a plant of any size.

Christoph Gebald and Jan Wurzbacher (below) founders of Climeworks.



## REMOVING CO<sub>2</sub>

The science demonstrates that if we are to meet established temperature targets, we need not just to reduce our emissions, but also to remove existing CO<sub>2</sub> from the atmosphere.

Much of the technology for carbon capture and sequestration has existed for decades: the problem has always been one of scale. Take, for example, direct air capture.

“Capturing CO<sub>2</sub> from the air is not new; it’s been used in submarines and in space travel, anywhere humans have needed to breathe in an enclosed space for a longer period,” explains Louise Charles, Communications Manager at Climeworks. “What Climeworks is doing differently is capturing CO<sub>2</sub> on a much larger scale.”

Founded by two Swiss mechanical engineers who studied direct air capture at ETH Zurich, Climeworks has developed large-scale direct air capture plants based on a modular system of CO<sub>2</sub> collectors. These collectors, each the size of a small car, can be stacked in any number of configurations to create a plant of any size that extracts CO<sub>2</sub> from ambient air. The CO<sub>2</sub> can then be sold for making fizzy drinks, carbon-neutral fuels or fertilizer. The captured CO<sub>2</sub> can also be stored underground by injecting a mix of CO<sub>2</sub> and water into suitable rock formations, where a chemical reaction turns the CO<sub>2</sub> into stone. The only requirement is a source of renewable energy, and if the CO<sub>2</sub> is to be stored rather than sold, a suitable geological site to store it.

“We currently have grey emissions of 10 percent, so for every 100kg of CO<sub>2</sub> we remove from the air, over the lifecycle of that plant we will re-emit 10kg. In other words: we have a net efficiency of 90 percent, and our goal is to bring that up to 94 percent. Direct air capture doesn’t require much land, and the process requires no water – in fact we produce water as a by-product.”

Climeworks holds several patents on its technology and is positive about their worth in terms of protecting its knowledge and helping to secure investment. Originally funded through accelerator programs and research grants, the company began operating in 2009, and has thus far secured CHF 50 million in investment.

“Direct air capture technology is very much part of a portfolio of solutions. It’s not a silver bullet in any way: the scale of the climate crisis is such that we need all solutions working together.”

But is there a robust market for this technology? The answer is yes. The renewable fuels industry is gaining momentum and the voluntary CO<sub>2</sub> removal market (as opposed to offsetting required for compliance) is growing rapidly. The latest report from Forest Trends on carbon capture shows a 52 percent increase in offsetting since 2016, and suggests the market is approaching its tipping point.

**“Direct air capture technology is very much part of a portfolio of solutions. It’s not a silver bullet in any way: the scale of the climate crisis is such that we need all solutions working together.”**

Louise Charles, Communications Manager, Climeworks.

## RETURNING TO NATURE

Other initiatives to tackle climate change, however, do not require much invention at all. Strikingly, the aforementioned Forest Trends report shows a 264 percent increase in offsets generated through forestry and land use activities – of which 57 percent are concentrated in Peru. Reforestation can have a dramatic effect on carbon sequestration, biodiversity and ecosystems in general.

In 2000, Isabella Tree and her husband Charlie Burrell began rewilding their 3,500-acre Knepp Estate in the UK, allowing it to return completely to nature. The results were startling: within two years, the land was replete with vegetation and thrumming with insects in numbers not seen for generations and is now a breeding hotspot for multiple critically endangered species of birds. But just as importantly, the Knepp Estate's value as a carbon sink, as assessed for DEFRA (the Department for Environment, Food & Rural Affairs) by Bournemouth University, has risen from a score of 1 to a maximum score of 5. According to Ms. Tree's book about the Knepp Estate, the assessment estimates that over 50 years, it will capture and store an additional GBP 14 million worth of carbon through its restored grasslands and broadleaved woodland.

But while the IPCC suggests that an increase of 1 billion hectares of forest is required to help limit global warming to 1.5°C by 2050, recent mapping of the Earth's canopy cover reveals that there may only be 0.9 billion hectares available for reforestation without disrupting current human use. The timescales are also a challenge:

“The carbon capture associated with global restoration could not be instantaneous, because it would take several decades for forests to reach maturity.”

Evidence of human ingenuity at work in the fight against climate change abounds. Project Drawdown, a research organization that reviews, analyzes, and identifies the most viable global climate solutions, lists over 80 categories of solutions ranging from reducing our food waste and family planning to innovative micro-grids and bio plastics.

But tackling such a complex problem isn't easy. Our climate is an interconnected system that depends on a multitude of factors. This means that even defining the right problems to solve – the normal first step to innovation – is in many ways harder than coming up with a solution.

What is certain in the race to save our precious planet is that new knowledge and know-how is being created at an unprecedented rate. Our success in overcoming this daunting challenge will likely hinge on a combination of inspired innovations, deep changes in living habits, and a more responsible attitude to this planet's biodiversity and natural systems. As David Attenborough recently told a five-year-old boy who asked what he could do to save the planet:

“Don't waste electricity, don't waste paper, don't waste food. Live the way you want to live but just don't waste. Look after the natural world, and the animals in it, and the plants in it too. This is their planet as well as ours. Don't waste them.”

# Sustainability and the circular economy

By **Cecelia Thirlway**, freelance writer



Photo: BsWai / iStock / Getty Images Plus

When we start perceiving waste as resources of equal – or even greater – value than those used to create it – we will have closed the loop and created a truly circular economy.

In *Back to the Future II*, Dr. Emmet Brown's iconic DeLorean time machine had been modified to run on household waste. That imagined future innovation, portrayed as happening in 2015, is already at least five years behind schedule. But while fueling vehicles with banana skins and plastic bags is not on the horizon just yet, there are ground-breaking innovations being made in the world of waste.

Without urgent action, annual global waste generation will rise to 3.4 billion tonnes by 2050, a 70 percent increase on 2018 levels, according to the World Bank. While more than one-third of waste in high-income countries is recovered through recycling and composting, only 4 percent of waste in low-income countries is recycled.

If we can tackle the recycling problem, we may also gain ground in solving the climate crisis and associated loss of precious habitats. The more virgin resources we use, the more we damage our planet. The World Economic

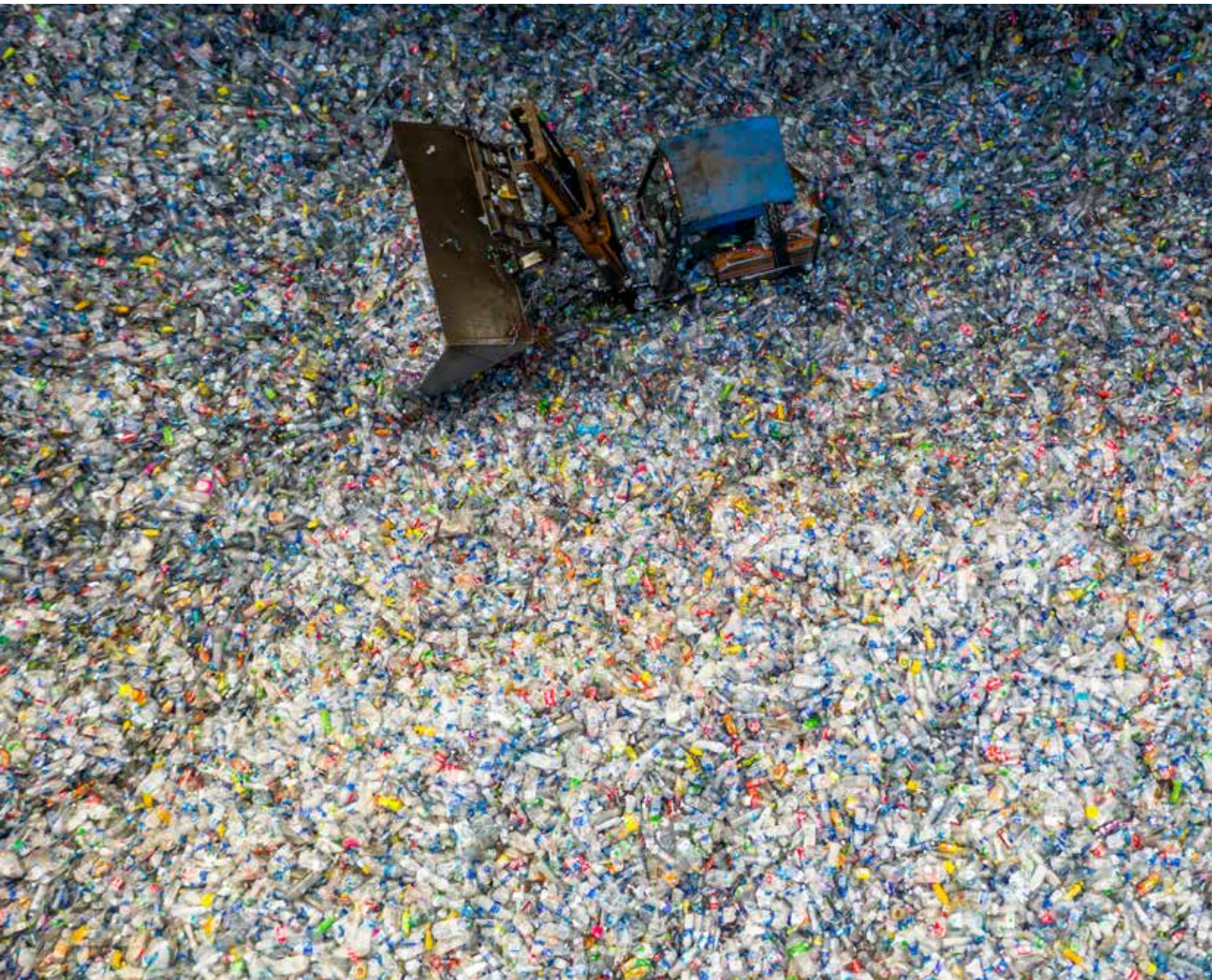
Forum (WEF) estimates that “resource extraction and processing alone cause over 90 percent of global biodiversity loss and water stress, and about half of the effects of global climate change.”

By reducing our dependence on the extraction of oil and minerals, we can avoid generating high levels of emissions and thereby help restore our planet's ailing ecosystems. And there is an opportunity here. As noted by WEF: “Smart resource use and business models that do not rely on natural resource extraction are a huge untapped field for innovation and for a new model of growth.”

