

# The Changing Face of the Off-Highway Drivetrain

Adapting to sustainable products, practices and technologies in the agricultural, construction and mobile equipment markets

Matthew Jaster, Senior Editor

If trade shows are still a major indicator of market growth, the construction and off-highway industries seem to be in a good place in 2023. CONEXPO-CONAGG and IFPE 2023 welcomed more than 139,000 attendees to Las Vegas in March. These visitors were treated to 2,400 exhibitors from 36 countries reaffirming the belief that innovation and sustainability will drive these markets in the coming years.

## Bonfiglioli Addresses Electrification Trends

Bonfiglioli is known for a wide variety of planetary gearboxes traditionally driven by hydraulic motors. The paradigm shift is currently the switch from hydraulic to electric mobility and Bonfiglioli is right at the center of some interesting developments in these areas.

“We’ve invested a large amount of capital into the development of low voltage-high voltage induction and permanent magnet motors that we’ve interfaced with our high-volume planetary gearboxes,”

said Kenneth Hartsell, business development manager at Bonfiglioli. “This puts us in a position to offer a very good system solution to the off-highway and construction markets.”

Bonfiglioli’s electric drives, for example, can be used as travel and swing drives. Hartsell said they are designed in principle like the company’s hydraulic models. They have all the technical necessities and properties needed for the switch to electrification.

The electric motor in its robust housing is air-cooled and corresponds to protection class IP67. The core of the drive, the permanent magnet motor itself, is maintenance-free. It is equipped with temperature and speed sensors. A single or multi-stage planetary gear is flanged directly to it, which is defined according to the requirements of the machine manufacturer. Its maintenance intervals are long, and maintenance itself is very easy thanks to the smart design.

“If you’re going to mount an electric motor to a gearbox that traditionally had an integrated hydraulic brake, now it’s an electric brake and the architecture of the

machine has to change to accommodate this,” Hartsell added. “A large percentage of our research and development at Bonfiglioli is going towards products to further promote green initiatives, sustainability as well as electrification.”

This electric trend is helping in other areas including condition monitoring and maintenance.

“We’re seeing major improvements thanks to these wholesale electrification changes across the board. We’ve developed a condition monitoring system, for example, that is scalable across many different markets giving operators the opportunity to pull data on maintenance intervals, engine oil replacement, etc. We’re able to provide so much more information in real-time for our customers today,” Hartsell said.

Rental companies that buy hundreds of pieces of equipment are a great example of this. Hartsell said they want a condition monitoring system that allows them to manage the fleet in the most effective way possible.

“Now, while gathering this data, it also helps the manufacturers learn more about what is and isn’t working in the field. Do we need new materials? Do we need to make improvements to the gear profiles? Are there things that we must change to enhance serviceability? These are all important questions as we attempt to match our customer’s expectations,” Hartsell said.

While many are still in ‘electrification infancy’ so to speak, Hartsell is seeing a two-phase approach to the transition.

“Many OEMs are doing this in a two-phase approach with the first phase being more of an electric-hybrid application where they still have a need to drive hydraulic components to eventually phase two which is the full transition to electrification,” he added.





Bonfiglioli displayed many of its electrification products and technologies during IFPE 2023.

[bonfiglioli.com](http://bonfiglioli.com)

The movement towards electric drive-trains and components means a mechatronics approach is needed from an engineering standpoint. There's been a large hiring of electrical engineers at Bonfiglioli to address these market changes.

"We have a great core group of mechanical engineers. At the same time, with the knowledge changing and the skills needed to understand how these mechatronic systems work, you need to have seasoned engineers put training seminars together internally for the sales teams, support teams, etc. as these electrification changes take place in our key markets. The end goal is to be known for our diverse range of electromobility technologies for the construction, off-highway, and heavy industrial markets," Hartsell said.

Hartsell said if IFPE was any indication the future for electrification and e-mobility is very promising. "There's an anticipation that we're turning a corner post-pandemic and these products and technologies will be extremely important to our diverse customer base for years to come."

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## Dana Updates Motion and Drive Technologies for Off-Highway Applications

During a press conference at IFPE 2023, Dana executives discussed the expansion of the company's drive production capacity as well as recently repositioning the final assembly of its line of heavy axles for mining and other extreme-duty applications to its Lafayette facility. The realignment helps Dana better address the supply-chain requirements and onshoring of North American OEMs.

These initiatives enhance Dana's reputation in gear engineering, manufacturing, and production. At CONEXPO, Dana showcased its ability to deliver precision-made Fairfield gears and gear drives for industrial and mobile applications as well as its push toward electrification.

"Our goal is to improve the performance, efficiency and durability of conventional and electrified construction vehicles and other off-highway machines," said Jeff Cole, senior director, corporate communications, at Dana during IFPE 2023.

Marcus King, vice president, off-highway global sales, business development, strategy and program management at Dana, said the organization is dedicated to strategic principles supporting its company-wide mission of "Powering Innovation to Move Our World."

