

engineering.

tomorrow.

together.



thysssenkrupp

engineering.  
tomorrow.  
together.

Three words to describe who we are,  
what we do, and how we do it.

... is part of our identity. It describes how we think. In the factory, in the office, in every location worldwide. It means developing solutions for our clients – both big and small. Today and tomorrow. As a diversified industrial group we deliver reliable, premium products, services, and solutions – on time and at affordable prices. We know our clients and their markets. We invest in important technological innovations and in this way help make the world a little better. We are a reliable partner – that is our promise.

A blue sports car is positioned in an anechoic chamber, surrounded by white acoustic foam. Two men are standing next to the car, looking at a tablet. The man on the left is wearing a black shirt and pants, and the man on the right is wearing a black shirt and blue jeans. The chamber is lit with several small lights hanging from the ceiling.

# engineering.



# tomorrow.

For over 200 years we have been shaping industrial history. From this history comes our strength and our knowledge. But a prestigious past is not enough to take on the challenges of the future. Which is why we are thinking today about what we want to accomplish tomorrow. We know now what the future world and our clients need. We are developing sustainable solutions to meet future demands, improving what already works and revolutionizing industries to make lives better and to give our customers a competitive advantage.



# together.

We share our knowledge, combining and leveraging it to create innovations – beyond the borders of individual companies, industries, and nations. Our enterprises profit from cooperation and collaboration across different divisions and departments. “together” is a promise to our clients, our partners, and each other. We trust and are trustworthy, working as a team, learning from one another and developing collectively. Because the greatest goals can only be achieved together.

## #urbanspaces

We live in the century of megacities. In just a few years two-thirds of the global population is expected to live in cities. The need for efficient, intelligent, and sustainable transportation solutions is constantly growing. This is a tremendous challenge for society but also a great opportunity that we are already taking advantage of.

- Page 14: MULTI
- Page 18: ACCEL
- Page 34: Cement production facilities
- Page 38: MAX

## #smartenergy

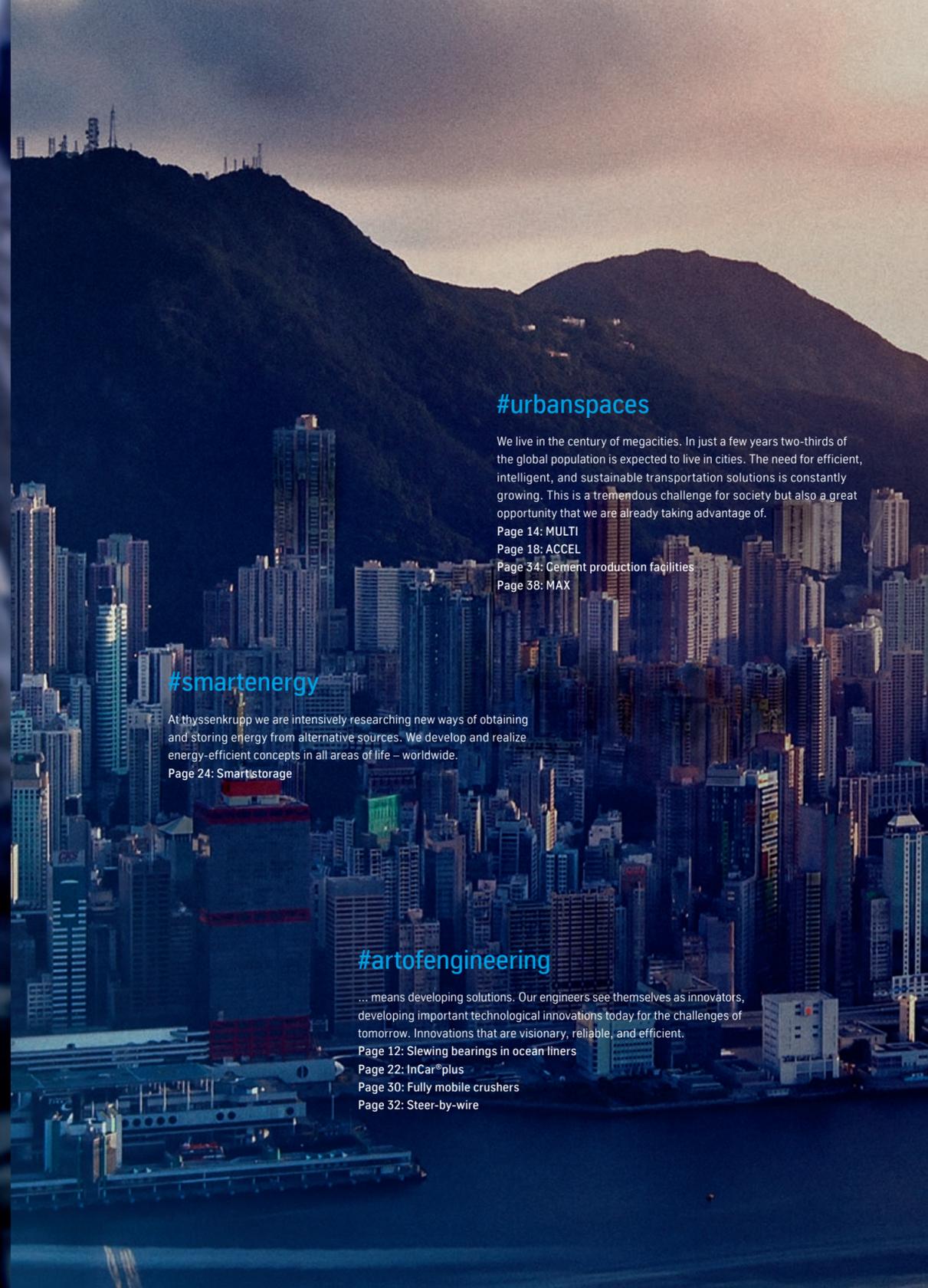
At thyssenkrupp we are intensively researching new ways of obtaining and storing energy from alternative sources. We develop and realize energy-efficient concepts in all areas of life – worldwide.

