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Benchmarking Advanced Technology Vehicles

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Argonne National Laboratory

Center for Transportation Research

Vehicle Technologies Program



ARGONNE'S OBJECTIVE: Provide to DOE and Partners the Best Advanced Vehicle Test Data

"Be the eyes and ears of technology development"



■ Advanced Powertrain Research Facility (APRF)

- Purpose built for DOE benchmarking
 - State-of-the-art 4WD chassis dynamometer
 - Custom multi-input data acquisition specific to hybrid vehicle instrumentation
- Staff at cutting edge of test procedures for new advanced vehicles
- Inventing new and novel instrumentation techniques



APRF's Unique Combination of Facilities and Capabilities



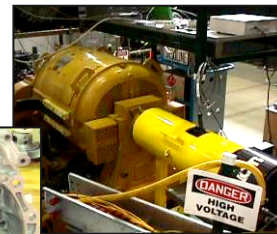
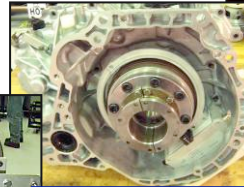
Multi-fuel Compatible Emissions Bench



FTIR Emissions Analyzer for non-Regulated Emissions



Hydrogen Testing Capability
gaseous & liquid
 H_2



Component Testing



Alternative Fuel Vehicle Testing Capability



Comprehensive Database Of Hybrids and PHEV's



Vehicle Benchmarking



Linking Models to Hardware

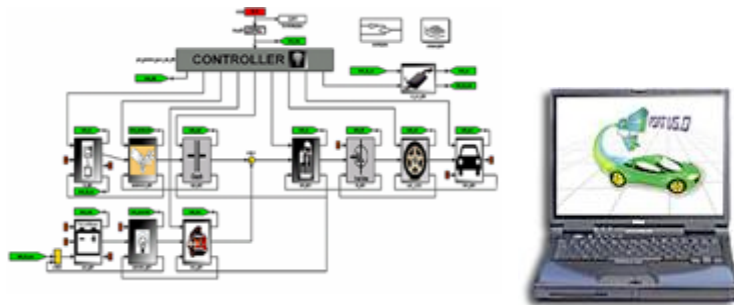


6 Channel Power Meter and High Precision Power Analyzer



In-House Data Acquisition

Integrated Testing and Analysis in the APRF is only Part of the Whole Solution



Modeling and Simulation (PSAT)

Powertrain Systems Analysis Toolkit: detailed analysis of conventional, hybrid and fuel cell vehicle systems

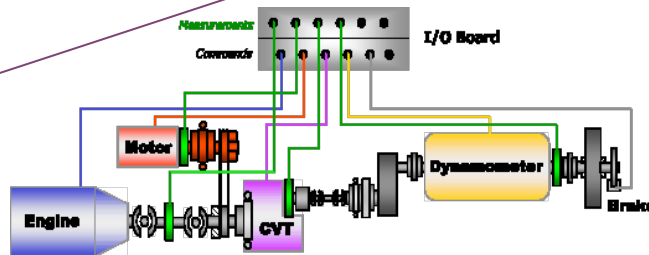
Simulation

Validation

Emulation

Benchmarking & Validation

Component and vehicle dynamometers, specialized fixtures, control systems, instrumentation and data acquisition – compatible with analysis tools



Component/System Emulation Hardware-In-the-Loop (HIL)

PSAT-PRO[®] (control SW based on PSAT) and dSpace[®] control systems to test in virtual vehicle environment: control strategies and component models developed in simulation can be evaluated in the laboratory

Accomplishments: PHEVs Tested from 2007-08

■ Prius Conversions

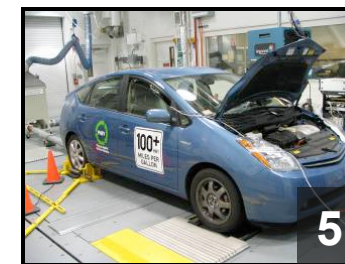
1. Hymotion (1st gen) Prius (highly instrumented)
2. HybridsPlus Prius (highly instrumented)
3. Hymotion (2nd gen) Prius (AVTA)
4. EnergyCS Prius ver.1 and ver.2 (AVTA)
5. Hymotion (3nd gen) Prius (owned by A123)

