Overview of Transportation Research

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Center for Transportation Research
Argonne National Laboratory

July 2013

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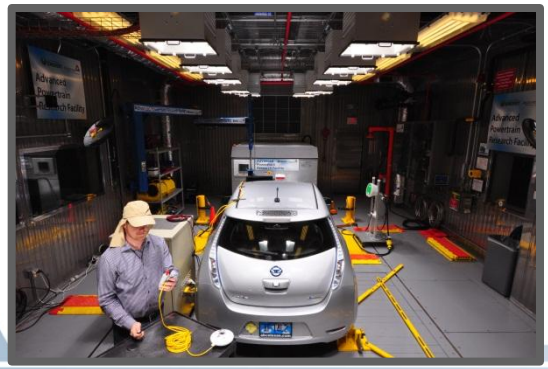
Argonne National Laboratory: A multipurpose national laboratory

The challenge: To do world-class fundamental science and engineering that provides solutions to the national challenges

DOE Energy Efficiency and Renewable Energy - Vehicle Technologies Program Office

Decrease petroleum dependency and Reduce greenhouse gases

Develop more energy efficient and environmentally friendly highway transportation technologies that enable America to use less petroleum. The long-term aim is to develop technologies that will provide Americans with greater freedom of mobility and energy security, with lower costs and lower impacts on the environment



Argonne's Center for Transportation Research
Unique Facilities and Depth of Expertise

