

# ontrack

by Voith Turbo — N° 05



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**Filling up Instead of Charging**  
 Fuel cells offer clear advantages over battery-electric concepts in many commercial vehicle applications – not only technologically, but also when it comes to operating costs.

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**The Race to E-Mobility**  
 The transformation of transportation is underway. With its innovative technologies, Voith is helping ensure that the transition succeeds on the road, on the rails, and in maritime applications.

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**To the NXT Level**  
 With its innovative recuperation unit, DIWA NXT makes it easier for bus manufacturers to convert their vehicle fleets to hybrid drive systems.

VOITH

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## The Changing Face of Mobility

How innovation, flexibility, digitalization,  
and new services are creating  
sustainable transportation concepts.

# Editorial ontrack N° 05



**Digitalization is a key component of mobility. It brings efficiency, sustainability, and reliability together.**

Nothing is as constant as change. And yet we all sense that the “mobility revolution” harbors something fundamentally new. Over the medium term, electric drive concepts will relegate the internal combustion engine, which has dominated the market for more than 100 years, to the status of a niche product. The energy that China, the United States – in other words, the world’s two largest economic powers – and now the EU are devoting to the expansion of e-mobility leaves absolutely no doubt that this is the case.

This means that in many sectors of infrastructure, this transformation will require us to fundamentally reimagine existing structures. When it comes to this mindset shift, Voith Turbo is living up to its role as a technology leader – we are already offering manufacturers, suppliers, and infrastructure operators solutions for tomorrow’s requirements today with a wide range of new technologies. And these requirements boil down to creating and maintaining a mobility system that is both efficient and sustainable. That’s why in this issue of ontrack, we’re highlighting precisely these new technologies. In this context, we don’t only have battery-electric concepts in mind. To us, the mobility revolution also means developing solutions for fuel cell drive systems. Or systematically advancing successful concepts like the DIWA NXT, which as a mild hybrid delivers significant fuel savings and therefore dramatically reduces carbon emissions.

Overlapping and complementing the mobility revolution is a second megatrend: digitalization. Used intelligently, it is also a key component of a mobility system that successfully brings efficiency, sustainability, and reliability together. In this case as well, the innovations presented in this issue of ontrack have already proven their practical value in the service of our customers.

I hope that reading this issue is not only enjoyable, but thought-provoking and inspiring.

**Martin Wawra**  
Executive Vice President & CEO of Voith Turbo Mobility

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ontrack@voith.com

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# The Global Mobility Green Deal

**COVID-19 has changed the world and even brought the transportation sector to a grinding halt in many areas. Planes were grounded, trains and ships stopped running. But markets are recovering, and around the world, policymakers are adapting to a mobility revolution driven by climate change. For players in the mobility industry, this means increased innovation, flexibility, digitalization, and new services. Voith has accepted these challenges.**

The world stood still as the COVID-19 pandemic dominated public life on every continent. Thanks to sophisticated hygiene guidelines and an increasingly global vaccination campaign, things are now returning to normal in almost every country around the globe. People are traveling again; working from home has proven its worth, but commuters are once again taking public transportation to get to their offices and workplaces. This is due to the fact that the pandemic has also shown us that direct human contact is truly essential in certain work and life situations.

COVID-19 won’t completely disappear from the agenda, but it is systematically losing its spot at the top. Replacing it is another issue that has been on everyone’s lips since the international conference of the same name that was held in Paris in 2015 – the climate, or more precisely, reducing global warming to well below two degrees Celsius and the massive reductions in carbon emissions that are needed as a result. Which brings us back to mobility, because globally, the traffic and transportation sector is responsible for 25 percent of all carbon emissions. ———>

### China Aims to Be Carbon Neutral by 2060

And so it isn't surprising that China, Europe, and the newly elected Biden administration in the United States are now tackling this issue with verve. China, already the global champion when it comes to e-mobility, size of the installed charging infrastructure, and the length of the high-speed rail network, isn't letting up in the face of climate change – the People's Republic's 14th Five-Year Plan clearly describes its four core goals for the coming years up to 2025: enhancing its infrastructure, raising the level of innovation, increasing competitiveness in various areas, and improving environmental protection. State and party leader Xi Jinping announced to the United Nations in September 2020, in a rather surprising move, that the country wanted to become carbon neutral "before 2060." In addition, he added that China aims for its carbon emissions to hit their peak "before 2030."

These are certainly ambitious goals for the Middle Kingdom. According to surveys conducted by the German Energy Agency (dena), these objectives seem achievable. Indeed, in the period between 2014 and 2018 alone, passenger numbers tripled to more than two billion people that travel on China's express trains. The Chinese central government is currently investing a further 101 billion euros in the expansion and modernization of the high-speed rail network, which covers more than 30,000 kilometers in total, in order to increase the average speed of the trains from 350 km/h to 400 km/h and to connect 80 percent of the country's cities with each other. As a result, in the future it would be possible to cover the 1,300 km between Shanghai and Beijing in 4½ hours. To put this into perspective, this corresponds to the distance from Berlin to Munich and back.

The coronavirus pandemic also caused rail freight traffic figures to explode, with 12,400 trains transporting goods worth around 50 billion dollars from China to Germany via Kazakhstan, Russia, Ukraine, Poland, and Slovakia in 2020 on what has been termed the "New Silk Road." This represents a 50 percent increase over the previous year, according to official figures from Chinese authorities. The 11,000-kilometer rail project, officially designated the "Belt and Road Initiative," is an infrastructure project of massive proportions. The government in Beijing has already invested over 700 billion dollars in the construction of railroads, roads, airports, and ports. This is because the New Silk Road also includes maritime shipping routes. One of these leads from China to Greece and on to Italy, France, and Spain. All in all, China plans to invest one trillion dollars in the development of all these transport routes by 2025.

### Leading the Way in E-Mobility

Made in China 2025 is the name of the strategy that aims to accelerate the country's industrial development of electric cars and batteries – with increasing success. Not only is China the global leader with around five million EVs on the road, followed by the United States with 1.77 million vehicles. No other country has as many charging points, either (1.2 million). European and US vehicle manufacturers also still frequently rely on Chinese suppliers for battery expertise. Moreover, the lead that China has gained in this market means that other countries will not be able to catch up any time soon. In the metropolis of Shenzhen, for example, the first pilot zone for electric-powered buses and taxis was already launched back in 2008. Today, more than 16,000 buses and taxis there run on electric power.

This is what it will take for the 14th Five-Year Plan to work. One of the plan's stated goals is to increase the urbanization rate to 65 percent by the year 2025. This means that by 2025, around 70 million people in China will become new city residents. Instead of being subjected to heavy smog, the goal is for them to increasingly draw their energy from solar and wind power, to be connected to a 5G cellular network, and to use environmentally friendly and emission-free public transportation. And if they are considering buying their own car, many Chinese today already prefer the heavily subsidized purchase and the accelerated registration of an electric vehicle. This is also one reason why, at seven tons of carbon emissions per capita, the Asian nation with a population of 1.3 billion still stands slightly below Germany at eight tons and is far better than the United States at 16 tons (based on 2019 figures).



**CN**  
Between 2014  
and 2018,  
the number of  
passengers  
on high-speed trains  
in China  
tripled to more than  
**two  
billion.**

## The United States Gives Climate Diplomacy a Boost

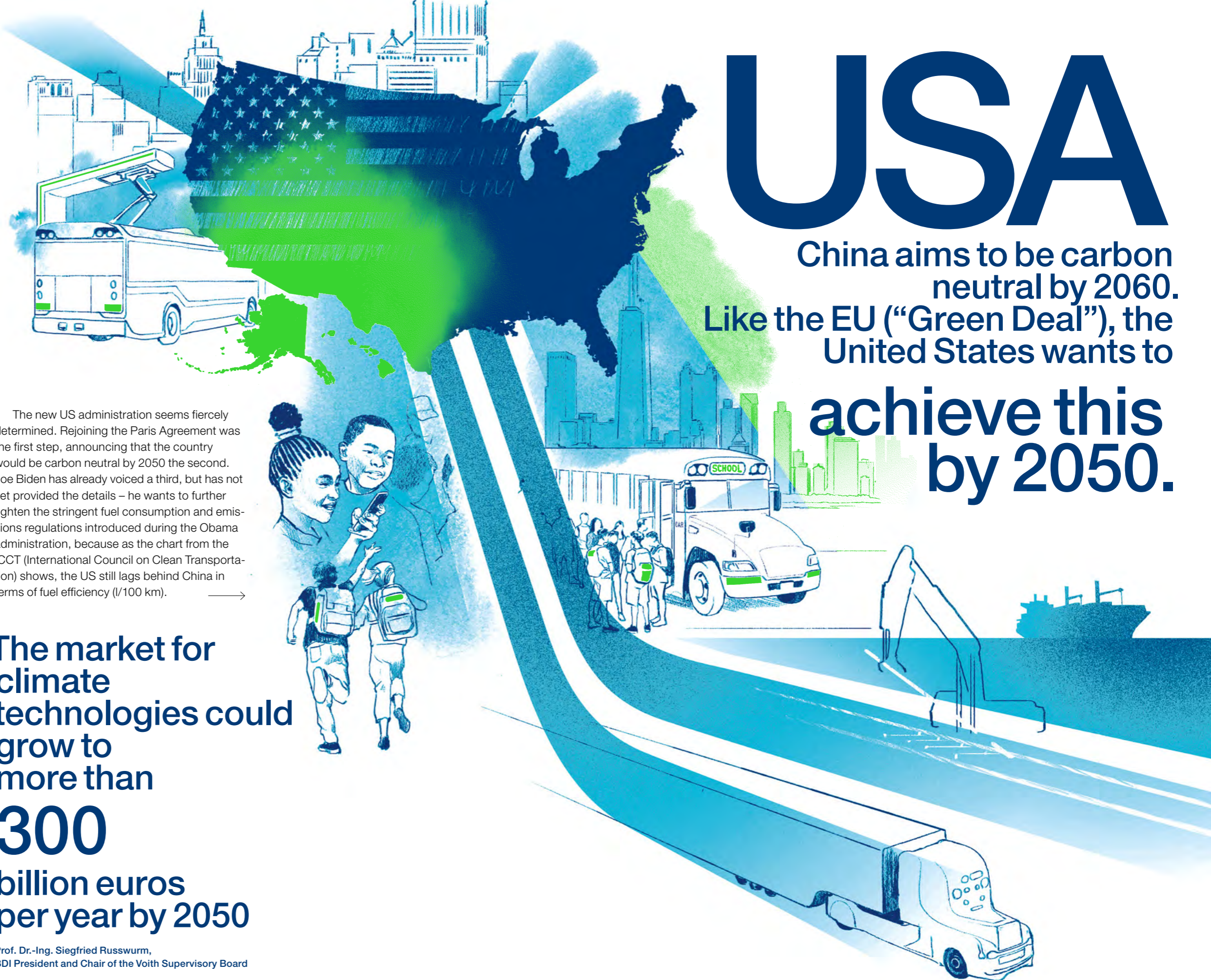
US President Joe Biden and his administration are well aware of this figure and the important role his country plays in the international climate agreement. The United States accounts for 13 percent of global greenhouse gas emissions. And that's why, as one of his first acts in office, he also reversed the country's withdrawal from the Paris Agreement carried out by his predecessor Donald Trump. But Biden is going even further, and aims to cut carbon emissions in the US in half by 2030 compared to 2005 levels, giving a huge boost to international climate diplomacy. This is because the European Green Deal aims to make the EU climate neutral by 2050; China, as already mentioned, wants to achieve this goal by 2060. And now the United States is following suit with investments of several hundred billion dollars in transport infrastructure and climate change mitigation. BDI President and Voith Supervisory Board Chair Prof. Dr.-Ing. Siegfried Russwurm commented on this development, saying: "The competition for the most promising ideas when it comes to combating climate change is also picking up speed in countries outside Europe. The market for climate technologies could grow to more than 300 billion euros per year by 2050."

Biden's stimulus package includes 2.25 trillion dollars in planned spending over the next eight years. Of that total, 621 billion dollars will be spent on transportation infrastructure alone. The plan includes modernizing 20,000 miles of roads and 10,000 bridges (at a cost of 115 billion dollars), expanding mass transit (85 billion dollars), and further expanding the rail network (80 billion dollars). Biden is an avowed fan of rail travel. Even as a senator, he commuted daily by train between his home in Wilmington, Delaware, and the nation's capital, Washington, D.C. He considers expanding "high-quality, zero-emission public transportation" in major cities with populations of more than 100,000 to be another top priority. By that, he means funding for electric school buses (20 billion dollars) and more zero-emission vehicles for public transportation (25 billion dollars). Furthermore, the Biden administration has earmarked 15 billion dollars for the expansion of the charging infrastructure and the creation of 500,000 new charging stations by 2030.

**The market for climate technologies could grow to more than 300 billion euros per year by 2050**

Prof. Dr.-Ing. Siegfried Russwurm,  
BDI President and Chair of the Voith Supervisory Board

The new US administration seems fiercely determined. Rejoining the Paris Agreement was the first step, announcing that the country would be carbon neutral by 2050 the second. Joe Biden has already voiced a third, but has not yet provided the details – he wants to further tighten the stringent fuel consumption and emissions regulations introduced during the Obama administration, because as the chart from the ICCT (International Council on Clean Transportation) shows, the US still lags behind China in terms of fuel efficiency (l/100 km). →



# USA

China aims to be carbon neutral by 2060.  
Like the EU ("Green Deal"), the United States wants to **achieve this by 2050.**



# EU

We've set ambitious targets for the entire transport system to ensure a sustainable, smart, and resilient return from the COVID-19 crisis.

Frans Timmermans,  
Vice-President of the European Commission

## EU: "Green, Smart, and Affordable Mobility"

The EU has the most stringent standards. Here, the transportation sector is responsible for nearly 31 percent of all carbon emissions. Since the EU Commission has set itself the goal of making the continent carbon neutral by 2050, urgent action is required. In December 2020, in the midst of the pandemic, the EU Commission published its plan for "green, smart, and affordable mobility." Over the next four years, a total of 82 initiatives will guide EU activities and "lay the foundation for how the EU transport system can achieve its green and digital transformation and become more resilient to future crises." This was announced by Vice-President of the European Commission Frans Timmermans together with Adina Vălean, EU Commissioner for Transport.

