Military Drives Toward Vehicular Fuel Cells

Vehicles powered by fuel cell technology are on the horizon. Unique demands on military vehicles could propel fast adoption of the technology.

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With the commercial fuel cell vehicle market starting to rev-up, it appears a move toward fuel cell-based military vehicles could happen concurrently with the commercial ramp-up over the next decade. For a host of reasons, the military is hot on the idea of fuel cells as a source of vehicle power.

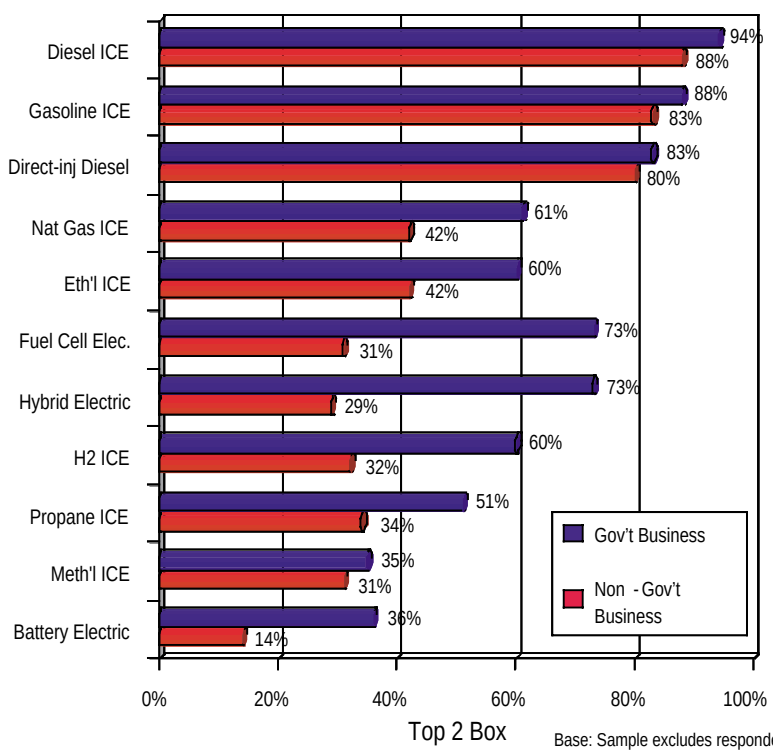

Figure 1

The graph shows fuel cells far ahead of other alternative fuel technologies. Note that fuel cell interest is 12 points higher than natural gas internal combustion engines (ICEs), and ethanol ICEs—and that's before anyone's even driven any of those. This demonstrates the enthusiasm in—at least the image of—fuel cell vehicles, particular amongst government decision makers (which include military.)

The statistics are compelling. According to data from the Army's Tank-automotive & Armaments Command's (TACOM) 21st Century Truck Initiative, fuel makes up 70% of the bulk tonnage needed to sustain a military force on the battlefield. That equates to around 600,000 gallons of gasoline per day. The Army itself has a fleet of over 246,000 tactical wheeled vehicles and drives 823 million miles annually. With all that in mind, it's not surprising that the Army's goal beyond 2010 is a 75% reduction in fuel requirements for a deployed force.

Commercial Ramp-Up Looming

In the wider commercial market the number of fuel cell vehicles forecasted to be introduced in the coming decade will reach 800,000 by 2012, according to a new study by research firm Allied Business Intelligence (ABI). For that to happen, says ABI, the U.S. will have to more aggressively execute its strategy of solving technology challenges and infrastructure layouts if it is to help early fuel cell vehicle introduction by the second half of the decade. Recent moves by the Bush administration to boost funding of hydrogen and automotive fuel cell research should help that along. Hydrogen and oxygen fed into a proton exchange membrane (PEM) fuel cell "stack" produces enough electricity to power an electric automobile, without producing harmful emissions.

Interestingly, government (including military) vehicle fleet decision makers seem more keen to shift to alternative fuel

types than their commercial fleet counterparts. According to a study (Figure 1) done by Market Facts Motoresearch, a division of Synovate, 73% of government fleet decision makers would consider fuel cell electric vehicles, compared to a mere 30% from the non-government sector. The study surveyed 243 decision makers operating government and private fleets in the U.S. and Canada. The study's tracking further revealed that the strong consideration of fuel cell vehicles occurs even despite very low familiarity with fuel cell vehicles.

Scott Miller, executive vice president, Market Facts Motoresearch, says his survey included some direct discussions with fleet decision makers. Such conversations revealed some of the deeper reasons why government vehicle fleets had some particular interest in fuel cells. Among them was the idea of using on-board auxiliary power units (APUs) to allow them to essentially run the vehicle all the time while it's stationary. A lot of specialized vehicles like heavy on-road construction vehicles need to do that. In the military, such requirements are particularly common. Running APUs from an internal combustion engine (ICE) requires idling or running at low speeds, both of which creates wear and tear on the ICE. A fuel cell APU could provide intense levels of electrical power, without having to run the vehicle.