## **ONE PERSON'S WASTE IS ANOTHER'S TREASURE**

The key to creating fully sustainable, closed loop systems, where resources are re-used, recycled and never discarded, lies in their economic value. When we start perceiving waste as resources of equal – or even greater – value than





**“The minute we put a value on plastic the problem will go away, in my view, because people will see it as a resource rather than a problem.”**

Martin Atkins, CEO, Green Lizard Technologies.



Photo: Avigator/Photographer / iStock / Getty Images Plus

those used to create it, we will have closed the loop and created a truly circular economy. This isn't a new idea. For example, in the seventeenth century whisky producers started re-using oak casks that brought sherry to their ports from Spain. This was a far cheaper solution for them than buying new oak, and it made little sense to send empty casks back to Spain for refilling. The flavor benefits of this approach were only discovered later.

Similarly, legislation passed in the United States in 1935 to protect the cooperage industry made it illegal to use bourbon casks more than once. This turned used bourbon casks into a waste stream, and resulted in a huge proportion of whisky in the UK (where casks can be reused as often as the wood allows) now being aged in American oak casks.

But how do we apply these principles to materials that are more difficult to re-use? In 2016, the world generated 242 million tonnes of plastic waste, leading many to view plastic as a problem material.

Plastic waste is cluttering our oceans, and micro-plastics are entering natural ecosystems and the food chain at an alarming rate. Many countries and cities around the world have already dramatically reduced plastic bag usage either by charging customers directly to use them, or by taxing retailers who supply plastic bags to their customers. In addition, initiatives such as Sky's Ocean Rescue in the UK and Plastic Free July in Australia are urging businesses and consumers to eliminate single-use plastic from their lives.

But is going completely plastic-free the answer? Plastic is a highly versatile material and finding suitable alternatives isn't always easy. Furthermore, it's important to ensure that the alternatives developed don't create new waste or emissions problems. One option might be to do better at dealing with the plastic we already have.

"The biggest problem we've got is that people now are classing plastic as the demon, as death and doom and gloom," says Professor Martin Atkins, CEO of Green Lizard Technologies. "But actually, if you look at the benefits of plastic, they far outweigh anything else that we can package and carry our food in, for example. The only problem with plastics is that we don't know how to treat them as waste properly."

Green Lizard Technologies, a spin-out company of Queen's University Belfast, focuses on finding green and sustainable solutions to industrial problems. Its solution for plastic waste is a process that converts waste PET (polyethylene terephthalate) to BHET (Bis(2-Hydroxyethyl) terephthalate), an organic compound that is now being commercialized through Poseidon Plastics UK.

"A lot of people are just burning plastic to get the energy back, and that's about the worst thing you can do because you generate carbon dioxide (CO<sub>2</sub>) in that process, and you don't actually get that much energy back. We've developed a process that takes plastic all the way back to fuels, to chemicals, to solvents to give them secondary and tertiary uses and convert them into products.

These are products you could make through another route, but this is much cheaper because you're using a feedstock which is classed as waste."

The crucial element of a process such as Green Lizard's is that the outputs can be re-used for a purpose of the same value as before.

Professor Atkins highlights that while managing plastic waste is a challenge, replacing it in the food supply chain might result in higher transport emissions from heavier packaging (e.g. glass), or greater food waste. But if discarded plastic could be reused in an economically viable way, that would change everything.

"The minute we put a value on plastic the problem will go away, in my view, because people will see it as a resource rather than a problem."

### **RECYCLING VERSUS DOWNCYCLING**

Conway Daw of toothbrush manufacturing company Reswirl agrees: "A lot of plastic that's returned for recycling isn't really recycled, it's downcycled. It's chopped up and turned into a lower grade material, and becomes park benches or watering cans or bollards, which gives it a second use, but it's not a continuous cycle. It's still going to end up in landfill eventually."

Reswirl is developing a manual toothbrush and replaceable heads for electric toothbrushes that, once worn out can be returned to the company for remolding into new brushes. The material and recycling process they use ensure that their outputs can be used again and again. And even if the toothbrushes do end up in normal waste channels, the handles will biodegrade safely because they are made from a biodegradable material called PHA (Polyhydroxyalkanoate).

Reswirl has applied for a patent for its recycling process and material, but as an experienced designer, Conway Daw thinks that the patenting process could place greater emphasis on a product's end of life.

"I firmly believe in the responsibility to consider not just how something is made, but how it is *un*-made at the end of its life. For patent applications for things, processes, or compounds that facilitate easy re-use or recycling, perhaps there could be additional criteria for examination."

### **BASE METALS**

"One material that has been successfully recycled for over a century is lead – as an expensive metal with a number of different uses, its value means it's worth the effort to recover as much of it as possible. But this brings its own problems," says Dr. Athan Fox of recycling company Aurelius Environmental.

"A lot of people don't realize this, but the lead acid battery is actually the world's most successfully recycled commodity product. The battery is contained in a plastic casing, which is recycled, and this plastic makes money, its value is preserved all the way to the new plastic. Then there is an electrolyte: an acid that is usually neutralized and converted into a value-added salt that can be used in various industrial applications. And then there is the lead metal, and that lead metal has been in use in batteries since the 1850s."

While this might sound like a perfect example of the circular economy in practice, the industry that recycles the lead from batteries is highly polluting, in part, because the process is expensive and highly energy-intensive, emitting large quantities of CO<sub>2</sub>.



Reswirl, a toothbrush manufacturing company, has developed a manual toothbrush and replaceable heads for electric toothbrushes that, once worn out, can be returned to the company for remolding into new brushes.

Photo: Courtesy of Reswirl



Aurelius Environmental has pioneered a process that can recover the active material in batteries, the so-called “leady oxide”, while reducing carbon emissions by more than 85 percent. This zero-waste process takes place in cold water rather than a furnace and thereby substantially reduces energy use.

“In our process, the old active material is converted into a new active material directly, without having to go through the refinement process and downstream conversion of materials,” continues Dr. Fox. “But the icing on the cake is that the active material that we produce through the recycling process has a higher porosity and lends itself to superior batteries; they are more energy dense than batteries produced from mined lead metal.”

This provides a powerful economic driver for the industry to adopt this new process and helps explain why Aurelius Environmental is currently negotiating licenses in all key markets across the world.

### **SCARCITY AND PLENTY**

Waste is in part driven by plenty: when resources are plentiful, they become cheap, so we don't value them sufficiently and allow them to fall out of use. The approaching scarcity of some of the resources we rely on – such as oil – coupled with a growing understanding of the problems caused by waste in landfill, are starting to drive innovation in how we use and re-use natural resources. However, whether this scarcity is driving innovation sufficiently fast, particularly in the context of climate change, is another question.

Sometimes the drivers for innovation around waste are not related to scarcity, but the opposite. Eoin Sharkey's company, The BioFactory, is working on a solution to the health problems caused by unsanitary toilet facilities in developing countries.

"Basic pit latrines provide the ideal environment for pathogens to grow, they're really difficult to clean, and they're often neglected and overflow into groundwater sources, which causes all sorts of problems," says Mr. Sharkey. "But one of the things we found is that the cost of building and maintaining toilets is a massive issue."

To solve this problem, Mr. Sharkey has spent the last year designing a toilet system that uses a form of bio digestion to convert human waste into fuel – biogas. The process of doing this isn't new but making it economically viable has always been tricky.

"The problem with sanitation is often a business problem, not a technology problem. A lot of other sanitation companies collect the waste and transport it to a waste processing plant, create their by-products and then sell them back to the users. So, we built a community toilet and waste processing system that does everything in one place."

By replacing some of the charcoal used as fuel by 80 percent of people in Africa with biogas, The BioFactory's system is helping to eliminate some of the health problems caused

by charcoal smoke, such as pneumonia and lung cancer. Also, by offering a sustainable alternative fuel source, the system is helping to prevent the deforestation threatening many African countries.

"We're launching a pilot project in Mozambique to provide toilets for 150 to 250 people who don't currently have access to basic facilities, and through that project we will be able to provide biogas at the same price for the same amount of energy as charcoal. We will initially trial this in schools."

Whether it's reducing emissions from the recycling process, creating value from a previously valueless material, or finding economically viable ways of diverting waste from landfill, it's clear that innovation around waste is happening all over the world. But the most recent report from the Intergovernmental Panel on Climate Change (IPCC) has demonstrated that we simply don't have time to waste on waste. We need to change our global attitude; we need to view every piece of waste as a missed opportunity to re-use a resource.

As Dame Ellen MacArthur, global sailor and founder of the Ellen MacArthur Foundation, has said: "We've paddled hard in the past, but we need to paddle a lot harder in the future because that circular economy opportunity is sitting there, waiting to happen, and it's up to us to make it happen."

Photo: Courtesy of The BioFactory



The BioFactory is designing sanitation solutions for use in refugee camps and rural communities in Africa. Its all-in-one latrine and waste processing plant uses bio-digestion to convert human waste into cooking fuel and soil conditioner.

# WIPO GREEN: supporting green innovation and technology transfer

By **Amy Dietterich**, Director,  
Global Challenges Division, WIPO

We all rely on a complex web of interwoven natural systems for our well-being. As such, we all experience the impacts of climate change, albeit to varying degrees, and we share a responsibility to encourage behaviors and solutions that will support the transition to a low-carbon future.

In our journey towards a green future, technological innovation is, without doubt, part of the solution. It is that part of the solution that the World Intellectual Property Organization (WIPO) is most actively and directly encouraging, in particular through its WIPO GREEN initiative.

A balanced intellectual property (IP) system that encourages and enables innovation is central to unleashing the creativity needed to develop cleaner, greener and more efficient technologies. These technological solutions will play a central role in allowing us to achieve sustainability targets in a world with finite natural resources and an expanding global population.

## **WIPO GREEN: CATALYZING GREEN TECH TRANSFER**

WIPO GREEN was launched in 2013 in a bid to catalyze and accelerate green technology innovation and its transfer to expand the uptake and use of environmentally friendly technologies in support of the transition to a low-carbon future.