Basic & Applied Combustion Research

APS – x-rays
Transportation Hutch

Materials Research
- Battery electrodes
- Fuel cell catalysts
- Tribology

Autonomie
GREET

High Performance Computing

Modeling and Simulation

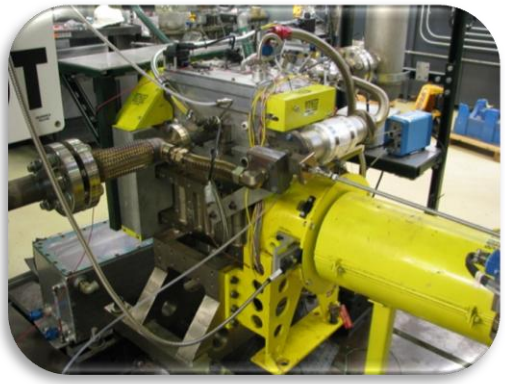
Advanced Powertrain Research Facility

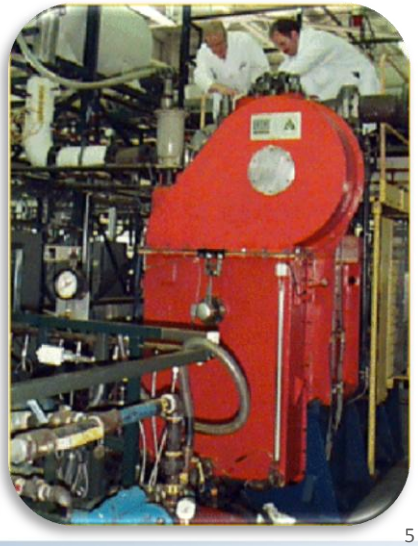
Fuel Cell and Battery Testing

Testing and Validation

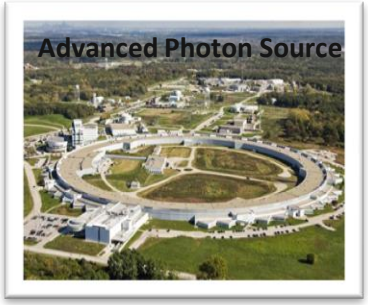
Student Competitions

Engine Research - Increasing Engine Efficiency
Automotive to Locomotive Size



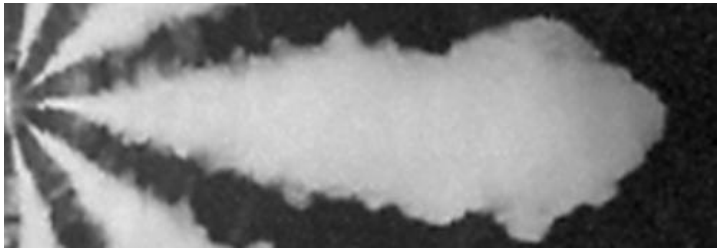


- **State of the art engine test facilities**
  - 7 engine dynamometer cells
  - Multi-fuel capability
  - Several emissions benches
  - FTIRs, Micro-Soot sensor
  - High-speed data acquisition systems
- **Diverse skill sets**
  - Engineers with backgrounds in mechanical engineering, electronics, physics …
  - 3-D CFD modeling performed in house
  - Highly trained technicians
- **Diverse funding sources**
  - DOE funded projects
  - CRADA agreements
  - WFO/TSA projects

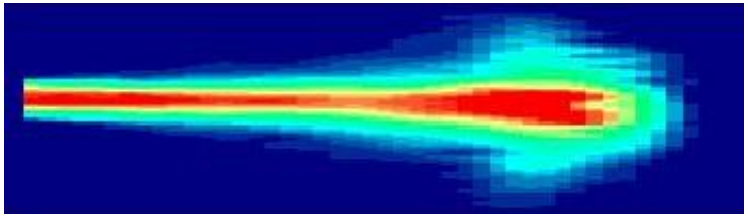


X-Ray Measurements of Fuel Injection and Sprays

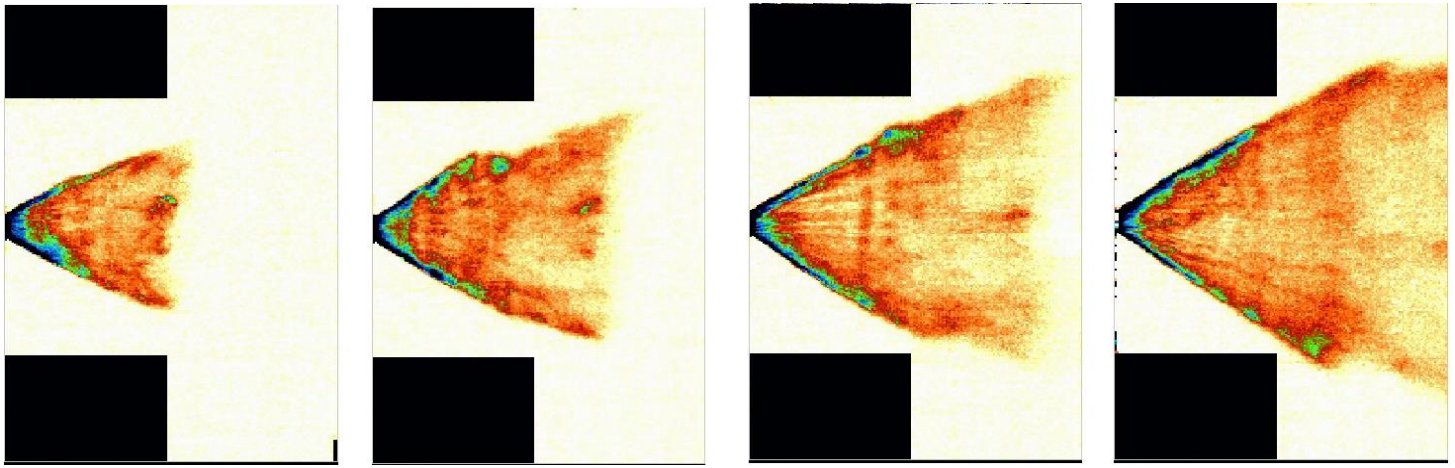
- Achieving high engine efficiency with low emissions requires a detailed understanding of fuel/air mixing
- Precise, quantitative measurements of fuel injection are required
- X-ray imaging gives time-resolved measurements of the fuel distribution



