

**From trend
to driving force**

How sustainability
is leading
to new growth

changes

What's driving the
process industry

#2/23

Sustainability is a term that comes from forestry. There it refers to the avoidance of felling more timber than is capable of regrowing, so as to preserve the resource for future generations. This principle is gaining new and powerful relevance in light of climate change, with many asking themselves how economies and ways of doing business can be adapted to curb global warming. Hence the focus at the first Endress+Hauser Global Forum on ways of making the sustainable transformation of the process industry a success. To demonstrate commitment to the cause, a sapling was planted for each participant. As sponsors, they can follow their trees' growth online.



Forward together

Endress+Hauser celebrated its 70th anniversary this year. We used this special occasion as an opportunity to make a statement for the future by welcoming 850 customers and partners to the inaugural Endress+Hauser Global Forum this summer. Mindful of climate change, we discussed ways to make the sustainable transformation of the process industry a success.

What were my takeaways from these three days of intense interaction? The biggest one was a sense of optimism that it is possible to keep planet Earth a place worth living on. The process industry is very much aware of its key role in achieving climate targets, as well as the urgency of the task at hand. That is why many companies have already chosen a path of change. Like us, they too are taking seriously the goal of reducing their carbon emissions and going climate-neutral in the long term.

However, the Global Forum also made it clear how far we still have to go. The energy transition alone is a project for generations to come. What's more, we are going to need any number of innovative solutions when it comes to things like green hydrogen, carbon capture and creation or use of a circular economy. That said, there is still tremendous potential for efficiency in existing process plants.

In this issue, you will find many examples of how our customers are transforming their processes for the benefit of the climate – and seizing the transformation as an opportunity to benefit their own businesses. That works best when companies connect, share knowledge and collaborate. After all, no one is capable of mastering this fundamental change alone. The only way to successfully navigate the path to a sustainable future is by taking the journey together, step by step.

Here's wishing you a thought-provoking read!

Yours

A handwritten signature in black ink that reads "Matthias Altendorf". The signature is fluid and cursive.

Matthias Altendorf
CEO of the Endress+Hauser Group



No one is capable of mastering this fundamental change alone.

Sustainability = opportunity



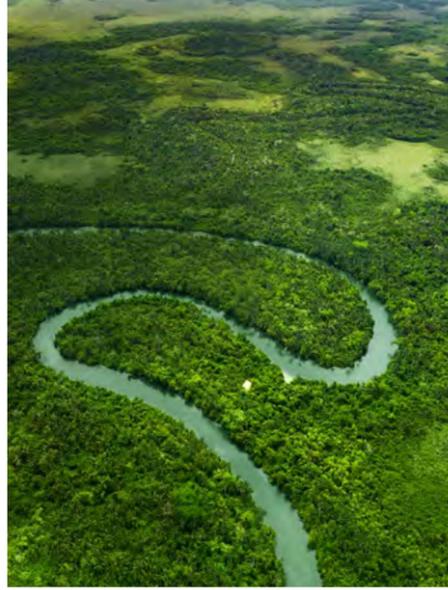
Climate protection is a major challenge – but also a business model. **Page 8**

A task for generations to come



How SMS group is making the metal industry more sustainable. **Page 14**

Green transformation



How is the drive for sustainability going? **Page 4**

Strong leverage



How Endress+Hauser is supporting the green transformation. **Page 26**

What matters now and in the future?



Klaus Endress on how he applies nature's lessons to business life. **Page 44**

Feedstock of the future



Algae have the potential to change entire industries. **Page 18**

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Green transformation

What was once a minor concern is now front and center: doing business sustainably is considered crucial to a viable future on our overburdened planet. What has already changed? Where are the remaining problems? And is sustainability an issue dividing the generations?

Text: Robert Habi, Ares Abasi, Lisa Schwarz
Photography and graphics: 3st kommunikation, Shutterstock, Stocksy

1.75 Earths

is what humanity needs to meet the current demand for renewable resources. To put it another way: on 2 August 2023, humankind exhausted nature's budget for the year. That date, known as Earth Overshoot Day, is determined annually by the Global Footprint Network. With a few exceptions, we have been using more natural resources year on year since calculations began in 1971. To amplify the point: were everyone on the planet to live the way people do in the United States, they would need the resources of 5.1 Earths. If their way of life resembled that of India's population, 0.8 Earths would suffice.

The color of revolution

The color green has come to stand for sustainability. But not for the first time in human history has the color been thus associated. As far back as ancient Egypt, green symbolized regeneration and rebirth. Etymologically speaking, the word green stems from the Germanic 'grho', meaning to grow, adopted almost verbatim into the English language. The word for the green pigment found in plants that makes life possible on Earth, chlorophyll, is a portmanteau of the ancient Greek words for 'light green' and 'leaf'. And although green has also been a proxy for love, poison or envy, depending on the century or region, today it once again symbolizes awareness of nature. But caution is advisable: the color green must be deserving of its name. Greenwashing, or creating a facade of seemingly green accomplishments, is widely disparaged.

Green trailblazers



Highest per capita generation of renewable energy: Iceland (100%)

Highest percentage of newly registered electric vehicles: Norway (63.7%)



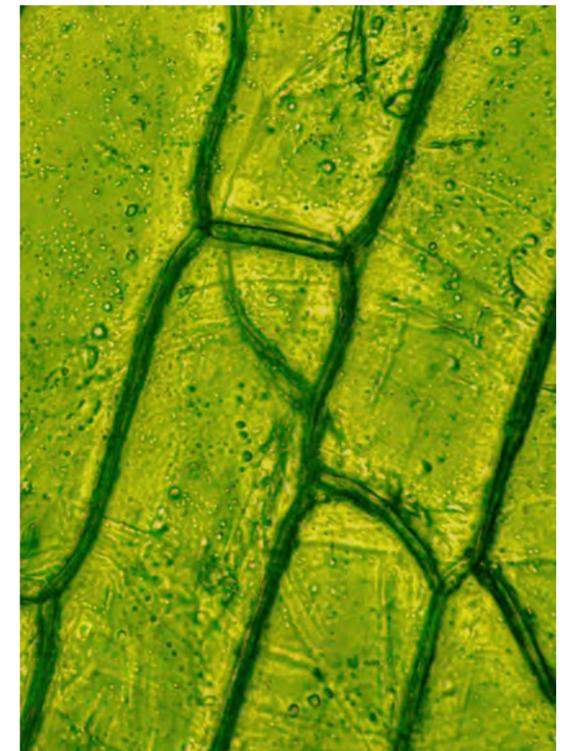
Highest recycling rate of residential waste: South Korea (60.8%)



Highest percentage of cycling commuters: the Netherlands (30%)



Highest percentage of vegetarians: India (38%)



“We have to look for the behavior, for the decisions, for the way of thinking that will orient our lives in a sustainable direction. That means the complete opposite of what we are doing today. It’s a bit like steering a hot-air balloon: if you want to change your direction, you have to change your altitude.”

Professor Bertrand Piccard, psychiatrist, adventurer and solar pioneer, creator of the Solar Impulse Foundation

How green is Generation Z?

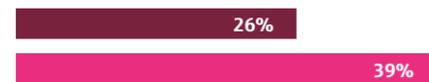
Some have brought climate change to the political stage with the Fridays for Future movement, begun by Greta Thunberg and other young activists. Others have launched eco movements, while also making their mark on the throw-away society and the fossil fuel economy. While issues between Generation Z (those born between 1997 and 2012) and baby boomers (1946 to 1964) arise time and again, the question remains: which generation really lives more sustainably? In terms of their consumption habits, a survey of 17 countries reveals a trend.

■ Boomers ■ Gen Z

“Over the past five years I have significantly or completely changed my behavior toward sustainability.”



“I’m willing to spend more money for sustainability.”



Source: Global Sustainability Study 2021

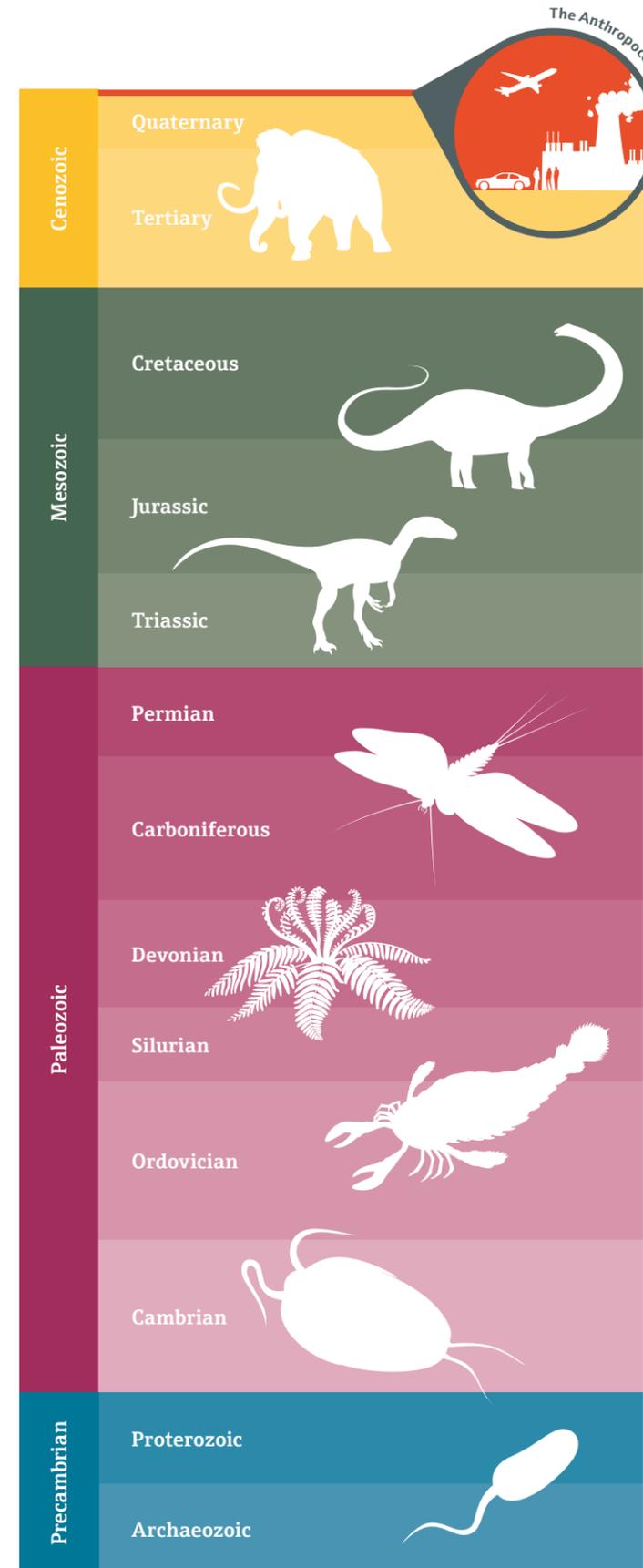


Back to the roots

In 1713 Hans Carl von Carlowitz, a tax accountant and mining administrator in the German province of Saxony, formulated the foundations of sustainability. At issue was the primary raw material in the fields of construction, energy and industry at that time: wood. In his work ‘Sylvicultura oeconomica’, von Carlowitz explained: “The quantity of felled trees should be limited to that which can be re-grown through planned reforestation, seeding and planting.” This basic tenet still holds today, although the term sustainability only came into being later. Along the way, our understanding has also changed to the current meaning: meeting present needs without impairing the opportunities of future generations.

High on the list

Climate change is viewed as the second most pressing problem for businesses, according to a survey of more than 2,000 top-level executives conducted by consulting firm Deloitte. That puts the climate ahead of other challenges such as supply chain difficulties and skilled labor shortages.



Welcome to the Anthropocene?

Are we living in the Anthropocene, a new geological epoch influenced by human activity? An international group of geologists has uncovered new evidence to support this hypothesis. In the well-preserved sediment from a lake bed in Canada, researchers found an abundance of markers left by various changes: rising atmospheric greenhouse gases, the advent of microplastics, the extinction of various species and traces of atomic bomb tests, to name a few examples of human-induced phenomena that have seen drastic increases since the 1950s. If the scientific community adopts the Anthropocene premise, the Holocene – the post-glacial period that is currently 11,700 years old – would have been replaced by a new epoch 70 years ago. A decision on the matter could be made in the summer of 2024.



“We need efficiency improvements more than ever.”

Mike Berners-Lee,
university professor and carbon footprint expert

“In 10 years, we will no longer view waste as waste, but as a raw material.”

Julia Binder,
professor of sustainable innovation and business transformation



FOCUS ON SUSTAINABILITY

At the inaugural Endress+Hauser Global Forum in Basel marking the Group's 70th anniversary, more than 800 customers and experts explored the question of how to achieve sustainable transformation of the process industry. The consensus was that companies can make valuable contributions to the fight against global warming right now. They can introduce more environmentally friendly processes and technologies, enhance their energy and resource efficiency – and operate more profitably as a result. This is where measurement technology helps with gaining necessary insights from the processes and consequently making decisions with sustainability in mind.

