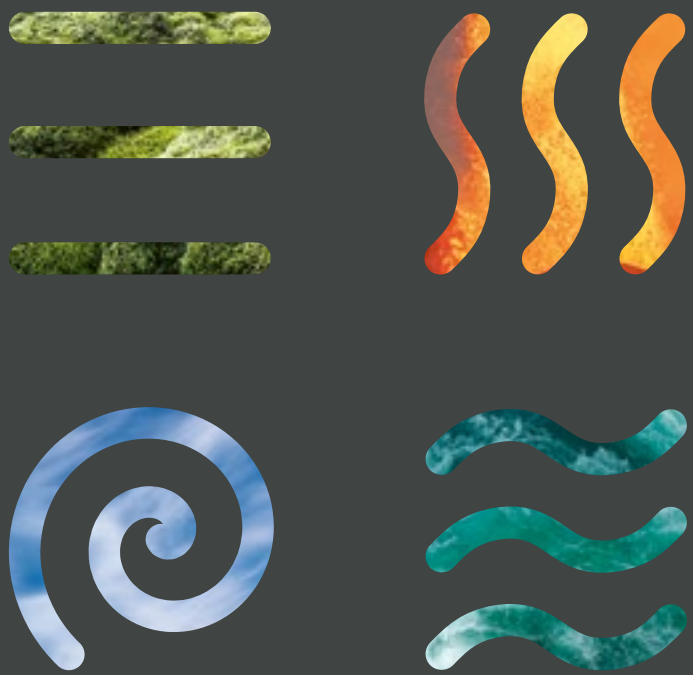
ESSENTIAL

FREUDENBERG SEALING TECHNOLOGIES



ENERGY of the Future

HOT TECHNOLOGIES
What the world can learn from Iceland's energy innovations.

ON THE UPSWING
The wind power industry is turning to ever-larger installations.

GREEN MOLECULES
Storing and transporting: Hydrogen is extremely multifaceted.

the magazine 1_23

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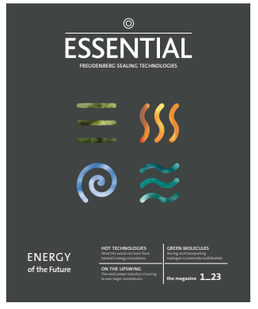
IN FIFTY WORDS



Water. Wind. Sun. The world needs energy. For heat, transportation and manufacturing. Fossil fuels are finite – but renewables offer potential. Who looks ahead at the right moment? Who will be there when innovations break through, and new capabilities unfold? Whether electrolyzers, wind turbines or photovoltaics, we're looking at tomorrow's energy.

Energy for the Future

By Claus Möhlenkamp, Chief Executive Officer
Freudenberg Sealing Technologies

Everything needs energy. It starts with the human body. We need a basic metabolic rate to live and an active metabolic rate to work, which in turn helps us nourish our bodies. Back in history, our most important power plant was our body, and nourishment was the source of energy. As we developed new sources of energy, we had the option of increasing its amount (by hunting larger animals), improving efficiency (cooked meat provided more energy), reducing the energy expended for the required activity (by using a plow in the field) or making better use of the land for energy production. Early on, people needed large forest areas to generate heat since wood was the main fuel. To supply a city with energy during the Middle Ages, wooded areas about 100 times the size of the city were needed. Humanity would have inevitably reached its limits had it not switched to coal. As a fuel for steam engines, it replaced oxen and horses as working animals and propulsion for transportation. People could begin to grow their own food on acreage that had been used for animal feed. For centuries, the same sectors represented the greatest demand for energy: heating, transportation and manufacturing.

The expected boundaries of physics have been continually pushed.

Does that seem far removed from today? Actually, the situation is not that different from what we have been doing since the dawn of the industrial age. We continue to increase the availability of energy: With the rise of the steam engine, coal consumption rose from 10 million tons a year in 1800 to about 800 million tons a century later. About 21 trillion kilowatt hours of electricity are consumed annually around the world. Our hunger for energy seems insatiable. Whenever we have more energy, we develop new technologies that consume more of it – interestingly, even in the sectors that were important over the course of our history. Heating and cooling account for about half of the world's energy consumption. Transportation is next with about one-third. And then there is the fact that developing countries are continually raising their standard of living – leading to a growing demand for energy.

Now it could be argued that the ability to innovate has consistently made more energy available. Take steam engines, oil exploration and the invention of the battery, for instance – the possibilities multiply with each new technical idea for using or storing energy more efficiently. We can be sure that human ingenuity will continue as a source of new supplies. And yet, we know that we are at a crossroads. We have reached a hard limit with today's fossil fuels, and it is similar to the one that humanity reached when it relied on wood. There is a need for new forms of energy, new ideas and new approaches to efficiency. In this connection, the word "new" is misleading. As is so often the case with innovations, many of the answers and solutions have long been on the table – in coming years, it will be a matter of implementing and scaling them to size. So, this is the "energy of the future."

We are already seeing much of that energy. For years, wind power has been setting new records in the size of its turbines and wind farms. The expected boundaries of physics have been continually pushed. Solar energy is on the move after the fulfillment of its promise lagged for years. And we finally see hydrogen being publicly discussed. We will be covering all of these topics in the latest edition of ESSENTIAL.

There is a great deal of potential in hydrogen – as replacement for fossil fuels as well as a multi-purpose storage and transport medium for green energy. Some of the questions remain, but this is precisely the point when technologies become interesting to forward-looking companies and engineers who are driven to be innovative. Freudenberg has been investigating hydrogen for more than 20 years – its time had not yet arrived just then. But such experiences are part of our history of innovation. They have given us a head start in expertise and material competency.

If you want to be around for the future, you have to get there early.

And that's what it comes down to: If you want to be around for the future, you have to get there early. Not every idea achieves a breakthrough. Will it be tidal or geothermal power plants that make an important contribution as an alternative form of energy? Given our recent experience with the way our reality can rapidly and suddenly change, we should probably be cautious about giving unequivocal answers to the many exciting questions in the energy sector. Instead, let's maintain an open-minded curiosity about the "energy of the future." The evolution of energy over the centuries has taught us how fascinating, astonishing and sometimes unexpected innovations have been. This edition of ESSENTIAL wants to do its part too.

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Powerhouse

The world's most powerful power plant is in China. With a capacity of 22.5 megawatts, the Three Gorges Dam significantly outpaces other hydropower plants and every nuclear power plant. Completed in 2012, the structure has more than 30 turbines, spans 2 kilometers (1.2 miles) and rises 185 meters (607 feet) into the air. Boats can navigate past it thanks to a multilevel system of locks on its flanks. The power plant, which dams the Yangtze River, produced 111 terawatt hours of electricity in 2020. However, the hydropower plant is not just a source of energy, it is also intended to prevent flooding in the lower reaches of China's longest river. On the other hand, the structure encroaches on the ecosystem, and many villages and cities have had to give way to the 600-kilometer-long (373-mile-long) reservoir. ©

Humanity’s Dream

It is the ultimate in wishful thinking: A machine that is constantly in motion without adding energy. Rather, people expect such a device to continuously divert energy for their own purposes. However, thermodynamic and physical laws unfortunately intervene. The law of the conservation of energy, for example, holds that energy can only be transformed from one form into another. That means a perpetual motion machine would have to be continually fed with energy to remain in motion indefinitely. Even a universal genius like Leonardo da Vinci was unable to overturn this law. Though the famous scholar tried in his sketches to draw such a machine. It moved on its own, using weights, springs and gears. ©

Primal Force

Anyone comparing the Mount St. Helens of today with photos taken before 1980 will hardly recognize it. The volcano, located in the U.S. state of Washington, erupted with such primal force on May 18, 1980, that it devastated about 600 square kilometers (230 square miles) of land surrounding it in less than 10 minutes. Fifty-seven people were also killed in the blast. Moments before, an earthquake had caused the north slope of the 3,000-meter (9,800-foot) mountain to slide away and release the pressure that had built up inside. The result was an eruption equivalent to 24 megatons of TNT, or several hundred Hiroshima-style nuclear bombs. The volcano lost up to 400 meters (1,300 feet) of its height due to the eruption. The explosion and the accompanying avalanche of lava shards and volcanic rock reshaped the surrounding area.

“Geothermal Energy is a Hidden Treasure”

Nearly all the electricity in Iceland comes from renewable sources. Is that just a peculiarity – or is it something that the island nation can teach the world? Nótt Thorberg is Director of the “Green by Iceland” platform, which plans to export know-how and promote cooperation and investment. A conversation about hot springs, innovation, and energy guzzlers.

Nótt Thorberg

Nótt Thorberg is Director of “Green by Iceland,” which collaborates with “Business Iceland” on the export of Iceland’s know-how and expertise on energy and green solutions and attracting investors – in this case with a focus on sustainable innovations. Thorberg was previously with Icelandair and worked for the leading global provider of food processing equipment, Marel, prior to that. She holds an MSc degree in Marketing from the University of Strathclyde.

> But decisions had to be made, the country had to make investments."

MRS. THORBERG, HOW DID ICELAND END UP GENERATING 85 PERCENT OF ITS ENERGY SUSTAINABLY?

We have taken a very unusual path over the last 100 years. It was not so long ago that we were one of the poorest countries in Europe – and, as an island, we were also isolated geographically. Our development basically emerged from crisis. First after World War I and later during the oil crisis in 1973, when the price of oil skyrocketed and, Icelanders decided that local, geothermal resources were a better bet for energy security than imported coal and oil.

AN ENERGY CRISIS IS PLAYING OUT TODAY AS WELL …

That's right. Back then, Icelanders had been using hot springs for bathing and washing clothes for centuries. The name Reykjavik even means "smokey bay" due to its steaming water. At first, geothermal energy was only used to heat houses. Today, however, heating accounts for 60 percent of our energy use. The idea to use geothermal as a source of electricity was new. It was a resounding success, making it all look easy in hindsight. But decisions had to be made, the country had to make investments and take on the risks of researching and expanding technology. In return, we now have very deep and comprehensive knowledge of geothermal energy.

ICELAND IS THUS QUITE A SPECIAL CASE …

Wait a moment. That's only half true. To be honest, geothermal energy is a hidden treasure. It is the world's most incredible secret. If you look at a map and see how many countries in the world could use geothermal, you might be surprised. There is potential on every continent. California is a classic example. The U.S. government has announced programs in this area. But this is not just an issue along the tectonic plates where an exceptional amount of heat is produced. There are also opportunities in many countries in Europe, and in large cities like Munich and Paris, to name a couple. Furthermore, even 50°C (106°F) water is hot enough to be useful. Geothermal heat is everywhere, and many industries require heat for their processes, such as greenhouses, aquaculture, and the cement and limestone industries.

WHY ARE SO FEW COUNTRIES TURNING TO GEOTHERMAL?

That's a fascinating question. As far as I know, there are now at least 80 countries that use geothermal energy, but very few on a large scale. I believe a transformation of this kind just takes time. Change takes time. It has cost societies a great deal of effort to switch from coal to gas. These types of shifts are always associated with increased investment and innovation. As I said, the government took on a pioneering role in Iceland. Today, the entire society is benefiting. And we have more than 200 public hot spring spas in our country. Our most important social discussions take place in hot water.

IT IS STRIKING THAT ICELAND USES COMPARATIVELY LITTLE WIND ENERGY.

There is a great deal of movement in the sector. Wind energy will become part of our portfolio. The government is preparing the legal framework. We aim to be carbon neutral and fossil fuel free by 2040. But once again, this shows how challenging it is to transition to new forms of energy. That applies to us as well and we can learn a few things about wind energy from other countries like Denmark and Norway.

WITH ITS ABUNDANT ENERGY, ICELAND HAS ALSO ATTRACTED ENERGY-INTENSIVE HEAVY INDUSTRY, WHICH ISN'T NECESSARILY SUSTAINABLE.

You have to look at this in the context of the time. The first aluminum smelter was built in 1969. It was urgently needed to compensate for the declining fishing industry. We had the ability to harness other natural resources, which attracted foreign investors, and this fast tracked our path to modern society.

Two continental plates extend diagonally through Iceland. Temperatures rise to more than 300°C (572°F) at the Gunnuhver geothermal area below the volcano of the same name.

Geothermics

The solid crust of our planet is not even 100 kilometers (62 miles) thick. Beneath it, the earth's core provides extremely high temperatures that can be used for heating. Geothermal energy involves using the heat energy stored in the earth's crust – for heating, cooling or for electricity. In the case of near-surface heat (up to 400 meters or 1,300 feet deep), heat pumps are usually needed to increase temperatures. Deeper layers can provide the required heat directly, but they require drilling.

Volcanic Iceland: The Hjálparfoss waterfall has exposed parts of the island's lava landscape in the riverbed below.

BUT THE METAL INDUSTRY, IN PARTICULAR, WAS NOT UNCONTROVERSIAL. IT'S NOT EXACTLY ENVIRONMENTALLY FRIENDLY.

There are several sides to it. Aluminum smelters chose to locate in Iceland to make use of renewable energy and make aluminum that has a lower carbon footprint than when produced elsewhere. Today, aluminum produced with renewable energy is in huge demand in the global market. More and more companies are looking at sustainable supply chains. I think every country must ask itself how to best use its resources. Incidentally, digitalization can help us become even more efficient.

IN WHAT WAYS?

By helping with forecasting and optimizing systems, for example. I worked for an airline previously. The job involved a lot of optimization effort and thinking ahead. You can approach the energy issue in the same way. How much energy will we need and how can we make the best use of it? Smart solutions will enable companies to optimize entire value chains across industries.

ICELAND IS CURRENTLY ATTRACTING NEW KINDS OF ENERGY-INTENSIVE COMPANIES: DATA CENTERS AND IT COMPANIES. IS IT A PROBLEM THAT THE AVAILABILITY OF ENERGY ALWAYS LEADS TO EXHAUSTION?

Iceland needs investors. If history has taught us a lesson, it's that every country has to find its proper balance. We are simultaneously pursuing a diversified economy involving tourism, seafood, energy, green solutions and more. Hence attracting new sectors is part of our strategy and I trust in the power of the overall market.

HOW DO YOU SEE THE FUTURE OF THE ENERGY SECTOR – AND WHAT INNOVATIONS ARE YOU HOPING FOR?

