The thyssenkrupp Steel magazine
Issue 01/2019
thyssenkrupp-steel.com

compact steel

Extra insert!
Two-page infographic on our e-mobility initiative selectrify®

Our path to climate neutral steel production

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thyssenkrupp

Helpers around the home

Living room, kitchen, bathroom – nd out where innovative steel products are moving into your home.

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Cladding as an art form

pladur® Relief Icecrystal facades give the Black Forest's Öschberghof golf resort that special sparkle.

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Find out how Grit Reiman (left), Manuela Ruthenberg, and their teams leave hydrogen with nowhere to hide.

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“We will combine our high technological and quality standards with an active climate strategy.”

The new thyssenkrupp Steel Executive Board (from left): Dr. Arnd Köfler, Premal Desai, Dr. Sabine Maaßen, Bernhard Osburg.

Anyone reading the financial papers over the last few months could be forgiven for believing thyssenkrupp is in the middle of the perfect storm. You shouldn't believe everything you read, but at the same time there's no denying that 2019 was a turbulent and challenging year for us. In spring, the joint venture we were planning to enter into with Tata Steel was blocked by the European Commission. As a result, steel will now remain an integral part of the thyssenkrupp Group. At the same time, we are working hard on a new steel strategy, and by the end of the year we will have a new structure in place that will enable our business to grow and enjoy sustained success in the long term.

The world around us is no less turbulent. Trade disputes are damaging our relationships with our international customers. In the same connection we are seeing a further rise in imports to Europe. This, too, is a challenge that requires us to work with the policymakers in order to keep jobs and production in Europe. A weakening economy coupled with highly volatile raw material prices also make 2019 a challenging year.

There can be no doubt that challenges are great. But we on the new Executive Board have a clear vision for the future of steel. We have already made one fundamental decision: we are launching a gradual transformation process that will eventually make our steel production completely climate neutral. To find out how we intend to do this, check out our cover story on page 8.

We look forward to following the path ahead together with our customers.

Premal Desai
CEO

Dr. Arnd Köfler
CTO

Dr. Sabine Maaßen
CHRO

Bernhard Osburg
CCO

Cover: Photo: Weis Communications GmbH | Pages 2–3: Photos: thyssenkrupp Steel | Graphics & layout: C3 Visual Lab

steelworks

BUILT BY ENGINEERS. MADE FROM STEEL.

reddot design award
best of the best 2019

Highly flexible seat tube for a comfortable, non-tiring ride

Weight comparable with aluminum thanks to durable thyssenkrupp DP600 steel

Innovative half-shell technology for an organic and aerodynamic shape

Highly rigid bottom bracket for optimum power transmission

Top performance with steel

A steel bicycle frame? Surely that's much too heavy compared with aluminum or carbon? Not at all – or at least not when thyssenkrupp Steel's engineers are on the case. To demonstrate what steel can do today, they designed steelworks, an unbreakable racing bike that's as light as a feather (well, almost). The steelworks frame combines: performance and comfort thanks to an extremely rigid bottom bracket and a highly flexible seat tube. Add in the material's intrinsic shock absorption and you've got a ride that won't tire you out. The half-shell production technology and 3D laser-welding technique used for the steelworks frame guarantee an aerodynamic shape and high-precision construction with almost invisible welds.

Automated laser welding for consistently high-end quality

Information online

You can find out all about steelworks at www.steelworks.bike or by following us on Facebook: www.facebook.com/steelworks.bicycles.

Photo: Andreas Hirsch

Knowledge & value

400

Our roots in Hohenlimburg
For 400 years

Anniversary

400 years in Hohenlimburg

It all began with Wessel Lappenberg's old wire drawing operation in the town now known as Hohenlimburg on the banks of the Lenne river. It was exactly 400 years ago that operations there were first recorded. At that time, the Lenne valley was a hub for metalworkers. With the advent of the 19th century, wire drawing was experiencing a robust boom, thanks primarily to the fact that visionary entrepreneur Gottfried Böing had recognized the industry's potential and invested in new technologies such as wire rod rolling. After emerging from a tumultuous period involving mergers, name changes, and a move to the city's Oege district, today's thyssenkrupp Hohenlimburg GmbH is carrying on its historic tradition of wire drawing. At this plant, the company produces high-quality precision strips under the precidur® trade mark.

thyssenkrupp Steel – follow us!

Connect with us on Facebook or follow us on LinkedIn and Instagram. thyssenkrupp Steel shares posts about current topics on all of its social media channels.

Duisburg plant tests electric company cars

thyssenkrupp Steel is strengthening its commitment to environmentally friendly mobility, and for the past few months the company has been testing an eGolf for its company fleet. Environmental and Climate Protection has erected a charging station at the site to power the new vehicle with sustainable energy from the plant's own production processes. "We in the Environmental Protection department want to lead the way for the company by gathering experience in this critical field," says department head Andreas Theuer.

According to Theuer, the eGolf was popular in the team and many employees even used it in place of their private vehicles on business trips. If e-mobility proves to be a successful venture, thyssenkrupp Steel plans to successively expand its fleet. There are also plans to extend the charging infrastructure in Duisburg and at other locations to allow employees to charge their own e-vehicles at the plant.

The electricity that powers the electric vehicles at the charging station will be sustainably produced using blast furnace gases generated by the steel production processes at the Duisburg location.

The vehicle has a range of around 200 kilometers. That's perfect for most business trips. The charging process takes around four hours.

Web

For information on the topic of e-mobility:
thyssenkrupp-steel.com

.. figures

20.6

million metric tons of steel products were exported by the European Union in 2018. Primary importers included other European countries, Turkey, Russia, and the Commonwealth of Independent States with total imports of around 7.5 million metric tons. The European Union imported almost double that amount, or 15.2 million metric tons, from this group of countries, which constitutes its most important steel trade partners.

"With our climate strategy, our vision for climate-neutral steel production is gradually becoming a reality."

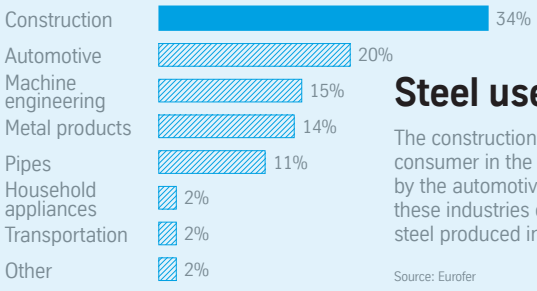
Dr. Arnd Köfler, CTO of thyssenkrupp Steel Europe

Did you know that…

…Electrical Steel is the best?

thyssenkrupp Electrical Steel GmbH was awarded the Ludwig Erhard Prize for comprehensive management services. The jury was impressed by the company's international production network, its customer focus, and the successful change process which began in 2017. Electrical Steel employs around 1,700 people at its locations in Gelsenkirchen, Isbergues (France), and Nashik (India), and supplies its customers with grain-oriented electrical steel. Electrical steel is used as a component in transformers and generators.

The industry in brief



Steel use in the EU

The construction sector is the largest steel consumer in the European Union, followed by the automotive industry. Taken together, these industries consumed over half of all steel produced in 2018.

Source: Eurofer

Three questions for…

Lena Kremer Advanced Product Development Specialist at KIRCHHOFF Automotive Deutschland GmbH

1

In a joint project with thyssenkrupp Steel, you are currently conducting customer-side tests of our MBW-K® 1900 for hot forming. Can you tell us more about your work?

In this project we worked together with thyssenkrupp Steel to test the use of new hot forming materials in crash management systems. Our goal was to produce a product that combined economic, lightweight construction with optimized crash performance.

One advantage of hot forming is that it allows us to produce complex geometries. Thanks to an innovative design that took advantage of the strength of the material, we were able to eliminate a locking plate from the cross beam of our crash management system. What sets our cross beam concept apart is that the direction in which the profile opens changes across the length of the beam. That allows us to create a part that is highly rigid in the center while increasing the effective crash box length at the edges, which helps to disperse energy more efficiently.

2

Are you pleased with the results?

Very. By using MBW-K® 1900 we were able to reduce the weight of the product by around 19 percent compared with the reference design while lowering costs by 8 percent.

3

What are the next steps for this project?

We still haven't carried out a real crash test, so that will be the next phase of the project. We already presented the hardware prototype at the International Motor Show Germany in September. The design and validation has only been conducted virtually thus far. The next step will be to carry out towing tests as well as a quasistatic three-point bending test.

Dates

Upakovka 2020

28 to 31 January in Moscow

At Moscow's Upakovka, the international specialist trade fair for packaging machinery and the production of packaging supplies, around 250 exhibitors will be presenting innovative technologies and materials. The Packaging Steel business unit will be making one of its regular appearances with its rasselstein® products.

#packagingsteel

Tube 2020

30 March to 3 April in Düsseldorf

Around 2,600 companies will be bringing their products to Essen for Tube, the world's leading trade fair for the tube industry. Exhibits will include machines and systems for tube manufacturing and tube processing as well as raw materials, tubes and accessories, tools used in processing, and measurement, control, regulation, and testing equipment. Steel Europe will be represented at Tube 2020 along with its sister company, Materials Services.

#tubeproduction

Coiltech

1 to 2 April in Ulm

The leading trade fair for coil manufacturing, electric motors, and transformers, which originated in Pordenone, Italy, will now be held in the Swabian city of Ulm. Companies will present visitors with products made using electrical steel – from magnetic cores and transformer coils to winding equipment. The Steel Europe business unit will be exhibiting its range of high-tech non-oriented electrical steels.

#electricalsteel

Photo: thyssenkrupp Steel

Climate neutral by 2050 – the transformation

500

million metric tons of steel are recycled annually, saving around one billion metric tons of raw materials. If more CO_2 can be saved in future production processes, its advantages will carry even more weight.

The target is clear: By 2050, **steel production at thyssenkrupp must be climate neutral**. With its climate strategy, the company is accelerating its initiatives to reduce emissions, promoting corporate social responsibility, and pledging its support for the Paris Climate Agreement of 2015.

Text Frank Gilges

Photo: Rainer Schroeer

In the Carbon2Chem® technology center, process gases from steel production are transformed into base chemicals for the chemical industry, replacing petrochemicals.

It has been four years since 195 countries agreed to work together to slow global warming. The binding international accord passed at the Paris Climate Convention in December 2015 was lauded around the world as a historic milestone. The long-term target of limiting the rise in average global temperatures to well below two degrees Celsius compared with preindustrial levels is a task for the entire international community and can only be achieved through carefully coordinated measures. The steel industry has many crucial roles to play here. In the first place, steel is and will remain an indispensable material – after all, without it, neither the energy transition nor e-mobility would be possible. Secondly, by enabling economic, lightweight construction, steel can help to reduce the carbon footprints of other industries – primarily the automotive sector.