Visible Light Imaging



X-ray Imaging

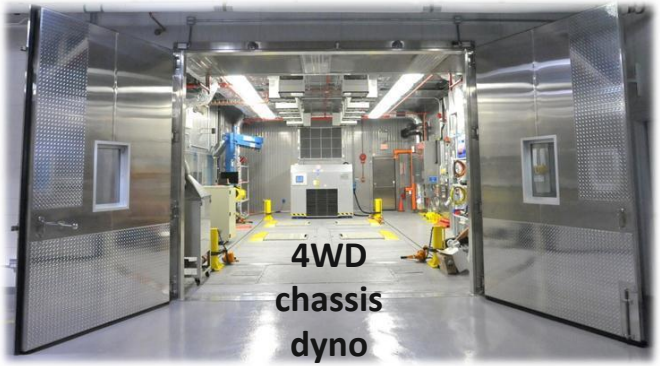


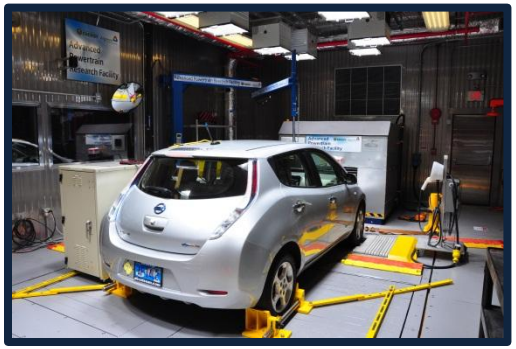
X-ray images showing the time evolution of a gasoline injection

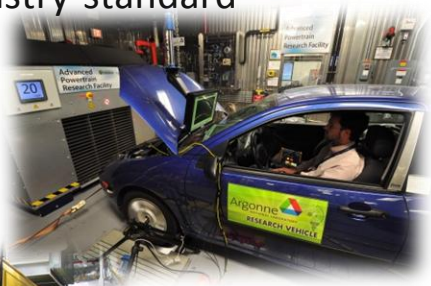
Argonne is the U.S. Department of Energy's Principal Lab to Evaluate Electric Drive Vehicle Technology

Electric Drive testing experience:

- 2-wheel drive and 4-wheel drive vehicle dynamometers
- State-of-the-art environmental chamber for vehicle tests ranging from 90° F (32° C) to 20° F (-7° C)
- Research of unique vehicles from conventional technology to alternative fuels and electric drive
  - E.g., Alcohols, biodiesel, hydrogen, CNG, LPG
- Extensive benchmarking of the latest advanced technology vehicles, e.g. EVs/PHEVs/FCEVs/ HEVs
- Developed HEV and EV test procedures and instrumentation used as the industry-standard

