

# compact steel

Issue 02/2017

The thyssenkrupp Steel magazine  
[thyssenkrupp-steel.com](http://thyssenkrupp-steel.com)

# thyssenkrupp goes IAA

The technology group is  
returning to the International Motor  
Show in Frankfurt.

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thyssenkrupp

# No electromobility without steel.

Steel is the predominant lightweight construction material in automotive manufacturing today.

Highly economical lightweight steel construction makes e-mobility affordable.

Highly efficient electrical steel is an essential base material for electric drivetrains.

» IAA 2017  
14 – 24 September, hall 8.

engineering.tomorrow.together.

## **The automotive industry**

is undergoing fundamental changes. Mobility tomorrow will differ considerably from the forms of mobility we know today. While technological trends used to develop largely coherently, they are now defined by sudden and disruptive bursts of progress. In a sector that is already characteristically innovative, this is further accelerating the pace of change.

## **thyssenkrupp**

has therefore evolved significantly over the past years, incorporating numerous structural changes. Embracing the new is part of our DNA, fuelled both by technological curiosity and the desire to create genuinely new and better solutions together with our customers and business partners. We strongly believe that thyssenkrupp will make a vital contribution to the transformative developments the automotive industry is currently experiencing.

## **IAA**

is a marketplace for us to present innovative products, ideas, and projects. On this marketplace, we are looking to meet and speak with key operators in the sector – this includes our long-term customers and partners as well as new market players. We have four key themes this year: E-Mobility, Intelligent Chassis Systems, Autonomous Driving, and the Future Automotive Factory.



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## blue.cruiser

The third solar car from thyssenkrupp and the Bochum University of Applied Sciences is ready to go.



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IAA dossier – thyssenkrupp will be returning to the International Motor Show in Frankfurt after a ten-year absence. Learn more about the major issues of the future, approaches to solving them, and the technology group’s special expertise.

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## Toyota

Products customized and ready for production in short time.



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## Vorwerk

Electric motors set the home in motion.



## Facts & figures

Are you someone who knows everything there is to know about steel? If so, do you know how many types of steel thyssenkrupp Steel has developed specifically for the automotive sector?

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## Flow forming

Application Technology now has a new flow-forming machine that allows the precise and realistic development of complex-shaped parts.

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## Absolute fail-proof

Gone are the days of broken pull tabs thanks to Solidflex, which makes it even easier to open cans. This material from thyssenkrupp Packaging Steel is light, sturdy, and flexible.

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#tkgoesIAA



e-

mobility  
for all

totally electrifies us!

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# IAA

thyssenkrupp is back at the International Motor Show. There are five good reasons for this:

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How quickly Toyota receives custom materials ready for production

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**Solarcar**

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Where thyssenkrupp explores innovative mobility concepts

# Sustainable, autonomous, connected. What defines us as a systems provider

Most of the manufacturers exhibiting at IAA already make use of **thyssenkrupp products**. Together with our customers, we are addressing the issues of the future and supporting the industry as it undergoes radical change.

They could be described as the modern-day augurs of the automotive sector. But instead of interpreting the will of the gods, their job is to predict the wishes of automotive customers in the future. Wolfgang Müller-Pietralla, head of the Future Research and Trend Transfer team at VW, is a good example. Originally a trained biologist, Müller-Pietralla has been saying it for many years now: CO<sub>2</sub> emission regulations will fundamentally change vehicle concepts, car sharing will fundamentally change consumer behavior, and cities will fundamentally change their infrastructures due to electromobility. Speaking at the 2015 VDI conference, Müller-Pietralla stated, “People expect that technology will adapt to their and also to the environment’s needs. Quality of life is a central concern in the 21<sup>st</sup> century.”

More than most others, the automotive industry is forced to engage with the major societal developments of our time – globalization, megacities, urbanizati-

on. Three quarters of all Europeans are predicted to live in urban environments by 2050; in the U.S., it may be up to 90 percent. This necessitates entirely new concepts of mobility and transport versatility. “The mobility of the future will connect all areas of life,” said BMW’s CEO Harald Krüger when presenting the BMW Vision Next 100 study.

#### IAA: presenting 4 topics for the future

The automotive segment of thyssenkrupp is meeting the big questions of the future head-on, employing innovation and expertise in the development of materials and components as well as in the design of state-of-the-art assembly lines. As a full-scale systems provider, thyssenkrupp enables automotive manufacturers and parts suppliers to produce vehicles that are at once sustainable, autonomous, connected, and suitable for mass production.

thyssenkrupp is one of the leading materials and components suppliers to the automotive industry, as well as a go-to partner for engineering services at this



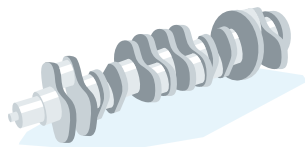
#### thyssenkrupp: materials

**Steel** – with around 27,000 employees, this Business Area represents one of the world’s leading suppliers of high-quality flat steel. Customers range from the automotive industry to machine and plant engineering, the energy sector, the packaging and construction industries, as well as special vehicles and domestic appliances.

thyssenkrupp Steel has been working for the automotive industry for a long time and knows this sector like few other suppliers do, offering extensive, industry-specific expertise for materials and technologies alike. The many advantageous properties of steel make it the material of choice for vehicle bodies, and its success will continue into the future of automotive manufacturing – sustainable, economical, and efficient.







## thyssenkrupp: components

**Components Technology** – with around 30,000 employees, this Business Area produces high-tech components for the automotive industry and for machine engineering. thyssenkrupp components can be found worldwide in nine out of every ten premium-class passenger cars, and every third heavy-goods vehicle features drive train components from thyssenkrupp.

In the industrial sector, Components Technology supplies parts for construction machinery, wind turbines, and numerous other types of machines and devices.

year's International Motor Show in Frankfurt; this is the first time in ten years that we are represented at this important trade show again directly. We have four key topics this year: E-mobility, Intelligent Chassis Systems, Autonomous Driving, and the Future Automotive Factory.

### Steel boosts electromobility

thyssenkrupp Steel devises innovative material concepts for lightweight construction as well as for high-performance electric and hybrid drivetrains. It represents an important contribution to the manufacture of vehicles that are weight-optimized yet secure, no matter what type of drive is involved. Internal combustion engines won't be disappearing overnight, and despite the lofty targets set by the German government, it seems highly unlikely that there will be one million electric vehicles on German roads by 2020.

Steel is still the most economical construction material for most types of vehicles. In cars with internal combustion engines, the weight reduction provided by lightweight construction achieves considerable reductions in fuel consumption and carbon emissions. Electromobi-

lity, on the other hand, is becoming more affordable thanks to cost-optimized steel solutions.

Steel is also highly advantageous in terms of safety. Used in the body framework, it provides excellent passenger protection thanks to its resilience and its ability to absorb impact energy. In electric vehicles, steel has an additional advantage: It is used to house the battery. A steel enclosure protects the battery against accident damage, which in the worst case is fire. Also, where would today's electric vehicles be if it weren't for thyssenkrupp's highly efficient electrical steel? This is crucial as a base material in the design of low-loss, high-speed electric motors. These qualities are the secret to making electric motors more efficient and expanding the vehicle's range.

### Predictive damping systems

The chassis experts at thyssenkrupp are also embracing innovation. Right now, they are developing active damping systems that can react to driving behavior and surface conditions in advance. These dampers are integrated into the vehicle's environment recognition system, interconnected via radar, camera, GPS and the cloud network. Electromagnetic dampers

Photo: Gettyimages Illustrations: C3 Visual Lab

can respond to each wheel individually, providing just the right amount of damping required for the driving situation. This increases passenger comfort, vehicle responsiveness, and even safety. Active chassis systems such as this are becoming more important for ensuring that passengers enjoy the best possible travel quality as autonomous driving gains in popularity – no matter if they are doing work while traveling or just surfing the Internet.

