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# ESSENTIAL

FREUDENBERG SEALING TECHNOLOGIES



**SUSTAINABILITY**

**One Step Ahead**

**“THINKING LONG-TERM”**

Interview with the COO,  
Dr. Matthias Sckuhr

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**“SPARING NO EFFORT”**

A factory in the Black Forest wants  
to move away from fossil fuel.

**SOLVENT-EATERS**

How a billion bacteria are  
helping to keep the air clean.

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IN FIFTY WORDS



Any prudent company thinks about tomorrow. It plans ahead and doesn't sabotage its foundations with overexploitation. Sustainability involves more than ecology. It maintains complex systems: society, nature and the economy. How can we all be sustainable? How can we conserve energy? Resources? Let's think holistically and stay one step ahead.



# One Step Ahead

By Claus Möhlenkamp, Chief Executive Officer,  
Freudenberg Sealing Technologies

People say sustainability is becoming “more and more important.” I personally believe that statement is inaccurate. Sustainability has always been important. Perhaps we didn’t notice this. Or we didn’t consciously give the concept a name. It is in any company’s best interest to think about tomorrow and to ensure that its business model will continue to function in the future, to look ahead and steer clear of ruinous exploitation that would ultimately undermine its opportunities. The term “sustain,” the notion of keeping a functioning system up and running, is embedded in the word. Not just thinking about the next step, but maybe even the one after that. Always being a step ahead.

If you keep selling the same product until it is outmoded, if your company doesn’t look at the future and see the technological upheavals on the horizon, if your employees

overwork continually and deliberately, you may earn a short-term profit, but you will get a long-term problem in return. The same applies to farmers who overfertilize and erode their fields until they can no longer be farmed. From a purely economic standpoint, all of this might not seem very serious as long as new employees, fields and resources are available. And, let’s be honest: That is exactly how some people and entire companies have operated in the past – with the attitude that there is always more of something available. But we now see that this is not the case. If you treat people and resources as disposable, problems will catch up with you. Natural catastrophes, poverty, wars. The damage can be huge. Since the problems have many causes, we often overlook inter-connections and don’t feel responsible for them.

That’s exactly the problem: The economy, society and nature are complex systems. The science of sustainability describes what is happening today as “nonlinear interactions” that lead to emergent phenomena, that is, consequences that are in part unforeseeable. For example, they could involve changes in the Gulf Stream as a result of climate change. Or successful battles against illnesses could quickly lead to antibiotic resistance. Every company is likely familiar with unanticipated consequences from their daily operations. Decisions that seem to make sense at first suddenly cause a problem in an entirely different area. To maintain a complex system over the long haul, you have to keep making adjustments to

**If you treat people and resources as disposable, problems will catch up with you.**

it, repositioning it, and questioning the direction you are taking. By the way, all of this suggests that nothing is going to change if sustainability is purely seen as a marketing concept. Companies should not look for pretexts to declare their products “sustainable” just to attract new customers. That’s not the right way to look at this. The meaning of sustainability threatens to blur if it becomes window dressing or a promotional cliché. Nothing you do is sustainable if it is done casually or superficially.

With its 17 Sustainability Goals, the United Nations has made clear how comprehensively it views sustainability: The battle against hunger and poverty fall under the rubric of sustainability. So do more education, less inequality, better quality of life, a robust infrastructure and the idea of sustainable urban planning. In public debate, the term sustainability is too readily limited to what is generically known as “green.” It is actually more than that. “Sustainable development is development that meets the needs of the present without putting the ability to meet the needs of future generations at risk,” the UN’s famous Brundtland Commission on Environment and Development stated in 1987. That has been the most common definition of sustainability to date. The term “needs” is well-chosen. It highlights how quickly ill-considered acts can lead to a lack of basic necessities. It underscores something else as well: the fact that we are talking about all of humanity. Sustainability is a project for humankind.

Freudenberg Sealing Technologies has taken up the cause of reducing its carbon dioxide emissions by 30 percent by 2025 when compared to 2020 levels, in terms of tons of CO<sub>2</sub> per million euros of revenue.

This requires taking a holistic approach: eliminating waste, reducing energy consumption or employing alternative forms of energy, adopting sustainable materials, and using water more efficiently. We want to conserve resources ourselves – even as we develop products and solutions that help our customers operate more sustainably. Incidentally, the example shows that sustainable actions have a certain domino effect. We all influence one another. The stories in this issue of ESSENTIAL explore just how multifaceted sustainability is, what projects are already underway and why it pays to be thinking at least one step ahead. ©

**Sustainable actions have a certain domino effect. We all influence one another.**

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## The Nuclear Option

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For many countries, the nuclear reactor accidents at Chernobyl and Fukushima have led to a loss of confidence in atomic energy. Yet many countries continue to rely on it. 57 nuclear reactors are currently under construction worldwide and another 97 are being planned. This powerful technology has picked up momentum over the course of the current climate protection debates. At the start of 2022, the European Union decided to classify certain nuclear power plants as sustainable. Even if nuclear energy creates fewer CO<sub>2</sub> emissions than fossil energy sources, the disposal of highly radioactive atomic waste remains unsolved. To date, no country has established a secure final disposal site. Future generations will inherit the problem of nuclear radioactivity. This conflicts with the very concept of sustainability. ©



## Multifaceted

Sustainability calls for more than just reducing carbon dioxide emissions – it involves an entire range of societal measures. In 2015, the United Nations set 17 goals for sustainable development. They included high-quality education and gender equality, along with humane work and economic growth, as well as peace, justice and strong institutions. The last objective involves efforts to sharply reduce all forms of violence and to guarantee public access to information, the rule of law and equal access to justice for all. That is exactly what Portugal's population experienced after 1974. That was when the "Carnation Revolution" by democratically-minded troops ended a 42-year dictatorship, which was marked by the arbitrary rule of the country's notorious secret police, PIDE. ©



## Weighty Matters

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During times of low interest rates, sensible, alternative ways of investing savings are in demand. Fund savings are a popular option. More and more Environmental, Social and Governance (ESG) funds are now recruiting savers. In making their investments, they sell financial products that are aligned with environmental and societal criteria as well as responsible company management. In the fall of 2021, the financial information company Morningstar put the global wealth invested in sustainable funds at about U.S. \$4 trillion. That gives investors a substantial lever to press for more sustainability in the economy. The more importance that ESG factors gain in the investment sector, the more important transparency and mandatory standards become. For example, there are still ESG funds that do not exclude investments in fossil fuels. ©



# “To Us, Handprints Are Important and Integral”

*Sustainability is the key. More and more companies are understanding this. But what's the most sensible way to achieve carbon neutrality? We talked with Dr. Bilguun Bayarmagnai, Head of Corporate Sustainability, about the resolute course the Freudenberg Group has charted.*



## Dr. Bilguun Bayarmagnai

Dr. Bilguun Bayarmagnai, who holds a PhD in chemistry, was born in Mongolia in 1988. When he was a young child, he accompanied his mother on her relocation to Germany for her studies and found a new home there. He joined Freudenberg after earning his doctorate and completing a research assignment at CaRLa – Catalysis Research Laboratory – in Heidelberg. Since 2020, Bayarmagnai has been Head of Corporate Sustainability for the Freudenberg Group and, as a strategic guide, coordinates a project called “Sustainability Drives Climate Action” on behalf of all 11 Business Groups.



**DR. BAYARMAGNAI, WHAT DO YOU PERSONALLY ASSOCIATE WITH SUSTAINABILITY?**

Living responsibly. It is a matter of a conscious, well-thought-out approach to our resources. Especially as a father, it is important to me to be fair to the coming generations. That also means doing without.

**WHAT ARE YOU THINKING ABOUT HERE?**

Turning more to seasonal foods. Eating less meat. But also repairing instead of discarding. My children's clothing is handed down from their cousins. We borrow books at the library. You don't have to own everything. You don't have to buy everything new. If something is manufactured, we should get the maximum use out of it.

**AS A CHEMIST, HOW DO YOU DEAL WITH SUSTAINABILITY?**

I am fascinated by it. I associate it with innovation and efficiency. In my PhD thesis, I dealt with the development of sustainable methods to produce substrates resembling active agents. I worked with a hydrofluorocarbon gas. It is a waste product generated during the production of Teflon. It is difficult to discard. It is 14,000 times more harmful to the climate than CO<sub>2</sub>. So how do you deal with a byproduct of this kind in a constructive way? By binding the gas and transforming it, a waste product harmful to the climate is transformed into a valuable active substance.

**WHAT ROLE DO SCIENCE AND ENGINEERING PLAY IN THE EFFORT TO ACHIEVE RESOURCE EFFICIENCY AND CLIMATE-RELATED GOALS?**

In my view, we are unable to achieve CO<sub>2</sub> neutrality without technical innovations. Science must generate knowledge which experts in the corporate sector can turn into innovative products. The interplay of science and engineering is crucial to meeting the challenges of the future.

**WHAT CHALLENGES ARE YOU REFERRING TO?**

The reduction of CO<sub>2</sub> and methane emissions in farming. The even more efficient generation of electricity from solar, wind and water power. Green hydrogen and electromobility as well. In the transportation sector, cars account for 47 percent of CO<sub>2</sub> emissions, trucks for 30 percent. Electric vehicles will have a positive impact even when they use fuel cells, assuming that the electricity and hydrogen are generated with renewable



The technologies are ready. We must resolutely adopt them. We cannot wait until better ones are available.”

energy. The technologies are ready. We must resolutely adopt them. We cannot wait until better ones are available. Considering the well-documented evidence of climate change, that would be a risk for our planet.

**SUSTAINABILITY FOUND ITS WAY INTO THE ECONOMY A LONG TIME AGO. WASN'T IT ALWAYS A DRIVER FOR COMPANIES OR DO YOU SEE A NEW ASPECT TODAY?**

I assume that most companies act responsibly. But I actually have the impression that sustainability has become even more important in recent years. The planet is heating up. Climate change is becoming more urgent. The public has a greater expectation of climate-friendly behavior. People are confronting companies directly.

**WHY IS SUSTAINABILITY SO IMPORTANT TO FREUDENBERG?**

Because it has always been important. Even if the term is new, sustainability is an integral component of our activities. Our guiding principles and values emphasize the importance of assuming responsibility for society.

**WHAT DOES FREUDENBERG SPECIFICALLY MEAN BY SUSTAINABILITY?**

Resource efficiency in energy and materials. Our idea of sustainability is strongly influenced by the UN's Brundlandt Report from 1987. It is a matter of being fair to future generations in our handling of resources. On this basis, we forged a common understanding of sustainability among all our business groups in 2015. There are two main dimensions in our strategy: First of all, minimizing our use of resources, our footprint. Secondly, using our products to maximize our customers' resource efficiency, that is, optimizing the handprint.

**WHAT DOES THE FREUDENBERG GROUP'S ROAD TO CO<sub>2</sub> NEUTRALITY LOOK LIKE?**

By 2025, we want to reduce our CO<sub>2</sub> emissions by 25 percent based on revenue. In 2045, we want the entire Freudenberg Group to be carbon neutral. To achieve this, we have looked at and analyzed various levers over the last two years and set our course. Our program, "Sustainability Drives Climate Action,"

consists of four steps: reduction, electrification, green electricity, and climate offsets.

**WHAT EXACTLY DOES THIS MEAN?**

We first reduce our energy consumption and our CO<sub>2</sub> emissions by boosting our efficiency. We also want to electrify our technologies, minimizing our dependence on fossil-based energy, whenever possible, using green electricity that we either produce ourselves or purchase. We turn to offsets to cover everything that we still lack to achieve carbon neutrality. At present, we are focusing on the first three steps, since they are in our own hands.

**HOW HAS FREUDENBERG MANAGED TO BECOME MORE ENERGY-EFFICIENT?**

With "Bee," our "Be Energy Efficient" project. As part of "Bee," teams analyze our facilities holistically. In the process, they continually ask themselves: What is the maximum level of energy efficiency that the site can achieve? The analysis results in a "to do" list of measures to take so we can reach this level.



For example, we achieve very rapid results with heat recapture and the management of machine shutoffs. The same is true when we use our many air compressors more efficiently or acquire more efficient equipment that better fits our current requirements. With “Bee,” our facilities are scrutinizing their use of machines and energy consumption. We see potential savings averaging 25 percent in this area.

#### HOW IS THE ELECTRIFICATION GOING?

We are checking to see which technologies use fossil fuels in our manufacturing operations and examining whether there are electric alternatives for them. Here electrification only makes sense if green electricity is available. It’s very difficult to electrify processes involving flames in production facilities. So we have to find alternatives.

#### WHAT WOULD THOSE BE?

Sticking with the technology, but using the most efficient equipment. Or optimizing processes. Consider the thermal afterburner as an example. At the end of a process, it incinerates chemical solvents and their gases. If we develop the process to the point where we don’t use solvents, we won’t need an afterburner.

