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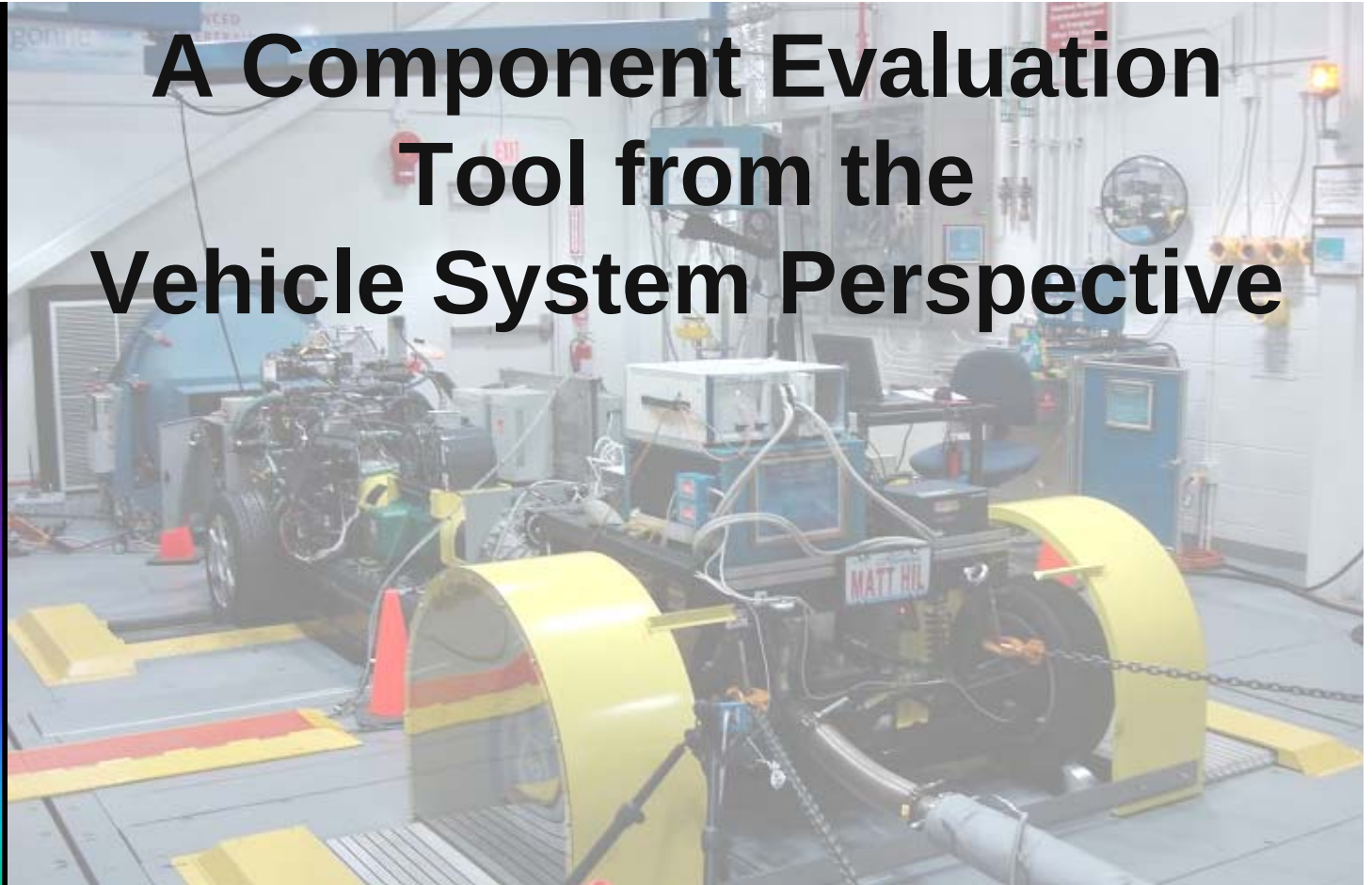


U.S. Department
of Energy

UChicago ►
Argonne LLC

A U.S. Department of Energy laboratory
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A Component Evaluation Tool from the Vehicle System Perspective



