CLEANTECH WAY

The technologies that
will take us to net zero

A BBVA project in collaboration with *Ethic*

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SOLVING THE DECARBONIZATION PUZZLE

Javier Rodríguez Soler
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Nearly a decade has passed since the signing of the historic Paris Agreement; a binding treaty that brought 195 countries together with a common goal: to slow the progression of climate change. The signatories committed to take the necessary steps to keep the Earth's global temperature below 1.5˚C compared to pre-industrial levels. To this end, cutting CO_2 emissions by approximately 45% from 2019 emission levels by 2030 was considered necessary as a preliminary step toward reaching net zero by 2050. One of the most significant challenges humanity has ever faced.

Aware of the consequences of inaction, 21st Century societies have accelerated the transition in recent decades, primarily through the rapid expansion of renewable energy. While it is true that a substantial number of green technologies have been established, reducing emissions in various sectors, considering that time is against us, is not sufficient. Developing and consolidating emerging clean technologies (cleantech) that can expedite emission reduction is essential to solving the decarbonization puzzle.

The good news is that this is an unstoppable transformation. Although we are entering a period marked globally by an increasing fragmentation and uncertainty, the clean technology revolution is going to be a great opportunity and a key leverage for the competitiveness of companies. Investment in both innovation and the massive deployment of cleantech will have an increasingly economic meaning. In the case of Spain and Europe, and in order to accelerate this opportunity for companies, it is essential to promote an investment-friendly environment marked by a radical simplification and an acceleration of bureaucracy, the promotion of public-private mechanisms for mitigating investment risks, and foreseeable industrial policies with clear demand signals.

In this publication, we aim to put the spotlight on some of these emerging technologies. While some may be somewhat unknown, they will be vital in the path to net zero. We are focusing on leading clean technologies that can be classified into four progressive categories: **electrification, green molecule development, circularity and carbon capture and storage.**

All of these technological innovations also represent attractive economic opportunities. According to the *International Energy Agency's Energy Technology Perspectives* report (2023), the clean technologies market could triple in the transition toward a low-carbon economy, reaching $650 billion annually by 2030.

Due to the cross-cutting nature of various sectors and the global reach of cleantech, investment in this field will be one of the most significant in decades. There is no doubt that the opportunities that arise from the challenges of the decarbonization age come with a wave of optimism that gives the momentum needed to reach the net zero goal successfully.

1. ELECTRIFICATION

The primary goal is to electrify everything possible. Achieving this goal entails innovating in energy generation and storage technologies that increase renewable energy to the fullest extent possible.

2. GREEN MOLECULE DEVELOPMENT

When electrification is not an option, the alternative is to produce clean fuels, such as hydrogen, biofuels and synthetic fuels.

3. CIRCULARITY

Efficient use of resources is the key to reducing greenhouse gas emissions through value chains that enable their reuse.

4. CARBON CAPTURE AND STORAGE

If none of the previous are possible, then greenhouse gases must be captured and stored to reach net zero.

THE GREEN TRANSITION RUNS ON BATTERIES

By Inma Mora Sánchez

The expansion of renewable energy has made it increasingly less surprising to encounter a field of solar panels or find windmills among the mountains. The biggest challenge currently facing fossil fuel-free electrical systems is developing large-scale storage infrastructure so that renewable plants do not depend on the weather's arbitrary behavior.

ERIC TRUSIEWICZ (RONDO ENERGY): "THE STORED ENERGY CAN BE DISPATCHED AS HEAT, ELECTRICITY, OR IN A COMBINED HEAT AND POWER CONFIGURATION TO SERVE A WIDE VARIETY OF INDUSTRIES AND APPLICATIONS"

Although it may not be in the media spotlight, battery capacity to store and manage energy efficiently is critical to transitioning toward electrical systems based on renewable energy, reducing greenhouse gas emissions, and creating new economic opportunities. According to **the World Economic Forum and the Global Battery Alliance (GBA),** by 2030, batteries could account for 30% of the carbon emission reductions required in the transport and energy sectors, provide 600 million people access to electricity, and create 10 million safe, sustainable jobs worldwide.

The expansion of renewable energy has accelerated in recent years. Nevertheless, this net zero emission future must overcome an inevitable challenge: large-scale storage infrastructure must be fully developed to power a decarbonized energy system. While automotive batteries are more established, battery energy storage systems (BESS) remain in the expansion phase on an industrial level.

These systems are designed to store the energy produced by renewable sources, such as solar plants or wind farms. The energy is collected during periods of low demand but high generation —in other words, when the wind and sun allow for more energy production than needed at the time. This energy is released during peak consumption or when weather conditions make energy production more difficult. Therefore, when we refer to BESS, we are referring not only to batteries such as those in a cell phone but also to a system capable of guaranteeing a renewable energy supply and providing operational continuity to the electrical system.

Batteries to electrify (and decarbonize) industry

Batteries will play a key role in meeting the commitments made by nearly 200 countries at COP28, which include a six-fold increase in global renewable energy capacity to 1.5 TW from 2024 to 2030. According to the International Energy Agency report Batteries and Secure Energy Transitions, lithium-ion battery capacity has increased by over 2,000 GWh worldwide, powering 40 million electric vehicles and thousands of battery storage projects. Although electric vehicles represent over 90% of battery use, more and more businesses are developing large-scale battery solutions for use in industrial and energy sectors.

Storage technologies are critical to achieving decarbonization targets for industrial systems that require heat —from metalworking to food industries. According to **Eric Trusiewicz, CEO of Rondo Energy,** "industrial heat accounts for 25% of global greenhouse gas emissions." In other words, preventing these emissions "would double the impact of electrifying all cars, motorcycles, buses, and taxis." Specialized in thermal batteries, also known as Electric Thermal Energy Storage (ETES), Rondo manufactures its systems with durable materials that can be used in the industrial facilities of multiple sectors, such as the food, paper or textile industries, among others. "We decarbonize those sectors by directly replacing the fossil fuels used in boilers with heat generated from intermittent renewable electricity sources," Trusiewicz explained.

But exactly how do these batteries work? "The simplest way to think of the Rondo Heat Battery is as a giant toaster oven with hundreds of bricks stacked like legos inside. We heat the bricks up to over 1,000 °C to generate continuous hot air or steam for industrial processes or power generation. Each brick in a Rondo Heat Battery stores more energy than a Tesla Model X when hot —without requiring hard-to-source critical minerals and with a much longer operational lifespan. Lithium-ion batteries chemically store electricity, which is not suitable for industry's demand for heat, and require expensive critical minerals. The Rondo Heat Battery stores electricity as high-temperature heat in low-cost bricks, which can be flexibly dispatched as heat, electricity or in a combined heat and power configuration to serve a wide variety of industries and applications," Trusiewicz described.

At the Breakthrough Energy Summit —a global conference that aims to accelerate innovation in clean technologies— a €75 million public-private partnership was announced between the **European Investment Bank and Breakthrough Energy Catalyst**. This investment will go to three pioneering projects Rondo will carry out to contribute to European industrial decarbonization.

Inga Petersen (GBA): "Seeing the engagement by battery manufacturers gives us great confidence in the potential for international collaboration"

The first project will take place at the Covestro plant in Germany, where Rondo batteries will generate steam by replacing fossil fuel heat sources with renewable energy to produce chemical products. The second project will take place at a green industrial park in Denmark. One of its most significant aspects is that the park will have one single energy infrastructure. As Trusiewicz explained, "Rondo will supply Greenlab a 100 MWh heat battery that will draw power from an 84 MW hybrid wind and solar park." Finally, Rondo will implement a third project to generate steam using solar power for a European food and beverage manufacturer. Although further details on the project are not yet available, Rondo assures that it will lead to significant decarbonization for the company. In short, these pioneering projects are expected to reduce one million metric tons of CO_2 emissions by 2050. "It's just the start for us and we plan on expanding these three projects across Europe more broadly," Trusiewicz added.

International cooperation to overcome global challenges

International cooperation plays a critical role in accelerating the transition toward a sustainable energy future. The GBA, founded in 2017 by the World Economic Forum, has become vital in this context. This association is leading the development of grid storage batteries, bringing together governments, businesses, non-profit organizations, and other actors to promote sustainable battery production and management.

Its flagship project, known as the Battery Passport, was presented at the annual meeting of the World Economic Forum in January 2023. Both manufacturers and solution suppliers participated in this project, such as Audi, BASF, CATL, Eurasian Resources Group, Glencore, LG Energy Solution, Umicore, Tesla, Volkswagen AG, IndustriALL Global Union, Pact and Transport & Environment, as well as international organizations like the United Nations Environment Programme (UNEP) and the United Nations International Children's Emergency Fund (UNICEF).

Inga Petersen, Executive Director of the GBA, explained: "The recent launch of our pilots, which engaged leading battery cell manufacturers (a battery cell is the main unit of a battery) including CATL, LG Energy Solution, Samsung SDI and others, together representing 80% global EV battery market share in 10 piloting consortia, has afforded us invaluable insights and learnings, which we will actively apply in the next phases." For the first time, cell manufacturers reported against harmonized sustainability performance expectations on seven key metrics: carbon footprint, human rights, child labor, forced labor, indigenous rights, biodiversity, and circular battery design.

The pilots are the world's largest effort by battery cell manufacturers to establish comparable battery passports and represent a major milestone towards issuing product level sustainability scores and certifications which the GBA aims to issue by 2027 leveraging digital passports. The Executive Director of the GBA is therefore optimistic: "Seeing the engagement by battery manufacturers gives us great confidence in the potential for international collaboration," she added.

STORAGE TECHNOLOGIES ARE CRITICAL TO ACHIEVING DECARBONIZATION TARGETS FOR INDUSTRIAL SYSTEMS THAT REQUIRE HEAT

MALTA INC.

“Our technology provides long-duration storage from 8 hours to 8 days”

As a child, **Ramya Swaminathan** experienced first-hand the consequences of an unstable electrical grid: in India and the Philippines (where she grew up), power outages at the school were constant. Now, named in 2020 one of *Business Insider’s* list of 21 Rising Stars in clean energy, in addition to advising public agencies dedicated to the electric grid in the United States, Swaminathan **advices Malta Inc.**, a startup that spun out from Google X that could be key for achieving a stable electrical network powered by 100% renewable energy. The company, named to *Time* magazine’s Top GreenTech Companies 2024, has developed a system that stores energy in the form of heat in molten salt and cold in a cooled water, which can be converted back into electricity as needed. In this interview, we talk to her about the main challenges of this industry, how to develop long-duration energy storage technologies for the electrical grid that are more cost-competitive and the role of public institutions to achieve this.

By **Carmen Gómez-Cotta**

Energy storage is key to our path to a successful low-carbon emission future. In the last few years, we've advanced installing short-duration storage to support the generation of renewable energy, but we still need to develop long-duration storage technologies. What are the main challenges in this kind of energy storage?

To power our grids with clean, reliable, and affordable energy, we need a broad range of storage technologies tailored to each region's specific needs and conditions and use case, which would be unachievable without long-duration energy storage (LDES) solutions. Incorporating LDES also enhances supply security, providing the grid with resilience and stability. One of the main challenges is securing the required initial investment in technology and infrastructure, which is higher than that of other storage solutions. This, combined with the limited commercial scale and deployment history of LDES, makes investors often view LDES projects as high-risk, deterring investment and leading to elevated return requirements. Another major obstacle is revenue stacking: existing revenue models in many markets do not yet provide adequate compensation for the range of services that LDES assets can offer, such as energy capacity and critical grid-support ancillary services. Also, regulatory frameworks must be adapted to recognize the value of LEDS in grid stability and renewable integration.

> "Compared to lithium-ion batteries, storage in molten salts has increased durability, with a lifespan of 25 to 35 years without degradation or the need for material replacement"

Malta's solution lies in thermo-electric energy storage. Why is this system so innovative, and what are its main keys?

It combines well-established thermodynamic principles with modern technological advancements to create a cost-effective, scalable, and efficient energy storage solution. The system stores energy as heat in molten salt and cold water, which can be converted back to electricity on demand. Molten salt storage systems like Malta's can store energy at temperatures up to 540 °C, which is much higher than the maximum temperature of other thermal energy storage technologies, such as sensible heat storage or phase change materials. Malta's system [also] achieves a power-to-power charge/discharge round-trip efficiency (RTE) of up to 60%, which is about 50% higher than other thermal storage systems without heat pump charging. In use cases where both the discharge power and the discharge heat are utilized, such as in district heating or industrial heat applications, the overall system efficiency can approach an RTE of up to 95%. Key features of our technology include its ability to provide long-duration storage from 8 hours to 8 days, its scalability for large-scale deployment of 300 MW and beyond, and its dual functionality in supplying electricity and heat, for industrial and district heating uses.

How many times can the materials used in the storage system (such as salt or liquid) be charged and uncharged? Does the process generate waste?

