

# **On Road vs Test Cycle Fuel Economy of HEVs: Results of DOE-Sponsored Test Fleets**



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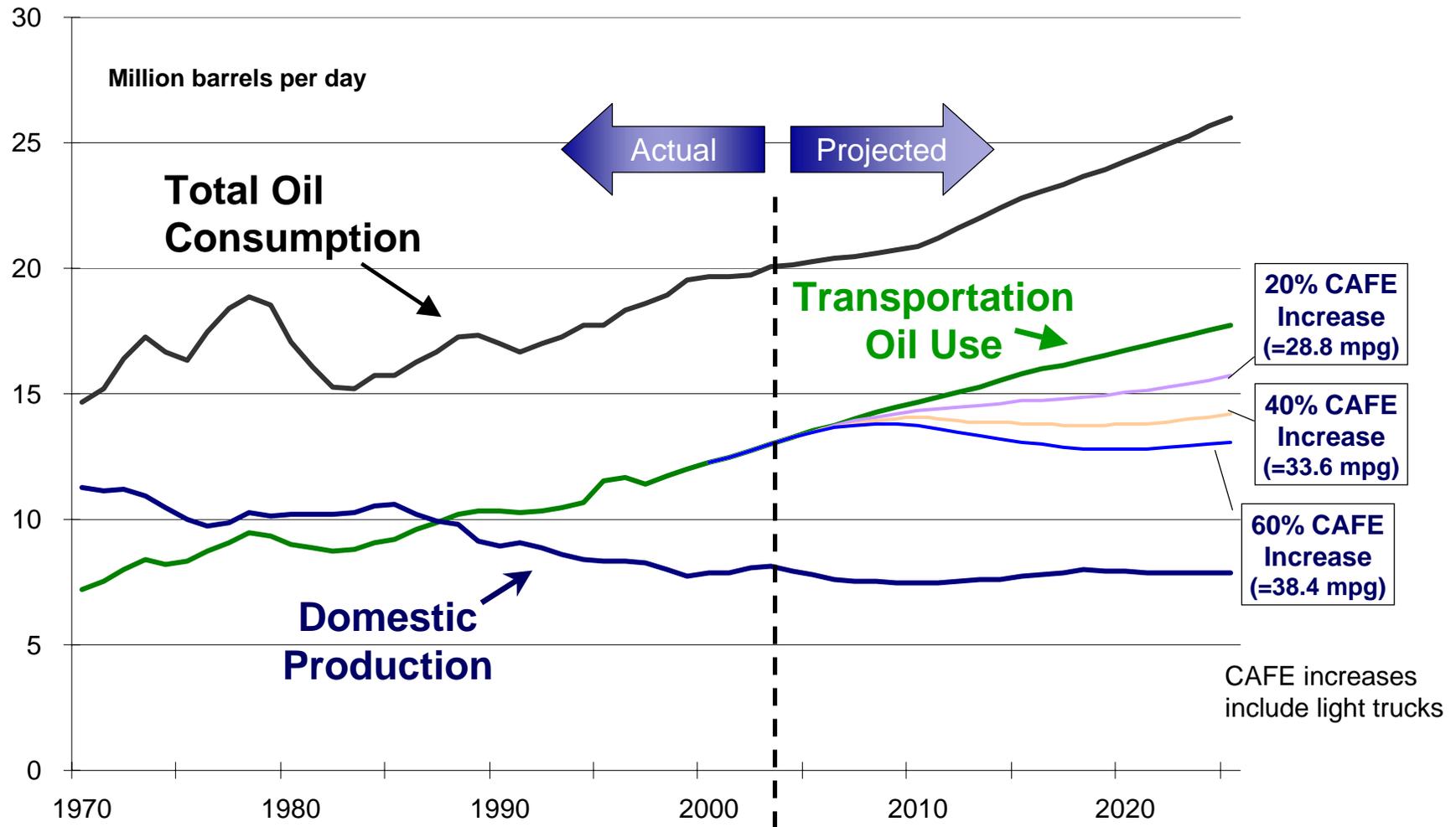


# Outline

- Energy Drivers
- DOE FreedomCAR and 21st Century Truck Goals
- Vehicle systems analysis and testing
- Field testing and evaluation of light-duty HEVs
  - Baseline performance
  - Fleet and accelerated reliability
  - End-of-life
- Information resources