But steel production must first turn a critical eye on itself, and new technological advancements will be necessary for the industry to reach climate targets. Blast furnace technology has been responsible for major advances, and as a result, Germany has cut its carbon emissions by more than half in the production of pig iron. Nonetheless, more radical measures are needed. The state of the art today is close to its theoretical optimum.

Two technological paths, one goal

As part of its comprehensive climate strategy, thyssenkrupp AG has committed to becoming a carbon neutral company by 2050, in line with the goals of the Paris Agreement. By 2030, the company plans to lower its emissions from production and energy consumption by 30 percent compared to the reference year of 2018. To this end, thyssenkrupp is investing in a technological transformation and taking practical research steps to achieve its aims. Climate neutral steel production means rethinking the entire plant structure. thyssenkrupp faces an industrial quantum leap.

This transformation will see thyssenkrupp employ two equally important technological methods. The first involves avoiding carbon dioxide during the steel production process by using hydrogen instead of pulverized coal (CDA = carbon direct avoidance). The second takes carbon dioxide from the production process and transforms it into valuable raw materials (CCU = carbon capture and usage), in a process referred to at thyssenkrupp as Carbon2Chem®.

> “We want to produce climate neutral steel by 2050.”
>
> **Premal Desai,** CEO of thyssenkrupp Steel

Steel reimagined: hydrogen instead of carbon

“Soon we’ll be replacing carbon with hydrogen as a reducing agent in the blast furnace,” explains Dr. Arnd Köfler, Chief Technology Officer at thyssenkrupp Steel. This step will take place in the fall. Chemical reduction using carbon releases carbon dioxide while reduction carried out with hydrogen simply produces water vapor. In the first step of this new development, hydrogen will be injected into conventional

How steel helps others to protect the climate

Social change

Climate protection and environmental consciousness are issues affecting all of society. Steel already serves as the basis for many products that are fundamental to a sustainable lifestyle.

Mobility transformation

Steel is indispensable for sustainable mobility, both as a basic material for efficient electric motors as well is in economic, lightweight construction concepts.

Recycling

Already sustainable: With its high recycling quota, steel is already saving enormous amounts of energy and raw materials.

Energy transition

No energy transition without steel. Steel is as vital to generators as it is for wind turbines and high-voltage power lines. The energy transition is simply not possible without steel.

blast furnaces. The transition will begin with just one furnace and expand to include all four blast furnaces in the Duisburg location by 2022, dramatically reducing the use of fossil reducing agents in the process.

Beginning in the middle of the next decade, thyssenkrupp Steel plans to build its first large-scale direct reduction (DR) plants. These plants will lay the foundation for the future of steel production. The sponge iron produced here will still initially have to be processed in the conventional manner, but it will already have reduced emissions considerably.

Starting in the 2030s, the sponge iron will undergo processing into crude steel in modern electric arc furnaces powered using renewable energy. By 2050, thyssenkrupp Steel will gradually transition all of its facilities to the new climate neutral steel production process. The necessary steps will need to be taken in the political arena in order to facilitate the creation of the infrastructure needed for such an undertaking. That includes ensuring the availability of sufficient sustainably-produced electricity and hydrogen, as these are critical elements in the operation of the electric arc furnaces and direct reduction plants.

Hydrogen's Duisburg debut

To turn this 2050 vision into a reality, thyssenkrupp has teamed up with partners Air Liquide and research institute BFI to conduct a special experiment at the Duisburg location in the fall of this year. It will be the first such test of its kind the world has ever seen. In one of the 28 tuyeres of blast furnace 9, the partners will be replacing the current reducing agent, pulverized coal, with hydrogen. They plan to expand the method for use in all 28 tuyeres by 2021. "Theoretically, replacing pulverized coal with hydrogen at this stage of the production process has the potential to reduce carbon emissions by ›

Photo: Shutterstock

How steel can become climate neutral

Political environment

The economic viability of European steel production – and climate-friendly steel production – is highly reliant on future political and regulatory policies.

Decarbonization

Two paths to a climate neutral future: thyssenkrupp explores two different methods for decarbonizing steel production by preventing the formation of CO_2 in production and utilizing any CO_2 emissions generated.

Carbon2Chem®

From pollutant to raw materials: Any CO_2 generated during steel production can be isolated and repurposed as a raw material for the synthesis of base chemicals, for example for fuels, plastics, and fertilizers. That releases the chemical industry from their reliance on petrochemicals.

Hydrogen method

Steel production of the future: In the future, the sponge iron produced by reducing the iron ore will be processed into crude steel in electric arc furnaces.

Renewable energy and H_2

The key to climate neutral steel production: Green energy will be used to produce green hydrogen for direct reduction. It will be necessary to simultaneously work to develop the fundamental infrastructure for production and logistics.

› up to 20 percent," explains Dr. Arnd Köfler. This first test phase will be supported by the state government of North Rhine-Westphalia, and is expected to yield important discoveries for the future of steel production.

Brand new infrastructure required

"Over the next few years we will by laying the foundation for the transformation of the steel industry, first by conducting research, then by rapidly implementing large-scale industrial solutions," reports Premal Desai, CEO of thyssenkrupp Steel. "Because of the lengthy investment cycles in the industry, we have already begun to carry out the transformation process." He appeals to parameters to give their firm and sustained support to this important task: "This kind of transformation is unprecedented in the history of the steel industry. We will need reliable political and regulatory parameters that enable fair competition in all dimensions. Transforming production towards climate neutrality will require considerable investment, which will have to be financed in the long term."

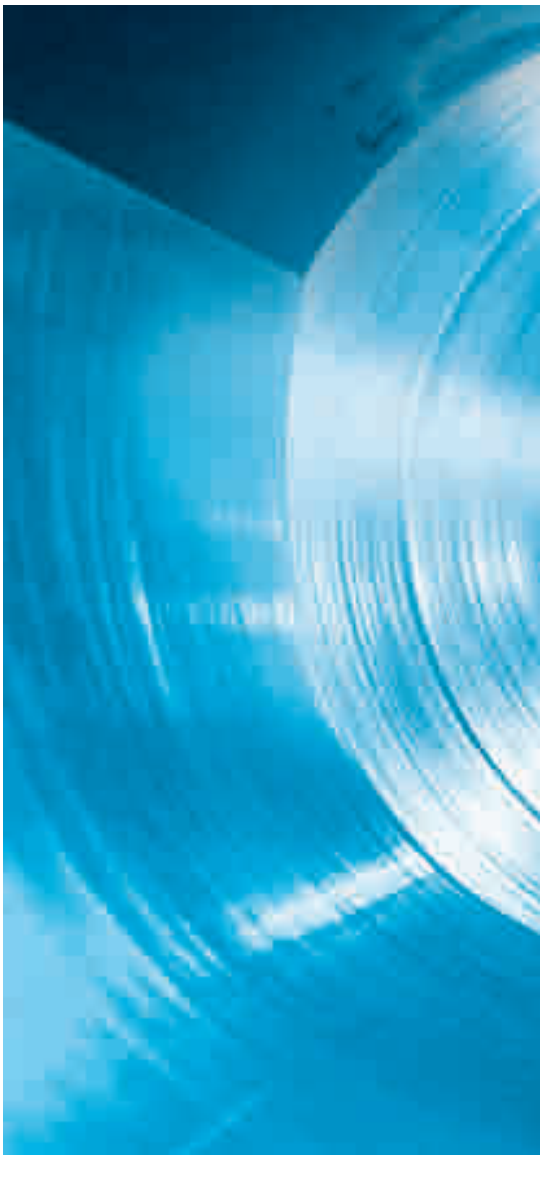
Using steel mill gases as raw materials

The second method thyssenkrupp is pursuing in its goal to become climate neutral by 2050 is its Carbon2Chem® project. This initiative focuses on capturing gases produced during the steel production process and processing them for later use. The German federal government has provided the project with a grant for over 60 million euros. "The steel production process yields steel mill gases with components that contain carbon. With Carbon2Chem®, we are able to generate base chemicals for use in the chemical industry, thereby eliminating the need for synthetic gas made from imported fossil fuels such as oil or natural gas," says Dr. Markus Oles, head of Carbon2Chem®, describing the project's central aim. "These base chemicals can then be used to make fertilizers, plastics, or fuels, for example."

Since September 2018, thyssenkrupp has been working on this technology at the Carbon2Chem technology center in Duisburg, and has – for the very first time anywhere in the world – produced ammonia and methanol from steel mill gases. The industrial pilot phase, which aims to produce methanol from steel mill gases from steel production, kicks off in 2020. The company plans to establish an industrial-scale plant by 2025. Both of these methods – Carbon2Chem® and the use of hydrogen as a reducing agent – will allow thyssenkrupp to considerably reduce the emissions of its existing blast furnaces, and Carbon2Chem technology can be employed in other industries as well.

Steel is key to the circular economy

Steel has established itself as a climate-friendly material. Large quantities of this durable metal have been circulating for decades, as steel is up to 100 percent recyclable. Around 500 million metric tons of steel are recycled each year, saving one billion metric tons of raw materials. "Steel production is and will remain energy-intensive," summarizes Dr. Köfler. "But many steel-based applications and products save more energy and carbon emissions over their life cycles than



Prevent the formation of greenhouse gases

Up to now, iron ore has been reduced using carbon, resulting in CO_2 emissions. Over the past few decades, thyssenkrupp Steel has made great strides in increasing the energy efficiency of its existing blast furnace processes and reducing emissions. In the future, sustainably produced hydrogen is set to replace carbon as a reducing agent. The additional processing needed to transform iron pellets into crude steel will soon be conducted in electric arc furnaces, rendering the process climate neutral.

are required for their production. Trying to do without them is like trying to stop the clock in order to save time." Life cycle assessment (LCA) is becoming an ever more popular evaluation tool, particularly in the automotive industry. It works like a kind of ecological and economic balance sheet covering every phase of a product's life cycle – from production and use all the way to recycling. Today, steel performs better than other materials in LCA comparisons. If more carbon dioxide can be saved during the steel production process in the future, its advantages will carry even more weight. Even during the production phase, alternative materials perform much worse when it comes to climate-based metrics.

No energy transition without steel

A climate neutral society is unimaginable without steel. Many products and industries are reliant on steel to unlock technical innovation and reduce their climate impact. There is real evidence for the claim that the energy transition would not be possible without steel: Wind turbines, for example, are up to 80 percent steel, and electrical steel serves as a basic component in efficient electric motors, generators, and smart power grids. Of course the other side of the story is that climate neutral steel production is not possible without clean energy. That recognition makes abundantly clear the importance of viewing climate protection in a holistic sense, and emphasizes the close link between industry and the energy transition.

