Argonne NATIONAL LABORATORY

THE ADVANCED POWERTRAIN RESEARCH FACILITY

Argonne's innovative vehicle testing facility leads the charge in hybrid and electric cars

The number and variety of cars – especially hybrid, plug-in and electric models – has exploded in recent years. As the types of powertrains multiply, industry suppliers often struggle to evaluate the impact of their technology on overall vehicle efficiency.

Unlike large auto manufacturers, small and midsized suppliers may lack vehicle systems experts or advanced testing facilities to gauge how their performance compares to competitors. Similarly, academic researchers and modelers need to dig deeper into detailed vehicle test data, beyond the headline fuel economy numbers set by the Environmental Protection Agency (EPA).

These stakeholders need an independent vehicle testing site and the expertise to reap its full benefits.

TECHNOLOGY ASSESSMENT AND TESTING STANDARDS

To address this problem, Argonne National Laboratory built the Advanced Powertrain Research Facility (APRF). Argonne's APRF offers experts in automotive testing standards and advanced instrumentation to test vehicles comprehensively via a thermal chamber and four-wheel drive chassis dynamometer.

Opened in 2002, Argonne's test facility measures performance and efficiencies of any type of vehicle – from conventional and hybrids to all-electric and alternative-fuel models in a controlled laboratory environment.

Argonne's facility is so versatile that it serves as the Department of Energy's (DOE's) premier benchmark laboratory, monitoring how advanced vehicle technologies develop. The facility also enables organizations to create automotive testing standards at a national and international level through its independent and public data.

RESEARCH FEATURES

- Research staff with expertise in instrumentation, testing standards and analysis
- Thermal chamber, facility cooling of experiment components, electric power in test cell 480VAC @ 200A & 208VAC @ 100A, ABC 170 capable of emulating a battery pack
- Detailed 10Hz vehicle- and component-level data since 1998 from hybrid and plug-in hybrid electric vehicles, battery electric vehicles and alternative fuel vehicles
- Modular and custom DAQ with real-time data display
- Custom robot driver with adaptive learning
- Experience with 2-, 3- and 4-wheel vehicles

ARGONNE'S HOLISTIC APPROACH AND EXPERTISE

Argonne's engineers use the facility to study vehicles holistically. Researchers first test each vehicle's performance, energy consumption and tailpipe emissions regardless of fuel type – from conventional to alternatives such as biofuels, diesel, hydrogen and natural gas. The engineers then examine how well each powertrain component – i.e., engine, battery, transmission – performs with state-of-the-art instrumentation. Finally, Argonne scientists create a blueprint of how all these components interact.

THE UNIVERSITY OF CHICAGO
U.S. DEPARTMENT OF ENERGY
Argonne National Laboratory is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC.

April 2017

For more than 15 years, Argonne's engineers have tested hundreds of cars, trucks and motorcycles (ranging from a few hundred pounds to a 15,000-pound delivery vehicle) under countless operating conditions, including simulated steep hills and extreme temperatures from 0°F to 95°F.

SYSTEM ENGINEERING APPROACH

With multidisciplinary expertise and a comprehensive approach, Argonne:

- Evaluates technologies in a systems context over a wide range of realistic test conditions, drive cycles and mapping tests
- Uses novel instrumentation to capture the power flow and energy balances between powertrain components
- Maps vehicle and component operating areas and efficiencies to help develop and validate simulation models
- Enables global standards organizations to develop test procedures for advanced vehicles and ensure technology claims are valid
- Develops and executes multi-vehicle and multi-fuel research studies to answer big questions with data

HISTORIC ADVANCED VEHICLE DATA PROVIDES CONTEXT

Argonne's comprehensive research approach generates 50 to 400 signals for each vehicle. Each of these data streams is measured and recorded 10 times per second (10Hz), yielding a wealth of insights unavailable elsewhere.

Argonne's engineers routinely work with industry to keep non-DOE research proprietary and have procedures to maintain physical privacy and digital security.

On the other hand, Argonne also releases some DOE-funded data free to the public via the Downloadable Dynamometer Database (D3), the web-based portal for Argonne test data.

Derived from investigative studies into advanced vehicle technology, the data enhances the understanding of how these technologies interact at the system level. The data is especially useful for researchers, students and professionals engaged in energy efficient vehicle research, development and education.

Only a small percentage of signals and subset of tests are posted on the web-based portal for each vehicle. If you are interested in more data or specific analysis on specific cars or technologies, please contact us.

FORWARD-LOOKING RESEARCH

Today Argonne researchers are evaluating the powertrain efficiencies of modern vehicles' autonomous driving features. Researchers find Argonne's closed and controlled campus and its upgraded communication and infrastructure ideal for evaluating autonomous vehicles.

The APRF is also performing hardware-based research on how grid-connected vehicles interact with the future smart grid in partnership with Argonne's EV Smart Grid and Interoperability Center.

INSTRUMENTATION HIGHLIGHTS

- High-precision power analyzers
- CAN decoding and recording
- Direct fuel flow metering
- Infrared temperature camera
- In-cylinder pressure indicating systems
- In-situ torque sensor measurement
- 5 gas emissions dilute bench with CVS (modal and bag emissions analysis)
- FTIR, mobile emissions unit
- Raw and fast HC and NOx bench
- Aldehyde bench for alcohol fuels

SUCCESSFUL PARTNERSHIPS

Engineers and scientists at Argonne's Advanced Powertrain Research Facility have partnered with dozens of the world's leading organizations, businesses and startups, including:

- Ford
- General Motors
- Chrysler
- Hyundai
- BMW
- Ricardo
- X prize
- FedEx
- Illinois Tollway Authority.

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