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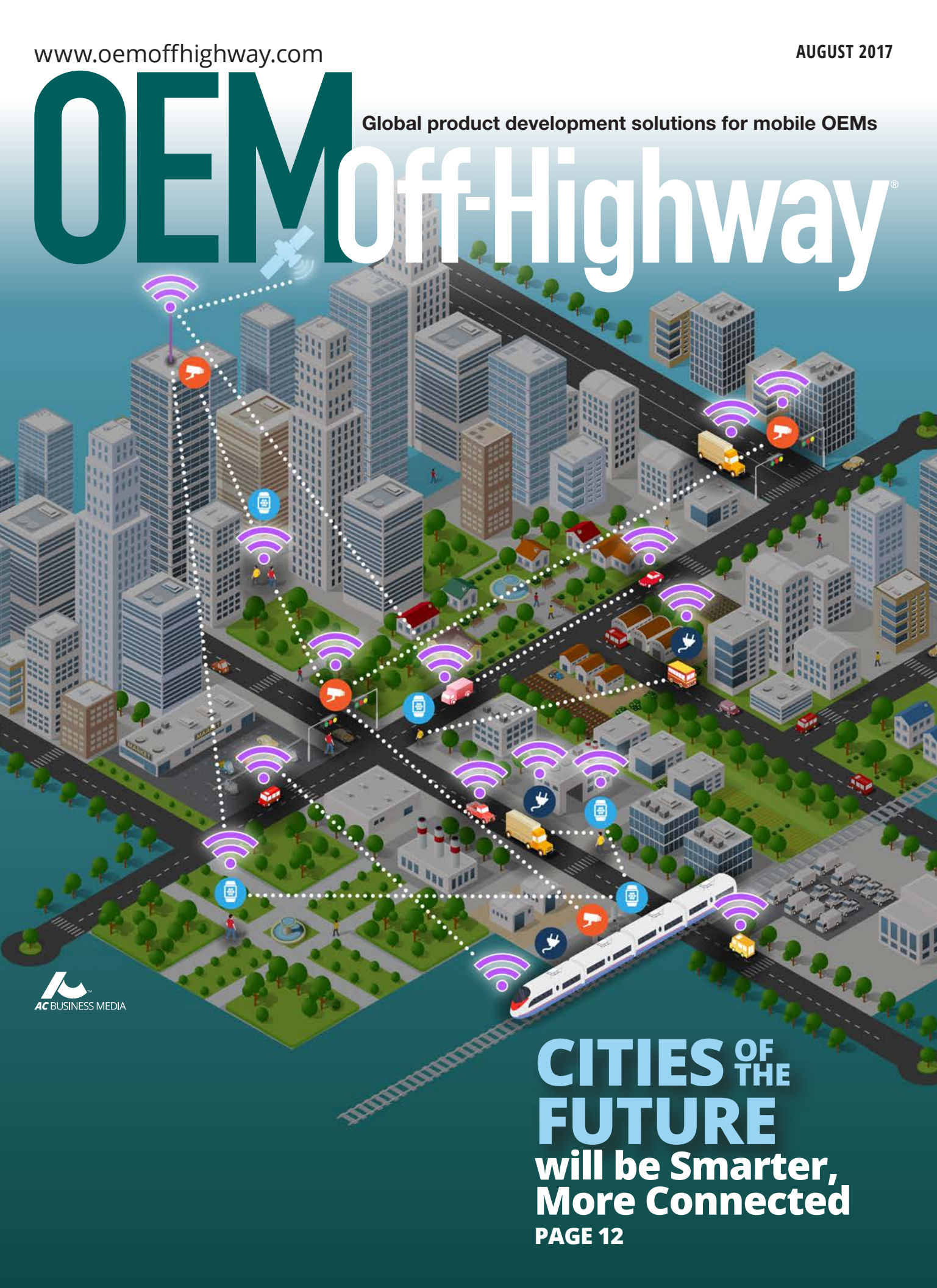

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PAGE 12

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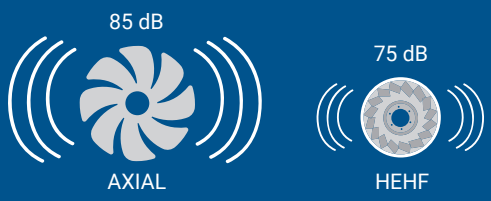

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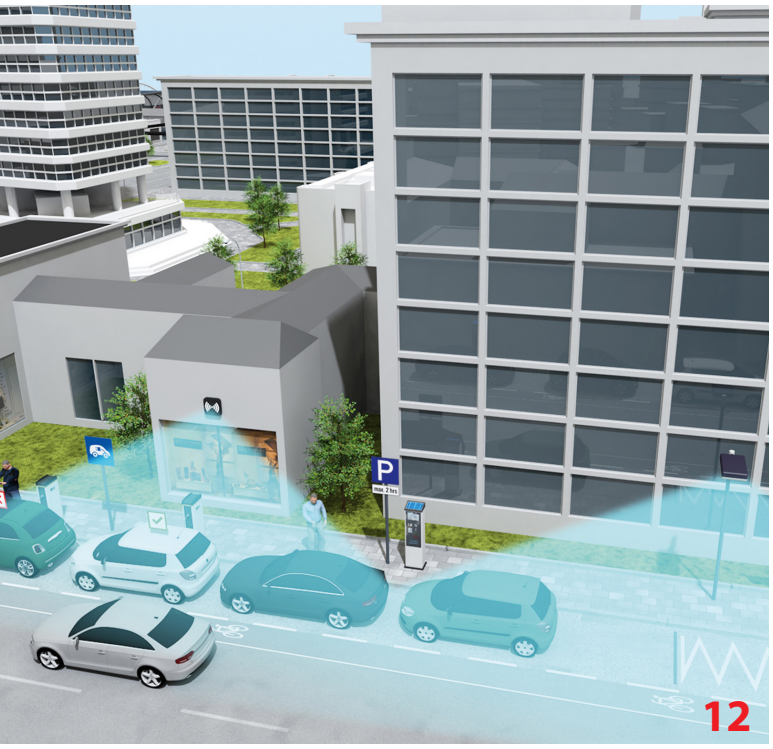
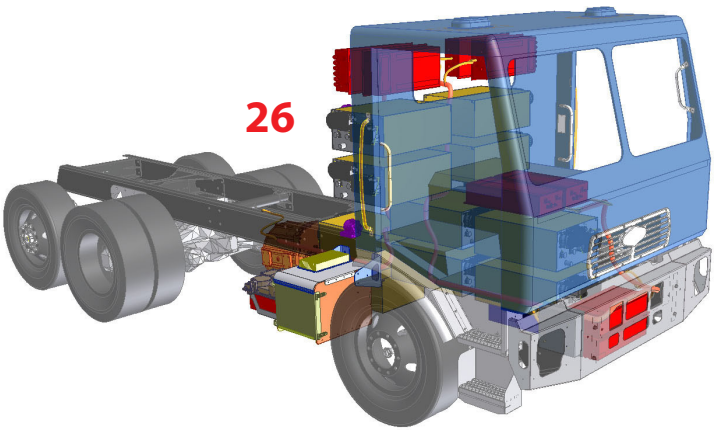


ON THE COVER

FEATURES



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Electrification Brings Cost and Emissions Savings

Development of a pure electric terminal tractor enables diesel-equivalent operation but with lower fuel costs and reduced emissions.

Search: 20866712

Growing Alternative Fuel Options

The number of alternative fuels available for use in heavy-duty equipment continues to increase, providing new opportunities for cost savings and emissions reduction.

Search: 20970405

Sustainability Takes the Stage in Montreal

Michelin's Movin'On Summit brought together technology and thought leaders from a variety of industries to discuss the current and future state of sustainable mobility.

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Volume 35, No. 5, August 2017

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A New Digital Magazine Platform

OEM Off-Highway has been providing every print issue of the magazine in a horizontally oriented format optimized for on-screen viewing for over 8 years. For the June/July Product Showcase digital edition, we launched a new platform that takes the already optimized horizontal issue and makes it scalable to any screen size, including your mobile phone!

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The digital format of the magazine is always part and parcel with the message of our "E" issue centered around the essential smart technologies, clean energy and forward-thinking ideas that propel the off-highway industry into a cleaner, more efficient future. Be sure to check out the fascinating cover story on the future of connected cities and electromobility starting on page 12.

Our global digital edition always includes everything you find in our standard print publication, plus exclusive digital content you won't find anywhere else. Just a few of those exclusive digital articles you'll find include the development of a pure electric terminal tractor, market growth in alternative fuel options, and sustainable technology launches. Check out the Table of Contents' Online Exclusive section for more information.

As always, we will keep working to advance and enhance the products we offer you, and always welcome feedback as to what we can improve on to make your job a little easier. Keep in touch.

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SEPTEMBER ISSUE

- Agriculture Market Report
- Operator Interface Advancements
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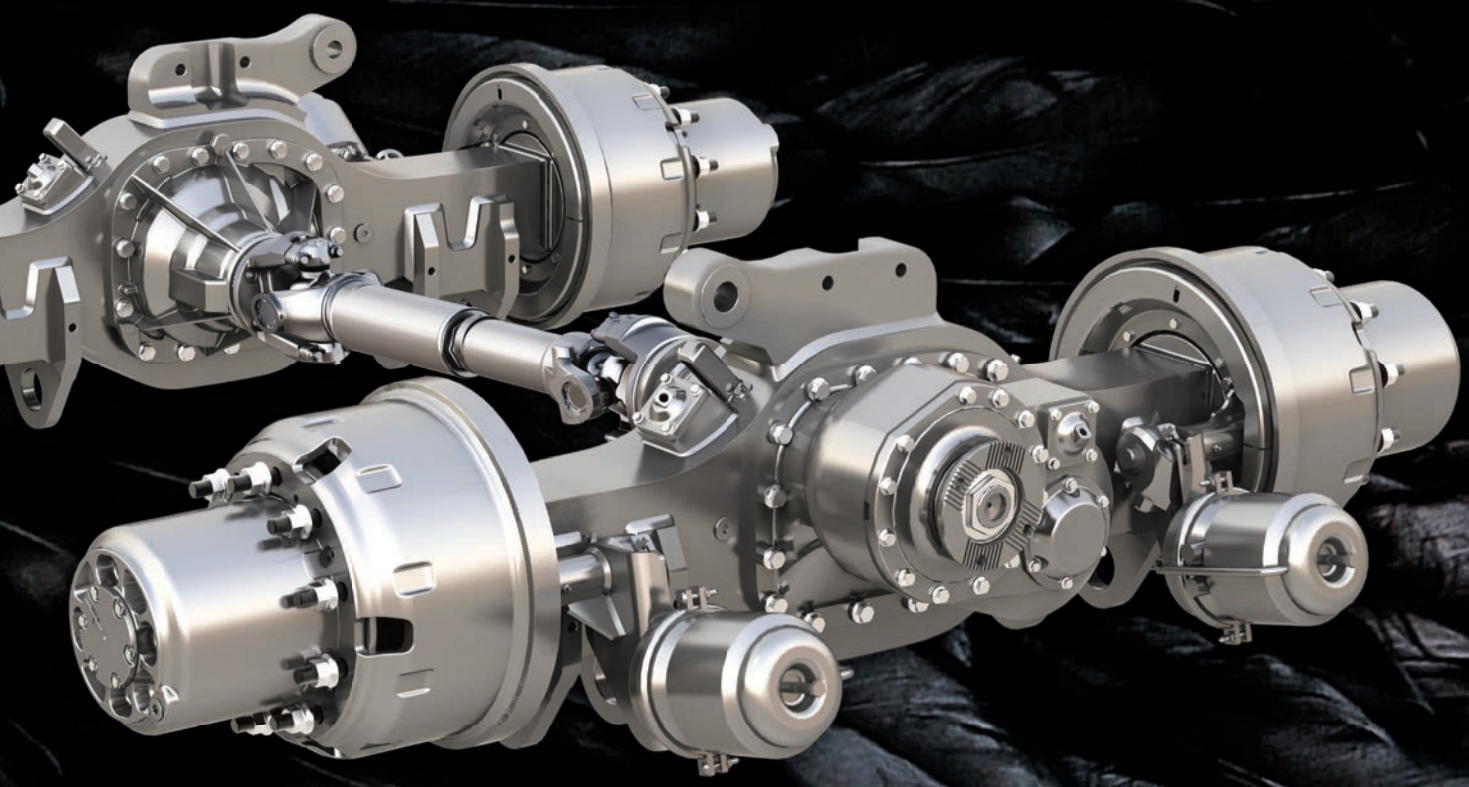

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RISE IN COMMODITY

Prices Driving Recovery for Mining in U.S. and Europe

A general rise in commodity prices is driving a rise in the U.S. mining machinery sector, while European mining machinery is recovering and will likely rise in the near term. Expansion in the construction sector indicates U.S. Construction Machinery Production will rise by late 2017, though year-over-year growth will not take hold until mid-2018.

U.S. Agriculture Machinery Production is recovering, but will likely remain below the year-ago level into the second half of 2017. Quarterly Europe Agriculture Machinery Production has transitioned to an accelerating trend and suggests recovery will persist in the near term.

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QUESTIONS?

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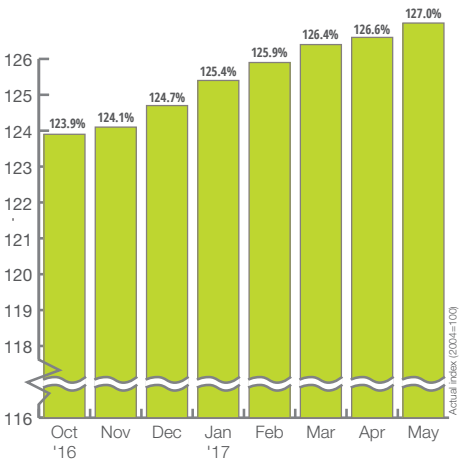
U.S. Leading Indicator:

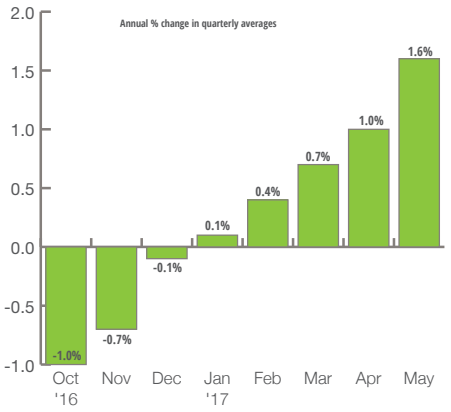
- The U.S. Leading Indicator rose further in May.
- Rise in the Indicator suggests rise for the U.S. economy into at least early 2018.