Steel is indispensable in achieving the world's ambitious climate targets. And to make sure we can keep producing steel as a climate neutral company, production processes must be revolutionized over the next three decades. thyssenkrupp has taken the first steps on that path.

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Photo: thyssenkrupp

Climate neutral steel from thyssenkrupp Steel will be just as excellent and innovative as today's steel. The change may not be visible but it will make all the difference.

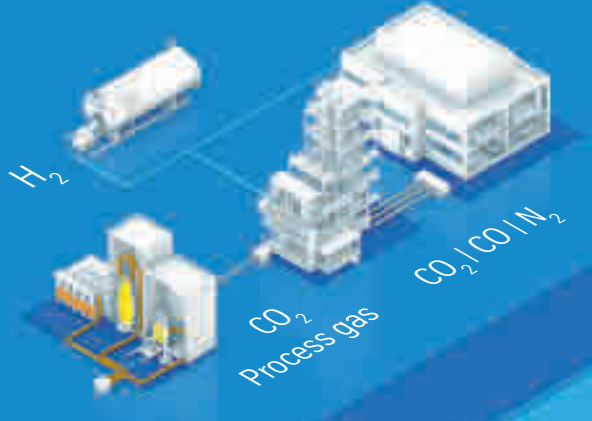
Two technological paths, one goal

thyssenkrupp is embarking on two parallel and equally important technological paths in order to produce climate neutral steel by 2050: avoiding of CO_2 through the use of hydrogen and utilizing CO_2 through Carbon2Chem® technology.

Starting in 2020

Industrialization

The pilot system at the Duisburg steel plant will use steel mill gases to produce base chemicals.



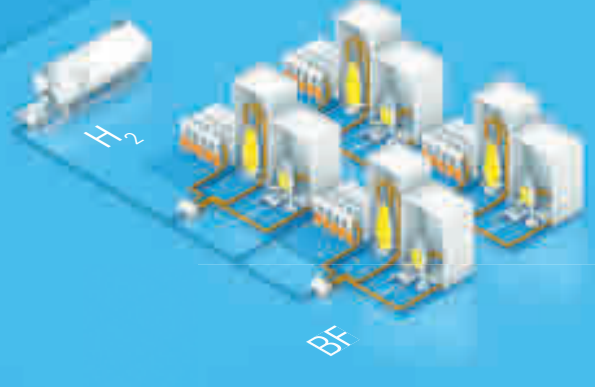
2018

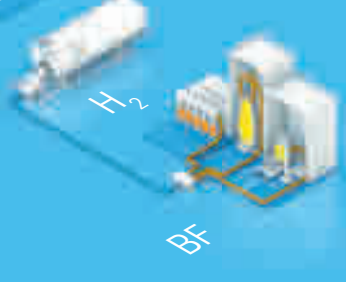
The world first

The concept: CO_2 becomes raw materials. In September 2018, thyssenkrupp produced ammonia from steel mill gases for the first time at its Carbon2Chem® technical center in Duisburg.

Using CO_2 (Carbon2Chem®)

Avoiding CO_2 (hydrogen method)





Starting in 2019

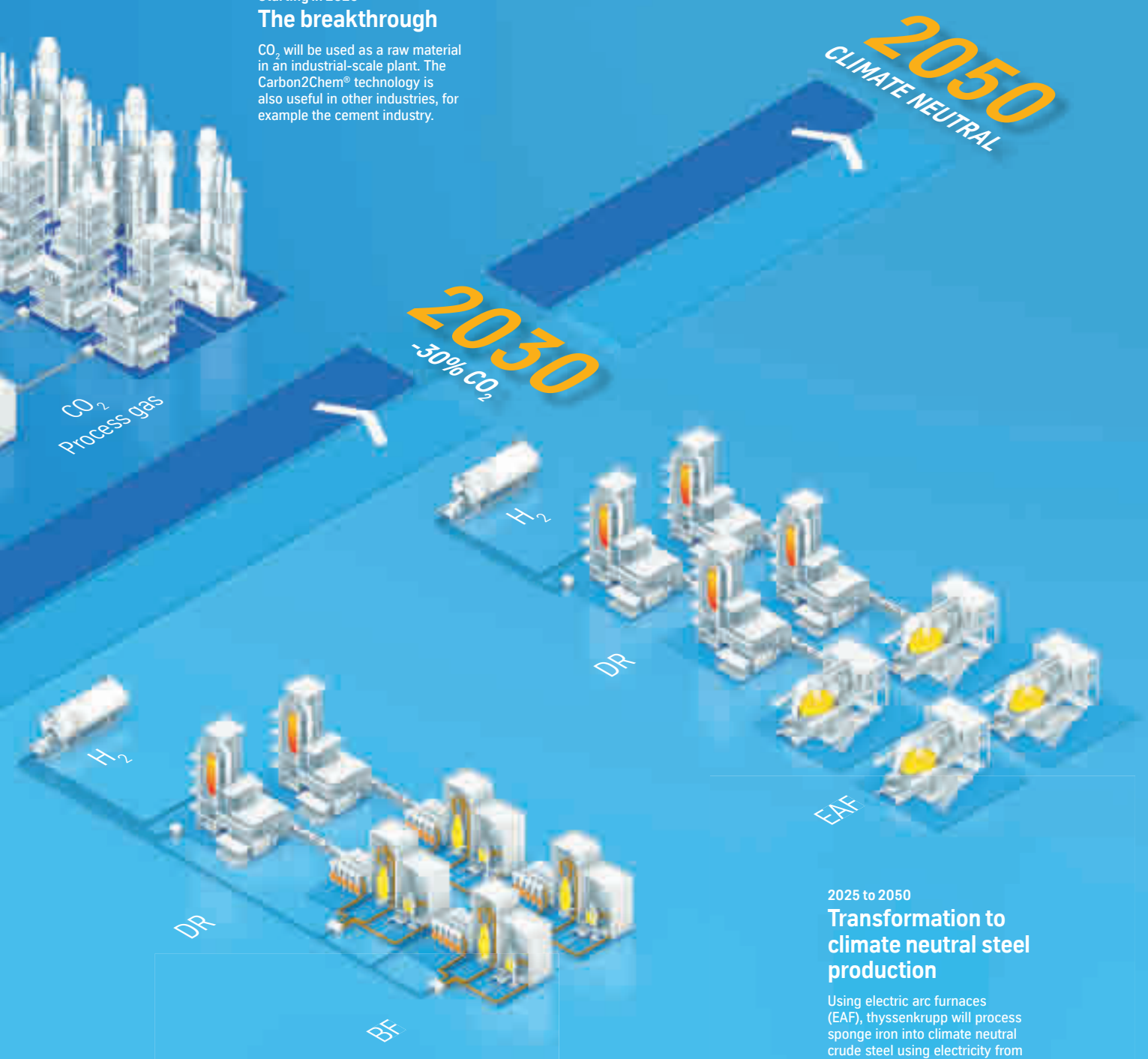
The test

thyssenkrupp will gradually replace pulverized coal in one blast furnace (BF) with hydrogen (H_2).

Starting in 2022

The introductory phase

Step by step, all three blast furnaces (BF) will be transitioned to H_2 injection.



Starting in 2025

The breakthrough

CO_2 will be used as a raw material in an industrial-scale plant. The Carbon2Chem® technology is also useful in other industries, for example the cement industry.

2025 to 2050

Transformation to climate neutral steel production

Using electric arc furnaces (EAF), thyssenkrupp will process sponge iron into climate neutral crude steel using electricity from renewable energy sources.

Starting in 2024

The milestone

Using large-scale direct reduction plants (DR) which will be operated using green H_2, thyssenkrupp will produce sponge iron which will then proceed to the blast furnaces (BF) for processing, allowing a further reduction in emissions.

Graphics: C3 Visual Lab

It's what's on the surface that counts

How can we make the **production of premium surfaces** that are suitable for outer paneling in the automotive industry more efficient and environmentally sustainable? That's easy: with a pioneering production plant equipped with the latest technology and innovative process techniques! With its **new FBA 10 hot-dip galvanizing line** in Dortmund, thyssenkrupp Steel can expand its production capacity and cater to the increasing demand for high-quality, thin, hot-dip galvanized steel sheets.

High performance

ZM Ecoprotect® o ers better processability and higher corrosion protection compared with conventional zinc coatings.

No more orange peel

With ZM Ecoprotect® in **primetex® quality,** the surface meets the highest of standards in terms of the paint appearance. With a higher peak count and reduced long waviness it has everything the outer paneling of a car needs.

An innovative remedy for corrosion

The combination of zinc and magnesium improves corrosion behavior with **significantly reduced coating thickness.**

Top application performance

Surfaces coated with ZM Ecoprotect® generate **less abrasion debris,** which in turn reduces adhesive tool wear. Tools don't require cleaning as often, and there are fewer interruptions to production. As such, ZM Ecoprotect® makes stamping plants **more efficient**.

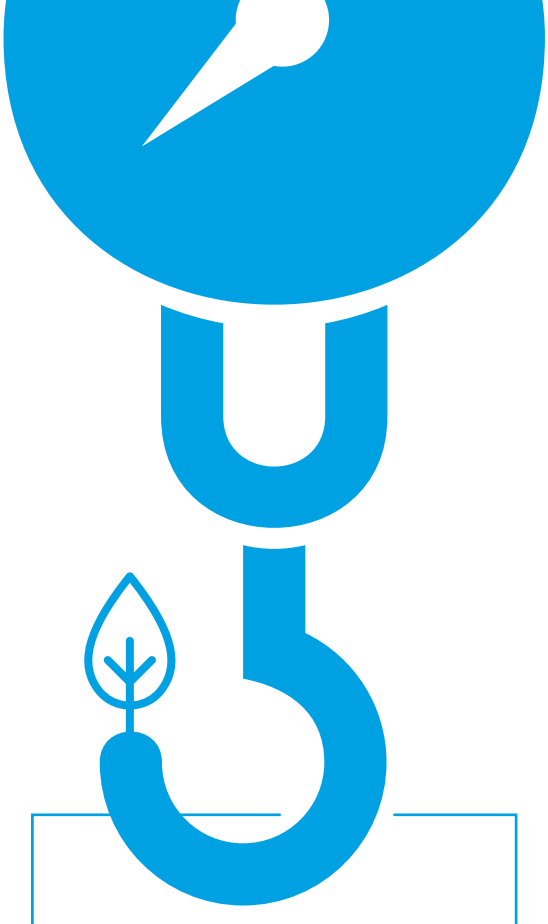
Graphics: C3 Visual Lab

FBA 10 offers high strip widths

The **new line in Dortmund** will be able to coat deep-drawing steels, IF and bake-hardening steels, and high-strength DP grades with zinc and zinc-magnesium.

