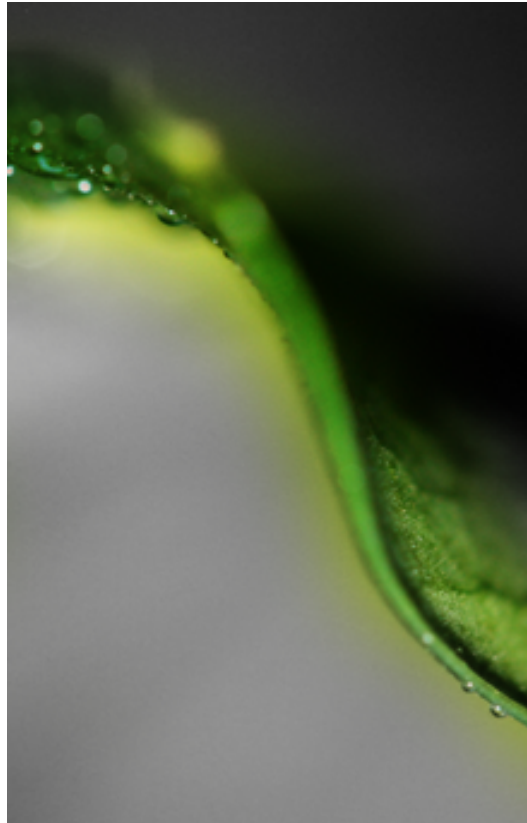


climate tech

for a Sustainable Planet

Quarterly review
N°7 — 2023

Con
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FOR TOMORROW



The planet is undergoing dramatic changes. While there is growing acknowledgment of the urgency of the situation, a lot remains to be done. We need all of the latest climate technologies to come to bear with behavioral changes and innovation to fight climate change.

The cover picture of this edition showcases nature in its most pristine form - an inspiration for all of us to work together to get the future we want.

Foreword



At Capgemini, we help organizations prepare for tomorrow by distilling the

unique insights and perspectives of leaders from global business, academia, the startup community, and wider society.

Climate Tech, sustainability, and what's next for our planet – from business leaders, scientists, gen next, and more

Through our quarterly journal, *Conversations for Tomorrow*, the Capgemini Research Institute identifies the strategic imperatives for the future of business and the society in which it operates. In this seventh edition of the journal, we look at the necessity to transform the way we live and do business – be that as individuals, organizations, countries, or the planet as a whole – through adopting and adapting, innovating, inventing, and embracing climate tech and sustainable practices. As a global society, we are seeing unprecedented change. Across organizations, sustainability is fast becoming a rallying cry. A key aspect of achieving sustainability goals is to drive greater adoption of technologies.

Low-carbon hydrogen holds the potential to decarbonize heavy industry. Solar energy is already a hot topic in many markets. Scientists are looking into new areas of bioengineering to come up with sustainable alternatives. Tech startups are innovating across a range of areas, including carbon capture, spatial intelligence, food waste, and more. Electric vehicles (EVs) are rapidly making their presence felt in the automotive industry. Alternative fuels and alternative plastics are now more than lab experiments and are being tested for commercialization. AgriTech is helping the farming community cut emissions.

Leading scientists have explained how they are innovating while simultaneously sounding the alarm that much more is

needed. Sustainability leaders at global organizations have told us how they are transforming their organizations. Gen next is making its voice loud and clear: they want to see governments and business act with urgency.

We would like to thank all the leaders and experts who have enriched this edition of the journal with their insights into climate tech and sustainability. By sharing insights from such a diverse range of accomplished individuals, we aim to present a clear view of the imperative to act, and the optimism that technology and science can bring to the table when it comes to tackling the existential issues that climate change poses.

Key contributors include:

- A Nobel Prize Laureate in Chemistry
- A world-renowned architect and author
- One of the world's leading climate scientists
- Senior executives from Air Liquide, P&G, Volvo Group, Enel Green Power, and L'Oréal
- The Deputy Executive Secretary of the United Nations Framework Convention on Climate Change
- Head of a solar panel gigafactory
- A range of startups, including a top unicorn in carbon capture
- Gen next climate activists from the US, Kenya, and India
- Capgemini's own subject-matter experts

Pulling together such a wide range of insightful perspectives was an extremely instructive exercise for us. We hope you enjoy reading this edition as much as we did putting it together for you.



Cyril Garcia

Head of Global Sustainability Services and Corporate Responsibility, Capgemini

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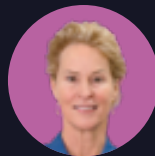


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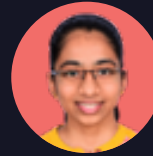
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The clock is ticking for organizations and individuals to act together to mitigate climate change. Soon, the alarm will go off. Sustainability is no longer an aspiration – it’s a global business imperative and a collective responsibility. Science, technology, corporate purpose, and all stakeholders must come together to address the ultimate challenge to our existence.



With every passing day, the need for technology for CO₂ removal becomes more urgent.”

Johan Rockström,
Director, Potsdam Institute for Climate
Impact Research

**The time
to accelerate on
sustainability initiatives
was yesterday**

We are very close to seeing irreversible changes to the planet. Our carbon budget is running out and there is little time left to do something about it. As of April 2022, humanity had already crossed six of the nine planetary boundaries, dramatically increasing the risk of large-scale irreversible environmental changes.

Johan Rockström Director, Potsdam Institute for Climate Impact Research, drives home the message: “We currently emit around 40 billion tons of CO₂ per year. With every passing day, the need for technology for CO₂ removal becomes more urgent.”

And it's not simply a matter of watching temperatures rise; every fraction of a degree of global warming results in loss of life and livelihoods. Ovais Sarmad, Deputy Executive Secretary, United Nations Framework Convention on Climate Change (UNFCCC), explains the situation in stark terms: "We are in a race against time to limit global warming not to exceed 1.5 degrees Celsius in order to protect, prevent and preserve our natural resources, livelihoods and lives in all parts of the world."

The fight against climate change needs Climate Tech

Today, there is a growing acceptance of the role of technology in accelerating our collective efforts to make the planet sustainable. Eliano Russo, Head of Enel Green Power's 3SUN Gigafactory in Catania, Italy, one of Europe's leading manufacturers of solar panels, comments: "By using key technologies, we have already achieved a certified level of efficiencies. Technology is a big driver for the increase in efficiency that we anticipate in the years to come."



Technology and data are central to everything we do."

Karin Svensson
Chief Sustainability Officer, Volvo Group



I'm fascinated with the overlap between technology and sustainability."

Virginie Helias,
Chief Sustainability Officer, P&G

Karin Svensson, Chief Sustainability Officer, Volvo Group, speaks on the importance of technology in the operations of an automotive giant: "Technology and data are central to everything we do. Being able to analyze data and take in data and to have our vehicles connected is a very important prerequisite in everything we do."

While technology is a key driver of new sustainability initiatives, it can also be a powerful force for good in terms of nudging customers towards positive behaviors. Virginie Helias, Chief Sustainability Officer at P&G, comments: "I'm fascinated with the overlap between technology and sustainability. The real-life data helps us with compliance and making interventions when needed immediately."

Getting Climate Tech right requires us to understand it

Effective use of technology will require a change in leadership behaviors. Pascal Brier, Group Chief Innovation Officer at Cargemini, comments: "Effective solutions will also require business leaders to understand the construct of technology. Today, every business is a technology business. And they must be aware of how digital innovation can help their organizations achieve their sustainability targets."

Directed evolution: Using nature to rescue itself

Nature has in her power the means to undo some of the damage that we have done to her. Frances Arnold, Nobel Laureate and Professor of Chemical Engineering, Bioengineering and Biochemistry at the California Institute of Technology, explains: "Nature is solving all sorts of problems – how to degrade plastic bottles, how to degrade pesticides, herbicides, and antibiotics. She creates new enzymes in response to these problems all the time, in real time. With 'directed evolution,' we can do the same; create new enzymes in response to new problems."

“

Nature is solving all sorts of problems – how to degrade plastic bottles, how to degrade pesticides, herbicides, and antibiotics.”

Frances Arnold,
Nobel Laureate and Professor of Chemical Engineering, Bioengineering and Biochemistry at the California Institute of Technology



The role of technology, computation, and automation is also acknowledged in academic research. Professor Arnold speaks on the importance of tech and AI: “Sustainability and evolution can be empowered by artificial intelligence and machine learning. I predict that, in the next few years, AI is going to be a powerful force - one capable of recoding life.”

Harnessing the power of the sun to deliver sustainable energy

Enel Green Power’s Eliano Russo, comments: “Solar energy will play a key role in meeting the growing demand for sustainable energy. Currently, we are at 1TW of installed solar capacity globally, but this is expected to increase sevenfold by 2040.” And as in other new areas of Climate Tech, digitization and automation can help in the transition to renewables. “Our factory has a strong level of automation and digitalization, which



Solar energy will play a key role in meeting the growing demand for sustainable energy.”

Eliano Russo,
Enel Green Power

allows us to fully exploit digital intelligence and machine learning for quality control, reduce waste, and improve circularity,” Russo states.

Shifting to low-carbon energy solutions will be key

The energy transition and the global imperative toward sustainability have driven organizations to explore new energy models and solutions. Hydrogen is gaining recognition as one of the possible routes to accelerating decarbonization of high-emission sectors that do not use electricity directly. As a major new fuel source, it could also enable nations and organizations to reduce their dependencies on fossil fuels. Our research found that energy and utilities (E&U) organizations expect low-carbon hydrogen to meet up to 18 percent of energy demand by 2050. Furthermore, currently 26 percent of E&U organizations are investing in low-carbon hydrogen initiatives and a majority (64 percent) are planning to invest by 2030; further, 98 percent plan to do so by 2050.

François Jackow, CEO of Air Liquide, highlights the opportunity: “Low-carbon electricity, which can be generated through both renewable and nuclear sources, will play a key role in the energy transition. This will be a principal contributor to our line of low-carbon-content products, as well as shrinking our customers’ carbon footprints.”

Executive Summary

The future of renewable and green energy is evolving. Enel Green Energy's Eliano Russo comments: "Renewable energy is currently the answer and the direction to go, and the focus should be on maximizing efforts to reduce CO₂ emissions because time is running out to stabilize concentrations in the atmosphere."

If we use technology as a catalyst and an enabler, the opportunities around low-carbon hydrogen are immense, as William McDonough, renowned architect and author, explains: "I would love to focus on the idea of conceptually separating the terms 'hydro' and 'carbon' in the word hydrocarbon. I'm very excited about the idea of a technology that can use hydrogen as a clean fuel and carbon as a durable good that does not go fugitive in the atmosphere or require sequestering in the geosphere."

Carbon capture: Need of the hour

To slow climate change, companies have set the target of dramatically shrinking their carbon footprints to reduce CO₂ emissions by at least 90 percent before 2050. However, that will still leave around 10 percent of current levels of unavoidable emissions. Carbon removal is crucial to neutralizing these emissions and keeping global warming around the 1.5°C target. Organizations are using a variety of technologies, including Direct Air Capture (DAC) technology, to capture CO₂ from the atmosphere. Nathalie Casas, Head of R&D at Climeworks, highlights the growing

importance of carbon capture: "The market for carbon dioxide removal has basically had an exponential development over the past two, two and a half years."

For sustainability initiatives to succeed, innovation must be supported by behavioral change

As organizations undergo the massive transition to sustainability, the debate turns to whether the focus of efforts should be encouraging changes in consumer behavior or the acceleration of innovation. The answer, however, lies in effectively combining innovation with behavioral nudges.



Nobel Laureate Dr Frances Arnold affirms the need for a combined approach: “We can offer scientific solutions, good or bad, but if people don't change and people don't want them, it's not going to happen.” P&G's Virginie Helias adds: “We are innovating our products while nudging the consumer to drive behavioral change. I could develop the best products out there but, if I cannot get our consumers to use it, there will be no impact. So, it needs to be both”

Climate Tech startups: The key to our fight against climate change

Over the past two decades, startups have become a critical source of innovation, from carbon capture to nuclear fission.

Nathalie Casas, Head of R&D at Climeworks, a leading Swiss company active in the carbon-capture space, comments: “We need to extract billions of tons of CO₂ between now and 2050, a task so gargantuan that we will need all known carbon-removal solutions to work together, uniting nature and technology in urgent symbiosis.”

We are all in it together

Gone are the days when an organization could take sustainability initiatives in isolation and at its own pace. Alexandra Palt, Chief Sustainability Officer at L'Oréal, highlights the criticality of the need for collective action: “We need to understand the climate crisis we are in and align our targets and ambitions together. There is very strong role of leaders today to foster innovation” “Climate change is not a local issue, it's a planetary issue. We have to take necessary decisions now, individually and collectively.”

Volvo's Karin Svensson underscores why we need to form partnerships across business ecosystems: “Unlike in the past, there is now a strong need to work with competitors, suppliers, and governments to ensure transformation of our products. The time now is about winning together and not winning alone.”





François Jackow
Chief Executive Officer,
Air Liquide



The CEO Corner

in discussion with



Aiman Ezzat
Chief Executive Officer,
Capgemini





The CEO Corner



François Jackow,
Chief Executive Officer,
Air Liquide

François Jackow joined the Group in 1993. He is the Chief Executive Officer of Air Liquide since June 1st, 2022. He chairs the Executive Committee of which he has been a member since 2014. After starting with Air Liquide, he has held various positions in Marketing, Business Development, Engineering and Strategy in the United States, the Netherlands and France.

From 2002 to 2007, François Jackow was in charge of Innovation, as Vice President of Research, Development, and Advanced Technologies for the Group. From 2007 to 2011, he was President and CEO of Air Liquide Japan based in Tokyo. From 2011 to 2014, he headed the Large Industries business line and from 2014 to 2016 was in charge of Corporate Strategy. From 2016 to 2022, he supervised Europe Industries, Europe Healthcare and Africa / Middle East / India hubs, as well as the Healthcare business line. From 2020 to 2022 he also supervised the Innovation, Technologies and Digital / IT functions.business administration both from France and the United States.



Aiman Ezzat,
Chief Executive Officer,
Capgemini

With more than 20 years' experience at Capgemini, **Aiman Ezzat** has a deep knowledge of the Group's main businesses. He has worked in many countries, notably the UK and the US, where he lived for more than 15 years. Aiman was appointed CEO in May 2020; prior to that, from 2018 to 2020, he served as the Group's COO and, from 2012 to 2018, as CFO. Aiman is also on the Board of Directors of Air Liquide and is a Member of the International Business Council of the World Economic Forum.

Capgemini is a global leader in partnering with companies to transform and manage their business by harnessing the power of technology. The Group is guided everyday by its purpose of unleashing human energy through technology for an inclusive and sustainable future. It is a responsible and diverse organization of 360,000 team members in more than 50 countries. With its strong 55-year heritage and deep industry expertise, Capgemini is trusted by its clients to address the entire breadth of their business needs, from strategy and design to operations, fueled by the fast evolving and innovative world of cloud, data, AI, connectivity, software, digital engineering and platforms. The Group reported in 2022 global revenues of €22 billion.

The Capgemini Research Institute spoke to Francois and Aiman to understand their views on the challenges of climate change, energy transition and the potential of emerging technologies to fight this planetary challenge

You took over the general management of Air Liquide as the energy crisis and climate change rose up the corporate agenda. How is this context affecting the Air Liquide Group?

— **François Jackow:** The energy crisis clearly presents us with a paradox: despite the risks and uncertainties, there are unprecedented opportunities to invest in the development of innovative, permanent solutions to the problems of our customers and of society in general. Decarbonization needs to play a key role in managing the affordability of energy and the security of the supply chain and this is a clear opportunity for Air Liquide. For instance, one of the services we now offer is oxy-combustion, which is a technique for making glass using oxygen; this reduces the use of natural gas by 10 to 35%, while also reducing CO₂ emissions, which are both significant benefits to our customers.



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Despite the risks and uncertainties, there are unprecedented opportunities to invest in the development of innovative, permanent solutions to the problems of our customers and of society in general.”

François Jackow

"Carbon capture, utilization, and sequestration (CCUS) is going to be very significant, particularly since all the technological bricks required (be it capture, transportation or storage) have now been proven safe and economical."

François Jackow

Which climate technologies will play important roles in the energy transition?

— **François Jackow:** One area that stands out is low-carbon electricity, which can be generated through both renewable and nuclear sources. This will be a principal contributor to our line of low-carbon-content products, as well as shrinking our customers' carbon footprints. I also think that carbon capture, utilization, and sequestration (CCUS) is going to be very significant, particularly since all the technological bricks required (be it capture, transportation or storage) have now been proven safe and economical. These technologies can be applied as of now to very large quantities, and could, therefore, have a huge impact across the spectrum of carbon emissions, notably in the hard-to-abate industries where no alternative exists. It is, however, important to keep in mind that, while CCUS will help us meet our short-term objectives, it should not be used as an excuse to halt the development of other technologies. We need to continue the structural transition to renewable and circular processes.

— **Aiman Ezzat:** The success of the shift to a low-carbon economy will depend heavily on

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The success of the shift to a low-carbon economy will depend heavily on technological innovations such as green hydrogen and CCUS, as well as the evolution of batteries."

Aiman Ezzat



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Transitioning to renewable energy or relying on climate tech will not be enough. We need to rethink our design and production methods to do business in new and better ways.”

Aiman Ezzat

technological innovations such as green hydrogen and CCUS, as well as the evolution of batteries. I believe there will also be an important contribution from alternative fuels and remain confident that nuclear will play a critical role in the energy transition. Solar is an underexplored arena; with advances in the efficiency of solar panels, solar energy could prove a key transition technology in many geographies. However, as François highlighted, it is important to note that transitioning to renewable energy or relying on climate tech will not be enough. We need to rethink our design and production methods to do business in new and better ways.

What do you see as the role of low-carbon hydrogen in the future energy mix and what are the challenges of scaling the relevant technology?

— **François Jackow:** The first challenge is to establish a secure supply of low-carbon electricity, either from renewables or nuclear; today, globally, this is the bottleneck. The second challenge is to scale up hydrogen-production technologies. Take electrolysis; Air Liquide operates today the largest proton exchange membrane [PEM] electrolysis unit in the world [its 20-MW unit in Canada]. We need to scale that up tenfold – perhaps even as much as a hundredfold – to make an even more significant contribution. Another big challenge is, obviously, to boost market demand, not only by improving the infrastructure, but also promoting the usage of hydrogen. That will rely on effective public-policy incentives.

— **Aiman Ezzat:** Hydrogen holds great promise as a sustainable, energy-dense fuel that could ultimately replace oil and gas as a principal energy source. Our research shows that energy organizations & utilities expect low-carbon hydrogen to meet up to 18% of energy demand by 2050. Investment in the area is already taking off and is set to increase significantly. But there are important obstacles starting with cost: low-carbon hydrogen is still 2–3 times more expensive to produce than carbon-based hydrogen. Moreover, the high costs of storage, transportation, as well as energy losses across the value chain all contribute to an increased total cost of operations. Finally, there are also engineering and skill shortage challenges that organizations must contend with.

In the US, the Inflation Reduction Act is driving a lot of investment towards sustainability. What should government be doing to drive investment in Climate Tech and low-carbon hydrogen especially?

— **François Jackow:** Governments must feel the sense of urgency, and the responsibility to take action now. Sovereignty and sustainability are closely related, and they offer business opportunities for any country - this is one of the key learnings of the recent past. In order to capitalize on these opportunities, governments must put in place a policy framework that recognizes the value of carbon, and which will then drive economic behaviour based on that recognition.



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Sovereignty and sustainability are closely related, and they offer business opportunities for any country - this is one of the key learnings of the recent past.”

François Jackow

— **Aiman Ezzat:** The US has made a good start and we are seeing growing momentum across Europe as well. Looking specifically at green hydrogen, France has already committed to spending over €9 billion (\$9.9 billion) to encourage the transition of heavy industry to hydrogen. The UK plans to invest £4 billion (\$4.8 billion) in creating a low-carbon hydrogen industry by 2030. It is targeting 5 GW of annual production capacity – sufficient to power around 3 million homes – as well as heavy industry. Globally, momentum is definitely growing but, as François mentioned, we need broader frameworks that incentivize businesses while encouraging the growth of Climate Tech.

Where are your organizations on their net zero journeys?

— **François Jackow:** Achieving net zero is a serious challenge for any manufacturing company, especially when you are undergoing an energy transition. We were the first company in our sector to set carbon-intensity objectives and we are now 25% below the 2015 carbon-intensity level. However, two years ago, we realized we needed to set more – and more specific – objectives in terms of our absolute carbon emissions. We have targeted carbon neutrality by 2050. Air Liquide’s target of reducing its scope-1 and -2 CO₂ emissions by 2035 has been validated by the Science Based Targets initiative (SBTi). We are the first organization in our industry to obtain such validation from a leading, independent authority such as the SBTi and this represents significant recognition of Air Liquide’s trajectory to reach carbon neutrality by 2050. CO₂ emissions reduction is a key objective of our strategic plan for 2025. Air Liquide’s strong commitment to a sustainable future includes not only reducing the carbon emissions of its own assets, but also helping our customers to reduce their CO₂ emissions and developing low-carbon ecosystems.

— **Aiman Ezzat:** At Capgemini, we are fully committed to sustainability. We are proud of being one of the first companies in the world to have its net zero targets validated against the new, more exacting SBTi standards published at end-2021. We have set more ambitious near-term (2030) and long-term (2040) carbon-footprint targets, notably with a 90% reduction in all emissions (scopes 1, 2, and 3) by 2040. As of end-2022, Group-wide carbon emissions had already fallen by 29% (and 46% per employee) against the 2019 baseline set by the SBTi.

Our ambitions are supported by initiatives such as our new-energy command center in India, which has used extensive digital data analysis to reduce our energy consumption by around 20%, across all our campuses. On the back of progress achieved by Capgemini in 2022, the Group was admitted to the Dow Jones Sustainability Index (DJSI) Europe at the end of the year.

How do you ensure that all stakeholders contribute towards the reduction of scope-3 emissions?

— **François Jackow:** Because we need to take into account the full value chain, it's critical that every stakeholder takes responsibility for reducing their own scope-1 and scope-2 emissions. Currently, we are sourcing renewable electricity and seeking to limit emissions from some of our units. However, what we really need for effective control of scope-3 emissions is a unified set of standards across sectors. We are working actively with associations such as the SBTi to develop an effective measurement and reporting framework, and are already reporting on nine of the 13 scope-3 categories. Working on a more consistent industry wide view of scope-3 emission reporting, we have decided to already set the objective to have 100% of our top-50 largest customers committed to carbon neutrality by 2035.

— **Aiman Ezzat:** Although we can't directly control all the scope-3 emissions in our value chain, as a global company, travel consistently contributes the largest share of Capgemini's carbon footprint. We are raising our near-term (2030) scope-3 targets for commuting and business travel to a 55% reduction per employee against a 2019 baseline. Similarly, sustainable businesses require sustainable supply chains. Establishing a reliable universal measurement mechanism is the first key action. There are no short-cuts; it involves working closely with all stakeholders to help them understand and act according to their roles in the value chain.

How are you aligning the organization to drive sustainability at all levels?

— **François Jackow:** Firstly, we need to set clear objectives - in line with our ambition to be Climate champions. Secondly, we must communicate them clearly to ensure that sustainability is at the core of the Group's growth strategy, business model, and value creation, and that all employees understand their role in achieving the objectives. Lastly, we need to ensure that we are consistent and credible, both within the organization and externally. For instance, one of the most powerful things that we have done is to implement a carbon budget: a few years ago, we allocated investment to creating a carbon envelope around our operations. This has changed the mindset of employees, who now prioritize projects that align with the company's carbon trajectory and emissions-reduction goals.

"Sustainability requires enterprise transformation, like the digital transformation programs that many organizations have launched."

Aiman Ezzat

— **Aiman Ezzat:** Sustainability must not be managed as a compliance project. Rather, it requires enterprise transformation, like the digital transformation programs that many organizations have launched. This transformation affects all parts of the business – from design of the business model and product line to operations and IT. It requires proper governance, headed by a C-suite executive. Having strong board support is also key to the success of sustainability initiatives. As a CEO, it is important to unify the organization in its purpose, removing silos and encouraging functions and teams to work closely to achieve their sustainability goals. Organizations must recognize the urgent need for viable sustainability initiatives, led and supported by realistic short-term goals.

How important do you think collaboration will be in achieving decarbonization?

— **François Jackow:** Collaboration is a key aspect of our sustainability journey. We work with our customers to invent new manufacturing techniques and set more stringent objectives. Today, our initiatives address not only product innovation, but also system innovation. We collaborate with different stakeholders, customers, suppliers, and partners, to develop an ecosystem of solutions. It is absolutely vital that different stakeholders each bring a piece of the puzzle and collaborate towards a common objective. We need a further-reaching, comprehensive outlook to impact all the stakeholders - not just customers, but also employees and shareholders - in the sustainability journey.



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Collaboration is a key aspect of our sustainability journey.”

François Jackow

— **Aiman Ezzat:** We can achieve a sustainable future only through deep collaboration with our clients, suppliers, and other stakeholders. Decarbonization will result from reconstructing the way we do business and rethinking our entire value chain and products. This requires an unprecedented level of cooperation and mobilization across industries. To find lasting, meaningful solutions, leading voices from business, academia, and government must come together to discuss our options as a society. The Conversations for Tomorrow journal is one of many such initiatives that Capgemini takes to juxtapose diverse viewpoints.

Our research indicates that most executives still view sustainability as a cost driver and an obligation, rather than a business opportunity. How do you convince your clients that sustainability is good for business?

— **François Jackow:** We engage with our customers regularly on these topics and we have identified three sustainability drivers. The first driver, particularly in Europe, is to reduce emissions sufficiently to avoid paying the EU Emissions Trading System (EU ETS) carbon tax. The second driver for engaging participation in a carbon-reduction project is helping customers meet their corporate commitments and objectives in terms of carbon trajectory. The third – and most important – driver is helping customers see opportunities to promote and develop low-carbon offers, services and products. When our customers realize that they can gain competitive advantage and create added value by offering sustainable products, that's when a sustainable business model really starts to take

shape. Decarbonization and sustainability shift to opportunity-driven goals, rather than compliance-driven obligations for the customer.

What new energy business models do you anticipate will emerge in the medium term?

— **François Jackow:** In their economic valuations, our customers are putting an emphasis on carbon reduction. By developing solutions that use traditional industrial products such as oxygen, nitrogen, and hydrogen, while also helping to reduce their own carbon footprint, we can create a lot of value for our consumers. But this will entail rethinking how we deliver our products, and exploring new schemes to package our offers. Secondly, we see a new business model for mobility. There's value to be created, not only in providing fuels for mobility, but also in changing the way transports (trucks, bus, train, etc.) are used logistically for example. Business models are changing because customers are willing to own fewer assets and embrace a different kind of business model, based on re-use.

— **Aiman Ezzat:** The energy transition is driving new business models in the energy and utilities market. These include clean energy; alternative fuels; grid-management services; and mobility services such as electric-vehicle (EV) charging stations, energy-storage solutions, and energy platforms. As the share of renewables in the energy mix increases, energy-storage solutions and grid-management services will be critical to managing intermittency in renewable-energy supply. Further, as consumers increasingly turn into prosumers,

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Decarbonization and sustainability shift to opportunity-driven goals, rather than compliance-driven obligations for the customer.”

François Jackow



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The energy transition is driving new business models in the energy and utilities market.”

Aiman Ezzat



there is growing demand for renewable-energy storage systems for residential and commercial use, and for platforms that facilitate peer-to-peer energy exchange. Our research on this topic found that most energy and utility industry executives expect new energy models to constitute their mainstream business within the next few years.

What advice would you give to your peers on how to manage large organizations in such a volatile and uncertain environment?

— **François Jackow:** Firstly, in a volatile, challenging environment, we need a clear strategy based on strong fundamentals.

My second piece of advice relates to execution; we need to be agile and adapt to changes in the environment. We cannot afford to waste time or resources, so we need urgent access to the tools and organizations that can provide efficacy and efficiency, while building more resilient business models.

Lastly, we must listen: to our customers, who will act as our guides, and - equally important - to our employees. We need to engage them, communicate with them, explain our strategy. They need to feel that they are on the journey together.