# U.S. Oil Dependence is Driven by Transportation

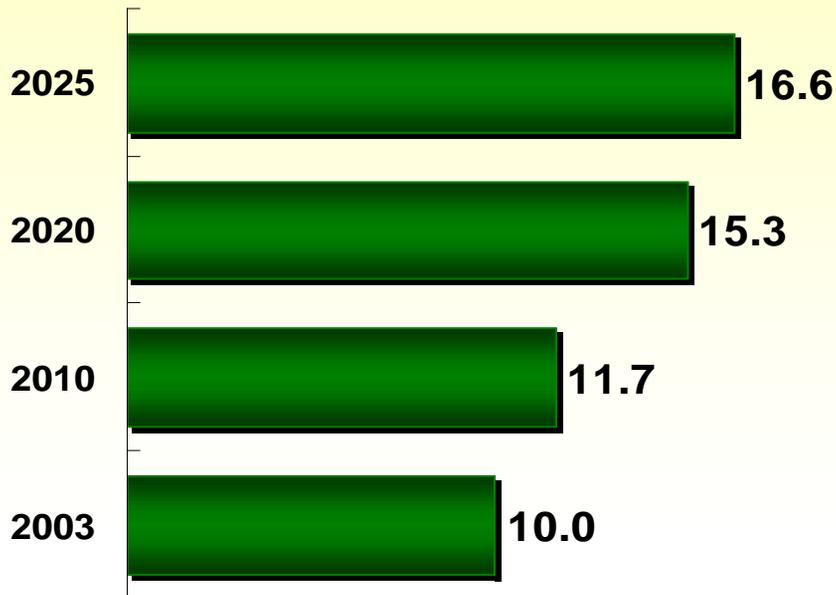


**Increasing fuel economy dampens oil use for next 2 decades, but does not offset long-term growth in consumption**

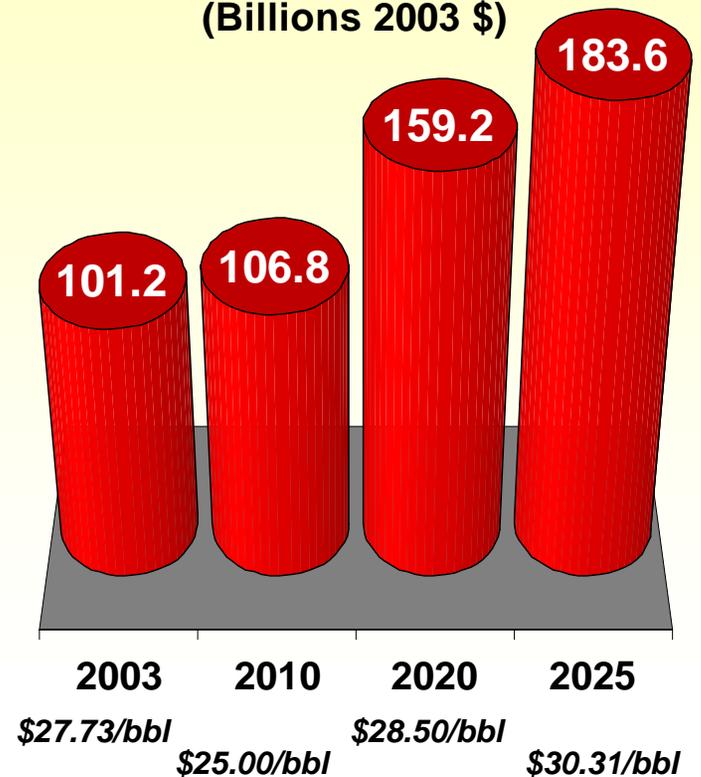


# Economics of Oil

**U.S. Imported Crude Oil  
(Million Barrels per Day)**



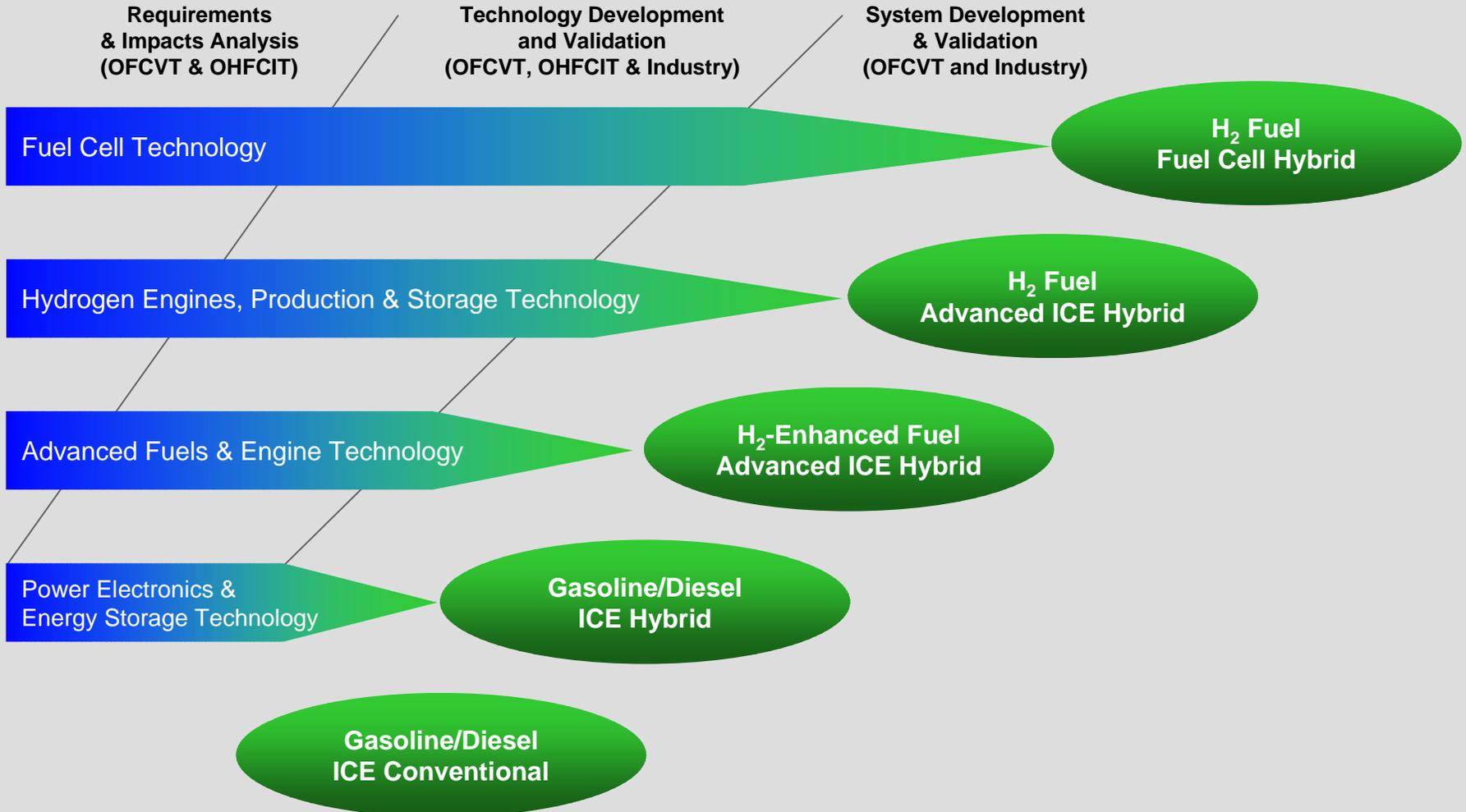
**Annual Cost of  
U.S. Crude Oil Imports  
(Billions 2003 \$)**





# DOE FreedomCAR and 21st Century Truck Goals

## *Transition to Hydrogen Vehicle Technology*





# Vehicle Systems Analysis & Testing

## Technology Requirements & Targets

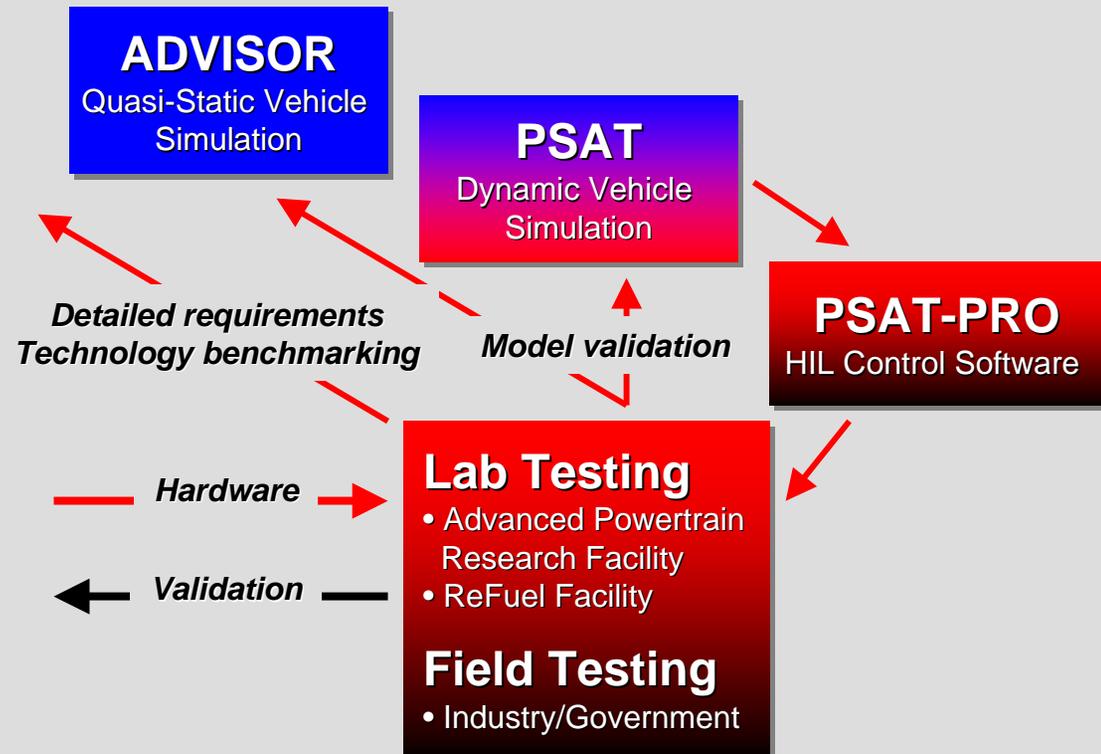
- Vehicle systems simulation & analysis
- Technical targets development
- Benchmarking

## Technology Development

- Advanced propulsion & vehicle efficiency
- Electrochemical energy storage
- Power electronics & electric machines
- Advanced combustion engines
- Materials
- Fuels
- Fuel cells and H<sub>2</sub> storage (OHFCIT)

## Validation & Introduction

- Laboratory testing & validation
- Field testing & evaluation
- Technology introduction