It's all in the coating

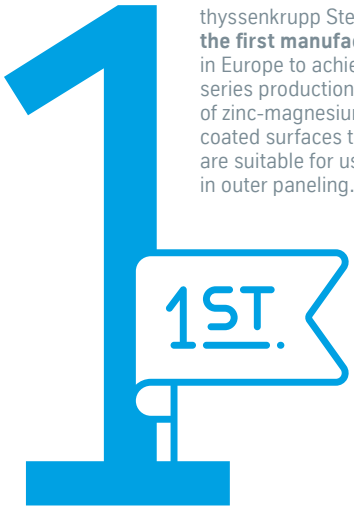
Compared with conventional zinc coatings ZM Ecoprotect" a ects neither paintability nor phosphatability. It also provides **wet and dry** paint adhesion and a high resistance to rust creep after stone chipping.



2 kg

lighter ...

That's the e ect that using ZM Ecoprotect® has on a mid-sized car, as coating weight can be reduced by 30% thinner without a ecting the corrosion protection. This makes for **outstanding environmental sustainability**, as ZM Ecoprotect® reduces zinc use by 30%.



thyssenkrupp Steel is **the first manufacturer** in Europe to achieve series production of zinc-magnesium-coated surfaces that are suitable for use in outer paneling.

zinc + magnesium = ZM Ecoprotect®

The future of outer paneling

No matter what powers the cars of the future – or whether we will even be driving them ourselves – they will always need outer paneling that **protects both the vehicle and the people inside,** and provides for an attractive finish.

The link to zinc:
www.thyssenkrupp-steel.com/en/ZM-Ecoprotect

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E-mobility based on steel

thyssenkrupp Steel's **selectrify®** e-mobility initiative demonstrates the company's capacity for innovation.

Text Christiane Hoch-Baumann | **Graphics/layout** C3 VisualLab

How might our cars look if they were all fully electric? Engineers, designers, technicians, and even material suppliers need to head back to the drawing board, since innovative technologies will change the look and design of vehicles in equal measure. A thyssenkrupp Steel development team has also been working to find answers to these questions of the future for some time, coming together under the name selectrify® to combine their materials and applications expertise in the field of electromobility.

"Steel is the most important lightweight material for the automotive industry today," says André Matusczyk, CEO of thyssenkrupp Steel's Automotive business unit. "With the help of our selectrify® initiative, we want to show our customers that the material also brings a superior property profile to electric vehicles. This begins with an unrivaled price/performance ratio for the lightweight construction of the vehicle structure and protection of the sensitive battery, and extends all the way to steels with special magnetic properties without which no electric motor could function."

The worldwide availability, established processing methods, and outstanding repairability and recyclability of steel make it easy for automotive manufacturers to integrate new steel solutions and concepts quickly into marketable electric cars. "Steel makes electromobility safe and easy, and contributes to getting electric vehicles out of the small-series model niche and making them affordable for the masses," says Matusczyk. selectrify® is also on hand for thyssenkrupp Steel when its customers need support in quickly implementing technologically demanding requirements in their mass production processes.

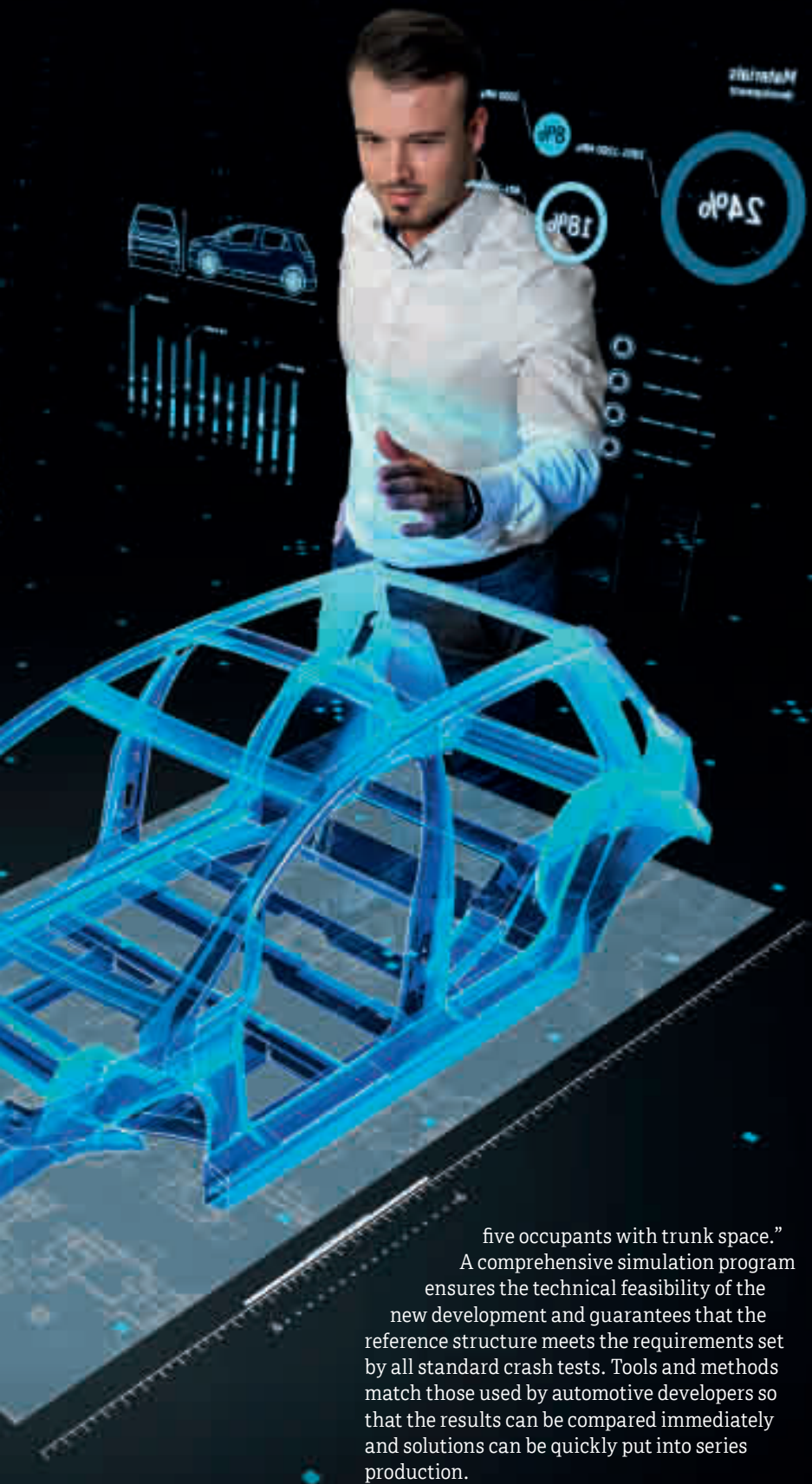
The selectrify® reference structure based on a compact-class electric car

As a long-standing partner to the automotive industry, thyssenkrupp Steel is once again able to demonstrate its expertise with the selectrify® reference structure. "Before we were able to implement our idea of a manufacturer-neutral electric car structure, we defined a variety of relevant criteria for the target vehicle – from the dimensions to the range," says Project Engineer Andreas Breidenbach, who takes on an interdisciplinary role working with colleagues from a wide range of departments. "The result is the virtual structure of an electric vehicle in the high-unit-volume compact class, which is designed for a practicable 500-kilometer range, and features seating for a total of ›

The reference structure

André Matusczyk (left) CEO of the Automotive business unit and selectrify®, and Project Manager Patrick Tlauka present affordable steel solutions for weight-optimized and safe electric vehicles in the form of a holistic and highly scalable stand-alone structure.

Photos: Rainer Kaysers



five occupants with trunk space."

A comprehensive simulation program ensures the technical feasibility of the new development and guarantees that the reference structure meets the requirements set by all standard crash tests. Tools and methods match those used by automotive developers so that the results can be compared immediately and solutions can be quickly put into series production.

The selectrify® reference structure is also based on a flexible platform that is scalable lengthways. Further derivatives and vehicle classes, such as SUVs or coupés, can be extrapolated from this basic structure. "That also increases the efficiency of our solutions."

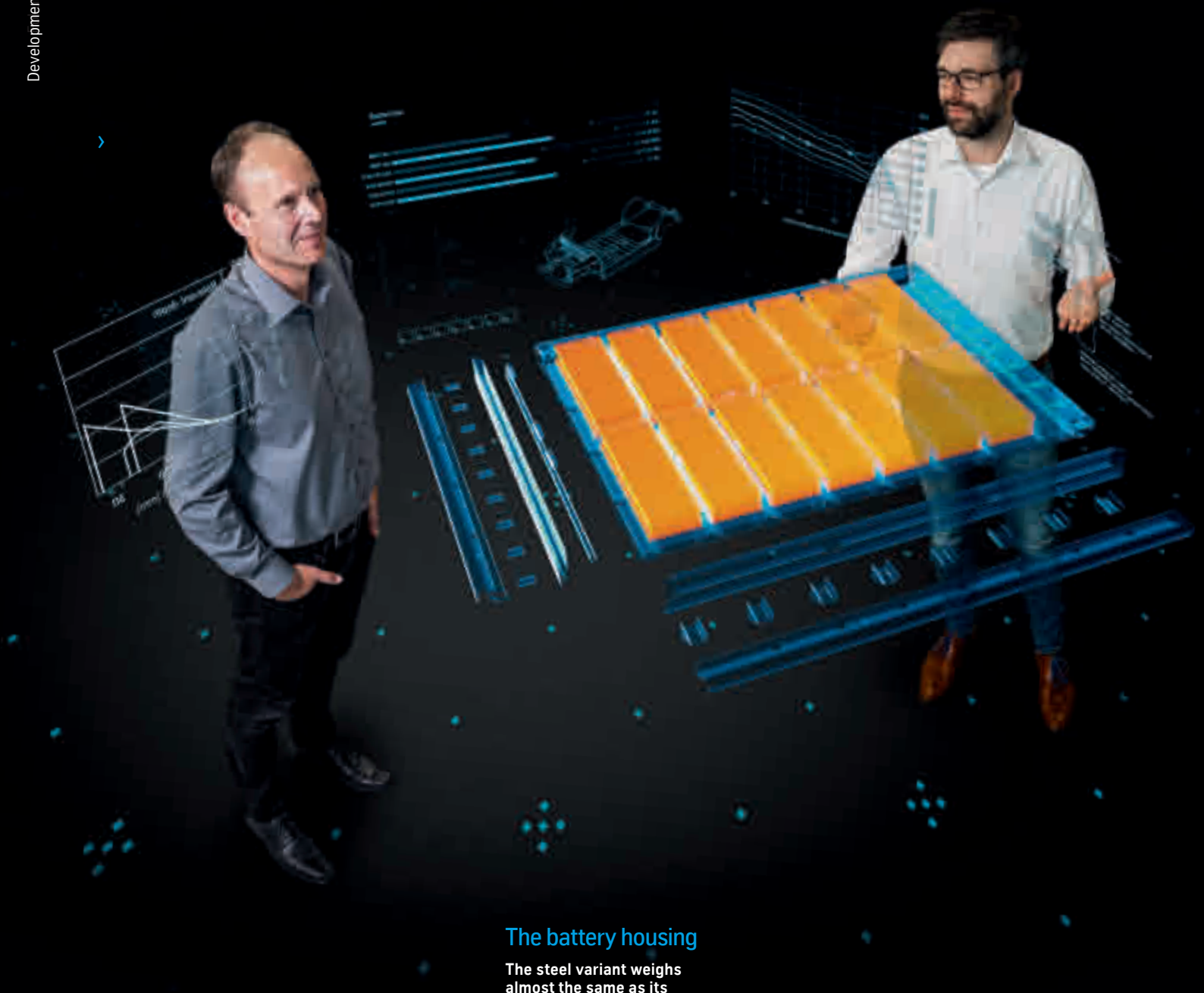
New steel concepts for new bodies

The elimination of conventional combustion engines with auxiliary units and transmissions also fundamentally changes the design of newly developed electric cars. Generally speaking, the front end looks neater, meaning the need for geometrically complex deep-drawn parts drops while the use of simpler structural components and profiles increases. However, current batteries are still very heavy and the resulting high overall weight of the vehicle continues to place great demand on the strength of the materials used.