A Malta storage unit can be charged and discharged 100% in unlimited cycles without degradation of the storage media. As the main storage medium, Malta has selected a natural thermo-solar salt sourced by solar evaporation (e.g., in the Atacama Desert of Chile). It does not degrade during charge/discharge cycles and therefore does not need to be replaced over the project lifetime. These nitrates are also commonly used as fertilizers in agriculture. At the end of the project, they may be reused in a follow-up storage project or as fertilizer. The mechanical components of the storage system (tanks, piping, heat exchangers, turbo-machinery) are made of various types of steel, which can also be recycled at the end of the project life. Compared to lithium-ion batteries, storage in molten salts has increased durability, with a lifespan of 25 to 35 years without degradation or the need for material replacement. Additionally, its storage capacity is easily scalable by adding more thermal storage volume.

“Instead of viewing China’s advancements as a threat, we should see them as an opportunity to accelerate the deployment of our energy storage solutions”

These cutting-edge energy storage technologies, such as Malta’s, imply large investments. As many experts say, financing is one of the main impediments to advancing faster and reaching the 2030 goals. How can we reverse this situation and develop more cost-competitive technologies?

The main financing challenge for LDES projects is replacing fossil fuels with a technology that needs to be financed upfront before the start of commercial operation of the LDES projects. To overcome financing challenges, a multi-faceted approach is necessary. First, continuous technological advancements, efficiency improvements, and the development of standardized scalable solutions are required to drive down costs over time. Second, deploying these solutions requires innovative financing mechanisms beyond existing market structures. Additionally, public-private partnerships, government incentives and subsidies can play crucial roles in mitigating financial risks and encouraging investment in these cutting-edge technologies. By combining these strategies, we can create a more favorable financial environment for advancing energy storage technologies and achieving our 2030 energy transition goals.

You mentioned public institutions. Let’s explore their role in financing these kinds of projects.

They play a crucial role in financing energy storage projects by providing grants, subsidies and low-interest loans to reduce financial risks for developers.In the EU, the Horizon Europe program offers substantial funding for research and innovation in renewable energy technologies, including energy storage. The European Green Deal also provides financial mechanisms like the Just Transition Fund, which supports regions most affected by the transition to a green economy. Another important initiative is REPowerEU, which aims to reduce the EU’s dependence on Russian fossil fuels and accelerate the transition to a more resilient energy system. Governments can also support research and development initiatives to drive innovation and offer tax incentives to companies investing in clean energy solutions.

“We need a broad range of storage technologies tailored to the specific needs and conditions of each region and use case”

In addition to direct funding support, what regulatory changes would be required in the power markets to attract investments in LDES projects?

The electricity sector agents agree on the need for new regulations and a stable framework to ensure and promote investments in LDES to replace gas-fired combined cycles. One very important mechanism is the introduction of capacity mechanisms to support renewable energy storage systems by providing an economic signal to attract investment in LDES projects. In a context where a significant increase in storage capacity is expected, capacity mechanisms provide the necessary stability and security for investments, enabling the growth of this crucial infrastructure to integrate intermittent renewable sources.

According to the study *How China became the global renewables leader,* the country has become a leader in grid-connected energy storage. Should we take this as a challenge, especially nowadays that the US and the EU fear China’s unfair competition in the renewable market?

China’s leadership in grid-connected energy storage presents both challenges and opportunities. While it is essential to recognize the competitive pressure it places on other markets, it also catalyzes innovation and improvement globally. [The fear of] unfair competition highlights the need for a level playing field, where fair trade practices and intellectual property rights are respected. Instead of viewing China’s advancements as a threat, we should see them as an opportunity to accelerate the deployment of our energy storage solutions. We can enhance our capabilities by fostering international collaboration, promoting fair competition, and investing in regionally manufactured technologies.

CLEANTECH LEADERSHIP: WHO IS BLENDING THE COCKTAIL?

Bianca Dragomir, CEO of Cleantech for Iberia

The European Union (EU), spurred by Spain and Portugal, stands poised to lead in clean technologies. Years ago, Europe's pledge to reach net zero emissions by 2050 marked a visionary call to action. Since then, concerted efforts have advanced this goal. In her 2024 reappointment speech, Ursula von der Leyen, the European Commission President, reaffirmed this commitment. She set a 2040 target: a 90% reduction in emissions from 1990 levels, enshrined in the European Climate Act. At the begining of 2025, she also unveiled a Clean Industrial Deal. She posed a decisive question: Will we be shaped by external events, or will we unite to steer our future?

The cleantech industry understands this well. To shape our destiny, we need four elements: technology, capital, political support, and public-private partnerships. **We have the resources to lead and achieve energy independence. But speed is crucial.** Rather than succumb to pessimism, we must change the narrative. We hold the power to do so. Climate change challenges offer opportunities to boost competitiveness, attract talent and investment, and raise awareness. Gathering these elements isn't enough; the cocktail must be appropriately blended.

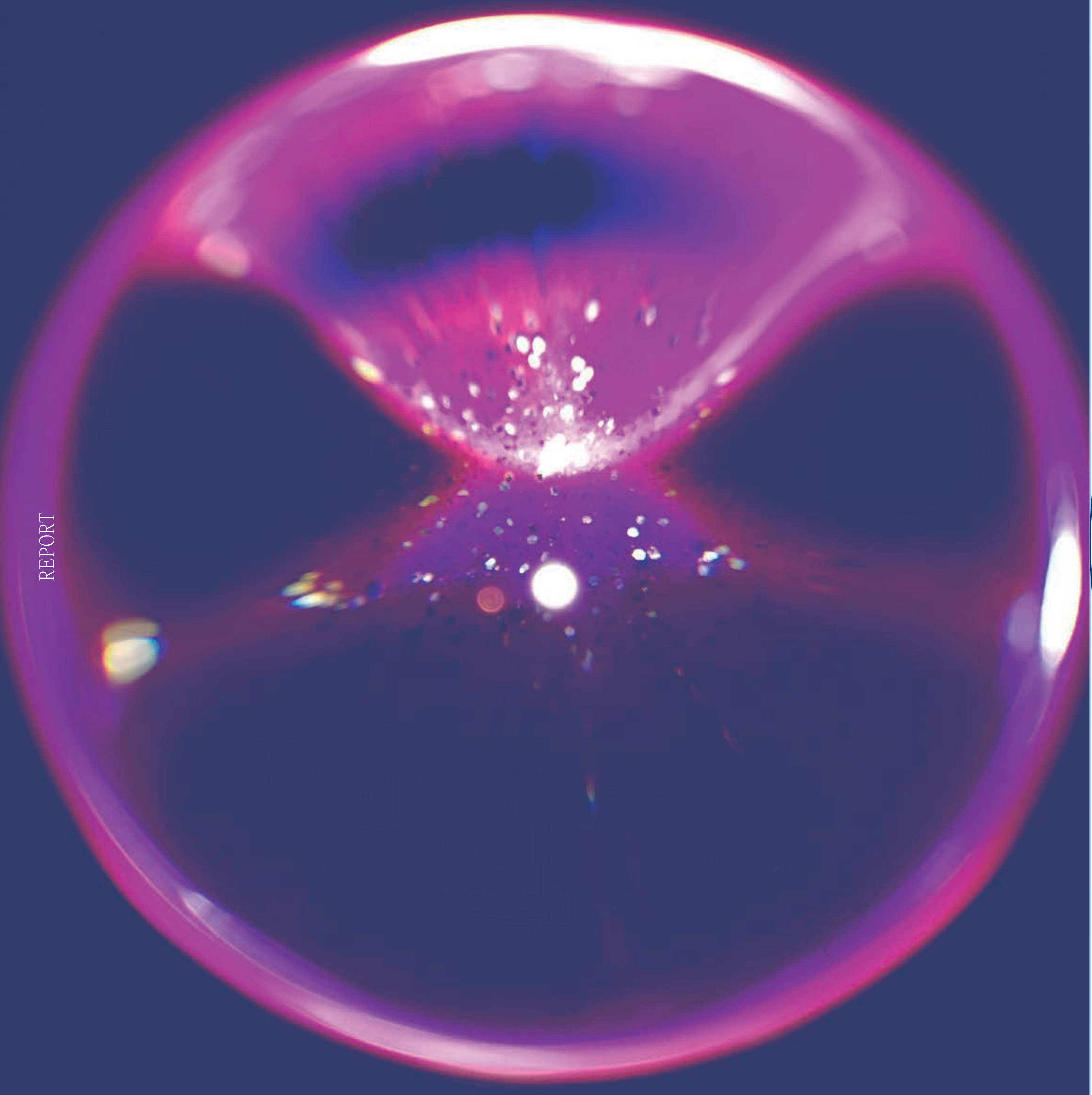
There are signs that this blend is building up. Over the next twelve years, EU Member States will see their funds quadruple, with a mandate to invest 25% of these revenues in promoting clean technologies. At the begining of 2024, the Council and the European Parliament agreed on the Net-Zero Industry Act. This act aims to boost the EU's industrial capacity for manufacturing technologies that support the transition to net zero, offering a significant opportunity to reindustrialize the continent and strengthen strategic autonomy.

Our Achilles' heel remains the scalability of innovation. While the EU produces 30% of the world's scientific papers, only 7% of market-ready innovations originate here. We lead in creativity, but others often reap the benefits.

To achieve our goals, we need innovative mechanisms to maximize investment. Some of our partners, like banks, are already moving in the right direction. Institutional support in the public sector is vital. Only these institutions can reduce uncertainty for private investors and minimize risks through grants, loan guarantees, tax incentives, or public-private financing.

A vibrant innovative ecosystem is crucial for the rise of clean technologies in the Iberian Peninsula. In recent years, investment in emerging cleantech in Spain and Portugal has increased sixfold. Today, there is a critical mass of investment funds specializing in cleantech, and international innovators like Stegra, Malta, Rondo, and Matteco are setting up factories here. Cleantech for Iberia unites leading investors and innovators in clean technologies for the first time. Together, they aim to create a more cohesive Iberian ecosystem, foster co-investment, and boost deal flow. This initiative also bridges the gap between the cleantech community and institutions.

The energy transition presents an excellent opportunity for our reindustrialization. We have the chance to lead in clean technologies, a journey that demands co-leadership and public-private cooperation. At Cleantech for Iberia, we are committed to changing the narrative, moving away from criticism and pessimism. We recognize that this pivotal moment calls for courage, determination, and leadership to drive the advancement of clean technologies.



NUCLEAR FUSION

MOVING CLOSER TO REPLICATING THE SUN'S ENERGY

Fusing the nuclei within atoms could offer humanity a clean and virtually boundless energy source, although various technical and economic challenges must first be overcome.

By **Jorge Ratia**

How exactly do stars manage to stay bright for so long? Humankind has been dreaming of finding an inexhaustible source of energy since the times of ancient Greece, when people were already looking up to the sky in wonder. It is an Utopian idea, as the first law of thermodynamics holds that producing infinite energy is impossible. Undaunted, scientific research has been unsuccessfully pursuing this dream for thousands of years. Today, we are close to achieving not only (almost) infinite, but also clean energy, thanks to nuclear fusion, a technology that mimics the process that keeps stars alive.

"Nuclear fusion is a process in which two light nuclei are brought together to form a heavier nucleus, releasing an immense amount of energy in the process. We know that this reaction occurs naturally in stars such as the Sun, but achieving the right conditions for this to happen on Earth is no easy task," explains **Dr. Erik Fernández, managing director of the Spanish Science Industry Association (INEUSTAR)**, which was set up to champion innovation and the advancement of science around the world.

Nuclear fusion should not be confused with nuclear fission, which is the well-known process used by nuclear power plants worldwide to generate electricity. Fission involves splitting atoms of elements such as uranium and plutonium —both heavy elements— to release energy. While this process is efficient and produces no direct greenhouse gas emissions, it has the disadvantage of generating waste that remains radioactive for thousands of years.

In contrast, nuclear fusion fuses light atoms, such as deuterium and tritium (hydrogen isotopes). Another big advantage offered by fusion is that, in addition to not emitting greenhouse gases, the waste loses its radioactivity over a shorter period of time. For these reasons, this solution has been considered the Holy Grail of energy for many decades.

The challenge of taming the energy of a star

Imagine two magnets that want to come together. If they approach each other with the same pole, they repel each other. Something similar happens with the nuclei of atoms, so if we want to fuse them, extreme conditions are needed to overcome this repulsion. According to Dr. Fernández, the atoms must be heated to extremely high temperatures, above 100 million degrees Celsius, so that the particles can pass into a state of matter known as "plasma." On top of that, we need to apply immense pressure to bring the nuclei close enough to fuse.

Here, the magnetic fields generated by superconducting magnets play a crucial role: they enable the plasma to remain in the right condition just long enough for the nuclei of the atoms to fuse. This is essential because, without this magnetic confinement, the particles would become scattered.

"This extremely complex process is what scientists and technologists are attempting to replicate in an efficient and controlled manner. If we succeed, it will be a truly momentous achievement in the field of energy by providing a clean, safe and almost limitless source of energy," proclaims Dr. Fernández. That said, "complex" does not necessarily mean "impossible," as nuclear fusion has been successfully achieved on several occasions. The main problem, however, is that in most cases, more energy has been put in to create the reaction than the amount ultimately released.