"Our vision is to improve our leadership position in both conventional and next generation driveline innovations. Dana is energy source agnostic. This is so important in both the construction and off-highway industries where the adoption of zero emissions can vary from region to region, from market to market, application to application, and even vehicle to vehicle," King said.

This balanced, full system approach was on full display at the Dana booth during IFPE 2023 in Las Vegas.

Drive and motion technologies were available for ICE applications and the company continues to expand

its offerings in performance and efficiency in these conventional areas. Furthermore, Dana is at the forefront of electric vehicle innovation as well with the e-Transmission and additional e-propulsion systems featured at IFPE.

"Most importantly, we help OEMs minimize development, integration, testing, and manufacturing as they track their paths through this energy transition," King added.

Leveraging Dana's field-proven powershift technology, the eSP502 e-Transmission offers a dual-motor, two-speed design that is built on a flexible platform to enable optimized performance at maximum efficiency in a compact package. The modular approach to the

transmission design allows for a single motor solution, as well as an optional power take-off, depending on the specific vehicle requirements.

Delivering high efficiency in a compact package that performs like a conventional powershift transmission, the dual-motor version supports continuous power outputs up to 326 hp (240 kW), while the single-motor configuration is engineered for 187 hp (140 kW) of continuous output.

The eSP502 is equipped with next-generation control software and functional safety readiness, enabling easy installation and smooth integration, and it features a patented clutch design that minimizes clutch drag to maximize efficiency.

*Dana showcased its ability to deliver precision-made Fairfield gears and gear drives for industrial and mobile applications.*



It is equipped with Dana TM4 high-voltage motors of up to 800 V to improve efficiency, reduce total package size, and provide redundancy as needed.

The eSP502 e-Transmission's compact and modular design allows it to be adapted for use in 4x2 or 4x4 vehicle applications with a range of ratio options to support a variety of vehicle types.

Developed for telehandlers lifting to 12,000 lbs. (5,400 kg), Dana's new driveline comes equipped with a compact Spicer 312 dropbox for high-power hydrostatic motors. This new hydrostatic dropbox functions as a continuously variable transmission without torque interruption, delivering enhanced performance with precise maneuvering at low speeds, reduced fuel consumption, and an integrated spring applied hydraulic release parking brake.

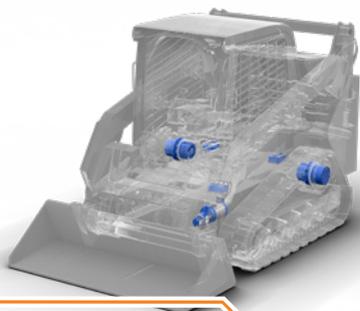
The system includes the field-proven Spicer 222 front and rear heavy-duty axles, which each feature a limited-slip differential and provide the customer with maintenance-free brakes. The complete driveline system is optimized for efficiency as well as noise, vibration, and harshness.

To support the industry's transition to zero-emission vehicles, Dana optimized the axles and driveline system to improve efficiency for a variety of architectures, allowing customers to retain the same driveline solution while choosing between implementing a hydrostatic dropbox or an electrically driven design.

To engage the rapidly increasing interest in CTLs and other tracked equipment in North America, Dana is nearly tripling its annual production of Spicer Torque-Hub track drives within the current footprint of its manufacturing and assembly hub in Lafayette.

Spicer Torque-Hub drives for CTLs offer output torque ratings from 5,000 to 17,000 Nm, delivering increased productivity with maximized motor displacements in a compact package.

[dana.com/off-highway](http://dana.com/off-highway)



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## Bosch Rexroth Offers Gearboxes for Electric Motors

The off-highway market is constantly evolving. Mobile working machines are becoming increasingly efficient. At the same time, exhaust gas and noise emissions need to be reduced. Machine manufacturers from all sectors recognize that electric drives are an important building block for a future-viable, sustainable product portfolio.

“We’re a strong, growing and thriving business in America. We’re investing in our mobile hydraulics partnerships. In North America, we’re responsible for our mobile hydraulics, industrial hydraulics and factory automation business which is somewhat unique to Rexroth and allows us to provide solutions to some of our key OEMs in their plants to help them automate and streamline their manufacturing processes,” said Greg Gumbs, president and CEO of Bosch Rexroth Americas.

“IFPE is all about our customers,” Gumbs said. “We want to earn the right to have our customers love doing business with us. Our booth at IFPE was more than just components, it was about manufacturing solutions.”

“A lot of our offerings at Bosch Rexroth are to reduce oil usage in our hydraulic systems, reduce energy consumption, etc.,” said Thomas Donato, chief revenue officer, Bosch Rexroth. “You will find custom apps that enables our customers’ to utilize these technologies.”

Regarding fluid control, Donato said that the boundaries of using software, electronics and electrification are becoming boundless.

“When you look at electrification, it’s a new space for many manufacturers in the off-highway and construction markets, and they’re looking for a partner with a really strong understanding of how these technologies can be applied on their machines.”