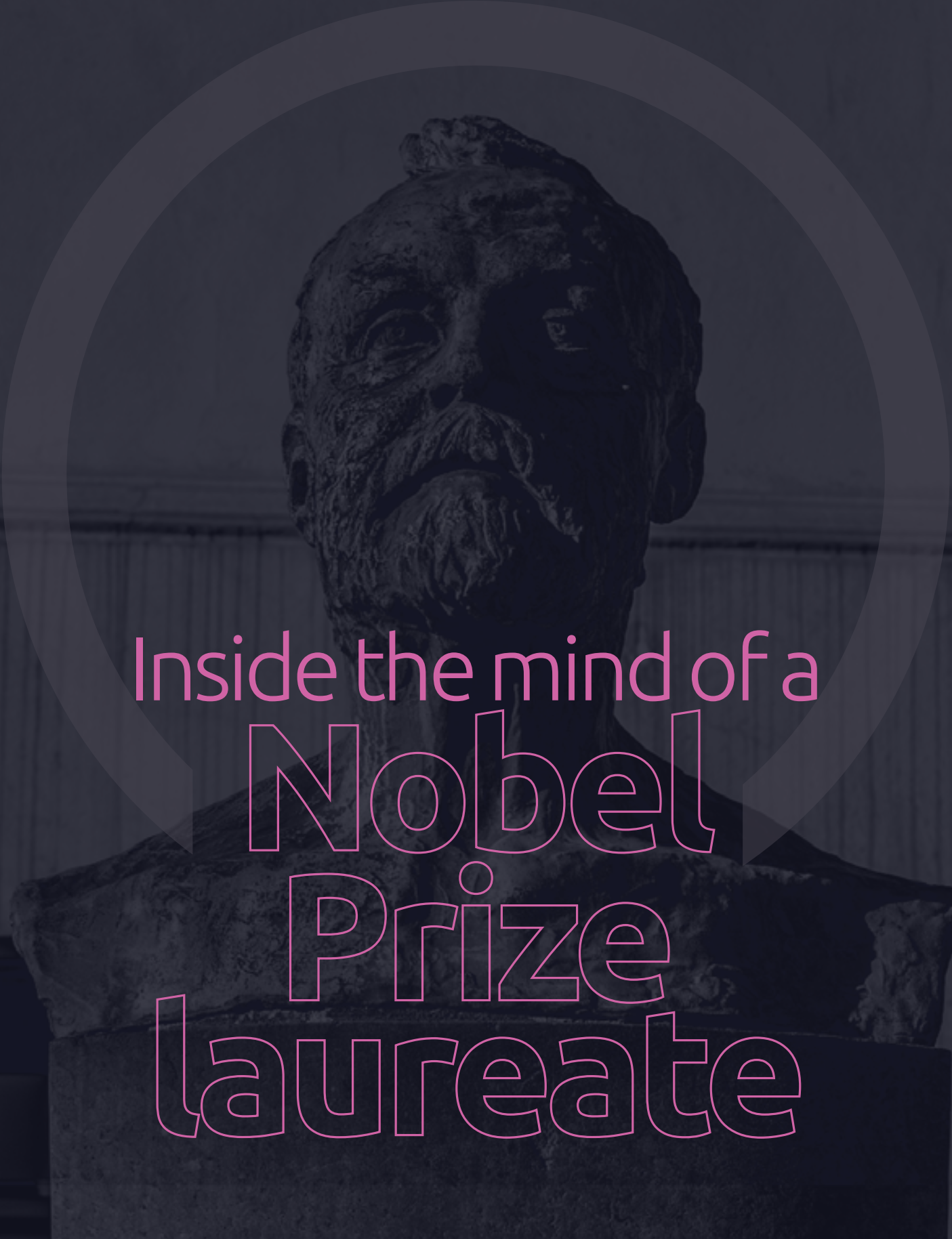
François Jackow
Chief Executive Officer,
Air Liquide

"In a volatile, challenging environment, we need a clear strategy based on strong fundamentals."



Aiman Ezzat
Chief Executive Officer,
Capgemini

"Decarbonization will result from reconstructing the way we do business and rethinking our entire value chain and products."



Inside the mind of a
Nobel
Prize
laureate

Inside the mind of a Nobel Prize laureate

Conversations
FOR TOMORROW



DR. FRANCES ARNOLD

Nobel Prize winner in
Chemistry in 2018 for
Directed Evolution
California Institute of Technology



GIVING EVOLUTION A SHOT IN THE ARM

Dr. Frances Arnold

Dr. Frances Arnold is the Linus Pauling Professor of Chemical Engineering, Bioengineering and Biochemistry at the California Institute of Technology (Caltech). Dr. Arnold received the Nobel Prize in Chemistry (2018) for pioneering directed enzyme evolution and has subsequently created enzymes for use in alternative energy, chemicals, and medicine. She is co-chair of the President's Council of Advisors on Science and Technology (PCAST). She has been elected to all three US National Academies of Science, Medicine, and Engineering, and is also a director on the boards of prominent companies such as Alphabet and Illumina. The Capgemini Research Institute spoke to Dr. Arnold to understand how directed evolution, coupled with the resilience found in nature, can help create a sustainable world.

Inside the mind of a Nobel Prize laureate

What got you interested in science?

I had all sorts of jobs when I was young, from taxi-driving to cocktail waitressing; but these were to pay the rent. Math and science were what made sense to me from an early age. I idolized my father, a nuclear physicist. I obtained a BSc in Mechanical and Aerospace Engineering and worked for a while in the nuclear industry and in solar energy, but my real love turned out to be something I did not even know could be possible until I went to graduate school at age 25: engineering the biological world.

WHAT IS DIRECTED EVOLUTION?

You won a Nobel Prize for your pioneering work on the directed evolution of enzymes. Can you help us understand what that is and how it can help society?

Enzymes are the catalysts responsible for all the wonderful chemistry of the biological world. We would like to use them in human applications, but they are not ideal for this. So, in the 1980s, I started to engineer amino-acid sequences for enzymes that would perform in human applications. Back then, no one knew which sequence would be required to encode a

desired function – enzymes are complicated. However, evolution can show us how to encode enzymes more effectively. The simple process of mutation and natural selection that has given rise to the rich diversity of the biological world can be harnessed by chemists. Using newly developed tools in the fields of molecular biology and high-throughput screening, I developed ways to practice “evolution by artificial selection” for enzymes.



I developed ways to practice 'evolution by artificial selection' for enzymes."

In other words, this is a simple optimization strategy for making random mutations at a low level and screening to find the mutations that can be most beneficial to us. Through various iterations, we find the best-performing steps. Nature is solving all sorts of problems that we throw at her – how to degrade plastic bottles, how to degrade pesticides, herbicides, and antibiotics. She creates new enzymes in response to these problems all the time, in real time. With directed evolution, we can do the same – create new enzymes in response to new problems.

THE SIMPLE PROCESS OF MUTATION AND NATURAL SELECTION THAT HAS GIVEN RISE TO THE RICH DIVERSITY OF THE BIOLOGICAL WORLD CAN BE HARNESSED BY CHEMISTS

ENZYMES FOR A GREENER PLANET

Much of your research focuses on sustainability. What about this area of study excites you most?

What excites me most right now is expanding the chemistry of the biological world to compete with human chemists. Making and breaking bonds. All my projects are about sustainability or bioremediation – making things in a cleaner fashion or breaking them down again. I love working with enzymes. Nature has developed a vast array of enzymes that do incredible chemistry, but there's a lot that hasn't been explored yet.

We could have better processes by getting enzymes to do chemistry that would, for instance, dramatically reduce the cost of manufacturing pharmaceuticals by replacing 10 chemical steps with one or two enzymes. One particular example I am proud of is how Merck [a multinational science and technology company] developed an enzyme using directed evolution to make the drug Januvia, which is used to treat diabetes. The initial, unrefined process used toxic metals, with a lot of waste products. Merck has managed to reduce the waste to around one-hundredth of initial levels and remove toxic-metal catalysts from their process, just using enzymes to synthesize the pharmaceuticals.

Inside the mind of a Nobel Prize laureate

I am also excited about reducing the cost and time necessary to develop these enzymes and the processes they are used in. I am working to incorporate machine learning [ML] and artificial intelligence [AI] into this evolutionary optimization. It promises to allow us to develop biological solutions much faster than in the past.



"Merck has managed to reduce the waste to around one-hundredth of initial levels and remove toxic-metal catalysts from their process, just using enzymes to synthesize the pharmaceuticals."

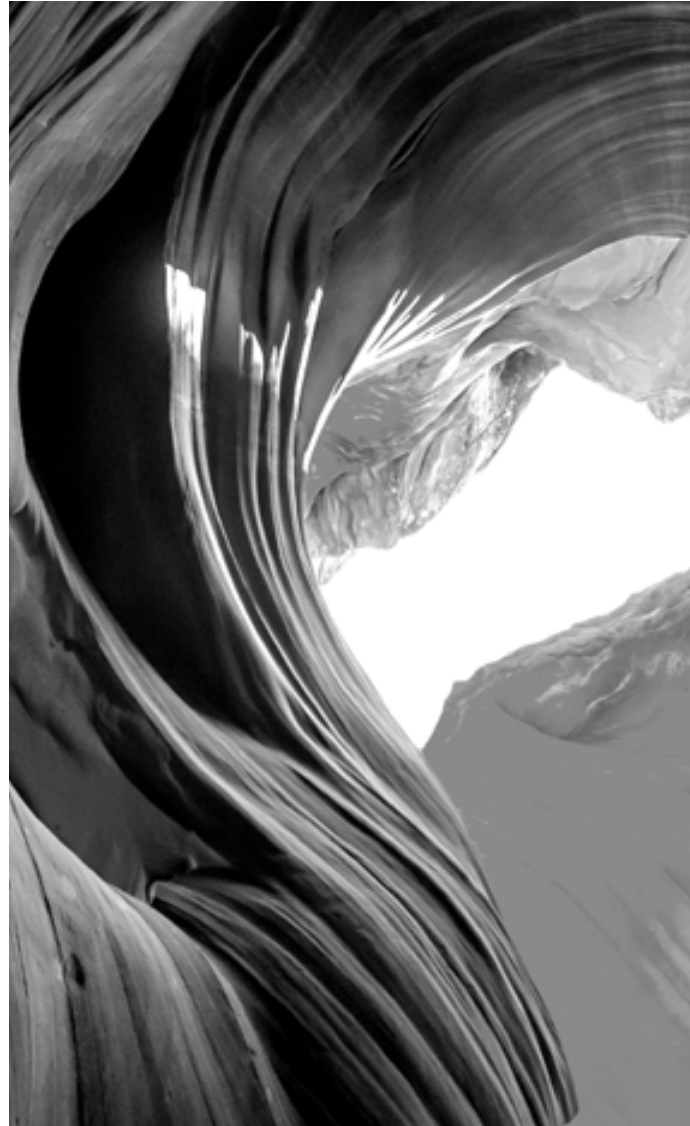
Inside the mind of a Nobel Prize laureate

How can bioengineering help the planet?

Everything that nature does is efficient. It's this highly evolved system that makes and breaks chemical bonds, creating chemicals and materials of magnificent functionality – but that won't persist forever. I think that biological chemistry, with its very high selectivity and power efficiency, can broaden our thinking around fabrication and recycling. Not only can we help break down everything we use in our daily lives into recyclable elements, we can also help create new products entirely, things which are not possible using traditional chemistry. Biological chemistry can have a beneficial effect on any application of conventional chemistry, and we should use it to find efficiencies. Life today is the product of 4 billion years of evolution, not of engineers in a laboratory. Nature has a lot to teach us.

You have co-founded three companies in the sustainable chemistry and renewable energy fields. Can you briefly describe them?

We founded Gevo [Green Evolution] in 2004 to make fuels from renewable resources. The concept was to engineer enzymes in yeast to make isobutanol, a precursor to jet fuel, instead of ethanol. Today, Gevo is one of the leaders in the development of renewable aviation fuel.



**"Everything
that nature does
is efficient."**

Inside the mind of a Nobel Prize laureate

The second company, Provivi, was founded in 2014 to replace toxic pesticides. We developed processes to make non-toxic pheromones, chemicals that serve as signaling mechanisms, which, when sprayed in the field, confuse the mating instinct of insects. Our focus is to create a new foundation for safer, affordable, and sustainable crop protection.

The third company, Aralez Bio, was formed more recently, in 2019. It uses enzymes to make pharmaceutical intermediates.¹ They can make hundreds of new amino acids and other chemical building blocks, while cutting waste, energy consumption, and costs.

**LIFE TODAY IS THE
PRODUCT OF 4 BILLION
YEARS OF EVOLUTION,
NOT OF ENGINEERS
IN A LABORATORY.
NATURE HAS A LOT TO
TEACH US.**

¹ Chemical compounds widely used in bulk pharmaceutical manufacturing and also in research.

USING AI TO CREATE NEW PROTEINS

How is new technology helping your research in bringing enzymes faster to market?

Evolution is a process. It's turning the crank of mutation and artificial selection. We can harness the power of evolution by automating and empowering it, using AI and ML. I have been publishing on this for 10 years. But even more exciting is that some of these generative AI capabilities are being used to invent proteins from scratch. Enzymes are more complicated, but I predict it will be possible to invent them, too, in the future. This is the convergence of experimental capabilities, understanding the features that really make up a successful protein and then harnessing the new methodologies made available through generative AI. I predict that, in the next few years, AI is going to be a powerful force – one capable of recoding life.

“

I predict that, in the next few years, AI is going to be a powerful force – one capable of recoding life.”



Inside the mind of a Nobel Prize laureate

How can generative AI help in creating new proteins?

I am on the board of Generate Biomedicines, a biotech startup which uses AI to generate therapeutic proteins that could be used to cure diseases. Machine learning algorithms can generate novel sequences for proteins that have never been seen in nature. These algorithms analyze hundreds of millions of known proteins, looking for statistical patterns linking amino acid sequence, structure, and function. Using these learned statistical patterns, the company generates custom protein therapeutics – from short peptides to complex antibodies, enzymes, gene therapies, and yet-to-be-described protein compositions.



MY ADVICE TO YOUNG WOMEN: BE FEARLESS

What is your advice to young women who want to enter the field of science?

Try different things. I tried many fields of science before I found what I love to do. If you're going to change the world, you've got to be fearless. Don't feel that you have to stick with something just because you said you were going to do it. If you don't like it, do something else.

THE IMPORTANCE OF THE INTERFACE BETWEEN SCIENCE AND PEOPLE

To what degree is finding the path to a sustainable world dependent on innovation from science/new technologies as opposed to behavioral changes?

It has to be both. What we have learned during the pandemic is, you can have all the science and technology you want, but if people won't be vaccinated, it doesn't do any good at all. We can offer scientific solutions, good or bad, but if people don't want them and don't accept the necessary behavioral changes, it's not going to happen. So, this interface between science and people is vitally important.

If you had a magic wand, in our transition to a sustainable world, what would you change right now?

I would love to see respect for biodiversity. I would love to see respect for the natural world that we rely on, but that we treat so badly. I would love to see the natural world being accounted for as an invaluable asset on which our very existence depends.

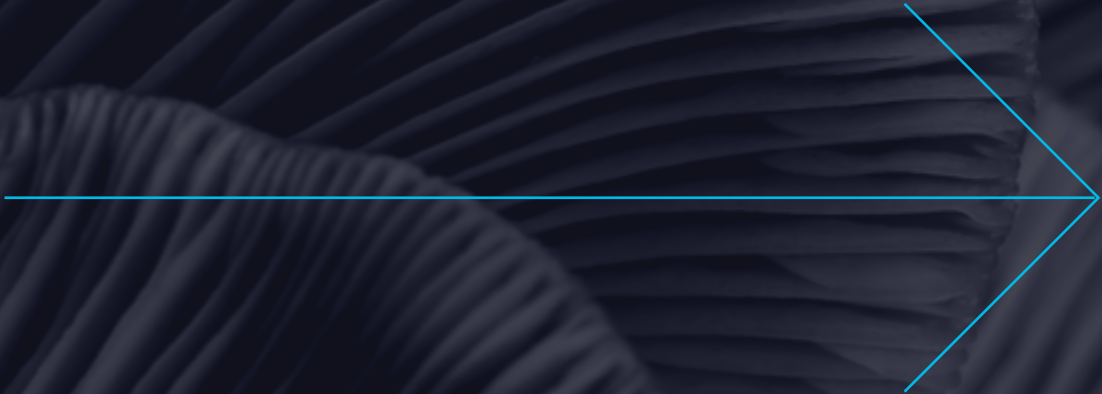
**I WOULD LOVE
TO SEE RESPECT FOR
BIODIVERSITY**

Inside the mind of a Nobel Prize laureate



Dr. Frances Arnold,
Linus Pauling Professor of Chemical
Engineering, Bioengineering and
Biochemistry
California Institute of Technology

"We can offer scientific solutions, good or bad, but if people don't want them and don't accept the necessary behavioral changes, it's not going to happen."



Executive conversations with...



L'ORÉAL

Alexandra Palt

Chief Sustainability Officer
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CRADLE TO CRADLE

William
McDonough

Designer, Architect, Innovator, Author
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PROCTER & GAMBLE

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POTSDAM INSTITUTE FOR

CLIMATE IMPACT
RESEARCH

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ALEXANDRA PALT

Chief Corporate Responsibility
Officer, L'Oréal, and CEO of the
Fondation L'Oréal

L'Oréal



COLLABORATION FOR A SUSTAINABLE FUTURE

L'ORÉAL G R O U P E

Founded in 1909, L'Oréal is one of the world's largest manufacturers of high-quality cosmetics, perfumes, hair care, and skincare products spread across 150 countries. In 2022, the company reported a revenue of \$38.2 billion with assets worth \$48.9 billion. The company currently employs more than 85000 people across 150+ countries. The company has been awarded a 'AAA' rating by CDP for seven years in a row.

Alexandra Palt is the Chief Corporate Responsibility Officer of L'Oréal and CEO of the Fondation L'Oréal. A lawyer by training, specializing in human rights, Alexandra joined L'Oréal in 2012 as Chief Sustainability Officer. She was instrumental in launching the Women4Climate initiative. The Capgemini Research Institute spoke to Alexandra about L'Oréal's collaborative sustainability journey.

What are your priorities as Chief Corporate Responsibility Officer of L'Oréal and CEO of the L'Oréal foundation?

At L'Oréal, I'm responsible for internal business-model transformation, making sure that we develop a circular economy within the planetary boundaries model.¹ As CEO of the L'Oréal Foundation, I'm in charge of the organizational contribution to tackling the greatest environmental and societal challenges we face today. These two functions present complementary targets. We cannot continue to follow conventional, profit-driven business models; we need an approach that combines two essential elements: internal transformation and mobilization of economic resources for impact investing.



Alexandra Palt,
Chief Corporate
Responsibility Officer of
L'Oréal and CEO of the
Fondation L'Oréal

**WE CANNOT
CONTINUE TO FOLLOW
CONVENTIONAL,
PROFIT-DRIVEN
BUSINESS MODELS**

¹ The planetary boundaries model sets a number of boundaries within which humanity must maintain its activities in order to preserve environmental equilibrium and preserve a safe, survivable operating environment (See interview with Johan Rockström)

SUSTAINABILITY TRANSFORMATION AT L'ORÉAL

Where is L'Oréal on its sustainability journey?

L'Oréal's sustainability journey started way back in 2013. We set ambitious sustainability goals throughout our value chain, which focused on reducing the environmental footprint of our products and increasing our social impact. This led to a profound shift in mindset, which prompted all our employees to begin to address these issues. As part of a virtuous circle, this helped us develop our next generation of sustainability targets. By 2020, we had reduced our carbon emissions by 78% from 2005 levels. We had reduced the carbon footprint of more than 90% of our products.



By 2020, we had reduced our carbon emissions by 78% from 2005 levels."

In 2020, L'Oréal launched L'Oréal for the future program, a strategy that included pledging to respect planetary boundaries. The strategy is based on setting quantifiable, measurable goals to minimize the impact of business operations on the climate, security of water supply, biodiversity, and natural resources, while addressing some of the most urgent social and environmental challenges facing the world. We aim to improve energy efficiency by transitioning to 100% renewable energy by 2025. And we intend that, by 2030, 100% of our packaging will be either from recycled or bio-based sources.



"We aim to improve energy efficiency by transitioning to 100% renewable energy by 2025."

In defining and setting our new targets, we not only focused on reducing emissions and carbon footprints; rather, we went about designing an entirely new, scientifically based business model that will assist us in maintaining our operations within the planetary boundaries. This won't be easy; it's a completely circular model that will oblige us to make difficult choices.

**WE ARE DESIGNING
AN ENTIRELY NEW,
SCIENTIFICALLY BASED
BUSINESS MODEL
THAT WILL ASSIST US
IN MAINTAINING OUR
OPERATIONS WITHIN
THE PLANETARY
BOUNDARIES.**

SHARING RESPONSIBILITY AND HELPING CONSUMERS MAKE THE RIGHT CHOICES

How does a global organization such as L'Oréal engage consumers on sustainability?

We engage our customers by advocating an approach based on shared responsibility. We believe it is our responsibility to produce the most environmentally sustainable products. We have started sharing information with consumers on the carbon footprint of our products and their material impact on the environment.

We also encourage the consumer to make sustainable choices; they might not be prepared for a major shift in their consumption behavior, such as refilling or recharging, rather than buying new every time. So, the onus is on us to help them make these choices. There are various strategies that can help us do this; for instance, by making refilling and recharging available in the most impactful categories; by encouraging specific behaviors through price discounts; and through nudges [using environmental factors such as in-store signage and advertising to subtly influence behaviors].



We have started sharing information with consumers on the carbon footprint of our products."

COLLABORATING WITH COMPETITORS FOR A SUSTAINABLE PLANET

How do you balance the pros and cons of the collective approach initiated by L'Oréal through the EBS Consortium² in a highly competitive industry?

As we strive for global sustainability, some things belong to a non-competitive space. There will be no business to compete for in a world where consumption is no longer possible. The challenge for us is not to occupy the leadership position, but how we can facilitate shared progress in a limited timeframe. Through the EBS, we can hold discussions across the industry about how to achieve sustainability and protect the environment without curbing our commercial ambition.

What are the key success factors in fruitful collaboration?

There must be a shared vision, and a willingness to look for common ground. We need to understand the realities of the climate crisis and align targets to maximum effect. By doing this, we can preserve our industry and continue to operate, create, and grow within the planetary boundaries.

**AS WE STRIVE
FOR GLOBAL
SUSTAINABILITY, SOME
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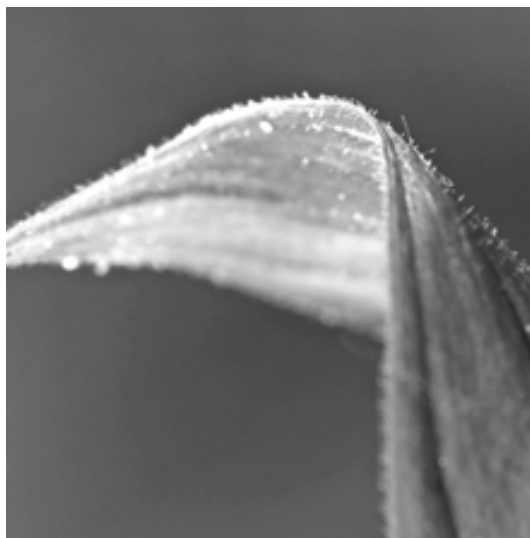
² The EcoBeautySystem Consortium, comprising around 60 leading industry players, has the aim of developing an industry-wide environmental impact-assessment and scoring system for cosmetics products.

INNOVATION AND BEHAVIORAL CHANGE NEED TO GO HAND IN HAND

Innovation or behavioral change – which will be the greater driver of the transition?

In order to overcome the challenges we face, we will need to pursue scientifically based innovation. It is the responsibility of organizational leaders to foster this approach. For the past half-century or so, since the climate became a topic of concern, people have reassured themselves by saying, "We will find a technological solution, we will find a scientific solution." But, to date, one hasn't been found. Even when someone does come up with a viable solution, that will only be half the battle, because we will need to find the financing to realize it.

Technology will be part of the solution, but only if we start to innovate with sustainability as the goal. Likewise, science will help us, but we will also have to change our consumption behaviors. Businesses need to accept that they are not just carrying on with business as usual, with a few green tweaks; they are looking at wholesale change of the business model. It doesn't matter how much it costs to do it either; the cost of not acting will be infinitely greater.



**"Science will help us,
but we will also have to
change our consumption
behaviors."**

MAKING THE TRANSITION FAIR FOR EVERYONE

Can you tell us a bit more about the “just transition” concept?

We still operate in a system that only works for a minority. Most of the global population lives in poverty and suffers from a lack of decent living conditions. As long as this situation persists, the environmental transition is going to be uneven.

We have to work together as a global society to provide populations with basic living essentials, so that they can then become invested in environmental issues. One of the most important issues is fair pay – it’s not just about our employees but also our value chain. Our suppliers have to pay a living wage.

But what is a living wage? A living wage is a salary that allows a person working in the value chain to cover their basic needs and the basic needs of their dependents.

Unfortunately, a lot of companies don’t consider this their responsibility. So, L’Oréal has decided not only to pay a living wage to our employees, but also to work with suppliers, where necessary, to help them do the same. By 2030, all our strategic suppliers will be paying living wages to employees in their value chain if they want to continue to work with us.

Climate change is not a local issue, it’s a planetary issue. We have to take vital decisions now, both individually and collectively.



Alexandra Palt,
Chief Corporate Responsibility
Officer, L'Oréal, and CEO of the
Fondation L'Oréal

"L'Oréal has decided not only to pay a living wage to our employees, but also to work with suppliers, where necessary, to help them do the same."



VIRGINIE HELIAS
Chief Sustainability Officer

Procter & Gamble



PUSHING THE BOUNDARIES OF SUSTAINABILITY THROUGH INNOVATION



The Procter & Gamble Co (P&G) is a manufacturer and marketer of fast-moving consumer goods. It operates through the Beauty, Grooming, Health Care, Fabric & Home Care, and Baby, Feminine & Family Care segments. More than 106,000 employees work at P&G. The company was founded in 1837 and is based in Cincinnati, Ohio.

Virginie Helias is P&G's Chief Sustainability Officer. Her mission is to develop the organization's strategies and goals on sustainability and operationalize them across businesses and regions. She has been part of P&G for over 30 years, working on brands including Pantene, Ariel/Tide, and Pampers. Capgemini Research Institute spoke to Virginie about sustainable product design and using innovation to drive sustainability and customer satisfaction.

ENABLING AND INSPIRING RESPONSIBLE CONSUMPTION

You have been with P&G for over three decades. How did you come to the Sustainability function?

When I first pitched my current role to the then CEO, sustainability was only loosely connected with business. I saw an opportunity to reinforce our business methods with scientific knowledge, with the primary mission of making sustainability integral to how we build our brands and innovate.

Over the years, my role has evolved from driving change on the periphery to being central to how we do business, and now I'm responsible for enabling our business to deliver our Ambition 2030 goals and helping our brands to develop irresistibly superior innovations that are more sustainable. It is also about helping the company meet the needs of all our stakeholders – consumers, retailers, employees, shareowners, and society at large, for whom sustainability is an ever-increasing expectation.



Virginie Helias,
Chief Sustainability Officer,
Procter & Gamble

Can you explain Ambition 2030 and the progress to date?

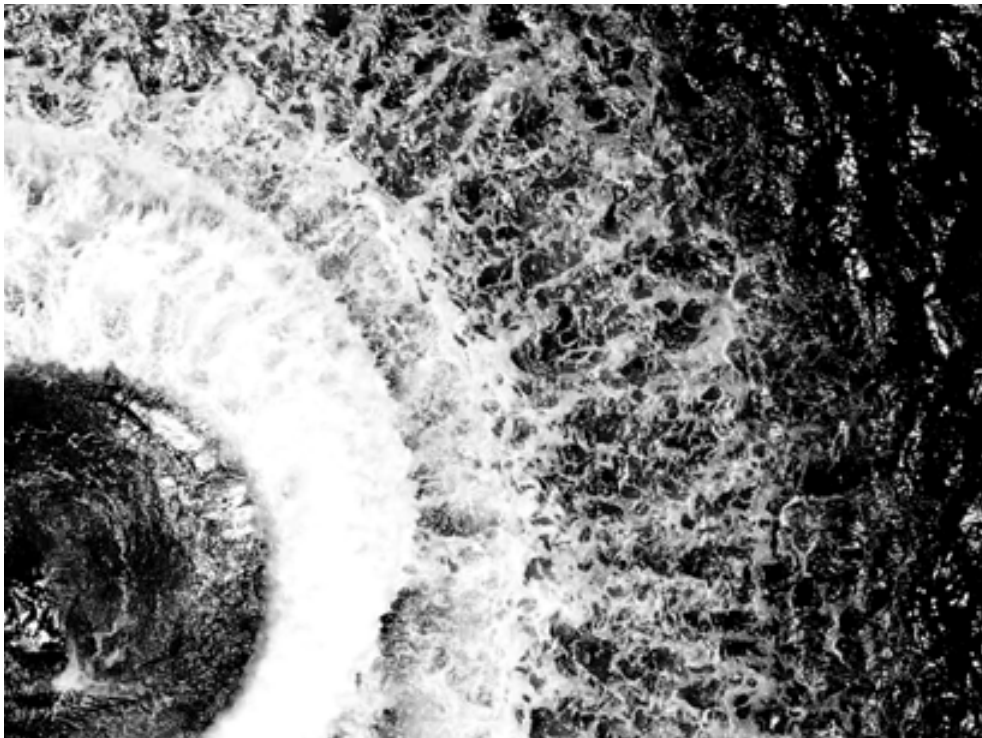
We launched Ambition 2030 in 2018, with the goal of enabling and inspiring responsible consumption through our supply chain, brands, employees, and partnerships. The ambitions have since been expanded and refined several times with specific goals for reducing greenhouse-gas emissions on the way to reaching net zero in 2040, increasing recyclability of our packaging and reducing our use of virgin petroleum plastic, and most importantly creating the systems and the culture to embed sustainability into the organization. The initiative is built on the strength of four science-based pillars: climate, waste, water, and nature.

From 2010 to 2022, we reduced absolute Scope 1 and Scope 2 emissions across our global operations by 57% through energy efficiency and renewable-energy sourcing. As we continue to reduce emissions, we are also advancing natural climate solutions, which will balance any residual emissions from our operations that cannot be eliminated by 2030. In September 2021, we set a new ambition to achieve net zero greenhouse-gas emissions across our operations and supply chain, from raw-material to retailers. Last year we reported close to 80% of recyclability for our packaging globally with 2 times more recycled content versus two years ago.



From 2010 to 2022, we reduced absolute Scope 1 and Scope 2 emissions across our global operations by 57% through energy efficiency and renewable-energy sourcing."

**LAST YEAR WE
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VERSUS TWO YEARS
AGO.**



 MAKING LONG-LASTING PRODUCTS

How far have you progressed on sustainable product design?

