



# Driving Heavy Vehicle Transformation



## The Changing Landscape of Heavy Vehicle R&D

The heavy vehicle industry covering buses, trucks, agricultural, and construction machinery - is undergoing one of the most significant transformations in its history. Driven by sustainability targets, tightening global regulations, and rapid technological advances, manufacturers face the challenge of designing machines that remain durable and high-performing while drastically cutting emissions and boosting efficiency.

Traditionally reliant on combustion engines and robust mechanical systems, the sector is shifting toward electrification, digital connectivity, and automation. While these innovations open the door to cleaner, smarter, and more efficient operations, they also introduce new complexities: from managing battery weight and charging infrastructure to ensuring system integration, cybersecurity, and long-term reliability under demanding conditions. The ability to overcome these challenges will determine not only the competitiveness of manufacturers but also the role of heavy mobility in building a sustainable and resilient future.



### Energy Efficiency & Emissions Reduction

Meeting stricter global standards for fuel efficiency and emissions. Optimizing hybrid, electric, and hydrogen fuel cell systems to reduce energy loss, extend vehicle lifespans, and minimize downtime.



### Charging Infrastructure & Grid Integration

Scaling fast-charging networks for heavy-duty fleets without overloading local grids. Testing interoperability, grid compliance, and power quality across diverse charging systems.



### Battery & Drivetrain Validation

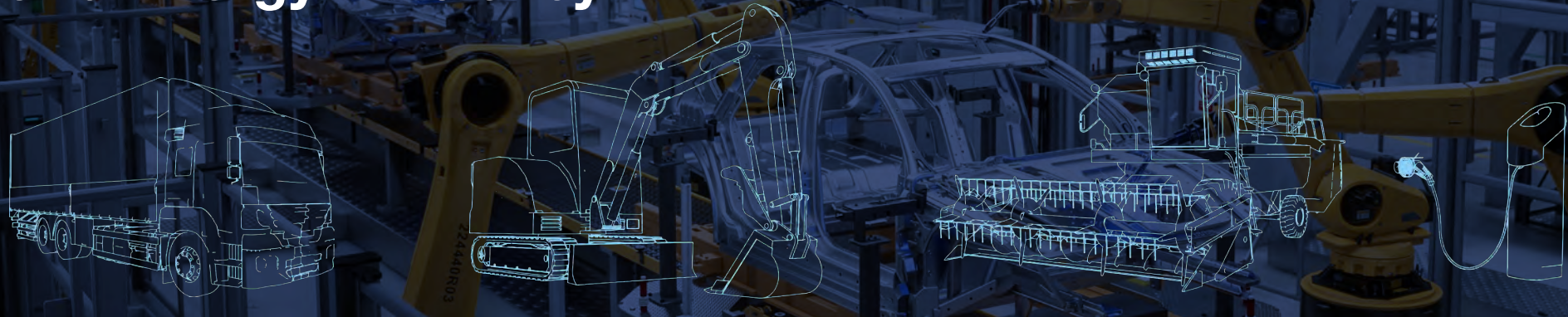
Ensuring durability, efficiency, and safety of high-capacity batteries under extreme loads and conditions. Precise testing of drivetrains for heavy-duty cycles in trucks, buses, and construction machinery.



### Automation & Reliability in Harsh Environments

Developing smart farming/construction vehicles that can be durable through dirt, vibration, and temperatures. Improving monitoring and predictive maintenance to reduce breakdowns in mission-critical operations.

# Supporting Vehicle Electrification and Energy Efficiency



## Heavy Road Transport

The transition to low and zero emission trucks and buses demands high degree of efficiency, safety, and durability across hybrid and electric drivetrains and power systems. For long distance transport, hydrogen fuel cells are used as energy source. These vehicles must deliver reliable performance under heavy loads and long duty cycles, while meeting stringent emissions and energy efficiency targets.

The high-accuracy measurement solutions of Yokogawa enable validation of powertrains, battery systems, electronic controls, helping manufacturers improve efficiency, ensure compliance, and accelerate the shift toward zero-emission heavy transport.

## Construction Vehicles

Electrification of construction equipment is increasingly necessary to meet sustainability requirements and regulatory standards. Beyond compliance, it also improves working conditions for operators by reducing vibration, noise, and harmful emissions. Battery-powered machines are becoming viable for remote locations, while grid-connected solutions are emerging for indoor and fixed-site applications. To handle heavy-duty tasks, hydraulic systems remain the backbone of these machines, now complemented by hybrid and electric actuators for greater efficiency and control.

