NORTH AMERICA'S PREMIER COLLEGE-LEVEL AUTOMOTIVE ENGINEERING COMPETITION

Crossover to Sustainable Mobility

May 12-May 21, 2008

NEW YORK CITY ■ MILLVILLE, NJ ■ PHILADELPHIA ■ BALTIMORE ■ WASHINGTON, D.C.

Challenge X is a unique four-year engineering competition that provides the opportunity for students across North America to develop advanced propulsion technology solutions that will increase energy efficiency and reduce the environmental impact of light-duty vehicles.

To address the issues surrounding personal mobility (like vehicle fuel economy and emissions), General Motors Corporation (GM), the U.S. Department of Energy (DOE), and other government and industry leaders have joined to create the advanced vehicle technology competition entitled ***Challenge X: Crossover to Sustainable Mobility***. This four-year competition managed by Argonne National Laboratory challenges 17 university engineering teams to redesign a Chevrolet Equinox SUV to minimize energy consumption, emissions, and greenhouse gases while maintaining or exceeding the vehicle's utility, safety, and performance.

Mississippi State University, First Place, Challenge X 2007

Year One of the competition focused on modeling, simulation, and testing of the vehicle powertrain and vehicle subsystems selected by each school. Teams integrated these components into their own Chevrolet Equinox donated by GM during Year Two, and the vehicles competed at GM's Desert Proving Ground in Mesa, Arizona, in June of 2006. For Year Three, students worked to further improve their vehicles and then competed in the 2007 competition held at the GM Milford Proving Ground where their vehicles were tested extensively to measure their fuel economy, emissions, and performance gains. University of Waterloo's dedicated hydrogen fuel cell vehicle. Mississippi State University took top honors in the 2007 competition.

Now, in the fourth and final year of Challenge X, teams are working to refine their Equinoxes to showroom quality while improving their vehicle's performance and consumer appeal and will demonstrate the reliability and dependability of their final vehicles during a 400-mile road rally from New York City to Washington, D.C. in May 2008.

Challenge X 2008 Team Technologies

TEAM	HEV ARCHITECTURE	ENGINE	FUEL	TRANSMISSION	ENERGY STORAGE	MOTOR
Michigan Technological University	Through-the-road Parallel	2.0-L 4 Cylinder Spark Ignition	Reformulated Gasoline	4-Speed Automatic	COBASYS, Nickel Metal Hydride - 336V	50 kW Solectria AC Induction Transaxle
Mississippi State University	Through-the-road Parallel	1.9-L GM Direct Injection Turbo Diesel	Bio Diesel (B20)	GM F40 6-speed Manual	Johnson Controls, Nickel Metal Hydride - 330V	45 kW Ballard Integrated Power Transaxle
Ohio State University	Series Through-the-road Parallel	1.9-L GM Direct Injection Turbo Diesel	Bio Diesel (B20)	Aisin-Warner AF40 6-speed automatic transaxle	Panasonic, Nickel Metal Hydride - 300V	67 kW Ballard AC Induction Transaxle / 10.6 kW Brushless DC Generator
Pennsylvania State University	Post-Transmission Parallel	1.3-L GM Turbo Diesel	Bio Diesel (B20) & Hydrogen	Aisin AF33-5, 5-speed Automatic	Lithium Tech, Lithium Ion - 300V	78 kW Solectria AC - 42 AC Induction
Rose-Hulman Institute of Technology	Power Split	2.5-L 4 CylinderDirect Injection Turbo Diesel	Bio Diesel (B20)	Custom Rose Hybrid 1-Mode Transmission (RH1T)	COBASYS, Nickel Metal Hydride - 336V	(2) 60 kW Custom AC Induction Motors
San Diego State University	Through-the-road Parallel	1.9-L GM Direct Injection Turbo Diesel	Bio Diesel (B20)	GM F40 6-speed Manual	Panasonic, Nickel Metal Hydride - 400V	150 kW AC Propulsion AC Induction
Texas Tech University	Parallel Hybrid	2.4L GM Ecotec VVT	Ethanol (E85) & Hydrogen	GM 4T45E, 4-speed Automatic	COBASYS, Nickel Metal Hydride - 36V	4 kW GM Belt-Alternator-Starter
University of Akron	Series Parallel 2 by 2	1.9-L 4 Cylinder Diesel Turbo Direct Injection	Bio Diesel (B20)	Direct Shift Gear Box (DSG) 6-Speed Manumatic	Nesscap, Ultracapacitor Bank - 370V	67 kW Ballard Integrated Power Transaxle / 36 kW Siemens Permanent Magnet Generator
University of California – Davis	Pre-Transmission Parallel Plug-In Hybrid Capable	1.5-L Atkinson Spark Ignition	Ethanol (E85)	UC-Davis Custom Continuously Variable Transmission	GIA Lithium Technology, Lithium Ion-346 V	75 kW UQM Permanent Magnet - Front /60 kW ENOVA AC Induction -Rear
University of Michigan	Series Hydraulic	1.9-L GM Direct Injection Turbo Diesel	Bio Diesel (B20)	Fixed Gear Reduction	Hydraulic Accumulators	Hydraulic 80 cc/rev & 55cc/rev Bent Axis Variable Displacement
University of Tennessee	Through-the-road Parallel	1.9-L GM Direct Injection Turbo Diesel	Bio Diesel (B20)	GM F40 6 Speed Manual	COBASYS, Nickel Metal Hydride - 288V	67 kW Ballard AC Induction
University of Texas at Austin	Through-the-road Parallel	1.9-L GM Direct Injection Turbo Diesel	Bio Diesel (B20)	GM F40 6-speed Manual	Johnson Controls, Nickel Metal Hydride - 42V	5 kW Hitachi AC Induction Belt-Driven Alternator/ Starter Hybrid
University of Tulsa	Through-the-road Parallel	1.9-L GM Direct Injection Turbo Diesel	Bio Diesel (B20) & Hydrogen	GM F40 6-speed Manual	COBASYS, Nickel Metal Hydride - 288V	67 kW Ballard AC Induction Transaxle
University of Waterloo	Series Fuel Cell Electric	65 kW Hydrogenics HyPM Fuel Cell	Hydrogen	Fixed Gear Reduction	COBASYS, Nickel Metal Hydride - 288V	(2) 67 kW Ballard AC Induction Transaxles
University of Wisconsin – Madison	Through-the-road Parallel	1.9-L GM Direct Injection Turbo Diesel	Bio Diesel (B20)	GM F40 6-speed Manual	Johnson Controls, Nickel Metal Hydride - 288V	45 kW Ballard Integrated Power Transaxle
Virginia Tech	Split Parallel	2.3-L Saab Turbo Spark Ignition	Ethanol (E85)	GM 5-speed Manual	COBASYS, Nickel Metal Hydride - 336V	52 kW Ballard AC Induction Transaxle / 8kW MES AC Induction Belt-Alternator/Starter
West Virginia University	Through-the-road Parallel	1.9-L GM Direct Injection Turbo Diesel	Bio Diesel (B20)	Aisin-Warner AF40 6-speed automatic transaxle	Maxwell, Ultra-cap - 750 kJ	(2) PML Wheel Hub Motors/18 hp AC Induction Generator