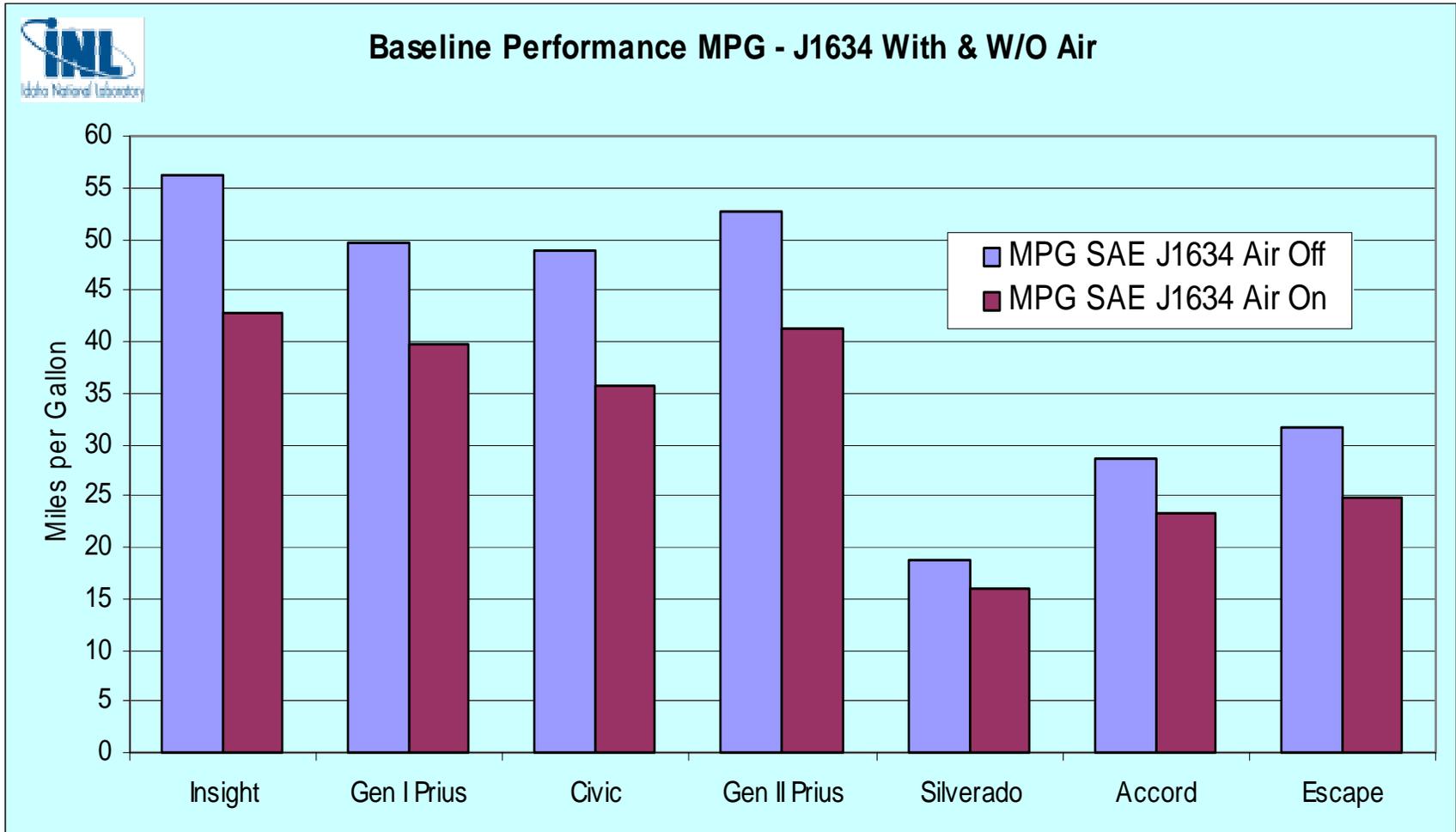
# HEV Field Testing Methods

- Qualified Vehicle Testers (50/50 cost share)
  - Electric Transportation Applications (lead), Bank One, Red Cross, Arizona Public Service
- Baseline Performance testing (dynamometer & closed track)
  - Acceleration, max speed, braking, handling & two fuel economy tests (SAE J1634 drive cycle - with & w/o AC)
- Fleet & accelerated reliability (AR) testing (real world)
  - Collect fuel use, maintenance & operations (M&O), miles & costs
  - 2 of each HEV model accumulate 160,000 miles
- End of life (160,000 miles) SAE J1634 tests, battery capacity (hybrid pulse power characterization), & power testing (static capacity)