- Page 24: Smartstorage

## #artofengineering

... means developing solutions. Our engineers see themselves as innovators, developing important technological innovations today for the challenges of tomorrow. Innovations that are visionary, reliable, and efficient.

- Page 12: Slewing bearings in ocean liners
- Page 22: InCar<sup>®</sup>plus
- Page 30: Fully mobile crushers
- Page 32: Steer-by-wire





Intelligent, efficient, and fast: thyssenkrupp's elevators travel at a speed of up to 10 meters per second and can reach the 100th floor in less than a minute. Their regenerative engines win back brake energy while traveling downwards and feed this energy into the building's electrical system.

TetraFlex, our new construction concept for wind turbines, makes it possible to build 200-meter-high towers that produce twice as much energy per year as standard turbines.

To ensure that enough food is delivered to the megacities of the future we are constructing high-performance, energy-efficient facilities for our clients in the fertilizer industry.

One of 1800 different types of steel delivered by thyssenkrupp was used to build this roof.

At thyssenkrupp we are developing battery technologies that can store up to 200 megawatt hours. This allows large amounts of regenerative energy to be stored – something that was once impossible.

Our engineers are capable of accurately simulating crash tests on computers – down to the micrometer. thyssenkrupp provides the automobile industry with important expert knowledge.

thyssenkrupp develops major mass-transportation projects, for example equipping an entire new subway line with escalators, moving walkways, and elevators.

Made of two aluminum layers and a polymer core, our ALUCOBOND® panels are light, stable, weatherproof, and resistant to impact and fracture. Ideal for facades, balconies, roofs, etc.

8000 energy-efficient LED modules from thyssenkrupp use just 1500 watts – a fraction of what standard illuminated signs consume.

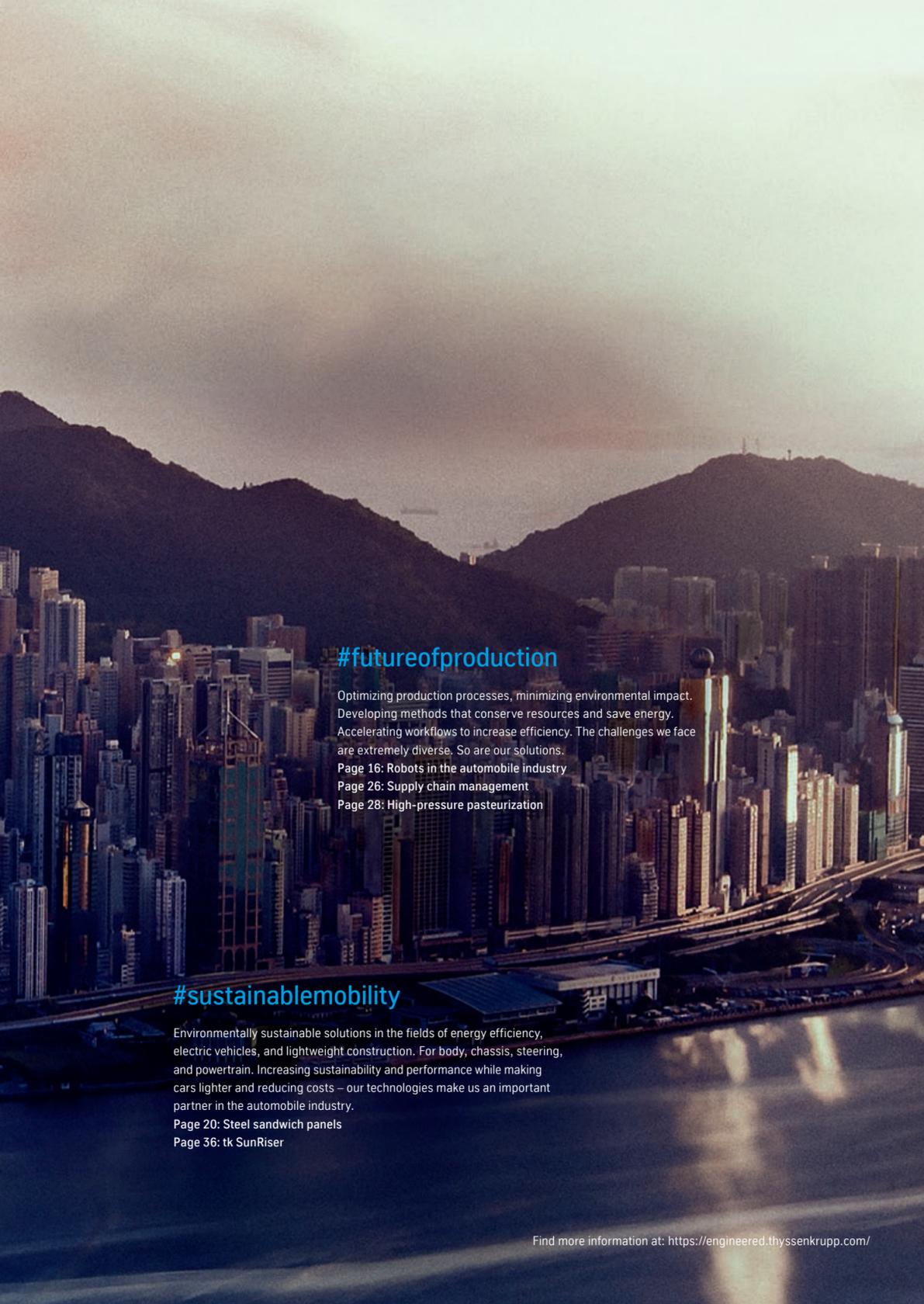
High-manganese steel from thyssenkrupp makes automobiles up to 30% lighter, which means that cars use less fuel and produce less CO<sub>2</sub>.

