Student Eco-Engineering Teams Announce Plug-In Hybrid EcoCAR Architectures

More Than $745M in Software, Hardware and Cash Donations from Sponsors to Build Highly-Efficient Vehicles

Today, the 15 North American universities participating in *EcoCAR 2: Plugging In to the Future* announced the vehicle architectures they will implement in their General Motors-donated 2013 Chevrolet Malibu. The three-year EcoCAR 2 competition, which is sponsored by the U.S. Department of Energy (DOE), Argonne National Laboratory, General Motors, and 20 other government and industry leaders, gives students the opportunity to gain real-world, eco-friendly automotive engineering experience while striving to further improve the energy-efficiency of an already highly efficient vehicle – the Malibu.

But teams don't get to stop there. Much like the challenges facing automakers, EcoCAR engineering students must balance the challenge of increasing the vehicle's energy efficiency and reducing the vehicle's greenhouse gas emissions and petroleum consumption with maintaining the performance, safety and overall consumer acceptability of the original Malibu.

To meet these technical challenges, each EcoCAR team designed its own unique Plug-In Hybrid Electric Vehicle (PHEV) architecture and utilized a crowd-sourcing format to select the powertrain components that it will integrate into its advanced technology vehicle over the three-year program. This technique mimics industry's global vehicle development process, which focuses on advanced controls and software to develop future vehicles. Hybrid vehicles on the road today already reach peak efficiency, so these teams must aim to get every last drop of energy possible out of the vehicle in order to reduce the environmental impact of a vehicle without compromising performance, safety and consumer acceptability. This hands-on experience is made possible by the numerous sponsor contributions to the 15 EcoCAR universities that exceed $745 million in software, hardware and cash donations.

"For this competition, we wanted to donate a vehicle that reflected today's consumers' needs, and the new 2013 Malibu made the most sense in terms of its size and flexibility," said Kent Helfrich, executive director, electronic controls and software engineering, of General Motors. "EcoCAR 2 students will take our Malibu and re-engineer their vehicle to reduce its environmental impact, yet still deliver real-life, practical results. This is not an easy job, but it's very rewarding. It's what we do at GM every day."

"The future in hybrid technology is happening now," said Patrick Davis, program manager of DOE's Vehicle Technologies Program. "It used to be that we were on the edge of this type of technology - now we are there, and these students are attempting to take it even further."

All of the EcoCAR team vehicle designs are PHEVs, which use an on-board battery to reduce fuel use. The battery can be recharged using a standard wall outlet. Once the plug-in range of the battery is depleted, the vehicle can still operate as a regular hybrid. The diversity of architectures the teams have selected rests primarily in the power-flow, which teams will aim to improve upon by using various combinations of fuel, transmission, battery system, electric motor, generator or charger choices. Some teams are even developing their own engine controller.

The powertrain components that the teams have selected to drive the vehicle are five unique combinations:

Parallel through the Road (PTTR) Plug-in Hybrid vehicles utilize electrical energy to power oneaxle, while an engine drives another axle. EcoCAR 2 teams using the PTTR architecture include: California State, Los Angeles; Purdue University; University of Washington; and Wayne State University.

Series Plug-in Hybrid vehicles consist of one or more electric motors driving the wheels, powered by a battery. An engine-generator is decoupled from the wheels at all times and provides supplemental electrical power to drive the vehicle when needed. Teams building a Series PHEV are: Embry-Riddle Aeronautical University; North Carolina State University; Pennsylvania State University; and University of Waterloo.

Series-Parallel Plug-in Hybrid powertrains have the ability to couple and de-couple the engine from the wheels while still providing electric power from the on-board battery to drive a motor. EcoCAR 2 teams using the Series-Parallel architecture include: Mississippi State University; The Ohio State University; University of Tennessee, Knoxville; University of Victoria; Virginia Tech.

Hydrogen Fuel Cell Series Plug-in Hybrid vehicles use an onboard fuel cell to convert hydrogen into electricity and either propel the vehicle or recharge a battery pack. The battery pack can be charged using a standard wall outlet. Colorado State University will build a Hydrogen Fuel Cell Series.

Split-Parallel Plug-in Hybrids utilize a motor connected to the engine's accessory belt that can charge the on-board battery, start the engine and provide additional power for acceleration. A separate motor provides additional power to the wheels. The EcoCAR 2 team using a Split-Parallel powertrain is Rose-Hulman Institute of Technology.

The various architectures will use B20, E85, or hydrogen to extend the range of the vehicles. B20 is a blend of 20% biodiesel and 80% petroleum diesel, and E85 is a blend of 85% ethanol and 15% gasoline.

The first year of EcoCAR 2 emphasizes the use of math-based design tools and simulation techniques for designing a successful vehicle foundation. Each team will receive a 2013 Malibu at the end of the first year of competition in May 2012. In years two and three, students will rebuild the vehicle based on their new architecture and continue to refine, test and improve the vehicle's operation.

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