LONG-TERM PROJECTS AND QUICK WINS

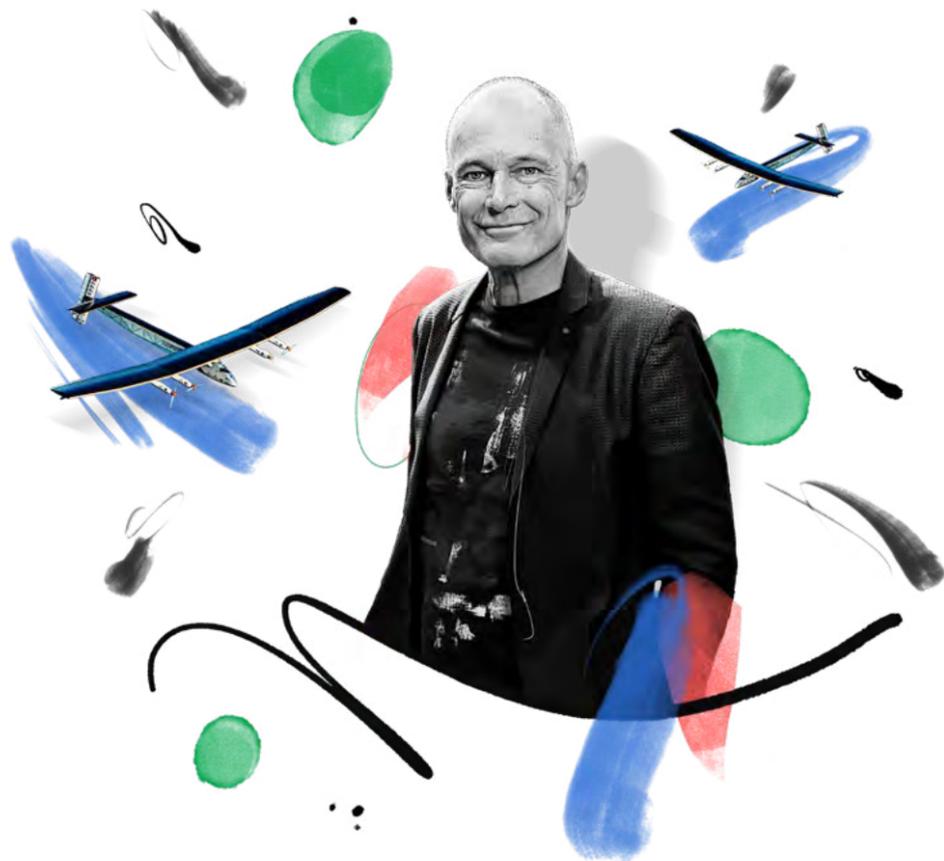
The International Renewable Energy Agency (IRENA) has already calculated the exact road to net zero: The strongest levers are the use of renewable energy and a substantial improvement in energy efficiency. Each of these by themselves could cover one-fourth of the reduction in greenhouse gases needed by 2050. Almost one-fifth could be reduced by electrifying the end-use sectors, more than one-tenth through clean hydrogen and its derivatives, and a further one-fifth through carbon capture, use and storage (CCUS).

Just how much is being done in this area, particularly in the electricity sector, is evidenced by the record addition of 300 gigawatts of global renewable capacity in 2022. Nonetheless, given the world's steadily growing hunger for energy, there would have to be new installations of more than three times that amount every year in order to stay on the 1.5-degree target. Development of the hydrogen industry also needs to accelerate, but that is conditional on new locations with large amounts of renewable energy available to permit the cost-effective operation of electrolyzers. Then there is the need to build infrastructure for transportation and storage of the hydrogen and its derivatives – and every one of these elements will need massive and coordinated upscaling.

While the energy transition is a project for generations, quick wins for the climate – with associated cost benefits – are more easily achievable in the area of energy and resource efficiency: these in general are measures that can be implemented in existing plants. “We need efficiency improvements more than ever,” says university professor and sustainability expert Mike Berners-Lee, who researches carbon footprints. Converting to renewable energy will be insufficient on its own, he says.

“Protecting the environment is not boring and expensive; it’s exciting and profitable.”

Bertrand Piccard,
solar flight record holder and eco pioneer



Industry could save a large amount of energy in process heat, particularly through energy optimization – 15 percent on average. But the overall potential is far greater, as a calculation from Germany shows: In 2021, nearly half of the industrial final energy demand could have been avoided using available energy-efficiency technology. That is the equivalent of the electricity production of eight large nuclear or coal-fired power plants. Almost two-thirds of this efficiency potential was left untapped for the sole reason of not delivering payback within three years. And yet, calculated over a longer period, such measures would surely have proved cost-effective.

CIRCULAR INSTEAD OF LINEAR VALUE CREATION

The circular economy offers another approach to cut the costs of the transformation and speed up progress toward net zero. According to the think tank Agora, with funders including the European Climate Foundation, better use of raw materials could save around 70 million tonnes of CO₂ in Europe alone by 2030, rising to as many as 239 million tonnes by 2050. Expressed in another way, that is up to one-third of the industrial emissions reduction required in the European Union. Depending on the process, recycling steel, aluminum or polyethylene products reduces the energy requirements by a factor of 5 to 12 compared to current primary production. With an eye to the future, a circular economy for these materials would also significantly decrease overall renewable electricity requirements – by 400 terawatt hours per year, to be precise – equivalent to the output of 60,000 wind turbines.

“In 10 years, we will no longer view waste as waste, but as a raw material,” asserts Julia Binder, professor of sustainable innovation and business transformation at the IMD private business school in Lausanne, Switzerland. That will also bring more stability to supply chains and counteract increasing scarcity of raw materials, she says. Moreover, a circular economy brings customers, suppliers, companies and researchers closer together, because the only way to develop viable solutions is jointly. “Business leaders now favor collaboration and transparency over competition and increasingly consider decarbonization as a win-win solution that does not necessarily entail extra costs,” is the opinion of the World Economic Forum.

More than this, a sustainable business model based around the core elements of energy transition, energy and resource efficiency, and a circular economy promises greater independence from global upheavals and thus long-term competitiveness. “In the coming years, we will experience a complete change in the economy,” says Gauri Singh, deputy director general of IRENA, who is not alone in her conviction. “Energy efficiency combined with renewables makes countries less dependent on imports and decouples economies from volatile international oil prices.”

FROM HINDRANCE TO BENEFIT

Real success for the green revolution also needs the right political and economic policy framework. A globally harmonized minimum price for CO₂ has been discussed time and again as an ideal tool to create the necessary incentives for market participants and to coordinate climate policy efforts. A glance at Europe shows the leverage effect a move like this could have: Sectors of the European economy that trade in carbon certificates have reduced their emissions considerably more than other sectors in recent years. That said, state subsidies are also needed to boost key technologies like hydrogen to the point of breakthrough, for example using them to get new processes ready for market or to build basic infrastructure. Lastly, it must be ensured that renewable energy is available cheaply, as quickly as possible, and in the gigantic amounts required, which makes green hydrogen competitive as a consequence.

The world of politics aside, more and more companies are recognizing sustainability as an opportunity. Thus, the vision of eco pioneer Bertrand Piccard would seem to be coming true. In 2016 he circled the Earth in a solar-powered plane – without using fossil fuels. He sees the Paris Agreement as the “starting point for a revolution in clean technology”. After his record-breaking flight, he initiated an alliance to promote 1,000 viable solutions for environmental and climate protection. “Up to now, we thought that economic development would be destroyed if we protected the environment. I wanted to show that it is an economic advantage to protect the environment, to be energy efficient,” says the founder. By now there are already more than 1,500 solutions – “devices, materials, processes and systems that benefit humanity and the planet”. Piccard is convinced: “If we make ecology the focus of economic development, we will be much more successful!”



POWERFUL ADVOCATES

High-profile speakers at the Endress+Hauser Global Forum deliberated on solutions for a sustainable future. **Mike Berners-Lee**, a carbon footprint expert, spoke about what it will take to ensure the survival of humanity. **Gauri Singh** from the International Renewable Energy Agency addressed sustainable energy supply. Scientist **Julia Binder** examined approaches for a circular economy. Solar flight pioneer **Bertrand Piccard** focused on resource and energy efficiency.



See more in the video interviews at changes.endress.com.

A task for generations to come



Industry faces immense challenges along the path to climate neutrality. The metals sector illustrates just how vast this task is. The good news is that the necessary technologies are at hand. Burkhard Dahmen, CEO of plant manufacturer SMS group, and Matthias Altendorf, CEO of the Endress+Hauser Group, discuss how to put those technologies into practice.

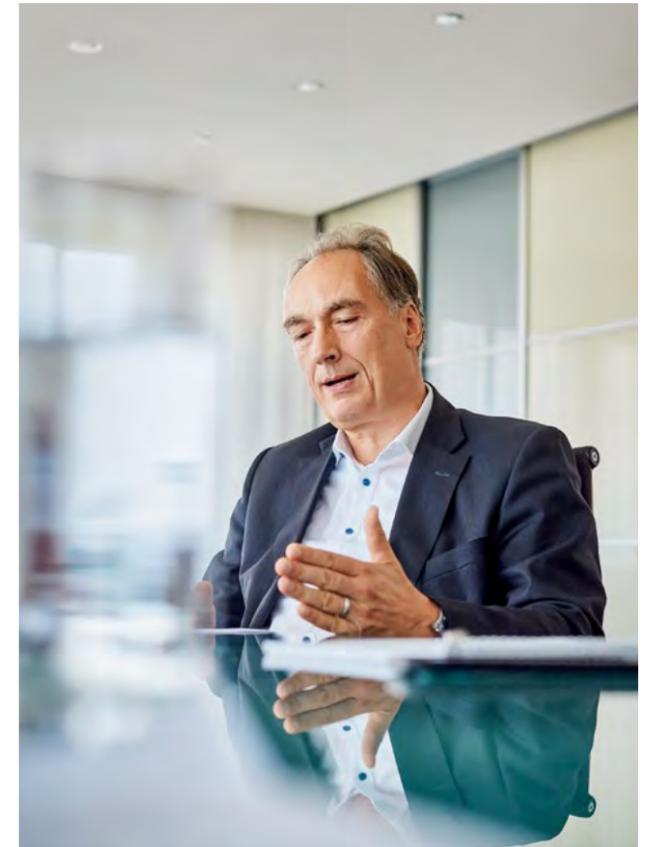
Questions: Laurin Paschek
Photography: Christoph Fein

Mr Dahmen, SMS group is one of the leading companies in plant construction and mechanical engineering for the metals industry. Your aim is to become a trailblazer of a CO₂-neutral metals industry, as embodied in the hashtag #turningmetalsgreen. How can your company contribute to the green transformation?

Dahmen: Conventional production of steel, aluminum and copper creates a lot of carbon dioxide, accounting for some 10 percent of all global CO₂ emissions. The steel industry is a particular factor because it uses coal to smelt iron ore in blast furnaces for producing pig iron. Carbon from the coal combines with oxygen from the iron ore to produce large amounts of CO₂. We're pursuing two technologies to change this. First, for converting iron ore into pig iron we're using a direct reduction process that replaces coal with hydrogen or synthesis gas. Ideally, the hydrogen for this process is produced with renewable energy. We are implementing the direct reduction process at Thyssenkrupp Steel in Duisburg, Germany, and at Swedish startup H2 Green Steel. But we have a long way to go before the entire steel industry is in a position to decarbonize with this approach.

Is that why you're pursuing an additional route?

Dahmen: Exactly. We can optimize existing plants by injecting additional hydrogen or syngas into the blast furnace process. That significantly reduces the amount of coal needed to produce the pig iron, which in turn reduces



“The green transformation is a huge opportunity. We're ready to go down this path with our customers.”

Burkhard Dahmen,
CEO of SMS group

CO₂ emissions by at least one-third – potentially even as much as two-thirds. Parallel to this, under the banner of #turningmetalsgreen we are pursuing an end-to-end approach that includes recycling metals and recovering waste materials. For example, we're working with Hamburg-based Aurubis to build a plant in the US for melting down and processing electronic waste. And our joint venture Primobius is developing a lithium-ion battery recycling plant for Mercedes-Benz where we first shred the batteries and then use a wet chemical process to extract their valuable raw materials such as cobalt and nickel.

Your examples show there is a lot of momentum. How significant are climate protection and sustainability as drivers of your business?

Dahmen: The green transformation is a huge opportunity for us because we have the necessary technologies. We're ready to go down this path with our customers. We're not only concerned with selling our products but also actively pursue project development. We view ourselves as long-term partners for our customers; we discuss a great deal together and we work cooperatively to keep driving projects forward.

Mr Altendorf, the Endress+Hauser Global Customer Forum focused on the green transformation of the process industry. How are your customers tackling the sustainability issue?