A public-private partnership, WIPO GREEN unites green tech innovators and those seeking green solutions, public and private entities supporting climate-friendly tech, as well as experts in green innovation and other relevant fields. Through WIPOGREEN, WIPO and its partners offer practical solutions that support the development, adoption and deployment of green technology solutions.

As an online marketplace for sustainable technology, WIPO GREEN helps to connect green technology providers (i.e. those responsible for developing such solutions) with technology seekers (i.e. those seeking a green solution to address a particular problem), such as sustainable access to water or climate-friendly sanitation management. It does this primarily through the WIPO GREEN database, which currently features more than 3,000 technologies and needs.



### THE WIPO GREEN DATABASE

The WIPO GREEN database is the backbone of the WIPO GREEN platform. It covers technologies that help to both adapt to and mitigate the impacts of climate change and includes prototypes as well as marketable products. The database also includes the expressed needs of entities who are seeking technologies and solutions to help combat climate-related challenges. All featured technologies are available for license, collaboration, joint ventures and/or sale.

At present, the database includes seven technology categories:

- Building and Construction;
- Energy;
- Farming and Forestry;
- Pollution and Waste;
- Transportation;
- Water; and
- Products, Materials and Processes.

Each category includes a series of related subcategories. For example, subcategories for Pollution and Waste include recycling, waste management, air pollution, etc.

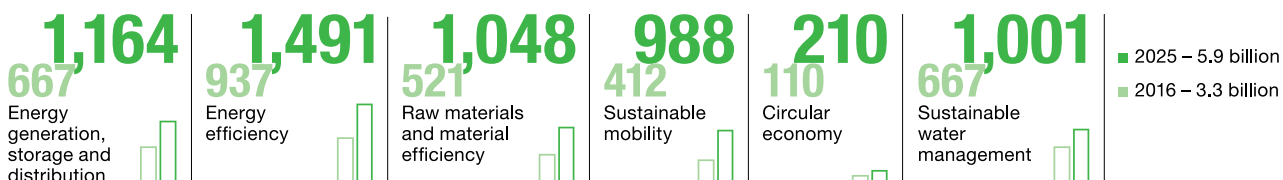
WIPO GREEN is accessible from anywhere in the world and at no charge. When registering, users are simply required to outline the environmental benefits of their technology. Today, the platform serves almost 1,500 international users from 63 countries,

WIPO GREEN is an online marketplace for sustainable technology. It helps connect green technology providers with technology seekers who are looking for an eco-friendly solution to address a particular problem.



## Green Technology Growth Outlook

(In billion euros)



Source: WIPO GREEN Strategic Plan 2019 – 2023.

including small and medium enterprises, universities and research institutions, as well as multinational companies. By way of example, these include:

ANAGEA Consultores S.p.A. (Chile)  
 Dalian Institute of Chemical Physics, Chinese Academy of Sciences (China)  
 Fujitsu Limited (Japan)  
 Kenya Climate Innovation Center (Kenya)  
 Korea Institute of Energy Research (South Korea)  
 PROvendis GmbH (Germany)  
 University of Pennsylvania (United States of America)

Any company or entity with a technology that has the potential to support the transition to a low-carbon future, and anyone seeking a specific solution to a climate-related problem, can sign up to WIPO GREEN. In doing so, they join the expanding WIPO GREEN ecosystem and may even go on to become a WIPO GREEN partner.

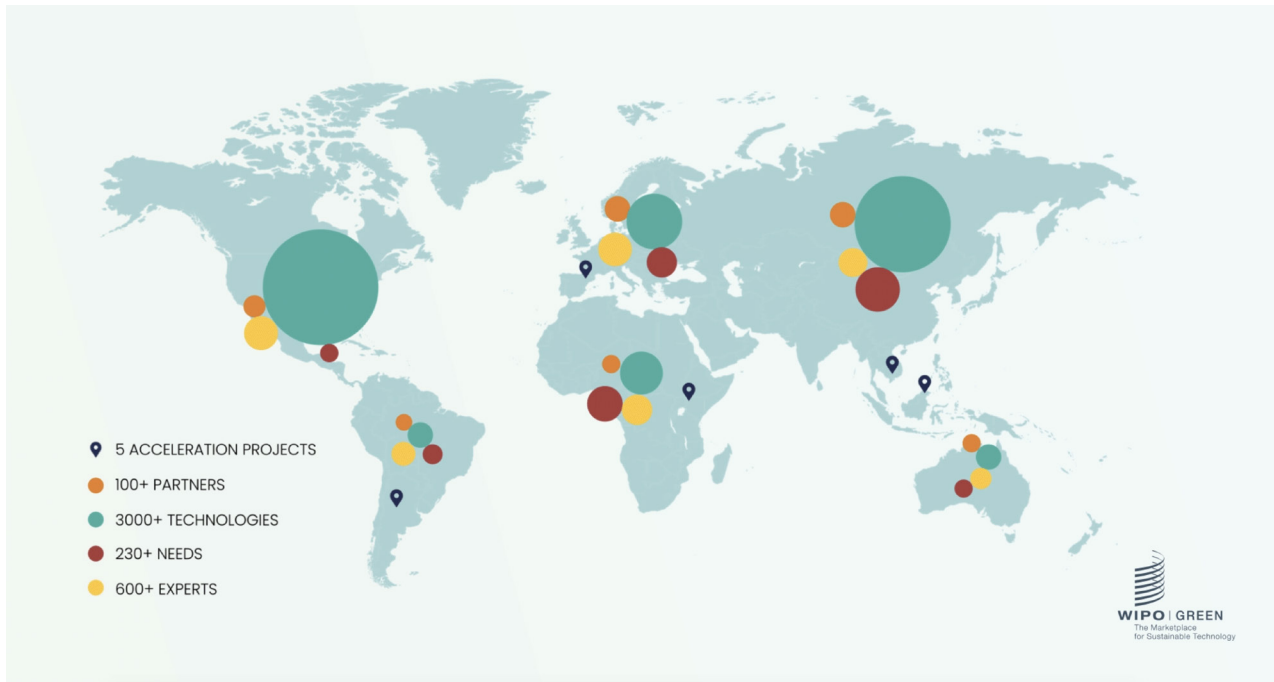
### CLIMATE CHANGE AND FOOD SECURITY

Last year, we unveiled the WIPO GREEN Strategic Plan for the period 2019 to 2023, which takes the program to a new level. It also identifies as one of its three strategic goals the need “to support member states to leverage IP and innovation in global efforts to address major policy issues related to climate change, food security and the environment.”

As climate change and its impact on agricultural production systems and food security are so deeply interwoven it seemed a natural next step to tie food security into the WIPO GREEN platform. For that reason, our Strategic Plan now includes an ambitious plan to enhance the WIPO GREEN database in the areas of sustainable food production technologies, including technologies to reduce food waste.

Issues of food security and climate change can be addressed in part through adaptation initiatives, such as climate-smart agriculture. This broad approach to agricultural development seeks to increase agricultural productivity, improve resilience and reduce vulnerability to climate change, and to reduce greenhouse gas emissions.

WIPO GREEN has a broad global network of supporters and a rich database of IP assets (inventions, technologies and know-how) containing innovative solutions, many of which are relevant to agricultural production and food security. Indeed, two of the last green technology “matchmaking” projects have sought to catalyze agriculture-related green technology innovation. Also known as “acceleration” projects, these initiatives enable green technology providers and seekers to connect, generate



Launched in 2013, WIPO GREEN seeks to accelerate green technology innovation and its transfer to expand the uptake and use of environmentally friendly technologies in support of the transition to a low-carbon future.

relevant knowledge about the green technology landscape, and act as a gateway to a range of key stakeholders.

In light of the significant potential of climate smart approaches to address environmental challenges, in 2019, together with its partners, WIPO GREEN began rolling out an acceleration project in Latin America to explore local challenges and identify potential opportunities to apply climate-smart solutions, for example to wine production in Chile and farming and land management practices in Argentina and Brazil.

There is huge power and possibility in connecting climate change, food security and indeed, global health, from an innovation perspective and in terms of public awareness.

#### **CLIMATE CHANGE AND INTELLECTUAL PROPERTY**

Innovation has a central role to play in tackling climate change, as affirmed in the Paris Agreement on Climate Change (Article 10), which states, “[a]ccelerating, encouraging and enabling innovation is critical for an effective, long-term global response to climate change and promoting economic growth and sustainable development.”

The IP system fosters innovation, as well as the transfer and dissemination of technology – including climate-friendly technology. While IP rights provide economic incentives to develop new solutions, they can also help in diffusing innovation to the places of greatest need, through for example, licensing agreements, joint ventures and more.

If you look at the United Nations Sustainable Development Goals, more than half of them require green technology solutions if they are to be achieved. That’s exciting, but it also underlines the urgency of developing and using environmentally friendly solutions.

## **GLOBAL NETWORK FOR CLIMATE-FRIENDLY INNOVATION**

Since its launch in 2013, WIPO GREEN has established a broad network of international actors engaged in climate-change mitigation and adaptation. This cross-sectoral group of partners currently includes over 100 international organizations, IP offices, trade and business associations, multinational corporations, government and financing institutions, universities and research centers. Each partner plays a different role in line with its particular expertise. For example, “database partners” add technologies to the database. WIPO GREEN also has established partnerships around policy, research and communication, technical assistance and finance. Each type of partnership makes an important contribution to WIPO GREEN’s mission to accelerate the transition to a greener global economy.

## **ACCELERATING GREEN INNOVATION REGIONALLY**

Since 2015, WIPO GREEN has organized various regional acceleration projects to catalyze innovation and technology diffusion on the ground within a particular sector. These include a wastewater treatment project in Indonesia, Philippines, and Viet Nam; an agriculture and water management project in Ethiopia, Kenya, and Tanzania; an international event on water management in Switzerland; and a project covering energy, clean air, water and agriculture in Cambodia, Indonesia and the Philippines.

The latest project, which launched in 2019, is exploring the challenges and opportunities for climate smart agriculture in Latin America referred to above. The project focuses on three sectors: wine production in Chile; zero-till or conservation agriculture in Brazil; and intensified crop rotation, soil re-carbonization and carbon sequestration, no-till and forest management in Argentina.

