DISCOVERY IN ACTION

Researchers at Pacific Northwest National Laboratory are advancing technologies to enable widespread adoption of plug-in hybrid vehicles, including development of the Grid Friendly™ Charger Controller, which automatically recharges electric vehicles when there is extra capacity on the electric grid and when it would cost consumers the least.

Keeping America on the move–cleanly and efficiently

This is the seventh of a 12-part series that features some of the scientific challenges PNNL has tackled over its 50-year history and highlights its vision for the future. PNNL is one of 10 national laboratories overseen by the U.S. Department of Energy's Office of Science and has been managed by Battelle since its inception in 1965. Through this enduring partnership—and by working closely with sponsors and collaborators—PNNL builds upon its legacy to advance science and solutions that improve the lives of Tri-Citians and people around the world. This edition focuses on some of PNNL's scientific and technological contributions for cleaner, more efficient and sustainable transportation.

PACIFIC NORTHWEST NATIONAL LABORATORY

The transportation sector consumes more than 70 percent of all the petroleum used in the United States and accounts for about 28 percent of the total energy we use, according to the National Academies.

At the Department of Energy's Pacific Northwest National Laboratory, researchers apply their scientific and engineering capabilities to reduce the impact of transportation on the environment, increase fuel efficiency and decrease the nation's dependence on imported oil.

"We've been working with automakers, engine manufacturers, and truck original equipment manufacturers for more than 20 years to develop new energy delivery systems, as well as technologies to make vehicles lighter and reduce emissions," said Jud Virden, associate laboratory director for PNNL's Energy and Environment Directorate. "We have a long history of using our chemistry and materials science capabilities to solve transportation problems with technologies that ultimately get deployed in the market."

Lighten up

PNNL has spent decades developing lightweight, durable materials that reduce a vehicle's overall weight and increase fuel efficiency. With the help of its computer modeling capabilities, PNNL researchers can simulate how materials will behave during manufacturing and in their actual use before the first prototype is ever built.

More than 20 years ago, PNNL began advancing a technology called superplastic forming that allows automobile parts to be formed from aluminum sheet materials instead of heavier materials, while maintaining their strength. The process involves identifying the right materials and heating them to the right temperatures, so that metal alloys can be shaped and manipulated using processes typically used on plastics. It allows more complicated shapes to be manufactured in less time and with fewer parts.

In 2000, PNNL was recognized with a Federal Laboratory Consortium (FLC) Award for its efforts to commercialize a cost-effective superplastic forming process for aluminum alloys. PNNL developed computer models that reduce the time needed to form complex parts, making it more practical to use this process in high-volume manufacturing. This technology was transferred to General Motors, MARC Analysis and Kaiser Aluminum and has been used in the Cadillac STS and Chevy Malibu Maxx.

Today, PNNL is working on a project to construct special lightweight fuel tanks for vehicles fueled by natural gas. Because natural gas exists as a vapor and contains less energy per volume than gasoline, it has to be compressed into pressurized fuel tanks to increase its energy density. Using superplastic forming, tanks made of aluminum can be made to fit a vehicle's limited space better than a standard cylindrical tank.

Another approach to trim the weight from vehicles is a joining process called friction-stir welding, which allows two metals to be joined without melting them. While PNNL didn't invent this technique, researchers did develop the tooling and parameters for this process that enable high-volume production of aluminum tailor-welded blanks by a commercial partner. The TWB Company is ready to supply these "blanks," or semi-finished parts, to automobile manufacturers. Ford, Honda, GM and others are evaluating the technology for their use.

Furthering fuel cells

PNNL is known for advancing fuel cells and related fuel processing systems. Instead of burning gasoline—like a conventional engine—fuel cells use a chemical conversion to produce electricity from hydrogen cleanly, efficiently and quietly.

In 1999, PNNL joined the Solid State Energy Conversion Alliance, or SECA. This collaboration among the federal government, private industry, academic institutions and national labs focuses on developing low-cost, modular solid oxide fuel cell technology that could use various fuels for a variety of applications including stationary power and transportation. PNNL coordinates SECA's Core Technology program, which addresses technical challenges identified by industry teams.

Fuel cells can provide the auxiliary power that would allow long-haul truck drivers and recreational vehicle enthusiasts to use the heat, air conditioning and electronic devices while stopped, without idling the engine or draining the battery.

Researchers at PNNL were recognized when Battelle and Delphi received a 2009 FLC Award for Excellence in Technology Transfer for their efforts to develop and deploy an auxiliary power unit for transportation.

Currently, PNNL is overseeing a demonstration project that involves using fuel cells to power refrigeration units in delivery trucks for frozen and refrigerated goods. These units are typically powered by a small diesel engine.