A historic breakthrough was achieved in December 2022, when the National Ignition Facility (NIF) in the United States achieved, for the first time, a net energy gain through nuclear fusion; that is, it generated more energy from the fusion process than the amount used to create it. This experiment has been replicated several times since, thus demonstrating that nuclear fusion is not just a pipe dream. However, the challenge now lies in implementing this experimental achievement on a large scale.

Toward industrial-scale fusion energy

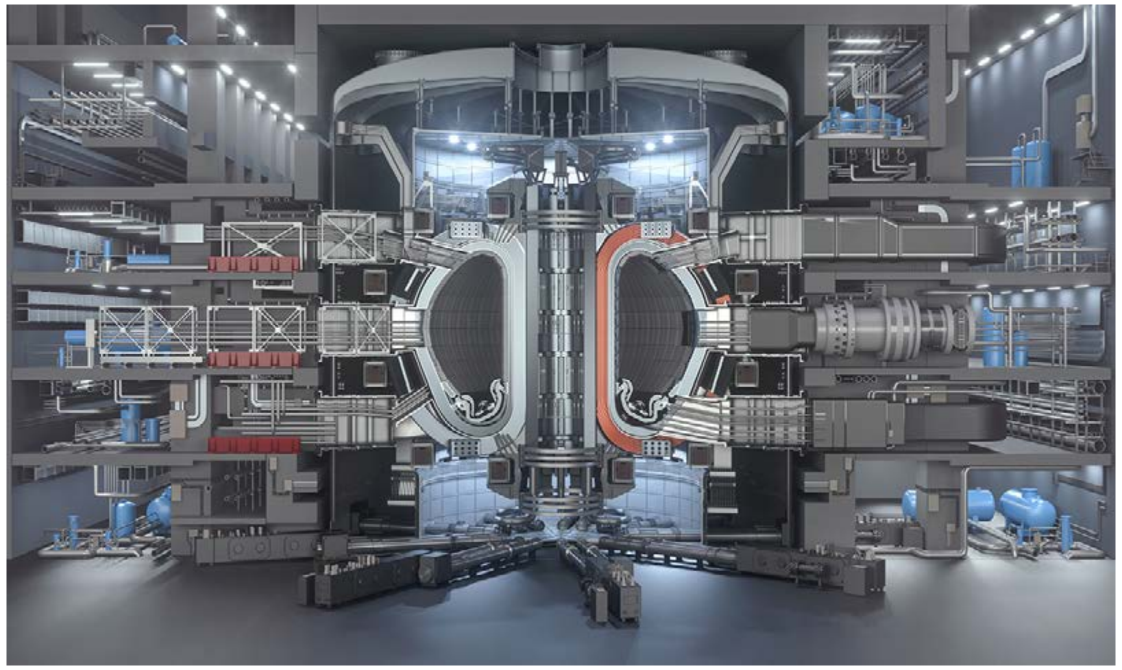
José Miguel Carmona, a doctor in physics from the Complutense University of Madrid and head of the fusion area at AVS (Added Value Solutions), notes that "immense progress has been made over the last few decades in nuclear fusion, partly thanks to the construction and operation of various experimental machines, which have given us the knowledge we need to find more efficient ways of producing energy." AVS is a Spanish company and a world leader in the design and development of complex space equipment for large scientific and space

Dr. Erik Fernández (INEUSTAR): "If we succeed, it will be a truly momentous achievement in the field of energy by providing a clean, safe, and almost limitless energy source"

Robert Arnoux (ITER): "Nuclear fusion is probably the most complex challenge humanity has ever faced from a technological and industrial standpoint and also in terms of the physics involved"

REPORT

DR. JOSÉ MIGUEL CARMONA (AVS): "IMMENSE PROGRESS HAS BEEN MADE IN NUCLEAR FUSION OVER THE LAST FEW DECADES, THANKS IN PART TO THE CONSTRUCTION AND OPERATION OF VARIOUS EXPERIMENTAL MACHINES"



facilities. This complexity lies in the fact that the equipment for large scientific and space facilities must continue to work while out in space, without breaking up amid such hostile conditions. These conditions happen to be similar to those found inside a nuclear fusion reactor: extreme temperatures, high magnetic fields, and copious amounts of radiation. It is precisely its know-how in creating the sophisticated and innovative technology needed to reach out into space that has prompted it to try its hand at nuclear fusion, a sector in which there are currently very few initiatives in progress, and which also happens to require a sizable capital outlay.

"Nuclear fusion is probably the most complex challenge humanity has ever faced from a technological and industrial standpoint and in terms of the physics involved. For fusion to become a viable energy source, we must achieve a net energy gain considerably higher than the amount put in to make fusion happen," explains **Robert Arnoux of ITER (International Thermonuclear Experimental Reactor),** the world's largest international fusion experiment. Since 1985, it has brought together 35 countries —including China, South Korea, the United States, India, Japan, Russia and various EU Member States— with the total investment exceeding €22 billion (according to a European Parliament document, the final bill could be many billions more). Unlike the NIF, ITER was conceived "as the key experimental step between the fusion research machines of today and the fusion power plants of tomorrow." It is now vying to produce 500 MW of fusion energy in exchange for 50 MW to make it happen.

Dr. Fernández reckons that "we can be optimistic that fusion will ultimately become a reality. It is only a matter of time before we overcome the technological challenges of building a facility capable of extracting energy from the fusion process in an efficient way." He believes it may be several decades before we can have fusion power in our homes, although the recent inflow of private capital may shorten this waiting time.

Further technological developments may also bring things forward, mainly in the fields of supercomputers and artificial intelligence. According to Arnoux, these key technologies may become very important for ITER, as they allow us to predict and avoid problems that could end up disrupting the fusion process: "Using models developed by AI we can predict faster-than-real-time fusion plasma evolution and be able to foresee potential problems, such as instabilities due to excessive pressures/current densities in the plasma, and adjust the parameters in real time to keep conditions stable", he explains.

Dr. Carmona believes that a paradigm shift is now upon us, thanks to the progress made in building ITER: "We are living in truly fascinating times, where major projects are still being built, satellite programs are providing invaluable information, and startups are taking advantage of the current state of the art —in some cases, standing on the shoulders of giants— as they try to show that their technology has the potential to outperform the rest." He adds: "Fusion is the air we need in this scenario; the water that quenches our thirst on hot days. And the economic impact would be just one aspect."

REPORT

JONATHAN GEIFMAN

HELIOS

“If we want to secure the future of the Earth, we need to expand into space”

By Óscar Granados

Helios was established over six years ago as a project to produce oxygen on the Moon, but in its first steps it discovered by chance a responsible way to obtain iron as a by-product. It all started with a question. **Jonathan Geifman —CEO of this Israeli tech company—** and friends wanted to know why human beings had not returned to the Moon since the Apollo 17 mission in December 1972. Despite the technological advances, there have been no new manned missions since then. They discovered that one of the most significant challenges is oxygen, essential for breathing and an oxidizing agent that makes it possible to burn fuel efficiently and generate the energy needed to propel a spaceship. In this interview, he explains how to extract oxygen from lunar soil and how they discovered that they could optimize steel production focusing on ironmaking and create new business opportunities.

Where did the idea to create Helios come from?

It emerged from curiosity and questions about why humans had not returned to the Moon since 1972. We asked ourselves why the lunar bases we see in science fiction do not exist and what prevented them from returning. When we started to look into it, we reached out to people at NASA and research centers in the U.S. We discovered a niche industry in the space sector called In-Situ Resource Utilization (ISRU). This industry focuses on technologies that make it possible to use the resources available in space. This is how we realized that NASA would need an essential element on the Moon: oxygen.

Why is oxygen so crucial to return to the Moon?

Oxygen is crucial not only to be able to breathe, but also to burn fuel. Around 70% of the mass of a rocket or spaceship that travels between the Earth and the Moon is oxygen. Producing it on the Moon would save a lot of money. Oxygen is available in the minerals in lunar soil. Just like on Earth, sand and rocks contain oxygen that is chemically bounded to metals like silicon, iron, calcium, copper and aluminum. The same occurs on the Moon. The challenge is that humanity has refined these minerals with carbon for thousands of years, but there is no carbon on the Moon. So, we had to develop new methods to refine these minerals without carbon or hydrogen.

What does the process you created entail?

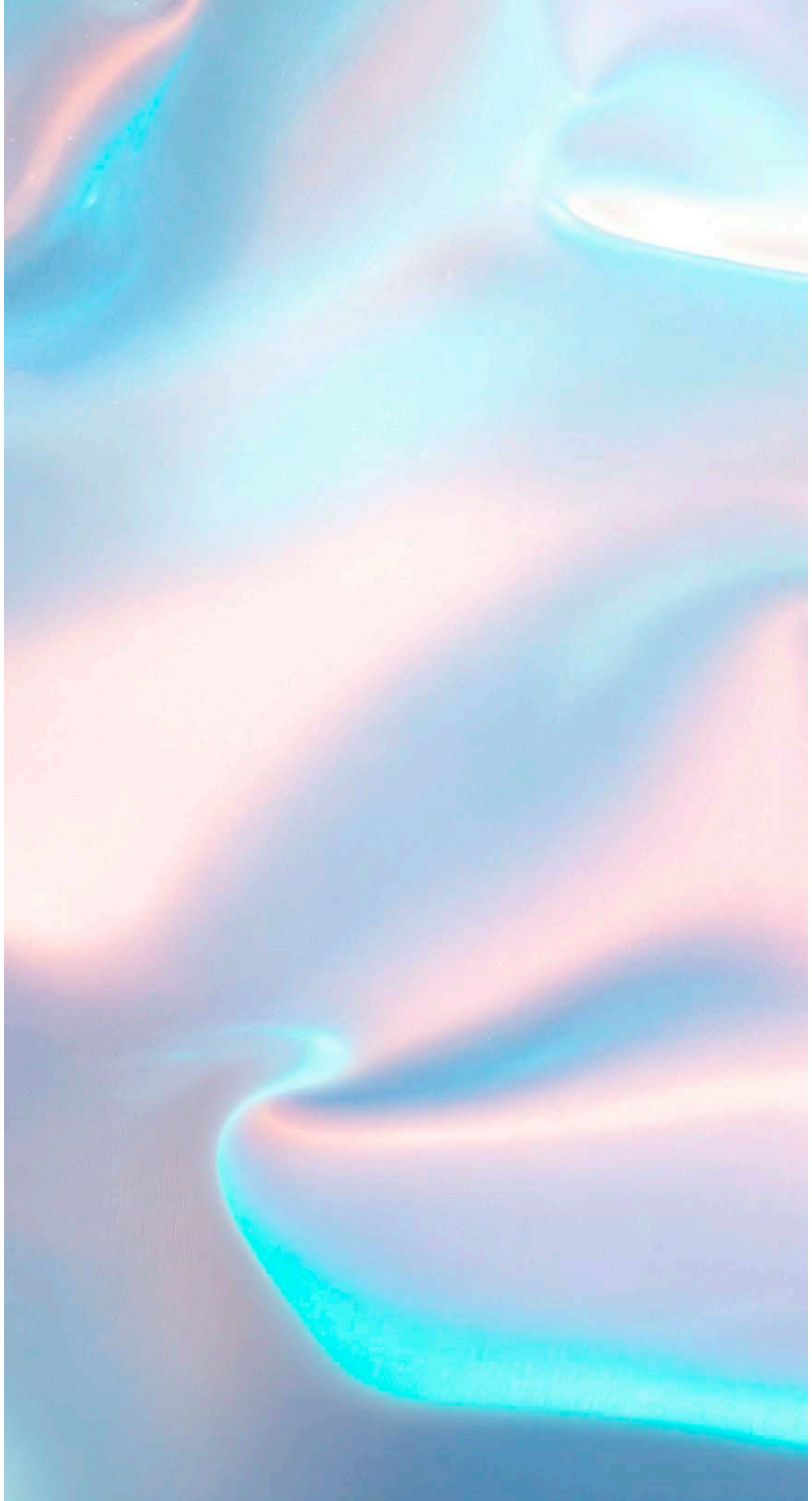
Our primary process, the Helios Cycle™, is a patented innovation that uses an efficient and sustainable chemical reaction to reduce metallic oxides. We combine a metallic oxide (such as iron, copper or nickel) with metallic sodium at temperatures between 250˚C and 300˚C. This exothermic reaction transfers oxygen from the oxide to the sodium, generating pure metal powder and sodium oxide. We then use a patented process to break down the sodium oxide into oxygen and sodium. The oxygen is released as a valuable by-product, and the sodium is constantly recycled, making the process a closed loop.

How did you discover the ironmaking process?

We obtained iron as a by-product of the chemical process during our space tech lab experiments. The efficiency of the process was a surprise, and after analysing it we realized we had an exciting opportunity to produce iron, which was different from our original idea of producing oxygen in space. Our iron production process does not emit carbon dioxide. Instead, it emits oxygen, making the production sustainable. Our goal is to mitigate the challenge of using humanity's resources. Therefore, we have focused on steel production for the past four years.

Is that your goal now?

