

ARGONNE'S VEHICLE SYSTEMS RESEARCH

Driving the Future



Accelerating the adoption of New Technologies



At Argonne National Laboratory's Center for Transportation Research, our goal is to accelerate the development and deployment of vehicle technologies that help reduce our nation's petroleum consumption and greenhouse gas emissions.

Our Vehicle Systems research focuses on maximizing vehicle performance and efficiency through in-depth studies of the interactions and integration of components and controls in a large, complex vehicle system.



Working with the U.S. Department of Energy (DOE) and the automotive industry, we investigate the potential of vehicle technologies ranging from alternative fuels to advanced powertrains, such as plug-in hybrids and electric vehicles. Funding for this work is largely provided by DOE's Vehicle Technologies Program.

In the following pages, you'll read about the tools, capabilities and expertise that our integrated team employs to identify and accelerate the best new transportation technologies to the marketplace, and ultimately get them on the road.



Argonne is Unique...

As a DOE national laboratory, Argonne is ideally positioned to be a leader in the understanding, improvement and validation of promising new transportation technologies, with our unique combination of:

- ▶ State-of-the-art dynamometer testing facilities
- ▶ Cutting-edge modeling and simulation capabilities
- ▶ World-class researchers with a wide range of vehicle expertise

Having all of these resources integrated under one roof is a significant advantage that puts Argonne at the forefront of transportation innovation.

Advanced Powertrain Research Facility (APRF)

Data- and Research-Driven Test Lab



Argonne's APRF enables engineers to conduct vehicle benchmark testing and research activities that provide data critical to the development and commercialization of next-generation vehicles.

APRF engineers use the facility's two-wheel drive (2WD) and four-wheel drive (4WD) chassis dynamometers and state-of-the-art instrumentation tools to reveal important information on performance, fuel economy, energy consumption and emissions output.

The APRF's features and staff capabilities include the ability to:

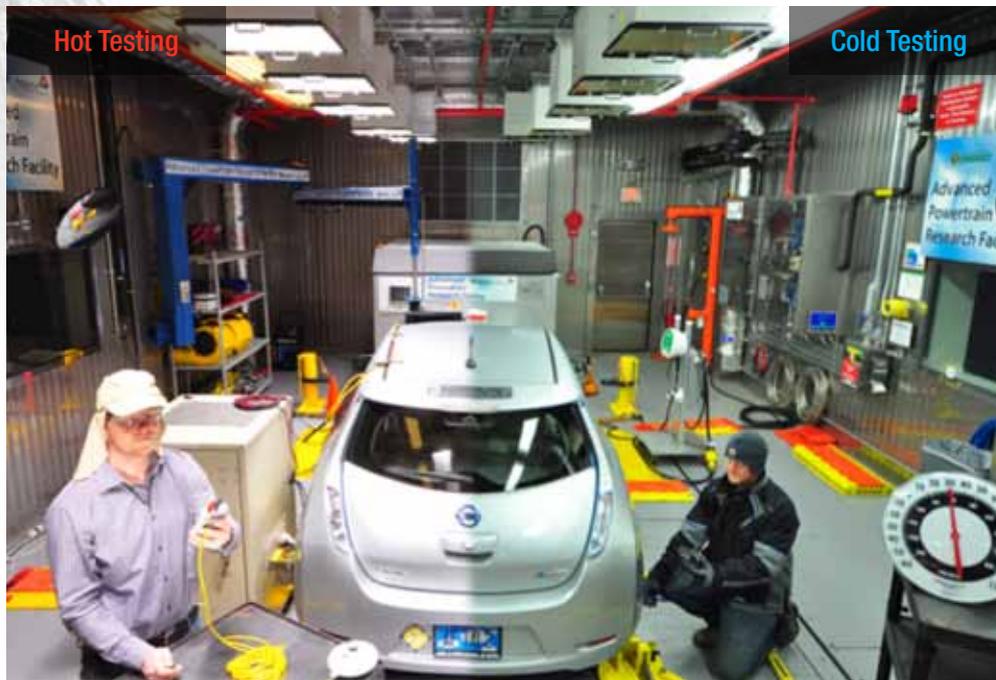
- ▶ Simulate road load and tractive effort of vehicles using 2WD and 4WD dynamometers (vehicles up to 12,000 and 14,000 pounds, respectively)
- ▶ Instrument components using innovative techniques that measure a full inventory of power and energy flows through vehicle powertrains
- ▶ Design and implement *in-situ* vehicle torque sensors to determine the precise efficiency of major components in the entire driveline system
- ▶ Measure criteria emissions of advanced technology vehicles



