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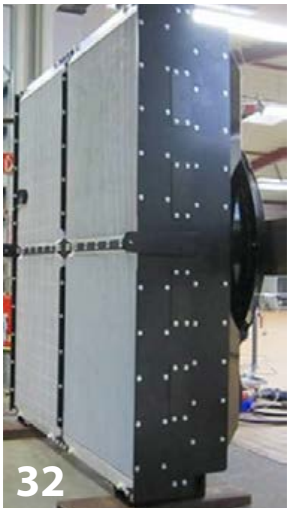
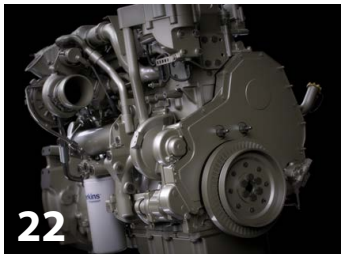
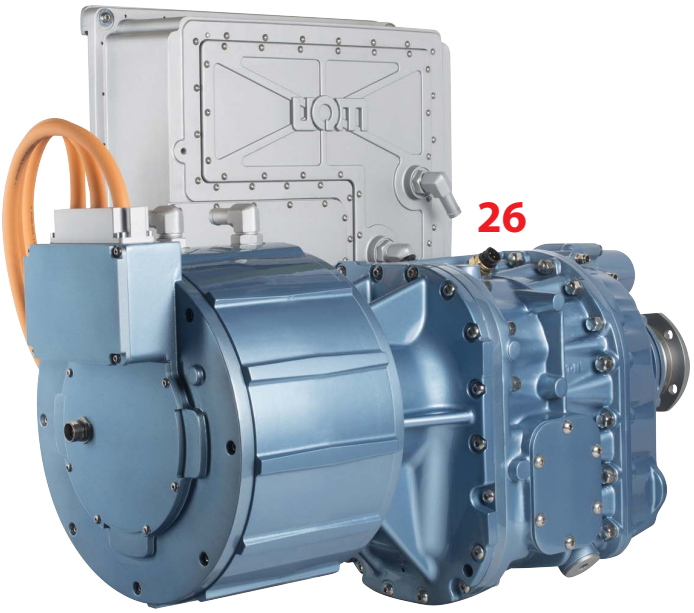




FEATURES



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OEM Off-Highway

Published by AC Business Media Inc.

AC BUSINESS MEDIA

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OEM Off-Highway (USPS 752-770; ISSN 1048-3039 print; ISSN 2158-7094 on-line) is published eight times per year: January/February, March, April, May/June, July/August, September, October and November/December by AC Business Media Inc., 201 N. Main Street, Fort Atkinson, WI 53538. Periodicals Postage paid at Fort Atkinson, WI and additional entry offices. POSTMASTER: Send address changes to: *OEM Off-Highway,* PO Box 3605 Northbrook, IL 60065-3605. Printed in the U.S.A.

Canada Post PM40612608. Return undeliverable Canadian addresses to: *OEM Off-Highway,* PO Box 25542, London, ON N6C 6B2.

Volume 34, No. 8, November/December 2016

PRESIDENT TRUMP and You

I waited until the last minute to write my editor's column this month specifically to be able to address the new President-elect that will be leading our country and implementing policy change for the next four years starting January 20, 2017. In a sneak attack to most major mainstream media outlets and pollsters, Donald Trump won the electoral vote and became the successor to current President Obama.

By 10 a.m. on Wednesday morning, AEM President Dennis Slater released a statement regarding the outcome of the 2016 election. In it, he reflected on the spotlight both candidates had placed on establishing a more substantial effort to repair our existing infrastructure and develop its long-term vision that accommodates economic growth and emerging technologies. "We stand ready to work with President-elect Trump to help advance this critically important policy priority," Slater stated.

He went on to say, "We cannot undermine U.S. manufacturers' global competitiveness for the sake of politically expedient soundbites," in reference to the anti-trade rhetoric used and foreign investment positions taken during the campaign. Slater went on to note the several other important issues that need to be addressed including the Farm Bill and the Renewable Fuel Standard.

He poignantly closed his statement with a call for government unity to propel action versus the stalemate inaction that has become hallmark. "That is why the men and women of the equipment manufacturing industry stand ready to work with President-elect Trump, Speaker Ryan and Leader McConnell to advance our shared priorities and promote manufacturing growth in America."

OEM Off-Highway, as a business publication, will provide any relevant coverage of the government and policies that play a role in the businesses of our OEM readers. The implications and effects of potentially significant changes in policy positions could be interesting to see develop, especially those related to the EPA and emissions, trade agreements, infrastructure and defense spending.

We would love to hear from you as to which issues you are planning to monitor that are important to your business and manufacturing operations. Contact me directly with your thoughts.

IN THE NEXT ISSUE

JANUARY/FEBRUARY ISSUE

- Compact Equipment Trends
- CONEXPO-CON/AGG & IFPE Pre-Show Coverage
- Fuel-Efficient On-Highway Concept Trucks
- Optimized Drivetrain System

+ The OEM Guide to CONEXPO & IFPE 2017

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HEADWINDS from depressed commodity prices diminishing

U.S. Mining Machinery Production has reached a tentative cyclical low as headwinds from depressed commodity prices diminish. Companies should expect the start of a recovery trend to take hold, but significant improvement will not be likely until at least 2017. Meanwhile, U.S. Construction Machinery Production is expected to decline further through the end of the year.

Negative internal trends for the European Construction and Mining indices indicate the current recession trend will continue until year-end. For the European Agricultural Industry, however, contraction has begun as recovering agricultural commodity prices stimulate renewed capital investment.

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QUESTIONS?

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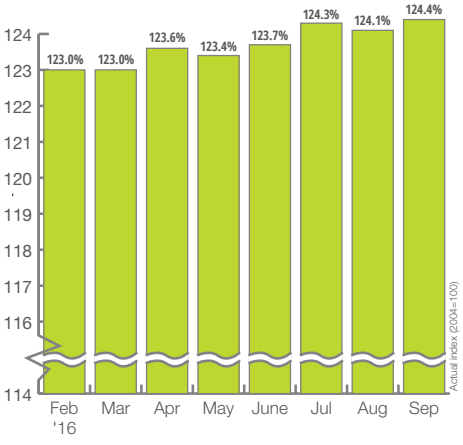
U.S. Leading Indicator:

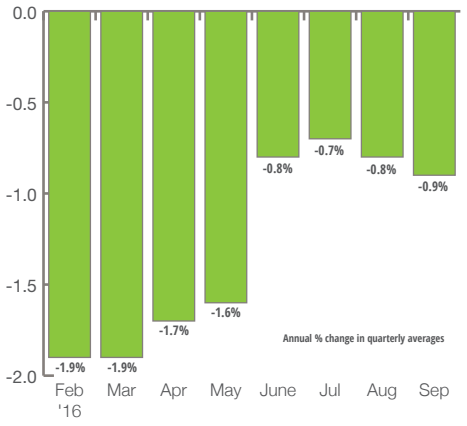
- The U.S. Leading Indicator rose in September.
- Rise in the Indicator corroborates our expectation for improvement in the U.S. economy in 2017.



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

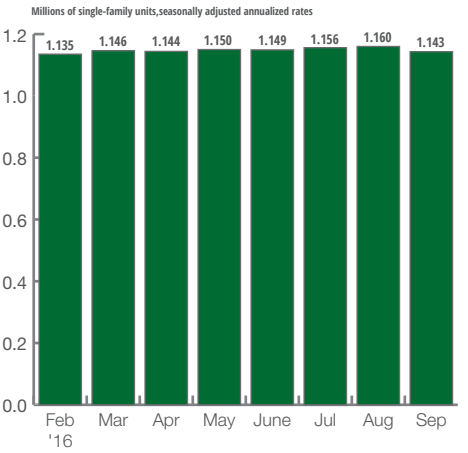
U.S. Total Industrial Production:

- Industrial Production in the three months through September was down 0.9% compared to the same quarter last year.
- Expect Production to transition to Phase A, Recovery, imminently as headwinds from the mining sector diminish.



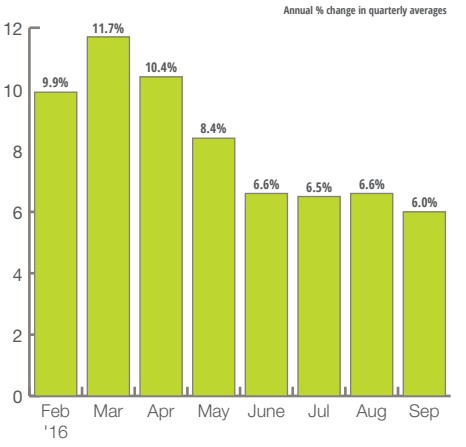
Housing Starts:

- Annual Total Housing Starts fell to 1.1 million units in the 12 months through September.
- Single family Housing Starts avoided the September dip and are growing.



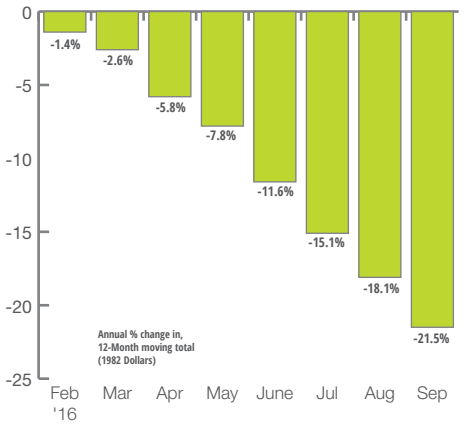
Private Nonresidential New Construction:

- U.S. Private Nonresidential New Construction in the three months through August was up 5.3% compared to the same quarter in 2015.
- Construction will grow at a slower rate through 2017.



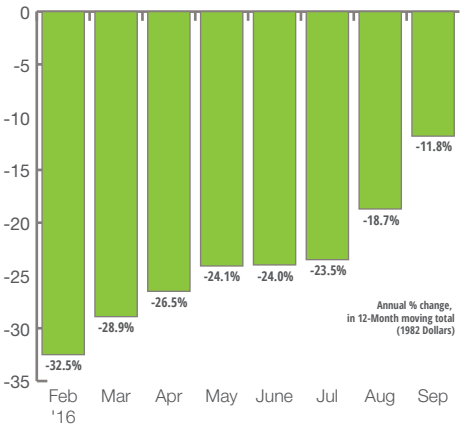
Construction Machinery, New Orders:

- U.S. Construction Machinery New Orders in the 12 months through August are down 18.1% compared to the previous year.
- The surface mining component of New Orders is hindering growth in this segment as U.S. coal production declines precipitously.