Sustainability is an integral design principle in P&G today – it is built-in, not bolted on. Previously, sustainability and innovation were treated as separate entities, but we have integrated them into one cohesive strategy, known as 'irresistibly superior and sustainable innovation.' Our goal is to have 100% of our innovations be irresistibly superior for consumers and represent an improvement on sustainability on any of the four dimensions (climate, waste, water, and nature). I would say today we are

halfway there. I am particularly proud of some of our recent 'irresistibly superior and more sustainable innovation.'

Gillette and Venus undertook a sustainable packaging upgrade to transition premium refillable razor packs to a plastic-free, recyclable cardboard box made with recycled materials and FSC certified paper. This is available in every P&G region globally and it delights consumers with its ease of opening and full recyclability. We estimate this packaging change saves the plastic equivalent of more than 85 million water bottles per year. The Ariel performance improvement in cold water

is another example. By addressing the biggest carbon footprint driver – the temperature of the washing cycle – Ariel is helping consumers reduce their own footprint while getting a superior clean in cold water. This is a win-win-win for people, as washing in cold helps clothes stay looking like new longer, for the planet and for our business.



Our goal is to have 100% of our innovations be irresistibly superior for consumers and represent an improvement on sustainability on any of the four dimensions (climate, waste, water, and nature)."

How do you find a trade-off between recyclability and biodegradability in packaging?

At P&G our goal is to design all of our packaging to be reusable or recyclable because we believe that packaging materials, such as plastic, have lasting value. Our efforts are focused on circular solutions so that our packaging materials can be used again and again. I often get asked whether to prioritize recyclability or biodegradability in packaging. This is complicated because, under some conditions, biodegradability can be counterproductive to recycling. It can become a contaminant in the recycling streams, and it can be a pollutant if the packaging ends up in landfill with no oxygen. There are certain regions of the world that lack waste management infrastructure and biodegradability may be relevant in these regions until good waste management infrastructure is in place. We are currently testing marine biodegradable packaging for shampoo for the Philippines market.

How does P&G as a corporation balance its responsibility for driving growth and increasing consumption with promoting sustainability?

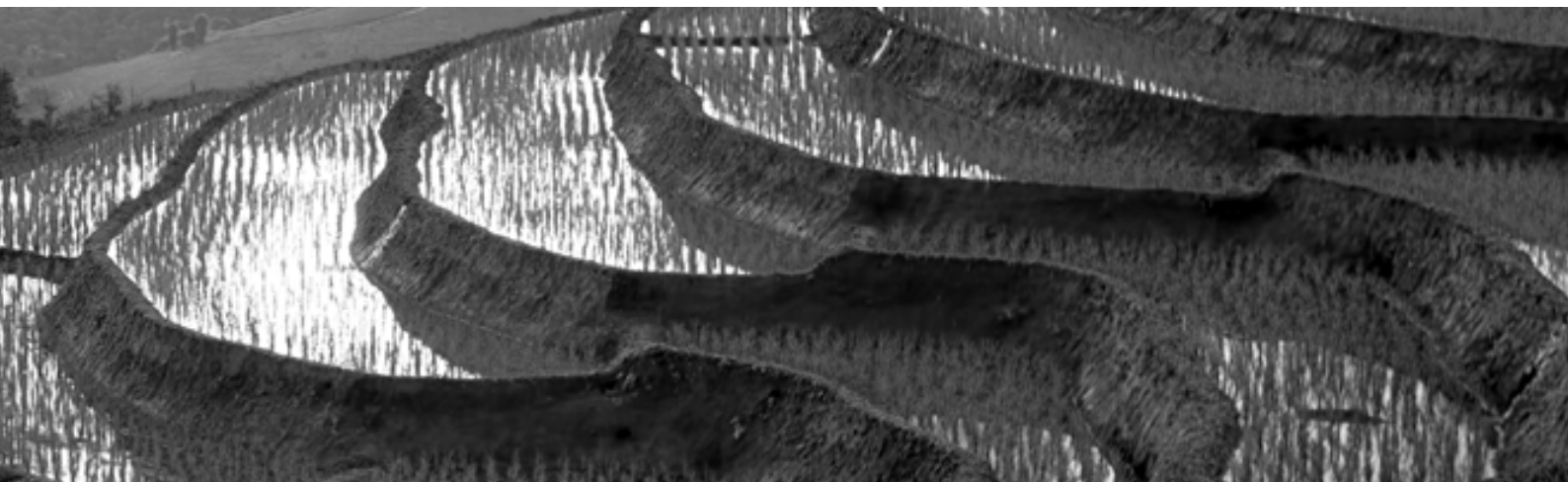
Let's look at our grooming products business. One of our key strategies here is to make products long-lasting. We are aiming to produce razors that are superior and more durable. On our new Gillette Labs Razors for instance, we are offering a lifetime warranty. Furthermore, we are engaging in reverse logistics to recover some of the components in used products. We are working with third parties to collect the handles and the blades for recycling. We have several programs globally to accelerate circularity and durability of our materials. It's completely central to our sustainability strategy.



MOST CONSUMERS WANT A PRODUCT THAT IS SUSTAINABLE BUT WITHOUT ANY TRADE-OFF.

Are consumers willing to pay a premium for sustainable products?

Only a small portion (10–15%) of consumers are currently willing to pay for sustainable products that do not offer performance or experience benefits. Most consumers want a product that is sustainable but without any trade-off. You will see in many surveys that a significant percentage of consumers globally are claiming they are willing to pay a premium for more sustainable products. But we are also seeing an intention-to-action gap between what people claim and their actual purchase behavior. In real purchase situations, sustainability is rarely the main driver (although it can be a tie breaker all things being equal). Therefore, the focus has to be on developing innovation that provides more delight and is more sustainable.



COMMUNICATING ENVIRONMENTAL INNOVATIONS TO CONSUMERS

How do you manage communication around sustainable innovation?

As I said before, the focus is on being irresistibly superior and sustainable. Therefore, we communicate how superiority enables sustainability or includes sustainability. For instance, when it comes to Ariel, 60% of its environmental footprint comes from the temperature of the washing cycle. We are developing products that have superior performance in cold water. This is what we communicate – with Ariel you can be confident your clothes will be clean when you wash in cold because “every degree makes a difference,” which is the name of the campaign. That means saving on your electricity bills and reducing your footprint at the same time. With that campaign, we have seen the average claimed wash temperature in Europe go down by 2 degrees, even more among Ariel users.



"When it comes to Ariel, 60% of its environmental footprint comes from the temperature of the washing cycle. We are developing products that have superior performance in cold water."

Another example is our Cascade brand. Dishwasher usage in the U.S. is low due to the erroneous belief that it wastes water and energy compared to manual washing. We have developed a product that works so well that you don't need to pre-rinse your dishes before putting the dishes in the dishwasher, a habit done by 75% of people in the U.S. We launched a campaign called "Do It Every Night," where we encouraged people to skip pre-rinsing dishes and run the dishwasher every night instead of doing it by hand. While this could mean running the dishwasher before it is full, it avoids people handwashing in between dishwasher loads, which turns out to be much less water efficient. A person can save up to 100 gallons of water a week if they run their dishwasher every night instead of washing those dishes by hand. This initiative has the potential to save 25 billion gallons of water in the U.S. The key to our successful sustainability communication is a combination of superior performance and sustainability innovation.

How do you at P&G manage your responsibilities around deforestation and biodiversity?

We take specific steps to ensure no deforestation in our palm, wood pulp, and paper packaging supply chains. We focus on understanding our business's dependency and impact on nature and where in the supply chain



Biodiversity is an exciting emerging field, with lots of possibilities."

that impact is greatest, and then concentrate our efforts there. We have committed to protecting 1.5 million acres of land and we follow closely the emerging standards for the Taskforce on Nature-related Financial Disclosures (TNFD). We have a Nature and Biodiversity leader in place to lead our holistic

program, including investing in natural climate solutions. This is an exciting emerging field, with lots of possibilities.

How can technology help us transition to a sustainable world?

I'm fascinated with the overlap between information technology and sustainability. We use satellite technology to monitor our palm-oil supply chain, for instance. The real-life data helps us with compliance and making immediate interventions, when required. Data can also help consumers understand their own impact on the environment. In the UK, for example,

I AM AMAZED BY THE POWER OF DIGITAL DATA TO CHANGE CONSUMER HABITS.

water-consumption levels dropped immediately when people had meters installed. They could see their consumption in real time, it made the invisible visible for them. I am amazed by the power of digital data to change consumer habits.

THE BEST EXPERTS FROM EVERY DISCIPLINE TO DRIVE SUSTAINABILITY

How has sustainability impacted skill development at P&G?

We are focusing on reskilling and upskilling at every level, from the top down. Last year, we conducted a massive sustainability upskilling program for 300 top executives, where we took them through our strategies and goals. I have also started a monthly Q&A session with all employees. And we just launched our new Sustainability Academy capability platform that is open to all employees globally. It includes a curated list of topics with on-demand training videos and resources; fundamental and advanced trainings are available to everyone in the company.

What suggestion would you give to young talent who want to follow in your footsteps?

Work toward sustainability in your current role; make it part of your job, not a separate topic. There are very few dedicated positions for sustainability experts – we can spark large-scale change when we all use our individual roles to drive sustainability. Champion sustainability where you are. We need the best marketers, best finance experts, and the best lawyers to make sustainability an integral part of the organization. When the best people in every discipline drive sustainability, this is how society will thrive.



Virginie Helias,
Chief Sustainability Officer,
Procter & Gamble

"When the best people in every discipline drive sustainability, this is how society will thrive."



KARIN SVENSSON
Chief Sustainability Officer

Volvo Group



WINNING THE SUSTAINABILITY RACE TOGETHER

V O L V O

The Volvo Group is one of the world's leading manufacturers of trucks, buses, construction equipment and marine and industrial engines. The Group also provides complete solutions for financing and service. The Volvo Group, with its headquarters in Gothenburg, employs about 100,000 people, has production facilities in 18 countries, and sells its products in more than 190 markets. The company was founded in 1915.

Karin Svensson has been a part of Volvo Group for over 27 years. Prior to her current role, she was Vice President Public Affairs and Group Strategy, roles in which she focused on public policy, the impact of industry, competitive trends on the current market and on the future of business. The Capgemini Research Institute spoke to Karin to hear her views on sustainability through collaboration.

HOW SUSTAINABILITY HAS BECOME BUSINESS CRITICAL

As a veteran of transport, how do you think the industry has evolved from a sustainability perspective?

We know how important it is from an environmental perspective, but over the past few years, sustainability has now become business critical. We feel increasing pressure from stakeholders, investors, customers, employees, and society in general. Sustainability is no longer just a government-driven agenda; now, businesses are leading the way and setting ambitious goals. We are talking about sustainability as a business opportunity, rather than just a compliance requirement.



Karin Svensson,
Chief Sustainability Officer
Volvo Group

"We are talking about sustainability as a business opportunity, rather than just a compliance requirement."

WE ARE LOOKING TO GOVERNMENTS TO SUPPORT SUSTAINABILITY INITIATIVES; IF THEY PUT IN PLACE RELEVANT FAVORABLE LEGISLATION, THEN WE CAN ADJUST OUR POLICIES TO MAKE THESE CHANGES HAPPEN MORE QUICKLY.

How much progress has Volvo made towards achieving its own climate-related goals?

For the business industry in general, there is an intense focus on the environment, but our sustainability agenda is broader and includes climate, resources, and people. Climate change is one of the biggest challenges today and road transport is a significant emitter of CO₂ and greenhouse gases. We are addressing this challenge by transitioning our range to electric. We have set ambitions for 2040, including achieving net zero, validated by the Science Based Targets initiative. We are focusing on reducing our use-phase emissions, as well as our Scope 3-upstream emissions along with Scope 1 and 2. We are rolling out our electric vehicles (EVs) across different regions; further developing our charging infrastructure; and ensuring that renewables make up a greater proportion of our energy mix. We are looking to governments to support such initiatives; if they put in place relevant legislation, then we can adjust our policies to make these changes happen more quickly.

WINNING TOGETHER RATHER THAN RISK LOSING ALONE

How do partnerships help you to achieve your sustainability goals?

Partnerships are key. We all need to think about working together – with competitors and suppliers. We have been doing this for a while. We partnered with Swedish steel company SSAB to produce steel materials without the use of fossil fuels. With [Danish wind-turbine manufacturer] Vestas, we have established a partnership to develop renewable-energy sources. Our partnership with [German auto manufacturer] Daimler Truck and Traton on charging infrastructure is an interesting example of how we partner with competitors to address the complexities of climate change. In essence, we are forming partnerships across the value chain. Rather than risk losing alone, we want to win together.

“

We all need to think about working together – with competitors and suppliers.”

“Our partnership with Daimler Truck and Traton on charging infrastructure is an interesting example of how we partner with competitors to address the complexities of climate change.”

What investments have been made in sustainability initiatives at Volvo?

We are investing a lot in sustainability initiatives through our R&D, both in battery-operated EVs and in fuel-cell electric vehicles [FCEVs]. But for some applications, the existing internal combustion engine will still be required, so we need to ensure they run efficiently at the same time as investing in the transition to fossil-free alternatives. Sustainability is at the core of our business and scaling our EV offering is a major part of our strategy. We are also investing significantly in reducing our future industrial footprint; for instance, we have invested heavily in the development of sustainable manufacturing techniques at our Skövde plant, with reduced consumption of non-renewable materials. Some investments are also being directed towards the development of technology platforms and re- and upskilling the workforce to ensure a successful transition to sustainability. This is what we are doing to tackle sustainability from the perspective of climate, people, and resources.

DEVELOPING SUSTAINABILITY SKILLS

How are you overcoming talent shortages related to sustainability?

Sustainability is a growing field of expertise and ensuring the right talent is in place to tackle our societal issues is a challenge for all manufacturers. It starts in school, and this is why we are pushing for more sustainability competency development in the educational system in Sweden, France, and the US, among other countries, to secure the talent pipeline for the future. Attracting and retaining employees with sustainability-focused expertise is crucial – not only for us, but across many industries – meaning there is significant competition for these skills. We are a business that is driven by our passion to deliver a net-zero society, so even with our existing employees we are all playing our part to drive change from the inside out. We are also developing specific competencies in areas such as human rights, where finding qualified individuals can be challenging.

Furthermore, as the scope of sustainability widens to include areas such as biodiversity, we will require access to a wider range of skillsets.

A THREE-PATH APPROACH TO TECHNOLOGIES

Our research found that 80% of the environmental impact of a product is linked to decisions made at the design stage. What are your views on product design and sustainability?

I agree, it's very important to influence the early design phase. We work closely with all departments – including purchasing, technology, and R&D teams, as well as our suppliers – to ensure this happens. Our decision to become a founding member of the First Movers Coalition, a public-private partnership seeking to commercialize clean technologies through advance-purchase commitments, is testament to this. Another example of this is our partnership with SSAB on fossil-free steel. We need to think about different types of materials we use within our products and find clever ways to mitigate their impact.



Volvo Group is a founding member of the First Movers Coalition, a public-private partnership seeking to commercialize clean technologies through advance-purchase commitments."

What are some of the key technologies accelerating your sustainability journey?

We believe three technologies are needed to reduce transport emissions. The first path is related to the technology around battery EVs. The second is around FCEVs, which includes technologies allowing longer driving ranges that circumvent issues around inadequate charging infrastructure.

The third path relates to our ICE range. We're looking into new types of biofuels and other fossil-free fuels, including hydrogen. This wide-ranging three-path approach is unique. Efficient data collection and effective analysis of that data are essential to making the right technology choices for the many varied applications we have in our industry.

Which challenges do you face in taking suppliers/partners along on your sustainability journey?

We are working both with members of our own supply chain and across sectors to address sustainability challenges. One challenge is that our network consists not only of large companies, but also several small and medium-sized companies. Another challenge is that we need to go very deep into our supply chain, not only by looking at our tier-one suppliers, but also at tiers two/three/four. So, when we talk about partnerships and making sure that we're all on this journey together, a lot of people need to be in alignment.

**WE NEED TO GO
VERY DEEP INTO OUR
SUPPLY CHAIN, NOT ONLY
BY LOOKING AT OUR
TIER-ONE SUPPLIERS,
BUT ALSO AT TIERS TWO/
THREE/FOUR.**



If you had a magic wand, what would you change to accelerate progress towards sustainability?

We need access to greater quantities of renewable energy for sustainability reasons, but also as a prerequisite for achieving our net zero targets. Currently, that's not something we can fix, so that's what I would do, given a magic wand.



Karin Svensson,
Chief Sustainability Officer,
Volvo Group

"We need access to greater quantities of renewable energy for sustainability reasons, but also as a prerequisite for achieving our net zero targets."



ELIANO RUSSO
Head of 3SUN Gigafactory

Enel Green Power



POWERING AHEAD WITH EUROPE'S LARGEST SOLAR PANEL GIGAFACTORY



Founded in 1962, Enel has grown to become one of the largest electricity and gas operators in Europe, with a focus on sustainability and clean energy solutions. The company is headquartered in Rome, Italy, and operates in more than 30 countries. Enel's Green Power's 3Sun Gigafactory, in Catania, Sicily will become Europe's largest solar panel factory by 2024

Eliano Russo is Head of Enel Green Power's 3Sun Gigafactory, in Catania, Sicily, which will become Europe's largest solar panel factory by 2024. 3Sun's mission is to produce new-generation photovoltaic (PV) panels and modules, combining research, innovation, and sustainability, thereby supporting a transition to clean energy. The Capgemini Research Institute spoke to Eliano about his work and the future of solar energy.

You are Head of the 3SUN gigafactory. Can you help us understand the factory and your own role?

The gigafactory started in 2010 when the technology deployed was thin film. In 2015, we started deploying bifacial technology internally and, around the same time, Enel Green Power incorporated 3Sun as an extra division. Last year, we committed to invest more than 600 million euros to increase production capacity fifteen-fold.

As CEO, I'm responsible for running the business, and for ensuring that the 3-GW production capacity will be fully operational by July 2024. We will start with the first 400 MW as early as September this year, with the intention of reaching full capacity in July 2024. My responsibility is to ensure that everything will happen on time and within budget.



Eliano Russo,
Head of 3SUN Gigafactory,
Enel Green Power

**CURRENTLY, WE ARE
AT 1 TW OF INSTALLED
SOLAR CAPACITY
GLOBALLY, BUT THIS
IS EXPECTED TO
INCREASE SEVENFOLD
BY 2040.**



What do you think is the role of solar energy in our overall transition?

Solar energy will play a key role in meeting the growing demand for sustainable energy. Currently, we are at 1 TW of installed solar capacity globally, but this is expected to increase sevenfold by 2040. We expect most of the additional demand to be satisfied by solar energy because it's easy to install and it's increasingly competitive with conventional and other renewable sources. It will certainly play a key role in ensuring that this transition is sustainable and will eventually allow us to stabilize CO₂ emissions in the atmosphere.

THE LARGEST SOLAR PANEL GIGAFACTORY IN EUROPE

In terms of scaling, how does a gigafactory differ from a traditional factory?

We stopped production of our existing lines in July last year, having reached the production capacity of 200 MW. We are now increasing capacity fifteenfold, to 3 GW annually. This will make 3Sun the largest European solar-cell and solar-module manufacturer. Our proposition is not based exclusively on efficiency and economies of scale. It's more closely related to the promotion of robust, unique technologies that we have developed since 2015; we've achieved a certified level of efficiency with a clear roadmap to continue developing this technology.

How are you making sure that the gigafactory is itself sustainable?

Sustainability is a key to everything we have been doing to date, from sourcing materials such as cement and iron, to grinding, excavating, and recovering materials. We are also embedding circularity principles; we use materials that are already recycled in the construction phase. We reused excavated ground as the foundation of this factory. We minimize consumption of water and electricity. Everything is finalized to create a real connection with the local environment and minimize the impact of what we are building here. We plan to achieve 100% recyclability soon. We would like to upcycle and make sure that most of our components can be recycled directly in our sector and reused to produce new modules.

**WE PLAN TO
ACHIEVE 100%
RECYCLABILITY SOON.**

ENTERING MANUFACTURING TO ACCELERATE DECARBONIZATION

What were some of the broader challenges you faced in setting up the gigafactory?

At Enel, we are not just talking about circularity and sustainability. We are asking ourselves what needs to be done differently. The challenges are enormous. We started before the pandemic reached its peak, but it was already a big issue, impacting logistics and availability of staff; then, the war in Ukraine started just as we made these investment decisions. But, thanks to the commitment of all the people working with us on time and in budget, we have reached our targets. Nevertheless, we are aware, of course, that there will be other unexpected events that will influence the way we execute and operate the factory.

What other roadblocks have you faced?

One of our biggest challenges was the decision to enter manufacturing. Although it's not Enel's core business, the move makes sense strategically, as it will accelerate decarbonization; remove bottlenecks in the supply chain; and promote energy independence. The challenge now is to ramp up operations, optimize throughput, minimize operational expenses, and hit our technology-development targets.

"One of our biggest challenges was the decision to enter manufacturing. Although it's not Enel's core business, the move makes sense strategically, as it will accelerate decarbonization."



BUILDING AN ECOSYSTEM OF PARTNERS

How do you collaborate with partners, other organizations, and stakeholders to drive greater adoption of solar energy?

In Europe, we want to achieve 740 GW of solar capacity by 2030, which requires building and installing an additional 540 GW. This cannot be achieved by just one single company or via a typical supplier-customer relationship. We are building an ecosystem of partners, in which we align interests to accelerate this process. We need to make sure that we have visibility of the entire value chain, to avoid developing new dependencies on other countries for key components. The only way to do it is by joining forces and building partnerships.

BIFACIAL SOLAR PANELS TO PRODUCE MORE POWER

Can you shed some light on the technological innovations in your own process to drive the efficiency of solar panels?

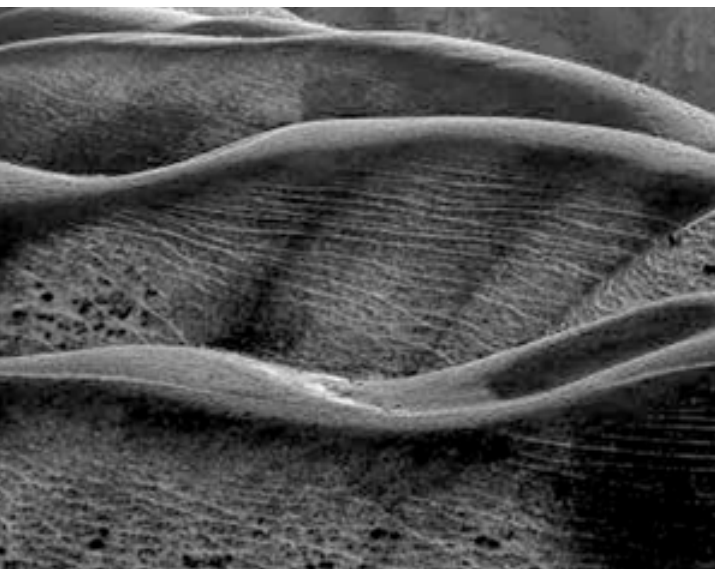
The key component of Enel's technology is bifacial solar cells, made of amorphous silicon and coupled with cells of monocrystalline silicon. We have achieved the highest bifaciality factor [power produced by the back side in relation to the energy absorbed by the front side] in the world, and the cells have already achieved a certified efficiency level of 24.6%. We plan to develop tandem technology by coupling monocrystalline cells with perovskite cells to capture a wider spectrum of light and increase efficiency. The heterojunction process, a process where we combine the two different types of solar cells used in our technology, is managed at a relatively low temperature, which allows for a longer lifetime, lower degradation, and higher energy production. We aim to employ materials that can be reused in the PV value chain for circular and sustainable technology.

Also, our factory has a strong level of automation and digitalization, which allows us to fully exploit digital intelligence and machine learning for quality control, reduce waste, and improve circularity. We plan to track everything that happens in the factory using a manufacturing execution system and build analytics and KPIs for continuous improvement. Technology will drive higher production efficiency. Ultimately, this will differentiate us from other players.

MAKING THE TRANSITION TO RENEWABLES REAL

Are policymakers doing enough to push renewable energy?

We need support, financial and regulatory, to incubate new industries such as ours. Financial support can help cover the funding gap that arises when competing against more traditional players, but regulatory support defines standards for compliance with carbon-footprint reduction, circularity, and labor laws.



**"We need support,
financial and regulatory,
to incubate new industries
such as ours."**

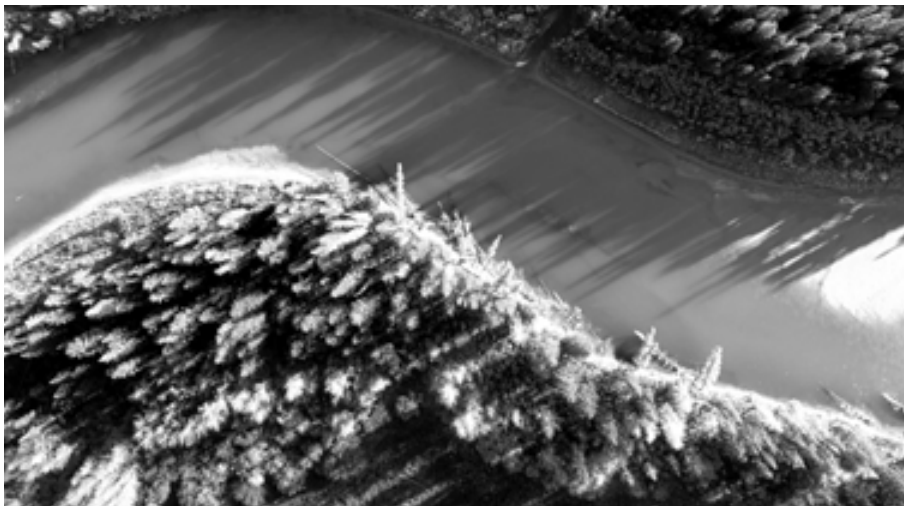
Executive Conversations

What do you see as the future of green energy, and what place does solar occupy in that?

Diversification is going to be key. The technology is getting cheaper, which will allow the renewables journey to accelerate. There are some sectors that are very energy-intensive and difficult to fully electrify unless you make green hydrogen viable. Renewable energy is currently seen as the answer and the direction to go, and the focus should be on maximizing efforts to reduce CO₂ emissions because time is running out to stabilize concentrations in the atmosphere. Our CO₂ budget is close to zero, though, so we must stay open to other options. We need to manage the transition and to make sure that those alternatives become viable, technically and economically. However, we cannot wait for new solutions and must continue to accelerate current efforts.

If you had a magic wand, what would you do to give clean tech a massive fillip?

We need the courage to make the transition to renewables real; this will require significant funding. I think we need to have the courage to start planning in one direction and providing support. My desire, my dream is that we really start thinking with some long-term vision, rather than staggering from crisis to crisis. To paraphrase Seneca, there is no favorable wind for those who don't know in which direction they want to go. If you only look at your feet, you will get lost. So, I would use that magic to give people the courage to look far enough ahead and then follow that vision.





Eliano Russo,
Head of 3SUN Gigafactory,
Enel Green Power

**"We need the courage to
make the transition to
renewables real."**



**WILLIAM
MCDONOUGH**

Designer, Architect,
Innovator, Author

Cradle to Cradle



DESIGNING A WORLD IN SYMBIOSIS WITH NATURE



The Cradle to Cradle Products Innovation Institute is a non-profit organization created to bring about a large scale transformation in the way we make things. The Institute's mission is to provide a continuous improvement quality standard to guide product manufacturers and designers in making safe and healthy things for our world.

William McDonough is a globally recognized leader in sustainable development. He is a green architect, designer, and author. He is the founding principal of William McDonough + Partners, co-founder of McDonough MBDC, and co-author, with Michael Braungart, of Cradle to Cradle: Remaking the Way We Make Things (2002) and The Upcycle: Beyond Sustainability – Designing for Abundance (2013). The Capgemini Research Institute spoke to William about his work, the role of design, and how carbon can be beneficial to humankind.

HOW CAN WE GO BEYOND “SUSTAINABLE” TO SHARED ABUNDANCE BY DESIGN?

You hold many unofficial titles: “Hero of the Planet,” “Father of the Circular Economy,” “Mr. Sustainability,” and so on. How do you see yourself?

I see myself as a designer working across many scales and contexts and I believe design is the first signal of human intention. I celebrate culture and commerce as powerful engines of both stability and change. For me, growing up in Japan and Hong Kong with summers in the Puget Sound, I always wanted to share the amazing things I saw with others. I always found beauty in nature – a smooth round rock or pebble on the beach, a leaf, a flower, a tree. Nature had a hard time being ugly, while human artifice had a rough time being beautiful – crushed sharp gravel, clear-cut forests, concrete and steel. I love working on designing the future we want for our children and their children, and trying to work in accord with the laws of nature. I’m not alone; there are many who think this way. We seek to design in a way that is true to nature and true to ourselves. It is difficult to summarize my occupation or characterize my work, but, essentially, I want to turn work into play while playing by nature’s rules – the laws of nature.



William McDonough,
Designer, Architect, Innovator,
Author,
Cradle to Cradle

“

I love working on designing the future we want for our children and their children, and trying to work in accord with the laws of nature.”

You suggest that the term “sustainability” is often insufficient to encapsulate what we should be aiming to achieve as a global society. Why is that?

