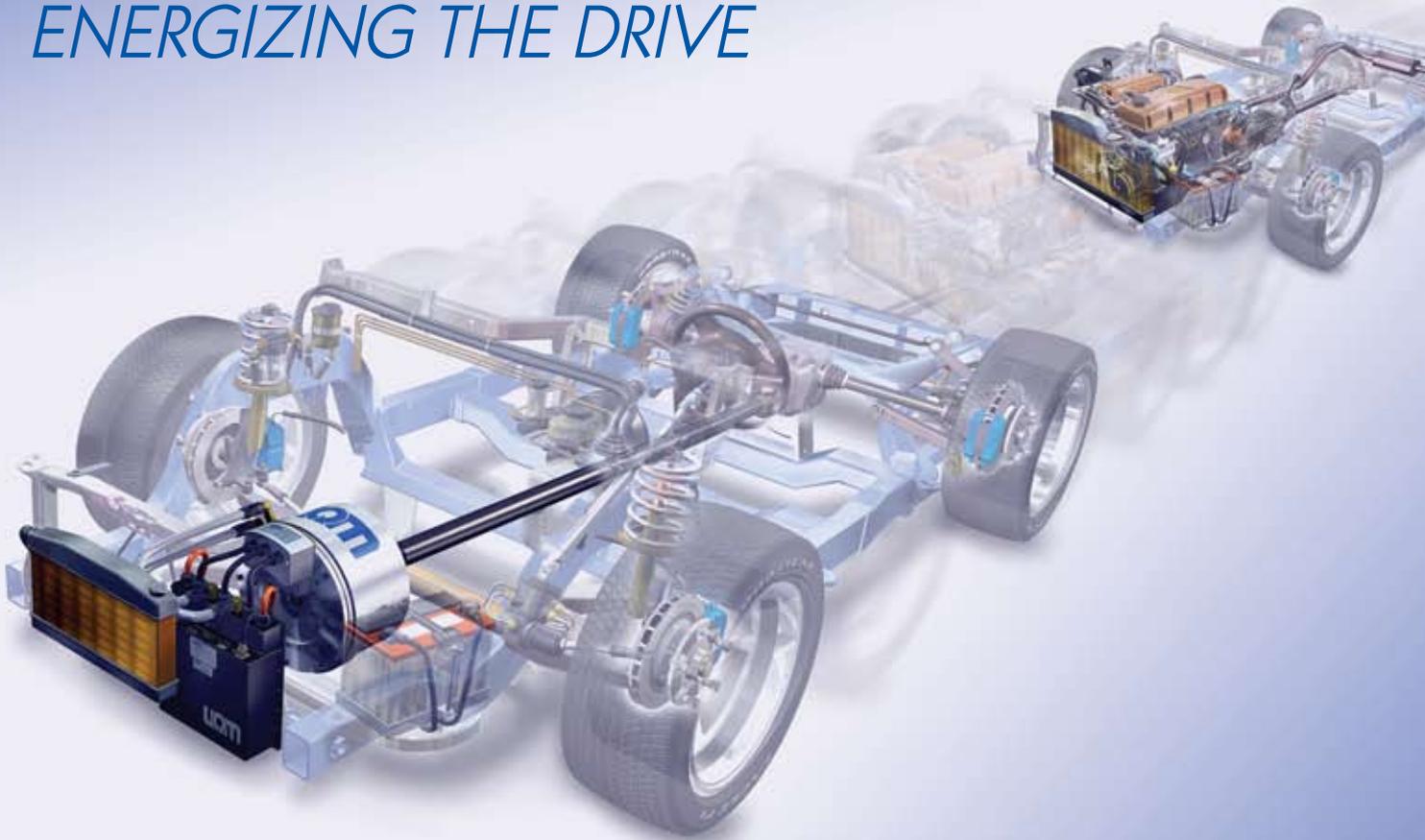


AS APPEARED IN

RON COGAN'S

GREEN CAR JOURNAL

UQM
ENERGIZING THE DRIVE



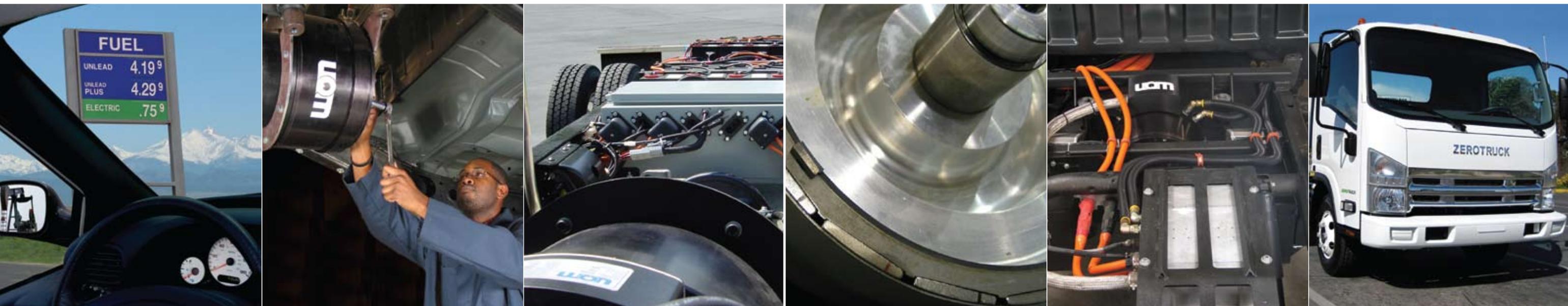
THERE'S A FUNDAMENTAL SHIFT at play in transportation today. Driven by the changing realities of energy supply, economics, and environmental impact, automakers large and small are focusing on new answers to the evolving needs of drivers everywhere.