In order to support and drive the electrification of off-highway machines, Bosch Rexroth has developed two axle drives designed especially for electric motors.

Bosch Rexroth has developed spur gearboxes which vehicle manufacturers can use to unlock the full potential of new electric motors. The one and two-speed gearboxes are installed in the central section of the vehicle and pool the energy to



*Technology is allowing customers in the off-highway and construction markets to better monitor oil usage, energy consumption and maintain equipment.*

drive up to two axles with just one motor. The clever integration of essential components is evidence of the wealth of practical know-how that was drawn on throughout the development process.

The 1-speed spur gearbox (eGFZ 9100) and the 2-speed shift gearbox (eGFZ 9200) are installed in the central section of the vehicle and therefore open a range of new options compared to previous approaches with individual wheel drives. Both gearboxes enable high power densities to be achieved while simultaneously ensuring noise optimization for high-speed electric motors such as the Rexroth EMS1H and the Bosch SMG, but also for motors of other manufacturers with similar power.

Permanent-magnet synchronous motors are famed for being compact and highly efficient. However, their high rotational speeds present real challenges in terms of noise emissions, temperature, impermeability, and splines. The eGFZ 9100 and the eGFZ 9200 have been specially developed for these applications. They also enable the power to be directed to one or both vehicle’s axles. For all-wheel drive, there is also the option to connect or disconnect an axle. A lockable center differential is also provided for permanent all-wheel drive.

When integrating the gearboxes into the installation space available and into the machine concept, Bosch Rexroth drew on the knowledge and experience gained from fulfilling requirements for

previous drives. Gearboxes not only have to be compact and reliable but also easy to integrate. While the 1-speed gearbox (eGFZ 9100) can be installed horizontally or vertically depending on the relevant requirements, both Rexroth series feature a plug and drive system. Components such as the heat exchanger and oil pump available in the gearboxes enable both gearboxes to be seamlessly integrated into the existing cooling circuit of the electric drive.

Even the sensors for monitoring functions are already integrated into the gearboxes and can be adapted to suit a wide variety of applications using a range of different options. Machine manufacturers pursue different strategies in terms of voltage supply and battery storage requirements. To ensure that the installation space within the frame of the vehicle can always be optimally utilized, the eGFZ gearboxes with DIN ISO-compliant flange types enable a diverse range of drive solutions to be achieved. These can be executed in two-wheel drive as a U-shape or S-shape gearbox version and in four-wheel drive as a Z-shape version.

Company-wide knowledge of telehandlers, wheeled loaders, and municipal machinery as well as tractors and reach stackers was pooled at the start of the development process to determine which of these drives could be driven electrically and centrally in the future—and with which load collectives. The new eGFZ

gearboxes were developed and optimized based on this set of requirements.

Bosch Rexroth now intends to work alongside its customers to determine the best solution for each specific application. The eGFZ 9100 and eGFZ 9200, which are currently being used in

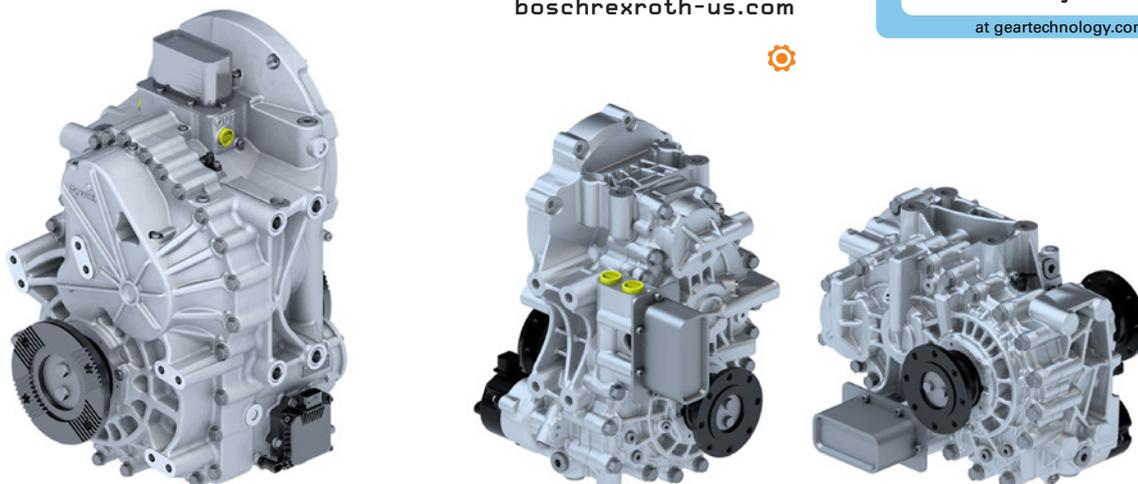
different pilot projects, will go into series production in 2022 as part of eLION. Rexroth's platform for the electrification of mobile working machines covers the full range of electric motor-generators, inverters, and accessories as well as tailored gearboxes, hydraulics, and software.

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