Research undertaken by multiple partners, including the national IP offices of Argentina, Brazil and Chile, has identified more than 40 green technologies and needs in the three countries. In the second phase of the project, WIPO GREEN is facilitating tangible links between the producers and the seekers of green technologies in the region.

## **TANGIBLE IMPACT**

Various new collaborations between technology providers and seekers have taken place, which demonstrate the positive impact of WIPO GREEN’s acceleration projects. For example, in 2018, through Southeast Asian WIPO GREEN acceleration project, The Green School in Bali, Indonesia, connected with Zero Mass Water (USA). This resulted in a collaboration that allowed the school’s Bali campus to use Zero Mass Water’s SOURCE Hydropanel to provide its students with a regular supply of clean drinking water.

Green School’s goal is to create a sustainable educational environment. The school has incorporated various clean technologies into its daily operations, including renewable energy sources, which supplies 85 percent of the school’s power needs, a water filtration system, a waste management center, a composting station, aquaponics and biodiesel buses.

In 2018, Green School’s Innovation Hub was searching for an easy-to-maintain way to generate drinking water for the campus, especially in the dry season. In June of that

year, staff from the school attended WIPO GREEN's Green Technology Matchmaking Event – part of the Southeast Asian acceleration project – where they met Zero Mass Water whose SOURCE Hydropanel uses solar power to extract moisture from the air to produce drinking water.

As noted by Baxter Smith, Innovation Hub Project Manager at Green School, “finding the right company to collaborate with is not always easy; the area of our work, geographical and climate context of our location – all these features play a role when we take a decision on incorporating a new technology. That is why, when we learned about the WIPO GREEN matchmaking event in Manila, it seemed like a great opportunity to build some in-person connections with innovators working particularly in our region.”

Such collaborations are also possible beyond WIPO GREEN acceleration projects, through the WIPO GREEN database, where registered users from all corners of the globe can contact each other directly, and start building partnerships that will enable them to find solutions to the climate-related challenges they face.

### **THE ROAD AHEAD**

All WIPO GREEN assets – the database, network and acceleration projects – are practical tools that support our journey towards a greener future. In its first five years, WIPO GREEN has seen encouraging growth in the number of green technologies listed in its database. Moving forward, we aim to acquire a better understanding of how we can support those who seek green technologies. To this end, the WIPO GREEN team is working to expand the functionality of its database and to provide WIPO GREEN users with relevant and useful green business intelligence.

Every day, the world learns more about the urgent need to do things differently and move in the direction of a green future. Efforts are required on all levels: as individuals, as organizations and on a systemic level. For WIPO and the WIPO GREEN team, making a practical and actionable contribution to the myriad environmental challenges facing the world today is our goal and our duty. Let's join together in celebrating this year's World Intellectual Property Day – Innovate for a Green Future and support our collective journey to a low-carbon future.







Photos: Courtesy of Green School, Bali

The Green School in Bali, Indonesia, has incorporated various clean technologies into its daily operations. Through a WIPO GREEN matchmaking exercise, it connected with Zero Mass Water and is now using their SOURCE Hydropanel, (which uses solar power to extract moisture from the air), to produce drinking water for its students.



An aerial photograph of the ocean's surface, showing a dense pattern of white foam from breaking waves against a deep blue background. The perspective is from directly above, looking down at the water's texture and movement.

# Water quality and inequality

By **Philip Davies**, Professor of Water  
Technology, School of Engineering,  
University of Birmingham, United Kingdom

In terms of quality, the world's water resources are distributed inconveniently. Most water (97.5 percent) sits in the oceans, and is much too salty to drink. Good quality surface water constitutes less than one-half a percent of the world's water resources.

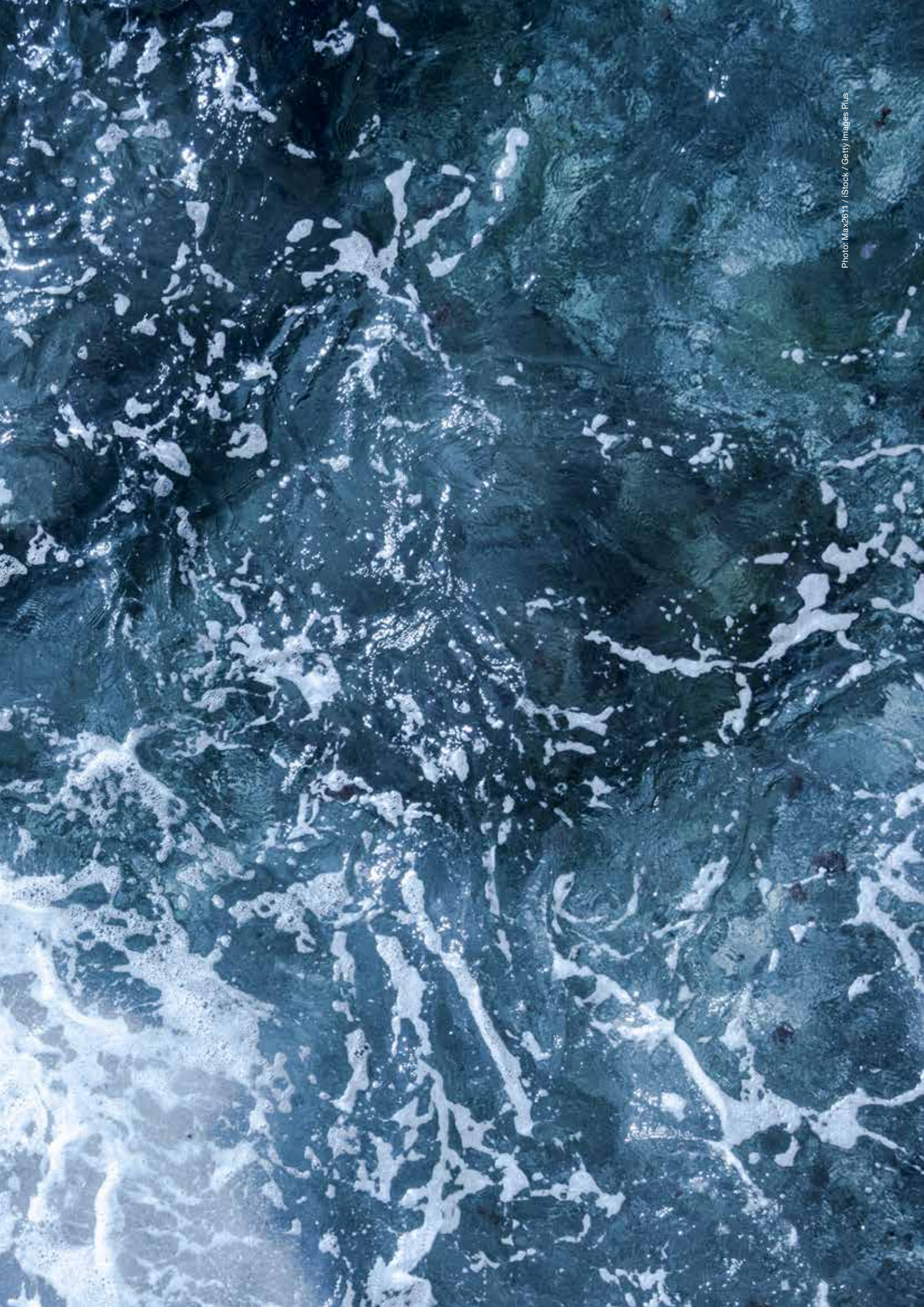


Photo: Tom Hanley / Alamy Stock Photo



Photo: PhotoStock-Israel / Alamy Stock Photo



Seawater desalination is an attractive option for increasing water supply to a large proportion of the world's water-stressed populations. Thanks to technological innovations, the capacity of desalination plants to produce freshwater has increased significantly and the energy consumption in seawater desalination over the last 20 years has almost halved, making it a lot more affordable.

About half a billion people presently suffer severe water scarcity all year round, and 1.8 to 2.9 billion people face severe scarcity for several months of the year. By 2025, half of the world's population will be living in areas experiencing water stress.

In terms of quality, the world's water resources are distributed inconveniently. Most water (97.5 percent) sits in the oceans, and is much too salty to drink. Good quality surface water constitutes less than one-half a percent of the world's water resources. Between these two extremes, there are other sources of water, such as groundwater, which, in many locations, is too saline to consume without treatment, and industrial waste streams, which may contain a broad range of natural and man-made pollutants.

Areas most vulnerable to water stress are those where demands for drinking and irrigation exceed natural replenishment from rainfall. These include desert regions (roughly between the latitudes of 15 and 45 degrees), especially in the Northern hemisphere. The countries in these regions have varying capacities to build infrastructure such as dams, pipelines and desalination plants.

Since much more water is needed for agriculture than for direct consumption, the economic capacity to import food is also an important factor. Currently, countries like Kuwait or Qatar, which have virtually no natural renewable water supply, get around this problem by desalinating water for drinking and importing food. Meanwhile countries like Somalia and Yemen, which have weak economies and challenging political landscapes, face severe water scarcity and suffer from catastrophic water shortages. In terms of forecasts, the hotspots of increasing water scarcity include Egypt, Pakistan, India and North and North West China.

### **COASTAL DESALINATION PLANTS**

Civilizations tended to evolve along coastlines. This means that seawater desalination is an attractive option for increasing water supply to a large proportion of the world's water-stressed populations. However, desalination plants are expensive to build, and until recently used up to three times more energy than traditional water treatment processes. This meant that in practice the largest users of seawater desalination were wealthy, fossil-fuel rich countries in the Gulf region.

These plants remove salt from saline water by using a process called reverse osmosis, which uses pressure to force water through a semipermeable membrane that allows water molecules and ions to pass through, but not the larger salt molecules. Thanks to innovative developments, the quality of these membranes has gradually improved, increasing the output of freshwater. As a consequence, the capacity of desalination plants has multiplied with individual plants now producing nearly 1 million cubic meters of fresh water per day.

This and other refinements in the technology used in desalination plants has almost halved the energy consumption in seawater desalination over the last 20 years, making it a lot more affordable. This trend will continue to some extent, but there is a lower limit on the amount of energy that seawater desalination consumes that cannot be improved upon – at best, the energy consumption could be halved from where it is now.

### **WHAT'S THE SOLUTION FOR INLAND POPULATIONS?**

There are many inland populations, including much of China, India and the United States, for whom transport of desalinated seawater may not be practical or affordable. People in these areas often rely on poor quality groundwater.