Henning Lohse-Busch
Vehicle Technologies Program
Sponsored by Lee Slezak

DOE Merit Review
28 February, 2008



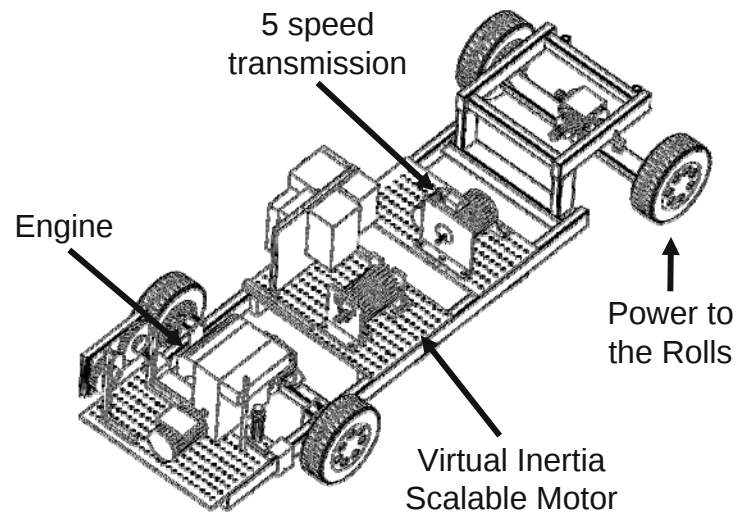
U.S. Department of Energy

Energy Efficiency and Renewable Energy

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

"This presentation does not contain any proprietary or confidential information"

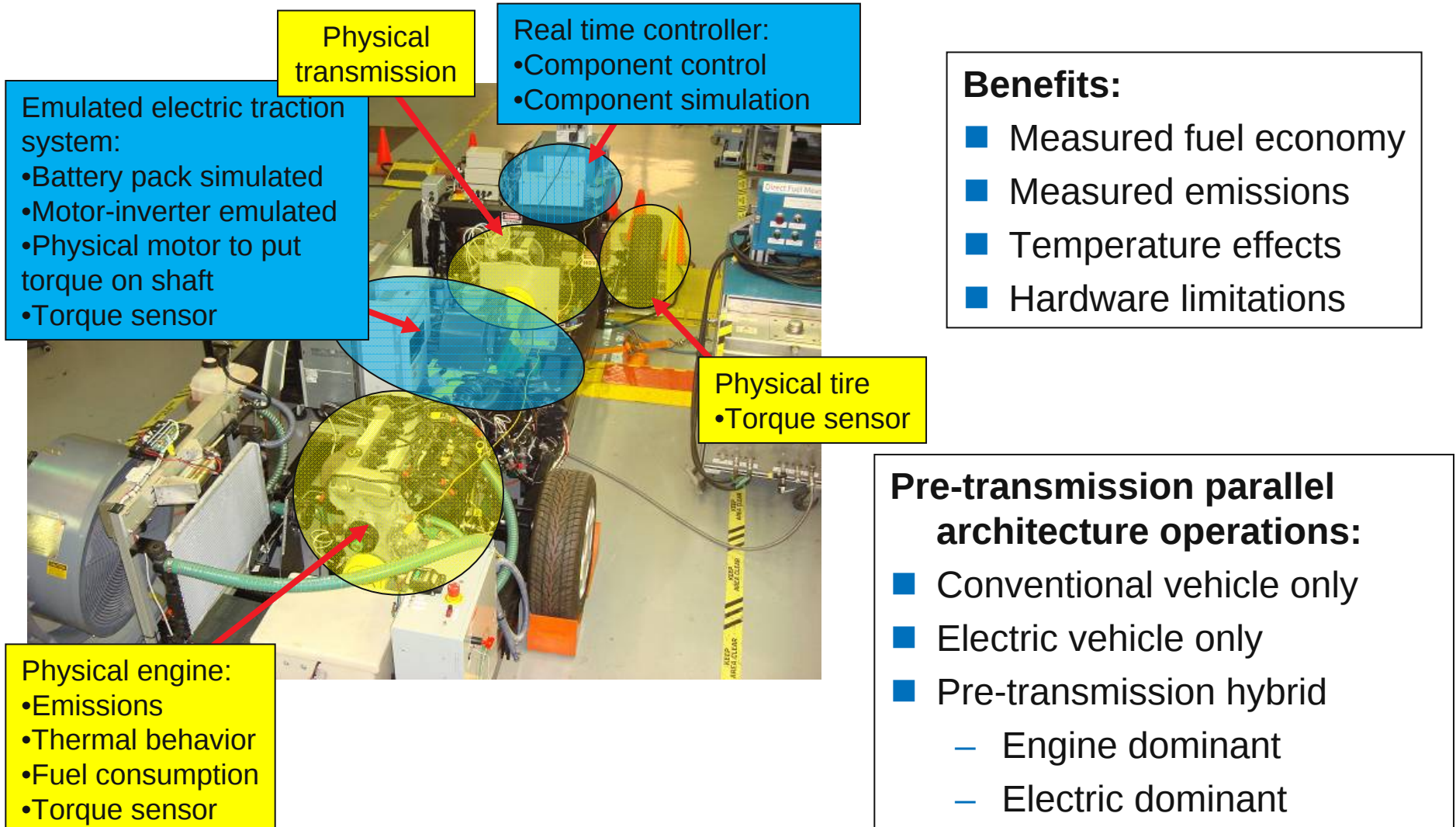
MATT (Mobile Advanced Technology Testbed) is a Modular Hybrid Test Environment for Component Evaluation



