

The Power Shift

Companies Look to Fuel Economy, Energy Efficiency and Operating Costs to Improve Off-Highway Applications

Matthew Jaster, Senior Editor

The big picture in automotive is quickly becoming the big picture in the entire transportation industry. For the off-highway market, this means keeping pace with energy efficiency regulations, changing fuel economy strategies, and reducing operating costs for customers when feasible. Companies like Eaton, BorgWarner, Dana and Thomson Linear continue to provide products and technologies to meet the changing demands of this market.

Off-highway is mirroring the automotive industry in terms of more efficient and productive vehicles and components today.



Eaton Expands Valvetrain Solutions in Off-Highway Applications

Eaton recently announced it has expanded its portfolio of valvetrain solutions for diesel off-highway vehicles to help OEMs reduce emissions and improve fuel economy. The company has supplied valves and valve actuators since 1930 with a diverse portfolio that includes cylinder deactivation systems, late (or early) intake valve closing, early exhaust valve opening, engine brakes, hydraulic lash adjusters, and valves, including sodium-filled valves and high-temperature resistant alloys.

In different ways the technologies listed above (except engine brakes which serve other purposes) are means to reduce CO₂ and NO_x emissions, which are typically conflicting objectives.

Fabiano Contarin, product director, commercial vehicle valve actuation, Eaton

Vehicle Group, caught up with PTE to discuss some of these valvetrain solutions.

Cylinder Deactivation (CDA), according to Contarin, consists of deactivating the intake and exhaust valve opening and the fuel injection on some of the cylinders when the engine is running at low load.

“By doing that, the total flow of air through the engine is significantly reduced while the total amount of injected fuel is nearly the same. This generates two effects: (1) the temperature of the exhaust gases is significantly higher (100°C+), allowing the NO_x aftertreatment to remain efficient at low load, which is key to meet future emission regulations and, (2) the overall efficiency of the engine increases, hence the CO₂ emissions are reduced,” he said.

Different than other technologies that

reduce NO_x at the expense of CO₂, CDA is able to reduce both NO_x and CO₂ simultaneously. NO_x reductions of 40%+ and CO₂ reduction of 5–8% on a low load cycle are to be expected.

Late Intake Valve Closing (LIVC), also known as the Miller cycle, consists of delaying the closing of the intake valve so the effective compression ratio is lower than the expansion ratio. This increases the thermal efficiency of the engine, improving fuel economy and reducing CO₂ emissions. By reducing the effective compression ratio, LIVC also enables higher geometrical compression ratios that further improve efficiency. Because of the reduced amount of air-flow through the engine (shorter intake stroke), the exhaust temperature is higher (+40°C), contributing to the thermal management of



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aftertreatment. Overall LICV can bring a 1–2% CO₂ reduction.

Early Exhaust Valve Opening (EEVO) consists of advancing the opening of the exhaust valve so that the exhaust gases are hotter (less energy is transformed into mechanical work, more goes into heat). By doing this EEVO is a powerful tool to get the aftertreatment warm after a cold start.

“Hydraulic Lash Adjustment (HLA) eliminates the need for periodical service to adjust valve lash. This has multiple benefits including reduced service time, reduced noise in operation, as well as more consistent valve timing to improve engine efficiency and emissions,” Contarin said.

“Additional benefits particularly interesting to the off-highway market include



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the ability to avoid valve lash setting in the field with risk of engine contamination and operator errors and it enables packaging the aftertreatment on top of the engine (in case of mechanical lash adjustment, aftertreatment would need to be removed to do the lash adjustment,” he added.

Improving emission performance often requires running with higher cylinder pressures and temperature. Eaton can also help on this front with proprietary valve alloys such as Crutonite, and

potentially leveraging the hollow valve technology widely used in passenger car applications.

Eaton’s valvetrain control functions offer a variety of flexibility and adaptability. “They are based on two building blocks: a rocker with a switchable capsule and a split rocker for full deactivation. By combining these two building blocks a wide variety of VVA strategies can be realized in virtually any engine architecture: single and dual overhead cam, as well as in cam-in-block engines,”

Contarin said.

Although plans for introducing new regulations are not firm, Contarin expects a new regulatory step in the 2027–2029 timeframe (Tier 5/Stage VI) imposing NOx reduction as high as 90% and CO₂ reduction of 10–15%. This is relatively similar to what is happening with on-road vehicles (EPA 2027, Euro VII), with a lag of 1–2 years.