Editor's Note: Please note that this chart has been modified on the Y-axis to show the trend more easily.

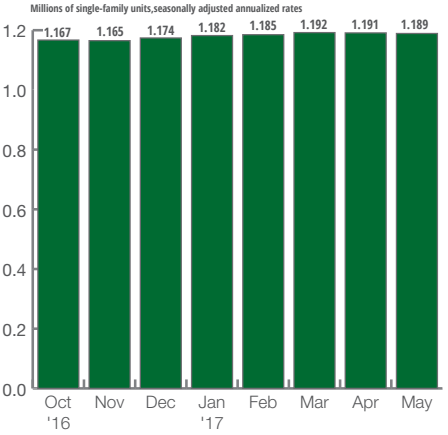
U.S. Total Industrial Production:

- Average U.S. Industrial Production during the 3 months through May was up 1.6% compared to the same 3 months of 2016.
- Expect growth to persist into late 2018 as manufacturing activity picks up and headwinds against the mining sector diminish.



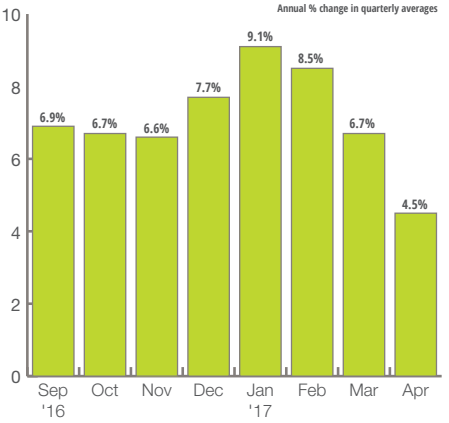
Housing Starts:

- U.S. Housing Starts totaled 1.189 million units in the 12 months through May.
- Expanding consumer spending will support rising Starts through 2018.



Private Nonresidential New Construction:

- Construction during the 3 months through April was up 4.5% compared to the same 3 months in 2016.
- Expect Construction spending to rise through at least the remainder of 2017.



Construction Machinery, New Orders:

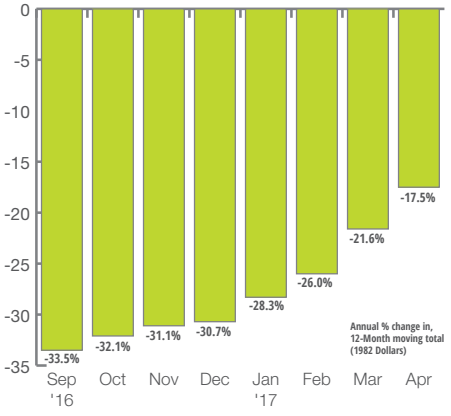
- The New Orders 12/12 is recovering.
- Expected cyclical rise in New Orders will extend into early 2018 as business-to-business activity and Housing Starts increase.

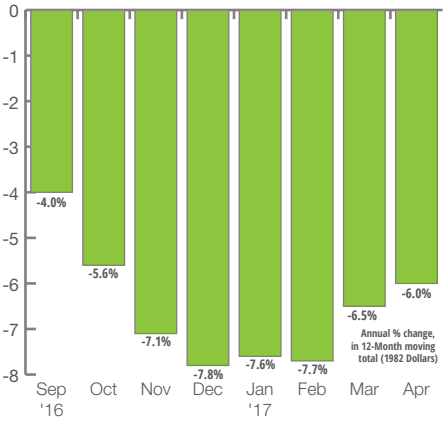
Farm Machinery & Equipment Shipments:

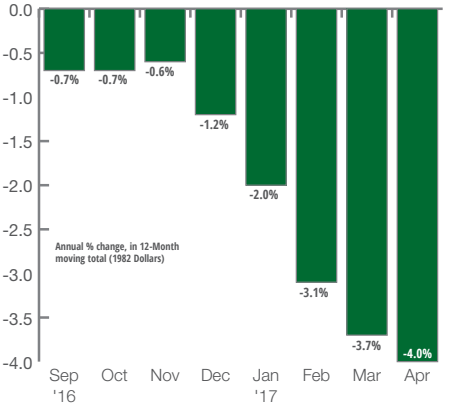
- U.S. Farm Machinery & Equipment Supplies is down 3.0%.
- Growing U.S. Food Production will provide upward momentum for Machinery & Supplies this year.

Total Public New Construction:

- U.S. Total Public New Construction during the 12 months through April was down 4.0% compared to the year-ago level.
- Construction is likely to reach a cyclical low late this year.

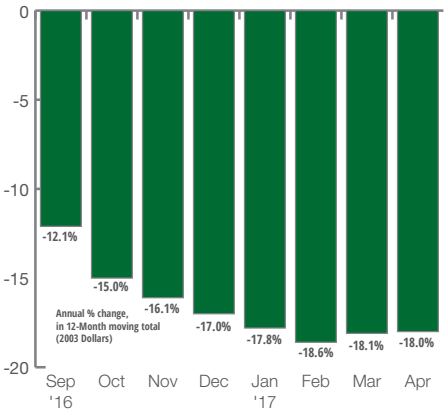






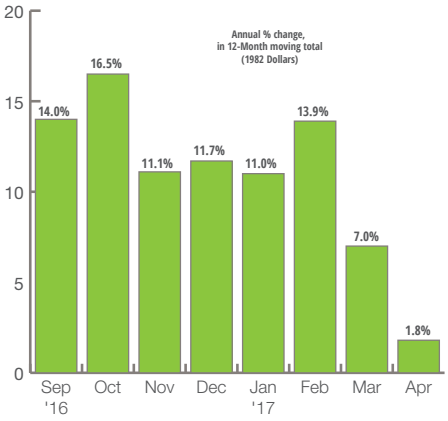
Heavy-Duty Truck Shipments:

- U.S. Heavy Duty Truck Shipments during the 12 months through April were down 18.0% compared to the year-ago level.
- Shipments are in a recovery trend. Cyclical rise will likely characterize at least the remainder of the year.



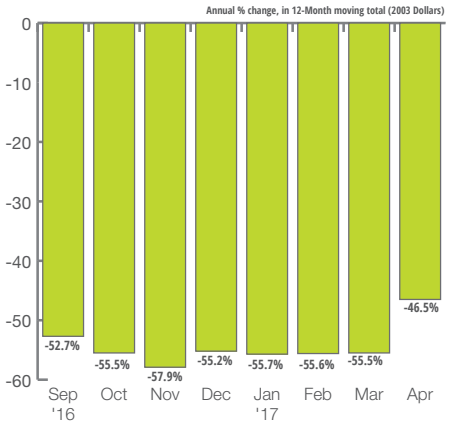
Defense Industry, New Orders:

- U.S. Defense Capital Goods New Orders is in a slowing growth trend, 1.8% above the year-ago level on an annual basis.
- Plan for this segment to mildly decline through the end of 2017.



Mining, Oil & Gas Field Machinery New Orders:

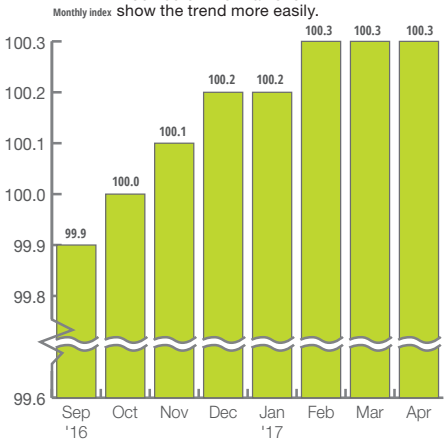
- U.S. Mining Machinery New Orders are recovering but are 46.5% below the year-ago level.
- Rising oil prices bode well for New Orders growth prospects this year.



Euro Area Leading Indicator

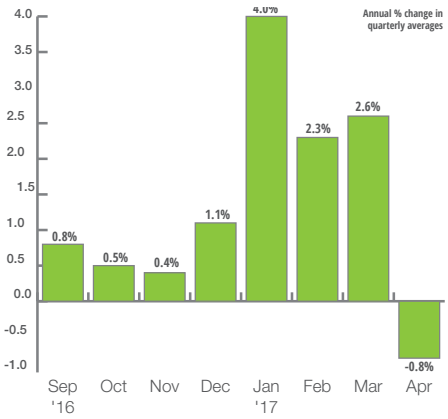
- The Europe Leading Indicator is rising.
- Rise in the Indicator signals there will be further growth within the European economy into at least early 2018.

Editor's Note: Please note that this chart has been modified on the Y-axis to show the trend more easily.



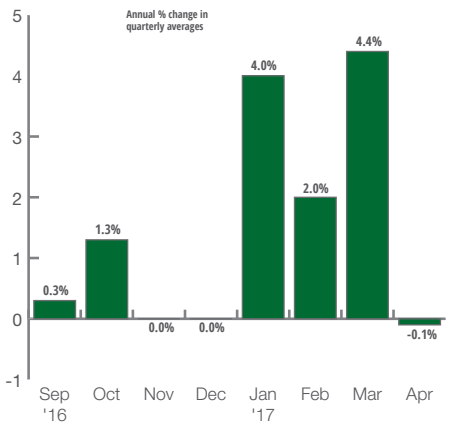
Industrial Production, United Kingdom:

- Average U.K. Industrial Production during the 3 months through April was 0.8% below the same 3 months in 2016.
- Previous decline in the U.K. Leading Indicator and the U.K. Purchasing Managers Index indicates Production will mildly decline in the near term.



Industrial Production, Germany:

- Average Germany Industrial Production in the 3 months through April was down 0.1% compared to the same 3 months 1 year earlier.
- Despite the tick down in quarterly Production, rise in the Germany Leading Indicator is a positive signal for Production growth in the second half of 2017.



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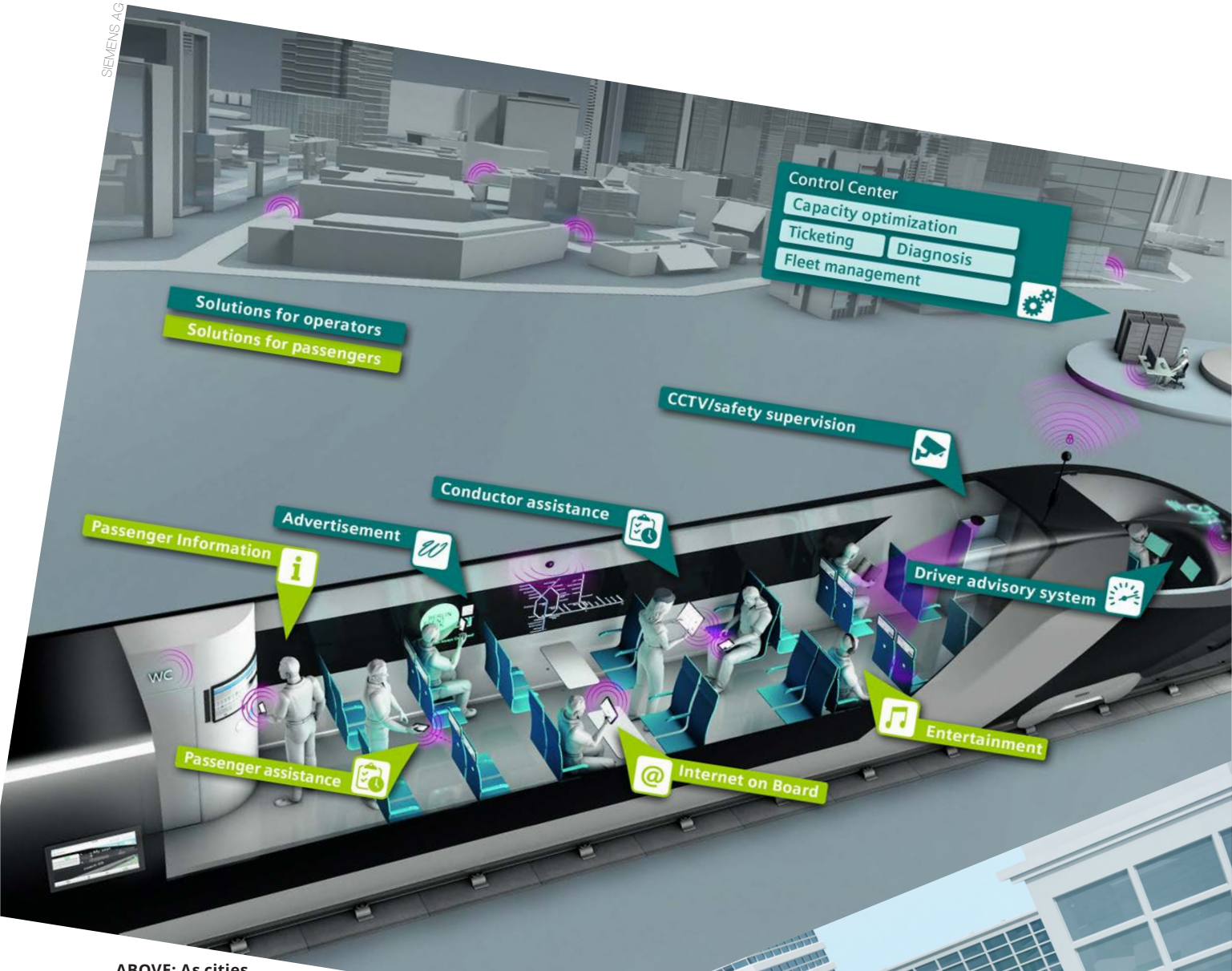

ABOVE: As cities work to become "smarter," technologies like Siemens' mobile passenger assistance system AlwaysConnected will aid city transport by providing passengers with up-to-date information throughout their journey while on a particular mode of transport, such as a train. The system consists of individual modules which the transport company can configure for each passenger.