One-third of all trucks are equipped with forged crankshafts produced by thyssenkrupp. In contrast to standard cast crankshafts, forged crankshafts are far more durable and lighter.

Over 500 robots assemble the body of the smart fortwo. The production system was planned, assembled, set up, and brought online by thyssenkrupp – and we also programmed the robots.

Our high-pressure pasteurizing technology keeps food fresh much longer while maintaining its nutritional value.

Lower weight, less fuel consumption, reduced CO<sub>2</sub> emissions. Assembled camshafts are up to 40% lighter. Over 100 million cars worldwide are equipped with these engine components from thyssenkrupp. This makes us the global leader in assembled camshafts.



### #futureofproduction

Optimizing production processes, minimizing environmental impact. Developing methods that conserve resources and save energy. Accelerating workflows to increase efficiency. The challenges we face are extremely diverse. So are our solutions.

Page 16: Robots in the automobile industry

Page 26: Supply chain management

Page 28: High-pressure pasteurization

### #sustainablemobility

Environmentally sustainable solutions in the fields of energy efficiency, electric vehicles, and lightweight construction. For body, chassis, steering, and powertrain. Increasing sustainability and performance while making cars lighter and reducing costs – our technologies make us an important partner in the automobile industry.

Page 20: Steel sandwich panels

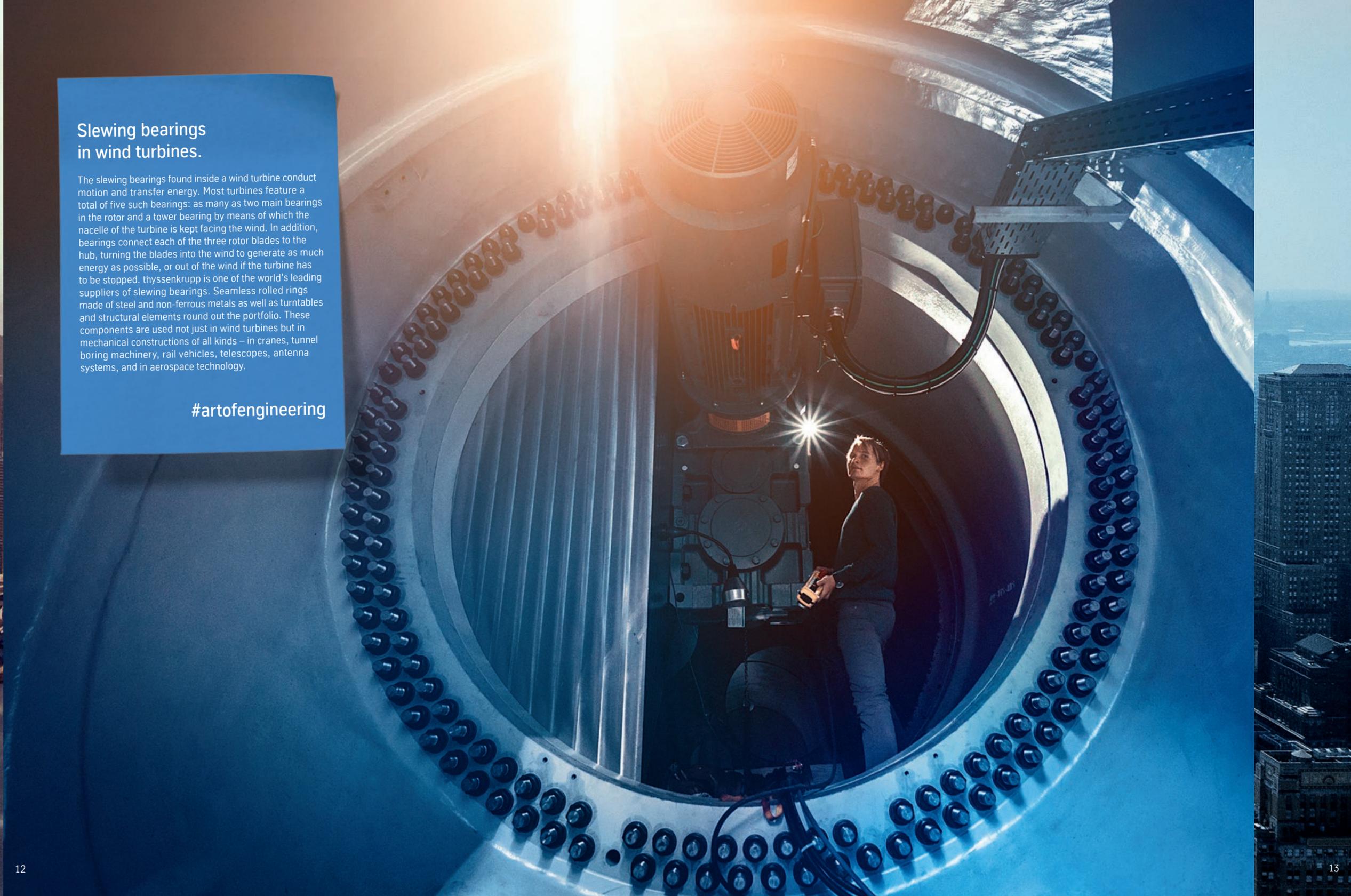
Page 36: tk SunRiser

Find more information at: <https://engineered.thyssenkrupp.com/>

### Slewing bearings in wind turbines.

The slewing bearings found inside a wind turbine conduct motion and transfer energy. Most turbines feature a total of five such bearings: as many as two main bearings in the rotor and a tower bearing by means of which the nacelle of the turbine is kept facing the wind. In addition, bearings connect each of the three rotor blades to the hub, turning the blades into the wind to generate as much energy as possible, or out of the wind if the turbine has to be stopped. thyssenkrupp is one of the world's leading suppliers of slewing bearings. Seamless rolled rings made of steel and non-ferrous metals as well as turntables and structural elements round out the portfolio. These components are used not just in wind turbines but in mechanical constructions of all kinds – in cranes, tunnel boring machinery, rail vehicles, telescopes, antenna systems, and in aerospace technology.