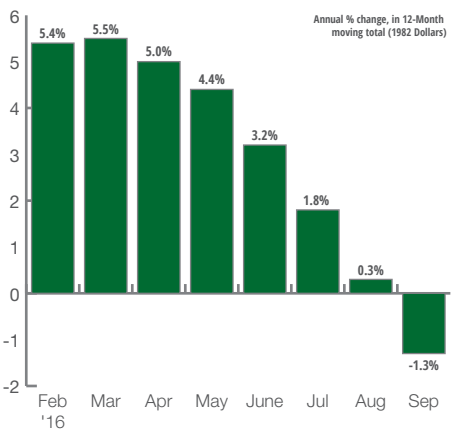
Farm Machinery & Equipment Shipments:

- U.S. Farm Machinery & Equipment Supplies Production in the 12 months through August declined 18.8% compared to the previous year.
- Weak business investment is hindering production growth as low agricultural commodity prices squeeze profit margins.



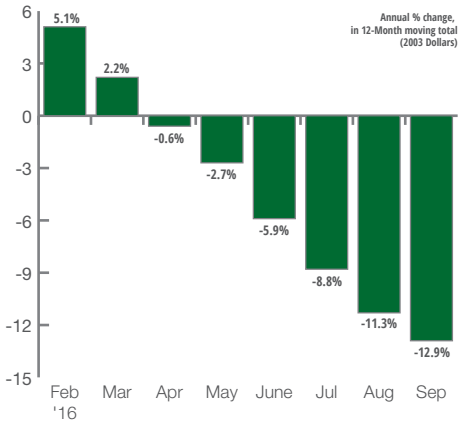
Total Public New Construction:

- U.S. Total Public New Construction in the 12 months through August is virtually even compared to the previous year.
- Unseasonably weak June-to-July performance could not be confirmed by leading indicator evidence, suggesting Construction may be subject to a data revision in the months to come.



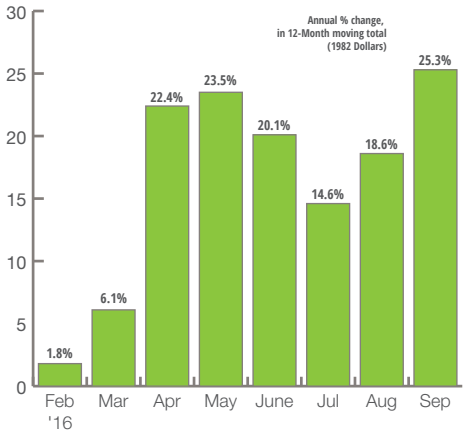
Heavy-Duty Truck Shipments:

- U.S. Heavy Duty Truck Shipments in August were down 19.9% year-over-year.
- Decline in the quarterly growth rate suggests further contraction in shipments is likely on a year-over-year basis through the remainder of 2016.



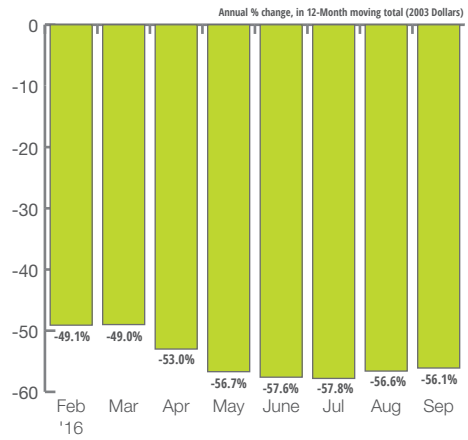
Defense Industry, New Orders:

- The U.S. Defense Capital Goods New Orders annual growth rate rose to 18.6% in August.
- New Orders will avoid year-over-year contraction through at least 2018.



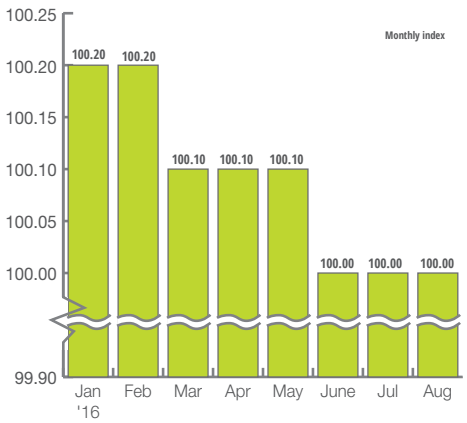
Mining, Oil & Gas Field Machinery New Orders:

- The U.S. Mining, Oil, & Gas Field Machinery New Orders annual growth rate ticked up to -56.6% in August.
- The tentative Phase A, Recovery, trend is likely to persist into 2017 as oil and mineral commodity prices recover.



Euro Area Leading Indicator:

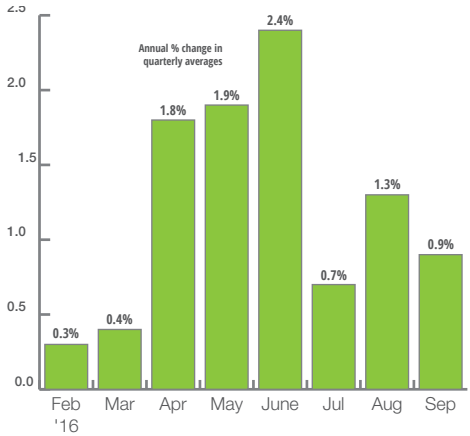
- The Europe Leading Indicator flattened in August.
- If further rise in the Indicator occurs it will signal increasing economic activity in Europe in the second half of 2017.



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

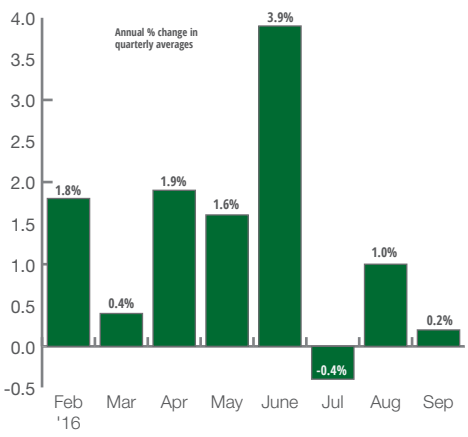
Industrial Production, United Kingdom:

- The U.K. Industrial Production quarterly growth rate rose to 1.2% in August.
- Expect Industrial Production to generally expand into mid-2018.



Industrial Production, Germany:

- Germany Industrial Production in the three months ending in August grew 0.9% compared to the same quarter in 2015.
- Expansion in the quarterly growth rate is a positive sign for growth heading into 2017.



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COST EFFECTIVENESS a Key Focus for Military Vehicle OEMs

Dealing with budget constraints, military vehicle OEMs are exploring ways to improve overall affordability through cost reduction in manufacturing and R&D.

by Michelle Kopier

According to Deepak Bazaz, Director of Artillery and Bradley Programs at BAE Systems, "In the current budget environment, the Army often has to choose between maintaining an existing fleet and developing new capabilities. We're investing in research and development to demonstrate cost-effective options for the Army to address current gaps."

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The JLTV Family of Vehicles was designed from the ground up to provide new levels of protected mobility in the light vehicle class, while supporting advanced networking, C4ISR suites and increased fire power.

At the Assn. of the United States Army (AUSA) Annual Meeting in Washington, D.C., BAE Systems featured its next generation Bradley fighting vehicle concept. By leveraging existing technology from other BAE Systems vehicles, the company is able to pass along significant savings in both development time and vehicle cost. Part commonality among the vehicles also provides long-term cost savings over the life of the vehicle and simplifies part logistics and vehicle support.

Similarly, Oshkosh Defense LLC, an Oshkosh Corp. company, announced it will use over 80% of common parts to streamline maintenance, training and cost efficiency of its recently awarded FMTV truck and trailer contract from the U.S. Army *(read more, 12264100).*

During its 7 years of FMTV production, the U.S. Dept. of Defense (DOD) recognized Oshkosh Defense with the Value Engineering Achievement Award (in the Contractor category) for reducing product life-cycle costs while improving performance and reliability. The U.S. Army Tank-automotive and Armaments Command (TACOM) Life Cycle Management Command (LCMC) nominated its industry partner for the award based on Oshkosh-proposed improvements that resulted in $10.7 million of cost savings for the U.S. Army.

The U.S. Marine Corps approved Oshkosh Defense to field its modernized Extendable Boom Forklift (EBFL-M) fleet. Oshkosh began delivering the EBFL-M vehicles toward the end of September 2016, and is scheduled to deliver 535 vehicles by late 2017 to both the Marine Corps and Navy—2 years faster than the program's projected completion date of 2019. Modernization upgrades include forklift options to handle 7,000- and 11,000-lb. (3,175.1 and 4,989.5 kg) payloads with smaller attachments and a relocated hydraulic manifold to more efficiently load and unload aircraft *(read more, 12259019).*

AM General is a part of the public-private partnership with the National Guard and Red River Army Depot to provide affordable upgraded and enhanced HMMWVs to keep the 230,000 active vehicles in theater. Vehicle modernization is a

key focus for AM General to support the U.S. armed forces while saving taxpayer dollars and preserving vehicle readiness to accomplish domestic and foreign missions. Its modernization process starts with an in-depth assessment of existing HMMWVs and its customers' resources, followed by joint development of cost-effective methods for adding capabilities, flexibility and service life to existing vehicles.

Earlier in the year, BAE Systems was awarded a $109.7 million contract from the U.S. Army to convert 36 M88A1 recovery vehicles to the new M88A2 Heavy Equipment Recovery Combat Utility Life Evacuation Systems (HERCULES) configuration. The conversions allow the M88A2s to recover the Army's heaviest vehicles, such as tanks, without the assistance of another vehicle *(read more, 12202891)*.

"The HERCULES is an integral part of the Army's Armored Brigade Combat Team and is essential to its recovery missions," says John Tile, Director of Recovery Programs at BAE Systems. "The ability to provide single-vehicle recovery for even the heaviest vehicles in today's fleet increases troop safety and provides significant cost savings to the Army."

While cost-effective development, unique parts reduction, and existing vehicle modernization practices are essential focuses for military equipment manufacturers, safer vehicles and advanced technology implementation is always paramount for protecting soldiers. The first prototype of the upgraded Stryker Infantry Carrier Vehicle, known as the Dragoon, features a fully-integrated commander's station, upgraded driveline components, and hull modifications.

The vehicle updates were deemed necessary following Russia's 2015 invasion of Ukraine where Army leaders stationed in Europe were able to identify a "capability gap that threatened our forces in theater," according to Army Vice Chief of Staff Gen. Daniel B. Allyn. The Russians had upgraded and fielded significant capabilities while the U.S. was engaged in Iraq and Afghanistan.

And, as electronic warfare becomes an increasingly common threat to military operations, it is leading the development of a more robust and resilient autonomous vehicle with global remote operational capabilities *(learn more, 20841665)*.