Now, providing the vehicle's occupants with complete protection starts with protecting the sensitive battery in the event of a side-impact collision. The acceptable level of intrusion in the battery area reduces to virtually zero. That increases strength and design outlay for rockers, B-pillars, and the surrounding environment. The most striking changes are the external ones when it to comes to purpose-design electric vehicles, that is, vehicles that are developed from the ground up exclusively for fully electric operation: "We're talking about longer wheelbases and short overhangs here," says Breidenbach. "We have made sure our portfolio of materials matches the new requirements of electric vehicles, so our strength in steel means that we are currently well-positioned for electromobility and have the right materials in our portfolio to meet any and all requirements."

But development isn't standing still. "In the long run, it's conceivable that the traditional development focus, especially in terms of cold-formed steels, will shift from firm and flexible towards higher-strength and more economical alloy concepts," says Project Manager Patrick Tlauka. "New types of forming technologies such as thyssenkrupp smartform® and hybrid materials are providing new ideas in terms of costs and the performance of steel construction."

The increasing trend towards higher strengths will continue since they are especially suitable for weight-optimized and safe vehicles. "Strengths have increased significantly in recent years. It's an enormous growth that nobody had dared hope for," says Tlauka. One glance at thyssenkrupp Steel's broad product portfolio makes it clear how much potential there is in the development of steels. The spectrum of dual-phase steels alone ranges from strengths of 500 MPa to 1,200 MPa. When it comes to steels for hot forming such as MBW®, press hardening can achieve strengths of up to 2,000 MPa. ›



The battery housing

The steel variant weighs almost the same as its aluminum equivalent, but is 50 percent cheaper and more environmentally sustainable. The concept developed by Dr. Daniel Nierhoff (right) and his team slots perfectly into the reference structure drawn up by Andreas Breidenbach (left) and his team. Together, the two components meet the highest requirements in terms of crash safety, weight, and overall costs.

The selectrify® battery housing: lighter, safer, and more efficient

The battery is a recent addition to electric vehicles, and a key component at that. The rechargeable lithium-ion batteries available today have an extremely high level of performance, but they are also immensely sensitive. Any sort of damage runs the risk of devastating fires, which can put passengers and first responders in harm's way following an accident. That's why comprehensive protection for the battery against crash impacts is first and foremost protection for passengers, and why automotive developers treat this issue with the utmost importance. "Safely housing the battery is the top priority when it comes to providing vehicle occupants with the best possible protection," says Dr. Daniel Nierhoff from the selectrify® project team. Batteries housed in steel offer several advantages. A steel solution in the 70-kWh class can meet crash performance requirements while being nearly as light as a traditional battery housing made from aluminum and only costing half the price to build. "Simply put, we're talking here about cost savings amounting to hundreds of euros without compromising on safety. That is a major difference in the area of car development, where costs are calculated in cents." In addition to this, steel also gains points in terms of fire protection and electromagnetic compatibility. Just like the reference structure, the battery concept is also scalable and can be flexibly adapted to the various different OEM platforms.

The selectrify® drive system with powercore® electrical steel

Another product from the selectrify® portfolio is used in drive systems: its trade mark powercore® electrical steel. "Electrified drive systems

Photos: Rainer Kaysers

demand a lot from steel as a material," says Volker Kamen, who is responsible for sales of the non-oriented electrical steel produced at the thyssenkrupp Steel location in Bochum. In principle, it is built into each and every electric motor. "Our powercore® NO grades meet the demands of high-performing and efficient drive systems. They are very thin, have homogeneous mechanical properties, low core losses, and a high polarization. We are also developing functional coatings for an economically efficient packet structure for automotive manufacturers as well as sandwich materials with a great deal of potential for improving productivity in the stamping process and better noise generation management in the drive."

powercore® electrical steel in charging stations

Electromobility is one way of lowering CO_2 emissions in the long term. However, simply developing and building electrically driven vehicles doesn't mean the job is done. In order for Germany to actually achieve its energy transition in the future, the country's electricity – especially that used in electric cars – must come from renewable sources. This electricity must be distributed intelligently and storage capacity must be created to utilize it. Ultimately, the number of charging stations along with the entire charging infrastructure needs to be expanded on a massive scale.

The drive system

Powercore® electrical steels guarantee ultra-efficient and high-performance electrical drive systems. Florian Herget (left) and Volker Kamen are in charge of development and sales for the project.

Find out more online

www.thyssenkrupp-steel.com/en/industries/automotivetrucks/e-mobility

The next generation of hot forming

With AS Pro, thyssenkrupp Steel is the first steel manufacturer to launch a new, game-changing coating for hot forming ultra-high-strength MBW® steels worldwide – to ensure **maximum automobile component reliability**.

Text Sabine Pollmeier | **Photos** Uebler and Seifert

AS Pro, the coating of the future: It ensures high reliability for safety-relevant structural body components.

Hot forming excellence: AS Pro is the new coating for hot-formed steels from the MBW® family.

As a pioneer in hot forming, thyssenkrupp Steel does more than simply deliver the right materials; it also develops solutions that offer the customer the best available benefits. This means the latest innovation, AS Pro, guarantees highly reliable components and processes in automotive manufacturing. The new coating ensures significantly lower process-related hydrogen absorption during the annealing process in hot forming, and also makes the manufacturing process more economical.

"As partners of the automotive industry, we see ourselves as drivers of innovation who know the challenges involved in hot forming and support our customers with solutions," says André Matusczyk, CEO of the Automotive business unit at thyssenkrupp Steel. "Thanks to our AS Pro-coated hot-formed steels, we can now put an end to energy-intensive, time-consuming extra measures that are normally needed in the hot forming process."

New alloying concept for hot forming

AS Pro is produced in thyssenkrupp Steel's modern hot-dip galvanizing lines just like a standard aluminum-silicon coating. Unlike the standard AS coating, a pinch of magnesium is added to the aluminum and silicon in the melt pool, which is then distributed homogeneously both in the melt and in the coating.

"This little tweak in the chemistry makes a considerable difference in the hot forming process," says Georg Parma, Product Manager for Hot Forming at thyssenkrupp Steel. This is because AS Pro ensures that significantly less diffusible hydrogen is produced during the annealing process, which can force its way into the material. This minimizes the risk of hydrogen-induced cracks forming, which can occur in the event of a worst-case-scenario combination of strength and stress when the content level of hydrogen is critical.

Demonstrably less hydrogen in the material

"The results produced with AS Pro are impressive," says Parma. Tests conducted in series production plants prove that the hydrogen content in a component after hot forming is reduced by 40 percent or more. Hydrogen absorption can even be reduced by up to 70 percent in a flexibly rolled material. "Thanks to our new coating for hot forming ultra-high-strength materials, cost-intensive countermeasures to reduce hydrogen will no longer be needed in the future."

The processing properties of AS Pro are also comparable with the standard product. Joining processes such as laser welding and resistance spot welding can be used as usual, while the abrasion properties remain completely unaffected and the component is still easy to paint. "Materials coated with AS Pro are available to our customers worldwide," says Parma. "The failure risk goes down, process reliability goes up, and the energy and manufacturing costs are optimized long-term. And that's all without any process adjustments or changes to processing properties."

In short: MBW® manganese-boron steels from thyssenkrupp Steel in combination with AS Pro are an automotive manufacturing milestone when it comes to the hot forming of weight-optimized structural components whose behavior is critical in the event of a crash.

More online

Learn more about AS Pro at
www.thyssenkrupp-steel.com/en/as-pro

Experience that makes complex processes simpler

As a pioneer of hot forming, thyssenkrupp Steel knows the challenges involved in the hot forming process and supports its automotive customers as a partner that always thinks one step ahead.

With MBW® AS Pro, the steel experts are optimizing process reliability during hot forming, maximizing the reliability of components, and reducing the energy and manufacturing costs along their customers' entire process chains.

New products such as MBW® AS Pro will put the hot forming process on a completely new footing. This shows that steel is the basis for sustainable and economical component production, both now and in the future – Hot forming excellence for you.

Maximum process reliability

How do you develop a new, groundbreaking surface for hot forming? You do what thyssenkrupp Steel did with **MBW® AS Pro**.

Text Judy Born | **Photos** Rainer Kaysers

Anyone who knows anything about hot forming is familiar with this challenge: During the heat treatment of aluminum-silicon-coated (AS) steels, hydrogen can force its way into the material. In the worst-case scenario, this can then lead to the hydrogen-induced failure of the part. The current solution strategies to minimize these failure risks only focus on the process, but these are energy- and cost-intensive.

Of course thyssenkrupp Steel, as a pioneer of hot forming and partner to the automotive industry – always looking for ways to solve problems – helps conduct research for its customers. This commitment was instrumental in producing a technical solution that significantly increases process stability, even under the most critical of conditions. Its name: AS Pro.

The new product is manufactured in the steel producer's modern hot-dip galvanizing line cycle just like a standard AS coating. "The only difference is that we add a pinch of magnesium to the aluminum and silicon in the melt pool, which is then distributed homogeneously both in the melt and in the coating," says Grit Reimann, Production Engineer for Hot-Dip Galvanizing Lines for thyssenkrupp Steel in Duisburg, Germany. "The new alloying concept ensures that the amount of hydrogen absorbed by the material during the hot forming process is significantly reduced."