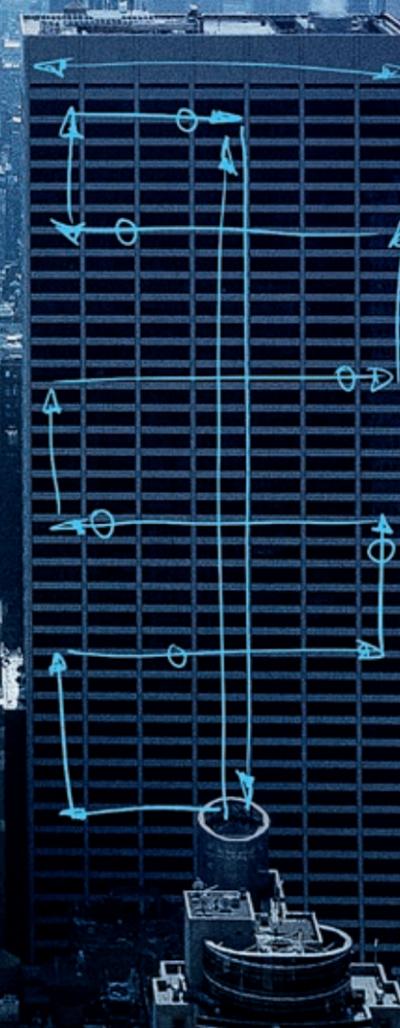
#artofengineering

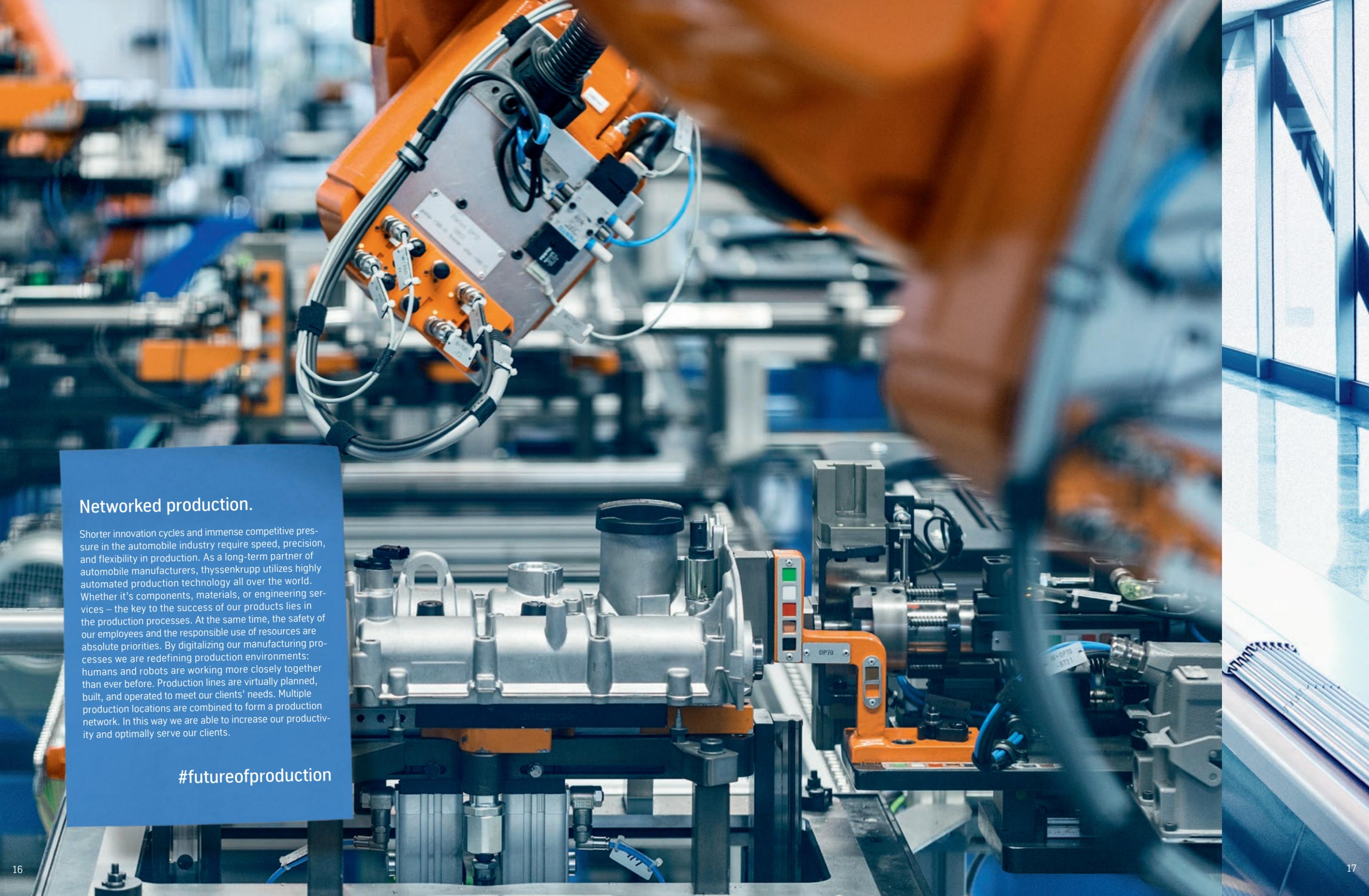


## MULTI.

MULTI is revolutionizing the elevator industry. Based on Transrapid technology, thyssenkrupp is developing a rope-free elevator system in which the cabins move both vertically and horizontally. In a single shaft multiple cabins can be operated independent of one another, thus increasing the overall transport capacity of a shaft by up to 50%. The space that the elevator occupies in a building can be reduced by a similar amount. MULTI provides architects with completely new possibilities in the planning and design of buildings, allowing for higher structures and entirely new forms and uses. In addition, MULTI requires smaller shafts than standard elevators, which can increase the usable floor and living space of a building by up to 25%. A further advantage is that MULTI cabins travel through the system at speeds of up to 5 meters per second. This means that passengers have to wait no longer than 15 or 30 seconds for the next available cabin.

#urbanspaces





## Networked production.

Shorter innovation cycles and immense competitive pressure in the automobile industry require speed, precision, and flexibility in production. As a long-term partner of automobile manufacturers, thyssenkrupp utilizes highly automated production technology all over the world. Whether it's components, materials, or engineering services – the key to the success of our products lies in the production processes. At the same time, the safety of our employees and the responsible use of resources are absolute priorities. By digitalizing our manufacturing processes we are redefining production environments: humans and robots are working more closely together than ever before. Production lines are virtually planned, built, and operated to meet our clients' needs. Multiple production locations are combined to form a production network. In this way we are able to increase our productivity and optimally serve our clients.