The policy goal has been clearly formulated: "We've set ambitious targets for the entire transport system to ensure a sustainable, smart, and resilient return from the COVID-19 crisis," said Timmermans. And Vălean went into further detail, saying: "Digital technologies have the potential to revolutionize the way we move, making our mobility smarter, more efficient, and also greener. We need to provide businesses a stable framework for the green investments they will need to make over the coming decades. Through the implementation of this strategy, we will create a more efficient and resilient transport system, which is on a firm pathway to reduce emissions in line with our European Green Deal goals."

## Carbon Emissions Fell by Seven Percent during COVID-19 Pandemic

Although the COVID-19 pandemic did cause carbon emissions to fall by seven percent, according to a study by Germany's Federal Ministry for Economic Affairs entitled "Logistics, Energy, and Mobility 2030," this figure still falls short of the target specified in the Paris Agreement, which is set at 7.6 percent per year. This means that despite a pandemic – with air travel coming to an almost complete standstill and rail traffic operating only to a limited extent – it still wasn't possible to reduce carbon emissions to the extent as required.

Massive efforts are obviously still needed to achieve the 90 percent reduction in carbon emissions necessary in Europe by 2050.

Timmermans and Vălean view the confluence of the pandemic and the European Green Deal as a "historic opportunity to make European transport not only more sustainable but more competitive globally." In order to make the systematic electrification and therefore decarbonization of all modes of transportation – regardless of whether battery-electric or fuel cell-powered – possible in

the first place, commercially viable products and systems are needed. The authors of the study "Logistics, Energy, and Mobility 2030" are certain that we will see an enormous surge in development in the field of battery technology in the next few years, resulting in significantly larger ranges. They also believe that hydrogen and the fuel cell will become a "flexible and mature propulsion technology" for heavy-duty and long-distance transportation by 2030. They forecast that the market for this technology will start to ramp up in 2030.

## Goal: "A Sustainable Transport System"

But what does the EU Commission actually mean by "sustainable transport"? The aim is to boost the uptake of zero-emission motor vehicles, ships, and aircraft, as well as renewable and low-carbon fuels, and to expand the necessary infrastructure, for example by installing three million public charging stations by 2030. Creating emission-free airports and ports is another aspect, e.g., through new initiatives to promote sustainable aviation and marine fuels. "Healthy and sustainable interurban and urban mobility" is to be achieved by doubling high-speed rail traffic and developing additional bicycle infrastructure over the next ten years. Doubling rail freight traffic by 2050 is intended to make freight transport greener. And according to the EU Commission's plans, better incentives for users will also be created, contributing to fair and efficient pricing across all modes of transportation.

In this context, Timmermans and Vălean aren't relying on the political power of the individual member states and the EU Commission, but on the innovative spirit of the business community. According to the two EU commissioners, new – and also digital – products, systems, and services from manufacturers and operators for and in the transport sector will transform the "historic opportunity" into reality, and achieving the goal of creating an intelligent passenger and freight transport system will significantly increase international competitiveness. —>

### Voith Innovations for the Global Green Deal

With the barrage of product innovations it has initiated in recent years, Voith Turbo, a global player in various areas of drive technology and in the development of new mobility concepts, is playing a key role in shaping the transformation process in the transportation sector. Voith has already launched new products on the market to meet the requirements of a globally evolving transport and transportation system and the EU initiatives specifically outlined. For example, the **Voith Electrical Drive System (VEDS)** is available today for the “electrification of public bus routes in urban and rural areas.” The powerful electric motor concept is suitable for single and articulated buses as well as double-deckers, supports all common battery systems on the market, can be integrated into any vehicle, and is also designed for use with **fuel cells**.

With its modular CargoFlex freight coupler, Voith offers the key to “efficient and environmentally friendly rail freight transport” – because this will double in the EU alone by 2050. This digital coupler makes it possible to connect rail cars up to a total length of 740 meters and to couple them without the need for shunting workers. But it isn’t just rail freight traffic that needs to become more environmentally friendly and efficient; this applies equally to passenger traffic. Subways, light rail vehicles, and streetcars rely on EmTrac electric traction systems from Voith. They are the key to increasing the share of eco-friendly mobility in public transportation. And Voith’s commitment to remaining open to all possible environmentally friendly drive concepts also applies in this case as well. Voith could supply the traction inverter for the “**Hydrogen Streetcar**” research project.

# Digital technologies have the potential to revolutionize the way we move, making our mobility smarter, more efficient, and also greener.

Adina Vălean,  
EU Commissioner for Transport

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### To the NXT Level

With its innovative recuperation unit, DIWA NXT makes it easier for bus manufacturers to convert their vehicle fleets to hybrid drive systems.

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### Quite the Intelligent Fleet

Pilotfish captures all of the relevant data from a vehicle, processes it, and displays the information in real time – a forward-looking approach to the digitalization of public transportation.

# 34

### Towed by Remote Control

Thanks to FernSAMS technology, tugboats will be operated remotely in the future, making port assistance services safer and more efficient.

# 43

### Using Digital Tools for Smart Service

Identifying service needs before the customer does – that’s the mission of Voith’s service team in Kiel. In this context, digital tools such as OnCall.Video or OnCumulus point the way forward.



And thanks to the eVSP, the door is wide open to a new generation of tugs, ferries, and offshore supply vessels that can be powered by both electricity from a rechargeable battery and a fuel cell. They play a fundamental role in “making shipping and ports emission-free.” But that’s not all – digital Voith solutions such as **Pilotfish**, an open communications platform for sharing relevant vehicle data for bus operators, or **FernSAMS**, which will make it possible to remotely control tugboats without a crew in ports in the future, are also key drivers in keeping pace with the growing trend toward green technologies.

### Environmentally Friendly Stoppag Technologies are Needed

The global mobility revolution is inevitable. Where the field of e-mobility is concerned, the stage is set for new drive technologies – whether battery-electric or fuel cell. But so far, neither the United States nor China, and only a handful of EU countries, have stamped an expiration date on the registration of new vehicles with internal combustion engines. Conversely, this means that combustion engines will continue to be needed in the coming years, particularly in the heavy cargo sector with its trucks, buses, trains, and ships. These will be state-of-the-art combustion engines, it is worth noting, that can meet extremely ambitious emissions standards and be operated with a carbon footprint that is as low as possible, if not fully carbon neutral.

And with **DIWA NXT**, Voith is pursuing the strategy of systematically expanding the use of mild hybrid technology. This can also be described as a necessary stopgap technology for bus operators, since thanks to this mild-hybrid tech, they can reduce fuel consumption by a total of 16 percent and thus cut carbon emissions by the same amount. This technology would also be ideal for trucks, heavy construction vehicles, and agricultural machinery. One thing seems clear – in order to find the right mobility concepts that will put us on a path out of the climate crisis, various drive technologies will have to be developed and advanced in parallel over the next ten years. In the heavy-duty sector, Voith is focusing on the fuel cell and will bring a corresponding mass-produced tank system for hydrogen-based drive systems to market by 2024, which will be used in buses, trucks, but also trains and ships.

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## Filling Up with Power Instead of Charging

Fuel cells offer clear advantages over battery-electric concepts in many commercial vehicle applications – not only technologically, but also when it comes to operating costs.



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## Actively Driving Transformation

TSA has been part of the Voith family since 2020. In an interview with Robert Tencl, the company’s general manager explains the traction drive expert’s innovations for the mobility revolution.

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## Service at the Intersection of the Orient and the Occident

Kazan is Voith’s central location for servicing rail vehicles in Russia – being close to customers, customized solutions, and comprehensive expertise all ensure that demand remains strong.

## EU Strategy for Sustainable and Smart Mobility

The EU Commission has divided the specific goals into ten key areas for action.

As such, by

# 2030

- At least 30 million zero-emission cars will be in operation on European roads
- 100 European cities will be climate neutral
- High-speed rail traffic will double across Europe
- Scheduled collective travel for journeys under 500 km should be carbon neutral
- Automated mobility will be deployed at large scale
- Zero-emission marine vessels will be market-ready

By

# 2035

- Zero-emission large aircraft will be market-ready

And finally, the EU Commission intends that by

# 2050

- Nearly all cars, vans, buses as well as new heavy-duty vehicles will be zero-emission
- Rail freight traffic will double
- A fully operational, multimodal Trans-European Transport Network (TEN-T) for sustainable and smart transport with high speed connectivity

And thanks to the eVSP, the door is wide open to a new generation of tugs, ferries, and offshore supply vessels that can be powered by both electricity from a rechargeable battery and a fuel cell. They play a fundamental role in “making shipping and ports emission-free.” But that’s not all – digital Voith solutions such as **Pilotfish**, an open communications platform for sharing relevant vehicle data for bus operators, or **FernSAMS**, which will make it possible to remotely control tugboats without a crew in ports in the future, are also key drivers in keeping pace with the growing trend toward green technologies.

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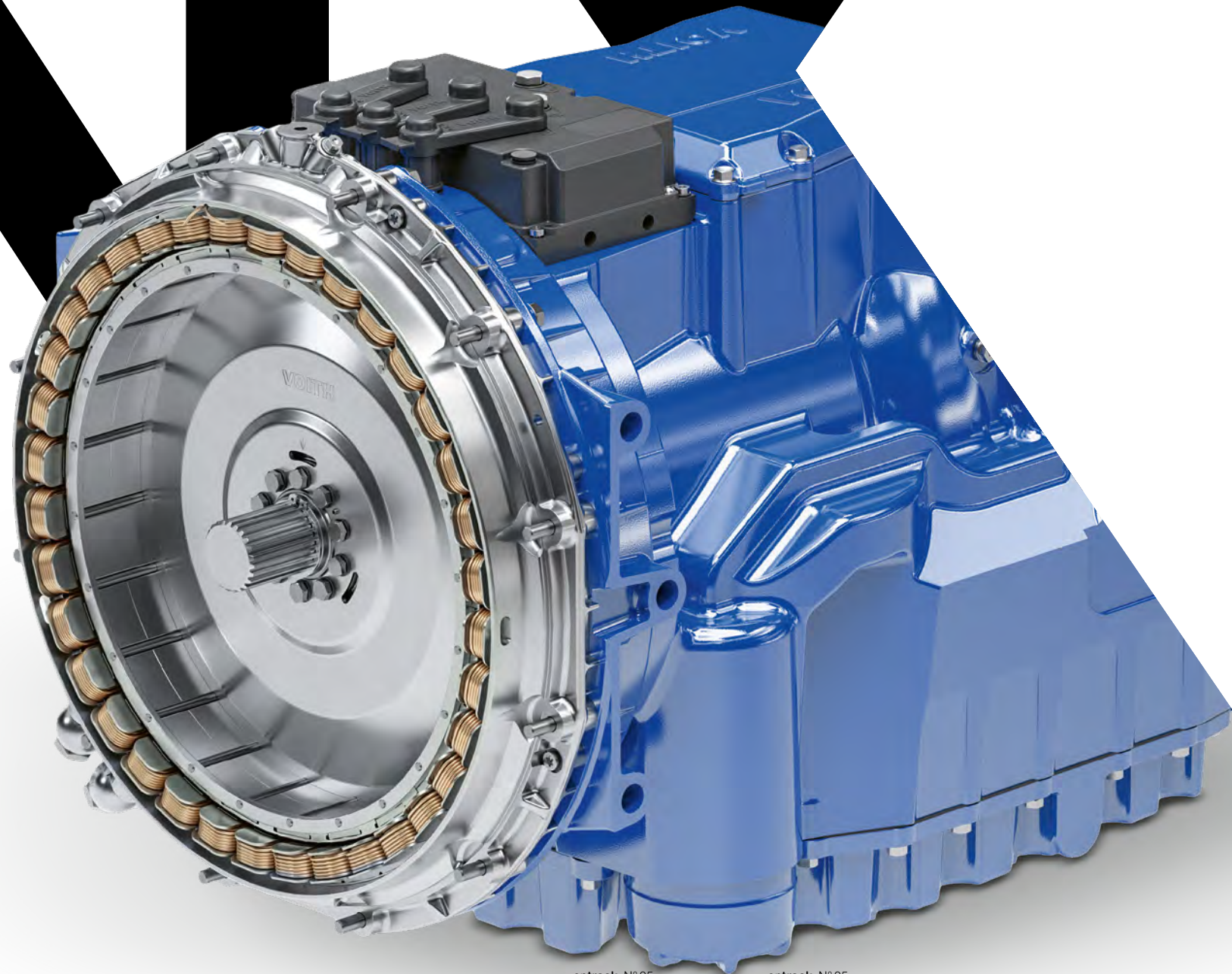
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# Level



Please unfold

and discover all the advantages of the latest generation of DIWA transmissions.



The DIWA NXT is much more than the latest generation of Voith's tried-and-tested automatic transmission. With its recuperation unit, it offers bus manufacturers a simple and fully comprehensive way to hybridize their vehicles. By using the system, operators can help make public transportation more environmentally friendly – and greatly reduce their operating costs in the process thanks to fuel savings of up to 16 percent.

# What's Next ? DIWA

The future of public transportation is electric. At first glance, a recent study by Bloomberg New Energy Finance (BNEF) entitled "Electric Vehicle Outlook 2020" confirms this in no uncertain terms. It says that by 2040, around two-thirds of all city buses worldwide will be powered by electricity. This includes battery electric vehicles (BEV) as well as those with hydrogen drive systems (FCEV). A deeper look at this forecast, however, also reveals some interesting details. This is because the researchers do not expect BEVs to be the only drive concept, even over the long term. In areas where it is difficult to install a widespread charging infrastructure, most buses will continue to be powered by internal combustion engines for many years to come.

"In our opinion, the battery electric bus will, at the latest, overtake the diesel bus as the dominant technology in the urban environment when total life cycle costs are identical. There will, however, still be applications in which the use of diesel buses will remain the only viable option for a long time to come," emphasizes Marc Osswald, Vice President Product Management DIWA at Voith, adding, "this means that, for the foreseeable future, it makes sense to continue advancing the established technologies in addition to the new ones and to adapt them to the new requirements in order to have a stopgap solution."

