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Building a Net Zero World

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Introducción

The target for the year 2050 is to achieve a carbon neutral world.

"Everything in our world, including the geopolitical order, was created and designed with other temperatures, for other temperatures", says Katharine Hayhoe, in one of the most eloquent sentences on the need to decarbonize our activities, as an unavoidable condition to mitigate global warming and adapt to climate change. "*Getting together to talk about it is the first step*", adds the atmospheric scientist and co-director of the Climate Science Center en la Texas Tech University, highlighting the relevance of this edition of the Future Trends Forum, held from June 14 to 16, 2022, in Madrid, organized by the Bankinter Innovation Foundation.

The name of this forum is **Building a Net Zero World**, as the target for the year 2050 is to achieve a carbon neutral world. The task at hand must start now because any reduction of greenhouse gases (especially carbon dioxide, CO_2) must start with concrete actions, today. This means that the reduction of CO_2 should be reflected in the measurements of the next six or seven years, in order to reach the first horizon—in 2030—with better prospects. This is where the experts agree.

"In absolute terms, we are not decarbonizing", says Professor Vaclav Smil forcefully, because the current industrial system is *"now more dependent than ever on fossil fuels, and, in fact, all countries have increased their dependence"*. Smil's detailed list drives the point home: *"Cement, steel, food production, natural gas, nuclear power plants and hydrogen production; any construction, devices, pipes, batteries and all commercial operations; also, raw materials, everything you eat, what you wear, where you travel, the fuselage of airplanes, plastics, etc... practically everything is transformed using fossil fuels". Furthermore, "83% of energy supply comes from coal, oil and natural gas, and per capita energy consumption will continue to grow".*

The equivalent of 10% of global GDP should be invested by 2050 if we are to achieve a Net Zero world.

This is a global mission: "*It's not about transforming something, but transforming everything at the same time and on a global scale*," says the writer and leader of awareness campaigns with the 350.org group. "*"We must start now, and so far, the international agreements reached are not binding (but 'voluntary contributions'). Engineers, together with civil society and climate diplomacy, make agreements, but that activity is as "noble as it is frustrating, so we need something new,"* says Smil. He also says that the equivalent of 10% of global GDP should be invested by 2050 if we are to achieve a Net Zero world.

A scenario of inequalities

The current climate negotiation scenario, marked by inequality between regions and populations, shows that the poorest 50% of the world's population emit only 7% of total greenhouse gases, while the most polluting countries are China, the United States, India, Russia, and Japan (in that order). It is a fact: responsibility for atmospheric pollution is not shared equally, nor are its consequences, while the gap between the richest and most vulnerable regions is widening day by day. Meanwhile, according to energy market analyst **Atul Arya**, the controversies between Europe's climate policies and the "non-political" policies of the United States continue, leading people to disconnect from warnings about the consequences of global warming and disengaging from potential solutions.

The outlook presents a great challenge, which requires new commitments and strategies that must be designed without delay. From this starting point in 2022, and realistically, it is still very expensive to move to a Net Zero scenario, so we must approach the goal step by step: according to Gonzalo Muñoz Abogabir, we only need courage to approach the goal gradually, but surely.

Atul Ayra

Energy Strategy
and Markets

Watch video

Vaclav Smil

Global energy in 2022

Watch video

Let's get to work

What are the options available today? According to activist and professor Bill McKibben, only "*energy from the sun and wind will enable a rapid and real transition to a time when we can implement a technology at affordable prices*".

Dimitris Zenghelis adds a dose of pragmatism: "*On our way towards 'zero carbon' we will have to redo the calculations, because experience has shown us that we overestimate the costs of renewable energies in all economic models and also those of cars and other devices*". This expert in finance is committed to "conditional optimism": ": for technology to go in one direction, it needs to be "pushed" in that direction.

Renewable energies will require stimuli and a strategic re-do to become the most profitable and efficient. Solar technology is undoubtedly spearheading current efforts.

"*Solar energy will play a key role in the Net Zero transition,*", says Alejandro Micó. This is not a dream, but a demonstrated reality. In the last 15 years, "*the market for solar technology has grown consistently, driven by innovation and lower costs*," according to the expert. Moreover, over the last three decades, solar photovoltaics "*have gone from being a specialized innovation, mostly used for power generation in remote locations, to a conventional source of energy* ".

Renewable energies will require stimuli and a strategic re-do to become the most profitable and efficient.

Dimitris Zenghelis

See profile

Photovoltaic race to reduce costs

Indeed, the efficiency of all photovoltaic technologies has bettered consistently for as long as records have been kept. According to a compilation by NREL, the U.S. government's National Renewable Energy Laboratory, innovations have been continuous over the decades. While efficiency in the mid-20th century was barely 1%, today there are prototypes that exceed 45%. This has also been reflected in the price, where green premiums have made it possible to significantly reduce the cost of photovoltaics. In 1976, producing one watt cost $100. But each time the installed capacity doubled, the cost fell by 20%, until today, when the cost of production is around €0.25/watt, and still dropping.

Ignacio Mártil, professor of Electronics at the Complutense University of Madrid, Spain, says that cost reduction "*accelerated especially in 2007 to 2008, when 2,700 MW of photovoltaic power were installed*" and the long-term effect of this is that "the price per watt of solar power is very competitive". In fact, the International Renewable Energy Agency confirmed in 2021 that photovoltaics is the cheapest way ever created to obtain electricity.

In short, it is an economic constraint. To make renewable energies even more cost-competitive, they need support.

Why is this a key moment in human history and the turning point towards decarbonization?

According to Professor Bill McKibben, there are three reasons:

01

Scarce and pricier fossil fuels—not to mention highly polluting for public health: "When you burn something, you leave toxic particles in the atmosphere. What we breathe kills 9 million people per year (more than the total number of deaths caused by Covid, HIV, malaria, tuberculosis, wars, and terrorist attacks), since one out of every five deaths in the world is linked to air quality".

02

Climate change, which is causing record high temperatures and extreme weather events (in America and Europe), long droughts in Africa in the last four years, melting of the poles and glaciers, with the associated risk of rising sea levels) and the prospect of new exoduses of "climate refugees". If the rise in global atmospheric temperature is not limited to between 1.5°C and 2°C above pre-industrial levels, there will be "horror, chaos and violence". At +3°C, these hazards would be irreversible.

03

The connection between fossil fuels and authoritarian regimes in the world: "*Fossil fuel autocracies represent a threat to our political systems*". Political radicalisms are a feature of this duo. Fossil fuels are concentrated in a few places on Earth, which gives inordinate economic power to those regimes, such as Saudi Arabia. The war between Russia and Ukraine, for its part, has impact on the price of gas.

This is a key moment in human history and the turning point towards decarbonization.

Bill McKibben

A new cold war in a warming climate

Watch video

However, there is good news. For McKibben, "*the energy transition is technically possible, combining the development of batteries with hydro power*", and, of course, because in recent decades, thanks to the work of engineers and scientists, the price of renewable energies has fallen enormously. "*Wind and solar will also have an impact on future prices (not only as a solution to combat climate change), because, in addition, by avoiding the costs of transporting fossil fuels, money will be saved*," he says.

Speed and scale

The challenges, summarized by Atul Arya, are to strike a balance between the lifestyles of the global North and the global South and to focus on scale, i.e., to invest in the production at scale of the most reliable technology in terms of energy savings and efficiency. The key words at this point in the journey are therefore **speed and scale**: speed in transforming innovative ideas into concrete solutions and the scale of these solutions in markets or its implementation by states, so that they eventually reach the general population. These changes take years.

These were some inspiring questions about the balance:

01

Are physical limits to our resource consumption needed? If not, how many planets are we going to consume per year?

02

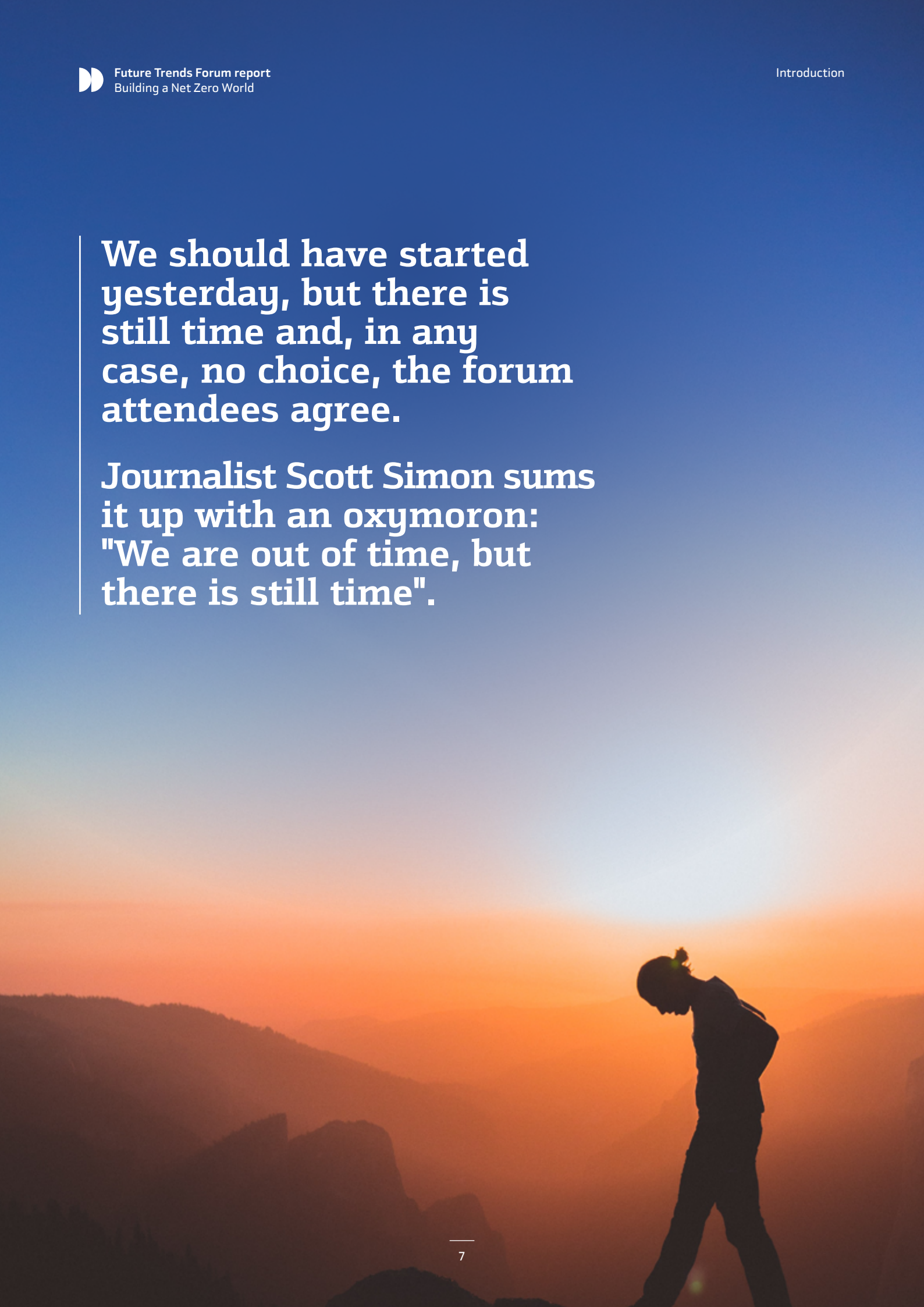
Besides counting on the resilience of the inhabitants of the global South—who were not the main cause of the problems—how to make a just energy transition while avoiding paternalism?