Various forms of energy will see breakthroughs. In the geothermal field, research is underway on drilling 5 kilometers (3.1 miles) into the ground, offering completely new opportunities due to the higher heat. Furthermore, I believe there is still plenty of potential in the interplay with the circular economy and cascading uses of energy. There will be a lot of development in this field in the future – vertical agriculture, mass applications in major metropolitan areas and more.

SO, YOU ARE OPTIMISTIC ABOUT TECHNOLOGICAL PROGRESS?

Yes, but we should not just think technologically. We must take a closer look at entirely new applications. New approaches for dealing with energy. I see more of a transformation than a transition by 2050. We are in an energy crisis. We must push limits. Iceland currently has a project to store CO_2 in the ground. That was unthinkable just a few years ago. But technology alone won't help us. We must change as a society.

HOW DO WE DO THAT?

Each of us should ask ourselves what our role in the transformation could be. My personal expectation is that we will see that "less becomes more." Localized communities. Circularity and zero waste thinking. A streamlining in many areas of life, including a changed pattern of consumption. This is all part of a sustainable approach to energy.

CAN THE WORLD LEARN SOMETHING FROM ICELAND OR IS THE COUNTRY A SPECIAL CASE?

Oh, we can certainly offer expertise and knowledge on geothermal energy, hydropower and even projects such as CO_2 storage and utilization. We are talking about a complete value chain, from research and planning all the way to implementation. The Icelandic firm Arctic Green Energy, for example, operates geothermal power plants in more than 60 cities in China by means of a joint venture. This has reduced emissions by 16 million tons of CO_2 – that is more than five times the amount of carbon dioxide as Iceland emits on its own.

SO, A SMALL COUNTRY CAN HAVE A MAJOR IMPACT?

Yes, we are a small nation, but we can demonstrate strength of leadership. The world is increasingly becoming aware of us, especially during this energy crisis. We have carried out international geothermal training programs in Iceland for 40 years, reaching hundreds of people at this point, and Icelandic companies have supported energy projects all over the world. I believe the world must cooperate on the current challenges, and we are eager to support other countries. If Iceland can help a little with this, that is a comforting thought. ◎

The interview in text and video:

INDUSTRY FOCUS

Hydropower

Even if there were more photovoltaic facilities and wind turbines, most renewable energy worldwide would still come from hydropower. What kinds of hydropower plants are there – and what are the challenges?

Key Facts

1. In 2021, hydropower ranked first among all the sources of renewable energy, with 40 percent of the energy produced worldwide. Wind and solar are catching up, however.

2. Based on the installed capacity of its hydropower facilities, Asia ranked ahead of Europe and North America with about 600 gigawatts.

3. The leading global producers of hydro turbines are currently in Austria, Germany and France. They have a market share of about 50 percent.

4. By 2050, one out of every five dams will be in locations subject to high flood risk due to climate change. Today, the number is one out of every 25.

Overview

If you stand near the turbine of a hydropower plant, you can feel the power of the water. People tap into this dynamic force at dams, rivers and pump storage power plants. In the last example, water is pumped into an elevated basin or reservoir when the need for electricity is low and released when demand is high. The energy output can thus be controlled. Tidal power plants are another example of hydropower plants, but they are a niche player. China, Brazil and the United States have the most installed hydropower capacity. In Europe, countries with high precipitation and large gradient differences benefit to a large extent from hydropower. Norway and Iceland cover most of their need for electricity through it. The figures for Austria, Switzerland and Italy are more than 50 percent.

Although wind and solar power are rapidly catching up, hydropower is still important. Scott Sharpless, Global Key Account Manager, Renewable Energy, at Freudenberg-NOK Sealing Technologies, knows why: “The African and Asian countries as well as India are following the example of China, which has accelerated its economic expansion by building many more hydropower plants.” With the damming of the Congo, the Grand Inga Dam is expected to become the world’s largest hydropower plant.

Challenges

In many parts of the world, it takes a long-term view to build a hydropower plant. And then there is the fact that dams, in particular, mean huge incursions into natural areas, which can have social consequences. A study published in the journal Water points to another problem. It found that 61 percent of all of today’s hydropower plants will be in high-risk areas for extreme drought, flooding or both between now and 2050. That means plans for new plants will need to take climate change into consideration.

Still, the current facilities provide reliable energy and will continue to operate for many decades. But this makes maintenance a challenge, according to Sharpless, who cites seals as an example. “The original drawings are often missing for the turbines that were installed decades earlier. So, you have to get the dimensions of the metal and draft new drawings if you want to replace the seals with complete precision.” In addition, seal technology has evolved just as materials have. You must pay attention to that issue in existing equipment.

Furthermore, there is no series production for hydropower turbines. Customized solutions are therefore in demand, in addition to standardized seals.

Freudenberg Expertise

A challenge that Freudenberg Sealing Technologies has mastered with its hydropower expertise: “We make custom-made parts for locks, dams and storm surge barriers, including those already in existence, in any shape or size,” Sharpless says. “Our portfolio includes long-lasting seals and applications that are installed in the widely used Francis turbine, among others, and withstand both vibration and pressure. We also provide main shaft seals and solutions for wicket gates as well as thrust and guide bearings.” The company’s Xpress business unit helps with the production of individualized solutions, which accelerates the manufacturing process. “We know what matters,” Sharpless concludes. “And that’s exactly what our customers appreciate.”

Components from Freudenberg Sealing Technologies have been installed in the following hydropower plants, among others:

- Three Gorges Dam (China)
- Carillon Generating Station (Canada)
- Sawra Kuddu Hydroelectric Project (India)
- Danube Sluice “Iron Gate Dam” (Romania) ©

CUSTOMER STORY

On the Upswing

The wind power industry has set its sights on ever larger and more powerful turbines. HINE is one of the companies driving this trend with its hydraulic systems. Based in Spain's Basque region, the company has worked closely with Freudenberg Sealing Technologies for several years.

HINE's wind energy experts assume that the total installed capacity for offshore facilities will increase tenfold by 2030.

HINE

Founded in 1974, the company is headquartered in Olaberria in northern Spain. HINE began to make a name for itself among manufacturers of wind turbines with its hydraulic systems in 1996. Today, many leaders in this industry rely on HINE products, which have been installed in more than 85,000 wind turbines worldwide. With more than 700 employees in Spain, China, Brazil, India, the United States and Mexico, HINE is not just involved in the construction of the turbines but in their maintenance as well. HINE also develops hydraulic products for the solar energy sector and many other industries such as mining, aeronautics, marine and railway.

When you travel by car down the A-1 toward Pamplona from the Basque capital of Vitoria-Gasteiz, you will eventually see the Aumategi on the left. The peak of this 1,200-meter (3,900-foot) mountain is a popular destination for hikers. Once you reach the summit, a strong breeze usually blows off the Bay of Biscay. The wind industry is putting the situation to good use. Dozens of small wind turbines are positioned on the Aumategi's sides.

The hamlet of Olaberria is no more than 40 kilometers (25 miles) away as the crow flies. Day in and day out, the wind plays a role here as well, at the headquarters of the HINE company. Today, its components can be found in the wind turbines built by the industry's most important manufacturers. HINE has specialized in the development of the hydraulic and cooling systems that are built into the nacelles of wind turbines. The company was founded in 1974 as a source for hydraulic systems for industrial applications. The technology has remained a pillar of the business down to the present. In 1996, the management decided to provide its expertise to the still-maturing wind power sector. It quickly turned out that it had backed the right horse. Revenue grew, and HINE founded subsidiaries in the United States and China just 10 years later. Today, its workforce has grown to more than 700 employees worldwide.

Shortly before HINE turned to the renewable energy industry, a mechanical engineering company in the region – Gamesa – began building wind turbines. Early on, HINE began cooperating with its countrymen, who now do business as Siemens Gamesa after their merger with Siemens' wind energy division. HINE has not only impressed its neighbors with its quality. Other industry leaders, such as Vestas, Nordex Acciona, GE, Goldwind and Mingyang Wind Power, put their faith in high-quality products from Olaberria.

60 %

is HINE's global market share for hydraulic systems in wind turbines.

Growing in Step with the Industry

But how did HINE components prevail in most of the hydraulic systems for the current wind power turbines, securing a market share of 60 percent? "With our systems, we helped a still evolving wind industry take off," says Alberto Frauca, Chief Sales Officer of HINE Group. "Due to our experience and the expertise of our engineers, we were able to create and install urgently needed products. So, we grew gradually with the industry." Due to their close contacts with manufacturers, the company's hydraulic specialists discover where problems lie at an early stage. Thanks to their expertise and the company's in-house research center, they develop made-to-order solutions for the latest challenges, first and foremost cylinders, hydraulic power units, fluid connections and cooling systems.

HINE also built up a powerful service division. Hence it is able to give operators fast, professional support globally, including spare parts, training and updated programs on the maintenance of their facilities. For example, its engineers came up with "wind tools" several years ago. They facilitate the safe operation of wind turbines as well as their simplified maintenance. There are tools that support the installation of rotor blades and power cables, the remote rotation of the drive train and the overall maintenance of the gearbox.

Today, HINE is developing its components for next-generation offshore turbines. They will have an installed capacity of 16 to 20 megawatts. The diameter of the rotor blades for these facilities exceeds 250 meters (820 feet). Even as the turbines grow in size, the expectation is that the products inside them will have to be more and more robust – and thus last longer. Alberto Frauca describes the challenge: "Today, the components have to function for more than 25 years, and they have to operate under harsh conditions that expose offshore turbines to corrosive saltwater at wind speeds up to 200 kilometers (128 miles) an hour."

HINE is working to take its systems for offshore facilities to the next generation.

HINE now has a large service department and provides customers with valuable wind tools.

Security and Confidence

That means the highest possible quality is required for all HINE components. When the company was looking for a manufacturer of powerful and durable accumulators for its hydraulic power units, HINE started teaming up with Freudenberg Sealing Technologies in 2015. The accumulators help moderate the powerful pressures that build up in a wind turbine's hydraulic system. If one considers the solution visually, then a pressure peak becomes a flattened curve. This relieves the entire system. "In Freudenberg Sealing Technologies, we have found a partner that demonstrates the same standard of quality as we do. It's a company that brings security and confidence to us," Rubén Martínez, Chief Procurement Officer of HINE Group, confirms. "At HINE, we need to develop complex systems in a short time; therefore, we have integrated solutions from Freudenberg Sealing Technologies into our systems. These Freudenberg products help us achieve our goals."

More than 200,000 HINE hydraulic pitch systems have been installed in wind turbines (hydraulic power units + pitch blocks) as well as more than 12,000 cooling systems. The hydraulic power units regulate the pressure inside the hydraulic system of a wind turbine, while accumulators provide the energy for turning the rotor blades toward and away from the wind. Freudenberg products make a contribution here as well. "Freudenberg is not standing still – it has a strong team that is continuing to develop technologies. That is a benefit to us," says Martínez. "Not least of all because we are called on again and again to find made-to-order solutions that meet our standards in a dynamic market. Freudenberg can support us with products developed especially for this purpose."

HINE believes that the wind industry's potential is far from exhausted. Quite the opposite. "We assume that the total global installed capacity will increase many times over," Alberto Frauca, CSO of HINE Group, projects. "It will triple for onshore facilities by the year 2030 and increase tenfold by 2050. That increase will already be achieved for offshore facilities by 2030." By 2050, the company expects wind energy to cover one third of the world's demand for electricity. HINE is responding to these forecasts by expanding its portfolio of products and services and by acquiring appropriate companies. HINE considers itself well prepared to continue to actively accompany the rise of the growing wind energy market. ◎

INSIDE

DIAPHRAGM ACCUMULATORS

Diaphragm accumulators from Freudenberg Sealing Technologies are built into numerous wind turbines. They have a specially developed elastomer diaphragm that withstands a considerable number of load cycles and exhibits extremely low permeation. A large portfolio of accumulator sizes, from 0.07 to 3.5 liters, and filling pressures up to 350 bar permit their use in the wind turbines of today and tomorrow while meeting an extremely wide range of system requirements.

Accumulator size from

0.07 to 3.5 liters

Operating pressures up to

350 bar

Read more here:
FST.com

NOW IT'S MY TURN:

Fusion Power Plant

I have potential. Huge potential, in fact. You humans are aware of this. Your hunger for energy begs to be stilled, and I – a fusion power plant – promise to deliver more energy than you would have to put into me. You have tried to achieve this for decades. Despite all your efforts, you still haven't reached your goal. In contrast to nuclear fission, I am concerned with fusing atomic nuclei. In my development, you have taken your cues from the sun. The hydrogen inside it is fused into helium under enormous heat and massive pressure. The energy released in the process is used here in photovoltaic systems 150 million kilometers (92 million miles) away. How phenomenal would it be to transfer the sun's principle into small reactors producing clean energy?

The hydrogen needed for nuclear fusion offers several advantages. For one thing, it is a component of water, which is abundant on earth. For another, the energy value of a kilogram (2.2 pounds) of hydrogen is equivalent to the amount of energy from 11,000 tons of coal. The crux of the matter: It takes an immense effort to fuse hydrogen into helium. For a process to be promising, temperatures exceeding 100 million °C (180 million °F) would have to prevail in the reactor's ring-shaped vacuum chamber. Then, with the help of a powerful magnetic field, the hydrogen atoms would form a plasma and start to fuse, giving off abundant energy. That's the theory anyway. By 2050, it should be possible in practice – with me producing clean, safe energy on a large scale. ◎

Herbert Mayer

For 23 years, Herbert Mayer has worked in sales at Freudenberg Sealing Technologies. He is now in charge of the power sector in the industrial division. This encompasses energy as well as power transmission and generation, along with power tools.

STRATEGY DISCUSSION

Energy Transition

Various forms of renewable energy are in flux or seeing bursts of innovation. Herbert Mayer, Vice President, Global Power Sector at Freudenberg Sealing Technologies, explains the opportunities for hydrogen, why seals are important for wind energy and why companies are investing in green energy worldwide.

MR. MAYER, IS THE HISTORY OF ENERGY A HISTORY OF INNOVATION?

Well, the ancient Egyptians had sails for their ships so they were making good use of wind energy. We talk about Edison's lightbulb, the steam engine and photovoltaic systems, which came along later. So, yes, innovation has always been a key factor in making energy useful and convenient to use.