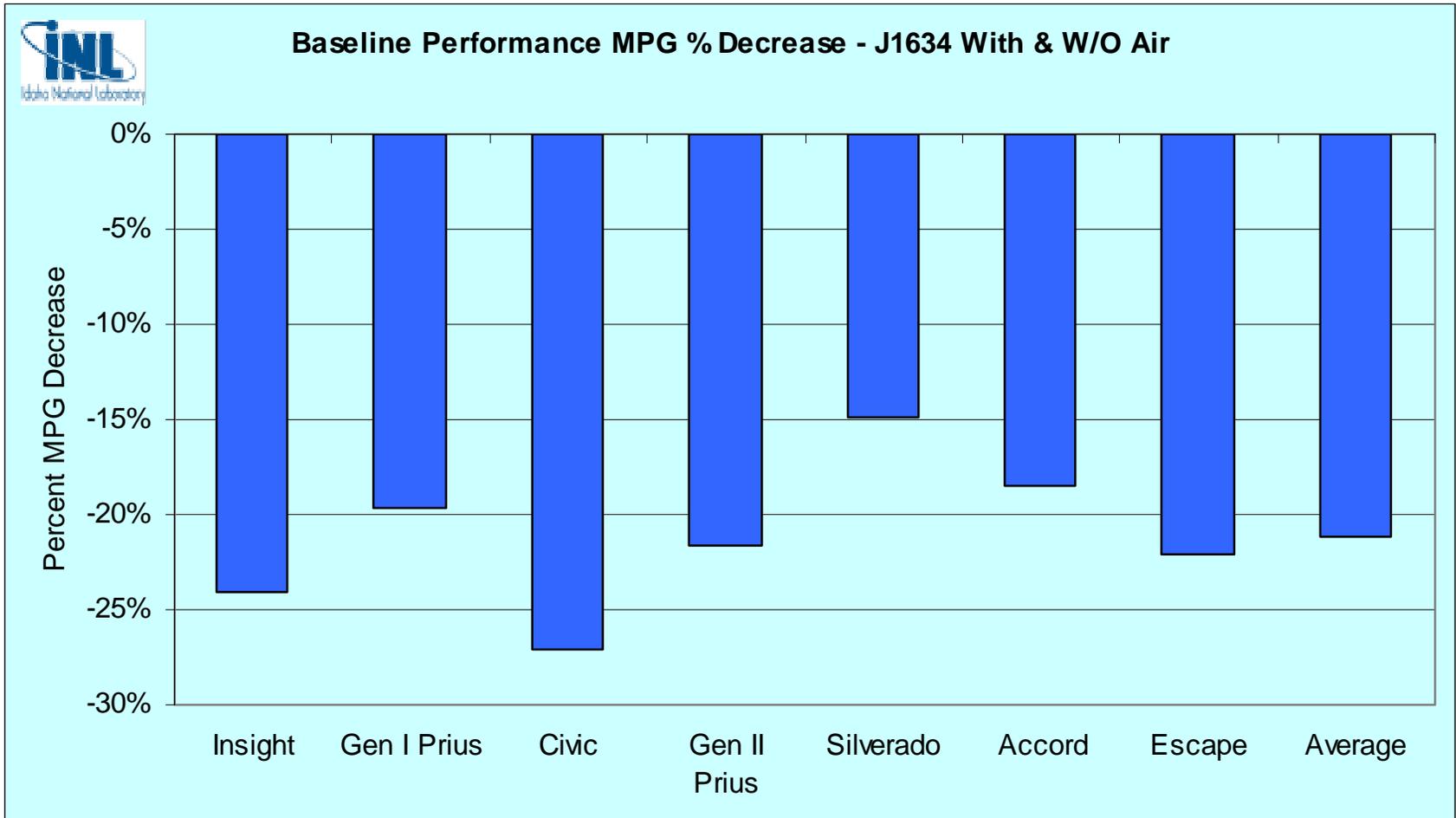


# HEV Baseline Performance MPG





# HEV J1634 MPG Difference (Air On/Off)





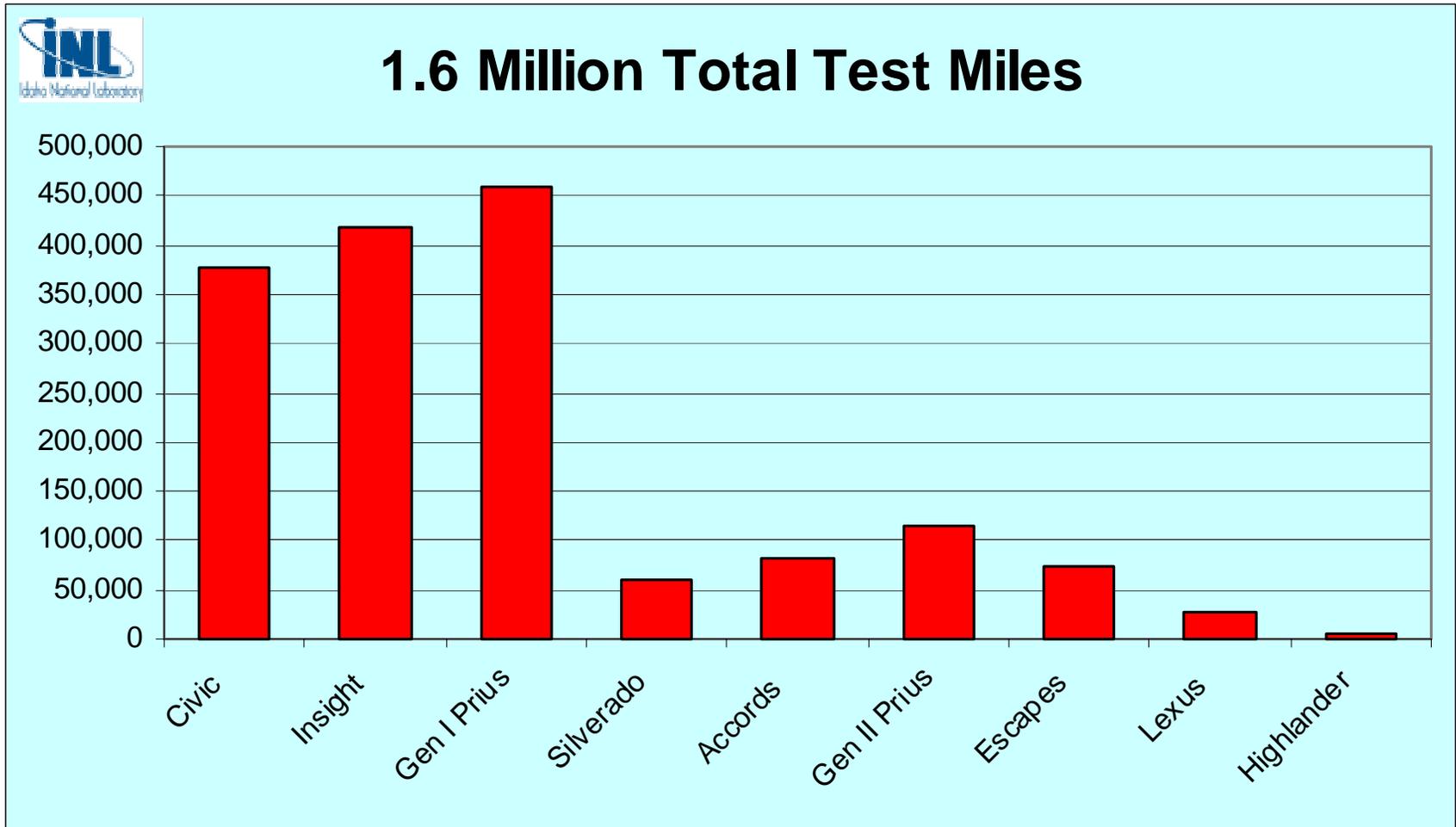
# HEV Fleet & AR Testing Status

- 6 MY 2001 Honda Insights: Aug/01 - March/05
- 6 MY 2002 Gen I Toyota Prius: Nov/01 - March/05
- 4 MY 2003 Honda Civics: May/02 - March/05
- 2 MY 2004 Gen II Toyota Prius: Nov/03 - ongoing
- 2 MY 2004 Chevrolet Silverado: Sept/04 - ongoing
- 2 MY 2005 Honda Accord: Jan/05 - ongoing
- 2 MY 2005 Ford Escape: April/05 – ongoing
- 2 MY 2005 Lexus RX400h SUV: May/05-ongoing
- 2 MY 2006 Toyota Highlander SUV: Oct/05-ongoing