“This will certainly drive technology implementation and different degrees of electrification. The off-highway market being very fragmented makes it difficult to speak in general terms, however we expect diesel engines to remain predominant in the mid-term, and VVA technologies to play an important role to enable OEMs to meet the new regulations. As mentioned above what makes VVA stand out from the alternatives is that it provides benefits on both the NOx and CO₂ front,” Contarin said.

All of this matters because of the number of off-highway vehicles there are vs. on-highway.

“Perception is it is a niche market, but in reality, it’s not. In 2020 4.3M engines were produced for off-highway applications while 3.5M were manufactured for on-highway. So making them cleaner is just as important,” he concluded.

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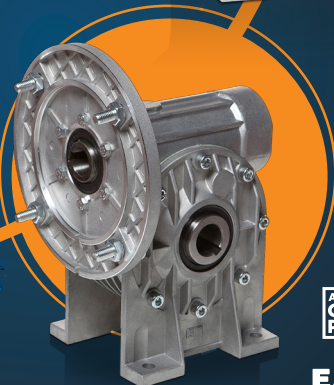
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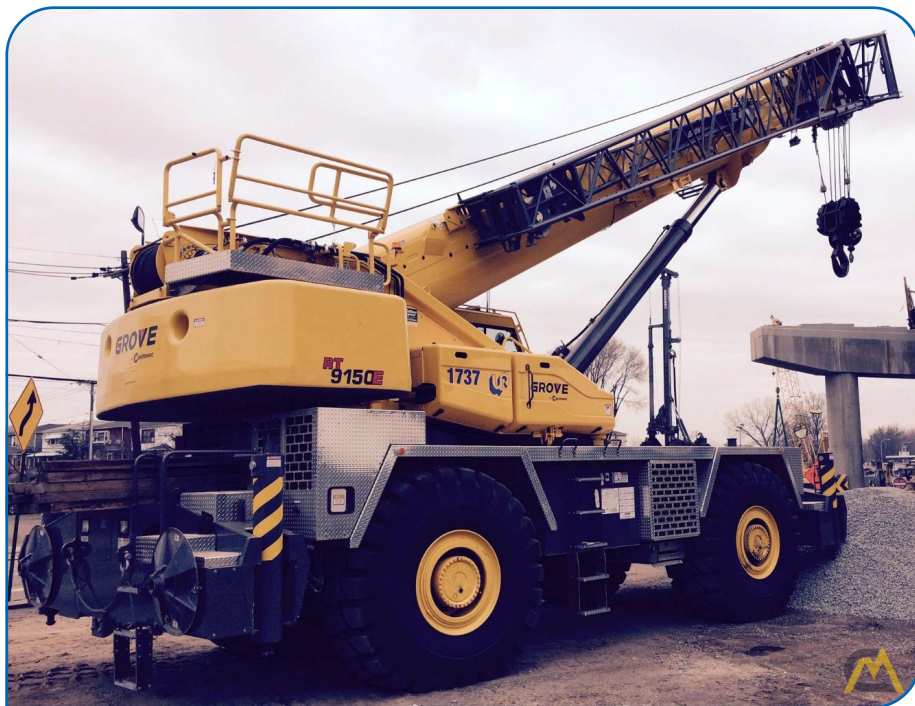
The Spicer 246 heavy-duty steer axle and Spicer C3300 remote torque converter are offered as part of a complete drivetrain solution for rough-terrain cranes that delivers premium performance through improved gradeability and travel speeds, higher efficiency in the field, increased productivity, and reduced operating costs.

“As the global construction market recovers, buyers are looking for high-performing vehicles that deliver exceptional productivity and efficiency,” said Aziz Aghili, president of Dana Off-Highway Drive and Motion Systems. “Dana’s large and growing capabilities for rough-terrain cranes enable us to anticipate market shifts and collaborate with original-equipment manufacturers to supply the drivetrain technologies that improve their competitiveness.”

Dana’s new heavy-duty Spicer 246 steer axle features a monolithic axle design and high integrity seals that deliver exceptional performance in the most severe working conditions. It features optimized steering geometries to minimize slippage, while the single universal joint design with outboard planetary gears provides high output torque and high-capacity braking with low drag at travel speeds.

Currently available for OEM field testing, the Spicer 246 axle can also be adapted for use with airport ground support vehicles, where it can be configured with optional wet brakes.