It all starts with annealing

"The tendency of hydrogen to embed itself in the steel during the annealing process on the customers' premises is dependent on the process," explains Manuela Ruthenberg. She is a Technical Project Manager in Product Development for Steel Coatings at thyssenkrupp Steel, and is responsible for the AS Pro project. "This is because the high temperatures in the atmosphere of the furnace lead to the surface reacting with the steam."

With standard AS, oxygen reacts with the aluminum and primarily produces aluminum oxide. With AS Pro, excessive magnesium oxide is produced due to the high oxygen affinity of magnesium. "A thin coating of oxygen forms on the surface in both cases." The crucial difference: "Significantly less hydrogen is produced with AS Pro-coated MBW® steels than with standard AS-coated hot-formed steels while this reaction is taking place. Consequently, less diffusible hydrogen is available to force its way into the material."

Once hydrogen has forced its way into the material, it will eventually need to leave again.

A guarantee for flawless surfaces: checking the material for imperfections.

Maximum automobile component reliability, thanks to AS Pro: Grit Reimann (left) and Manuela Ruthenberg check critical points on a component.

Experts

Grit Reimann holds a Dipl.-Ing. Diploma in Mechanical Engineering and Forming Technology and works as a production engineer at a hot-dip galvanizing plant. She played a major role in implementing the plant technology side of the AS Pro project.

Manuela Ruthenberg was the Technical Project Manager in charge of the development of AS Pro. The materials technician has long been conducting research on the topics of hot-dip aluminizing and the optimization of surfaces.

This is because exceeding a critical amount of hydrogen combined with high stresses and high strengths can cause failures. Up to now, the moisture in the furnace atmosphere is reduced using complex dew point control. Another possibility is hydrogen effusion annealing of the finished component. This requires 30 minutes in a furnace at around 200 °C.

"This releases the hydrogen that has embedded itself in the microstructure," say Reimann. "Both options, dew point control and effusion annealing, are energy- and cost-intensive. With our new AS Pro coating, our customers will be able to dispense with both methods in the future."

Reducing process costs while maximizing component reliability

This is a groundbreaking development in hot forming. Particularly in automotive manufacturing, hot-formed steels in combination with AS Pro represent a milestone in the production of weight-optimized structural components whose behavior is critical in the event of a crash. "If, in the future, the critical phase in the annealing process can be eliminated, the failure rate will fall," says Ruthenberg. Process reliability for the manufacturers will increase, and lasting energy savings can be made. "The process windows will also grow for the processing companies – an advantage that should not be underestimated."

Confirmation in series production plants

The new AS Pro concept was tested in the Technology and Innovation division at thyssenkrupp Steel during the course of many operational tests and checks. In addition, the hot forming processes were recreated on the customers' premises – including those that required long periods in the furnace. "We took all the unpredictable factors into account, and can now say, following our comprehensive investigations, that our new AS Pro coating keeps its promise, even in series production plants," says Ruthenberg.

The same goes for further processing. "Our new coating offers at least comparable processing qualities to surfaces treated with the standard AS. Whether this is laser or resistance spot welding, or painting, none of these processing steps require any adjustments to the processes taking place on the customers' premises. AS Pro-coated steels are also corrosion resistant, just like our standard AS coating."

Hot-formed steels with an AS Pro coating are available worldwide. They offer customers tangible benefits: improved component and process reliability and proven energy and cost savings.

Contacts

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Shaping our own future

The Research and Development department of thyssenkrupp Steel's **Application Technology Center** has had its finger on the pulse for 50 years, helping and advising its customers on how to get the most out of steel.

The name says it all: as thyssenkrupp Steel's innovation lab, the Application Technology Center aims to do more than simply develop and manufacture new steel materials and technologies – it also strives to ensure that the company's customers get the most out of these developments. This is achieved through analysis, design, experimentation, simulation, forming, joining, revision, correction, and industrialization.

"As the technological backbone of everything our customers do, we can never stop questioning ourselves," explains Dr. Lutz Keßler, Head of Application Technology. In keeping with this principle, employees in the Application Technology Center use their decades of processing experience to keep revising and improving the company's products to incorporate the latest technological possibilities and ensure that they meet the standards required of the materials.

"Our expertise smooths the way for our customers, helping them with the practical use of our material in a way offered by no other steel manufacturer." This process includes both in-depth, individual consulting and a holistic approach to the technological and financial concept – for customers in any industry.

System partner to the automotive industry

The large-scale concept studies published at the start of the millennium, such as the NSB® NewSteelBody report, were superseded by the InCar® Group-wide innovation package, which in turn gave way to its successor, InCar® plus, one car generation later. Crucially, none of these concepts is limited to a specific manufacturer, and the sample applications, proposed solutions, and processing recommendations they contain for innovative steel grades always offer scope for customization and scaling. One example of this is the selectrify® initiative, the company's latest automotive electromobility concept. "The au-

Flow forming

The idea: A testing facility that can be used to process ultra-high-strength steels and work in combination with other forming and heating technologies.

The innovation: The new ow-forming machine produces rotationally symmetrical parts that are up to 50 percent lighter than previous models.

E-Mobility Center Drives

The idea: To develop high-strength electrical steel with as little energy loss as possible in order to make electric motors even more efficient and powerful.

The innovation: An in-house test bench for the development of high-tech electric drive systems that has already cut core losses to almost 30 percent below those of standard grades.

InCar® plus

The idea: To make the vehicles of the future safer, lighter, more comfortable, more efficient and more environmentally friendly.

The innovation: Around 40 separate solutions for the car body, chassis & steering, and powertrain, which are tested and validated along the entire value chain to ensure their effectiveness.

NSB® NewSteelBody

The idea: To present thyssenkrupp Steel's new lightweight materials and production methods in a compact reference concept.

The innovation: The study, which was conducted using a concrete production vehicle, shows how intelligent, lightweight steels and tubular design can cut body-in-white weight by up to 24 percent.

tomotive industry's influence on technological development is unrivalled by any other sector," Keßler explains. "Thanks to our technological expertise and consulting skills, we have acted as a development partner to this sector for years: We worked with Porsche on the first fully galvanized car body back in 1975, and were early proponents of press hardening for structural components."

'Never stand still and never stop thinking about tomorrow – or even the day after!' That's the Application Technology motto. You can't change everything overnight – especially not with production cycles that run for several years at a time. thyssenkrupp Steel provides its customers with new ideas and works with them closely to develop these concepts.

Process-optimized innovation

Over the last 50 years, the steel company has also continued to actively evolve in terms of its own processes and products. The automotive industry is often the driving force behind innovations, though the energy, construction and packaging sectors have also proven influential. As the decades have passed, the company has grown to become a technological expert that both produces and coats steel, as well as showing its customers the best way to use and work the high-tech, flexible material. To this end, each of the Group's business units has its own on-site Research and Development department. thyssenkrupp's steel experts can simulate entire process chains, such as the production process used for hot forming at automotive stamping plants. Different customers in different industries can be helped by thyssenkrupp Steel's applications experts, whether in Duisburg, Dortmund or Gelsenkirchen, in Bochum, Hohenlimburg or Andernach. The company has long since grown beyond its role as a producer of materials, and now also acts as a provider of solutions and services for its customers' process and product development structures – right up to the series production stage. Keep moving, keep questioning yourself, and keep evolving – that is the key to long term success. The best way to prepare for the future is to shape it yourself.

Contact

Dr. Lutz Keßler, Head of Application Technology,
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One shape, many variants: The amazing properties of steel coils are hidden behind an unassuming exterior.

smartform®

The idea: A reliable production process for making components with a high level of dimensional accuracy using ultra-high-strength steel grades and cold forming techniques.

The innovation: A process that has provided a solution to the springback problem and can be used to produce highly complex shapes with a high degree of dimensional accuracy using ultra-high-strength materials.

Tailored tempering

The idea: An automotive production technique that combines safety with lightweight construction. The components need to be strong and ductile in order to absorb impact energy in a controlled way.

The innovation: Different cooling rates in different areas of a forming die. Precisely defined zones with different levels of strength and ductility can be produced in one operation.

tribond®

The idea: To combine a variety of sometimes contradictory steel properties in a single product and optimize them for different applications.

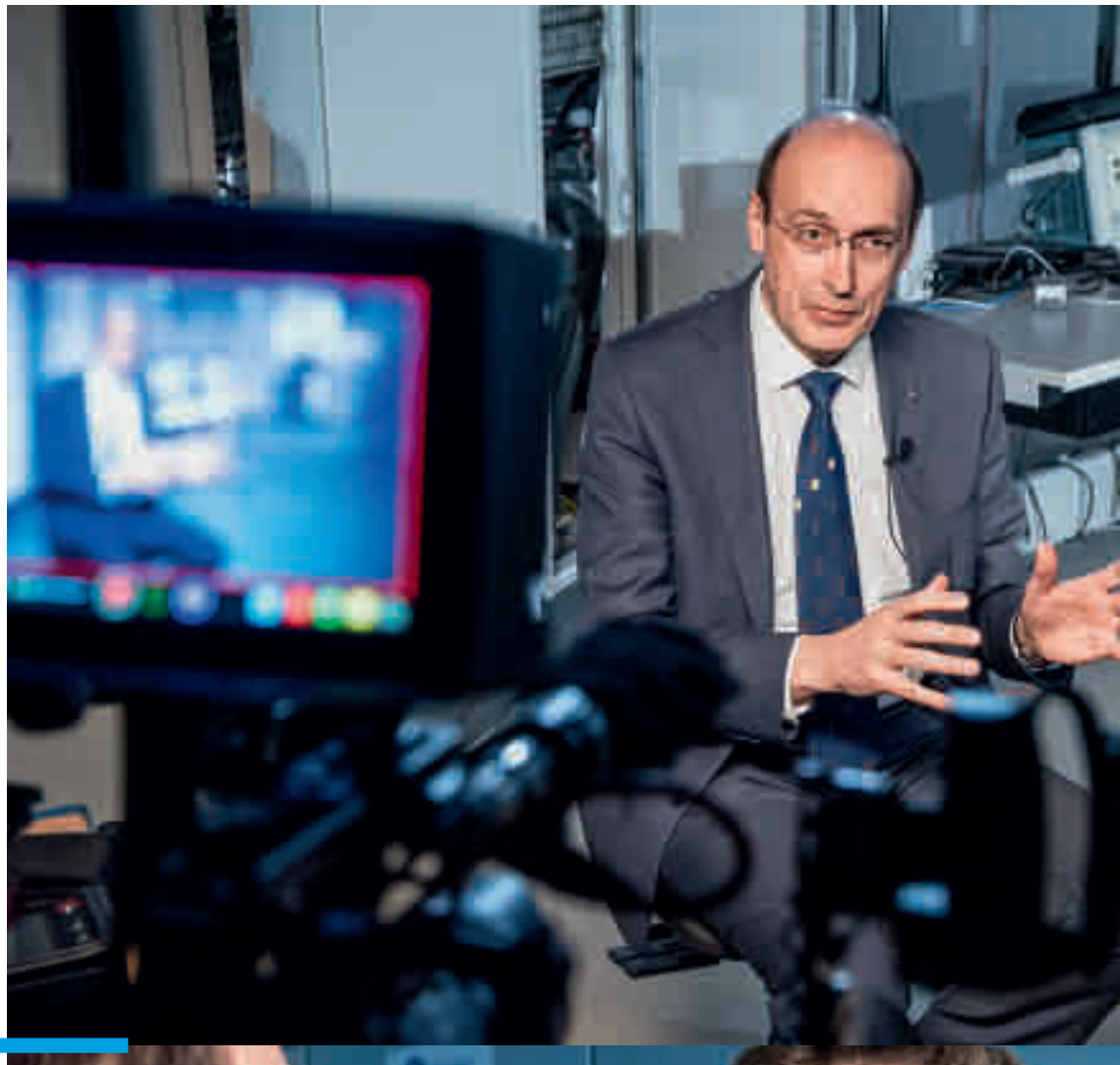
The innovation: A triple-layered composite material with a ductile steel outer and a high-strength core.