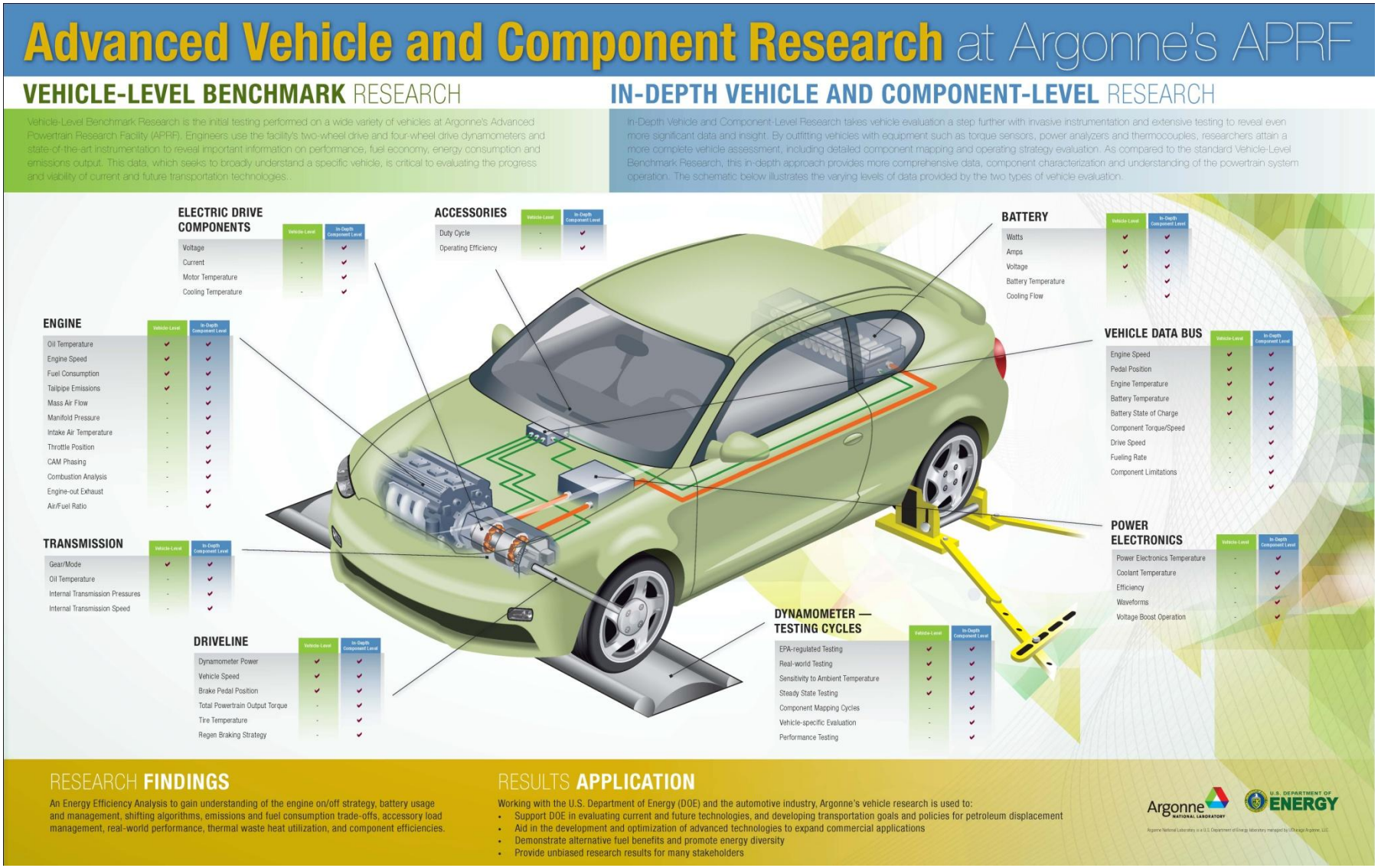






U.S. DEPARTMENT OF ENERGY

Dynamometer Vehicle Benchmark Testing Approach



Argonne Develops Advanced Battery Technologies for Electric-Drive Vehicles

Argonne is leading the nation in developing revolutionary energy storage systems that enable electric-drive vehicles and greening of the energy grid through:

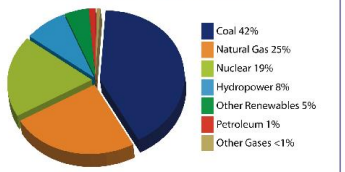
- Advancing electrochemical storage beyond lithium-ion batteries to other systems with new material discoveries (Energy Frontier Research Center)
- Developing and demonstrating energy storage prototype, manufacturing, and recycling processes and technologies
- Developing large energy storage and power management systems that improve grid reliability and efficiency, and enable steady power supply from renewable sources
- Optimizing efficiency, performance, and emissions of electric-drive powertrains

Interoperability: Vehicle - EVSE - Home - Utility

HOW YOU WILL CONNECT TO THE SMART GRID

Argonne NATIONAL LABORATORY

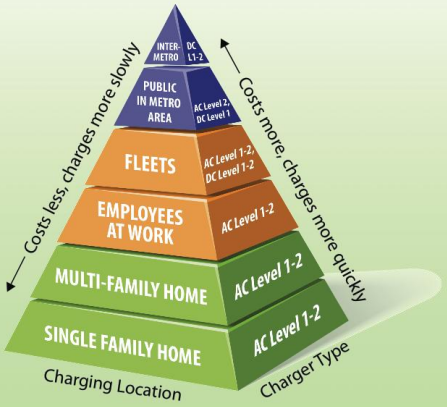
U.S. Energy Sources



Energy sources and percent share of total for electricity generation in 2011 (Source: U.S. Energy Information Administration)

The smart grid involves updating the existing power grid to employ real-time, two-way communication technologies that allow consumers to connect directly with power suppliers. This will give consumers the ability to choose when they charge their electric vehicles and at what price. Utilities can also better manage their energy loads by informing customers to reduce or shift their energy use during peak demand periods in return for an incentive. Researchers are developing reliable standards so you can securely connect to the grid using any electric vehicle.