### Autonomous driving

thyssenkrupp's steering specialists have a new area to focus their development on: steer-by-wire systems. With these, the steering motions are translated entirely electrically, just like in an aircraft. This technology makes it possible to integrate the steering function into entirely new vehicle architectures. The cockpit can be designed very differently because the mechanical connection between the steering column and the wheels on the road is largely made redundant. Steer-by-wire also eliminates the need for different construction designs for right-hand and left-hand steering. And when – in the not-too-distant future – there will be driving situations where the steering wheel is not needed at all for sustained periods of time, this technology even makes it possible to move the steering wheel out of the way. This will open up truly new possibilities for the passenger cabin.

### Automotive factory of the future

The digital transformation will drastically affect the entire automotive industry. At last year's IAA, Daimler CEO Dieter Zetsche described his vision of the future: "Manufacturing plants will become smart factories, and systems and components will be seamlessly connected through networks. Most importantly: Robots and human workers will complement each other in the future."

thyssenkrupp System Engineering develops and assembles individually-tailored systems for automotive manufacturers and parts suppliers – both for vehicle assembly as well as the production of engines, transmissions, and batteries. No matter if it's individual components, prototypes, or entire systems, thyssenkrupp's engineers can provide the required tools and assembly lines. This ensures that customers can produce both cost-efficiently and at top quality levels – anywhere in the world. The concept of the Future Automotive Factory is already being im-

thyssenkrupp makes an important contribution to the manufacture of vehicles that are weight-optimized, safe, and cost-efficient – no matter what type of drive is involved.



### thyssenkrupp: engineering

Industrial Solutions has around **21,000 employees**, specializing in the construction of large-scale industrial plants. This Business Area not only designs but also builds and services plants and systems for customers from across the chemical, fertilizer, cement, mining, and steel industries.

In the automotive area, Industrial Solutions develops and supplies process chains for the assembly of vehicle bodies and drive trains, as well as the corresponding testing systems. In addition, this Business Area works closely with the battery and aviation industries, as well as developing highly specialized solutions for naval vessels.

plemented very successfully and extends into areas such as Industry 4.0, data analytics, and the Internet of Things, as well as virtual reality, robotics, and human-machine collaboration.

The bold vision proposed for tomorrow's automotive factory is that productivity will be increased and energy consumption reduced. Maximum process flexibility will be pursued without compromising product quality. Different processing steps will be ergonomically matched, and they will require less floor space. Perhaps most importantly, every single aspect – from assembly right through to product shipping – will be fully traceable.

Horizontal as well as vertical networks will enable the individual workstations to function both independently and in tandem; operators will be able to engage manually at any time and interact directly with any of the automated modules. Before all this can happen, however, the assembly line of the future is planned out in every little detail: layout, operation, system response, process control, and many other aspects, too. All the individual parts can be inspected and modified using a virtual 3D model of the line. Operators use wearable computer sensors, smart glasses, and other augmented-reality devices in order to interact with the digital assembly line. Another important aspect is the harmonious and safe interaction of humans and robots in shared working situations. While robots may be unable to make complex decisions and are generally not very flexible, they do offer incredible accuracy as well as continuous operation.

All these examples demonstrate that thyssenkrupp is positioning itself as an innovative force within the automotive industry. Most of the manufacturers exhibiting in Frankfurt are already taking advantage of thyssenkrupp products. That's why we will present our Group in exactly the right place at IAA: by our customers' side.

Contact: Marcus van Marwick, Brand & Customer Communications, + 49 203 52 41005, [marcus.vanmarwickthyssenkrupp.com](mailto:marcus.vanmarwickthyssenkrupp.com)



# Electric mobility would not be affordable for many people without steel

**Andreas J. Goss**, CEO of thyssenkrupp Steel, is a firm believer that steel will continue to prove its versatility, both in electric and non-electric vehicles.

**Mr. Goss, thyssenkrupp will be returning to the IAA this year after a ten-year absence. Could you explain why?**

**Goss:** The automotive sector is one of the top industries in Germany, generating about €400 billion in sales. It is also a key driver of technological innovation. thyssenkrupp has worked closely with the industry for decades, where it generates roughly one quarter of its sales from products and services. The sector is currently in the process of massive upheaval. This makes it the perfect time for us to go to IAA and discuss in-depth with industry insiders future topics in the field of mobility.

**What are you seeking to achieve by taking part at IAA?**

**Goss:** IAA is the world's largest car show. OEMs and their suppliers will all be there at the event, representing all companies across the entire value-added chain. This makes it one of the main platforms for showcasing new technologies, products, and trends. We view the event as a forum that allows us to speak in-depth with experts from the international automotive industry and work with them in identifying, defining, and reassessing the requirements of the future. We are looking to use the opportunity that IAA presents to provide suppliers and OEMs with more targeted support as the industry undergoes fundamental change.

**What type of support might this be?**

**Goss:** The automotive sector is undergoing radical change: OEMs are moving away from just making cars to become mobility service providers, while Internet companies like Google are starting to manufacture automobiles. The long-established borders between companies along the value-added chain are disappearing. The automotive sector is being forced to focus their R&D activities on multiple trends like autonomous driving and electric mobility. This requires major investments on their part, all while they face pressure to keep prices down. As a material services provider, we have a comprehensive overview of the entire industry as well as the changing demands placed on it. We will continue to offer attractively priced, lightweight steel

solutions for vehicles with conventional drive systems, while also providing material concepts that help foster the transition to electric mobility.

**Does that mean thyssenkrupp will be supplying new materials for both drive variants?**

**Goss:** Yes, that's correct. Our R&D activities related to developing more advanced electrical steel for use in electric vehicles will focus on improving the efficiency of motors and increasing the range of cars. That, along with cost, is a key factor in broadening the appeal of electric cars. We are primarily focusing on high-strength, lightweight cold and hot forming solutions for conventionally powered cars. This includes more advanced products for use in safety-related components, for example. They allow carmakers to continue to offer the same level of protection for vehicle occupants in the event of an accident while reducing weight at the same time.

**Is lightweight construction still relevant with respect to electric vehicles?**

**Goss:** We believe there will be a reassessment of lightweight construction in relation to electric vehicles. The general rule of thumb is that the lighter a vehicle is, the longer its range will be. This gain in range is much less than one might think, however. According to our calculations, reducing the weight of an average vehicle by 100 kg will only deliver roughly a 10 km improvement in its range.

**How then will it be possible to extend a vehicle's range?**

**Goss:** The battery and drive are much more important in achieving gains here. Regenerative braking, or how effectively the drive train is able to recapture energy generated during braking, is the key here. That said, lightweight steel will continue to play a role in the future. For instance, it will help make electric vehicles affordable to the masses thanks to the low-cost material solutions available.

**What role does steel play in electric mobility?**

**Goss:** Steel is essential for e-mobility. Generators, transformers, and electric motors would not work without electrical steel. The material is absolutely critical in all phases of the process, from generating energy, to transporting and distributing it to charging stations, and finally

in propelling electric vehicles. Steel will also continue to be used as a material in the body of future generations of cars. It is better able to meet the requirements regarding impact-resistant cases mandated for high-voltage vehicle batteries than any other material.

**What is thyssenkrupp Steel specifically working on at the moment?**

**Goss:** We are expanding our range of dual-phase steels to include new, high-strength grades. At the same time we are upgrading our portfolio in this area. We are also working to increase the global availability of our innovative and highly popular zinc-magnesium coatings. Along with that, we are developing groundbreaking new products such as our tribond® multi-layer steel composite material. We believe that R&D will increasingly shift towards optimizing component costs while maintaining the same level of protection for vehicle occupants and pedestrians, as well. In our estimates, steel has excellent prospects in this respect, which is why we are continuing to further develop our range of steel products.

**Will radical changes to vehicles and their drives necessarily lead to changes in steel as a material?**

**Goss:** Absolutely. Our job each and every day is to ensure our customers receive just the right materials they need for both conventional applications and for entirely new ones as well. Steel is constantly proving its versatility. I am a firm believer that there is still vast potential in terms of the materials we produce.