And this is exactly what the DIWA team has done with the latest generation of DIWA technology. The DIWA NXT fills a gap between diesel-powered drive systems and alternative concepts, some of which are still in the development stage. And as such, it already offers a viable solution today to a fundamental challenge that the development departments at manufacturers and suppliers worldwide are currently grappling with. This is because exhaust emission standards around the globe, which have been tightening for years, demand a reduction in harmful emissions that is pushing conventional internal combustion engine technology to its limits. In order to nevertheless satisfy the various government requirements with respect to climate change mitigation, hybrids are increasingly becoming the only alternative as a stopgap technology. In these concepts, electricity is recovered during driving and used to ease the load on the vehicle's on-board electrical system, for stopping and starting the engine, or as extra energy for acceleration.

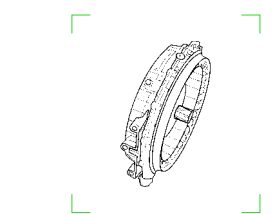
This is also the case with the DIWA NXT. Its primary component for the hybridization of buses is visible as a distinctive ring with copper coils on the input cover of the transmission housing: the central recuperation unit (CRU), which significantly increases the efficiency of the vehicle by recovering kinetic energy from the driving.

The optionally available CRU provides 25 kW of continuous power and a maximum power of 35 kW. This is perfectly sufficient for reliable stopping and starting operations, which are an important key to fuel savings during regular service in urban areas. After all, it's not just traffic lights that bring buses there to a stop. Instead, having the engine running at every bus stop is what significantly drives up fuel consumption.

In addition, the system can deliver supplementary power while driving and supply electrical devices in the vehicle. "The system can essentially replace two alternators," Osswald says. Used consistently,

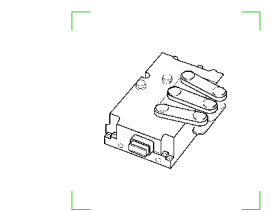
## DIWA NXT Automatic transmission for all kinds of bus operations.

The DIWA NXT is the latest generation transmission for city, regional and touring buses. Its standout feature is optimized efficiency – it is equipped with a second overdrive, a separate retarder, and an optionally available central recuperation unit (CRU) that uses 48 V technology to keep fuel consumption as low as possible.



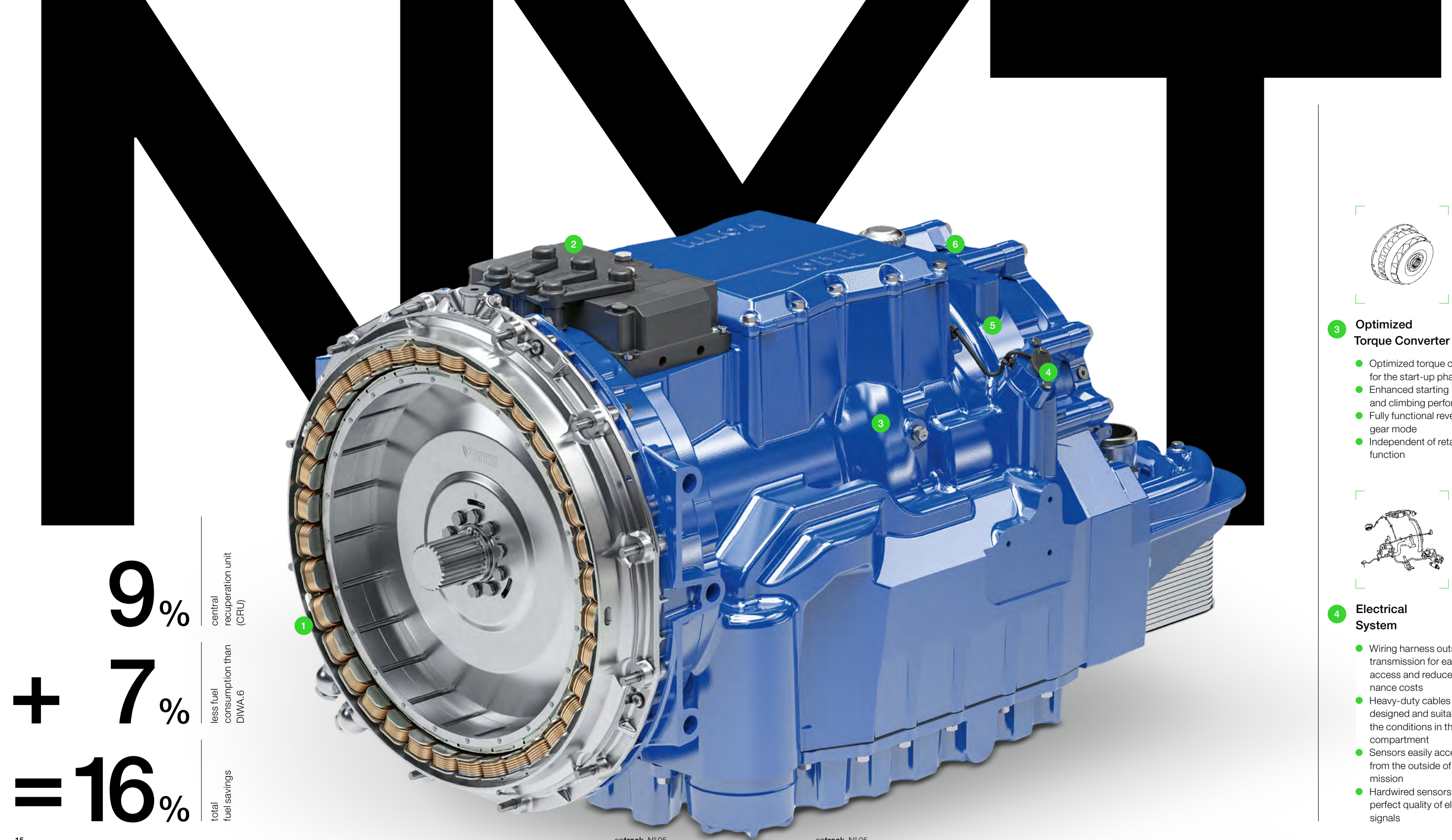
### 1 Central Recuperation Unit (CRU)

- The CRU is integrated into the flywheel housing
- The CRU provides 25 kW of continuous power
- Peak power from energy recovery stands at 35 kW
- Liquid-cooled system
- 48 V motor with 300 Nm engine starting torque for all types of combustion engines
- Integrated system with minimum possible additional axial length
- CRU can replace up to two alternators
- The CRU system enables active engine stopping/starting
- Start-up assistance through active boosting
- Reduces load on vehicle's on-board electrical system thanks to recovered energy
- Coasting in development



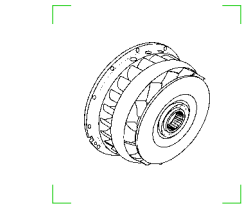
### 2 Built-In Frequency Converter

- The frequency converter is integrated into the transmission housing. No additional space required for installation
- High efficiency due to short cable lengths
- Liquid cooled with water-based coolant
- IP6K9K
- ISO 26262



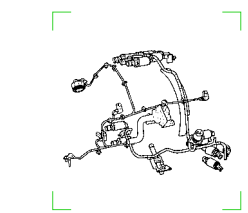
9% + 7% = 16%

central recuperation unit (CRU)  
less fuel consumption than DIWA.6  
total fuel savings



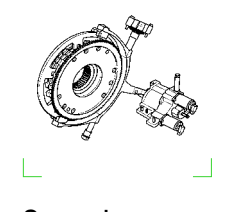
### 3 Optimized Torque Converter

- Optimized torque converter for the start-up phase
- Enhanced starting and climbing performance
- Fully functional reverse gear mode
- Independent of retarder function



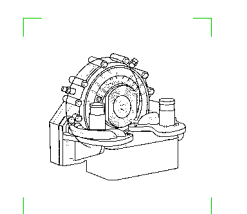
### 4 Electrical System

- Wiring harness outside the transmission for easier access and reduced maintenance costs
- Heavy-duty cables specially designed and suitable for the conditions in the engine compartment
- Sensors easily accessible from the outside of the transmission
- Hardwired sensors ensure perfect quality of electrical signals



### 5 Second Overdrive (7th Gear)

- Can now also be used for intercity and long-distance buses thanks to the second overdrive gear
- Highest overall gear efficiency on the market
- Best TCO thanks to lowest fuel consumption and maintenance costs
- Additional comfort for passengers thanks to smoother engine speed adjustment to the driving situation
- Lower noise emissions due to reduced average engine speed
- Lower carbon and pollutant emissions thanks to optimized engine speed adjustment



### 6 Built-In Secondary Retarder

- Retarder functionality almost to a complete standstill
- Better retarder control
- Faster torque ramp-up
- Optimized for cruise control

## Increased Efficiency for Rail Vehicles

Not only road vehicles can benefit from the advantages of the DIWA NXT. With its DIWAraile NXT model, the technology company also offers a version of the transmission for railcars. The first prototypes are currently being tested.

## Plug-and-Play Hybridization for Trucks

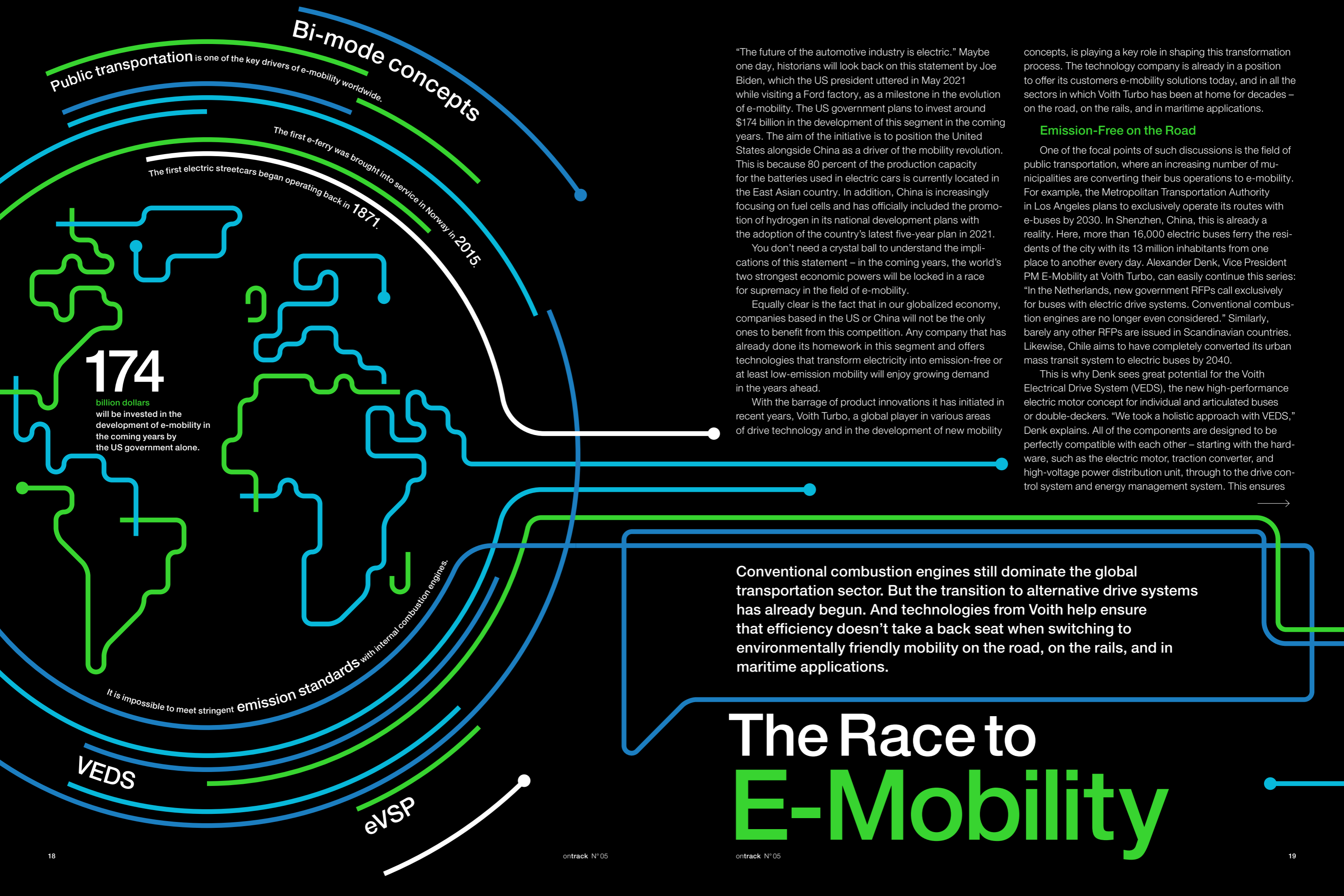
Since the CRU is completely independent of the transmission unit, Voith also offers it as a stand-alone solution for trucks. Thanks to standardized SAE-1 connections, manufacturers can easily integrate the recuperation unit into their own proprietary systems and thus reduce their vehicles' fuel consumption.

the CRU alone can reduce fuel consumption by up to nine percent. Incidentally, Voith makes the DIWA NXT available to all bus manufacturers, thereby offering the majority of OEMs the only option currently on the market that allows them to supply their customers with hybrid vehicles at short notice, which government RFPs are also increasingly calling for.

The only additional components on the transmission itself are the CRU and the liquid-cooled frequency converter. Both are so perfectly integrated into the transmission that its dimensions have hardly changed compared to the DIWA.6. In fact, the DIWA NXT has grown by just four centimeters compared to its predecessor. "Space in the drivetrain of a city bus is extremely limited. For OEMs, this small change in overall length means that they need to make either zero or only minor design adjustments to their vehicles in order to be able to offer their customers a hybrid version," analyzes Osswald. All of the system's other components, such as the DC/DC inverter, the cooling system, and the extremely powerful battery, are installed in a weatherproof housing on the roof of the vehicle. For the battery, Voith relies on lithium titanate oxide (LTO) technology, which is known for its exceptional resistance to aging. In a moderate climate, the batteries can supply the electrical equipment in the bus with power for around ten years.