BUT ONLY ONE DRIVER OF MANY?

With one invention, you can take a big step forward, but it must also be carried out technically and made available to a broad public. For example, more than two-and-a-half decades ago, Freudenberg Sealing Technologies began developing sealing concepts for hydrogen and fuel cell technologies. At the time, it was thought they would have potential for the auto industry at some point. The timing was wrong. But we learned a great deal that is immensely helpful to us today. We know hydrogen is an important topic in fields well beyond the automotive sector – from its use in ship engines all the way to the green hydrogen produced in electrolyzers.

THE RANGE OF APPLICATIONS FOR HYDROGEN HAS BECOME INCREDIBLY DIVERSE.

Indeed. There is a lot of public discussion about the use of hydrogen as a substitute for fossil fuels. But we must consider the entire value chain, that is, from its production and transport to its use as a storage medium. There are a great many projects worldwide that deal with these aspects. In electrolyzer plants, we have already reached the scale of several hundred megawatts, and we definitely need to be thinking in terms of gigawatt factories over the next few years. That will allow us to replace the power plants that burn fossil fuels in the medium term. Products and materials from Freudenberg Sealing Technologies can make a major contribution to these developments.

WHY ARE SEALS SO CRUCIAL IN THESE CASES?

Because the core element of any fuel cell and any electrolyzer is the stack, meaning the plates through which hydrogen and oxygen are conveyed. These plates need to be leak-tight and resistant to the media that pass through them, as well as the

> We are seeing an extremely strong focus on renewable energy – and on the need for investment."

media created during the process. And it all must be scalable to industrial production levels. This is crucial, and it takes material expertise to do it. This is hardly a trivial matter. It brings us back to the topic of innovation.

BUT HYDROGEN IS MORE THAN JUST A FUEL.

As I mentioned, it is a storage medium as well. I can use it to store green electricity to make it easy to manage. I can transform hydrogen into various aggregate states – into a gas for pipelines, into a liquid, or into ammonia – and then store and transport it.

DOES THAT MAKE IT SUPERIOR TO BATTERIES?

That depends on the application. Battery-electric systems are a very useful means of storage, but it is very expensive to scale them up for large industrial installations. In these cases, hydrogen can be the better alternative. We are now seeing global competition between technologies. This brings us back to innovation. It all comes down to whether the concept can be carried out efficiently and economically – and whether you can guarantee its availability. In the end, the activation for the end-user always involves costs. Innovation, as an end in itself, doesn't work. It requires social acceptance and structures.

THAT APPLIES GENERALLY TO GREEN ENERGY. ARE YOU OPTIMISTIC ABOUT THE POLITICAL AND ECONOMIC FRAMEWORK FOR IT?

We have noticed that it is not just green startups that are talking about renewable energy – it is established energy companies from the fossil fuel sector as well. They sense that the transformation is coming and want to help shape it. We are seeing an extremely strong focus on renewable energy – and on the need for investment. We are simultaneously seeing heavier financial flows into climate-related investments. There are significantly greater opportunities for growth in renewable energy right now. Freudenberg Sealing Technologies is involved in many of these future-oriented projects, and the door is open to development partnerships with customers all along the value chain. Take wind power for example: We see Asia, and especially China, as the most dynamic region for this type of energy.

The interview continues in text and video:

EARLIER THIS YEAR, AN 18-MEGAWATT WIND TURBINE WAS ANNOUNCED THERE.

Four to five megawatts are the standard for onshore installations worldwide. The figure is about 12 or 14 megawatts for offshore installations. Rotor diameters for large installations have now exceeded 250 meters. Just the installation of these turbines takes a huge logistical effort. We are not even talking about operation and maintenance at this point. These dimensions naturally impose other technical requirements, including for longevity. The maintenance of an offshore facility is only feasible by ship or helicopter and at great cost. Freudenberg Sealing Technologies comes into play as a sealing expert here as well. We are setting new performance standards with our Seventomatic® seal for large bearing diameters, while supporting our customers in their efforts to achieve greater sustainability. China is in the headlines due to increased CO_2 pollution. But in many fields, the country is a pioneer in making alternative technologies commercially viable.

TO WHAT EXTENT IS THE SUSTAINABILITY OF TURBINE SEALS AN ISSUE?

Lubricating liquids are used in wind turbines, to cite one example. No one wants to see oil slicks on their land or at sea. This is especially the case when the slicks are adjacent to a nature preserve. There are more stringent demands on seal performance in these areas. The same applies to hydropower plants.

THAT TECHNOLOGY HAS BEEN AROUND FOR SO LONG THAT PEOPLE OFTEN SEEM LESS AWARE OF IT.

Existing hydropower plants are often well accepted – but when new facilities, pump storage power plants, and reservoirs are considered, the public becomes highly sensitive to the problems associated with them. We know that they are not necessarily good for flora and fauna. Incidentally, that's why discussions have been underway for years on whether hydropower plants could be used "offshore," that is, as power stations harnessing tidal flows at sea. There have been numerous pilot projects in the field, but there hasn't been a breakthrough yet. We are watching the developments with interest since the technical demands on seals would increase due to the aggressive nature of saltwater over their lifespan. In this area, Freudenberg Sealing Technologies can capitalize on its material expertise.

THAT ALSO APPLIES TO SOLAR ENERGY.

Yes, there are challenges there as well: The regions where solar farms can be operated efficiently pose special challenges, with regard to UV resistance, for example. Effective measures to seal the installations against dust, sand and water are also necessary. A lot of money is being invested in solar power and bringing opportunities to the global South. These regions have been unable to build up their own industries. Incidentally, hydrogen plays a role here, too, enabling energy transport over fairly long distances to developed countries.

WHERE DO YOU GET YOUR ENERGY?

From good conversation with friends and family – and from a day in the mountains. In a sense, I am my own pump storage power plant. Professionally speaking, from cooperation with my team, the variety of tasks in my everyday work, and the willingness to go off the beaten path at times. That is a source of joy and energy. ◎

Maximum Energy Efficiency for Time-keeping

It lives on next to nothing: the Atmos desk clock from Jaeger-LeCoultre.

Its manufacturer self-confidently describes the clock as a "perpetual motion machine," and it comes close to that ideal: Its delicate mechanism draws power from variations in air pressure. The clock is never wound up and has no battery or power cable. A recent invention? No, the Atmos has been manufactured in Switzerland since 1937. The company's loyalty to its techno-artwork testifies to its affection for it. Customers are returning the love. They are ready to pay at least 8,450 euros for the company's most basic version. To pay that much, they must be extraordinarily impressed by the objects sitting on their desks.

It was the principle of operation that impressed Atmos inventor Jean-Léon Reutter (1899–1971). In his free time, Reutter, actually an x-ray specialist, did experiments on how atmospheric changes could be transformed into kinetic energy and then utilized. The breakthrough came with his "thermomotor," which has a metal chamber filled with a saturated, high-expansion gas. When the temperature changes, the chamber expands or retracts, providing the clock's drive energy. Reutter's second contribution: His conception of a clock requiring just one-sixtieth of the energy of a wristwatch. Its torsion pendulum completes a full cycle just once a minute. The efficiency is tremendous: With an increase or decrease of one degree in the temperature, the Atmos can run for two days. ◎

Tiny Connectors Harness the Sun's Power

These sealing rings are small, even tiny. Yet they are indispensable for generating electricity. Here's why every solar facility has them – and why producing energy in a desert is complicated.

Spring is here. The day is cloudy and cool with a slight wind. But when a gap in the clouds opens up and the sun comes out, it is suddenly warmer. The sun is a source of heat as well as light. Early on, these qualities encouraged people to use the sun's energy to their advantage. The ancient Greeks designed their houses to maximize the heat from solar radiation.

Using the sun as an energy source is one of the most important technologies available today to support the energy transition. Photovoltaic systems are flexible enough for use on virtually any open space. "The solar energy sector is growing at a fast pace," explains Marcel Schreiner, Global Segment Director, Energy, at Freudenberg Sealing Technologies. Solar panels that transform sunlight into usable energy rely on many individual photovoltaic cells. They are generally made of semiconductors such as silicon. When sunlight hits the cells, the semiconductor absorbs light particles called photons, and the electrons within the material react. Some break free from their bonds and migrate into an electric circuit inside the solar panel, and electricity begins to flow.

> It is certainly a very small product, but it is crucial for the production of solar energy."

"When one light fails, everything goes dark"

A solar facility is composed of individual panels. Special connectors are needed to link them with one another. The plug connections have highly conductive contact points so the current can continue to flow even when there is a defect in the panel. "Otherwise, it would be like with those old Christmas tree lights," Schreiner explains. "They were connected in a series, and when one little light failed, everything suddenly went dark." The connector is sealed completely to protect this crucial connecting element within the system – often with a seal from Freudenberg Sealing Technologies.

"Above all, the seal must ensure that nothing from outside – especially water – penetrates into the connector," Schreiner adds. Moisture in the connector can lead to the corrosion of the contacts. "At that point, if not even sooner, you lose power during the contact transfer." The loss of power in a solar module reduces the efficiency of the system and produces heat. In the worst-case scenario, this can lead to a fire. "The seal is a security feature in both senses of the term: It safeguards the module's electrical output and reduces the risk of fire," says Schreiner.

No Compromise on Quality

The sealing rings are made of silicone and have a diameter of about 7 millimeters. "But they have what it takes," Schreiner notes. The product is designed to seal the connector over its entire operating life. The exact lifespan depends on the external conditions at the solar facility's location. "In Europe, the first panels on rooftops have now been in operation for about 20 years." The seals are living up to these requirements without difficulty. Since solar facilities need connectors to function, the demand for them and their seals is especially high. "We are talking about the production of several hundred million seals per year," he emphasizes. "There is no time for mistakes." Freudenberg Sealing Technologies relies on automation and quality assurance in its manufacturing processes because its seals ultimately ensure the flow of electricity through the entire

Individual modules in some installations track the sun's course to draw as much energy as possible.

Marcel Schreiner

Marcel Schreiner is Global Segment Director for the energy segment at Freudenberg Sealing Technologies. Schreiner and his team are responsible for sales activities in the energy technology area and support customers throughout the world. "Especially in the renewable energy field, these technologies are experiencing dynamic growth," says Schreiner. "That's why it is especially important to stay flexible and work closely with our customers."

system. "We are not making any compromises on quality here," he adds.

"It is certainly a very small product, but it is crucial for the production of solar energy," Schreiner continues, noting that it makes no difference where the solar facility is constructed. "The seals in the connectors are the same whether the system is installed on a rooftop in northern Europe or in the Sahara." The connectors, however, are exposed to more severe strains in deserts. Ultraviolet light, heat and aridity can increase the porosity of the connectors. But these factors have less impact on seals since they are usually located inside the components.

The Trouble with Power Generation in Deserts

If the modules work as well in a sweltering desert as on a residential roof, why not supply the entire world with green energy produced in deserts? The founding members of the Desertec project asked themselves that question back in 2004. Large facilities in the Sahara were supposed to be built to produce electricity for export to Europe. But the first large companies exited the project just five years after its founding. A dispute had emerged over how the green energy was to be transported to Europe.

Therein lies the still-unsolved problem: Power cables would have to be laid beneath the Mediterranean to bring huge quantities of energy to Europe's grids from their points of origin in the Sahara. Two were already in existence at the Straits of Gibraltar, transporting green energy from Morocco to Spain.

To bring the planned quantities of electricity to Europe, it would have taken at least 500 cables of this kind. There is also the matter of energy losses during power transmission over long distances. At an early stage, engineers and investors were forced to admit that there were financial and physical limits to the transmission of electric power from deserts.

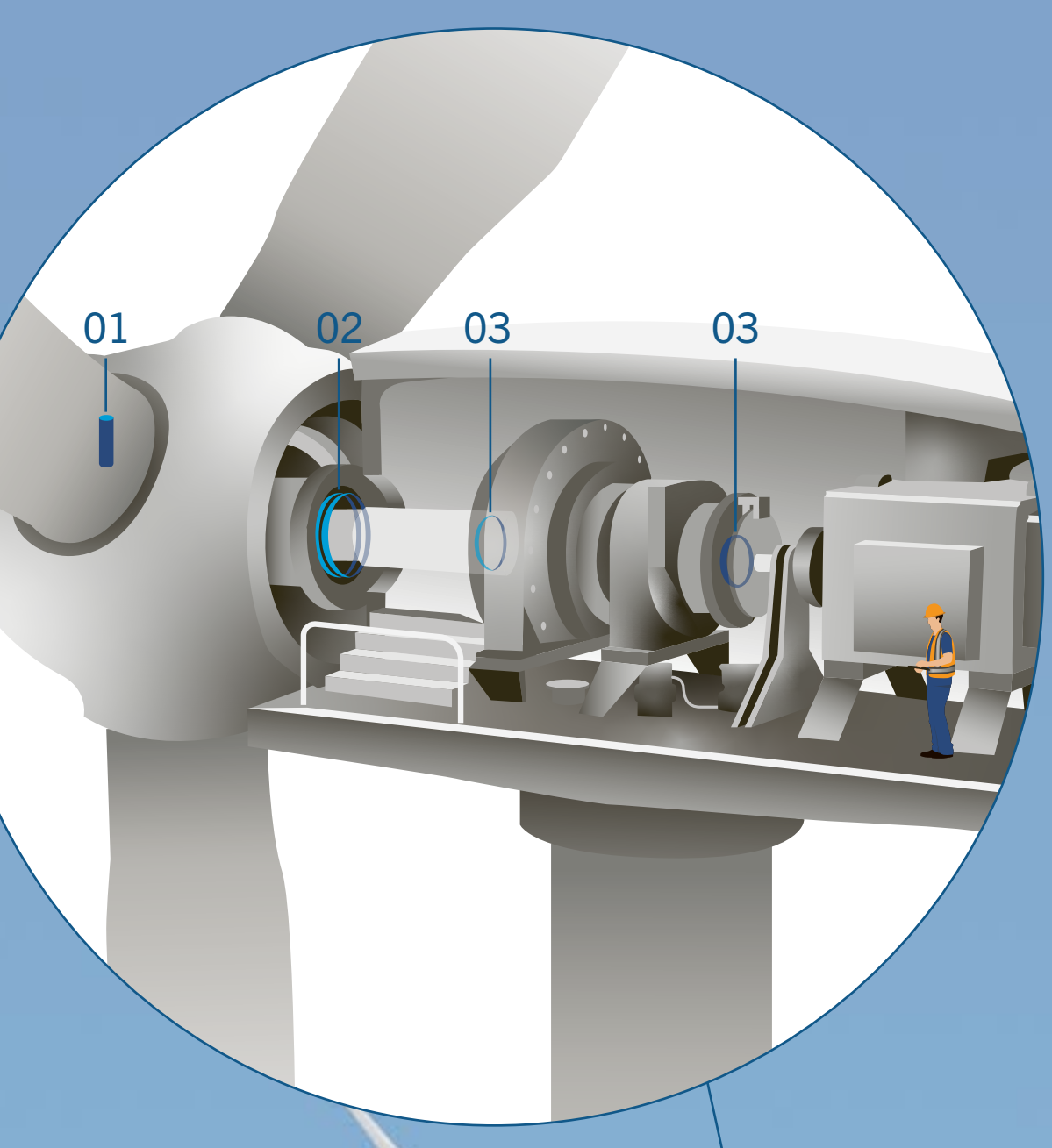
An Alternative: Green Hydrogen

But Desertec's first efforts did not signal an end to plans for solar facilities in deserts. The project is now focused on supplying countries bordering the Sahara with green electricity. In the future, solar power is expected to be a source of green hydrogen, which can be exported to Europe and the rest of the world. Huge solar energy facilities are being planned for this purpose, with thousands of solar panels strung together, each linked by a small connector, protected by an even smaller seal. ◎

INSIDE

Growing Larger Offshore

The sizes of offshore wind turbines are growing. Long-lasting seals are in demand to equip these giants for the massive forces out on the open sea. Here are seven key points where Freudenberg Sealing Technologies is helping to ensure that the turbines keep on moving as long as possible.