With the 2017 military budget expected to increase to $538 billion in funding with every capability funded tied to a particular security goal for the country, the coming years are poised for continued technology demand and vehicle development.

ADVANCED POWERTRAINS

Generate ROI Despite Low Fuel Prices

The focus for advanced powertrains and hybrid drive systems in today's construction equipment looks beyond fuel economy to increased performance and ease of operation.

by Curt Bennink

JOHN DEERE

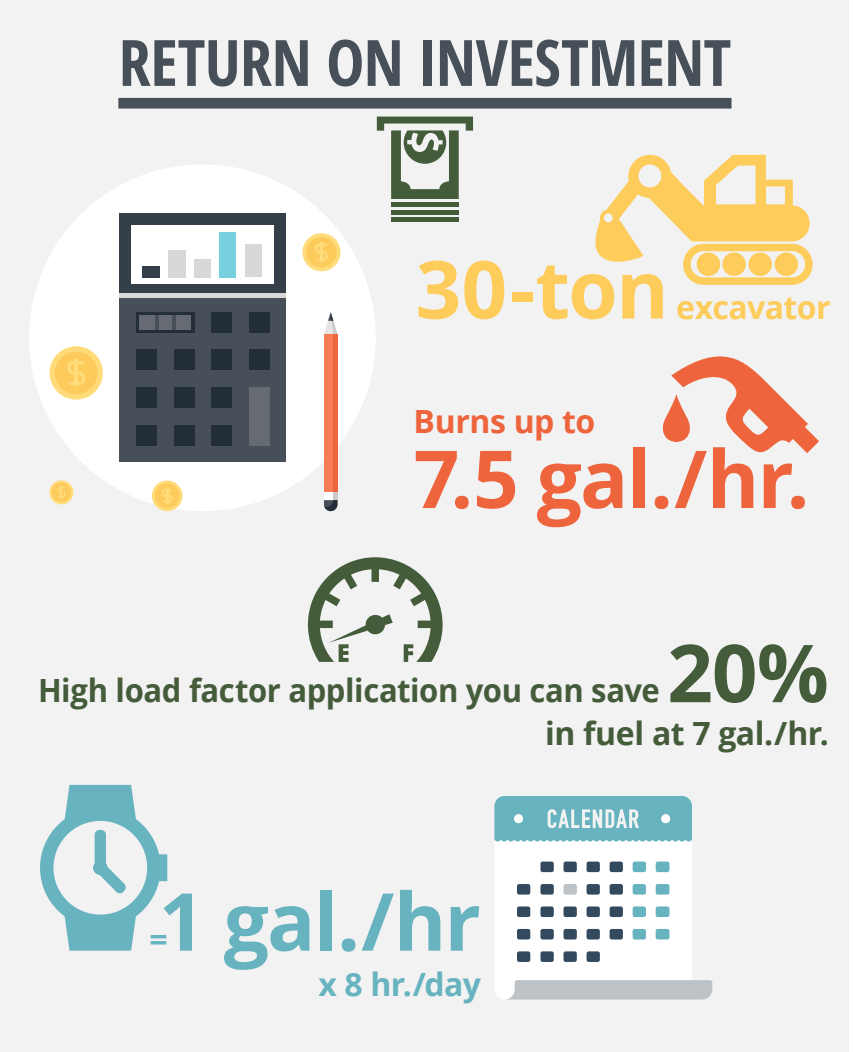
The 536 hp 944K Hybrid Wheel Loader boasts the biggest cab, quickest boom-raise time, and fastest cycle times in its class.

When on-road diesel fuel prices spiked over $4 per gallon approximately 3 years ago, off-road manufacturers stepped to the plate with innovative solutions, including hybrid technology for earthmoving machinery and advanced powertrain systems. Some manufacturers have succeeded with this technology, while others never got past the prototype stage, or temporarily shelved their solutions as diesel fuel prices began a rapid descent—to around $2.31 for on-road diesel at the time this was written. So do hybrid and advanced powertrain technologies justify price premiums that can reach as high as 20% when fuel prices remain relatively low?

The answer really depends on the technology and its application. “At the end of the day, our customers want to make more money by getting jobs done faster and at a lower input cost,” says Wes Holm, Chief Engineer, Caterpillar Medium Tractor Products. “So you have to weigh the importance of ownership period, productivity, cycle times, fuel efficiency, ease of operation, maintenance cost and emissions requirements offered by the advanced powertrains. Ease of operation shouldn’t be overlooked as skilled operators become scarcer.”

The increased performance that many hybrids offer is starting to gain prominence over actual fuel savings. “We expect the attitude toward hybrid technology to start taking a completely different twist,” says Kurt Moncini, Senior Product Manager for Tracked Products, Komatsu America. “It is very important to look at what type of hybrid technology is used. Systems that return energy to the whole system instead of just the swing circuit provide performance that will factor in as a bigger benefit and fuel savings becomes the icing on the cake.”

Moncini explains that evaluating ROI on hybrids depends on price, utilization, performance and fuel savings. Evaluation needs to be about more than just fuel savings, because fuel alone can be misleading. A 20- to 30-T excavator typically burns 3.5 to upwards of 7.5 gph depending upon utilization and application. If you have a high load factor application and can save 20% in fuel at 7 gph, that is a 1 gph savings. Multiply that by an 8-hour day at the current cost of diesel and the fuel savings alone would make a difficult case for ROI.



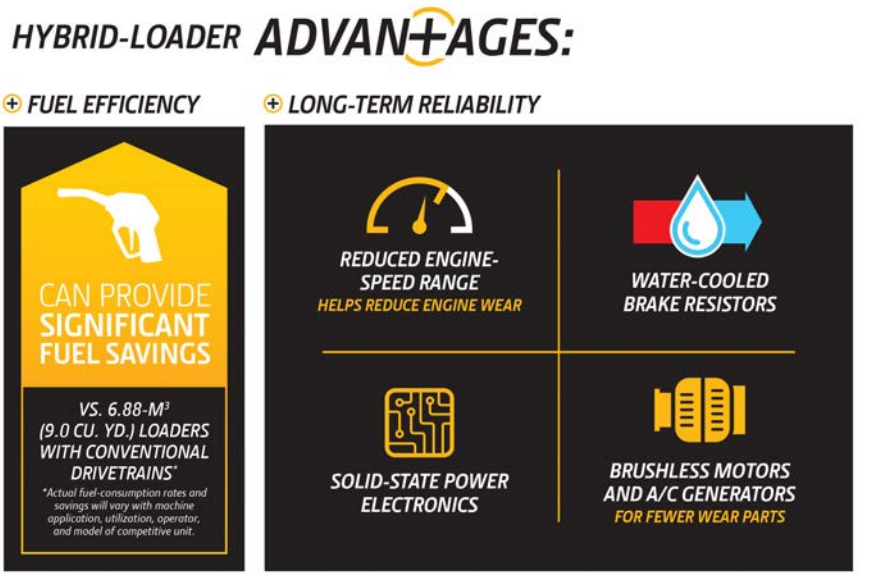
When you factor in a potential productivity advantage, the case becomes much clearer. “Looking at the electric swing drive/generator/ultracapacitor technology we used in the HB215LC-1 and the direction we will be taking with future models, that technology ends up providing more than just better fuel efficiency,” Moncini asserts. “It gives us performance plus energy savings.”

The list price premium for a John Deere 644K Hybrid wheel loader is about 7% compared to its conventional counterpart with a torque converter. While the hybrid reduces fuel consumption by about 25% on average, that is only part of the story. “Customers make it very clear they can no longer hire operators,” says John Chesterman, John Deere Construction & Forestry. “They are getting ‘drivers.’” The hybrid technology makes it much easier for a less skilled operator to run a wheel loader more productively.

Recapture wasted energy

Excavators are a natural target for hybrid technology since there is a lot of energy wasted braking the upper structure.

Komatsu was the first to introduce a hybrid excavator to the U.S. mar-



JOHN DEERE

The wheel loader's hybrid-electric drive recaptures energy while slowing the loader when the operator lets off the accelerator.

ket. "We have an electrically driven swing that charges an ultracapacitor when decelerating and draws stored power for swing when required," says Moncini. "A generator/motor between the engine and hydraulic pumps can draw energy from the ultracapacitor to provide additional power to the whole hydraulic system for improved performance. The energy captured by the ultracapacitor helps boost engine power available for all functions."

"That captured energy input back to the hydraulic system can provide up to 60 additional horsepower, which is pretty significant, especially when it comes to a smaller four-cylinder engine," says Justin Latin, Excavator Product Marketing Manager, Komatsu America.

"On the HB215LC-1, we actually went to a smaller engine and use stored electrical energy to supplement the total power input to the hydraulic system," says Moncini. "It is the same approach as used on high-performance hybrid cars. They use electric motors to add power to a traditional mechanical drivetrain for better performance."

This shows up in the machine's response. "My initial perception of the HB215LC-1 was that it was a very peppy or snappy machine," recalls Moncini.

Looking forward as technology improves, there is a definite opportunity to scale hybrid technology up to larger models. "Today, if you look at smaller machines—which is where our hybrids are—they tend to be lower in annual usage and consume less fuel," notes Moncini. The situation could become even more favorable toward hybrids as you move to larger machines that consume more fuel and have higher utilization rates. "Komatsu intends to introduce a larger hybrid excavator in the U.S. later this year."

Komatsu Europe introduced its HB365LC-3 36-tonne hybrid excavator at bauma 2016 featuring a 20% fuel savings. The HB365LC-3 has the same SAA6D114E-6 engine (202 kW/271 hp) as the PC360LC-11, with up to 53 kW extra electric power supplied by Komatsu's hybrid system *(learn more, 12198691)*.

The kinetic energy generated during the swing-braking phase is converted to electricity, which is sent through an inverter and captured by the Komatsu Ultra Capacitor. When accelerating under workload conditions, the captured energy is discharged quickly for upper structure rotation and to assist the engine as commanded by the hybrid controller. The reserve power stored by the hybrid technology represents additional horsepower that is available to maximize machine performance by supporting the engine, or is used for swing power.

The type of application also has an impact on the economics of excavator hybrid technology. "If you look at typical excavator applications, hybrid systems really come into play when you are swinging more than 90 degrees," says Moncini. "In a traditional earthmoving job, if you are swinging 90-180 degrees, that is not a very efficient way to move dirt. You want to be between 45 and 90 degrees." Typically, above-ground operations with a large repetitive swing cycle are most beneficial for a hybrid model.

Caterpillar spent years developing and testing both electric and hydraulic hybrid technologies prior to introducing its hydraulic hybrid excavator in 2013. It says the electric

hybrid option would have required special technician training on the unfamiliar electronics and battery storage system. In comparison, the hydraulic hybrid components are familiar to standard machines and easy to maintain.