Altendorf: Our customers all believe as a point of principle in their responsibility to take action against human-made climate change, while also mitigating its social consequences. This is the path we aim to travel down with them. The steel industry is a prime example of our support all along the value chain, from mining, transport and smelting of the iron ore, to manufacture of the end product. With our measurement technology we can reveal the points and processes that have the potential to reduce the CO₂ footprint. Yet it is my opinion that the path to carbon-neutral steel production still has a long way to go. We must be clear that the green transformation won't be complete in just a few years but will be a project for generations to come.

Can you quantify that? How big of a task is it?

Altendorf: The size of the task becomes clear when you look at the numbers. Installed capacity stands at around 1.9 billion tonnes of raw steel worldwide. A single green plant with a direct reduction system produces only around 2.5 million tonnes – or just 0.13 percent of the global capacity. This is what makes it so important for CO₂ reduction measures to span the entire value chain; in other words, not only the actual steel production, but also mining and transportation of the raw materials. We also need to take a closer look at how we generate hydrogen, because for the foreseeable future the available solar, wind and hydroelectric power plants will nowhere near suffice to cover the demand for renewable electricity to produce green hydrogen. Europe cannot manage the generation of green hydrogen on its own – it has to be done in other regions of the world as well.

Dahmen: I'd like to add here that we need to protect our own industry in Europe. Climate goals established in Germany and Europe in general are much more ambitious than other countries. Hence my belief that it is key to tax imports from sources that don't meet our climate targets.

Altendorf: I see it that way as well. Policymakers must create the necessary frameworks for fair competition in order to boost attractiveness of investments in green technologies. That also means protecting European industry up to a certain point.

What role do partnerships play in achieving climate and sustainability targets?

Altendorf: When the road ahead is long and involves taking the occasional risk, you need reliable business partners. Our customers know that we are not just selling them measurement technology but that we will still be in business 10 to 15 years from now, still helping them to operate their plants. Moreover, we continually invest in improving our products and services, so operators in turn can further optimize their processes and plants. In steel

manufacturing and metals recycling, for example, we work to understand upcoming requirements and then drive our product development in that direction. Partnerships are also becoming increasingly important in the wake of digitalization, so that field data acquired by our instruments can be converted into knowledge by plant builders and passed on to the plant operators.

Dahmen: When we build a plant, we need partners who are in it for the long haul, from project initiation and execution to on-site service while in operation. This needs flexible, solutions-oriented approaches where both partners have their sights on the common goal, not just their own interests. In this respect in particular, our experience with Endress+Hauser has been excellent.

What do you see as noteworthy strengths in the partnership with Endress+Hauser?

Dahmen: As a family-owned company, we are pleased to work with other family companies: there's that similar corporate culture with its high regard for personal and professional interaction. Also, Endress+Hauser is well positioned with its global network. We've had excellent experience with availability, ad hoc service and on-site support at our construction sites. Last but not least we have a sustainable partnership. We develop solutions hand-in-hand with Endress+Hauser, and we see in them the potential to offer customers added value through new instrumentation for cutting-edge fields such as hydrogen.



“When the road ahead is long, you need reliable business partners.”

Matthias Altendorf,
CEO of the Endress+Hauser Group

Both of you will soon hand over your responsibilities to someone else: Mr Dahmen in October and Mr Altendorf at the end of the year. What, for you, were the most important aspects in arranging your successors?

Dahmen: First off, I think it's great that with Jochen Burg we found an internal candidate who is not only familiar with the corporate culture but personifies it. This will ensure strong continuity with respect to corporate values: highly important for a family company, particularly when it comes to the workforce and works council. Secondly, my successor is customer oriented, with the strategic vision to keep the company on course for the long term. This carries more weight than a short-term, profit-oriented mindset.

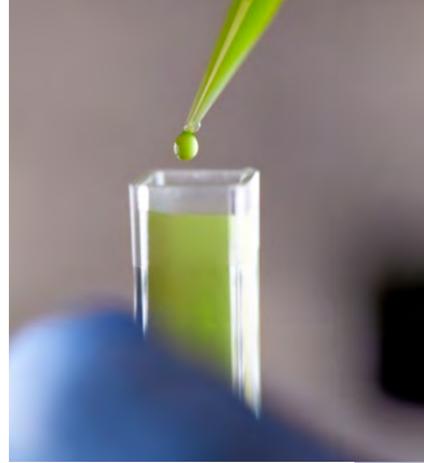
Altendorf: I too believe that a long-term perspective is crucial. My successor Peter Selders will have time to shape the company. We're not talking about years, but decades. I also think it's important that the new CEO advances the human-centric worldview that we have as a family-owned company. This vision gives our employees the confidence they need to effectively tackle the major challenges of the future.

TRANSFORMATION TRAILBLAZERS

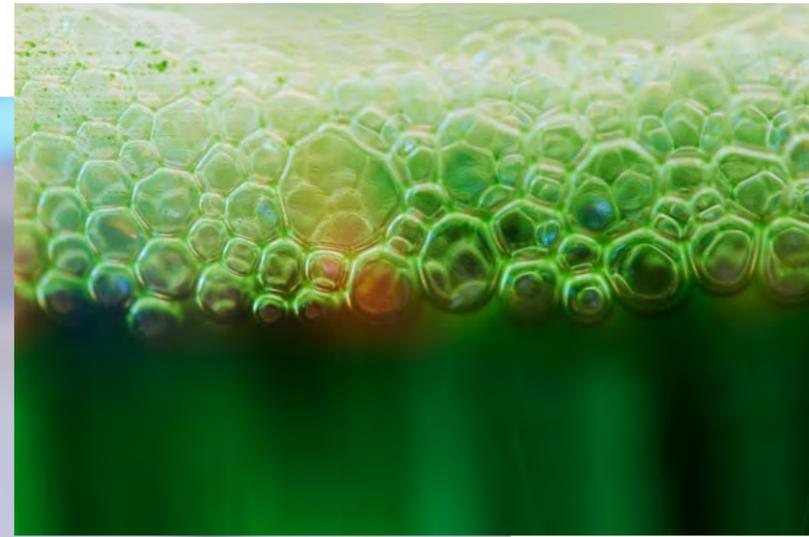
Burkhard Dahmen (born 1964) studied business administration at the University of Münster (Germany) and the University of Warwick (UK). He began his career with SMS group straight after graduation in 1990. He worked in various management positions before joining the management board in 2004. He took over as CEO in 2012, a position he held until 1 October 2023. He will advise and support his successor Jochen Burg until March 2024.

SMS group is a global leader in plant construction and mechanical engineering for the metals industry. The family company with German roots generated sales of 3.1 billion euros in 2022. SMS, with 14,400 employees at over 100 locations, supports its customers with advanced technologies, outstanding service and digital expertise throughout the life cycle of their plants. The company celebrated its 150th anniversary in 2023.

1



4



- 1 Microalgae such as chlorella can be used in food and personal care products and as a feedstock.
- 2 The versatile microorganisms require nutrients, heat, light and CO₂ to grow.
- 3 Food technologist Borna Semenjuk checks the pH in one of the vessels where algae are multiplying.
- 4 Thriving algae bind carbon dioxide and release oxygen.

Feedstock of the future

3

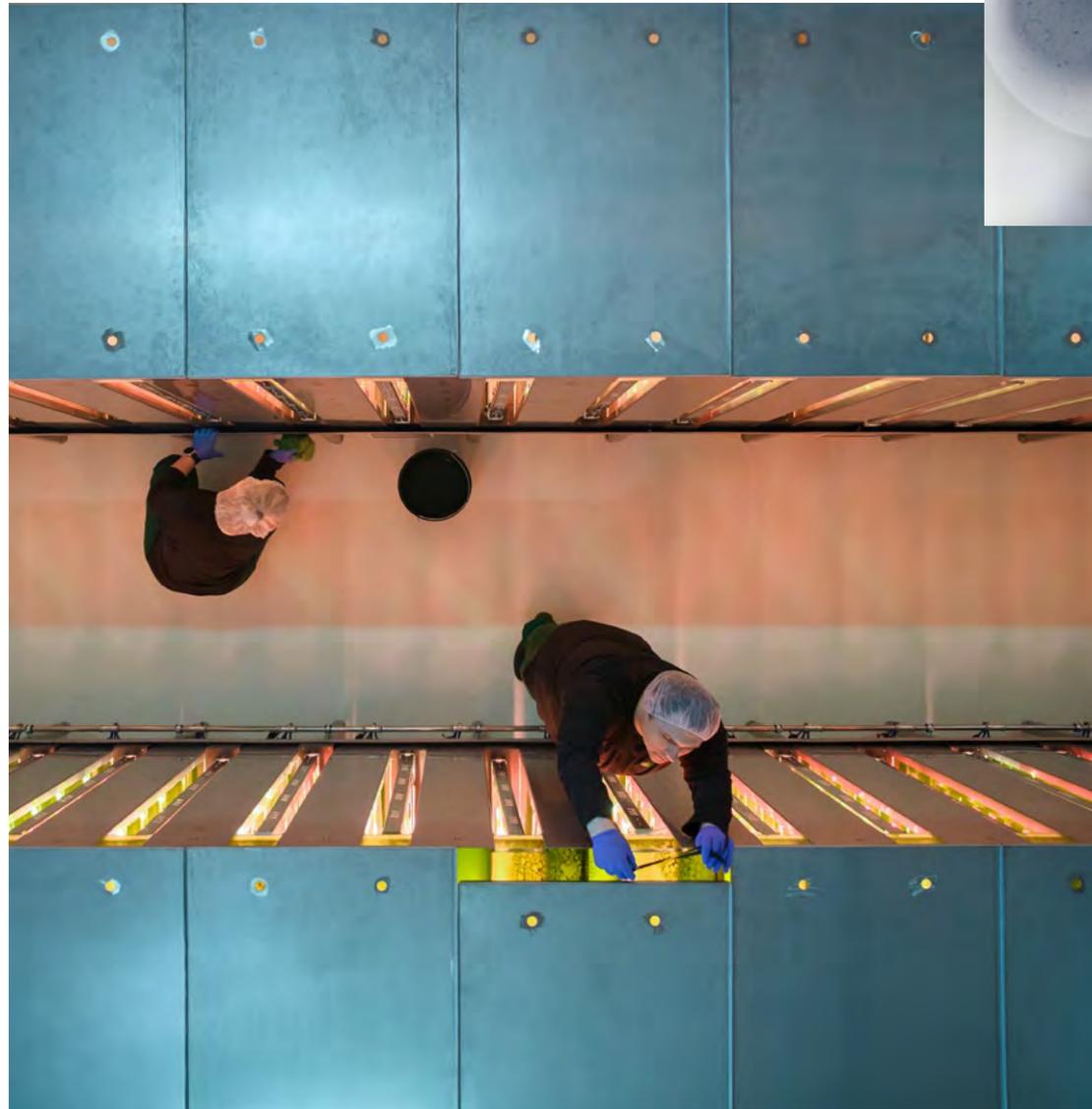


2

Algae, with their many potential uses in medicine and as a superfood or biofuel, could help feed the world and benefit the climate. We reveal what makes them the natural resource of the 21st century – and how Phyox is taking its algae cultivation to the next level.

Text: Kirsten Wörnle
Photography: Enno Kapitza
Graphics: 3st

1



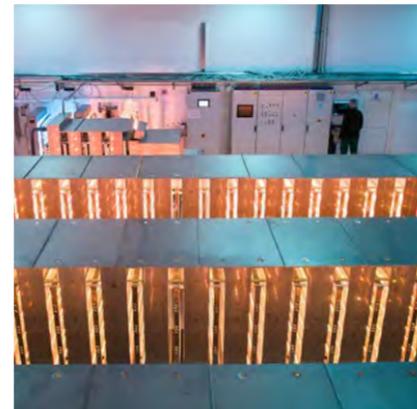
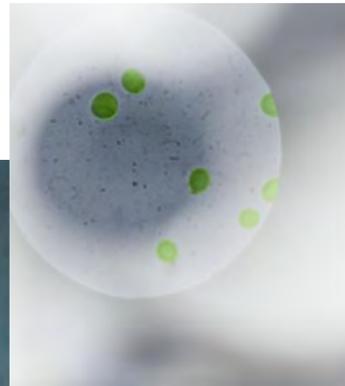
1
Phyox produces algae in closed bioreactors that are unaffected by external factors.

2
Under controlled conditions, the chlorella algae grow three to five times as big as in a natural environment.

3
The LED light intensity and pulse rate are precisely tailored to the needs of the algae.

4
Measuring technology monitors processes and conditions at the highly automated plant in Croatia.

2



3

The air in the 600-square-meter building is pleasantly fresh. A reddish hue emanates from 11 steel and glass production lines where microalgae are thriving under LED lights. Borna Semenjuk dips a pH sensor into a 30-liter glass cylinder where algae are forming at the head of a big cultivation line. There's a deep green shimmering through the glass. The production engineer points to a fine line of these single-cell organisms that have settled on the cylinder wall. "The algae are agglomerating because they don't have enough carbon," says the 26-year-old, who then glances at the display: 6.6 – indeed a bit on the low side. He presses a button on the wall, and fine CO₂ bubbles effervesce through the cylinder.