But the recuperation system isn't the only component that makes the DIWA NXT more environmentally friendly and economical. The development team took a close look at almost all of the central transmission unit's assemblies and optimized them even further. "We incorporated over 60 years of transmission engineering experience into the development of the DIWA NXT, creating a system that combines all the strengths of previous generations and eliminates their weaknesses. More than 80 percent of the transmission is new," Osswald proudly emphasizes. Separating the torque converter from the retarder, for example, yields a significant improvement in traction and braking performance. In addition, drag torque was reduced at various points. Also new is an additional overdrive gear that makes the transmission even more flexible and fine-tuned when it comes to adjusting the number of revolutions per minute. The particularly tall gear is used primarily in intercity and long-distance bus travel. It makes it possible to drive fast for long periods at low engine speeds, which not only lowers fuel consumption but also reduces transmission wear.

Overall, fuel savings of around seven percent are possible with the transmission thanks to this detailed work. "Together with the nine percent from the CRU, the DIWA NXT can reduce consumption by around 16 percent – and as a result, significantly cut carbon emissions. At 2.65 kilograms of CO<sub>2</sub> per liter of diesel, that's well over ten kilograms of CO<sub>2</sub> per 100 kilometers, depending on the vehicle. That's quite a lot," Osswald calculates. The DIWA NXT is in the final stages of development. Field testing will begin in 2022 with the first OEMs and a limited number of units. At the same time, the transmission is being adapted and homologated in numerous applications and will then be available on a large scale starting in 2023.



Public transportation is one of the key drivers of e-mobility worldwide.

## Bi-mode concepts

The first e-ferry was brought into service in Norway in 2015.

The first electric streetcars began operating back in 1871.

# 174

billion dollars will be invested in the development of e-mobility in the coming years by the US government alone.

It is impossible to meet stringent emission standards with internal combustion engines.

VEDS

eVSP

"The future of the automotive industry is electric." Maybe one day, historians will look back on this statement by Joe Biden, which the US president uttered in May 2021 while visiting a Ford factory, as a milestone in the evolution of e-mobility. The US government plans to invest around \$174 billion in the development of this segment in the coming years. The aim of the initiative is to position the United States alongside China as a driver of the mobility revolution. This is because 80 percent of the production capacity for the batteries used in electric cars is currently located in the East Asian country. In addition, China is increasingly focusing on fuel cells and has officially included the promotion of hydrogen in its national development plans with the adoption of the country's latest five-year plan in 2021.

You don't need a crystal ball to understand the implications of this statement – in the coming years, the world's two strongest economic powers will be locked in a race for supremacy in the field of e-mobility.

Equally clear is the fact that in our globalized economy, companies based in the US or China will not be the only ones to benefit from this competition. Any company that has already done its homework in this segment and offers technologies that transform electricity into emission-free or at least low-emission mobility will enjoy growing demand in the years ahead.

With the barrage of product innovations it has initiated in recent years, Voith Turbo, a global player in various areas of drive technology and in the development of new mobility

concepts, is playing a key role in shaping this transformation process. The technology company is already in a position to offer its customers e-mobility solutions today, and in all the sectors in which Voith Turbo has been at home for decades – on the road, on the rails, and in maritime applications.

### Emission-Free on the Road

One of the focal points of such discussions is the field of public transportation, where an increasing number of municipalities are converting their bus operations to e-mobility. For example, the Metropolitan Transportation Authority in Los Angeles plans to exclusively operate its routes with e-buses by 2030. In Shenzhen, China, this is already a reality. Here, more than 16,000 electric buses ferry the residents of the city with its 13 million inhabitants from one place to another every day. Alexander Denk, Vice President PM E-Mobility at Voith Turbo, can easily continue this series: "In the Netherlands, new government RFPs call exclusively for buses with electric drive systems. Conventional combustion engines are no longer even considered." Similarly, barely any other RFPs are issued in Scandinavian countries. Likewise, Chile aims to have completely converted its urban mass transit system to electric buses by 2040.

This is why Denk sees great potential for the Voith Electrical Drive System (VEDS), the new high-performance electric motor concept for individual and articulated buses or double-deckers. "We took a holistic approach with VEDS," Denk explains. All of the components are designed to be perfectly compatible with each other – starting with the hardware, such as the electric motor, traction converter, and high-voltage power distribution unit, through to the drive control system and energy management system. This ensures

Conventional combustion engines still dominate the global transportation sector. But the transition to alternative drive systems has already begun. And technologies from Voith help ensure that efficiency doesn't take a back seat when switching to environmentally friendly mobility on the road, on the rails, and in maritime applications.

# The Race to E-Mobility

that the system is extremely reliable and also makes it possible to achieve a particularly compact design, which in turn facilitates integration of the system into a vehicle. This is even the case when the VEDS is used in continuously low-floor accessible buses, making it the perfect drive system for the mobility revolution. "There are only a few major bus manufacturers who equip their vehicles with their own systems. Thanks to our systems approach, VEDS is therefore helping the many smaller manufacturers make the switch to e-mobility. The large manufacturers that have developed their own power management system including accessory load concept can also purchase only the electric motor and converter from Voith. This flexible approach means we have the right solution for everyone," Denk emphasizes. This philosophy allows the system to use power from battery systems from a wide range of manufacturers. "Connecting it to a fuel cell is also not a problem," adds Denk.

The first customers are already in the process of converting their fleets to Voith's VEDS. For example, Northern Irish bus manufacturer Wrightbus has selected Voith as its exclusive partner to supply the electric drive system for its new generation of battery electric and fuel cell buses in Europe. Translink, the operator of the buses, plans for its entire fleet to be emission-free by 2040. Scottish bus manufacturer Alexander Dennis Limited (ADL) has also announced that it will have its first hydrogen-powered double-decker bus with VEDS on the road this year.

"We don't want to stand in the way of manufacturers' in-house developments," Denk notes. "That's why we can also just supply them with individual system components, if they so desire. We offer our customers maximum flexibility. Only the motor and converter form a fixed unit for us." This is because these two components play a decisive role in the

outstanding efficiency of the VEDS, which ensures the vehicle always has plenty of power available and a long range, even during challenging driving cycles. And not just in urban traffic. This is because Voith also offers the system in a more powerful version featuring optimized efficiency for intercity bus operation.

As Denk sees it, this is far from the end of the list of potential applications: "A garbage truck places very similar demands on a drivetrain as a city bus, namely relatively short travel distances with frequent stops and ever-changing load conditions." This is why Denk can also imagine the use of an appropriately adapted VEDS in many other commercial vehicles. "It's certainly a challenge, but we're already working on appropriate solutions."

Commercial vehicle operators around the world are already facing the problem that their fleets will be permitted to emit less and less carbon in the coming years. Beginning in 2025, for example, the fleet-wide target in Germany will have to be 15 percent lower than in 2021. And this figure is even set to rise to 37.5 percent from 2030 onwards. It is true that the law is, in principle, technology-agnostic. Looking at how commercial vehicle fuel efficiency has developed over the past two decades reveals, however, that development departments are slowly reaching the limits of what is technologically feasible in the realm of conventional internal combustion engines. In the near future, alternative drive systems such as the VEDS will therefore play an increasingly important role in commercial vehicle fleets.

### Solutions for Rail Vehicles

But back to public transportation. It doesn't just take place on the roads, after all. In most of the world's major metropolitan areas, transportation networks would collapse

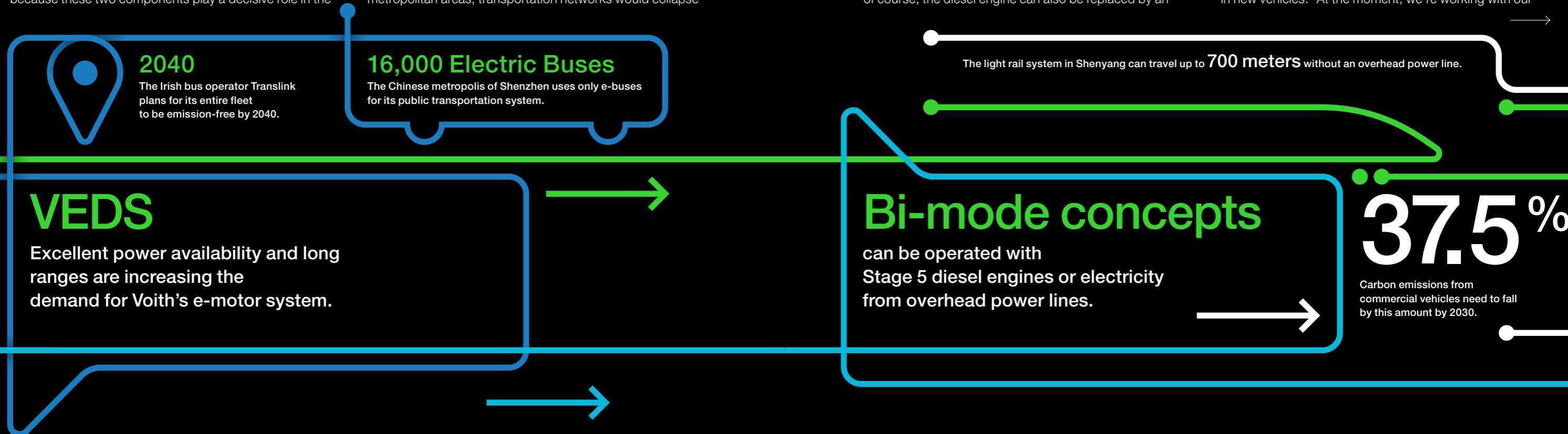
in a heartbeat if there were no commuter trains, subways, or streetcars. The level of electrification in this urban environment is high and has a long tradition. The first electric streetcar entered operation in Berlin all the way back in 1871, and the first electric-powered railcars were in service on the London Underground in 1890. The situation is different, however, when it comes to regional and intercity transportation. Although the level of electrification in Central Europe is fairly high, drive systems powered by fossil fuels still dominate in many other countries around the world and on most secondary routes throughout Europe. But similar to road vehicles, stricter emissions regulations are driving increased global demand for a shift to alternative drive system solutions in this sector as well (such as hybrid, battery electric, or hydrogen-powered vehicles).

In many countries, the focus is still on the traditional solution involving overhead power lines. But the electrification of stretches of railroad that were previously free of overhead lines is extremely cost-intensive and takes a long time. "This means that even in the long term, but especially for the years to come, a technology is needed that can achieve such emission targets, even if many stretches still do not have an overhead power line," says Peter Robert Winter. The Vice President Sales & Product Management at Voith has hybrid concepts in mind for drive systems for rail vehicles. "Bi-mode trains" draw their energy either from a diesel-electric RailPack with a modern Stage 5 diesel engine or from the overhead power line via a transformer and a converter. On a non-electrified stretch of track, the vehicle can be powered by the engine. On electrified sections, power comes from the overhead line. An optional battery also allows the train to enter and exit stations with zero emissions. In the future, of course, the diesel engine can also be replaced by an

alternative energy source, such as hydrogen. "We are combining our expertise and many years of experience in the field of systems engineering for mechanical and diesel drive systems in Heidenheim with our electrical drive technology know-how in St. Pölten. This unique constellation opens up completely new opportunities for us," emphasizes Winter.

"At the moment, we are offering a customer a parallel hybrid, i.e., a hydromechanical driveline with DIWARail transmission, cardan shafts, and gear units that is powered by a battery via an electric motor from our partner TSA and a traction inverter from St. Pölten. These are the solutions that the market expects and demands from us. As such, we at Voith Turbo are demonstrating that we are the go-to partner for all of a customer's drive system needs."

But Winter and his colleagues aren't just focusing on equipping new vehicles with innovative technologies. They know that there are still many diesel-powered rail vehicles in operation around the world that haven't yet come close to reaching the end of their life cycle. "Just take a look at the United Kingdom," Winter says. "Because of the old and low Victorian-era bridges there, many stretches of track aren't electrified. The UK operators have large fleets in operation with vehicles that are only 15 to 20 years old. But 40 years and more is the norm. In other words, the cars are only at the end of the first half." In many cases, fleets are still powered by engines that are well beyond current emission standards. In order to save costs on fuel and meet the demanding emission targets, operators are looking for options that will allow them to replace the old engines with state-of-the-art, low-emission, and efficient drive concepts. This would allow them to use their existing fleets for many years to come and save them the substantial costs of investing in new vehicles. "At the moment, we're working with our



**2040**

The Irish bus operator Translink plans for its entire fleet to be emission-free by 2040.

**16,000 Electric Buses**

The Chinese metropolis of Shenzhen uses only e-buses for its public transportation system.

## VEDS

Excellent power availability and long ranges are increasing the demand for Voith's e-motor system.

The light rail system in Shenyang can travel up to **700 meters** without an overhead power line.

## Bi-mode concepts

can be operated with Stage 5 diesel engines or electricity from overhead power lines.

**37.5%**

Carbon emissions from commercial vehicles need to fall by this amount by 2030.

colleagues from Voith in England on a project in which we're replacing the old, hydrodynamic RailPacks with our new RailPacks with Stage 5 diesel engines. In addition, the vehicles will be equipped with traction inverters with a battery permanently integrated into the system." Winter is convinced that a large market will develop in this segment in the coming years.

### EmTrac – Electric Drive Systems for Demanding Applications

In the case of the EmTrac traction inverter product line, which Voith manufactures in St. Pölten, Austria, Winter can point to numerous references from the last 15 years, noting that "our systems can be found in streetcars and subways all over the world. This includes, for example, the light rail systems in Manila, Helsinki, and Shenyang, and soon in Würzburg." In Shenyang, the streetcars can even travel up to 700 meters without an overhead line thanks to built-in supercapacitors, i.e., capacitors with a high power density. They can supply a large amount of power in a very short time without it negatively impacting their lifespan.

As Winter explains, the developers are already working on opening up additional and new markets with their "hybrid flex inverter": "The system makes it possible to draw alternating current from the overhead power line via the transformer or even from a generator via an input controller that can be operated both as an active rectifier and as a four-quadrant controller. This makes it suitable for RailPacks as well, thereby meeting the requirements for a hybrid system." The engineers are looking to make their innovation even more flexible, however. "We are already in initial talks with a manufacturer who wants to use the inverter for battery electric vehicles," Winter notes. "Wherever we power heavy rail vehicles, we can build on the modular concept of the hybrid flex inverter in the future."