#futureofproduction

## ACCEL.

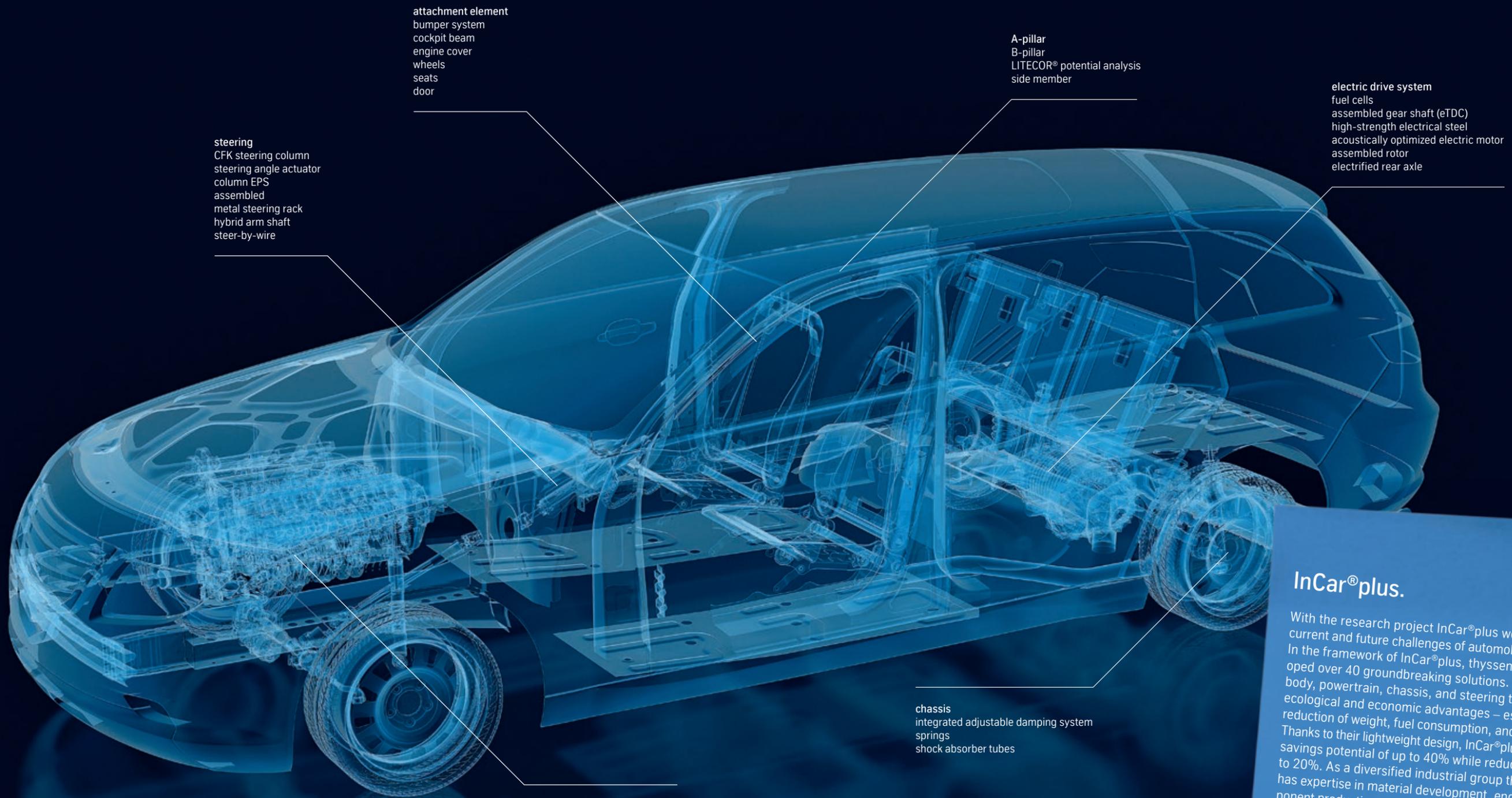
ACCEL is thyssenkrupp's groundbreaking passenger transport system that makes public transportation more attractive. The transport system is based on Transrapid linear motor technology and impresses users with its high capacity and speed – even for short routes and without waiting. ACCEL transports up to 30% more passengers than conventional moving walkways and can reduce transfer times – for example in airports – by up to two-thirds. The walkway accelerates from an initial 2.5 kilometers per hour (1.5 mph) to a maximum velocity of 7.2 kmh (4.2 mph). This is made possible by a new kind of pallet band. In the entry area the aluminum pallets are positioned close together. As the speed increases they separate, before shifting together again towards the end of the walkway. Ideal for passenger transport in cities, airports and for distances of up to 1.5 kilometers (just under one mile).