Electric Vehicle Charging Options



Cars charge most often where they are parked most often.

Types of Chargers

Level	Volts	Amps	kW
AC-1	120	20	2.4
AC-2	240	<80	<19.2
DC-1	<450	<80	<36
DC-2	<600	<400	<240

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Visit www.transportation.anl.gov to learn more!

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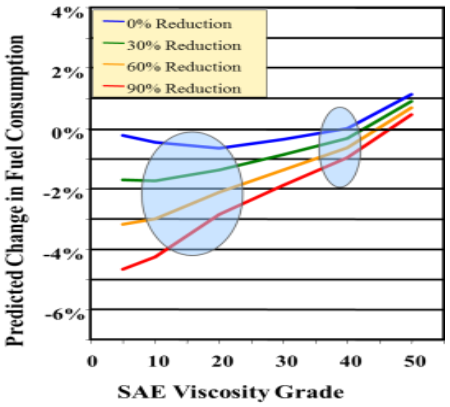
Tribology, Friction and Wear

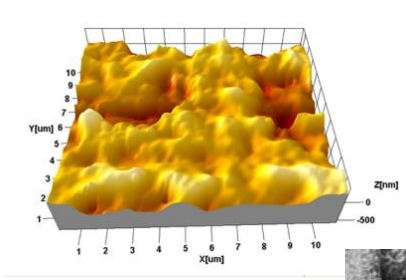
Modeling Impact of Friction on Fuel Economy

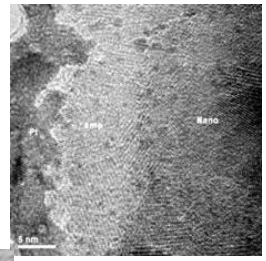
- Viscosity, asperity friction, surface finish…
- Drive cycle



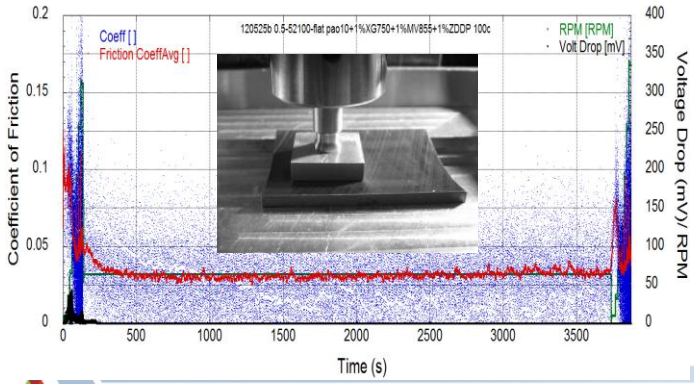
Characterization of Tribological Surface