In many ways those needs are a constant, reflecting the same desires drivers have had for decades: mobility available on demand, in ways that make travel effortless and affordable. But in other ways, these needs are new and forever change the dynamics of driving. No longer can we count on cheap

oil. Gasoline and diesel costs have skyrocketed to the point where budgets are strained and buying patterns are changing in real time. New car buyers are demanding greater fuel efficiency and environmental performance. This has evoked a reassessment by automakers long used to building vehicles in traditional ways, for traditional markets. It is the beginning of a new era.

This is a time for fresh ideas, uncompromising efficiencies, and the kind of creative solutions that can only come from the most dedicated minds envisioning a world of change. It is a world ideally suited for the work of UQM Technologies.

CONTINUED >>



UQM'S NEW ELECTRIC PROPULSION MOTOR, WHICH GENERATES 170 HORSEPOWER IN A 90 POUND PACKAGE, IS CREATING SUBSTANTIAL INTEREST IN THE INDUSTRY.

The auto industry is awakening to the reality that near-total reliance on the internal combustion engine no longer represents a sound business strategy. While conventional engines will continue to be refined and offer enhanced efficiencies through more intelligent engineering, it's electrification that stands to make the most profound difference in the motor vehicles of our future.

This revelation is generating increased auto industry interest in the companies and suppliers that can provide the electric drive products Original Equipment Manufacturers (OEMs) require. UQM Technologies, with its considerable capabilities, is increasingly the subject of OEM and supplier interest. It's no wonder: UQM Technologies has focused on vehicle electrification for over 35 years with its development and manufacture of energy efficient, compact, and power-dense electric motors, generators, and related power electronics.

These UQM® components have been selected for use in a variety of vehicle electrification programs by many noted integrators in the industry, as well as by OEMs themselves. With the industry's shifting focus to the integration of advanced electric drive products and systems for mass production vehicles, UQM Technologies, with its broad range of experience and technology advances, is well positioned to capture this business. During the past year, the company has made significant investments in its manufacturing capabilities to support a number of anticipated production intent development programs, and has shipped over 32,000 motors.

ELECTRIC DRIVE IS KEY

One day, electric propulsion may well be defined more narrowly than it is today, with the market deciding which systems offer the best balance of efficiency, environ-

mental performance, and cost. Today's world is not so straightforward. It's unknown whether batteries, hydrogen fuel cells, parallel or series hybrids incorporating fossil or alternative fuel combustion engines, or plug-in hybrids utilizing grid power will prevail as the motor vehicle's predominant propulsion source. Time, and perhaps geopolitical and societal influences, will tell.

In the interim, it has become increasingly clear that electric drive is coming into its own. It is the common link for all of these advanced propulsion systems, proving its worth in high profile ways today in the high efficiency gasoline-electric hybrid models now available, and the plug-in and hydrogen fuel cell vehicles being developed and in demonstration on public highways. A new generation of battery electric vehicles is also poised for introduction in the short years ahead.

UQM's line of advanced electric propulsion motors – like its new motor that generates 170 horsepower in a 90 pound package – is ideal for these applications and is creating substantial interest in the industry.

REDUCING PARASITIC LOADS

While electric drive offers one of the most direct paths to vehicle efficiencies, electrification goes far beyond just propulsion motors. By electrifying conventional belt and gear driven “under-the-hood” auxiliaries that normally draw power from an internal combustion engine – such as water and oil pumps, heating and air conditioning, cooling fans, and power assisted steering and brakes – the load on the engine is lessened. The result is fuel efficiency improvement and reduced emissions. UQM Technologies offers a line of electric actuators, generators, fan motors, and compressor motors from 100 W to 25 kW for such applications.

Electric auxiliaries offer additional benefits. Their operation is independent of engine speed, which enables variable speed and power modulation, improved control, and greater reliability. Since these under-the-hood auxiliaries are no longer dependent on engine power, they can be located at other areas of a vehicle. This allows more flexible vehicle designs and improved component accessibility for service and maintenance. A higher power generator replaces the standard alternator to supply additional electrical power to run these electric auxiliaries.

The electrification of auxiliaries is on an evolutionary path that has been unfolding over time, witnessed by some car models that now use electrically-assisted steering and brakes. Although electrifying on-board systems comes at additional cost, today's high fuel prices are changing the equation. Justifying the additional cost of electrification is becoming more feasible, especially when the economic and functional benefits are weighed. This creates opportunity for UQM Technologies and its products.