"The primary reason we introduced our hydraulic hybrid is because it lowers customer owning and operating costs while maintaining the same high level of production as our standard 336," says Brian Stellbrink, Caterpillar Excavator Product Application Specialist.

He points out that the 336 hybrid has three ingredients contractors can think of as "conserve, optimize and reuse." It conserves fuel with the use of a high-efficiency pump. Performance is optimized with Caterpillar's Adaptive Control System (ACS) valve—the "brain" that puts the energy where you need it when you need it. And it recovers and reuses otherwise wasted swing energy through the use of an accumulator.

"Considering an excavator typically stops and swings every 15 seconds in a high-production application, there is a significant opportunity for energy savings," says Stellbrink. "But customers in any application—including utility applications—will benefit from the 'conserve' and 'optimize' elements."

According to Stellbrink, the bottom line is that Caterpillar's hydraulic hybrid excavator is less complex and less costly than other hybrid technologies, thereby resulting in a shorter time to recoup upfront costs.

"You save money with either high or low fuel prices because our hydraulic hybrid excavator burns up to 20% less fuel than our standard model," he says. "We have a calculator for contractors to see for themselves how quickly they can achieve a return on their investment."

Combining hydrostatic and mechanical drives

New driveline technology takes advantage of the strengths and efficiencies of both hydrostatic and mechanical drives.

"The Liebherr XPower loaders possess a power-split transmission, which combines two drive paths: a mechanical path for acceleration and traveling long distances, and a hydrostatic path for loading and gear shifting," says Nick Rogers, Product Specialist, Liebherr USA. "With the integration of this transmission, we are able to achieve maximum efficiency out of every drop of fuel."

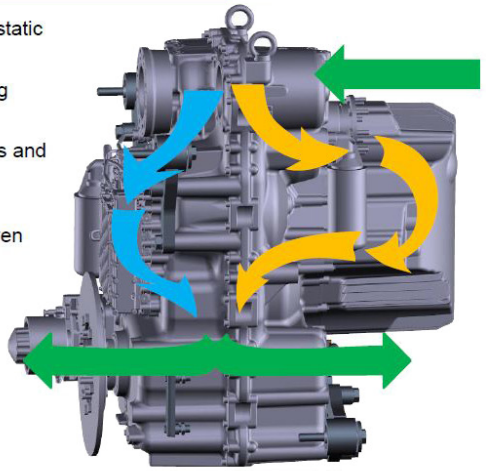
Power supplied by the diesel engine is split via a planetary gearbox to a hydrostatic branch and a mechanical branch. The two branches are then combined again so that full performance is available. During operation, the ratio between the two branches is variably adjusted. Comparative tests have shown that XPower wheel loaders require up to 30% less fuel than conventionally driven wheel loaders.

Caterpillar added a continuously variable transmission (CVT) to the 966 and 972 wheel loaders that combines mechanical and hydrostatic systems. The XE version of the 966M and 972M loaders with CVT provides up to a 25% improvement in fuel consumption versus the current series, and over 35% versus previous generation machines.

The CVT replaces a traditional driveline's torque converter with a hydraulic pump and motor (variator),

Liebherr XPower® driveline

- XPower® driveline brings together hydrostatic and mechanic transmission
- Hydrostatic transmission for short loading cycles
- Mechanic transmission for long distances and driving uphill
- CVT gearbox adjusts different drives continuously and automatically to the given application



4 Gschwend: New Liebherr wheel loaders XPower®

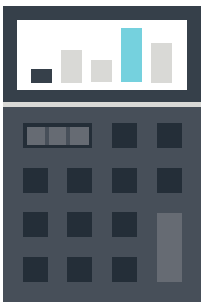
LIEBHERR

Comparative tests have shown that Liebherr's XPower wheel loaders require up to 30% less fuel than conventionally driven wheel loaders.

CATERPILLAR INC.

The Caterpillar 336F XE hydraulic hybrid excavator burns up to 25% less fuel than the standard 336F model while delivering the same level of production.

which allows for smooth, continuous ratio changes between engine speed and machine speed. Power is transmitted through the CVT in a parallel mechanical path, much like a power-shift transmission. It is combined with variator power through a series of planetary gear sets. Transmission operation is automated and transparent to the operator.



"The main fuel savings are accomplished by two distinct features," says Lucas Sardenberg, Caterpillar Medium and Large Wheel Loader Marketing Consultant. "First, the new transmission replaces the torque converter in the powertrain. Torque converters are very inefficient, especially during the dig portion of the cycle. If you focus on the dig cycle alone, the fuel benefit of an XE is as high as 50% over a conventional transmission.

"Second, the new technology allows the engine to run at lower rpms as compared to a regular powertrain," he continues. "In addition to lower engine rpm, Caterpillar matched the hydraulics to provide full implement speed at lower engine speed, so the whole system works together to maximize efficiency while keeping the productivity demanded by customers."

Machine momentum during slowdown—for instance, when approaching a truck or a hopper—is also used to power implements and the fan, further reducing fuel consumption.

Calculating the ROI on the CVT is complicated because it depends on the application, hours of operation per year and the model of machine replaced by the XE technology. "On the low end with less than 1,500 hours annually and fuel savings of 0.5 gph, payback is more than 4 years," says Sardenberg. "However, with 3,000 hours per year and a fuel savings of 1.5-2.0 gph, the payback can be shorter than 2 years."

He adds, "It is important to stress the comparison to the equipment being replaced. More than one customer replaced larger machines by XEs, thus payback was really short due to the fuel savings. Another important point to consider is that the XE technology can bring other benefits aside from fuel alone, with ease of operation with only two pedals being a major one noticed by operators, and also hill-holding capability and retarding."

Electric drive optimizes power band

Certain machines, like the Caterpillar D7E diesel-electric dozer and John Deere 644K Hybrid and 944K Hybrid wheel loaders, have benefited by moving to electric drive. Because the diesel engine basically acts as a generator, it can be optimized to run

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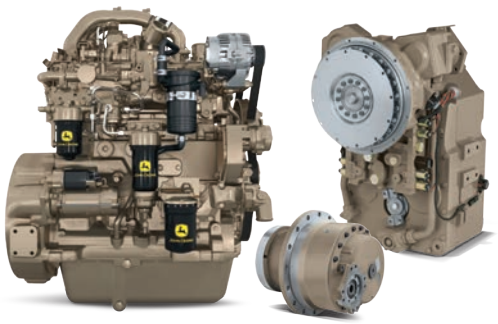

JohnDeere.com/OEMpower

at a set speed. Engines that run at constant speeds have much longer lives than those that are continually hunting up and down the rpm range to make power.

The John Deere 644K and 944K Hybrid loaders use hybrid electric drive, which results in greater ease of operation. A conventional torque converter-equipped wheel loader requires the operator to perform a balancing act. "The engine speed really controls how hard the machine pushes," explains Chesterman. "As [operators] step on the accelerator, they are basically telling the engine to rev up, but at the same time, the engine speed is proportional to the speed of the hydraulics. As I go from the typical 1,200 engine rpms to 1,800 rpms, I have 33% faster hydraulic speed."

Filling a bucket requires coordinating all of the inputs. "In a typical bucket load, roughly half of the fill of the bucket is literally the bucket pushing into the pile," says Chesterman. This needs to be done without spinning out. "If the operator cannot effectively push that bucket into the pile, he will have a very hard time just trying to use the boom and the bucket to roll material into it. This is a skill that a good operator develops."

The electric drive greatly simplifies the demands on the operator. "We can control those electric motors extremely fast with solid-state electronics," says Chesterman. "That allows us to control the smoothness of how the machine shifts during reversals." It also allows the wheel motors to rapidly switch from providing power to the wheels to recovering energy and putting power back into the system.

The electric wheel motors control traction and prevent slip, while the engine always runs at a constant speed, providing full hydraulic power at all times. "With our hybrid technology, speed has nothing to do with pushing power," says Chesterman. "One of the great benefits of electric motors is they essentially have their maximum torque at near-zero speed. For the lower skilled operator, they don't [have to maintain] that balancing act with the engine speed, power range and hydraulics. They just need to step on the pedal."

Plus, the loader is much more efficient when loading. Consider that when a conventional 644K loads a bucket, the engine is at full load rated torque. "It is at maximum fuel delivery rate during that peak work cycle just to load the bucket," says Chesterman. "On the hybrid version, the engine is at about 25% load. That comes back to the very high efficiency of the electric drive system to develop very strong pushing forces at low loads compared to a powershift torque converter."

KOMATSU

The Komatsu HB215LC-1 Hybrid excavator captures wasted energy with an ultracapacitor. When needed, this energy can be kicked back into the hydraulic system, providing up to 60 additional horsepower to the hydraulic pump.

Caterpillar says the D7E dozer will move more material per gallon of fuel, burn up to 20% less fuel, improve productivity 10% and reduce lifetime operating costs by 10% compared to the D7R Series II.

The D7E's electric drivetrain generates high torque at low speeds. Because there are no friction clutches, driveshafts or belts—and fewer parts overall—it more efficiently transfers engine power to the ground. And with no gears, there are no peaks and valleys in powertrain efficiency. The continuously variable electric drive is efficient over the entire operation range.

"Fuel savings is the easiest to measure on payback, and higher fuel prices make for a quicker payback," says Holm. "We estimate that our D7E customers worldwide have saved over 9 million gal. of diesel fuel since the machine was introduced. So if you are looking at $2.60 diesel, that's more than $23 million back to the customers' bottom line."

Factors that go into the overall ROI include the application, materials, environmental requirements for the jobsite, operating technique, etc. "We've had some customers report that they're burning half the fuel they were using for the same job with an older machine. That's a substantial payback, regardless of the price per gallon," Holm states.

"You can move up to 35% more material per gallon of fuel," he continues. "The machine is easy to operate, so even less experienced operators can achieve better productivity. That all translates to more house pads per day, more miles of road in a week, more trash moved in a landfill and a more precise job."