- Structure, Composition, Chemistry



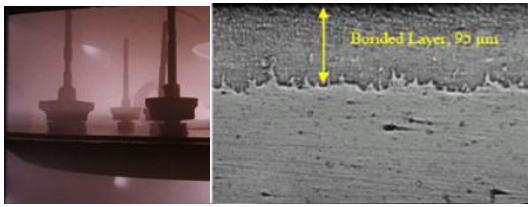


Lab Scale Testing of Materials, Coatings and Lubricants



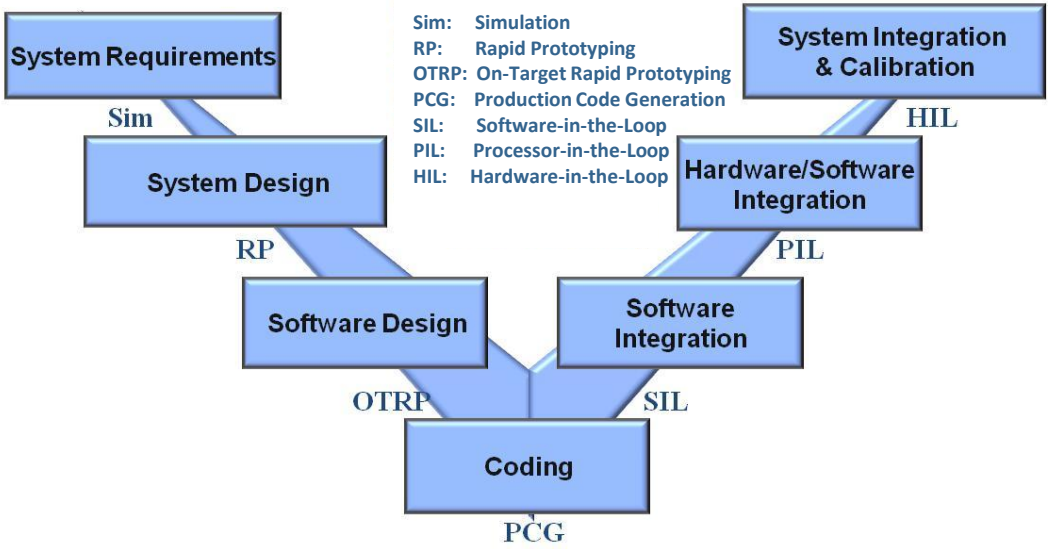
Technology Development

- DLC, Superhard NanoComposite coating, Ultrafast Boriding
- NanoAdditives



AUTONOMIE – Model Based Design Approach to Accelerate the Vehicle Development Process

Model Based Design Process



Problem:

- Heavy reliance on hardware leads to high cost and longer development time
- Integration of new technologies in a system lowers true benefit

Result:

Wasted Opportunities, Time, and Resources (People & Budget)

Solution:

AUTONOMIE developed for fuel consumption analysis, control development, virtual powertrain evaluation with application from the concept phase to production mode for OEMs and researchers