#### THERE IS STILL GREEN ELECTRICITY.

We have a team that is keeping an eye on its availability in individual markets and makes proposals on what we should do. One tried-and-tested approach involves bilateral long-term contracts with green electricity providers. By guaranteeing the volumes we are willing to buy, they can invest in their expansion.



Green electricity is not available to the same degree everywhere. There isn’t even a price for CO<sub>2</sub> everywhere. We consider this in our strategy. We have to reshape the situation.”

#### ARE ALL FREUDENBERG’S BUSINESS GROUPS ON THE SAME PATH TO CARBON NEUTRALITY?

The four-point plan applies to everybody. All are obligated to minimize the use of fossil fuels in manufacturing and to use green energy. But the forms and volumes of energy that are used vary considerably from group to group, since they depend on different production processes. So we leave it to them to choose a path and set the pace.

#### POLITICIANS ARE NOT SETTING THE SAME STANDARDS AND INCENTIVES FOR CLIMATE MEASURES EVERYWHERE. HOW IS FREUDENBERG TAKING COUNTERMEASURES IN LIGHT OF ITS MORE THAN 200 PRODUCTION SITES WORLDWIDE?

Green electricity is not available to the same degree everywhere. There isn’t even a price for CO<sub>2</sub> everywhere. We consider this in our strategy. We have a way to reshape the situation. How? Wherever there is no CO<sub>2</sub> price, we internally calculate 25 euros per ton of CO<sub>2</sub> output. This allows the energy savings to more quickly amortize the investment. Sustainable investments thus pay off for our facilities in situations where no price has been set for CO<sub>2</sub>.

#### GOALS ARE ONE THING. SHOWING THAT THEY HAVE BEEN ATTAINED IS ANOTHER MATTER. HOW IS FREUDENBERG PROCEEDING IN THIS AREA?

It is important to measure our progress verifiably and make it transparent. This is important for our credibility and helps us with our internal controls. It is the only way to see whether we are moving at the right pace and are keeping an eye on our goal. Our facilities will become more efficient with these measures, and we want to show this. This year we started using a new tool for sustainability reporting to allow external auditors to check and confirm our key figures.

#### WHAT DO CUSTOMERS EXPECT FROM FREUDENBERG’S BUSINESS GROUPS WHEN IT COMES TO SUSTAINABILITY?

Customer requirements have risen quantitatively and qualitatively in the last few years. This is reflected by the bidding processes. You are only considered if you have met certain sustainability criteria. For this reason alone, it is important to have a special strategy and reporting tool with verifiable data. We sometimes have very specific requirements. They range from the purchase of renewable energy and the proportion of recycled materials to the reduction of scrap. The amount of CO<sub>2</sub> that our products release “baggage” over their entire lifespan is also of interest. In the end, the standards vary from customer to customer and from market to market. You find the most specifications and inquiries where customers have the highest expectations.

#### HOW DOES FREUDENBERG AFFECT ITS CUSTOMERS’ HANDPRINTS?

First of all, handprints are an important and integral component of product development. For each product, we ask ourselves how we can maximize its handprint. We make sure that we look at sustainability comprehensively and especially from the standpoint of the customer. This can be seen in the sealing and compressor solutions that one of our groups develops. They make it possible to significantly reduce methane emissions. The savings potential is the equivalent of several million tons of CO<sub>2</sub>. Another Freudenberg group recycles several billion PET bottles per year, keeping about 150 kilotons of CO<sub>2</sub> out of the atmosphere. Freudenberg Sealing Technologies is setting a very good example by focusing on the reduction of friction, CO<sub>2</sub>, size and weight. Our customers appreciate this. ©

To slow the evaporation of costly drinking water, the operators of this reservoir have created a protective layer consisting of countless small plastic plates.

# Troubled Waters

*Many cities are increasingly having problems with water. Sometimes water supply is dangerously scarce. At other times, heavy rains lead to flooding. Caught between these contradictory situations, metropolises are seeking solutions. 'Sponge cities' could be an answer.*

One-quarter of cities with a million or more inhabitants are doomed to have problems with their water supply. Each year, they use more than 80 percent of their available ground and surface water. An international team of researchers arrived at this finding back in 2014. In the last few years, metropolises such as Los Angeles, Mexico City, Cape Town, Chennai and Beijing saw what happens when water runs low. Water-related stresses in urban areas have diverse causes: waste, outmoded infrastructure, mismanagement, population growth and drought.

## **Plastic Balls, Seawater Desalination and an Iceberg**

The cities are tackling the problems in very different ways, and few are sustainable. In Los Angeles in 2015, authorities arranged for several million black plastic balls to be dumped into the Sylmar reservoir. The balls were supposed to prevent the evaporation of the costly liquid after several years of drought. The officials later put the savings at about 1,150,000 cubic meters (about 304 million gallons) of water per year. Researchers at the Massachusetts Institute of Technology (MIT) made their own calculations. Their conclusion was that just the production of the apple-sized plastic balls would have consumed about 2,900,000 cubic meters (766 million gallons) of water.



## 2.5 million

Cape Town, South Africa, was hit by a water shortage in 2018. After three years of severe drought, the most important reservoir for the city and its millions of inhabitants held only 10 percent of its capacity. In response, the city administration ordered steep cutbacks on water use. Even a shutoff of the water supply seemed possible. The city took other steps as well. It collected groundwater, ordered the recycling of industrial water and urged residents to limit their consumption. In addition, farmers diverted their water supplies into a reservoir. These measures and the arrival of rain ultimately defused the situation. One sign of the utter desperation was the idea of a South African shipping expert to tow an iceberg to the Cape Town area from Antarctica, which is about 3,000 kilometers (1,800 miles) away. This would have guaranteed up to 150 million liters (nearly 40 million gallons) of water a day over the course of a year. On the other hand, the city authorities began to build systems to desalinate seawater. The approach is indeed used worldwide, but it is expensive and energy-intensive.

### Water from the Ground and by Train

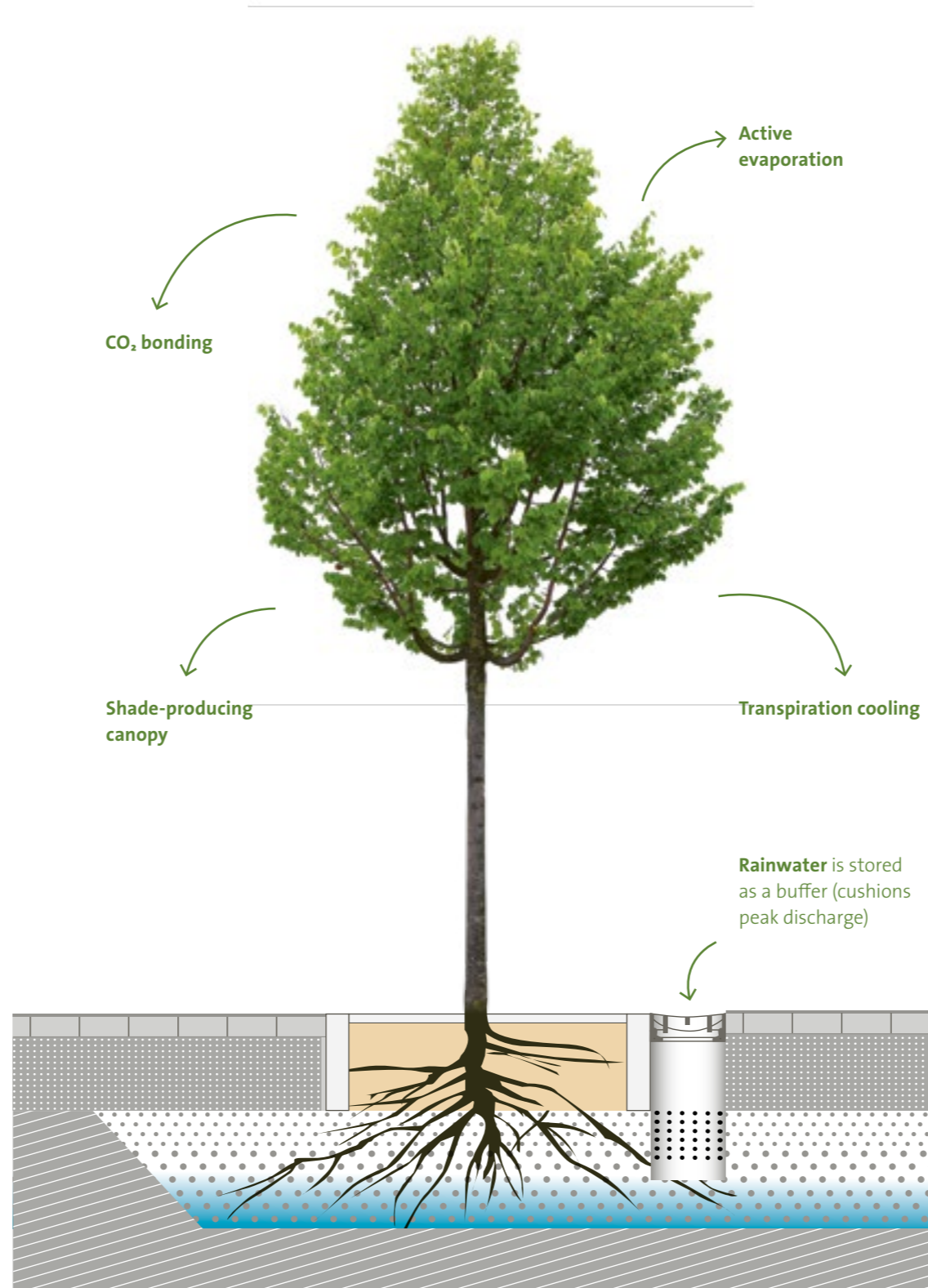
Along with drought, massive growth in the city's population contributed to the crisis. Like Cape Town, other cities responded to the trend by exploiting their groundwater. The example of Mexico City shows what can happen. The earth dries out and parts of the city sink. In the area around the cathedral, the ground is said to have sunken about 12 meters (39 feet) in the last 150 years.

Thanks to the monsoon, India has abundant water. Between June and September, it delivers 75 percent of the

liters. At times, trains have carried this amount of water to Chennai, India, from a reservoir 2,000 km kilometers (1,200 miles) away. The transport was designed to alleviate a water emergency in 2019.

annual rainfall in this populous country. But if it ever becomes less plentiful, serious consequences will loom for the water supply to the country's many cities with a million or more inhabitants. In 2019, Chennai, once known as Madras, saw the results of several periods of inadequate rainfall. When the supply of stored water was nearly exhausted, trains brought in 2.5 million liters (660,000 gallons) of water each day from a reservoir 200 kilometers (124 miles) away. Just four years earlier, Chennai was literally under water after severe rainfall.

Chennai serves as a bellwether for more and more cities that will have to adapt to extreme weather. Climate change is reducing the temperature difference between the two poles and the equator. This is calming the jet stream and high and low pressure areas are moving more slowly due to weakening winds at high elevations. The result: These conditions remain longer above a region and can thus produce extreme aridity or heavy rainfall. In addition, as temperatures rise, clouds absorb more moisture, which can result in more precipitation.



### 'Sponge Cities' for Water Storage

More and more cities will have to learn to deal with water shortages and heavy rains. Their structures are compact and cover the earth, causing them to heat up very quickly. Yet severe cloudbursts quickly overwhelm their drainage systems, since they are not designed to drain away large amounts of rainfall. 'Sponge cities' are a possible solution. They are designed to absorb huge quantities of water like a sponge and release it later. This requires subterranean drainage and storage, along with water-permeable ground covering and tree trenches. In these trenches, cities plant trees whose root systems tolerate water temporarily stored around them. All of this requires costly, well-planned reconstruction.

It is easier to plan for retention basins and open spaces that can store precipitation when new neighborhoods are created. Low-lying sports fields can be temporarily flooded. Sponge cities also become greener. In addition to the creation of new lawns and parks, façades and roofs are covered with greenery. They absorb rainfall – they don't just

drain it away like conventional roofs and cement façades. They also give off moisture through evaporation and make a city's climate more comfortable.

Those responsible at the city of Hamburg view the idea positively. They even have a plan to landscape about two-thirds of all the city's roofs to catch 60 percent of its precipitation. For every construction project, the Danish capital Copenhagen precisely specifies how much water the built-up surfaces have to hold. For several years, 30 metropolises in China have been pursuing the 'sponge city' approach. Someday 70 percent of their rainwater is supposed to be captured and reused – or permeate the landscape. Beijing, which was hit by severe flooding in 2012, is among those 30 cities. And yet the capital is located in the country's arid north, which is why the World Wide Fund for Nature (WWF) called it one of the world's 20 megacities that are especially susceptible to water-related stress. The concept of a sponge city could help Beijing manage its rare heavy precipitation and make the water available during dry periods. An ambitious, if certainly sustainable, plan, indeed. ©

Trees are important for sponge cities. Inlet systems for precipitation can help drain water away efficiently. A number of ground layers store water as trees evaporate it.

