

GE's "Plug in" to Hybrid and Battery Technologies



GE researchers are developing the advanced technologies needed to bring the hybrid locomotive to market. They also are evaluating how GE's hybrid technologies can accelerate advancements for other hybrid transportation platforms such as tugboats, buses and passenger cars.

Background:

When you look at key trends in the transportation and energy sectors, one thing is becoming increasingly clear. New advancements in hybrid and battery technologies are changing the way we transport and power the world.

In transportation, we are witnessing increased hybridization across the transportation infrastructure from big locomotives to small passenger cars. With fuel prices remaining high and concerns about the environment heightening, new breakthroughs in hybrid technologies would promote cleaner transportation alternatives.

Today, the world has fuel cells, batteries, ultracapacitors and motors to make it work. Demonstration vehicles are on the streets today. The challenge is making the necessary technological advances in each of these areas to make them safe, reliable, and economical. Can we develop systems for these vehicles that make them as affordable as vehicles running on gasoline or diesel fuels? And can it be done while also delivering enhanced performance?

In energy, cost-effective battery technology has the promise to help distribution systems manage their peak load, allowing infrastructure upgrades in substations and transmission wires to be deferred. Energy storage also can be used to stabilize grid frequency, displacing the need for generation units that traditionally have provided this service. In some cases, renewable energy resources that serve areas without strong interconnections to the bulk grid may benefit from intermittency management provided by energy storage devices. What improvements in batteries will be needed to provide the right solution?

GE's deep understanding of electric power and deep experience with integrating electric power into complicated systems such as a power plant, locomotive, airplane and even passenger car, make it uniquely positioned to change the way we power and transport the world.

GE Technology Focus:

Today, GE researchers are developing the battery and hybrid systems technology to bring the hybrid locomotive to market. GE's hybrid locomotive will provide an additional 10% fuel savings and 10% emissions reduction, capturing energy in the

braking process and storing it in batteries to provide a ready supply of clean power to supplement the diesel engine during acceleration.

Beyond the hybrid locomotive, researchers are engaged in other hybrid research activities that will help enable a plug-in hybrid vehicle infrastructure. GE Global Research is working to hybridize virtually every sector of transportation from railways and waterways to highways and beyond.

GE researchers have several projects with the U.S. Department of Energy (DOE), which includes a proposal with Chrysler to demonstrate economically viable plug-in hybrid vehicle technologies within the next three to five years. The goal is to achieve an electric driving range of at least 40 miles for a vehicle platform, well above the average daily commute for motorists. GE will be responsible for developing a unique, dual battery energy storage system, while Chrysler will be responsible for the vehicle integration piece.

GE also has three other projects with the DOE to accelerate hybrid vehicle advancements. In January, GE's Hybrid Vehicle team reached a milestone with the DOE, successfully demonstrating the world's first and only hybrid mine haul truck. The hybrid off-highway vehicle, used for open pit mining operations, was modified with a 600hp battery pack that captures braking energy to save fuel and increase productivity and uses the same batteries as our hybrid locomotive. GE also has projects with the DOE related to the development of smaller, lower cost, higher performing hybrid drivetrain motors and advanced high temperature, high energy density capacitors. Both technologies are seen as critical enablers for an affordable hybrid vehicle infrastructure.

In addition to GE's work with the DOE, researchers have a \$13 million project with the Federal Transit Administration (FTA) to develop and demonstrate a zero emissions hybrid fuel cell bus.

GE's research activities also extend into battery development for electric cars. Earlier this year, GE Energy Financial Services announced capital investments in the Norwegian electric car manufacturer TH!NK and lithium-ion battery manufacturer A123Systems. GE Global Research is performing some research in conjunction with A123 to support their battery development, including batteries for the TH!NK vehicles.

In May 2008, GE announced it is developing a hybrid tugboat in cooperation with the C-MAR Group. GE's hybrid tug propulsion system, which features its V228 or V250 medium-speed diesel engines, a battery, a generator, and control technologies, will decrease both fuel consumption and emissions. The tugboat platform will build on the previously mentioned hybrid technology projects for locomotives, city buses and off-highway vehicles.

In addition to transportation, GE researchers also are studying batteries for potential long-term energy storage solutions in the stationary power sector. From power plants, wind farms and the grid to oil and gas pumping stations, GE's business portfolio touches many different types of energy systems. In each of these systems,

energy storage continues to arise as an opportunity to improve efficiency, environmental benefits and performance.

GE research and development activities in hybrid and battery technologies are all part of GE's ecomagination initiative. Ecomagination represents the company's commitment to develop new environmentally friendly technologies and products to solve our toughest environmental challenges. Under ecomagination, GE has pledged to more than double its level of investment in the development of cleaner energy technologies from \$700 million to \$1.5 billion during the next five years. GE Global Research is looking at technology across the transportation and power sectors to deliver cleaner, more sustainable solutions.

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