Speed in transforming innovative ideas into concrete solutions.

It is necessary to ensure affordable, secure and sustainable access to energy throughout the world, through initiatives such as the "Grand Bargain". According to this expert, in order to reach a Net Zero world, it is much more convenient to invest in less developed countries than in developed ones. For this, financial incentives are needed so that investing in Nigeria or India is not six times more expensive than investing in the US or Europe.

We should have started yesterday, but there is still time and, in any case, no choice, the forum attendees agree.

Journalist Scott Simon sums it up with an oxymoron: "We are out of time, but there is still time".



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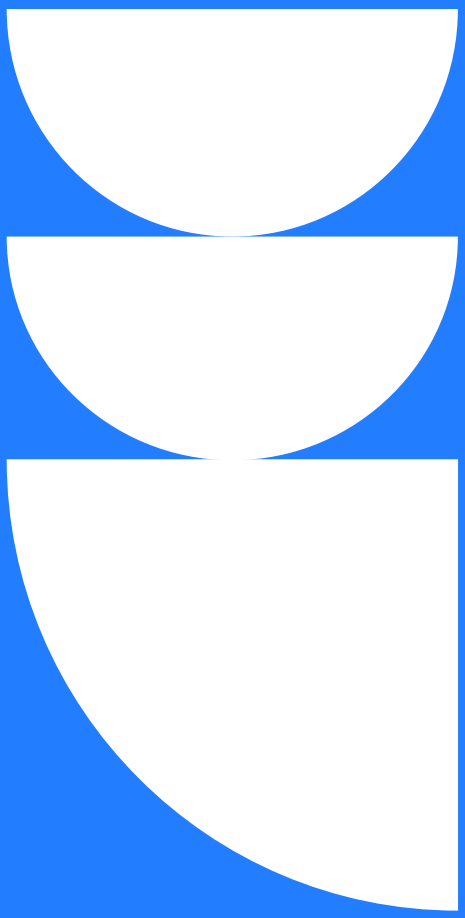


Energy in a Net Zero World

Green Hydrogen

Carbon Capture

Nuclear Dilemma

1

Energy in a Net Zero World

Renewable means endless, whether these resources exist in nature (and are renewable) or are obtained through infinite processes. Therefore, **solar and wind** are the absolute best renewable sources, together with the products of the Earth, such as certain plants and organic waste, which give way to biomass and biofuel. Also, from the Earth (and its hot rocks) comes geothermal energy, and from water (hydraulic) energy, produced through gravity, or by tides and marine currents.

These processes result in 'clean' or green energies generate little environmental impact and emit a small (or null) volume of greenhouse gases into the atmosphere. Then, there are other technology-enabled processes, as well as **new synthetic fuels** that are shaping up as serious contenders to supply the energy needed by great economic sectors, which still rely on fossil fuels for energy at the moment.

Among the key sectors of our economy, road transportation, aviation and the maritime industry topple the ranking. Their emissions could be reduced using biofuels produced from bio-based raw materials (forest waste, lipids); synthetic fuels (from renewable H_2 and captured CO_2) and other low-carbon fuels from non-biological waste.

Technologies based on green or renewable hydrogen (H_2), as well as eco-fuels, are our hope for the coming years, in order to achieve the longed-for decarbonization.

Green Hydrogen

Part of the carbon footprint produced today by electricity generation and industrial processes in general, as well as agriculture, transportation, and waste management, can be mitigated through the use of energy from renewable sources. However, there are economic sectors in which neither solar nor wind energy, nor electrification, are good solutions. In these cases, technologies based on green or renewable hydrogen (H_2), as well as eco-fuels, are our hope for the coming years, in order to achieve the longed-for decarbonization.

Renewable H_2 is undoubtedly a clean energy vector: it is obtained by the electrolysis of water using electricity from renewable sources, and that can be used to generate electricity directly by means of hydrogen fuel cells and to produce biofuels. However, H_2 still has some development ahead of it: there are technical challenges (related to the generic difficulties of gases) and economic fundamentals to be resolved.

Some key facts

01

The demand for hydrogen in 2020 was 90 million tons, virtually all for refining and industrial applications and produced almost exclusively from fossil fuels. But there are encouraging signs of progress.

02

Global capacity of electrolyzers, needed to produce hydrogen from electricity, has doubled in the past five years to just over 300 MW by mid-2021. Some 350 projects currently under development could bring global capacity to 54 GW by 2030.

03

Another 40 projects, totaling more than 35 GW of capacity, are in the early stages of development. While this is a significant figure, it is still far short of the 80 million tons needed by 2030 on the path to net CO_2 emissions by 2050, according to the IEA's roadmap for the global power sector.

Main obstacles or problems:

Price

There are also obstacles on the road ahead before H_2 can be used as a fuel, such as price. "Green hydrogen is still very expensive (it is four times more expensive than natural gas), so we are going to use hydrogen where there are no other viable technologies," said Marcelino Oreja, speaking at the Future Trends Forum. Oreja adds that, despite this, there are technologies that can be combined, such as electric vehicles that also consume hydrogen. And as for prices—although it is "difficult to predict prices"—hydrogen will become more competitive if fuel costs continue to rise, so blue hydrogen (i.e., obtained from fossil fuels but with CO_2 capture) could be used until green hydrogen can be produced at scale.

Volume

Among the challenges that give engineers the most headaches are the fact that, with the same performance as kerosene, H_2 has the disadvantage of being more voluminous. As a gas that is not very dense, if you want to transport a lot of energy, you need very large volumes, because that energy is difficult to concentrate. This means that it will have to be compressed or liquefied, for example, to run airplanes and/or ships with pure hydrogen. In the latter case, very low temperatures (-253°C) are required for the H_2 to liquefy, and very heavy tanks are needed.

Marcelino Oreja

See profile

Global race behind synthetic fuels that will harness biomasses, captured CO_2 and renewable hydrogen is on.

The race for synthetic fuels

The choice of renewable raw materials in the production of energy for electrolysis (separation of water molecules) by which H_2 is obtained, and the next step for the production of synthetic fuels could include, in the near future, CO_2 captured from the atmosphere or from some industrial process.

Indeed, with the major fossil fuel companies themselves already engaged in this research, as well as in adapting the operating technology of combustion engines, the global race for synthetic fuels that will leverage biomass, captured CO_2 and renewable H_2 is on.

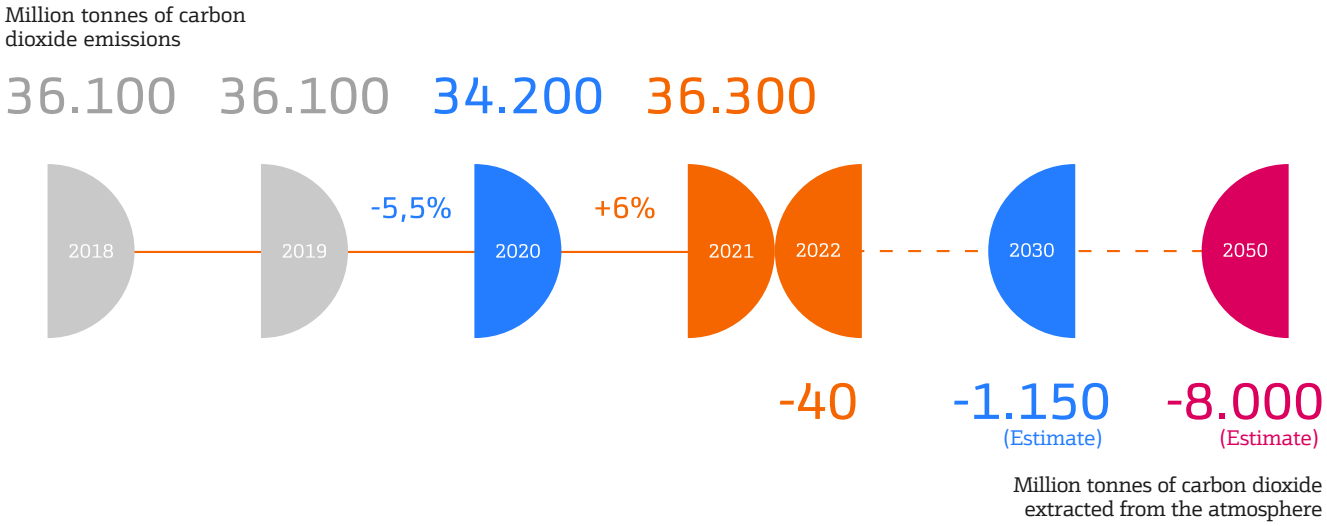
Technologies that will shape the future Net Zero

Watch video

The energy-related carbon dioxide emissions reached a new global record.

Carbon Capture

In 2021, energy-related carbon dioxide emissions reached a new global record, at 36.3 billion tons (due to the increased use of coal, following the pandemic hiatus), according to figures from the International Energy Agency (IEA). In fact, the IEA itself recommends carbon capture, utilization and storage (CCUS) as one of the best solutions for extracting tons of CO_2 from the atmosphere every year. Specifically, if installed in industrial plants to capture what is released on site, it is estimated that this technology could avoid the emission of eight billion tons of CO_2 by 2050, and would facilitate the decarbonization of highly difficult sectors, as explained by Ana Karen– COO at Climate Trade– at the Future Trends Forum.



It is a set of technological innovations with plenty of promising developments ahead of it.

Some data on current projects:

As of today, only some 20 projects worldwide based on these technologies are up-and-running, so there is a **huge business opportunity associated**, she says, with technologies and innovations that lower capture costs.

Currently, there are 16 projects in advanced planning stages, including several facing a final investment decision (FID) in the next 12 months, representing **a total estimated investment of more than $27 billion**. This is almost double the investment in projects commissioned since 2010.

Nuclear Dilemma

In view of the difficult energy situation the world is going through, many scientists and engineers involved in this activity are wondering whether the time has come to review nuclear energy policies, so that it can once again become a viable alternative to fossil fuels. This time, they argue, it could be added to the list of "clean" energies, since it does not release greenhouse gases, although the thorny issue of hazardous waste remains unresolved. One such scientist is Atul Arya, who advocates "clean" electricity through nuclear, hydroelectric, and geothermal energy, while responding to the investments needed by emerging regions to contribute to the decarbonization of their own economies. Very recently, the European Parliament approved the European Commission's decision to qualify as "green" all nuclear power plants that have a construction permit before 2045.