# A Billion Microorganisms

*They cannot be seen with the naked eye. Yet they do important work at Freudenberg Sealing Technologies in Germany. The bacteria that are part of Reichelsheim's bio exhaust air system protect the environment from solvent vapors.*

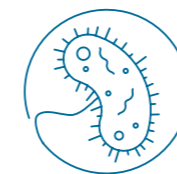
Gray on the outside, a spectacle on the inside: bacteria devour solvent vapors in Reichelsheim.

**A** billion bacteria are bustling around. They work day and night, filtering the exhaust air from the production area. These creatures, microscopically small, cannot be seen with the naked eye. Even their home cannot be viewed from the outside. The microorganisms live in containers filled with layers of cattle mulch. This bio exhaust air treatment system at the Freudenberg Sealing Technologies site in Reichelsheim is located right behind the factory hall.

**Bacteria Produce Clean Exhaust Air**

The biological system has been filtering exhaust air at Reichelsheim for 10 years. Without it, there would not merely be unpleasant odors permeating

the environment – another advantage is that it uses significantly less energy than other options. “For us, this made a lot of sense. We use large quantities of organic solvents that are nonetheless readily water soluble,” said Annette Reisner-Schaab, who has been in charge of environmental issues and job safety for 15 years. “These solvents have to be broken down.” Among other products, the Reichelsheim facility makes seals consisting of a metal or plastic carrier part and an elastomer. To make sure the elastomer adheres to it, the carrier part has to be cleaned, coated and dried. The process produces solvent vapors that can only be released into the environment in strictly regulated amounts. “Production has risen sharply. So has our use of sol-



**4 years**

That is the length of time that the bacteria live in the containers. Then the biomass is recycled and replaced.



It takes teamwork to protect the environment: Ralf Schmid, Annette Reisner-Schaab and Dr. Clemens Elliger (from left).

vents, unfortunately,” Reisner-Schaab said. In 2011, the environmental engineer and her team studied different ways to solve the problem. Could the amount of solvents be reduced or could the processes possibly be outsourced? What technology could be used to eliminate the emissions? “In terms of operating costs, it was quickly clear to us that the biological option would be the best,” she said. “For anything else, we would have needed more energy.” For example, if the exhaust air were burned with the help of natural gas, more CO<sub>2</sub> emissions would have been produced and higher costs would have resulted.

**A Godsend for Hungry Microbes: Solvents**

This biological solution gets by with less energy. Once it is connected, the system does its job almost independently. The streams of exhaust air first run together through an active carbon filter before a scrubber moistens them. The moist air is then distributed over the cattle mulch mixture in the large containers. The air literally serves up the microorganisms’ next meal. “The bacteria like our exhaust air,” Reisner-Schaab said. They separate the carbon compounds into water and carbon dioxide and use the energy to expand their population. The filtered exhaust air ultimately goes up a chimney



Clean solution: Biological exhaust air treatment spares the environment and reduces operating costs.



The biological system is alive: To keep it that way, it has to be kept moist.



**Prof. Dr.-Ing. Franjo Sabo**

Back in the 1980s, Franjo Sabo was already developing high-performance biofilters for his doctoral work. Today he is the CEO of Reinluft Umwelttec, a professor at the RheinMain University, and a member of various expert committees such as those of the Association of German Engineers.

and reaches the outdoors. The process mimics what would occur in nature – except that the unit makes it more concentrated and controlled.

But this bio-solution requires space. While an incinerator can burn different quantities of exhaust air, the ratio between the bacteria and the solvent must be carefully calibrated. More solvent also means more bacteria and that, in turn, means more containers. The benefit: This gives the plant flexibility: “We can respond quickly and effectively when the capacity changes,” said Reisner-Schaab. “For example, if we were to have less solvent or more watery processes, we could cut out one of the containers and return it to the manufacturer.”

**High Tech to Handle Exhaust Air**

A company called “Reinluft” is the system’s manufacturer. Prof. Franjo Sabo, the company’s Managing Director, has been supplying bio exhaust air systems to customers like Freudenberg Sealing Technologies for nearly 40 years. “The unit in Reichelsheim is quite well developed,” he said. Future generations of the system will be more heavily automated and more easily monitored, he said. Especially when it comes to ways to keep the moisture level constant, Sabo explained that “it is hard to believe how difficult it is, even in the 21st century, to keep compost moist. It is one of the biggest challenges.” That’s because the biological mass is a living, nonlinear system and is more difficult to control as a result.



**Annette Reisner-Schaab**

Annette Reisner-Schaab has worked on environmental issues and occupational safety at Freudenberg Sealing Technologies for fifteen years. She is in charge of the area of Health, Safety & Environment at the Reichelsheim facility.

“During manual maintenance, the technician takes a sample of the material and looks to see whether everything is in order. Now you have to imagine how a computer could manage that.” Sabo and his team have developed an automated control system that responds to all the metrics within the unit and provides feedback via a traffic light-type signal.

**Is Compost Being Replaced?**

Reinluft is focusing on another idea as well: alternative carrier materials for the bacteria. “The compost and the bacteria are an absolutely well-established technology,” Sabo said. “But as an engineer, you ask yourself whether you might be able to get away from the compost and move to a standardized material.” A carrier material like plastic could take up less space than the biomass, which has to be changed every four years. Here Sabo sees opportunities for markets outside of Europe. “Interest in bio exhaust systems is growing quickly in response to global pursuit of sustainability,” he said. “The technology is enormously

popular in China. The problem is that there is almost no compost material there.” Shipping large quantities of compost would be complicated and expensive. As long as alternative carrier materials have not become fully mature, the world will continue to turn to this well-established combination.

**Biological Systems are Booming**

Reichelsheim’s system has become an internal benchmark within Freudenberg. “As sustainability has taken on increasing importance, we have been fielding more inquiries from our colleagues in Germany and abroad,” Reisner-Schaab said. She has already introduced the plant’s system to various visitors. She has also noticed a growing consciousness of the climate and environmental protection. “The approach to sustainability has become broader. It increasingly involves what is happening in the value creation chain before and after production. The question of the CO<sub>2</sub> footprint for each individual product will soon be asked.” ©

# “Dance — Or the Lights Will Go Out!”

*Coldplay took two years to plan a sustainable world tour. The result: the “Music of Spheres” tour of 2022. The British band is traveling halfway around the world on the tour — with half of the CO<sub>2</sub> emissions.*

The crowd trembled. Chris Martin was off and running. While the Coldplay front man was jumping into the air with his legs crossed, confetti fountains next to him erupted into the air. What seemed like a grand finale was just the kickoff to the band’s “A Head Full of Dreams Tour” in 2017. For two decades, Coldplay has thrilled its fans with live concerts worldwide. It has filled even the largest stadiums with its concerts. A laser show, fireworks and huge video screens are standard performance fare.

After the release of its “Everyday Life” album in 2019, Coldplay’s global fan base received a shock: The British band announced that it would not be going on tour for now — for the sake of the environment. In an interview with the BBC, the lead singer Chris Martin explained that they would only begin touring again when concerts became more sustainable. The band planned to take one to two years to make this happen.

#### More Than Just PR

It was not the first time that Coldplay had championed climate issues. For example, the band promoted forestry projects on its CDs before sustainability became a household word. Doubts were voiced in the music world after the decision not to tour. Would Coldplay actually succeed in touring the globe without damaging the world’s climate? After all, world tours are not exactly known for their sustainability. On the contrary, many of their features leave an ecological footprint behind, ranging from electricity for the stage, to air travel to the venues, to catering and merchandise. When 11 Live Earth concerts promoted climate protection worldwide in 2007, the German news magazine “Der Spiegel” closely scrutinized the flipside of these benefit events and put the concerts’ combined CO<sub>2</sub> footprint at 110,000 tons. That corresponds to the CO<sub>2</sub> emissions generated by 20,000 people annually. The most recent Coldplay tour in 2016 and 2017 drew about five times as many spectators as the Live Earth concerts. It can be assumed that their CO<sub>2</sub> emissions were accordingly much greater.



Coldplay has geared its world tour to sustainability: Jonny Buckland, Chris Martin, Guy Berryman and Will Champion (from left).

#### Kickoff in Costa Rica

But now the band has kept its word: This year, Coldplay is heading out on a world tour again — with the idea that CO<sub>2</sub> emissions need to be cut in half compared to its last tour. In addition, some of the concert income is used to fund other environmental projects. For example, for every ticket sold, a tree is planted in Brazil, the Andes or in Haiti. The “Music of Spheres” tour started in Costa Rica on March 18. It’s a symbolic beginning: Throughout the world, the Central American country is considered a pioneer in the protection of the climate and the environment.

#### Protecting the Climate Around the Globe

“I really need you to jump up and down. Because if you don’t, the lights go out.” When Chris Martin



The “Music of Spheres” tour is expected to cut emissions by 50 percent and set new standards.

calls for his audience to dance during the current world tour, it’s not just out of pure pleasure. There is a kinetic floor at Coldplay concerts. When people jump, they generate energy. And that keeps the concert going. The band is also relying on renewable energy stored in batteries developed especially for the tour. They are developed from recycled batteries from electric vehicles. The show itself is supposed to be staged nearly climate-neutral. Coldplay also motivates the audience to embrace sustainability. A discount code awaits fans who can prove they arrived at the concert by bicycle or train. A tour app is designed to record the arrivals. Biodegradable confetti and multiple-use – not single-use – products are available on site. Visitors can bring their



The 12-point plan of the “Music of Spheres World Tour”: <https://sustainability.coldplay.com/>



beverage bottles from home and fill them up at water dispensers. The band has also designed its own travel to be as sustainable as possible. Accordingly, the concert route is mapped out to minimize the amount of air travel. When flights are unavoidable, the band turns to CO<sub>2</sub> compensation and to bio-jet fuel to power the plane. All the details can be reviewed in the 12-point plan that an expert team has developed for Coldplay.

#### There’s Even More?

Climate researchers at the Imperial College in London are accompanying the tour to evaluate the band’s measures. One of them is Jem Woods. In a blog article for the college, he explained that he especially sees potential in the concerts’ broad reach. The message of sustainability is making it into the headlines and resonating. He hopes that Coldplay can be a template for other bands and that it will set new standards in the music and entertainment industry with its concept.

Nonetheless, Coldplay has been exposed to criticism. The burning issue is whether the band – whose last tour included 114 shows and was among the most commercially successful tours of all time – would not succeed in cutting emissions by more than one half. In an interview with BBC Radio 2, Martin accepted the criticism and admitted that the concept is far from perfect. But the band is making a commitment to do everything in its power to make the tour as sustainable as possible and to share what it has learned along the way. That, too, is sustainability: rethinking processes and demonstrating the courage to attempt what is purportedly impossible. ©



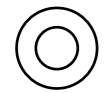
## BY THE NUMBERS

# 72 Percent



Almost three-quarters of the world’s population considers climate change to be a major problem. That’s the finding of a Pew Research study conducted in the fall of 2021. Now, the world has always been difficult to survey. In reality the responses came from 16 industrial nations, ranging from Canada and Spain to Singapore. So 178 countries were missing. Nonetheless, the numbers matched earlier results. In 2018, people from 26 countries, including Kenya, Indonesia and Tunisia, were surveyed, and 68 percent of the respondents saw climate change as a “very big problem.” In 2020, Oxford University surveyed more than 80,000 people in 40 countries. In this case, 90 percent of the people in Chile and Kenya saw climate change as a “difficult problem,” though the figure for Norway and the Netherlands was just 40 percent. But although the results are very clear, it seems that a much lower percentage of people are ready to make changes in their lives. There are statistics for that, too: In surveys, people admit that they are doing too little to prevent climate change. One reason is related to psychology. For example, the “normalcy bias” allows us to believe that an unprecedented catastrophe is not likely to occur. Statistically speaking, that bias affects 70 percent of the population. ©





## Every Color Is Green

*The fashion industry is not exactly a poster child for sustainability. The proportion of synthetic fibers it uses is actually increasing. Yet, alternatives such as biologically-based plastics already exist. And some manufacturers are ready to head in more original directions.*

Dries quickly, based on castor oil: the “Skarvan Biobased Pants” from VAUDE



“Once again, sustainability is not a priority this season. Why is that?” the fashion magazine Vogue wrote in the spring of 2021. Despite a range of voluntary commitments to climate neutrality by 2050, hardly a brand has actively promoted the issue or taken the initiative. By 2030, the industry’s CO<sub>2</sub> emissions are projected to rise to nearly 3 billion tons of CO<sub>2</sub> per year, largely because the annual volume of new clothes and shoes keeps rising to dizzying heights. Furthermore, more than 70 percent of the sector’s emissions are released during the production of its raw materials. One striking feature: The use of plastics in textiles has doubled over the last 20 years. In 10 years, about three quarters of all the fibers in our clothing could be synthetic, according to estimates.