RIGHT: Real-time information provided by digital technologies will enable drivers within smart cities to find parking more easily, helping to reduce road congestion.

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CITIES OF THE FUTURE will be Smarter, More Connected

Further electrification and connectivity between vehicles, infrastructure and people will lead to the creation of smarter, more efficient cities.

by Sara Jensen

With the world's urban populations anticipated to continue growing in the coming decades, the need for safer, more efficient and sustainable mobility solutions will increase.

Many envision this will be achieved by using the Internet of Things (IoT) and other digital technologies to create connected, or smart, cities. People, vehicles and infrastructure will all be able to interact with one another to help better manage a city's assets—including transportation systems, community and government services—through the use of technology, with the ultimate goal of improving efficiency and quality of life for its citizens.

Data collection and analytics will play a key role, as well, enabling transport operators, for instance, to monitor when modes of transport are most used to better plan routes and arrival times to meet travel needs.

Siemens is one of many companies currently researching vehicle-to-infrastructure (V2I) technology. In 2016, it announced a partnership with the Tampa-Hillsborough Expressway Authority (THEA) to provide V2I technology for a Connected Vehicle pilot project funded by the U.S. Dept. of Transportation (DOT; *learn more, 12186654*). Siemens' V2I technology will allow vehicles and pedestrians to communicate with traffic infrastructure—such as intersections and traffic lights—in real time to help reduce congestion.

The THEA project will use Dedicated Short Range Communication (DSRC) to enable transmissions between about 1,600 cars, 10 buses, 10 trolleys and 500 pedestrians with smartphone applications along its test route. THEA will work with various partners to create a region-wide Connected Vehicle Task Force to support uniform deployment of connected vehicle infrastructure in the region. The project's aim is

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RIGHT: Establishing charging infrastructure will be a key enabler for increased electromobility as cities work to become more sustainable. The pictured charging station from Siemens is capable of recharging buses from various manufacturers.

BELOW: As electric vehicles are typically silent and emissions free, they have the ability to operate in various areas and at times of day that a conventional vehicle may not, such as at night or in noise-sensitive parts of the city.

SIEMENS AG

VOLVO BUSES

to use both vehicle-to-vehicle (V2V) and V2I to relieve congestion, reduce collisions and prevent wrong-way entry on freeway exits; technologies to be used include End of Ramp Deceleration Warning, Intersection Movement Assist and more.

On July 18, the company introduced its SEPAC "Peer-to-Peer" traffic software which allows controllers located at intersections to share information with one another on traffic and pedestrian conditions, enabling the on-street network of controllers to adaptively respond to changing traffic conditions in real-time; this technology further adds to its connected city solutions.

Creating a smart city

In cities of the future, everything from vehicles to buildings to streetlights will have the potential to be connected via digital technologies such as sensors, Wi-Fi and IoT. By doing so, vast amounts of data can be collected and analyzed in real time to see how various functions of the city are operating, and what improvements can be made to create more efficiency.

Smart mobility will be a large part of smart city development in order to make travel more efficient. Cameras and sensors on traffic lights will provide real-time monitoring of traffic flow, and adjust the timing of light changes to help keep it moving as best as possible. Further digitization and connectivity of buses, trains and other modes of public transport will be an aspect, as well, to optimize travel routes and times.

The trends of automation, connectivity and electromobility will contribute to the creation of smart and sustainable cities, says Helena Lind, responsible for media relations at Volvo Buses and corporate communications for Volvo's involvement in the ElectriCity project.

Automation, she says, will lead to increased efficiency and safety, among other things. One way it will be used for future public transport is high capacity buses running on dedicated lanes in Bus Rapid Transit (BRT) systems. In a BRT system, there may be bus-only lanes, and the bus given priority at intersections where it will potentially interact with other traffic. In addition, it may include features to help reduce delays caused by passengers boarding the

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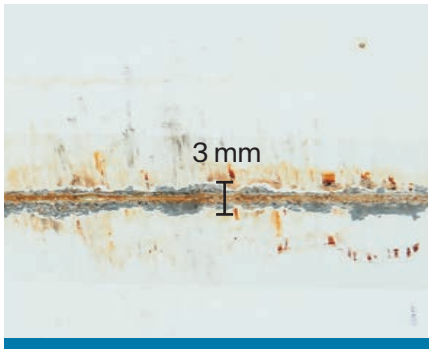
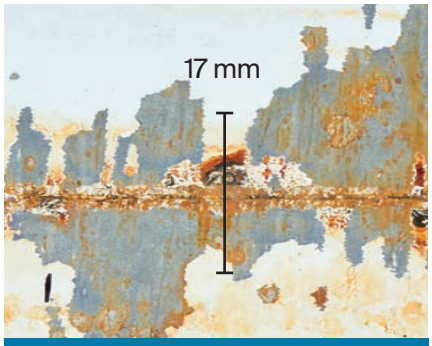


Spectracron AdvantEdge HPP Primer



Standard Two-Component Epoxy Primers

bus or purchasing fares. The ultimate goal of the system is to provide faster travel and reduce delays.

"These vehicles can use platooning technology for increased efficiency and capacity of the bus system," she says. "We see automation will take place first in controlled environments such as terminals or bus depots. Large scale introduction of fully automated commercial vehicles without a driver on public roads and city traffic is further into the future."

Volvo's pedestrian and cyclist detection system provides audio and visual cues to bus drivers, as well as the nearby road users, to alert them of one another's presence.

One of the connectivity solutions she says is available today in Volvo's city buses is its Zone Management System in which vehicles comply with restrictions and specific requirements depending on geographical positioning, or geofencing. Map boundaries are set and downloaded to a vehicle's fleet management software to create zones to apply recommendations, rules and restrictions to vehicles entering a zone. With this system, an electric hybrid bus, for instance, can be programmed to run at low speed and in electric mode in city centers.

The company also offers a pedestrian and cyclist detection system which detects unprotected road users near an electric bus. A sound is transmitted to warn them that the bus is approaching, while sound and light signals within the bus are used to alert the driver of the other road users.

Barry Einsig, Global Automotive and Transportation Executive, Cisco Systems, stated during the recent sustainable mobility summit Movin'On by Michelin *(learn more, 20864950)* that now is the most exciting time in mobility and transportation. He said this is because there are two big industries moving toward one another at lightning speed; one is the vehicle manufacturing industry which is focused on automated systems, while the other is the public sector and the infrastructure associated with it.

Bringing these two industries together and further digitizing them may sound difficult and complex, he said, but lessons can be learned from other industries in which similar changes have taken place, such as retail and banking. Technology will be a key element, particularly to enable fast data transfer; it's likely implementation of 5G internet speeds will be necessary to achieve this.

"If you look at all the things that have to happen in an automated vehicle once there's no human being involved—[looking] at traffic lights, digital signs, sensors—all this information that your eyes and ears are collecting in order to make these decisions, that all has to be digitized and published into the vehicle in real time so the vehicle can make those decisions without human interaction," explained Einsig. "There are things that need to be developed, there absolutely are, but there's a lot of fundamentals we can focus on and get started with [today]."

As digital information transfer between vehicles, buildings and critical pieces of infrastructure progresses, concerns about cybersecurity have grown, as well. Einsig said much of the framework for protecting critical

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Learn more about projects mentioned in this article.

ElectriCity
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DOT Connected Vehicle Deployment Program
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VOLVO BUSES

infrastructure is already in place—security best practices, information security—and the vehicle manufacturers are in the process of working with their associations to create cybersecurity standards.

"I think ultimately we can borrow from the other industries we've already worked in," to ensure cybersecurity in both sectors, he said. What will be unique, though, is the public and private aspect. "Public and private, as we move into multiple connectivities, will have to merge and be secure as one system, and share data between systems," he said.

Creating harmonized, or common data languages will be of importance, particularly as connectivity between modes of transport evolve. Einsig noted that multiple modes of transport are often necessary to get to a final destination, and so it will be necessary to create data systems which can move between

the various transportation methods to ease the experience for the user on all fronts—trip planning, scheduling and payment. "If I have to do a fare payment transaction today for taking a car share to an airplane, to potentially a mass transit system on the other end, that's three scheduling systems, three planning tools, three route optimizations, three payment systems," he said, all of which has to merge together to create a truly smart mobility system.

VOLVO BUSES

Electric buses such as the Volvo one being operated in Sweden as part of the ElectriCity project will help to reduce emissions and noise within cities, all part of the increased efficiency goals of smart city creation.

The role of electric vehicles

"Smart cities are about sustainability," says Lind. "Changes to the transport sector are essential if we are to create next-generation cities."

Due to the massive trend toward urbanization, there will be more people in cities increasing the need for transportation. "In order to solve the problems of congestion, air quality and noise we need to develop more sustainable transport systems," she explains. "Electric vehicles have an important role to play here, since they are silent and emissions-free (when run on renewable energy), and allow us to plan and use our cities in entirely new ways."

Electric vehicles have an important role to play since they are silent and emissions-free.

Because they're silent and emissions-free, electric vehicles can operate in parts of a city that conventional vehicles cannot such as sensitive city areas and inside buildings. They can also operate at night without disturbing people. "Imagine, for example, an autonomous [electric] refuse truck picking up garbage in the city at night, contributing to the city road space being more efficiently used," says Lind.

The ElectriCity project, she says, provides an opportunity to show in real life the benefits of electromobility and how it can transform cities into more attractive places. "By testing in real conditions and real traffic we can learn a lot," she adds.

"Electrification is on the march within the global transport sector, and the next challenge is to integrate electrification with investments in future smart and sustainable cities," said Erik Brandsma, the Swedish Energy Agency's Director General, in a press release announcing Volvo's expansion of its ElectriCity research project in Gothenburg *(learn more, 20864834).*

The trial period for ElectriCity has been extended to 2020, and will see the addition of two electrically powered high-capacity buses to route 16 in Gothenburg. Charging infrastructure and bus stop facilities for electrified high-capacity traffic will be added to the route. The demo area will also include other electrically powered, emissions-free heavy-duty vehicles. Volvo and its project partners will test automation solutions, such as automatic bus stop docking, and bus platooning, as well.

"Changes to the transport sector are essential if we are to create a sustainable society and next-generation cities," said Niklas Gustafsson, Chief Sustainability Officer for Volvo Group, in the press release. "We need to implement sustainable transportation of both people and goods in our cities. That's why it feels particularly gratifying that we are now expanding the ElectriCity demo arena and beginning to examine solutions for automation that can help make electrified vehicles even more efficient."

As the shift toward urbanization increases, the number of people who own a car will most likely decrease as people will live within closer proximity to necessary services and public transportation. This will help give further rise to Transportation as a Service (Taas)—also referred to Mobility as a Service (MaaS)—the use of vehicles on an as-needed basis. Current examples of this include Uber, Lyft, and car and bicycle sharing services.

According to the report "Rethinking Transportation 2020-2030" published by RethinkX—an independent think tank which analyzes and

forecasts technology-driven disruption and its societal effects—this shift will also help lead to the further growth of the electric vehicle market. In the report, author Tony Seba says "cost per passenger-mile" will be an important metric as value is shifted to the TaaS provider from vehicle manufacturers (particularly automakers). As such, they will want to utilize long-lasting, maintenance-free vehicles—e.g. electric vehicles, and eventually autonomous vehicles

Younger generations will also be influential on this shift as they are more environmentally conscious and service oriented. When moving around a city, they want to know if there's a traffic jam and how to get around it, what other modes of transport are available, and to have that information provided quickly and easily, which the further growth of TaaS and connectivity within cities will provide.

"I think from a technology perspective, we are on the way," said Guillaume Gerondeau, Senior Director Transportation & Mobility Asia, Dassault Systemes, during a panel on smart mobility at Movin'On by Michelin. What will be a challenge is data protection and the difference between the various countries.

"If every city, every state, every municipal government wants to have a role in this [smart] mobility, but if we all create separate rules on a city or regional or national basis, then all the opportunity associated with this will be destroyed," added Einsig. Instead, it will be necessary to create scalable systems around regions and countries so manufacturers will not struggle to cost-efficiently build vehicles which can be used in various parts of the world.

Public policy has role, he said, and it needs to be harmonized as broadly as possible. "It may not be 100% harmonized around the world," he said. "Our [Cisco Systems] service providers are not harmonized, but still work on common platforms. I think that's really key for governments to have in mind to have a significant role in connected, highly automated systems and the whole mobility platform."

"All big cities in the world have started this journey; there is not one city that does not think mobility needs to be taken seriously…I think it's irreversible," concluded Gerondeau. "The speed is going to be different [at which they achieve it], but it has started everywhere. Cities have understood that taking the leadership is absolutely necessary."

Visit oemoffhighway.com/20866922 to read an extended version of the article.

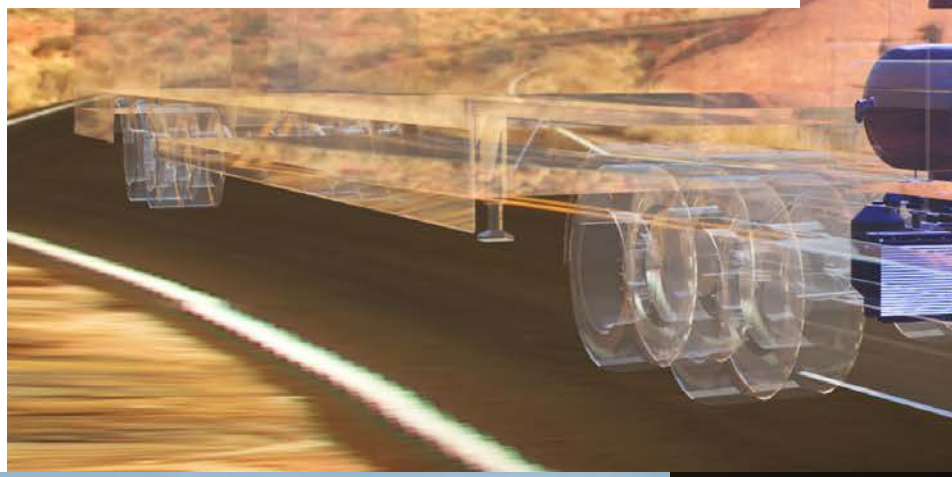
HYDROGEN Proves its Potential in Heavy-Duty Applications

Development of hydrogen fueled systems is on the rise as manufacturers see the emissions-free operational benefits it can provide.

by Sara Jensen

The use of hydrogen as a fuel source has been growing in recent years as vehicle manufacturers continue to shift their efforts toward the development of more sustainable and emissions-reducing power sources. Hydrogen is an attractive option as its only emissions are air and water, making it a truly zero-emission fuel.