#urbanspaces

## Steel sandwich panels.

Which materials will shape the future? How will the next generation of cars be manufactured? How can we conserve limited resources? Our state-of-the-art engineering is providing the answers to these questions. In developing materials we utilize the most innovative approaches and are pioneers in the use of hybrid materials. For example Litecor® – a polymer core encased in two thin steel plates. This new material has the positive attributes of steel but weighs far less, thus making cars significantly lighter, which in turn reduces CO<sub>2</sub> emissions. Or Tribond, a three-layer steel composite material with entirely new properties. It makes it possible to reduce the weight of cars while maintaining the same level of safety. And to ensure that our innovations perform in the production lines of the automobile industry as precisely as we have calculated, our development engineers carry out complex test simulations.

#sustainablemobility



**steering**  
CFK steering column  
steering angle actuator  
column EPS  
assembled  
metal steering rack  
hybrid arm shaft  
steer-by-wire

**attachment element**  
bumper system  
cockpit beam  
engine cover  
wheels  
seats  
door

**A-pillar**  
B-pillar  
LITECOR® potential analysis  
side member

**electric drive system**  
fuel cells  
assembled gear shaft (eTDC)  
high-strength electrical steel  
acoustically optimized electric motor  
assembled rotor  
electrified rear axle

**chassis**  
integrated adjustable damping system  
springs  
shock absorber tubes

**conventional drive system**  
exhaust system  
hybrid sliding cam element  
low-friction camshaft  
hybrid cylinder head cover  
oil separation system (POSS®)

## InCar®plus.

With the research project InCar®plus we are solving the current and future challenges of automobile production. In the framework of InCar®plus, thyssenkrupp has developed over 40 groundbreaking solutions. Innovations for body, powertrain, chassis, and steering that offer greater ecological and economic advantages – especially in the reduction of weight, fuel consumption, and CO<sub>2</sub> emissions. Thanks to their lightweight design, InCar®plus solutions offer savings potential of up to 40% while reducing costs by up to 20%. As a diversified industrial group thyssenkrupp has expertise in material development, engineering, component production, and the construction of facilities, tools, and prototypes. Integrating these disciplines together yields unique synergies and reliable and economical production solutions that quickly establish themselves in the market.

#artofengineering



## Smart storage.

How can regenerative energy be stored efficiently and sustainably? This is now a crucial question, as the storage capacity currently available worldwide will soon only cover a fraction of global demand. For this reason at thyssenkrupp we are working to optimize redox flow storage technology. As a result it is now possible to extract up to 80% of the electricity fed into this type of battery, which is a remarkable rate of efficiency. At the same time we are continuing our research into an electrolysis process that can generate energy from hydrogen and thus serve as a basis for power-to-gas technology. Here too we have experienced great success. Surplus electricity from renewable energy sources can be converted into synthetic natural gas, which can then be fed into the natural gas network.

#smartenergy

## Supply chain management.

Like a giant puzzle, a Boeing 747 is constructed of millions of individual parts. Each stage of the production process flows into the next. Since 1998 thyssenkrupp has exclusively organized the entire supply chain for the materials aluminum and titanium. In the field of aircraft construction the contract with Boeing is one of the most comprehensive of its kind worldwide. As a multinational system integrator we are responsible for the entire supply chain, reducing complexity and centrally coordinating material deliveries. Component suppliers to Boeing from all over the world – altogether over 500 companies – contact thyssenkrupp directly when they need metals. The material is then cut, packaged, and shipped to precisely meet each supplier's needs. Here thyssenkrupp follows the motto "cut to size, just in time." With over 40 service centers in 19 countries, thyssenkrupp's aerospace division is present on five different continents.

#futureofproduction

## High-pressure pasteurization.

thyssenkrupp has made it possible to keep fruit, vegetables, and meat fresh for much longer without the use of preservatives. Smoothies, for example, stay fresh six times as long. To achieve this food products are subjected to water pressure of up to 6000 bar. This corresponds to the energy of a water column shooting 60 kilometers (more than 37 miles) into the air. In this way the bacteria, fungi, and germs that cause food to decay are denatured. The pressure is evenly applied from all directions, thus allowing the products to maintain their texture and flavor. This so-called HPP principle ("high-pressure pasteurization") has been known for some time. What's new is the technology developed by thyssenkrupp that renders the method flexible and industrially viable on a large scale. Food producers can thus expand their delivery range and enter new markets.

#futureofproduction





## Fully mobile crushers.

In large open-pit mines hundreds of dump trucks are used to move up to 400 tons of material daily. These trucks often transport high-quality raw materials and waste over great distances to unloading stations, where the material is made smaller or collected in piles. To make this process more economical and ecological, thyssenkrupp has now brought the crushers directly to the open mines: fully mobile crushers with fixed caterpillar tracks are filled with large blocks of material. Such a machine can crush up to 14,000 tons of material in just one hour. The crushed raw material is then transported onwards by shiftable conveyor belts. Three to four specialists operate the electrically powered crusher-belt systems, thus replacing hundreds of trucks. The effects are dramatic: a reduction of up to 350,000 tons in CO<sub>2</sub> emissions annually and far lower operating costs.