The first globally referenced definition of sustainability (Brundtland Commission, 1972) had to do with meeting the current generation’s needs while allowing future generations to meet their own needs. It’s an evocative term derived from ancient wisdom and has inspired thousands of current policies and business programs. But sometimes the term loses much of its positive meaning when it is seen as minimal maintenance or even when it leads to

people focused only on the economics of being efficiently less bad, trying to not do something – for example, looking for net-zero. Sustainability is a nice, accessible term but is often awkwardly defined in so many situations because, like politics, all sustainability is best recognized on a local level, even when it may be responding to perturbations caused by global behaviors, like climate change and supply chain disruptions. It can be most vividly described in detail by its effects on local ecosystems and the stories of people in a place. That’s part of the issue, and that is why I focus on developing principled design tools that work anywhere at any scale and can be used by everyone to consider and execute net-positive activities. These tools include books, Cradle to Cradle and The Upcycle, the circular economy and, now the circular carbon economy. We can continue to build on sustainability only if we build with it in mind and deed. I prefer to think of sustainability closer to its original description but with the potential for growth – intergenerational stewardship and growth of a living planet. Even as we reduce our fugitive carbon in the atmosphere, we want to be increasing our use and reuse of materials and energy. We have come to realize that what we thought was an energy problem is a materials problem since we use carbon as both a material and a fuel. We can return much of the carbon in the air to the biosphere as living carbon (nature-based solutions) or earth-bound as durable carbon. We need a positively defined system of use and reuse of growth cycles that goes beyond sustainability toward abundance that we can share.



We have come to realize that what we thought was an energy problem is a materials problem since we use carbon as both a material and a fuel."

IN NATURE, WASTE = FOOD

You say that nature doesn't have a design problem – people do. Can you elaborate?

In nature, waste from one system can provide nourishment to another. Nature does not have resources, rather it has sources. One of the fundamental values of human activity is that we can turn nature's sources into resources that we use over and over again, reducing our need for our extraction or destruction of natural sources. For me, this is not simply taking the existing take-make-waste linear economy and twisting it into a circle; it is actually a continuously resourceful activity within a regenerative biosphere (which are natural living systems) and circular technosphere which are objects of human intention, purpose, and use.

When it is not unbalanced by human interference, nature finds itself in symbiosis: everything is in a mutually beneficial relationship with everything else. I want to quote Thomas Jefferson: "The earth belongs to the living." We can see ourselves as stewards safeguarding nature from one generation to the next. Furthermore, the recent language surrounding the circular economy is slightly problematic because terms reflecting undoing such as "decoupling economic growth from resource use" and "decarbonizing" do not accurately reflect the positive relationship that can exist between humans and nature. For example, we can focus on re-carbonizing things like soil and living things while turning natural sources into resources available for continuous use and reuse.

"For me, this is not simply taking the existing take-make-waste linear economy and twisting it into a circle; it is actually a continuously resourceful activity within a regenerative biosphere (natural living systems) and circular technosphere (objects of human intention, purpose, and use)."

WE CAN SEE OURSELVES AS STEWARDS SAFEGUARDING NATURE FROM ONE GENERATION TO THE NEXT.

You describe climate change as a “design failure”; can you elaborate on that?

Climate change is the result of breakdowns in the carbon cycles, which we have caused; it is a design failure. If design is the first signal of human intention, did we intend to do this? Emerson in the 1830s referred to nature as unchangeable essence – the mountains, oceans, leaves, and air. These things are all seen as too big to imagine destroying. As we see modern-day damage to ecosystems at every scale, we find ourselves needing to regulate the human activities that are overwhelming and destructive to the commons. Whenever we see a need for regulation, we see a sign of design failure. Our intentions were flawed.

I am not against regulation. Society needs to regulate its own behavior in order to keep our world habitable. But what we need from regulations is a level playing field that provides society with a clear set of rules. If people are not playing by the rules, it makes it harder for everyone to work and live. Executives can ask the right questions to find innovative solutions. They can focus on the right intentions and build cost-effective solutions around them. We did this with Ford Motor Company and their River Rouge facility. In order to meet the Clean Water Act requirements, instead of building chemical treatment plants and massive piping systems, we designed and engineered the world's largest green roof and integrated water purifying landscapes that saved Ford as much as \$35 million in CAPEX over conventional systems. With cars coming out of factories with a 5% margin, this is equivalent to an order of \$700 million worth of cars. Regulation can be useful in keeping our world clean and safe, but we need to be mindful of why it is necessary in the first place.

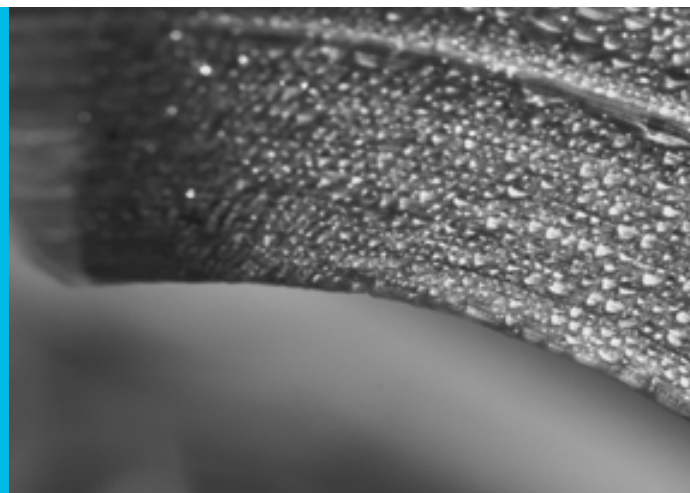
WORDS DRIVE ACTION

You have said that “carbon is an innocent element” and that “not all carbons are equal.” Could you help us understand your perception of carbon?

Anthropogenic greenhouse gasses in the atmosphere make airborne carbon a material in the wrong place, at the wrong dose, and for the wrong duration. This is a description of a toxin. Imagine lead and mercury in drinking water – they are toxic to humans. It is we who have made carbon problematic. In the right place, carbon is both a resource and a tool. It is also a source of life. Carbon dioxide is the currency of photosynthesis, a source of Earth’s capacity for living things and regeneration. Earth-bound carbon is one of the guarantors of terrestrial and marine ecosystems and food and water security. Carbon atoms are the building blocks of life. We are carbon and it is us who make carbon toxic.

The world’s current carbon strategy promotes a goal of reaching net-zero carbon emissions. There are terms such as “low-carbon,” “zero-carbon,” “negative carbon,” and even a “war on carbon.” The design world needs to adopt values-based language that reflects the desire to live in a safe, healthy, and just world. In this new paradigm, by building urban food systems and cultivating closed-loop flows of carbon nutrients, carbon can be recognized as a critical asset, rather than a toxin, and the life-giving carbon cycle can become a model for human design.

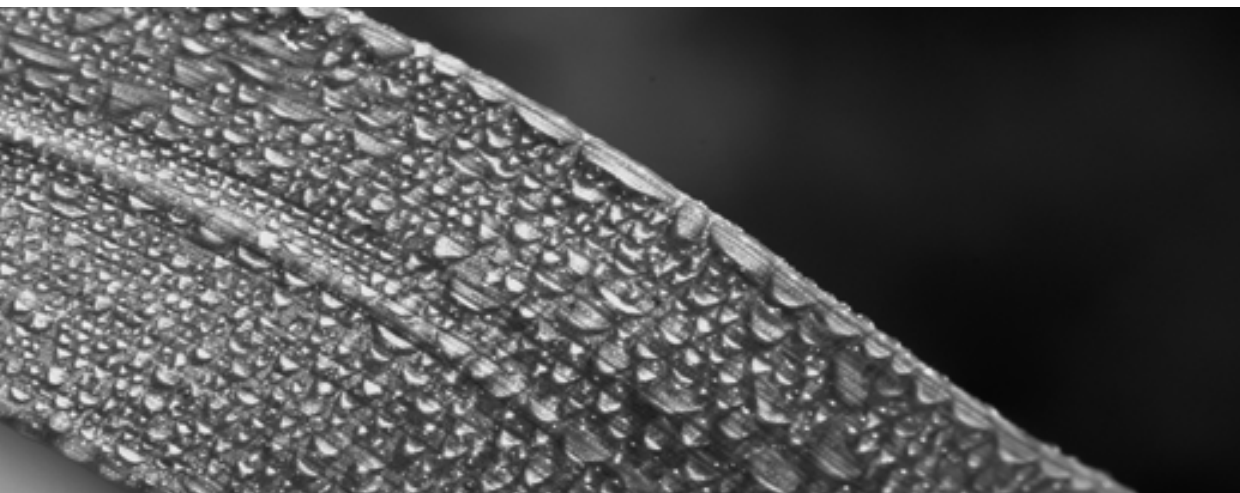
**"In the right place,
carbon is both a resource
and a tool."**



The point I wanted to make here is that we have started to refer to carbon as the enemy, but carbon is not our enemy. It is our friend. We are carbon. Carbon moves through all living things in an endless cycle that makes life possible. It's an innocent element in all of this. I think we need a new language around carbon.

The term “Triple Top Line” was coined in the book Cradle to Cradle to describe the rich opportunities for revenue and growth inherent in sustainable design. Can you expand on that?

The Triple Bottom Line, referenced often since the Earth Summit in 1992, has been about balancing traditional economic goals with social and environmental concerns and has become a measure of corporate performance. One realizes, however, that a business strategy focused solely on the bottom line does not expose opportunities to innovate and create new forms of value in the design process. This new design perspective actually creates Triple Top Line growth: products and processes that protect nature and society while generating revenue and economic growth. Designing for the Triple Top Line involves giving commerce the tools to develop systems and products that generate economic prosperity while combining with social benefit and ecological intelligence.



Executive Conversations

Are there any new innovations that you are excited about when it comes to sustainability?

Too many to mention here, but I would love to focus on the idea of conceptually separating the terms “hydro” and “carbon” in the word hydrocarbon because I’m very excited about the idea of a technology that can use hydrogen as a clean fuel and carbon as a durable good that does not go fugitive in the atmosphere or require sequestering in the geosphere. On the carbon side, I’m very excited about our ability to use natural gas to produce graphene. I’m also very excited about graphene as a material because of its elegance, strength, and conductivity. In 50 years’ time, I hope to see a shift towards hydrogen-powered energy and renewable energy combined with battery and high-temperature thermal storage for industrial heating uses. And in the middle of it all, durable and living carbon once again is an integral – rather than feared or fugitive – element supporting our global life support system.





William McDonough,
Designer, Architect, Innovator, Author,
Cradle to Cradle

"In 50 years' time, I hope to see a shift towards hydrogen-powered energy and renewable energy combined with battery and high-temperature thermal storage for industrial heating uses."



**JOHAN
ROCKSTRÖM**
Director

**Potsdam Institute for
Climate Impact Research**



PLANETARY BOUNDARIES: A SCIENTIFIC GUIDE TO OUR SUSTAINABILITY JOURNEY



The Potsdam Institute for Climate Impact Research has a two-fold mission —advancing the scientific frontier on inter-disciplinary climate impact research for global sustainability and contributing knowledge and solutions for a safe and just climate future. It was founded in 1992 and has over 400 employees of whom over 250 are scientists.

Johan Rockström is Director of the Potsdam Institute for Climate Impact Research. In addition, he is also Professor at the Institute of Earth and Environmental Science at Potsdam University, and Professor in Water Systems and Global Sustainability at Stockholm University. Johan gained international recognition for his role in the development of the Planetary Boundaries framework, which has since become a universal benchmark of sustainability science. His research activities cover a range of topics within Earth system science and global sustainability in the Anthropocene, with the overarching research question: “What is the safe operating space for humanity’s future on Earth, and which sustainable transformations can take us there?”

The Capgemini Research Institute spoke to Johan about the principles behind Planetary Boundaries and how the framework is helping to drive conversations – and action – on sustainability.

PLANETARY BOUNDARIES

In 2009, you helped design the Planetary Boundaries framework. Can you help our readers understand the concept behind it and its implications?

The Planetary Boundaries framework was the result of the integration of three scientific advancements. The first is the evidence that humans have entered the Anthropocene¹ era as the dominant force of change on our planet. The second is the overwhelming evidence that the Holocene² is a unique state of equilibrium that has enabled the development of modern civilizations. The third is the understanding of “tipping points,” where irreversible shifts in the biophysical processes that regulate the climate on Earth permanently alter our living environment.

In essence, the Planetary Boundaries framework is a scientific guide to our journey through the Anthropocene: what we, humanity, can do to keep the planet in a manageable state. The framework provides boundaries that, if observed with discipline, give us a good chance of keeping the planet in a safe operating space, not too dissimilar to that provided for us by the Holocene period. Going beyond these boundaries, however, risks reaching the tipping points that will undermine the Earth’s life-support systems.



Johan Rockström,
Director,
Potsdam Institute for
Climate Impact Research
Impact Research

“
The Planetary Boundaries framework is a scientific guide to our journey through the Anthropocene.”

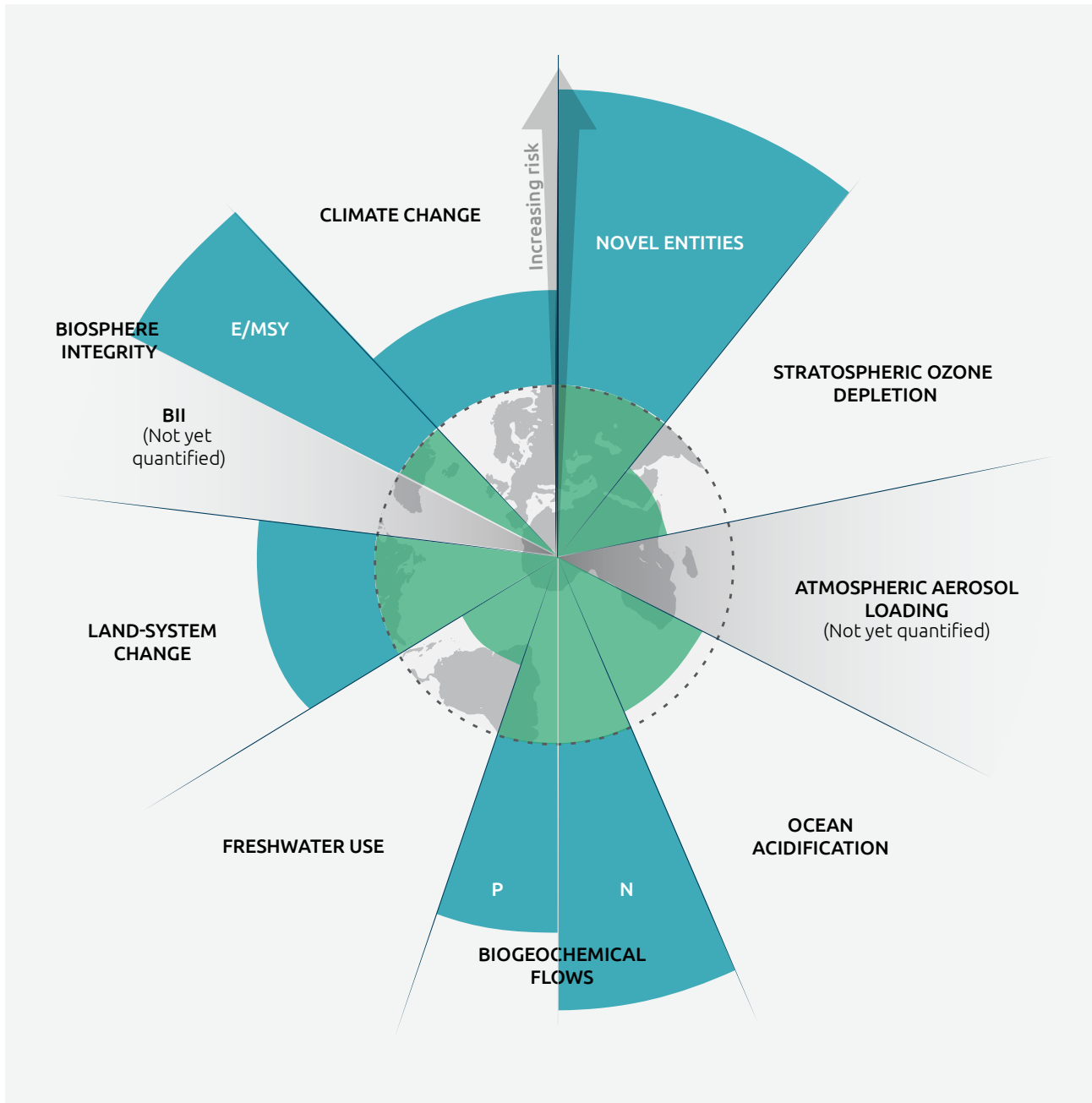
- ¹ The Anthropocene Epoch is an unofficial unit of geologic time, used to describe the most recent period in Earth’s history when human activity started to have a significant impact on the planet’s climate and ecosystems.
- ² The Holocene Epoch covers the past 12,000 years of warm and stable interglacial climates.

We invited scientists across all disciplines to help us identify the nine boundary systems, a framework we finalized in 2015. To my mind, the Planetary Boundaries framework is an essential guide to our transformation to sustainability and to a safe landing for humanity.



**GOING BEYOND THESE
BOUNDARIES RISKS
REACHING
THE TIPPING POINTS
THAT WILL UNDERMINE
THE EARTH'S LIFE-
SUPPORT SYSTEMS.**

Figure 1: Planetary Boundaries framework



Source: Stockholm Resilience Centre. Estimates of how the different control variables for seven planetary boundaries have changed from 1950 to present. The green shaded polygon represents the safe operating space.

You have said in the past that there is a risk that net zero targets will be misused. Can you expand on that?

To achieve a safe landing on climate, we need to cut emissions by half by 2030 and continue cutting them by half every decade to reach a net zero world economy by 2050. However, these models are based on assumptions that global agriculture and farming practices will provide a significant carbon sink over the next 30 years, and that natural ecosystems on land will continue to provide major carbon sinks. These models also assume that the oceans will continue to absorb CO₂ until the end of this century. These are huge carbon offsets that are already factored into our assumptions and they therefore can't be factored in again as mitigating possibilities when we calculate time to net zero.

So, the only way to make net zero work is if we add carbon uptake beyond what is already factored into the assumptions in the models. Can we do that? There is certainly room for true net zero compensation by, for example, afforesting completely degraded lands; planting forests in completely unforested areas; or restoring soil carbon in completely degraded regions. However, these measures must be taken without slowing down the phasing out of fossil-fuel emissions. It has to be additional, not an offset.



"The only way to make net zero work is if we add carbon uptake beyond what is already factored into the assumptions in the models."

3 CRITICAL FACTORS: PRICE ON CARBON, TECHNOLOGIES AND REGULATION

What are your views on a carbon tax?

Putting a price on carbon is an absolute necessity of modern economic policy. Burning fossil fuels and damaging the climate without paying for it is the world's largest market failure. Sixty countries in the world have a price on carbon today but it needs to be a universal standard.

Currently there are only small, voluntary green investments in a few markets. We need a price on carbon to be set by widescale legislation across markets and geographies; that is the only way to secure the scale of investment required. The challenge here is to ensure that the revenue from a tax on carbon stores in wetlands or forests is not lost to inefficiencies, but rather returned to the communities that manage these systems, which are often home to invaluable biodiversity and indigenous communities.

Which technologies will drive us to a sustainable future?

We currently emit around 40 billion tons of CO₂ per year. With every passing day, the need for technology for CO₂ removal becomes more urgent. We need to start not only scaling different forms of carbon capture and storage [CCS] technologies, but also supporting R&D into direct air capture. Apart from imposing a price on carbon and investing more heavily in R&D, regulation and governance to support the business and technology development are also key.

"With every passing day, the need for technology for CO₂ removal becomes more urgent."

We need to have a very open discussion on governance, to ensure that carbon-removal technologies are carefully regulated. Too intense a focus on CO₂ removal could impede the transition from fossil fuels, so regulation and governance are necessary to strike a viable balance between reducing emissions and developing renewable-energy sources. Hence, we require a comprehensive approach to supporting the development of carbon-removal technologies, which incorporates both business and technology development and regulation to ensure that these technologies do not create new problems while solving others.

ADJUSTING OUR ECONOMIC MODEL

Can we balance economic growth with a sustainable transition?

Our current economic growth model will not give us the future we need and want. Completely abandoning capitalism to pursue a “degrowth” path would undermine most populations, which rely on conventional economic growth to provide them with a structured life that offers the basics required for subsistence. We don't have time to redesign the global economic system from scratch; we must make adjustments to the current economic model rapidly by setting planetary boundaries, science boundaries, putting a price on pollution and other damage, health threats, climate damage, and biodiversity loss.

We also need to halt the destruction of the Earth's surface; we cannot afford to lose any more of the natural world. It is interesting to see how, even within a conventional economic growth paradigm that is not aligned with the principles of sustainability, there are still potential workarounds to keep it within the planetary bounds operating space. That's where we need to start. In the long term, we need to move away from the over-consumption paradigm and support economic development within scientifically defined boundaries, to ensure social stability and avoid conflict.

Executive Conversations

How do you think the Planetary Boundaries framework can help large organizations?

I'm positively surprised – almost overwhelmed – to see how the Planetary Boundaries framework has become a mainstream part of organizations' culture around the world. Already, around 4,000 companies have adopted science-based climate targets. This year, we'll be launching the science-based target network for the remaining planetary boundaries. Many big companies are ready to move beyond climate and set their business models along a more science-based pathway, starting with biodiversity, and potentially expanding to include water, nutrients, and other essential aspects of planetary conservation. However, as always, there is much more work that needs to be done.





Johan Rockström,
Director
Potsdam Institute for Climate
Impact Research

"Apart from imposing a price on carbon and investing more heavily in R&D, regulation and governance to support the business and technology development are also key."



The Climate Tech Startup Corner..



CAPGEMINI VENTURES

Lucia Sinapi

EVP and MD,
Capgemini Ventures
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CLIMEWORKS

Dr. Nathalie
Casas

Head of R&D,
Climeworks
P.114

**CLIMATE TECH
START-UPS**

P.126

HOW CLIMATE TECH STARTUPS CAN HELP US TRANSITION TO A CARBON-FREE WORLD



LUCIA SINAPI

EVP and MD,
Capgemini Ventures

THE KEY TO OUR FIGHT AGAINST CLIMATE CHANGE

Capgemini 

Over the past two decades, startups have become a critical source of innovation as a perfect blend of technology and talent, supported by unprecedented private capital funding: since 2015 the Venture Capital industry (VC) investments into startups amount to \$2.6 trillion¹ globally. This has been, and still is, the era of cloud, data and software, contributing to the digital transformation of the economy and disrupting nearly every industry.

The changes required to achieve 2050 Net Zero target and return to pre-industrial CO₂ levels in the atmosphere go beyond digital and will require massive investments to transition to clean energy, transform our production and consumption models, or minimize our use of natural resources.

Interestingly, Venture Capital industry is now also directing investments into promising startup solutions active at building our future carbon-free world. After a record 2021 year, VC funding was not immune from the geopolitical context in 2022 and is taking a more conservative stance post recent negative newsflow, however the climate tech segment is showing some resilience.

We believe there are fundamental factors supporting startups engaging in sustainability and climate tech moving forward. And this is why.



Lucia Sinapi,
EVP and MD,
Capgemini Ventures

**OVER THE PAST TWO
DECADES, STARTUPS
HAVE BECOME A
CRITICAL SOURCE OF
INNOVATION.**

1 CB Insights data



Re-imagining energy is on the critical path, as it contributes to 34%² of global carbon emissions.

VC industry is currently backing about 38%³ of startups engaged in the race for clean energy supply (also referred to as Energy Tech)⁴, which received \$26 billion⁵ funding in 2022, a 40% CAGR over 2018 - 2022⁶ (4 times the global VC funding growth over that period). Renewables, energy storage⁷ and management⁸ still receive the lion's share, but VC industry is also fostering emergence of Green Hydrogen and New Generation nuclear energy (including fusion) breakthrough solutions.

According to International Renewable Energy Agency recent report, investment into climate tech would need to annually quadruple until 2050, while current pledges and plans lead to an emission gap of 16 GT.

2 <https://www.lesechos.fr/monde/enjeux-internationaux/climat-ce-quil-faut-retenir-des-six-derniers-rapports-du-giec-1917145#:~:text=Le%20rapport%20sur%20un%20monde,%25%20d'ici%20%C3%A0%202030>

3 Traxcn data

4 Energy Tech top-funded sub-sectors are: energy storage tech (Energy Storage Systems, Battery Systems, Charging Solutions), energy efficiency tech (Energy Management Systems, Utility Bill Management), smart grid (Advanced Metering Infrastructure, Green Utilities), renewable energy tech (Horizontal Software, Solar Energy, Bioenergy)

5 Traxcn data

6 Traxcn data

7 In 2022 the top-funded startup was Sweden-based Northvolt.

8 Eg: US based Form Energy uses a low-cost battery system to store wind and solar energy for a long duration and dispatch it on the electric grid all year round/ Canada based Hydrostor - Advanced Compressed Air Energy Storage solution for smart grid energy storage

Carbon Capture Utilization & Storage solutions are expected to address close to 15%⁹ of total CO2 reduction by 2050

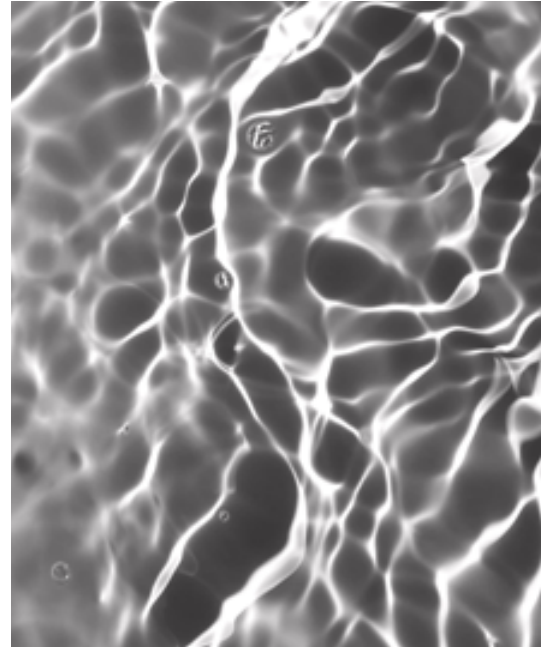
Startups focusing on direct carbon capture and/or storage solutions from the air¹⁰ or at industrial sites¹¹ are attracting major funding for their projects by corporates¹², on top of VC funding, which accounts in 2022 for \$3.3B¹³.

Another area of high potential is carbon-recycling technologies¹⁴, carbon transformation¹⁵ or even carbon sequestration solutions¹⁶.

VC backed innovation can be adjacent but critical to climate tech and sustainability agenda

New space-based Earth observation imaging systems and AI allow for natural resources monitoring and climate intelligence¹⁷, as well as biodiversity monitoring¹⁸.

Pending the promises of Quantum Computing, synthetic biology is already opening new frontiers when it comes to



synthetic biology is already opening new frontiers when it comes to the development of new materials."

9 International Energy Agency <https://www.iea.org/data-and-statistics/charts/global-energy-sector-co2-emissions-reductions-by-measure-in-the-sustainable-development-scenario-relative-to-the-stated-policies-scenario>

10 Switzerland based Climeworks - Designs and manufactures devices for extracting carbon dioxide from ambient air (see article in this edition)

11 Canada based Svante - technology that traps carbon produced from industries such as cement, steel

12 Microsoft announced in July 2022 a 10 year carbon removal agreement with Climeworks

13 CB Insights

14 US based LanzaTech – Bioprocessing technology to capture and recycle carbon from industrial off-gases and syngas

15 US Based Carbix – Produces carbon enriched concrete

16 Iceland based Carbfix – Converts carbon captured from the atmosphere into underground rock

17 France based Prométhée - NewSpace operator of nanosatellite constellations for earth observation, Israel based Agroscout - Provider of crop scouting solutions and UK based Cervest-Climate intelligence platform

18 UK based Nature Metrics - Developer of molecular methods for biodiversity assessment, Norway based Spoor - Provider of cloud and AI-driven biodiversity monitoring solutions

INNOVATION CAN ALSO BE INSPIRED BY NATURE, AS REFLECTED BY BIO-MIMETIC SOLUTIONS.

the development of new materials¹⁹, or enabling biodegradable plastics to be created from waste recycled using enzymatic bioprocesses²⁰. Innovation can also be inspired by nature, as reflected by bio-mimetic solutions, while sustainable product design and manufacturing is already made possible by 3D printing technology²¹.

Public research, policy and carbon markets provide the tailwind for climate tech...

Climate tech development is enjoying a unique combination of levers, among which the ability to leverage IP from academic and public research : UK based Mimicrete comes out of Cambridge University research, US based Verdox's CO2 removal technology was developed at MIT²². Similarly, in the nuclear field, startups Hexana and Stellaria developing fourth-generation small AMRs²³ are stemming from France's CEA Research labs²⁴.

Public policies and regulation mandating change towards energy transition (alike EU Green Deal) or funding climate projects through tax credits (alike US IRA²⁵) foster investments into new infrastructure, as reflected by the Gigafactories for batteries being currently built in Europe and North America. They also pave the way to bankable business cases for entrepreneurs in Deep Tech, who consequently are more likely to be eligible

19 US based Bolt Threads – Produces protein-based silk fibers or Japan based Spiber- Produces protein-based yarn

20 France based Carbios

21 German based Aeditive - for ready-to-use precast concrete

22 BusinessWire, "Verdox Wins \$1M XPRIZE Carbon Removal Award Together with Partner Carbfix", April 2022

23 AMR : Advanced Modular Reactors

24 CEA : Commissariat à l'Énergie Atomique et aux Énergies Alternatives – French Atomic Energy and Alternative Energy commission

25 IRA : Inflation Reduction Act

The Climate Tech Startup Corner

for VC funding, despite climate deep tech being more capital intensive and longer horizon ROI compared to software.