Dana has also developed the new Spicer C3300 remote torque converter



Performance upgrades are essential for rough terrain cranes in the off-highway market.

specifically for rough-terrain cranes. It is optimized for engines up to 195 kW (260 hp) and can be packaged with Spicer remote transmissions. Dana is the only manufacturer worldwide that supplies a remote torque converter with three large pump drives for implements.

The Spicer C3300 remote torque converter is available with an optional lockup that improves efficiency while providing higher braking effort during downhill operation. It features new converter wheel sizes configured to

optimize the performance of today’s low-RPM engine designs.

Available now, the Spicer C3300 remote torque converter is already in use in terminal tractor applications, where it enables lower heights for fifth wheels.

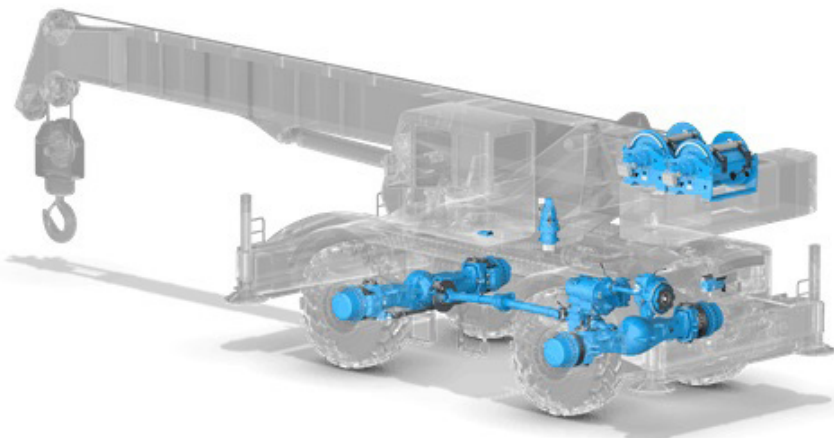
Dana has a large and growing selection of drive and motion technologies for manufacturers of tracked and wheeled cranes.

Earlier this year, Dana introduced a new series of Spicer Torque-Hub drives for crawler cranes and other large-tracked vehicles. With torque ratings from 80,000 N-m up to 450,000 N-m, the new drives offer flexible packaging and gear ratios to meet manufacturer preferences for tracked and wheeled applications.

Also, Dana offers high-performance Brevini winches for cranes and other applications with lift capacities from 1.1 tons (990 kg) to 33 tons (30 tonnes).

Additionally, Dana supports the work functions of cranes with a wide selection of Brevini slew drives, hydraulic pumps and motors, and proportional directional valves.

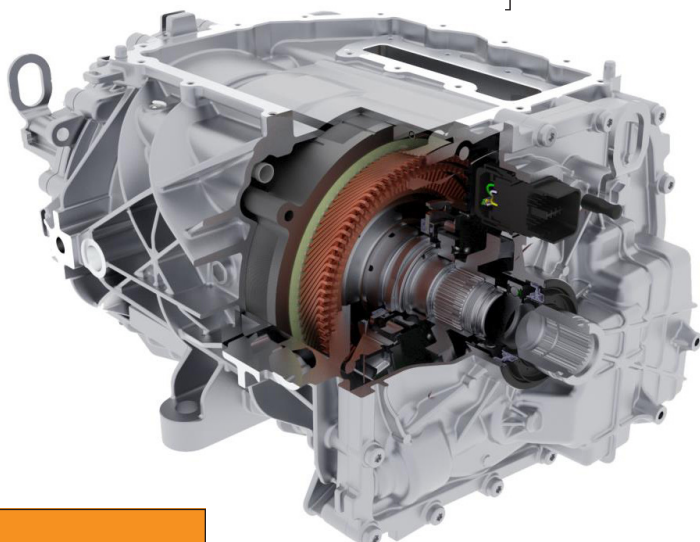
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Dana has anticipated market shifts with its latest drivetrain technologies.

BorgWarner Powers Commercial Vehicles with HVH 320

BorgWarner's High Voltage Hairpin (HVH) electric motor, the HVH 320, can power a variety of hybrid and electric applications for commercial vehicle manufacturers, including a large European OEM. Production of the HVH 320, which is equipped with 800-volt capabilities and available in four variants, is expected to kick off in 2024. Its multi-faceted platform will support the manufacturers' goal of a common electric drivetrain and deliver



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approximately 97% peak efficiency and over 400kW of power.

