U.S. Department of Energy
FreedomCAR and Vehicle Technologies Program

U.S. Department of Energy's "More Electric Truck" Hits the Road

The More Electric Truck Program is a government-industry collaboration

Initiated by:
The U.S. Department of Energy

Administered by:
Argonne National Laboratory

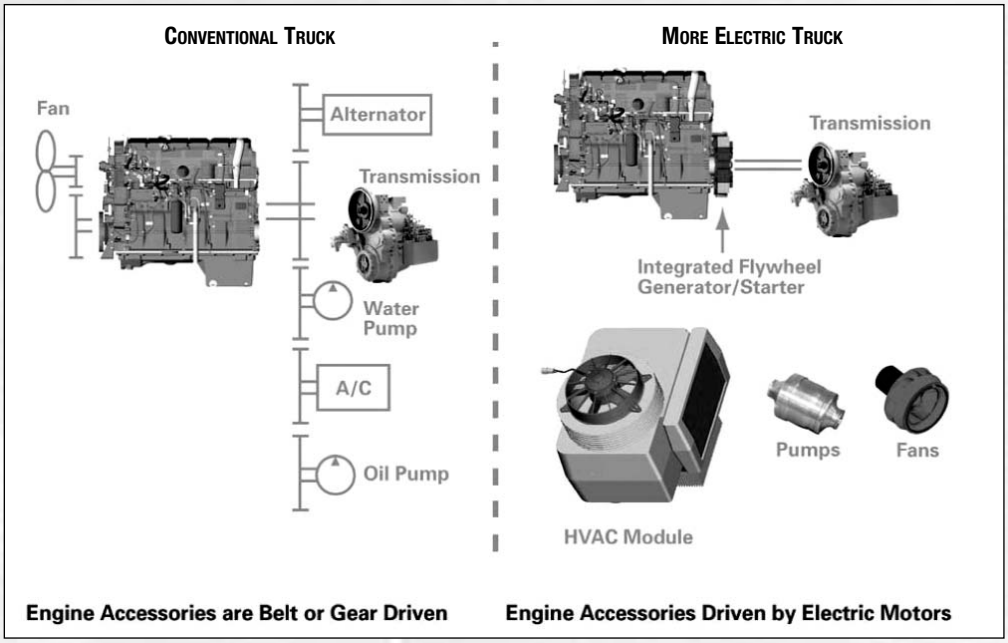
Industry Partners:
Caterpillar Inc.
Kenworth Truck Company
Emerson
Engineered Machined Products

The engine compartment on today's trucks is a hot and crowded place. Pumps, alternators, compressors, and other engine accessories all give off heat as they compete for space and for the energy they need from the engine. These accessories have little effect individually on engine power, but together – via belts and pulleys – they can rob much of a diesel engine's fuel efficiency.

Now, thanks to a collaboration launched in 2000 between private industry and the U.S. Department of Energy (DOE), the life of a diesel engine in long-haul trucks is about to get easier, as in cooler and more efficient. A DOE project called the "More Electric Truck" is introducing new technology that takes a big load off the engine by using electrically powered accessories, instead of mechanically powered ones. Electrical power allows the accessories to operate independently of the engine, so they can perform at the precise speed, pressure, or flow rate required.

"The More Electric program is a collaborative government and industry effort initiated by the U.S. Department of Energy through Argonne National Laboratory, in partnership with Caterpillar, Kenworth, Emerson, and Engineered Machined Products," said Sid Diamond, the DOE's More Electric Truck Technology Development Manager. "Right now the prototype More Electric technology has been installed in a Kenworth T2000 truck for testing, and in 2004 we plan to build additional trucks incorporating key elements from the DOE truck demonstration. These vehicles will be out on the highways to prove the equipment's reliability and durability, and to demonstrate its improved fuel economy in fleet operations. The technology is expected to become commercially available to truck OEMs and fleets nationwide in late 2005."

The prototype vehicle has already been showcased in Washington, D.C., for members of Congress. It features an electrically driven heating, ventilating, and air-conditioning (HVAC) module, and a high-efficiency 30 kW generator. Other features include an integrated auxiliary power unit (APU) and a "shore-power" connection that permits the truck to plug in like a recreational vehicle at a campground. Shore power is being installed at a few initial truck stop demonstration sites and its availability is expected to grow quickly, so drivers won't have to idle their big diesels to stay comfortable and to keep their engines warm. The new More Electric accessories are not just add-on pieces of hardware, but are part of a highly integrated system specifically designed to meet the needs of the truck industry while minimizing weight and costs.



More Electric technology uses a generator to provide high-efficiency electrical power to drive several accessories on a flow/pressure/power-on-demand approach. The technology provides fuel savings, improved reliability, and several benefits such as better cold weather starting.

NEW CONCEPT IS GENERATING INTEREST

A More Electric Truck uses electrically driven accessories powered by a generator located inside the flywheel housing, which also serves as the starter motor. The accessories converted to electrical power on the research demonstration vehicle are the HVAC, brake air compressor, and oil and water pumps. These and future electrically driven devices, once commercially developed and validated, will start to appear on vehicles throughout the trucking industry.

TEST RESULTS ENCOURAGING

According to the program's technical leader, Caterpillar's Dr. Marcelo Algrain, "the test results showed that the fuel economy of the More Electric truck improved by 8 percent overall – 2 percent in over-the-road driving, and almost 6 percent from not idling the main engine overnight."