Synthetic, meaning made from petroleum. A large share of our plastics are still produced using oil. It is not just that fossil materials are being consumed – CO<sub>2</sub> emissions are being produced as well. There could be alternatives: One involves plastics made from agricultural materials. Even if they are incinerated at the end of their life, they release only the CO<sub>2</sub> that the plants stored away as they were growing.

### A Special Plant

But bioplastics have their own sets of problems. They are often based on plants such as maize, sugar cane or sugar beets. These are foodstuffs that could be used in other ways, and their cultivation consumes a great deal of water. Climate-neutrality is indeed the result, but the approach is not necessarily “sustainable.”

This is where the castor beans come into play. Castor beans grow in arid regions and require comparatively



102

million tons of clothing are projected for production in 2030. The figure is currently 62 million.

little water. But the plant is basically unfit for consumption by humans and most animals. Some of its contents are even poisonous. Oil can be extracted from their seeds, about 500 to 2,000 liters per hectare (about 53 to 214 gallons per acre). In ancient times, castor oil was used in medicines and cosmetics. A polyamide that is a high-performance plastic can be produced from the oil with today's methods. Some time ago, the chemical company Evonik found castor oil to be an alternative raw material and is introducing a polyamide called Vestamid Terra that is based on it.

#### Breathable, Robust and Elastic

But can biologically-based plastics actually replace conventional plastics? All plastic is not alike. In most cases, there are very specific requirements to meet. A plastic fiber in the clothing industry, for example, should feel pleasant on the skin and be breathable, among other characteristics. This applies even more to the outdoor industry, whose trousers and jackets have to fulfill very specific purposes. They must be robust, watertight and stretchable. So do customers have to accept compromises to save their ecological consciences?

The answer is no, according to the outdoor outfitter VAUDE after experimenting with Vestamid Terra. It is somewhat impressed already. "This plastic is not just more sustainable – it also has better characteristics than conventional polyamide material," said René Bethmann, Innovation Manager Materials and Manufacturing at VAUDE. Its moisture manage-

ment, wearing comfort and antistatic behavior to resist bacteria are at least equal, and in some areas even better than the typical petroleum-based plastics. Vestamid Terra absorbs less moisture and is well-suited for hiking through wet grass or for protection during a short rain shower. In what was an unusual step for the industry, VAUDE contacted Evonik directly about the material. In 2021, the first trekking trousers were introduced under the trade-name Skarvan Biobased Pants, and a second line of jackets and trousers has already come out.

#### Leaving the Well-Trodden Path

VAUDE didn't just happen to take the initiative. Under CEO Antje von Dewitz, the outdoor brand has charted a clear course toward sustainability. Bioplastics are a good fit with its product line. "We like to be pioneers," said VAUDE's Benedikt Tröster. "We are leaving the well-trodden path." Von Dewitz is a second-generation CEO of the family-owned company. She has openly and energetically committed it to all aspects of sustainability, whether in dealing with the company's employees or in the attentive handling of raw materials. "Wouldn't it be



Alternatives to conventional polyamide should be just as high-performing: "We are happy to be pioneers," a source at VAUDE said.

great if we could just assume that our preferred products were manufactured ecologically and fairly?" she wrote in her book "Mut steht uns gut," ("Courage looks good on us"). In it, she describes how companies with the right spirit can be successful. She frankly explains how hard it was to find sustainable materials at first – and even to win some of her own employees over to the cause. But she has been proven right. While the higher costs are not totally passed on to customers, VAUDE says the company grew by 15 percent in 2021, reaching revenues of more than 125 million euros.

And VAUDE is not the only company in the textile industry to identify biologically-based plastics as a market niche. In Italy, for example, yarn producer Fulgar became the first textile maker to pay attention to Vestamid Terra. Fulgar is one of the world's leaders in the field of polyamide yarn, producing about 36 million kilograms of it per year. Aside from liking the material for its lightweight feel, the company highlights the fibers' moisture management. Fulgar is now supplying biologically-based yarn to companies in a wide range of categories, from



Wouldn't it be great if we could just assume that our preferred products were manufactured ecologically and fairly?"

Anke von Dewitz, CEO,  
VAUDE Sport GmbH & Co. KG



Shoes made of mycelium fabric: Adidas has its first model on the market.



## 60 Percent

more clothing is being bought today by the average global consumer than 15 years ago.

outdoor clothing to underwear and even formal wear. It also has a unique cooperative venture underway with the Italian zipper maker Nyguard, another company enamored with biologically-based plastic. Fulgar makes trousers with Nyguard zippers that are made of the same material. From a manufacturing standpoint, this could greatly increase the recyclability of clothing, which is much more difficult when different materials are interwoven.

### Mushrooms, Not Leather

A very different idea shows how diverse the options for biologically-based plastics can fundamentally be. The idea: clothing and shoes made of mycelium, the root-like network that mushrooms form underground. The material resembles leather; numerous startups now have engineers and scientists looking into it. One of its advantages is that mushrooms require relatively little water, are anti-microbial and are expected to need less fertilizer and fewer chemicals. Several major companies have already brought out products. They include designer Stella McCartney and Adidas with its “Stan Smith Mylo” sports shoe, which has been available since the fall of 2021.

In the truest sense of the word, this is about growth. But many more manufacturers will have to embrace such innovations. After all, individual innovations do nothing to change the projections for increased textile output. ©

# Demand Without Supply



*It will take huge investments to reduce the greenhouse gases generated during steel production. The demand for green steel is rising fast. The steel industry is responding, but it is still impossible to find climate-neutral steel.*

Think of the steel industry as a country. It would rank just behind China and the United States and just above India on the list of the world's biggest CO<sub>2</sub> emitters. The World Steel Association puts the sector's CO<sub>2</sub> emissions at about 2.6 billion tons, or 8 percent of global emissions. Despite more efficient steel mills, Europe's share is still 5.7 percent, according to the European Union. The person to blame is Abraham Darby, the British cooking pot manufacturer who built the earliest forerunner of a modern blast furnace at the beginning of the 18th century. It burned hard coal rather than charcoal, a process seemingly without an alternative for a very long time since. The reason: To process the abundant iron ore in the earth's crust into steel, it must first be freed of oxygen which – depending on the source of the raw material – accounts for 30 to 50 percent of its total weight. In blast furnaces, the oxygen bonds with carbon and escapes into the air. A global

average of 1.85 tons of carbon dioxide is released per ton of steel. The figure is somewhat more favorable for Europe. For a long time, the only economical alternative in steel production was the smelting of scrap steel in electric arc furnaces. In any case, about 40 percent of the steel produced entirely in Europe comes from recycled material. If the electricity needed for the smelting comes from renewable energy sources, this electrically produced steel is almost completely climate-neutral. The world's appetite for steel is still growing and it cannot be covered solely with recycled materials, especially since electrically produced steel is mainly used in construction. The complex alloys that go into high- and highest-strength steels for the auto industry are almost exclusively based on newly extracted iron.

#### Retrofit or Build New?

There are basically two ways to make steel production more climate-friendly:



1

either continue to use coal-fueled blast furnaces, but with the carbon dioxide separated out of the metallurgical gas or reduce the oxygen content in a so-called shaft furnace using renewably produced hydrogen. Each process has advantages and disadvantages. CO<sub>2</sub> separation merely requires retrofitting existing steel mills. But how do the mills get rid of the separated CO<sub>2</sub>? It can be stored safely underground or bound in porous stone. But these methodologies require billions in investment with zero rate of return – in an industry already subject to high costs and competitive pressures. The separation would become the basis of a business model if the carbon dioxide could be used as a raw material, perhaps for fertilizer or synthetic fuels. ThyssenKrupp has already demonstrated the technical feasi-

2



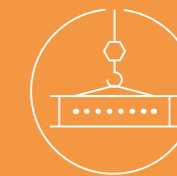
1\_Scrap steel is already being processed electrically.

2\_The hydrogen for green steel is expected to be produced using wind power.

3\_So far, flat steel for the auto industry has almost always come from blast furnaces.



3



# 1.85

tons is the average amount of carbon dioxide released during the production of 1 ton of steel in Europe.

bility of this kind of recycling in a pilot plant in Duisburg (see ESSENTIAL 2/2019).

For large-scale steel production, producers are increasingly turning to direct reduction with hydrogen, even if this is tantamount to constructing a completely new steel mill. In Germany, Salzgitter AG is leading the way. The company, which has its steel mill in the city of the same name, is now responsible for about 1 percent of Germany's total CO<sub>2</sub> emissions. The company expects its production to be completely converted to hydrogen by 2050. "To us, hydrogen is the reagent of choice," said former CEO Heinz Jörg Fuhrmann. The major challenge is that there still isn't enough green hydrogen available. So Salzgitter is investing in production on the company's property. To generate the green electricity it needs, the

company has erected seven wind turbines with a total output of 30 megawatts. For the transition, Salzgitter is also turning to natural gas, which scores better than coal on the emissions balance sheet.

#### Plenty of Demand, No Supply

"From a technical standpoint, steel produced with green hydrogen as a reducing agent would be used on a one-to-one basis," said Thomas Bleimling, who is in charge of metals procurement in Purchasing at Freudenberg Sealing Technologies. "The company processes more than 20,000 tons of flat steel in Europe every year to make diaphragm accumulators, for example. But Freudenberg primarily uses steel to produce metal cases for Simmerings®. In some cases, the company manufactures the cases internally be-

fore they are over-molded with elastomers. Green steel would have an even higher degree of purity," Bleimling said. But at present, the material is not available for purchase anywhere, not even as samples. "Even in 2030, the share of green steel out of total production will still be very small," he predicted. "But the auto industry, which purchases about 20 percent of the steel produced in Europe, is driving the trend." Aside from cost, quality and supply security, the CO<sub>2</sub> emissions per ton of the material count as a criterion for procurement at some vehicle manufacturers. "We are following the trend among suppliers and customers very closely," Bleimling said. He is optimistic that the steel industry will gradually reposition itself – and even see an upswing due to the technology transition. ©



# Leaving No Stone Unturned

*Eliminating fossil fuels as fast as economically possible: Freudenberg Sealing Technologies is demonstrating that this is possible at the Oberwihl plant, on the southern edge of the Black Forest in Germany. But you have to operate many levers at the same time to make it happen.*



We are noticing that more and more of our customers want to offer climate-neutral products, so we have to get moving but do it in a way that we are working sustainably and economically.”

**F**reezing cold under a bright blue sky, with views extending into the Alps. In January 2022, half a foot of snow – less than the usual amount but snow, nonetheless – lay upon the fields. This manufacturing site on the edge of Oberwihl, sitting at an elevation of 700 meters (2300 feet), is embedded in the most beautiful natural setting that the southern portion of the Black Forest has to offer.

But even if Hans Bruno Hänle, an avid cross-country skier, is able to enjoy the surroundings, the fact that he wants to improve the climate balance sheet of the facility – where Freudenberg Sealing Technologies produces more than a billion O-rings – is not a personal matter at all. Hänle, Commercial Director of the O-Ring Division, rather sees measures to protect the climate as an investment in the plant’s future capabilities. “We are noticing that more and more of our customers want to sell climate-neutral products, so we have to move forward, but in a way that we are working sustainably in an economic sense.”

In 2015, a factory expansion, the partial equivalent of a new plant, laid the groundwork for the current measures. Energy efficiency rose significantly as a

result of numerous activities. One was related to heat recapture in the building’s climate control system. Another involved the installation of an energy monitoring system in the finished plant, which could be used to record energy consumption for individual manufacturing areas (see ESSENTIAL 1/2018), and set limits for the maximum load. These efforts paid off: When the Freudenberg Group was looking for two plants in 2019 to showcase climate neutrality, Oberwihl was high on the list. At the time, the plant’s annual energy consumption was about 10 gigawatt hours, of which 82 percent came from the electrical supply and the rest from the consumption of heating oil, which had already declined. The CO<sub>2</sub> emissions rooted in energy purchases came to 4,500 tons per year, an amount equivalent to the average



Hans Bruno Hänle sees climate protection as an investment in future viability.

annual CO<sub>2</sub> emissions from about 500 German citizens. With the help of a professional energy services provider, the plant's management first identified all the ways that the facility could be made climate-neutral. One initial condition applied: The efforts had to bring real savings. Merely offsetting the emissions by paying compensation was not one of the measures envisioned. "There were also some crazy ideas," said Dr. Rainer Weiss, who is in charge of both employee safety and sustainability measures at the site. For example, experts have calculated that it is possible to convert the entire supply of electricity to photovoltaics – if solar energy systems were set up on an area the size of five football fields near the plant.