Owned by the U.S. Department of Energy; operated by Battelle; and supported by academic, industrial and governmental collaborators, Pacific Northwest National Laboratory is celebrating 50 years of inspiring and enabling the world to live prosperously, safely and securely. Interdisciplinary teams at PNNL address many of America's most pressing issues in energy, the environment and national security through advances in basic and applied science. With an annual budget of about $1 billion and nearly 4,300 staff members, Battelle is the largest employer in the Tri-Cities.

Learn more about PNNL at **www.pnnl.gov** and through stories to commemorate 50 years of scientific discovery contributed by employees, retirees and the community at **www.celebrate.pnnl.gov**.

Charge it up

According to a 2007 PNNL study, if all the nation's light duty vehicles were powered by electricity instead of petroleum, the capacity in our existing power system that sits idle at certain times of the day could fuel 70 percent of them.

Researchers have developed a smart charging system that allows plug-in hybrid vehicles to receive signals from the electricity grid so they can be charged when this idle generation and transmission capacity is available, which could help lower consumers' electric bills and increase grid stability. AeroVironment, Inc. has licensed the PNNL-developed technology with plans to incorporate it into a prototype charging system.

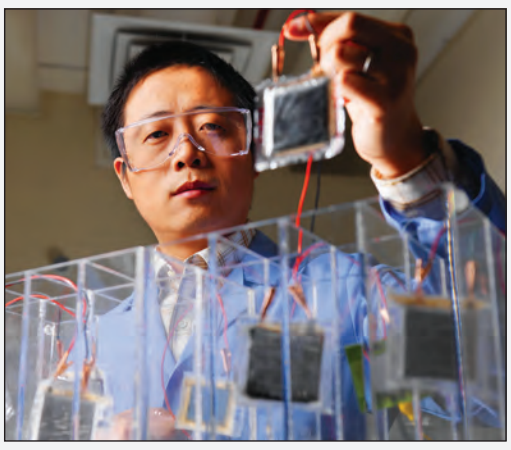
Researchers are also looking to improve the batteries for electric vehicles, with a focus on improving performance and lowering costs. For example, lithium-sulfur batteries could allow cars to travel farther than the lithium-ion batteries used today; however, their overall lifespan is shorter. PNNL researchers are looking at how to increase the number of times lithium-sulfur batteries can be recharged so they last longer.

Cleaner diesels

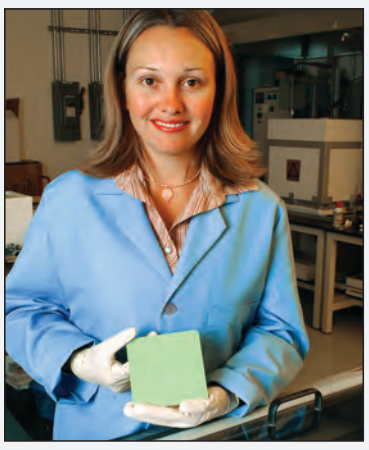
Diesel engines may be more fuel efficient than their gasoline engine counterparts, but they also produce more harmful emissions.

PNNL partnered with engine manufacturer Cummins Inc. and Johnson Matthey, a supplier of catalysts, to improve lean-burn diesel catalytic converters for powerful vehicles. As a result of their efforts, the catalytic converter first used in the 2007 Dodge Ram—and later in other fuel-efficient diesel vehicles like the Volkswagen Jetta TDI—was able to meet 2010 emission standards, while improving fuel efficiency by 25 percent over conventional engines.

"This is a perfect example of how a fundamental understanding of the problem helped pave the way to a solution," Virden said. "Together with DOE and industry, PNNL is keeping America on the move, while addressing national and global challenges like climate change, pollution and energy independence."



Researchers develop and test batteries for vehicles and transportation, including investigating new materials and using advanced models to predict how and why batteries fail. Energy storage solutions are needed for electric vehicles, which can reduce our dependence on imported oil and the environmental impacts of fossil fuels.



Researchers aim to improve fuel cell's performance, lower their operating temperature and increase their efficiency—as well as to develop fuel reformer systems that can quickly convert traditional fuels into hydrogen.

At PNNL's exhaust emissions laboratory, researchers can use a suite of instruments to develop and evaluate vehicle exhaust after-treatment systems. As seen here, a diesel car can be on a chassis dynamometer—a treadmill for vehicles that provides realistic road operating conditions for testing new technologies.

Researchers developing advanced materials, including lightweight materials for vehicles, use processes such as friction stir welding that offer benefits over conventional manufacturing processes. For example, friction stir welding allows metals to be joined without melting them like welded joints.