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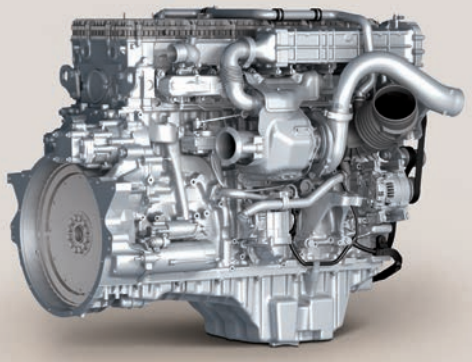

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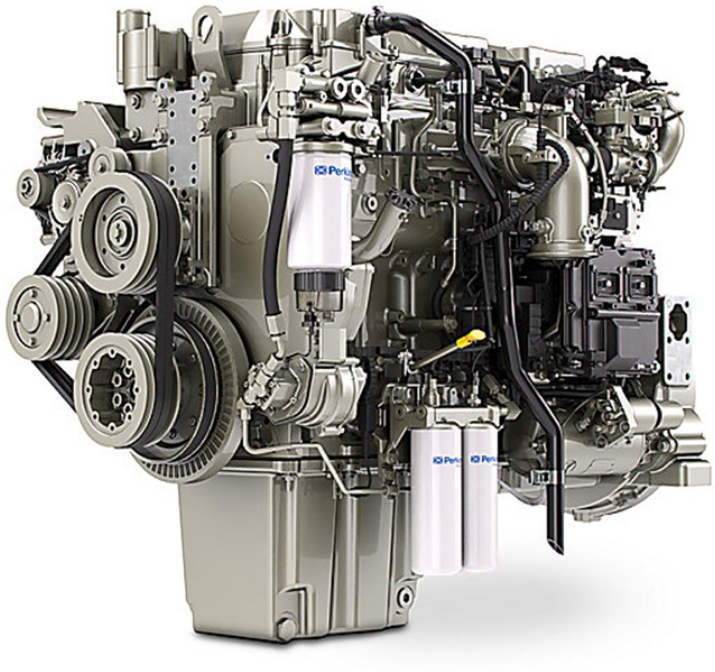
TOP 10 NEW PRODUCTS

2016 Award Winners

The Top 10 list features the most visited new products on OEMOffHighway.com in 2016. This year, Perkins Engines Co. Ltd. garnered a lot of attention with its numerous engine launches throughout the year at major tradeshows in Europe including Agritechnica and bauma Munich.

Besides the engines, this is the most diverse group of products we've had in the Top 10, which only highlights the wide range of needs our OEM readers have when researching components for their vehicle designs.



Power Rating	
Minimum power	385.0 hp
Maximum power	520.0 hp
Displacement	763.0 cubic in
Rated speed	1400-2100 rpm
Maximum torque	1755.0 lb-ft @ 1400 rpm
Emissions	EU Stage IV/U.S. EPA Tier 4 Final
Engine Dimensions*	
Length	50.1 in
Width	39.2 in
Height	44.6 in
Dry weight	2520.0 lb

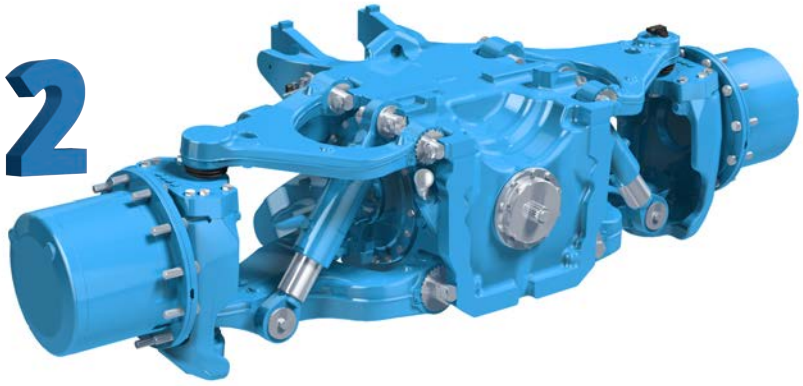
Final dimensions dependent on selected options

1 12.5-L Stage IV/Tier 4 Final Engine

Perkins introduces its turbocharged aftercooled 2206F-E13TA, a 12.5-L variable speed engine designed to meet EU Stage IV/U.S. EPA Tier 4 Final.

- Designed to meet the specific needs of the agricultural market
- Delivers up to 375 kW (503 hp) at 1,900 rpm and 405 kW (543 hp) at 1,700 rpm
- Optimizes fuel efficiency by matching operating cycles of a wide range of equipment and applications
- Compact package size, which still delivers exceptional power density, is suited for applications with a narrow engine compartment
- Uses DPF, DOC and SCR to meet emissions standards

oemoffhighway.com/12144711



2 Suspension Steer Axle

Dana Holding Corp. has introduced the Spicer Model 990 suspension steer axle for high-horsepower tractors.

- For agricultural tractors from 285-370 kW (380-500 hp) in continuous use
- Independent front suspension offers isolation from body vibration and provides improved vehicle control, operator comfort, traction and handling characteristics for safer operation, especially at on-road speeds
- Designed for integration into vehicle's frame
- Reduces complexity and simplifies final assembly on OEM production line
- Central housing integrates pneumatically actuated multi-disc wet brakes and 100% differential lock capability, offering better traction at higher speeds with improved comfort
- Housing features front three-point hitch and a power take-off
- Capable of on-road travel up to 60 km/h (37 mph) with a lower-rpm engine
- Includes anti-lock braking system (ABS) and central tire inflation system (CTIS)

oemoffhighway.com/12138795

4 Control Box for Machine-Controlled Excavation

Topcon Positioning Group introduces the GX-55 control box for machine-controlled excavation.

- Provides users with visual and audible features to safely and efficiently grade for 2D or 3D excavating tasks
- Delivers real-time project information quickly
- Features lightweight package for easy machine transfer, storage and quick cable attachment
- Large 6.5-in. sunlight-viewable and color LCD touchscreen is surrounded by integrated LED light bars for a continuous grade reference of the bucket's teeth
- Includes customizable audible tones for grade reference, integrated virus protection and easy-access USB ports for saving and downloading job files

oemoffhighway.com/12132753

3 1.7-L Turbocharged Engine

Perkins has launched the 1.7-L, 3-cylinder turbocharged 403F-E17T engine which is a new addition to its 400 Series range.

- Designed to meet U.S. EPA Tier 4 Final emissions standards
- Features common rail direct injection and full authority electronics
- Compact package size and sleek engine architecture, featuring a small diesel oxidation catalyst (DOC), enables use across many compact applications including small agricultural equipment, wheel loaders, hydraulic excavators and aerial lift platforms
- Addition of common rail fuel system and full authority electronics provides increase in performance and allows greater flexibility in tailoring the engine to specific applications
- Offers power output of 30 kW (40 hp) with a maximum torque of 125 Nm at 1,800 rpm, while rated speed is up to 2,800 rpm
- Does not require air-to-air charge cooler, saving valuable space in very tight engine compartments and allowing OEMs to reduce installation cost and complexity
- Provides class-leading torque, better load acceptance and smooth operation
- Testing has shown an 11% improvement in specific fuel consumption (SFC) previously gained at Tier 4 Interim
- Offers easy servicing as DOC-only aftertreatment is service free while fuel and oil filters have standard 500-hour service interval

oemoffhighway.com/12144686

www.oemoffhighway.com/20844263

5 Urea Quality Sensor

The urea quality sensor from VOSS Automotive is designed for use in diesel engine SCR aftertreatment systems.

- Optimized for OEM specifications
- Fully integrated with VOSS Quick Connector
- Features supply current of 40 mA at 12V or 30 mA at 24V
- Urea concentration range of 5.0-62.5%
- Measuring temperature range of -8-60 C (-17.6-140 F)
- Maximum allowed pressure is 15.5 bar (224.8 psi)
- Features CAN J1939 communication interface

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Want to see your product in the Top Ten in 2017? Submit product releases to Editor Michelle EauClaire-Kopier at *Editor@OEMOffHighway.com*.

7 I/O Controller

maximatecc introduces CrossFire SX, a safety certified I/O controller.

- Offers I/O flexibility and range of options for software programming
- Provides open platform for easy design of safe machine control systems
- Based on modern ARM Cortex R4 Safety CPU, enabling efficient implementation of safety functionality
- Meets ISO 13849 PL d and IEC61131 SIL2 safety requirements
- Features 16 inputs and 16 outputs, all totally configurable in terms of I/O type
- Inputs support digital, current, frequency and voltage on different levels
- Outputs support high and low current outputs, PWM, PWMi, Digital HS/LS and H-bridge
- Freely programmable in either C or CoDeSys
- CANopen Safety and set of safety features make it easy for system developers to implement safety functions
- Includes three CAN interfaces supporting either CANopen or SAE J1939

oemoffhighway.com/12124659

6 4-Cylinder Engines

Perkins has launched the Syncro range of 4-cylinder, 2.8- and 3.6-L common rail diesel engines.

- Delivers 45-100 kW (60-134 hp)
- Meets multiple global emissions standards including EU Stage V and U.S EPA Tier 4 Final
- Engineered to integrate into more than 80 different machine models
- High power and torque density provides OEMs opportunity to move to smaller, more compact engines
- Provides increase in power density of 22% when downsizing
- Offers 8% improvement in fuel economy during machine use
- Powers up to 100 kW (134 hp) with 500 Nm of torque available with 3.6-L version
- Maximum of 55 kW (74 hp) with torque of up to 325 Nm possible with 2.8-L turbo aftercooled variant
- Includes suite of technologies including common rail fuel system, electronic control, advanced air systems and aftertreatment configurations
- Provides 90% commonality between 2.8- and 3.6-L engine interfaces to give OEMs freedom to determine machine platform strategies that suit their businesses and markets
- Modular design ensures ease of integration into existing and future generations of machine
- Features flexible aftertreatment options for both displacements, with an array of engine and off-engine mounted options for optimized packaging in all machines
- Aftertreatment system offers 40% reduction in package size due to use of the latest technologies and design principals

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8 Operator Display

Rexroth expands its BODAS modular system for mobile electronics with the BODAS DI4 display, a universally useable operating unit for mobile working machines.

- Enables programming with CODESYS 3.5 development environment, allowing individual visualization and allocation of functions
- Simplifies diagnosis and re-parameterization of BODAS controllers connected via CANbus by loading new data sets via integrated USB interface and "flashing" them onto corresponding controller
- Can be freely designed and flexibly incorporated into cockpit designs
- CODESYS 3.5 development environment enables users to visualize any machine functions both statically and dynamically
- Two hardkeys for set functions and 12 freely programmable function buttons are available
- Allows drivers to intuitively select functions without visual contact with the control panel with a turn/push button
- Can be used as stand-alone unit and positioned extremely flat, almost flush in the cockpit either in a portrait or landscape position
- Rotates in 90-degree steps and is equally suitable for left-handers and right-handers due to symmetrical layout
- Standard version includes two video interfaces, two CAN 2.0B interfaces and a USB interface, as well as numerous analog and digital inputs and outputs
- PRO version includes touchscreen, Ethernet interface and will have Bluetooth interface in future

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9 Independent Suspensions

AxleTech International has shipped the first custom order of its 2000 Series model of independent suspensions and is releasing standard versions of Independent Suspension Axle Systems (ISAS) to its customer base.