**Saving Energy Is Still Important**

By the time all the options were on the table, the first wave of COVID hit. But Hänle and Weiss were not held up for long: A second energy services provider jumped into the race with significantly more concrete guidelines, including the amount of investment and amortization timeframes. During the spring of 2021, there were specific, achievable proposals on the table. At their core, they could be divided into three pillars of activity: One, to continue boosting energy efficiency; two, to provide energy to heat the plant without resorting to heating oil, a fossil fuel; and three, with assistance from decentralized systems, generate green energy in amounts that made economic sense.

2



Energy for heating as far as possible without fossil-based heating oil.”

1



Technician Günter Kaiser cites the example of a rolling mill where a primary elastomer material is processed into a thin layer that is used to produce seals. He points to the fact that energy efficiency in manufacturing is far from being maximized. "It is like a pasta machine. When you feed the mass inside at the start, the machine needs a great deal of power. Later, when the layer is rolled again, the required effort declines with each pass." So far, hydraulic drives that always operate at maximum output have been used in these rolling mills – as in many other machines. By converting to adjustable servo-hydraulic drives, a substantial share of the drive output can be saved. Kaiser plans to determine the exact amount of savings in the next few months, laying the foundation for investment decision-making. The situation seems similar in many other areas. For example, waste heat generated by machine cooling systems is still not being used. And the copious data that would come from the continuous monitoring of building technology could be analyzed prospectively using artificial intelligence, to identify anomalies more quickly.

- 1\_ Sustainability Manager  
Dr. Rainer Weiss
- 2\_ Energy monitoring: everything in view
- 3\_ Energy efficiency: new compressors



3

**New Sources of Heat and Electric Current**

In Oberwihl, however, all machines – including the ovens needed for downstream heat treatment – are heated electrically. But the building heating continues to use fossil fuel heating oil. With the Black Forest on its doorstep, the solution is literally not far off: wood chips, generated by the nearby woodworking industry, are the fuel for two heating boilers. Equipped with an automatic filling system, they produce more than 600 kW of heat output. The construction application for the boiler house has already been submitted. The boilers should go into operation in early 2023. The amount of heat produced from wood could continue to increase if a small combined heat and power plant is added to the facility. "Then it would be possible to reduce the current heating oil consumption by up to 96 percent," Weiss said.

The conversion to renewable electricity is easier in some respects – and more difficult in others. It is easier because the electricity for all the Freudenberg plants in Germany is sourced centrally, so a rapid conversion is more efficient due

to the large volumes being purchased. It is more complicated because Oberwihl hopes to generate a portion of its electricity on its own, on the plant grounds. The plan to cover the entire employee parking lot with solar surfaces is dormant for now. That's because simple stilts are not an option due to the amount of snow in the region. The structure would have to be made of steel. Thus, the overall system is not being amortized over a long depreciation period, at least in terms of current steel and construction costs. "We are now examining what we can achieve with roofs," Hänle said. The work won't be easy: Exhaust air systems and light hatches are obstacles. Yet it is important to him to leave no stone unturned as he monitors every aspect of sustainability, including the economic issues. The bottom line is that he and his colleagues are helping to keep the Black Forest covered in a blanket of snow each January. ©



**CO<sub>2</sub> BALANCE OF THE EARTH'S FORESTS (PER YEAR)**

Net storage capacity: ~ 8 billion tons of CO<sub>2</sub>  
(equivalent to 1.5 times the USA's annual CO<sub>2</sub> emissions)

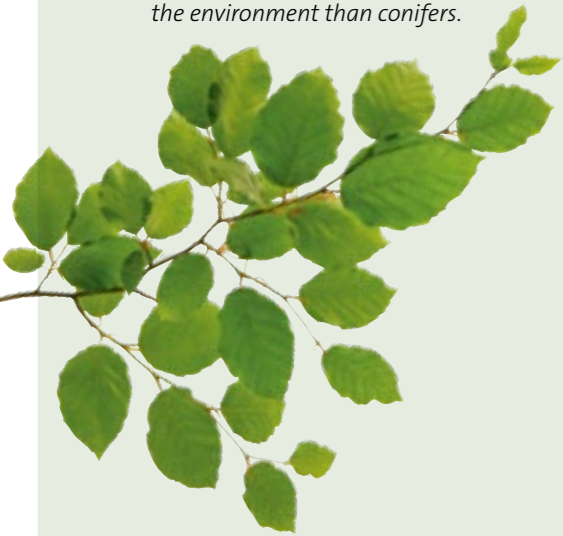
Absorption:  
**16 billion tons** CO<sub>2</sub>  
(= 16 gigatons of CO<sub>2</sub>)



Emissions: (e.g. combustion, rotting):  
**8.1 billion tons** CO<sub>2</sub>

**STORAGE CAPACITY OF TREE SPECIES**

Deciduous trees generally remove more CO<sub>2</sub> from the environment than conifers.



**Beech** up to **3.5 tons**  
of CO<sub>2</sub> over 120 years

**Spruce** up to **2.6 tons**  
of CO<sub>2</sub> over 100 years

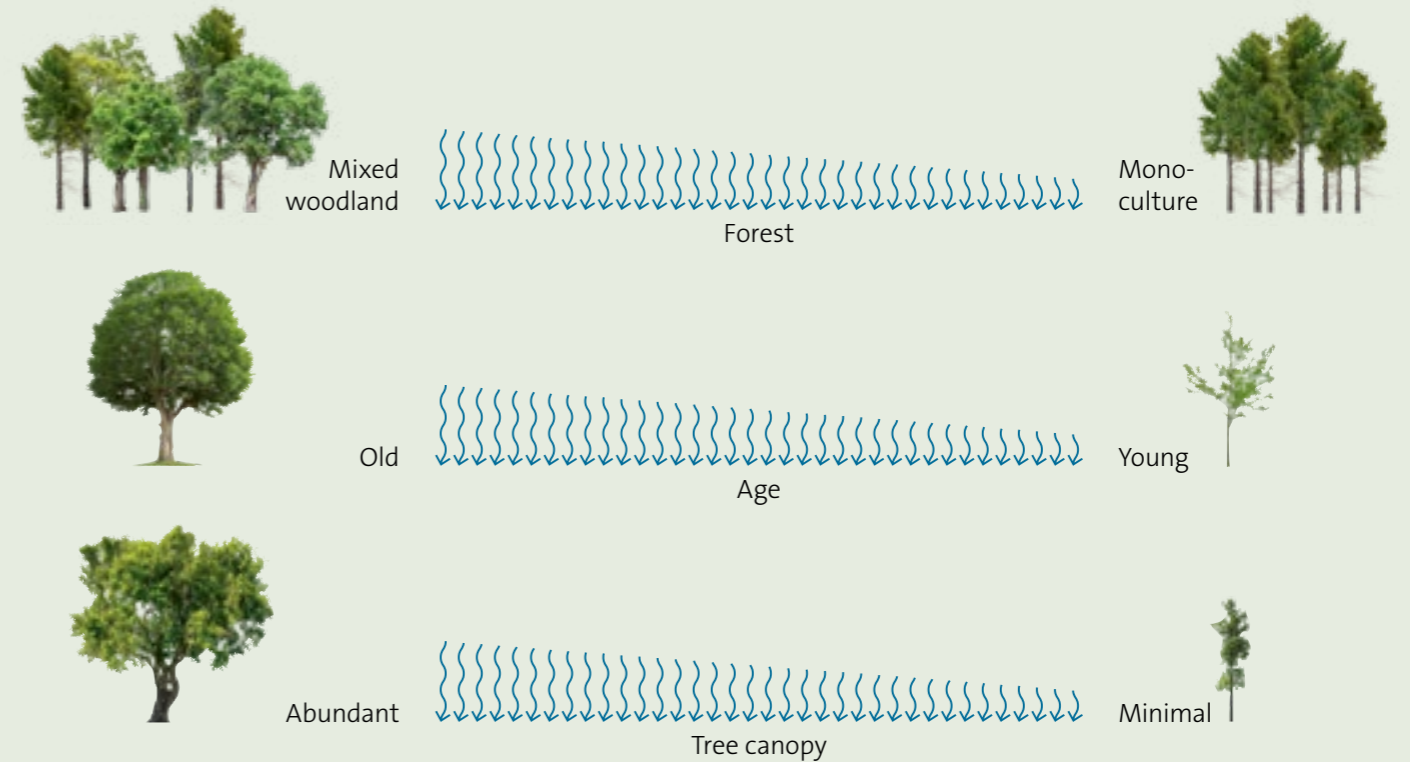


# CO<sub>2</sub> Thieves

Trees are natural storage systems for carbon. They use photosynthesis to draw carbon dioxide (CO<sub>2</sub>) from the environment, give off oxygen, and store carbon. But at what scale? And what makes trees so efficient?

**DETERMINING FACTORS FOR CO<sub>2</sub> STORAGE CAPACITY**

The differences affect how much CO<sub>2</sub> trees and forests absorb from the atmosphere.



**IS MAIZE A MIRACLE STORAGE SYSTEM? NO ...**



... the lifespan of maize as a storage system usually ends within one year when it rots or is harvested. Its CO<sub>2</sub> is released when it is consumed as feedstock or processed in biogas facilities, or even decomposes naturally. By comparison, 1 acre of forest stores an average of 4.25 tons of CO<sub>2</sub> year in and year out.

**1 ha of forest**  
**11 tons**





# “Disruptions Are a Dream for Experts”

*The road to sustainability includes higher energy efficiency and lower CO<sub>2</sub> emissions. How will Freudenberg Sealing Technologies achieve these objectives at its global manufacturing sites? And how will the company’s material expertise support sustainability efforts? Dr. Matthias Sckuhr, COO of Freudenberg Sealing Technologies, talks about lean processes, historic trends and the role of employees.*

#### **DR. SCKUHR, HOW CAN ENTREPRENEURSHIP AND SUSTAINABILITY BE COMBINED?**

This is not something we need to manage. Entrepreneurship and responsibility are intrinsically connected to one another. This is especially true when it comes to responsibility for the future of society, that is, for environmental protection, health and work standards. It is undeniable that the climate is changing and the environment is threatened. The logical response for us as entrepreneurs is to think sustainably.



Entrepreneurship and responsibility belong together. Especially responsibility for the future of society.”

#### **HAS THIS ALWAYS BEEN THE CASE?**

The sustainability of products and processes has always been a responsibility that Freudenberg has lived and breathed. Yes, entrepreneurs have to think long-term, and that means thinking about sustainability. Otherwise they won’t survive. If they don’t address sustainability, they won’t survive.

#### **BUT WHAT STEPS CAN WE TAKE TO CONSERVE RESOURCES AND ENERGY?**

At the outset, there are always questions: Where do we stand? How much are we consuming? What industrial process accounts for this consumption? At Freudenberg, we want to tackle this holistically. That’s why we have firmly anchored energy savings in our culture and our continuous-improvement programs. We call the initiative GROWTTH: “Get Rid of Waste Through Team Harmony.” It includes ongoing training of our employees around the world. We have to think lean. That means removing every type of waste from our processes. We also need reliable figures, data and facts so we can measure our real progress. As part of this effort, we are introducing a global energy consumption measurement system that will ensure that all sites have the same key figures available and that we achieve maximum transparency.

#### **ENERGY EFFICIENCY IS NOT AN END IN ITSELF.**

Of course not. We need energy to manufacture our products. That is the very reason we, as a company, have always tried to make our processes as energy-efficient as possible. At Freudenberg Sealing Technologies, we are in a good position. We have already converted 85 percent of the energy we need into electricity. The only open question is





We need to think ‘lean,’ which means getting every form of waste out of our processes.”



The interview continues in text and video at:  
<https://youtu.be/nOttPtz3T3A>



are considered. Suppose a machine is somewhat more expensive to buy, but is more energy-efficient. That becomes part of the calculation. We want to make it easier for our departments to invest in machines of this kind.

#### HOW CAN EMPLOYEES BE PERSUADED TO THINK AND ACT MORE SUSTAINABLY?

I don’t know if we really still need to persuade employees. The issue is so prevalent, so emotional, and so cross-generational. We are receiving a lot of proposals and ideas. I am convinced that most of our employees have already internalized this: They want the next generation to inherit a world that is livable. That is a worthwhile goal and I can only encourage everyone to make a contribution. After all, we don’t have forever to do it.