"In this respect, we are guided entirely by the needs of the manufacturers," Winter emphasizes. This is because,

similar to the market for road vehicles, there are major railcar manufacturers that have developed their own drive systems for their vehicles. On the other hand, there are numerous smaller manufacturers that source central components and systems externally and therefore rely on a partner's systems expertise and system integration capabilities. Thanks to its many years of expertise as a supplier of drive systems, Voith is a highly sought-after partner in this field.

### Streetcars Powered by Fuel Cells

Looking ahead, Winter points to other areas of interest as well. On the one hand, Voith has been called on to help create a concept for the development of a streetcar powered by fuel cells, a project being funded by Germany's Federal Ministry of Transport. In addition, TU Berlin is working on a platform for new types of double-decker multiple-unit trains. "Deutsche Bahn wants to be able to transport more people without having to extend the length of the platforms," explains Winter. "To achieve this, the cars need small compact drive systems, among other features." The concept developed by TU Berlin involves compact gear units as a highly integrated motor-transmission unit with a high-revving traction motor. "This is where we can leverage our core competencies in the form of a perfectly compatible energy-efficient drive system consisting of traction inverters and engine-transmission units."

### Eco-Friendly on the High Seas

The shift toward electrified propulsion systems is also clearly evident on the water as well, with Norway leading the way. The very first electric-powered ferry began operating here back in 2015. Norway's government plans to only have zero-emission ships operating off the coast and in the fjords of the Scandinavian country by the year 2050. As a result, demand for propulsion concepts that meet these

requirements is growing – and Voith is along for the ride. On behalf of the Østensjø shipping company, Voith is currently building four new service operation ships for the offshore wind industry in Spain. Each of the 80-meter-long vessels will be powered by two eVSPs, the latest generation of the renowned Voith Schneider Propeller, which, for the first time, is operated using electricity.

"The eVSP is the systematic advancement of an operating principle that has proven itself many times over," says Dr. Dirk Jürgens, Vice President Research and Development at Voith, and continues, "low exhaust emissions will also play an increasingly important role in the shipping industry. We're focusing on systems that make completely zero-emission propulsion possible. Since the eVSP also has the permanent-magnet synchronous motor built directly into the propeller, the system is much more efficient than conventional power transmission using gears." This is because this design principle allows the electric propulsive power to be transmitted with a very high degree of efficiency. The performance advantage is remarkable – comparative model tests have shown that the eVSP requires around 15 percent less energy than a conventional ducted propeller during operation.

### eVSP – Quieter, Greater Comfort, and Suitable for Use with a Fuel Cell

In addition, the eVSP is significantly quieter than conventional propulsion systems and therefore makes the time spent on board more comfortable. This was achieved through a variety of measures, including completely eliminating the gearbox. In other words, there is no transmission or gears that could cause vibrations to occur. Incidentally, this also frees up installation space, which benefits the overall cost of building a ship.

The Voith Turbo Marine development team was also able to further increase the famously fast response to control

commands in the eVSP. "This allows us to achieve much better dynamic positioning," says Jürgens. This feature is particularly important for offshore service operations, making the eVSP an ideal propulsion system for the vessels that Østensjø is currently having built at shipyards in Spain. When it comes to propulsion, the shipping company is initially relying on the conventional technology of a diesel-electric propulsion system. But all of the systems are already equipped for a conversion to fuel cells – and the eVSP can also easily handle power sources of all kinds.

The fact that Voith has struck a chord with shipbuilders with its eVSP concept is also reflected in the impressive list of inquiries that Dirk Jürgens has already received for the system: "All over the world, shipbuilders are seeing the need to use alternative propulsion systems in maritime applications as well. The eVSP offers an attractive and efficient solution in this respect, as it makes zero-emission shipping possible on the basis of a tried-and-tested technology." And last but not least, there's also the FernSAMS project, in which Voith is leading the development of remote-controlled tugboat technology (see page 34). In this case as well, the focus is naturally on the eVSP as the propulsion concept.

**15%**

less energy is required by the eVSP than a conventional screw propeller.

## eVSP

The eVSP is much more than just the evolution of a proven principle.

## Electric Tugs

The FernSAMS project focuses on remote-controlled tugboats with eVSPs.

**2050**

Starting in 2050, only zero-emission ships will be allowed to navigate Norway's waters.

# Filling Up with Power Instead of Charging

For many years, the fuel cell remained nothing more than a niche concept as a drive system for vehicles. But for the past year or two, the hydrogen-based version of e-mobility has been increasingly attracting the attention of politicians and industry. This is because hydrogen has clear advantages over other energy sources in many commercial vehicle applications in the off-road and heavy-duty sectors, for example – both technologically and in terms of operating costs.

The oxyhydrogen test has secured its top spot in the eternal hit parade of the most popular experiments in chemistry classes. In the experiment, hydrogen (H<sub>2</sub>) reacts quite spectacularly with oxygen (O<sub>2</sub>) after being ignited. With the loud bang still ringing in their ears, the students then write down the insight that energy is released in an explosion, as students have been doing for many decades. Christian Friedrich Schönbein discovered how to harness this phenomenon back in 1838 – in the fuel cell he developed, gaseous hydrogen reacts with oxygen to produce electricity (see info box). The residual product of this process? Nothing but pure water.

It really doesn't get any more emission-free and environmentally friendly than this. And this makes the fuel cell an ideal platform for powering environmentally friendly vehicles. Mercedes-Benz unveiled the first prototype of a car powered by a fuel cell, the NECAR 1, in 1994. At the time, the equipment needed to generate electricity still filled the entire cargo space of a van. In the successor model presented about three years later, the technology had already shrunk enough to fit into an A-Class. Nevertheless, the technology has so far remained nothing more than a niche product. Today, however, against the backdrop of the mobility revolution, this seems to be changing.

Patrick Seidel, Product Owner H<sub>2</sub> Storage Systems at Voith, generally shares the view of many experts who see hydrogen as the third important pillar of future mobility, alongside battery electric drive systems and more efficient hybrid combustion engines. At the same time, however, he makes one thing clear: "Fuel cells are only a viable alternative if emission-free hydrogen, also referred to as green or turquoise hydrogen, is used in the process." He mentions this because a large amount of hydrogen is still currently produced from natural gas via a process known as steam reforming. With the help of inexpensive renewable energy

## H<sub>2</sub> can be used to store and transport large quantities of renewable energy.

Patrick Seidel  
Product Owner H<sub>2</sub> Storage Systems at Voith

available today, on the other hand, in the future green hydrogen could be produced from water via electrolysis and thus play a significant role in decarbonization. Seidel already has suggestions on how this hurdle can be easily overcome: "Hydroelectric power plants, for example, run almost continuously at full load and therefore generate a constant amount of electricity for many hours, which can then be used to produce hydrogen by electrolysis. This process is clean and emission-free – making the resulting hydrogen green." Excess electricity generated by offshore wind farms could also be used to produce hydrogen, Seidel says. In both cases, Voith already has technologies in place that can help produce green hydrogen. What also makes hydrogen crucial for the decarbonization of the economy and society is the fact that H<sub>2</sub> can be used to store and transport large quantities of renewable energy. In the future, green hydrogen could be imported to Germany from Africa or America, for example. And incidentally, technology from Voith can also play a key role in this respect as well. In addition, it takes much less time to "refuel" an H<sub>2</sub> vehicle than it does to recharge a battery. After all, even at fast-charging stations with over 50 kW, a car needs about 45 minutes until the battery is 80 percent full again. Typically, however, charging takes significantly longer. In contrast, an H<sub>2</sub> truck with a range of 800 kilometers can be back on the road again in eight to 15 minutes, depending on its size.

Seidel doesn't view these advantages as a repudiation of other drive concepts, however. In fact, over the long term, he believes they will all have their role to play. Each drive system has its own unique strengths, depending on the application. "In passenger cars, the use of battery electric drive systems is a viable solution," Seidel emphasizes. Fuel cell technology's unique strengths can, on the other hand, be leveraged in heavy-duty vehicles, construction site vehicles, and comparable off-road applications. The use of hydrogen also makes sense in various applications for rail vehicles or ships, for example in high-performance ferries such as those already in use in Norway.

When it comes to Voith's new storage system, the focus is particularly on heavy-duty transport applications. The concept has already successfully passed through the initial development stages. Industrial production of the system is scheduled to begin in early 2025. And not a moment too soon, because sometime between 2025 and 2030, according to a recent study by the Hydrogen Council, the total cost of ownership of hydrogen-powered commercial



## 800 km 15 min

Depending on its size, an H<sub>2</sub> truck with a range of 800 kilometers can be back on the road in eight to 15 minutes.

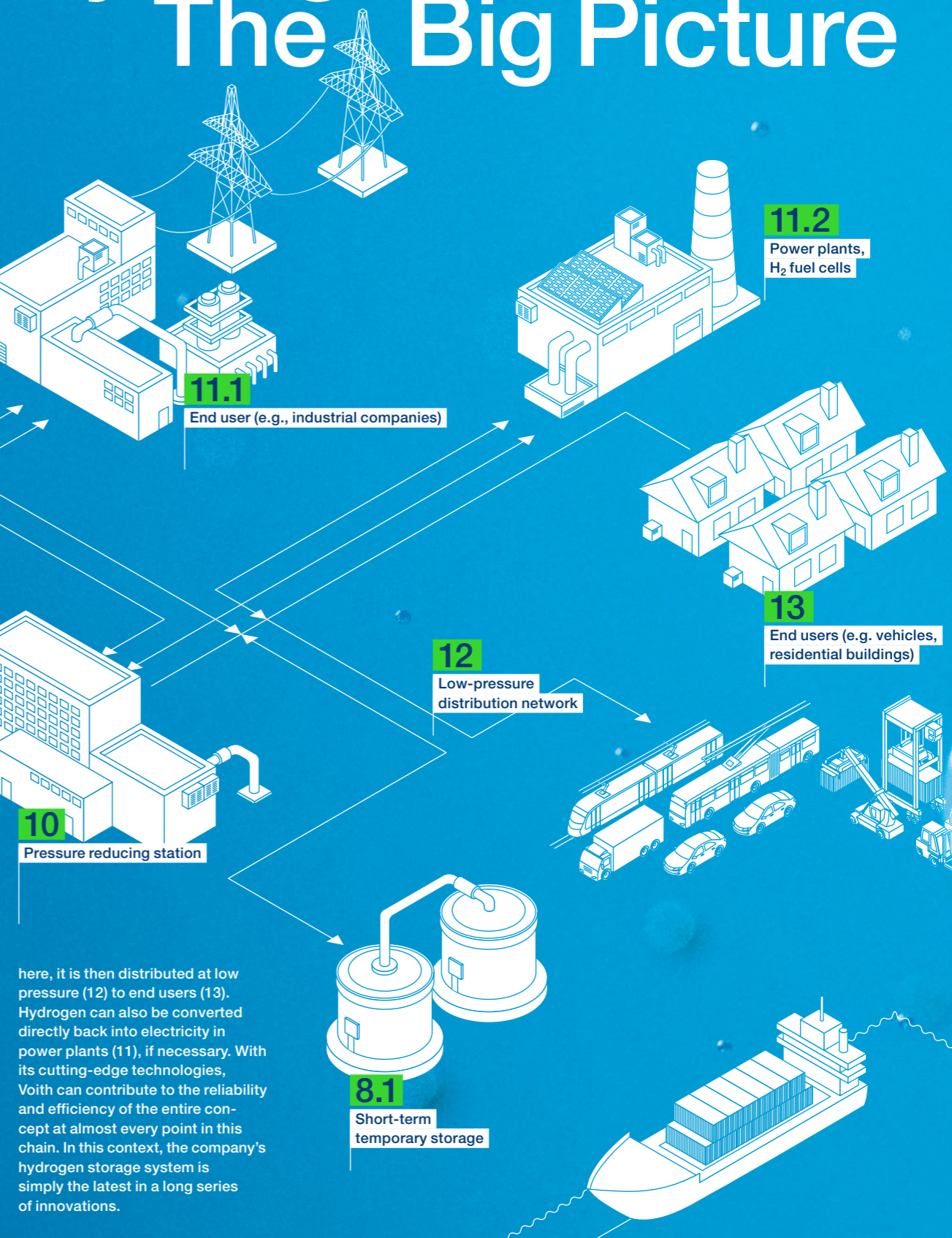
# From Production to the Consumer

Voith and its technologies play a key role in many aspects of green hydrogen production and its widespread distribution to consumers.

# Hydrogen: The Big Picture

**1** Renewable energy from onshore sources (e.g., hydropower plants)

Hydrogen has a long journey before it ends up in a vehicle's fuel cell. Ideally, production is based on renewable energy sources such as hydropower or wind power (1, 2, 3, 5). Alternatively, natural gas (4) or coal (7.2) can be split into hydrogen and carbon (7.1). The carbon is subsequently processed further (6). The hydrogen can also be stored in large quantities until it is needed (8.1 and 8.2). Distribution (9) to decentralized pressure reducing stations (10) takes place via a high-pressure pipeline network. From



here, it is then distributed at low pressure (12) to end users (13). Hydrogen can also be converted directly back into electricity in power plants (11), if necessary. With its cutting-edge technologies, Voith can contribute to the reliability and efficiency of the entire concept at almost every point in this chain. In this context, the company's hydrogen storage system is simply the latest in a long series of innovations.

vehicles will be cheaper than that of today's diesel systems or comparable battery electric drivelines in other systems. "Demand for H<sub>2</sub>-powered commercial vehicles is going to increase significantly, at the latest when this occurs," Seidel predicts.

The system designed by Voith is based on a 700-bar type IV pressure vessel made of a CFRP material specially designed for use in commercial vehicles. Voith is using "towpregs" for the first time in the production of these tanks: "With these pre-impregnated fibers, we are setting a new standard. We manufacture the towpregs in-house at Voith Composites and can therefore also perfectly tailor the material parameters to this challenging application," describes Seidel. Voith's plug & drive H<sub>2</sub> storage system thus marries two of the company's core competencies. "Most of the other competitors either come from the automotive supplier space and don't have a CFRP background or are CFRP manufacturers without automotive expertise. We're at home in both fields."