> "Our iron production process does not emit carbon dioxide. Instead, it emits oxygen, making the production sustainable"



> "Our end goal is to be leaders in green iron and steel industry"

We focus on developing and commercializing innovative technologies to produce iron and steel more cleanly and efficiently. In four years, we have made significant progress in the research and development of our technologies, scaling up from the laboratory to small prototypes and demonstrating its technical and economic viability. We are currently building a larger prototype to produce several hundred tons of iron per year. Our end goal is to be leaders in green iron and steel industry, both as technology providers and plant operators on a large scale. We have achieved significant milestones, such as producing high-purity iron powder with few impurities in the laboratory, and we are designing a large-scale prototype to reach industrial capacities. We are working on a demonstration plant to be operational by 2026, producing 500 tons of iron annually. It would be a global reference and validate our technology on an industrial scale. In the long term, we plan to start with a first commercial plant by 2028 —with the capacity to produce fifty thousand tons by the end of 2028—, and twenty million tons within a decade from now.

You were looking for an answer for the Moon and found a solution for Earth.

We developed a versatile technological platform that adapts to the various industrial processes, focusing on the sustainable production of metals like iron. This platform significantly reduces the environmental impact, uses cleaner and more efficient processes, promotes the circular economy by giving value to mineral waste, and represents a commitment to innovation to fight climate change and resource scarcity. Our technology could be applied to the production of other strategic metals, such as copper, nickel and cobalt, contributing to a more circular and sustainable economy. Our vision is ambitious: we want to transcend extraction on Earth and take advantage of extraterrestrial resources, such as oxygen production on the Moon.

Is the future of humanity in space?

To ensure a sustainable future on Earth, we must expand into space. This will make it possible to reduce the environmental impact on Earth. We can imagine an ideal future centuries from now, where we only live and have fun on Earth. All heavy industry operates beyond our atmosphere. In this scenario, the Earth would house services, residences and jobs that do not require heavy industry. Mineral extraction, power generation and emissions would occur in places that do not affect the Earth's environment. To achieve this goal, we must expand our presence beyond the Earth, developing the capacity to live on the Moon, in nearby space, Mars and beyond. This is a vision for the future.

INNOVATION REMAINS THE KEY TO SUCCESSFUL CLEAN ENERGY TRANSITIONS

Tim Gould, Chief Energy Economist at the International Energy Agency

The global energy sector has been through extremely turbulent times in recent years. Many consumers around the world are feeling the bruises from high and volatile fossil fuel prices, especially for natural gas, which led to major pressures on the cost of living. The world has not yet turned the corner on emissions, and the accumulation of these emissions in the atmosphere is having increasingly visible and destabilising effects on the global climate.

But amid all the stresses and warning signs, there are some more hopeful trends. Clean energy deployment has picked up rapidly and the latest investment data from the International Energy Agency (IEA) suggest that almost twice as much capital has gone in 2024 to clean energy projects than is going to fossil fuels. Most new power generation plants are now based on clean technologies, led by solar PV and wind. For consumers, clean choices for heating, cooling and mobility are increasingly also the cheapest ones, especially when lifetime costs are taken into account.

These positive trends are testament to the power of innovation in bringing new technologies to market and bringing down their costs, underpinned by research and development efforts, policy support, inflows of venture capital and competition between manufacturers. Innovation has brought us to a point where many key pillars of a clean energy economy are mature, proven and cost-competitive.

However, the need for continued clean energy innovation is far from over. The world does not yet have all the tools that it needs to reach net zero emissions. And there is still plenty of scope to improve the performance, cost and interoperability of many existing clean technologies.

Progress is needed across the board, but two areas merit particular attention. First, is the role of innovation in sectors such as heavy industry and long-distance transport, where low-emissions technologies and processes are not yet readily available. Second, is the need to make innovative technologies more accessible in developing economies and to support the emergence of local, self-sustaining innovation ecosystems in these markets.

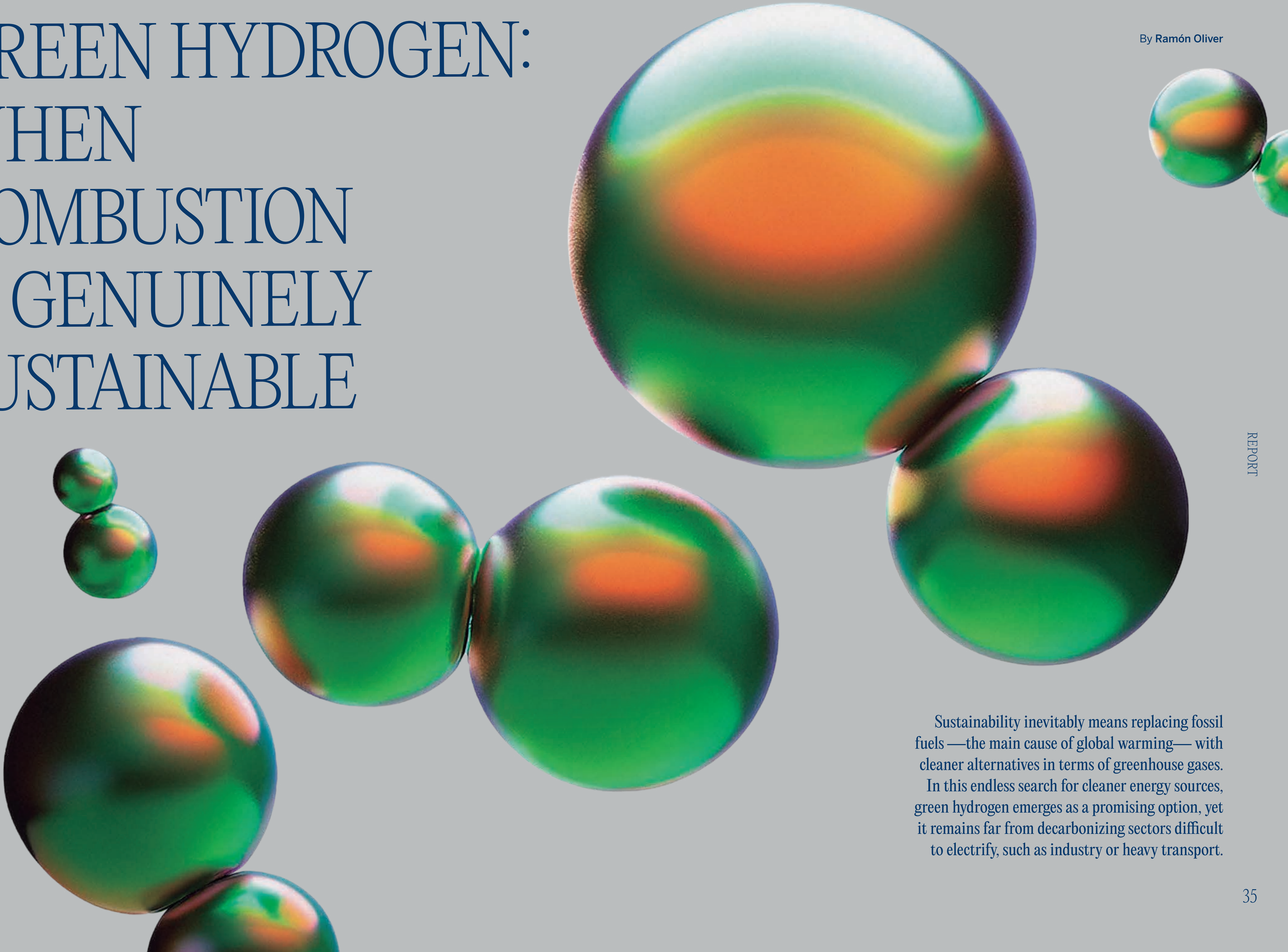
On the first point, we estimate that around one-third of the emissions that need to be avoided to 2050 to limit the rise in global average temperatures to 1.5 degrees do not yet have 'off the shelf' technologies. That means we need a rapid pace of innovation in areas such as new battery chemistries, carbon dioxide removal technologies and low-emissions fuels for shipping and aviation. Supportive government policies remain vital, especially at a time when access to capital has become more expensive. These policies typically encompass funding for technology development and demonstration, as well as measures to create markets for new technologies via public procurement or regulatory instruments like standards.

Another major challenge is to bring innovative technologies to the developing economies that will need them most, where energy demand is rising fast and where steel, cement and other energy-intensive industrial goods will be needed to build up national infrastructure and support rising standards of living. **International funding, collaboration and partnerships are indispensable** to allow the brightest minds and the most creative companies in developing economies to work on the clean technologies that are best suited to local needs, and to accelerate knowledge transfer and support technology diffusion to a much wider range of countries and communities.

We don't know exactly what mix of technologies will bring us to a safer and more sustainable energy system. But a large and complex energy system will need a wide range of solutions, embracing modular products like batteries, new fuels like low-emissions hydrogen, digital services like virtual power plants, new and imaginative building designs, new sectors like lithium extraction, and many more. The task is to give innovators the best possible conditions in which to work, to test new ideas and try out improvements to existing ones, and then open up opportunities and mechanisms for them to reach markets at scale.

GREEN HYDROGEN: WHEN COMBUSTION IS GENUINELY SUSTAINABLE

By **Ramón Oliver**



Sustainability inevitably means replacing fossil fuels —the main cause of global warming— with cleaner alternatives in terms of greenhouse gases. In this endless search for cleaner energy sources, green hydrogen emerges as a promising option, yet it remains far from decarbonizing sectors difficult to electrify, such as industry or heavy transport.

Rafael Cossent (ICAI-ICADE): "Cheaper electricity is needed, as well as reducing consumption per kilogram generated, improving the efficiency of electrolysis and enhancing plant design to optimize processes"

Harnessing the power of water as a source of energy. The fantasy that the renowned author Jules Verne envisioned in his novel, *The Mysterious Island*, is close to becoming reality thanks to low-emission hydrogen, and particularly green hydrogen. This fuel created through the electrolysis of water (decomposition of the H_2O molecule into hydrogen and oxygen) using renewable energy sources could hold the key to the decarbonization of some sectors in which direct electrification is still very complicated, such as heavy transport or certain industrial processes.

Some of the biggest benefits of green hydrogen include its versatility, its low level of harmful emissions, and minimal waste. "Green hydrogen is a replacement for gray hydrogen (produced using natural gas and other polluting hydrocarbons) and greatly diminishes emissions compared to other options. Its use is crucial to the decarbonization of the steel sector, and other sectors that use natural gas or coal, such as the aluminum or cement industries. It also holds the key to the decarbonization of the shipping and steel sectors through the production of green methanol, or sustainable aviation fuel (SAF)," explained the engineer **Gotzon Gómez Sarasola, Head of Spain and Portugal for the Stegra Project.** This Swedish startup is dedicated to the decarbonization of the economy, and has become one of the leading companies in the production of green hydrogen in Europe.

According to estimates in the European Union report *Hydrogen Roadmap Europe: A sustainable pathway for the European Energy Transition*, clean hydrogen could prevent 560 million tons of CO_2 annually in Europe by 2050. The EU believes that it has the potential to generate around 2,250 TWh of hydrogen across all sectors, or one-fourth of Europe's total energy demand. This energy could power approximately 42 million large cars, 1.7 million trucks, or more than 5,500 trains. It would also heat the equivalent of 52 million homes and cover up to 10% of energy demand for buildings. Furthermore, combining captured carbon or biomass with 120 TWh of hydrogen could produce synthetic feedstock for 40 million tons of chemical products by 2050.

This is one of the reasons that Brussels is one of the biggest defenders of this technology. The EU set a goal of producing 10 million tons by the end of this decade.

Challenges remain

However, several challenges must be overcome before it can be established as a real alternative to fossil fuels. At the moment, the high cost of this gas compared to the fuels it seeks to replace is one of the biggest obstacles. Gómez Sarasola stresses that financing for projects of this kind is conditioned by the high value of the so-called 'green premium', or the higher price

Gómez Sarasola (Stegra): "Green hydrogen holds the key to the decarbonization of the shipping and steel sectors"

Franz Bechtold (Lhyfe): "The massive adoption of renewable energy and government aid will both be key elements"

consumers are willing to pay for a sustainable, but more expensive alternative compared to a cheaper, more polluting one. "Many green hydrogen production projects do not get off the ground due to a lack of buyers willing to assume this 'green premium' over gray hydrogen," he warned.

Rafael Cossent, a researcher at the Institute of Technological Research (IIT) of the ICAI School of Engineering at Comillas Pontifical University, is one of Spain's leading experts in hydrogen. He currently co-directs the Chair of Hydrogen Studies at ICAI-ICADE, a prestigious educational institution linked to the University. The expert explains that the investments related to green hydrogen are high because they often entail also making adjustments to the equipment so they can use this fuel. "New engines, furnaces, and burners for industry are needed... It means developing supply structures and creating new facilities."

Reducing investment costs is a priority, but the same applies to operating costs, this expert noted. "Cheaper electricity is needed, as well as reducing consumption per kilogram generated, improving the efficiency of electrolysis and enhancing plant design to optimize processes."