Hydrogen can be burned in internal combustion engines or used in fuel cells to power electric motors and other components. This second area is where much of the development efforts have been focused for vehicle applications; heavy-duty vehicles in particular are seen as an application which could benefit from using hydrogen fuel cells as they do not require as large a space claim as batteries.



TOYOTA MOTOR NORTH AMERICA

LEFT: As part of Project Portal, Toyota's prototype truck will be operated at the Port of Los Angeles to determine the feasibility of using hydrogen fuel cells in heavy-duty applications.

RIGHT: The engine compartment of Toyota's hydrogen fuel cell operated prototype truck.

TOYOTA MOTOR NORTH AMERICA

The Toyota prototype truck will use two of the company's Mirai fuel cell stacks for the majority of vehicle travel.

TOYOTA MOTOR NORTH AMERICA

According to Stephan Olsen, Director of Product Planning at Kenworth Truck Co., there are three zero-emission technologies available today to generate power—nuclear, battery and hydrogen fuel cells. He says nuclear power has not yet been developed for transportation applications, and batteries can be heavy, reducing payload capacity in heavier duty vehicles. Batteries also require a significant amount of time to recharge.

Hydrogen fuel cell vehicles, on the other hand, are able to carry sufficient fuel for a full day of regional operation, says Olsen, and can be refueled in under 30 minutes. "Hydrogen is the most plentiful element on earth, and is available virtually everywhere," he adds, helping to further enhance its appeal.

Amanda Lyne, CEO of ULEMCo Ltd., adds that hydrogen can be made from a variety of sources including renewables such as wind and biomass, and as a by-product from industrial applications. She says these aspects help make hydrogen an important energy storage and long-term renewable fuel option.

Development efforts

Several companies have announced use or development of hydrogen fuel cells in recent months. In September, Nikola Motor Co. announced the electric drivetrain for its all-electric Class 8 truck in the U.S. and Canadian markets will be powered by a custom-built hydrogen-electric 800V hydrogen fuel cell *(learn more, 12252872)*. Trever Milton, CEO of Nikola, said in a press release announcing use of the fuel cells that the hydrogen will be produced via zero emission solar farms built by the company.

In May of this year, Kenworth announced several projects focused on developing low- and zero-emission trucks *(learn more, 20860490)*. One of those is a hydrogen fuel cell version of its T680 day cab. Work on the program, called the Zero Emission Cargo Transport Demonstration, is supported by a grant from the U.S. Dept. of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) with Southern California's South Coast Air Quality Management District (SCAQMD) as the prime applicant.

The hydrogen fuel cell version of Kenworth's T680 day cab utilizes Proton Exchange Membrane fuel cells to provide sufficient power in a small package size.

An electric motor will be used to drive the rear tandem axle through a four-speed transmission. The motor will be powered by lithium-ion batteries, the fuel cell or both technologies, says Olsen. The fuel cell will also recharge the batteries, eliminating the need to plug the vehicle in between trips.

Olsen says a Proton Exchange Membrane (PEM) fuel cell—provided by Ballard Power Systems—is being utilized as it is the best means at this stage in development to use hydrogen fuel to power the truck. "This technology can provide sufficient power in a small enough package to make it viable for exploratory use in trucks," he says.

He adds that PEM fuel cells are more efficient in producing electric power than burning the hydrogen and using the combustion energy to drive a generator.

PEM fuel cells use a membrane to separate the anode and cathode, explains Olsen, with hydrogen being supplied to the anode side and air to the cathode side. Use of special catalysts on the anode enable the hydrogen molecules to be processed so their protons pass through the membrane. Once they reach the cathode side, the protons are processed by another catalyst with oxygen molecules from the air to form water molecules. "Meanwhile, the electrons left over after removing the hydrogen's protons pass through a circuit external to the membrane, providing the electrical power output of the fuel cell," he says.

The truck is expected to run in regional operation within the Los Angeles basin, having a minimum range of 130 miles depending on load and duty cycle. Thirty of those miles will be all-electric, says Olsen.

Toyota Motor North America Inc. also announced earlier this year its plans to test a hydrogen fuel cell powered truck at the Port of Los Angeles *(learn more, 20858891)*. Known as Project Portal, Toyota will conduct a feasibility study to determine the potential of using fuel cells in heavy-duty applications.

The Toyota vehicle will utilize the company's Mirai fuel cell stack currently employed in its hybrid passenger cars. Knowing the need to expand emissions-reducing technologies to all vehicle types, Toyota decided to test the fuel cell's use in a Class 8 truck as it is the largest application in the U.S. in which to apply the company's fuel cell technology says Tak Yokoo, Senior Engineer, Toyota R&D North America. Once it's understood how the technology works in a heavy-duty application, it will be easier to have a pathway for extending it to the entire vehicle transportation industry.

Toyota will use two Mirai fuel cell

stacks in its prototype truck, along with an electric motor, battery and other necessary power electronics. When running at a steady state, the fuel cell will provide the power necessary to move the vehicle. Once extra power is needed, such as for acceleration or pulling a heavy trailer, the battery will be used in tandem with the fuel cell. As soon as a steady state is reached again, the fuel cell will recharge the battery.

Yokoo says one of the things that sets the Toyota prototype truck apart is the size of battery it will employ. Pure battery electric Class 8 trucks typically use a large battery of about 300 kWh, he says, and even some fuel cell versions have one in the 100-kWh range. However, the Toyota truck will only need a 12 kWh battery. This is because the fuel cell will be used the majority of the time to power the vehicle. "Any kind of vehicle when driving constant speed uses less than 200 kW of power," he explains. And that power need can be met by the two fuel cell stacks, each of which develops 118 kW of power (236 kW in total).

Even when the battery power is needed, it's usually not for an extended period, often less than 1 minute, says Yokoo. As such, the company attempted to find the minimum size battery which would provide only the necessary extra power.

Both the Kenworth and Toyota trucks have on-board hydrogen storage tanks to ensure a continued fuel supply for the fuel cells.

While many are focusing on hydrogen fuel cell development, ULEMCo is working on the engine side of things, converting them to use hydrogen. The company has the ability to covert engines to 100% hydrogen operation, but that is usually done with spark ignition engines which Lyne says are less efficient than diesel compression engines. In addition, she says that when hydrogen burns in an engine, precautions need to be taken to manage NOx (nitrogen oxides).

Because of this, much of the company's work is in developing dual-fuel engines operating on a mix of diesel and hydrogen. Lyne says ULEMCo can convert any conventional diesel engine to dual-fuel; the benefit of doing so is the engine being able to still operate on diesel when no hydrogen is available. "By using a mix of fuels and an efficient engine we can provide an optimized solution," she says. "Also, by having the capability to run as a conventional diesel engine when hydrogen is unavailable, the vehicle or off-road equipment can still perform its duties."

Lyne says the core of the compa-

ny's technology is its engine control unit (ECU) and hydrogen supply system consisting of hydrogen storage, pressure regulators, pipes and safety measures. The system works by injecting hydrogen into the air inlet of the engine and controlling the ratio of diesel and hydrogen to optimize the engine for performance, emissions and fuel use.

Larger vehicles are the main focus for the technology as there is more room onboard the vehicle for hydrogen storage. Last year the company converted a bin lorrie in Scotland to dual-fuel operation *(learn more, 12210898)*. Most recently it announced a collaboration with H2B2 to accelerate the commercialization of hydrogen fueled vehicles in Spain and the UK *(learn more, 20857140)*. H2B2's work is in economic, green production of hydrogen while ULEMCo and its customers provide an avenue for that fuel to be used, making the two companies a good fit for the partnership.

For now the company is focusing on conversions as OEMs consider their strategies on hydrogen, Lyne says. "We are looking to get whole type approval status for our approach (currently this is not technically possible in the regulations), and continue to explore options for the longer term."

Hurdles yet to overcome

Refueling infrastructure is one of the biggest challenges associated with making hydrogen a more commonly used fuel source. While availability of public refueling stations is growing, Lyne notes it's from a small base of sources. The lack of scale in the supply chain of infrastructure equipment also makes the capital cost of facilities high in comparison with those for conventional fuels. "However, there are options for back-to-base fleet operations or off-highway sites with sufficient vehicles or equipment to achieve a comparable cost with diesel," she says.

"Hydrogen fueling stations for heavy trucks are virtually non-existent today," says Olsen. "There will need to be a considerable investment in refueling infrastructure before the use of hydrogen commercial vehicles can become widespread."

Kenworth sees three major hurdles to be overcome in order for hydrogen fuel cell trucks to become more commonplace. The first, says Olsen, is the size of fuel cells. He notes the one currently being used in Kenworth's prototype truck fills the entire engine compartment. However, the company's suppliers are working on improving power density to provide more power in a smaller package.

Fuel cell cost is another challenge; they are expensive due to the precious metals being used by the catalysts on both the anode and cathode. "With improvements in the efficiency of these catalysts and the rest of the system, along with increased production volumes, they are expected to come down in cost over time," Olsen says.

The final hurdle is the on-board hydrogen storage tanks, as they take up a lot of real estate on the truck chassis. "Hydrogen is a very small molecule. Even though there is three times the energy in 1 kg of hydrogen than in 1 kg of diesel fuel, hydrogen's tiny molecules want to take up a lot of space," explains Olsen. "Even compressing hydrogen to 350 bar or 700 bar (5,000 psi or 10,000 psi), it still takes up a lot of space on the truck chassis – by the time the tanks are wrapped, plumbed and mounted in a cabinet on the truck, the hydrogen fuel storage system takes up 30 to 40 times the amount of space as a diesel fuel tank containing the same amount of energy. We are looking into ways to make more efficient use of space with the hydrogen tanks on the truck."

Even with these challenges, many see the value in hydrogen as a fuel source, and so will continue to develop and enhance the necessary technologies to make it a viable option.

In January, 13 leading energy, transport and industry companies formed the Hydrogen Council, a global initiative focused on providing a united vision and long-term ambition for hydrogen being an integral part of the energy transition *(learn more, 20849445)*. Daimler, Shell and Toyota are among the members of the council. At its launch, the members confirmed their ambition to accelerate investments in the development and commercialization of the hydrogen and fuel cell sectors. Investments are estimated at a total value of €1.4 billion per year.

With so much interest from manufacturers, fuel providers and other organizations, hydrogen's future appears it will continue in a positive direction.

ULEMCo converts engines in heavy-duty applications to dual hydrogen and diesel operation to enable use of either fuel based on refueling availability.

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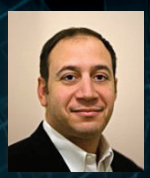

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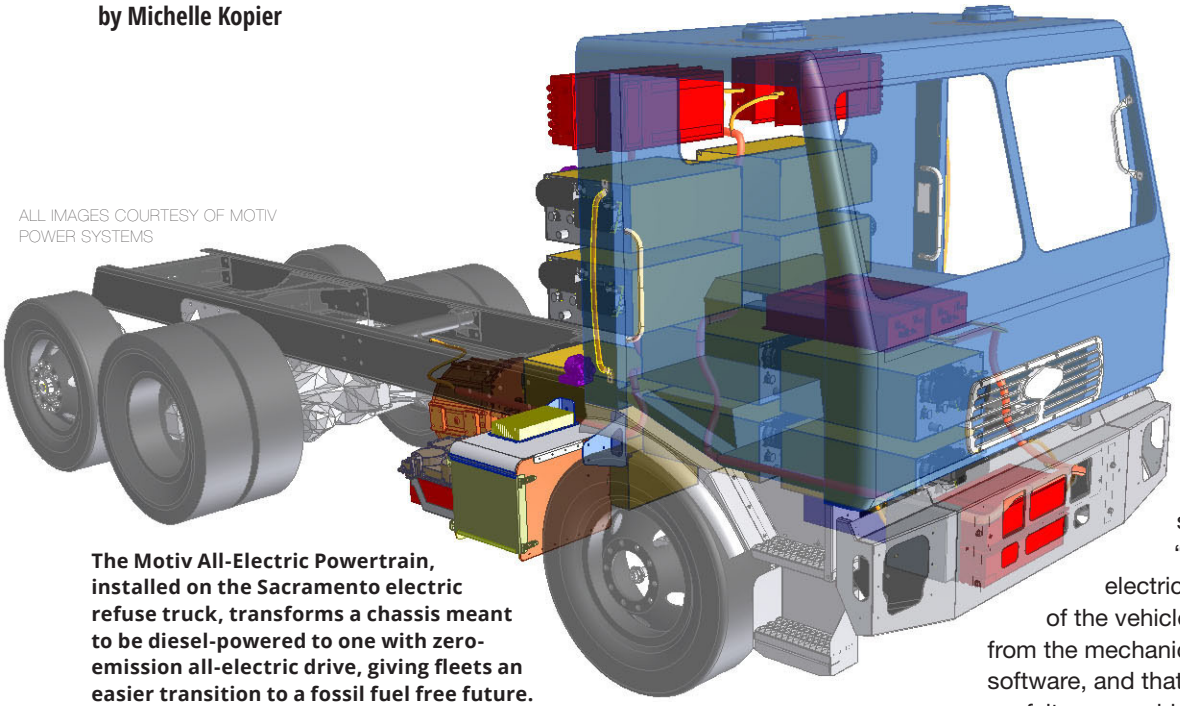
Eliminating Fossil Fuel Dependence ONE ELECTRIC VEHICLE AT A TIME

A scalable, all-electric powertrain kit with power electronics, controls, and software makes transitioning a specialty vehicle from diesel to zero-emissions simple.

by Michelle Kopier

ALL IMAGES COURTESY OF MOTIV POWER SYSTEMS



The Motiv All-Electric Powertrain, installed on the Sacramento electric refuse truck, transforms a chassis meant to be diesel-powered to one with zero-emission all-electric drive, giving fleets an easier transition to a fossil fuel free future.