**In this context, does digitization have a role to play in steel production?**

**Goss:** We are naturally monitoring trends in digitization and exploring the potential impact Industry 4.0 will have on our production. In this regard, we are looking to become increasingly networked with our customers in the future. This is necessary for us to be an effective partner for them in meeting the challenges of tomorrow and dealing with the pressure to change and evolve, which is being felt in Germany's biggest industrial sector. IAA will present plenty of opportunity to discuss and then tap the potential available here and elsewhere. We look forward to working with customers in helping to shape the transformation taking place in the automotive industry. This represents a tremendous opportunity to develop innovative new products and services for sustainable, efficient mobility, which we look to seize on."

# Why are you attending IAA?

Carrying out technology projects, developing new materials and processes, and manufacturing components are all ways in which we can work with companies in the automotive sector. We asked **four managers from thyssenkrupp's Steel division** why they will be attending IAA.



## Prof. Hans Ferkel

### Head of Technology and Innovation

Prof. Hans Ferkel and his team are fully focused on meeting the needs of customers. Their goal is to speed up the process of designing new products and bringing them to market.

**IAA is a marketplace** for ideas and products. We are looking to meet and speak with key operators in the sector. This includes our long-term customers and partners as well as new market players. The goal is to get to know them better and learn more about their material processing methods. This in turn will allow us to find out what materials and processes will be in demand in the future. This relates to steels for hot and cold forming as well as coatings and process technologies.

The future of travel belongs to electric mobility. This trend is driving our efforts to optimize our electrical steel in order to minimize losses and improve its magnetic and mechanical properties. A potential longer-term goal is likewise to define common industrial standards. A critical factor in e-mobility succeeding is having highly efficient electric drive systems, which include everything from the battery to the electric motor. IAA is the perfect place to meet and discuss such topics with companies operating in the sector.

## Dr. Heike Denecke-Arnold

### CEO Precision Steel business unit

**In brief** — thyssenkrupp Hohenlimburg GmbH became the Precision Steel business unit back in 2016. At this time, Dr. Heike Denecke-Arnold was appointed CEO of the BU where she is in charge of the precision strip business in Hohenlimburg.

**Did you know that about 80 percent** of our precision strip is supplied to the automotive sector? Our materials find their way into a number of safety-related components like height adjustment mechanisms for seat belts as well as seat and chassis components. Precision strip offers maximum safety, the narrowest tolerances, and excellent forming properties.

These are all attributes that will continue to be in strong demand in the mobility of the future. Our bainitic steels, which have already found their way into the body of a prototype electric vehicle, are a prime example of this. They can be shaped into complex forms and make it possible to produce ultra-light, highly sturdy components. Also worthy of note is our high-grade manganese steel that hardens substantially during forming, making it possible to further reduce weight in safety-related components. We would like to discuss this and much more with you at IAA.



## Jörg Paffrath

### CEO Industry business unit

**In brief** — The former Sales Industry unit has been operating as the Industry business unit for one year now. Jörg Paffrath contributes his many years of experience in this sector as CEO of the business unit.

The **automotive supplier industry** has been among our core group of customers for some time. We are looking to discuss the changes being faced in the sector with them in Frankfurt. Newly developed manganese-boron steels are now part of the products we deliver to customers in the automotive sector via precision tube manufacturers. These steels are primarily used in chassis stabilizers and dampers, in camshafts and gear shafts, and in steering rods. The requirements in terms of torsional rigidity, strength, and lightweight construction have grown significantly over the past years with regard to these components.

We are looking to the future as well. That means we need to continue to pursue topics like the use of hot-rolled strip with the narrowest tolerances (scalur® and scalur®+Z) for use in high-precision parts like seat rails and chassis components independent of future drive concepts. Being able to offer a full range of products and services makes us the ideal partner for materials thanks to our ability to fully and quickly meet our customers' requirements, whatever they may be.

## Come visit us!

**As we see it, IAA is** a marketplace for innovative products, ideas, and projects. We are looking to meet and speak with key operators in the sector at the event. This includes our long-term customers and partners as well as new market players.

We are looking to discuss the challenges regarding the mobility of tomorrow and hear what others have to say on the subject at our booth. We will be providing a number of interesting events and have great staff on hand at our booth. We look forward to seeing you there.

## André Matusczyk

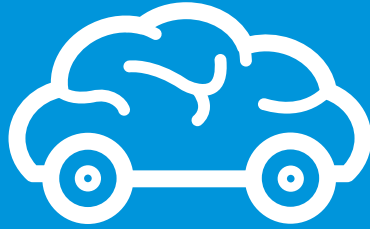
### CEO Automotive business unit

André Matusczyk has headed up the Automotive business unit for close to one year now. He has both in-depth expertise in materials designed for the sector as well as extensive knowledge of the market.

**We were able to acquire extensive expertise** in the automotive sector over the past 30 years through our involvement in a number of technology projects. We are looking to IAA in a time of massive change to discuss this with our customers. Steel is the primary material used in the chassis and in the structure of conventional drives and hybrid concepts. Our focus in this area continues to be on affordable lightweight solutions. We are able to offer our customers just the right material for their respective application by developing new, high-strength dual-phase steels, employing cutting-edge processes like hot forming, and combining steel with other materials to create composites.

We are also focusing on electric mobility. After all, electric vehicles would not exist were it not for steel, especially electrical steel. Our R&D activities are centered on low-cost materials within the scope of lightweight concepts and on individual components with special safety requirements such as battery cases. We want to speak directly with the companies in the sectors at IAA in Frankfurt so we can explore ideas, projects, and partnerships together with them.

#tkgoesIAA



We help you  
to build smarter cars. And to build  
**Cars**  
smarter.

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# Facts & figures



At present, more than **three quarters** of all vehicle chassis manufactured in the E.U. are made exclusively or primarily out of steel.

# 1,800

**types of steel** have already been developed by us for the automotive sector, and we are constantly working to improve them.

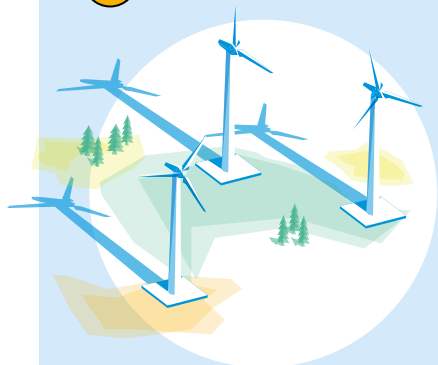


-100 kg =  
+8 km

**Weight** has a negligible impact on **range** when it comes to drive systems featuring regenerative braking. This is primarily influenced by the drive and battery technology being used.

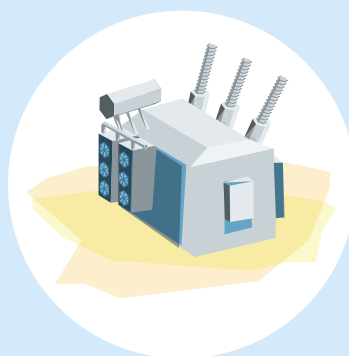
## Steel is essential for electric mobility

1 Generation



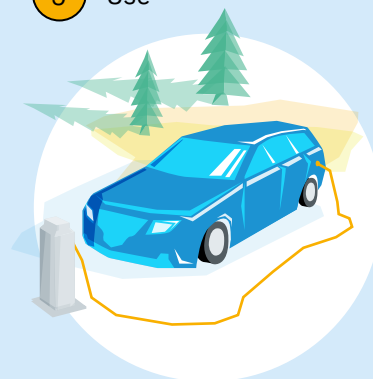
Non-oriented electrical steel is used for example to build wind turbine generators.

2 Transformation and distribution



Grain-oriented electrical steel is a core component of transformers.

3 Use



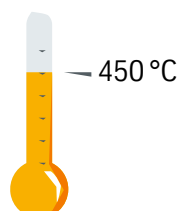
Non-oriented electrical steel is used in the drive and auxiliary motors of electric cars.



The automotive sector is responsible for roughly **25 percent of all sales** generated by thyssenkrupp.

# 100 years

thyssenkrupp has experience in the area of **materials, components, and systems**. It is also a reliable partner for the international automotive sector.



In thyssenkrupp's hot-dip coating lines steel is dipped in a zinc or zinc-magnesium **bath heated to roughly 450°C** to provide anti-corrosion protection and ensure flawless surface quality.