# HEV Fleet & AR Testing

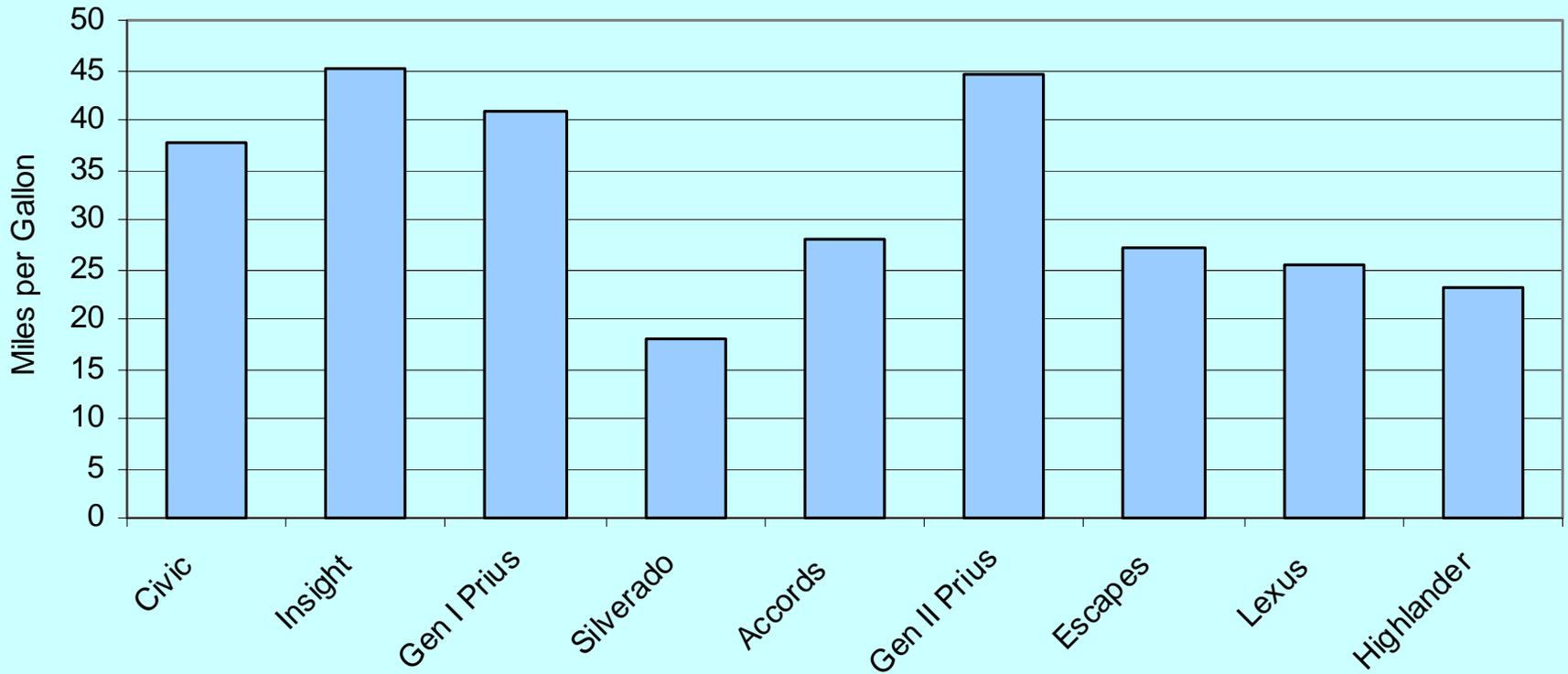




# HEV Fleet Testing Average MPG

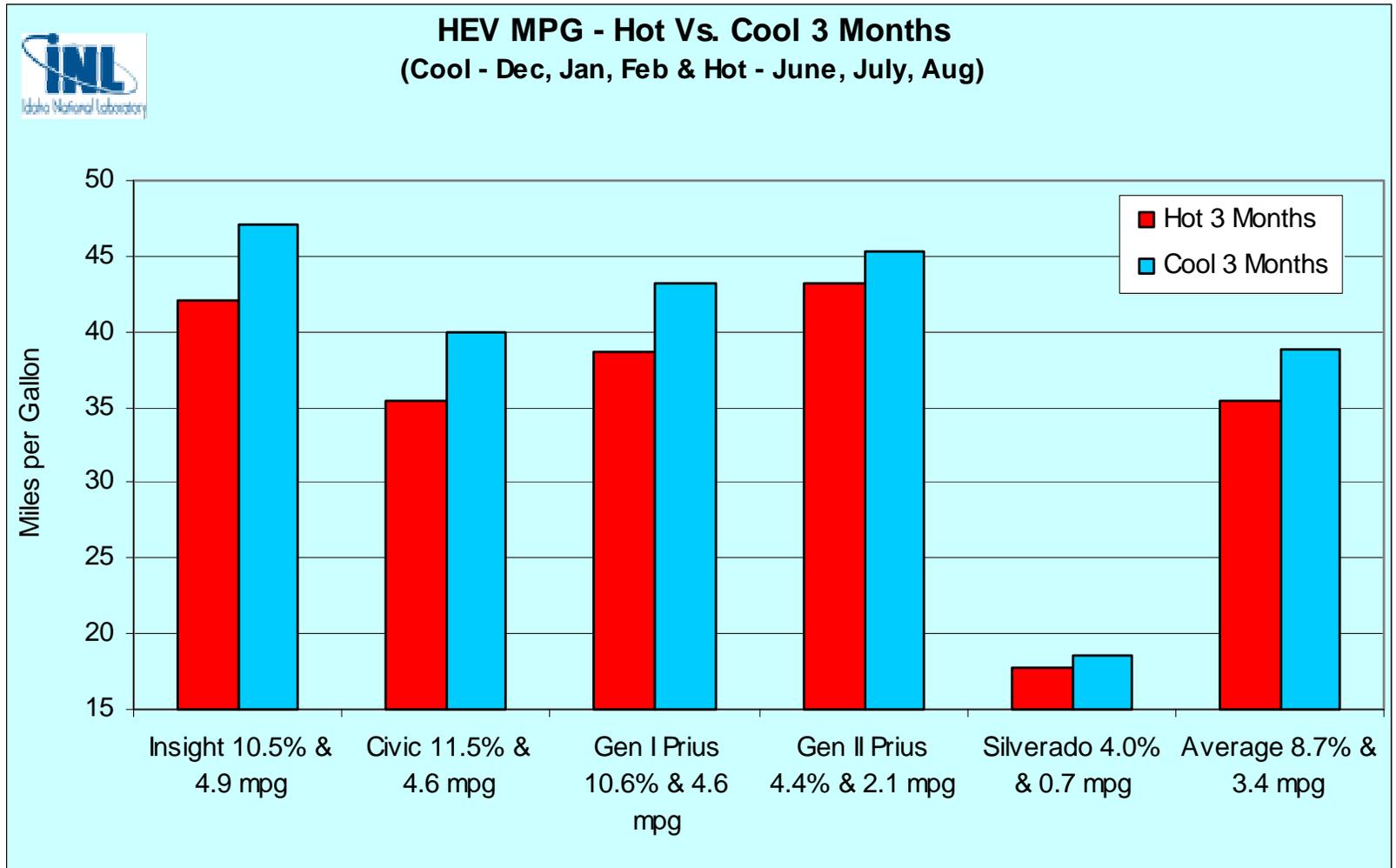


HEV Cumulative Fuel Economy



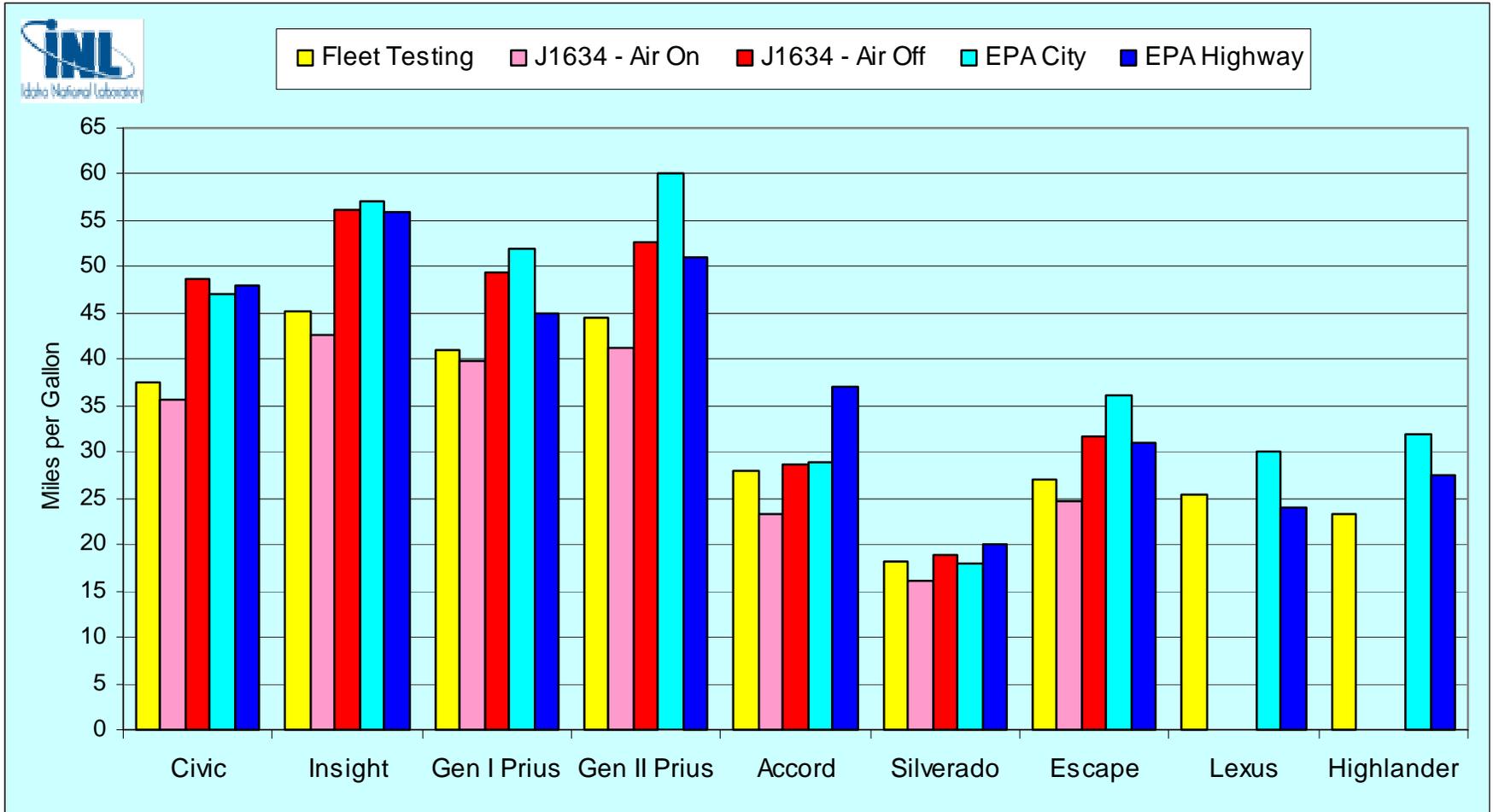


# Fleet Testing MPG Hot & Cool Months



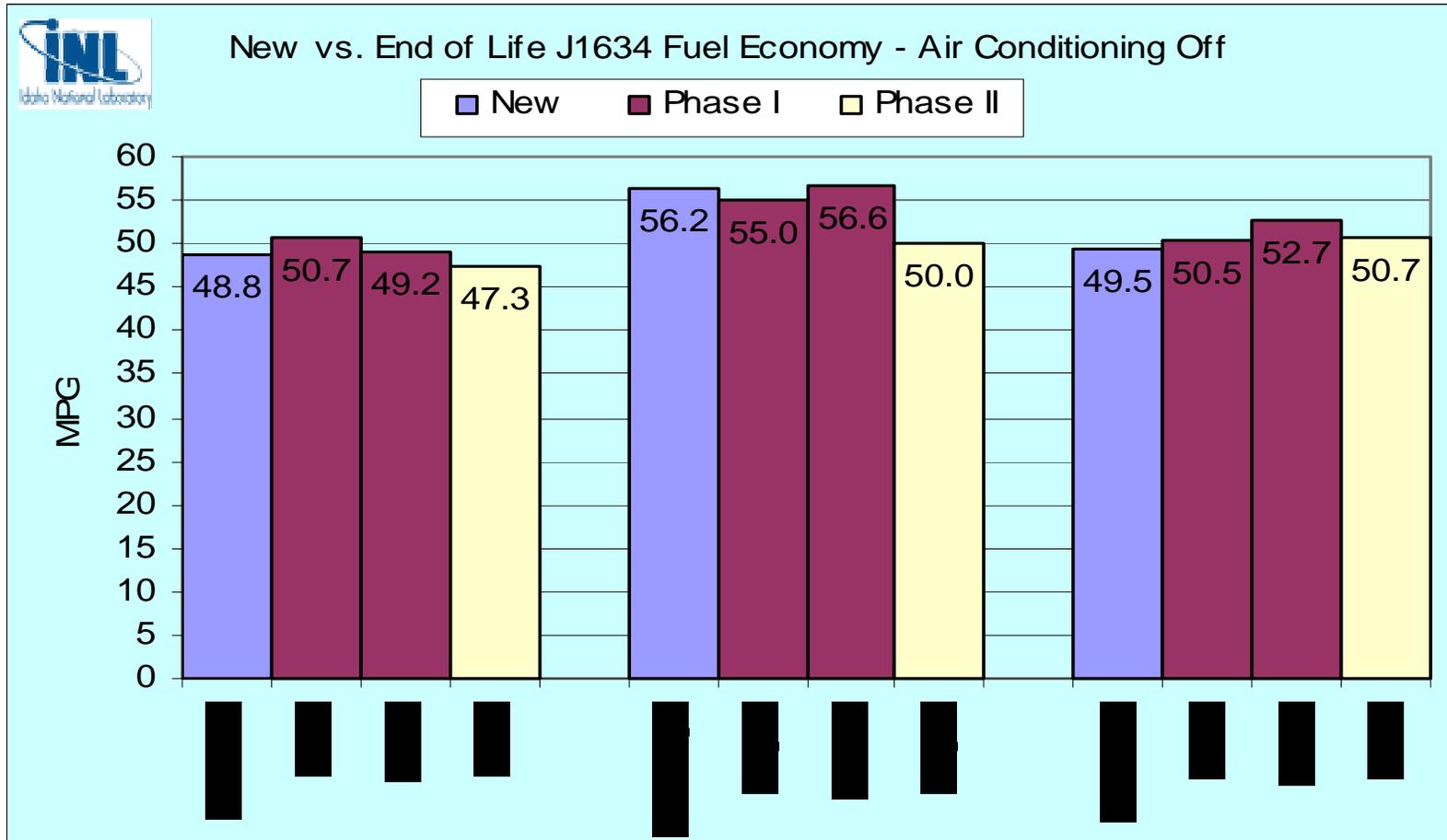