MATT's features:

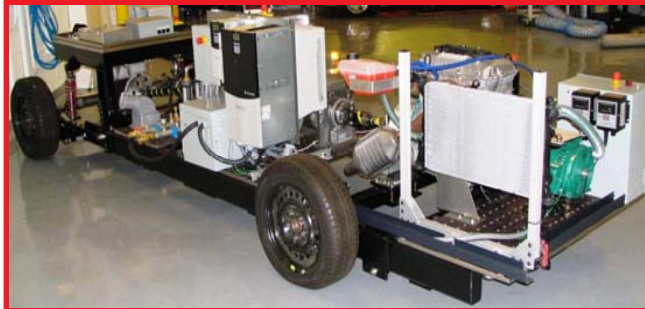
- **Flexibility:** component modules
- **Powerful:** emulated and physical components
- **Open control:** PSAT-PRO HIL/RCP
- **Realism:** APRF emission data
- **In-depth:** full instrumentation
- **Validation:** simulation complement

MATT (Mobile Advanced Technology Testbed) is a Modular Hybrid Test Environment for Component Evaluation

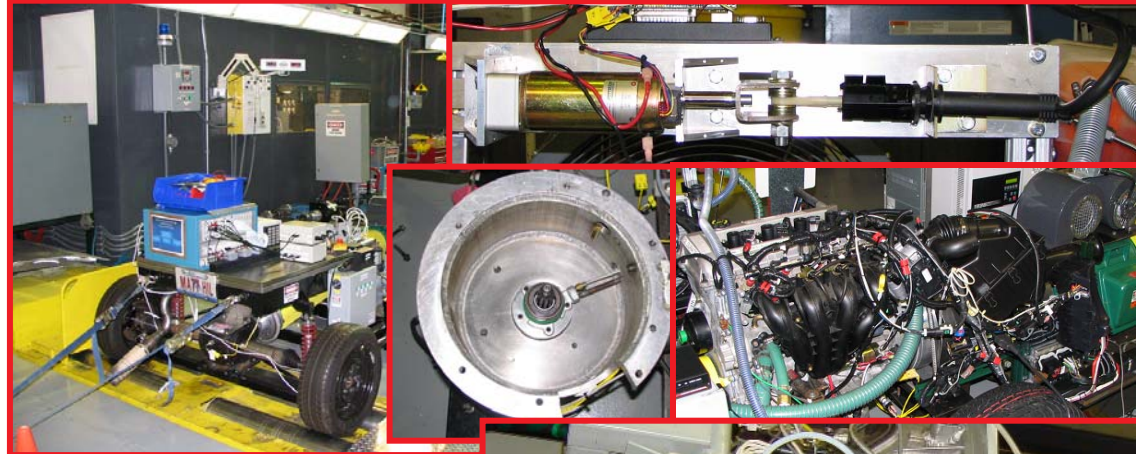


The Hardware Build Up and Development Phase was Complex

First the build...



... then the development and hardware upgrades



Component debugging

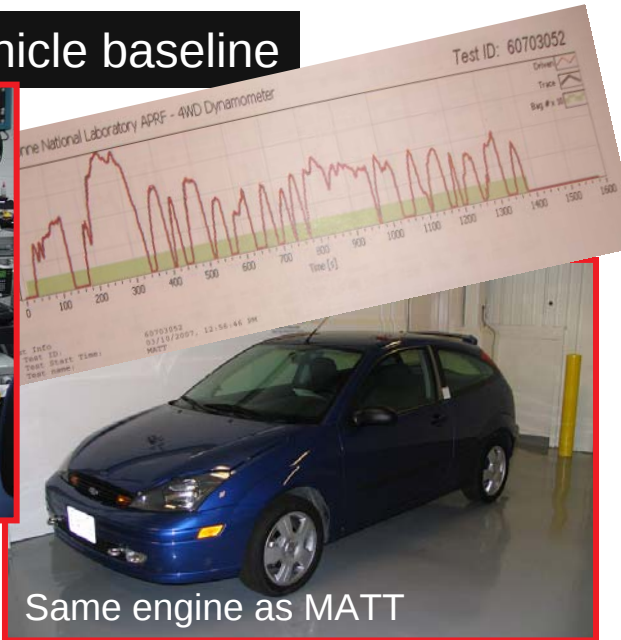
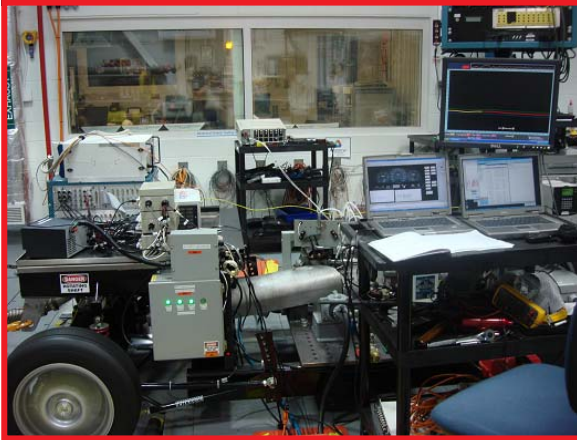
- Clutch controller
- Coolant system
- ECU and throttle control
- Transmission
- Motor
- Virtual scalable motor