My own research in North Western India has made me acutely aware of this predicament. According to the Food and Agriculture Organization of the United Nations, 64 percent of agriculture relies on groundwater. Groundwater surveys show that about half the land area of India lies above aquifers that are too salty to meet normal drinking water standards.

However, this groundwater is usually quite a lot less salty than seawater, so in theory, the energy used to desalinate it could be lowered. This leaves room for inventive solutions to make groundwater desalination more affordable, and therefore more accessible to economically disadvantaged populations.

### **OUR TECHNOLOGY**

At the University of Birmingham, we have developed a technology that is targeted primarily at treating groundwater. A particular challenge when treating groundwater is disposing of the residual brine. Our technology is "high

recovery”, meaning that the maximum fraction of the groundwater gets turned into freshwater with minimum levels of residual brine. This is difficult to achieve because increasing recovery goes against lowering energy usage.

We started by modelling the energy usage of existing reverse osmosis systems, and, by designing a system that is specifically purposed to save energy. We delivered a desalination solution that can work “off-grid” and is powered by renewable energies.

The “energy budget” in reverse osmosis (RO) systems is defined by laws of thermodynamics – as the pressure in the feed water rises, the volume decreases (at a standard temperature). The critical part of the equation is the energy used to keep the salinized water under pressure. This energy has to be supplied by a high-pressure pump, which is the energy-hungry part of a desalination system. Our system only needs to use pressures slightly above those defined by thermodynamics, whereas conventional systems use several times more.

From the outset, we challenged ourselves to design a system that could be built entirely from existing components. We opted for a “sealed loop” design that recycles the saline concentrate to keep pressure to a minimum. Critically, our design uses an arrangement of valves that prevents the recycled concentrate from mixing with the feed water, which would compromise efficiency and increase the energy consumption.

This new valve arrangement also allowed us to replace the separate purge and refill stages with a single combined “purge-refill” stage that flushes the system at high speed and clears deposits away from the membrane. This single stage also minimizes downtime and increases the output of the system.

We called the system “sealed-loop RO” to distinguish it from earlier reverse osmosis systems. Compared to existing systems our approach is expected to generate energy savings of between 33 percent and 66 percent at a recovery rate of 80 percent.

But the advantages of our sealed-loop reverse osmosis system don’t stop there. The design opens the way to use low-pressure membranes, which work at lower pumping pressures. We expect these membranes will have a longer working life, which will lower maintenance costs. Its flushing operation also means the system is self-cleaning, meaning it can be operated in remote locations by non-technical staff.

#### **WHY PATENT?**

We made the system from readily available, off-the-shelf components. However, we’re open to all models of commercialization, including social enterprise, and we chose to go down the route of patenting in order to keep our options open. We are seeking to protect our technology in multiple markets through the Patent Cooperation Treaty.



A sealed-loop reverse osmosis system developed by researchers at Birmingham University in the UK is an energy-saving, “off-grid” solution, powered by renewable energies. It is ideal for use by economically disadvantaged communities.



Photo: ABHISHEK KUMAR SAH / iStock / Getty Images Plus

We have a project underway in the Jordan Valley, which is a good testing ground for our technology. The Jordan valley is a hydrological dead end so not surprisingly, salt accumulates, making the Jordan River Basin a problematic area in terms of water management for agriculture.

Groundwater depletion in this region of the world is a transnational concern. International agreements limit access to groundwater for Palestinians living in the West Bank, and poor management has led to over-pumping, with record highs of water salinity leading to changes in cropping patterns. Cash crops intolerant to salinity have been replaced by Medjool date palms, which demand large quantities of water and could cause groundwater supplies to run out within five years.

The project is a continuation of previous work with students from Arava Institute in Israel, who helped build our technology prototype. We are now returning to the region to build and test a scaled-up version of our system. The components are being acquired right now by our partners in Ramallah and construction is expected to start later this year.

# Airbus: making the blue skies green

By James Nurton, freelance writer







Photo: Courtesy of Airbus

In February 2020, Airbus revealed MAVERIC (Model Aircraft for Validation and Experimentation of Robust Innovative Controls); its “blended wing body” scale model technological demonstrator. Its disruptive design has the potential to reduce fuel consumption by up to 20 percent compared to current single-aisle aircraft.

**“Airbus is leveraging emerging technologies to pioneer the future of flight. By testing disruptive aircraft configurations, Airbus is able to evaluate their potential as viable future products.”**

Jean-Brice Dumont, Executive Vice-President of Engineering, Airbus

Airbus, the world’s biggest aircraft manufacturer, is developing a variety of initiatives to tackle climate change. The results will not just benefit the aviation industry, but other sectors too.

Tackling climate change has become a priority for the aviation industry worldwide. It is estimated that aviation currently accounts for up to 3 percent of carbon dioxide (CO<sub>2</sub>) emissions, but with air travel expected to double every 15 to 20 years, action needs to be taken now to make future air travel more environmentally friendly.

The aviation industry is complex, with many private and public sector participants, including commercial airlines, private jet operators and government agencies, as well as manufacturers and suppliers of aircraft, engines, parts and associated infrastructure.

This means that licensing and technology transfer have an important role to play in ensuring that the benefits of innovations to tackle climate change are shared across the industry. Many of these innovations have applications beyond the aviation industry and through effective use of intellectual property (IP) rights, can be licensed to other companies in completely different fields.

As the world’s biggest aircraft manufacturer, producing both civil and military aircraft worldwide, Airbus is leading the way in helping the industry develop and commercialize new technologies that support its environmental goals. As the company states on its website: “The future of flight is electric, autonomous and zero-emission. At Airbus, we believe innovation can contribute to a more sustainable world. By taking an unconventional approach to the challenges of today, we can build the sustainable aviation of tomorrow.”

The company has already contributed to progress in reducing the noise and emissions produced by recent models of aircraft. For example, the A350 XWB offers a 25 percent reduction in fuel burn and CO<sub>2</sub> emissions compared to previous generations of aircraft. Similarly, the A330neo brings a 25 percent advantage in fuel burn per seat compared to previous aircraft in the same class.

Looking ahead, Airbus is investing in research and development (R&D) in various areas such as cleaner technology (including electric power), materials and solutions. The results could be seismic for the aviation industry. At the Singapore Air Show in February 2020, the company unveiled a scale model technological demonstrator (2 meters long and 3.2-meters wide) for a curvaceous aircraft called MAVERIC (Model Aircraft for Validation and Experimentation of Robust Innovative Controls). The blended-wing design could cut carbon emissions by 20 percent compared to current single-aisle aircraft. Unveiling the MAVERIC, the company’s Executive Vice-President of Engineering Jean-Brice Dumont said: “Airbus is leveraging emerging technologies to pioneer the future of flight. By testing disruptive aircraft configurations, Airbus is able to evaluate their potential as viable future products.” He added, “We need these disruptive technologies to meet our environmental challenge. It is the next generation of aircraft; we are studying

Photo: Courtesy of Airbus



The Airbus AlbatrossOne demonstrator, inspired by the legendary albatross sea bird – which can soar kilometers without flapping its wings – is the first aircraft to trial in-flight, freely flapping wing-tips. With this it can reduce drag, combat the effects of turbulence and wind gusts and make for lighter aircraft in the future.

an option.” According to Mr. Dumont, the MAVERIC could be “instrumental in bringing about change in aircraft architectures for an environmentally sustainable future for the aviation industry.”

### MAKING AVIATION SUSTAINABLE

In line with commitments outlined in the 2015 United Nations Climate Change Conference (the Paris Agreement), the Air Transport Action Group (ATAG), an independent industry-wide body that promotes sustainable growth, has set out three environmental goals. The first is to improve global fleet fuel efficiency by 1.5 percent per year from 2009 to 2020. This goal has already been achieved with more than a 2 percent CO<sub>2</sub> reduction throughout the period. The second goal is to cap net CO<sub>2</sub> emissions starting in 2020 through carbon offset measures, and the third is to ensure that CO<sub>2</sub> emissions in 2050 are half what they were in 2005.

These goals are underpinned by five pillars of climate action: technological innovation; operational improvements; infrastructure efficiencies; sustainable aviation fuels; and market-based measures to offset growth in CO<sub>2</sub>.

IP rights have an important role to play in achieving the goals, in particular in promoting the development of new technologies to make aircraft more efficient and exploring the use of alternative fuels. As Carsten Sprenger, Senior Legal Counsel, Airbus, says:

### Did you know?

In the last 50 years, the aviation industry has:

- cut fuel burn and CO<sub>2</sub> emissions per seat/kilometer by more than 80 percent;
- reduced NO<sub>x</sub> emissions by 90 percent;
- lowered noise levels by 75 percent.

By 2036, air traffic is set to grow by 4.4 percent per year and it will be necessary to build 35,000 new aircraft to meet that rise in demand for air travel (Airbus Global Market Forecast).



Photo: Courtesy of Airbus



Airbus has been developing electric and hybrid-electric systems since 2010 and in November 2017, launched the E-Fan X, a hybrid electric demonstrator, in partnership with Rolls-Royce.

“The intellectual property system promotes innovation and the development of new technology. Firstly, by protecting the investment in green innovation, for example, through patents, which give exclusive rights to the inventor. Secondly, by enabling the dissemination of technology assets through licensing, patent publication, joint R&D and other forms of collaboration.”

“Airbus considers the existing IP system to be well prepared to incentivize green innovation. Under the existing IP system, IP strategies can be well adapted to support environmental/green objectives,” Mr. Sprenger says. He adds that IP rights are also important in making innovation available across different industries: “In particular for sustainable technology, IP rights enable the access to such technologies across different sectors and industries worldwide.”

#### AREAS OF INNOVATION

Airbus is a highly innovative company, with an annual R&D budget of some EUR 2 billion, self-financed R&D investments totaling EUR 3.4 in 2019 and more than

1,000 scientists and researchers worldwide. In total, the company holds about 37,000 patents across a wide range of technologies. “Many of Airbus’ technical developments in the field of green innovation are protected through patents,” says Mr. Sprenger.