An overhead shot of the Motiv system on the Ford F59 chassis.

Eight years ago, Jim Castelaz, now CEO and founder, launched Motiv Power Systems with a mission – to free truck and bus fleets from their dependence on fossil fuels. A former fellow with the Department of Homeland Security, Castelaz noticed that trucks, buses, and heavy commercial vehicles were not only the workhorses of our economy, but also the most dependent on fossil fuels.

"While looking at that market segment and how the vehicles were built, I saw an opportunity for energy independence. There were a lot of specialty vehicle manufacturers with varying routes, but they all essentially used the same set of core components from a few major suppliers," says Castelaz. The need was in the increasingly complex nature of the software necessary to control electrified vehicle systems.

"As vehicles go electric, the complexity of the vehicle is shifting away from the mechanical and toward the software, and that's an area where we felt many vehicle manufacturers wouldn't have internal expertise," Castelaz says. As a result, Motiv was formed and a model was developed to create a scalable all-electric powertrain kit complete with software. OEMs can now easily drop in a Motiv all-electric powertrain into their existing vehicle platforms to offer an all-electric version of their vehicle models.

"Our expertise is around the software; our value proposition for a vehicle builder is that they don't have to build custom software to have an electric vehicle option available to their customers. It is the same idea as computers or phones—each manufacturer does not need to develop its own software but instead can use Android or Windows, respectively," Castelaz explains. For a prototype, any

LEFT TO RIGHT:
Chicago's Electric Refuse Vehicle is powered by Motiv's all-electric powertrain system. A Sacramento school bus equipped with a Motiv system. Four all-electric community shuttle buses, funded by Google in a two year pilot project, are on the road in Mountain View, CA. The shuttle buses use a modular, plug-and-play electric powertrain technology from Motiv Power Systems.

vehicle design team could create a basic software platform, but for commercial viability on a vehicle model, there is software infrastructure that needs to be developed to allow for software updates, support diagnostics, and create industry-acceptable safety parameters.

System hardware and software

"We have one technology platform—the electric powertrain platform, and the operating system of the vehicle, plus our power electronics and controls," says Castelaz.

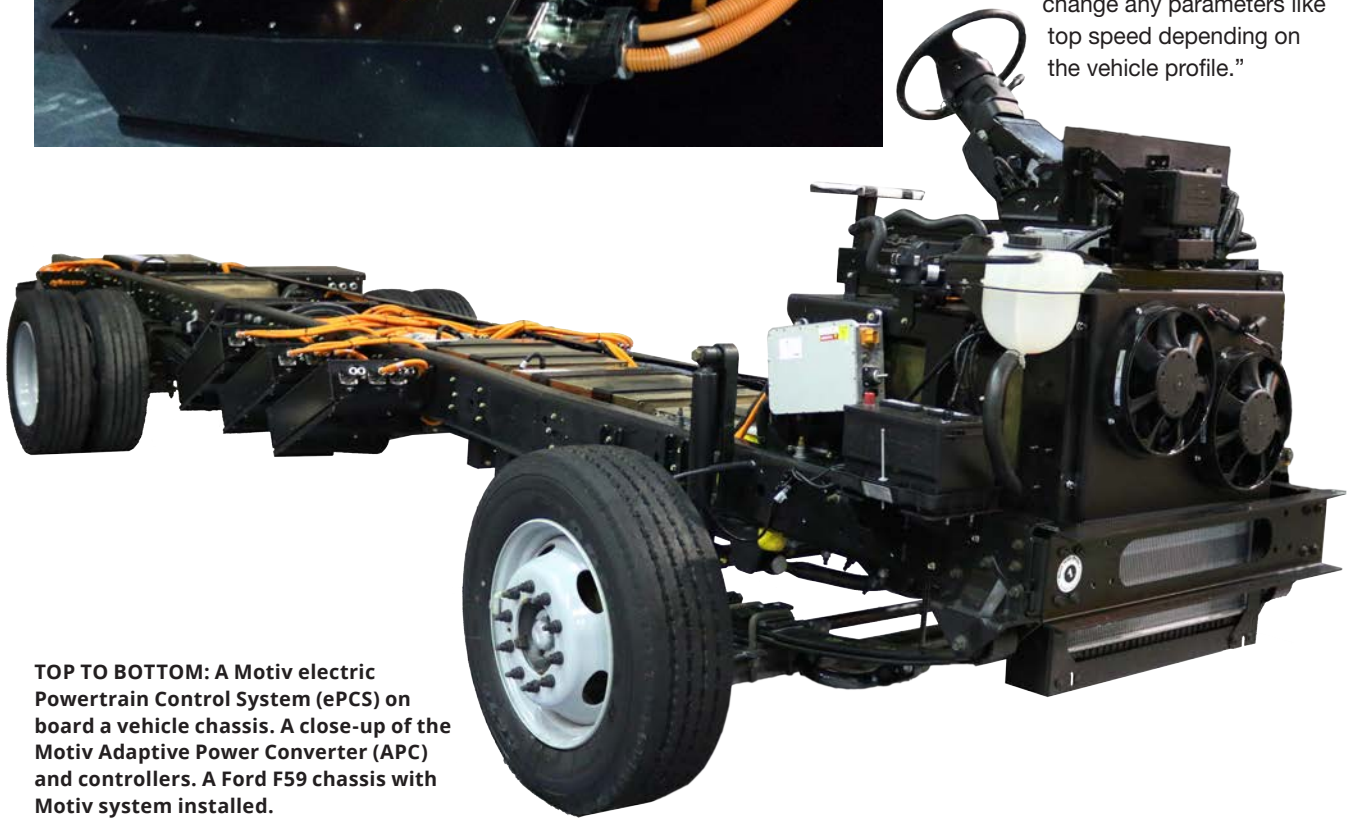
At the heart of the powertrain's scalability is a Motiv Adaptive Power Converter (APC), a voltage converter to move the power between the battery and the vehicle. This core component gives Motiv the ability to integrate any number of battery packs with different chemistries, voltages, and current charge and discharge specifications. The technology also allows Motiv to use commercially available battery packs.

"We have school buses fitted with four battery packs, and we have garbage trucks with upwards of 10 or 12- battery packs. Our scalable system allows us to scale the amount of energy storage on the vehicle as is appropriate for the weight of the

vehicle as well as the route style. It is really the only solution available to avoid either customer battery pack design or custom vehicle design—both of which introduce cost, time, and reliability and supply risk," says Castelaz.

The other significant part of the powertrain kit that allows for scalability is the software. The powertrain software system networks all of the system components together into a central powertrain control unit which communicates with the instrument panel and ABS module in both the chassis software and the driver-facing software. "The batteries have their own controllers and battery management system, we have our own controllers and high voltage accessories that have control units, and we created the powertrain central control unit to allow them to talk to one another and other vehicle systems," explains Castelaz.

"We also have administrative software to create a secure channel for firmware updates over, diagnostic software, and configuration management to allow the end-user fleets to change any parameters like top speed depending on the vehicle profile."



TOP TO BOTTOM: A Motiv electric Powertrain Control System (ePCS) on board a vehicle chassis. A close-up of the Motiv Adaptive Power Converter (APC) and controllers. A Ford F59 chassis with Motiv system installed.

Motiv uses the same software on all vehicles versus the more conventional approach of designing customized software for each different vehicle application. “Our single software product is in very diverse routes already, from delivery trucks to school buses,” Castelaz says.

In the vocational vehicle space, where there is a high mix of vehicle types for a broad range of applications, each application may not have the critical mass to justify the cost of custom engineering. That’s why the Motiv common software operating system and flexible battery pack kitting makes for an affordable alternative for small-volume OEMs that want to offer an all-electric version of their vehicle models.

Applications and expansions

Due to the restrictions of current battery technologies, the Motiv system does not yet support long-haul applications. Instead Motiv looks to applications running up to 85 miles per day. This targets more urban and suburban vocational vehicles. However, the electric powertrain system is not limited to the on-highway market. “We have had many inquiries from the off-highway segment. Our core software is applicable for vehicles in construction, agriculture, and mining, for example,” Castelaz says.

One factor affecting the company’s active participation in off-highway applications is the lack of incentive funding for end-user fleets that want to pursue electric zero-emission vehicles. Conversely, for on-highway fleets there are substantial dollars to be awarded.

While Motiv currently has a robust portfolio of tested and proven battery, motor, and high voltage accessory options available to place into an electric powertrain kit, some may not be robust enough for the more rugged off-road industry. However, “we could find the correct subset of hardware that would work for off-road application routes and then be able to use our proven powertrain software to minimize the development timeline,” confirms Castelaz.

According to Motiv, approximately one third of the 8 million fossil fueled trucks and buses in the U.S. are ideal for electrification. These are the vehicles which drive on planned local routes such as school buses, garbage, and delivery trucks, and shuttle buses, with frequent starts and stops for regenerative braking energy reclamation, as well as an overnight storage depot with the infrastructure necessary for charging the vehicles.

As the popularity of vehicle electrification and emissions elimination continues to grow in the public eye and pull the electric vehicle progress forward, there is also continued regulatory pressure for emissions regulations, national security, and oil dependency pushing fleets toward alternative power sources. Motiv is already demonstrating its ability to offer low-volume, specialty application vehicle electrification using its common software platform and powertrain kit for those OEMs wanting to dip their toes in the water without taking on the development themselves.

Battery Technology and Vehicle Investments Continue to EXPAND

Clean and emissions-free vehicle development shows no sign of slowing down, and battery technology is driving its success forward around the world.

by Michelle Kopier

According to IDTechEx's latest report, "Electric Buses 2018-2038," the hybrid and electric bus market is set to grow to a $500 billion market as city populations continue to grow and regulatory demands increase around the world *(read more, 20867496).* More people worldwide are moving to cities each year. The U.N. predicts the estimated global population of 9.8 billion people by 2050 will see approximately 66% of them living in cities. That idea is putting increasing pressure on finding clean transportation solutions. Even now large cities are announcing future bans on internal combustion engines in city centers.

Battery manufacturers invest, grow

In the past year, several financial investments and acquisitions in the battery, fuel cell and ultracapacitor space have demonstrated that the interest in improving existing battery technology is only increasing. *Learn more about the differences between batteries and ultracapacitors in Sara Jensen's article, "Increase Efficiency by Distributing the Workload," at www.oemoffhighway.com/10733401.*

BMZ expands in Europe

BMZ Group, a lithium-ion system solution manufacturer, announced it will be expanding its Poland production facility and its 650 employees to a larger building "to respond to the strong growth in the market for lithium-ion battery systems, and…to further expand our production," says Sven Bauer, CEO & Founder of the BMZ Group. BMZ Poland is focusing on developing E-bus batteries for public transportation *(learn more, 20866897).*

BMZ also recently completed a collaboration with AKKU Mäser GmbH to assemble lithium-ion battery systems and expand manufacturing into Austria and Switzerland. "In the future, BMZ will manufacture prototypes and series products in cooperation with AKKU Mäser," says Bauer.

Maxwell makes strategic moves in China

In February of 2017, Maxwell Technologies Inc., a manufacturer of capacitive energy storage and power deliver solutions, expanded its partnership with CRRC-SRI to localize manufacturing of its ultracapacitor-based modules for use in the China new energy bus market. Under the terms of the agreement, localized production of its ultracapacitor-based modules is expected to begin in China in the second half of 2017, coinciding with the peak buying season for China's new energy bus market. The production

of bus modules extends Maxwell's strategic partnership with CRRC-SRI and will enable Maxwell to compete more effectively in the China bus market moving forward *(read more, 20850738).*

By April, Maxwell had signed an equity investment agreement with China's SDIC Fund Management to allow the company to sufficiently invest in strategic technology development and expand its presence in the Asian market *(learn more, 20857735).*

One month later, Maxwell announced it had completed its acquisition of Nesscap Energy Inc., a small- and medium-cell ultracapacitor technology producer, which will round out Maxwell's portfolio of products that concentrates more heavily on large cells. The Nesscap business includes research, development and manufacturing of energy storage and power delivery solutions with operations in Korea, Germany, and China. The key benefits of the transaction include expanded and solidified opportunities in the wind, automotive, and industrial markets that are expected to accelerate top-line growth, diversify revenue, accelerate innovation, and reduce product time to market with an expanded portfolio and improved cost competitiveness through manufacturing efficiencies.

Microvast invests in the U.S.

Microvast had a record year in 2016, delivering more than 7,500 all-electric and hybrid-electric buses for metro transit use worldwide. The company also announced plans to expand operations in the U.S., where it expects to put its first e-buses on the road in 2017. As of the end of 2016, more than 15,000 Microvast battery-powered buses were operating in public transport networks in China, as well as in five countries in Europe *(read more, 20851008).*

Due to its successful 2016, the company is advancing its activities in the U.S. This includes a primary emphasis on the e-bus sector, while also pursuing opportunities in truck electrification, mining processes, grid-scale energy storage, and other markets. "We're moving forward with a major expansion of our U.S. activities, beginning with establishing a manufacturing facility, hiring more staff, and creating partnerships to support that effort," says Hanko Song, Microvast Vice President of Marketing.

