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Diesel engine turbocharger



DualTronic clutch module

Driving technology for a cleaner future

Someday you may reminisce about filling your car with gasoline, just as your grandparents may have told you about the old days when homes were heated with wood or coal. But chances are that it will be perhaps 25 years before you will have that opportunity. While we may not know precisely what propulsion technologies will drive us in the future, we are fairly certain that the internal-combustion engine will continue to offer economical performance for the foreseeable future.

According to a study by **DRI•WEFA** (now called **Global Insight**) and **Arthur D. Little**, petroleum will be the primary fuel through 2020. Other fuels offer promise for the future, but petroleum still packs more energy into the most manageable package at a relatively low cost. Car makers face a difficult challenge: to meet increasingly stringent emissions and fuel-economy standards on the current fleet while developing the clean technology of tomorrow at a price consumers are willing to pay.

A number of technologies will provide cleaner, cost-effective mobility, including cleaner diesels, increased power density in downsized engines, optimized engine parameters, reduced parasitic losses, intelligent control systems, and improved combustion systems. For more than 100 years, **BorgWarner** companies have been leaders in developing advances in the automotive industry. Our expertise is in developing strategies to manage engines for fuel efficiency, reduced emissions, and enhanced performance, as well as innovations in transmission technologies and torque management. Combining this portfolio of technologies will improve the efficiency of the entire powertrain, resulting in economical, high-performance, and environmentally friendly mobility for the future.

From "well to wheels," diesels are still the most fuel-efficient engines. In fact,

since the introduction of turbocharged direct injection, the diesel engine's European market share has risen 30% in the past 10 years, and diesel market share is forecast to reach 60% of European light-vehicle sales within the decade. Furthermore, availability of clean-diesel technology and low-sulfur fuel is expected to boost light-vehicle diesel engine share in other global markets, including North America, Korea, China, and India. In the future, direct-injection diesel engines will experience an upsurge in power and torque, become increasingly sound environmentally, and provide more and more driving comfort. In addition, advances in cold-start technology from BorgWarner/**Beru**, such as optimized glow plugs with electronic controllers, make diesels more desirable to consumers.

Turbochargers will play a key role in increasing power density while improving fuel economy. Turbochargers boost engine power by obtaining higher specific output from the engine. Variable turbine geometry and regulated two-stage boosting systems make turbochargers even more responsive over a broader range of speeds. In addition, as gasoline direct-injection engines gain acceptance, the combination of direct injection and turbochargers will grow in popularity. For gasoline engines, boosting systems provide world-class torque, power, and driveability while improving fuel economy up to 15%.

Automatic transmissions of the future will play a greater role in total-vehicle fuel efficiency, especially in North America. Transmission and engine control strategies will become more integrated than ever before. Aimed at improving the efficiency of power distribution from the drivetrain to the wheel, powertrain innovations will strive to optimize trade-offs between performance, emissions, and



fuel consumption. In Japan, continuously variable transmissions will remain popular, while dual-clutch transmissions—such as the BorgWarner DualTronic-equipped **Volkswagen** DSG (direct shift gearbox)—will drive increased automatic transmission demand in Europe and emerging markets. Through advanced electrohydraulic controls and a unique two-clutch wet-friction system, BorgWarner's DualTronic transmission technology offers the convenience of an automatic transmission with the fuel efficiency of a manual transmission while delivering responsive, fun-to-drive performance and lower emissions—without the “torque-interrupt” of an automated manual.

To optimize future engine performance, advanced technologies will focus on “variable everything.” Adding on-demand and variable controls to almost any system can improve fuel economy and lower parasitic losses. BorgWarner's patented variable cam timing uses camshaft oscillation to deliver extremely high actuation rates independent of engine speed, oil pressure, and oil temperature, providing greater emissions reduction and improved fuel efficiency compared with competitive technologies in the federal EPA cycle.

By capturing camshaft torsional energy, BorgWarner's Cam Torque Actuated variable valve timing system allows engine calibrators to adjust engine timing quickly over a broader range of speeds and operating conditions, resulting in improved engine response and lower pumping losses. Air management systems with electronic modulating speed control can precisely control temperature at all times, extending the life of the entire cooling system while providing improved fuel economy. In addition, air-pump technology reduces hydrocarbon emissions by as much as 41%. Advanced electrohydraulic

control modules, transmission solenoids, and mechatronic control systems all help improve fuel economy and emissions while enhancing vehicle performance.

Homogeneous charge compression ignition (HCCI) engines are expected to become a viable alternative to today's conventional spark ignition (gasoline) and compression ignition (diesel) internal-combustion engines by 2020. Because HCCI is a high EGR (exhaust gas recirculation) rate combustion process, it has the potential to dramatically improve fuel efficiency while drastically reducing emissions. Improvements in precision EGR technology will drive HCCI advancements (sometimes called controlled auto-ignition, or CAI, when referring to gasoline engines) for both diesel and gasoline engines.

Already, BorgWarner's rotary-axial valve movement provides reliable, durable EGR for the most challenging diesel and gasoline direct-injected engines. Its high operating forces combined with fast response and flow accuracy support the most stringent emissions reductions.

Hybrid-electric vehicle powertrains, hydrogen-fueled internal-combustion engines, and fuel-cell vehicles may all play a part in propelling us in the future. In the meantime, consumers will enjoy a broader range of engine options—from turbo-boosted clean diesels and gasoline direct injection to HCCI—as well as the convenience of automatic transmissions that deliver safety, comfort, and convenience without compromising performance, fuel efficiency, or driver involvement.

There is still much to be gained from the internal-combustion engine and the efficient transmission of engine output to driving wheels. Continuous innovation focused on this 100-year young technology will produce further advancements for decades to come. **aei**



Variable cam timing system



Exhaust gas recirculation technology