Current areas of focus for the company include:

**Sustainable aviation fuel (SAF):** Airbus is studying how synthetic fuel using renewable energy could be a substitute for kerosene. This fuel could be made from recycled materials such as used cooking oil, agricultural residues or municipal waste and could reduce CO<sub>2</sub> emissions by 80 percent. The company has offered delivery flights powered with SAF since 2016 in Toulouse (France), Mobile (USA) and Hamburg (Germany). In September 2018, Airbus became the first industry member of the Hydrogen Council. In December 2019, it started to introduce SAF to power its industrial transportation needs.

**Electric and hybrid-electric:** Airbus has been developing these systems since 2010 and in November 2017, launched the E-Fan X, a hybrid electric demonstrator, in

partnership with Rolls-Royce. It is expected to make its first flight in 2021. Airbus has also developed two vertical take-off and landing demonstrators called Vahana, an all-electric, single-seat, tilt-wing vehicle, which has flown over 80 test flights to date, and CityAirbus, an all-electric, four-seater multicopter, which conducted its first take-off in May 2019. Autonomous flying taxis of the future perhaps? In 2018, its solar-powered high-altitude pseudo-satellite called Zephyr set the longest flight duration record of any aircraft. It promises to revolutionize defense, humanitarian and environmental missions across the globe.

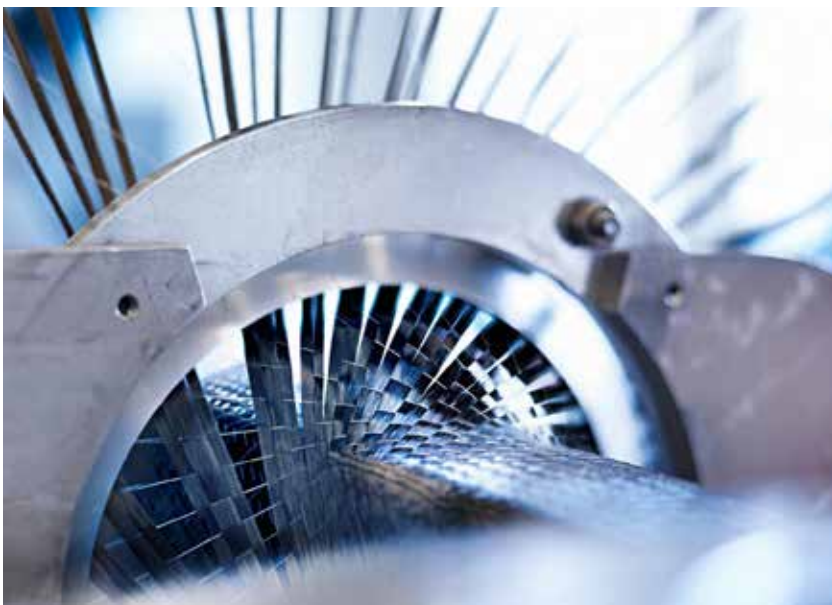
**New eco-efficient materials:** Airbus is considering a diverse range of materials, which include lightweight and functional composites, such as Carbon Fibre Reinforced Plastic (CFRP), which offers greater fatigue and corrosion resistance, and therefore longer in-life use than traditional metallic materials and has significant weight and fuel saving properties. It is also looking at bio-sourced materials such as spider silk (it's stronger than steel, tougher than Kevlar and incredibly lightweight), which promise to revolutionize aerospace design. It is also experimenting with advanced surfaces and coatings and ultra-high temperature materials and ceramics. These new surfaces and materials, such as tungsten carbide coating and new metal alloys, can be used on key aircraft parts such as compression flap pads and turbine blades to provide greater efficiency and replace environmentally damaging materials.

#### WORKING WITH PARTNERS

As well as its considerable internal R&D, Airbus works with various organizations by forming research and technology partnerships, which it sees as a way to accelerate and disseminate innovation. Examples of such partnerships include:

**The Clean Sky Program**, a European initiative to drive aeronautical research and innovation to make air transport more eco-efficient, as well as to strengthen

Photo: Courtesy of Airbus



Airbus is considering a range of new composite materials, such as CFRP (carbon-fiber reinforced plastic), which is lighter than aluminum, stronger than iron and more corrosion-resistant than both. Here an aircraft component is fed through a high-tech loom that braids the carbon fiber into place.

the competitiveness of Europe's aerospace industry. The program seeks to promote the development of technologies to reduce noise, lower CO<sub>2</sub> and cut gas emissions. Airbus, a major player in the program, is leading the development of a number of cutting-edge technologies to meet established environmental targets. These include:

**UltraFan**, a collaboration with Rolls-Royce. UltraFan offers a 25 percent improvement in fuel efficiency over the first generation of Rolls-Royce's Trent engine. Airbus and Rolls-Royce are working to integrate the UltraFan demonstrator for flight-testing (a project co-funded by Clean Sky), with a view to integrating the engine into future aircraft.

**BLADE** (Breakthrough Laminar Aircraft Demonstrator in Europe). Airbus heads a team of more than 20 partners on this project. BLADE modifies the shape, materials and surface of wings to transform commercial aviation by reducing drag by up to 50 percent. The project is also part of the Clean Sky program.

**Wing of Tomorrow**: Airbus' largest research program worldwide is the product of an industry-wide partnership aimed at creating a revolutionary new structural and systems architecture for carbon wings. The project seeks to imitate the flight technique of the legendary albatross sea bird – unlike any other bird, it can soar hundreds of kilometers without flapping its wings – to design lighter and more fuel-efficient aircraft.

**MOZAIC**: Airbus also takes part in the Measurement of Ozone by Airbus in-service Aircraft (MOZAIC) alongside six airlines (Lufthansa, China Airlines, Air France, Iberia, Cathay Pacific and Air Namibia) by equipping seven wide-body aircraft with measurement devices to capture data such as concentrations in ozone, water vapor and carbon monoxide.

In working with partners, Airbus can make use of its patents and other IP rights, says Carsten Sprenger: "In the field of electric propulsion, Airbus is using IP rights in its transactions with R&D partners to create complementary fields of use, such as giving rights of use to Airbus for air transport and to the partner for ground transport. This supports the considerable investment some of these technologies require and fosters a broad dissemination of the results."

Moreover, he adds, IP rights can also be licensed to other industries to ensure that the potential of the innovation is fully exploited: "We have used licensing agreements to make available technology that was originally developed at Airbus for aerospace applications to green industries like the wind energy sector."

## **EVOLVING IP STRATEGY**

The various means of using IP rights means there is no simple answer to the question of what benefits they bring, says Mr. Springer: "There are literally hundreds of contextual use-cases [that demonstrate] how a company can use IP rights. The benefits depend always on the objectives of the IP rights owner." He adds: "In the context of innovation for a green future, we expect that global warming and environmental issues might provoke the development of IP strategies adapted to support the technological, environmental and political aims of actors in the green technology space."

# Bio-engineering: unlocking nature's treasures

By **Catherine Jewell**, Publications Division, WIPO

Photo: Courtesy of Oded Shoseyov



Pioneering materials engineer, Professor Oded Shoseyov holds 62 patents and is the scientific founder of 14 companies, "I believe universities have a responsibility that goes beyond teaching and educating engineers and scientists. With our scientific discoveries we have an opportunity to affect the lives of so many people," he says.

For Oded Shoseyov, a pioneering materials engineer, serial inventor and entrepreneur, nature is a source of inspiration. For the past 30 years, he has been unlocking nature's secrets to come up with exciting new plant-based materials that offer significant advantages over petroleum-based synthetic materials, particularly in terms of their sustainability. Professor Shoseyov discusses some of his most significant inventions and highlights the importance of intellectual property (IP) rights in ensuring that their benefits are widely accessible to society.

### ***How did you get into plant nanotech?***

I was born into farming and have always been interested in agriculture. My family has been managing vineyards for more than 130 years. I started out studying chemistry and then moved into agriculture and the bio-engineering of proteins. In 1990, I joined the Faculty of Agriculture at Hebrew University as Professor of Plant Molecular Biology, where I now run a relatively big laboratory with many students working on protein engineering and nano-biotechnology.

Plants have always been my focus, but my research also extends to industrial and medical areas. For example, for many years now, I have been developing ways to use genes sourced from humans to produce human collagen in plants. I don't confine my work to plants but always find myself going back to them to produce proteins, or make composites with plant-derived materials. Plants are very efficient; they produce everything for us including oxygen and are very resourceful.

***As a serial inventor, with 62 patents to your name, how did you first encounter patents?***

It's a long story and it didn't come naturally. As a young scientist, when I started out my primary focus was to publish scientific papers and secure my tenure. But shortly after joining the Hebrew University of Jerusalem, over a serendipitous lunch with the co-founder of a company I was consulting for, I found myself deferring publication of my scientific paper until a patent application covering my research findings had been filed. I was also offered a handsome research grant to find an application for my research and a promise from the co-founder that if I found a useful application, he would establish a company and give me 4 percent equity in it and a fair share of licensing royalties. Needless to say, I did find a useful application for the research, which led to us setting up Futuragene, which was later acquired by Suzano, one of Brazil's largest paper companies, for USD 100 million. It was a great success, but it made me realize that I could do more with my research; it didn't need to end in a scientific paper. That was my first exposure to patents and their importance in driving economies.

***What was the application you found?***

This particular application made it possible to accelerate the growth of eucalyptus plants for the pulp and paper industry. These were the first commercially available transgenic forestry plants to gain regulatory approval in Brazil. Since then, I have established a number of companies, including, Melodea, and Collplant (see box). While I am not involved in their day-to-day management, I still play a role in them, either as a consultant, a board member or chief scientist.

***Is there a common thread to your inventions?***

Yes. They all relate to materials science and biomaterials in particular. Biomaterials are far superior to synthetic materials. As the former minister of oil of Saudi Arabia once said, the Stone Age did not end for lack of stone; similarly, the Oil Age is going to end long before we run out of oil. And I would add that there is a good reason for this, namely that biomaterials are much better. We simply need to look and learn how natural systems function and we have to innovate!

## More about Oded Shoseyov

Professor Shoseyov has authored or co-authored more than 200 scientific publications and holds 62 patents.