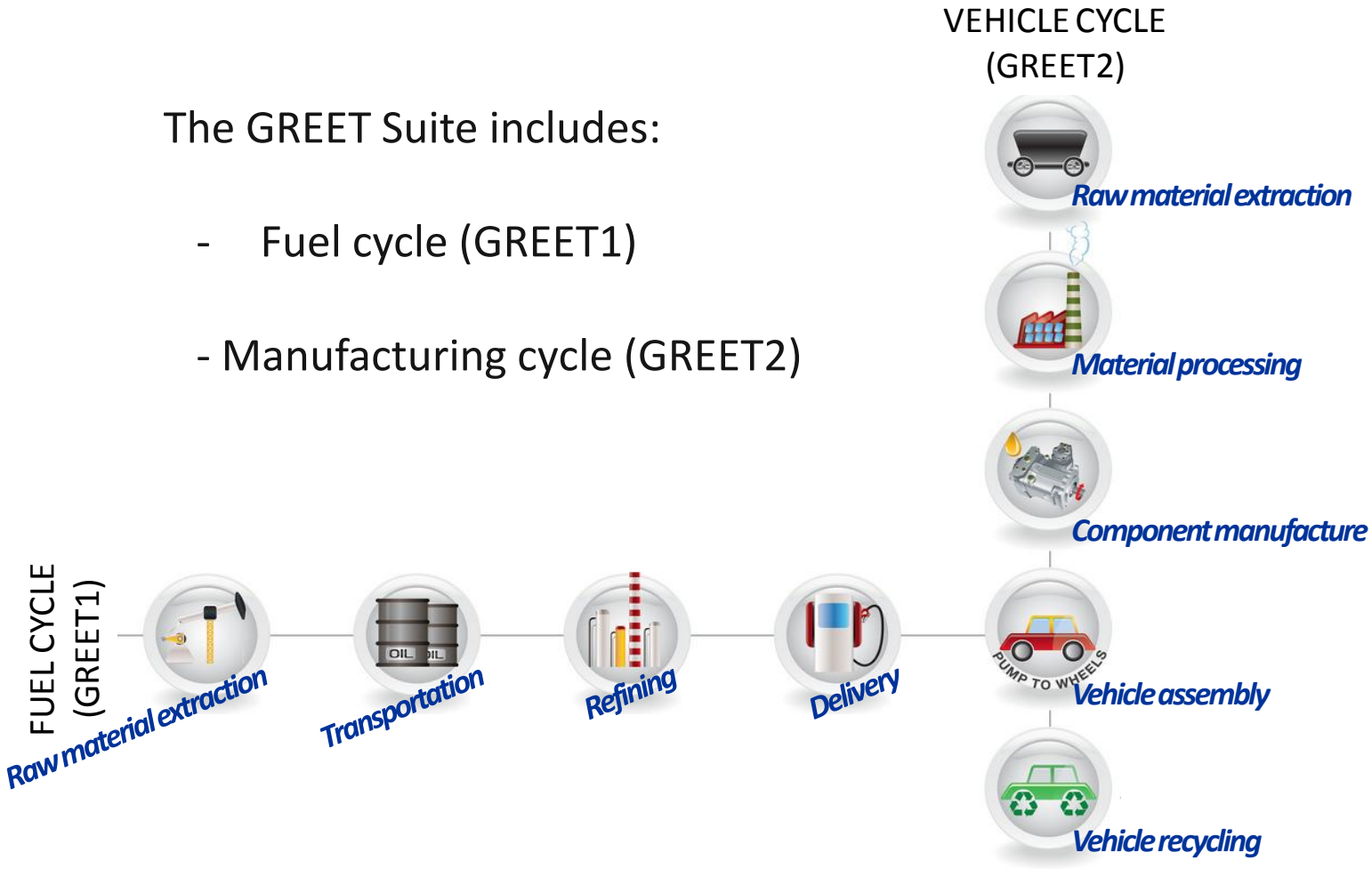
Argonne's GREET Model

GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation)
Model is known as the gold standard for life-cycle analysis

The GREET Suite includes:

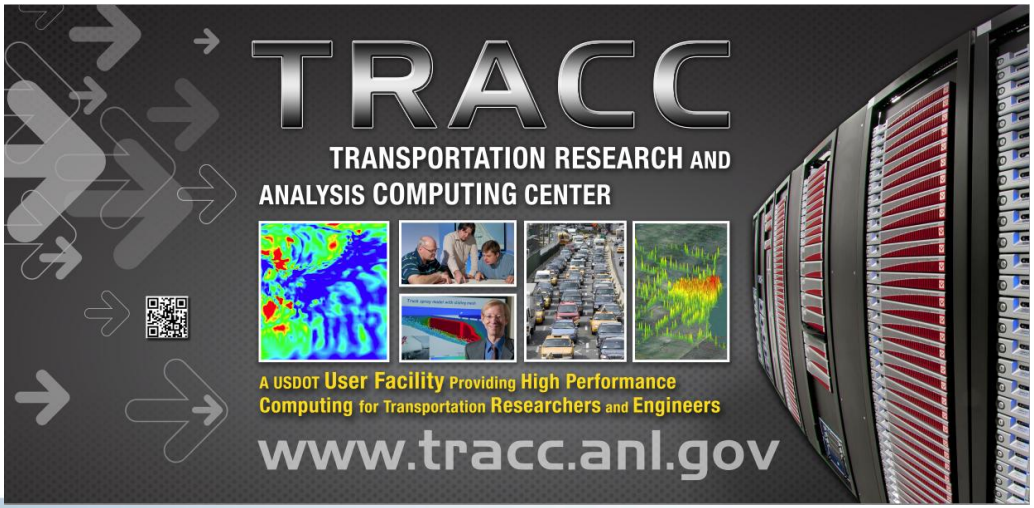
- Fuel cycle (GREET1)

- Manufacturing cycle (GREET2)