# HEV Fuel Economy-Fleet, Baseline (SAE J1634), and EPA Test Cycles





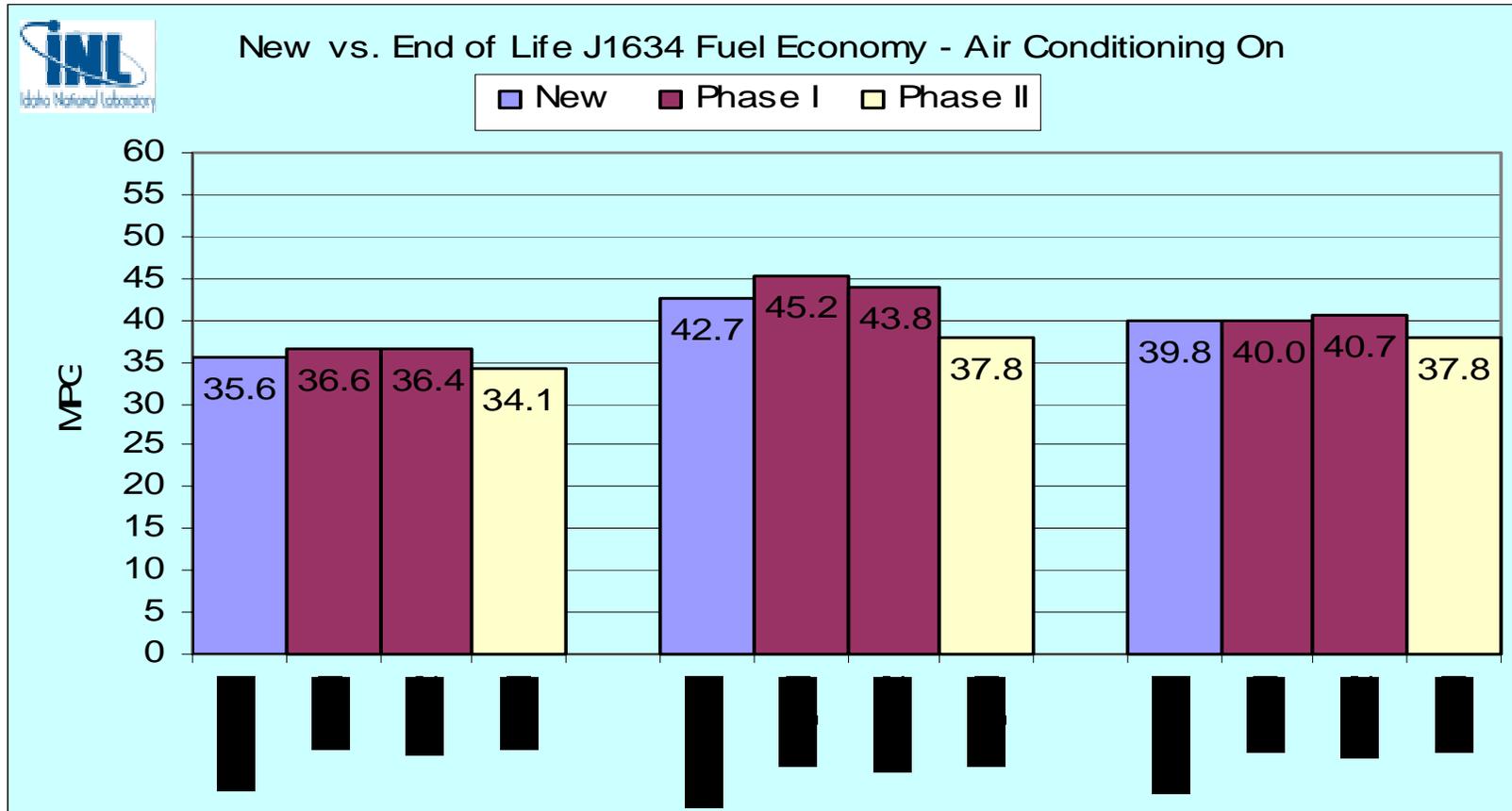
# End-of-Life (160k miles) MPG - AC Off



\*Gen I Prius



# End-of-Life (160k miles) MPG - AC On



\*Gen I Prius

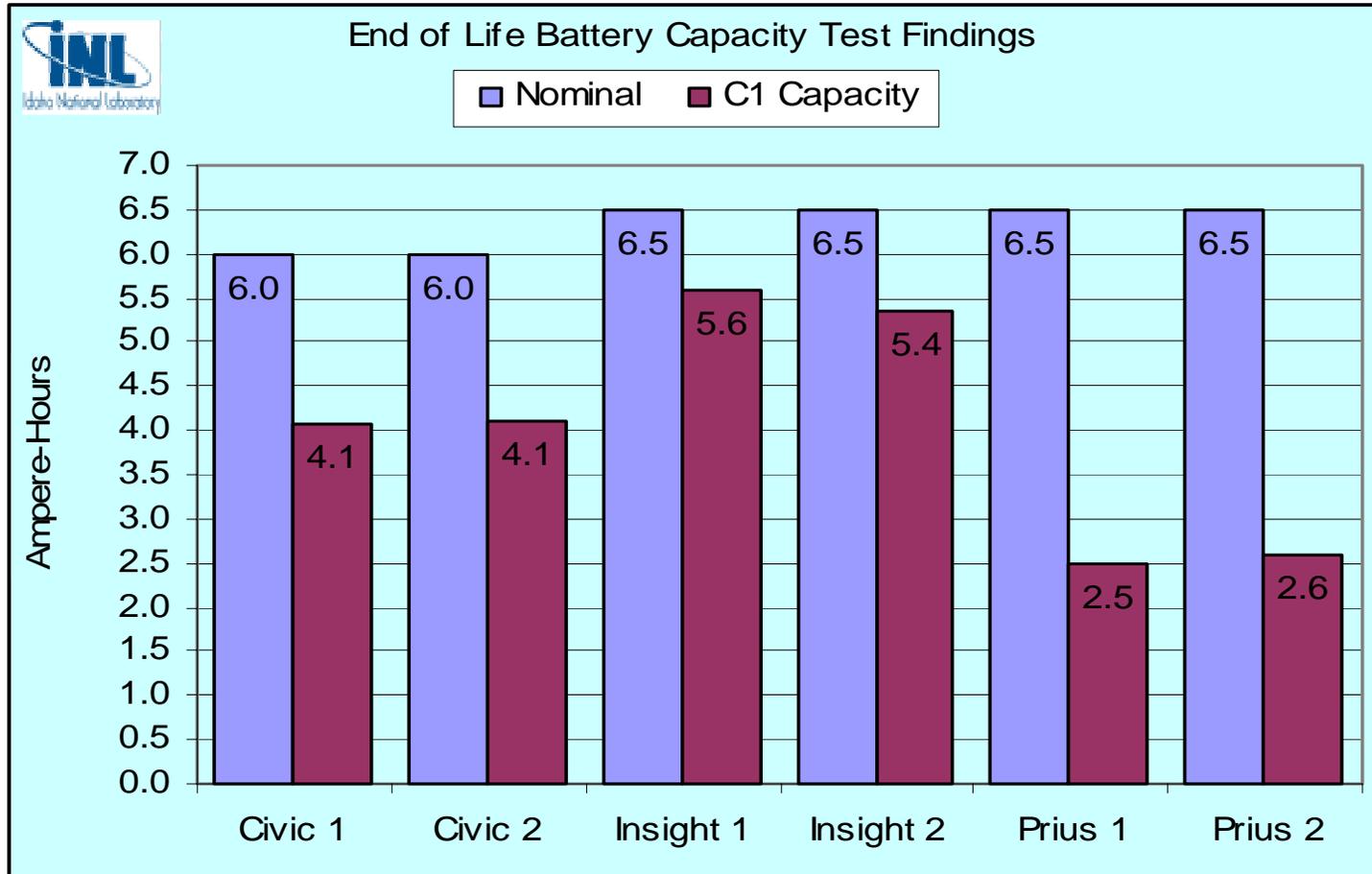


# End-of-Life Phase II (SAE J1634) Vs Onboard Vehicle Computer MPG

End-of-life Phase II HEV MPG Testing	Onboard computer fuel economy percentage above Phase II SAE J1634 fuel economy
Civic 1 AC off	+21.7%
Civic 1 AC on	+21.0%
Insight 1 AC off	+11.0%
Insight 1 AC on	+11.7%
Gen I Prius AC off	+15.7%
Gen I Prius AC on	+14.7%