Yokogawa provides advanced testing solutions to validate hydraulic systems, electronic controls, and structural performance. With precise data capture and analysis, we help ensure construction machinery meets modern efficiency and safety requirements.

## Agricultural and Farm Machinery

Modern farming machinery is evolving with electrification, automation, and smart power management as well. Precision agriculture requires reliable sensors, efficient PTO systems, and robust power distribution to boost productivity while reducing environmental impact. To improve farmers efficiency autonomous vehicles become available, which require to process more sensor and GPS data to operate precisely.

Our test and measurement solutions deliver insights into battery systems, electronic controls, and power distribution networks, enabling agricultural machinery manufacturers to optimize energy efficiency, advance precision farming, and accelerate the shift toward sustainable agriculture.

## Charging Infrastructure

Rapid expansion of charging networks require safe, efficient, and interoperable systems to support the growth of electric mobility. Grid connection, power conversion, and communication modules must operate reliably under varying loads and conditions. In addition, flexible charging solutions are essential for remote locations where grid access is limited, ensuring consistent availability and enabling broader adoption of electric vehicles.

Yokogawa test and measurement technologies deliver accurate evaluation of charging systems; from cables and converters to control modules, while ensuring efficiency, thermal safety, and seamless interoperability across charging infrastructure.



# Heavy- and Light Commercial Vehicles Challenges



## Powertrain

Boosting powertrain efficiency and reducing losses in engines, motors, inverters, and transmissions remain key challenges, along with evaluating regenerative braking and dynamic response. Precision power analyzers verify efficiency, high-speed DAQs capture transient events, and mixed-signal oscilloscopes reveal inverter switching and motor control anomalies.



## BMS (Battery Management System)

Safe and efficient batteries require accurate monitoring of cell voltages, temperatures, and charge cycles. Yokogawa's high-speed DAQs capture detailed cell and thermal data, while precision power analyzers ensure reliable efficiency testing of battery charge and discharge.



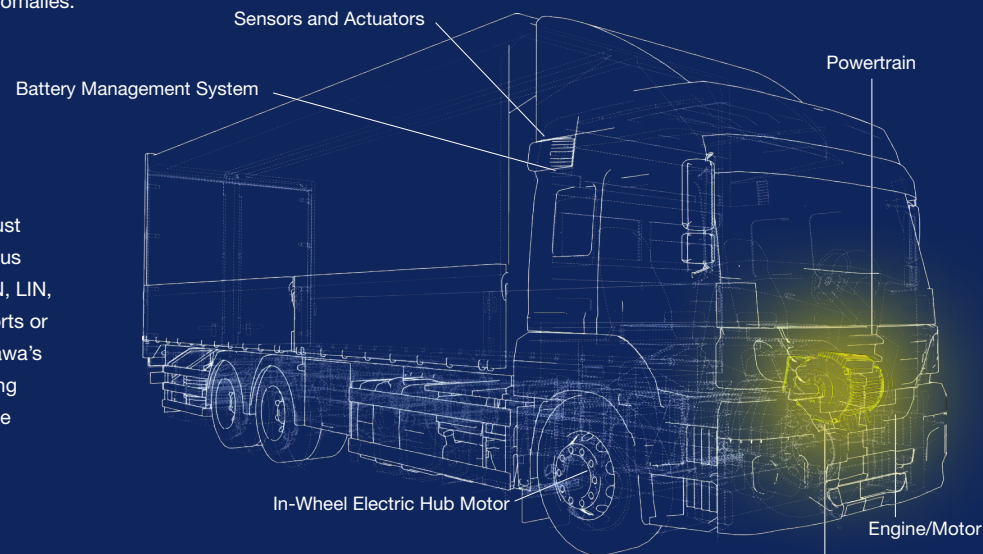
## Vehicle Control Units & Wiring Harness

Reliable vehicle operation requires accurate ECU communication and robust wiring integrity. Engineers must verify bus performance on protocols such as CAN, LIN, and FlexRay, while also diagnosing shorts or intermittent faults in harnesses. Yokogawa's oscilloscopes provide powerful decoding and triggering for debugging automotive networks with precision.



## Hydrogen Fuel Cells

Accurate, efficient, and safe DC-DC conversion is essential for EV battery performance. Our power analyzers validate efficiency and accuracy, data acquisition units monitor stability and protection events, and oscilloscopes analyze ripple and transients.