Last, but not least, offset mechanisms provide eligible startups with an additional funding source, as corporates investing into their projects to fast track their NetZero targets can benefit from offset credits. On that front, digital marketplace solutions are aiming at making the carbon credit markets more efficient²⁶, some being blockchain technology based²⁷. No doubt that quality of carbon credits and transparency in trading are prerequisites for an efficient carbon credit market that will further back the climate tech expansion.

... as well as sense of purpose!

Every day I meet talented startup founders fully determined to bring their solutions to market, enthused and energized by the unique confluence of public and private interests in preserving the planet. This fuels my confidence about our collective ability to embark on this new industrial revolution and address the existential challenge of our age.



26 US based Aspiration – Tech platform to source high-quality nature-based carbon projects

27 Singapore based AirCarbon - Provider of blockchain-based carbon credits trading exchange



Lucia Sinapi,
EVP and MD,
Capgemini Ventures

**"Offset mechanisms
provide eligible startups with an
additional funding source."**

WHY CARBON-REMOVAL SOLUTIONS ARE KEY TO FIGHTING CLIMATE CHANGE



**DR. NATHALIE
CASAS**

Head of R&D,
Climeworks

CARBON REMOVAL – THE KEY TO FIGHTING CLIMATE CHANGE



Zurich-based start-up Climeworks was founded in 2009 to help address the massive challenge of climate. The company uses direct air capture (DAC) technology to capture CO₂ directly from the air, reducing the atmospheric concentration of CO₂ by only using renewable energy, energy-from-waste, or other waste heat as energy sources. In addition to getting corporate clients to pay for future removals, Climeworks has raised more than \$810 million from a wide variety of investors to scale up.

Dr Nathalie Casas heads R&D at Climeworks. She is also a member of the innovation council of Innosuisse – the public Swiss innovation agency. The Capgemini Research Institute spoke to Dr. Casas to understand why carbon removal is key in our fight against climate change.

The enormity of the challenge posed by global warming can be daunting. What can any individual, organization, or even country do to fight climate change? We can and must make changes to our current lifestyles, but this alone won't be enough to stop temperatures from rising. The science is clear: to have a chance of keeping the global rise in temperature below 1.5°C, we need to get the world to net zero, as quickly as humanly possible.

This means doing everything we can to reduce our carbon footprint and actively removing the CO₂ we have already emitted into the atmosphere. We need to extract billions of tons of CO₂ between now and 2050, a task so gargantuan that we will need all known carbon-removal solutions to work together, uniting nature and technology in urgent symbiosis.



Dr. Nathalie Casas
Head of R&D,
Climeworks

“

We can and must make changes to our current lifestyles, but this alone won't be enough to stop temperatures from rising.”



"We need to extract billions of tons of CO₂ between now and 2050, a task so gargantuan that we will need all known carbon-removal solutions to work together."



“

Carbon removal is crucial to neutralizing CO₂ emissions and keeping global warming at around the 1.5°C target.”

Why is carbon removal so important?

Let's talk about unavoidable and historical emissions.

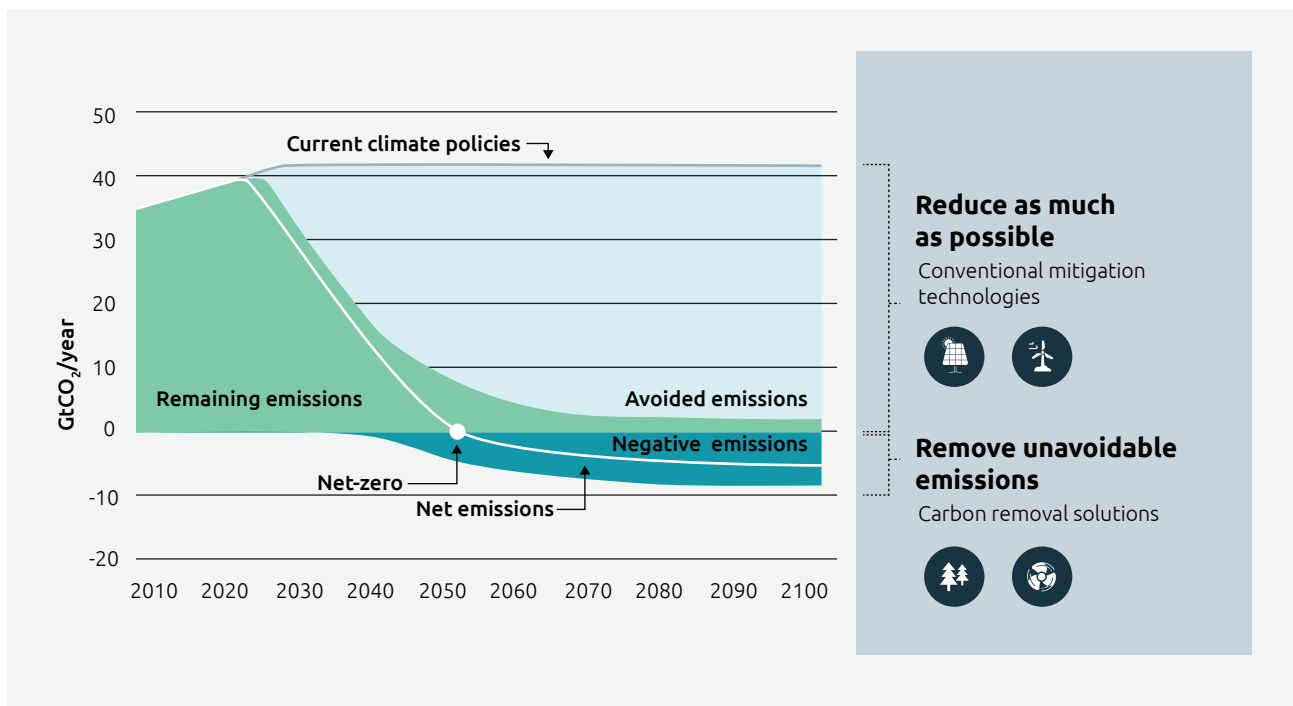
The most important thing any of us, individuals or companies, can do to stop global warming is to shrink our carbon footprints. According to the Intergovernmental Panel on Climate Change (IPCC) and the Science Based Targets initiative (SBTi), companies must reduce their CO₂ emissions by at least 90% before 2050. However, that will still leave around 10% of current levels of unavoidable emissions. Carbon removal is crucial to neutralizing these emissions and keeping global warming at around the 1.5°C target.

Then, there's the matter of "historical" CO₂ emissions already released into the atmosphere. There are billions of tons of historical CO₂ emissions in our atmosphere, which must be removed if we are to go beyond carbon neutrality and achieve net negative emissions (i.e., removing more CO₂ from the atmosphere than we pump into it). Carbon removal is the only way to achieve this and, in doing so, take the first steps in restoring balance to our climate.

Beyond unavoidable and historical emissions, carbon removal is also an important safeguard in the fight against climate change. If, despite drastic efforts to reduce emissions, a temperature overshoot takes us above 1.5°C, additional carbon removal could help us bring the temperature down again.

THERE ARE BILLIONS OF TONS OF HISTORICAL CO₂ EMISSIONS IN OUR ATMOSPHERE, WHICH MUST BE REMOVED IF WE ARE TO GO BEYOND CARBON NEUTRALITY.

Figure 1: Why carbon removal matters



Source: Climeworks.

Some effective carbon-removal solutions:

There are a variety of carbon-removal solutions available. Let's look at some of the more viable options.

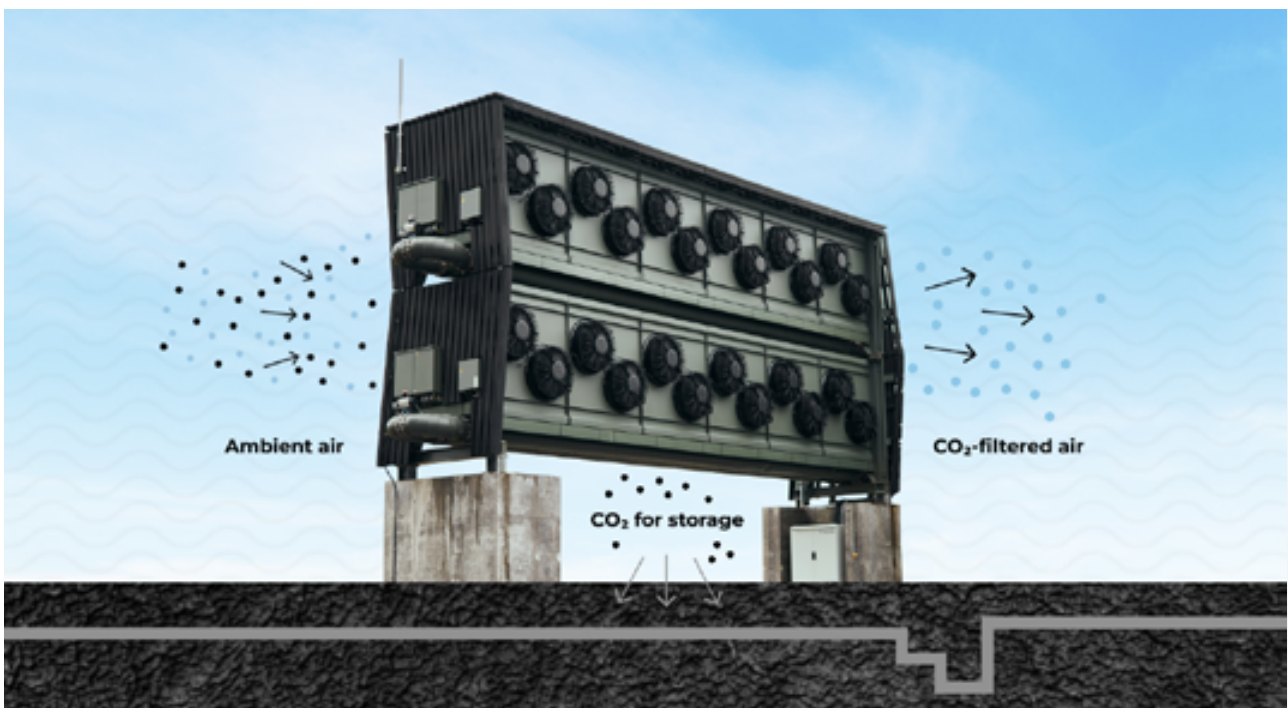
Direct air capture:

Direct air capture (DAC) is a technology that captures CO₂ directly from the air and, when combined with storage technology (DAC+S), locks the captured CO₂ permanently deep underground. Our storage partner – in Iceland, this is Carbfix – transports the CO₂ deep underground, where, through a natural reaction with basalt rock, it transforms into stone, theoretically remaining in this state for over 10,000 years. This allows us to offer companies and individuals a high-quality, effective, and permanent removal of unavoidable and historical emissions.

In practice, DAC is a three-step process:

1. Air is drawn in using fan-generated suction. Once inside, it passes through a filter that traps the CO₂ particles.
2. When the filter is completely full of CO₂, the collector closes, and the temperature rises to about 100°C – the same temperature it takes to boil water for a cup of tea.
3. This causes the filter to release the CO₂ so we can finally collect it.

Figure 2: Climeworks' DAC plant in Iceland: Orca



Source: Climeworks.



Direct air capture (DAC) is a technology that captures CO₂ directly from the air and, when combined with storage technology (DAC+S), locks the captured CO₂ permanently deep underground."

There's global potential for DAC+S, from the Middle East to North America. We're currently investigating new opportunities in the US, Norway, and Oman.

Climeworks' DAC system is one of the key technological weapons in the battle against climate change. It captures CO₂ directly from the air, reducing the atmospheric concentration of CO₂ by only using renewable energy, energy from waste, or other waste heat as energy sources.

Each solution, whether natural or technology-based, has its benefits and drawbacks, making

it essential that all approaches work in synergy if climate targets are to be achieved. Below are the **benefits of DAC:**

- **Location-independent:** CO₂ concentration is the same everywhere in the world. As there is no specific emissions source, this means that DAC plants can, in theory, be located anywhere there is a renewable-energy source and a suitable site for CO₂ storage.
- **Highly scalable and measurable:** Climeworks' plants are based on a modular-technology design, making them highly scalable. We can also measure exactly how much CO₂ our machines capture.
- **Efficient land usage:** Climeworks' plants require less land than other techniques. For example, on a land area of 0.42 acres, our Orca plant can remove 4,000 tons of CO₂ from the air every year – this is almost 1,000 times more efficient than trees (the same land area would host around 220 trees with an estimated capacity of 22 kg each, giving an annual carbon-removal capacity of only 4.62 tons of CO₂).



Our Orca plant can remove 4,000 tons of CO₂ from the air every year – this is almost 1,000 times more efficient than trees."

Afforestation: Planting more trees

Trees are an excellent natural solution because they reduce the amount of CO₂ in the atmosphere by absorbing it and storing it for long periods of time – centuries, in some cases.

Naturally, however, there are downsides:

- Trees are vulnerable to fire and disease; once cut down or rotting, they release all the carbon dioxide they've captured up to that point.
- A tree can only store CO₂ over its lifetime (average ~100 years).
- Afforestation requires a great deal of water, and, most importantly, time; young trees absorb far less CO₂ than do mature ones, meaning that a newly planted forest could take decades to absorb the levels of CO₂ we need to lock away.
- Trees need a lot of space: to generate sufficient CO₂ storage capacity we would need to afforest an area the size of Europe.
- Protecting and strengthening our forests to ensure that they continue to serve as natural carbon sinks is of the utmost importance, but pinning our hopes on tree planting is not credible.

**A NEWLY PLANTED
FOREST COULD
TAKE DECADES TO
ABSORB THE LEVELS OF
CO₂ WE NEED TO
LOCK AWAY.**



Bioenergy with carbon capture and storage (BECCS)

To prevent CO₂ emitted from biomass, such as trees, from ending up in the atmosphere, the biomass can be burned in a power plant, following which the CO₂ released is captured and then buried. BECCS allows for the creation of energy as a secondary activity.

Why has it not yet been implemented at scale?

- To achieve the required level of CO₂ removal, this process would require access to an area of arable land equivalent to more than twice the size of India (i.e., half the current global arable land area).
- The required levels of water and fertilizer are very high and could impact food production if redirected to BECCS.
- It is imperative that CO₂ emissions from the growing, harvesting, and processing of biomass don't outweigh total carbon captured.

Enhanced weathering

Enhanced weathering is a technology that mimics and accelerates the natural climatic weathering process of rocks. Rocks exposed on the Earth's surface absorb CO₂ from the atmosphere and, in the presence of water, transform it into other compounds, retaining CO₂ for a long time. This solution accelerates this process by spreading finely ground rock over the land surface (farmland, beaches, forests, etc.); this results in a greater area of rock surface being exposed to the atmosphere, and therefore available to absorb carbon.

The Climate Tech Startup Corner

Benefits include improving degraded soils and plant growth and helping to reverse ocean acidification. However, there are a few uncertainties:

- Scientists suggest that rapid, uncontrolled changes in pH value, carbonate-saturation state, and dissolved aqueous CO₂ could affect ocean ecosystems.
- Although this technology mimics a natural process, it's not itself natural per se; the substance used is released into ecosystems at much higher rates than normal and could create "dead zones" in which oxygen levels are too low to support life.
- These are only some of the available solutions; all must be evaluated carefully and as a matter of urgency, including in terms of scaling potential and applicability to the central struggle against climate change.





Dr. Nathalie Casas,
Head of R&D,
Climeworks

"Trees need a lot of space: to generate sufficient CO₂ storage capacity we would need to afforest an area the size of Europe."

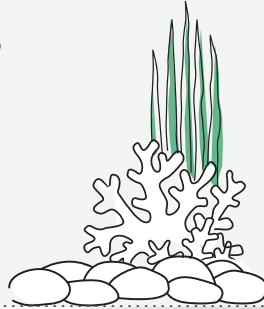
CLIMATE TECH START-UPS

CARBON CAPTURE

RUNNING TIDE

FIGHTING CLIMATE CHANGE WITH SEAWEED

- **Running Tide** is a start-up whose goal is to curb climate change by harnessing the ability of seaweed to capture carbon. The company plans to remove CO₂ from the atmosphere with the help of carbon buoys made of kelp (large brown sea algae), which then absorbs CO₂ through photosynthesis.
- After a period of capturing carbon, marine engineers sink the buoys into the depths of the ocean, where they remain, containing the captured CO₂.



TRAVERTINE

- **Travertine** is a CO₂-removal and industrial-chemical production company.
- The startup aims to capture CO₂ from the air, mineralize it, and, as a by-product of the process, produce sulfuric acid, which has significant industrial applications. Sulfuric acid is the world's most used inorganic chemical and is traditionally produced by burning a by-product of fossil-fuel production; a process which generates massive quantities of environmentally hazardous waste sulfates.
- Travertine works on eliminating that waste stream and upcycling sulfuric acid. At the same time, the company eliminates CO₂ from the atmosphere by removing carbonate minerals. This happens through water electrolysis, which produces equal quantities of acid and base.

Travertine eliminates CO₂ from the atmosphere by removing carbonate minerals.

CHARM INDUSTRIAL

PUTTING OIL BACK INTO THE UNDERGROUND TO FIGHT CLIMATE CHANGE

- **Charm** uses plants to capture CO₂ from the atmosphere; it converts inedible biomass such as corn stover recovered from agricultural operations into a stable, carbon-rich liquid, which it then pumps into EPA (Environmental Protection Agency)-permitted deep underground reservoirs where the bio-oil sinks and solidifies in place. This permanently removes CO₂ from the atmosphere, putting it out of reach of potential release by wildfires, soil erosion, or land-use change.

Cellulosic
biomass currently
captures >100 Gt
CO₂/yr.

- At a large scale of bio-oil production, Charm will use it to make carbon negative iron. The bio-oil helps transform the iron ore into metallic iron at lower temperatures than traditional fossil fuel methods. By capturing the cleaner gaseous carbon waste stream, Charm could turn the 6% of global emissions from iron-making (2x that of aviation) net negative.

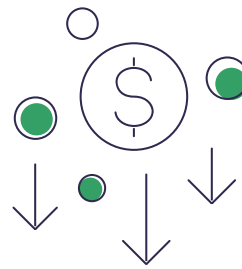


“By 2050 [humanity needs] the carbon-removal industry to grow by 2 million times, with a compound growth rate of 65%. I think it’s possible. It’s going to be very hard, but it’s also a problem that the government and a lot of people are throwing their weight behind.”

Peter Reinhardt
CEO, Charm

CARBFIX

- **Carbfix** uses its cutting-edge technology to capture CO₂ from the air and turn it into stone, which is stored underground.. The technology extracts CO₂ from emissions and dissolves it in water (effectively making carbonated water). The water is then injected into specific rock formations that react with the CO₂ and transform it into stone to form stable minerals, providing a permanent and safe carbon sink. The process takes less than two years.
- The process has a low up-front capital cost and is low-cost overall compared to other processes.
- In 2020, the company signed an agreement with Climeworks, a Swiss company that captures CO₂ from the atmosphere and then stores it at its location-independent plants. It will significantly scale up carbon removal and storage, permanently removing 4,000 t/yr of CO₂ from the air.



The process has a low up-front capital cost and is low-cost overall as compared to other processes.

Permanently removing 4,000 t/yr of CO₂ from the air.



SMART IRRIGATION

LUMO

- Agriculture accounts for 70% of global water use and Lumo provides a solution to enable farmers to reduce water consumption by as much as 50%.
- Lumo is a California-based irrigation technology company obsessed with helping growers conserve their most precious resources – time, money, and water.
- Built alongside some of the best growers in the world, Lumo's smart irrigation valve is wireless, cloud-managed, and contains an embedded flow meter to track water consumption and detect leaks – the first of its kind in the industry.
- Presently, Lumo's smart irrigation solution is being used by 15 growers in California, including Wente Vineyards and Driscoll's



Lumo provides a solution to enable farmers to **reduce water consumption by as much as 50%.**



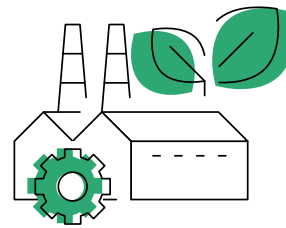
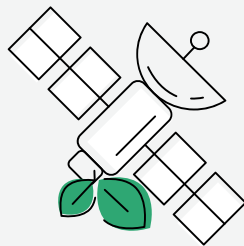
“Imagine a device that is located permanently in the fields, providing real-time visibility of systemic health, and that can be controlled remotely to deliver the exact amount of water, not a drop more or less.”

Devon Wright
CEO & Co-Founder, Lumo

IN-SPACE MANUFACTURING

SPACE FORGE

- **Space Forge** is a UK start-up that is leading the clean industrial revolution by harnessing the benefits of manufacturing in space. It is developing fully reusable satellites capable of manufacturing the next-gen supermaterials in space for a return to Earth as part of the move to low-carbon technologies.
- Space Forge focuses on developing technologies that enable in-space manufacturing and resource utilization, which can reduce the need for resource-intensive launches and enable more sustainable space activities.



Leading the
clean industrial
revolution

Enable
more sustainable
space activities.

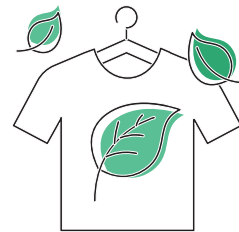
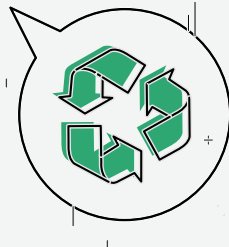


SYNTHETIC BIOLOGY

HYDGENE RENEWABLES

CONVERTING BIOMASS INTO HYDROGEN

- **Hydgene Renewables** reprograms bacterial microbes by using synthetic biology techniques to produce clean, renewable hydrogen gas from feedstock.
- The company is developing a hydrogen solution that is produced on-site on farms, from renewable plant-based feedstock, which removes the high costs of transport and storage associated with hydrogen.
- In 2022, the company won Australia's climate tech award in the Newcomer category.



BOLT THREADS

FASHION FROM MUSHROOMS

- **Bolt Threads** is a start-up that uses synthetic biology to develop sustainable materials to supply to the apparel industry. One such material is the synthetic spider silk called Microsilk, which replicates properties of a silk fibre produced by a spider. Their newly launched product Mylo is derived from mushrooms.
- The company's technology helps reduce the environmental impact of the textile industry, which is known for its heavy use of water and chemicals.
- In October 2022, the company launched a multi-project in collaboration with Ginkgo Bioworks to increase production efficiency and enhance performance.



The company's technology helps **reduce the environmental impact of the textile industry.**

BIODIVERSITY FINTECH

TREECARD

WOODEN DEBIT CARD THAT PLANTS TREES

- Founded in 2019, TreeCard is a climate tech start-up that has developed a debit card that uses the revenue generated from merchant fees to fund reforestation projects around the world.
- When customers use their treecards to make purchases, a portion of the merchant fees generated from the transactions is automatically donated to reforestation projects.
- In addition to funding reforestation projects, TreeCard also aims to reduce the carbon footprint of its customers. The company has developed a carbon-tracking feature that allows customers to track their carbon emissions and offset them through the purchase of carbon credits.



TreeCard also aims to **reduce the carbon footprint of its customers.**

A portion of the merchant fees generated from the **transactions is automatically donated to reforestation projects.**



BIODIVERSITY MONITORING

SPOOR

- Founded in 2020 in Oslo, Norway, Spoor uses computer vision and AI to detect, track, and classify birds in wind farms to help developers and operators gain insights and guide mitigation measures.
- It has developed AI-powered software for bird monitoring on wind farms. It uses machine vision for monitoring, managing, and reporting environmental impacts.



“We use artificial intelligence to monitor bird activity around wind turbines both onshore

and offshore. By focusing on highly advanced software over cumbersome traditional hardware, we are able to build a comprehensive global database as part of our detection and monitoring work, which to date has successfully tracked over 126,000 birds in about 18,562 hours.”

Ask Helseth
CEO, Spoor

NATUREMETRICS

- **NatureMetrics** is a technology start-up that uses genetic techniques to monitor biodiversity. The company uses spatial intelligence technology that taps into information derived from environmental DNA (eDNA).
- Each species carries a unique genetic signature in all cells. When an organism's cells are shed into the environment, its genetic signature is also released. NatureMetrics isolates these signatures from water or sediment samples and uses them to determine which species are present.
- The startup offers a subscription service that allows companies to gain insights into the biodiversity impact of their operations.



CLIMATE INTELLIGENCE

CERVEST

- **Cervest's** Unified Climate Intelligence™ (UCI) platform is enabling enterprises, public bodies, and financial institutions to measure interconnected climate risks and opportunities on built and natural capital assets – across physical and transition risk.
- Powered by cutting-edge Earth Science AIM and globally comparable climate risk ratings, Cervest's flagship product EarthScan provides UCI-driven insights that Chief Risk & Sustainability Officers use to increase asset resilience and meet climate-related financial disclosure requirements.
- By connecting and de-risking decisions on every built and natural asset through UCI, Cervest is powering a Climate Intelligence Network™ whose climate-aligned decisions will drive a chain reaction of adaptation actions to build a more resilient world



Unified climate intelligence is the **new decision-making superpower of the 21st century.**



“We are now in the era of climate volatility, where decision-makers will need access to a unified picture of climate risk that encompasses physical and transition risk, and attributes value to natural capital assets alongside net-zero targets.

From climate-aligning critical infrastructure development to supporting national renewable energy schemes, establishing sustainable supply chains to protecting and restoring environment ecosystems and their vital services, unified climate intelligence is the new decision-making superpower of the 21st century.”

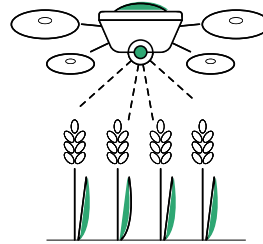
Iggy Bassi,
Founder & CEO of Cervest

SPECIAL INTELLIGENCE

AGROSCOUT

- **Agroscout** uses drone and satellite technology to help farmers monitor crop health and optimize irrigation and fertilizer use. The company's goal is to improve yields while reducing environmental impact.
- The platform collects data to create powerful analytics for actionable insights into crop management. AgroScout monitors the crop size from emergence stand count through canopy coverage estimates and plant biomass.

The company's goal is to **improve yields while reducing environmental impact.**



PLANET LABS

- **Planet Labs** owns and operates a fleet of 200 satellites that image the entire Earth landmass daily. The company's satellite-imagery data helps companies and governments to map and understand the agricultural evolution of Earth.
- On an average, Planet Labs has 1,700 images across every location.

The company's satellite-imagery data helps companies and governments to **map and understand the agricultural evolution of Earth.**

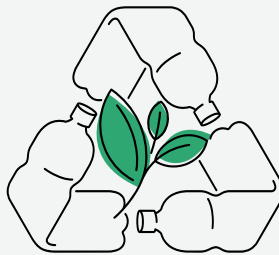


WASTE MANAGEMENT

GLACIER

FIGHTING CLIMATE CHANGE WITH WASTE RECYCLING

- Only 5% of plastic in the US is recycled today.
- Conventional recycling facilities rely significantly on manual labor, which is being heavily hit by a labor shortage. Glacier provides a low-cost, high-performance sorting robot to superpower these facilities.
- Founded in 2019, Glacier uses AI-enabled robots to identify and sort recyclables in these facilities. Their robots can distinguish between different recyclable materials such as cartons, plastic bottles, and containers. These robots are already being adopted by facilities across the country and have diverted millions of recyclables from landfill to date.



Glacier provides a low-cost, high-performance **sorting robot to superpower conventional recycling facilities.**

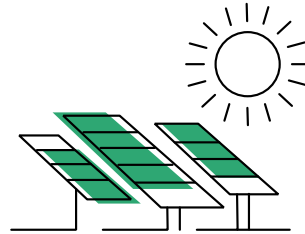


“We as a society have become really good at producing and consuming, but we haven't figured out what to do with all our stuff when we're done with it. Glacier exists to solve that problem, to solve the circular economy.”

Areeb Malik,
Co-Founder, Glacier

CARBON CURE

- **Carbon Cure** uses technology to reduce carbon emissions in the construction industry. It has developed a process that injects CO₂ into concrete, reducing the amount of cement needed and lowering levels of carbon emissions.
- Implementing Carbon Cure's model globally could reduce CO₂ emissions by 700 Mt annually – equivalent to the emissions of 150 million internal combustion engine vehicles.



SUNFUNDER

- **SunFunder** is the leading debt-financing provider for distributed solar power in Africa and other emerging regions, bringing access to energy and long-term climate investments.
- It has issued over \$150 million in loans to 57 solar companies working in off-grid solar, mini-grids, agri-solar, and other commercial and industrial (C&I) solar projects. These investments mitigate carbon emissions by replacing fossil fuels, and also help communities adapt to climate change by increasing the resilience of local economies and food systems.
- SunFunder's investments have directly resulted in over 750,000 t/yr of CO₂e mitigation.

KEBONY

BUILDING A GREENER FUTURE WITH FOOD WASTE

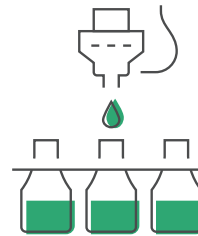
- **Kebony** focuses on using food waste to produce sustainable softwood.
- The company uses technology that uses food waste and modifies it to reproduce the qualities of tropical hardwood.
- Kebony's technology permanently modifies the wood by enhancing the properties of sustainable softwood to mirror premium hardwood characteristics.



SunFunder is the leading debt-financing provider for distributed solar power in Africa.