System and control debugging



Running MATT as a Conventional Vehicle was the First Monumental Milestone

Conventional gasoline vehicle baseline



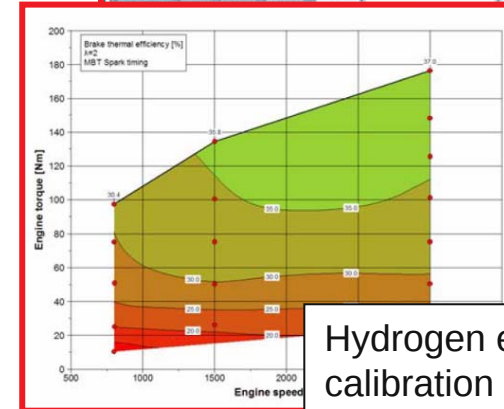
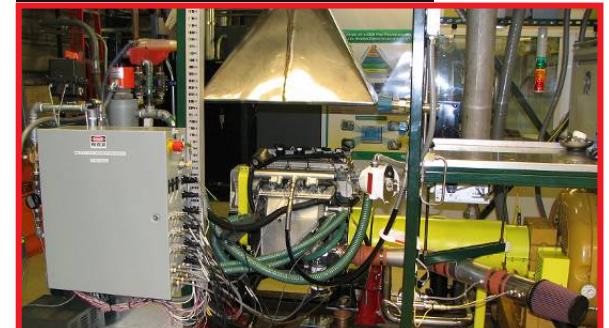
Same engine as MATT

Fuel economy in mpg	MATT conventional	Correlation Focus
UDDS Cold	24.8	26.6
UDDS Hot	25.7	27.5
HWY	39.8	38.0
US06	27.7	26.0

Challenges

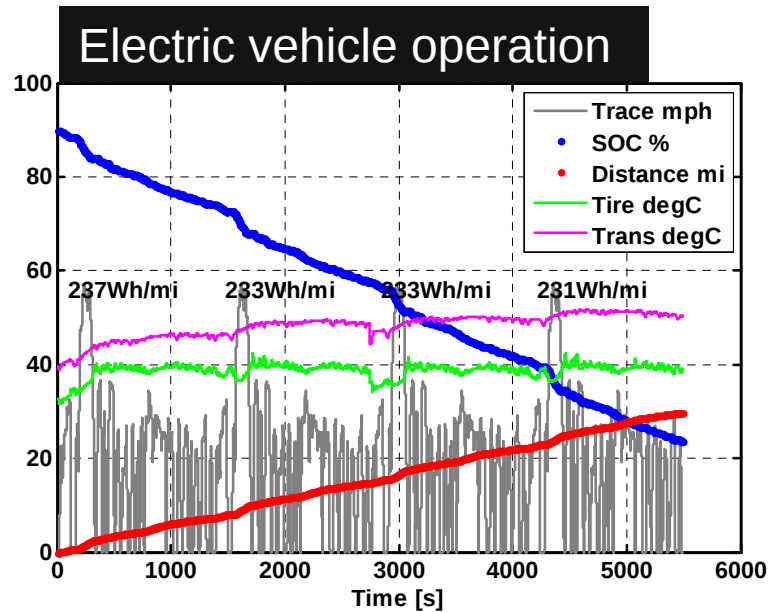
- Electric clutch launch
- Computer driver calibration
- Automated shift control

Hydrogen engine



Hydrogen engine calibration is done

Once MATT was Running each Milestone Increased the Hardware Refinement



Simulation:
 •V, I, SOC
Physical emulation
 •Tmax, Tregen



Project correlation

- Battery HIL battery pack emulation
- Data correlation with Battery HIL and PSAT

Large and small vehicle emulation



	Honda Insight	Ford Focus	Ford Escape
Coast down	yes	yes	yes
HWY Conv (mpg)	45	39.8	36
UDDS Conv (mpg)	30	25.7	23.5
UDDS Electric (Wh/mi)	210	308	375

Hybrid operation development

- EV to full hybrid
- Conventional to mild hybrid (engine assist)
- Preliminary PHEV



MATT's Roadmap for FY08

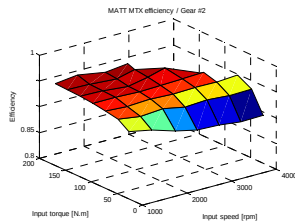
Budget: \$1,000k/Year & \$250k Spent to Data