#artofengineering



## Steer-by-wire.

thyssenkrupp is researching new steering technologies, including steer-by-wire – a system in which there is no continual mechanical connection between the steering wheel and the wheels themselves. In the future steer-by-wire will allow for completely new steering and assistance functions in vehicles, making driving safer and more comfortable. The system can be integrated more flexibly than previous technologies into a vehicle's architecture and allows for entirely new space usage. What's more, steer-by-wire offers a single solution to replace the great number of different steering systems currently available. The new technology is an important step toward autonomous driving – thyssenkrupp has already equipped a test vehicle with the system.

#artofengineering



**Cement production facilities.**

Every year over four billion tons of cement are produced worldwide – an extremely energy-intensive process that usually involves the burning of such fossil fuels as coal, gas, and oil. As a result the CO<sub>2</sub> emissions of cement factories are extremely high. To reduce these emissions thyssenkrupp offers technologies and facilities for the use of alternative fuels. Biomass, paper or wood, unneeded raw materials, household and commercial waste – these “alternative fuels and raw materials” can be used to replace large amounts of fossil fuels. The use of alternative fuels increases the sustainability of new facilities, preserves increasingly scarce fuel resources, and can ideally lead to a 40% reduction in direct CO<sub>2</sub> emissions in the production of cement.

#urbanspaces

## tk SunRiser.

A performance test in the wind tunnel is a must for every new vehicle, including the thyssenkrupp SunRiser. The solar car that was created as part of a collaborative research project with the Bochum University of Applied Sciences features impressive aerodynamics, thus minimizing wind resistance and saving energy. The focus of the project was the sensible use of energy, the conservation of resources, and visions for sustainable transportation. In these areas electric vehicles will play a central role and thyssenkrupp is researching many aspects of this. One example is our long-standing support of the Bochum University of Applied Sciences in the construction of solar vehicles. Integrated into the SunRiser sport sedan are innovative technologies from different company divisions, including shock absorbers, a lightweight steel rollover bar, and electrical strips for the powertrain. With these innovations we're helping bring sustainability to the streets.

#sustainablemobility





## MAX.

MAX is a groundbreaking innovation that enables pre-emptive service for elevators, cutting downtime in half. Based on Microsoft Azure IoT (internet of things) technology, elevators are able to “communicate” with service technicians. The system automatically indicates when repairs or maintenance are needed. Service staff is informed of any necessary replacement parts or repairs and of approaching scheduled maintenance. The MAX system could make life easier for a billion elevator passengers worldwide, increasing both safety and availability. The time saved from improved elevator availability could amount to as many as 95 million hours each year.

#urbanspaces

# 13 kilometers

For the over 13-kilometer (8-mile)-long rail tunnel under the Bosphorus that will connect Europe with Asia, thyssenkrupp has supplied 198 elevators and 165 escalators – for 1.5 million passengers daily.

# 1.5 million passengers

# 73 elevators 12 moving staircases

For the new One World Trade Center in New York thyssenkrupp developed 73 elevators and 12 moving staircases. A collective project by engineers from Brazil, Germany, the U.S. and Korea.

# 34 percent

The A-pillar developed by thyssenkrupp allows for a 34 percent reduction in angle of visual obstruction. It is narrower, 10 percent lighter, and as stable as conventional models.

# 40 pioneering innovations

Our research project InCar®plus has yielded over 40 pioneering innovations in powertrain, chassis and steering, and body for the automobile industry.

# 232 meter

The thyssenkrupp elevator test tower in Rottweil, Germany has a 232-meter (761 foot)-high public observation platform – the tallest in the country.

Helmut Jahn, the architect of our elevator test tower in Rottweil, knows a thing or two about tall buildings: he has built, among other soaring structures, the Sony Center in Berlin with its Bahn-tower and the Trade Fair Tower in Frankfurt.

# five times as large as the country of Monaco

Our steel plant in Duisburg is almost five times as large as the country of Monaco. Every day four blast furnaces produce over 30,000 tons of raw iron. Annually some 12 million tons of steel are produced here.

# 2,200 axles every 45 seconds

In Puebla, Mexico thyssenkrupp manufactures 2,200 axles every day for the automobile industry – every 45 seconds a new axle is completed.

# 3,200 young people

Over 3,200 young people are currently completing professional training programs at thyssenkrupp. Over 100 instructors work with the students in 30 workshop training facilities and 54 training centers.

# 20 million tons CO<sub>2</sub>

When used comprehensively, the so-called oxygen-depolarized cathode technology that thyssenkrupp has helped develop can potentially reduce annual CO<sub>2</sub> emissions in industrial chlorine production by up to 20 million tons.

# 3,710

thyssenkrupp's highest regional office is located in Oruro, Bolivia. Here our colleagues work over 3,710 meters (12,000 feet) above sea level.

# 190 tons

The largest slewing bearing made by thyssenkrupp for rotating oil platforms weighs 190 tons – as much as a blue whale.

# 11,000 tons of iron ore daily

thyssenkrupp's ship loading system in the Port of Narvik is one of the largest and most advanced in the world. It can load up to 11,000 tons of iron ore daily.