Another issue that must be addressed is how to get this fuel to consumers. "Transportation in trucks is already a reality for small volumes and short distances, but establishing a large-scale open hydrogen network has to deal with uncertainty surrounding the development of sufficient demand", Cossent argued.

Franz Bechtold of Lhyfe, a pioneering business group that opened the world's first green hydrogen production plant directly connected to a wind farm in 2021, pointed to other factors that are hindering the change. "The lack of infrastructure is blocking many projects and raising the final production cost of others." The same goes for the absence of "clear administrative guidelines regarding what will occur in the future in terms of both emission taxes and other medium-term aid," he warned.

Momentum in Europe

Despite these obstacles, the potential of this technology to decarbonize heavy industry means that green hydrogen projects are on the rise. Lhyfe, which is present in 11 European countries, is also developing projects in the Iberian Peninsula, such as the Vallmoll plant (Tarragona), and intends to weave a renewable hydrogen network throughout the country. Besides, Gómez Sarasola from Stegra confirms the potential of the Iberian Peninsula for the deployment of this technology: "Spain and Portugal are the only countries, apart from northern Scandinavia, that have the capacity to produce renewable electricity in large volumes and at a competitive price. The electricity grids of the two countries are expected to have 80-85% renewable energy by 2030," he argues.

The European Hydrogen Bank —an initiative created by the European Union with the aim of promoting the renewable hydrogen market through subsidies for companies to cover the cost difference between renewable hydrogen and fossil fuels— recently completed a pilot auction for €720 million, benefiting seven projects: three in Spain, two in Portugal and the remaining two in Norway and France.

For Betchtold, "the massive adoption of renewable energy and government aid will both be key elements in order to make hydrogen one of the most viable solutions to reduce greenhouse gas emissions." Another factor that could accelerate this time frame, Gómez Sarasola added, is "reinforcing grid interconnections between generation plants and consumption projects."

HOW IS GREEN HYDROGEN OBTAINED?

01. GENERATION

Green hydrogen is produced using electricity generated from renewable energy sources, such as wind and solar power.

02. ELECTROLYSIS

This clean energy powers an electrolyzer, which splits water into its fundamental components: hydrogen and oxygen.

03. BY-PRODUCT

Green hydrogen is a clean energy source, as its production emits no carbon dioxide during electrolysis. The only by-product is water steam.

04. STORAGE

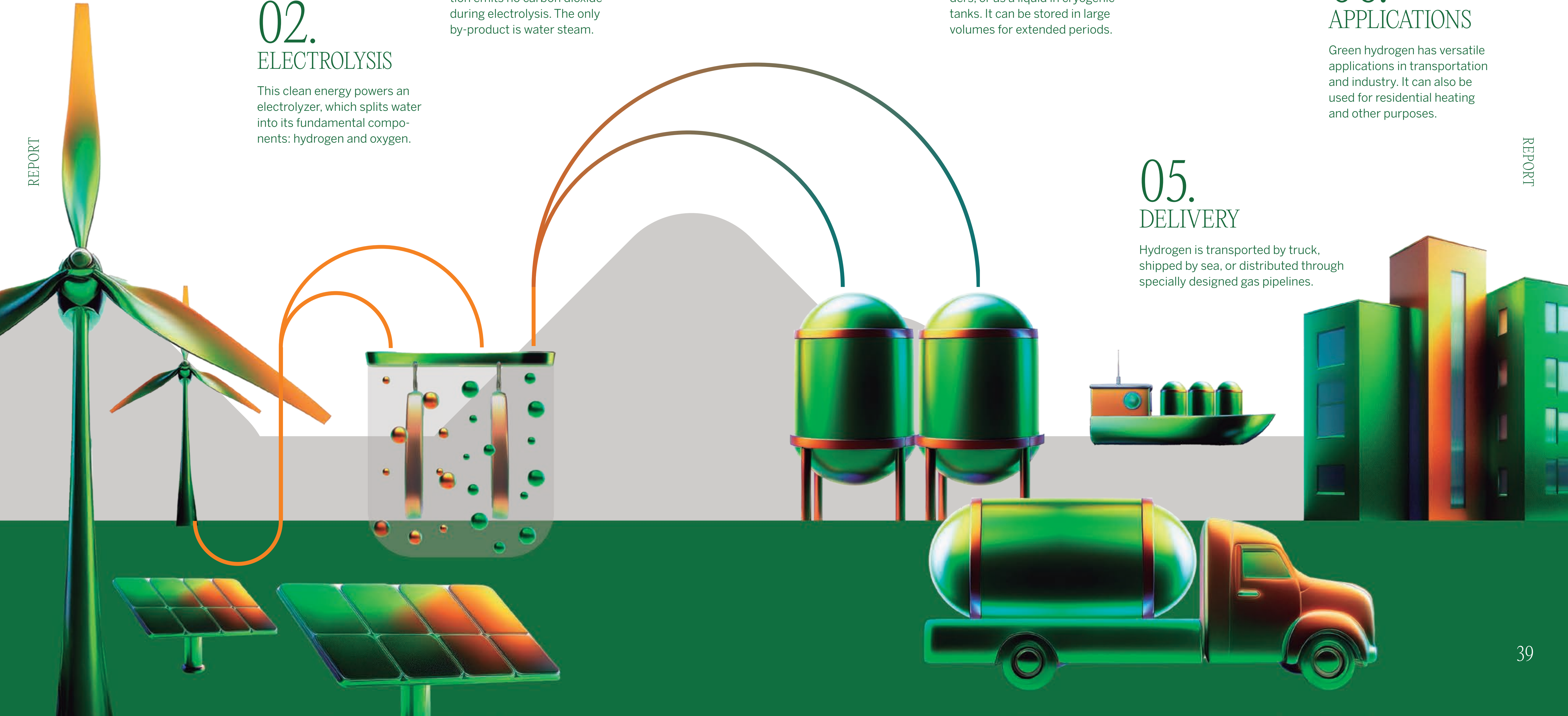
The hydrogen produced is stored in high-pressure gas tanks or cylinders, or as a liquid in cryogenic tanks. It can be stored in large volumes for extended periods.

05. DELIVERY

Hydrogen is transported by truck, shipped by sea, or distributed through specially designed gas pipelines.

06. APPLICATIONS

Green hydrogen has versatile applications in transportation and industry. It can also be used for residential heating and other purposes.



GREEN IS BACK IN FASHION

Clothing is much more than something to keep us warm: it is a powerful expression of our identity, culture and ideas. Brands are becoming increasingly aware of the importance of creating quality clothing that is not only attractive, but also sustainable, and that showcases their commitment to the planet and the future.

Por Inma Mora Sánchez

The relentless consumption of natural resources, including water, along with greenhouse gas emissions are some of the biggest challenges now facing the fashion industry. For example, the European Union's study *What if fashion were good for the planet?* estimates that around 2,700 liters of water are needed to make a single cotton T-shirt. Meanwhile, according to a 2024 McKinsey report, the global fashion industry accounts for between 3% and 8% of total greenhouse gas (GHG) emissions, and the industry's emissions are expected to increase by around 30% by 2030 if no further action is taken.

Against this backdrop, the industry must look to transform its production model to comply with national and international agreements promoted in recent years. At the global level, this should be achieved through the Fashion Industry Charter for Climate Action, approved at COP24 and updated at COP26 in 2021, whereby major fashion brands pledged to reduce their emissions by 30% by 2030 (compared to 2015 levels) on the path to becoming net zero by 2050. On a regional scale, in Europe the EU Strategy for Sustainable and Circular Textiles aims to make all textile products durable, recyclable and environmentally and socially responsible by 2030. This strategy also envisions the possibility of prohibiting the destruction of unsold products and fostering clearer information on textiles through the creation of a digital product passport.

The transition toward circular fashion

"In our current economy, we extract materials from the Earth, manufacture products from them, and ultimately discard them as waste. In other words, the process is linear. Conversely, in a circular economy we stop producing waste right from the outset," explains the **Ellen MacArthur Foundation.** The creation of a garment begins with the raw materials used to make it —which can be natural (such as cotton or linen), artificial, where natural raw materials are transformed into fibers through chemical processes (such as viscose) and synthetic, the most polluting throughout the product's useful life as they are mostly composed of petroleum derivatives (such as polyester or elastane)— and their useful life cycle ends when such garments are thrown away. The circular model redesigns our production systems to reuse materials, minimize waste and give enough time and space for nature to regenerate before extracting more raw materials. For this to succeed, we must recycle garments, either by giving them a second life (second-hand clothing) or by disposing of them and using the materials to create new clothes.

The Ellen MacArthur Foundation has been a key player in promoting this approach through the Make Fashion Circular initiative, which works alongside different brands, manufacturers and industry professionals to investigate and champion the use of sustainable materials, the collection of used clothing and the implementation of processes that extend the useful life of garments.

But what does circularity in textiles involve exactly? At **Mango**, a leading global fashion group and one of the first companies to set up a sustainability department 20 years ago, they explain that it all starts with a design based on easily recyclable and durable garments that also happen to generate the smallest amount of waste. For a garment to be considered easily recyclable it must be monomaterial (prioritizing the use of a single fiber) and reduce fittings to a minimum, so that at the end of its life it is easier to separate the materials and recycle them. On the other hand, materials selected for their durability and reinforced construction ensure that garments remain in good condition over time. "Quality and durability go hand in hand," they explain.

So, how can consumers identify which garments are sustainable? According to Mango, it is important for citizens to start learning about all these attributes that are linked to this more sustainable fashion model and lower impact products. Clear and complete labeling is an absolute must. "At Mango we have introduced a QR on our labels that takes you to our website, and that's where all the information is readily accessible," they explain.

> Mango: "For a garment to be considered easily recyclable it must be monomaterial and reduce fittings to a minimum, so that at the end of its life it is easier to separate the materials and recycle them"

> MycoWorks: "A new biology-led approach is propelling us into this new era in which natural solutions and biomaterials are taking center stage"

Scientific innovation is also key to the development of circular production models. For example, **Infinited Fiber** has developed a process to recycle used textile fibers, even those that are of poor quality, and transform them into a new high-quality fiber known as Infinna™, which is already being used by various big brands, including the likes of Adidas, Patagonia and Calvin Klein.

From earth to hangar: growing materials to reduce the environmental impact

Creativity and science have come together to produce some welcome results, not only in helping to form a complete circle in the life of a product (through formulas such as recycling), but also by developing new materials. Like those created by **MycoWorks,** a biotech company founded in 2013 by Philip Ross and Sophia Wang, two artists and pioneers in the field of biomaterials. As they explain at MycoWorks, "the company was created from Phil Ross's deep understanding of mycelium, an abundant and complex organism and a structural marvel." Ross began to cultivate this fungus for use in his sculptures in the 1990s discovering in his experimentation its versatility in shape, texture and color.

Meanwhile, Sophia Wang, the daughter of two molecular cell biology researchers, was formally trained as an artist and writer, but always showed a keen interest in nature's living systems. While writing her doctoral dissertation on poetry, Wang worked with Ross on a series of public programs exploring the culture and history of bioreactor design. As interest in Ross's creations began to grow worldwide and opportunities arose to collaborate with brands seeking innovative materials, Ross and Wang decided to set up a company.

Thanks to Ross's in-depth knowledge of mycelium, they developed Fine Mycelium™: a system for manipulating mycelium during its growth to create unique, attractive, resistant and durable biomaterials; a concept that has captivated companies from various sectors, including Hermès, Ligne Roset and General Motors. After years of research, this system has culminated in a first product for the luxury sector: Reishi™, an improved version of mycelium similar in appearance and texture to animal hide, but with a much smaller environmental footprint.

Its low-carbon footprint is due in part to its passive growth process: mycelium does not require additional food, water, light or other inputs to support its growth. Even more, the Fine Mycelium™ process allows for a much cleaner, shorter, streamlined "re-tanning process" jumping straight to dyeing and finishing without the use of chrome, cutting water and chemistry usage comparatively to traditional processes.

According to the founders of MycoWorks, Reishi™ ushers in a new era in sustainable design, allowing materials to be customized from the growth process, thus offering unparalleled levels of control over a natural material, available at scale.

As **Matt Scullin, CEO of MycoWorks,** has pointed out on several occasions, brands are calling for new materials with a lower environmental impact to deliver on their climate commitments and, at the same time, the appetite for fashion and luxury requires new sources of materials to drive growth. In other words, society is demanding high quality products that also happen to be sustainable.

By **Carlos Madrid**

For **Ismael Olmedo, CEO of Captoplastic**, seeing clean, vibrant waterways is priceless —a value he cherishes more with age. He finds his company's work particularly gratifying; they have developed technology to capture microplastics as small as one micron (0.001 mm), which are otherwise elusive and harmful to nature and health. We spoke with Olmedo to learn how this technology can cleanse ecosystems of these tiny pollutants and protect the environment.

ISMAEL

CAPTOPLASTIC

"Our technology doesn't just capture microplastics, but also offers a solutions for the protection of human health and the defense of the environment"

INTERVIEW

OLMEDO

How are microplastics created? How do they affect us?