#### LOOKING BACK OVER YOUR CAREER, ARE THERE INSTANCES WHERE PLANNING FOR THE FUTURE DID NOT GO FAR ENOUGH?

Actually, I often ask myself this question. At one point or another, you could always have taken a different approach. But not much really comes to my mind with regard to sustainability because conserving resources has always been a sensible goal. There is something else that can be assessed critically in retrospect, however: long supply chains. In the past, it was nearly impossible to have an impact on long supply chains. Now I believe things are going to tighten up. We would like to avoid deliveries over thousands of miles / kilometers whenever possible.

#### SO DOES SUSTAINABILITY ULTIMATELY MEAN CHALLENGING YOURSELF AGAIN AND AGAIN?

Yes, because, over the course of time, we keep discovering new opportunities. We are talking about continuous improvement, a concept that is firmly anchored at Freudenberg Sealing Technologies. ©

how quickly political leaders and energy producers actually make sustainable electricity available to us. Basically, we have nearly stopped using fossil fuels. At most, we are using natural gas for heating.

#### YOU ARE HOPING TO CUT EMISSIONS BY 30 PERCENT BY 2025 COMPARED TO 2020 AS EXPRESSED IN TONS OF CO<sub>2</sub> PER MILLION EUROS OF REVENUE. HOW IS THAT GOING?

First of all, it is important to clarify which CO<sub>2</sub> emissions we are talking about. CO<sub>2</sub> occurs along the entire value chain. We are considering Scope 1 and 2. That means direct emissions from our own activities and the indirect emissions from the electricity or heat that we purchase. Scope 3 would relate to steel that we purchase, for example. We naturally want to reduce CO<sub>2</sub> along the entire chain. If we buy “green” steel, that is an important reduction of our footprint. But it doesn’t flow into our internal calculation. And we are not just looking at our footprint. We are considering what we call our hand-

print as well: What effects do our products have on our customers? When we provide our customers with low-friction seals, for example, we reduce their resource consumption.

#### WHERE DOES FREUDENBERG SEALING TECHNOLOGIES CURRENTLY STAND?

Like many companies in 2020, we emitted fewer tons of CO<sub>2</sub> due to the lower sales and production demand the pandemic created. That was welcome news, even if it was predictable. But in 2021, we again managed to emit fewer tons of carbon dioxide per million euros of revenue. So the trend is heading in the right direction.

#### DOES MATERIAL EXPERTISE HELP TO DECREASE EMISSIONS AS PART OF THESE EFFORTS?

Yes. Processes can be improved when changes are made to materials. Take post-curing for example. A large share of our seals still have to be cured in an oven after molding. That takes energy. During the

last few years, we have developed new materials that do not require post-curing. That saves energy.

#### IS PROCESS OPTIMIZATION AT THE HEART OF ENERGY CONSERVATION?

Process optimization has always been a driver – at least for engineers. It was more of a financial incentive in the past. Today, it also includes looking at the environment. In any event, an end-product that requires fewer resources is a good thing. Recycling also makes sense, and our material scientists think about all of these issues. Frankly, this is an ideal time for engineers, technicians and scientists. They can do creative, scientific and innovative work during this environmental disruption. For experts, it is a dream come true.

#### BUT FINANCIAL INCENTIVES CONTINUE TO BE IMPORTANT.

Of course, they do. For example, CO<sub>2</sub> effects are taken into account when investment proposals



# Fresh From the Lab



“Just a steak from the 3D printer with high-tech vegetables, please.” That’s what your restaurant order could sound like even today, thanks to new food concepts created to feed a growing global population.

**W**e are increasing in number. Projections by the United Nations suggest that around 9.7 billion people will be living on our planet by 2050. That’s nearly 2 billion more than today. Can their hunger ever be stilled? Resources are finite. Our appetite is already straining the planet. Year after year, huge stretches of forest give way to farming. Ecosystems are endangered and industrial livestock farming is releasing large quantities of greenhouse gases that accelerate climate change. Scientists and startups around the world are looking for new ways to feed humanity. And they have found a few. The alternatives, in the form of meat from labs and vegetables grown without sunlight or fertile soil, are reaching maturity.

#### 250,000 Euros for a Lab Burger

Anyone who gets the chance to try a slab of meat from the lab, known as “in vitro meat,” is likely to barely notice a difference. After all, it not only looks like real meat, but it closely tastes like the real thing, too. This is confirmed by diners at “The Chicken” in the Israeli city of Nes Ziona. Chicken burgers are served there during taste tests. The meat is grown from muscle and fat cells of chickens. It is enriched in the lab ahead of time with a plant-based solution of nutrients. The diners even get a look at its production during their visit. Only a glass partition separates the lab from the dining room. “The Chicken” is owned by Supermeat, a food manufacturer. While the company works on the development of laboratory meat, it tests its products in the adjoining restaurant. Its vision: to provide a sustainable alternative to meat from large-scale livestock farming.

Supermeat is not alone in its mission. Scientists and startups have been doing research on laboratory meat for nearly 20 years. The first clean meat product was approved in Singapore in 2020. It consisted of cultivated chicken meat from Eat Just, an American company. But the costs are still an obstacle to its introduction to the public. The first laboratory burger was presented in England in 2013; it reportedly cost about 250,000 euros to produce. Today the cost of producing a patty is estimated to be under 50 euros. But the Good Food Institute, a nonprofit organization, estimates that prices for lab meat could be competitive by 2030.



The heaviest artificial beefsteak so far weighs more than 110 grams. It comes from a 3D printer.

**Meat from a 3D Printer**

Researchers have not just succeeded in improving the production process for “in vitro meat.” They have also refined its taste. The size of the pieces continues to increase. Last year, another Israeli food technology company produced the heaviest artificial beefsteak so far. The lab meat weighs 110 grams (nearly 4 ounces) and was created with a sophisticated 3D printing operation. The process involves extracting and then replicating real muscle and fat cells from tissue samples. In the next step, the beef cells are integrated into so-called “BioInks.” They can then be printed with a 3D printer and take the form of a steak. The printed product then matures in an incubator where the animal cells divide into fat and muscle cells. The resulting steak matches the original in terms of its appearance and consistency.

**High-tech Vegetables from an Indoor Farm**

The urban concept of so-called indoor farming is also based on vertical growing technology. Here, fruits and vegetables are grown in indoor spaces. LED lights replace sunlight. The process does not

even use soil. Instead, the plants thrive on peat or recycled plastic. Irrigation and lighting systems create ideal conditions. The plants are mostly raised on top of one another on multiple levels. So-called vertical farming requires significantly less ground space than conventional agriculture.

High-tech cultivation is already a reality in many countries. The world’s largest indoor farm is now being developed in Dubai. The company, CropOne, has established a number of products in the American market, and up to 3,000 kilograms of leafy vegetables can be harvested every day in the new production facility. This major project emerged from a joint venture with the Emirates Group. Vegetables grown indoors are expected to be served on airline flights. The company’s compelling argument is that the system requires minimal amounts of water. It says its vegetables need about 95 percent less water than their counterparts grown in fields.

**Basil and Tilapia in Symbiosis**

But the concept also works one size smaller. Some startups have developed farming systems that can be integrated with the vegetable depart-



Cultivation under LED lights: The vegetables in this indoor farm grow without sunlight.



As long as the fish are swimming, the basil keeps growing. Hydroponics combines animal and plant growing systems.

ments of supermarkets. The German company ECF Farming has come up with further variations: The company’s so-called aquaponics method raises both basil and tilapia together. Plants and animals are connected by a common circuit, and they benefit from one another. The fish swim on the floor level directly above the supermarket, and the basil crop is one floor higher, under a glass roof. Water circulates between the two levels. While the plants are drawing nutrition from the water inhabited by the fish, the latter are using the oxygen the plants produce. The setup has enabled a supermarket in Wiesbaden, Germany, to raise fish and basil on its own. This allows transport distances and cooling chains to be shortened, improving the CO<sub>2</sub> balance sheet.

An entire steak emerges from a few animal cells, and vegetables grow to perfection without soil or sunlight. So will we be able to do without natural resources in the future and thus conserve them? So far, no complete array of products can be re-produced, either in labs or indoor greenhouses. In addition, high costs are dampening aspirations for mass production. And the concept of artificial meat may not appeal to people for some time. But the skepticism won’t necessarily last very long, as vegetarian and vegan meat substitutes have shown. They are now on supermarket shelves and enjoying growing popularity. ©



# Making Carbon

*The world cannot do without technical plastics. But if the extraction of fossil materials comes to an end, new sources of carbon will be needed. Successes have been already achieved in the lab, but new industrial options are still in the works.*

Consider a world without petroleum and natural gas. It would do the climate some good, but would also mean that we would have to obtain carbon, the basis of all organic compounds, in other ways. Or the world would have to completely do without the element. But substitution with another material is often impossible in the case of technical plastics, which account for about 10 percent of the global annual plastic production. Some examples are the seals that are used in electric household appliances and wind turbines. They contain materials that address unique environmental challenges and thus promote longer product life cycles. Plastic components also significantly reduce the weight of today's vehicles – and thus their energy consumption.

## Recycled

So what would you do if natural gas and oil are no longer available as sources of carbon at some point? "In theory, there are three alternative approaches," said Dr. Ruth Bieringer, lead materials researcher at Freudenberg Sealing Technologies. "One involves the use of recyclates for the production of new plastics." Recyclates are used materials that have been cleaned and crushed. "Carbon dioxide can also be obtained from biomass or carbon dioxide," she said. Methods of carbon recycling are the furthest along – in the recycling of PET (polyethylene terephthalate), for example. Fibers for running shoes are salvaged from discarded plastic bottles.



Production scrap from certain thermoplastics can be fed back into the production process. Freudenberg already does this, for example, with polyether ketone (PEEK). But in many cases, classic recycling – collecting, crushing, melting down – faces serious limitations, if only because plastics are not fully sorted when collected. In addition, long carbon molecules become shorter during their use, when exposed to ultraviolet radiation or during processing, for instance. In the case of elastomers, the carbon chains are interconnected with molecular bridges – a process that is not reversible. "We would have to use chemical reduction and recycle individual components, not the complete carbon compounds," Bieringer said. In-depth research is now underway on what is called chemical recycling. The solution would be a crazy professor-style automated system. The old material would go in on top and separate molecular building blocks would come out at the bottom. But that would take some time to develop.



# 13 million

carbon compounds are known. No other element is as multifaceted.

## Grown

Biogenic plastics based on plant matter – and not on foodstuffs – could offer a sustainable way to provide a supply of carbon. Here, the problem is not the available volume: About 400 million tons of plastics are currently produced per year, while the global renewable quantity of biomass is more than a thousand times greater. Furthermore, the percentage of water is not included in the calculation. For example, wood is 20 to 30 percent lignin, a substance left as a residue when paper is produced. "Biochemical processes could help us produce high-quality basic materials," Bieringer said, highlighting a field that is also heavily researched. The situation is similar with the cultivation of algae. It not only can be directly used as biomass. Organic compounds can even be excreted from it by modifying its metabolism.



# ZERO CARBON

## Separated

A third way is the extraction of carbon dioxide using technical processes or from the air. In cement production, for example, one carbon dioxide molecule is released for each lime molecule over the course of a chemical reaction. The disadvantage: Both the separation process and the unlocking of the very stable CO<sub>2</sub> molecule are energy-intensive. New catalytic materials, also a subject of research, could reduce the energy requirements and thus simplify the recycling of the greenhouse gas.