Other voices are strongly opposed to reconsidering the "advantages" of nuclear energy and propose instead to put the emphasis on developing solar and wind, investing more in the grid to supply for electric vehicles and standardize all related processes and designs.

However, two possibilities for harnessing nuclear energy are emerging on the horizon:

01

Innovations in the field of nuclear fission, specifically the so-called small modular reactors (SMRs). COne of the most promising startups in the design, construction and commissioning of this type of solution is TerraPower founded by Bill Gates and backed by Warren Buffett, It expects to have the first plant operational in 2028, with its modular reactor Natrium.

02

Continue to support innovations and developments in nuclear fusion (the union of atoms that release energy), instead of nuclear fission (which consists of splitting the nucleus of the atom). This fusion technology, which is still in its infancy, is also mentioned as one of the decarbonization solutions that will be available by 2050 (but probably not before 2045). In this field, the work of ITER (International Thermonuclear Experimental Reactor) and many startups are making spectacular progress in the two types of solutions being developed:

- Inertial confinement nuclear fusion, (ICF), including Germany's Marvel Fusion.
- Nuclear fusion by magnetic confinement (MCF). So far led by the international ITER consortium, but with new players such as TAE Technologies, which promises a commercial solution within a decade.

Two possibilities for the use of nuclear energy

The Future Trends Forum, a place for discussion

The debates at the Future Trends Forum covered the responsibility of governments and politicians in supporting innovative energy projects and citizen protests that sometimes turn into outright opposition to the installation of windmills for wind energy generation or solar panels in their territories.

Additionally, when discussing energy sources, there is no shortage of stories about self-supply experiences, in contrast to those who defend electricity grids, the progress they bring and what they have meant in the life of contemporary societies. To the question of whether to decentralize the system, Alejandro Micó answers that both options are compatible (even to prevent outages), as long as a person/household that is self-sufficient can connect their surplus energy to the grid and sell it.

In short, policy making must be flexible enough to enable disconnecting from the grid or switching sources, or even setting up small, sustainable, and interconnected grids, in rural or urban areas. Indeed, microgrids (parallel or decentralized power grids) can boost the development of renewable energy user communities that contribute to the decarbonization of the whole.

Alejandro Micó

See profile

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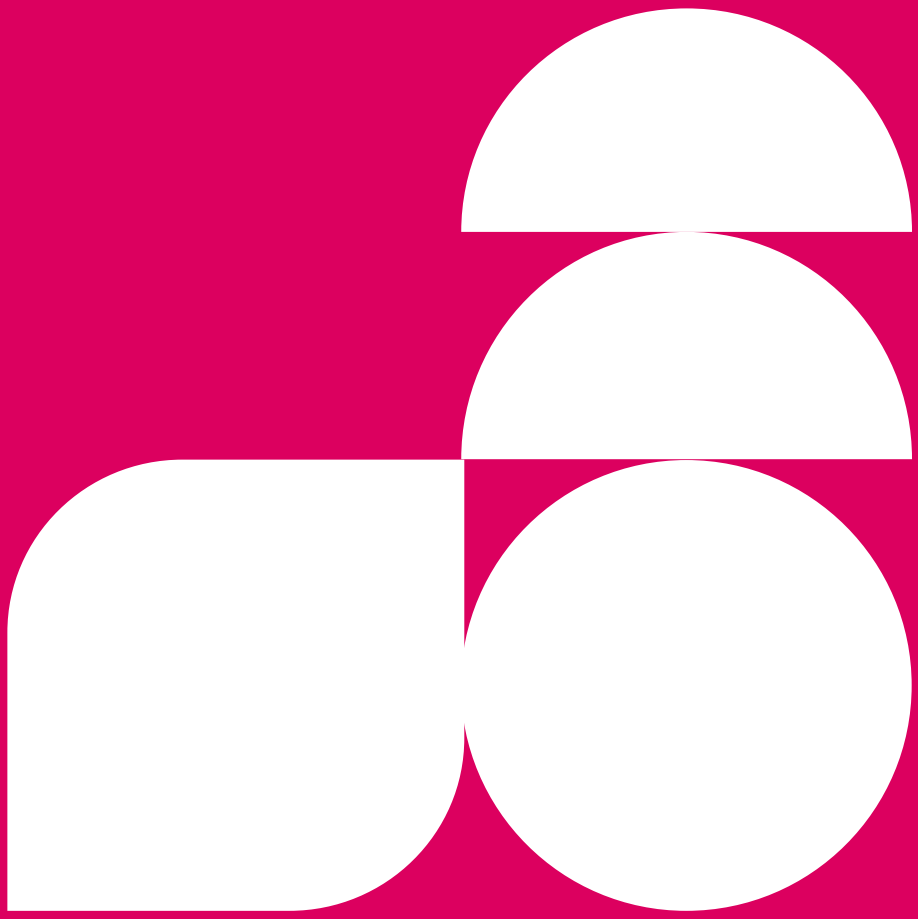


Economics in a Net Zero World

Agrobusiness and regenerative crops

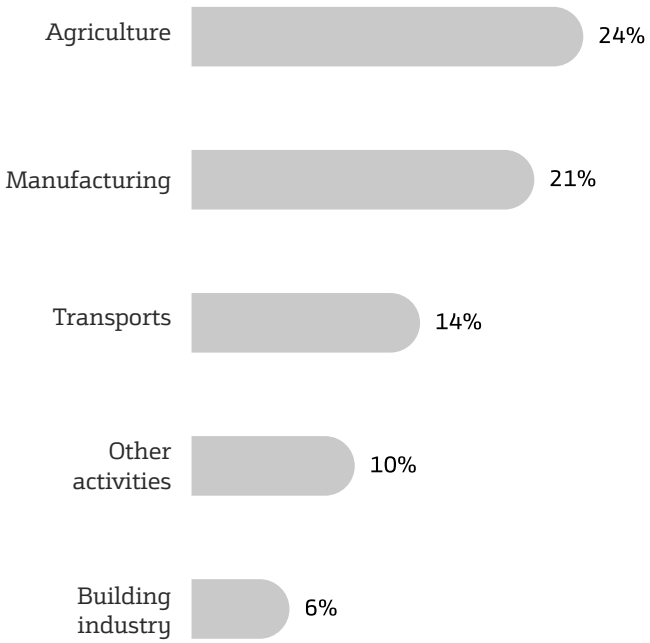
Energy, Industry and Transportation

2

Economics in a Net Zero World

There are as many ideas and business opportunities as there are stones to overcome along the way towards a decarbonized economy.

According to the Intergovernmental Panel on Climate Change - IPCC (2014 report), this is the ranking of economic sectors based on their total greenhouse gas emissions:



The decarbonization of the electricity sector has advanced thanks to rapid growth in the deployment of wind and solar photovoltaic power. Transportation will require a broader set of responses (electric vehicles, biofuels, and synthetic fuels). In addition, financial tools such as carbon credit trading and differentiated taxation will play a greater role, according to Atul Arya. Meanwhile, in agro-business, some of the best responses are in natural carbon sequestration that occurs in healthy, oxidation-free soils.

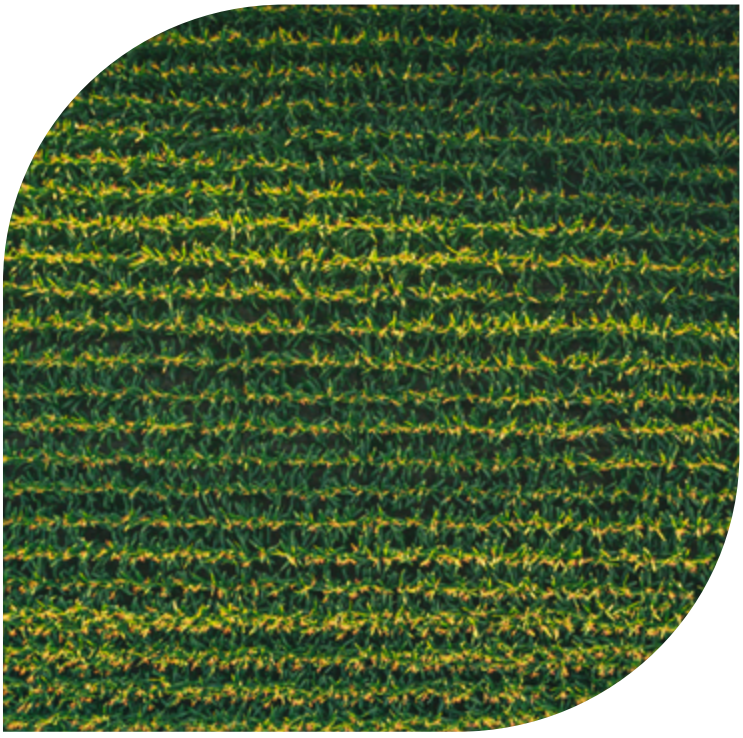
Context matters

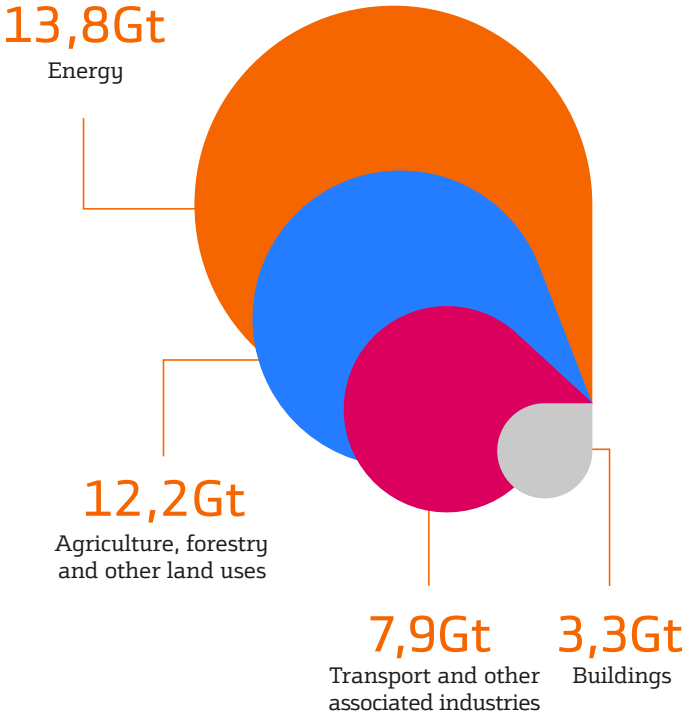
Indeed, there are as many ideas and business opportunities as there are stones to overcome along the way towards a decarbonized economy. As Marcelino Oreja indicated in the meeting's kick-off document , the historical context marked by the war in Ukraine will accelerate the need to reduce dependence from Russian gas and gas in general. Not to mention the fact that the difficulties in the production and marketing of grains and basic raw materials are being felt more and more acutely internationally. Thus, **carbon neutrality will no longer be driven solely for environmental reasons, but for fundamentally economic reasons**.