■ Escape Conversions

6. Electrovaya Escape (AVTA / NYSERDA)
7. Hymotion Escape (AVTA / NYSERDA)
8. HybridsPlus Escape

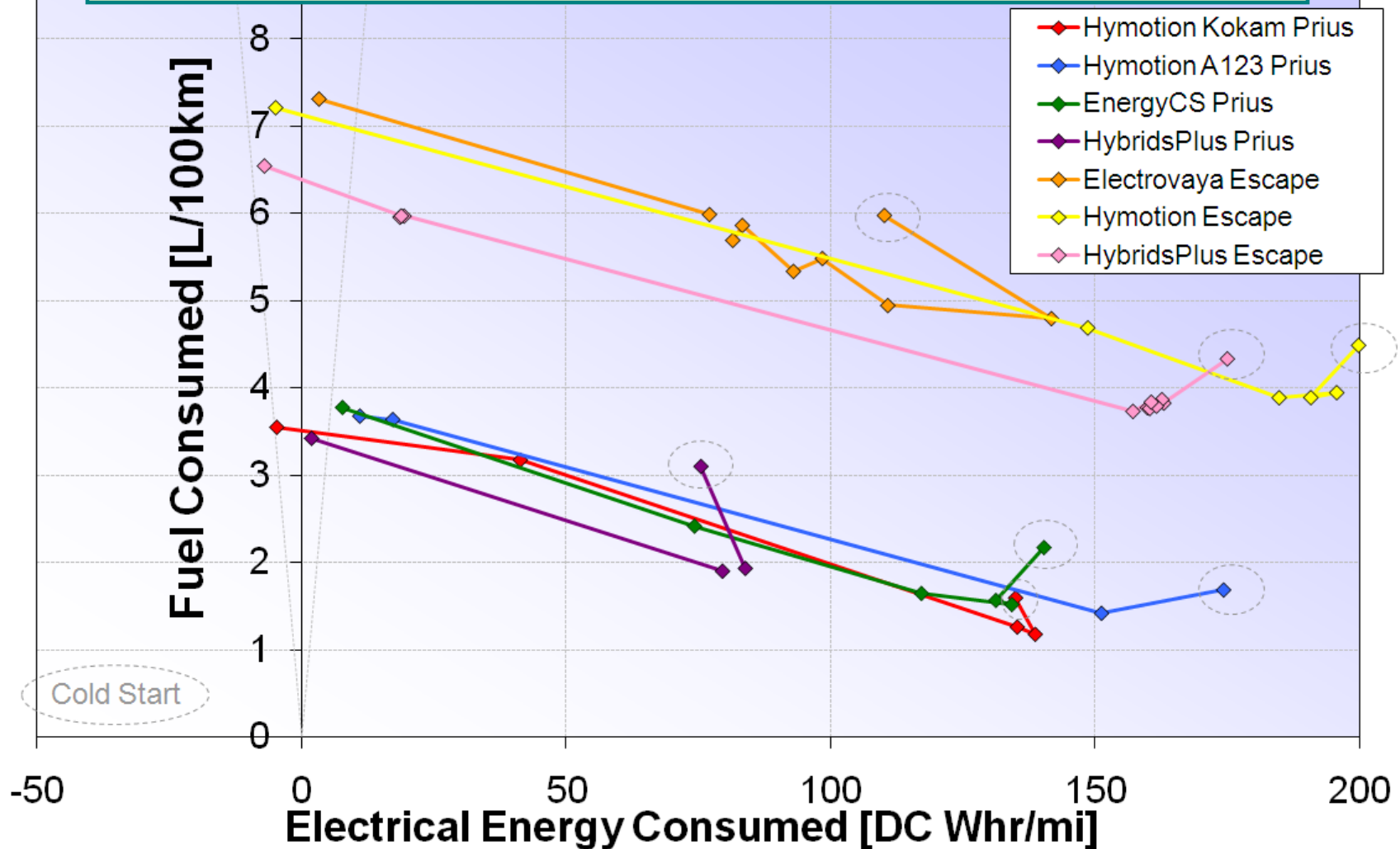
■ OEMs

9. Renault Kangoo
10. OEM PHEV Mule (NDA-protected)
11. Extensive instrum/testing of OEM – 2009
12. More OEM PHEVs – FY09



Energy Consumption Test Results of Prius and Escape PHEV Conversions

FTP Energy Consumption of Seven PHEV Conversions





Dynamometer Testing and Development of PHEV Components in a Systems Context

- Evaluate various Battery technologies in a systems context
- Evaluate All-Electric operation on battery & motor requirements
- Control System development and calibration
- Dyno testing Fuel Consumption and Electrical Energy Consumption, and Emissions
- Development of standard Test Procedures for PHEV vehicles



Test Procedure Development

				
	SURFACE VEHICLE RECOMMENDED PRACTICE	J1711		REV. PropDft JUN2006
		Issued	1999-03	
		Revised	Proposed Draft 2006-06	
		Superseding	J1711 MAR1999	
Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles				

- Benchmarking of Conversion PHEV's aids the development of Test Procedures
 - Soak Time sensitivity to Fuel Consumption
 - *cool-down time between tests*
 - Charging measurement and analysis
 - Evaluate proposed test produces

Summary

- Quality and Flexibility and Experience
 - APRF has unique testing capabilities that enables detailed Benchmarking of Advanced Technology Vehicles for DOE
- Harmony with Modeling and HIL (Hardware In the Loop) Studies closes the loop on the Technology Development Cycle

Future Work

- More PHEV benchmarking
 - OEM proto-types
 - AutoX Prize top entries
 - 5 cycles testing
- Battery Electric Vehicles (BEV) benchmarking
- Alternative Fuel vehicles benchmarking



Thank You

We would like to gratefully acknowledge the sponsorship of Pat Davis, Acting Program Manager and Lee Slezak, Manager, Advanced Vehicle Systems Simulation & Evaluation Team, Office of Vehicle Technologies Program, U.S. Department of Energy.

Vehicle Technologies Program