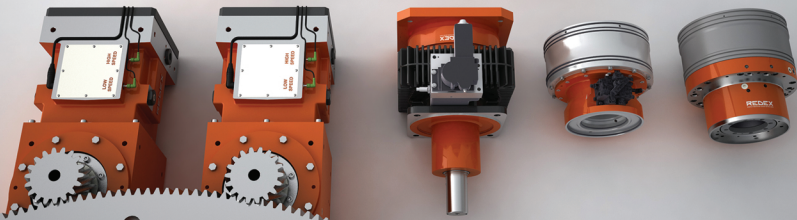
BorgWarner leveraged its motor production experience to design four variants of its modular and flexible HVH 320 motor platform to meet the customer's requirements. The motor offers clean and quiet operation, while reaching a torque output of up to 1270 Nm. Also, the technology supports the vehicle's shifting sequence and charges the battery by generating power while braking or driving downhill.

The HVH 320 motor is the newest addition to BorgWarner's portfolio of HVH series motors, which are offered to both light-duty passenger cars and heavy-duty commercial vehicles. These versatile motors feature patented stator winding technology, are easy to integrate and are available as fully housed motors or as rotor/stator assemblies. Additionally, the motors can be used in a variety of architectural positions throughout a vehicle. BorgWarner also offers inverters that can achieve the same, next-generation 800-volt level.

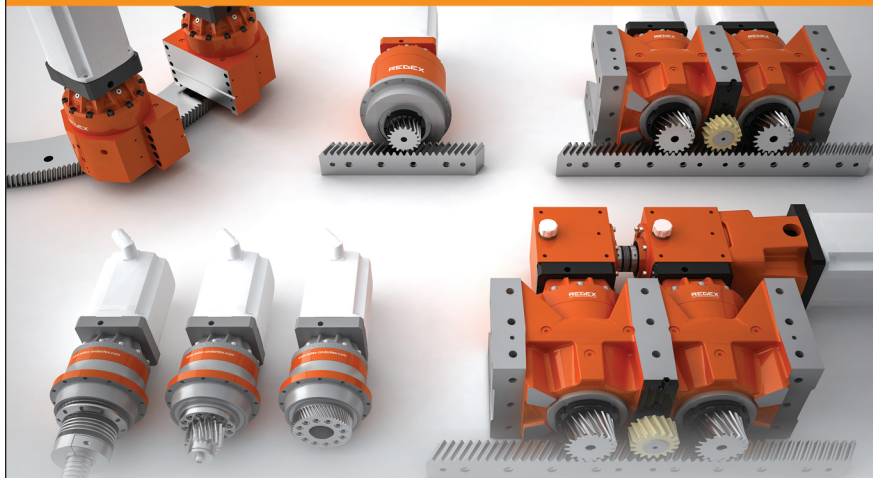
"Adding the HVH 320 to our electric motor family bolsters our offerings and is an excellent example of BorgWarner's commitment to delivering state-of-the-art clean propulsion technologies that match market needs," said Dr. Stefan Demmerle, president and general manager, BorgWarner PowerDrive Systems. "Using our 800-volt rated machine, customers can significantly reduce charging time and achieve a higher power density, enabling an even brighter future for electric trucks."

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Thomson Offers H-Track Electro-Hydraulic Linear Actuators

Designers for heavy duty motion control applications have traditionally specified hydraulic cylinders for their high speed, heavy load handling and resilience. However, recent advancements that embed hydraulic technology within electric linear actuators have been delivering the benefits of hydraulics without the common drawbacks.

H-Track actuators incorporate a patented fluid power design, which provides high load capability for extreme duty use, a more compact pin to pin than other actuators of the same load capability, excellent ingress protection and corrosion resistance. The H-Track uses an external gear pump connected to a reservoir and actuator, yielding the most impact resistant

Warner actuator. The H-Track pump is burnished, cleaned, flushed and vacuum filled with degassed hydraulic fluid. The system is completely sealed with no hoses to leak. This ensures you receive contaminant free and maintenance-free product for the life of the actuator.

The H-Track electro-hydraulic linear actuator is an all-in-one, self-contained

system that can tolerate extreme shock loads, prevents leaks and features a higher speed profile. It allows personnel to avoid the messes, complexities, contaminants, and maintenance associated with traditional hydraulic cylinders. For more information regarding these innovations download Thomson's white paper, "Why Electric Actuators are Increasingly Replacing Hydraulic Systems," here:

www.thomsonlinear.com/en/products/linear-actuators/white-paper.



H-Track actuators from Thomson Linear incorporate a patented fluid power design, which provides high load capability for extreme duty use.

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