CARBON EQUITY

- Founded in 2021, Carbon Equity enables people to invest more easily in climate funds. Carbon Equity makes it possible to invest in small ticket sizes, starting from €100k.
- As of 2023, the company had sourced more than 800 climate private equity funds, including venture capital, growth equity, and buyouts.

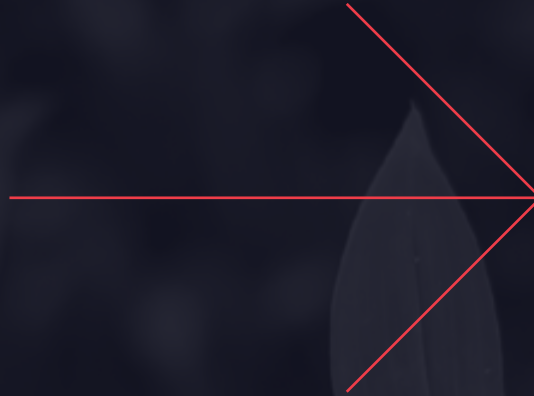


SOLAR FOODS

RELIEVING AGRICULTURE OF THE BURDEN OF FOOD PRODUCTION

- Food production requires significant land use and negatively impacts the environment. Solar Foods aims to liberate protein production from the challenges of agricultural production methods.
- Solein – the company’s sustainable alternative to animal-derived proteins – is an edible bacterium: a single-cell microbe that is grown using gas fermentation. Producing Solein requires only air, water, and energy, without taking up vast tracts of land.

You can listen to many of these exciting startups on the Hardware to Save a Planet podcast from Synapse, Part of Capgemini Invent at www.hardwaretosaveplanet.com



Voice of Gen Next...



**Arielle
Kouyoumdjian**

Teen Podcaster,
Founder, Changing Planet Justice, US
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**Rahmina
Paullete**

Climate activist at Fridays For
Future International,
Founder of Kisumu Environmental
Champs, Kenya
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**Vinisha
Umashankar**

Founder, Solar Ironing Cart, India
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ARIELLE KOUYOUMDJIAN

Teen Podcaster,
Founder, Changing Planet
Justice, US

Arielle Kouyoumdjian is a podcaster, wilderness enthusiast, and climate justice activist. She is the producer of the podcast “Changing Planet Justice,” which dives into environmental justice and social equity. She actively talks about climate change’s impact on vulnerable communities. She has won various awards, including the “Best of SNO Journalism Award” and “The NYTimes 4th Annual Student Podcast award,” among others. She is based in Virginia, USA.

WE NEED TO ADDRESS THE GROWING APATHY TOWARD CLIMATE CHANGE AMONG YOUNGER GENERATIONS.

You are the producer of the Changing Planet Justice podcast. Could you tell us what inspired you to start a podcast and what impact you wanted to make?

From second to eighth grade, I was always listening to something stimulating: Science Friday, BrainsOn, TEDx, Moth Radio Hour, Fresh Air, and a plethora of other podcasts. At age 12, I decided to combine my passions for podcasts, national parks, and environmental activism; I believed that even someone as young as I was could make a difference. Climate change terrified me, but I wanted to spread awareness without resorting to alarmism. My podcast evolved into an exploration of how climate change disproportionately affects marginalized communities.

“

My podcast evolved into an exploration of how climate change disproportionately affects marginalized communities.”

Today, I try to explore the intersections of climate change and social justice in a way that is both engaging and accessible to the public. I aim to amplify the voices of those on the front lines of the climate movement.

FINANCIAL INCENTIVES TO DRIVE BEHAVIORAL CHANGE

You chose podcasting as the medium through which to spread awareness about climate change and drive behavioral change. What are some of the other approaches that interest you in terms of inducing a change in society?

I'm still searching for the most impactful ways to catalyze change. Sometimes, I wonder why the raw facts of climate change aren't sufficient on their own to scare those in power into overhauling social, political, and economic systems. Civil disobedience can be an effective way to drive widespread change but, beyond protests, we need positive action that everyone can get behind. I think that financial incentives would encourage adults to commit to behavioral change: taxing and/or capping carbon emissions; cutting financial support for fossil fuels; and subsidizing sustainable energies would all make a big difference.

“

I think that financial incentives would encourage adults to commit to behavioral change.”

Additionally, we need to address the growing apathy toward climate change among younger generations; when it seems like the climate is changing but government, politics, and society fail to respond, young people begin to grow hopeless and passive.

Telling my story, voicing my fears, and amplifying the voices of those who have more power than me are what I feel I can do to take the future of this Earth into my own hands and make a difference.

Which is more important to achieving sustainability: a shift in consumer behavior or disruptive innovation to create solutions/products that are sustainable by design?

Consumer change is key to becoming a more sustainable community. While novel, “greener” products are eye-catching and garner abundant media attention, they are often inaccessible to a large section of the general public. Instant gratification is at the core of much of today's consumption issues; if consumers and capitalists can curb their desire to develop, produce, consume, receive, and travel as fast as possible, we can massively cut the carbon emissions that are the corollary of prioritizing efficiency at all costs. Rather, consumers and producers need to make the most of the assets we already have, funneling technology and other reusables into circular economies, drawing on renewable resources, and recycling.

WHY THE WEALTHIEST NATIONS HAVE THE GREATEST OBLIGATIONS

What sort of support do you expect from society in terms of protecting the environment?

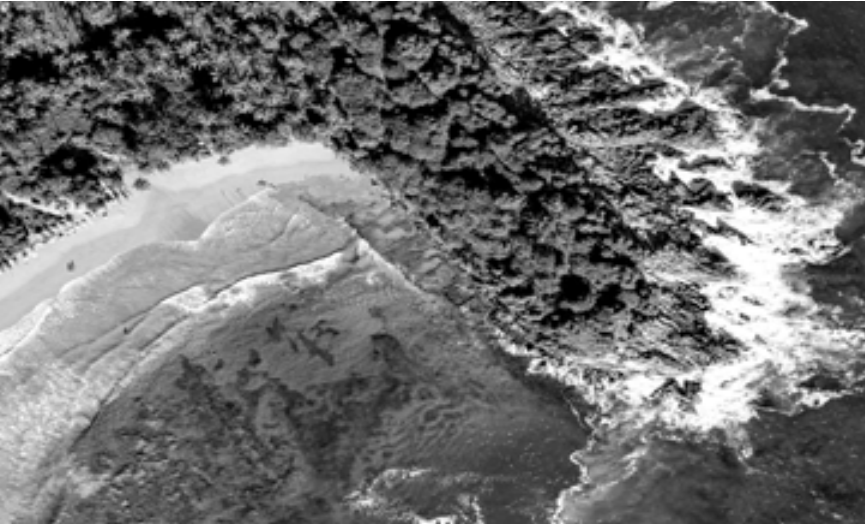
Everyone can contribute to collective change. I believe that, as individuals, our only responsibility is to do the best that we can with the resources we have.

The wealthiest nations have the greatest obligation to make sustainable investments, not only because they are historically responsible for climate change, but because they are the least vulnerable to its effects. Developing countries that contribute negligibly to climate change should receive the full support of developed countries as they grapple with its most devastating impacts. As a young person, I wish that adults would invest in sustainable initiatives, rather than continuing to fund the fossil-fuel industry. It seems that older generations prioritize the short-term benefits and rapid rewards of fossil fuels over the long-term social and environmental rewards of renewable energy. I'd have a lot more faith in society if I knew that it valued the survival of future generations over momentary prosperity. I believe a larger portion of taxpayers' money should be allocated to achieving sustainability goals.



“

The wealthiest nations have the greatest obligation to make sustainable investments, not only because they are historically responsible for climate change, but because they are the least vulnerable to its effects.”



I'd have a lot more faith in society if I knew that it valued the survival of future generations over momentary prosperity."

HOW LARGE ORGANIZATIONS CAN WORK WITH YOUNG ENVIRONMENTAL ACTIVISTS

How can large organizations collaborate with younger environmental activists such as yourself to achieve these goals?

Providing youth activists with a podium, amplifying our voices, and empowering us to speak up keeps the climate movement in motion. In a corporate-controlled society, kids' inability to contribute financially, pay taxes, or vote renders us socially powerless – or at least, it often feels that way. When large organizations allow us to participate in their initiatives, it gives us some sense of agency in a society that sometimes makes us feel overlooked and even trampled. At times, the sense of social inertia becomes so pervasive that it feels like young people and adults are each waiting for the other to save the world.

Large organizations can gain the trust of young people by inviting, encouraging, and motivating them to work alongside adults. Then, instead of feeling helpless and restricted by our youth, we feel both acknowledged and appreciated. By combining the business and technical knowledge of the adult generation with the fresh perspectives and idealism of youth, we are far better equipped as a society to combat our common Earth-destroying enemy.

You have won various environmental impact awards. Where do you see yourself in 10 years?

In 10 years, I hope to be a broadcast journalist on public radio, covering climate justice. I understand the transformative impact that green spaces can have on children growing up; to be able to run, play, picnic, and relax in a public park is a privilege I took for granted but, now, I value it more than ever.

If you could have one superpower to change the way things are today, which would you choose?

I've always said my superpower would be persuasion: rhetoric so powerful that it could unequivocally convince anyone who listened. Climate change, and the impending devastation of our planet, constantly weigh on me. I want to convince everyone, young and old, that change is possible. This requires us to build momentum, show



When large organizations allow us to participate in their initiatives, it gives us some sense of agency in a society that sometimes makes us feel overlooked and even trampled."



Stay hopeful, but not too hopeful. Stay frightened, but not paralyzed."

dedication, and endure discomfort, but change is possible and within reach. We may have reached the "point of no return," but there is no point at which we cannot begin.

What is the one piece of advice that you would like to give to your peers?

Stay hopeful, but not too hopeful. Stay frightened, but not paralyzed. Passivity is the worst crime. Your voice is more powerful than you think it is, and our voices are most powerful when we speak up together. I want my peers to assert themselves when they see an opportunity to promote and drive sustainability. Contrary to what we've been taught, sometimes we need to push back against adults: email the head of school about your idea for implementing solar energy in school buildings; teach your dad about reducing food waste as he prepares a meal; show your grandmother how to recycle; talk about politics and environmental issues at the dinner table. Climate change is a global crisis, which also means it's a global fight that, like it or not, we're in together. So, no matter where you are in the world, how old you are, or how loud or quiet your voice is, speak up, push back, and keep going.



VINISHA UMASHANKAR

Founder,
Solar Ironing Cart, India
TEDx and COP26 Speaker,
The Earthshot Prize Finalist

Vinisha is a student, a TEDx speaker, an innovator, and an environmentalist. She is known for her innovation, the Solar Ironing Cart. She was only a school student when she was selected as the youngest Earthshot Prize 2021 finalist. She spoke along with Prince William, the Duke of Wales, at COP26. Her 5-minute speech went viral on social media and may have been seen over 30 million times. Despite her age, Vinisha advocates change through innovation. She was the recipient of the EarthDay Network "Rising Star" award in 2021 and the Children's Climate Prize in 2020, among many other awards. She lives in a rural town in Tamil Nadu, India.

THERE MAY BE 10 MILLION TRADITIONAL IRONING CARTS IN INDIA, WHICH BURN ABOUT 50 MILLION KILOS OF CHARCOAL EVERY DAY.

You developed a solar-powered ironing cart as a clean alternative to the charcoal-powered version prevalent in India. What inspired you?

In my neighborhood, six ironing vendors use charcoal to heat a heavy cast-iron box for pressing clothes and usually throw the burnt charcoal away with the garbage. It made me think about this being done all across India. There may be 10 million traditional ironing carts in India, which burn about 50 million kilos of charcoal every day. Think of how much CO₂

and toxic pollutants mix with the air! About 7 million people worldwide die every year due to toxic air pollution. I looked for a viable solution and discovered that solar energy could effectively replace the 300-year-old tradition of using charcoal as a fuel, thus eliminating its harmful impact on the Earth, humans, and animals.

At the moment, people have no choice but to breathe toxic air. When scaled up, the solar ironing cart will eliminate the use of charcoal for ironing clothes in India and other developing countries. Prevention is still the best solution!



DRIVING CHANGE IN SOCIETY

In a powerful speech that you have given on various platforms, including COP26, you have emphasized the impact that the younger generation can have on climate change. What are some of the approaches through which young people can induce change in society?

Being able to express myself through speeches is great, but the world requires action. Spreading the word, keeping up the political pressure, using public transport, cutting down on electricity use, buying locally grown produce and locally made products, eating plant-based meals, not wasting food, buying fewer clothes, planting trees, and recycling used products are some of the ways in which everyone can help change society.

Protesting is a democratic choice. But climate change activists are increasingly turning to acts of civil disobedience to make their point, and this can be counterproductive. In April 2022, hundreds of scientists from more than 35 countries planned and synchronized actions, including blocking highways, picketing infrastructure, and spray-painting and pasting large climate posters on monuments. In May 2022, the UK government initiated efforts to ban the climate action group Extinction Rebellion on the grounds that it is an organized crime outfit, in light of the group's plan to blockade oil companies across the country. Such radical actions – and the

official responses to them – will hinder non-destructive climate activism and negatively affect public support for climate change mitigation.



Climate change activists are increasingly turning to acts of civil disobedience to make their point, and this can be counterproductive."

SCIENCE AND BEHAVIORAL CHANGE

As an innovator and inventor, what do you see as more important to the transition to sustainability: a shift in consumer behavior, or disruptive innovation to create solutions/products that are sustainable by design?

I would say that both are key to progress. Science can't solve all the problems humanity has created; some we will have to resolve for ourselves through changes to our behavior. We, as consumers, should take full responsibility for our actions. The resources that we are using are finite. We are answerable to future generations.

“

Science can't solve all the problems humanity has created; some we will have to resolve for ourselves through changes to our behavior."

If it continues, our reckless use of major resources will hamper the economic and financial well-being of posterity. We have to be responsible consumers.

What support do you expect from society in protecting the environment?

Failing to solve our environmental problems is not an option. No one country or group of countries can do this for the whole world, either. We have to identify, understand, and work collectively to do this.

How can large organizations collaborate with younger environmental activists such as yourself to achieve these goals?

Large organizations can help and collaborate in a variety of ways by engaging with, investing in, and empowering young environmental activists. Young people are taking the initiative to address climate change, from volunteering to raising

funds for environmental initiatives. We need support to develop a climate action framework and a green economy. Large organizations must work with governments to support youth innovations to combat climate change through grants and capital or zero-interest loans to scale solutions quickly.

If you had a superpower to change the way things are today, which would you choose?

I would like the power to turn people who cut down trees and pollute soil, water, and air into rock statues! Deforestation and air pollution are the two most serious environmental issues of the 21st century. Deforestation is happening on a large scale to produce palm oil and cocoa. The land is sprayed with gallons of weed killer, which permanently damages the soil. Air, be it on Earth or in space, is being polluted to the point that clean air may one day go extinct! We have become the most careless people the Earth has ever seen.

“

Large organizations can help and collaborate in a variety of ways by engaging with, investing in, and empowering young environmental activists."



RAHMINA PAULLETE

Climate activist at Fridays For Future International,
Founder of Kisumu Environmental Champs, Kenya

Rahmina Paullete is a Kenyan teen climate activist and a speaker at COP. She is involved with Fridays for Future MAPA (Most Affected People and Areas), which provides a platform to those most affected by the climate crisis. She is the head campaigner for #LetLakeVictoriaBreatheAgain, which advocates for the restoration of Lake Victoria, one of the African Great Lakes. She is the founder of Kisumu Environmental Champions, for environmental, wildlife conservation, and climate change advocacy. She has won many awards since 2016, including the Green Kids Award, 2018; Environmental Ambassador Kisumu County, 2018; and the Eco Warrior Tourism Change Maker Award, 2019; Africa Kids Awards 2021; ICPAC Climate Action Awards East Africa by IGAD, 2021 among a host of others. She is based in Kisumu, Kenya.

POLLUTION OF LAKE VICTORIA AND RELATED FLOODING HAVE ACCELERATED, POSING MANY THREATS TO MY COMMUNITY.

You launched a campaign called Let Lake Victoria Breathe Again, to support the restoration of the lake's ecosystem. How did your journey start? (Lake Victoria is one of the African Great Lakes, and is the world's largest tropical lake, spread over nearly 60,000 square kilometers across three countries.)

Pollution of Lake Victoria and related flooding have accelerated, posing many threats to my community. So, I began the work of restoring Nam Lolwe [the name of the lake in the local Dholuo dialect), the lake that my ancestors grew up with.

You are also a part of Fridays for Future; what impact did you want to make as a member of the group?

Being part of Fridays for Future has allowed me to amplify my knowledge of the critical problems caused by the climate crisis



“

Large organizations can help fund younger environmental activists' work and help them amplify their message, through access to corporate media channels, for example.”



and centering on the importance of vocal collectiveness for Most Affected People and Areas (MAPA).

Which is more important to the sustainability effort: a shift in consumer behavior or disruptive innovation to create solutions/products that are sustainable by design?

We have no time left to decide between the two. However, I guess I would slightly prefer solutions through innovation since this would create a huge impact on existing global issues.

What support do you expect from the older generation in protecting the environment?

It would be interesting and useful to learn from older generations, to understand how they view climate change and work with them towards greater sustainability. They could add social weight to existing projects and perhaps teach us about environmental solutions that have seen success in the past.

How can large organizations collaborate with younger environmental activists such as yourself?

The main way is to fund younger environmental activists' work and help them amplify their message, through access to corporate media channels, for example.



I see myself as a policymaker on climate change and the environment."

Going forward, do you aspire to start any environmental initiatives? Where do you see yourself in 10 years?

I founded my organization, Kisumu Environmental Champs, back in 2020, to allow kids, teens, adults, and older people to dedicate their time to environmental conservation, climate activism, and wildlife advocacy. In ten years, I feel like our work on the restoration of Lake Victoria will have made great progress in terms of the lake ecosystem being restored. I also see myself as a policymaker on climate change and the environment.

If you had one superpower to change the way things are today, which would you choose?

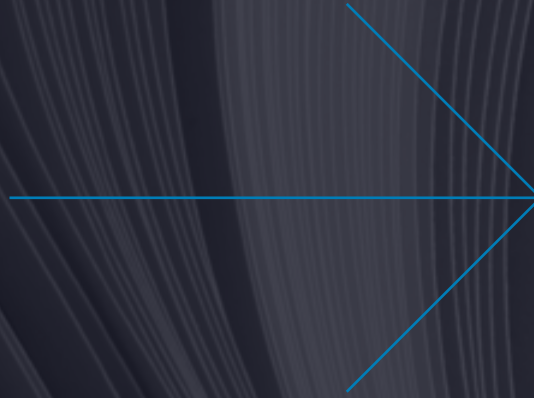
I would want the power that world leaders have; that is key to changing the world. It is unfortunate that world leaders don't seem to know how to use this power.

Which one piece of advice would you give to your peers?

I would say just use your voice to advocate for the planet; while it may seem like a small contribution, you can make a big impact.



It is unfortunate that world leaders don't seem to know how to change the world."



From the desk of...



Ovais Sarmad,

Deputy Executive Secretary
United Nations Framework
Convention on Climate Change
(UNFCCC)

COP28: BUILDING MOMENTUM FOR CORPORATE CLIMATE ACCOUNTABILITY



United Nations
Climate Change

Ovais Sarmad is Deputy Executive Secretary of the United Nations Framework Convention on Climate Change (UNFCCC). Mr. Sarmad advises the Executive Secretary on a range of issues relating to intergovernmental affairs and strategic planning of the UNFCCC process. He provides oversight of the operations of the UNFCCC, covering human and financial resources, as well as organizational development. Prior to taking up his post at the UNFCCC, Mr. Sarmad held several senior posts at the International Organization for Migration for over 27 years. He is based in Germany.

Time for climate action

In a speech to the UN General Assembly in February 2023, Secretary-General António Guterres made a stark declaration: "If you cannot set a credible course for net zero, with 2025 and 2030 targets covering all your operations, you should not be in business."¹



Every fraction of a degree of global warming results in loss of life and livelihoods. In 2015, with the near-universal recognition of the Paris Agreement, world leaders agreed to take steps to limit global warming to no more than 2°C, with a strong preference for imposing a limit of 1.5°C. However, we have already passed 1.1°C and the trajectory, based on the current level of greenhouse-gas (GHG) emissions, poses danger to lives, livelihoods, and nature, a reality already beginning to be experienced around the world.

Every fraction of a degree of global warming results in loss of life and livelihoods."

We are in a critical decade. Climate action must reduce GHG emissions by 45%,² while also progressing towards the targets of UN Sustainable Development Goals³ by 2030. In recent years, there has been growing

**IF YOU CANNOT SET A
CREDIBLE COURSE
FOR NET ZERO,
WITH 2025 AND 2030
TARGETS COVERING
ALL YOUR OPERATIONS,
YOU SHOULD NOT BE
IN BUSINESS.**

From the Desk of



We have seen a tectonic shift of capital. Sustainable investments have now reached \$4 trillion. Every company and every industry will be transformed by the transition to a net-zero world."

recognition of the need for sustainability in both work practices and general living, accompanying a shift in global attitudes towards the environment. This has provided a significant push towards the incipient mega-trend of driving systems transformation across society and business.

This phenomenon has spread, especially during the last two years, in particular owing to mounting geopolitical tensions and the COVID-19 pandemic, which have acted as significant disruptors of business. Multinationals worldwide are now typically climate-aware, with 64% of executives globally saying sustainability is part of their leadership agenda.⁴ As Larry Fink's annual letter to corporate CEOs and investors in his company, Blackrock, said in 2022: "We have seen a tectonic shift of capital. Sustainable investments have now reached \$4 trillion. Every company and every industry will be transformed by the transition to a net-zero world."⁵

1 https://www.un.org/sg/en/content/sg/statement/2023-02-06/secretary-generals-briefing-the-general-assembly-priorities-for-2023-scroll-down-for-bilingual-delivered-all-english-and-all-french-versions?_gl=1*1i5syt3*_ga*MTg0ODA3NzcyOS4xNjQ2NDAzNDg0*_ga_TK9BQL5X7Z*MTY3NTkzMzgxMy4xLjEuMTY3NTkzMzgyMC4wLjAuMA (last retrieved on February 10, 2023).

2 In line with the temperature goals of the Paris Agreement: https://unfccc.int/sites/default/files/english_paris_agreement.pdf (last retrieved on 10th February 2023).

3 <https://www.un.org/development/desa/jpo/wp-content/uploads/sites/55/2017/02/2030-Agenda-for-Sustainable-Development-KCSD-Primer-new.pdf> (last retrieved on 10 February 2023).

4 Capgemini Research Institute, "A world in balance," 2022.

5 <https://www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter> (last retrieved on 10 February 2023).

For many, particularly Millennials and Gen Z, environment, social, and governance (ESG) considerations have become increasingly important when evaluating the impact of organizations worldwide. Today, clients and stakeholders take a different perspective to the traditional financially driven considerations, focusing on the long-term purpose of an organization and ensuring its net-positive effect in terms of sustainable development.

Public climate-action protests around the world, frequently spearheaded by the younger generation, are another source of disruption that is building in potency. Movements such as Fridays for Future, Extinction Rebellion, and Last Generation are calling urgently for climate action and sustainable living and embody the growing social drive towards public- and private-sector accountability.

The growing momentum of such movements has been in evidence at the annual UNFCCC Conference of the Parties (COP) over the past seven years (since the adoption of the Paris Agreement in 2015). Rising numbers of delegates from businesses, NGOs, and civil organizations are testament to this, as is the rising value of financial pledges in the Glasgow Financial Alliance for Net Zero (GFANZ)⁶ and the swelling number of partners in the UN Race to Zero campaign.⁷

Learnings from COP27



COP27, held in Sharm El-Sheikh, Egypt, on 6th–18th November 2022, and presided over by the Egyptian government, brought together over 45,000 participants to share ideas and innovative solutions, and to build partnerships and coalitions towards the implementation of the Paris Agreement operationalization agreed upon at COP26 in Glasgow in 2021. Representatives of businesses, indigenous people, local communities, cities, and civil society, including young people, showcased the ways in which they are addressing climate change and shared their experiences of how these efforts are impacting both their lives and their communities.

⁶ <https://www.gfanzero.com/> (last retrieved on February 10, 2023).

⁷ <https://unfccc.int/climate-action/race-to-zero-campaign> (last retrieved on 10 February 2023).



The Sharm el-Sheikh Implementation Plan estimates the expected annual financial requirements of a global transformation towards a low-carbon economy at \$4-\$6 trillion a year."

The Sharm el-Sheikh Implementation Plan⁸ estimates the expected annual financial requirements of a global transformation towards a low-carbon economy at \$4-\$6 trillion a year. If apportioned with forethought, this investment could generate significant returns, both financially and in terms of contributing to sustainable development. Delivering such funding will require a swift and comprehensive structural transformation of the financial system and engaging governments, central and commercial banks, institutional investors, and other financial actors.

At COP27, much was said about the compelling need for transparency and accountability in relation to climate action taken in the private sector, specifically in the context of the drive towards carbon neutrality. The UN Secretary-General's High-Level Expert Group on Net-Zero Emissions Commitments of Non-State Entities released a report⁹ at COP27 that illustrates the need to develop stronger and clearer standards for net zero emission pledges by businesses and to create stricter, monitored programs for their implementation. The Secretary-General invited non-state actors to put forward credible and transparent transition plans in time for COP28 in 2023 as a key milestone towards the emissions-reduction global plan for 2030.

⁸ <https://unfccc.int/documents/624444> (last retrieved on 10 February 2023).

⁹ https://www.un.org/sites/un2.un.org/files/high-level_expert_group_n7b.pdf (last retrieved on 10 February 2023).

Another important outcome of COP27 was the establishment of a new dedicated Fund for Loss and Damage to assist developing countries in coping with the consequences of climate change. A transitional committee has been established to make recommendations on operationalization of the fund at COP28.

COP27 also saw significant progress on the Global Goal on Adaptation, which will conclude at COP28 and inform the first global stocktake of progress towards the goals set out in the Paris Agreement, improving resilience among the most vulnerable countries. New pledges, totaling more than \$230 million, were made to the Adaptation Fund at COP27.

Governments cannot, on their own, implement this transformation across business and society. Multilateralism is the key to finding an inclusive and effective way forward. Inclusive multilateralism means involving non-state actors, including businesses, NGOs, academics, young people, and civil society in general, to play an active role in the journey to carbon neutrality and sustainable living. This opportunity for regulatory support and governmental cooperation represents an opportunity for the corporate world to put climate accountability at the core of revised business strategies. Through inclusive, multilateral collaboration, we can achieve the systemic transformation necessary for a sustainable future.

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The Secretary-General invited non-state actors to put forward credible and transparent transition plans in time for COP28 in 2023 as a key milestone towards the emissions-reduction global plan for 2030.”



"Inclusive multilateralism means involving non-state actors, including businesses, NGOs, academics, young people, and civil society in general, to play an active role in the journey to carbon neutrality."

Looking forward to COP28

The upcoming COP28, to be held in Dubai, UAE, in November and December 2023, must see significant progress in addressing the climate crisis. The first global stocktake of the Paris Agreement¹⁰ will independently evaluate both the progress made by governments and the adequacy of the goals set. As well as resetting the agenda for action on climate change, it will offer businesses the opportunity to showcase their sustainability and climate actions and demonstrate how they are accelerating the transition to a green business model.

The New Collective Quantified Goal on Climate Finance (NCQG) is expected to see real progress ahead of 2025, especially at COP28, in terms of meaningful mitigation and greater transparency of implementation plans. Developed countries have agreed to set an NCQG from a floor of \$100 billion per year, considering the needs and priorities of developing countries.

¹⁰ <https://unfccc.int/news/global-stocktake-is-about-ambition-accountability-and-acceleration> (last retrieved on 10 February 2023).

The operationalization of the Loss and Damage Fund represents another key element of COP28 in the UAE and will consequently provide clarity on which countries will be contributing to the fund and who will be eligible to benefit from it.

In a nutshell, we are in a race against time to limit global warming by avoiding a global temperature rise in excess of 1.5°C – to preserve our natural resources, and to preserve our livelihoods in all parts of the world, especially those regions that are on the front line in terms of battling severe climate impacts.

There is hope. Global warming can still be limited. Young people are pushing for urgent climate action, and we are already seeing positive developments, such as the expansion of renewable-energy production and use, a shift towards the circular economy, and increased sustainability awareness and climate literacy, to name just a few examples. But, for this vision to become reality, businesses must put the environment and sustainability front and center in their planning and actions. The time for corporate climate accountability is now. Sustainable systems transformation cannot be achieved if we don't pull together. All of us have the means to advocate and push for climate action and carbon neutrality in our spheres of influence. Our future will be the sum of the decisions we make today, individually and collectively. It can be and it must be done!



Perspectives from Capgemini





WHY CLIMATE TECH IS PIVOTAL TO ACHIEVING A SUSTAINABLE PLANET

Cyril Garcia, Head of Global Sustainability
Services and Corporate Responsibility,
Capgemini

Florent Andrillon, Climate Tech global
lead, Capgemini

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SOLVING THE SUSTAINABILITY EQUATION

Pascal Brier, Group Chief Innovation Officer
and member of the Group Executive
Committee

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ALIGNING LEADERSHIP WITH SUSTAINABILITY

Elisa Farri, Vice President and Co-lead of
Capgemini Invent's Management Lab
Gabriele Rosani, Director of Content
and Research at Capgemini Invent's
Management Lab

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Cyril Garcia

Head of Global Sustainability Services and Corporate Responsibility, Capgemini

Cyril Garcia was appointed Global Sustainability Services and Corporate Responsibility Head on January 1st, 2023. He is responsible for the integration of sustainability across Capgemini's portfolio of client services, as well as driving the Group's own sustainability agenda. Cyril is also responsible for Capgemini's Corporate Social Responsibility activity. Cyril has been a member of the Group Executive Board since 2018.