Microplastics are tiny plastic particles that come in various forms, including foams, beads, pellets, and fibers. They fall into two categories: primary microplastics, which are manufactured in small sizes like those in cosmetics, and secondary microplastics, which result from the breakdown of larger plastics through sun, wind, and water exposure. Most microplastics are released into the environment from sources such as washing machine wastewater and tire wear. For instance, washing synthetic clothing often releases fibers that enter wastewater and eventually flow into rivers and oceans. According to a WWF study, we ingest about five grams of plastic each week —the equivalent of a credit card. This can cause cardiac and carcinogenic problems, among other health issues.

How do microplastics end up in our bodies?

Microplastics are often present in the food we eat, the water we drink or the air we breathe. Although the European legislation recognizes their danger and the need for measurement —such as in EU Directive 2020/2184 on drinking water quality and the recently published EU Directive 2024/3019 on urban wastewater treatment—, there is still no explicit obligation to capture them. Despite regulatory progress, regulations seem to be one step behind the problem, especially regarding the control and elimination of microplastics in wastewater.

How do microplastics get into the water cycle?

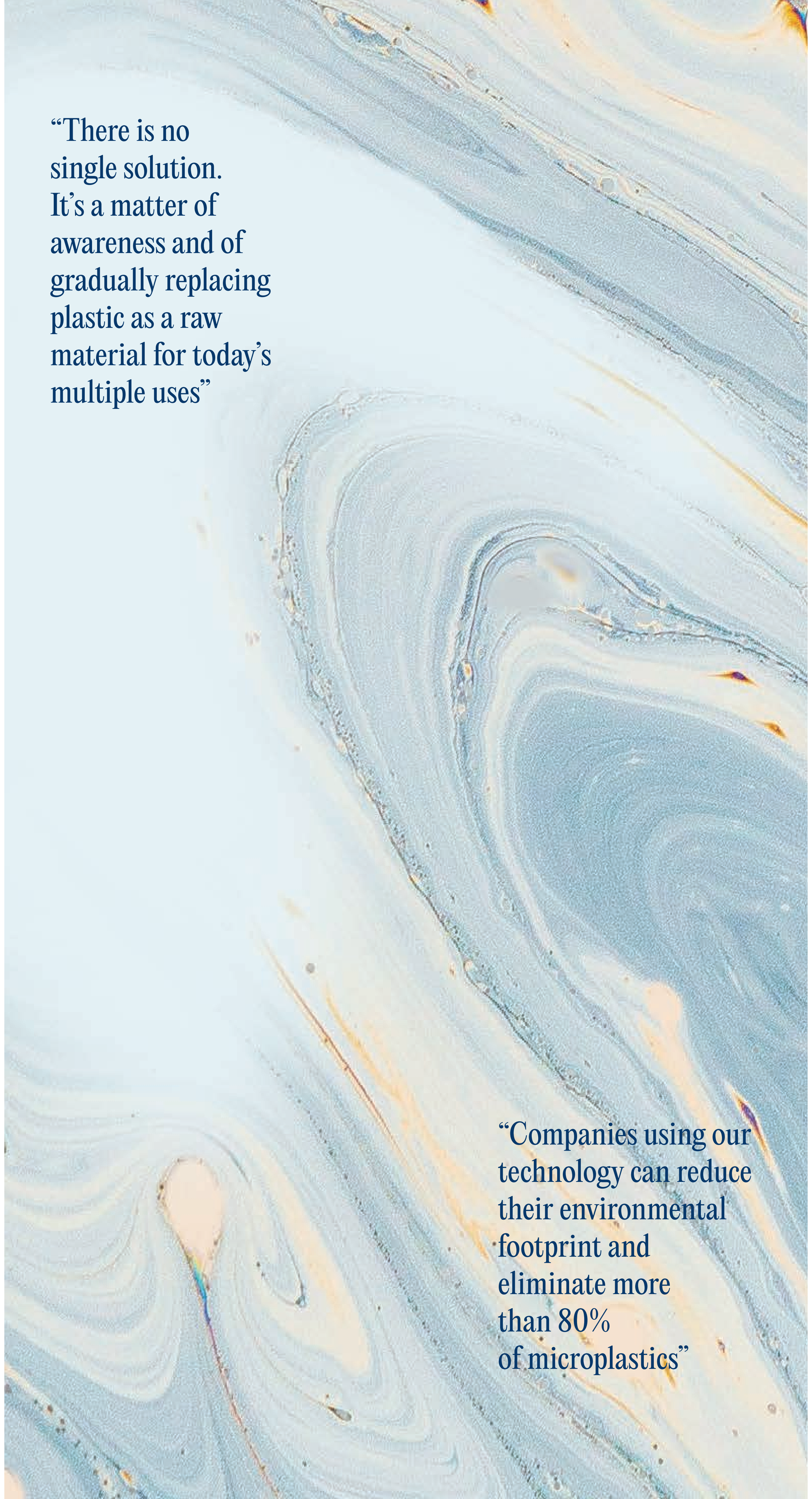
Urban and industrial wastewater, which Captoplastic targets, is a major source of microplastic pollution that contaminates rivers and oceans. The concentration of microplastics varies widely, depending on factors such as the water's industrial source or population density. In Spain, according to our estimates, untreated water contains between 30 and 100 milligrams of microplastics per liter.

Doesn't a standard sewage treatment plant remove microplastics?

In the standard purification process, larger particles are removed first. This is followed by settling and biological treatments. Both primary and secondary treatments generate sludge, where microplastics often accumulate. The problem is that this sludge is used in agriculture or composting, potentially reintroducing microplastics into the environment.

Captoplastic was founded in 2020 to address the microplastics problem. What inspired you to start the company, and what is your background?

It all began when researchers at Spain's Universidad Autónoma de Madrid developed a patent for an innovative solution to capture and control microplastics, a global concern. This patent caught the eye of **BeAble Capital**, a Spanish fund specializing in Deep Tech (based on fundamental research), due to its environmental impact and potential as a disruptive technology against microplastic pollution. BeAble Capital recognized the patent's commercial potential and provided funding and strategic support to turn it into a company. Thus, Captoplastic was born in 2020. We now hold ten patents for the identification, quantification, and removal of microplastics and employ about fifteen people. I am the CEO, but before this role, I spent 25 years as a director at Aguas de Barcelona and have a background in finance and management. Surrounding me are young engineers and chemists who possess extensive knowledge and a strong environmental awareness.



What does your technology consist of and how does it contribute to solving the problem of microplastics?

We have two distinct product lines. First, we focus on the identification, quantification, and analysis of microplastics in water. Second, we work on their removal. To remove microplastics, we add a magnetic catcher to the water, which adheres to microplastics as small as one micron —while other solutions are limited to particles of five microns or larger. We then use a magnetic field to extract the aggregates. Finally, once the aggregate is out of the water, we separate the microplastics from the catcher, which we then reuse in the water to repeat the process continuously.

Why is your technology innovative in this area?

Our technology stands out for its simplicity, sustainability, and efficiency compared to other market solutions. For instance, hydrocyclones, which separate solid particles in liquid media, require significant energy to generate the centrifugal force they need to operate effectively. In contrast, our technology consumes much less energy. Another alternative, membranes, require frequent replacement, an issue we don't face since our catcher is reusable. This contributes to our lower operating costs compared to other solutions.

Other technologies can also generate secondary waste, whereas our system captures microplastics before they reach the sludge without adding additional waste in the process.

And our technology doesn't just capture microplastics, it allows them to be reused. A particular advantage of our system is its ability to recover microplastics without degrading them. The key to our uniqueness lies in the precision of our collection system and the ease with which we can separate the plastics without altering their structure. This capability opens the door to recycling and reuse initiatives in various industrial or design applications, such as creating panels or furniture from recycled plastics, thereby contributing to a circular model.

How can businesses benefit from your technology?

Our technology benefits a wide range of enterprises, including urban and industrial water treatment plants, plastics manufacturers, the textile industry, water testing laboratories, and appliance manufacturers. It is also useful for the food and beverage industries that use large volumes of water. All of these sectors can eliminate more than 80% of microplastics and stay ahead of future regulations.

How can we prevent microplastics from ending up in the water?

In this regard, we are developing a capture plant technology for industrial laundry and another that will incorporate a mechanism in the domestic washing machine that captures microplastics before they reach the wastewater treatment plants. Additionally, tires could be made from materials that degrade less and release fewer microplastics —an important consideration since many sewage systems combine wastewater and stormwater, causing all the water to end up in the treatment plant when it rains. Reducing the overall use of plastics would also be a significant measure to help lessen their environmental presence. There is no single solution. It's a matter of awareness and of gradually replacing plastic as a raw material for today's multiple uses.

THE CHALLENGE OF FINANCING

THE CLEAN INDUSTRIAL DEAL

Ciarán Humphreys, Research Fellow at the Institute for Climate Economics

The world is entering a new era of global competition, and cleantech manufacturing is at its heart. Reindustrialisation has brought industrial policy back into the mainstream, with China's Made in China 2025 programme, and the American Inflation Reduction Act (IRA) investing billions of public funds to capture a share of a global market likely to reach $650 billion by 2030.

The European Union (EU) has also made its own strides forward, with its Green Deal Industrial Plan creating the regulatory framework for a faster build-up of cleantech factories across Europe. This looks set to continue under a new Clean Industrial Deal, which Ursula von der Leyen announced as she was voted to her second term as Commission President.

However, creating the right market conditions is only part of the answer. If anything is to be learned from the US and China, it is that competition requires public finance. Building a cleantech factory in Europe is both risky and capital-intensive, and private investors are at times unwilling to support European companies on the difficult journey to scale. Public finance has an important role to play by both de-risking those investments and providing the necessary "patient capital" to allow promising, innovative companies to grow.

It is encouraging, therefore, that in addition to the Clean Industrial Deal, President von der Leyen has put forward a European Competitiveness Fund. This Fund would be part of the next EU budget, the negotiations around which have begun in 2025. The hope is that the Competitiveness Fund can succeed where the Sovereignty Fund (which has since become the Strategic Technologies for Europe Platform, or STEP) has failed —and deliver a significant injection of public funds targeted at manufacturing strategic clean technologies.

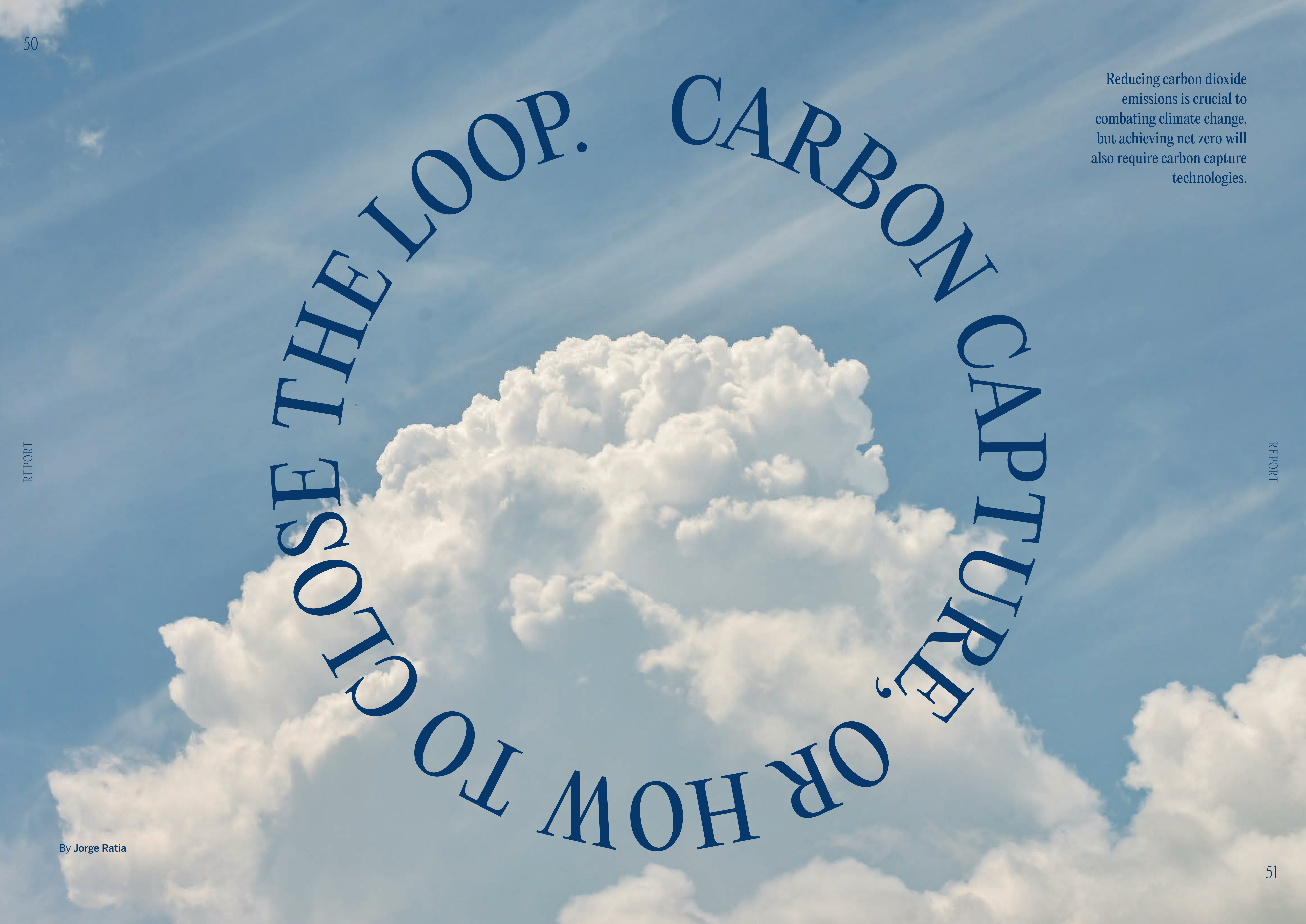
However, even if the Competitiveness Fund can live up to its potential (the negotiations with Member States are far from easy), it will not be able to do so until at least 2028, when the next EU budget comes into force. Three years from now is a long time in this global cleantech race, and Europe cannot afford to wait. Finding interim public financing solutions, both at EU and Member State level, is therefore key.