One key hurdle slowing the widespread move to fuel cell vehicles is the lack of refueling infrastructure. Here government and military fleets face less of a barrier. Government and military vehicle fleets are more likely to use a centralized refueling point—within the campus or compound of a military base, for instance.

Tactical Truck Sports Fuel Cell

Taking an early step into military fuel cell vehicles, General Motors and the U.S. Army in January took the wraps off a diesel hybrid military pickup truck equipped with a fuel cell auxiliary power unit (APU). Dubbed the military Silverado (Figure 2), the truck could become the model for the Army's new fleet of 30,000 light tactical vehicles by the end of the decade. The diesel hybrid improves Army fuel consumption by 20 percent over conventional diesels, reduces emissions and provides troops with clean, reliable electrical power.

Figure 2

Developed by General Motors and the U.S. Army, the military Silverado is a diesel hybrid pickup truck equipped with a fuel cell APU. The truck's 5-kW regenerative fuel cell APU with its metal hydride hydrogen storage system produces electricity quietly with a low temperature signature, zero emissions and better efficiency than the conventional generators ICE-powered units.

The fuel cell APU replaces the loud engine- and battery-based stationary generators the Army now uses for field power. This meets the Army's "silent watch" capability—the ability to operate undetected by the enemy. Fuel cells are much quieter than engine generators and do not give off as much heat, making them less likely to be picked up by enemy heat sensors. The fuel cell unit also familiarizes the military with the next generation of commercially developed fuel cell technology. That's expected to ease the way for military vehicles to be powered by fuel cells within the next 10 years.

The Silverado's 5-kW regenerative fuel cell auxiliary power unit with its metal hydride hydrogen storage system is a key component of the vehicle. Designed and built by GM's strategic fuel cell alliance partner, Hydrogenics (partly-owned by GM) the APU provides a solution for the Army's increasing electrical power needs in the field while enhancing the military's ability to operate undetected by the enemy. The fuel cell APU was built by Hydrogenics especially for the U.S. Army TACOM.

The hydrogen-powered APU produces electricity quietly with a low temperature signature, zero emissions and better efficiency than the conventional generators powered by internal combustion engines, and provides 6 to 10 times the endurance of battery-based systems of comparable power. According to GM, the unit is considerably more efficient in cold weather than batteries and eliminates any issues related to toxicity and recycling.

Powering Computers, Comms gear

The APU is a boon to the Army's growing reliance on surveillance equipment, computer and communications electronics in the battlefield. Today, the electricity to power this equipment typically must be provided by either operating the engine or by storage batteries. In a "silent watch" mode, the engine cannot be operated without the vehicle being detected, and battery technology alone cannot provide sufficient energy for the extended operating times required.

The APU's design relies on the regenerative, or reversible, properties of proton exchange membrane (PEM) fuel cell technology. While the vehicle is driving, engine-produced electricity operates a PEM electrolyzer unit, which breaks down water into hydrogen and oxygen. The hydrogen is stored in a metal hydride solid

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material. When the vehicle's engine is off, the hydrogen is combined with oxygen from the air and fed to a fuel cell unit to generate electricity, with water as a byproduct. Water is stored to repeat the cycle.

The storage unit provides enough gaseous hydrogen to operate for three hours at a peak power of 5 kw, or five hours at an average output of 3 kw. An external hydrogen fuel supply is not required. Hydrogen for the APU is stored at low pressure and released at low temperature in a metal hydride container. The metal hydride stores about 1 percent hydrogen gas by weight.

The hydrogen is stored very compactly in a space smaller than if the hydrogen were liquefied. If the metal hydride were punctured, very little hydrogen would be released at ambient temperatures. The combination of compact storage and inherent safety of metal hydride makes it suitable technology for military applications. The APU produces DC power to meet the specifications of the particular applications. In the event that the application requires AC power, the unit's power electronics can be designed to offer this.

Split Power Scheme

The hybrid system, under early development by GM for commercial applications, uses a patented split power continuously variable transmission (CVT) with integral electric motors and an energy storage system, to deliver power efficiently to the wheels. The lightweight nickel-metal hydride-based energy storage system weighs a third less and is half the size of lead-acid battery storage systems. The diesel-electric hybrid powertrain can operate as a self-contained generator, with the capability of providing up to 30kw “exportable” DC and AC electricity for troop operations in the field. This eliminates the need for separate, less efficient, bulky motor-generator sets typically used.

The diesel hybrid truck is one of eight different militarized prototypes based on the Silverado that GM Defense will deliver to the Army later this year as part of the Commercially Based Tactical Truck (COMBATT) program. The goal of COMBATT is to leverage commercial technology to reduce the cost of developing and acquiring a light tactical vehicle. ▮▮

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