TRACC - A National User Facility to Meet Advanced Computation Needs

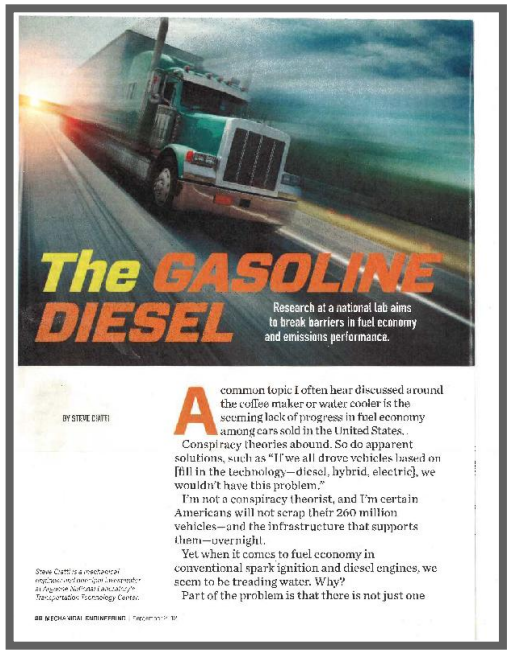
- U.S. DOT and U.S. DOE transportation research programs are moving to simulation-based design and analysis for improvements in efficiency, economics, and safety
  - Requires higher fidelity analysis in areas such as crashworthiness, aerodynamics, combustion, thermal management, weather modeling, and traffic simulation
  - Requires access to state-of-the-art computational and visualization facilities
- Argonne expertise in high-performance computing and transportation system analysis provides the basis for a national HPC user facility and a focal point for computational research for transportation applications



DOE Advanced Vehicle Technology Competitions (AVTC)

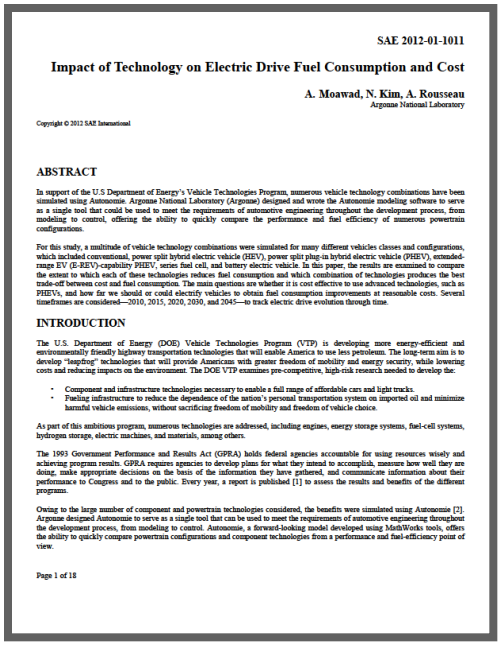
- Since 1987, DOE has sponsored AVTCs in partnership with the domestic auto industry to simulate the development of advanced propulsion and alternative fuel technologies and provide the training ground for the next generation of automotive engineers
- Advanced Vehicle Technology Competition:
  - Managed by Argonne National Laboratory and have involved more than 15,000 students from more than 600 educational institutions
  - Challenge students to design and build advanced vehicles with the goal of increasing energy efficiency and minimizing the environmental impact of personal transportation
  - Provide real-world, systems-level engineering challenges for students using industry-leading engineering tools, components and hardware and mimic the auto industry's vehicle development process

Examples of Ways Argonne Transfers Research Results

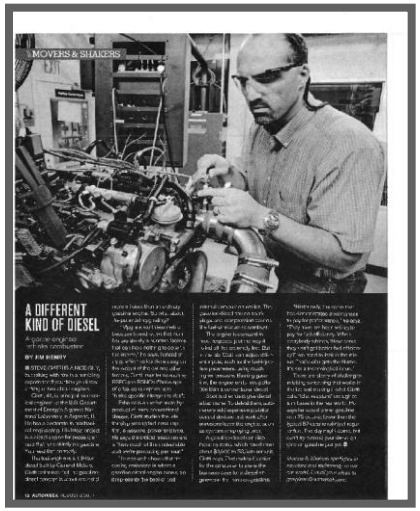


Mechanical engineering ASME 9/2012

Journals and Trade Technical Publications



SAE World Congress 2012



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