When almost everything that's a staple is at stake, new strategies for approaching the goal must be devised, and clear priorities must be set. For Cristopher Upton one of the first tasks to be undertaken is to "decouple food production from fossil fuels, starting with agriculture". This is undoubtedly the source that guarantees food, and the sustainability of agriculture also depends on the preservation of forests and, with them, grasslands, which function as one of the main natural carbon sinks. Photosynthesis is, in fact, an essential, natural mechanism for CO_2 capture.

Agrobusiness and regenerative crops

To address the issue of sustainability in the agri-food sector, it is important to know that out of the total 53 gigatons of greenhouse gas emissions (as of 2017, according to FAO), 13.8 correspond to energy, 12.2 to agriculture, forestry and other land use (AFOLU), 7.9 to transportation and the same amount to other associated industries, as well as 3.3 Gt to buildings. As for the carbon footprint caused by food waste, it is estimated at 3.3 billion tons of CO_2 per year.





Currently, 24% of greenhouse gases come from the agri-food sector. In this case, restoring 15% of agricultural land could capture 30% of the total CO_2 emitted since the Industrial Revolution.

However, regenerative agriculture could contribute to at least minimize the impact of tillage by maintaining plant cover throughout the year, through crop rotation (high nitrogen vegetables and deep-rooted perennials), integrated nutrient management (compost, manure, reduction of chemical inputs, soil enrichment with biochar or clay) and a mixed use of crop and livestock on the land.

Currently 24% of the greenhouse gases come from the agri-food sector. In this case, restoring 15% of agricultural land could capture 30% of the total CO_2 emitted since the Industrial Revolution. The estimate, according to Cristopher Upton and Julie Sigles, could capture two to five Gt of CO_2 per year by 2050. This, in turn, would facilitate biodiversity conservation and restore ecosystem services, reducing the risk of desertification, while reinforcing food security, preventing the increase in food prices and, consequently, many of the conflicts that are starting these days and that result in massive, forced migrations.

Some uplifting platforms

Hence, according to Sigles and Upton, digital platforms complement the different experiences of rural producers and provide them with various services (advice, online payments and other IT developments) and the possibility of obtaining carbon sequestration credit certifications, according to international mechanisms.

These are initiatives that could be integrated into government programs at different levels of the Administration, such as the one that concerns Gita Syahrani, an expert in governance and sustainability, who leads an association that brings together several Indonesian districts, aligned with open government models and guided by the sustainable development goals and reduction of emissions through economic models that include the restoration of ecosystems.

Christopher Upton y Julie Sigles

Challenges and Opportunities for Agriculture

Watch video

Gita Syahrani

Going green:
an Asian view

Watch video

Cleantech sector in transportation and logistics is booming in terms of investment in startups.

Energy, Industry and Transportation

Solar energy is the least expensive way to produce electricity, says energy expert Rosa Sanz. The technologies that will be used to produce tomorrow's energy are, today, prototypes. With this in mind, it is necessary to reduce consumption (A plan for energy savings and efficiency in air conditioning has been approved in August 2022 in Spain) and to advocate for energy sovereignty, as we may be facing possible disruptions in the supply of imported materials for the construction of solar panels and other devices needed for the renewable energy sector.

If a country wants to move towards energy sovereignty, it must invest in innovations that allow it to control most of the entire energy chain, always bearing in mind energy security, as understood by the International Energy Agency, i.e., as the uninterrupted availability of energy sources at an affordable price, together with environmental sustainability. Therefore, the quest for energy sovereignty will bring us closer to Net Zero.

It is a propitious moment to promote "innovative markets", with incentives and the necessary participation of citizens. It is therefore an opportunity for the economy, but also for citizens.

Rosa Sanz

Main energy opportunities

Watch video

Decarbonizing without losing competitiveness

This is the imperative that Cristina Rivero, raises at the CEOE, since the European Union itself intends to be the first carbon neutral region in the world by 2050 (the same goal in China has been postponed to 2060). The action plan with this horizon includes:

01

The Next Generation Funds recovery plan.

02

A European taxonomy of sustainable activities, which includes a classification of these activities according to their actions towards sustainability (mitigation/adaptation to climate change, rational use of water and marine resources, transition to a circular economy, prevention and control of pollution and protection and restoration of biodiversity and ecosystems), in order to measure environmental impacts and/or access to public aid, among others.

The key to decarbonizing industry is to reduce emissions in industrial heat generation. The expert also points to **the recycling of materials** as another way of reducing energy needs. In Europe, only 12,8 percent of material resources come from recycled or recovered products.

Cristina Rivero

Keys challenges and opportunities of industry

Watch video

According to Atul Arya, industries such as steel, cement and fertilizer must first be decarbonized before moving towards neutrality in the electricity sector. The road transportation sector is among the most difficult, since it is very difficult to electrify (such as freight and long-haul transport), together with the maritime sector and aviation.

Some key figures

01

Road transportation (cars, vans, trucks, and buses) produces **more than 70 % of the total greenhouse gas emissions** of the transportation sector in Europe.

02

The remainder comes mainly from maritime and air transport. So says the European Environment Agency.

03

It also warns that **transport consumes a third of all energy** consumed in Europe and accounts for a quarter of all greenhouse gas emissions and is the main cause of air pollution in cities.

04

Worldwide, transportation is the sector most dependent on fossil fuels and accounts for 37% of CO_2 emissions, according to the International Energy Agency.

The cleantech sector in transportation and logistics is booming in terms of investment in startups: in 2021 it broke the record for total venture capital investment, with more than $51 billion, according to the specialist portal Cleantech.

There are some initiatives in the United States to achieve fuel efficiency in the use of large trucks that use gasoil and still have no close prospects for energy conversion. At the Future Trends Forum, Daniel Burrows presented TruckWings, which could help reduce up to 100 million tons of CO_2 per year.

Daniel Burrows

Challenges and Opportunities in Mobility and Transport

Watch video

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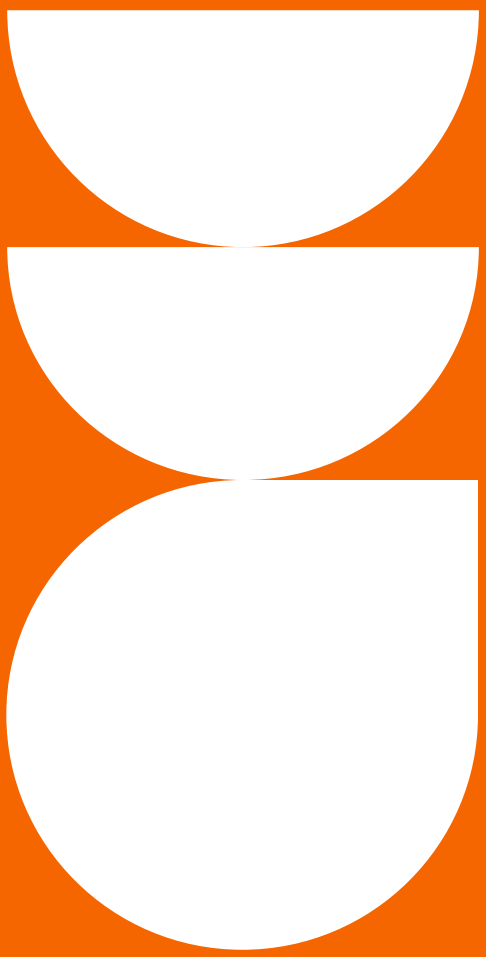


Technology to Build a Net Zero World

Sun and Wind

Energy Storage

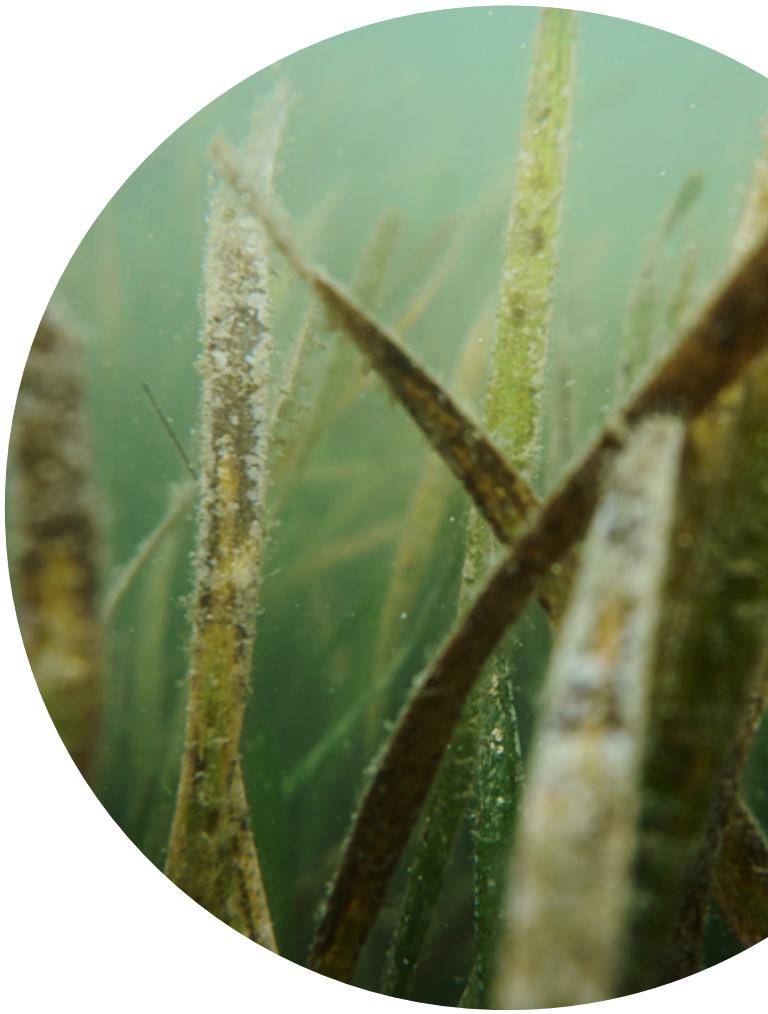
3

Technology to Build a Net Zero World

All technological solutions have, for the time being, their limitations. All energy generation devices still must replace parts derived from fossil fuels—even when renewable sources of energy are used. And then, in the quest towards decarbonization we must net greenhouse gases already emitted and still present in the atmosphere. Hence, any innovation related to carbon capture and storage is welcome, especially if it is a nature-based solution.