- Engineered for lightweight tactical and combat vehicles with a GVWR of up to 15,400 lbs. (7,000 kg)
- Features company's double-wishbone design for unrivaled ride control and handling with superior cross-country mobility and safety in various terrains
- Fills gap for 6-7.5 T vehicles that are lacking independent suspensions

oemoffhighway.com/12155461

10 Cab System for John Deere 1 Family Sub-Compact Tractors

Curtis Industries LLC announces the release of its cab system for the John Deere 1 Family sub-compact tractors.

- Fits the 1023E, 1025R and 1025R with factory installed loader backhoe
- Frame, doors and roof are constructed of powder-coated, commercial grade steel for durability and long life
- Venting windshield of tempered safety glass is supported on gas shocks
- Total seal doors are pin hinged and remove in seconds - without tools - for open air operation in warmer weather
- Premium cab also features a removable rear panel and dual sliding glass windows for superior ventilation in any weather condition
- Rear glass panel lifts out in seconds for backhoe operation
- Fully backhoe compatible and color matched for factory look
- Premium cab includes a 12V DC windshield wiper, with optional rear wiper also available
- Customizable by adding accessories such as roof-mount LED strobe and work lights, rear work lights, mirrors and heater

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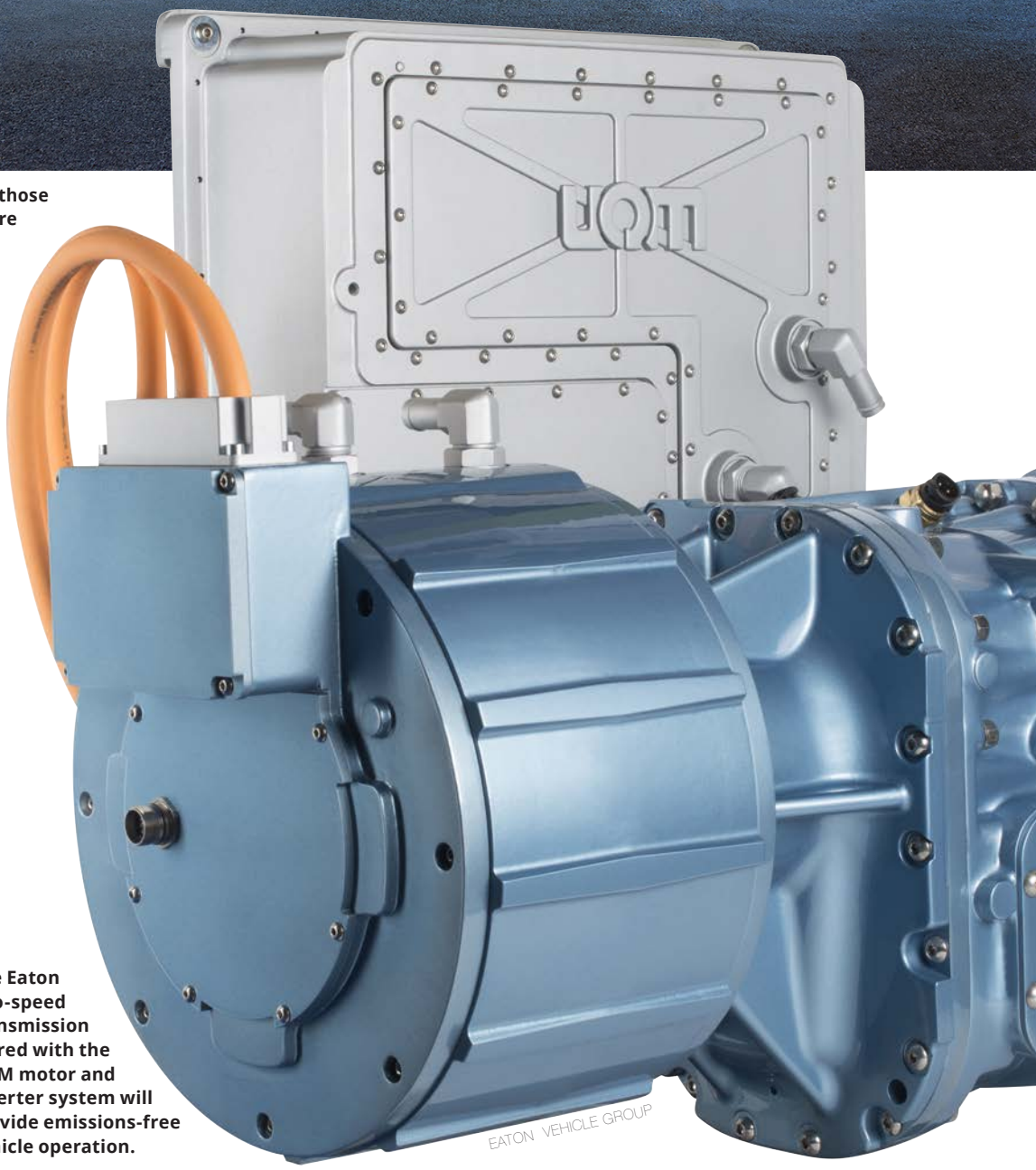
UQM TECHNOLOGIES

While transit buses, like those developed by Proterra, are the first application for the PowerPhaseDT, the system can also be used in most types of heavy-duty vehicles, including off-highway equipment.



The Eaton two-speed transmission paired with the UQM motor and inverter system will provide emissions-free vehicle operation.

EATON VEHICLE GROUP

PARTNERSHIP Makes for Faster Development, Time to Market

Working in partnership with other industry suppliers enables one e-drive manufacturer to provide OEM customers with a turnkey electric drivetrain solution.

by Sara Jensen

Vehicle electrification continues to be an area of focus for many OEMs as they look for ways to provide more sustainable means of transportation. Joe Mitchell, CEO of UQM Technologies, says the company is seeing strong adoption of electronics in the commercial vehicle market due to its set routes, current infrastructure and control capabilities being suited to the use of such technologies.

UQM has been a supplier of electric motors, inverters and other electronics components to OEMs in both the on- and off-road markets for several years.

As the shift toward vehicle electrification has increased, the company has found that many OEMs are looking for turnkey solutions instead of having to source various parts from multiple suppliers and integrate the components themselves. "Strategically, we determined we needed to offer that entire powertrain solution," says Mitchell.

In June, UQM announced its partnership with Eaton and Pi Innovo to develop a full electric drivetrain system *(learn more, 12221973)*. By partnering with Eaton and Pi Innovo, UQM will be able to quickly bring to market a fully integrated system because the components being used are all existing products which have been proven and validated for use in heavy-duty applications. "Time to market from our end is very important," says Mitchell. "When the customers need to go out and source all of these various components separately and do all the validation, it takes time and signifi-

By partnering with Eaton and Pi Innovo, UQM will be able to quickly bring to market a fully integrated system because the components being used are all existing, proven and validated products.

OEMs are looking for turnkey solutions instead of having to source parts from multiple suppliers.

cant investment. We're able to bring them a turnkey solution that will get them to market much quicker."

The company says this capability is particularly beneficial for the rapid development and use of electric vehicle technologies in regions such as China and India.

Bringing proven technologies into a single system

The UQM PowerPhaseDT is composed of UQM's PowerPhase HD220/HD250 motor and inverter system, an Eaton two-speed transmission, and Pi Innovo transmission control unit. Josh Ley, Vice President of Engineering at UQM Technologies, notes that the PowerPhase HD system is available in three versions with power outputs of 140-250 kW. Either a standard or customized version can be used for the drivetrain to meet the performance requirements of the vehicle application without the need to make adjustments to the Eaton transmission.

At the 2016 IAA Commercial Vehicle show, Eaton announced the introduction of its two-speed transmission for electric vehicles which will be used in the UQM drivetrain system *(learn more, 12270638)*. The system is based on an existing component the company uses in conjunction with its four- and five-speed transmissions.

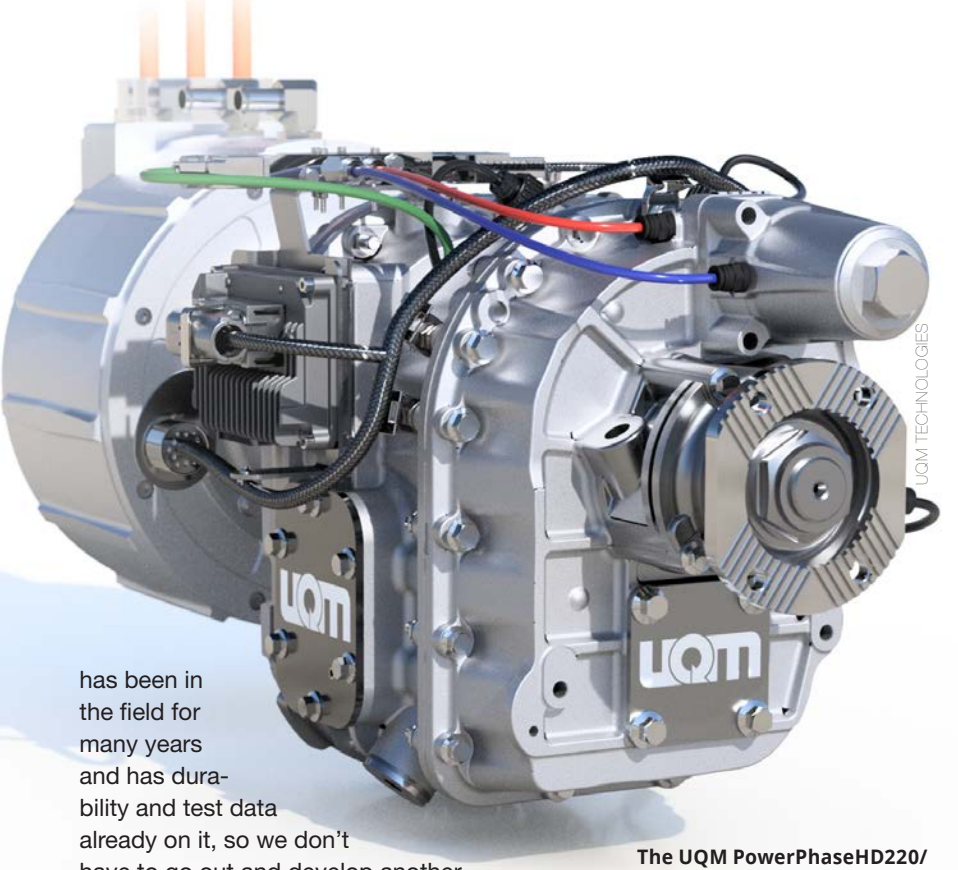
Gerard DeVito, Chief Technology Officer, Eaton Vehicle Group, says the transmission is an efficient, streamlined planetary transmission which the company was able to repackage for the PowerPhaseDT system. Because many existing aspects of the technology were used, such as the gear chain, it did not require "a lot of big investment and capital in re-engineering to create something that was very good for the application."