# 30 million

compact cars over the past 25 years or so have been produced using corrosion-resistant steel from the thyssenkrupp **hot-dip galvanizing line** in Bochum.


# Trial period successfully completed

thyssenkrupp Steel has conclusively demonstrated the strength of two completely different products to **Toyota**. The materials, which were developed in cooperation with the customer, will be used **in volume production** in the future.

Text Judy Born

**L**istening is absolutely essential. You need to truly put yourself in your partner's shoes in order to ensure they are more than simply content. This holds true in business relationships as well as in personal ones and requires a tremendous amount of trust, openness, reliability, and commitment to the common cause. The working relationship between Toyota and thyssenkrupp is an exemplary illustration of this maxim.

thyssenkrupp has had a very close relationship with the Japanese car manufacturer for many years in its role as a supplier. One year ago, the car-maker began to look for an additional, dependable supplier specifically for the highly complex side panel for its Corolla model in Europe. A material from the thyssenkrupp Steel division came under consideration. "They were interested in a very soft deep-drawing steel that we offer for parts that need to be formed," says Stefan Slawik, Key Account Manager for Toyota. An additional zinc iron alloy



Highly adaptable: Stefan Slawik (l.), Recai Cetin (r.), (both thyssenkrupp), and Edip Özer Arman (Toyota) with a structural component made of the customized material DP 1200.



Side view: Dr. Jürgen Schramm, Dr. Patrick Kuhn, Stefan Slawik, Hagen Pflugradt (from left to right).



Schramm, responsible for the Surfaces product management. “The large side panel is extremely difficult to form. The surface needs to meet the highest standards. We delivered a consistent level of quality and completed the trial period successfully.” This in turn has made it possible to use the material in other Toyota models across Europe.

The DP 1200, a material that is also intended for use at Toyota’s European operations, entailed even more intensive collaboration. The strategy of the carmaker – the second largest in the world – is to source the materials required for manufacturing activities locally as far as possible. For European operations this means as much content as possible from reliable Europe-based suppliers. “In this case, these materials include high-strength steel for structural components that reinforce the roof and doors,” says Schramm. “This steel is another product from our premium segment with properties that are diametrically opposed to those of the soft, deep-drawing material used for the side panel.”

The DP 1200 proved that an existing high-quality product can be adapted to the respective requirements in close collaboration with the customer, for example, by maintaining its strength while changing its yield strength. “We had special requirements for the material”, says Edip Özer Arman, Senior Engineer at Toyota Motor Europe. “With those requirements we addressed the steel experts and searched for solutions together.” Slawik says: “There was a very narrow window of time, but the development phase was completed and the material approved in just two years.”

“We are ready to use the DP 1200 in volume production”, says Arman. thyssenkrupp worked very closely together with the customer during this time. Every individual production step and every change was described in detail and agreed on. A good working relationship between the material supplier and customer is essential for fast and successful completion of any project. “Our relationship is built on trust and competence, that makes us so successful as partners”, says Arman. A clear commitment to one another is also the cornerstone of a successful partnership in business.

Contact: Stefan Slawik, Automotive business unit, +49 203 533 5185, stefan.slawik@thyssenkrupp.com

Photos: thyssenkrupp Steel Europe/Fotografie (2)

“

We are proud to bring DP 1200 into production together with Toyota.

Stefan Slawik, Key Account Manager, Business Unit Automotive

coating layer improves the long-term corrosion protection.

thyssenkrupp provided an additional forming lubricant so that the material could be integrated into Toyota’s standardized production process immediately. “The tools do not need to be adapted; the material can be used right away and the manufacturing process can proceed without any problems.”

#### Quality holds up after extensive testing

But the Japanese partner was not won over quite so quickly. thyssenkrupp needed to prove itself first. “We ran a test phase that lasted several months in order to demonstrate that the material can be processed reliably,” says Dr. Jürgen

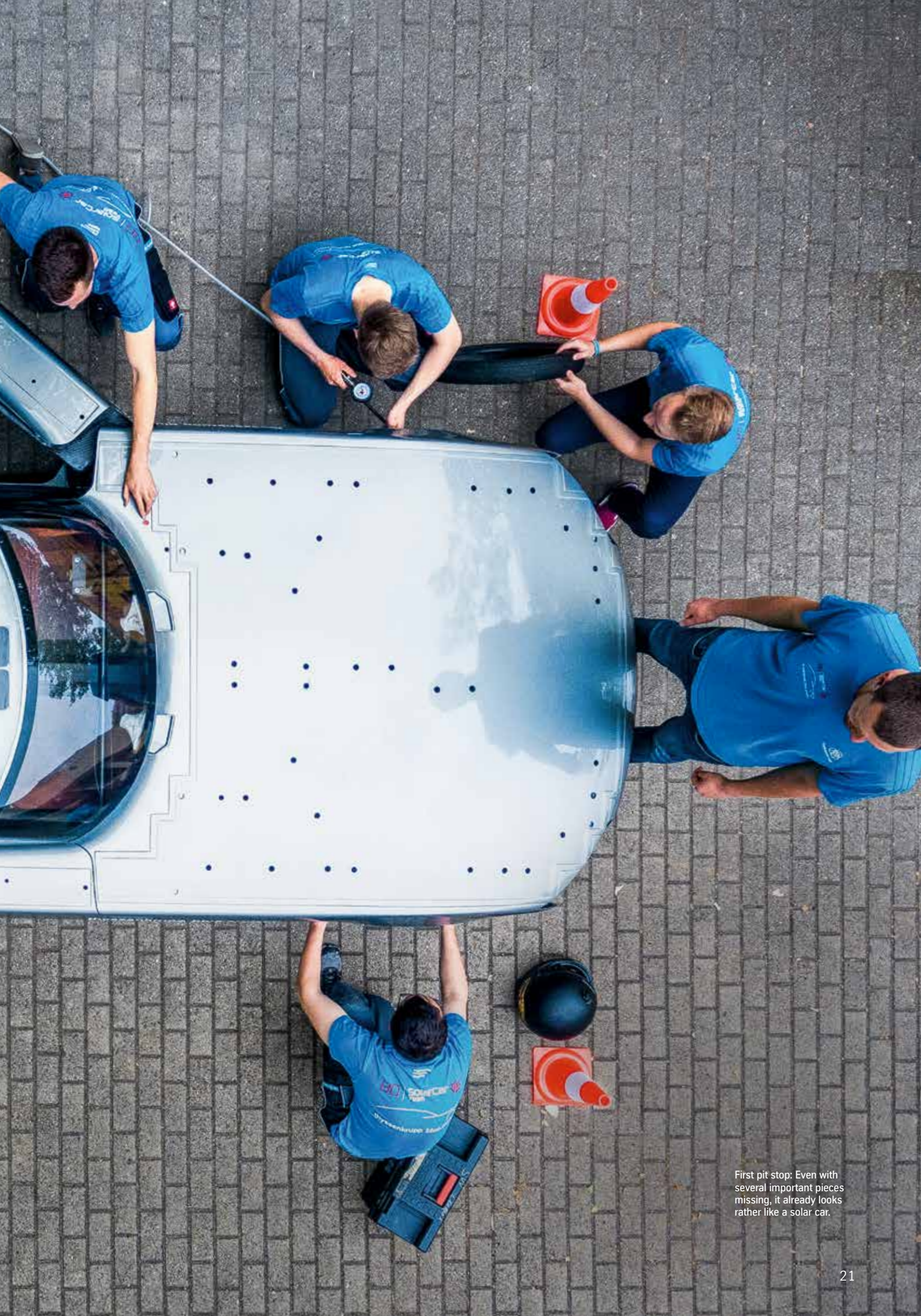
# Out of the shadows

The time is ripe for sustainable **solar vehicles** that are practical for everyday use. Students at the Bochum University of Applied Sciences proved this is possible with the **thyssenkrupp blue.cruiser**.

Text Judy Born

Photos thyssenkrupp Steel Europe Fotografie





First pit stop: Even with several important pieces missing, it already looks rather like a solar car.



Excellent bending properties: Antonie Bauer and René Berger examine a model of the tube frame.