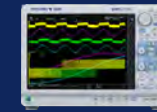


## Sensors and Actuators

Accurate sensors and responsive actuators are vital for ECU performance under harsh conditions. Yokogawa's high-speed data acquisition units capture diverse signals and actuator feedback with precision, while optical spectrum analyzers validate the integrity of fiber optic sensors in ADAS systems.

## Data Acquisition Units

Capturing a wide variety of signals simultaneously



DL950  
ScopeCorder



SL2000 High-Speed  
Data Acquisition Unit



DL350 Portable  
ScopeCorder

## Precision Power Analyzers

High-precision efficiency analysis



WT5000 Precision  
Power Analyzer



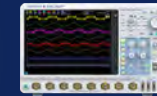
WT1800R Series  
Precision Power  
Analyzer



PX8000 Precision  
Power Scope

## Oscilloscopes

Detailed signal integrity analysis



DLM5000HD / DLM5000  
Signal Oscilloscope



DLM3000HD / DLM3000  
Signal Oscilloscope

## Optical Spectrum Analyzers

Characterizing and validating optical sensors and lasers



AQ6370E Optical  
Spectrum Analyzer

# Construction Vehicles

## Challenges



### Engine & Hydraulic Power Unit

Optimizing hydraulic performance requires precise measurement of pressure, flow, and temperature, along with efficient integration of engine and pump. Yokogawa's DAQs capture hydraulic and engine parameters, power analyzers ensure accurate efficiency testing, and oscilloscopes verify control signal integrity for valves and actuators.



### Structural Components & Undercarriage

Heavy-duty equipment demands precise monitoring of stress and vibration to ensure strength and durability. Yokogawa's high-speed DAQs provide long-term strain and vibration analysis, helping detect weaknesses and extend component lifespan.



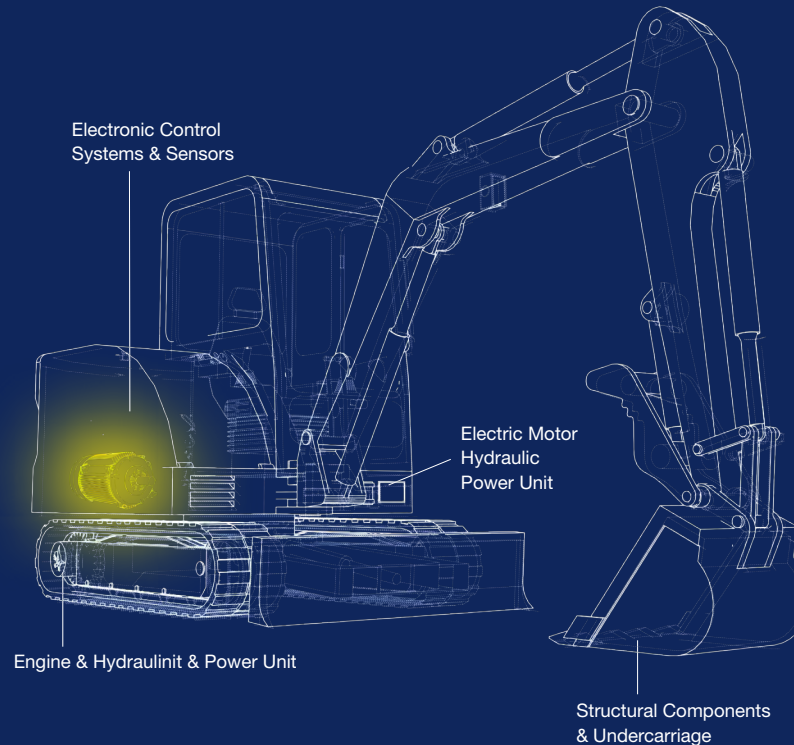
### Electronic Control Systems & Sensors

Accurate control and reliable sensors are essential for machine performance, even in harsh conditions. Yokogawa's high-speed DAQs capture diverse sensor inputs alongside control signals, ensuring precision and robust system analysis.



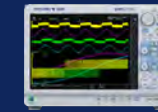
### Electrification

Developing fully electric machines requires maximizing efficiency and minimizing losses. Yokogawa's DAQs capture key electrical signals, while precision power analyzers ensure accurate efficiency testing of drivetrains and components.