It is still not clear which option will make it possible to create plastics without fossil materials, according to Bieringer. "A lot can be done in the lab, but there are hardly any solutions that industry can use." "Developing them is a challenge for the chemical industry," she added. But she offers this assurance: "As users, we are ready to work with our suppliers and customers to test new approaches." ©



# Gigantic Opportunities

*More than 20 countries have adopted a national hydrogen strategy so far. One key aspect is the mass production of “green hydrogen.” Freudenberg Sealing Technologies’ solutions have made it a pioneer in the field.*

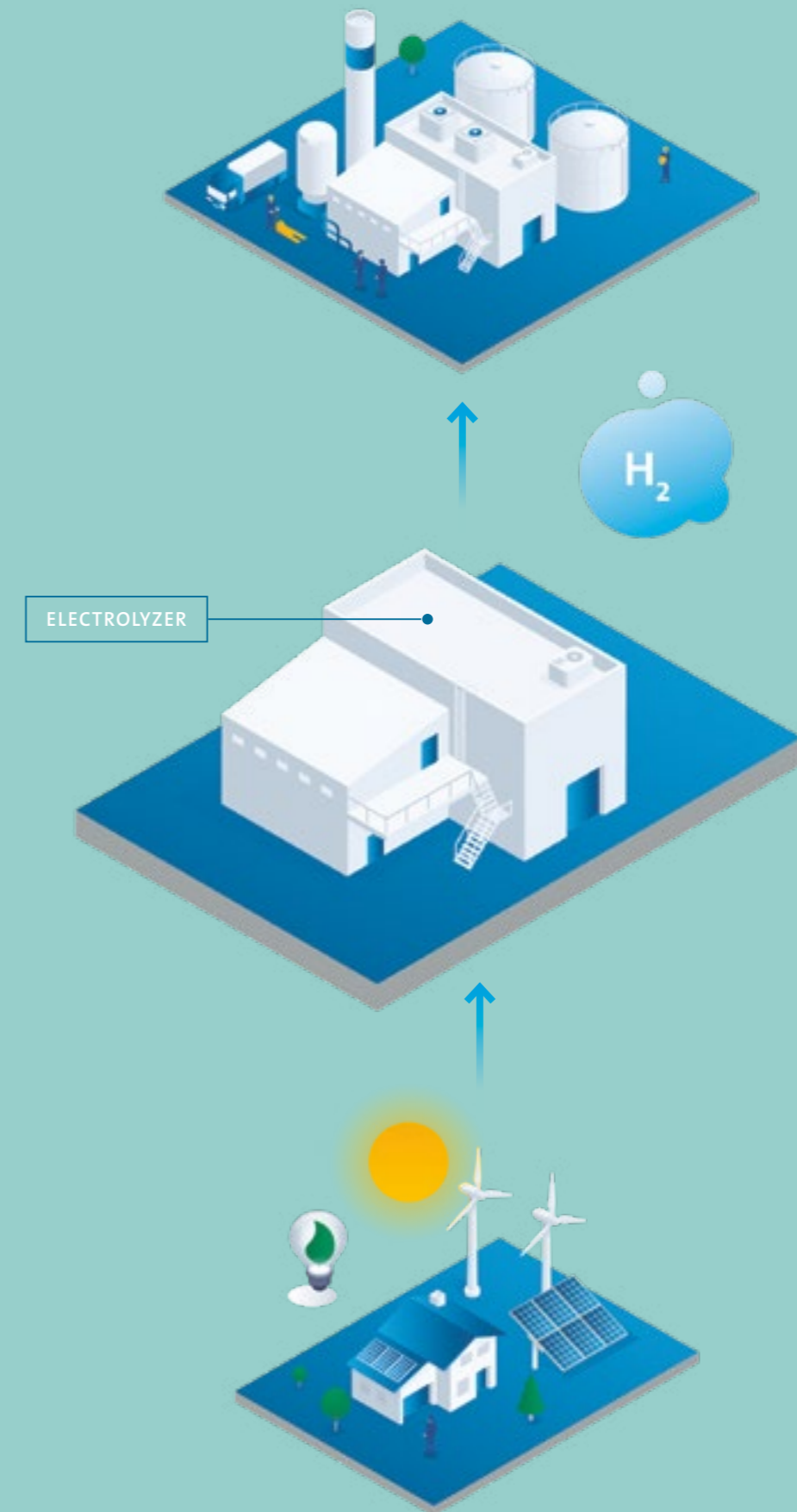
There are many ways to produce hydrogen. But there is only one way that promises to decarbonize industry and the atmosphere: “green hydrogen” production. It uses electricity generated with renewable energy to separate oxygen and hydrogen from water. Hydrogen is well-suited to serve as an interim storage medium for the surplus energy from wind turbines and solar installations. Green hydrogen is also in demand as an energy source for CO<sub>2</sub>-intensive, difficult-to-electrify industries. Companies can then eliminate fossil fuels. However, the amount of green hydrogen produced has been very modest so far. Global capacity is a mere 250 to 300 megawatts. Only 0.03 percent of hydrogen production comes from electrolysis powered by renewable energy.

## Green Hydrogen on the Upswing

The production of green hydrogen will speed up tremendously, however. Artur Mähne is convinced of that. “Many companies are now working on the manufacture of electrolyzers, the core of green hydrogen production. Along with established firms, many new companies are making their way into the market.

We are seeing a Big Bang right now,” said Mähne, Global Segment Manager, Hydrogen Technologies, at Freudenberg Sealing Technologies. The climate objectives of large industrial nations are the reason. As industrial energy requirements grow, the number of competitors building electrolyzers increase and the facilities get larger. While these installations generate an average of 1 megawatt today, there are about 80 production facilities under construction or in the planning stages worldwide that are expected to produce 100 megawatts each or more. Green hydrogen production is poised to reach new dimensions.

The International Renewable Energy Agency (IRENA) underscores this. It considers an increase in the global production capacity for green hydrogen to more than 250 gigawatts to be possible. To achieve that scale, huge production capacity must be built up quickly. One point of leverage: the accelerated production of electrolyzers. Until now, they have been largely produced manually. “The production process has to be industrialized. This is the only way that production capacity can reach the gigawatt range, with economies of scale to reduce costs,” Mähne said.



### Standardized and Automated Production

The expert on hydrogen technologies assumes that the operation of gigafactories will shed light on other opportunities for optimization. A more efficient process will likely bring higher temperatures and pressures in its wake. A key goal for electrolyzer system requirements is a long product life. Freudenberg Sealing Technologies is actively involved in this mission since seals are important to the operation of electrolyzers. “An electrolyzer consists of several stacks, and they in turn are made of numerous cells. Our products seal the cells against one another so that hydrogen and oxygen are completely separate from one another. Otherwise the equipment would be damaged,” Mähne said.

To manufacture electrolyzers cost-effectively, with automation, the fast installation of seals up to 1 meter high is critical. This step was done manually until now. But Mähne and his team are now turning to integrated instead of loose seals. They are either attached or sprayed directly onto a frame or bipolar plate. Both approaches speed up the assembly of the electrolyzers. The stacking of the cells can then take place more quickly with a standardized process. Sources of error are minimized and more systems are built in a shorter time. In the process, each sealing solution is tailored to the customer’s requirements. “We advise our customers on how and where a seal is best attached. It is a proven advantage for us to be on board at the early stages of the stack’s conception, to develop the ideal seal design jointly with manufacturers,” Mähne said. Ideally, the timeframe from the first conversations to the finished series-production seal is twelve to eighteen months. Deliveries in greater quantities are then possible.

### Remove Pain Points

Apart from engineering, the expertise of the Freudenberg Sealing Technologies team covers the selection of the right high-performance elastomers for seals. The aggressive environment of electrolysis is anything but ideal for them. They have to be chemically resistant, cope with high temperatures and withstand immense compressive deformation. With more than 20 years’ experience in the manufacture of components for fuel cells, Mähne and his team can give electrolyzer manufacturers expert advice. “They are always happy to see us remove critical pain points for them. Thanks to our integrated solutions, they reach their goal more quickly.” That is a crucial factor for the buildup of greater production capacity for green hydrogen. Mähne finds the prospect of helping to appreciably reduce CO<sub>2</sub> emissions to be as fascinating as it is gratifying. ©



# 250

gigawatts could represent the global production capacity for green hydrogen by the year 2030, according to the International Renewable Energy Agency (IRENA).



NOW I’M TELLING YOU

# Tower Bridge

I have spanned the Thames for 128 years. I like it when the river rises and falls with the rhythm of the tides. After all, the sea is only about 55 kilometers (27 miles) away. Since 1984, the Thames Barrier at the gates of London has kept it from flooding around me. Typically, the barrier only has to be closed four to five times a year. But when there were severe storms here in 2014, it had to close 29 times in just 10 weeks. It has kept enormous surges from the North Sea at bay while allowing water from swollen tributaries to move past the city.

Climate change is what worries me. Due to higher temperatures, seawater is expanding and rising. Today the annual rise at the Thames estuary has more than doubled. Water from melting glaciers and other ice will likely

accelerate the growth. Warmer weather in England is also expected to lead to increased rainfall. At that point, the Thames Barrier will probably no longer be useful. It was not designed to regulate water levels permanently.

What does that mean for London? The website [coastal.climatecentral.org](http://coastal.climatecentral.org) offers a possible answer. A map shows how my hometown will be flooded if the sea rises by 1.3 meters (4.25 feet) by the year 2100 – as some studies predict. Large portions of the city districts south of me would then be underwater. The cost of the required protective measures would likely be in the billions. Climate change will end up being quite expensive, either because of structural damage or because of the expense of preventive construction projects. ©





# Taking Care – Together

*Companies around the world want to operate more sustainably. With the “We All Take Care!” program, Freudenberg Sealing Technologies pays tribute to sites with the best initiatives for improving their sustainability.*

## WINFRIED HEISER

has worked for Freudenberg since 1990. As Director, Health, Safety and Environment Europe, he is responsible for occupational safety and environmental protection at Freudenberg Sealing Technologies' European sites.

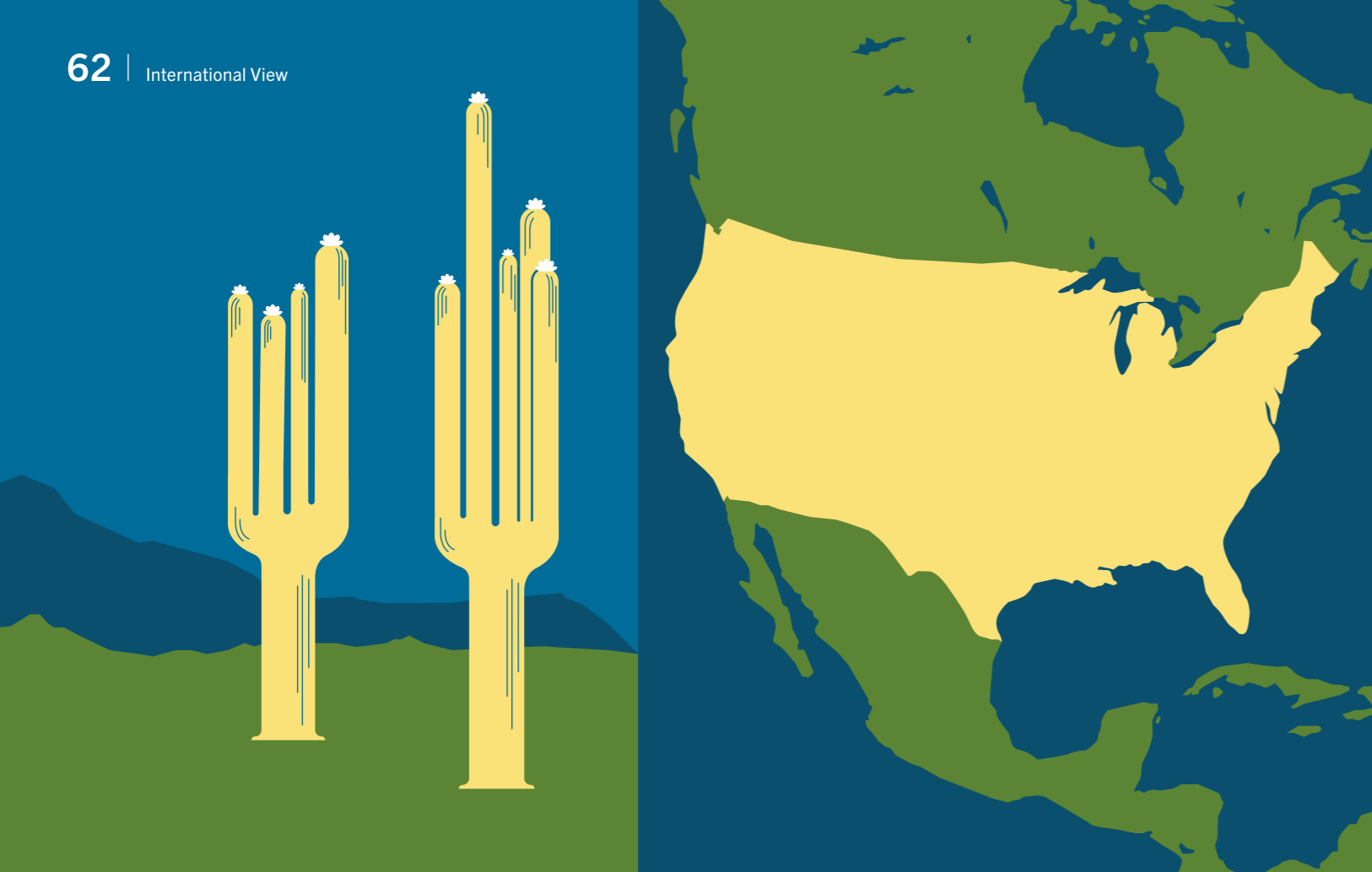


I can clearly remember how it all began about 20 years ago. We were at a global meeting of 200 Freudenberg managers and wanted to improve job safety for our employees. There were still too many work-related accidents. The situation was out of step with our company philosophy. Working for Freudenberg should not come at the risk of injuring employee health. The “We All Take Care!” program was designed to promote occupational safety. Freudenberg’s CTO then inserted the word “All” by hand, tweaking the phrase so it would address and motivate everyone. “We All Take Care!” breathes life into our company’s Guiding Principles. WATC provides a way for our employees to highlight their best practice improvements.