October 07

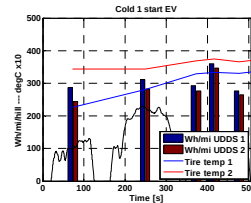
FY08

October 08

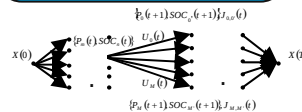
Component characterization



EV temperature effects on EC



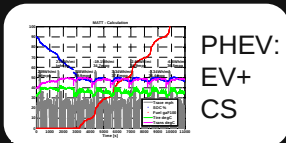
Global optimization validation



PHEV emissions and fuel displacement trade-offs based on control strategy

FY08 Continuing efforts

J1711 Support
Proposed PHEV test procedure

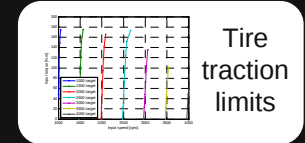


Hardware maintenance and improvement

Transmission repair



Feedback hardware limitation and validation to PSAT



The Cold Start Energy Penalty for Electric Vehicle Operation is Over 10% Compared to a Hot Start on the UDDS

Electric vehicle operation In depth look for J1711

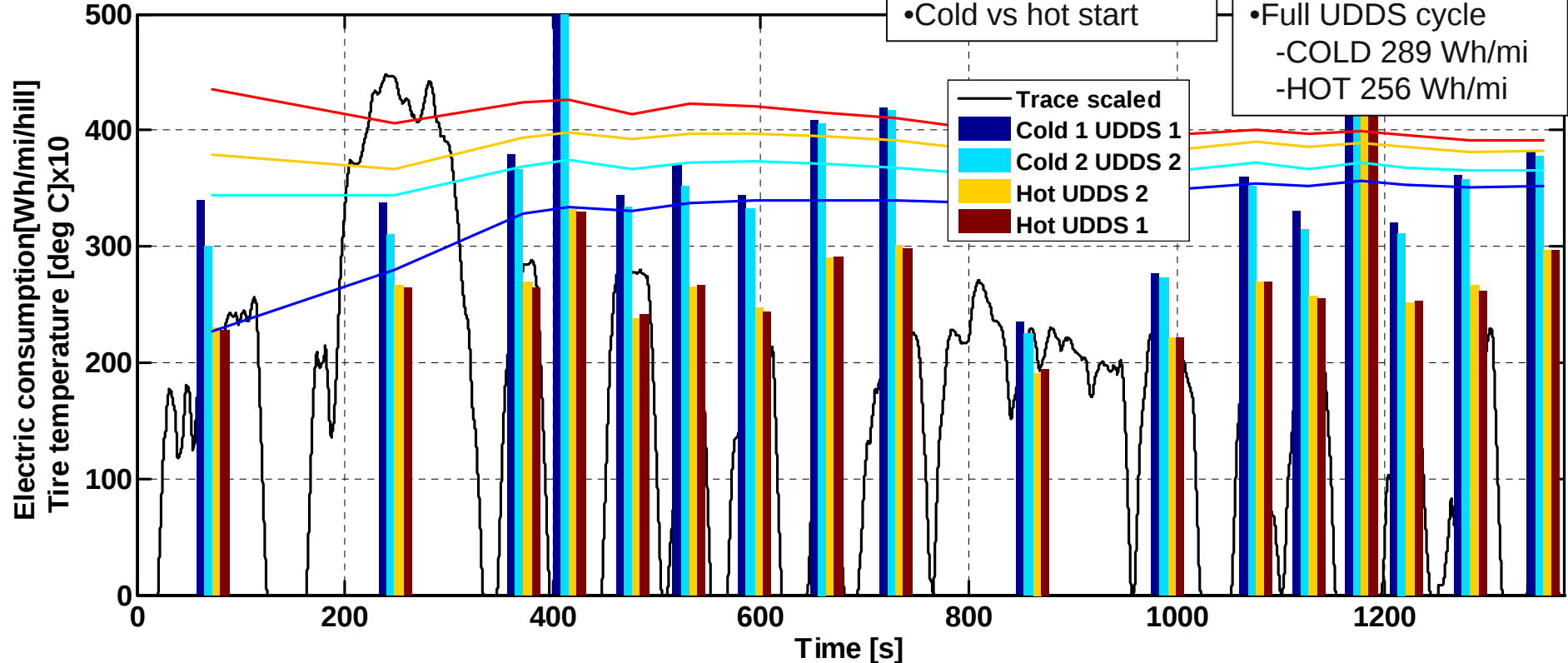
- 'Cold start': 12 hour soak at room temperature
- 'Hot start': ran cycle to warm up components

Test information:

- UDDS cycle
- 3rd gear only
- EV only (SOC init 70% no regen limit)
- Cold vs hot start