Virtual engineering

The idea: Development processes that are not tied to one location, instead being performed in digital, three-dimensional spaces.

The innovation: The selectrify® initiative is a virtual reality experience – the first step toward a virtual reality environment you can work in from any location.

Photos: thyssenkrupp Steel



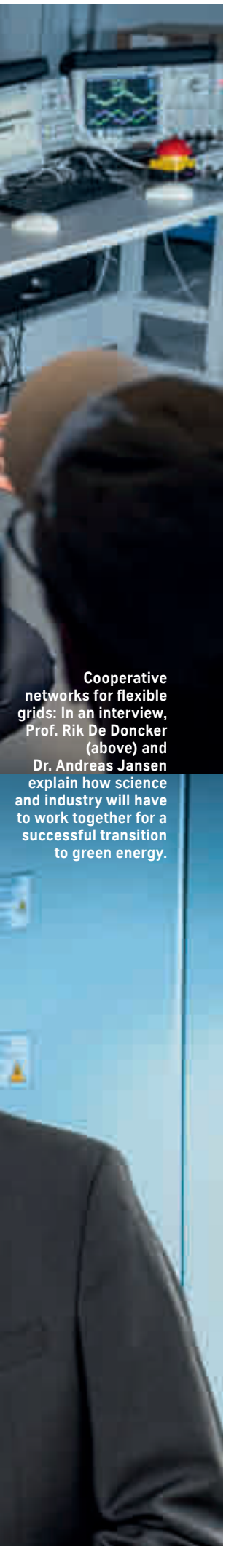
Experts

Prof. Rik De Doncker

has been with RWTH Aachen University since 1996, where he currently heads the Institute for Power Electronics and Electrical Drives, as well as the E.ON Energy Research Center and the FEN research campus.

Dr. Andreas Jansen

has headed Quality Assurance and Product Development in the Electrical Steel business unit at thyssenkrupp Steel since 2017. In this role, Jansen – who holds a degree in chemistry – is responsible for the Gelsenkirchen, Isbergues, and Nashik locations.



Cooperative networks for flexible grids: In an interview, Prof. Rik De Doncker (above) and Dr. Andreas Jansen explain how science and industry will have to work together for a successful transition to green energy.

Sustainably distributing green energy

We need **flexible electrical grids** to supply energy generated from renewable sources. The FEN research campus has made it its mission to develop them.

Text Judy Born | **Photo** Rainer Kaysers, Rainer Schroeer

If the transition to green energy is to succeed, generating electricity from renewable sources will not be enough; that electricity also needs to be distributed sustainably. Although green energy generated from wind turbines and solar power systems is good for the environment, we can only be certain that this energy is distributed reliably if it can be fed into the transmission networks at a consistent frequency and voltage. A growing number of consumers now produce their own electricity, for example, using solar panels installed on their roofs. This leads to a steady increase in the number of decentralized, regenerative energy sources.

That's why the Flexible Electrical Networks (FEN) research campus at RWTH Aachen University took it upon itself to research and develop a flexible power grid. Among other things, the aim is to develop new technologies that allow this energy to be distributed efficiently, securely, and affordably in the future. The consortium consists of representatives from the fields of science and business.

In this interview, Professor Rik De Doncker, Managing Director of the FEN research campus, and Dr. Andreas Jansen, Head of Quality and R&D in the Electrical Steel business unit at thyssenkrupp Steel, discuss the use of renewable energies and what role grain-oriented electrical steel has to play in this process.

Prof. De Doncker, you are in charge of the FEN research campus at RWTH Aachen University. What is this project all about?
De Doncker: Our electrical supply system will continue to shift towards environmentally friendly, decentralized energy sources. However, this requires new grid infrastructure to transport, distribute, and store this energy in a more efficient and flexible way. But these types of electrical grids cannot be developed and implemented without a high degree of transdisciplinary research and interdisciplinary cooperation.

What does that mean in practice?
De Doncker: Here at RWTH Aachen University, we have set up a local medium-voltage and DC grid for demonstration purposes. This five-megawatt DC grid is operated within the university's infrastructure and couples the Center for Wind Drives with the E.ON Energy Research Center's five-megawatt laboratory for medium-voltage converters. This enables us to develop new DC voltage components such as DC converters for modern substations, wind turbines, or fast-charging stations.

Who is involved in the FEN project?
De Doncker: The research campus is funded by the German Ministry for Education and Research (Bundesministerium für Bildung und Forschung; BMBF). It is an association ›

› of institutes at RWTH Aachen University as well as a consortium of 21 partners from different sectors. One of those is thyssenkrupp Steel – specifically, its Electrical Steel business unit.

Dr. Jansen, why is the Electrical Steel business unit involved in the FEN project?
Jansen: We think it's exciting and hugely important that alternative concepts for the transportation and distribution of electricity are not only being developed here, but are actually being implemented – because if we want to take the transition to green energy seriously, we have to find new technical solutions to tackle it and produce evidence that these solutions work. It is important for us to know what power grids will look like in the future when it comes to the issue of transporting energy. If the grids change, then the associated transportation equipment will also change.

Which is where Electrical Steel comes in?
Jansen: Exactly, because you need transformers to transport electricity, and grain-oriented electrical steel is at the heart of every transformer. For us, it is about optimizing our materials at an early stage so that they can fulfill any future requirements.

What sort of requirements do you mean?
De Doncker: If we want to feed in more renewable energies – or even exclusively renewable energies – in the future, we also need to create a storage system for that purpose. And we need flexible grids that are capable of distributing energy in the location in which it was generated.

Why can't we do that now?
De Doncker: If you have a photovoltaic system on your roof right now, you can't transfer any excess energy directly to your neighbor. As it stands, this electricity is normally fed back into the high-voltage grids, meaning that its voltage level is increased again before it is transported via the overhead medium- and high-voltage grid and redistributed.

What is your solution?
De Doncker: The key to this is DC technology, which enables distribution grids to be coupled with one another at the same voltage, creating a direct flow of energy between the generator and consumer. Multiple customers in the same grid can be connected with one another via these decentralized solutions and exchange energy locally. This turns consumers into prosumers who do not just use energy, but also produce it.

What role does grain-oriented electrical steel play here?
Jansen: Electrical components and systems such as DC transformers are required to set up and operate this type of DC network. The core of a device like this consists of magnetically soft electrical steel, which is designed to perform with the utmost efficiency. For the FEN project, we are using the thinnest material available to us right now to first set up a three-phase solid-state transformer.

What is so important about the material?
Jansen: First and foremost, the magnetic power loss must be reduced to a minimum. But thermal stability and strength are also important. This type of transformer is constantly in operation. The transformer and its grain-oriented electrical steel core have to perform 24 hours a day, 365 days a year. If it fails, it can lead to major economic losses or create a safety hazard.

Would the transition to green energy be possible without grain-oriented electrical steel?
Jansen: No, without our powercore® electrical steel, there can be no transition to green energy.

"Without our powercore® electrical steel, there can be no transition to green energy."

Dr. Andreas Jansen, Head of Quality Assurance and Product Development, Electrical Steel business unit

> DC technology turns customers from *consumers* into *prosumers*."

Prof. Rik De Doncker, Managing Director of the FEN research campus, RWTH Aachen University

It doesn't matter if we are talking about wind turbines or photovoltaic plants; they all require a transformer to feed power into the grids. Electromobility also doesn't work without grain-oriented electrical steels, since every charging station has a transformer in it.

The efficiency of electrical steel has improved by up to 40 percent in recent years. Is there still room for improvement?

Jansen: I'm absolutely certain there is, and that's what drives us to keep innovating. Sophisticated heat treatment processes are needed to manufacture electrical steel with the lowest levels of loss possible. We are always investing in the latest technologies in research, development, and production. That is precisely why we are also involved in the FEN project: so that we can identify trends early and prepare our materials for the future.

De Doncker: Besides, all of our studies have shown that the grain-oriented electrical steel from thyssenkrupp Steel gives us the highest degree of efficiency. Given the current state of power electronics, both the thermal and electromagnetic properties achieve outstanding results.

What makes the transformer for a flexible power grid different from a transformer for our current grid?

Jansen: It's a lot smaller and lighter, and it's fitted with a lot more electronics. Currently, this new type of transformer can only be manufactured using our extremely thin and low-loss powercore®. The best thing about it is that the transformer isn't just an idea; it is actually being built here in Europe by one of our customers on the FEN research campus, meaning it can be reproduced and could go into series production immediately.

If it has power, there's powercore® inside: One of the many electrical boxes on the FEN research campus at RWTH Aachen University.

Contact

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How steel helps out around the house

We call it #tksteel inside: an iron-carbon alloy that shapes our homes. Without thyssenkrupp Steel's innovative products, **'home sweet home'** wouldn't be half as sweet!

Text Judy Born | **Illustration** C3 Visual Lab

Rails and ships, cars and planes, bridges, pipelines and gas tanks – without steel our world would grind to a halt. But it's also important for the little things, and is actually just as integral to everyday life in our own homes. Researchers and developers are constantly pushing the boundaries of what steel can do, and this is reflected perfectly in thyssenkrupp Steel's products and applications. 'Thinking the future of steel' is our motto and we apply it to all kinds of domestic appliances and white goods, from ovens and refrigerators to washing machines, dishwashers and driers.

The outstanding formability and corrosion resistance of innovative materials and surfaces makes them the perfect raw materials for these products. One example of this is the galfan® coating, which is used in all kinds of applications that require optimum corrosion protection and maximum formability, such as the front and side panels of built-in appliances. In addition to this, the steel company also offers a range of cold-rolled steel sheets for customers to form and enamel themselves.