While training as a food technologist a few years ago, Semenjuk learned how to banish algae. Now he does everything to help them proliferate. The right mix of nutrients, heat, illumination and CO₂ keeps the microorganisms happy. In a matter of days, the chlorella in this glass cylinder will have multiplied to the point where they can be moved to intermediate storage in two progressively larger tanks and then decanted into one of the eleven 10,000-liter production lines.

Semenjuk works for Phyox in Novska, which is a good hour's drive from the Croatian capital Zagreb. Here the company has been manufacturing dry powder from chlorella algae for the pharmaceutical, cosmetics and food industries since late 2022. Phyox is involved both in customer business and on the development side. It aims to create ideal conditions for the industrial production of algae and plans to increase capacity twentyfold in the near future. This would make Phyox one of the world's larger manufacturers, if not the largest, of high-purity microalgae powder.

SUSTAINABLE AND VERSATILE

The constituents of microalgae have already made them attractive to a wide range of industries as a superfood, an ingredient in cosmetic products, a binding agent, colorant or stabilizer. Algae can be found in gummy bears, ice cream and toothpaste. Pharmaceutical manufacturers make use of their blood-thinning properties, while the chemical industry uses them to produce environmentally friendly paint and fertilizer.

Algae may be set to play an even greater role in our lives. They contain the highest density of nutrients in the plant kingdom and multiply rapidly in a small space. With their proteins, vitamins and unsaturated fatty acids, they could help solve the problem of feeding the world's population of more than eight billion and rising. Algae might enable the mass production of green plastic by the plastics industry, sustainable fabric by the textile industry, bioasphalt by

“Phyox’s visionary ideas fascinated me from the start.”

Christian Fischer,
technical sales manager, Endress+Hauser Germany



GREEN PIONEER

The German-Croatian joint venture Phyox has been producing microalgae in Novska, near the Croatian capital Zagreb, since 2022. The company's name derives from the initial letters of phytoplankton and oxygen. A total of 6.8 million euros has been invested in the plant, which consists of 11 independent production lines with a total capacity of 20 to 30 tonnes of dry biomass per year. A patented technology that uses LEDs instead of sunlight enables round-the-clock production. Phyox currently manufactures chlorella algae for the food, pharmaceutical and cosmetics industries. It also plans to produce other varieties of algae.

the construction sector and other resource-saving materials. Medical research is also actively interested because of algae's effectiveness against hazardous bacteria, viruses, cancer cells and possibly a plethora of diseases. Meanwhile, aviation fuel experts are investigating them as a source of biokerosene. Macroalgae with their high oil content make good candidates for a wide variety of biofuels; it is merely a question of cost and scalability.

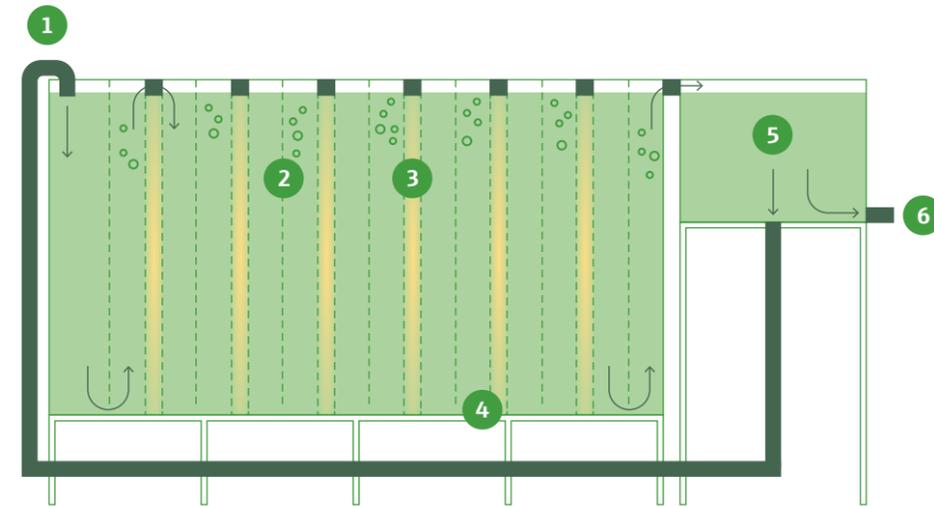
Phyox CEO Bernd Herrmann opens the laptop in his office. Having started out in industrial plant engineering, three years ago he founded the company together with German and Croatian partners. Their original plan was to breed organic shrimp. "We were going to sell them to wholesalers," he recalls and laughs. "That's what got me into microalgae – as feed." Herrmann, who is as visionary as he is down-to-earth, quickly realized that the green protozoa are much more interesting than shrimp. "Weight for weight, algae contain more omega-3 and omega-6 fatty acids than fish, more calcium than milk and masses of protein, as well as vitamins, trace elements and chlorophyll." And to



“Our 600-square-meter production plant has the same annual oxygen output as 40 hectares of forest.”

Bernd Herrmann,
CEO of Phyox

ALGAE CULTIVATION IN A BIOREACTOR



Water containing the algae flows through interconnected upright glass vessels, passing LED illuminators along the way and receiving regular infusions of oxygen and CO₂. After the last vessel, it recirculates back to the start. Water ripe for harvesting is channeled into a separator. Each production line yields around 20 kilograms of dry algae powder per harvest. Filtered water from the separator then feeds back into the system.

- 1** Intake vessel
- 2** Individual reactor vessels
- 3** LED illuminators
- 4** Oxygen and CO₂ nozzles
- 5** Outlet vessel
- 6** Algae harvest

top it all, they are photoautotrophic organisms able to convert light into chemical energy, meaning they ingest carbon dioxide and excrete oxygen as a waste product. "Our 600-square-meter production plant has the same oxygen output as 40 hectares of forest," says Herrmann, which explains why the air in the building is so good. That fact also attracts investors on the lookout for carbon-offsetting options.

BIOREACTORS DEVELOPED IN-HOUSE

While other producers grow algae outdoors in open tanks or closed glass tubes, Phyox has moved its manufacturing to proprietary indoor bioreactors. Water containing the algae meanders past LED strip lighting with an intensity and pulse rate precisely tailored to the needs of cultivating the chlorella algae. Fine nozzles on the bioreactor floor pump in a blend of oxygen and carbon dioxide, ensuring even distribution of warmth and nutrients while steadily propelling the liquid forward. At the end of the line, algae in suspension are pumped back to the start and continue repeating their transit until a turbidity sensor indicates that it is time for the harvest. A separator then extracts algae from the water and the permeate – the filtered water – flows back to the line, where it is manually replenished with fresh stock.

"Phyox's visionary ideas fascinated me from the start," says Christian Fischer of Endress+Hauser Germany. "This kind of production is not dependent on the sun or the seasons. Nor are there any contamination risks, unlike with open tanks," adds the technical sales manager, who has been helping to oversee the project since its inception.



Plant automation ensures consistent quality and the highest possible yield.

1



3



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- 1 Each production line yields around 20 kilograms of dry algae powder per harvest.
- 2 Laboratory work delivers new findings on the large-scale cultivation of algae.
- 3 If customers want it, Phyox can produce algae with very specific properties.

So Phyox can continue manufacturing 24 hours a day, 365 days a year in a highly controlled environment, he says. Along with process instrumentation, Endress+Hauser also supplied the automation solution including remote access.

“Control and sensor technologies lie at the heart of it all,” says Bernd Herrmann with conviction. In Endress+Hauser, he has found a partner that not only implements his ideas but is also willing to dig down into the complex subject matter. “Algae are highly sensitive creatures, so you need to develop a precise understanding of them.” Any tiny shift in things such as flow rates, water parameters or illumination intensity and color will have consequences. That’s why the water is constantly monitored for flow and level, turbidity, pH and conductivity. Based on those measurements, nutrients or water are dosed automatically. Memosens technology allows the same analysis techniques to be used in manufacturing and in the laboratory.

Automation plays its part by ensuring high quality of production. “Should bacteria start spreading among the algae at three in the morning, we need to respond immediately,” Herrmann stresses. In such events, the Phyox plant automatically switches to ultra-filtration and, if necessary, rescues the algae by initiating the harvesting process.

ALGAE EXTRACTS MADE TO ORDER

All this allows Phyox to do more than just make a high-purity product and maximize production yields. “We can also cultivate microalgae with very specific properties for precise customer requirements.” Indeed, the focus has long since shifted away from algae as a straightforward generic product and toward individual extracts such as carotene and lutein. Adding just a single gram of phosphate to the nutrient mix can make the difference here. “Every measurement value is a field of research in its own right,” says Herrmann, who aims to take the facility to the next level by creating a fully automated and digitalized ‘plant 5.0’ for up to 15 different varieties of microalgae. The plan is also to use artificial intelligence to ensure optimum cultivation conditions.

Algae are both sensitive and highly diverse organisms. For example, while chlorella must be vigorously agitated to prevent adhering to the glass cylinder wall, dunaliella drift freely through the water. Some varieties of algae need a lot of light, others prefer it a little darker. Herrmann regrets the lack of support from academic research: “Most of the work to date has been with small quantities, so it’s not particularly useful for volume production.” With its planned expansion, Phyox therefore wants to build a campus for algae research. The goal is to develop the largest algae cultivation plant in the world with scientifically based, highly automated production.

The fact that this is a realistic vision is evident from the interest shown by investors as well as industrial and research partners worldwide. And the chlorella algae at Phyox give a helping hand too. In a natural habitat, the organisms reach around five to eight micrometers in diameter. But at Phyox, they grow three to five times that size. “Without losing any of their constituents,” says Herrmann. “And right now, we only know a fraction of what there is to learn about algae,” he adds with a smile.

2 tonnes of CO₂

go into producing 1 tonne of algae.



Expansion plans for the plant in Novska include building a campus for algae research.

Step by step

Energy and resource efficiency, decarbonization, circular economy... The green transition is challenging companies around the world. Endress+Hauser is a dependable partner for customers on their transformational journey, providing precise measurement technology along with a flair for sustainable ideas.

Strong leverage

Climate and environmental protection are now major drivers of change in Europe's industrial production. Michael Sinz, director of strategic business, explains how Endress+Hauser is supporting the transition to greater ecological sustainability throughout industry.

Questions: Christine Böhringer
Photography: Andreas Mader

TRANSITION

You are responsible for developing business with key customers in every sector of industry.

How much does sustainability matter to them?

A lot! This is an issue being tackled by all companies – and I really mean all. They are clearly focused on ecological aspects, with even more attention being paid to decarbonization since the UN climate change conference in Glasgow. Every industry around the world is tackling the energy transition with full force. Resource conservation and the circular economy are also core topics gaining traction.

What has gotten things moving so fast?

Investors, governments and society in general are by now broadly committed to climate protection. On a parallel track, the legislative and formal frameworks that companies need have been put in place, especially when it comes to decarbonization. CO₂ reduction is already a more or less intrinsic element in the economy. To achieve that reduction, when companies set their climate goals they have to work in collaboration with their entire supply chains. That means effecting transition all the way up and down the line. I'm convinced that we will see this same effect take hold when it comes to other environmental issues.

What are the biggest challenges being faced by customers as they advance toward sustainable transformation?

They all have to adapt, optimize or establish completely new production processes while continuing to produce economically and meet increasing demand. That calls for massive investment and speedy adaptation to new technologies. The extent of the changes and the focus of the measures differ, of course, not least in proportion to how much a given industry depends on fossil carbon. The oil & gas industry has to reinvent itself. The steel industry must switch



MICHAEL SINZ

Michael Sinz is director of strategic business for the Group and responsible for developing global business with key customers who engage closely with Endress+Hauser. The 52-year-old physicist has been with the Group for more than 25 years. After a stint in product development for level measurement technology, he spent 11 years working for Endress+Hauser in China, most recently as director of marketing. Since returning to Switzerland, his focus has been on strategic business. He also handles sustainability audits from the sales side.

to hydrogen-based direct reduction plants. The cement industry needs to capture its emissions, which are mostly inherent to the production process. The chemical industry has to find alternative raw materials, recycle plastics and develop new products. The focus for the pharmaceutical, food & beverage and life sciences industries is on energy and resource efficiency, with water conservation a major issue.

How is Endress+Hauser helping customers through this transition?

Precise and reliable measurements are fundamental to addressing the challenges. Measurements deliver insights into processes and help make them safe, energy efficient and less demanding of resources. Customers can use our instruments and solutions for systematic reduction of their ecological footprint while reducing costs at plant level. All that gives measurement technology significant leverage. And when you hear buzzwords like hydrogen, carbon capture and utilization, or electric vehicle batteries, you can be quite sure that our instruments are playing a role here as well. Our close customer relationships, our willingness for long-term collaboration with them, to learn from them and to jointly tackle their specific challenges as best we can has enabled us to tap into the field in its infancy and get involved right from the start.