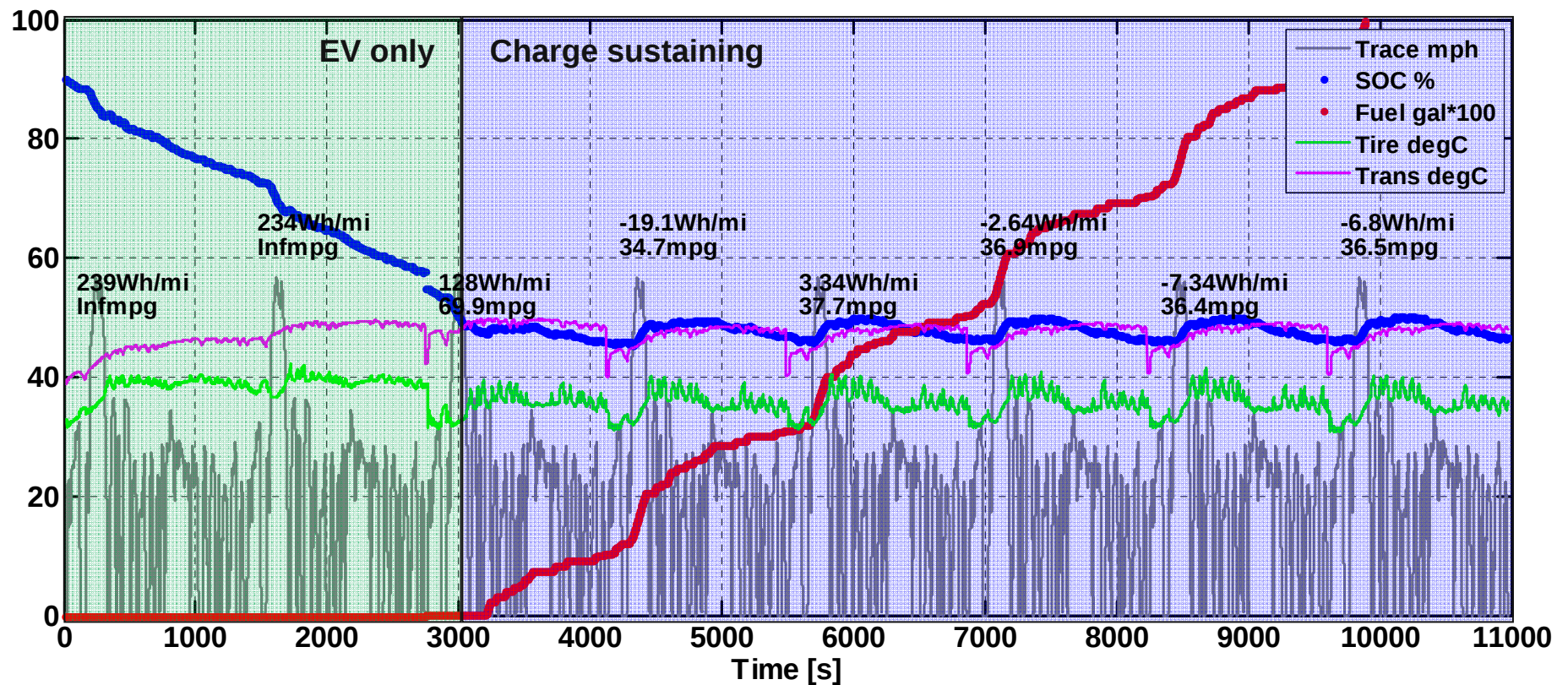
Conclusion:

- Cold tires and transmission increase the energy consumption by 27% for hill 1
- Full UDDS cycle
 - COLD 289 Wh/mi
 - HOT 256 Wh/mi



The full picture with PHEV fuel and electric consumption data along with temperature and emissions data