01 Piston Accumulators

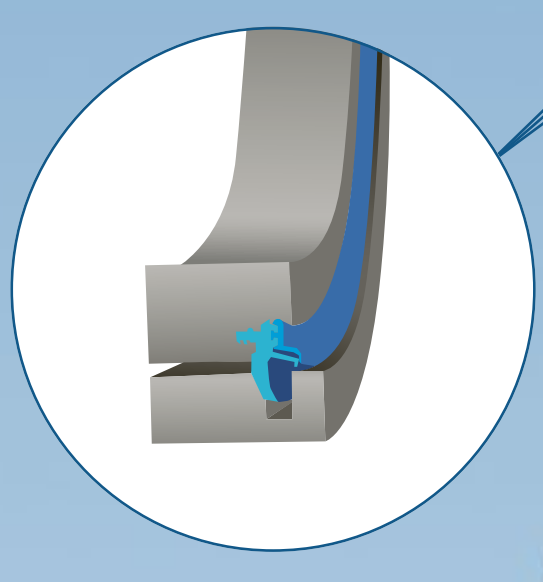
Depending on the turbine, rotor blades can be up to 250 meters (820 feet) in diameter. Hydraulic solutions using piston accumulators have proven themselves as a way to move these colossal blades. The system, which consists of a cylinder and an accumulator, reliably rebalances fluctuations in pressure and counteracts overloads.

02 Main Bearing Seal

The main bearing of a wind turbine ensures that the rotor constantly rotates around its axle. The continual motion puts severe stresses on all adjacent components. The job of a Seventomatic® seal at a main bearing is to cope with major deflections and guarantee a long operating life.

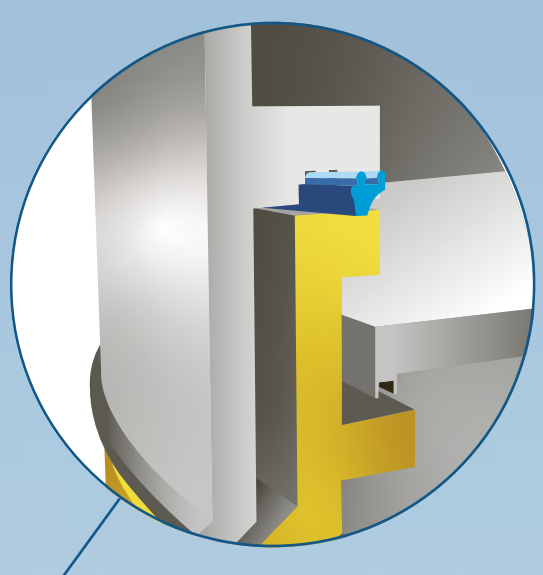
03 Simmerring®

Simmerring radial shaft seals are located at the inlets and outlets of gearboxes. They are made of material optimized for friction and wear. They guarantee that a wind power facility's operating life needs not be compromised – even as increasingly large shafts generate greater circumferential speeds.



Pitch bearing seals

Pitch bearing seals lie at an especially important contact point: where the rotor blades meet the rotor. Movement is predicted here as well: The rotor blades are oriented to the wind direction. Extruded seals protect these key locations from deformation and prevent leaks.

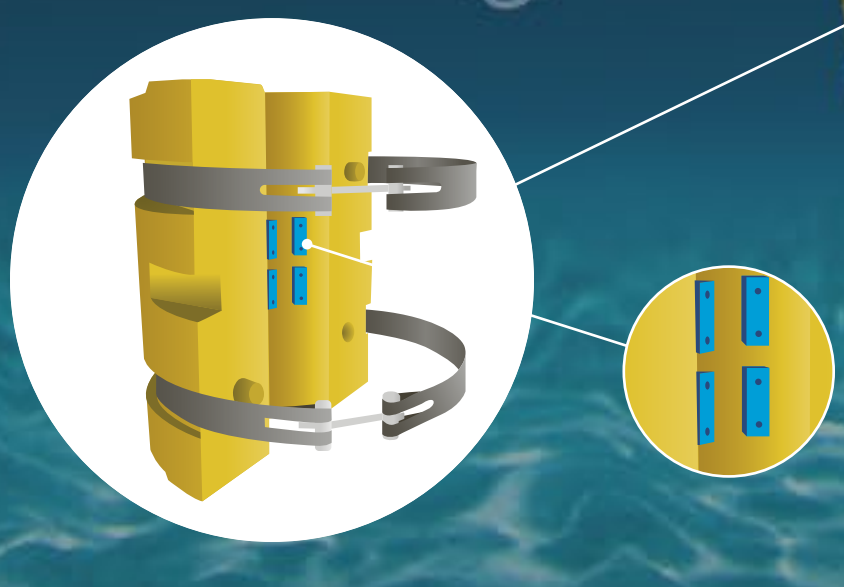


Flange Seals

Monopiles form the foundation of a wind power facility. The actual tower of the turbine is mounted on them – or, in the jargon of the industry, "flanged." This is a thorny matter since some of the parts are no longer accessible after the installation. The flange seals installed there thus determine the wind turbine's operating life.

Airtight Platform Seals

Ladders and work platforms for maintenance and repairs are located inside foundation structures. Special platform seals protect workers from fermentation gases produced by the algae in seawater. This increases safety during maintenance work.



Ballast Modules with Rubber Pads

Floating wind power facilities often find themselves hundreds of meters above the sea floor. Ballast modules keep high voltage cables that transport the electricity at a fixed water depth. This helps to reduce the stresses on the cables and prevent damage. The ballast modules require clamping systems with rubber pads between the module and the cable. These Freudenberg Sealing Technologies solutions protect the cables from damage.

The Human Power Plant

The human body is not just a consumer of energy. It is a producer as well – and delivers some of it to the environment. So, could our bodies be the source of useful energy?

Humans are electrified in the truest sense of the word. With every step, muscle contraction and reaction in our cells, our bodies produce energy. At rest, the human body generates an average of 100 watts of output. During sports activities, it reaches 300 to 400 watts. That's the equivalent of burning 2,000 calories a day. Or, from a different perspective, the energy used by an LED floodlight over a 24-hour period. The body itself uses a large share of the energy it produces: for thinking, for movement or for organs and cells. It even consumes energy at night. What's left escapes into the environment as heat.

Body Heat, Nature's Own Furnace

A room full of people generates heat just by their presence. The warmth of their bodies functions as a natural heating system. And it can also be used on a larger scale: One example is the Mall of America, the largest shopping center in the United States. Every year, 42 million shoppers make their way through this consumer paradise near Minneapolis, generating comfortable temperatures in the process. Even without central heating, a temperature of 21°C (70°F) prevails in winter. Body energy is also used systematically in Sweden. The warmth of 250,000 travelers builds up each day at the main train station in Stockholm. It is captured by heat exchangers before dissipating without effect. A system of underground water tanks and pipes stores the energy and conducts it into the heating system of a neighboring office building.

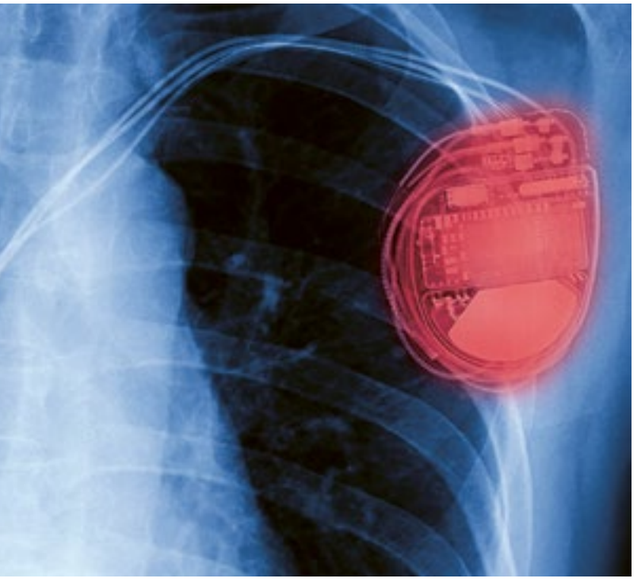
250,000

people pass through the main train station in Stockholm every day. Their body heat is captured, stored, and transported to an office building.

Early projects in the United States and Sweden use the body heat of pedestrians.

Walking Generates Energy

If you look at the human body as a power plant, you can extrapolate the usable energy. For example, 1 watt of energy can toast 133 slices of bread or blow-dry your hair for an hour. So, could household appliances be run with the help of energy from our bodies? The idea does not seem so far off. After all, radios were invented in the 1940s that could be powered by cranking. Progress in batteries soon made crank radios unnecessary. But dynamos on bicycles are still in use in many places, generating electricity purely by muscle power. The principle is now in general use in some parts of the world. An American startup has installed four streetlamps on a public square in



Several manufacturers are already experimenting with the idea of using the human body as an energy source for pacemakers.

Las Vegas that draw electricity from sunlight and the footfalls of passers-by. In addition to a cap made of solar cells, the lamps are equipped with kinetic tiles on the ground. The tiles sink slightly when they are stepped on, much as a bathroom scale does. The mechanical energy is transferred to small generators directly under the tiles. They transform the kinetic energy into electricity. Each footfall can generate 4 to 8 watts, depending on the amount of pressure.

Dancing, Sweating for More Wattage

Night clubs have also made use of this kinetic energy; operators are installing kinetic plates in the floor. The more energetically the guests dance, the more electricity is generated. In Glasgow, the Scottish club SWG3 is the first of its kind. It draws body heat from the dancers while transforming the kinetic energy. Heat pumps and fluids capture the heat in the interior and feed the energy derived from it directly into the club's air-conditioning system to cool the guests.

8 watts

is the maximum amount of electricity that a pedestrian can generate by walking on kinetic tile flooring.

The concept of using human-generated energy is neither far-fetched nor new. But how far can the concept take us? What are the limits of the human body as a power plant? So far, the answer is sobering. Compared to other renewable energy sources such as wind or solar power, body energy is not available on a large scale. It can certainly be used to generate enough electricity for a few streetlamps, but the needs of a city or even a village clearly exceed its capacities.

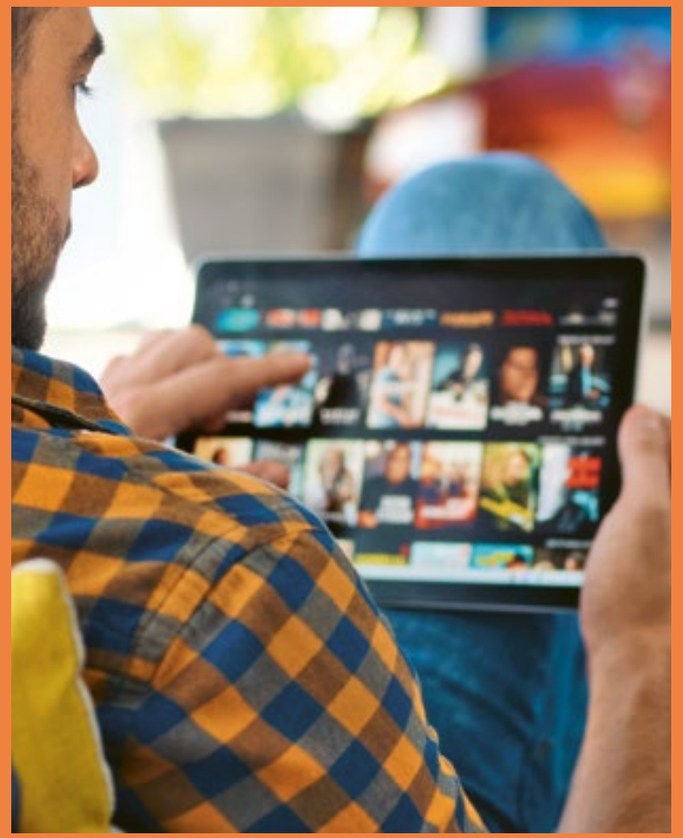
Opportunities for Small Electronic Devices

So, the concepts for its use must be limited and small in scale. With this in mind, a Swiss startup now plans to introduce a new kind of wearable, not merely worn on the body but powered by it as well. It has a prototype for a wristwatch that operates with the help of thermoelectric generators. One side of the mini-generator lies right against the user's skin while the other is adjacent to the clockwork. The temperature difference between the body and the material generates the energy that powers the watch.