CCS (CO_2 capture and storage) technology is fundamental to the energy transition, yet there are only 20 commercial operations in the world that leverage it at present, according to **Ana Karen**. Why? The costs: both when capturing direct emission sources or CO_2 diluted among other gases or in the air, which is even more expensive. This is why technological innovations such as **BioUrban**, which performs the function of a tree—but bigger—are being followed with great interest by the market. It is a container with microalgae that feed on polluted air and following a natural process of photosynthesis, can release oxygen and produce biomass. "Each of these devices captures between 40 and 60 tons of CO_2 from the atmosphere each year, the equivalent to the amount of oxygen produced by 368 trees," says the Climate Trade executive.

Algae and fungi are irreplaceable allies in this transition to a decarbonized economy, as every day we discover that their CO_2 capture capacity is greater than imagined. These explorations in carbon capture (both nature-based solutions and those based on technological progress or a combination of both) still lack scale in the transformation, storage (or compression), as well as in the use of CO_2 for the design of viable and affordable biofuels.



The Potential of Biogas

However, there are other possibilities currently available and within reach, such as the production at scale of biogas, a fuel generated by the biodegradation of organic matter in the absence of oxygen (waste-to-energy). Biogas from plant waste can be used to produce heat or generate electricity. **Katrin Puetz** aims to help countries in the global South to produce biogas locally, so that they do not depend on financial aid from the developed world. Puetz, who has worked on the construction of a transportable biogas set with the University of Addis Abeba (Ethiopia), says that 80% of the energy consumed in Africa is for cooking, so biogas would be a relevant response to their needs. On the basis of her constructive tests and her own experience in energy self-consumption, her mission is to contribute to the creation of an international biogas market that will nurture a "new economy" and the economic and energy independence of developing countries.

Speaking of waste and emissions, **Gleb Yushin** is also committed to

01

Reducing them (or at least preventing the decomposition of various organic compounds that contribute to pollution) .

02

The massive adoption of efficient, low-cost technologies to complement all renewable efforts towards net zero. With this idea of energy efficiency in mind, he works especially in the field of new energy storage materials and devices, batteries, and their impact on transportation and grid applications.

Katrin Puetz

See profile

¿And what about the batteries?

There are multiple challenges around batteries, because materials and designs must be replaced in order to reduce their size and also to limit their costs, which tend to skyrocket in times of crisis in the supply of raw materials—as is currently the case. From his point of view, there will come a time **in technological development when the useful life of batteries will be extended by several decades** and the user will be able, for example, to take them from one car to another, in order to optimize and/or reduce the purchase of new materials and thus reduce waste. "Revolutionary batteries revolutionize products" is one of the mottos of **Sila Nanotechnologies**, a company co-founded by Yushin, which focuses on setting up factories that enable the scale production of new storage cells. Having luxury electric vehicles with efficient batteries on the market is no longer a utopia.

Sun and Wind

The great solar revolution of the last 40 years continues. The good trends continue. **Alejandro Micó**, a specialist in solar energy, reinforces the idea that costs are going down and efficiency is going up in this sector. In his own words, there are panels today that generate 700 watts and, ten years ago, they did not exceed 200 or 300 watts. People today can easily install solar panels in their homes; laboratories continue to innovate and the market feeds from these innovations. In his opinion, developments show that it is necessary to continue exploring alternatives, making mistakes, testing, analyzing possible scenarios for combining energy sources (for example, generating alternating current with solar and hydrogen) and resolving paradoxes such as the one that indicates that the best prices for solar energy are in the desert (where it would be necessary to bring water to enable electrolysis to obtain renewable hydrogen). In any case, according to Micó, big problems need to be broken down into smaller, more manageable problems that allow progress to be made step by step.

Kite power alert

As for wind power, there is a vast sky to be tapped, given the expectations opened up by kite power (high altitude wind power generation). Currently, wind power on the market is limited to fixed windmill structures, with a height of no more than 200 meters. However, in kite power, airborne devices leverage wind at higher altitudes, where air currents are significantly stronger and more persistent, generating a steady stream of power. For some years now, this technology has already been developed in prototypes consisting of an inflatable membrane attached to a motor/generator at ground level.

Prototypes of biofuel-powered airplanes, are already being tested, and a prototype ship, is even being prepared, equipped with solar panels and producing hydrogen from seawater. Oceans could be another source of clean energy, harnessing deep sea currents.

In any case, according to Micó, big problems need to be broken down into smaller, more manageable problems that allow progress to be made step by step.

Finally, extremely promising technologies are currently being developed around quantum computing. The quantum approach to problems makes it possible to multiply scenarios and states to provide more accurate calculations in a few steps. Having simulations and opening new logic gates through quantum computing technology will make it possible to make broader and more reliable estimates on materials. It is also important for GPS applications/ navigation systems, any remote connection (radio communications, satellite information) and a wide range of computing capabilities (such as those being studied by Q4Climate) that will be able to generate new algorithms to analyze and predict climate change impacts and contribute to mitigation or adaptation. As Tracey Forrest points out, quantum computing will bring about significant advancements, creating new materials in the fields of high-temperature superconductors and the efficiency of solar panels, among others.

The advancement of data programming interfaces will favor the development of delocalized communities.

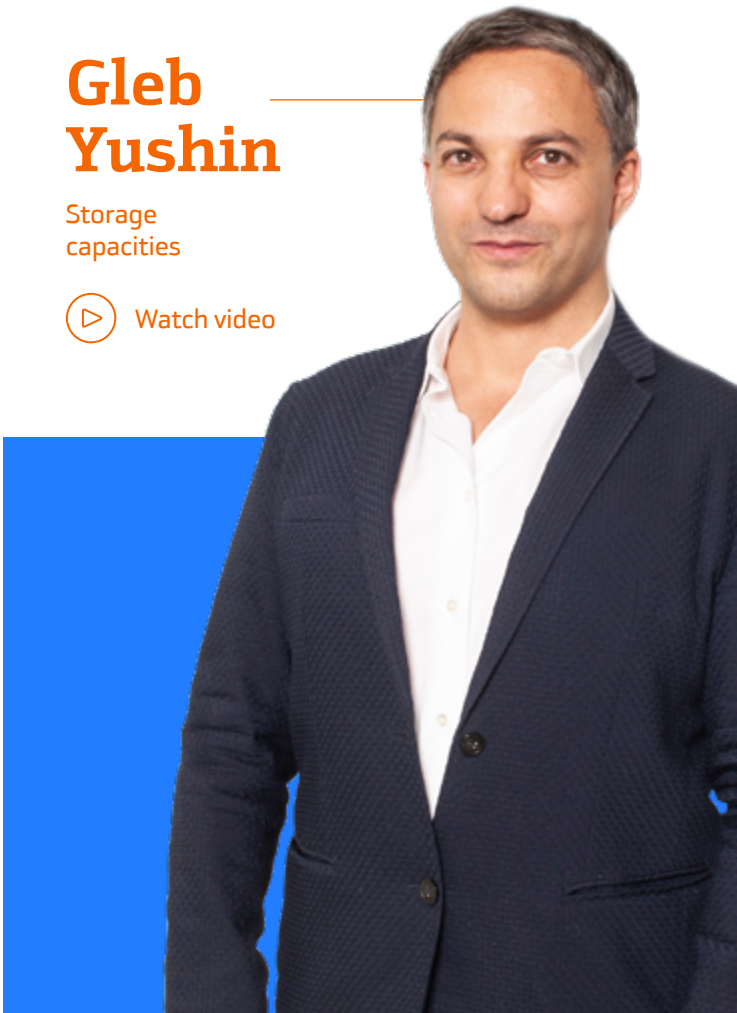
Energy Storage

According to nanotechnology expert Gleb Yushin, a new generation of materials will enable the construction of batteries that are "twice as small, three times lighter and significantly cheaper than today's batteries". Yushin estimates that these new materials will be available in about a decade. The cost of energy storage will then be cut in half (from the current $100 per kilowatt-hour to about $50 per kilowatt-hour). In his projection, these batteries could cost about $30 per kilowatt-hour in two decades.

These calculations are very promising for transportation, since in the not-too-distant future, electrification will be possible not only in automobiles but also in other types of vehicles and could reach sectors such as aviation and green storage. Yushin is optimistic about this "inevitable" transformation, which will lead, in two decades, to an almost complete renewal of the vehicle fleet and, therefore, to a 80% or 90% share of electric vehicles out of the total.

Tracey Forrest

See profile



Gleb Yushin

Storage capacities

Watch video

Energy Storage

Synergy between all technologies is needed and there is unanimity on this. The answer lies in combining energy sources and forms of power distribution, while investing in:

01

The development of batteries made of inexpensive materials, with high energy density and fast charging.

02

Innovation to improve energy production, storage, and transportation.

03

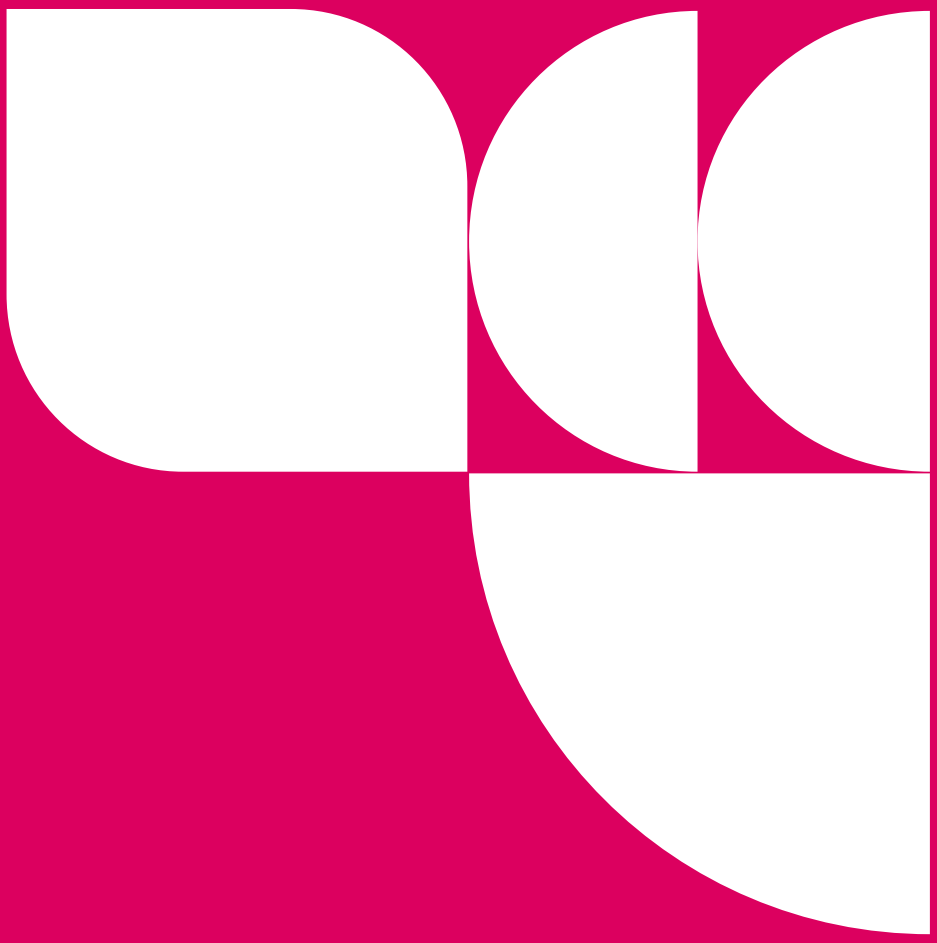
Capture, storage, and reuse of CO_2 solutions (CCUS).