Storing the hydrogen is much more complex than with a diesel tank, however. "We're dealing with highly volatile molecules," Seidel explains. This is actually an understatement, because under normal pressure, hydrogen already boils at a temperature of -252 degrees Celsius. Designing a sealing system that prevents the energy source from flowing out of the tank with absolute reliability was therefore a key challenge facing Seidel's team. But it's also just one of many innovations in the H<sub>2</sub> storage system. Piping, valve technology, and the flows in a gas system also have to

## We're setting a new standard with this system.

Patrick Seidel  
Product Owner H<sub>2</sub> Storage Systems at Voith

be reengineered. The same goes for the entire mechanical structure or electrical control system, by the way. This is necessary because the path of the hydrogen from the tank to the fuel cell is significantly more complex than with a conventional diesel tank. A complex valve system, for example, ensures that the pressure of the energy source is reduced from 700 bar to the desired target pressure on its way from the tank to the fuel cell.

The modular design of the system is also high on the development team's agenda. This allows the layout of the system to be easily adapted to individual customer requirements, essentially enabling any vehicle manufacturer to use the system. The only thing that isn't included is the fuel cell itself. "Our customers receive a plug & drive H<sub>2</sub> storage system from us," says Seidel, summing up. A standardized interface allows vehicle manufacturers to connect the tank system quickly and easily. The aim is for customers to be able to install the complete system in their vehicles in the shortest possible time. This takes no more than seven minutes, Seidel calculates.

The vast market potential of the fuel cell and thus also of Voith's storage system can already be seen today in Switzerland, Norway, and China, for example. The Swiss have been trying to channel the growing quantity of goods that crosses the Alps day in and day out into environmentally friendly routes for decades. Much of this is being shifted to rail, where tunnel routes under the Gotthard Pass or the Lötschberg help reduce traffic congestion on the roads. The stiff carbon tax – around 88 euros per ton of CO<sub>2</sub> has been due since 2018 – has also led operators of commercial vehicles to rethink their approach. Hyundai, for example, will deliver a total of 1,600 hydrogen-powered trucks to Switzerland between now and 2025, with the first vehicles hitting the road in October 2020.

In Norway, on the other hand, ships powered by hydrogen are currently coming into focus. This is due to the fact that strict environmental regulations will apply in the Scandinavian country's waters starting in 2026. According to these rules, only ships with zero-emission solutions will be allowed to navigate through the fjords and near the coast. Battery solutions are not a viable alternative for large ships that travel long distances at high speed. This is because the batteries simply cannot provide enough power. In addition, the ships sometimes travel in sparsely populated areas. These regions may either lack a suitable high-voltage infrastructure or the infrastructure is already reaching the limits of its capacity, making it impossible to charge the batteries. The law has therefore put Norwegian shipping companies in a bind. At present, hydrogen remains the only alternative that is both emission-free and commercially viable. The first ships powered by H<sub>2</sub> recently began operating in Norwegian waters. Plans are already in place to retrofit the ships that operate on the legendary Hurtigruten route as well.

Seidel also sees another field of application for Voith's plug & drive storage system: "Our technology is easily scalable. That's why we think gas station operators will also be interested in the storage system." After all, the success of fuel cells as a propulsion system depends on a reliable hydrogen supply network.



## Modular

The layout of the storage system can be adapted to individual requirements.

Voith is currently preparing the first prototypes of the tank system for use in customer vehicles. The final certification process to the ECE-R134 standard is scheduled to begin in 2023 and will take about a year. Within the scope of a comprehensive test cycle, both the tank and the overall system must pass a wide variety of pressure, drop, and fire tests. In addition, its performance will be tested under a wide variety of different conditions. In addition, Voith will also perform its own tests in order to broaden the regulatory framework and deliver best-in-class quality to its customers. Afterwards, the company will prepare for industrial production. "Production will be carried out at our sites worldwide. Keeping distances to manufacturers short helps to significantly reduce the carbon footprint," Seidel emphasizes. "With this product, there is a strong focus on sustainability anyway. For example, Voith is conducting intensive research into recycling CFRP materials."

The first vehicles with Voith's storage system should then be in operation by 2025 at the latest, complementing the various approaches to decarbonizing mobility and the innovative solutions in the H<sub>2</sub> ecosystem offered by the technology company.

## The Hydrogen Advantage



Hydrogen is the first choice for heavy-duty vehicles, construction site vehicles, and similar applications.



Long charging times are a no-go for trains. Hydrogen can be refueled in a short amount of time.



Hydrogen is a viable solution for coastal vessels.

## Fuel Cells: E-Mobility without Batteries

Fuel cells aren't energy storage devices, but energy converters. They typically use hydrogen and oxygen for this purpose. The inside of a fuel cell consists of several layers. On the outside are bipolar plates that channel the gas, followed by gas diffusion layers. On the very inside are two electrodes (an anode and a cathode) coated with a catalyst – usually platinum. What's known as an electrolyte membrane separates the two electrodes from each other. During operation, gaseous hydrogen is supplied to the anode and oxygen to the cathode. Both react with each other. The difference in potential between the two electrons generates an electric current that can be used to power the vehicle.



Hydrogen is the actual fuel that reacts with oxygen.



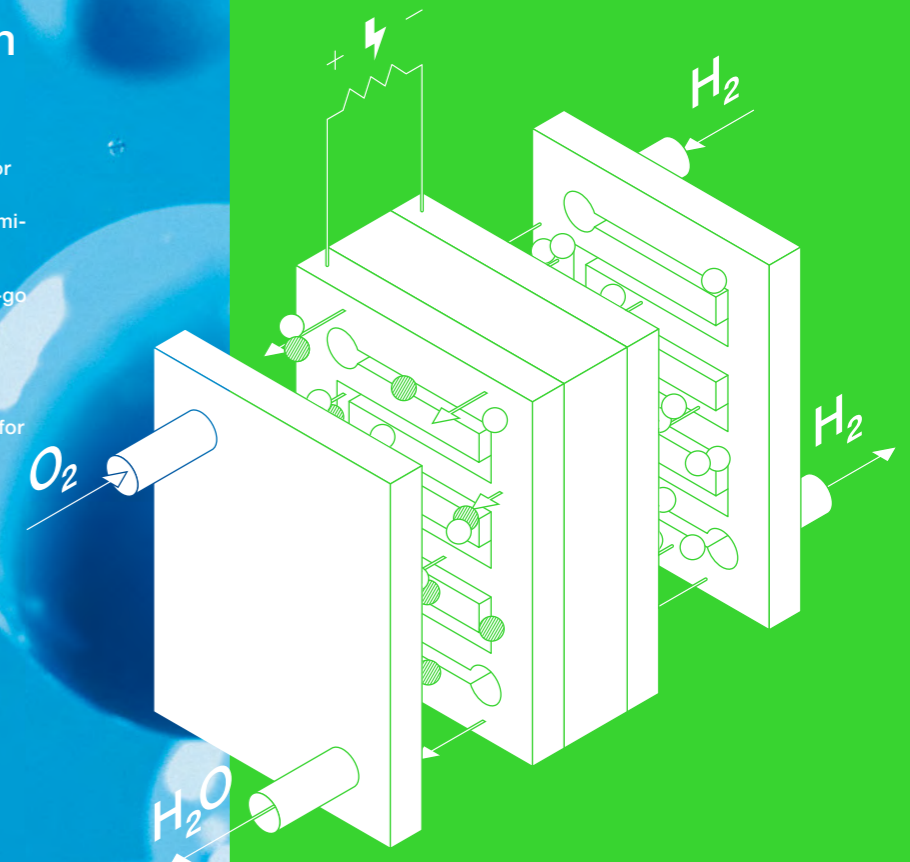
Energy is produced by a chemical reaction between the anode and cathode.



Oxygen serves as an oxidizing agent and is reduced when it reacts with hydrogen.



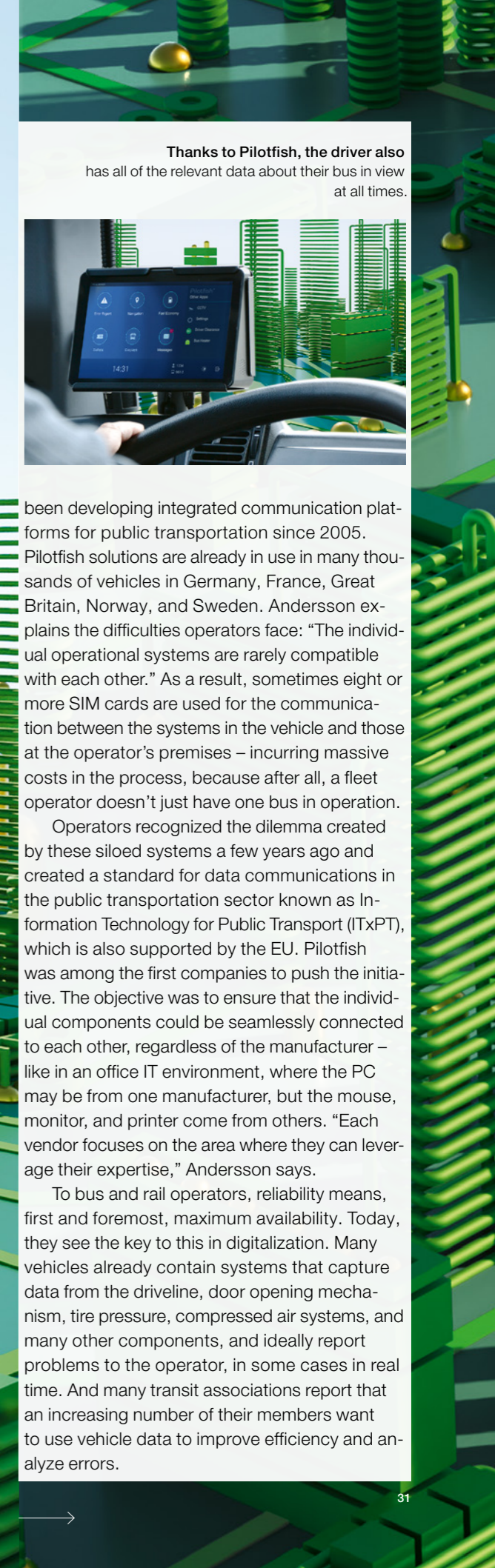
The final product of this "cold combustion" is pure water.





# Quite the Intelligent Fleet

Pilotfish's integrated open digital platform offers a forward-looking approach to the digitalization of public transportation. The system captures all of the relevant data from a vehicle, processes it, and displays the information virtually in real time – to report malfunctions or provide tips on how to drive more sustainably, for example. The goals include lower fuel consumption, maximum vehicle availability, reduced service costs, and improved passenger comfort.



Thanks to Pilotfish, the driver also has all of the relevant data about their bus in view at all times.



In mid-May 2021, Anne Hidalgo, mayor of Paris, presented concrete plans to largely pedestrianize the center of the city on the Seine by 2022. In the future, through traffic will be prohibited in the inner four districts of the capital, as well as the parts of the fifth, sixth, and seventh districts located north of Boulevard Saint-Germain. Hidalgo isn't the only one with such plans. London, Barcelona, New York, Tianjin, and Rome are just a few of the major cities around the globe that are either in the process of implementing similar measures or have already banned the stream of cars from entering their downtown areas.

But it isn't just major tourist destinations that hope to improve environmental conditions and thus the quality of life by reducing private motor vehicle traffic. A similar mindset shift has also begun in smaller communities. Whether major metropolitan area or small town, the expansion of a reliably operating local public transportation system plays a pivotal role in successfully transforming mobility. In this process, digital solutions are the key to success. But this is about much more than simply established applications such as digital destination displays or ticketing as part of a higher-level operations control system. An increasing number of such systems are found in buses, whose electronic architecture is becoming more and more complex as a result. "And as complexity grows, so do the problems," points out Magnus Andersson, CEO of Pilotfish Networks AB. The Swedish company has

been developing integrated communication platforms for public transportation since 2005. Pilotfish solutions are already in use in many thousands of vehicles in Germany, France, Great Britain, Norway, and Sweden. Andersson explains the difficulties operators face: "The individual operational systems are rarely compatible with each other." As a result, sometimes eight or more SIM cards are used for the communication between the systems in the vehicle and those at the operator's premises – incurring massive costs in the process, because after all, a fleet operator doesn't just have one bus in operation.

Operators recognized the dilemma created by these siloed systems a few years ago and created a standard for data communications in the public transportation sector known as Information Technology for Public Transport (ITxPT), which is also supported by the EU. Pilotfish was among the first companies to push the initiative. The objective was to ensure that the individual components could be seamlessly connected to each other, regardless of the manufacturer – like in an office IT environment, where the PC may be from one manufacturer, but the mouse, monitor, and printer come from others. "Each vendor focuses on the area where they can leverage their expertise," Andersson says.

To bus and rail operators, reliability means, first and foremost, maximum availability. Today, they see the key to this in digitalization. Many vehicles already contain systems that capture data from the driveline, door opening mechanism, tire pressure, compressed air systems, and many other components, and ideally report problems to the operator, in some cases in real time. And many transit associations report that an increasing number of their members want to use vehicle data to improve efficiency and analyze errors.



**Fuel Economy**  
Helps optimize driving performance.



**Bus Heater Control**  
Uses algorithms to save heating costs.

A technical standard for sharing this data relevant to maintenance and servicing even exists in the form of the Fleet Management Interface. But there is a large gap between technical and operational systems that prevents data from being shared. Dr. Robert Müller, Director Driver and Driveline Apps at Voith, explains the implications: "All of the vehicle's systems work in parallel, but they can't communicate with each other. This makes it hard to leverage potential efficiency gains. In addition, this means extremely complex systems are also needed on the 'land side,' i.e., at the operator's control center, that can handle the data landscape in the vehicles." In other words, more data does not automatically mean greater reliability. This is exactly where Pilotfish comes in. The platform effectively builds a bridge between the two worlds (in the bus and on the land side) and at the same time provides an answer to increasingly complex systems in the vehicle. Pilotfish's solution makes it possible to combine a wide variety of data streams on the one hand and simplify analysis on the other, so that all of the relevant information is always in view.

In this context, the open platform allows operators to put together a package of apps from various providers that is tailored to their own requirements, similar to what people are used to on a smartphone or tablet. During operations, the different apps can access the data they need simultaneously. With Pilotfish, data is exchanged in a standardized manner. This is carried out, for example, via Voith's cloud-based, end-to-end encrypted IIOT platform OnCumulus. Other cloud solutions can, of course, be integrated in the same way – such as into existing systems at the customer's site. To Andersson, it goes without saying that the data is shared virtually in real time.