Will partnerships be even more important in the future?

Absolutely, because it takes collaboration to combine sustainability with growth. We need long-term, dependable partnerships not only to achieve climate neutrality by mid-century but also to ensure success with digitalization – the other major future topic for our industry. Everyone involved contributes puzzle pieces to the solution, which must fit together perfectly into the overall context. Besides quality, on-time delivery, application expertise, innovation skills and global reach, customers expect end-to-end sustainability. Shared visions and values will matter more and more.

How do these changing needs affect the development of Endress+Hauser?

On the product side, we have in recent years strengthened the analysis business with inline and online measurement techniques. Customers monitor quality-relevant parameters as a means to optimizing their processes in real time and enhancing their efficiency. Of course we are involved in IIoT solutions, too. Digital connectivity creates even greater transparency across the entire value-added network. Digital twins can help to simulate processes at the engineering stage and create resource- and energy-efficient designs. Product design, too, increasingly incorporates sustainability aspects. Take single-use systems for the biotech industry as an example: we are developing instruments with recyclable components. And of course we are thinking about reasonable ways to decarbonize our portfolio in the future – sustainability is driving us toward innovations, too!

From problem to product

Greenhouse gas emissions cannot be avoided in the cement industry. Is that a bad thing? Not for Holcim Germany. The building materials manufacturer sees it as a great opportunity for the future.

Text: Christine Böhringer
Photography: Matthias Haslauer, Holcim

1



CARBON CAPTURE

To see into the future of the cement industry, travel to northern Germany and Holcim's operation in Lägerdorf. Rich chalk deposits there have been used for more than 160 years to produce the coveted binding agent for concrete around the clock. This amounts to 1.5 million tonnes annually, in the process releasing 1.2 million tonnes of CO₂ into the atmosphere. The cement industry is one of the world's largest greenhouse gas emitters. But this is set to change, at least in Lägerdorf. "We want to be one of the very first cement works to become climate neutral in the next six years," says Arne Stecher.

Arne Stecher is head of decarbonization at Holcim Germany. In his 25 years there in management roles, he has never seen anything like the current situation. "We are currently in the midst of a global transformation, with fossil value chains disappearing and new green ones emerging. All companies must change," says Arne Stecher. Not just to save the climate, but also to safeguard their own future. But while many industries can go green by switching fuels or processes, that does not work in cement manufacturing: two-thirds of emissions arise from burning the cement clinker in a kiln. This process decomposes chalk, or calcium carbonate (CaCO₃), into calcium oxide (CaO) and CO₂. "There will never be cement without carbon dioxide," says the process engineer.

In 2016 the Paris Agreement on climate change had just come into effect. This led top managers at Holcim, one of the world's leading building materials groups, to ask themselves two questions: How can we economically capture millions of tonnes of unavoidable CO₂? And what will we do with it then? "We scanned the market and the research on carbon capture technologies, identified 80 interesting approaches and initiated

"CO₂ will be a coveted raw material in future."

Arne Stecher,
head of decarbonization, Holcim Germany

50 pilot projects worldwide," says Arne Stecher. "This will produce maybe 25 real-life industrial projects, and a handful of technologies will ultimately emerge."

All three of the company's German plants are implementing pilot projects. In Lägerdorf, construction will begin in 2024 of a new kiln line using the innovative oxyfuel process, which involves blasting pure oxygen into the combustion chamber where clinker is made, in place of the atmospheric air commonly used to date. The resulting flue gas stream is almost entirely ultrapure carbon dioxide, which is simple to collect and use. "However, there are modifications and new construction involved, as well as investments costing hundreds of millions of euros, so this integrated approach only works at large sites with long-term raw material availability," says Arne Stecher.

ECONOMICAL USE

At other sites, end-of-pipe technologies are set to be upgraded: The process will remain unchanged, and the CO₂ will be separated from the flue gas stream downstream. To do this, at the other two works Holcim is developing new amine scrubbing and membrane technologies with research and technology partners.



2

8%

of global CO₂ emissions are produced by the cement industry.



3

- 1 At the Lägerdorf works, a new kiln line is being built to use innovative oxyfuel technology. The flue stream from incinerating cement clinker in this process is made up almost entirely of ultrapure CO₂.
- 2 Arne Stecher is head of decarbonization at Holcim Germany.
- 3 In Beckum, Endress+Hauser handles the measurement side of testing the latest amine scrubbing technology.

Endress+Hauser is involved in this effort with instruments to monitor process safety and efficiency. "Carbon capture is nothing new for us. In the oil and gas industry, carbon dioxide has long been separated for use in oil recovery. We have extensive application knowledge in this area," Frederik Effenberger, industry manager for decarbonization at Endress+Hauser, explains. The aim of the tests is to achieve the highest possible separation rates and high purity with minimal expenditure of resources.

So, does that make decarbonization first and foremost a technology issue for Holcim? "No," says Arne Stecher. "The major transition is taking place beyond our own works, because to use the CO₂ we have to build new value chains and think in terms of material cycles. For this we need partnerships." At Lägerdorf, for example, oxygen for the oxyfuel process will come from the electrolyzers of other companies that split water into hydrogen and oxygen using green electricity. Holcim and its partners seek to process the CO₂ for the petrochemical and other industries, which in turn will use it together with hydrogen to produce e-fuels, e-chemicals and e-methanol. The CO₂ could also go directly to the chemical industry as a primary feedstock. Making

all this happen requires logistics, infrastructure and buyers, as well as carbon dioxide in varying grades of purity. "The material streams must flow continuously," says Arne Stecher, who was head of purchasing at Holcim for 11 years. "That again makes supplier partnerships one of my key focal points."

COVETED RAW MATERIAL

Holcim Germany, says the decarbonization expert, is a first mover in carbon capture and utilization (CCU), both within the group and for the industry as a whole. Arne Stecher is convinced that the pioneering role is worthwhile: When he first started taking interest in CCU, a ton of CO₂ cost 20 euros in European emissions trading; in 2022, the price was 80 euros. "The time has already come where it makes sense to invest in avoidance technologies," he emphasizes. As a first mover, Holcim also occupies an emerging market: the market for CO₂. "The new green value chains will not function without CO₂; the chemical industry alone will always need a carbon source," says the head of decarbonization. And that is something Holcim can supply in the immense quantities required. CO₂ will go from being a problem to a product. "I believe that CO₂ will be a coveted raw material in future," says Arne Stecher.

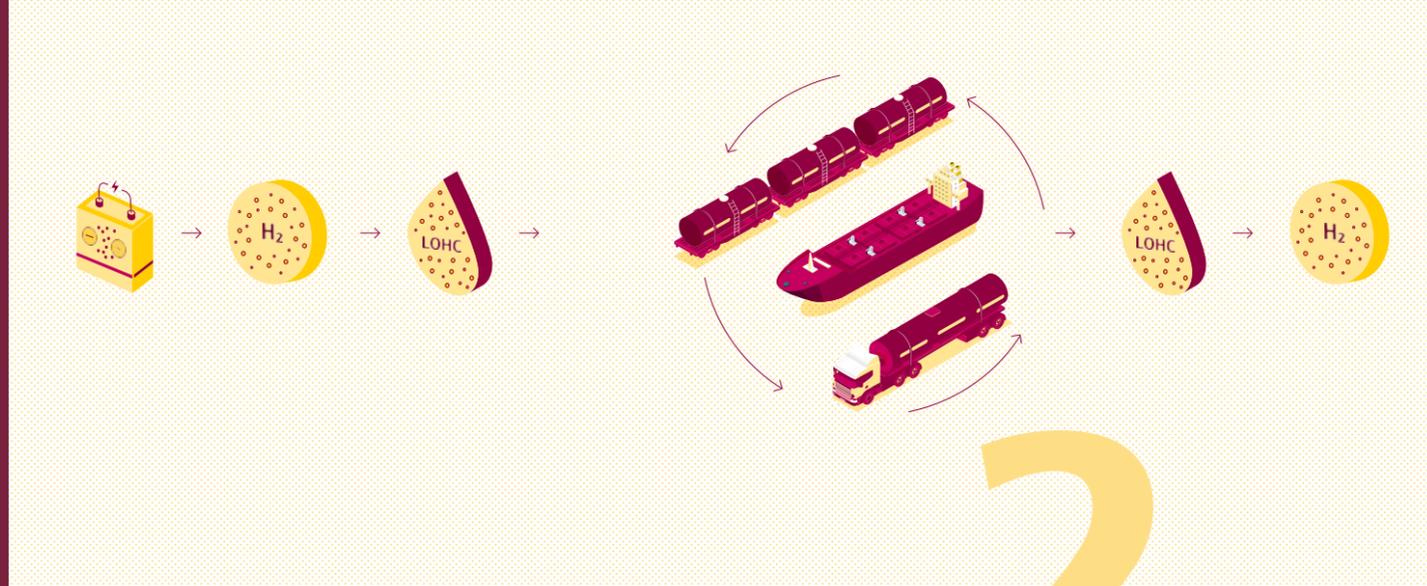
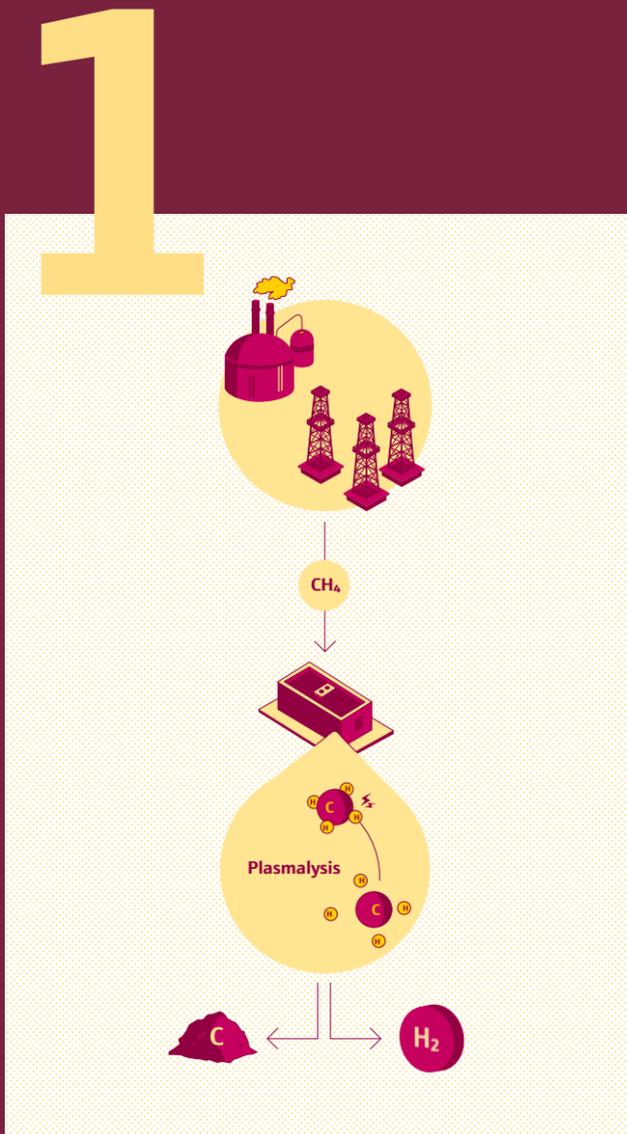
All for one

Hydrogen is considered key to the energy transition and climate neutrality of entire industries. All along the value chain, companies are working on innovative technologies and applications to help this new energy carrier achieve a breakthrough. Here are three examples.