For the development of the PowerPhaseDT, Eaton is working with UQM and Pi Innovo to ensure the transmission is controlled in the correct manner, helping to guarantee it's a robust and reliable

system. DeVito notes aspects such as duty cycle information and how the transmission is shifted need to be taken into account, and which Eaton is providing guidance on. “We have a large hybrid business and electric vehicle business where we actually automate and do all the electrification for those transmissions,” he explains. “We have a lot of experience in this field, so we’re just trying to work with [UQM] to make sure requirements are aligned and make sure it pleases the customer.”

Mitchell says it was a natural fit to work with Eaton on the project due to the companies having worked together before, and the transmission is already a proven technology. “From a mechanical validation perspective, this product has been in the field for many years and has durability and test data already on it, so we don’t have to go out and develop another transmission source,” he says.

Pi Innovo, another company



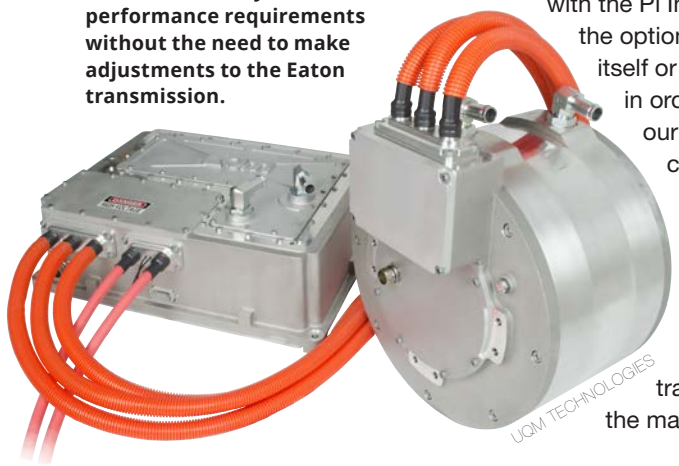
UQM TECHNOLOGIES

The UQM PowerPhaseHD220/ HD250 motor and inverter system is durably designed for use in various operating environments.

UQM has worked with previously, will provide its M220 transmission controller. As part of the company's OpenECU line of rapid control prototyping controllers, the M220 enables quick development and production of the controller.

Dwight Hansell, Vice President Business Development at Pi Innovo, explains that the hardware and platform software are existing technology, while the application software is the part which needs to be developed for each individual application in which the controller will be employed. "With our platform, which allows everything to be done with model-based controls using Simulink, our team can very quickly develop the actual application that will go into production for [UQM]," he says. "They can have a very quick turnaround to have production-level controls ready to go into production for their system at a very cost-effective price."

Hansell says one of the benefits to using the Pi Innovo transmission control unit (TCU) is the fact that UQM will be able to tailor the controls to individual applications. Typically when a company receives a TCU, it's a black box which requires going back to the supplier for any changes or modifications. However, with the Pi Innovo unit, UQM has the option to modify the controls itself or work with Pi Innovo in order to do so. "By using our controller and our controls, UQM's going to be able to go in very quickly and respond to their customers' needs and give them exactly what they want with respect to transmission controls for the market," says Hansell.


UQM TECHNOLOGIES

UQM's PowerPhase HD system is available in three versions with power outputs of 140-250 kW. Customized versions can be used for PowerPhaseDT system to meet performance requirements without the need to make adjustments to the Eaton transmission.


PI INNOVO

Benefits to OEMs and their customers

The PowerPhaseDT offers many benefits in comparison to direct drive electric vehicle systems, which many markets are moving away from. Ley says the three main benefits the UQM system provides are reduced size and weight, a reduced cost in volume production and improvements in efficiency.

Direct drive systems usually consist of a large electric motor driving directly into the rear axle, and do not require the use of a transmission. Using a transmission in the system, however, multiplies the torque from the electric motor, lowering its torque requirement which allows the size of the motor to be reduced. This enables the amount of materials within the motor, such as copper and magnets, to be reduced as well. "We reduce the size of the electric motor by three or four times and add a transmission, the size of which is roughly the same as the electric motor, but the materials in the transmission are much less expensive,"

Pi Innovo's M220 transmission controller is part of its OpenECU line of products which can be quickly modified to applications through the use of model-based software.

says Ley. "That reduces the size and cost of the overall drivetrain."

Including a transmission in the system also benefits efficiency by keeping the electric motor in the most efficient operating range over more of the drive cycle, says Ley. "Similar to how a diesel engine is kept within its power band by shifting gears, the electric motor and transmission combination will be shifted such that it's kept in its most efficient operating region for a larger part of the drive cycle, therefore the overall vehicle efficiency can be optimized."

"I think a lot of people thought when you went to EVs, transmissions would no longer be needed and now they're realizing they're providing a huge benefit," adds DeVito.

As battery costs have begun to come down, many transit agencies are seeing the benefits of pure electric vehicles, says Mitchell. Not only do electric vehicles provide opportunities to reduce fuel costs and emissions, but also reductions in maintenance costs. He says a study conducted by King County in Washington found a typical diesel bus, running continuously for 36,000 miles, cost around $1 per mile to maintain while an electric bus cost $0.06 per mile.

With these benefits becoming more evident, it's likely more OEMs will look to make the move toward offering full electric vehicles. If an OEM chooses to use the PowerPhaseDT system for such a vehicle, UQM will work with that manufacturer to integrate the system.

While the initial application for the drivetrain is transit buses, Ley says it could be used in several types of on- or off-highway applications. "It really is applicable across the board in terms of industrial and commercial vehicle applications," he says.

Ley notes that both the UQM motor and Eaton transmission have been used in heavy-duty off-highway applications, and as such are able to withstand the shock and vibration associated with those types of working environments. Other than mounting hardware, Ley does not foresee any changes needing to be made to the system whether it's used in an on- or off-highway application.

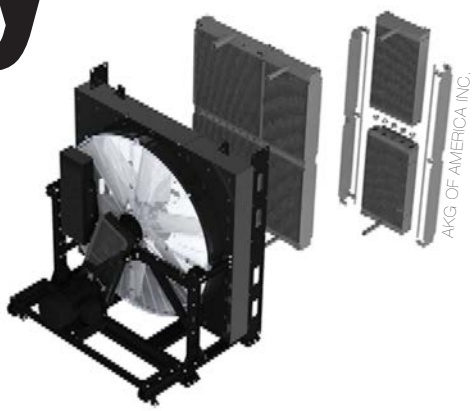
The all-electric drivetrain is currently going through pilot programs with a few customers in North America and China *(learn more, 12253651)*, and UQM anticipates production of the system will begin in 2017.

www.oemoffhighway.com/12273074

MODULAR DESIGN Eases Field Serviceability

Development of a modular engine cooling system allows for faster and easier field serviceability, as well as space-saving opportunities.

by Sara Jensen



AKG OF AMERICA INC.

The MCS Series cooler has a modular design to ease field serviceability.

Responding to customer requests for a larger engine cooler which could be easily serviceable in the field, AKG developed its new MCS Series cooler and introduced it at this year's MINExpo INTERNATIONAL *(learn more, 12260755).*

The cooler works with engines operating from 1,500-5,000 hp (1,118.6-3,728.5 kW) and is composed of individual sections which can be replaced as needed. "If one of those sections gets damaged in the field, you can remove it and replace it with just hand tools, avoiding the cost and time of replacing the entire cooling package," says Michael Ellis, Business Development Engineer at AKG of America Inc.

Design features and benefits

AKG says typical competitive cooling products in the high horsepower market utilize technology consisting of replaceable individual cooling tubes. The company heard from customers that while those systems were long lasting, end users were becoming too proficient at fixing the coolers in the field, which meant they were having to fix the systems often. Ellis says customers wanted a modular system that could be fixed in the field if something broke, but with a more robust core technology that would not allow end users to get practice at fixing.

"The challenge is...to keep the engine package the same size even though there's more stuff being [added]," says Michael Ellis, Business Development Engineer at AKG of America Inc.

To meet these requirements, the MCS system is composed of multiple bar and plate cooler sections that can be removed on an individual basis if a problem occurs. The entire system is made up of these modular cooler sections which can be configured as needed by a customer to fit their application. While a typical application can have anywhere from

HYDAC INTL.

To help save space in crowded engine compartments, cooling systems like HYDAC's SSC Series diesel engine cooler are designed to offer multiple capabilities. The SSC Series, for instance, provides both charge-air and engine water/glycol cooling.

two to 64 modular coolers, Ellis says in theory, there is no limit to how many sections can be in a system.

Adam Jury, Engineer Manager at AKG of America Inc., says one of the issues with the competitive removable tube style designs is the fact that seals in these systems are often leaky and if the problem tube is deep within the system, it requires a large portion of the radiator to be removed in order to find and replace that tube.

With its block-shaped cooling sections, AKG's MCS eliminates the need to remove and replace several pieces of a system. "It's much easier to replace the section you need instead of removing each individual tube and large portions of the radiator to find the actual leak," says Jury.

The modular design of the MCS has proven beneficial when installing the system, as well. One of the first applications to use the system was a wind turbine; because of its height, a large crane would have been needed to lift a full-sized cooling system to the top of the turbine, which would have been a significant expense. Instead, the modular design allowed each cooling section to be hoisted up individually by a smaller crane built into the wind turbine mast and assembled once it reached the top.