Body energy holds real potential for small electronic devices. Various manufacturers are now experimenting with self-powered hearing aids and pacemakers powered by heartbeats. Piezo fibers that charge smartphones could conceivably be sewn into clothing. These fibers transform mechanical into electrical energy. If the last idea is more fiction than reality, it still offers a major advantage, even if the human power plant will likely play a secondary role among the alternative forms of energy: There are obviously billions of people in the world. Even if the scale of the technology is small, there is huge potential lurking in such large numbers. ◎

BY THE NUMBERS

3.2 Kilograms



That is the amount of CO_2 allegedly generated by one hour of video streaming. It is the equivalent of a compact car being driven 20 kilometers (12 miles) on the highway. The figure 3.2 kilograms (7 pounds) has been ascribed to a 2019 study by the French thinktank Shift and has been in circulation even until today. But Shift later spoke of a misinterpretation and corrected the figure to 400 grams (0.88 pounds). George Kamiya, an analyst at the International Energy Agency (IEA), countered with another figure – 36 grams (1.27 ounces) per hour. The problem lies in the details: How much energy does a computing center consume, how efficient is the data transfer, and how can the different figures be transformed into a single result? Computers and servers clearly need electricity for their processors and for cooling. Computing centers are becoming more efficient every year. Depending on their efficiency, a terabyte of data varies from 105 to 153 kilograms (331 to 337 pounds) of CO_2 annually. The average user on the planet watches online videos 90 minutes a day. Streaming platforms such as Twitch and YouTube reported more than 7 billion hours of online videos per day in 2022. The great mass of humanity is watching videos. Similarly, the 8 billion search requests on Google add up to huge quantities of CO_2. Incidentally, Shift says more scientific exchanges with experts like Kamiya are welcome. ◎

Electric Cars Keep Pressing Ahead

Electric cars are part of the energy transition in many countries. More and more are coming onto the market. Is the trend continuing?

Numerous energy challenges are keeping the world on its toes. The effects on everyday life – including our mobility – are gradually becoming clear. In some countries, a growing number of electric cars are on the road. But there have been dynamic developments in the energy sector in much of the world. Has there been a change in the high priority given to electric mobility?

"Not that we've been able to perceive," claims Prof. Eberhard Bock, Vice President, Technology and Innovation at Freudenberg Sealing Technologies. He keeps an eye on trends in the market. "Many countries have already set their course. Automakers are bringing more and more electric vehicles to market and have still more in the pipeline. The overall direction is unchanged."

Electric Cars: Part of the Mobility Transition

China is one example: It is the world's biggest market for electric cars. But the registration numbers are climbing in the United States, too. Nearly half of all Americans can see themselves driving an electric car instead of a vehicle powered by an internal combustion engine, according to surveys. Incentives are expected to facilitate the switch, paralleling programs in many European countries. The transformation is driven not least of all by the unambiguous legal framework approved by the European Union (EU). It wants to see its member-nations completely climate-neutral in 2050. Starting in 2035, it will be impossible to register new private passenger cars with internal combustion engines, and the limits for fleet emissions will gradually become more stringent.

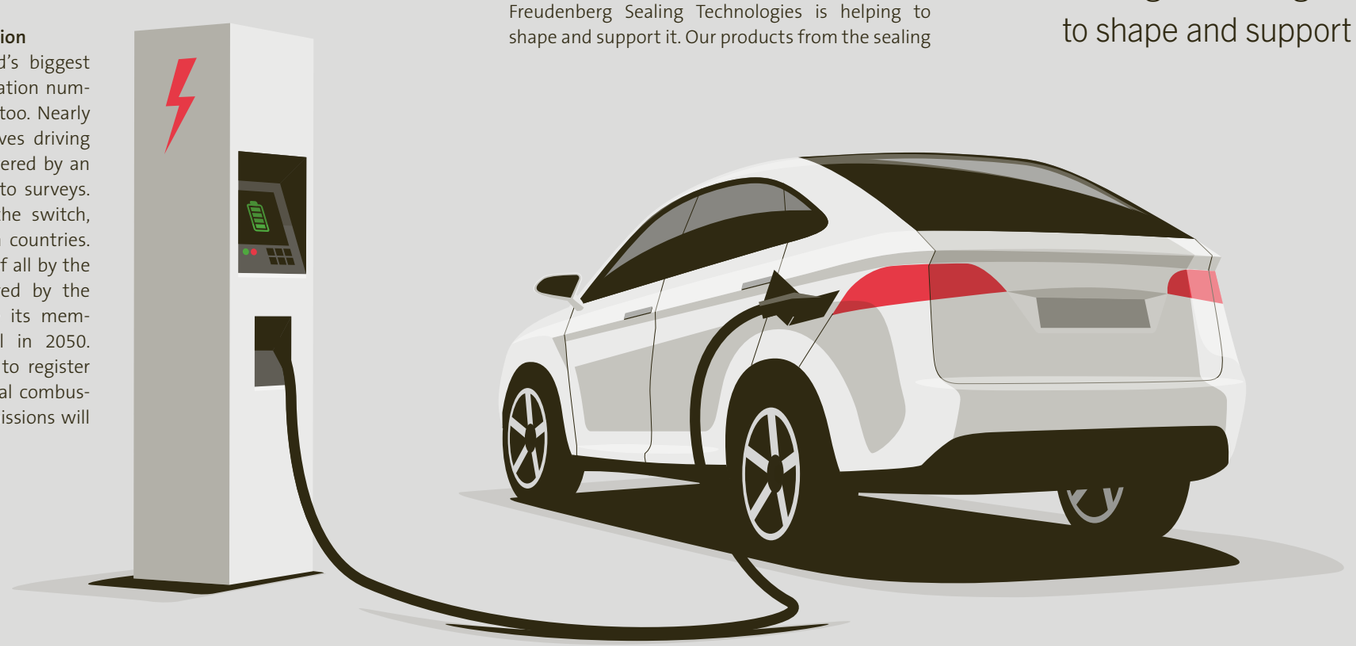
"A passenger car may currently emit 95 grams of CO_2 per kilometer. That corresponds to fuel consumption of 3.6 liters (0.95 gallons) of diesel or 4.1 liters (1.08 gallons) of gasoline per 100 kilometers. Automakers that do not achieve the EU fleet limit have to pay penalties. And they aren't negligible," says Prof. Mario Hirz, Deputy Director of the Institute of Automotive Engineering at the Graz University of Technology.

"In 2030, the limit is projected to drop by one-third to a little below 60 grams. It will be impossible to achieve these goals with internal combustion engines. That's why there will be a switch to fully electric drives in new vehicles in roughly the next 12 years." Their numbers will increase on European roads as the figure for private vehicles with internal combustion engines gradually declines.

Cars as a Growth Market

"The mobility transformation is in full swing. Freudenberg Sealing Technologies is helping to shape and support it. Our products from the sealing segment and beyond are used in many components – whether in vehicles with internal combustion engines, electric drives or fuel cells. We are dealing with all the variations," Bock adds. "The automotive sector is even a growth market for us outside of powertrains. For example, we will be delivering key components for the new, innovative radar systems needed for autonomous driving and driver assistance functions. This area is developing rapidly as well."

> The mobility transformation is in full swing. Freudenberg Sealing Technologies is helping to shape and support it."



Will we increasingly see smaller and lighter electric cars in the future? Hirz offers some perspective on this: “A scenario is looming for Europe, where established automakers are less interested in them. The production of a vehicle with an electric drive is significantly more costly than one with an internal combustion engine. This is primarily due to the battery, which accounts for 30 to 50 percent of the production costs, boosting prices for electric cars by one-third or more,” he explains. “Many automakers are gravitating to the higher price segment. That is where you find customers willing to pay more. That doesn’t mean there won’t be affordable electric vehicles. But we could see Asian manufacturers dominating this market segment.”

Automakers, suppliers and scientists around the world are working on a range of systems and components: drivetrains, energy storage systems, cell systems and thermal management. Beyond its sealing technologies, Freudenberg Sealing Technologies’ innovative spirit and openness to technologies are on display in heat shields for battery cells and thermal barriers for battery housings, among many other products.

And there is still a focus on internal combustion engines, for hybrid vehicles, for example. In any case, many countries have not yet ordered an end to cars with conventional powertrains. China is one of them. Still, it is energetically promoting the use of electric cars in cities. All of this means the energy transition could offer an opportunity for synthetic fuels. If they are manufactured using renewable energy sources, they could improve a country’s CO_2 footprint.

Hydrogen as an Energy Source

Vehicle categories besides privately owned cars must be taken into account. Both experts believe fuel cell powertrains have a future in trucks and buses. “The tank is full of hydrogen, which is transformed into electricity inside the vehicle. The electric current powers the motors. Fuel cells are ideal for long-distance vehicles, perhaps for the immensely long routes in the United States. The technology is also attractive for ships,” Bock says. The carbon footprint is ideal if the hydrogen is produced with renewable energy.

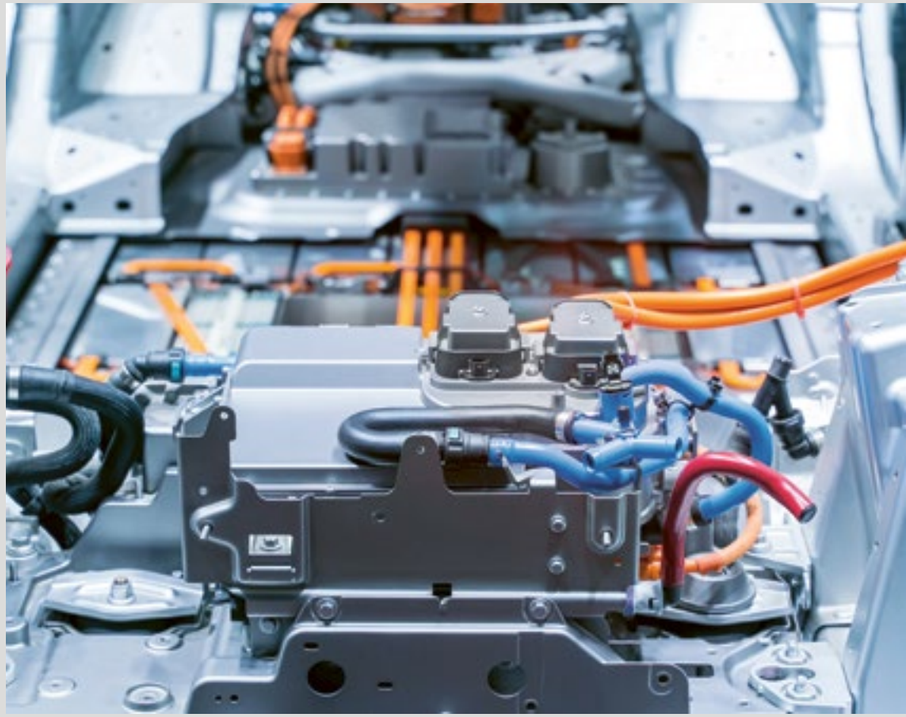
Internal combustion engines can also be fueled with hydrogen. Would that compete with fuel cells? “You have to decide which propulsion system is best, based on the application. In some cases, the fuel cell is a better choice due to efficiency of up to 60 percent, while internal combustion can offer advantages at higher load levels,” Hirz is convinced.

As of **2035**

no privately owned vehicles with internal combustion engines can be issued new registrations.

“Internal combustion engines that use hydrogen could also be a transitional solution. You can make a lot of progress toward an improved CO_2 footprint with them,” Bock adds. One advantage is that the hydrogen does not have to be as pure as it does for fuel cells, so its production is not as complex. The experts’ conclusion: “We should generally be open to alternative technologies since it will take more than electric mobility to manage the energy and mobility transitions. Overall, we will see a great variety of powertrain concepts and sources of energy. We will have to use every lever we can on the road to climate neutrality.” ◎

We should generally be open to alternative technologies since it will take more than electric mobility to manage the energy and mobility transitions.”



Wired components: the powertrain of the electric car.

Green Molecules from the Desert

The barren landscape around Lüderitz offers perfect conditions for green energy production.

Abundant sunlight and strong winds make the Namibian desert an ideal location for renewable energy. A small port city will be a base for global energy exports in the future.

So far, there are just three wind turbines operating near the Namibian port city of Lüderitz. And yet these three turbines – the only ones in all of Namibia – are just the start of a much larger project. By 2025, solar power plants and more wind turbines are expected to be generating electricity to produce green hydrogen. The location near this small city is ideal for the project. “The area is a huge desert, without a single tree dotting its expanse, but the wind is very strong,” says Sören Borghardt. He is an advisor to the longtime German State Secretary Rainer Baake, who has been named the Special Commissioner to the German-Namibian climate and energy cooperation by Federal Minister for Economic Affairs Robert Habeck. In this role, Borghardt recently visited the project site on the Namibian coast.

Ideal Conditions

Only a few locations on the planet rival this region of Namibia for the production of green energy. “A combination of strong winds and abundant solar radiation prevail there,” Borghardt explains. Near the project site and at other locations in the country, you could have solar power plants with up to 2,700 full load hours. By comparison, facilities in Germany achieve about 900 full load hours. The figure for California can be as high as 1,500. The conditions for wind energy in Namibia are above average. “After holding your hand against the wind, it is covered with sand. That is how hard the wind blows there,” he adds. The three wind turbines at Lüderitz achieve about 4,400 full load hours each, making them more efficient than their counterparts in the North Sea, which usually come in at 3,500 full load hours. The Namibian desert is thus windier than the open sea, creating superb conditions for wind power.

Yet the project at Lüderitz is not just about wind and solar energy. The renewable energy generated there will be used to produce green hydrogen. Hydrogen is a key factor in the energy transition: It is a multifaceted element and can be used as a fuel and as an energy storage medium. When it is combusted, it gives off water vapor but no harmful emissions. The water vapor goes back into the water cycle. But hydrogen today is

There still isn't much evidence of the new major project in Lüderitz.

80 %

of its electric power Namibia currently imports from neighboring countries, especially South Africa.

Green hydrogen could be one of Namibia's most important exports in the future.

The wind is often stronger in Namibia's desert than it is on the high seas.