In the U.S., Microvast sees a significant opportunity to electrify

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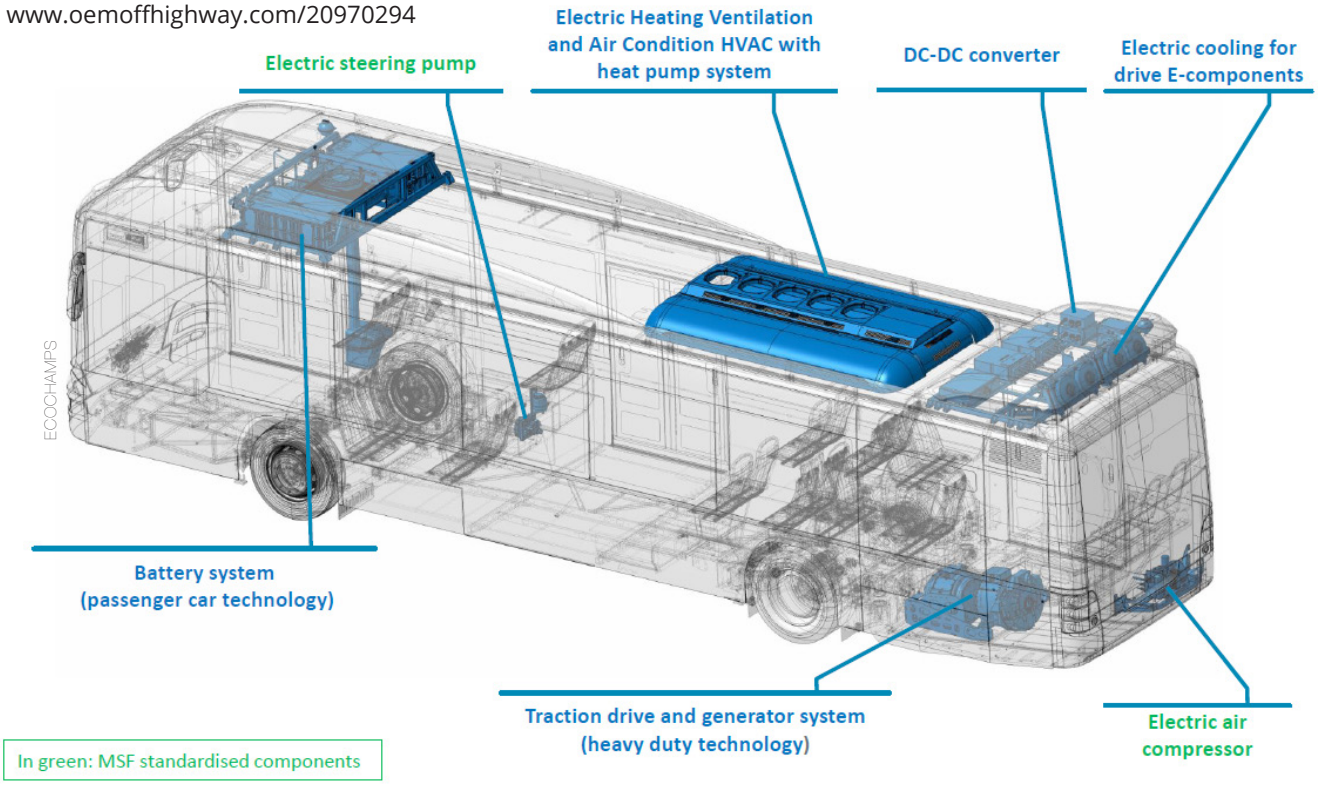
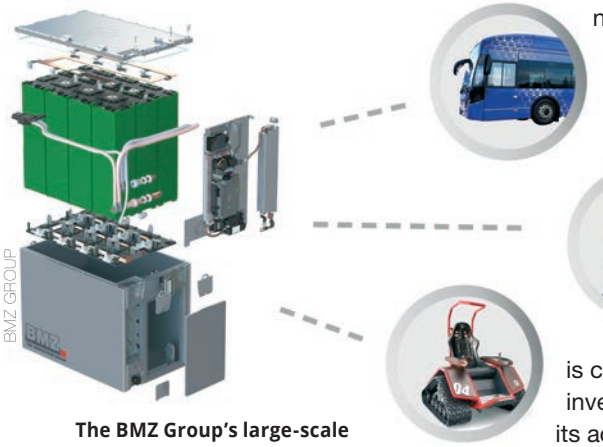


MAN is developing a concept for a basic vehicle with electric driveline. Different energy sources can be integrated, for example a diesel generator or a fuel cell. This will also make it easy to add additional storage capacity to a purely battery-electric vehicle which is charged in the depot.

public transport like it has in other countries. To that end, the company established a U.S. headquarters near Houston that will expand to include additional engineering, service and production personnel. Nearby in Sugar Land, TX, Microvast will open a new battery pack manufacturing facility, which will be in compliance with the FTA's Buy America program.



The BMZ Group's large-scale lithium-ion batteries for vehicles like buses and forklifts feature quick-charging capabilities with 24-48V that can be connected in parallel and cascaded up to 800V.

The company's subsidiary, Microvast Power Systems (MPS) received a $400 million investment to launch its next generation of higher density products and expand its production facility *(learn more, 20858932).* "The funding we received will be used for continued research and development, as well as scaling production capacity. We will also implement our Clean City Transit strategy in China, North America, the EU and Asia Pacific area," says Yang Wu, CEO of Microvast Inc. "The fast-charging approach is becoming an industry trend," says the director of this investment from CITIC Securities. "Microvast is committed to a high level of investment in R&D to maintain its advantage in advanced battery technologies. The company is also accelerating the commercialization of those technologies, which makes us very confident in its potential."

Cleaner cities

Most of the large, heavy-duty vehicle manufacturers have announced an interest or investment in expanding their reach into the electric vehicle market. The ElectriCity project, for example, has brought together companies, researchers, public authorities, and the city of Gothenburg, Sweden, since 2013 to test and develop new solutions for sustainable transport and sustainable urban development.

Already with 2 years of successful testing for 10 all-electric or partially electrified buses on route 55 in Gothenburg, Sweden, Volvo and the ElectriCity partners recently announced it would be expanding its electric bus operations *(read more, 20864834).* According to the original plan, the tests were scheduled to end in 2018, but now the trial is being extended with additional vehicles and the test period will continue to 2020.

When the Volvo Ocean Race comes to Gothenburg in June 2018, two electrically powered articulated

buses will showcase the latest developments as they operate between Nordstan and Frihamnen. These two prototype buses will then run on route 16, which will be equipped with charging infrastructure and bus stop facilities for electrified high-capacity traffic.

The EU's Horizon 2020 ECO-CHAMPS (European **CO**mpetitiveness in **C**ommercial **H**ybrid and **A**uto**M**otive Powertrain**S**) project is a consortium of 26 partners whose aim is to gain a leading position in hybrid powertrain technology, extend its use in the marketplace, and significantly reduce CO_2 emissions from road transport to have a positive effect on air quality.

Two of its several vehicle concepts are the DAF XF heavy tractor and the MAN city bus *(pictured on pg. 32)*. MAN is constructing a hybrid bus that should be up to 20% more efficient in the driveline. "In the city bus segment in particular, we are seeing huge potential for using eMobility applications. However, the total cost of ownership (TCO) plays an especially significant role for transport operators and carriers," explains Dr. Götz von Esebeck, Head of eMobility at MAN Truck & Bus. The concept vehicle with electric driveline can have different energy sources integrated, for example a diesel generator or a fuel cell. The flexibility will also make it easy to add additional storage capacity to a purely battery-electric vehicle which is charged in the depot *(learn more, 20863692)*.

Montreal, Canada recently acquired three 100% electric buses by Nova Bus as a part of its Montreal City Mobility project. The vehicles were acquired by the Société de transport de Montréal (STM) in accordance with a financial support from the Green Fund of the Government of Quebec. This project is a result of the Quebec Transport Electrification Action Plan 2015-2020 which seeks to get 100,000 rechargeable electric and hybrid vehicles registered in Quebec *(read more, 20862944)*.

Earlier in January, New Flyer completed a successful three-week demonstration of the New Flyer Xcelsior XE40 battery-electric bus for the Metropolitan Atlanta Rapid Transit Authority (MARTA). New Flyer integrates Michigan sourced lithium-ion batteries into a durable energy storage system designed for North American applications. Close to MARTA in nearby Alpharetta, GA, Siemens manufactures high-efficiency electric motors and power systems for the Xcelsior's propulsion and regenerative braking system *(read more, 20849643)*.

New Flyer electric buses have the ability to quick-charge at an

ATLAS COPCO

Atlas Copco worked with Artisan Vehicle Systems—a manufacturer of electric and hybrid powertrain systems—to develop its Scooptram ST7 battery vehicle. Artisan supplied the battery, as well as the electric motors and drives.

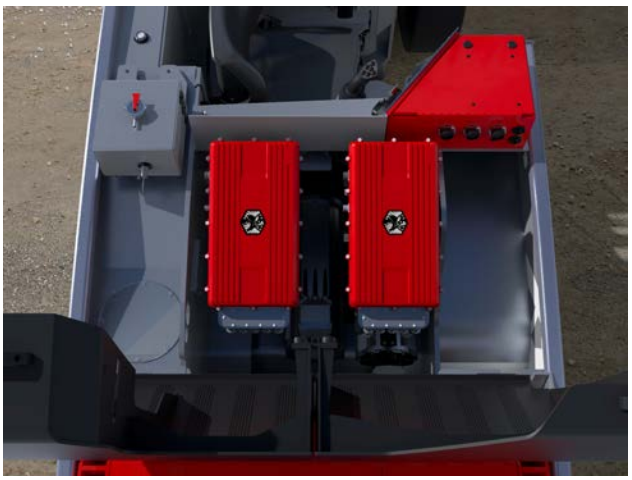
equipped bus stop. This capability typically requires only 6 minutes of re-charge for every hour of service operation. New Flyer also builds extended range electric buses with more battery capacity. These buses can operate for longer periods during the day, then recharge over-night using plug-in charging. MARTA is considering both charging methods.

"Our zero-emissions battery-electric bus demonstration in Atlanta follows MARTA's debut of New Flyer's clean-air compressed natural gas (CNG) articulated buses in May 2016. Whether it's battery-electric or low emissions CNG, each propulsion system with New Flyer's Xcelsior platform offers both environmental and operational benefits," says Paul Smith, New Flyer Executive Vice President, Sales and Marketing.

Off-road application growth

The bus and public transportation market is just one area where battery development can be a benefit. Although the use of batteries in heavier-duty off-road applications still faces hurdles with higher power applications due to their large size and heavy weight, another report by IDTechEx, "Electric Vehicles for Construction, Agriculture and Mining 2017-2027," forecasts those markets will total approximately $81 billion by 2027. Considering the lower volume of off-road equipment versus on-highway trucks, buses and municipal applications, that is a significant value *(read more, 20859895).*

ARTISAN VEHICLE SYSTEMS



One of the Artisan Vehicle Systems lithium battery solutions on board its own 153 1.5 yd., 3 ton load/haul/dump (LHD) underground mining vehicle. The 153 has 300% of the horsepower of a diesel 2.0 yd. LHD.

Last year at MINExpo in Las Vegas, several of the major mining OEMs released battery-powered underground mining vehicles. Besides creating a quieter working environment, it also significantly benefits the safety of a confined underground mine site. For a site manager to be able to employ vehicles that emit zero emissions, it can mean a huge cost savings for the ventilation needs of the mine. There is also substantially less heat emitted from a battery-electric vehicle versus a diesel engine-powered mine truck, and less noise. *Learn more about the trend toward battery-power for underground mining applications in Sara Jensen's article, "A Matter of Survival," at www.oemoffhighway.com/12246203.*

Atlas Copco, for example, released its Scooptram ST7 battery-powered scoop in 2016 *(read more, 12216146).* "Loaders and trucks consume about 80% of the diesel fuel underground. The loaders are most often used in dead ends of the mine, which are the most difficult to ventilate. To make the greatest impact on work environment and ventilation costs, it was an obvious choice for Atlas Copco to launch a battery driven loader as our first product of this type," says Lars Senf, Vice President Marketing at Atlas Copco Underground Rock Excavation division. It also generates 80% less heat, helping further reduce operational costs for mines. "The diesel machines generate so much heat you have to optimize your air conditioning system which is also very expensive," says Erik Svedlund, Global Product Manager, Electric Vehicles – Underground Material Handling at Atlas Copco.

Atlas Copco worked together with

Artisan Vehicle Systems—a manufacturer of electric and hybrid powertrain systems—to develop the ST7. Artisan supplied the lithium battery, as well as the electric motors and drives. Two 630V AC electric motors are used within the machine, one for the drive system and one for the hydraulics. Both are variable speed motors designed to run only when necessary and at the speed required for operation, making the system more energy efficient.

Sandvik introduced two battery-powered vehicles at MINExpo. Its battery-powered loader, the Sandvik LH307B, uses a lithium titanate oxide (LTO) battery *(learn more, 12270372),* and its DD422iE mining jumbo utilizes a molten salt (sodium-nickel chloride) battery technology *(learn more, 12266992)*.

The global battery industry is seeing strong manufacturing support from a wide array of heavy-duty vehicle markets from on-highway transport solutions to underground mining. As battery technology is continuing to improve in capacity, reduce in size and lower in price, the solution is becoming more feasible for low-volume vehicle applications. The coming years are predicted to see a huge growth in the hybrid and electric bus market, and in turn drive an already growing battery market.

Volvo's EX2 produces zero emissions while providing 10 times higher efficiency and 10 timess lower noise levels. Read more online, oemoffhighway.com/20861738.
VOLVO CE

A L.E.A.P. into Workforce

One manufacturer is partnering with educational institutes to help train the next genera

by Sara Jensen

In February 2017, Siemens announced the launch of its Lifelong Educational Advantage Program (L.E.A.P.) with the aim of offering workforce development training to secondary and technical schools across the U.S. *(learn more, 20853383)*. Through the program the company will provide educational institutions with the tools to teach students the skills necessary for a career as a CNC (Computer Numerical Control) machinist.