Building from the ground up: Jan Kniprath makes adjustments to one of the motors developed by his team, which features electrical steel from thyssenkrupp.

It's a mild 13 degrees in New South Wales in late August. But the small group of students from Germany are still sweating it as they wait with bated breath for customs officials to release their container at Sydney Harbor. The officials check the forms, cross-check the bills of lading against the inventory lists, and inspect the container and its contents. Loaded onto a ship in Hamburg in early July, the container has inside it all the tools and equipment needed for the latest solar car created by Bochum University of Applied Sciences. It also contains much of the luggage of over 50 fellow students: from a car trailer, tents, and sleeping bags through to a partially disassembled car battery.

The World Solar Challenge takes place every two years in Australia. It is held on public roads, as the cars traverse the continent from the north to the south. The race kicks off on 8 October in Darwin, on the coast of the Northern Territory. The participants will arrive in Adelaide, the capital city of the state of South Australia, six days later after journeying across 3,000 kilometers. The team from Bochum will take their place at the starting line with the thyssenkrupp blue.cruiser, which will be flown out to the Australian Outback from Germany along with its creators in August. This is the third research partnership between thyssenkrupp and the university, which has been building solar-powered electric cars for over 15 years. The thyssenkrupp blue.cruiser will enter the Cruiser Class event of the race like its predecessor. Success in this category is determined not by speed but by the car's suitability for everyday use. "Our goal is to develop a car that people will actually be able to drive in the near future," says Friedbert Pautzke, Professor of Electrical Engineering at Bochum University and founding member of the solar car project. The vehicle needs to be street legal in its country of origin in order to enter the Cruiser Class event and offer at least two seats – which is no problem for the blue.cruiser, which offers four.

The coupe was designed by a student at the prestigious Folkwang University of the Arts in Essen. He created an elegant, dynamic design in close collaboration with the budding engineers from Bochum. "Our solar car models are guaranteed to catch people's attention," says Friedbert Pautzke full of pride. The car is also packed with technological features



Founding members of the project: Dirk Bartels (thyssenkrupp, left) and Heribert Pautzke (Bochum University) are pleased to be taking part in the third race together.

“We hope that this partnership will make students feel enthusiastic about thyssenkrupp and join us in the future, bringing their research skills and entrepreneurial spirit with them.”

Dirk Bartels, thyssenkrupp

from thyssenkrupp. The Steel division provided the material for the roll cage of the cabin and for the wheels that were produced specially for the solar car. The division also supplied the electrical steel for the electric motor as well as the back seat, which is made of a steel-polymer sandwich material.

Dirk Bartels, who has been head of innovation management at thyssenkrupp for five years, says: "What's appealing about the project for us as a company is the fact that we can collaborate with the university to gain experience that will help us more effectively apply and use our wide range of materials and components in solar vehicles." Colleagues from Components Technology and Materials Services are also involved, though the Steel division serves as the main partner for the project. "But to be fair, I must say that a large number of other departments within the Group have been contributing to the project over the years, even though the idea originally came from thyssenkrupp Steel."

The aim of the project is to develop technical innovations but also to help mold the aspiring engineers. "I wanted to hand over responsibility to the students," says Pautzke. "We wanted to train them to think and act independently and to make decisions and stand by them later on in their professional and personal lives." As such, the students



“  
Our solar car models  
are guaranteed  
to catch  
everyone’s attention.”

Friedbert Pautzke,  
Bochum University

take a practical approach that is based on problem solving. This means they need to develop their knowledge and abilities independently or as a team. “This aspect of training young students is just as important to us as gaining new technical knowledge,” says Bartels. “We hope that this partnership will make students feel enthusiastic about thyssenkrupp and join us in the future, bringing their research skills and entrepreneurial spirit with them.”

The students are initially supported by more experienced team members or professors, but they are increasingly left to their own devices over the course of the project, whether they are creating the design, building the car, or organizing the trip to Australia. “15 students were involved when we were creating the very first solar car,” says Pautzke. “Now there are over 60.” The project has not only become more popular, it now also includes students from a wider range of degree programs. The newest members of the team are part of the Sustainable Development course, which has been offered at Bochum University for four years. This is also an important field for thyssenkrupp. This year’s project entails carrying out a life-cycle analysis (LCA) for the solar car for the very first time. Bartels says: “We approach sustainability from three angles, considering environmental, social, and economic factors. We need employees with the appropriate



It is finally ready: The solar car team has overcome the last hurdle in receiving approval for the car’s use on public roads.

training in order to find the right balance between these three parameters. This is another way in which we can benefit from the partnership.” Indeed, the project as a whole is perfectly in line with the Group’s motto: ‘engineering.tomorrow.together.’

The students are also bound together by a sense of community. Every student who has contributed to the success of the project is entitled to travel to Australia, where they will be given additional responsibilities, whether this is as a member of the technical or media team, the kitchen crew, or transportation team. Even the logistics team will continue to ensure that everything is in

the right place at the right time in the coming weeks after the container makes it into the country. The students have already achieved so much. They have gained a tremendous amount of knowledge, insights, and experience as well as self-confidence – regardless of how quickly the thyssenkrupp blue.cruiser reaches its destination in October.

Contact: Dirk Bartels, thyssenkrupp AG,  
+49 201 844 536287, a  
dirk.bartels@thyssenkrupp.com



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# Steering wheel.

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# The new solar system

The **thyssenkrupp blue.cruiser** is economical, sustainable, and suitable for everyday use. This sleek four-seater is the third solar vehicle jointly developed by thyssenkrupp and Bochum University of Applied Sciences.

New: more steel, more natural fibers

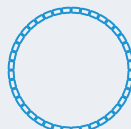
The **thyssenkrupp blue.cruiser** features more steel components than ever. Among others, it contains lightweight elements as part of the body, electrical steel inside the motor, and high-tech components in the chassis. The vehicle's high level of sustainability results from a life-cycle analysis of the environmental influences exerted by production, service life, and recycling.

Using steel instead of CFRP and aluminum has significantly reduced the vehicle's greenhouse gas emissions. Alternative materials both on the interior (such as linen and pineapple leather) and the exterior (such as balsa wood and bio resin as laminate substitutes) also help to reduce the thyssenkrupp blue.cruiser's environmental impact.



**1**  
**ELECTRIC MOTOR**

The **hub motor** contains high-quality electrical steel from thyssenkrupp's Steel segment. A high-strength automotive steel grade forms the basis for this efficient drive technology. The interplay between the electrical steel and the permanent magnets is crucial to this.