Florent Andrillon

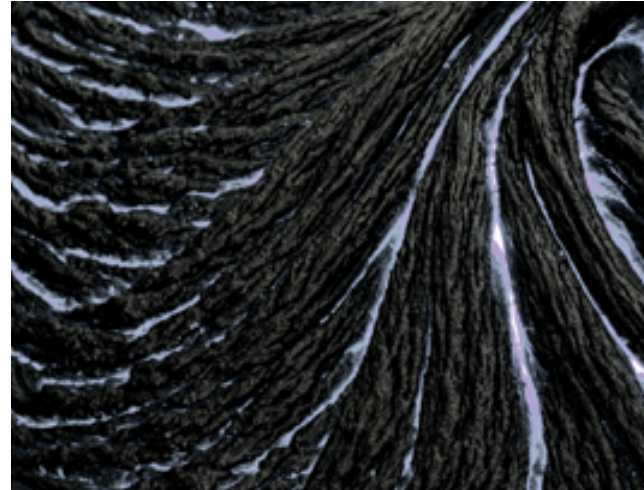
Climate Tech global lead, Capgemini

Florent leads in bolstering the Cleantech business development with all sustainability teams across the Group and he has more than 20 years of experience in the energy and utilities sector, helping clients to achieve their sustainability goals and transition to a low-carbon economy. He has a strong focus on the energy, resources and cleantech market, as well as on sustainability, climate and energy transition issues. He leverages the capabilities of the Capgemini and its external partners to deliver innovative and impactful solutions.

WHY CLIMATE
TECH IS
PIVOTAL TO
ACHIEVING A
SUSTAINABLE
PLANET

CLIMATE TECH, TOWARDS A LOW- CARBON INDUSTRIAL REVOLUTION

We have less than seven years to halve global greenhouse gas (GHG) emissions and reduce methane emissions by a third if we are to limit global warming to 1.5°C.¹ To get there by 2030, we need to go beyond incremental innovations and behavior change. We must make systemic changes in technologies, institutions, and practices on a huge scale. We need a new industrial revolution.



The Climate Tech landscape

Climate Tech players are tackling the challenge from multiple angles. They are working to:

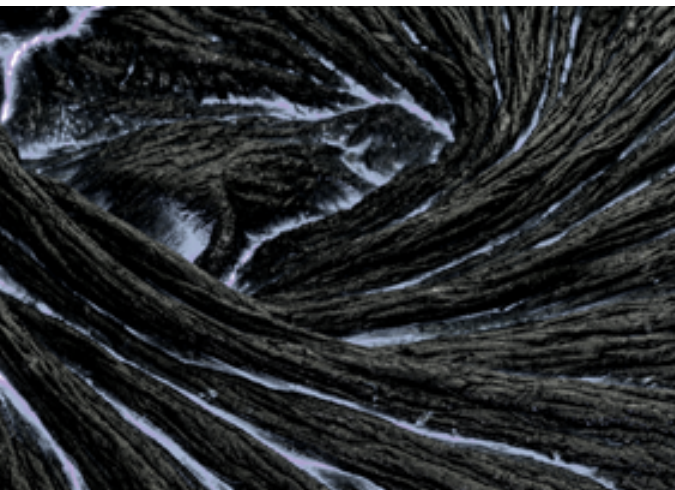
- Reduce CO₂ in the atmosphere with renewable energy sources such as wind and solar, energy-efficient building and transportation, and carbon capture/storage technologies.
- Help us adapt to climate change through, for example, sea-level-rise protection and drought resistant crops.
- Reduce agriculture's impact on ecosystems through efficient irrigation and precision agriculture technologies.

Synthetic biology also has an important role to play in the climate transition, whether by reducing emissions through circular manufacturing, using bacteria to reduce plastic pollution, or the sequestering

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We need systemic changes in technologies, institutions and practices at a scale comparable with the ones experienced in past industrial revolutions.”

¹ Intergovernmental Panel on Climate Change (IPCC).



"Synthetic biology has an important role to play in this climate transition."

carbon through soil, oceanic, lithospheric, or anthropogenic sinks. And when it comes to hard-to-abate industries, clean hydrogen will help reduce emissions, potentially reshuffling the global industrial landscape.

While most of the technologies we need to reduce emissions for the 2030 target are already available, the path to 2050 relies on newer technologies, particularly in sectors that are hard to decarbonize, such as heavy industry and long-distance transport. To help unleash these technologies and make them more cost-competitive, we must compress the traditional 25-year innovation cycles and accelerate development. This would have financial as well as ecological advantages. An Oxford University research team² found that the faster the transition, the greater the saving (at least US\$12 trillion compared to continuing our current levels of fossil fuel use), as a result of the potentially enormous decline in costs that comes with technology learning.

The rise of Climate Tech

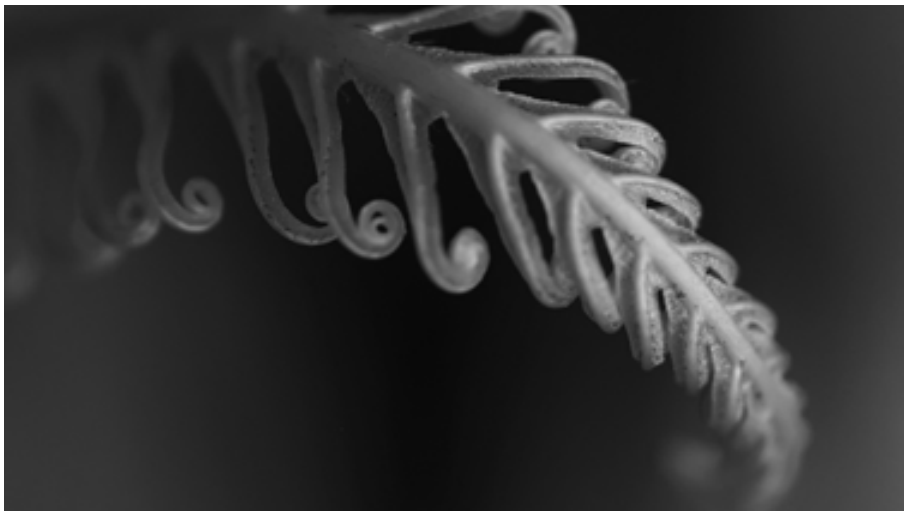
Between 2010 and 2022, the number of Climate Tech firms worldwide rose by over 400% to 44,595. In 2021, Climate Tech companies raised around US\$111 billion – more than enterprise software (US\$104 billion) and only just behind HealthTech and FinTech (US\$ 119 billion and US\$129 billion, respectively).³

While integrating most climate technologies into existing infrastructure, hardware, software, and operational systems may be complicated, there are reasons to be optimistic.

² Empirically grounded technology forecasts and the energy transition, University of Oxford [https://www.cell.com/joule/fulltext/S2542-4351\(22\)00410-X](https://www.cell.com/joule/fulltext/S2542-4351(22)00410-X)

³ Tech Nation, Climate Tech Report 2022, November 2022.

SINCE 2010, THE NUMBER OF CLIMATE TECH FIRMS WORLDWIDE HAS RISEN BY OVER 400%.



Factors helping climate technologies move into the mainstream include:

- **Affordability:** The learning rate for clean technologies to date suggests they can deliver the necessary advances and cost reductions to reach parity with incumbent alternatives.
- **Attractiveness:** Pledges from large organizations to decarbonize their operations and product lines in the effort to reach net zero give confidence to entrepreneurs and backers that there will be strong demand for new technologies.
- **Availability of 'green money:'** There is a notable rise in investments earmarked for sustainability and environmental, social, and corporate governance (ESG) objectives.

- **Policy support:** Governments are lending strong fiscal support to low-carbon innovation and related infrastructure.

A combination of these enabling factors and growing interest in green technologies means that many major climate technologies are now getting closer to their 'tipping point' (the point at which they attain mainstream adoption). See Figure 1.

Figure 1: Hype curve of select climate technologies



Source: SVB, "The Future of Climate Tech", 2022

The need to scale up at speed

The next challenge is scaling new technologies at an unprecedented speed, for which more substantive work, more public support, and more investment are urgently required. The UN estimates that global transformation to a low-carbon economy will require at least US\$4–6 trillion a year until 2030.⁴

There has been important progress in 2021/22, including in R&D in key areas such as low-carbon hydrogen-based steelmaking, small modular nuclear reactors, and lithium-free batteries.

4 UN – COP27, Sharm el-Sheikh Implementation Plan, November 2022

Perspectives from Capgemini

Governments globally are now actively supporting the industrialization and deployment of impactful climate technologies, with an increasing focus on:

- heavy industry
- green hydrogen
- batteries
- sustainable fuels
- carbon capture, usage and storage (CCUS)
- and other critical energy technologies.



The race to net zero has begun, and climate tech is at its core."

In the United States, for instance, the combined Inflation Reduction Act (IRA) and Infrastructure Investment and Jobs Act provides ~US\$470B in new energy and climate funding over 10 years. This is more than 3 times the Marshall plan, which provided over \$130 billion (in 2020 dollars) in economic aid to European countries between 1948 and 1951. And this trend is global: the European Union has the Net Zero Industry Act and Critical Raw Materials Act; Japan has a Green Innovation Fund; and China has set strong climate target and investment priorities in its 14th Five-Year Plan.

The opportunities ahead

The race to net zero has begun, with Climate Tech at its core. Those countries that take the lead in speeding up the development of clean technologies could reap considerable economic benefits, including significant job creation. Climate technologies will reshape and in many cases remove the boundaries

"Climate technologies will reshuffle the boundaries between industries and open new frontiers for innovation and growth."

between industries and open new frontiers for innovation and growth. Climate Tech is set to transform the way we interact with the world more profoundly and on a larger scale than the digital revolution. Most businesses will need to integrate new climate technologies into their operations to decarbonize and reduce their environmental impact. This brings with it an incredible range of opportunities for innovation. For example:

- With wider use and distribution of solar, landowning businesses such as retailers could become power providers, or use this renewable energy to charge electric trucks.
- CO₂ captured from an industrial process (e.g. at a cement plant) could become a tradeable byproduct for use in a clean fuel refinery.
- Similarly, carbon removal technologies like biochar are used for CO₂ offsetting, but have the valuable side-effect of enriching agricultural soil.
- Shipping companies or airlines looking to secure their supply of clean fuels could move up the value chain and produce the green hydrogen themselves.

The need for 'intelligent industry'

Intelligent Industry can be a great lever to accelerate the deployment of climate technologies. Climate Tech innovation is distinct from the digital transformation of recent decades. Climate change is, inherently, a hardware problem – it requires large infrastructure projects to transform how our economy operates. While software has its role, and can be a great facilitator of emissions reduction, hardware is essential across all sectors if we are to build a sustainable and habitable society.

Intelligent Industry can provide innovative ways to ramp up climate technologies. **Better data and improved application**, for example, mean more



Climate change is, inherently, a hardware problem which necessitates large infrastructure projects that transform how our economy operates."

Perspectives from Capgemini

productive use of fewer resources; such as energy and raw materials, less scrap, and a genuine end-to-end product lifecycle. It helps in simulating and understanding the full impact of a product's impact through its usage, as well as its design, manufacture, transportation, and end of life. Digitization also has an important role: , revealing current blind spots through a comprehensive analysis.

Digital twins of wind projects, for example, make deployment easier, faster, safer, and more cost effective. Likewise, Virtual Validation, Generative Design, and AIDevOps can all help the renewable energy industry break technological and performance barriers.

In the fight against global warming, **industrial automation and smart industries** are critical. Digital technology can help climate tech players and leaders in decarbonization replace dirty and high-emitting manufacturing processes with more resource-efficient and environmentally friendly ones. Automation, robots, 3D printing, virtualization, and other Industry 4.0 technologies can dramatically enhance efficiency and economics.

Climate Tech offers incredible opportunities for engineers, data scientists, and business innovators. We need to upskill and mobilize them to work on these challenges now to ensure our future.

The transition to a low-carbon economy is as big as the Industrial Revolution, but we need to deliver it at the pace of the Digital Revolution. Let's act now!





"The transition to a low carbon economy is as big as the Industrial Revolution, but we need to deliver it at the pace of the Digital Revolution."



Pascal Brier

Group Chief Innovation
Officer and member
of the Group Executive
Committee

Pascal Brier was appointed Group Chief Innovation Officer and member of the Group Executive Committee in 2021. Previously, and starting in 2005, Pascal was a member of the Executive Committee of the Altran Group. Since September 2018, he was Executive Vice-President of the Altran Group in charge of Strategy, Technology, and Innovation, based in the Silicon Valley. In this position, he drove Group strategy, the portfolio of offers, marketing, and service lines, as well as the implementation of the research and innovation roadmap and the Group's high-value-added activities (Altran NextCore). Prior to this, he was Executive Vice President in charge of Altran's global accounts and business development for the Group.

INCREMENTAL
AND
DISRUPTIVE
INNOVATION IS
THE ROUTE TO
SURVIVAL

Perspectives from Capgemini

The struggle for sustainability is a game with high stakes. Global targets to reduce carbon emissions are being set against the backdrop of a fast-growing global population and untenable pressure on our finite natural resources. We believe the only answer to this seemingly impossible equation is to innovate.

Let's consider the equation in more detail, beginning with carbon-reduction targets. To limit global warming to no more than 2°C – and avert the worst impacts of climate change, as called for in the Paris Agreement – global greenhouse-gas emissions would need to be cut by 45% by 2030 and reach net zero by 2050.¹

Let's also consider in parallel population and economic growth. Fifty years ago, there were just under 4 billion people on the planet; since then, that figure has doubled to more than eight billion. The UN predicts the global population could rise to close to 10 billion by 2050.² Combine this with the rapid growth of developing economies and aspirations of improved standards of living across the globe and, by 2050, we may need 40% more water and energy to sustain ourselves.

Finally, let's consider our resources. Fossil fuels – including coal, oil, and natural gas – currently supply about 80% of the world's energy needs. However, these resources are finite and nearing exhaustion: we have already passed peak oil and coal, and peak gas is on the horizon. In addition, their detrimental effect on the environment and our own health is well documented.



1 <https://www.un.org/en/climatechange/net-zero-coalition>
2 <https://www.un.org/en/global-issues/population>



Combine these factors and the complexity of the equation is alarming:

How can we produce sufficient energy to support 10 billion people, while also slashing carbon emissions, all as macro-economic chaos rages around us, arising from pandemics, geopolitical tensions, and other, as yet unknown, exogenous shocks?

In short, we are in a climate and energy emergency. We are all the time asking more of a planet that will soon have no more to give.

To solve the equation, we believe there is only one solution, consisting of two interdependent approaches: frugality and innovation.

"We are all the time asking more of a planet that will soon have no more to give."

The energy transition: aiming for responsible frugality

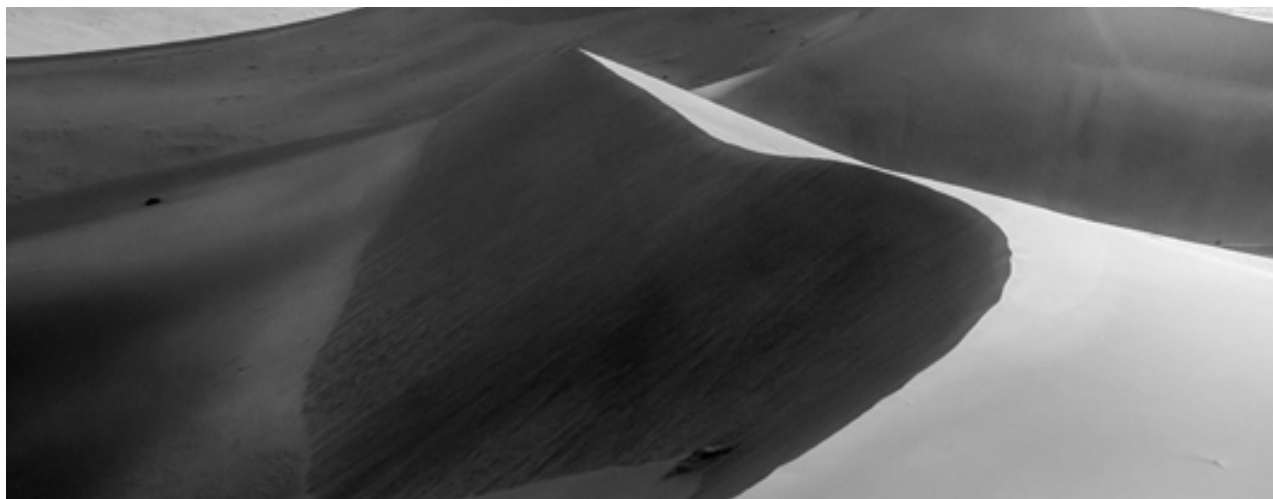
Frugality boils down to a global commitment to an economy of both production and consumption.

The first level of frugality – which I would describe as “responsible frugality” - means choosing to do things differently. This kind of frugality **halts** unnecessary waste and emissions, but allows for the continuation of everyday activity, albeit in a **more sustainable manner**.

For example, individuals will still be able to drive a private car, but car manufacturing would be systematically optimized to require fewer natural resources. We would build cars using lighter materials; maximize recycling in the manufacturing process; replace road-supply chains with more efficient rail and shipping infrastructure; encourage car dealers to reduce their energy and water use; and actively develop alternatives to individual ownership. With

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Responsible frugality means choosing to do things differently. This kind of frugality halts unnecessary waste and emissions, but allows for the continuation of everyday activity, albeit in a more sustainable manner.”



responsible frugality, it should still be possible to enjoy motoring without causing devastation to the environment.

However, getting to this point involves major challenges, whether that's encouraging behavioral changes, setting regulations, or evolving economic imperatives. Moreover, as populations rise and finite resources dwindle, moderate frugality of this nature is unlikely to be enough to maintain equilibrium. Full frugality would involve a radical change to our current way of life: no air travel, no devices, no concrete, no meat – and that's just the start.

However, such an austere approach is both unfair and fundamentally unrealistic. It is unfair to expect developing countries, who have done comparatively little to contribute to the current climate-related issues, to give up on their dreams of economic prosperity. The developed world has long been accustomed to a consumerist lifestyle and, understandably, the developing world wants to experience the benefits of that as well. Equally, citizens in developed economies will not take kindly to being asked to degrade their lifestyles precipitously. It is not realistic to ask people to give up all their personal comforts and aspirations, for themselves or for posterity.

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Full frugality would involve a radical change to our current way of life: no air travel, no devices, no concrete, no meat – and that's just the start.”



"It is unfair to expect developing countries, who have done comparatively little to contribute to the current climate-related issues, to give up on their dreams of economic prosperity. "

PINNING ALL OUR HOPES ON FRUGALITY GOES AGAINST HUMAN NATURE.

So, while there is much to be said for the frugal route, pinning all our hopes on frugality goes against human nature. The notion that we can put a hard break on established patterns of behavior is both unrealistic and counterproductive, leading people to believe there is no longer anything worth fighting for.

This is where **innovation** comes to the fore.

Essentially, **the more we are innovative, the less frugal we will have to be.** By investing in innovation now, we can develop an answer to the intractable equation of a fast-growing global population balanced against finite natural resources, and an increasingly jeopardized overall climate balance.

Changing the world for the better

This innovative route will include both incremental and disruptive paths.

Incremental innovation involves a concerted effort to reduce energy consumption and carbon emissions in both production and consumption, targeting true efficiency from the design phase onward. This is valid for all industries; all companies should be cognizant of their current emissions (scope 1 to 3) and energy consumption. It is the responsibility of all business leaders to reduce their company's environmental footprint by improving product and service design, engineering and manufacturing processes, supply chains, and – at a fundamental level – behaviors and company culture.

The IT sector, for instance, which accounts for a growing 4% of total emissions, is full of new technologies that are deployed alongside the

Perspectives from Caggemini

legacy systems they are replacing, creating what I call a “technical debt.” As an example, cloud computing is often touted as a major pathway to green IT, but as older systems continue to run in parallel, they will continue to do damage.

Here’s another example: nuclear fusion promises limitless, carbon-free energy. This disruption in power could have a life-changing impact on our economies and societies. But we are a long way from unlocking the potential of nuclear fusion. Scientists will need to figure out how to produce energy on a large scale. They’ll also need to work out how to harvest the energy produced and transfer it to the power grid as electricity. While pioneering developments occur all the time, and while renewables such as solar and wind power are developing, we must also turn the lens of innovation on our existing technologies. For nuclear energy, this could take the form of building smaller, modular nuclear plants that consume fewer resources, are cheaper and faster to build, and allow us to scale up our energy generation without adding to the climate crisis.

Incremental innovation can help to transform our manufacturing chains. Most industrial processes currently rely on traditional methods, such as molding and milling, where only a fragment of the raw material is used, and the rest thrown away or (less than efficiently) recycled, with a significant environmental impact. As an alternative, 3D printing offers a less wasteful approach, where manufacturers use 3D printers to create products using precise amounts of resources with upgraded designs instead of extracting shapes from blocks of raw material.



Fostering disruptive innovation

Disruptive innovation permanently changes the way our societies and economies operate. While disruptions on the horizon could help us address the climate emergency, there's also a series of enduring challenges that we must overcome. Take the example of the transition to new energy sources such as wind, solar, and – notably – hydrogen.

Green-hydrogen fuel cells would be a true disruption: energy for a new generation of devices, emitting water vapor instead of greenhouse gases. Hydrogen-powered vehicles could reduce life-cycle CO₂ emissions to around 60g/km, well below the emissions produced by even electric vehicles (EVs) powered by renewable electricity.³

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Green-hydrogen fuel cells would be a true disruption: energy for a new generation of devices, emitting water vapor instead of greenhouse gases.”



³ The Week, “Hydrogen cars explained: fuel cells, efficiency and zero emissions”, September 2021

However, the shift to hydrogen-powered cars will require huge investment in research and infrastructure, whether developing and refining fuel cells or building the gas stations to power vehicles.

Also, the much-vaunted “clean” fuels are inherently problematic; hydrogen is created with electricity powered by fossil fuels. Many people are also concerned about the combustible nature of hydrogen; understandably, no-one wants a potentially explosive fuel cell in their car.

As we create game-changing innovations, we must ensure we disrupt with care. The disruptive impact of nuclear power has been limited because people are afraid of something going wrong with devastating consequences. The past disasters of Chernobyl and Fukushima are still fresh in people’s minds.

Just as nuclear power became associated with a fear of impending disaster, high-profile failures could mean hydrogen struggles to gain public trust. Dealing with the climate emergency successfully will entail ensuring the disruptive technologies we adopt are not hamstrung by an unfavorable public perception.

A natural solution

Another example of an innovation for which there is great hope is synthetic biology, which involves the application of engineering principles to redesign natural systems. Synthetic biology holds the alluring promise of replicating the bounty of nature without depleting natural resources.

One often-cited example is lab-grown “meat,” a synthetic food source that could sustain the ever-growing global population without the carbon-intensive farming of animals. Forecasts in 2020 suggested spending on cultivated meat could reach \$150 billion by the end of this decade.



Synthetic biology holds the alluring promise of replicating the bounty of nature without depleting natural resources."

Perspectives from Capgemini

Synthetic biology could also give us the means to eradicate disease and bacteria and boost agricultural production. Nevertheless, despite these appetizing opportunities, people retain deep-seated suspicions about the application of such synthetic products.

While the technology that could power disruption continues to proliferate at a searing pace, the governance required to pave the way for innovation is often lacking. We as a global society need to start thinking about this aspect of innovation now, and begin to prepare for true disruption incrementally, so that, when it arrives with full force, we are ready.

Everyone has a part to play

All business leaders must start investigating creative solutions to the climate challenges we face. Sustainability is now a must-have objective, not a long-term nice-to-have. Incremental innovation will be crucial, but at some point, we will be required to intensify our activities and focus on “moon-shot” efforts. All organizations can play a role in this.

Enterprises in the automotive and aerospace sectors, for example, can investigate hydrogen fuel cells and batteries manufactured without rare-earth materials. General manufacturers might think about how advances in synthetic biology could



"While the technology that could power disruption continues to proliferate at a searing pace, the governance required to pave the way for innovation is often lacking."

Perspectives from Caggemini



help reduce global emissions.

To deliver effective solutions will also require business leaders to understand the role and significance of technology – today, **every business is a technology business**. They must acquire a thorough understanding of how digital innovation can help their organizations achieve sustainability targets.

Let's be clear: there is a huge amount to do in a very short timeframe. We must remain both positive and realistic; humanity is capable of finding solutions to all the problems we face. However, we can't sit back and leave it to someone else to find the answers.

The innovative solutions to our challenges will come from a collective approach. We must each engage with the equation and think about how our organizations will develop an answer to the climate emergency. By working together, we can continue to develop as a society and keep frugality at bay.

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The innovative solutions to our challenges will come from a collective approach.”



Elisa Farri

Vice President and Co-lead of Capgemini Invent's Management Lab

Elisa Farri is a Vice President and Co-lead of Capgemini Invent's Management Lab, bridging the academic and business worlds. Over the last ten years she worked in strategy and innovation consulting, advising Fortune 500 corporations in transformative projects. Prior to consulting work, she worked at the Harvard Business School's Europe Research Center in Paris, France. Elisa is a regular contributor to leading management reviews and business magazines like HBR.org and Rotman Management, and a speaker on strategy and innovation management.



Gabriele Rosani

Director of Content and Research at Capgemini Invent's Management Lab

Gabriele is Director of Content and Research at Capgemini Invent's Management Lab. He has more than fifteen years of strategy consulting experience with particular focus on innovation management and business transformation. In parallel to his consulting experience, Gabriele is a contributor for leading management magazines, including HBR.org, Dialogue Review, "I" by IMD, and The European Business Review. He also contributed to management books in collaboration with Thinkers50, PMI, and the Business Ecosystem Alliance.

ALIGNING LEADERSHIP WITH SUSTAINABILITY

"The major obstacles to confronting climate change are not tech or policy. Organizational challenges are those to overcome. We need to create urgency today to shift the traditional culture of leadership and make it fit for sustainability."

Gunnar Trumbull

Philip Caldwell Professor of Business Administration,
Harvard Business School Impact Research

The legacy of the profit-only paradigm

Whatever its history, whether stretching back centuries or just a handful of years, every organization comes with its own set of expectations based on that history. To date, sustainability has very rarely featured in this.

Put simply, the vast majority of organizations were not built with sustainability as the keystone, or even one of the pillars supporting their vision. Given this, it is unsurprising that, when it comes to organizational culture and leadership, there exists what can be described as a "sustainability deficit." The majority of today's senior executives were educated at prestigious business schools; gained professional experience via a well-worn, traditional path; and built their careers within a profit-only paradigm based on hitting quarterly and annual financial targets. They

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The majority of today's senior executives were educated at prestigious business schools; gained professional experience via a well-worn, traditional path; and built their careers within a profit-only paradigm."

achieved this within a conventional business framework based on competing for market share, gaining leverage with key suppliers, and squeezing the margins of other players in the chain. This engendered a strict "command-

and-control" managerial style, with an emphasis on organizational efficiency and optimizing use of resources (including human resources). The legacy of this paradigm is still predominant in many organizations and tends to hinder the transition to a sustainable management model.

Taking real action – Not just playing a part

Sustainability requires a different management style and a new set of behaviors. Changing people's hearts and minds is the biggest challenge – and it must start with the C-suite. While leaders broadly recognize the pressing need for change, they often end up following a simplistic, even superficial approach to implementing it. They "change the narrative," bringing in buzzwords such as "purpose," "care," "trust," "collaboration," "openness," "psychological safety," "empowerment," and "tolerance of failure." In practice, however, executives do not walk the talk: the change in vocabulary is not reflected in a change in attitude and behaviors as expressed through everyday work tasks. We describe this superficial attitude to sustainability as sustainability theater.

Employees soon pick up on a lack of genuine and coherent commitment to change on the part of their leaders and, as the perception gap widens between the values that executives espouse and the leadership styles and behaviors they display, employee cynicism and dissatisfaction will grow in parallel. This misalignment risks undermining the credibility of sustainability

SUSTAINABILITY REQUIRES A DIFFERENT MANAGEMENT STYLE AND A NEW SET OF BEHAVIORS.

strategies within the organization – leading to employee disenchantment – and outside it – feeding skepticism among customers, suppliers, investors, and institutions.

So, what should executives do to avoid becoming actors in sustainability theater?

Management research into corporate-culture change emphasizes a focus on leaders' observable behaviors, rather than on vague, abstract values disseminated by the HR department. Authentic cultural change is not simply a recalibration of the existing mission statement or a freshly drawn up manifesto of values. Simply changing the narrative will backfire if it is not backed up by a meaningful change in leaders' actions, behaviors, and decisions in relation to their employees, customers, suppliers, and local communities.

40 behavioral cards for leadership in the sustainability era

Identifying and defining distinct observable behaviors makes it easier to monitor, assess, and review the adoption of those behaviors. Under the supervision of V. Kasturi Rangan, Malcolm P. McNair Professor of Marketing at Harvard Business School and co-chairman of the School's Social Enterprise Initiative, we developed a set of 40 behavioral cards applicable to leadership in the sustainability era.



"Simply changing the narrative will backfire if it is not backed up by a meaningful change in leaders' actions, behaviors, and decisions."

Prof. V. Kasturi Rangan,
Malcolm P. McNair Professor of
Marketing at Harvard Business School
and co-chairman of the School's
Social Enterprise Initiative.