Brian Hamilton, L.E.A.P Program Manager at Siemens, says for several years the Siemens Cooperates with Education program has provided workforce development for PLCs (Programmable Logic Controller). As the current manufacturing workforce begins to age and leave for retirement, the industry is struggling to find skilled replacements, which is why Siemens decided to expand its training efforts. "We have a lot of large companies out there clamoring for people that know the Siemens Sinumerik control, and can go in working on it [right away]," he says. "We decided to develop this program so that companies out there could actually have an educated workforce."

He notes that Siemens' control technology is used by numerous machine tool manufacturers, helping lead the company to its decision to work directly with schools to offer certification.

How the program works

To take part in L.E.A.P., a school simply needs to sign up for the program and own a machine tool with a Siemens control, and Siemens will provide all of the necessary course materials and documentation. It will also train the instructors on how to set up, operate and program a CNC machine equipped with Siemens' control product so that they are also certified and better able to teach and certify the students on how to work with the machinery.

Once a school is signed up with the program, it also receives deep discounts on Siemens products.

The CNC machinist training consists of two machine tool disciplines—one for milling and the other turning. Each one is divided into different educational levels to provide basic to advanced competencies. Milling includes a total of three levels; the first, says Hamilton, is a conversational program called Shop-Mill. This is an introductory level, he explains, providing an easy way for students to get into CNC without needing a lot of trigonometry or other high-level math skills. The following two levels advance upon the introductory one offering training in G-code programming and then five-axis programming.

Two training levels are included in the turning discipline—an introductory level called Shop-Turn and the advanced level, Shop-Turn programGUIDE.

A key element of the training program is the use of Siemens' Sinu-Train PC-based software. Hamilton says it is an engineering software used by the company's engineers to help customers troubleshoot machine issues. For L.E.A.P., it provides students a tool with which to learn how to program CNC machines.

Siemens offers the program to the schools at a discounted rate; students can purchase a full product version in the student store also at a discounted rate, allowing them to install it on their home PCs so they can practice programming the machine, and easily transfer files back and forth via a USB stick. "The students can program the machine, do everything at home, proving out their program before running it on the CNC machine," says Hamilton. "It's very graphically advanced, so

Development

tion of CNC machinists.

they can see the product after it's done. They simulate it, see what it looks like, take it in [to the classroom] and run the product right off the bat, so it really streamlines the whole process."

Hamilton says the main difference between L.E.A.P. and other similar programs out there is that Siemens offers it free of charge to educational institutions. "This is something we're doing as a service to the community and the institution; they can offer something that no one else is offering."

In its first year, Siemens had nine schools taking part in L.E.A.P. This year there are 17 additional educational institutions involved with the program, including universities and community colleges. "It's been a great success," says Hamilton, as the schools enjoy the accreditation its instructors and students receive.

The SinuTrain software features an advanced graphical interface for ease of use.

ALL IMAGES COURTESY OF SIEMENS CORP.

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Multi-Function Displays

In a market dominated by single-purpose monitors, ACTIA is deploying a new generation of Multi-Function Displays (MFDs).

- High performance HMI with 4.3-, 7- and 12-in. WVGA TFT screen
- Dedicated graphics/video processor allowing four channel real time video display
- Sunlight readable luminosity (1000nit/1000:1)
- Multiple interface options and protocols with the vehicle/vessel or machine
- Multi-Touch PCAP Technology with optional capacitive or resistive touch screens
- ACTI-GRAF ready
- Ruggedized to IP65/67
- Flexible Linux OS allows the OEM to autonomously design applications and integrate functional solutions on many platforms where the elements are of concern

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Don't forget to...
SEARCH for more product information online using the unique **URL** under each product!

Electroless Nickle, PTFE and Nanodiamond Coating

Nanodiamond material specialist Carbodeon of Finland has worked with metal finishing specialist CCT Plating of Germany to develop an electroless nickel, PTFE and nanodiamond composite coating.

- Electroless nickel-PTFE (EN-PTFE) coatings provide excellent anti-adhesive and low friction properties
- Combining NanoDiamond particles with EN-PTFE coating improves abrasive wear resistance without compromising sliding or release properties
- Nanodiamond material consists of small, spherical diamond nanoparticles which are specially treated to make them disperse in coating liquids and carry a positive electrical charge on their surfaces
- Features Taber Wear Index 30% better than equivalent EN-PTFE coatings
- Can be heat treated, bringing Taber Wear Index down to 14 or lower
- Coefficient of friction matches existing EN-PTFE systems – less than 0.2 when measured against steel counterparts
- No increase in wear of counterpart
- Process contains no hexavalent chromium, making it environmentally friendly and free of complex regulations
- Low diamond content makes affordable and easy to apply

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Post-Compensated, Sectional, Load-Sense Valve

Muncie Power Products has expanded its valve line with a post-compensated, sectional, load-sense valve – the L125.

- Features 33 gpm (124.9 lpm) nominal flow rate
- Inlet is capable of maximum of 40 gpm (151.4 lpm) and its work sections a maximum of 26.4 gpm (99.93 lpm)
- Provides good flow sharing parameters and multiple spool flow options
- Electro-hydraulic and manual shift versions are available
- Suitable for utility, agriculture, snow and ice, and refuse markets in addition to specific applications such as truck-mounted cranes, forestry cranes, and plow and spreader functions

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Rocker Switches

APEM's KR and KL Series rocker switches feature an up-to-date design with a large selection of colors and markings, extreme robustness and high ratings.

- Now available with 20A 12V DC rating (6.35 quick-connect terminals only)
- Can be connected directly to monitor vehicle functions (illumination, motor, etc.)
- Elastomer membrane prevents actuator movement, protecting against dust
- Can now be sealed up to IP69K due to new silicone gasket surrounding switch frame and covering housing top
- 10-terminal connector includes spring terminals, making them quicker and easier to mount, with unchanged robustness
- Suited for applications such as agricultural machinery, handling equipment and construction vehicle cabins

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Solid AWP Tires

The AWP solid tires for rough-terrain scissor lifts and boom lifts from Trident Industrial feature a low-profile section with extra-deep tread.

- Designed for elevated work platforms ranging from 20-ft. rough-terrain scissors to 150-ft. boom lifts
- 100% flat proof
- Supplied as ready-to-fit tire and wheel assemblies
- Range includes solid replacements for popular pneumatic sizes (445/50D710, 445/65D22.5, 385/65D22.5, 385/65D19.5, 15-625, 355/55D625)

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MultiPoint Automatic Lubricator

The new SKF MultiPoint Automatic Lubricator TLMP Series introduces a centralized and ready-to-use lubrication system to automatically lubricate multiple bearing lubrication points in rotating equipment applications across a variety of industries.

- Features pluggable outlets
- Packaged as complete kit
- Designed for easy installation and user-friendly programming via keypad with LED display
- Able to supply from one to 18 lubrication points on controlled and timely basis
- Maximum operating pressure of 120 bar (1,740 psi)
- Performs in temperatures from -25-70 C (-13-158 F)
- Includes high IP protection rating to resist vibration, withstand repeated equipment wash downs, and prevent ingress of contaminants
- Features low-level and malfunction alarms – with notifications even at remote locations – alerting when reservoir is empty or an outlet is blocked
- Enables machine steering to temporarily disable lubrication by removing power

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Linear Variable Differential Transformer Sensors

The Inelta ILAT Series Miniature LVDT (Linear Variable Differential Transformer) Sensors provide precision measurements of position and path in the range of single-digit millimeters.

- Available in Models ILAT 2, ILAT4 and ILAT10
- Provides exact measurements of ±1 mm (0.039 in.), ±2 mm (0.078 in.) or ±5 mm (0.19 in.) traveling distances
- Tiny dimensions, with housing length of 79 mm (3.1 in.) and diameter of 8 mm (0.3 in.) and weight of 30 g (including cable; 1.06 oz.)
- Operates free from wear
- Provides linearity tolerance of <0.25%
- Available with smaller linearity tolerance of <0.1%
- Robust design with stainless-steel housing in protection class IP65, optionally also in IP67
- Nominal temperature rating is 0–70 C (32-158 F)
- Linear guiding operates by virtue of locking mechanism of probe and provides more than 10 million cycles
- Suitable for many applications, including engineering, agriculture and navigation

oemoffhighway.com/20865605

Drive-Position Tire

Michelin Americas Truck Tires, a division of Michelin North America Inc., has introduced the MICHELIN X Multi D, a regional drive-position tire.

- For use in less-than-truckload, pick-up and delivery, food and beverage, and other demanding vocational segments
- Advanced regenerating tread provides water evacuation and traction throughout life of tire
- Full-depth Matrix siping allows for biting grip as tread wears
- Features co-extruded scrub-resistant rubber for first-class mileage
- Cooler running rubber helps minimize heat build-up for increased casing life
- Designed to excel in high torque applications
- Pass-through open shoulder allows quick evacuation of water, mud and slush from beneath tread surface area
- Biting edges of tread allows tire to grip onto surfaces right away
- Gets up and running 80% faster than a leading competitor tire
- Achieves 65% better mileage than MICHELIN XDE M/S tire
- Sidewall features TW6 OzoneShield technology for increased protection against weathering
- Serves demanding needs of regional fleets, specifically those with 4x2 and 6x2 configurations
- Available in the United States, Canada and Mexico in 11R22.5 size in load ranges G and H, and 11R24.5 size in load range H, with additional sizes to follow

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Positioning and Heading OEM Board

Hemisphere GNSS announces the release of the Vector Eclipse H328, the next offering in a line of refreshed, low-power, high-precision, positioning and heading OEM boards.

- Provides simultaneous tracking of all satellite signals including GPS, GLONASS P-code, BeiDou, Galileo, and QZSS
- Includes Hemisphere's new and innovative hardware platform, and integrates Atlas GNSS Global Correction Service
- Centimeter-level accuracy in either single-frequency mode or full performance multi-frequency, multi-GNSS, Atlas-capable mode that supports fast RTK initialization times over long distances
- Features fast accuracy heading of better than 0.17 degrees at 0.5 m antenna separation, and aiding gyroscope and tilt sensors for temporary GNSS outages
- Measures 60 x 100 mm (2.36 x 3.94 in.)

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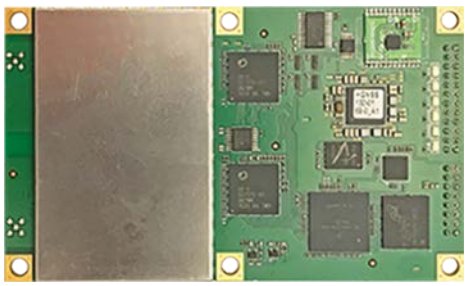

NFPA INDUSTRY & ECONOMIC OUTLOOK CONFERENCE
Westin Chicago North Shore
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nfpahub.com/events

AUTONOMOUS VEHICLES 2017
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autonomousvehiclesevent.iqpc.com

THE GREAT AMERICAN TRUCKING SHOW
Kay Bailey Hutchison Convention Center
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FARM PROGRESS SHOW
Farm Progress Show Grounds
Aug. 29-31, 2017 | Decatur, IL
farmprogressshow.com

NEVADA MINING ASSOCIATION ANNUAL CONVENTION
Harrah's Lake Tahoe
Sept. 6-9, 2017 | Stateline, NV
www.nevadamining.org

GREAT LAKES LOGGING & HEAVY EQUIPMENT EXPO
UP State Fairgrounds
Sept. 7-9, 2017 | Escanaba, MI
www.gltpa.org

OLD CONSTRUCTION & MINING EQUIPMENT SHOW
Harrison Coal & Reclamation Historical Park Grounds
Sept. 9-10, 2017 | Cadiz, OH
www.facebook.com/OCMES

STUMPTOWN STEAM THRESHERS REUNION & SHOW
Harrison Coal & Reclamation Historical Park Grounds
Sept. 9-10, 2017 | Cadiz, OH
www.facebook.com/StumptownSteamThreshers

BIG IRON FARM SHOW
Red River Valley Fairgrounds
Sept. 12-13, 2017 | West Fargo, ND
bigironfarmshow.com

OIL SANDS TRADE SHOW AND CONFERENCE
Suncor Community Leisure Center
Sept. 12-13, 2017 | Fort McMurray, Canada
oilsandstradeshow.com

FTR TRANSPORTATION CONFERENCE
Crowne Plaza Hotel Downtown at Union Station
Sept. 12-14, 2017 | Indianapolis, IN
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HUSKER HARVEST DAYS
Husker Harvest Days Exhibit Field
Sept. 12-14, 2017 | Grand Island, NE
huskerharvestdays.com

THE BATTERY SHOW
Suburban Collection Showplace
September 12-14, 2017 | Novi, MI
www.thebatteryshow.com

ELECTRIC & HYBRID VEHICLE TECHNOLOGY CONFERENCE
Suburban Collection Showplace
September 12-14, 2017 | Novi, MI
www.evtechexpo.com

SAE NEW ENERGY VEHICLE FORUM
Crowne Plaza Shanghai Anting Golf
September 12-13, 2017 | Shanghai, China
www.sae.org/events/nev

BLUEFIELD COAL SHOW
Brushfork Armory-Civic Center
Sept. 13-15, 2017 | Bluefield, WV
www.bluefieldchamber.com/bluefield-coal-show

VALVE MANUFACTURERS ASSOCIATION ANNUAL MEETING
The Ritz-Carlton, Amelia Island
Sept. 13-15, 2017 | Fernandina Beach, FL
www.vma.org

SUNBELT AG EXPO
Spence Field
Oct. 17-19, 2017 | Moultrie, GA
sunbeltexpo.com

SAE COMMERCIAL VEHICLE ENGINEERING CONGRESS
Crowne Plaza Chicago O'Hare Hotel and Convention Center
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www.sae.org/events/cve

AMCON DESIGN & CONTRACT MANUFACTURING EXPO
I-X Center
Sept. 19-20, 2017 | Cleveland, OH
www.amconshows.com/fall-shows/rochester-ny

BICES 2017
New Beijing International Exhibition Center
Sept. 20-23, 2017 | Beijing, China
www.e-bices.org

ION GNSS+
Oregon Convention Center
Sept. 25-29, 2017 | Portland, OR
www.ion.org/gnss

NORTH AMERICAN COMMERCIAL VEHICLE SHOW
Georgia World Congress Center
Sept. 25-29, 2017 | Atlanta, GA
nacvshow.com

NTEA TRUCK PRODUCT CONFERENCE
Sheraton Detroit Novi Hotel
Sept. 26-28, 2017 | Novi, MI
www.ntea.com

SAE ON-BOARD DIAGNOSTICS SYMPOSIUM U.S.
Wyndham Anaheim Garden Grove
Sept. 26-28, 2017 | Anaheim, CA
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THE MINING SHOW
Dubai International Convention & Exhibition Center
Oct. 2-3, 2017 | Dubai, United Arab Emirates
www.terrapinn.com/exhibition/mining-show

ICUEE 2017
Kentucky Exposition Center
Oct. 3-5, 2017 | Louisville, KY
www.icuee.com

AD INDEX

The Side-by-Side D9

Seeking increased material handling, a double-vehicle solution was created placing two dozers next to one another with a shared, long dozer blade.