> Shipments of green ammonia from the port are expected to begin in 2027."

primarily "gray," meaning that it is generated with the help of fossil fuels. It is only called "green" if it is produced with renewable energy. That makes it a zero-emission fuel, though it takes hydrogen production plants to do that. Those are being built in Lüderitz as well. Desalinated seawater is conducted into an electrolytic cell and is split into its components, hydrogen and oxygen, at the cell's anode. Hydrogen ions are then combined with negatively charged electrons at the cathode, creating hydrogen molecules.

Conversion into Ammonia

The Namibian government has recognized the potential of green hydrogen. "Namibia is struggling with high youth unemployment," Borghardt explains. But the energy sector offers a tremendous opportunity to create jobs. When Namibian President Hage Geingob asked his economic advisors to work out a plan for the country's future, it was clear that it had superb conditions for the development of renewable energy and could capitalize on the demand that has been rising for the green molecules, especially in Europe. Aside from hydrogen, European industry and agriculture urgently need green ammonia. It is also being produced from natural gas. But the addition of nitrogen under high pressure and temperatures can turn green hydrogen into green ammonia.

This conversion is helping the project's managers in Lüderitz solve yet another problem: transportation. "Hydrogen can be transported without difficulty via pipeline or tanks over relatively short distances," Borghardt explains. "But if you want to transport it over longer distances, by ship, for example, you have to convert it." In Lüderitz, the harbor area is being redesigned for this activity. Shipments of green ammonia from the port are expected to begin in 2027. Namibia is initially turning to petroleum-fueled tankers or container ships for transport. "There aren't any other fuels for this yet," says Borghardt. Coincidentally, it turns out that ammonia could be an alternative fuel for freighters long-term. "The project itself could be part of the solution."

Securing Power Supplies

Green ammonia was the original focus of the project announced by the Namibian government. But now the country has identified other benefits, including the production of electric power. "Namibia now imports about 80 percent of the electric power it needs from neighboring countries and is heavily dependent on exports from South Africa," notes Borghardt. But he adds that the neighbor is not a reliable source since it has its own serious problems in the sector. Its grid is often overloaded, and the power is switched off at times. "That means Namibia is dependent on a country that actually needs the power for itself."

The government intends to change that by exploiting its outstanding conditions to produce green electricity. Renewable energy, as far as possible from its own production, is expected to flow through Namibia's power grid by the end of the decade. Some will come from Lüderitz, even if it has mainly been conceived as a source of hydrogen and ammonia. "Due to the fluctuations in the amount of electricity generated with wind and solar power, there will be surplus power time and time again. After it is adapted, it can easily be used for the grid," Borghardt emphasizes.

New Industrial Center

There is something besides electricity needed for hydrogen production: fresh water. It is in short supply in Namibia – especially in the desert. But the Lüderitz area has the right conditions for freshwater as well. The project site borders the South Atlantic. "A desalinization plant is being built to treat

The small port city of Lüderitz could be an important industrial center in a few years.

seawater and supply fresh water for the production of hydrogen," Borghardt explains. It will run on renewable electricity. The desalinated water will then be conducted by pipeline to the project site in the desert. The facility will also supply the city of Lüderitz with fresh water.

Electricity, sunlight, proximity to the ocean: Each of these elements favors the location. The project could soon turn this small Namibian port city into an industrial center with a passion for green molecules. "During its call for proposals, the government insisted that at least 90 percent of the employees be Namibian," Borghardt says. Employment and a secure supply of water and electricity would make the area especially attractive to jobseekers. The number of wind turbines is expected to rise from three to 600 or 700 over the next few years, and they will be joined by two large solar projects. That is one of the location's other advantages: "There is an extraordinary amount of space," he adds. Even more than is needed for construction. The project site covers 5,000 square kilometers (nearly 2,000 square miles) from which green ammonia is soon expected to be shipped around the world. ◎

Sören Borghardt

Sören Borghardt works for the Climate Neutrality Foundation and is Senior Advisor to the Special Commissioner for the German-Namibian climate and energy cooperation. He spent his first workday in this capacity on site in Lüderitz, Namibia. He began focusing on climate and energy policy during his studies and later worked as an advisor to the energy partnerships of the German Federal Ministry for Economic Affairs with Japan and South Korea.

Material Expertise for Electrolyzers

To produce hydrogen, water must be broken down into its components, hydrogen and oxygen. Two methods in particular have been established to do this: alkaline electrolysis (AEL) and acid electrolysis using a proton exchange membrane (PEM). "Both technologies offer advantages," explains Artur Mähne, Segment Manager, Hydrogen Technologies, at Freudenberg. Alkaline electrolysis is designed to operate continuously while PEM electrolysis can ramp up to full load within seconds. This is especially important for wind and solar energy due to their fluctuating peak loads.

The Right Material

"Freudenberg Sealing Technologies offers the right sealing solutions for either process," says Freudenberg Material Specialist Dr. Alexander Hähnel. "We work with an FKM, a fluoro rubber for PEM electrolysis. It is resistant to the process's acid medium and high oxygen pressures." Another requirement: The seal may not release substances into the water before it is split into its components. "That could have a negative impact on the operating life of the remaining components. That is why we take the purity of the seal into account during a material's development."

In the case of alkaline electrolysis, an EPDM material is used for the seal since the process takes place in a base environment to which FKMs are not resistant. Both materials are applied right onto the thermoplastic carrier frames or bipolar plates with presses. "The seal has a significant impact on the system's operating life," Hähnel notes. Even though the seal in the electrolyzer is a comparatively inexpensive part, it protects more expensive components such as titanium plates and platinum catalysts.

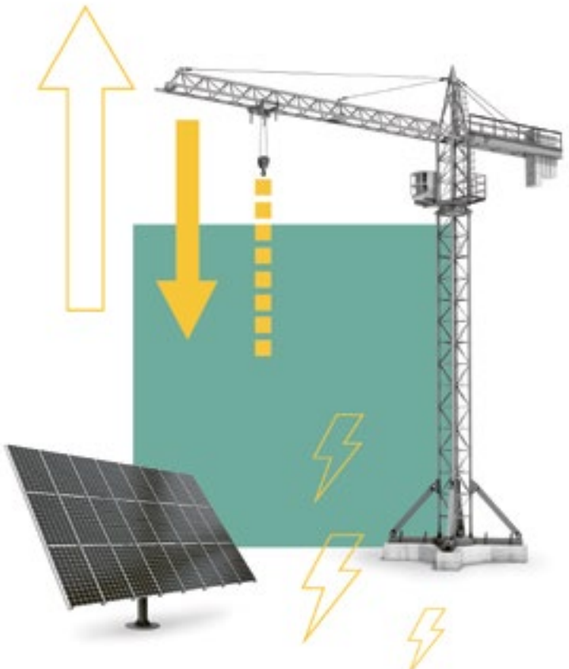
Process Optimization

It all comes down to the carrier material, the material itself and the binding agent system. "We have the expertise in-house to coordinate all this," says Hähnel. His team works closely with electrolyzer manufacturers. "The goal of the customer is to produce hydrogen at a lower cost." On the one hand, this is accomplished with the automated manufacture of the systems, and, on the other, with an optimized operating point, such as slightly higher temperatures and increased pressure.

"We are aligned with the market in all of this," Hähnel adds. His team continues to develop these materials further – they are supposed to meet all future requirements. "Moreover, we are refining our testing procedures to ensure that our seals function reliably in electrolysis systems, even over long timeframes." ◎

Charging Up the Think Tank

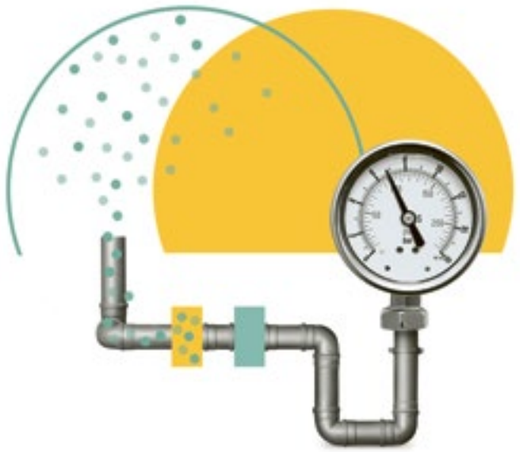
Wind, water and the sun are sources of green energy, but not around the clock. That's why there is a demand for efficient energy storage methods. Here are three surprising solutions that hold out real potential for innovations.



Blocks from Debris

Simply ...
Energy is generated when concrete blocks are moved from place to place. The Swiss clean technology company Energy Vault, which is listed on the U.S. tech stock exchange, has developed a formula for success out of this ostensibly simple concept. The process starts with a 120-meter (393-feet) crane that stacks concrete blocks. The latest generation of this energy storage system consists of a box-shaped structure. The mode of operation is always the same. When there is an energy surplus, an artificial intelligence system elevates the materials for the structure, storing the available energy. It is released when the materials are lowered. The approach resembles the operation of a pump storage plant. The difference is that the blocks, not water, are the storage medium. They are made of earth, sand and debris gathered locally.

... Genius
If a solar or wind park is connected to this type of long-term storage system in the standard 500 megawatt hour size, the plant is capable of replacing a large coal-fired power plant. The cost of the system is expected to be $5 to $10 million – a cost that can compete with pump storage plants. The storage system needs no water, lithium or cobalt, and is not affected by the weather.



CO_2 as Benefactor

Simply ...
When it comes to the climate, CO_2 emissions do not exactly enjoy the best reputation. An Italian startup has now managed to transform this disagreeable compound from villain to hero. And it is taking a simple approach: The CO_2 is held in a dome-shaped repository. When energy is injected, the gas leaves the dome as it is compressed and liquefied, and then is stored outside it under pressure. At discharge, the liquefied CO_2 takes the reverse path, returning to its original form. In the process, the compound expands, creating large quantities of compressed air to drive a turbine and generate electricity.

... Genius
The dome-shaped structure adapts flexibly to a particular volume, compensating extraordinarily well for pressure differences. The technology has long been used in biogas systems. The closed cycle handles exactly one charge of CO_2 without expelling any of it into the air. Thanks to its large size, this sustainable energy storage technology is ideal for a connection to a wind or solar farm in rural areas. A system can store electricity for about eight hours.

Pumps in the Deep Sea

Simply ...
Sometimes the solution is 700 meters (2,300 feet) down. Researchers have discovered that the principle of a pump storage plant also works on the ocean floor. After all, the ocean has everything needed for it: ample space and water and enough of a pressure gradient. If hollow concrete balls 30 meters (about 100 feet) in diameter are lowered to the ocean floor and a valve opens up, water under high pressure flows into the hollow space inside. The water drives a turbine that produces electricity using a generator. If there is surplus energy, the turbine functions as a pump and conveys the water out of the ball in the opposite direction.

... Genius
The seawater storage system ought to be able to feed about 5 megawatts of output into the grid. This comes close to the average performance of an offshore wind turbine and thus suggests huge potential for this method of storage worldwide. In fact, suitable locations such as the coastal waters off Norway, Spain, the United States and Japan could potentially store more than 800 terawatt hours. That is 80 times what the world will need per year through 2040, according to forecasts. However, this approach has not yet made it past the prototype stage. ◎

Having Fun as You Save

A playful approach can be an effective and entertaining way to save energy – taking on the challenge of reducing fuel consumption as you drive, for example. It can work in companies, too.

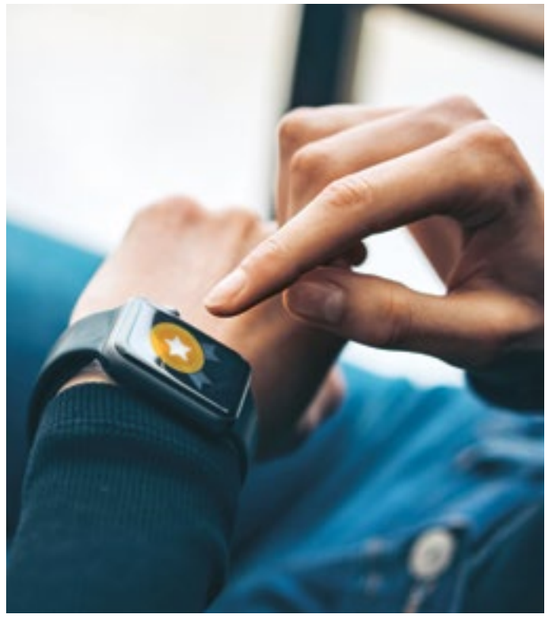
Making the energy transition comprehensible: Siemens Energy's "energy landscape simulation."

Work is not always fun. But it's easier to reach your goal if your attitude is more laid back. The digital world, in particular, makes this possible across a broad range of activities. For example, minigames can make learning a foreign language easier. Or a smartwatch can award you a virtual medal when you achieve a goal in your favorite sport.

"The concept is known as 'gamification': Playful elements in a non-game scenario increase motivation," explains Madlen Günther, a research associate at the Cognitive and Engineering Psychology Research Group at the Chemnitz University of Technology in Germany. "Gamification came out of the advertising and entertainment fields to create long-term connections with customers. Today, it can be found in nearly every aspect of life." The group has dealt with gamification in several projects. One of them explored ways of promoting energy-efficient driving with electric cars as part of a carsharing program.

Companies are using gaming elements to promote employee commitment, among other things. They are also used to encourage staff to achieve climate goals. Why is it worth contemplating gamification in this area? "Because it can bring about changes in behavior that can be sustained," Günther said. The psychologist zeroes in on the main lever: "The feedback provides the most important stimulus – the response triggered by the behavior or success. A number of factors turned out to be less important. They included comparisons with other participants, perhaps based on rankings, along with awards, virtual rewards and real financial incentives." Prof. Josef F. Krems, head of the research group, adds: "The thing to remember is that this is not a game. The context is serious. Individual game elements – but not a complete series of them – are employed."

Sophisticated: Gearing cars for energy savings. The representations are sometimes very elaborate.



Gamification in daily life: It already has wide-ranging uses – including apps for smartwatches.