The reduction in engine idling alone could save over 600 million gallons of diesel fuel every year and annually reduce engine emissions equal to that produced by 15.5 million cars. Argonne National Laboratory researchers have shown that by eliminating overnight idling, more than $2,000 a year per truck could be saved in fuel and engine maintenance costs. Argonne's work also shows that trucks idling overnight put an estimated 7.6 million tons of carbon dioxide, 140,000 tons of nitrogen oxides, and 2,400 tons of carbon monoxide into our atmosphere.

MORE ELECTRIC IS MORE RELIABLE

Using electricity, instead of mechanical power, to operate engine accessories offers significant benefits for truck builders in their quest to manufacture "million mile accessories." Electrically driven accessories are typically more reliable than mechanical ones and also improve serviceability by permitting mechanics to easily swap out the modular units. Historically, when it comes to component reliability, the alternator and HVAC's air-compressor have been among the top five most problematic components on heavy-duty trucks. And it usually requires a specially trained refrigeration technician to service a truck's air-conditioning unit.

The More Electric APU is integrated with truck subsystems to produce a lower cost and weight package. This eliminates the need to idle the main diesel engine, which saves fuel, reduces emissions and lowers noise.

Conventional mechanical water pump (left) and equivalent More Electric electrically driven water pump.

The More Electric truck's new HVAC system combines everything into one preassembled, precharged, and pretested module that eliminates up to 65 parts. The new HVAC unit replaces the two separate heating and air-conditioning units used today on most trucks with sleeper cabs (one in the dashboard and one usually under the sleeper cab bunk). When used with the More Electric truck's integrated idling reduction features, an operator will have a more comfortable and quieter sleeping environment that enhances driver comfort and job satisfaction.

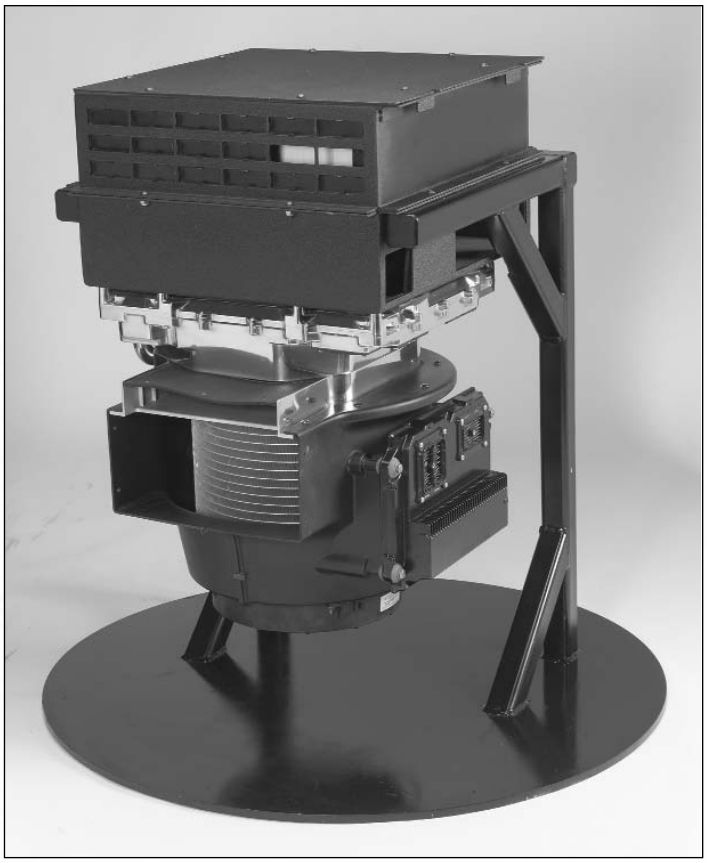
On a More Electric truck, the HVAC's electrically powered, hermetically sealed compressor and electric motor are located inside a sealed housing, which eliminates the refrigerant leaks from the shaft seal that are common with belt-driven automotive air conditioners. The resulting HVAC unit is five times more reliable and lasts up to three times longer than conventional air-conditioning systems. Electrically driven HVAC modules also permit truck OEMs to relocate the condenser coil from the engine compartment to other areas on the vehicle in order to increase space under the hood and take the air conditioner's thermal load off the radiator.

COLLABORATIVE GOVERNMENT-INDUSTRY TEAM EFFORT

Each partner brought core competencies to the $4.8 million, cost-shared More Electric Truck project, with Caterpillar providing engine technology, mechanical design, electronics, controls and overall systems integration; Kenworth supplying truck expertise, test vehicle and testing capabilities; Emerson offering its electric motor and power electronics knowledge; and EMP developing the new electrically driven water and oil pumps.

Making a more reliable and efficient truck is a primary reason why Kenworth is participating in the project. "People expect a very efficient truck when they buy a Kenworth, one that helps them lower their operating costs," said Dr. John Duffy, Senior Project Engineer in Kenworth's Advanced Concepts Group. "We believe that, in the future, electrically powered components will make our trucks even more durable and that the increased efficiency will offer a quick payback. This is what the industry wants to see before investing in new technology such as this."

As more truck and component OEMs seek to offer longer product life, and as the need for cleaner, more fuel-efficient vehicles continues to increase, More Electric technology will be there to meet the needs of the truck industry. "It's definitely a win-win-win technology," says Randall Blanton, Director of Caterpillar's Advanced Electric Systems. "The production version of this technology is expected to have an estimated 18-month payback period. For the added investment in More Electric components, truck owners win by gaining an increase in fuel savings and from a significant improvement in the durability of two historically problem-prone accessories, the HVAC and the alternator. It's also a win for drivers, who will appreciate the dramatically improved cab environment during rest periods. And by reducing emissions and noise from idling trucks, More Electric technology is also a win for our environment."



The More Electric HVAC module has an electrically powered, hermetically sealed compressor.