"Cards can be a powerful tool for triggering meaningful discussions, both in an executive classroom and in corporate-leadership meetings," explains Professor Rangan. "There's an increasing need to support leaders in raising awareness of the impact of their individual behaviors on the sustainability agenda," he adds.

The list of behaviors is organized around four dimensions:

- **Purpose:** Once clearly defined, leaders must embrace their purpose and encourage the organization to follow it as a guiding "north star"
- **Trust:** Leaders must act authentically and credibly in order to gain the trust of employees, suppliers, and partners
- **Collaboration:** Leaders must be open to different perspectives, co-creating with partners and finding systemic (rather than siloed) solutions
- **Innovation:** Leaders must build creativity and encourage experimentation outside comfort zones; incremental solutions alone will not be enough to solve sustainability challenges – more immediately impactful solutions are required

Each of the four dimensions comprises ten specific behaviors: five designated "positive" behaviors that should be initiated and/or encouraged; and five "toxic" behaviors that should be eliminated. Each behavior should be articulated using clear descriptors that enable managers to enact them. We encourage managers to customize the standard list to fit the specific business context and to encompass both environmental and societal dimensions of sustainability.

Perspectives from Capgemini

After fostering environmentally conscious decisions and actions, it is important to examine the social and people components. "If leaders care for the planet, they should also care for the people," affirms Guido Stratta, Chief of People & Organization at Enel, a global leader in the fields of electrification and decarbonization. Enel combines an environmental focus with the concept of "soft leadership," based on exhibiting "kindness" towards the firm's multiple stakeholders. Enel's model of soft leadership incorporates valuing and nurturing personal relationships, trust, and respect for the abilities and commitment of others, while simultaneously maintaining a focus on achieving sustainable business objectives.

In the table below, we present an excerpt of the 40 behaviors that includes two for each of the four dimensions: one example with a positive connotation and another with a negative connotation.



"Enel combines an environmental focus with the concept of 'soft leadership,' based on exhibiting 'kindness' towards the firm's multiple stakeholders."



DIMENSIONS	POSITIVE BEHAVIORS – EXAMPLES	NEGATIVE BEHAVIORS – EXAMPLES
PURPOSE	<p>Make significant changes in the firm to embed purpose</p> <ul style="list-style-type: none"> Systematically rethink all business processes (including KPIs and method) to integrate purpose into decision-making Be prepared to drop projects or activities that, while profitable, are problematic in ESG dimensions 	<p>Predominantly focus on financial goals</p> <ul style="list-style-type: none"> Meeting time largely devoted to margins, market share, competitors, and potential efficiencies Sustainable purpose relegated to "nice-to-have" status, secondary to profit
TRUST	<p>Listen and empathize with stakeholders</p> <ul style="list-style-type: none"> Foster an open, transparent, and regular dialog with external actors, considering different perspectives Put people first, both internally (employees) and externally (suppliers, local communities, and other stakeholders) 	<p>Act opportunistically to serve own agenda</p> <ul style="list-style-type: none"> Pursue self-interest (of the organization or of the individual), rather than looking after the interests of colleagues, customers, and other stakeholders Prioritize personal advancement, rather than contributing to shared purpose
COLLABORATION	<p>Co-create solutions with partners</p> <ul style="list-style-type: none"> Jointly define problem spaces, considering multiple perspectives Run initiatives with partners across the entire value chain, upstream and downstream (e.g., in developing a circular economy) 	<p>Think always in terms of win/lose</p> <ul style="list-style-type: none"> Deal opportunistically with value-chain partners (suppliers, distributors, etc.), taking advantage of them and squeezing their margins where possible, rather than considering them true partners Value control and power in the partner relationship over consensual contribution to a mutually beneficial solution/outcome
INNOVATION	<p>Promote experimentation</p> <ul style="list-style-type: none"> Within a clear strategy, define, prioritize, and run a portfolio of experiments aimed at validating critical assumptions Involve partners and stakeholders in innovation programs, grassroots initiatives, and trial balloons 	<p>Follow the mainstream</p> <ul style="list-style-type: none"> Wait for others to move and follow their lead, rather than taking the initiative in new markets Use existing approaches as the benchmark, rather than formulating an original strategy

"By providing time and space for candid discussion and assessment, leaders can facilitate the transition to the new behavioral framework."

In our work with clients, we have found the list highly useful in encouraging executives to focus on three or four positive behaviors to commit to, and the same number of negative ones, which they will commit to abating. This exercise works equally well when conducted on either individual or team level. Once the level and type of commitment are defined, it's important to make monitoring of the commitment transparent and to bring it into practice as part of everyday activities.

Respecting and upholding the new behavioral structure requires sustained effort. Despite leaders' best intentions, after the initial burst of commitment, it is tempting to slip back into the accustomed management style. To help leaders, teams should introduce new routines and team practices to support planning and monitoring of new behaviors, including periodic retrospective sessions to discuss the progress of adoption. For example, a specific behavior could be added as a focal point in each departmental meeting. By providing time and space for candid discussion and assessment, leaders can facilitate the transition to the new behavioral framework.

Feedback and discussion should not be limited to executive peers; leaders should incorporate feedback from employees and other stakeholders beyond the company walls (suppliers, partners, customers, etc.) in relation to progress on behaviors relevant to that group.



In light of the importance of internal organizational behaviors, as detailed above, it is surprising that discussion of behaviors tends to concentrate on consumer behaviors rather than behavioral

change at leadership level.

Executive and managerial

behavior is pivotal to project

credibility and nurturing

trust inside and outside the

organization. Simply defining

a new manifesto of values and

cascading it down from the top

in the hope that change will

follow is rarely successful. If

managers can set themselves

a series of concrete, defined

behaviors to follow or

eliminate, organizations will see measurable change and

tangible benefits.



Leaders should incorporate feedback from employees and other stakeholders beyond the company walls."

IF MANAGERS CAN SET THEMSELVES A SERIES OF CONCRETE, DEFINED BEHAVIORS TO FOLLOW OR ELIMINATE, ORGANIZATIONS WILL SEE MEASURABLE CHANGE AND TANGIBLE BENEFITS.

Insights from the Capgemini Research Institute

GREEN HYDROGEN

Low-carbon hydrogen a path to a
greener future

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A WORLD IN BALANCE

Why sustainability ambition is not
translating to action

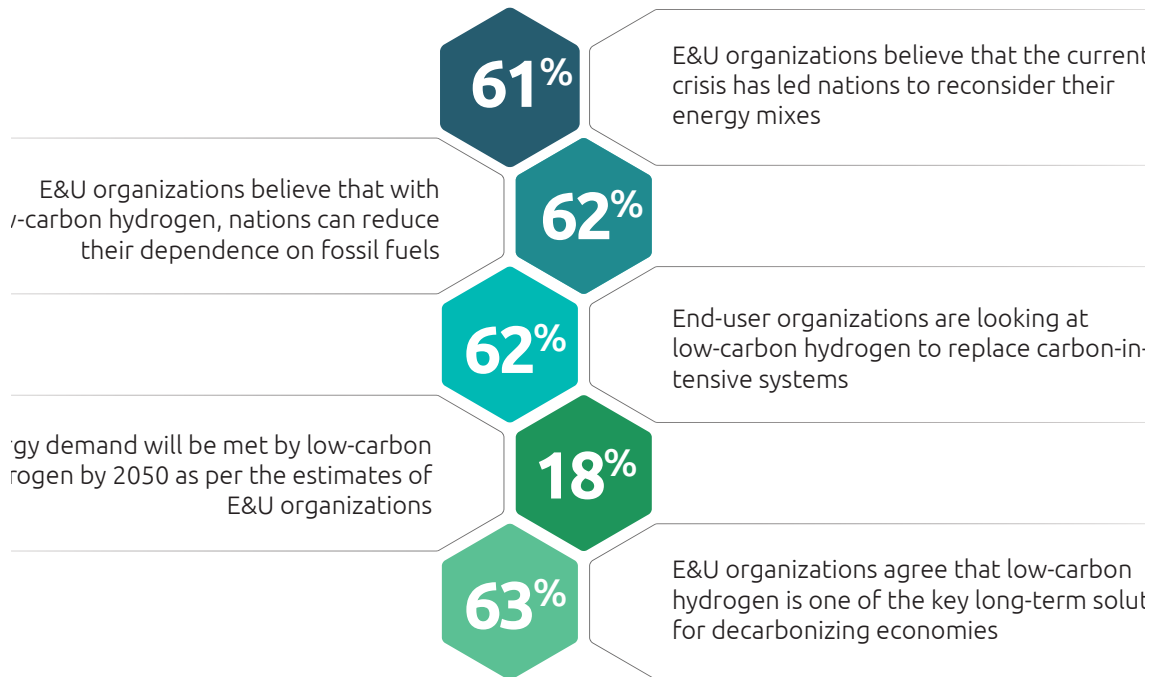
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GREEN HYDROGEN

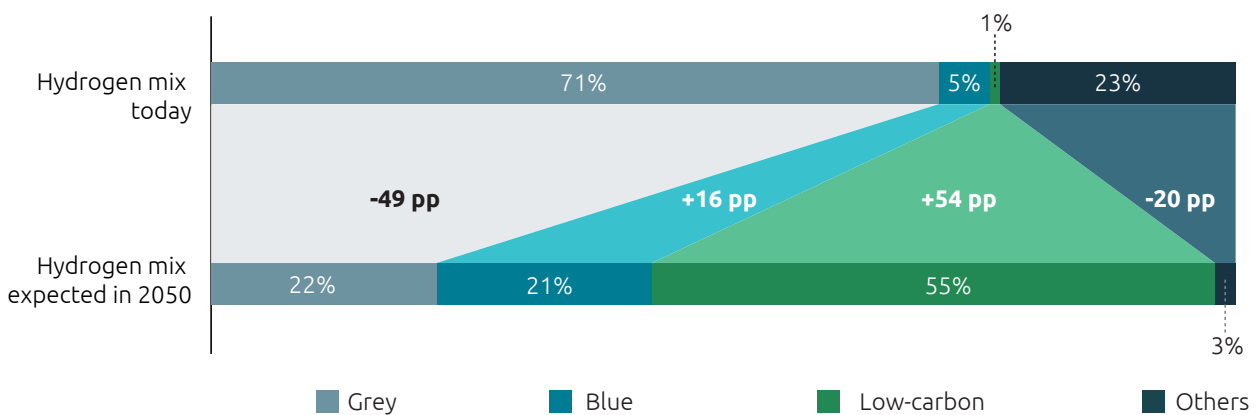
LOW-CARBON HYDROGEN A PATH TO A GREENER FUTURE

For details on the research methodology and to read the full report, please visit:
<https://www.capgemini.com/insights/research-library/the-people-experience-advantage/>

Organizations are optimistic and ambitious about low-carbon hydrogen



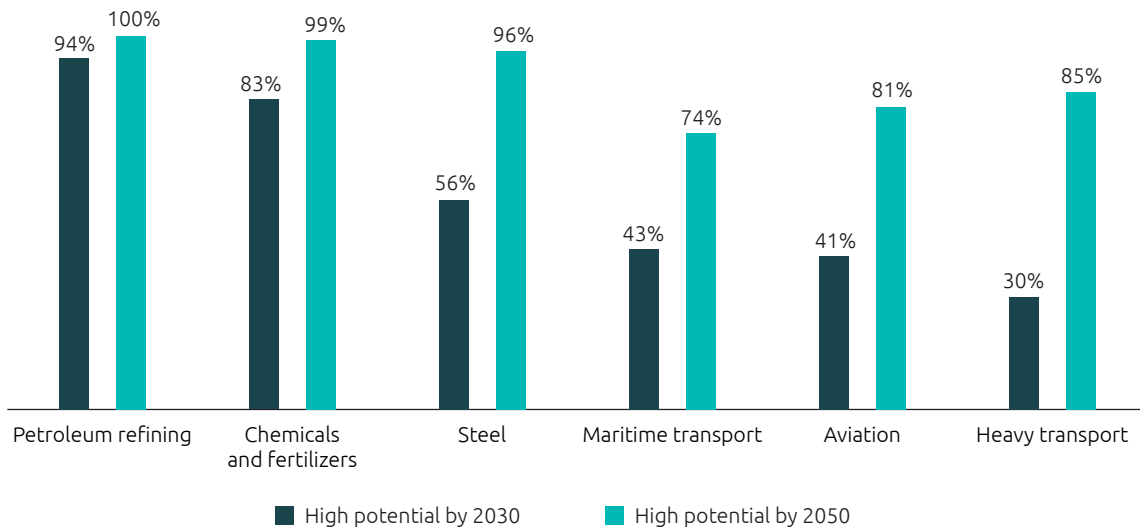
E&U organizations expect low-carbon hydrogen's share of the total hydrogen mix to increase significantly by 2050



Note: This represents subjective organizational expectations for low-carbon hydrogen and is not based on present capabilities and investment levels.
Source: IEA, Hydrogen Tracking Report, September 2022; Capgemini Research Institute, low-carbon hydrogen survey, November-December 2022; N=500 respondents from unique energy and utilities organizations.

Industries such as refining, fertilizers, and chemicals will widely harness low-carbon hydrogen

% of respondents who see high potential for low-carbon hydrogen in their respective industries

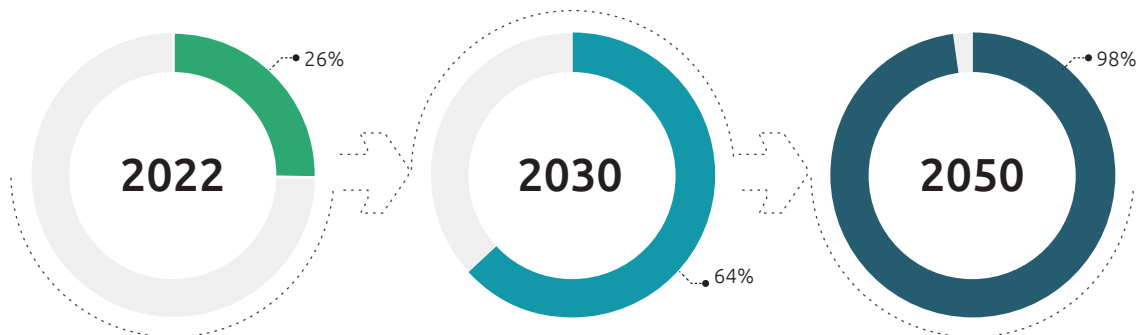


Note: Respondents from each sector answered about potential for their own industry only.
Source: Capgemini Research Institute, low-carbon hydrogen survey, November–December 2022; N=360 respondents from unique end-user organizations.

Investment in low-carbon hydrogen is on the rise

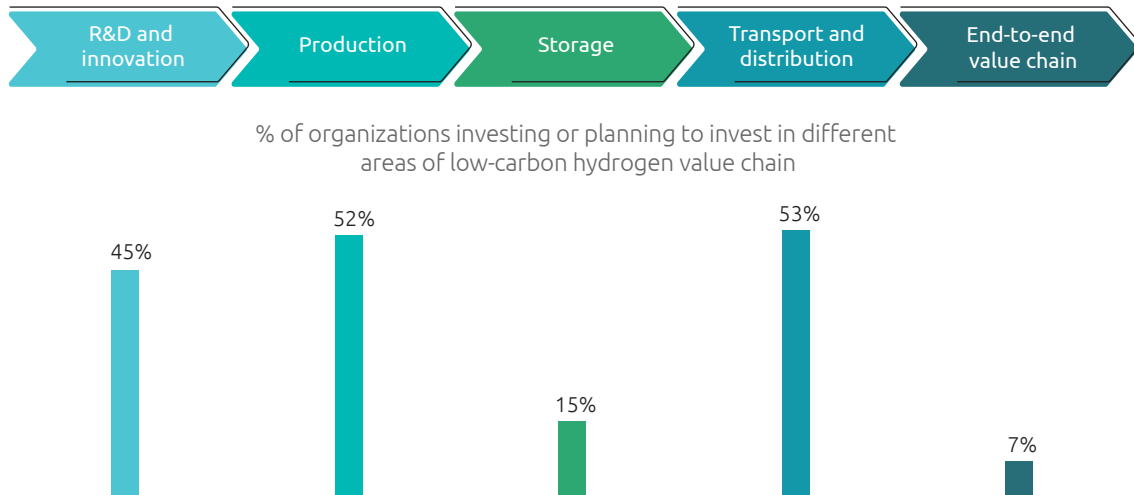
A majority of E&U organizations are planning to invest in low-carbon hydrogen initiatives

% of organizations that are investing/planning to invest in low-carbon hydrogen



Source: Capgemini Research Institute, low-carbon hydrogen survey, November–December 2022; N=447 respondents from unique energy and utilities organizations.

E&U organizations are making investments across the low-carbon hydrogen value chain



Source: Capgemini Research Institute, low-carbon hydrogen survey, November–December 2022; N=500 respondents from unique energy and utilities organizations.

Cost, engineering, and skills challenges are yet to be addressed

Cost Challenges

Low-carbon hydrogen is **2-3 times more expensive** to produce than fossil fuels

Engineering & Infrastructure Challenges

Half of E&U organizations rank **high energy consumption during production** as one of the top production challenges

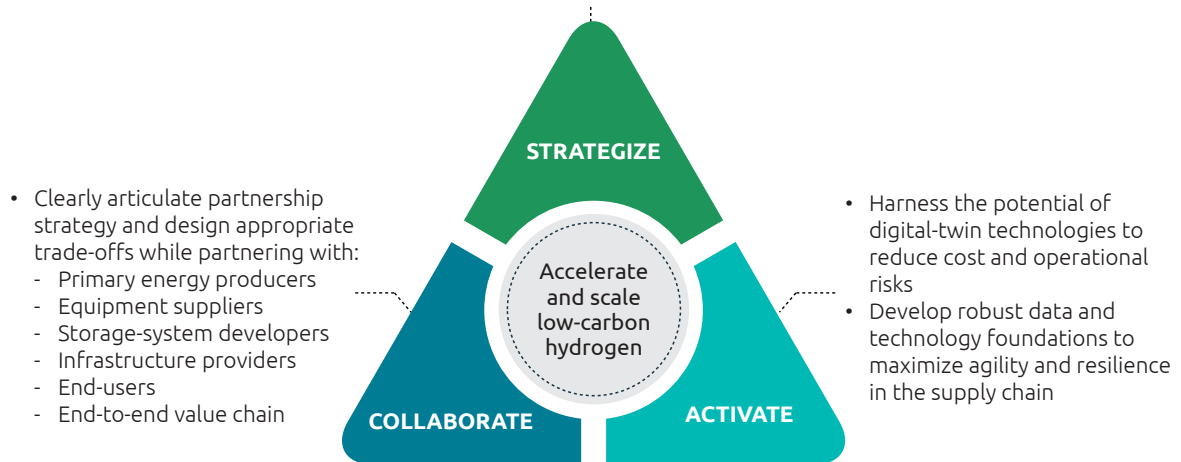
A majority of E&U organizations rank **safety concerns, specificity of storage conditions and insufficient existing hydrogen pipeline infrastructure** among the top challenges

Skills Challenges

Around half of E&U and end user organizations rank **lack of skills and expertise** among the top five challenges to scale hydrogen

Investment in low-carbon hydrogen is on the rise

- Tailor the business-case assessment to your organization
- Establish governance models to support new business models
- Establish hydrogen-competence centers for skills development



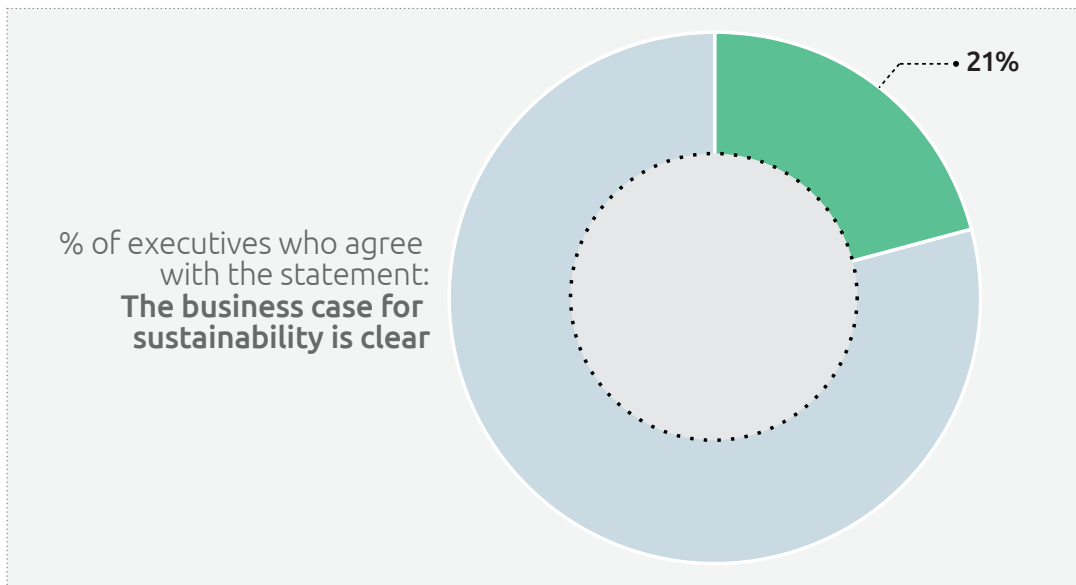
A WORLD IN BALANCE

WHY SUSTAINABILITY AMBITION IS NOT TRANSLATING TO ACTION

For details on the research methodology and to read the full report, please visit:
<https://www.cappgemini.com/insights/research-library/quantum-technologies/>

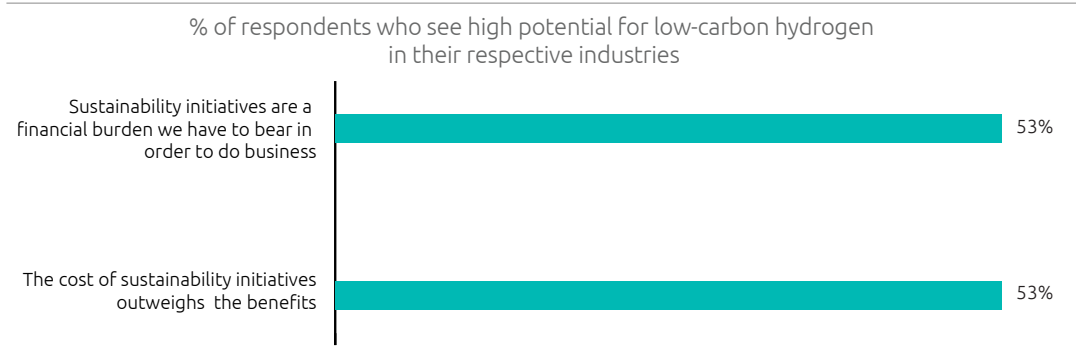
Organizations view sustainability as a cost driver, not an investment

The business case for sustainability is currently largely underestimated or misunderstood



Source: Capgemini Research Institute, Sustainability Transformation Trends Survey, August–September 2022, N = 2,004 executives, 668 organizations

Organizations often see sustainability initiatives as obligatory and unprofitable



Source: Capgemini Research Institute, Sustainability Transformation Trends Survey, August–September 2022, N = 2,004 executives, 668 organizations

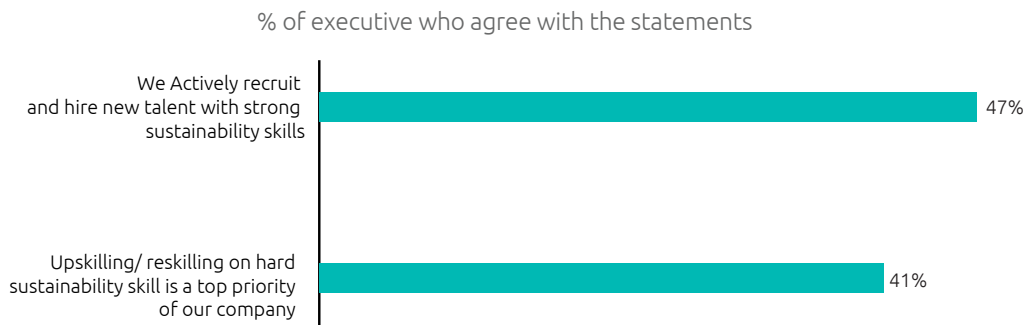
Our research suggests that environmental sustainability is financially viable

We identified a set of frontrunners, who have progressed further on their sustainability transformation than the rest of the companies we surveyed. One in ten organizations (11%) in our survey are categorized as a sustainability frontrunner. From 2020 to 2021, frontrunners realized:



People and culture challenges limit enterprise-wide collaboration and adoption

Less than half of organizations are focusing on sustainability recruitment/upskilling

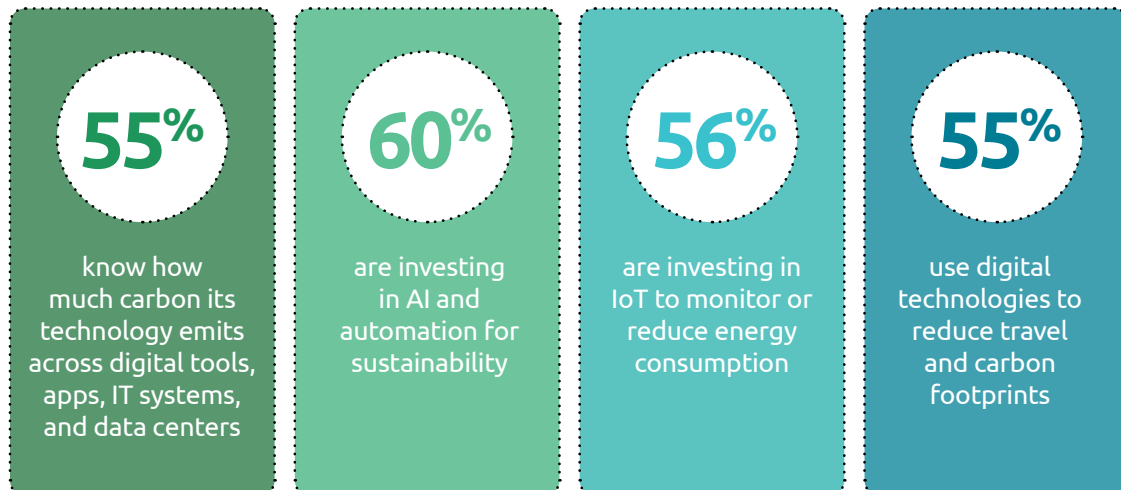


Source: Capgemini Research Institute, Sustainability Transformation Trends Survey, August–September 2022, N = 1,003 executives in corporate functions.

50% of respondents say that their organization provides autonomy to employees to develop solutions to sustainability challenges

About half of respondents say that their organization acts on the concerns of internal stakeholders when shaping sustainability initiatives

Some organizations are investing in technologies to limit environmental impact



How organizations can accelerate toward sustainability

This report shares recommendations for how eight C-suite positions can accelerate their companies' sustainability ambitions, which must be implemented in a combined, collaborative view:

- The CEO must make sustainability a business priority
- The CFO must articulate the business case for sustainability and ensure it is understood throughout the organization
- The CMO must implement protocols to avoid greenwashing sustainability credentials
- The chief design/product officer needs to embed sustainability as a core design principle
- The chief procurement/supply chain officer needs to work with suppliers to ensure they achieve sustainability goals
- The CTO/CIO must strengthen sustainable IT initiatives
- The COO needs to build the foundation of the sustainable organization
 - And, of critical importance, the CHRO needs to staff for sustainability, which requires new skill sets and a new leadership model.

We are grateful to all our guest contributors for sharing their experience and insights as well as to their teams and in particular Francois Jackow (Air Liquide), Domitille Fafin (Air Liquide), Christel Des Royeries (Air Liquide), Dr Frances Arnold (Nobel Prize laureate), Alexandra Palt (L'Oréal), Karin Svensson (Volvo Group), Anna Arbius (Volvo Group) Virginie Helias (P&G), Ana Sofia Hernandez (P&G), Johan Rockström (Potsdam Institute for Climate Impact Research), William McDonough (Cradle to Cradle), Celeste Weaver (Cradle to Cradle), Marcie Siegel, Ovais Sarmad (UNFCCC), Monica Gavriluta (UNFCCC), Emanuele Taddei(UNFCCC), Eliano Russo (Enel), Belén Alarcón Silva (Enel), Elisa Moioli (Enel), Nathalie Casas (Climeworks), Judith Hebekeuser (Climeworks), Claudia Garcia (Climeworks), Peter Reinhardt(Charm Industrial), Areeb Malik, (Glacier), Devon Wright(Lumo), Ask Helseth(Spoor), Iggy Bassi, (Cervest), Arielle Kouyoumdjian (Changing Planet Justice), Vinisha Umashankar (Solar ironing cart) and Rahmina Paullette (Kisumu Environmental champion), Emmanuel Fonteneau, Dany Tello, Lucia Sinapi, Priya Bohra, Andy Heppelle, Dylan Garrett for their contributions to the journal.

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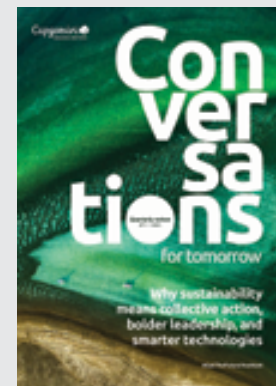
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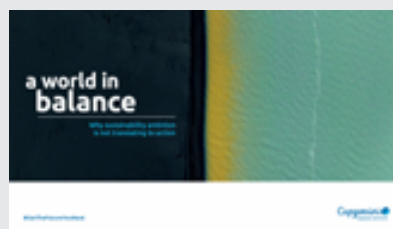
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