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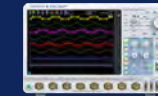
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# Agricultural Vehicles/ Machinery Challenges



## Engine & Power Take-Off (PTO) System

Maximizing productivity requires efficient fuel use and accurate measurement of PTO power delivery. Yokogawa's power analyzers validate engine and PTO efficiency, while DAQs log fuel flow and operating data over time.



## Electrification

Batteries, inverters, and on-board chargers must operate efficiently and reliably to support safe and effective electrification. Yokogawa's power analyzers deliver precise efficiency and loss measurements across these systems.



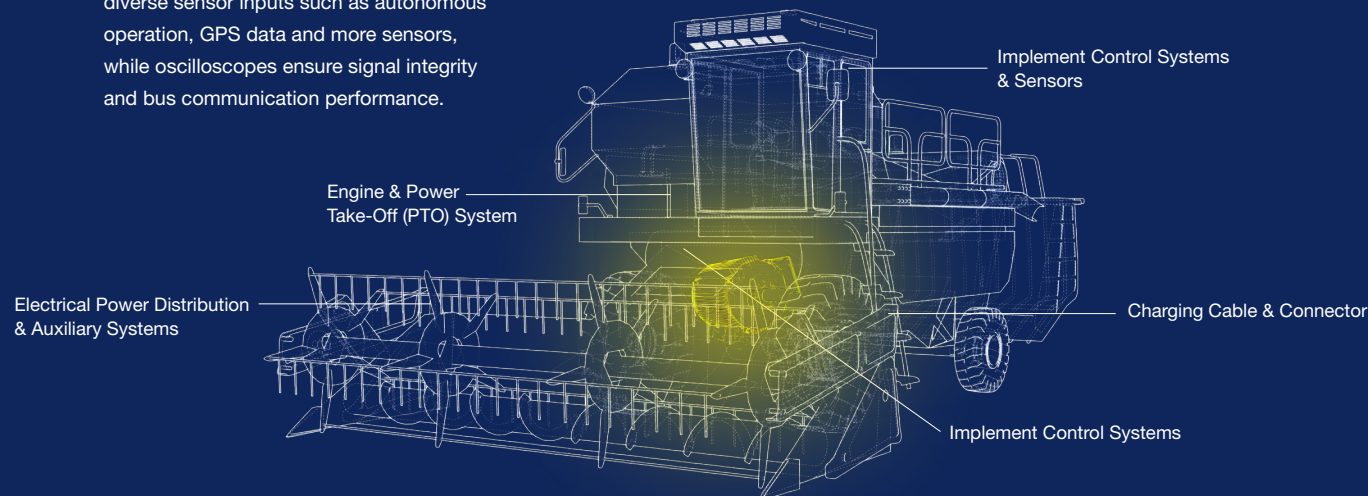
## Electrical Power Distribution & Auxiliary Systems

Stable voltage supply and efficient auxiliary power use are vital for overall performance. Yokogawa's DAQs track long-term voltage and current behavior, while power analyzers measure auxiliary system consumption with precision.



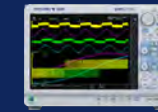
## Implement Control Systems & Sensors

Optimizing yield and quality relies on accurate sensor data and reliable control signals, even in harsh field conditions. Yokogawa's DAQs capture and correlate diverse sensor inputs such as autonomous operation, GPS data and more sensors, while oscilloscopes ensure signal integrity and bus communication performance.



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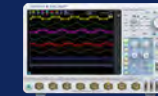
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# Charging Infrastructure Challenges