Text: Christine Böhringer
Graphics: 3st

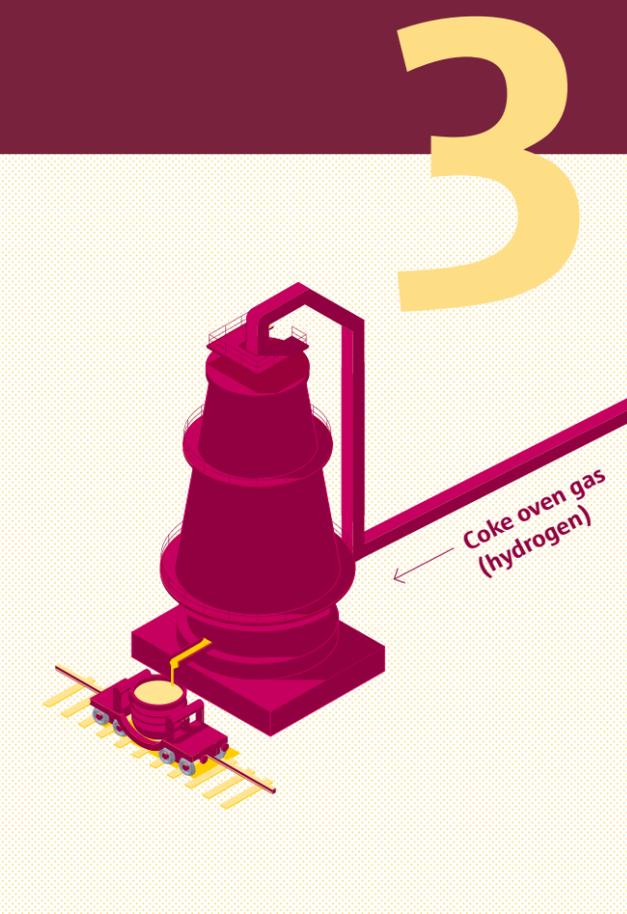
1 PLASMALYSIS TAPS NEW HYDROGEN SOURCES

To produce climate-neutral hydrogen, the raw material in strongest focus at the moment is water (H₂O). Electrolysis powered by green electricity splits it into hydrogen (H₂) and oxygen (O). But hydrogen is not just found in water. It is also a constituent of numerous hydrocarbon and nitrogen compounds in wastewater, slurry and gases. Berlin-based company Graforce wants to extract hydrogen from these residual materials: It has developed a plasma electrolysis ('plasmalysis') process where a high-frequency plasma field is generated using renewable energy. The plasma field splits the ammonia molecules (NH₃) in sewage, or methane molecules (CH₄) in natural gas or biogas, into their atomic constituents. "Water bonds H₂ more strongly than other chemical compounds. That is why methane plasmalysis can generate a given amount of hydrogen using only one-fifth of the electrical energy of water electrolysis," Dr Jens Hanke, managing director of Graforce, explains. This cuts production costs considerably. Furthermore, putting methane through the plasmalysis process produces, in addition to hydrogen, solid carbon (carbon black) that finds uses in the construction and steel industries, for example. And with biomethane, CO₂ is not emitted from the process but actually extracted from the natural carbon cycle. Running the technology with natural gas as the methane source would be useful in the oil and gas industry, which could consequently avoid flaring off the gas and so achieve its climate targets. The modular Graforce plants are already market-ready. Endress+Hauser supplies the measurement technology for methane plasmalysis. "Plus points include our large portfolio, our application expertise, online technical documentation and the on-site support we can offer all over the world," Mathias Christ, a technical sales employee of Endress+Hauser Germany, explains.



2 INNOVATIVE CARRIERS SIMPLIFY LOGISTICS

It is frequently uneconomical to produce green hydrogen at the place where it is actually needed. So how can it be transported? The gas grid can only blend in a limited amount of hydrogen with natural gas. For seaborne logistics, the highly flammable hydrogen must be liquefied at -250°C; cooling and compression use a lot of energy. Now there is a new solution: liquid organic hydrogen carriers (LOHCs) – unsaturated, generally aromatic hydrocarbon compounds that can absorb hydrogen through a catalytic reaction. H₂ bonded in this way is very easy to store and move around under atmospheric conditions, with no pressure or cryogenic containers needed. So transportation can use existing logistics infrastructure for liquid fuels, such as tankers, tanker trucks and tanker wagons. The hydrogen finally gets released from its liquid carrier at the point of use. "Measurement technology is indispensable both for hydrogenation at the source and for dehydrogenation at the destination: it helps monitor and control the chemical reactions," says Jens Hundrieser, Endress+Hauser's European industry manager for mining, minerals & metals. "Furthermore, process photometers using inline colorimetry enable quality control and purity monitoring of LOHCs."



3 COKE OVEN GAS MAKES BLAST FURNACES TRANSFORMATION-READY

Hydrogen has a large part to play in the future of steel production. The idea is to use the gas in new production processes like direct reduction that will supplant the classic carbon-based blast furnace route. But blast furnaces have long investment cycles and direct reduction requires green hydrogen in very large amounts. So bridge technologies are needed on the road to carbon-neutral steel. "One possibility is to inject coke oven gas into the blast furnaces," says Jens Hundrieser. Coke oven gas contains 55 percent hydrogen; this replaces coal as a reducing agent and energy carrier for the process. The benefit here is an immediate way for manufacturers to lower emissions while also laying the groundwork to operate their blast furnaces with green hydrogen in future. In Germany, Dillinger and Saarstahl have been using this new technology since 2020; the injection systems come from plant builder Paul Wurth. Long-standing, partnership-based customer relationships have led both companies to equip their plants with Endress+Hauser measurement technology, including 200 Cerabar pressure sensors.



6 fermenters turn potato remnants into biogas for electricity generation at the Wernsing plant in Addrup.

is added twice an hour. The gas given off, with an average methane content of 62 percent, is dried and purified. Then it is used to run five combined heat and power (CHP) units that generate up to four megawatts of electricity. At a temperature of 450 degrees Celsius, the exhaust gas from the CHP units helps to dry the dewatered sludge produced during fermentation. What remains is a natural fertilizer, which the company sells.

PRECISE MEASUREMENT WITH BIOGAS EXPERTISE

Process instrumentation is at the heart of the wastewater treatment and biogas system. In its search for robust and durable instruments, Wernsing turned to Endress+Hauser as a full-range supplier. The right measuring technology also helps to master the various applications' specific challenges, resulting in flawless system operation around the clock. For wastewater, the partners came up with a solution that manages air supply to the aeration basins in sync with the biodegradation process, thereby optimizing energy use. When it comes to biogas, another solution ensures that the sensors in the fermenters are cleaned regularly. Along the pipes and ducts leading to the CHP units, 19 Prosonic Flow B 200 ultrasonic flowmeters measure the quantity of gas precisely, even under fluctuating conditions. The unique measurement technology also directly detects methane levels in the biogas, so fermentation anomalies are identified and corrected without delay.

Projects like these have nurtured a partner-like relationship between Wernsing and Endress+Hauser. And the company's path to greater efficiency continues: There are firm plans in place to process the treated wastewater using ultrafiltration and reverse osmosis for subsequent use in technical equipment. There will also be a biomass heating system to generate steam for the production processes. Taking the 2018 figure for carbon emissions as a baseline, the company's climate strategy calls for a 40 percent reduction by 2025, with the amount of electricity produced from biogas also slated to increase by 40 percent to over 20 gigawatt-hours a year.

Using it all

Wernsing turns potatoes into french fries and hash browns – as well as into heat and electricity. Precisely tailored solutions ensure that every process is optimized.

Text: Tim Schrodt
Photography: Christoph Fein

RESOURCE EFFICIENCY

Sustainability? Extracting the most out

of what's available? Circularity? Those concepts aren't new for the Wernsing Food Family. The group of companies processes around half a million tonnes of potatoes every year into french fries, croquettes, hash browns and other specialties at 15 locations around Europe. The plant at Wernsing's headquarters in the north German village of Addrup has been utilizing every last bit of potato for the past 20 years. The site leverages the potential of wastewater and production waste to cover a substantial portion of its electricity needs for the energy-intensive manufacturing processes.

The core element is generation of biogas. Wernsing channels remnants from potato and food product manufacturing into six fermenters, where fresh material

Closing the circle

CIRCULAR ECONOMY

A mere nine percent of global plastic waste currently gets recycled. Increasing that figure is virtually impossible with mechanical processing, the predominant method used to date. The mechanical approach also requires plastic waste to be separated to transform it into new products of the same plastic type and color. However, such perfect separation and pre-processing are difficult to achieve in reality. Chemical recycling overcomes these limitations. "What's more, the resulting plastics are of high quality and can even be used for food packaging or medicine," says Dr Simone Moos, a product manager at Analytik Jena. "That was previously inconceivable with mechanical recycling." For this and many other reasons, and despite being relatively new, the chemical method has long featured in circularity strategies endorsed by the European Union and adopted by many countries. The chemical industry is also following suit with a growing switch from crude oil to recycled carbon.

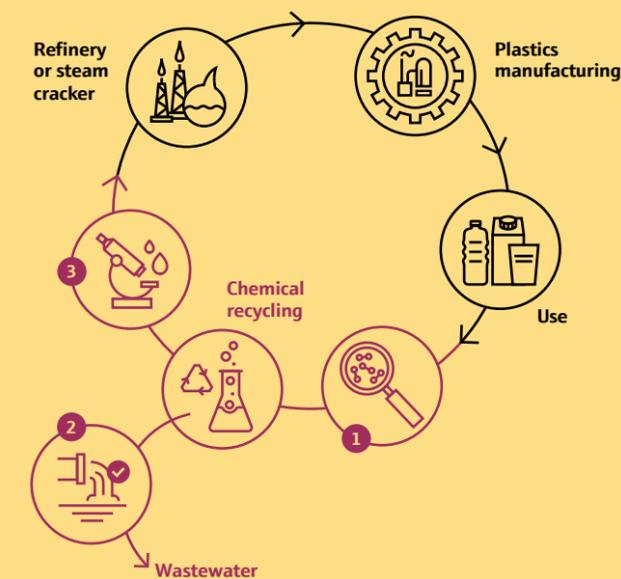
BREAKING THE CHAINS

Chemical recycling puts a circular economy for plastics within reach. The key process is pyrolysis, which breaks up the plastics' polymer chains in an oxygen-free environment at around 600°C. The result is a viscous pyrolysis oil – the starting material for further processing. Depending on its weight, the oil is further broken down into compounds such as ethene or propene, either at a refinery or directly in a steam cracker. From those compounds new plastics can be formed, and the circle is closed. Endress+Hauser subsidiary Analytik Jena provides equipment that measures the quality of the starting materials, by-products and end products of chemical recycling with the utmost precision in just minutes.

Chemical recycling can help industry save millions of tonnes of fossil-based primary feedstocks and mitigate the global plastic waste problem. Analytical instruments deployed in the recycling process deliver key decision-making data.

Text: Robert Habi
Graphics: 3st

QUALITY ASSURANCE IN CHEMICAL RECYCLING



- 1 Incoming inspection**
The purpose of chemical recycling is to extract pyrolysis oil. Its purity depends on a number of factors, including the quality of the plastic waste being processed. That's why it makes sense to check the chlorine content of the waste – something the macro elemental analyzer from Analytik Jena can help with.
- 2 Wastewater analysis**
Pyrolysis generates wastewater. Instruments from Analytik Jena can help to determine whether that wastewater has been processed sufficiently for reintroduction into watercourses by measuring the content of total organic carbon (TOC) and adsorbable organic halides (AOX).
- 3 Testing and checks**
To prevent plant damage, pyrolysis oil needs to be clean and may require purification prior to processing. Analytik Jena has instruments that use inductively coupled plasma optical emission spectroscopy (ICP-OES) to verify compliance with limits on silicon and metal content. The company also offers a micro elemental analyzer to check compliance with chlorine and nitrogen limits.

Shrinking the footprint

Endress+Hauser aims to gradually decarbonize its portfolio over the coming years. But how is that possible when you need steel to produce your measuring instruments?

Text: Christine Böhringer
Photography: Andreas Mader



Looking at the big picture: Hans Joachim Fröhlich, director of technology and portfolio, is pursuing various ways to improve the carbon footprint of measuring devices.

use of two-wire technology in measuring instruments: relative to four-wire, it needs less power to operate and fewer electronic components.

MOVING TO MODULAR DESIGNS

The circular economy is an additional focus of attention at Endress+Hauser. “Our instruments already have long service lives of 15 to 20 years, and our main goal is to continue extending that,” Fröhlich says. Again, the instruments’ electronics can play a part in these efforts, since they don’t last as long and are more prone to technological obsolescence than sensors and mechanical systems. As one example, the latest generation of the Proline 300/500 transmitter family for flow measurement was designed to have easily replaceable main electronics and communication modules. This approach enables the straightforward addition of future communications standards and new functionalities.

But there are limits to the refurbishment and reuse of measuring devices. “Due to the large number of variants, almost every one of the three million instruments we produce each year is unique,” Fröhlich explains. Other obstacles to refurbishment are the lack of standardized measurement technology in plants, industry-specific standards, individual process requirements and the criticality of many measuring points. Yet there is potential to reduce the product-related carbon footprint during instrument operation: “Most new field devices from Endress+Hauser now include Heartbeat Technology with

diagnostic, verification and monitoring functions. This makes it possible to optimize calibration cycles and precisely schedule service calls,” he says.

Fröhlich sees one thing as certain: decarbonization of the portfolio will shape innovation at Endress+Hauser. That will take close cooperation with customers, whose current priority is to tackle the major emissions drivers at their plants, such as energy supply, machinery, pumps and pipework. “At a large chemical site, measuring technology accounts for only half a percent of the carbon footprint,” he says.



Less is more

Simon Weidenbruch has come up with a totally new way of generating high voltage. Here he explains why that makes a radiometric level measuring device more sustainable.

