Not since the invention of the automobile has the future of transportation held such potential. The Center for Transportation Research (CTR) at Argonne National Laboratory is blazing the way forward, leading on advanced transportation research and development and contributing expertise, tools and facilities for innovation.

EV-SMART GRID INTEROPERABILITY
In order for electric vehicles (EVs) to gain wider market share and significantly influence America’s energy portfolio, they need to be universally interoperable, reliable and simple to charge. Ensuring that EV charging meets those demands requires cooperation across a variety of stakeholders. In response, Argonne plays an active role in EV standards development and integrates plug-in vehicles, buildings and renewables via numerous research initiatives.

VEHICLE SYSTEMS RESEARCH
The laboratory’s Advanced Powertrain Research Facility (APRF) staff performs focused research and technology evaluations critical to the development and commercialization of next-generation vehicles. CTR researchers use the APRF to evaluate technologies over a wide range of environmental conditions, driver use profiles and fuels.
ENGINES AND FUELS OPTIMIZATION
Increasing efficiency and fuel portfolio diversity requires an enhanced understanding of the interactions between fuels and engines. Superior high-performance computing capabilities (via the Argonne Leadership Computing Facility) provide the basis for critical modeling and simulation efforts. CTR researchers explore the fuel/engines relationship via a number of projects, including the evaluation of technologies for improved fuel efficiency; the study of renewable and alternative fuels and the characterization of engine particle emissions and catalysis.

COMBUSTION ENGINE DEVELOPMENT
Internal combustion engines propel more than 90% of America’s vehicles and generate critical electrical power for manufacturing facilities. The CTR advances combustion research and development (R&D) via enhanced three-dimensional computational fluid dynamics modeling, high-fidelity combustion simulations, and exploration of low-temperature combustion systems. Argonne researchers have conducted groundbreaking research aimed at better visualizing the flow inside an engine’s fuel injector nozzle using X-ray beams at the Advanced Photon Source, work that requires high-level modeling tools to predict the influence of in-nozzle flow on fuel spray and combustion.

SURFACE AND LUBRICANT ENGINEERING
Argonne works with manufacturers across the transportation spectrum to increase efficiency and extend component life by understanding the interactions of lubricants and coatings with materials. This requires a robust and diverse research effort, including developing and applying laboratory-to-engine correlation techniques; advancing mechanistic models of material wear and failure mode analysis of metal and composite materials components and creating and evaluating lubricant systems and additives.

THERMAL SYSTEMS AND MATERIALS
The CTR’s approach to reducing energy consumption and emissions includes innovative heat transfer concepts and novel energy storage concepts. Researchers use the laboratory’s advanced facilities and tools for promoting advanced heat transfer technologies, utilizing one- and two-phase heat transfer and evaporative cooling, and developing applications for thermal energy storage using phase-change materials, among other critical efforts.

EDUCATION AND OUTREACH
For more than 26 years, Argonne has managed the Department of Energy’s Advanced Vehicle Technology Competitions (AVTCs), providing a unique educational experience for next-generation engineers while accelerating the development and demonstration of advanced technologies. AVTCs not only provide a real-world training ground for future engineers, business and communications students; they also foster engagement with local communities and the larger public by illuminating the benefits of alternative and energy-efficient vehicles.

TOOLS FOR TODAY AND TOMORROW
CTR researchers have developed several tools used throughout the industry, including:
- **Autonomie**—simulation tool for vehicle energy consumption and performance analysis
- **POLARIS**—agent-based modeling framework designed to simulate large-scale transportation systems
- **VERIFI Multi-Dimensional Models**—high-fidelity, advanced engine combustion simulation tools

WORKING WITH THE CTR
Access to Argonne technology, facilities, and research assistance is available to industries, universities, and other federal agencies through a number of partnership models.

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