Thermal Studies

Heating and air conditioning systems have significant impacts on vehicle efficiency and electric vehicle range. To fully understand these impacts, Argonne's APRF is equipped to evaluate vehicles and components under extreme hot and cold temperature conditions (from 20°F to 95°F). This capability enables researchers to:

- ▶ Validate performance targets for battery packs, drivetrain components, control strategies and accessory loads across a range of temperatures and duty cycles
- ▶ Quantify the impacts of air conditioning and heater/defrost operation on energy consumption and vehicle performance
- ▶ Develop vehicle-level control solutions to mitigate temperature-related impacts
- ▶ Generate cold and hot operational characteristics and data to be integrated into Autonomie, Argonne's modeling and simulation tool



Alternative Fuels Research

The primary focus of Argonne's alternative and advanced fuels research is the acquisition and dissemination of emissions, efficiency and performance data from engines and vehicles operating on various fuels. This is accomplished using Argonne's extensive engine and vehicle testing facilities combined with the latest data acquisition equipment for in-cylinder combustion, as well as exhaust system analysis. Fuels being investigated include:

- ▶ Clean diesel
- ▶ Natural gas
- ▶ Butanol
- ▶ Ethanol
- ▶ Hydrogen
- ▶ Synthetic fuels

Argonne researchers developed the Green Racing Simulator as a fun outreach tool to educate consumers on the benefits of alternative fuels and advanced technologies.



Component Evaluation in a Systems Context

Component-in-the-loop evaluation allows researchers to study component technologies and their system-level impacts without building and disassembling an entire vehicle each time a component is changed. Argonne engineers can perform prototype component evaluations within a vehicle context (component-focused experiments) and vehicle-level evaluations that require real components (vehicle-focused experiments).

- ▶ Permits study of physical components by using a “virtual vehicle” (computer model) to simulate controls and drive cycles
- ▶ Allows for the evaluation of components, such as engines, batteries and motors, as if they are operating in a real car
- ▶ Provides quick evaluation of energy management, performance, thermal losses and emissions
- ▶ Shortens R&D time, leading to more rapid commercialization of new technologies

Modeling & Simulation with Autonomie

Argonne’s Autonomie is a flexible “plug-and-play” simulation software package that allows for the rapid evaluation of new component technologies and powertrain configurations.

- ▶ Allows engineers to experiment with many concepts and strategies in simulation before building their concepts in hardware
- ▶ Simulates subsystems, systems or entire vehicles (designed to be used as a single tool throughout the different phases of Model-Based Design)
- ▶ Predicts and analyzes fuel economy and performance
- ▶ Available for licensing. Users include automakers, vehicle component manufacturers, government laboratories and other research institutions



www.autonomie.net

Codes and Standards Development

Argonne researchers are contributing to the development of codes and standards that will enable widespread and streamlined adoption of advanced vehicle technologies.

For example, Argonne led the revision of the Society of Automotive Engineers' (SAE) J1711 standard for measuring the fuel economy and emissions of hybrid and plug-in vehicles (dynamometer testing). The U.S. Environmental Protection Agency referenced SAE J1711 as it developed new fuel economy labels for hybrid vehicles.

Other standards being developed with Argonne support include:

- ▶ SAE J1634: Dynamometer testing standard for battery-electric vehicles
- ▶ SAE J2711: Dynamometer testing standard for medium- and heavy-duty vehicles
- ▶ SAE JXXXX: Dynamical modeling and simulation



Smart Grid Research

Argonne engineers are helping establish standards for plug-in and electric vehicles that enable "smart" interaction with the electric grid, including:

- ▶ SAE J1772: Plug-in hybrid and electric vehicle conductive charge coupler
- ▶ SAE J2847: Communication between electric vehicles and the utility grid

The research team is also:

- ▶ Evaluating communication technologies for vehicle-grid connectivity to validate standards, while plotting a deployment path for charging infrastructure
- ▶ Developing a smart grid metrology system that is a fraction of the cost and size of the existing technology used to measure and communicate energy usage information



Our Mission

- ▶ Reduce our country's dependence on petroleum through the development of more energy-efficient and environmentally friendly transportation technologies
- ▶ Identify the best new vehicle innovations and accelerate them to the marketplace
- ▶ Provide unbiased technical evaluations to help guide transportation policy for the U.S. Department of Energy

FOR MORE INFORMATION

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