Fortunately, the EU already has many tools at its disposal to bridge this gap —whether support to companies through the European Investment Bank (which has backed success stories such as battery manufacturer Verkor and green steel leader Stegra), or the channelling of state aid through Important Projects of Common European Interest (IPCEIs).

One of Europe's most promising tools is the EU Innovation Fund. Funded by revenues from the EU's carbon market, the fund is capable of disbursing €4 billion annually, with that figure —according to Institute for Climate Economics calculations— set to rise to over €20 billion by the end of the decade, mirroring the increase in carbon prices. The Fund has already been productively used to support competitive EU cleantech, whether through the Hydrogen Bank auction, the manufacturing call under REPowerEU, or the recently announced Battery Fund (supporting the industry which represents the lion's share of public and private cleantech investment needs).

As the EU's largest fund targeted at cleantech innovation and scale-up, the Innovation Fund should remain the cornerstone of our future green industrial policy. Its impact can be expanded by replicating the Hydrogen Bank model in other sectors, or combining grants with guarantees and venture debt received from the EIB.

In the words of President von der Leyen, "the race is on". European cleantech manufacturing is at a critical juncture. **Only by making the best use of the EU's available funds, and particularly the Innovation Fund, can Europe build a cleantech industry ready to face the challenges of the decades to come.**



CARBON CAPTURE, OR HOW TO CLOSE THE LOOP.

Reducing carbon dioxide emissions is crucial to combating climate change, but achieving net zero will also require carbon capture technologies.

By **Jorge Ratia**

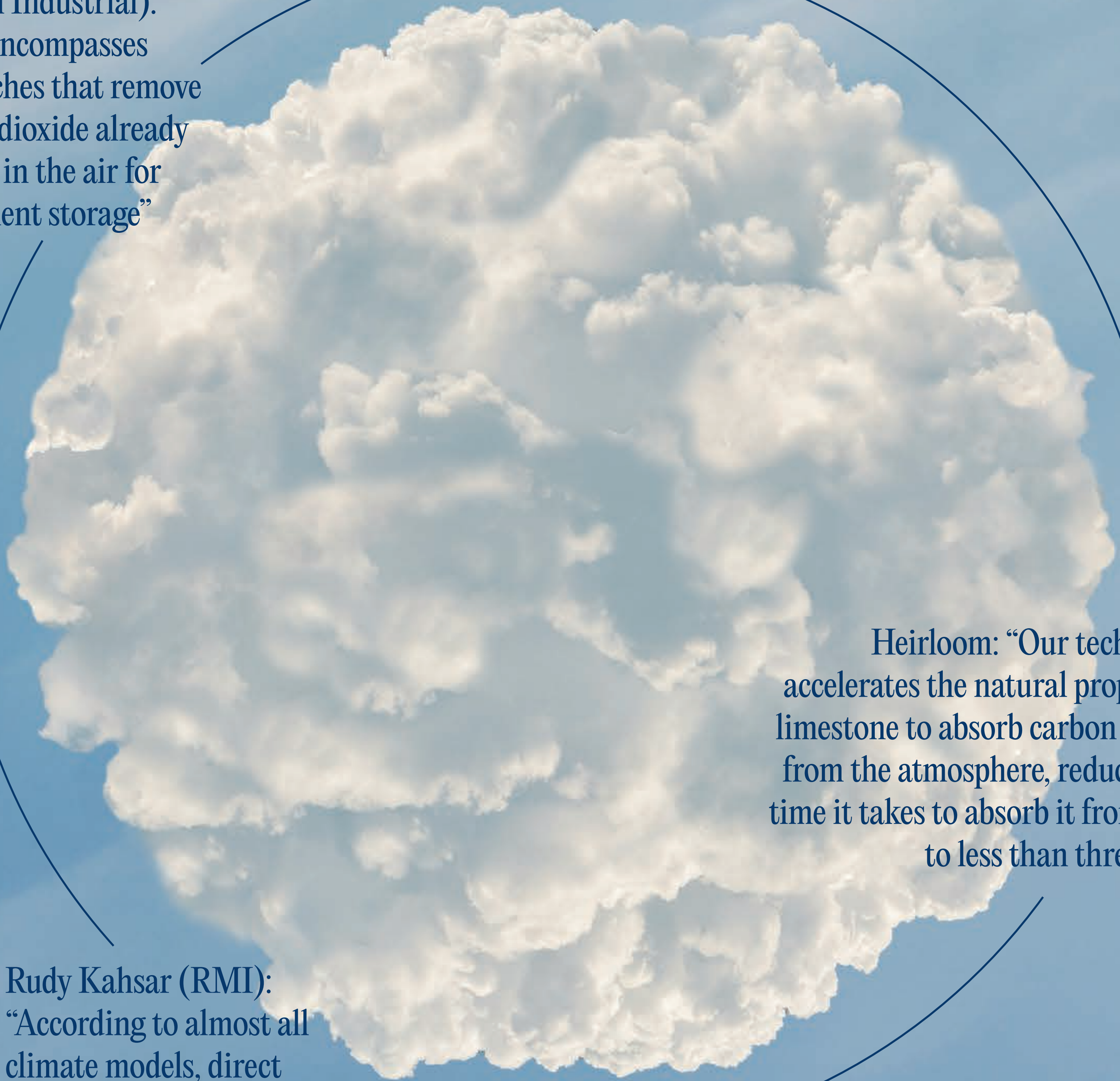
Human history has developed through innovation and progress. It has undoubtedly improved the general welfare of its species, but it has also undermined the health of the Earth. Action is needed to mitigate the adverse effects of climate change from greenhouse gas emissions. The UN Intergovernmental Panel on Climate Change (IPCC) reports that 10 billion tons of carbon dioxide must be removed globally each year by 2050. The scientific consensus, governments, and companies agree that cutting carbon emissions is essential, though some sectors and processes find this challenging. Does this mean we should abandon the goal of a decarbonized future? What if we could capture carbon dioxide?

While it should be seen as a complementary solution, there are already methods to trap carbon dioxide and prevent it from adding to the greenhouse effect. This is known as Carbon Capture, Usage, and Storage (CCUS). Carbon can be captured directly at the production source or from the atmosphere —a process called Carbon Direct Removal (CDR)— using natural or technological means. "CDR includes methods that remove carbon dioxide from the air using technical or biological processes for permanent storage," says **Harris Cohn of U.S.-based Charm Industrial.**

Charm has become a leader in carbon capture, eliminating over 7,000 tons of carbon dioxide since its founding. Their innovative method uses plant waste, where carbon dioxide is absorbed by biomass via photosynthesis. This waste is converted into a carbon-rich substance called bio-oil, which is injected into depleted oil wells. This process mimics a cycle of synthetic oil production and storage, but with an emphasis on permanent carbon sequestration.

"By processing leftover biomass, such as fallen trees or forest residues, Charm helps reduce the fuel load in forests, thus preventing fires. Such actions create economic benefits for rural communities by offering farmers new opportunities to sell crop residues. Additionally, using by-products from this process enhances soil health by boosting its carbon and nutrient content," explains Cohn. Together, these technologies can help mitigate climate change and promote resilience in local ecosystems.

Harris Cohn (Charm Industrial): "CDR encompasses approaches that remove carbon dioxide already present in the air for permanent storage"



Heirloom: "Our technology accelerates the natural property of limestone to absorb carbon dioxide from the atmosphere, reducing the time it takes to absorb it from years to less than three days"

Rudy Kahsar (RMI): "According to almost all climate models, direct carbon capture will be critical in limiting global warming"

Heirloom is another leading company that captures carbon dioxide from the air, specifically through technological atmospheric capture. Their innovation involves using limestone, an abundant and inexpensive mineral. "Limestone can be broken down into calcium oxide and carbon dioxide. When carbon dioxide is removed from limestone by heat, the remaining calcium oxide hydrates with water to form lime. Lime eagerly absorbs carbon dioxide from the atmosphere, acting like a sponge, as it seeks to return to its natural state of limestone." "The carbon dioxide extracted from the limestone is stored underground or in concrete. Heirloom's technology reduces the time for limestone to absorb carbon dioxide from years to less than three days," the company states.

The company claims that by 2035, a billion tons of carbon dioxide could be eliminated at a cost of less than $100 per ton. They believe Heirloom could play a significant role in achieving global carbon elimination targets.

A promising solution

Direct capture of carbon dioxide from the atmosphere is considered one of the most promising emerging technologies on the journey to net zero. **The Rocky Mountain Institute (RMI),** a non-profit organization focused on global energy decarbonization through research, industry collaboration, and policy development, has identified 32 different approaches to direct carbon capture. Additionally, they have created a roadmap to advance these technologies from their current state to achieve large-scale technical feasibility by 2050.

Even if only a fraction of these technologies are developed, the impact on combating climate change is expected to be significant. **Rudy Kahsar of RMI** said, "Carbon capture will be a crucial component from the midpoint of the coming century. To contain warming, accelerated decarbonization of industry and households, along with carbon sequestration, will be necessary. Currently, we are behind global targets. If climate events become more severe, the pressure for action will increase. Over the next fifty years, these changes will drive the implementation of numerous capture projects."

JOHANNES

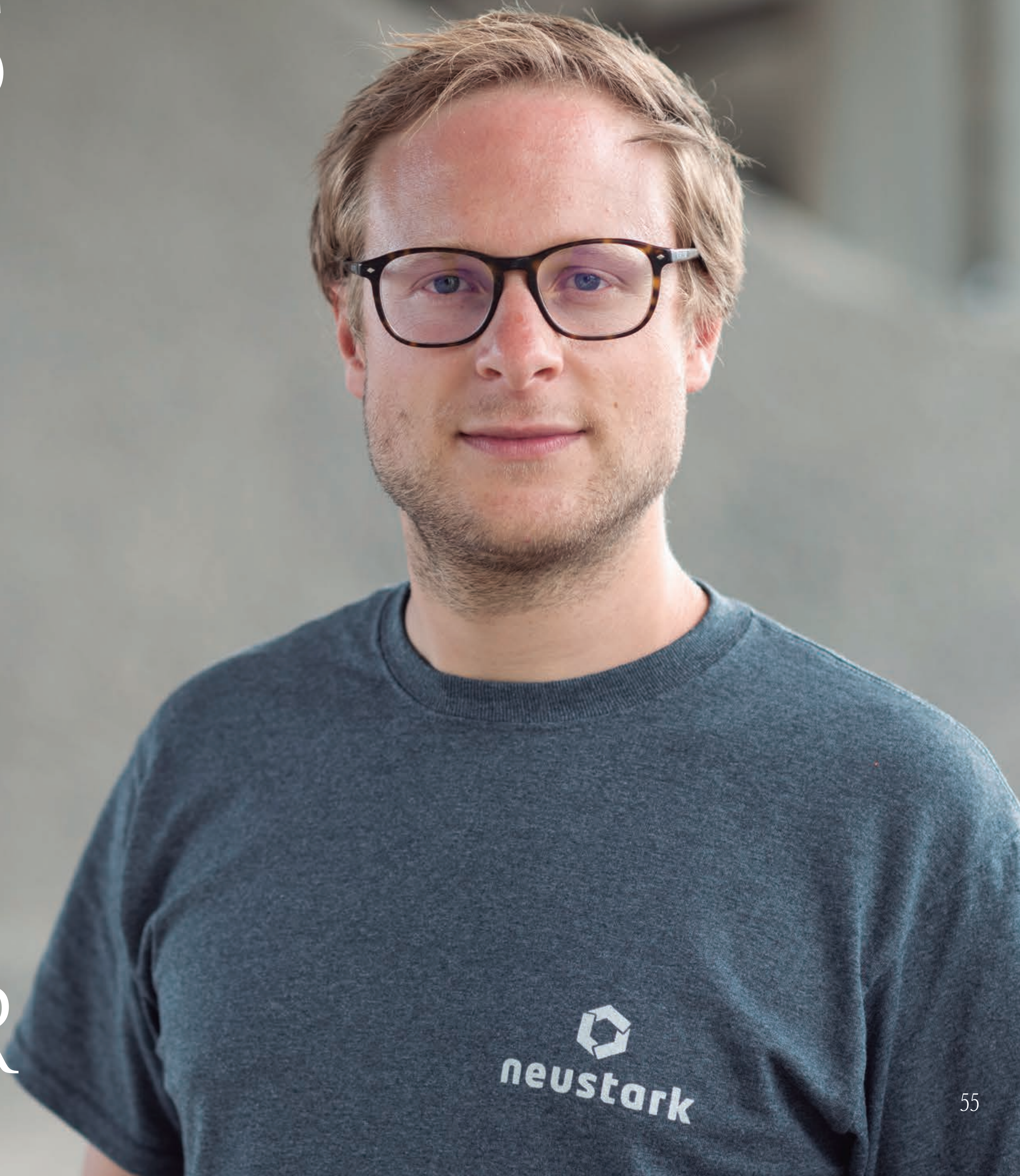
NEUSTARK

“Without technologies that eliminate carbon dioxide permanently, we will not be able to stop global warming”

By **Óscar Granados**

Neustark, founded just five years ago, has developed a technology that captures carbon dioxide from the atmosphere and stores it within concrete, which is capable of retaining it for hundreds of thousands of years. This is a novel contribution to the fight against climate change.