04

Technologies for the creation, compression and storage of hydrogen and new synthetic fuels.

At the same time, greater **energy efficiency** is being pursued through innovations in artificial intelligence and Internet of things (IoT) leading to Internet of Energy (IoE) mientras se desarrolla la computación cuántica que impulsará new solutions, new materials and new ways of tackling problems.

4



Social Change and Behaviors in a Net Zero World

4

Social Change and Behaviors in a Net Zero World

Agents Involved in the Change

Trust and commitment to building a Net Zero world depend, to a large extent, on the fairness with which the process towards the decarbonization of the economy is managed, since so far the fight against climate change has not been perceived as an equitable negotiation among nations and, in fact, energy consumption per capita is still very different in Africa, China, the USA and Europe.

More than four billion people, precisely those who are the least responsible for global warming, suffer its consequences on the front line. Hence the imperative to shift the fight against climate change from a voluntary approach to a real and joint commitment, engaging not only protocols between states, but also non-state actors (cities, regions, associations), companies and financial institutions.

This is the enthusiastic claim of Gonzalo Muñoz –a Chilean businessman elected as 'High Level Climate Action Champion' after the signing of the Paris Agreement–who calls for multilateralism with negotiators from the "real world". Because the implementation of an agreement "requires scholars, businessmen, banks and non-state agents", i.e., non-governmental organizations, municipalities, cities, regions, district managers and representatives from the rural world.

A model that raises awareness

Muñoz, being a businessman who "follows science", developed an agenda to whip up willpower around compliance with the recommendations of the United Nations COP, held in Paris in 2015. The result? In just three years, ten thousand entities adhered to commitments to reduce emissions, with the aim of ensuring that the planet's temperature does not rise more than 1.5°C during this century, compared to pre-industrial values. Specifically, it is an alliance in which there is "money committed to not supporting actions based on fossil fuels or companies that promote deforestation" and that

act with solidarity as a guide, bearing in mind that the global South is not the party responsible for most of the pollution and that, nevertheless, it is the poorest—and particularly women—who are the most resilient in contemporary society.

Muñoz is convinced that there is a possibility of "contagion" (in the good sense of the word) or transmission of behaviors between companies, regional entities, scholars, and governments, as long as politicians are not left alone to design relationships.

Regarding the alliance (called Climate Action Agenda) that, within the framework of the United Nations, is made up of a thousand cities, almost six thousand companies and investors and a thousand educational institutions, among others, Muñoz asks non-rhetorical questions:

Is there greenwashing there?
Yes.

Do these practices need to be cleaned up?
Yes.

But the truth is that more than 20% of sectors led by the planet's major economic players have signed to follow the dictates of science, validate a joint plan, implement it, and publish the results of this effort once a year.

The achievements outlined by Muñoz could not be fully understood without considering that the narrative towards a Net Zero world has also shifted in a short period of time: from a 2°C ceiling for 2050, to a maximum accepted temperature increase of 1.5°C by the end of the century, according to the latest review of recommendations by the Intergovernmental Panel on Climate Change (IPCC).

Given the magnitude of the goal, it matters little whether the commitment of the institutions is guided by economic interests, because even so, they are a step forward, says the businessman, determined to "do things differently". The conclusion, therefore, is that the narrative that green is only aspirational must be abolished because today positive actions enjoy an excellent reputation. "This is happening," Muñoz concludes.

Gonzalo Muñoz

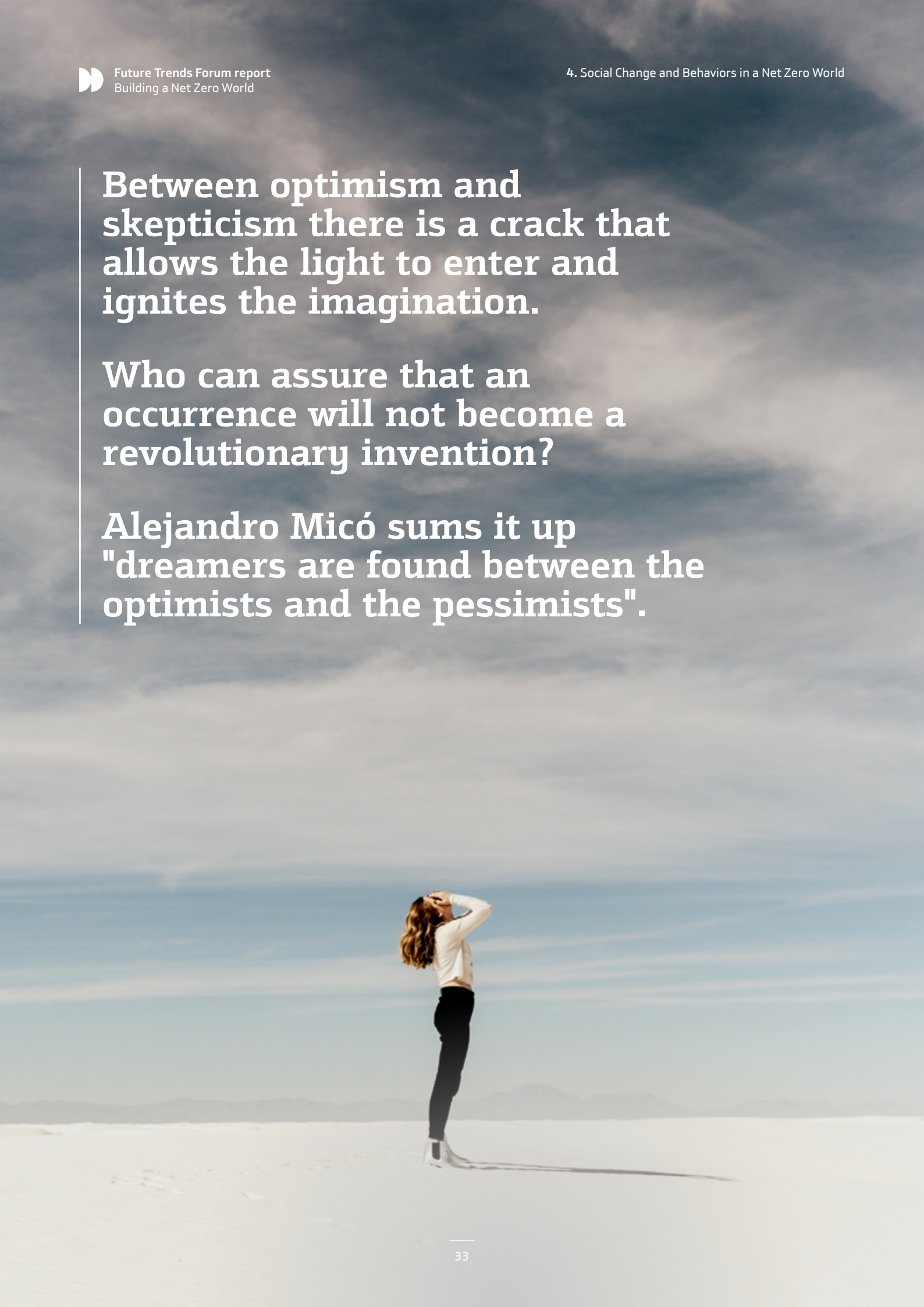
International collaboration in a Net Zero world

Watch video

Between optimism and skepticism there is a crack that allows the light to enter and ignites the imagination.

Who can assure that an occurrence will not become a revolutionary invention?

Alejandro Micó sums it up "dreamers are found between the optimists and the pessimists".



We must stop seeing climate change as a distant or future issue.

Human Behavior

Sometimes the barriers to skepticism have more to do with culture and behavior than with technology and innovation, and there is agreement on this. Although confidence in achieving a Net Zero world by 2050 is around 50%, even among the group of experts participating in the think tank. This means that there is optimism, but moderate.

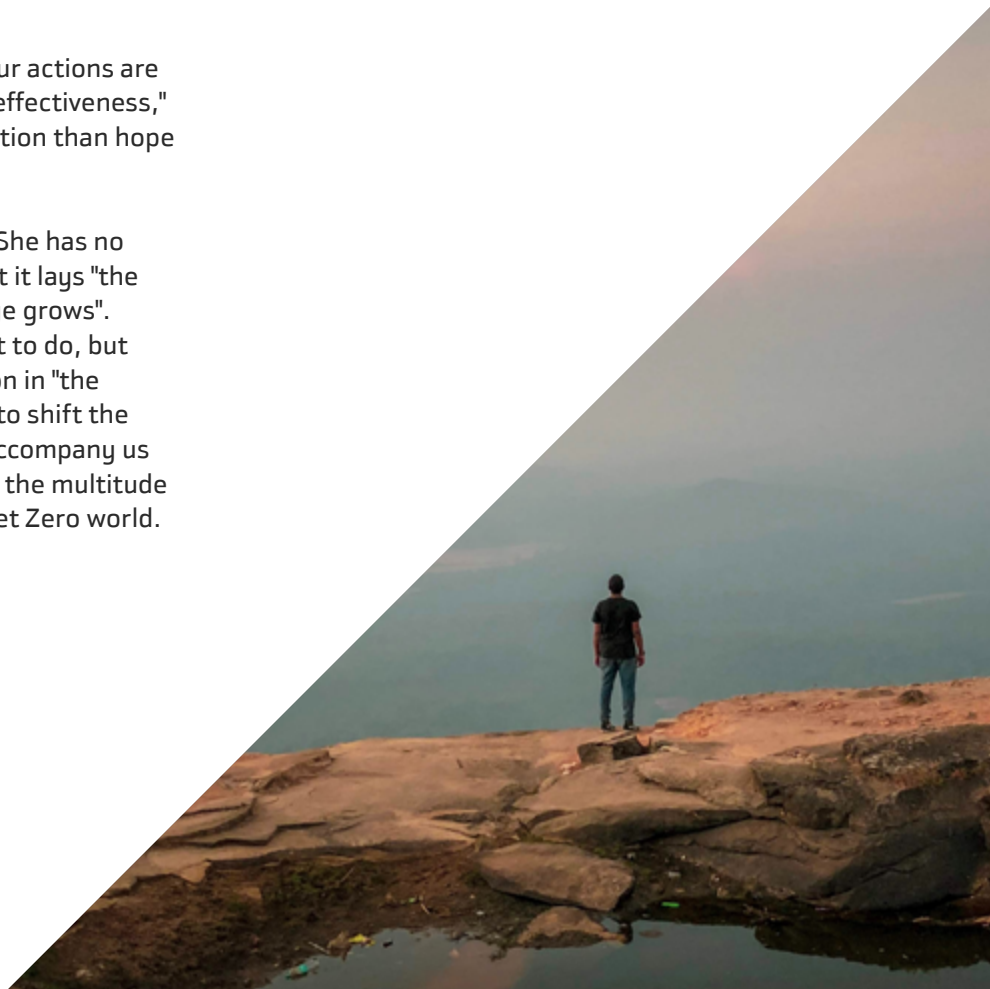
Scientist Katherine Hayhoe argues that the key to mobilize most of the population against climate change is to stop seeing it as a distant or future issue. It is necessary to confront the concrete threats of excess CO_2 in the atmosphere, in the present and in the region in which we live. There is no use in talking about polar bears in Texas, for example, but if we understand the risks we are exposed to in our own homes, we will act, he says.