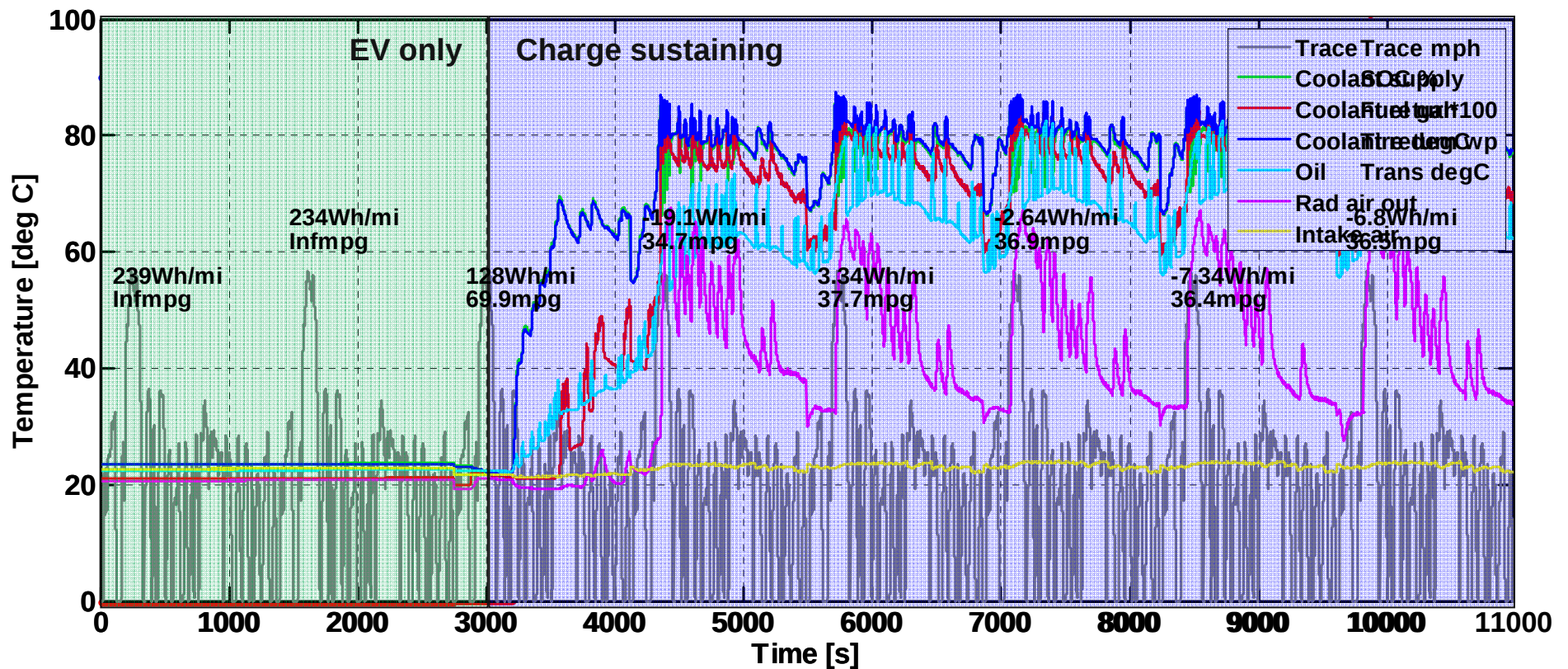
1. Electric consumption Fuel consumption



The full picture with PHEV fuel and electric consumption data along with temperature and emissions data