Each of the cooler sections are bolted together with a seal-and-plug which not only provides a strong seal but is also ruggedly designed for use in high temperature environments. Because of this, Ellis says the MCS can be used as a charge air cooler and oil cooler in addition to an engine radiator. "This allows us to build one cooler

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Michelle Kopier, Editor, *OEM Off-Highway* and **OEMOffHighway.com**
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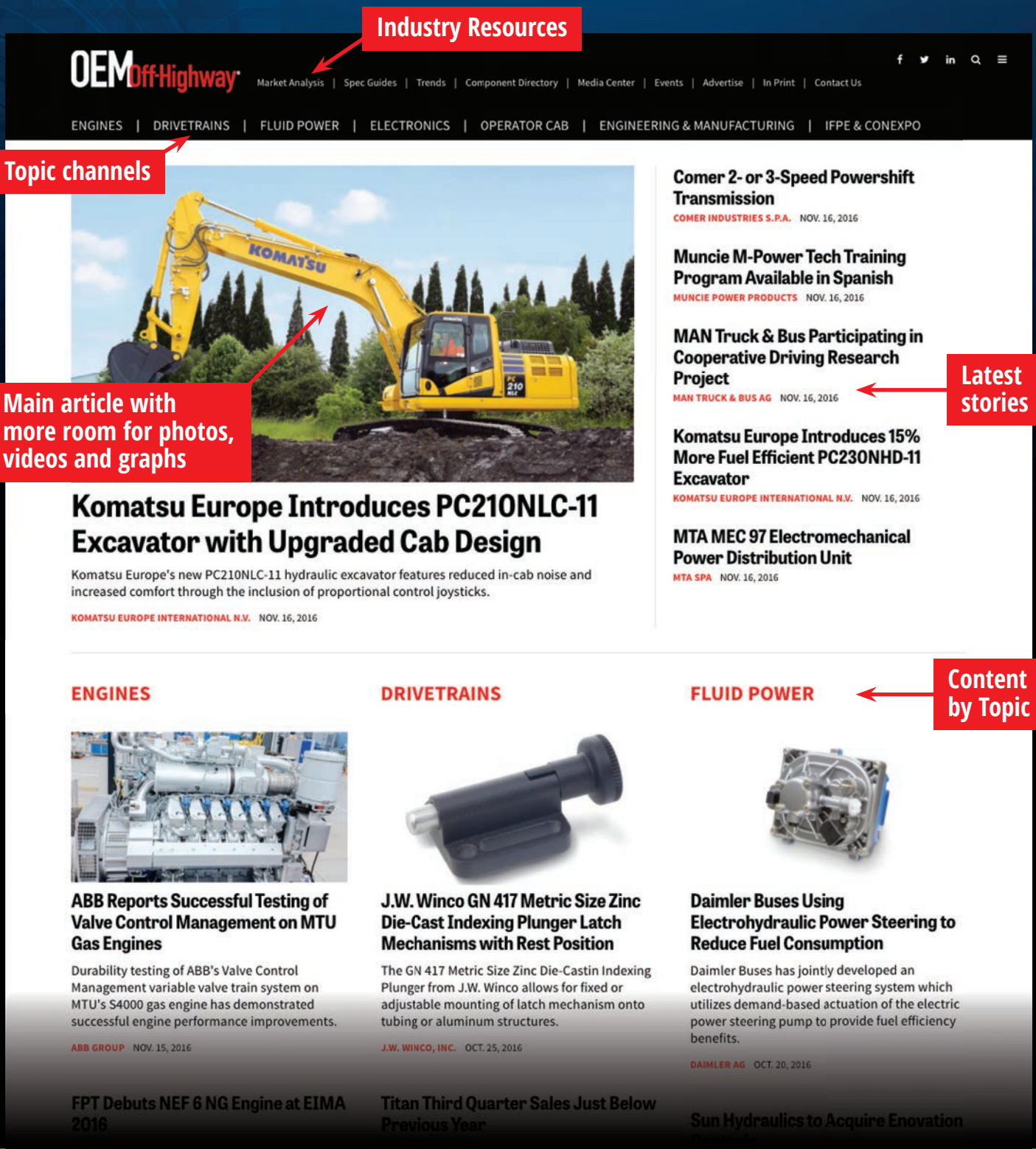

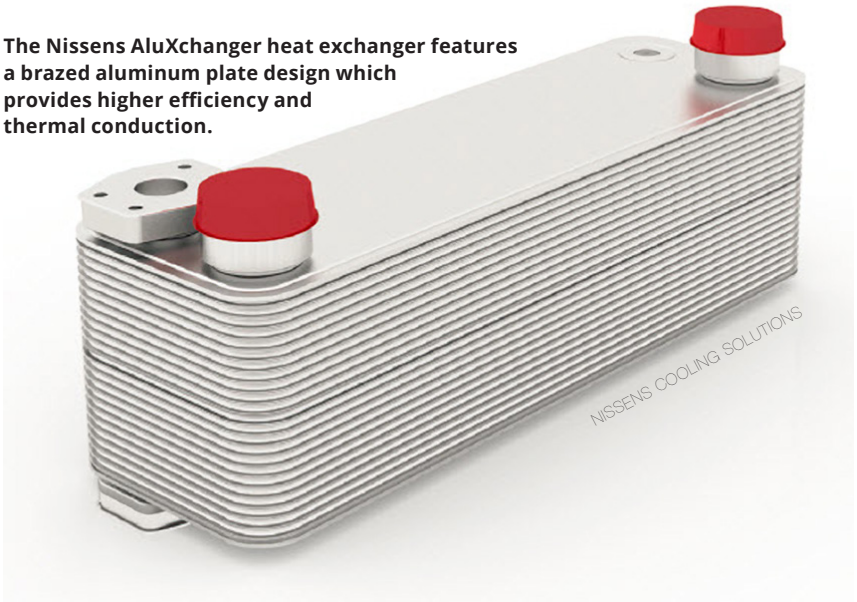

The Nissens AluXchanger heat exchanger features a brazed aluminum plate design which provides higher efficiency and thermal conduction.

that's handling all of those different fluids in one cooler package," he explains.

Having a single modular cooler design which meets various cooling needs helps save on space within crowded engine compartments, as well as enables end users to keep just one type of replacement part in stock.

The cooler's bar and plate style construction helps improve cooling efficiency as it allows several circuits to be placed side by side instead of front to back, lowering the temperature of the air as it enters the system. "You can typically get more [cooling efficiency] in the same face area than you would with the traditional front to back style package," explains Jury.

Higher heat transfer efficiency is also possible with the bar and plate style design due to the presence of turbulators in the process rows which increase active heat transfer surface area and turbulate the flow of the working fluid. AKG's deep core technology allows for more heat exchangers to be included in the same installation envelope, as well. By using aluminum material for the heat exchanger cores, the company says customers can take advantage of the material's good conductive and inert properties by reducing cooler size and providing durability in corrosive environments.

Alleviating space constraints

Progressively stricter emissions regulations have caused the amount of space within engine compartments to diminish as a result of the need to now include aftertreatment and cooling system technologies. "The challenge is…to keep the engine package the same size even though there's more stuff being [added]," says Ellis. "They're changing the tolerances on the heat loads to make everything more precise, but we don't have any more space to work in."

Added to this is the need to make systems accessible for maintenance personnel; Jury notes that a system such as the MCS may require a small amount of additional space to ensure accessibility to the modular sections of the unit.

However, he says the bar and plate design of the system can help overcome these challenges by allowing the cores to be placed deeper within the cooling system package. "Instead of putting more heat transfer surface in the face area of

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AKG OF AMERICA INC.

The MCS cooler can be packaged in various ways to meet an OEM's individual application needs.

the cooling package, which takes up more room, you can actually go deeper [within the package design]," explains Jury. "In many cases we can go as deep if not deeper than some of the more traditional removable tube style products."

Working together with an OEM in the early stages of the design process can be beneficial to overcoming these challenges, as well. "We work very closely [with OEMs] and design systems to fit into their machine," says Ellis. "The sooner we get started in the design process, the better we're able to tailor the cooling package to the machine and make sure everything fits and works exactly right the first time out."

The cooling system often starts with standard parts, he says, and progresses toward a customized package design tailored to the application needs. Jury adds that being able to leverage standard components, fittings and core block sizes helps minimize the overall cost of the system once a final design concept is realized.

Currently large mining and construction equipment, as well as wind turbines and large gensets, are among the target markets for the MCS cooling system. Some larger material handling equipment, rail, and power generation equipment are also potential areas of implementation, concludes Ellis.

Customers wanted a modular system that could be fixed in the field, but with a more robust core technology.

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Read about more recent engine cooling product introductions at *oemoffhighway.com*.

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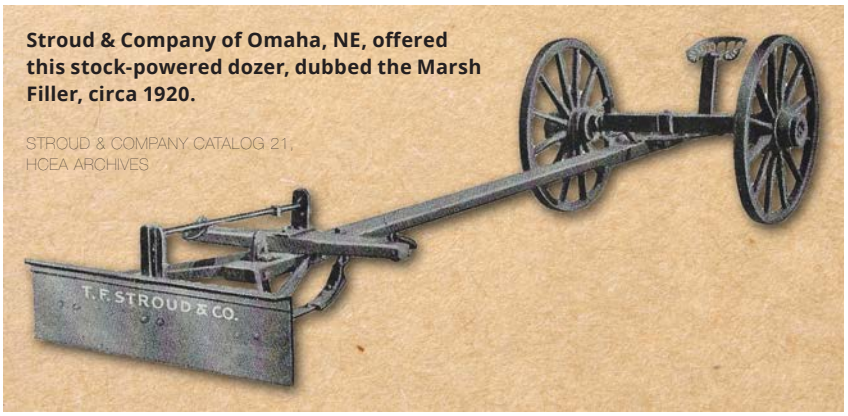
The Earliest Bulldozers

From primitive to mechanical, the evolution of the bulldozer begins in the 1800s and is interjected with a contribution from the agricultural industry with crawler tractors.



Stroud & Company of Omaha, NE, offered this stock-powered dozer, dubbed the Marsh Filler, circa 1920.

STROUD & COMPANY CATALOG 21; HCEA ARCHIVES

by Thomas Berry, Archivist, Historical Construction Assn.

Ever since we started rearranging the surface of the earth, there has been a need to push piles of dirt and rock and, especially, to push it into holes or over the edge of a bank. It could certainly be done with hand tools, but only with great effort and much time. The difficulty arose with how to do it mechanically.

Horses were great at pulling machinery, and did reasonably well with pull graders to spread material behind them as they walked. But how to use horses to spread material ahead of them?

Its year of invention and the name of the inventor are lost to history, but in the mid- to late-1800s a device was developed to solve this problem. Details vary, but the general design consisted of a long beam with a perpendicular, vertical blade at one end and an axle and teamster's seat at the other. With horses attached to both sides of the beam, it provided a handy means of using the original form of horsepower to push material in advance of the team. The earliest examples known to this author were built circa 1880, and these primitive "bulldozers" were produced as late as the early 1920s.

As crawler tractors were introduced into agriculture and logging in the late 1910s, it was only natural that these eminently practical machines should be adapted for construction. Not only were they far superior to stock for pulling wagons and scrapers; over time, their potential use with bulldozers emerged as well. Benjamin Holt reportedly tested a blade on the front of a steam tractor as early as 1902, and experimented with a blade on a crawler tractor in 1916.

The first successful use of a dozer blade on a crawler tractor is believed to have been an invention by LaPlant-Choate Manufacturing Company in 1920 for use at the City of South Milwaukee garbage dump. The blade could not be lifted or lowered; like the blade on the stock-powered dozers, it simply flipped up and dragged on the ground when backing up.

As the idea of a tractor-mounted blade evolved, so too did variations on the design. An adjustable angle dozer was developed for situations in which spoil had to be moved to the side; indeed, several manufacturers called angle dozers "trail builders" because of their suitability for cutting roads and trails along cross slopes. Other dozers were designed for specific applications such as land clearing, pushloading scrapers, mine reclamation, and gathering and pushing large volumes of bulk material. As hydraulics improved, multi-positional six-way dozers that could be angled and/or tilted came into widespread use.

Over the years, the crawler tractor came to be known by the name of its bulldozer attachment, and many models of crawler tractors are designed specifically for dozer service.

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. 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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