Historically high fuel prices, along with significantly higher Corporate Average Fuel Economy requirements mandated for coming years, have combined to drive the auto industry in new directions. Heightened consumer interest in more efficient vehicles has accelerated the need to incorporate advanced technologies that will make more efficient vehicles possible. Because of these new realities, the auto industry has not foreseen such an immediate need for efficiency enhancing electrification and many auto manufacturers are unprepared, with their supplier base still focused on 12 volt systems and conventional under-the-hood auxiliaries.

In contrast, vehicle electrification is a specialty at UQM Technologies, where expertise in power electronics is combined with industry-leading software sophistication, controller hardware, and systems with high energy flow. There is a quantum shift occurring in the auto industry that requires such specialization and UQM is poised to fill the need.



> PowerPhase® 125 170 hp
(125 kW) Traction System





ENERGIZING THE DRIVE

MEETING MILITARY IMPERATIVES

There is a growing need in the military for high efficiency, high performance powertrains for vehicles ranging from the HMMWV to the large Family of Medium Tactical Vehicles, or FMTV. High power electric drive is increasingly viewed as the most logical pathway to achieve this goal. UQM Technologies offers core products ideal for these applications.

Electric propulsion's unique capability of providing higher low speed torque in battery-electric and hybrid-electric systems enables improved obstacle and grade climbing capabilities important to military missions. The superior high speed performance of electric-drive vehicles also offers distinct advantages for on-road convoy transport, pursuit, and dash-and-evasive maneuvers. There are stealth advantages as well since hybrid electric military vehicles operating solely on battery electric power are quieter and have minimal heat signatures.

These capabilities are needed not only to improve fighting and support capabilities, but also to mitigate growing fuel costs. The U.S. military is the single largest energy consumer in the world and much of this energy is site delivered in the form of fuel to tactical and non-tactical vehicles. Electric drive brings greater fuel efficiency to these vehicles along with lower tailpipe emissions and decreased production of greenhouse gases.

DIVERSE APPLICATIONS

UQM Technologies' propulsion systems are sought after for diverse vehicle development programs for the U.S. military. The prototype hybrid electric FMTV, built by DRS Technologies for Stewart & Stevenson, Inc., incorporates UQM® electric propulsion motors and generators. In the HMMWV demonstrator, a UQM® generator is used along with 100 horsepower UQM® motors at each wheel. UQM Technologies propulsion motors and controllers are also used in a Defense Advanced Research Projects Agency (DARPA) unmanned combat

ground vehicle demonstrator developed through Carnegie Mellon University's National Robotics Engineering Consortium.

Hybrid electric power is made possible in such large vehicles through UQM's energy dense motors and its advanced method of control, which delivers substantial improvements in torque delivery, constant power, and peak power. The result achieved by powering these military vehicles with electric and hybrid propulsion speaks volumes. Consider a 12,100-pound GVW hybrid electric HMMWV with four 100 horsepower electric motors that does 0 to 50 mph in 7.5 seconds, climbs a 60 percent grade, and is capable of operating in stealth mode. Importantly, these considerable capabilities come with fuel consumption 30 percent less than that of a conventional HMMWV powered by an internal combustion engine.

Recently, UQM® propulsion motors and electronic controls have been integrated into a Quantum Technologies diesel-electric hybrid system powering prototype "Aggressor" Alternative Mobility Vehicles (AMVs). The pre-production prototype Aggressor is part of a development program for the U.S. Army's Tank Automotive Research, Development, and Engineering Center, a part of the military's National Automotive Center.

MOBILE POWER GENERATION

In addition to its efficiency and performance benefits, hybrid propulsion can serve the military's need for additional electric power on the battlefield. This power is required for electrical loads ranging from command and control centers, medical equipment, and construction equipment to battery charging and air conditioning. These needs are now met with towed generator systems that can weigh from 900 to 10,000 pounds, prompting considerable interest in hybrid drive systems that can supplement or replace towed generator power and provide ready mobile power.

The U.S. military is encouraging its vehicle producers to look toward innovative companies as a resource for integrating export power systems into their vehicles. This, combined with similar efforts geared toward achieving greater levels of fuel efficiency, performance, and functionality, signals a growing opportunity for UQM's proprietary technologies.

UQM Technologies' work with the U.S. military extends beyond providing advanced electric motors, controllers, and other proprietary systems.

Technology development contracts include work with the U.S. Air Force focused on silicon carbide power electronics, with the U.S. Army for high torque electric wheel motors, and with the U.S. Navy for advanced shipboard electric motors. The U.S. military's interests, like those of the consumer and commercial transportation industries, are increasingly turning toward vehicular electrification. The enabling technologies from UQM Technologies are poised to provide the needed solutions that allow meeting their critical goals.



For additional information visit uqm.com

UQM Technologies, Inc., 7501 Miller Dr.,
PO Box 439, Frederick, CO 80530
(303) 278-2002

© 2008 UQM