Optimized Energy Consumption

Companies qualify as a serious context. They are facing major challenges related to energy consumption. "The issue is already extremely important in decision-making when considering the purchases of new machines or installations. Energy use, of course, can be represented numerically. But we wanted to go a step further," says Hans Kloos, a member of Freudenberg Sealing Technologies' sustainability team. He focuses on Energy Auditing and Investments together with four colleagues. "As of this year, a 'smiley' system has been supplementing our investment planning tool. When an employee applies for the purchase of a new machine, he enters the technical data into a digital form – and sees at a glance how it affects energy consumption." If a sad, red smiley face looks back at him, the energy consumption is higher than it has been with the current equipment. But if the new machine improves productivity, a green face smiles back: That means the investment would reduce relative energy consumption in kilograms of CO_2 in relation to revenue.

"Gamification functions in a serious environment. You have to choose and design the elements appropriately," Günther explains. "Other factors need to be taken into account, as well." For example, employees need time to become familiar with the system. And transparency is important: What happened? Why is it important? The gaming elements also have to be tailored to the target audience, the cultural sphere and the right age. Gaming approaches find much greater acceptance in Asia. You can take them much further there than in the United States or Europe. And the young tend to be more open to gamification than their elders.

Playing Energy Manager

Siemens Energy has made gaming elements part of an energy landscape simulation. Among other things, the energy technology company produces equipment for power plants and energy transmission systems – and thus the energy transition. For instance, the simulation uses animation to show a city, an industrial area, a port and traffic routes. Employees and visitors are the target audience. "The energy landscape makes the energy transition and all its challenges comprehensible. It turns you into an energy manager. In a fun way, you can test how CO_2 emissions and grid stability change when wind energy or photovoltaics replace coal-burning or nuclear power plants," says Project Manager Fabian Jung.

The energy landscape can be viewed on a four by two-and-a-half meter (thirteen-by-eight foot) LED wall and is controlled with a touch table. "You immerse yourself in the action in a virtual space. If an unstable electric grid is on the horizon, it lights up red. If the stabilization succeeds, it signals rewards," Jung said. There was a deliberate decision to use a highly simplified representation and largely avoid specific numerical values. "The CO_2 reductions are not accurately presented down to one or two percentage points. The overall picture is what is important – and what levers are available for decarbonization." A zoom function, on a wind turbine, for example, shows the technology in detail.

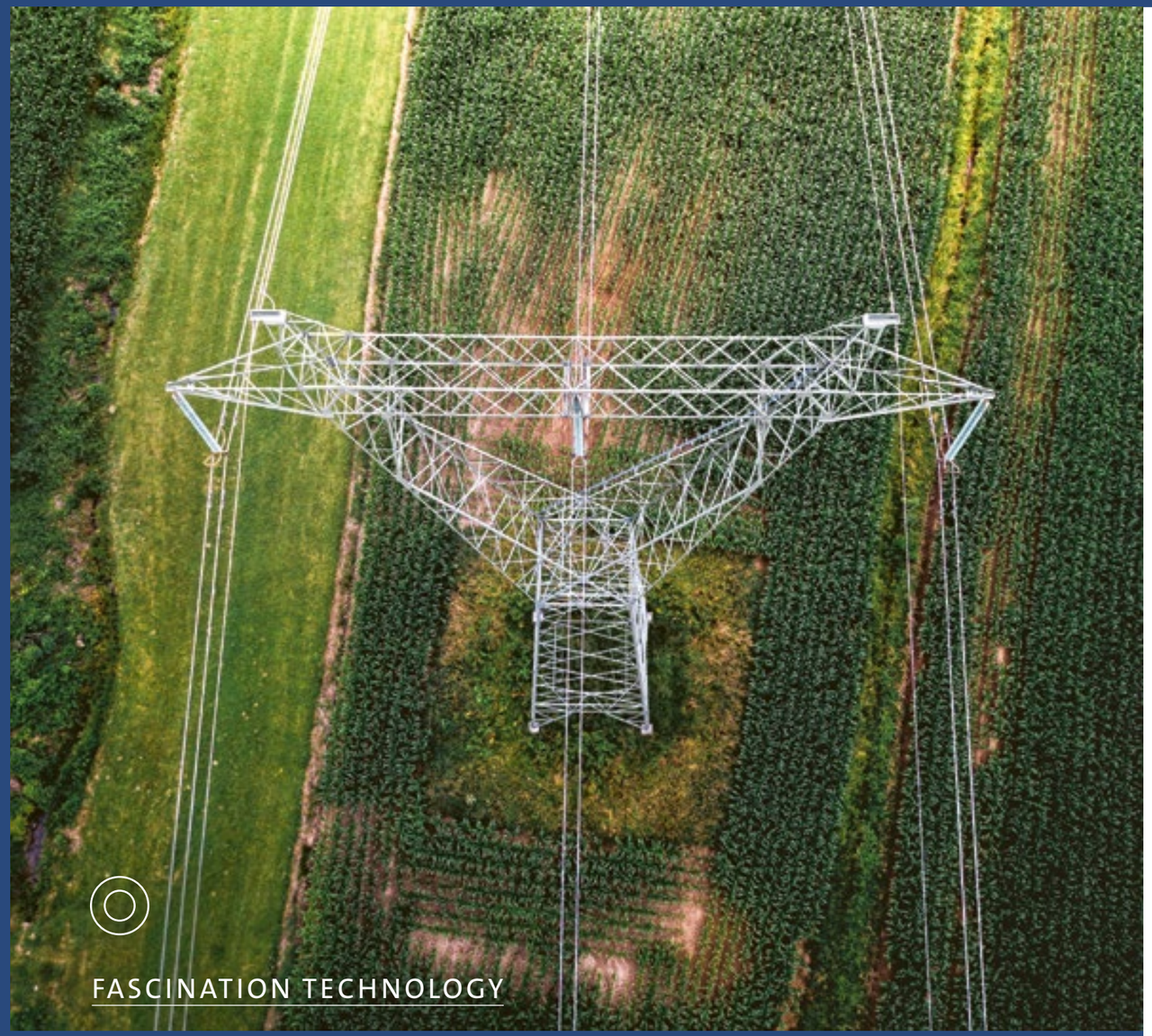
Effective Stimuli

Companies usually use graphic representations of operating figures and derive measures from them. For example, Freudenberg Sealing Technologies works with the energy monitoring system Econ Solutions at many of its locations. "Consumption peaks are shown in red and can be recognized at a glance. The operator takes countermeasures, so consumption is evenly spread out over the course of the day," explains Karl Stein, Freudenberg's sustainability team lead for factory standards and sustainable technology alternatives. "Who knows? Perhaps visualization is the prelude to incorporating other game elements to spur actions in the future."

> "The stimulus has to be well thought-out. For example, if the playful aspect is too enticing, the serious objective can be lost."

"From our use of smileys in the investment approval process, we know how effective these elements can be. On the sustainability team, we continually consider other uses for gamification," agrees Lea Harmening, who handles sustainability stakeholder coordination for the team. "Yet, we are aware that a typical work environment has different boundaries than private applications have."

"The stimulus has to be well thought-out. For example, if the playful aspect is too enticing, the serious objective can be lost," Krems admits. "There can be no undesirable side effects either. Consider driving: If the distraction from gamification to reduce energy consumption is too great, this could cause an accident." Apart from the health consequences, the cost-benefit ratio would be all wrong and no energy would be saved … ◎



FASCINATION TECHNOLOGY

Rubber Sealing Material in Eletric Substations

When electric current has to cover long distances, it reaches consumers with the help of substations. Protective gases perform a vital service in high-voltage switchgears at these facilities. Seals make sure that the gases stay where they are supposed to. But how?

Initial Situation

In many countries, the expansion of renewable energy is an imperative. To ensure the energy transition's success, it will be crucial to transport the electricity generated in hydroelectric plants and in solar and wind farms to consumers with minimal energy loss. New electric power lines are now expected to supplement those already in existence. After all, more energy from windy coastlines has to travel deep into the interior. Distribution stations and substations are part of these high-voltage networks. They connect overhead power lines, which transmit electricity at more than 110,000 volts, with local distribution networks that operate at low voltages. Substations can be designed more compactly with completely encapsulated, gas-insulated switchgear as opposed to those using ambient air. Accordingly, gas-insulated switchgears can be used in buildings in a space-saving manner, which is important in urban areas. When electric circuits are switched on and off, electric arcs can occur in switchgear. The protective gas helps to prevent these arcs or to extinguish them immediately.

The Challenge

Seals make sure that the protective gas remains in place as long as possible. For a long time, their job was to seal against sulfur hexafluoride gas (SF6), which is extremely harmful to the environment and is composed of large molecules. They do not migrate through seals very quickly. But system operators are now turning to more ecologically friendly, CO_2-based protective gases. These gas mixtures contain molecules with a smaller volume than those of SF6. They penetrate the EPDM rubber sealing material typically used with SF6 more easily. The phenomenon is familiar to anyone who has ever seen a balloon gradually lose air. It was therefore imperative to find the right material mix to counter the permeation, that is, to keep the gas from penetrating, transmigrating and escaping past the seal.

The Solution

Freudenberg Sealing Technologies has developed compounds based on chlorobutyl rubber (CIIR). They can be counted on to keep carbon dioxide gas molecules in check. Seals composed of CIIR ensure that their operating life extends over several decades, a key goal in industry. They operate flawlessly between - 60°C and + 130°C (- 76°F and + 266°F) and offer long-term resistance to oxygen and ozone acting on their exterior.

But how do CIIR seals manage to slow down diffusion, that is, the penetration and transmigration of the gas through the seal? Their three-dimensional network of polymer molecules is considerably denser than the former option. It could be compared to an extremely fine sieve. Even the molecules of carbon dioxide gases have a harder time making it past the polymer chains. Accordingly, the migration of the gas through the seal slows down. The moment of desorption, when gas molecules make it to the exterior of the seal, is delayed considerably. ◎

Freudenberg Sealing Technologies is pursuing a wide range of approaches at its sites to minimize the use of fossil fuels.

Efficiency as a Driving Force

Economies are facing massively higher energy costs. Using energy more efficiently and sustainably is in greater demand than ever. Freudenberg Sealing Technologies has taken both imperatives to heart for some time.

Numerous work steps are required before a seal takes its final shape. Its materials are blended, kneaded, folded and rolled, among many other steps. Machines play a role at every station, and they need one thing above all else: energy.

A Groundbreaking Technology Decision

Electricity and heat are key factors in the production of high-performance products, the kind that Freudenberg Sealing Technologies manufactures worldwide. The company wants to use the energy for these processes as efficiently, cost-effectively and eco-compatibly as possible. Fortunately, it can play the cards it was dealt decades ago when a groundbreaking technology decision was made. In effect, the company's leaders anticipated Freudenberg Group's current sustainability program. Among other things, it advises each business group to electrify technologies to become less dependent on fossil fuels.

"Back in the 1980s, we started out by exiting steam-heated presses," explains Hans Kloos, who is in charge of the Sustainability Program, Investments and Energy Auditing at Freudenberg Sealing Technologies. "There were practical reasons for this at the time. Our management was turning to smaller machines that were supposed to be erected and relocated flexibly based on production requirements. The fact that they could do without fossil fuels, usually consuming less than 50 kilowatts of power input, was a welcome side benefit." In any case, vulcanization presses have long been heated electrically and steam-driven presses have given way to electrical systems.

"Our goal is to completely do without fossil fuels," highlights Karl Ludwig Stein, one of Kloos' colleagues. "In manufacturing, we use them at very few locations. It is therefore increasingly a matter of doing without them for the heating and air-conditioning of buildings or for systems such as exhaust air treatment equipment." These systems filter solvent vapors generated during the coating of steel or plastic carrier parts. The coating ensures that elastomers adhere reliably to the carrier portion of the seals after the forming process. To keep the vapors from escaping into the air, they are suctioned away and often burned with a gas ignition mixture. There are also electrical alternatives to this process, although Freudenberg Sealing Technologies is taking a different approach at some sites, such as Reichelsheim in Germany and Kufstein in Austria. "We are forcing solvent-infused waste air through a kind of composting system where bacteria break down the pollutants. This biological approach saves heating energy in the process," Kloos explains.

Several sites are using bacteria to filter out solvent vapor as a way to purify exhaust air.

200

private households could be powered by the energy saved by the company's plant in Kufstein, Austria, in one year.

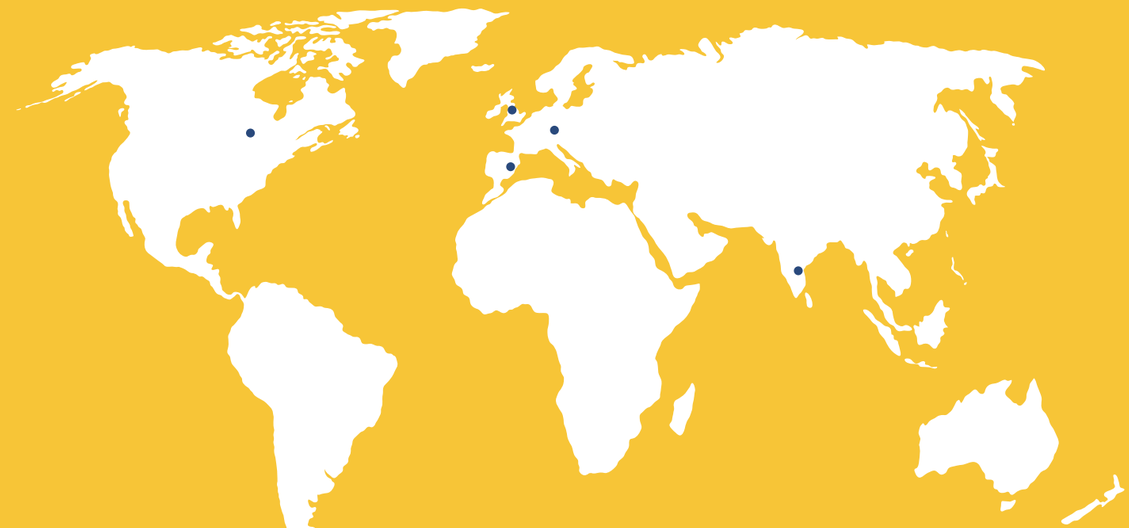
Success with a Mix of Measures

The company is striving to use green electricity as much as possible and even producing its own. "We are pressing ahead with the expansion of photovoltaic systems where it makes sense," Kloos says. The company's sites at Emmerich in Germany, Chennai in India and Parets in Spain are already equipped with large photovoltaic systems. More locations will follow. Besides the increased use of solar energy, Kloos, Stein and the plant managers are examining sites where energy storage systems can cover energy needs at night. The switch from gas to hydrogen is also on the agenda.