At the same time, if we perceive that our actions are effective, then there is hope. "Hope in effectiveness," Hayhoe reinforces. Therefore, more action than hope is needed.

Where do we start, asks the scientist. She has no doubts about the answer: talking about it lays "the fertile ground in which a cultural change grows". This does not mean telling people what to do, but rather broadening people's participation in "the conversation". Dialoguing will allow us to shift the focus from threat to hope, which will accompany us in undertaking effective approaches to the multitude of activities that are underway, for a Net Zero world.

The significance of social movements

Then, regarding social movements in the digital era (with their swift calls to action and hyper-popular leaders in social media), the unwavering ethics of Generation Z, those born since 1997, stands out. This generation will soon take over from the current climate diplomacy. In the climate negotiation scenario, a more dynamic way of doing things is already emerging, since exemplary and ecologically friendly behavior, although important, is not enough to achieve the Net Zero objective. Among the groups with a more international projection, the active youth group of Fridays for Future and the 350.org organization stand out, accompanied by the experienced activists of Third Act, a group made up of people over 60 years of age, as Bill McKibben pointed out in the Future Trends Forum.



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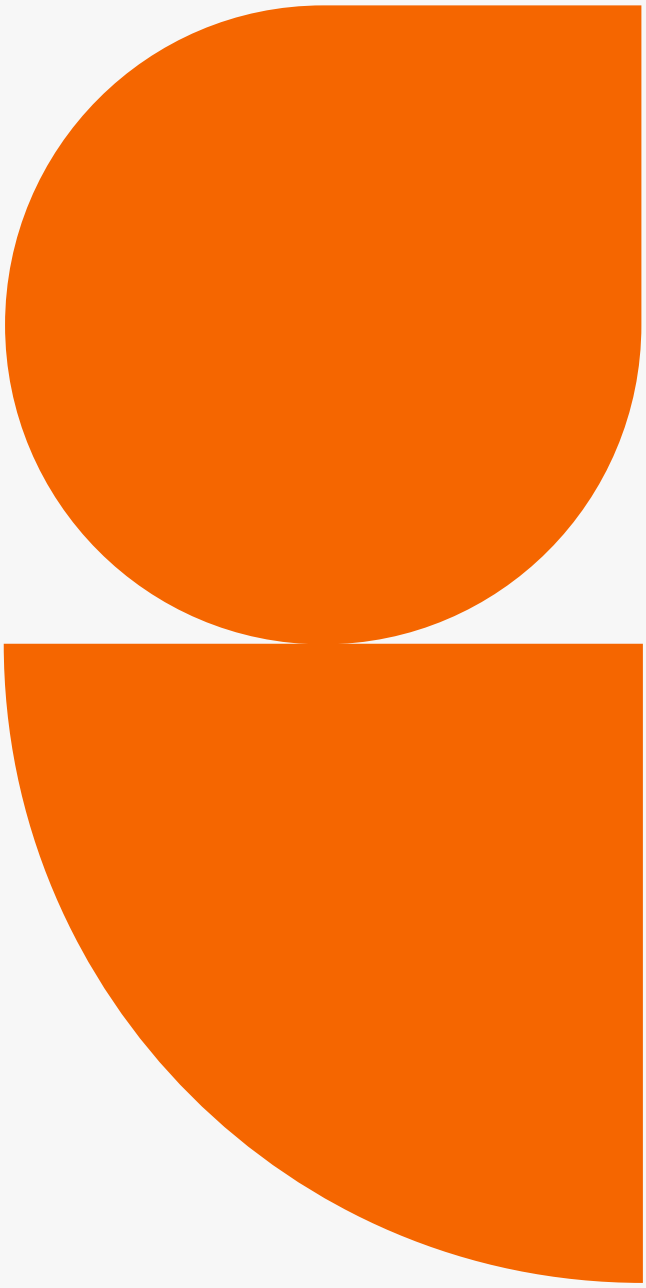


Recommendations for Building a Net Zero World

5

Recommendations for Building a Net Zero World

Future Trends Forum attendants point to another type of growth in this field, which could become the first stop on this journey: a 50% reduction of global emissions in this same decade.

Decisions and actions on the road to building a Net Zero world are not immediate or quick, they take time. For example, battery technology does not support short-term thinking.

Time is also required when the researchers and entrepreneurs themselves who are contributing to the energy transition talk about investing not only in new materials and designs, but also in the training of students in basic sciences. The mathematical, physical, or chemical knowledge acquired by these young people will inevitably take time, not days or weeks but years, to be applied.

New materials are needed to develop revolutionary batteries to overcome the limitations of transport electrification, for example. Algorithms are needed for quantum computing to process huge amounts of data to enable simulations and calculations of the best options; also, to optimize connections and remote actions.

Future Trends Forum attendants point to another type of growth in this field, which could become the first stop on this journey: a 50% reduction of global emissions in this same decade (which would make it possible to achieve a Net Zero world in 2050, according to Gonzalo Muñoz). The technology is within reach and what is lacking is the will to fulfill the commitments made.

In summary, the four areas into which the proposals emerging from the Future Trends Forum are classified to bring about this paradigm shift are: **innovation, technology, politics and economics, and social**. Among the specific recommendations for each of these, we have selected those that could make up a basic decalogue for climate action:

1.

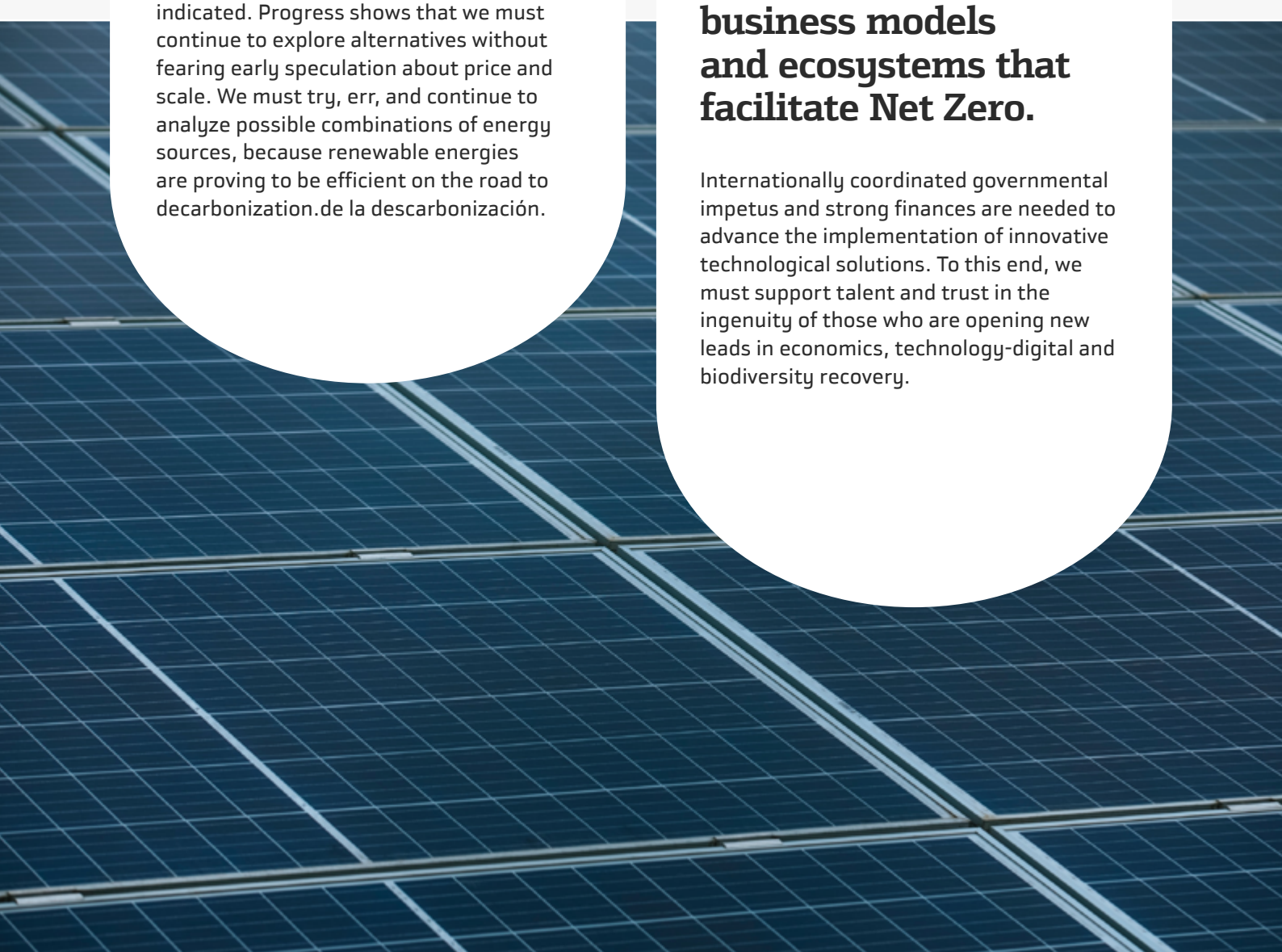
To promote the development of sustainable energy, with solar energy as the lead.

Since its inception, solar energy has been offering more comprehensive solutions at unexpectedly lower costs than estimates indicated. Progress shows that we must continue to explore alternatives without fearing early speculation about price and scale. We must try, err, and continue to analyze possible combinations of energy sources, because renewable energies are proving to be efficient on the road to decarbonization.de la descarbonización.

2.

Foster and finance business models and ecosystems that facilitate Net Zero.