1. Electric consumption
Fuel consumption

2. Temperature
information

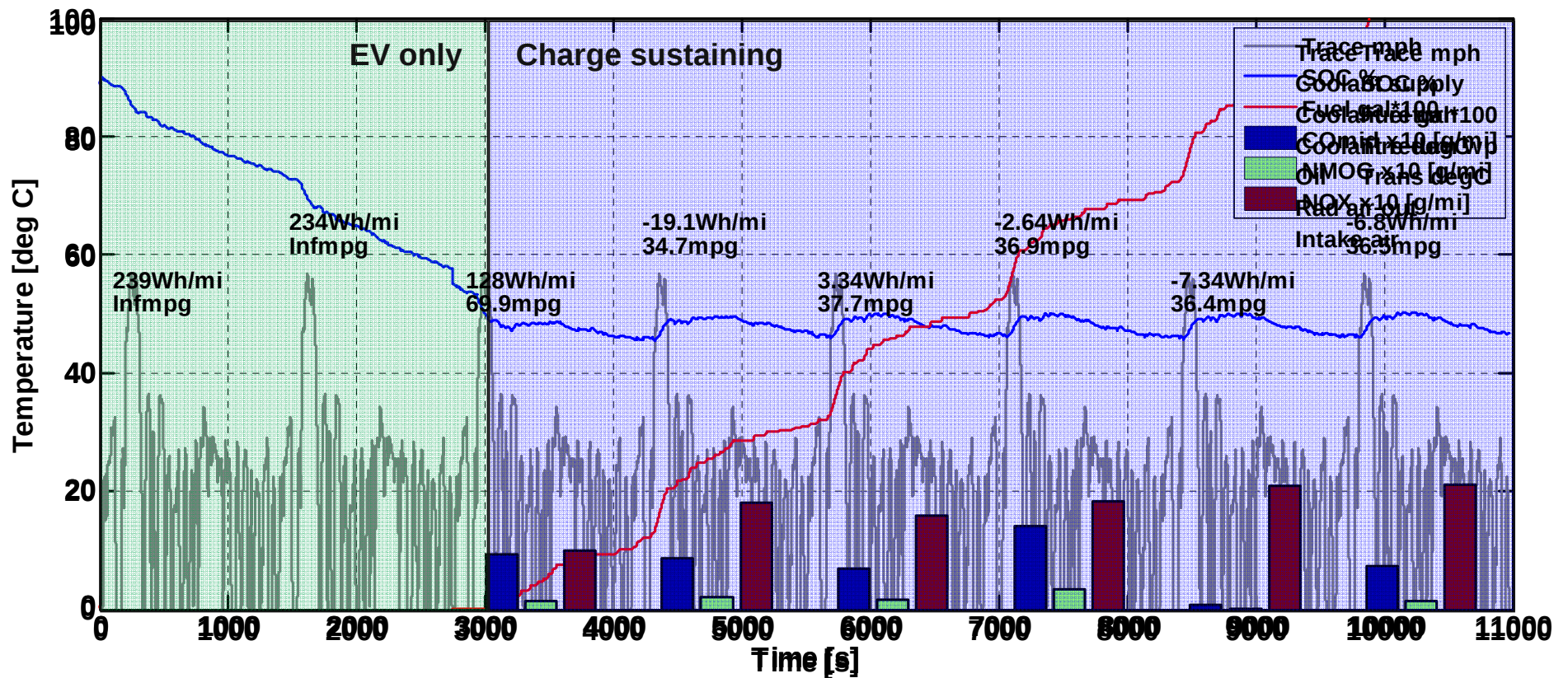


The full picture with PHEV fuel and electric consumption data along with temperature and emissions data

1. Electric consumption
Fuel consumption

2. Temperature
information

3. Emissions
data



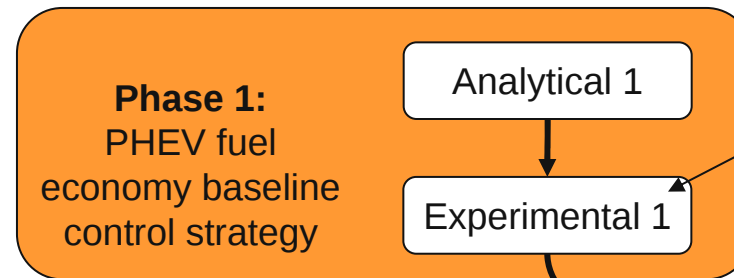
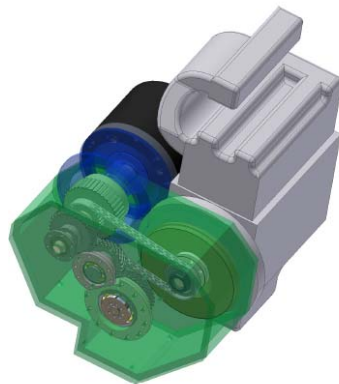
Parallel Project of PHEV Control Strategy Impact on Fuel Economy and Emissions

- Problem statement: identify trade-offs and gain insight into achieving a balance between tailpipe emissions and fuel economy through supervisory control methods

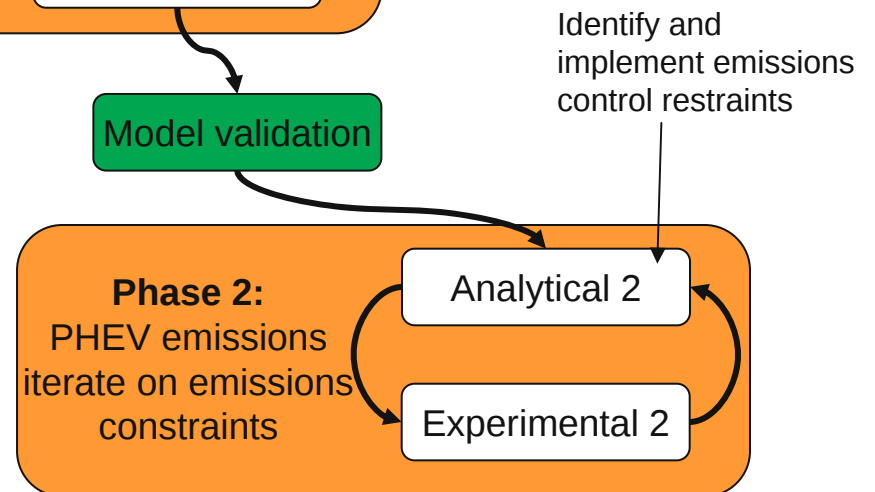
	MATT	UT
Engine	2.3L Ford Duratec	2.3L Ford Duratec*
Motor	Emulated UQM 75	UQM 75kW PM*
Battery	Emulated JCS VL41M	Emulated JCS VL41M by ABC-150
Coupling	Straight shaft	Pre-trans-parallel hybrid coupling*
Control software	PSAT-Pro	PSAT based
Transmission	Automated MTX	Automatic transmission

Physical component
 Emulated component

*leveraged DOE Advanced Vehicle Student Competition resource



Baseline emissions and fuel economy incl drivability issues



The Linkages and Future Work for this Tool