On the other hand, the company's facility in Öhringen, Germany, has no heating system whatsoever. The waste heat from the manufacturing machinery is fully sufficient. Due to the green components of the power supply mix, the site has been operating nearly CO_2-neutrally for about 15 years. The new plant in Emmerich is following its example by substituting waste heat for a heating system. At sites where using waste heat would be insufficient or impossible, the heating systems will be gradually modernized. "Energy efficiency and a departure from the use of fossil fuels are approaches that we have been pursuing globally for a long time," Stein said. "The underlying quest for CO_2 neutrality has already taken us a long way and will continue to be a driving force at all of our facilities."

The Chennai plant in India is betting heavily on photovoltaics.

All over the world, Freudenberg facilities are turning to sustainable approaches and energy conservation. Here are a few examples:



India

The company's facility in Chennai covers part of its energy needs with a large photovoltaic system on its roof. Consequently, the Morinda plant that is scheduled to be put into operation in 2024 will also get one. In addition, there are plans to bring the energy-intensive phosphating system to the proper temperature with a combination of a heat pump and waste heat from the production area.

Austria

A mountain stream crosses the factory grounds in Kufstein. Its water is not only used to cool the incoming fresh air in the production areas, but also the machines and tools. The savings in energy consumption are equivalent to the supply for 200 private households for a year.

Spain

A new plant, including a warehouse and administrative area, is being built at the company's site in Parets. A photovoltaic system on the building's roof will provide a portion of the energy that it consumes. Waste heat from machines will be used for heating and hot water. A biological system handles the exhaust air treatment for the production area, thus saving energy. Fossil-based energy has been ruled out. The annual energy savings is projected to reach 844 megawatt hours, with annual CO_2 savings of 110 tons.

England

The North Shields facility located near Newcastle has reduced its natural gas consumption by nearly two-thirds. Destratification blowers under the ceiling send heat back to the work area and prevent heat loss through the roof. In the summer, roof ventilators reduce the need for air-conditioning.

USA

Freudenberg Sealing Technologies plans to move in a different direction on climate control at its manufacturing plant in Necedah, Wisconsin. As part of the planned replacement of the heating and cooling systems there, the waste heat from the cooling system will be pumped into the ground during the summer and be recovered during the winter by using heat pumps. ◎

The Brewing Process Makes the Difference

Coffee is a popular energy booster. But how much energy goes into coffee on its path from the field to the steaming cup on your table? Answers to an interesting question.

Coffee drinkers know the signals: Something is hissing and bubbling in the kitchen, and an aroma is circulating through the room. You have a steaming cup in front of you a short time later. The first sip is a delight. Or just a welcome burst of energy. Coffee is the most popular drink in many countries. About 2.25 billion cups are consumed worldwide each day.

Caffeine is the most potent ingredient of this pick-me-up. It blocks the effect of adenosine, a neurotransmitter, producing the sense of being wide-awake.

59.1 Grams of CO_2 per Cup

But how much energy goes into this beloved energy booster as it travels from the field to the coffee cup? A few numbers for orientation: For example, the German coffee company Tchibo determined the CO_2 footprint of a type of roasted coffee not long ago. On average, it turned out to be 59.1 grams of CO_2 per cup. That figure can be broken down at each step. The cultivation of the plants accounted for the largest portion, 33 grams, including fertilizer and crop protection agents. Following that was the preparation of the coffee at 18 grams on average. Depending on the process, the figure could range from 10 to 60 grams of CO_2 per cup. Taken together, ocean transport, roasting and packaging come in just under 4 grams. Another 4.3 grams of the total relates to the beans' delivery to the sales point, the consumer's trip to the store, and finally the disposal of the coffee grounds into the organic waste bin.

Power Consumption as a Factor

An electric kettle is the most energy efficient way to brew coffee. About 70 watt hours go into the preparation of a single cup. That was the finding of a study commissioned by the World Wildlife Fund of Switzerland and the Zurich district's electric power station. The electric kettle was followed by the drip coffee maker, the pod machine and the fully automatic coffee maker with about 100 watt hours. The biggest user was a mocha coffee pot with a glass-ceramic cooking plate, registering 250 watt hours per cup.

Consumers thus have a major impact on the CO_2 footprint of their coffee consumption. The issues are straightforward technically, but not always emotionally. One person swears by coffee from a drip machine as his energy booster, another prefers classic espresso and the third sings the praises of the French press.

Electricity from renewable sources can significantly reduce a CO_2 footprint, and there are other ways to reduce the CO_2 emissions generated by a cup of coffee, such as your choice of a cup or mug when you enjoy the drink away from your home. It makes a difference whether it is a single- or multiple-use cup. The CO_2 footprint is also less if you substitute a plant-based alternative for standard milk.

The Tea Drinker's Advantage

Some of the factors cited here clearly apply to tea, although it is considered markedly more environmentally friendly than coffee. Experts say tea production uses nine times less land than coffee cultivation, when everything is taken into consideration. Its processing is also less energy intensive.

Coffee beans are dried, washed, roasted and ground. Tea leaves, by contrast, are merely rolled after the harvest and then dried with hot air. And that's it. Taken together, the harvest, rolling, drying and transport represent about 20 percent of the overall energy consumption. Boiling the water for tea represents 80 percent of the total energy input.

So, is it time to switch to tea? That's not an option for a true coffee lover. It would be better to consider how changes in your daily behavior could improve your personal CO_2 footprint. Which is not a bad thing anyway. ◎

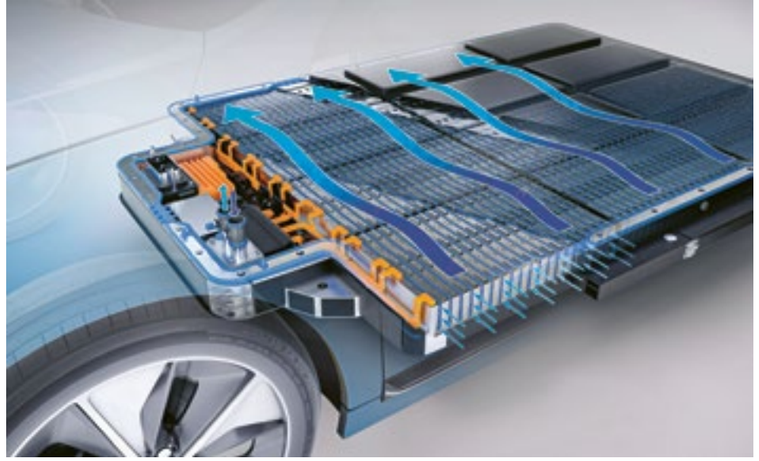
The impact of enjoyment: Every coffee drinker prefers a particular method of preparation.

Seals for a Better Experience

From the fields to the cup: Many Freudenberg Sealing Technologies products are used at many points in food production, and the coffee business is no exception. One goal is to improve energy efficiency. Among other areas, the products can be found at the end of the chain. Micro seals in fully automatic coffee machines are one example. After all, the devices are small, complex processing systems in and of themselves.

March 2023

E-Mobility: Sealing Materials for Cooling Fluids

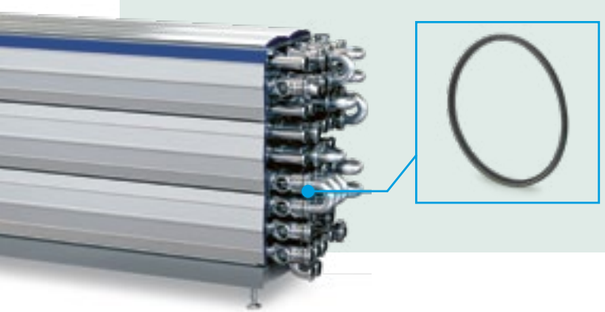


Traction batteries heat up significantly during the "supercharging" of electric cars and extreme power output. With a novel system called battery immersion cooling, the battery cells are embedded directly into a specially developed cooling medium that efficiently draws off heat. In a study, Freudenberg Sealing Technologies explored how typical polymer materials in seals and other components behave in cooling fluids of this kind. Tests were run on ester-based and isoparaffinic oils that are specified for – and widely used – in direct battery cooling, along with other types that fluid manufacturers are developing right now. The new fluids and earlier coolants differ substantially in terms of their behavior. Still, Freudenberg was able to identify appropriate sealing materials for them. The study thus provides an excellent foundation for the development of future spacers and seals for series production. ◎

January 2023

Certified Safety

Technical components in the packaging industry are subject to strict standards, including country- and industry-specific hygienic requirements such as the EHEDG (European Hygienic Engineering and Design Group) guidelines. The Tetra Pak tubular heat exchanger with a specially developed Freudenberg seal is the only product of its kind on the market to receive the EHEDG approval. The hygienic sealing product connects the stainless-steel components of the tubular heat exchanger. In the food industry, it is used anywhere liquid products with different viscosities and solid content are heated to improve shelf life.



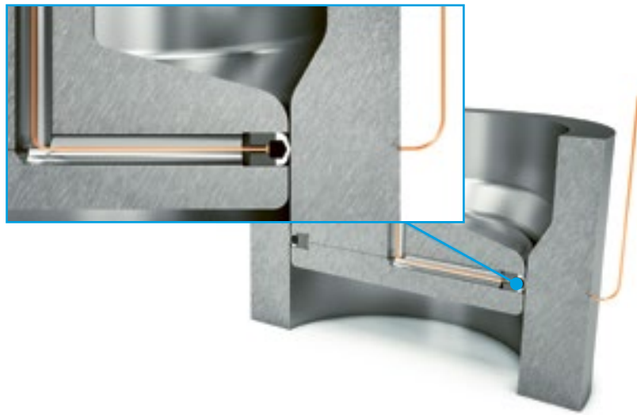
The sealing material is resistant to CIP/SIP (cleaning in place/sterilization in place) media, covers a broad temperature range, including very high temperatures, and is designed for a long operating life. The newly developed sealing system is helping to make food-industry processes safer. Tetra Pak is now having it manufactured in series, with four more dimensions planned. ◎

February 2023

Measuring the CO_2 Footprint

Freudenberg Sealing Technologies is developing a way to measure the CO_2 footprint associated with the production of seals and other components. The emissions balance sheet for a component is strongly influenced by the choice of the sealing material and production method. Since today's seals are often made from compounds, all the individual components must be taken into account to eliminate false incentives in the selection of a particular material. Freudenberg has developed its own "green index" to create greenhouse gas balance sheets for materials. All the index values are stored in a companywide materials database where development engineers can access them. Since component lifespans and wear resistance have an impact on customers' ecological balance sheet, these factors flow into the process of selecting materials. Measurement-based knowledge is important on the production side – namely, how much energy is consumed in the individual process steps, in relation to weight, volume or surface area. ◎

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



February 2023

Self-Diagnosing Seals

Freudenberg Sealing Technologies has proven the practical value of smart seals in a feasibility study. Moving beyond their original scope – reliable sealing – these seals can now prevent leaks and monitor their own wear levels, improving the reliability and safety of equipment and plant facilities.

Freudenberg created a "built-in" sensor function by fine-tuning the interplay of materials and design. For example, one of the company's in-house developments, a rod seal, is transformed into a capacitor. It consists of an electrically insulating elastomer (for the outer layers) and an electrically conductive elastomer with a metallic housing wall (for the inner layer). If the seal is worn by abrasion on the insulating layer, the distance between the electrically conductive layer and the metal housing is reduced and the capacitance increases. The seal's condition is captured in real time. The advantage is that maintenance can be planned proactively and be scheduled for a definite time. Leak damage is eliminated, and the risk of contamination is decreased. In addition, fully functional seals are not replaced earlier than they should be. The approach is more sustainable and optimizes operating costs.

Smart seals also meet all relevant standards and requirements for acid and base resistance, service life and manufacturability. The first tests on PTFE seals used in hydraulic applications were highly encouraging. ◎

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** 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.

If you no longer want to receive ESSENTIAL, simply send an email including your address to: **essential@fst.com**

We look forward to a dialogue with you!
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Outstanding Communication

We cover current, entertaining and astonishing topics for you with the same passion that drives our development of high-performance products. With some success, as these awards for our company magazine Essential clearly show.

BCM Award 2022 – Silver
Category Magazine Industry, Chemistry, Pharma, Health

BCM Award 2022 – Silver
Trailer, Category Moving Image Fiction

BCM Award 2022 – Gold
Trailer, Category Audience Award

BCM Award 2019 – Silver
Category Magazine B2B Commerce / Transportation / Logistics

FOX AWARDS 2022 – Gold
Category Industry, Technology, Production

FOX AWARDS 2022 – Silver
Trailer, Category Industry, Technology, Production

FOX AWARDS 2021 – Gold
Category Industry, Technology, Production

FOX AWARDS 2020 – Gold
Category Transport, Logistics

FOX AWARDS 2019 – Gold
Category Industry, Technology, Production

FOX VISUALS 2022 – Gold
Category Industry, Technology, Production

FOX VISUALS 2022 – Silver
Trailer, Category Industry, Technology, Production

FOX VISUALS 2021 – Silver
Category Industry, Technology, Production

FOX VISUALS 2020 – Silver
Category Transport, Logistics

FOX VISUALS 2019 – Gold
Category Industry, Technology, Production

ICMA 2021 – Best of Decade
Category Customer Media B2C

Galaxy 2022 – Silver
Category Brochures – Corporate Magazine

Galaxy 2022 – Gold
Trailer, Videos – Promotion

Galaxy 2019 – Gold
Category Corporate Magazines

Internationaler Deutscher PR-Preis 2021 – Finalist
Category Corporate Media (Print and Online)

Internationaler Deutscher PR-Preis 2019 – Shortlist
Category Methods & Tools – Corporate Media (Print and Online)

PR Daily Award 2019 – Winner
Category Print Publication

Videographer 2019 – Gold
Trailer Thirst, Category Video Production | Video | 43. Other

Videographer 2019 – Gold
Trailer Digitalization, Category Video Production | Video | 43. Other

Communicator Awards 2019 – Silver
Category Marketing / Promotion – Magazine-Corporate

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AIR WATER

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SEALING TECHNOLOGIES

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INNOVATING TOGETHER