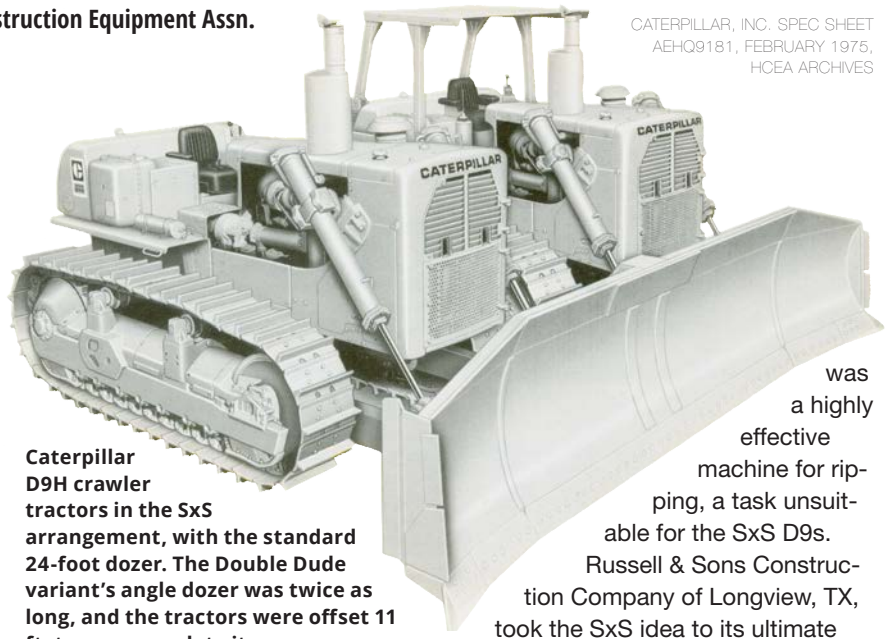
by Thomas Berry, Archivist, Historical Construction Equipment Assn.

Strip mining, by its very nature, requires massive amounts of earthmoving. Not only must the mineral be uncovered, but the overburden must be replaced to reclaim the land. As with other large-scale earthmoving operations, efficiency, cost reduction and other issues were best addressed by machines designed for the task.

Buster Peterson combined two Cat D9Gs end-to-end to create a single pushloading tractor with twice the power, but for high-volume material handling with a crawler tractor, the issue wasn't so much the horsepower as it was blade capacity.

In 1969, the same year that Caterpillar Inc. introduced the Dual D9G for pushloading, it also introduced the SxS D9G. The concept was similar to the Dual D9G, but instead of end-to-end these worked side-by-side (SxS). The two tractors were physically connected with ball and socket joints at the rear and at the two inside crawlers, and they pushed a 24-ft. wide modified U dozer. The ball-and-socket joints provided optimum traction under load and on rough ground. The operator was stationed on the left-hand unit, as seen from the rear, and operated both machines through a joystick and air over hydraulic controls, with the control lines on the rear tie bar. The two tractors could be separated for individual use as needed.

CATERPILLAR, INC. SPEC SHEET AEHQ9181, FEBRUARY 1975, HCEA ARCHIVES



Caterpillar D9H crawler tractors in the SxS arrangement, with the standard 24-foot dozer. The Double Dude variant's angle dozer was twice as long, and the tractors were offset 11 ft. to accommodate it.

The two D9Gs combined for 770 hp, and the SxS D9H, which replaced it in 1974, was rated at 820 hp. The SxS concept met with limited success; 11 D9G sets and 13 D9H sets were built until discontinuance in 1977.

When the D11N was introduced in 1986, it had a substantial competitive advantage over the SxS and Dual D9s. Although the paired D9Gs had the same horsepower at 1,375 rpm that the D11N generated at 1,800 rpm, the D11N cranked it out of 8 cylinders versus 12 for the two D9s. That, combined with greatly improved engine control systems, gave the D11N a decided advantage in fuel consumption. Also, the D11N was a highly effective machine for ripping, a task unsuitable for the SxS D9s.

Russell & Sons Construction Company of Longview, TX, took the SxS idea to its ultimate form in 1976. They modified one of their two SxS D9H sets so that the right-hand tractor was offset 11 ft. behind the left-hand machine, and equipped it with an enormous 48 ft. 8 in. long, variably curved angle dozer fabricated by Balderson.

The dozer alone weighed some 27,600 lbs. plus hardware. The curvature and angle of the blade was designed to move the most material possible to the side with minimal resistance, and working in passes up to 70 ft. long it moved 14,210 cu. yd. of overburden in one hour in 1977. Named Double Dude, the massive machine has been retired for some years, and Russell & Sons has restored the blade as a unique billboard.

The Historical Construction Equipment Assn. (HCEA) is a 501(c)3 non-profit organization dedicated to preserving the history of the construction, dredging and surface mining equipment industries. With over 4,000 members in 25 countries, its activities include publication of a quarterly educational magazine, Equipment Echoes*; operation of National Construction Equipment Museum and archives in Bowling Green, OH; and hosting an annual working exhibition of restored construction equipment. The 2016 show is September 16-18 at the museum. Individual memberships are $35.00 within the USA and Canada, and $45.00 U.S. elsewhere. HCEA seeks to develop relationships in the equipment manufacturing industry, and offers a college scholarship for engineering and construction management students. Information is available at www.hcea.net, by calling 419-352-5616 or e-mailing info@hcea.net.*

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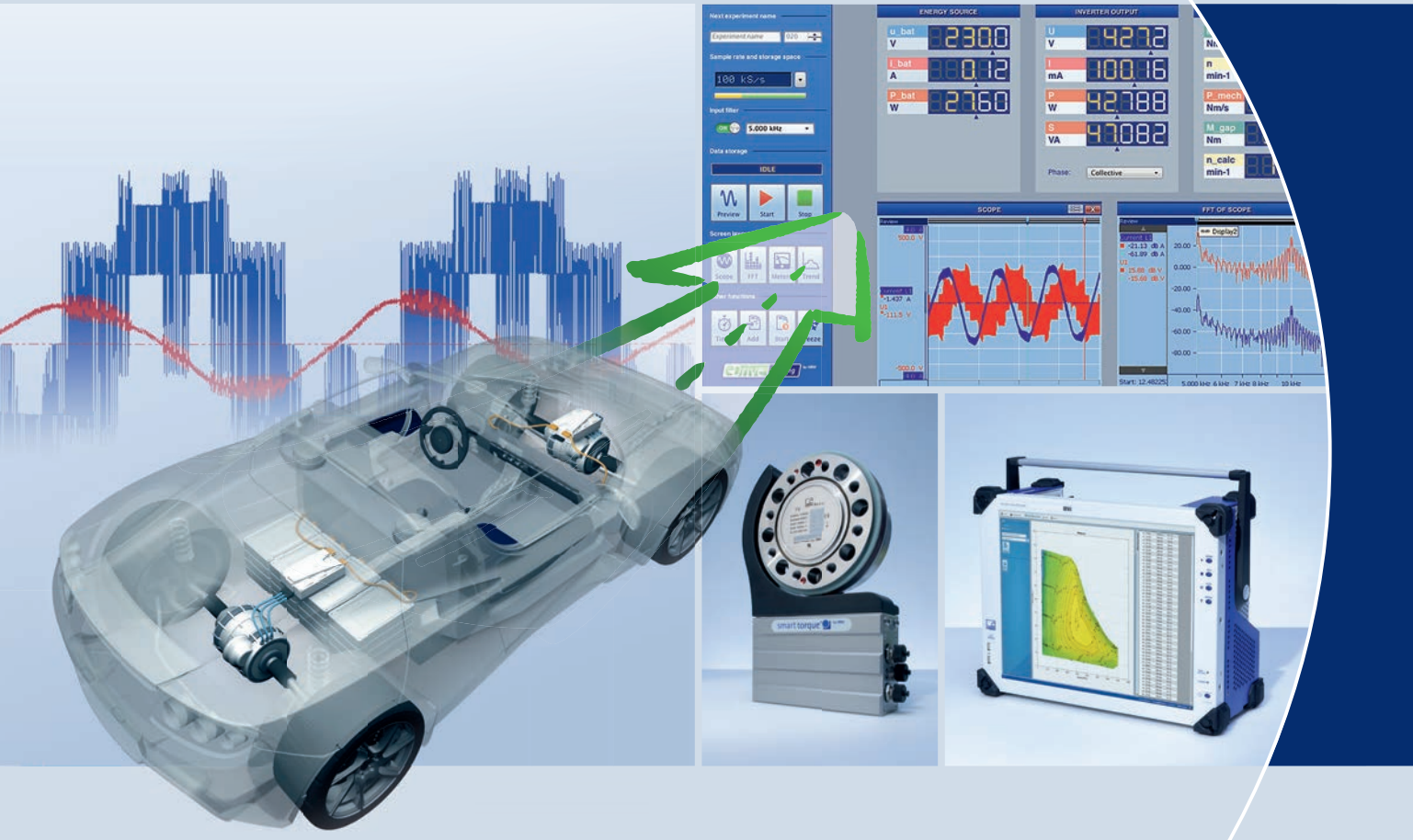

- Easily expandable from 3 to 6, 12 or more phases
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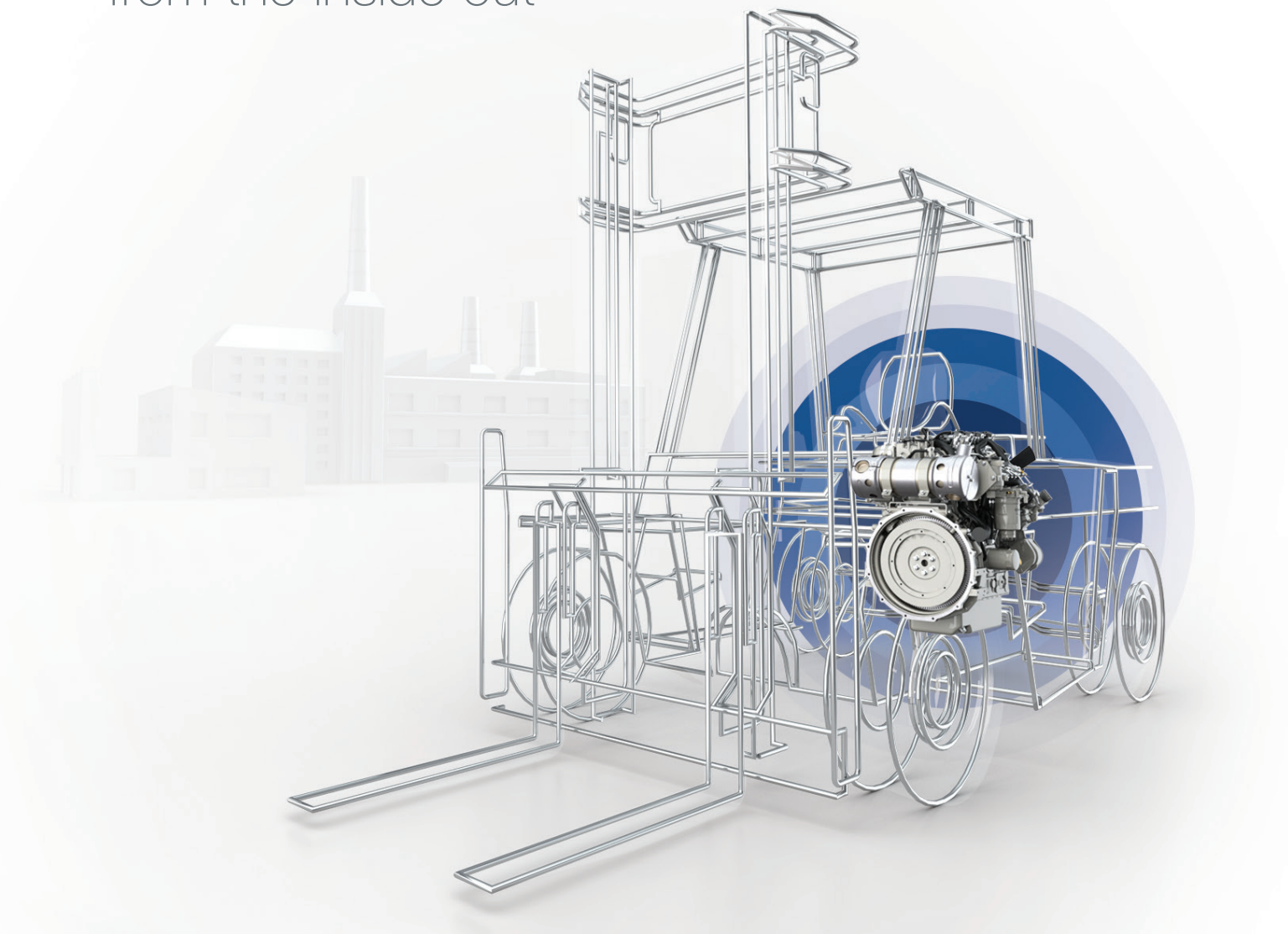

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