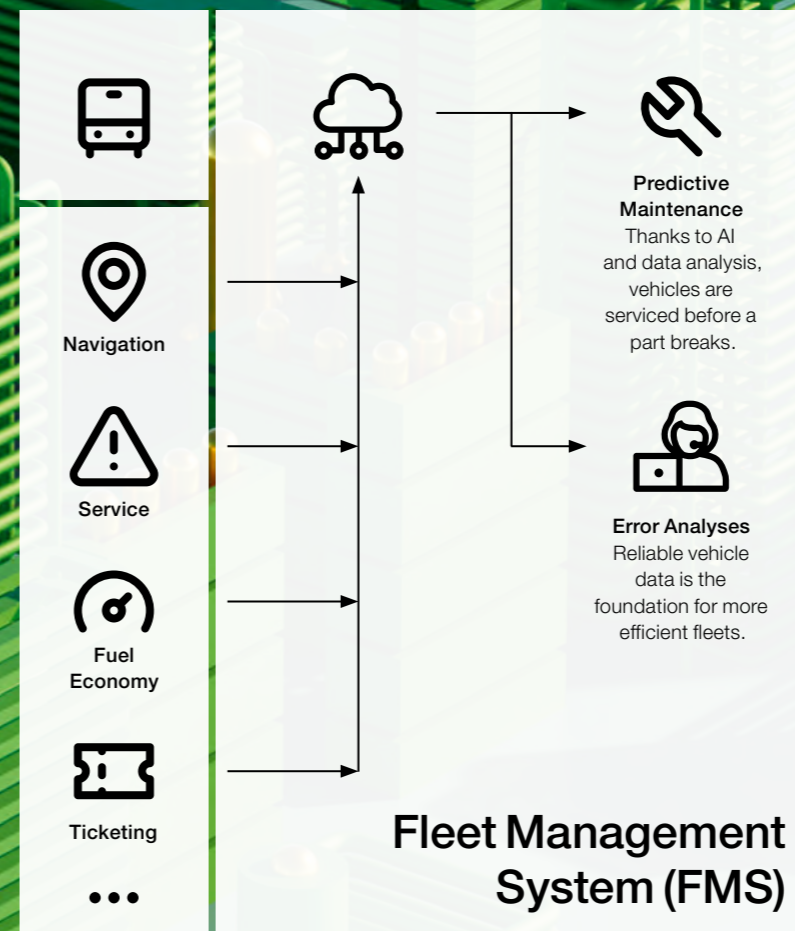


Thanks to Pilotfish, the garage can plan all of the steps of a service appointment before the vehicle returns to the depot.

Voith and Pilotfish are jointly optimizing their applications to offer operators maximum value in terms of reliability and efficiency. This is because Pilotfish has been a subsidiary of the technology company since 2019. For example, customers can access visualizations of their data on customized dashboards from OnCumulus via the MyVoith customer portal. Here the operator has access to all of the necessary maintenance and service documents in the form of EDocs and can find numerous other support options. Likewise, the portal significantly reduces the time needed to procure required spare parts by providing direct access to the online store. In this context, Voith's IT architecture ensures that all of the data is extremely well protected against cyberattacks at all times.

But most importantly, OnCumulus can be used to prepare the data for analysis tools. In addition to the latest customer data, the algorithms used in this process also make use of empirical values that Voith has been able to gather over the past few years. This includes, for example, the comprehensive data that Voith has been able to acquire from automatic transmissions over the years through its innovative DIWA SmartNet monitoring system. DIWA SmartNet has been enabling fleet operators to perform predictive maintenance for 14 years. This involves cutting costs and saving time by replacing critical components when the vehicle has a scheduled downtime anyway. As a result, Müller is convinced that the use of artificial intelligence in conjunction with technical expertise will significantly expand these possibilities in the future and make public transportation even more reliable.

He believes Pilotfish's communications platform is the ideal tool for the efficient public transportation system of the future: "As a provider of systems along the driveline, we were able to create a perfect symbiosis between physical components and digital applications." The platform processes the data generated by the vehicle into a single data highway, presents all of the relevant information clearly, and automatically reports malfunctions. "We can peer deep inside the component diagnostics," Müller describes. For example, the in-house diagnostic system ALADIN for DIWA transmissions is also integrated into the Pilotfish environment via OnCumulus.



At the same time, third-party providers can be integrated into the system without having to disclose their data. "We already implemented this back in 2015 with a well-known manufacturer of vehicle doors," Müller emphasizes. "And because Pilotfish can also monitor tire pressure, operators always have their two biggest concerns in plain sight with Pilotfish."

This means that, ideally, the garage can already plan all of the steps of a service appointment before the vehicle returns to the depot. But it isn't just these kinds of service tools that can be aggregated through Pilotfish. "Wherever data is generated in the vehicle, it can be captured centrally with Pilotfish, shared, and then analyzed with the appropriate apps," Müller emphasizes.

And in addition to applications for vehicle maintenance and operators, the platform also features information systems for drivers. One such app is the tried-and-tested Fuel Economy driver assistance system, which helps the driver further improve their driving performance. One way it does this is by helping the driver optimize how they accelerate and apply the brake. In day-to-day operations, this results in fuel savings of up to ten percent. For an operator with 100 vehicles, this translates into cost savings of around 250,000 euros and cuts carbon emissions by around 650 metric tons – year after year. At the same time, it can reduce brake wear and make the ride more comfortable for guests. With all of these benefits, it comes as no surprise that Fuel Economy has been Pilotfish's most successful application to date.



**OnCumulus**  
Enables secure data sharing.



**Tire Pressure Monitoring**  
An integral part of Pilotfish.



**Error Messages**  
Can be created manually or automatically.

Wherever data is generated in the vehicle, it can be captured and analyzed with Pilotfish.

**Dr. Robert Müller**  
Director Driver and Driveline Apps at Voith

FernSAMS technology is revolutionizing port assistance services. This system uses remote-controlled tugboats to bring cargo ships to their berths quickly, safely, and cost-effectively.

# Towed by Remote Control



1

2



The eVSP is the latest generation of the tried-and-tested concept that facilitates fast and precise maneuvering thanks to its combination of drive and control system. All of the critical maneuvers and operations can be controlled from a safe distance. In the new electric-powered eVSP, this efficiency has been increased even further.

- 1 All of the critical maneuvers and operations can be controlled from a safe distance.
- 2 With FernSAMS, the unmanned tugs are coordinated via a central remote control station.

## Tremendous Savings Potential

FernSAMS technology makes tugs more cost-effective by eliminating the need for a bridge to control the vessel, eliminating the need for expensive insulation, and eliminating the need for sanitary facilities as well as accommodations. The tugboats can be used around the clock, as there is no longer a crew on board that has to observe mandatory rest periods.

The Port of Rotterdam. With over 435 million tons of seaborne cargo handled in 2020, it is one of the largest seaports in the world and the largest deep-water port in Europe. The port itself and the port-related industries contribute around seven percent to the Dutch gross domestic product. The romanticism of the harbor whose praises have often been sung gave way many years ago to hustle and bustle – both on land and on the water. Around the clock, tugboats ensure that the huge container ships are towed quickly, efficiently, and safely to their berths. These assistance services are becoming increasingly complex. This is because about 90 percent of cargo worldwide is transported by seagoing container ships. And the global flow of goods is steadily increasing, with no signs that this trend will change any time soon. To handle this growth, ever larger container ships are being built. Just before Christmas 2020, for example, Hapag-Lloyd ordered six new container ships, each with a capacity of 23,500 standard containers. This is a growing challenge for port tugboat fleets, which are expected to perform their duties at ever shorter intervals. After all, time is money.

“FernSAMS is our answer to the challenges faced by shipping companies due to increasing cost pressure, higher transport volumes, and continuously growing ship sizes, while the dimensions of waterways and port facilities remain unchanged,” explains Dr. Dirk Jürgens, Vice President Research and Development at Voith Turbo Marine and head of the project. The acronym is short for “Ferngesteuerte Schlepper bei An- und Ablegemanövern großer Schiffe” (remote-controlled tugs for docking and casting-off maneuvers of large ships) and describes a project that Voith has implemented together with several partners (see “FernSAMS: A Joint Project” on page 37). Its innovative technology is designed to make the work of tug teams more efficient and at the same time safer. “The main idea is to replace one or more tugboats in a team with unmanned vessels. They can then be controlled remotely from on board one of the other vehicles involved,” adds Jürgens. Tugs that operate autonomously are not a part of the FernSAMS project. Instead the tugboats are controlled via a remote control stand that leverages virtual reality. —>

In mid-May, the project participants presented the first working model of such a tugboat at the National Maritime Conference under the patronage of German Chancellor Angela Merkel in Rostock. "The feedback has been extremely positive across the board, as everyone immediately recognized the benefits of the concept as well as the need for it," Jürgens is pleased to report. The reactions didn't come as a complete surprise. This is because the project team had already received a number of inquiries from port operators interested in FernSAMS, says Jürgens: "In-depth talks are already underway with a port in the Middle East."

During the demonstration in Rostock, the key visual differences between conventional tugboats and the FernSAMS concept also became clear – crew quarters or sanitary facilities aren't required. Noise insulation and even the bridge can also be eliminated. This reduces the weight of the floating powerhouses, making them even more maneuverable and lowering energy consumption. The safety advantages of the technology also impressed the guests, because currently towlines are mostly passed over by hand. This means that a tug operating in front of the ship must steer directly in front of the bow of the moving freighter. The lines are subjected to immense forces, which can easily reach more than 100 tons during dynamic maneuvers. Thanks to the remotely controlled FernSAMS tugs, all such critical maneuvers and operations are carried out from a safe distance.

## FernSAMS is our response to higher shipping volumes and growing vessel sizes.

**Dr. Dirk Jürgens**  
Vice President Research and Development  
at Voith Turbo Marine



## FernSAMS: A Joint Project

FernSAMS is a joint project initiated by Voith. In this project, the tech company is collaborating with Hamburg University of Technology, the Fraunhofer Center for Maritime Logistics and Services, Germany's Federal Waterways Engineering and Research Institute, the crane and winch manufacturer McGregor, the Marine Training Center (MTC) Hamburg, and the communications specialists from MediaMobil. In addition, the project is receiving funding from Germany's Federal Ministry for Economic Affairs and Energy (BMWi).

## Controlling Towing Maneuvers from a Distance

- 1 Each tug involved can be precisely controlled from the central control station.
- 2 Performance data from the tugboats involved always remains in view.
- 3 Large monitors help to keep an eye on the entire maneuver.
- 4 Augmented reality makes it easier to control the individual tugboats.



The concept opens up entirely new possibilities when it comes to the design of the remote-controlled ships, since, for example, there is no longer any need to consider a deckhouse when accommodating the towing gear. Robert Allen, perhaps the world's most famous tug designer, has already embraced the concept and is working on an ideal design for a remote-controlled tugboat. It comes as no surprise that he intends to use a Voith Schneider Propeller (VSP) as the drive system. "The drive system has proven its worth in many tugs, as its fast and accurate power transmission enables agile as well as precise maneuverability. And thanks to the new electric version – the eVSP – the efficiency and sustainability of the entire system have increased significantly once again," emphasizes Jürgens.

Although the first remote SAMS fleet is not yet in operation, the feedback has already made one thing clear to the Voith project team: "Standardized, automated ship assistance will significantly reduce costs for shipping companies and port operators in the future and increase the speed of individual ship maneuvers."

# 100t

It is not uncommon to have a force of more than 100 tons on the towlines.

The VR headset virtually puts the tugboat captain on each of the vessels involved.



Traktionssysteme Austria (TSA) has been part of the Voith family since 2020. In this interview, Robert Tencl, general manager of the traction systems manufacturer, explains the synergies resulting from the merger and why customers can expect innovations for the mobility revolution as a result.

# Actively Driving Transformation



INNOVATIVE. INDEPENDENT. IMPASSIONED.

**Traction motors** from TSA are all custom-made and therefore perfectly tailored to the desired requirements.

**Why do customers choose to work with TSA?**  
**Robert Tencl:** TSA has been involved in the development of innovative electric propulsion solutions for over 60 years. We are continuously working to further advance our product portfolio. In this respect, our customers expect increasingly efficient, lighter, and more reliable products for both rail and commercial vehicles. Our understanding of comprehensive support over the entire product life cycle also includes intelligent maintenance and service concepts with spare parts management, guaranteed lead times, in-depth diagnostic reports on the technical condition of the drive system, and innovative upgrades.

**TSA has been part of the Voith family since last year. How do your products complement Voith's existing product range and where do you see the main synergy effects?**

**Tencl:** We firmly believe that electric drive systems will become increasingly important in all areas of mobility. Everything that can be electrified will be electrified. Voith's expertise and decades of experience in mechanical drive solutions, combined with TSA's electric rotating machine technology, form the basis for new product developments in drive technology and thus for the future of modern e-mobility. We want to actively shape this transformation together with Voith.

**What can Voith learn from TSA? What can TSA learn from Voith?**

**Tencl:** A business relationship that has lasted for years will almost automatically lead to mutual learning effects. Our shared expertise offers both companies the opportunity to identify future trends and developments at an early stage and incorporate them into our work. In this case, a medium-sized company is learning from a large corporation, and vice versa. This can have positive effects for both sides.

TSA is the only company in the world that specializes only in engines and generators for traction.



Robert Tencl  
General Manager of TSA

**Our customers expect more efficient, lighter, and more reliable products.**



Further information on the Hyperloop

**TSA's focus to date has been on rail vehicles. But you've recently stepped up your activities in the commercial vehicles sector. What are the reasons for this and what potential do you see for TSA in electric mobility solutions for the road?**

**Tencl:** Rail vehicles are actually the oldest electric mobility solution – and have been for over 100 years. We want to apply this expertise to commercial vehicles and thus offer more efficient, lighter, and more reliable drive solutions for the road as well. Through its Clean Vehicles Directive, the EU has, for the first time, adopted specific targets for the procurement of clean and energy-efficient road vehicles. The market for electric buses and commercial vehicles will therefore grow strongly in the coming years. We are going to play a key role in this with our products.