TIEFENTHALER



Johannes Tiefenthaler was, until recently, a laboratory scientist who enjoyed exploring physical and chemical phenomena on a tiny scale. In 2016, while pursuing a PhD in Mechanical and Process Engineering at ETH (Federal Institute of Technology) in Zurich, he realized he wanted to create something with a global impact. "There was a lot of hope. The Paris Agreement had been signed a year earlier, and I wanted to contribute to a better world," he explains. Three years after that initial inspiration, together with his business partner Valentin Gutknecht, they developed a unique solution on the market to capture carbon from the atmosphere.

They founded Neustark, a name derived from two German words meaning "new" and "strong." "Both concepts connect with construction and technology," explains Tiefenthaler. Their technology triggers an accelerated mineralization process, where the injected biogenic CO_2 reacts with the minerals within the demolition concrete aggregate, binding the CO_2 to the pores and surface of the aggregate. "It's a very effective way to fight climate change and promote the circular economy by reusing materials." Neustark has innovated a method for storing carbon in demolished concrete and is now collaborating with companies across Europe that demolish buildings and concrete structures.

Before diving deeper into the project, please briefly describe your background.

I studied Mechanical and Process Engineering at ETH Zurich, where I identified carbon capture and storage as being crucial in combating climate change. This was in 2016, shortly after the Paris Agreement was signed. It became evident that, aside from reducing emissions through traditional methods like electrification and renewable energy, solutions were still needed to address unavoidable emissions in sectors such as cement, steel, waste management, and the chemical industry.

Developing technologies that could permanently remove carbon dioxide from the atmosphere was crucial to addressing the emissions we cannot avoid. Without these technologies, we would have no chance of slowing global warming. That was the start of my journey. At that time, I was about 25 years old.

How did the idea of creating Neustark come about?

When I was a PhD student at ETH Zurich, I met Valentin Gutknecht, who would become the co-founder of Neustark. He was also in the city, exploring the possibility of storing carbon dioxide in demolished concrete. A mutual friend introduced us. In 2019, we founded the company with a viable business model. Although the process might seem simple, it involved a lot of idea-sharing and numerous meetings. We patented the concept, which is common practice at ETH Zurich —if you develop something, you apply for a patent. However, we knew we were serious about the project when we applied for a grant from the Swiss Federal Office for the Environment to run a pilot model of the technology. This grant enabled us to demonstrate that it was possible to scale up our laboratory achievements to apply to several tons instead of just a few grams.

"Our technology initiates an accelerated mineralization process that permanently fixes the carbon dioxide in the concrete"

How does your technology work?

With our solution, biogenic carbon dioxide —naturally produced by living organisms— is captured in biogas plants, where it is liquefied and transported to construction waste recycling facilities. At these facilities, carbon dioxide is injected into concrete granules from demolished buildings and other mineral wastes. Our technology initiates an accelerated mineralization process that permanently fixes the carbon dioxide in the concrete. The resulting carbonated recycled product can be used for road construction or in the production of new recycled building materials. This process enables the captured carbon dioxide to be stored for hundreds of thousands of years, with virtually zero risk of reversion, providing a long-lasting and effective solution for carbon capture and storage. The storage yield can also be converted into certificates —documents that attest to the elimination of greenhouse gas emissions, allowing companies and organizations to purchase carbon credits— which we trade for our customers in the voluntary certificate market.

Why is Neustark's technology so cutting-edge?

We provide technology that allows our partners to eliminate carbon dioxide. Our goal is to eliminate one million tons of carbon dioxide by 2030. This approach is viable today, and I believe we are among the pioneers in scaling this business within an established industry. We currently have 20 plants operating in Europe and more than 50 under construction. While we're primarily focused on Europe at the moment, we have plans to expand into the North American market soon.

Why is carbon removal essential to address global challenges?

When we consider climate targets, we essentially aim to halt global warming, which means we must stop emitting greenhouse gases into the atmosphere. This implies we cannot operate engines that run on oil, gas, or other fossil fuels, and we cannot continue to produce more cement, as it's an activity that emits significant amounts of carbon dioxide.

There are two main reasons why we need carbon removal. First, we are unlikely to achieve zero emissions; there will always be some residual emissions. We won't eliminate all diesel engines or stop using fertilizers, so we need to offset these unavoidable emissions by removing them from the atmosphere. Second, we have a limited carbon budget, and exceeding it will lead to a sharp increase in temperatures. The only way to prevent this is by capturing atmospheric carbon dioxide. However, this should be a last resort. Our primary focus should be on reducing emissions first.

INNOVATION: MAKING A VIRTUE OUT OF NECESSITY

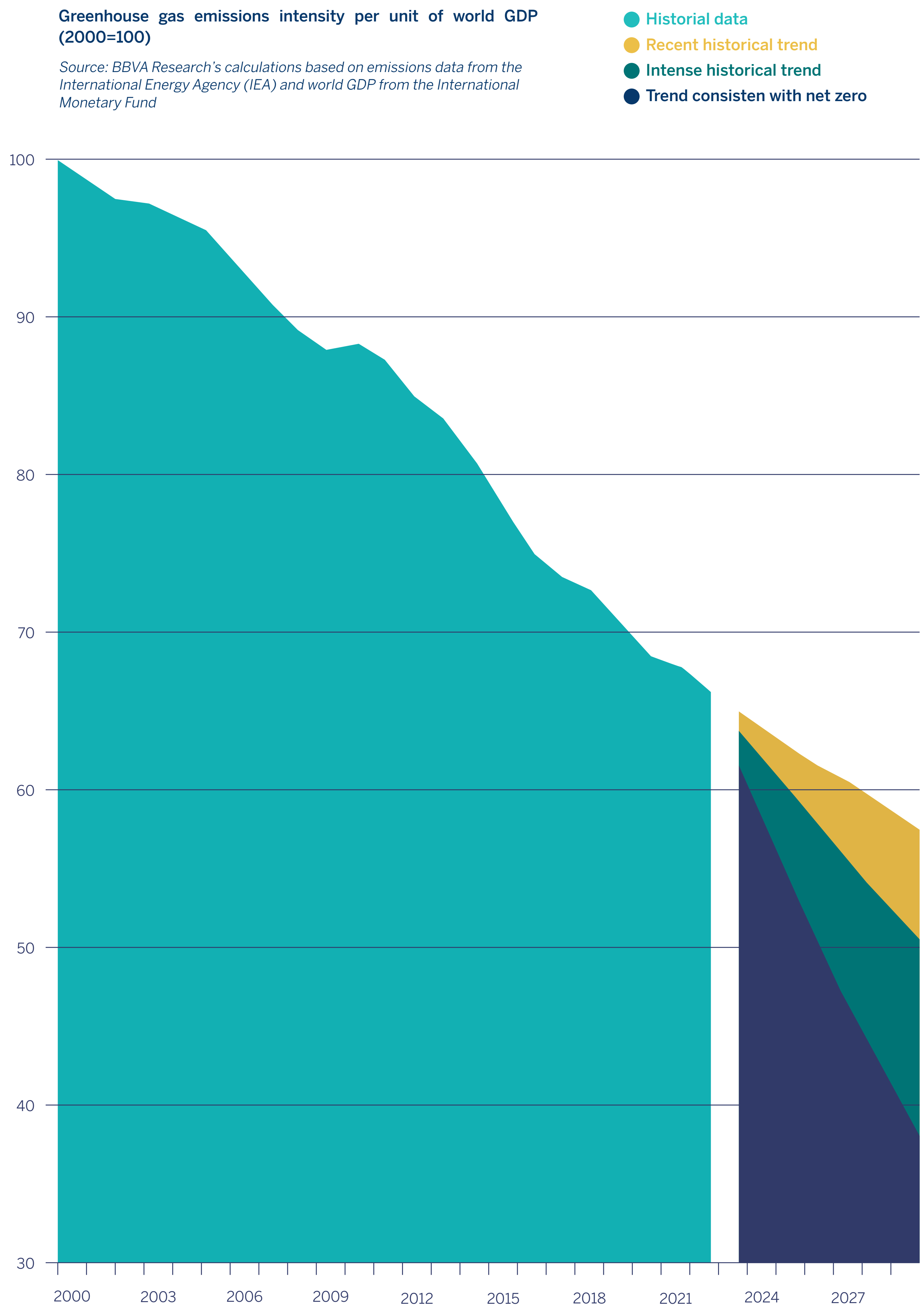
OP-ED

J. Julián Cubero

Lead Economist
at BBVA Research

Greenhouse gas emissions intensity per unit of world GDP (2000=100)

Source: BBVA Research's calculations based on emissions data from the International Energy Agency (IEA) and world GDP from the International Monetary Fund



A simple accounting identity shows that greenhouse gas emissions that build up in the atmosphere and cause climate change evolve according to GDP and emissions intensity per unit of GDP. Global GDP grew by 114% between 2000 and 2022, while emissions intensity fell by 33%. Assuming a trend economic growth of 3%, the current rate of improvement in intensity (1.8% per year on average) makes it impossible to achieve one of the objectives of the Paris Agreement: to limit the global temperature increase to well below 2 °C compared to pre-industrial levels, and to make efforts not to exceed 1.5 °C. In other words, net emissions should be zero by the middle of this century.

We need to reduce the energy intensity ratio and innovate if we hope to make a meaningful leap forward in the emissions trend and put their path on a trajectory consistent with net zero. This is particularly important when we consider that climate policies that seek economic degrowth to reduce emissions are impracticable due to their negative impact on the population's welfare.

Climate change mitigation policies, while exceptionally diverse in the instruments they rely on, essentially pursue the same goal: to make emissions into the atmosphere more expensive to encourage the transformations needed to ensure that production and consumption do not ultimately resort to them. An example of how to make a virtue out of necessity is the oil crisis that took place in the 1970s: the increase in the price of oil and the very real threat of rationing, in addition to making oil drilling profitable in latitudes geopolitically more stable than the Middle East, led to tighter efficiency standards for combustion engines in transportation or increased innovation and greater investment in both nuclear power and renewable energy. All in all, according to World Bank data, the intensity of oil use per unit of GDP fell from 0.12 tons of oil equivalent back in 1970 to 0.05 in 2022, equivalent to a 58% decline Similarly, decarbonization requires innovation, spurred not only by geopolitics and the advantages of having a secure energy supply (as is currently the case), but also by the costs of climate change internalized within economic flows. We also have the sheer price-competitiveness gains provided by certain renewable energy sources that are already cheaper than fossil fuels for power generation. An improvement in the relative prices of renewable energy, once they become consolidated, would lead to further incentives to continue innovating and moving away from fossil energy sources.

Available empirical analysis shows that, in general, countries with more climate policies in place file more patents for innovations aimed at mitigating climate change or receive more "green" foreign direct investment, which may, in turn, boost economic growth in the medium-term. That innovation will eventually lead to more activity is not a given. Europe shares leadership with the United States and China in basic science research, the first stage of innovation, yet in the US marketplace advances end up becoming products in a more pronounce way. Europe is shackled by its below-par private risk financing mechanisms, and public financing also has room for improvement in adapting to the needs of different stages of project maturity to attract more private funding. Notably, the recent Draghi report points to various levers for increasing the financing of public goods, such as innovation, where the gap with the United States goes to the heart of the problem of Europe's low productivity. Aside from the need to increase public financial capacity via a safe asset issued by the European Union, we would also do well to end the fragmentation of European capital markets by completing the Capital Markets Union while at the same time reforming the financial securitization market or extending the mandate of the European Investment Bank (EIB) to collaborate with venture capital initiatives.

It will not be the lack of proposals that will prevent us from making a virtue out of the need to respond to the climate crisis as we look to achieve a meaningful increase in socially and environmentally sustainable welfare.

BBVA