**2**  
**MAGNETS**

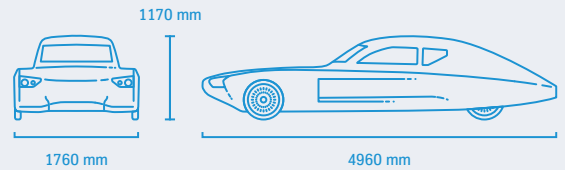
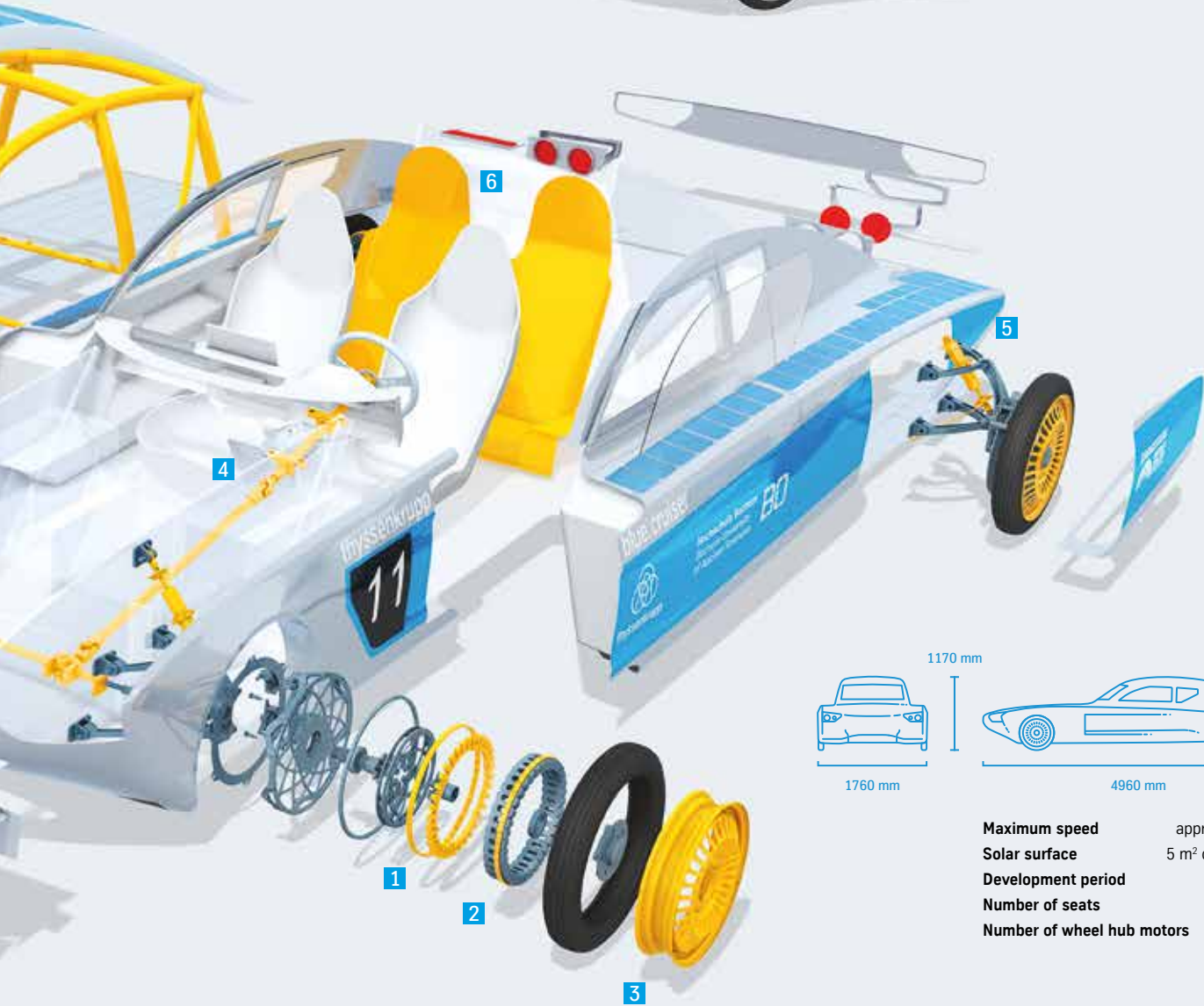
The **innovative magnet technology** is supplied by our Materials Services business area. The special layout of the permanent magnets optimizes the magnetic flow, which improves the energy efficiency of the electric motor. A total of 200 individual magnets are installed for each drive unit.



**3**  
**STEEL WHEELS**

**Unlike its predecessor**, the thyssenkrupp SunRiser, the blue.cruiser features wheels made from dual-phase steel rather than aluminum. However, the weight level is the same. The active section of the electric drive is located on the wheel suspension behind the steel rim.



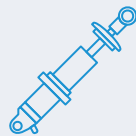


<b>Maximum speed</b>	approx. 120 km/h
<b>Solar surface</b>	5 m <sup>2</sup> of silicon cells
<b>Development period</b>	2 years
<b>Number of seats</b>	4
<b>Number of wheel hub motors</b>	4



**4**  
**STEERING**

The **steering system** is a proprietary development from thyssenkrupp Components Technology. Thanks to the deployment of CFRP components, the steering shaft is approx. 60 percent lighter than a conventional steel shaft but still ensures high strength.



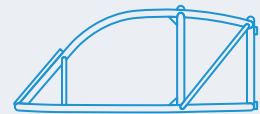
**5**  
**SHOCK ABSORBERS**

The **shock absorbers** were manufactured to a compact motorsports design specification, featuring manual height adjustment as well as the Bilstein B16 ridecontrol® adaptive damping system. The driver can match the damping forces to the road conditions and change between sport and comfort modes.



**6**  
**BACK SEATS**

For the **back seats**, litecor® was used. This steel-polymer sandwich consists of two very thin steel sheets and a plastic core. The back seats support the vehicle's lightweight design and offer room for two additional passengers.



**7**  
**TUBULAR FRAME**

The **extremely light tubular frame design** is based on ultra-high-strength steel with improved crash characteristics. The roll cage both protects the passengers and serves as a connection for the floor and the load-bearing structures.

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## Go with the flow

Transforming a material: Sustained pressure from the rotating rollers creates a new form.

New flow-forming machine produces rotationally symmetric components that are **up to 50 percent lighter** than previous parts.

Imagine a potter who effortlessly molds clay with his expert hands. He applies a bit of pressure here, gently pulls there, and after a few minutes, the material has taken on an entirely new form. Flow-forming relies on a similar principle; it is a technology used to transform circular or tubular blanks into parts that are rotationally symmetric with varying wall thicknesses and complex geometries. Only instead of clay the raw material is steel.

Flow-forming is used primarily to manufacture wheels and drive train components. The process begins with using high-strength hot-rolled strip to make a blank in the form of a disk,

tube or cup. The workpiece is clamped and rotated. Rollers then push against selected parts of the rotating workpiece, pressing it against the inner shape of the tool and stretching it in the axial direction. This is how a short, thick tube, for example, is transformed into a long, thin component with superior surface quality. Such a part is also capable of bearing heavier loads, lasts longer, and can be manufactured with far greater precision than if produced by machining. thyssenkrupp Steel commissioned a new flow-forming machine this spring.

### Combinable with other technologies

The new machine makes it

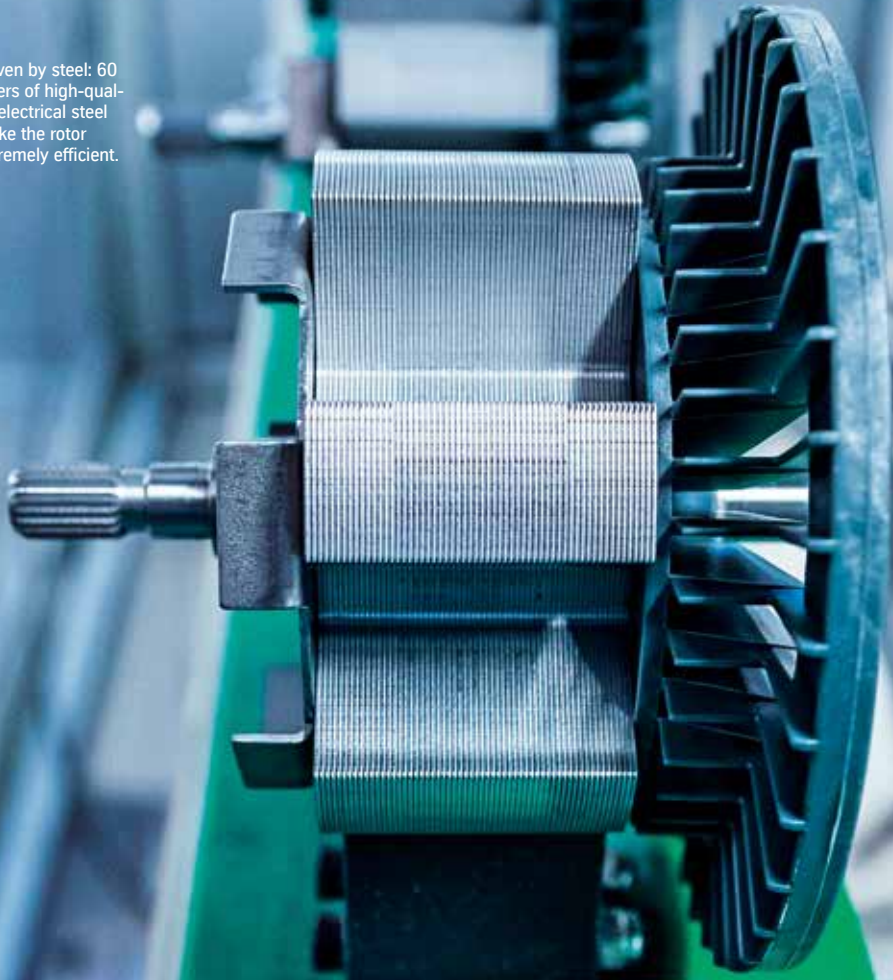
possible to research material properties that are important for flow-forming and optimize these to meet customer requirements. Precision strip from the Precision Steel business unit can also be used as a reference material. It means Application Technology in Duisburg is able to transfer the test results to simulations and develop new processes and grades – either for its own purposes or for a particular customer.