He is the scientific founder of 14 companies. Among them are:

- **Futuragene Limited**, which develops transgenic eucalyptus trees for the pulp and paper industry.
- **Collplant Limited**, which produces human recombinant Type I collagen in transgenic plants for medical implants used in tissue engineering and regenerative medicine.
- **Biobetter Limited**, which produces therapeutic antibodies in tobacco plants.
- **GemmaCert Limited**, which offers a smart solution to assure the standardization of medical cannabis products.
- **SP-Nano materials Limited**, which manufactures protein-based nano-coating solutions for the composite industry.
- **Melodea Limited**, which develops and manufactures CNC from paper sludge for structural foam, composites and adhesives.
- **Valentis Nanotech Limited**, which develops and manufactures nano-bio-based transparent film for food packaging and agriculture.
- **Paulee CleanTec Limited**, which aims to be the world leader in the collection and disposal of pet waste with its AshPooPie device, and to turn human waste into odorless, sterile organic fertilizer via its daughter company Epic-Cleantech.
- **Smart Resilin Limited**, which is developing ways to isolate resilin to allow manufacturers to incorporate it into their products to achieve better fatigue resistance and more elastic properties. Sensogenic Limited, which develops a food allergy diagnostic device.
- **Karme Yosef Winery**, established in 1999 by Professor Ami Bravdo, a leading scientist of modern viticulture, and Oded Shoseyov, his former student.





Photo: StockRocket / iStock / Getty Images Plus

**“If you want to have a new idea, open an old book! That book was written over 3 billion years of evolution, and the text is the DNA of all living organisms. All we need is to read that DNA code and start our progress from there.”**

Images: Courtesy of Oded Shoseyov



## Large scale human collagen produced in tobacco plants

For the past 30 years, Professor Shoseyov has been unlocking nature's secrets to come up with exciting new plant-based materials that offer significant advantages over petroleum-based synthetic materials, particularly in terms of their sustainability. For example, by genetically modifying tobacco plants, he has found a way to produce plant-based collagen.



## Converting an environmental problem into a goldmine

Electron microscope image of CNC

Melodea and its partners are addressing a major environmental headache, by transforming the millions of tonnes of sludge produced by the paper industry each year into eco-friendly packaging for non-consumable products.

Nature has had billions of years of evolution to develop functional materials that are sustainable. In 200 years of modern chemistry, scientists have not been able to do so. That's why we are seeing new islands of plastic in the oceans. So, we need to do something different, but we don't need to reinvent the wheel. I always say, if you want to have a new idea, open an old book! That book was written over 3 billion years of evolution, and the text is the DNA of all living organisms. All we need is to read that DNA code and start our progress from there.

***What is so appealing about working with bio-materials?***

The strength and functionality of biomaterials comes from the fact that they are self-assembled; they are built from the bottom up. The synthetic implants that orthopedic surgeons screw into our bodies often fail because their mechanical properties don't fit with the surrounding tissues. Why? Because they are not self-assembled. Nobody takes my head and screws it onto my neck or takes my skin and glues it to my body. In nature, every living organism is made from cells that self-assemble to create tissues and organs. That's life. And that's the right way to build things.

***Tell us more about CNC (cellulose nano crystals) and its applications.***

CNC is great. It derives from cellulose fibers, nature's most abundant material. It's renewable and it's made of sugar, but on a weight basis, CNC is nearly 10 times stronger than steel, which makes for many exciting applications. When you mix CNC with water at a 3 percent concentration, it transforms into liquid crystals, and when you apply that solution to any surface – paper, plastic, concrete – as the water evaporates, the crystals self-assemble to form a very strong and transparent film. It also creates a barrier to oil and oxygen. That makes it a great packaging solution. In the past, standard juice cartons were made of a laminate of a polymer (e.g. polyethylene or PET), aluminum and cardboard. While it's a very good packaging solution, it's non-recyclable.

One of my companies, Melodea, has found a better and cheaper alternative using 100 percent recyclable cellulose. Melodea was established around a patented technology developed in my research lab. It develops and manufactures CNC and works with customers to develop various applications. This is important because they (the customers) have a better understanding of the need and have channels to the market. For example, it is working with Sweden's Holmen AB, and Brazil's Klabin SA, to produce CNC-based bio-packaging on an industrial scale.

In fact, Melodea and its partners are also addressing a major environmental headache, namely the millions of sludge produced every year by the paper industry. Europe alone produces 11 million tonnes of it annually. For Melodea and partners, however, it's a valuable raw material, which is transformed into eco-friendly packaging for non-consumable products. When it comes to food packaging, however, for safety reasons, we use virgin pulp.

## Awards

Professor Shoseyov has received the:

- Outstanding Scientist Polak Award for 2002;
- The Kay Award for Innovative and Applied Research in 1999 and 2010;
- The Israel Prime Minister Citation for Entrepreneurship and Innovation in 2012; and
- The Presidential Award for his contribution to the Economy and Society of Israel in 2018.

Professor Shoseyov and his team are working on resilin, a protein found in arthropods (insects, like dragon flies that fly short distances), which he calls the “best rubber in the world.” In future, he wants to use it to make eco-friendly tires.

Photo: coopder1 / iStockphoto; enot-poloskun / iStockphoto



CNC can also be used to strengthen textiles. If you take cotton yarn, and coat it with a thin layer of CNC, just 1 percent is added to its weight, but its toughness increases 500 percent. Similarly, coating glass with CNC makes it tougher, providing a useful option for glass construction and aviation where there is a need for lightweight but durable windshields, etc.

### *What other secrets has nature revealed to you?*

We have also been working on resilin, the protein that allows cat fleas to jump 200 times their height! It's the best rubber on earth! You find it in arthropods; insects, like dragon flies that fly short distances. We're working with different partners to develop a sports shoe with a resilin mid-sole and flexible electronics, like touchscreens. For these purposes, we can produce it cost-effectively by embedding the resilin gene into bacteria (E.coli) and fermenting it. In future, we want to use it to make eco-friendly tires, but for such large-scale production, we will need to produce it in plants and at high yields to bring costs down. We're working on it, and in time it will happen.

### *How did your work on plant-based collagen come about?*

Products to rejuvenate skin (using dermal fillers, for example) have become increasingly popular. Personal care companies were looking for a safer, cheaper and more effective alternative to mammalian collagen and to hyaluronic acid, so I started looking into whether collagen could be made in plants. It was a complex challenge because it involved taking five human genes to make a single functional protein. I wrote a short paper on how to do it and eventually, with the backing of a technology incubator, I did a proof of concept and set up a company. That's how Collplant started.

### *So how do you produce plant-based collagen?*

We genetically engineered tobacco plants (because they're not in the food chain), which now contain the five human genes needed to produce collagen. We propagate the plants from seed in the 25,000 square meters of greenhouses we have across Israel – and distribute the plantlets to farmers to grow. When harvested, the leaves are transported in cooling trucks to Collplant's factory, where they are crushed to extract the juice and concentrate the collagen, which we then purify in clean rooms and make different medical implants. We recently

completed clinical trials and secured regulatory approval in the European Union and Israel for an injectable product to treat diabetic foot ulcers and tendonitis.

We have also developed a plant-based collagen bio-ink for 3D printing of tissues and organs. It's still at the pre-clinical stage but we have an exciting project underway with two companies in the United States, namely, United Therapeutics and 3D Systems, to 3D-print human lungs. You will see that around 2024.

***How are IP rights important to your companies?***

As a business asset, IP rights are as important as your staff. With IP rights, it is possible to work with partners like United Therapeutics and 3D Systems and achieve remarkable things. Without IP rights and the protection they offer, my companies would be vulnerable and it would be practically impossible to attract investors. Like regulations, IP rights are essential tools. Without them, we risk losing our ability to maintain healthy societies on this planet.

***Why was it important for you to commercialize your research?***

I believe universities have a responsibility that goes beyond teaching and educating engineers and scientists. With our scientific discoveries we have an opportunity to affect the lives of so many people. Commercialization and IP protection are the only way to assure these discoveries are realized.

***What is your next project?***

I have several projects brewing in my lab at Hebrew University focused mainly on improving plant systems to produce animal proteins for the food and the pharma industries. We are also developing novel bio-based composite materials with superior mechanical properties as well as novel 3D printing technologies.

***Who is your greatest inspiration and why?***

Leonardo de Vinci by far. He was the ultimate multidisciplinary scientist and inventor.

***What advice do you have for young aspiring researchers/entrepreneurs?***

Stay away from people who say no. Always look for the highest targets and collaborate with smart people.

**“As a business asset, IP rights are as important as your staff. With IP rights, it is possible to work with partners ... and achieve remarkable things. Without IP rights and the protection they offer [...] it would be practically impossible to attract investors.**

# Climate action and sustainability: Indigenous peoples are part of the solution

By **Oluwatobiloba Moody**,  
WIPO Nigeria Office

*“Indigenous people must be part of the solution to climate change [...]. The important value of [traditional] knowledge simply cannot—and must not—be understated. [Indigenous people] are also essential in finding solutions today and in the future...”*  
(Patricia Espinosa, Executive Secretary of the UNFCCC)

The world’s climate is in turmoil. Extensive bushfires in Australia causing massive destruction to lives (both animal and human), property and the environment have attracted global media attention for months. In the Arctic, there are haunting images of polar bears starving as their natural habitats disappear due to rising waters and melting ice caps, and in Kenya, changing patterns of ocean circulation have created conditions for locusts to ravage pastures. These extreme events point to a stark reality: our climate is changing because of our actions, with serious implications for humanity, ecosystems and global biodiversity.

## **A KEY CHALLENGE OF OUR TIME**

Between 1998 and 2017, climate-related disasters claimed an estimated 1.3 million lives, causing direct economic losses of around USD 3 trillion. The United Nations Development Program (UNDP) estimates that by 2050 global temperature extremes will breach today’s levels by 2°C with temperatures over the Arctic Ocean rising by 3 to 5°C. At current trends, temperatures in tropical West African and the Sahel are expected to rise by 4 to 6°C by the end of the century. Among other effects, increasing temperatures will cause fluctuations in rainfall with consequences for global food security, health, water resources and biodiversity. We cannot ignore climate change. It is threatening the sustainability of our environment, the irreplaceable haven where humanity can thrive.