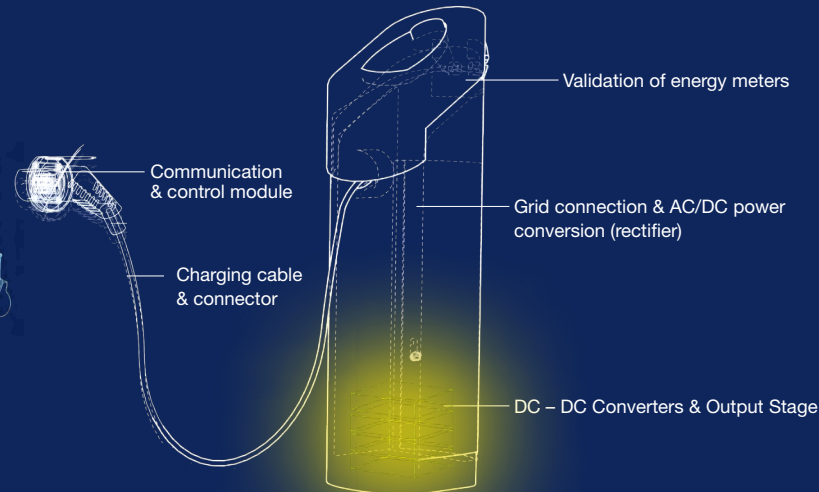
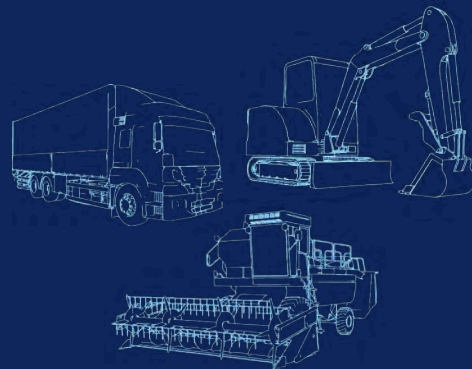
## Grid Connection & AC/DC Power Conversion (Rectifier)

Maximizing efficiency and maintaining grid compliance require precise analysis of conversion losses, harmonics, and thermal behavior. Yokogawa's power analyzers ensure accurate efficiency and harmonic testing, DAQs track thermal and transient events, and oscilloscopes capture high-frequency switching performance.



## Charging Cable & Connector

Safe, efficient charging requires monitoring thermal performance, minimizing resistance, and verifying safety interlocks. High-speed data acquisition units capture detailed temperature behavior during charging cycles.



## Communication & Control Module

Reliable charger communication requires protocol compliance, secure data exchange, and low standby consumption. Yokogawa's oscilloscopes validate signal integrity, power analyzers measure standby efficiency, and optical tools ensure robust fiber optic connectivity.

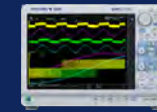


## DC-DC Converters & Output Stage

Accurate, efficient, and safe DC-DC conversion is essential for EV battery performance. With increasing power demands and higher voltage platforms, our power analyzers validate efficiency and accuracy, data acquisition units monitor stability and protection events, and oscilloscopes analyze ripple and transients, enabling innovation in next-generation high-power systems.

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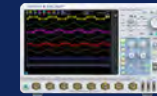
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# Successful Applications



## Improve powertrain efficiency of heavy trucks

"We tested the electric powertrain of heavy trucks using the Yokogawa WT5000 power analyzer. Its high accuracy and stability enabled us to significantly improve powertrain efficiency." – Heavy truck manufacturer, Italy



## Enhance powertrain control with real-time ECU signal analysis

"To optimize signal control in the powertrain and tractor bus systems, we used Yokogawa's data acquisition system. Connected to the ECU and installed in the cabin, it captured signals in real time while also recording them for detailed analysis." – Tractor manufacturer, Italy



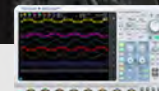
## Reduce test time during vehicle development

"Powertrain testing became far more efficient with Yokogawa's SL2000 high-speed data acquisition unit. It allowed us to capture multiple parameters simultaneously, reduce test time, and enhance product efficiency." – Light commercial vehicle manufacturer, Spain



## Extend EV driving range and lower material costs

"Using Yokogawa's high-accuracy power analyzer, we developed a highly efficient radial-flux e-motor for EVs, extending driving range by up to 20% while reducing motor weight by half, which also lowered material costs." – EV drive unit manufacturer, Germany



## Cut R&D costs for construction vehicles by halving test time

"By running ECU tests with Yokogawa's oscilloscope and its 32-bit input channels, we performed verification twice as fast, ensuring the central computer and controlled systems of our trucks functioned flawlessly." – Construction vehicle manufacturer, Sweden



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[tmi.yokogawa.com/eu](http://tmi.yokogawa.com/eu)

At Yokogawa, our test and measurement instrumentation are built for tomorrow's aerospace landscape – supporting electrification, sustainability, and mission-critical innovation.

Whether you're testing electric motors, validating space optics, or certifying flight systems, Yokogawa helps you move from idea to implementation – faster, safer, and with greater confidence.

Precision is all around us.  
In everything we see,  
everything we touch.

It means the  
difference between  
success and failure,  
safe and unsafe,  
sustainable and  
unsustainable.

But precision  
doesn't just happen.  
It's made.

**We are the Precision Makers.**