As told to Christine Böhringer
Photography: Andreas Mader

“Could we do the same with less energy?” After a customer asked me this question in 2008, I couldn’t get it out of my head. We were talking about the Gammapilot, our radiometric level instrument whose operating principle requires generating a high voltage inside it. That consumes 800 milliwatts of power, which may not seem like much but it is a lot in potentially explosive areas. So the power must be safely isolated from the surrounding environment. And it needs to come from a dedicated supply, meaning that two additional wires must be connected to the device, which requires a lot of effort. I started looking into this question during our regular Friday afternoon time slot when we are allowed to pursue our own pet projects. I assessed the state of the research, tried out circuitry and pondered effective ways of producing a continuous high voltage. It took me two years to make the breakthrough and in 2010, I presented a prototype that generated high voltage from just 40 microwatts. At first, nobody wanted to believe that radiometry with a two-wire compact transmitter was even possible. But we kept working on my idea, and the instrument made it to conventional development in 2016 before being launched on the market in 2019. The Gammapilot FMG50 is much more sustainable thanks to its novel and patented voltage generation technology. Our new device requires significantly less electrical power compared to its predecessor, only a third of the electronic components, several kilos less steel and no expensive additional cabling. I’m glad I persevered with it. As for the customer, they installed the new instruments straight away and now come exclusively to us for this kind of measuring technology.

Simon Weidenbruch is an electronics engineer and has been working for Endress+Hauser since 2004. In his role as a systems architect, he is currently involved in developing new level sensors.

Hot stuff

Utilities are essential to the operation of industrial plants. The problem is that lots of process energy vanishes unused. To do something about that, you need to make the right adjustments – using the right measuring technology.

Text: Christine Böhringer
Photography: Andreas Mader, Shutterstock, Heizkraftwerk Zwickau Süd



40%

of the fossil energy consumed by the process industry goes to generating steam in boilers.



Systematic savings: steam generation, distribution and utilization can be readily optimized in existing plants.

OPTIMIZATION

When Oliver Seifert talks about utilities, he likes to use the acronym WAGES, which stands for water, air, gas, electricity and steam. He thinks it's a fitting term. "Utilities are like service providers," says Seifert, a vortex flowmeter and steam management expert at Endress+Hauser. "They keep a plant's core processes running." Taking a closer look at them is worthwhile for any business looking to improve sustainability. "Since utilities are among the biggest consumers of energy in the industrial sector, the potential for decarbonization is huge – but often still overlooked," Seifert adds.

The most effective lever is process heat, usually generated from gas, coal or oil. In Europe, that heat accounts for two-thirds of total industrial energy consumption, with a quarter of this estimated to be process steam. To reduce their emissions, plant operators can switch steam generation to non-fossil technologies such as electric boilers or industrial heat pumps, which reclaim waste heat. But that often requires significant investment, and the technical feasibility needs to be proven first. "In existing plants, it's usually just easier to increase energy efficiency," Seifert says. Installing precise, state-of-the-art measuring technology in crucial places helps cut costs and enhances safety.

ELIMINATING WET STEAM

A pivotal factor here is steam quality. "One hundred percent dry, saturated steam provides optimum efficiency," Seifert explains. But that steam can condense on the way from the boiler house to consumers due to poorly

lagged pipes, faulty steam traps or pressure and temperature fluctuations. That causes wet steam to form. Its moisture results in energy losses and, in many cases, dangerous water hammer. "Endress+Hauser Prowirl 200 is the world's first vortex flowmeter that precisely measures steam quality in pipes and alerts you if wet steam is detected," Seifert says. That allows operators to take fast action if necessary.

The quality of feed water also matters. "If it's not right, you'll get corrosion or deposits in the boiler, which will impair efficiency and reduce its life span," Seifert explains. Many plant operators still take manual samples for lab analysis of specific parameters. But they only do so every few days. Endress+Hauser has developed a compact, plug-and-play analysis system especially for industrial steam generators. It continuously takes samples, cools them and measures their pH, conductivity and dissolved oxygen. "With its sophisticated design, our solution does the job with only a fraction of the sample quantity

that conventional systems require," Seifert says. That brings a corresponding reduction in energy and cooling water consumption.

Plant operators can further improve efficiency by replacing all of a boiler's standard measuring technology with modern instruments. "Now we are able to monitor the boiler's specific energy consumption and efficiency, then use those insights to minimize fuel consumption," Seifert adds. Much hinges on the precise measurement of flow, pressure and temperature, which is another area where instruments such as the Prowirl 200 vortex flowmeter come into their own. While the presence of wet steam can cause measurement errors of typically five percent or more in other devices, the Prowirl 200 continues to deliver high-precision data. Users can leverage the solution's full potential by collecting, evaluating and duly analyzing that data, Seifert says. "Thorough energy monitoring can reduce energy consumption in steam processes by up to 15 percent."

THE POWER OF STEAM

Steam makes an ideal heat transfer medium and finds extensive use in the chemical, food & beverage and life sciences industries, among others. It can absorb five to six times more thermal energy than the comparable mass of water. Because it flows through pipes literally under its own steam, it can be effectively distributed over long distances and easily put to work in manufacturing processes that require direct or indirect heating, such as beer brewing, sterilization and distillation.

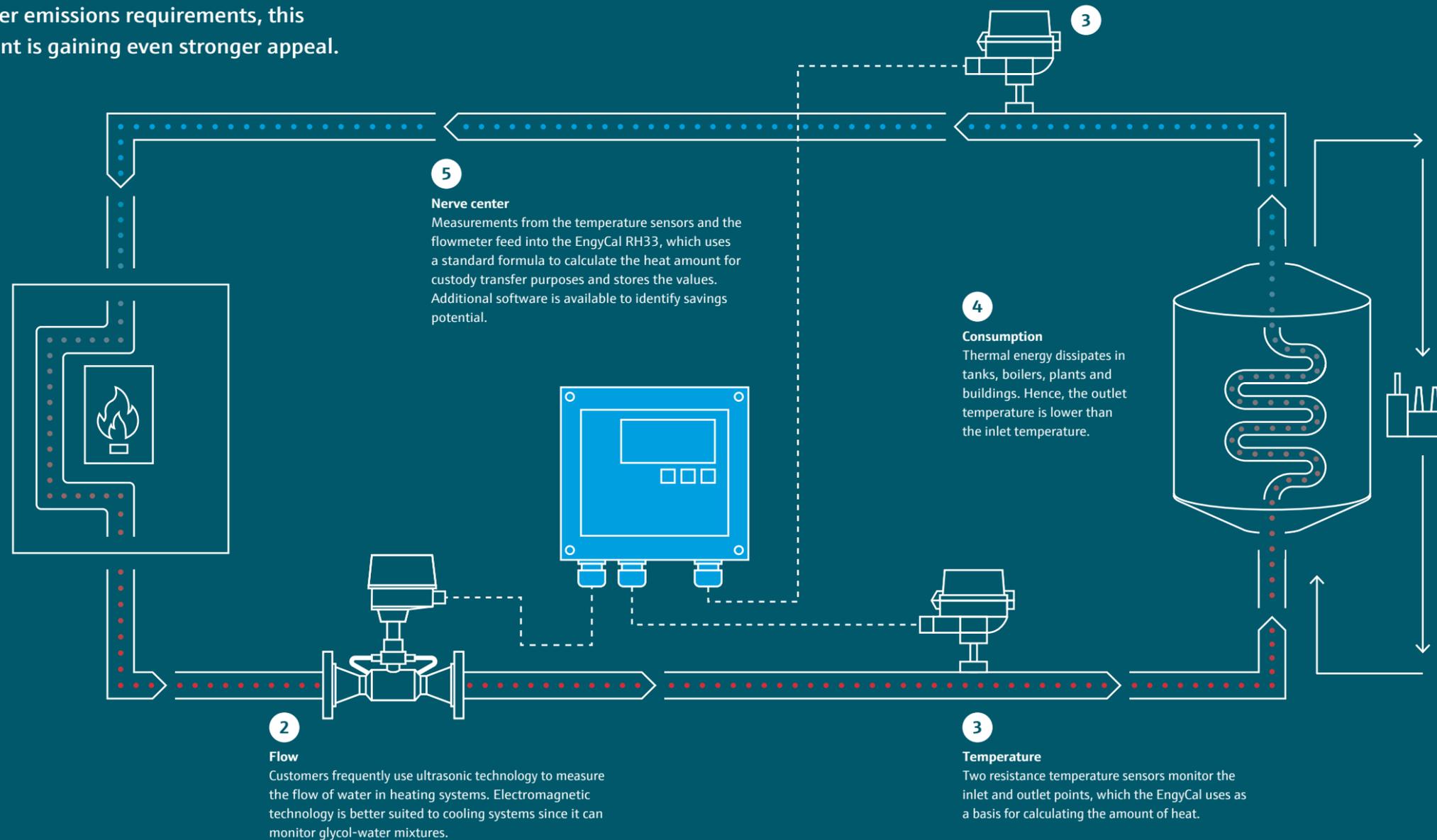


Measuring what counts

To save energy, you first need to know how much is being consumed. Which is exactly what the EngyCal RH33 BTU meter has been measuring for years. Given the rising cost of energy and stricter emissions requirements, this evergreen instrument is gaining even stronger appeal.

Text: Robert Habı
Graphics: 3st

1 Energy
Thermal energy generated at a power plant is supplied to an industrial plant using water as the heating medium.

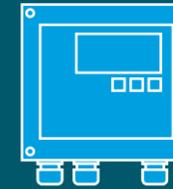


2 Flow
Customers frequently use ultrasonic technology to measure the flow of water in heating systems. Electromagnetic technology is better suited to cooling systems since it can monitor glycol-water mixtures.

3 Temperature
Two resistance temperature sensors monitor the inlet and outlet points, which the EngyCal uses as a basis for calculating the amount of heat.

4 Consumption
Thermal energy dissipates in tanks, boilers, plants and buildings. Hence, the outlet temperature is lower than the inlet temperature.

5 Nerve center
Measurements from the temperature sensors and the flowmeter feed into the EngyCal RH33, which uses a standard formula to calculate the heat amount for custody transfer purposes and stores the values. Additional software is available to identify savings potential.



ENGYCAL RH33

- Custody transfer BTU meter for heat transfer fluids such as water, glycol-water mixtures and thermal oils
- For monitoring and billing energy usage in heating and cooling systems
- Stores detailed metering values, error messages and threshold violations
- Suitable for connecting and providing power to common flow, pressure and temperature measuring points
- Remote readout via Ethernet and fieldbuses; connectivity with the Endress+Hauser Netilion IIoT ecosystem
- Version available for steam applications: the EngyCal RS33 uses volumetric flow, temperature and/or pressure to calculate the mass of steam and energy flow

Heating and cooling are musts for industrial production. Processes taking place in vessels, tanks and piping systems often need to run at specific temperatures, and then there are buildings to be heated or cooled. A full 60 percent of industrial electricity consumption is used for heating and cooling, a statistic that illustrates the vast potential for optimization. It also shows the importance of every kilowatt saved when energy is scarce and costly and there are climate goals to be reached. Joachim Hajek sees the most savings potential in thermal energy. "Countless thermal processes exist for generating hot water and steam," says the global product manager for system components at Endress+Hauser. There has to be clear data on those processes. For years Endress+Hauser has offered a proven product for that precise purpose: the EngyCal RH33 BTU meter.

This custody transfer instrument operates using two resistance temperature sensors and a flowmeter. Their temperature and flow measurements feed into the EngyCal, which calculates an energy consumption figure for later billing, much like the electricity meter in your home. "The instruments alone don't save energy, but they do show where there are savings to be had. Which is precisely what customers have their sights on: they need a basis for devising energy-saving measures," says Hajek. Customers are able to draw further inferences from the mix of energy consumption, peak load and time of use relative to the size of the plant. Energy providers can then use this information to generate invoices, while energy managers can monitor usage across entire industrial complexes. "By installing our solution at various points around a process system, you get a precise overview of where the energy is going."

Hearts and minds

People are what make the difference at Endress+Hauser. They value the past, they shape the present, they think about the future. And not least in this 70th-anniversary year, it is they who have collectively put in motion an abundance of initiatives: for customers, for themselves – and for a sustainable world.

Text: Christine Böhringer, Sereina Manetsch
Photography and illustrations: 3st kommunikation, Endress+Hauser, Marc Gilgen

70

is the age Endress+Hauser reached in 2023 – an anniversary celebrated around the globe.

600

apprentices and students swapped experiences and ideas at a networking event.

5,500

employees, more than one-third of the total workforce, gathered in Basel to celebrate.

850

customers discussed the sustainable transformation of the process industry at the Global Forum.

Setting the course



1

2



3



Where have we come from? What makes us tick? Where do we want to go? And how can we continue making the world a better place? These have been dominant questions in 2023, the year that Endress+Hauser turned 70. Starting as a two-man operation, the Group has evolved over seven decades into one of the world's leading providers of process and lab technology, automation solutions and services. Behind this success are the people. "Our customers value us, our employees are committed to the company and our shareholders maintain a long-term mindset," emphasized CEO Matthias Altendorf. "We can be proud of our accomplishments as we look confidently to the future."