## **THE BRUNDTLAND COMMISSION**

More than three decades ago, the Brundtland Commission coined the term “sustainable development,” which it defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. In its 1987 report, “Our Common Future,” the Commission explored in detail, the relationship between human development and the environment, noting the inseparable nature of “the environment” (where we live) and “development” (what we do to improve our lot



Photo: parkerphotography / Alamy Stock Photo

Engaging with Indigenous peoples to benefit from their knowledge, while respecting their world view and ensuring the sustainability of their way of life, must remain central to global responses to climate change.

within that abode). It also noted the unsustainable nature of many of the development paths of industrialized countries whose decisions, given their political and economic power, would “have a profound effect upon the ability of all peoples to sustain human progress for generations to come.”

The Brundtland Commission similarly warned that, if unchecked, the emissions arising from human development – in particular, industrialization, and rising fossil-fuel usage – would over time provoke higher median global temperatures, altered weather conditions and irreversible consequences for our future.

### **ENGAGING INDIGENOUS COMMUNITIES: A MUST**

As the global community focuses on ways to combat the effects of climate change and to transition to a low-carbon future, the impact on Indigenous peoples must not be overlooked for at least three reasons.

First, Indigenous peoples are dependent on local biodiversity and ecosystem services for their sustenance and well-being. This means these communities are more vulnerable than most to the impacts of climate change. For example, Arctic Indigenous peoples are in the frontline of increased food insecurity arising from thawing permafrost.

Photo: Jennifer Watson / iStock / Getty Images Plus



Recent extreme environmental events point to a stark reality: our climate is changing because of our actions, with serious implications for humanity, ecosystems and global biodiversity.

Photo: UN Photo/Eskinder Debe



Indigenous peoples are dependent on local biodiversity and ecosystem services for their sustenance and well-being. This means these communities are more vulnerable than most to the impacts of climate change. They possess a wealth of environmental knowledge, which can be critical in effectively adapting to climate change.



Photo: UN Photo/Steve Winter



The International Labor Organization (ILO) suggests six “unique risks” that unite the experiences of Indigenous groups in the context of climate change. They are poor; they depend on renewable natural resources; these natural resources are vulnerable to climate change; Indigenous communities have high migration rates due to climate change; they are characterized by gender inequality; and they are often excluded from decision-making on issues relating to their rights. These factors limit their ability to access remedies, which increases their vulnerability and undermines their ability to mitigate or adapt to climate change. They also threaten their ability to uphold and secure their rights.

Second, Indigenous peoples possess a wealth of environmental knowledge, which can be critical in effectively adapting to climate change. As Terry Williams and Preston Hardison note in *Culture, Law, Risk and Governance: Contexts of Traditional Knowledge in Climate Change Adaptation*, Indigenous peoples possess considerable knowledge on issues related to climate change adaptation. Their knowledge is valuable, among other reasons, for helping with the reconstruction of historical baselines, ensuring culturally appropriate adaptation, and facilitating coping mechanisms for climate change, all of which continue to support Indigenous peoples’ survival in harsh conditions.

In Australia, for example, Emeritus Professor Bill Gammage discusses a 50,000-year-old Aboriginal fire prevention practice whereby small fires are used to clear the land of debris, scrub, undergrowth and certain grasses to prevent large-scale bushfires. Such practice lessens the impact of bushfires on insects and animals and protects trees and forest canopies. Getting this environmental management art right, however, requires “a lot of local skill.”

Such local skill, or traditional knowledge, refers to the know-how and learnings of Indigenous peoples developed and handed down across generations. UNESCO notes that such knowledge operates at a finer spatial and temporal scale than science and includes understandings of how to cope with and adapt to environmental variability and trends. Traditional knowledge extends to all areas of human activity and its role in predicting and adapting to climate changes and mitigating its inevitable consequences is now increasingly recognized. For example, in North Eastern Ethiopia, the Afar pastoralists use livestock, insects, birds, trees and other wildlife to predict weather and climate patterns. Similarly, the Sapara Nation in the Ecuadorian Amazon use their local insights and perceptions of environmental change and their customary institutions to improve agricultural and natural resource management practices. These are just two instances in which traditional knowledge is helping Indigenous peoples’ adaptation, sustainability and resilience.

Third, and in light of the above, is the right for Indigenous peoples to be involved in making decisions on issues that affect them and their right to be consulted about how their knowledge is used. Traditional knowledge provides Indigenous peoples with tools to manage their natural resources, but it is also a way of life and a distinctive way of seeing the world. Where policies are being elaborated on issues that affect Indigenous peoples and their long-standing relationship with their lands and resources, they have a right to participate in such consultations. They also have a right to be consulted and to share in any benefits deriving from the use of their knowledge and resources in line with relevant domestic and international standards. Engaging with Indigenous peoples to benefit from their knowledge, while respecting their world view and ensuring the sustainability of their way of life, must remain central to global responses to climate change.

## **PATHWAYS FOR ENGAGEMENT**

Various international agreements provide for engaging with Indigenous peoples over the use of their knowledge and practices and/or when issues affecting them are in focus. Fundamentally, the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) creates a minimum standard of rights guaranteeing respect, recognition and equity in terms of engaging with Indigenous peoples. The Paris Agreement on Climate Change requires that actions taken to address climate change must respect, promote and consider the respective obligations on the rights of Indigenous peoples and local communities. The Local Communities and Indigenous Peoples Platform established by the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) recognizes the need to incorporate solutions from Indigenous communities into conversations on climate change. However, ensuring the integration of these ideas into mainstream policymaking requires further work. The Convention on Biological Diversity (CBD) and its Nagoya Protocol also recognize the importance of obtaining the prior informed consent of Indigenous peoples and of establishing mutually agreed terms for benefit sharing with respect to the utilization Indigenous peoples' traditional knowledge. On-going negotiations within the Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore (IGC) at WIPO also have the potential to add to the range of rights available to Indigenous peoples when seeking to protect or defend their interests in instances where their knowledge is sought and/or used to develop climate-relevant technological products and processes.

## **INTEGRATING TRADITIONAL KNOWLEDGE INTO CLIMATE ACTION: CHALLENGES**

According to Kanyinke Sena, a former chairperson of the United Nations Permanent Forum on Indigenous Issues, several challenges exist in integrating traditional knowledge into climate change actions, particularly in African countries. These include the absence of enabling legal frameworks, disinterest of key decision makers and sectors, lack of documentation about relevant traditional knowledge and a shortage of the necessary expertise and resources. Documentation of climate-related traditional knowledge, in particular, has received much attention as an important way forward. Yet, it raises a number of intellectual property (IP) issues and must be approached with care. It is therefore a welcome development to see WIPO working closely with the UNFCCC as IP advisor to its Local Communities and Indigenous Peoples' Platform. WIPO's capacity building toolkit for documenting traditional knowledge also provides helpful guidance to Indigenous communities and/or stakeholders when considering documentation options.

Building the capacity of Indigenous peoples to engage in complex international negotiations, including in relation to IP, must be a priority. This will help identify gaps in the documentation of traditional knowledge as well as opportunities in policy and legal frameworks to establish partnerships with the scientific community that will enhance the contributions of traditional knowledge to climate action and the Sustainable Development Goals (SDGs). Such capacity building will also create opportunities for information exchange, and will strengthen the ability of Indigenous peoples to engage with local authorities in designing and implementing mutually beneficial climate mitigation efforts.

## **CHANGING ATTITUDES: GREEN SOLUTIONS COME INTO FOCUS**

Broader recognition of the scale of the climate crisis is fueling the search for green solutions. In broad terms, the concept of "greening" represents a global attitudinal shift towards environmental consciousness in human activity, and in the design and implementation of development policies and frameworks. The international agreements referred to above acknowledge the



Photo: WIPO / E. Berrod

Building the capacity of Indigenous peoples to engage in complex international negotiations, including in relation to IP, and to make effective use of IP rights, must be a priority. Participants (above) in a WIPO workshop on IP for women entrepreneurs from Indigenous Peoples and Local Communities.

important contribution that Indigenous peoples and their environmental management principles can offer in terms of the sustainable management and use of biodiversity. Indigenous lands cover 22 percent of the world's land and around 80 percent of the planet's biodiversity. They also lie adjacent to 85 percent of the world's protected areas. As such, and thanks in large part to traditional approaches to natural resource management, these lands are a sink for hundreds of gigatons of carbon.

Various institutional approaches, which reflect a growing global commitment to finding environmental solutions, are also emerging. Examples include WIPO GREEN, an online platform for the exchange of green technologies (see page 17), The Green Initiative (ILO), and the Green Growth Framework (African Development Bank). Such approaches must also prioritize active engagement with Indigenous peoples to ensure the sustainability of their livelihoods and experiences.

The 2030 Sustainable Development Agenda, identifies as a priority the need to “[s]trengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries” (SDG 13.1). As such, active engagement with Indigenous peoples is essential. Not least, because it will help ensure that the design and implementation of well-intentioned “green projects” do not have a negative impact on the resources, livelihoods and cultures of Indigenous communities. Failure to mainstream traditional knowledge into the design and implementation of climate-change-mitigation strategies risks undermining the livelihoods and resilience of Indigenous peoples and weakening customary rights to their lands and natural resources. It would also represent a lost opportunity to complement scientific data with invaluable insights about Indigenous adaptation and mitigation practices.

# Patenting trends in renewable energy

By James Nurton, freelance writer

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





Photo: alexsi / iStock / Getty Images Plus

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

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

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

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

#### **THE BIG PICTURE**

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

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

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

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

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

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

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

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

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

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

## OVERALL TRENDS

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

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

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

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

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

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

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

Figure 1

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

Source: Economics and Statistics Division, WIPO.

## TECHNOLOGY BREAKDOWN

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

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

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



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

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

Figure 2

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

Source: Economics and Statistics Division, WIPO.

## REGIONAL BREAKDOWN

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

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

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

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

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

Figure 3

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

Source: Economics and Statistics Division, WIPO.

## IMPROVING TECHNOLOGIES

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

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

Following a strategic review, from 2020,  
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34, chemin des Colombettes  
P.O. Box 18  
CH-1211 Geneva 20  
Switzerland

Tel: +41 22 338 91 11  
Fax: +41 22 733 54 28

For contact details of WIPO's External Offices  
visit: [www.wipo.int/about-wipo/en/offices](http://www.wipo.int/about-wipo/en/offices)

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