The machine is suitable for processing ultra-high-strength steels and can be combined with other forming and heating technologies. As a result, certain components produced using flow-forming can be made up to 50 percent lighter. This

innovative application will enable thyssenkrupp Steel to provide its customers in the automotive and machinery sectors with even better support in the future. –jb

Contact: Thomas Flöth, Technology and Innovation, Tel.: +49 203 524 4924, [thomas.floeth@thyssenkrupp.com](mailto:thomas.floeth@thyssenkrupp.com)

Driven by steel: 60 layers of high-quality electrical steel make the rotor extremely efficient.



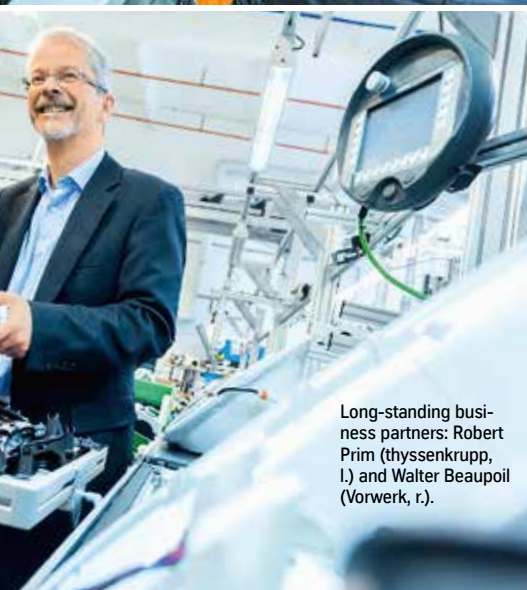
# Electrical helpers in the household

**Vorwerk** is a market leader in domestic appliances. Its success is based among other things **on motors made in Wuppertal** – using electrical steel from thyssenkrupp.

Text Sonja Bördner



Thermomix TM5: The highly versatile 12-in-1 kitchen aid.



Long-standing business partners: Robert Prim (thyssenkrupp, l.) and Walter Beaupoil (Vorwerk, r.).

## Innovative

The Vorwerk group, based in Wuppertal, Germany, has a presence in 75 countries. More than 625,000 people across the world work for Vorwerk, 612,000 of them as freelance sales consultants. The family-owned company insists on producing its own motors for its many different domestic appliances. That's why Vorwerk will be investing in its main production site at Wuppertal in the coming years. A new research & development center is also to be built there.

Space is getting tight at Vorwerk. At the group's biggest production site in Wuppertal, the buildings are nestled closely against the banks of the Wupper river traversing the premises. Behind the site, the narrow valley quickly turns into steep green hills; there isn't much room for expansion. Nevertheless, that's exactly what Vorwerk wants: "We are one of those companies that likes to keep its core competencies right at home," says Walter Beaupoil from the company's strategic purchasing department. "That's why Vorwerk will keep investing into this location for some time yet." There is plenty of evidence for this: A new motor plant and a state-of-the-art R&D facility on the premises are pegged for completion by late 2018. Some of the existing production halls will be demolished to make room for the bigger new buildings.

Technical expertise and a bold take on innovation are in the blood for this family-owned company, which started in the late 1920s with the Vorwerk engineers turning a gramophone motor into a compact and versatile vacuum cleaner. The name given to this, Kobold, soon became synonymous with the company's reputation for specialized sophisticated domestic appliances, all distributed through direct sales. This strategy has proved enormously successful ever since. "Being in close contact with our customers provides important development stimulus and makes it easier for us to identify new trends," says Beaupoil. "This has helped us develop a number of very special products that are right at the forefront of the market today."

The current star of the Wuppertal company's product range is the Thermomix® TM5, which has been causing something of a revolution in kitchens across the world. This Internet-connected kitchen whiz offers a total of 12 functions for chopping, mixing, and cooking. The Thermomix® links up with the Cookidoo recipe portal to access specifically-developed recipes that are shown on the appliance's display; the Guided Cooking function then provides step-by-step instructions for preparing the meal. With such a recipe for success, Vorwerk has made cooking both easier and more versatile than ever.

Even for the well-established appliance manufacturer, the success of the Thermomix® TM5 was a bit of a surprise, and since its launch in 2014 more than

one million units have been produced every year – all for direct sales. "It seems our product has really hit a nerve," says Beaupoil. To him, it's the combination of smart and simple: an intelligent solution paired with intuitive operation and a modern design. Fittingly, the Kobold has also received a facelift, and as a roaming robo-vac it now cleans floors and carpets autonomously – all controlled via a mobile app.

## Motor manufacturing is precision work

No matter if it's a Kobold vacuum cleaner or a Thermomix®, there is one aspect that all of these devices have in common: Their motors are made in Wuppertal, and the motors are built using electrical steel from thyssenkrupp. For more than 30 years, we have been reliably supplying high-quality steel to Vorwerk, more than 3,000 metric tons per year. Currently, this takes the form of narrow strip coils at a width of 53-122 mm, bundled into shipping units weighing 500-1,000 kg.

"Manufacturing motors is a precision job," says Robert Prim, a customer adviser from thyssenkrupp in Bochum. On the Thermomix, the rotor and the stator – the rotating and stationary components of the motor – are each made of 60 stacked laminations of 0.5 mm thick electrical steel. The motor's magnetic field is generated in-between these two components, which are separated by an air gap that should be as small as possible. "Vorwerk has extremely tight stamping tolerances," says Prim. "In order to maintain consistent motor quality, the electrical steel's grain structure and strength need to comply with very stringent quality requirements."

Vorwerk will continue to bank on innovations from its R&D department, aiming to release one new appliance per year. This may be an ambitious goal but it is in keeping with the ever-shortening production cycles of the digital age. For the development of its electric motors, Vorwerk will continue to rely on thyssenkrupp steel. "The technical demands on materials such as this will keep rising," says Beaupoil. "That's why it is crucial for us to be working with a competent, well-established supply partner – one that we can collaborate with in the development and integration of suitable materials."

Contact: Robert Prim, Business Unit Automotive, +49 234 508 51214, robert.prim@thyssenkrupp.com

Domenic Boos, Nina Kolbe, and Christian Heet (left to right) are trialing the system.



# How steel copes with continuous wear

**H**heavy plate equals big plate, eye-catchingly big: Enormous crawler excavators and front-end loaders, mile-long conveyor belts, giant shredders, and scrap compactors. It's the type of machinery that needs to withstand extreme mechanical stresses and aggressive wear.

Heavy plate grades, such as the XAR® product range, are therefore characteristically hard and tough, and highly resistant to wear. Materials researchers understand wear to be the progressive deterioration of a solid body's surface caused by mechanical stress. "To put it simply: Something keeps rubbing or grinding on the material and thus removes particles from the surface," says Dr. Christian Heet, who is in charge of the new wear laboratory at thyssenkrupp Steel in Duisburg. First and foremost, the wear lab investigates the material properties of heavy plate. In addition, Heet and

At the new wear laboratory, **wear-resistant steel grades** are tested for their resilience against abrasion.

his team also examine other types of steel. Their work helps to determine very early on which steels are suitable for which purposes, and how to develop them further to be more resistant to wear. "When we make a recom-



Material fatigue: A steel sample after the abrasion test.

mendation, we can back it up black-on-white – we've got all the evidence," says Dr. Nina Kolbe, a technical customer adviser in the Heavy Plate business unit. "That's beneficial not just to our heavy plate customers."