The company's 16,000 employees, numerous customers and members of the shareholder family celebrated at both small and large events across the world. The high point was the anniversary week in Switzerland, where 5,500 employees gathered to take stock of the past seven decades. More than 900 employees participated in internal conferences and 600-plus young people shared their experiences during the Young Generation Day networking event. In addition, 850 customers discussed the

sustainable transformation of the process industry at the inaugural Endress+Hauser Global Forum. Users and experts shared their perspectives on topics such as decarbonization, the energy transformation, the circular economy, and resource and energy efficiency.

The event also provided an opportunity to honor the lifetime achievements of Dr Klaus Endress, president of the Supervisory Board, who will step down at the end of the year. Succeeding Dr Endress will be Matthias Altendorf, whose role as CEO of the Group is to be filled by Dr Peter Selders. The family will continue having two representatives on the Supervisory Board. Alongside Sandra Genge, Steven Endress will be representing the family interests as of 2024. Said Matthias Altendorf: "We can do so many good things at Endress+Hauser because we have shareholders with a long-term vision. They offer insight, values and human warmth and show their respect for the performance of the people at the company. It's always the people who make the difference!"

Trust and appreciation

They represent the future – and will shape it, too. More than 600 young employees and students from around the world came together at the Young Generation Day networking event on the occasion of the 70th anniversary of Endress+Hauser. Two participants share their experiences and their takeaways from the gathering.



“It was great to get to know people from other countries and areas of the company, to network with them and to learn from one another. What really impressed me was that the shareholder family joined us and shared their thoughts, not to mention the interest they showed in our thoughts. This taking interest in one another

is really a wonderful thing that sets the Endress+Hauser culture apart! It’s a mindset I first got to know during two internships at Endress+Hauser while completing my dual engineering studies; I’m now studying manufacturing technology. As I see it, the culture is the foundation of the company’s success.”

Frank Hund, student at the German Karlsruhe Institute for Technology (KIT)



“Since obtaining my degree in electrical engineering, I’ve been working as a rotational engineer at Endress+Hauser in Greenwood. In this program, I move through various departments to expand my technical skills and get to know the company better. I have also completed summer internships at Endress+Hauser, including one in Barcelona! It seems that whatever the country, the company’s culture, values and style of personal interaction are always the same. I noticed this again during the Young Generation Day. I always feel welcomed, valued and trusted at Endress+Hauser!”

Riley Parshall, rotational engineer at Endress+Hauser in Greenwood, Indiana, USA



Incubator for innovation

The innovative spark often jumps across organizational interfaces when people share ideas in a creative environment. Mindful of this, Endress+Hauser took six units, each individually specialized in sensor technologies and software solutions, and grouped them into an innovation center at the faculty of engineering on the campus of the University of Freiburg. The teams collaborate closely in an embedded setting composed of research institutes, startups and other companies. CEO Matthias Altendorf views the new location as an incubator for the measurement technology of tomorrow, where disciplines are intentionally mixed to complement and inspire one another.



>€52,000

The amount that Endress+Hauser donated for earthquake victims in Türkiye. The country’s southeast region was hit by two strong earthquakes in early 2023. 30,000 people lost their lives, 80,000 were injured and numerous buildings were destroyed. The proceeds from the campaign, initiated by the sales center in Türkiye, were used to purchase living containers for families left homeless by the disaster.

Three times around the globe

In light of the Group’s 70th anniversary, employees set a special goal as part of the Endress+Hauser Water Challenge: circumnavigating the world in 70 days. First launched in 2019, the Water Challenge involves team effort to complete a predefined route by running, cycling, swimming or other physical activity and collecting the corresponding sponsorship donations. Endress+Hauser matches each donation with the aim of giving people access to clean water. The result topped all expectations: 622 participants in 84 teams across 20 countries completed a total of 133,049 kilometers – activities even included sack racing – thus circumnavigating the globe not once, but three times. The donations went to building two water houses in the highlands of Vietnam that will safeguard the water supply for more than 1,000 people.

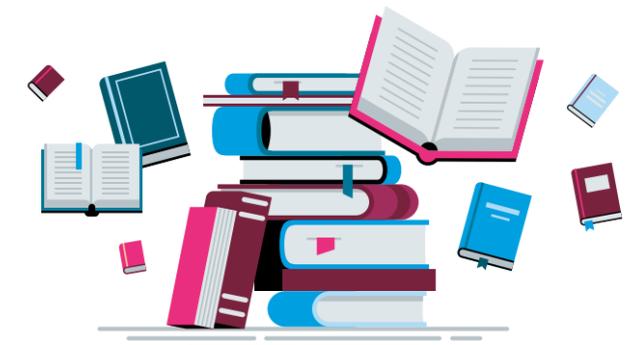


Yes to climate protection

Endress+Hauser supports the 1.5-degree goal outlined in the Paris Climate Agreement and aims to reduce its greenhouse gas emissions to net zero by the year 2050. That was the spirit in which the Group joined the Science Based Targets initiative (SBTi) in March of this year. This initiative helps companies establish climate protection goals based on scientific findings, and focuses on reduction of emissions – not compensation – along the entire value chain. A corresponding climate strategy, with concrete intermediate objectives, is currently in development.

Outstanding engagement

Social engagement has always been deeply rooted in the Endress+Hauser culture. The Group’s 80-plus international sales representatives share these values as well and are committed to helping disadvantaged people, improving education and protecting the environment. Now the international sales organization has honored this commitment with a Corporate Social Responsibility Award. The inaugural award recognized two education initiatives started by Endress+Hauser International Asia-Pacific and the Myanmar sales representative, which made it possible for disadvantaged children to attend school.





What matters now and in the future?



Klaus Endress is handing over his responsibilities as president of the Supervisory Board at the end of 2023. In our interview, he looks back at 45 years with the company – and talks about his career, the role of the family and what he has learned from nature.

Questions: Martin Raab
Photography: Andreas Mader

Mr Endress, your path into the company was mapped out early...

There never was a master plan for my career with the company – only chances, opportunities.

Was being the son of the founder an advantage?

With every position I assumed within the company, the gist was always, 'Let's wait and see...'. External recruits were introduced with all their past accomplishments, whereas I had to keep proving my capability in each new role. I certainly didn't have it any easier than others!

How did you manage to step out of your father's shadow?

It was my intuition back then to study production engineering and computer science: fields that were of less interest to my father, yet which matter just as much to a successful company as its market, customers and products. In this way I could establish myself without getting in my father's way too much. We had very different strengths, incidentally. He was a pioneer, able to create something out of nothing. That's not my forte! I need something that already exists, which I can then improve. But I never had the feeling that I was standing in my father's shadow. I always had enough sun. And with increasing success, I received increasing recognition.

What gave you the strength and courage to pursue your goal all the way?

I wanted to continue my father's life's work and grow the company further. Healthy growth and secure jobs have been my constant drivers. I never had any doubts and I never despaired. And I never gave up. This has been true for almost my entire life. The greater good always mattered to me. And that's what I dedicated myself to. It benefitted everyone, myself included. And I would do it all over again!

A LIFE DEDICATED TO THE FAMILY COMPANY

Dr Klaus Endress (born 1948) obtained a degree in industrial engineering from the Technical University of Berlin. He joined his father's company in 1979, took over the reins of the Group in 1995 as CEO and moved to the Supervisory Board in 2014 as president. He will hand over this responsibility to Matthias Altendorf in January 2024, while remaining president of the Family Council. Klaus Endress is married and the father of two grown children. A passionate equestrian and mountain biker, whenever possible he heads outdoors and into nature, accompanied frequently by Maya, the family dog.



How did your nature-inspired business philosophy take shape?

To some extent, the nature/tree philosophy was born out of necessity. Why? When I make important decisions, I need assurance. But who can tell me if the decisions are right, not just now, but into the future? People are never impartial in their judgments. This is where nature has been a constant inspiration for me; observing its growth and change, coupled with my interest in philosophy. For me the tree symbolizes the company. Consider the crown, roots and trunk, and it becomes clear: for the company to be successful, I cannot neglect any part of it. I have to develop it as a whole. Other important principles include doing the same things in the same way, and eliminating internal competition.

How has this been reflected in the company?

This mindset lay behind the decision to settle on a single enterprise software system, and later on to consolidate IT into a single entity. We had a number of projects in sales to streamline internal structures and to strengthen our market and customer activities in a bid for higher sales without higher costs. Or take the development of unified product platforms: our current liquid analysis transmitters can connect with sensors for all parameters.

When you look back, which changes and developments were especially important for the Group? What gives you particular pride?

One important step for the Group was globalizing production, hence the establishment of factories in the US, India, China and Brazil. It made us more independent of exchange rate developments and enabled worldwide growth. Another milestone was our focus on life sciences, in tandem with the expansion of process analysis and our entry into the laboratory business with Analytik Jena. The pandemic highlighted the full significance of this move. Another successful strategy was opening up our Memosens technology to third parties. Everyone benefits: our customers, our competitors and ourselves.



“Healthy growth and secure jobs have been my constant drivers. I never had any doubts. And I never gave up.”

Klaus Endress,
 president of the Supervisory Board of the
 Endress+Hauser Group

Nature as a role model

Klaus Endress draws strength and develops his thoughts from nature. “Nature has evolved and continuously adapted over three and a half billion years. I see its successful principles as inspiration for entrepreneurial activity.” He derives many of his insights from the tree as symbolic of the company. Nature also influences his people-centric approach.

“Customers, employees and shareholders are what make the company,” he says. “The better their interaction, the better our company will do. And best of all is interaction in a spirit of trust and loyalty.” The basis here is respect, quality and mutual benefit. Customers get first-class products, solutions and services. For employees it means secure, well-paid jobs. And the shareholders can be proud of the company while receiving an appropriate dividend.

SEEING THE COMPANY AS A TREE

The crown signifies sales as an interface to the market and customers. The root system is production, which serves as a technological anchor for the company. Innovation and logistics processes, along with support functions such as finance, human resources and IT, connect everything together in the trunk.

SUSTAINED SUCCESS

Nature’s large and strong creations take their time to grow. The fast growers stay weak and die early. So it is important for companies to adopt an evolutionary development path and not depend on boom markets.

STYLE OF INTERACTION

A tree is not to blame if it does not thrive. Looking for culprits does not help in the business world either. What’s needed is to identify and rectify the cause of the problem. People are important. The better they interact, the greater the benefit to the company.

MANAGED DIVERSITY

Nature can seem extravagantly varied. Yet the underlying, invisible structures are often similar. This same principle helps companies manage the diversity demanded by markets and customers. Internal standardization frees up resources that can be used for external differentiation.

EQUAL IMPORTANCE

A tree develops day by day and without neglecting any part of its structure, because each one is essential to life and survival. Good leaders develop and grow the company as a whole – and show appreciation to all who contribute to success.

PART OF THE WHOLE

Like a tree, the company belongs to an environment on which it depends. The wider benefits of its existence play an important role here: what the tree provides in the form of fruit, shade and oxygen, the company provides in the form of salaries, profit and taxes. Just like nature, good companies are sustainable.



*“I hesitate to offer unsolicited advice.
But I’m always here if anyone is looking
for my guidance.”*

Klaus Endress,
president of the Supervisory Board of the Endress+Hauser Group

If there is such a thing as your corporate legacy... Looking beyond your departure from the company, what do you see as important things to be preserved?

In nature, everything has a purpose. The purpose of our company is to help customers improve their products and manufacture them even more efficiently. Such total focus on the market and customers is always the right approach. We must follow this rigorously and uncompromisingly, because a winning formula is something you stick with. Just like in a family, cohesion and cultivation of common ground are important for the company. We must treat each other well; no one should feel that they are superior. This is why the top priority of Group management is to ensure that fundamental rules and procedures are upheld and observed: our vision and mission, the Spirit of Endress+Hauser, the Group strategy... In addition, every entity needs executives who network globally, both inside and outside the company. All of these things keep us on course, bring us success and help us in times of uncertainty.

An important anchor for the company is the family. What will it take for the family company to endure?

Compared to publicly listed companies, family companies develop either significantly better or considerably worse. There is just one thing they are not: average. The family, united or otherwise, is what makes the difference. Our Family Charter fosters unity and solidarity through solid institutions and clear principles. These are guidelines to live by. One of my major insights has been that companies and families alike need similar structures. Which is why we have the Family Council, a kind of executive board for the family, and the Family Charter, which sets out a vision and the values that count for us.



Although you are leaving the Supervisory Board, you will remain president of the Family Council and of course an Endress+Hauser shareholder. Where and how will we continue to see you in the company?

Although I will no longer serve as president of the Supervisory Board as of January, I shall still be around. My personality will continue to bear. And I will be visible through my role as president of the Family Council. I will keep my office here and stay abreast of developments within the company, because one of my responsibilities is to maintain the flow of information to the family. I’m nevertheless looking forward to being less driven, slowing down and having more time for my wife and children – in the hope of staying healthy for a long time to come.

A final word... What advice for the future would you like to share with us?

I hesitate to offer unsolicited advice. It can be perceived as intrusive, even if it’s valuable and shared with good intentions. But I’m always here if anyone is looking for my guidance.

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