**Over the past few years, TSA has repositioned its innovation landscape. Where will these changes be visible to customers?**

**Tencl:** Systematically reducing the noise emissions of our specially developed engines has, for example, enabled a major European city's subway vehicles to be operated much more quietly. In another application, our innovative concepts helped enable one of our customer's rail vehicles to be built with more passenger space. Innovation management at TSA even goes so far as to develop engines for transportation systems that don't even exist yet – such as for the Hyperloop!

**Do you believe that "electric" is synonymous with "battery electric," or will concepts such as the fuel cell play a greater role in the future?**

**Tencl:** Not at all, because electric drive solutions can be powered with primary energy from a variety of sources. This power can come from batteries, overhead lines, or hydrogen. The choice of these power sources will likely be determined by the intended use and location of the vehicle in question.

Being close to the customer, tailor-made solutions, and comprehensive expertise – thanks to these competencies, Voith Turbo is laying the foundations for efficient and reliable mobility beyond Russia's borders at its service location in Kazan. Because Russia is systematically expanding its rail infrastructure, manufacturer-agnostic maintenance and repair services for rail vehicles are becoming increasingly important in this regard.

Service at the Intersection of the

# Orient and the Occident



Since its founding more than 1,000 years ago, Kazan, capital of the Russian Republic of Tatarstan, has been an important hub for trade between the Orient and the Occident. Numerous trade routes between China, Europe, and the Arab states crossed paths in the city, which is located about 800 kilometers east of Moscow. The Volga, a mighty river that borders Kazan to the west, has also been a heavily used trade route for centuries. Today, the trade routes that cross here also include several well-developed rail lines, making Kazan an ideal location for servicing rail vehicles. —>

## Flexibility

All of the company's service packages are precisely tailored to customer needs.



## New Silk Road

More than 11,000 freight trains make the journey between China and Europe every year. Russia's railroads benefit from this rail traffic transiting through the country.



## Expanded Expertise

Servicing rail vehicles is becoming increasingly important at Voith's Kazan location.

Voith Turbo has had a subsidiary here for more than 20 years. Initially, the company manufactured DIWA transmissions and performed maintenance work on buses. Today, servicing components for rail vehicles from every manufacturer is increasingly on the order books. This represents an important expansion of the company's competencies. After all, trains are the most important means of intercity transport in Russia and a major economic factor – freight services account for 5.5 percent of Russia's gross domestic product. In addition, the routes are increasingly used for transit traffic between China and the European Union. According to the railroad company China Railway, around 11,000 trains ran between Chinese and European cities in 2020 – i.e., about 30 per day, and the trend is increasing. One focus in this context is, incidentally, on Kazan. This is because, thanks to Chinese loans, the city will soon be connected to Moscow via a high-speed rail line. Plans are also being made to extend the route eastward and connect it to China's industrial centers. And Russia has been significantly expanding its rail infrastructure since 2008 anyway. By 2030, the government will invest around 380 billion euros to connect remote regions to the network with 20,000 kilometers of new rail lines – for both passenger and freight traffic. Part of these funds will be used to purchase new locomotives and railcars.

The high volume of rail traffic ensures that the capacity of the halls in Kazan is well utilized. "Just this fall, we were able to finalize a long-term deal with Siemens Mobility for the major overhaul of the company's train couplers," says Michael Klug, who is responsible for sales for the entire Eastern European and Russian market at Voith Turbo. This contract covers more than 3,800 couplers used in passenger trains. After around one million kilometers, they are due for their first major overhaul. "We inspect all of the components for wear. If necessary, we then replace individual parts. In rare cases, we also replace entire couplers. This is a routine job that increases the availability of the vehicles over the long term," adds Klug, who is currently in talks with other operators. "Our service philosophy includes maximum flexibility. Our offers are precisely tailored to the customers' requirements," emphasizes Klug. Voith Turbo's comprehensive systems expertise simplifies the work and lays the foundation for efficient operations and thus favorable pricing. But being close to the customer is just as important in this respect, as Klug emphasizes: "By maintaining close working relationships with our customers, we get to know their needs, requirements, and, of course, their products inside out, and are able to offer a service package that is perfectly tailored to their needs."

In addition to the growing demand for the maintenance and repair of rail vehicles, however, Klug also sees considerable potential to further expand operations in the field of buses as a result of the global debate on the subject of the transformation of the mobility sector. Although still in its infancy in Russia, Klug is certain: "We're going to see significant demand here as well." For example, the city of Moscow is planning to convert its entire bus fleet to zero-emission drive concepts in the coming years. And it comes as no surprise that Voith is already in talks with bus manufacturers regarding these initial steps. "It would make perfect sense to have maintenance performed in Kazan," Klug points out.

# Freight services account for 5.5 percent of Russia's GDP



# Using Digital Tools for Smart Service

When it comes to the innovative concepts developed at Voith Turbo's service location in Kiel, digital tools are increasingly playing a key role. The facilities on the Kiel Canal are a popular port of call for all rail vehicle manufacturers and operators who expect more from service than just repairs.

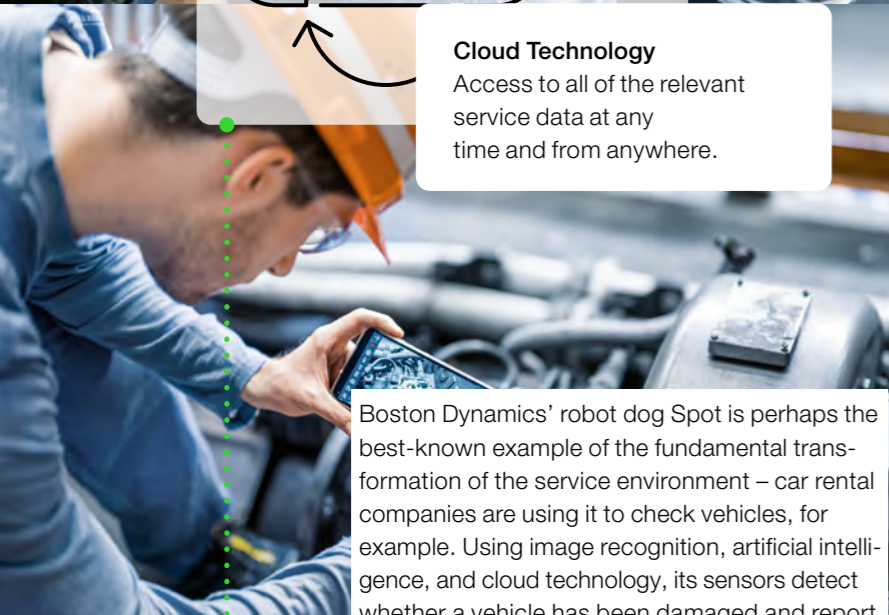


**OnCall.Video**  
Access to expert knowledge and fast solutions from anywhere and at any time.





**Cloud Technology**  
Access to all of the relevant service data at any time and from anywhere.



Boston Dynamics' robot dog Spot is perhaps the best-known example of the fundamental transformation of the service environment – car rental companies are using it to check vehicles, for example. Using image recognition, artificial intelligence, and cloud technology, its sensors detect whether a vehicle has been damaged and report this to the repair shop, if necessary. Only then does an employee have to get involved. At another company, Spot is responsible for inspecting pipes in industrial facilities for rust and more – a task that humans find tedious and boring. And yet it is still important, because the data must be accurate and consistent at all times in order to detect and correct errors at an early stage.

There's no doubt that robotics, artificial intelligence, and video collaboration platforms have once again expanded the possibilities for maintenance and servicing. And this goes far beyond simply outsourcing routine work to machines. At least if you understand service the way Voith Turbo does: "Our service teams' top priority is to ensure the maximum availability of our customers' vehicles. Operators should be able to fully concentrate on their primary tasks – transporting passengers or freight from A to B," says Ulf Klaua, Director Sales Rail at Voith Turbo. At Voith Turbo, service means more than just repairing a vehicle. Instead, the company is always exploring opportunities to improve and modernize in to increase



**Communication**  
Notes, screenshots, or video recordings can be easily shared for documentation purposes.



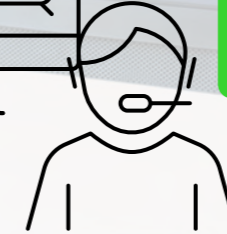
efficiency when working with customers. "Digitalization gives us the ability to develop innovative concepts that we can use to provide our customers with increasingly targeted support in real time, even remotely," emphasizes Dirk Schwarzer, plant manager at Voith's service location in Kiel. In this context, the coronavirus pandemic is accelerating this transformation to smart service.

A prime example of this was the acceptance of a locomotive for the Belgian freight transport specialist Linesas. The challenge was that in February of 2021, the pandemic made it impossible to visit the customer in person. The solution was OnCall.Video, an audiovisual communication system with a built-in video collaboration platform. The team in Kiel equipped an employee with smart glasses. Voice control and noise cancellation ensured that the connection with the customer in Brussels was smooth and allowed the participants to interact with each other. Thanks to the platform, the customer had all of the relevant documents on their screen and could take notes, create screenshots, or record videos for documentation purposes throughout the acceptance process.



**Digitalization gives us the ability to develop innovative concepts that we can use to provide our customers with increasingly targeted support in real time, even remotely.**

**Dirk Schwarzer**  
Plant manager at the Voith service location in Kiel



**Collaboration**  
Global knowledge sharing in real time across locations.



**Digitalization**  
overcomes system discontinuities between the repair shop and administration.

Martin Arndt, project manager at Voith Turbo, can easily imagine the use of OnCall.Video more frequently in the future: "If we equip customers with the system, we could provide support from Kiel. The employee on site could then see the instructions directly in their glasses." Such digital tools have further improved the efficiency of activities in many areas in recent years. And Arndt sees tremendous potential here that is still a long way from being exhausted. "Digitalization always makes sense when it improves customer satisfaction," emphasizes Nicolai Lindemeier who, as Supervisor Main Overhaul Systems, develops the technical specifications for the maintenance teams in Kiel. One example that comes to mind is a new database for order creation. It contains all of the individual activities relevant to the service.

"When we receive an inquiry, we can access it from this digital memory and use it to generate a transparent quote for the customer," Lindemeier explains. At the same time, such data can be used to specifically plan repair shop capacity utilization and reconcile it with inventory levels. "This enables us to overcome system discontinuities between administration and the repair shop," adds Frank Grünthal, Senior Manager Maintenance Management. An in-house app that, incidentally, also works across locations serves as a tool for this purpose. And it goes without saying that the customer also receives all of the maintenance reports in digital form. "All operations and steps are documented throughout the process. The result is ideal and efficient quality control for the customer," says Grünthal.

One cornerstone of the rail industry – a long-term approach – has not been affected by digitalization. Rail vehicles are designed to be in service for several decades. Many service contracts are structured accordingly. "We view ourselves as a long-term partner of the railroad companies to whom we provide our engineering services," says Klaua, describing this philosophy. One way is by making in-house efficiency tools available to other brands and helping customers make the most of them, as is the case with OnEfficiency. StopStart. Voith's tried-and-tested automatic start-stop system can reduce fuel consumption by up to 30 percent. To achieve this, however, it must be used consistently: "The regularly generated reports provide us and the operator with important information on how the system is operating. How often was it switched on? When did the engine not stop, and why? What savings has the automatic system generated? We then work with the customer to identify optimization potential," says Jürgen Dohrmann, Manager ESS Turbo, explaining the procedure. In this case as well, digitalization offers opportunities that go far beyond traditional maintenance, with service understood as consulting closely with customers as partners. Ideally, this means identifying the customer's needs even before they are aware of them. Voith Turbo's comprehensive expertise and the enormous data pool that the company has accumulated and evaluated over the many years benefit every single customer. This is because this treasure trove forms the perfect basis for identifying optimization opportunities.



# WHAT DRIVES YOU?

## Enabler of the global mobility revolution

Mobility drives us. As a technology partner and enabler, we make energy-efficient mobility possible for people and goods. With our drive technologies, we are already fit for the future, and a large number of our solutions and systems are already designed for alternative drives, digitalization and maximum efficiency. We always combine innovative technologies with maximum safety, and accompany operators and manufacturers on the road to resource-saving mobility.

We supply innovative technologies and mobility concepts to accommodate the continuing global population growth and urbanization. At the same time, the major issues of the present are driving us forward, above all climate change, which requires us to develop drive technologies that conserve resources and are future-proof. Based on more than 150 years of experience in power transmission, we have developed an unparalleled understanding of the entire drivetrain. This comprehensive expertise allows us to develop system and service offerings that are precisely tailored to the needs of our customers. As a reliable partner with a product portfolio that is ready for the future today – with alternative drives as well as powerful automation and digitalization solutions – we open up new paths for our customers and provide stability in the mobility revolution.



**DRIVE**



# DRIVE

## Growing mobility needs visions

The world is moving faster and faster. Today's global challenges will determine tomorrow's mobility, as the continuing population growth increases the need for new mobility concepts in megacities as well as in freight transport. In this upheaval, we see ourselves as a driver of innovation and a companion to our customers.

## Alternative drives are without alternative

Our core competency lies in the drivetrain. We complement our existing portfolio with innovative drive solutions from the fields of electrification and hydrogen, enabling customers to build on our many years of expertise, depending on their requirements and application.



# NEW



# WAYS

## Together to the climate goal

A constant and reliable partner in the present, a pioneer for the future: With our portfolio of alternative, sustainable drive solutions, we at Voith, together with our customers, are driving forward the resource-saving mobility of tomorrow. Our common goal: to significantly reduce emissions in mobility.

## Drive excellence goes online

We are responding to the changes in the mobility sector with digital solutions to enable significant efficiency gains for operators and manufacturers. We combine more than one and a half centuries of experience in the manufacturing of drive technologies with digital innovations to offer our customers decisive advantages in the global mobility revolution.



## Technology is human

As an innovation driver and technology leader, we appreciate the human factor. The dynamic transformation of industries requires collaborative and trusting relationships. With our global network of qualified service employees and the latest digital tools and communication channels, we always provide our customers with the right service – anytime and anywhere.

# The market for climate technologies could grow to more than

# 300

# billion euros per year by 2050.

Prof. Dr.-Ing. Siegfried Russwurm,  
BDI President and Chair of the Voith Supervisory Board

# VOITH