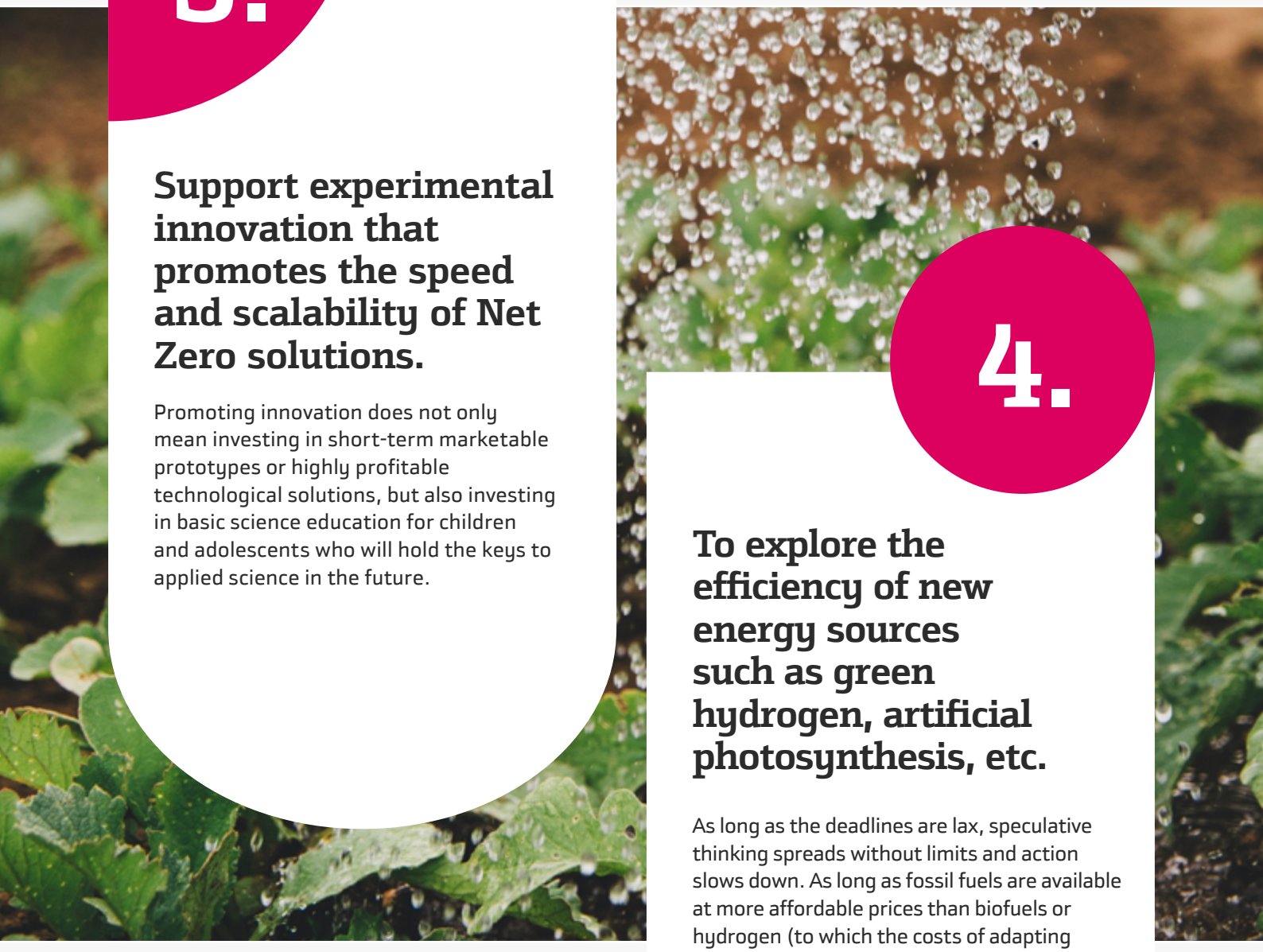
Internationally coordinated governmental impetus and strong finances are needed to advance the implementation of innovative technological solutions. To this end, we must support talent and trust in the ingenuity of those who are opening new leads in economics, technology-digital and biodiversity recovery.



3.

Support experimental innovation that promotes the speed and scalability of Net Zero solutions.

Promoting innovation does not only mean investing in short-term marketable prototypes or highly profitable technological solutions, but also investing in basic science education for children and adolescents who will hold the keys to applied science in the future.



4.

To explore the efficiency of new energy sources such as green hydrogen, artificial photosynthesis, etc.

As long as the deadlines are lax, speculative thinking spreads without limits and action slows down. As long as fossil fuels are available at more affordable prices than biofuels or hydrogen (to which the costs of adapting infrastructure must be added), decisions are postponed. A commitment to clean energy sources will improve their efficiency, make them competitive and overcome the inertia in the use of fossil fuels.

5.

Improve energy efficiency in industry, transportation, etcetera.

In the quest towards Net Zero, the energy transition necessarily implies a transition in emissions. It is an absolute must to research into technologies to eliminate CO_2 already emitted and existing in the atmosphere. Billions of tons of greenhouse gases will have to be eliminated, until industries such as cement can be converted to produce it (or obtain substitutes) by other processes. The speed of improvement is not rapid: we cannot expect a revolution, but rather cumulative progress. As for freight and long-distance transport (including aviation), hopes are pinned on biofuels, green hydrogen, and the evolution of batteries.

6.

To develop new technologies for massive energy storage.

The technological innovation sector must succeed in developing new materials and establishing processes that enable energy storage to be viable on a large scale and at low cost. One of the focuses of this evolution must be on constantly improving batteries.

7.

To develop policies for international and governmental collaboration with industries and consumers.

Solidarity between regions and countries is essential, as is the accountability of the most polluting regions. These policies must include the creation of incentives for the growth of local and global innovation ecosystems and the emergence of new business and consumption models guided by the Net Zero objective. In addition, it is useful (and crucial) to promote collaborative platforms with effective governance to facilitate complex multi-stakeholder initiatives.

8.

To develop financial tools that enhance Net Zero activities.

Through support for Agrifoodtech innovations aimed at reducing the consumption of animal products, as well as those that promote regenerative agriculture and waste-to-energy solutions (to produce biogas). It is also necessary to encourage innovation for the capture of CO_2 in the soil and to support innovative ventures based on wind and oceans as sources of energy.

9.

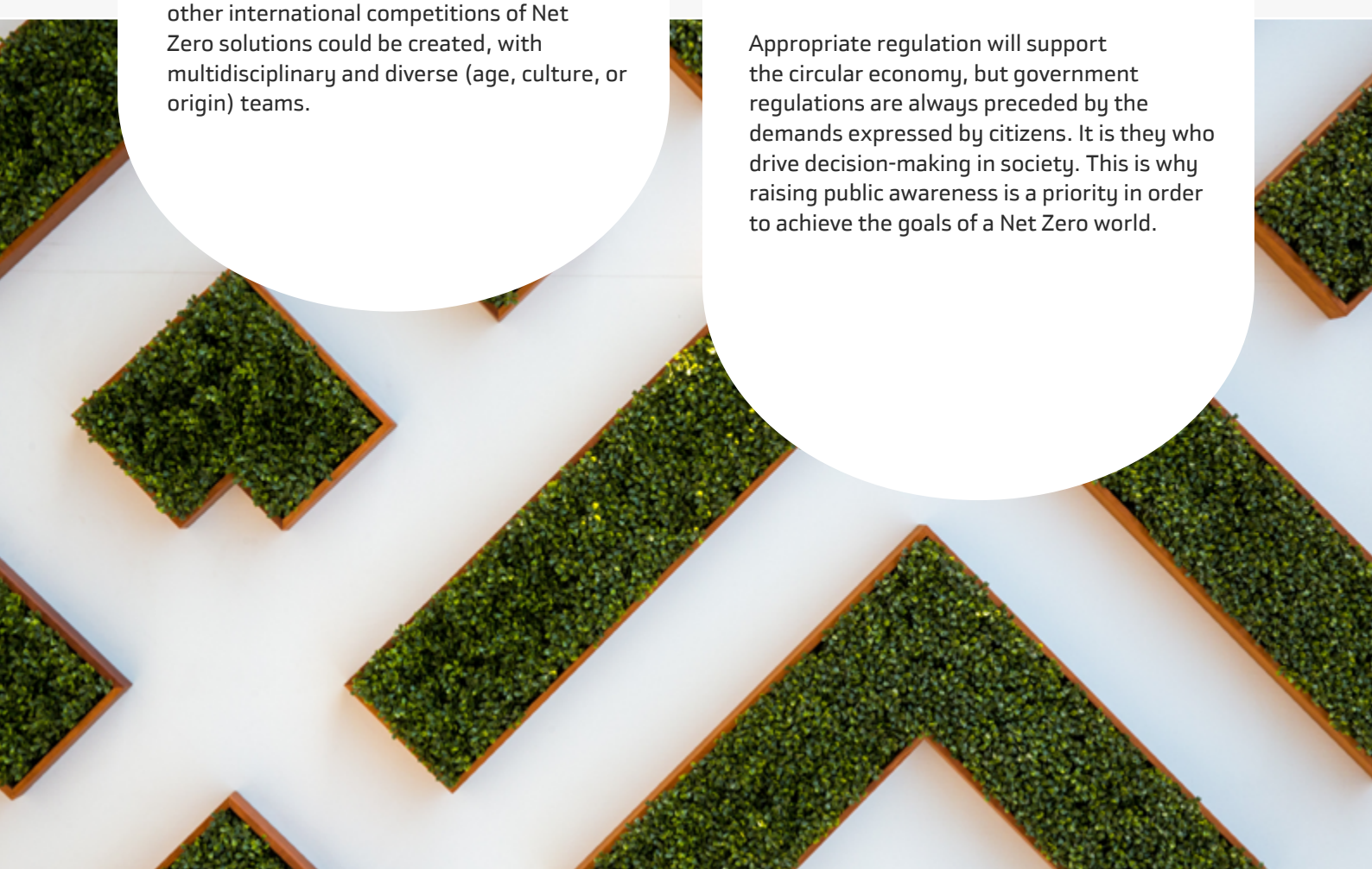
Change the narrative on climate change and introduce it into the education system.

Not only educate at school, but also through entertainment (video games, series, movies), to promote sustainable habits such as reducing energy consumption, using public transport, or sourcing green energy. In addition to sports competitions, other international competitions of Net Zero solutions could be created, with multidisciplinary and diverse (age, culture, or origin) teams.

10.

Raise awareness of the need and sense of urgency to build a Net Zero world.

Appropriate regulation will support the circular economy, but government regulations are always preceded by the demands expressed by citizens. It is they who drive decision-making in society. This is why raising public awareness is a priority in order to achieve the goals of a Net Zero world.



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The opinions expressed in this report are those of the writer and do not reflect the views of the experts who took part in the **Future Trends Forum** meeting.

Building a Net Zero World

October 2022

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