Challenge X 2008: Coast-To-Coast Showcase

The final year of Challenge X will evaluate the consumer appeal of the teams' vehicles, as well as their reliability and dependability. The Year Four competition, taking place throughout the 2007-2008 academic year, includes:

- Vehicle Ride and Drive at the Peterson Automotive Museum in downtown Los Angeles
- Road Rally from Los Angeles to Anaheim, CA
- Vehicle display and Ride and Drive at the Electric Vehicle Symposium (EVS 23) in Anaheim
- Safety and dynamic vehicle evaluation at the New Jersey Motor Speedway
- 400-mile Road Rally along the East Coast, including stops in New York City, Millville, NJ, Philadelphia, Baltimore, and culminating in Washington, D.C.
- Vehicle Ride and Drive at Capitol Hill and vehicle display in front of the U.S. Department of Energy on L'Enfant Promenade in Washington, D.C.

The Virginia Tech E85 hybrid achieved a 77% reduction in petroleum energy use

Participating Schools

Michigan Technological University
Mississippi State University
Ohio State University
Pennsylvania State University
Rose-Hulman Institute of Technology
San Diego State University
Texas Tech University
University of Akron
University of California, Davis
University of Michigan
University of Tennessee
University of Texas at Austin
University of Tulsa
University of Waterloo
University of Wisconsin-Madison
Virginia Tech
West Virginia University

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U.S. Department of Transportation

University of Waterloo's dedicated hydrogen fuel cell vehicle

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Silver Sponsors

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Johnson Controls-SAFT Advanced Power Solutions
Ballard Power Systems, Inc.
Michelin North America
Renewable Fuels Assocation

Bronze Sponsors

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Vector CANtech, Inc.
Intrepid Control Systems, Inc.
Hydrogenics Corporation
MotoTron Corporation
UGS
XM Radio
OnStar

Challenge X 2007 Competition Results

Teams performed impressively during the 2007 Challenge X competition: 12 teams successfully completed 12 different vehicle testing events and gave five presentations to industry and government representatives. The events tested every aspect of the vehicle, including handling, braking, acceleration, fuel economy, emissions, traction control, driveability, and trailer towing. Eleven teams demonstrated vehicles that surpassed the fuel economy of the control vehicle during the on-road fuel economy test, with Mississippi State University achieving the highest fuel economyof 30.0 mpgge (miles per gallon gasoline equivalent) – a 48% improvement.

Virginia Tech achieved the lowest well-to-wheel petroleum energy use, reducing its vehicle's petroleum use by 77% compared to the stock vehicle. In total, 11 teams were able to develop vehicles that used less petroleum than the stock vehicle by increasing their vehicle fuel economy or by switching to bio-based fuels or other fuels (like hydrogen and electricity) that require less petroleum to create.

The total greenhouse gas impact (GHG) of the vehicles includes upstream (production) factors and downstream (vehicle) emissions. Fourteen of the 17 teams were able to reduce the GHG impact of their vehicles, with the University of Wisconsin-Madison reducing the GHG impact of its vehicle by 52% compared to the stock vehicle.

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Challenge X is an advanced vehicle technology competition managed by Argonne National Laboratory's Center for Transportation Research.