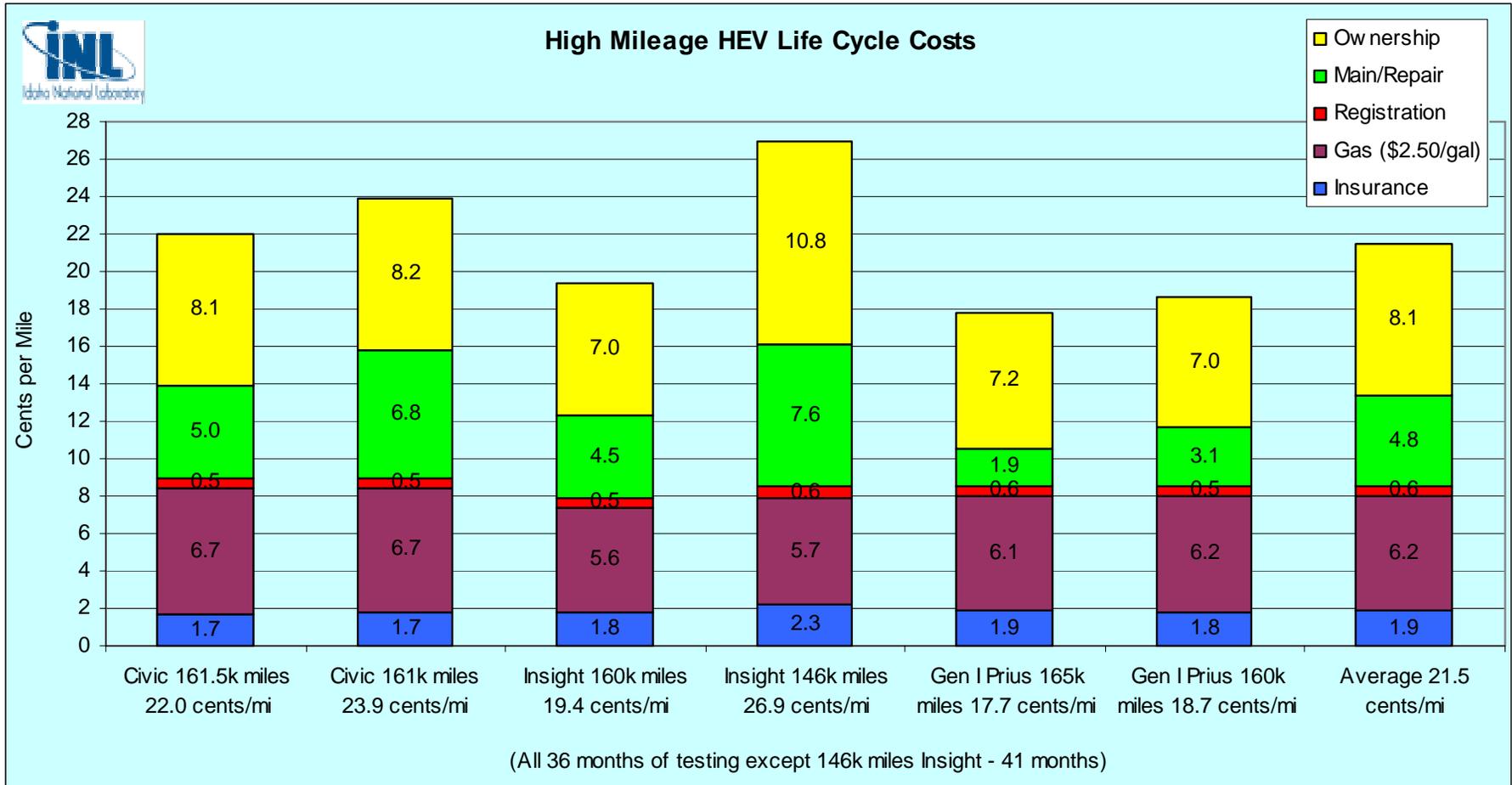
# End of Life (160k miles) Battery Capacity



\*Gen I Prius

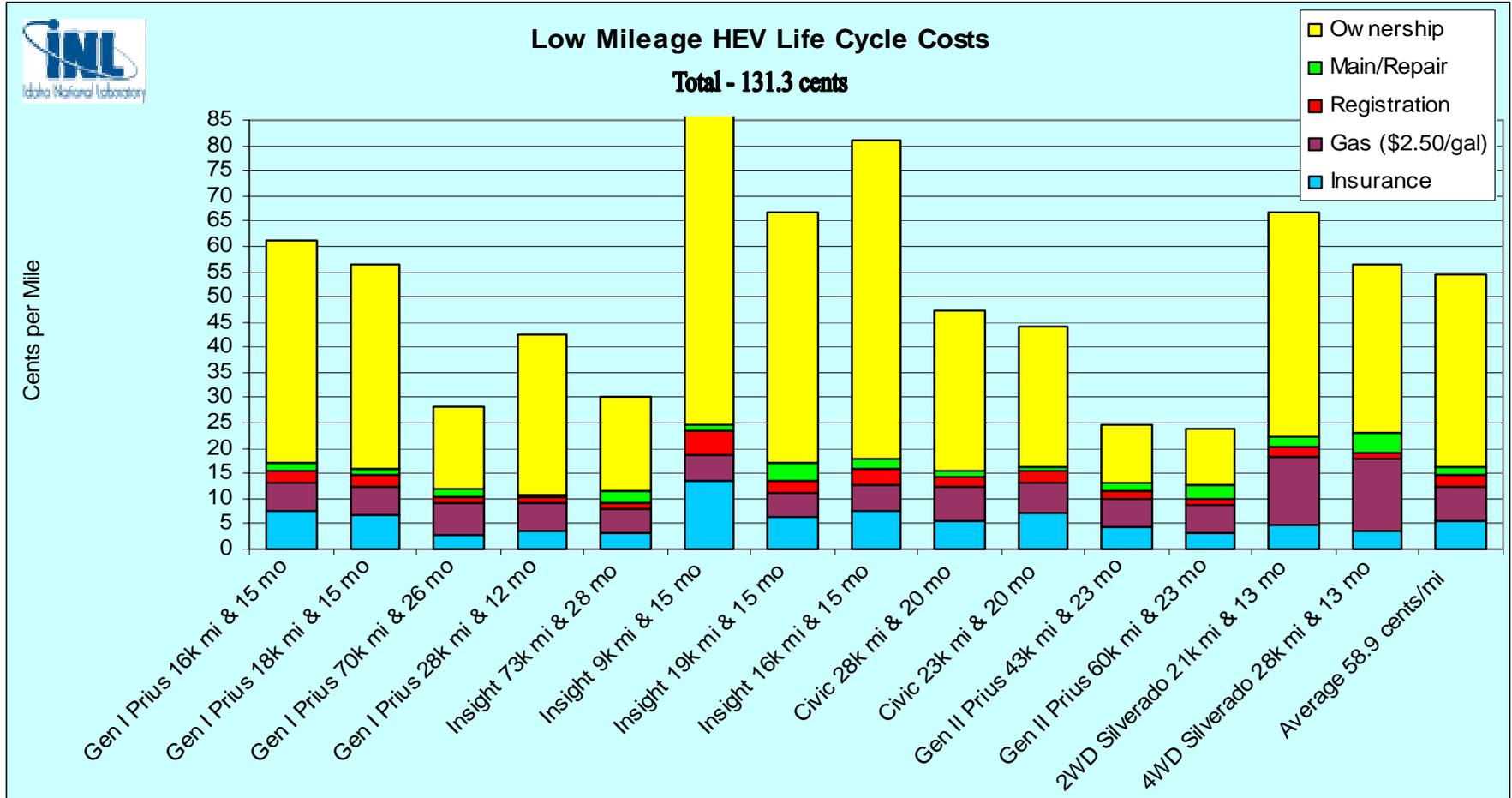


# Life-Cycle Costs (high mileage HEVs)





# Life-Cycle Costs (low mileage HEVs)





# Additional Near-Term HEV Testing

- Hydrogen ICE HEV (HICEHEV) Hydrogen Prius from SCAQMD/Quantum
- Plug-in Diesel or Gas HEV (PIDHEV or PIGHEV) Dodge Sprinter (lithium) from Dodge
- PIGHEV Escape (lithium or lead) from vehicle converter Energy CS
- PIGHEV Gen II Prius conversion (Valence Li-Ion) from vehicle converter Energy CS
- Other OEM HEVs and/or Plug-ins?



# For More Information

- FreedomCAR and Vehicle Technologies

- [www.eere.energy.gov/vehiclesandfuels](http://www.eere.energy.gov/vehiclesandfuels)

- Advanced Vehicle Testing Activity (AVTA)

Test reports, fact sheets, and maintenance logs available via-

- <http://avt.inl.gov> *or*

- <http://www.eere.energy.gov/vehiclesandfuels/avta/index.shtml>