The laboratory is used right across the different sales areas and for a wide range of industrial sectors. "Our results enable us to provide even better advice to customers with wear applications, and to help them select the best possible materials," says Dr. Franz Domenic Boos from Product Management. In the future, testing will also be adapted to match specific real-world customer requirements, enabling thyssenkrupp Steel to provide fully individual advice to its customers.

The system is already being practised with Global Wear Parts Management at sister company Industrial Solutions. "Our colleagues there test rock abrasivity, while we investigate the wear

resistance of the metals used to work the rock," says Heet. "It's a nice synergy effect."

How does it work? Essentially, there are two methods. Firstly, the amount of wear depends on the amount of force being exerted on the material. That's why Heet's team subjects its test samples to different levels of pressure. Testing with an abrasion vessel makes it possible to vary this pressure by altering the amount of abrasive material, which is usually quartz sand or gravel. The hardness of the sand and the speed at which it traverses the steel sample also affect the result. With an abrasion vessel, the real-world conditions that the material will be subjected to can be simulated very accurately.

Secondly, a so-called rubbing wheel is used to test a material's more general wear characteristics. With this method, a lever arm pushes the test sample against a rubber-coated wheel rotating at a set speed. At the same time, sand trickles down from above and gets caught between the wheel and the sample, thus causing wear. Both of these testing methods work with dry as well as wet types of sand. "The rubbing wheel test takes between 30 seconds and 30 minutes," says Heet. "A test using the abrasion vessel, on the other hand, usually takes three days." –jb

Contact: Dr. Christian Heet, Special Testing, +49 203 5243667, christian.heet@thyssenkrupp.com

Photo: thyssenkrupp Steel Europe Fotografie (2), Gettyimages



# Opening up new possibilities

The recently developed **Solidflex** material grade will make tin cans lighter, sturdier, and easier to open.

**W**ho actually uses a can opener these days? Many food cans now feature a ring that can be pulled up, saving consumers a great deal of trouble. Gone are the days when the ring would break off or your finger would swell up while pulling with all your strength in an attempt to remove the lid.

Cans are now easy and convenient to open, thanks to the improved quality of steel. But it is still possible to produce new innovations even in the most established packaging materials such as those used in making food cans. This is something the Packaging Steel business unit in Andernach proves time and again. Its new material, rasselstein® Solidflex, makes it possible to use thinner materials that are just as sturdy as the old ones. The material is also perfectly suitable for the small rivets that connect the tear-off ring to the lid.

The rivet needs to be hard and solid to ensure that the connection to the lid does not give way. But the rivet also needs to be soft and flexible so that it can be easily pulled up off the lid. In short, it needs to be both solid and flexible, hence Solidflex. Anyone who opens a can made of the new tin plate will immediately notice the difference. The greater hardness of the material also changes the way the lid opens, meaning even less force is required. "rasselstein® Solidflex is the

latest product that demonstrates our continuous efforts to deliver real benefits to our customers," says Dr. Peter Biele, CEO of the Packaging Steel business unit. "More efficient use of materials helps reduce costs and improve the customer's competitiveness."

The reduced thickness allows the customer to save money in many different ways. The customer uses less tin plate to make the same number of lids, which in turn reduces the carbon footprint of each package. On a similar note, the reduced weight makes it possible to transport a larger number of units at a time.

## Endless possibilities

rasselstein® Solidflex will be used not only as a packaging material for food for humans as well as their pets. It will also be used to make the bottoms and domes of aerosol cans. The tin plate will soon be available for new product applications. Manufacturers who were previously using thicker materials could then opt for Solidflex, thanks to the remarkable properties it offers. A number of departments at thyssenkrupp Steel teamed up to develop the new material grade.

The hot-rolled steel that is used to produce the tin plate in Andernach is sourced from Duisburg. This is where the steel is manufactured to precisely defined specifications. "In collaborating on a technical front with the thyssenkrupp

## Did you know that ...

... over five million people in Germany consumed canned vegetables several times a week last year?

... the production value of beverage cans made of iron/steel in Germany in 2015 was almost €238 million?

steel production team, we are able to draw on a wealth of collective experience," says Dr. Helmut Oberhoffer, Head of Research at Packaging Steel. "This ensures that the starting materials have a very high degree of purity." This is what makes it possible to develop such a thin and sturdy material in the first place. Such synergies allow us to develop new products time and again. rasselstein® Solidflex may well be the next generation of tin plate, but it certainly won't be the last. –ms

Contact: Christian Pürschel, Packaging Steel BU, Tel.: +49 2632 3097 2294, e-mail: christian.puerschel@thyssenkrupp.com



2017

September



**COILTECH**

27–28 September, Pordenone/Italy

Coiltech is a trade show for coils, electric motors, and transformers that covers many different types of materials and machines, as well as the production technologies associated with these. thyssenkrupp's Steel segment will be represented at Coiltech by its Automotive and Electrical Steel business units, who will exhibit information about our grain-oriented and non-oriented products for the energy production sector.



**BLECHEXPO**

07.-10.11., Stuttgart

Das praxisnahe Messe-Duo Blechexpo und Schweisstec findet im zweijährigen Rhythmus und im Wechsel mit der Euroblech in Hannover statt. Sie befasst sich als weltweit einzige Veranstaltung mit den komplementären Technologien Blechbearbeitung und Fügetechnik. Der Stahlbereich von thyssenkrupp informiert gemeinsam mit thyssenkrupp Materials Services über innovative Lösungen für diverse Stahlanwendungen.

**IAA 2017**

14–24 September, Frankfurt/Germany



thyssenkrupp is back at IAA! For the first time in ten years, the Group is exhibiting its technologies at the Frankfurt trade show again. There are four main exhibition themes: Autonomous Driving, E-Mobility, Intelligent Chassis Systems, and the Future Automotive Factory.

thyssenkrupp's Steel segment will present innovative material concepts for lightweight vehicles as well as for powerful electric drives and hybrid designs. The team from Components Technology will present autonomously-controlled steering systems, electrically-adjusted shock absorbers that can be controlled at the press of a button from inside the cabin, as well as other innovations. thyssenkrupp Systems Engineering will demonstrate the construction of digitized assembly lines for vehicle, battery, and powertrain production, as well as presenting a virtual plant planning system. Overall, the company will present itself as an innovative and reliable go-to provider right across the process chain, enabling customers to access the future of mobility here and now.

November

**ALIHANKINTA**

26–28 September, Tampere/Finland

This trade show for the subcontracting industry will be held for the 29th time this year. thyssenkrupp's Steel segment will again be presenting its heavy plate products featuring high-strength and wear-resistant steel grades. The Heavy Plate business unit from Hüttenheim will be exhibiting at the same booth as its long-standing trade partner Finkenberg.



Marcus van Marwick, Head of Brand & Customer Communications, is responsible for all publications and events geared towards customers and business partners.  
+49 203 524 1005, marcus.vanmarwick@thyssenkrupp.com

**CREDITS**

**Published by:**  
thyssenkrupp Steel Europe AG  
Kaiser-Wilhelm-Strasse 100  
47166 Duisburg, Germany  
—  
Tel.: +49 203 520  
Fax: +49 203 522 5102

**Editorial staff:**  
Kilian Rötzer (legally responsible)  
Communications  
—  
Christiane Hoch-Baumann  
(Editor in Chief)  
Brand & Customer Communications  
Tel.: +49 203 522 4515  
E-mail: christiane.hoch-baumann@thyssenkrupp.com

**Photographic department, layout, and production:**  
C3 – Creative Code and Content GmbH  
Heiligegeistkirchplatz 1  
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Please contact us to share your comments and suggestions:  
compact.tkse@thyssenkrupp.com

**compact<sup>steel</sup> was there**

The thyssenkrupp blue.cruiser cleared its final hurdle by being licensed for use on public roads by DEKRA. This so happens to be one of the key criteria for taking part in the World Solar Challenge in Australia. That's reason to celebrate for every employee and anyone who helped out in the project. It's also great news for Antonia Bauer (Communications, Solar Car Team) and Christiane Hoch-Baumann (Communications, thyssenkrupp Steel).



Photo: PR (4), thyssenkrupp (2), Jungblut/iaf

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