Today, the program is ingrained in our company culture. It is still generating momentum. It pays tribute to projects that have made impressive improvements. It is our safety Oscar, even though other categories have been added. Project submissions are of extraordinary quality, and our European sites are striving to improve even more. When “We All Take Care!” was launched, it focused on job safety and then added employee health. Today, a major cutting back is on environmental protection. This means cutting back on the use of water, energy and raw materials while generating less CO<sub>2</sub> and waste. Every facility wants to achieve results. Of course, management requires this, but the facilities themselves recognize the benefits for their operations. The savings reduce our costs and create a competitive advantage. A growing number of customers are asking us how sustainably we operate. And that is pushing our facilities to identify still more ways to save – and to use environmentally friendly technologies.

Three winning projects have especially impressed me over the years. One facility designed a flat seal that uses less material at no expense to product quality. Another project contributed to the development of a seal that creates less friction, enabling customers to conserve energy. The third project culminated in a new production process that generates much less scrap in producing the gasket. “We All Take Care!” has helped us become a learning organization. It motivates employees and recognizes achievement.





**ROBERT "BOB" SAMS**

has worked for Freudenberg-NOK in Plymouth, Michigan, since 2006. Two years ago, he assumed the position of Director, Health, Safety and Environment. As such, he is directly involved with sustainability issues at the company's North American operations.

Sites from every Freudenberg business unit participate in "We All Take Care!" The core idea is for the individual sites to present the projects they have developed to improve employee health, occupational safety and environmental protection. The best projects are singled out for awards. Many of our North American sites are very ambitious. Sometimes they hesitate to participate because they think their chances of winning are too low. We should rethink this attitude since "We All Take Care!" is first and foremost about sharing ideas.

Great improvements in our environmental projects have been made during the past three years. They have led to less scrap and packaging waste. I think we have generally become more efficient in the area of environmental protection and have also done so in the United States, where sustainability, as a societal issue, is not routinely considered in the decision-making process because of the country's comparatively low energy costs. Our North American sites have nonetheless been focusing on sustainability for some time, thanks to a number of Freudenberg programs. Plant managers have also been very committed to the effort. They appreciate the benefits, including the reduced costs that come from material savings. Many of our sites are working on production processes to make them more efficient and reduce the amount of waste they generate.



I consider 'We All Take Care!' to be a very valuable platform. It represents our commitment to become more and more sustainable."

Continuous improvement projects are given very high priority at our facilities. There are more of them now than a decade ago and our associates actively contribute ideas at all levels. Some sites have even organized educational campaigns to show their fellow employees how they can shrink their ecological footprint outside of work. I consider "We All Take Care!" to be a very valuable program. It stands for our commitment to become more and more sustainable and promotes the sharing of ideas through projects, whatever their size or complexity. ©





The first CO<sub>2</sub>-neutral yacht is scheduled to set sail in 2030.

June 2021

## Sustainable Yachts

Freudenberg Sealing Technologies recently began working with Lürssen Werft, the market leader in the yachts sector. They jointly came up with a technology roadmap for yachts that eliminates internal combustion engines. By 2025, at the latest, the first ship should be able to anchor for more than 15 days or cruise more than 1,000 miles (1,600 kilometers)

emission free. In the process, the fuel cell-battery system performs the functions of conventional generators at times. The first CO<sub>2</sub>-neutral yacht is expected to be a reality by 2030.

Along with other partners, Freudenberg and Lürssen are collaborating on the publicly funded project known as "Pa-X-ell 2,"

which is developing and testing a hybrid energy system using a new generation of fuel cells for yachts and oceangoing passenger ships. An integrated fuel-cell-battery system will power the vessel's energy needs, including its main propulsion system. The integrated system will generate sustainable, cost-effective energy in a two-digit megawatt range. Thanks to its fuel cell and battery expertise, Freudenberg will be a single-source supplier of the solution. Its marine fuel cell systems can be run on hydrogen, methanol or liquid natural gas (LNG).

One advantage is that the system is more efficient than internal combustion engines. Its fuel consumption and maintenance costs are lower as well. In the future, fuel cells in continuous operation are expected to cover the basic load and batteries will kick in when peak output is needed. This interplay will increase the operating life of all the system's components and improve overall efficiency. ©

September 2021

## More Output From Electric Motors

Freudenberg Sealing Technologies has developed new advanced materials for electric motors. These thermoplastic compounds provide reliable heat-conductivity and improved electrical insulation. They are known as TCEI (thermally conductive, electrically insulating) materials and are used in the manufacture of coil bobbins for electric motors.

Bobbins made from these materials have a leaner design, offer more space for the copper wire, and thus increase the motors' output. The new material family performs markedly better than the options currently available on the market. Customized component designs can also be produced from the materials. ©



October 2021

## Below Ground



XALT Energy and Freudenberg Battery Power Systems are working with MacLean Engineering on the emission-free operation of heavy-duty battery-electric mining machinery. Canada's largest manufacturer of mining machinery came to Freudenberg for help in reaching its customer's sustainability goals. The battery subpack XMP76P turned out to be the best possible solution for a range of powertrains. Several subpacks can be connected in series to achieve energy output of more than 106 kilowatt hours per vehicle. Their flexible housing allows customer-specific electric and refrigeration interfaces. The premium batteries make clean, sustainable mining possible. ©

November 2021

## Emission-Free Travel

In teaming up with ZF Friedrichshafen AG and FlixBus, Freudenberg has launched the HyFleet research project. By 2024, the partners intend to launch a high-performance fuel cell system for long-distance buses that completely replaces diesel powertrains. They are also exploring the hybridization of electric drivetrains with the use of fuel cells and batteries.

When used for long-distance bus transportation, hydrogen-based fuel cells offer better range and shorter refueling times than all-battery-electric powertrains. Freudenberg is developing a long-distance fuel cell system that will be tested in a demonstration bus. The technology's durability and efficiency is expected to increase, and benchmarks for total cost of ownership are being established. Another focus is on the hybridization strategy for powertrains that optimizes the fuel cell-battery combination. Research into these hybrid systems is highly relevant to all heavy-duty segments.

The first phase of the HyFleet project deals with the optimization of the system's behavior under continuous operation and



the maximization of fuel cell efficiency over its entire operating life. It should be possible to apply the results across all heavy-duty segments, especially for commercial trucks. Travel buses could become a trailblazer in the rapid conversion to hydrogen-based mobility. They could ensure that the refueling infrastructure being built along freeways has reliable levels of use. ©



More news at:  
<https://on.fst.com/2PCI9mR>





# The Glue of Civilization

*Cement ensures that the ingredients of concrete adhere to one another. And the global demand for concrete continues to grow. But that creates an emissions problem in many respects. The construction industry is facing a challenge if it wants to make its operations carbon-neutral.*

Concrete needs limestone, which is obtained with surface mining, using stepped mining levels that are blasted into the rock.

The residential complex “Habitat 67” in Montreal is made of 96,000 tons of concrete. A 60-story skyscraper would require the same amount.



Terms like “energy” or “transportation” are easy to find on lists of industrial sectors that produce high amounts of CO<sub>2</sub> emissions. But the terms “building” and “housing” are less common, although these sectors account for a whopping 38 percent of global CO<sub>2</sub> emissions. In many reports, they crop up in a range of different sectors. Buildings are assigned to the energy sector, along with heating, electricity and gas – and building materials in turn fall under the category of “industrial processes.”

Construction materials, in particular, are significant. About 2.8 gigatons of carbon dioxide are produced in the cement industry. This amount is partially driven by the extremely high temperatures used to produce cement. This involves burning limestone at 1,450°C (2,642°F) to create “clinker.” The process is energy intensive and mainly relies on fossil fuels, even if the industry is now increasingly burning waste, sewage sludge or waste oil. At least 30 percent of the required energy still comes from brown or black coal. Still, the energy expenditure is responsible for just one-third of the CO<sub>2</sub> emissions.

#### Emissions From Burning Lime

Here’s a much greater problem: When crude lime is transformed into potassium oxide, limestone is de-acidified. That releases enormous quantities of

bound CO<sub>2</sub>. While it is at least conceivable to draw on green energy for the energy input, this chemical process cannot be changed – the raw material itself is the problem. You would have to find a substitute for either the lime or the cement that comes from it.

The cement ensures that the components, including sand, water and gravel, coalesce into concrete. It is the glue of civilization today. Factories are built with concrete, as are warehouses, bridges, dams, roads as well as many residences and office buildings. Concrete offers benefits: It is extremely pressure-resistant, and it effectively protects steel from moisture and corrosion. It is estimated that about 6 billion tons of cement are produced annually, and the amount is rising. Continuing urbanization is leading to another construction boom that could extend far into the future. In just two years, more concrete was produced in China than in the United States over its entire history. And the construction industry is sticking with concrete. It is a proven, known material that is very affordable.

#### Textile and Carbon Concrete

Alternatives exist but have yet to generate widespread interest or commitment. The first possibility is to replace the lime, perhaps with volcanic ash or so-called Belterra clay, the layer of clay that covers bauxite deposits. It has to be removed from the



Belterra is the name of the clay that is layered around deposits of bauxite, especially in the tropics.

bauxite anyway during extraction. Researchers have used it to develop a cement where the clay replaces at least half of the lime. One positive side effect: At 1,250°C (2,282°F), the firing temperature of the clay is lower than the firing temperature of limestone. This could reduce CO<sub>2</sub> emissions by nearly 60 percent, overall. Other alternatives include textile-and-carbon concrete. They are composite materials made of fine concrete, carbon, glass or basalt. Since carbon fibers replace steel in this approach, less concrete is needed. The materials have been in use since 2005, though they are complicated to produce and process, and thus many times more expensive. They also raise issues for recycling, since it is hard to separate the carbon fibers from the concrete.

So if it is hard to replace lime, is less cement an option? Concrete for lightweight structures, so-called “gradient concrete,” could reduce material and energy costs by about 30 percent. This involves incorporating porous hollow spaces in the concrete where it is less stressed. But more research is still

needed before lightweight concrete can be used widely and safely. And then regulators and experts will have to enact laws and standards to certify its safety.

#### Recycling Doesn't Solve the Emissions Problem

Completely replacing concrete with wood also creates significant challenges. Wood has been such a hot commodity lately that prices for it have risen noticeably, and the already expensive material has been in shorter supply. To replace just one quarter of the concrete used each year, you would have to plant forests covering the equivalent of India. So wood is not a viable option for the foreseeable future.

Another possibility: recycling. This is important at least from the standpoint of resource efficiency. Recycled concrete does not need to be created all over again. But researchers are skeptical about its contribution to climate protection. To recycle concrete, it has to be crushed and ground – and even this takes energy. And, in the bargain, even recycled



# 340

kilograms of CO<sub>2</sub> are emitted during the production of one cubic meter of steel-reinforced concrete. That is the equivalent of what 4,000 trees can convert to oxygen in a single day.

concrete requires new cement as a bonding agent, exactly the material responsible for substantial emissions in the first place. Still, there is another benefit of recycled concrete: It is possible to set up a resource cycle limited to a local area. This would especially have an impact on transport distances and the emissions tied to them. Transporting concrete requires heavy-duty vehicles, making the practice energy-intensive. The vehicles would also be hard to electrify.

#### Separation as an Innovation?

The construction industry would ideally like to adopt CO<sub>2</sub> separation. Several million tons of CO<sub>2</sub> can be eliminated with so-called CCUS (Carbon Capture Usage and Storage), according to estimates. This involves separating out the carbon dioxide that is produced and transporting it over pipelines to storage sites. It could also be transformed into synthetic fuels. Researchers have worked on the innovation for more than a decade, and the first pilot projects have emerged. But it is still unclear whether the infrastructure required for CO<sub>2</sub> transport can even be financed.

So there are some solutions, and the cement industry has expressed support for them for a long time, especially in industrialized countries. At the same time, concrete continues to be affordable – too affordable. There is little public push for the adoption of construction alternatives, especially in the fast growing urban centers throughout the world. But one thing is clear: If we don't leave the glue of our building methods behind, it will be almost impossible to reach our climate goals. ©



Concrete can be recycled but it has to be crushed beforehand – and that takes a lot of energy.

# Feedback and Contact

## More Information

Would you like to learn more about Freudenberg Sealing Technologies, our products, solutions and services? Then take a look at [www.fst.com](http://www.fst.com) and discover our wide-ranging portfolio. On our Internet site, you can also download all the issues of our company magazine as PDFs or subscribe to the magazine at no charge.

## We look forward to a dialogue with you!

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