Appearances are everything

The organic-coated carbon steels in the pladur® range bring a touch of class to the look and feel of any surface, and have been meeting the highest standards of aesthetics, quality, formability, color variety and cost efficiency for 60 years. One of the most important factors for domestic

60 years of pladur®
design meets function

60 years of pladur®: design meets function

Organic coated carbon flat steel from thyssenkrupp Steel is functional and colorful prepainted steel for premium manufacturers. Our range includes over 8,000 different colors and a huge range of textures in different coatings and steel grades. In the construction sector pladur® is used for facades, interior finishing and roofs. Other uses include domestic appliances, garage doors and trailers.

The house practically looks after itself… Well, not quite, but at least the steel products make things much easier!

appliances is the range of surfaces available, an aspect that covers both coated products and steel products with decorative overlays. Steel products are also found in many kitchen appliances, for example: powercore® electrical steel in motors as well as inenamel cookware and baking trays, and even in the design of coffee makers.

Steel for your home and interior design

Modern tubular steel and modular furniture first conquered our living rooms and offices many decades ago, to the extent that many such designs are now regarded as iconic. Here too, manufacturers often choose material from Duisburg when making their designs a reality.

However, steel also has many less obvious applications, such as in curtain rails and window profiles. If you want to see the difference perfect, high-quality steel can make, just compare the runners of your soft-close drawers to those of a conventional drawer: the soft-close design uses scalur®+Z, a hot dip galvanized flat product commonly found in telescopic runners in shelves and other furniture. This product offers thickness tolerances as tight as ± 0.06 millimeters – on both strip length and width.

So as you can see, it's not all heavy machinery; steel also has a lot to offer on a smaller scale, and plenty of its potential around the home remains untapped.

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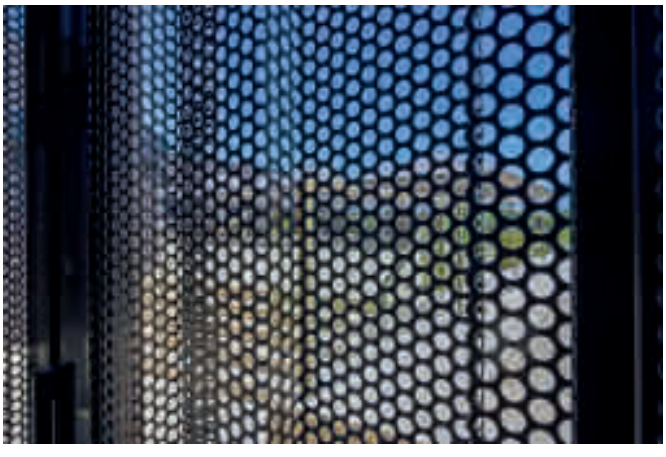
A fresh facade: The texture of pladur® Relief Icecrystal lends the building an elegant look.

Stylish living in steel

After 40 years, it was time for the 'Der Öschberghof' hotel complex to get a facelift and expansion. The result is a **5-star exclusive resort** with an exterior that, thanks to its pladur®-coated steel facade, blends perfectly into the surrounding landscape. ›

Text Judy Born | **Photos** Rainer Schroeer

More than just a facade (from left): Marcel Glapski (Arnold AG), Klaus Kottkamp (thyssenkrupp Steel), Daniel Burkhard (Öschberghof project coordinator), Mirko Bartl (Öschberghof management).



More than meets the eye: You can hardly see it from the outside – some elements of the facade allow you to look through walls.

How do you expand a hotel complex without changing its overall look? How do you incorporate the surrounding environment without making the buildings stick out against the landscape? And how do you convert a historic location into a modern resort without completely breaking with tradition?

This was the task set by the owners of the Öschberghof hotel in Donaueschingen, in the Black Forest region of Germany. Around five years ago, they held a competition to find the right architects for the job. The design by Munich-based architecture firm Allmann, Sattler, Wappner came out on top. Their concept was essentially based on an archetypal farmstead, consisting of little clusters of individual gable-roofed houses. Originally, the roofs and facades of the new building were supposed to have copper paneling. "But we had to drop that idea again pretty quickly," says Daniel Burkhard, the project coordinator for the Öschberghof hotel renovation. "The resort is focused on sustainability, so we collect rainwater to water the green spaces and parts of the golf course, for example. But water ionized with copper would kill off the grass over the long term."

The designers realized they needed to look for a different material – one that could be used to create both the draping effect that the architects had originally intended for the facade, and the shining, shimmering effect of the original material. And they needed to find someone who could manufacture and implement it. "That's how we got involved," says Marcel Glapski, a project manager at Arnold AG who was ultimately put in charge of designing the new facade. Arnold AG is headquartered in Friedrichsdorf, near Frankfurt, Germany. A medium-sized firm, it is one of the country's leading metalworking and metal processing companies. "It was our job to find the right material, plan the design, and ensure that production was completed smoothly."

High-quality pladur® effect

The right material turned out to be coil-coated steel product pladur® Relief Icecrystal from thyssenkrupp Steel. "It's an excellent material for facade paneling; it has all the right technical properties, and it opens up an incredible range of design opportunities that impressed the client and architects alike," Glapski says. Klaus Kottkamp, customer consultant in the Industry business unit at thyssenkrupp Steel, can only agree: "The special feature here is the very high quality coating, which ensures that the material stays durable and colorfast and also lends it an attractive tactile quality."

Additionally, the steel products score points for sustainability, as they can be recycled at any time. The material also boasts exceptional corrosion properties and ease of processing – it stands up to even the most complex forming processes. "We conducted initial tests and made our own profiles with the sheet metal samples Mr. Kottkamp provided to us," Glapski says. "Then, we worked together to determine to what extent we could bend the metal during forming. It went extremely well; it's exactly the kind of collaboration I always hope for."

The material stress test even went a step further, as the Öschberghof hotel is located in a region that is prone to hailstorms. "And what better way to test the resistance of a golf resort's facade than by firing golf balls at it?" says Daniel Burkhard. "So we built a model of the building, with pladur® paneling, and we used that to test whether the roofs and facades could withstand a massive hailstorm." As it turns out, they could! "Obviously, a project like Öschberghof doesn't have a major impact on our order books, volume-wise," Kottkamp says. "But it's an impressive demonstration of how versatile pladur® is and all the different options this premium product has to offer."

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As far as the eye can see: The various folds and edges in the trapezoidal profiles create a draping effect. The visible structure in the paint coating is what makes the cladding so interesting.

Solid and extremely flexible

The new material grade for cans from thyssenkrupp's Packaging Steel business unit o ers a range of advantages. We call it **rasselstein® Solidflex**.

1

An innovative material
The thyssenkrupp Packaging Steel business unit has developed a steel grade in rasselstein® Solidflex that will transport conventional steel packaging into the future. The new material is extremely strong, yet also boasts very good forming properties, thus enabling the use of lower material thicknesses without reducing stability.
This property is particularly important in the production of food cans that are opened using a pull tab. The 'rivet' is what is essential here. This component connects the lid to the pull tab and should not detach as soon as you pull it. At the same time, the packaging steel has to be soft and ductile enough for the rivet to be formed from the sheet metal and for the lid to be effortlessly pulled from the can. This means that the material has to be both solid and flexible – or in other words, 'Solidflex!'

rasselstein® Solidflex spray cans – light, sturdy and sustainable.

Only works under pressure – the perfect spray can is light, safe and easy to use.

2

A safe material
Alongside the aforementioned cans for foodstuffs with 'easy-open ends,' rasselstein® Solidflex is particularly suitable for manufacturing aerosol cans. The specially designed bottoms and lids of spray cans are ideal applications for this material.

From deodorant and hairspray, to spray bottles for perfume and room scents, right through to spray foam for ovens and acrylic paint for furniture and cars – tinplate packaging is an essential part of everyday life. However, manufacturers may only bring aerosol cans on to the market under special conditions according to EU law. Depending on the product that is being sold, it stipulates the exact pressure the spray can has to ensure before it 'fails.'

This 'deformation pressure' is desirable, as it serves as a warning for the consumer. It can be seen from the lid and bottom of the can slowly bulging outward. This means that you don't have to worry about cans exploding, as the consumer's safety takes top priority.

Photos: Istock (2), thyssenkrupp steel (3)

3

A sustainable material
rasselstein® Solidflex is considerably stronger than the material that has been used for spray cans up to this point. Its ductility is also different from conventional material. Its higher strength makes components more stable and means that they can be produced from thinner material. This allows more cans to be produced using the same quantity of tinplate.

Most importantly, spray cans made from rasselstein® Solidflex are lighter than conventional aerosol cans. This results in a weight reduction of up to 14 percent compared to standard spray cans.

Using rasselstein® Solidflex doesn't just help customers reduce their material costs – it also enables them to minimize their CO_2 footprint per can. Paired with the high recyclability of 95 percent for tinplate packaging, cans made from rasselstein® Solidflex are environmentally friendly and good for the climate.

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Interview

thyssenkrupp Steel uses drones for transport

"Mr. Lostak, how does your company benefit from the use of drones?"

Intralogistics is very important to us, so we are keen to discover the extent to which we can incorporate drone transport into our processes. The tests we're running here haven't been done before – we're pioneers in this field right now. Basically, we can optimize the utilization of our labs by just sending off a few raw material samples at a time. At the moment, we wait until we have enough to fill a delivery car. Using drones can also save us time, as they can make the trip in just six minutes or so. That's a speed that cars simply can't match – after all, our site is about five times the size of Monaco! Drones also offer a way of cutting the traffic on our site, which is also important in terms of occupational safety; we have a lot of level crossings here. If they perform well in routine operations, we want to increase our transport drone numbers in the medium term.

Dr. Thomas Lostak is project manager for drone logistics at thyssenkrupp Steel.

"Mr. Jarzombek, what potential do you think drone technology can offer us in the future?"

In the hands of professionals, drones can be of great benefit to our society. Take the maintenance of railway tracks or high-voltage lines, for example: a drone is much quieter, more flexible, and less expensive than a helicopter, which is what we often use for these kinds of work today. They can also be very helpful to the police and fire brigade, for transporting medical goods, and in development aid. However, we need to make sure that there are strict restrictions in place for the use of drones in urban areas when it comes to safety, noise emissions, and data privacy. It's also important to note that the capability for flight with no visual contact – and even to combine drones with automated flight – is essential to how almost every innovative business model works. As such, I'm glad that the new European permit regulations are so progressive – while still maintaining high safety standards, of course.

Thomas Jarzombek is the Federal German government's German Aerospace Coordinator.

Steel

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Photo: schwartz GmbH

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