



U.S. Department of Energy FreedomCAR & Vehicle Technologies Program - Advanced Vehicle Testing Activity

Advanced Technology Vehicle Testing

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Outline

- **Advanced Vehicle Testing Activity (AVTA) goal**
- **Testing partners**
- **Advanced Technology Vehicle Testing**
 - **Hydrogen/CNG production and fueling Station**
 - **Hydrogen internal combustion engine (ICE) vehicle testing**
 - **Hybrid, urban, and neighborhood electric vehicle testing**
 - **Airport Ground Support Equipment (GSE) testing**

AVTA Goal

- **Provide fleet managers and other potential advanced technology vehicle (ATV) users with accurate and unbiased information on vehicle performance and infrastructure needs so they can make informed decisions about acquiring and operating ATVs**

AVTA Testing Partners

- **Qualified Vehicle Testers**
 - **Electric Transportation Applications (lead)**
 - **Arizona Public Service (APS)**
 - **Bank One**
 - **Ford Motor Company**
 - **Luke AFB**
 - **New York Power Authority**
 - **Red Cross**
 - **Southern California Edison**
 - **Salt River Project**
 - **Cities of Palm Springs, Palm Valley, Phoenix, Vacaville, and San Diego**

APS Alternative Fuel Pilot Plant

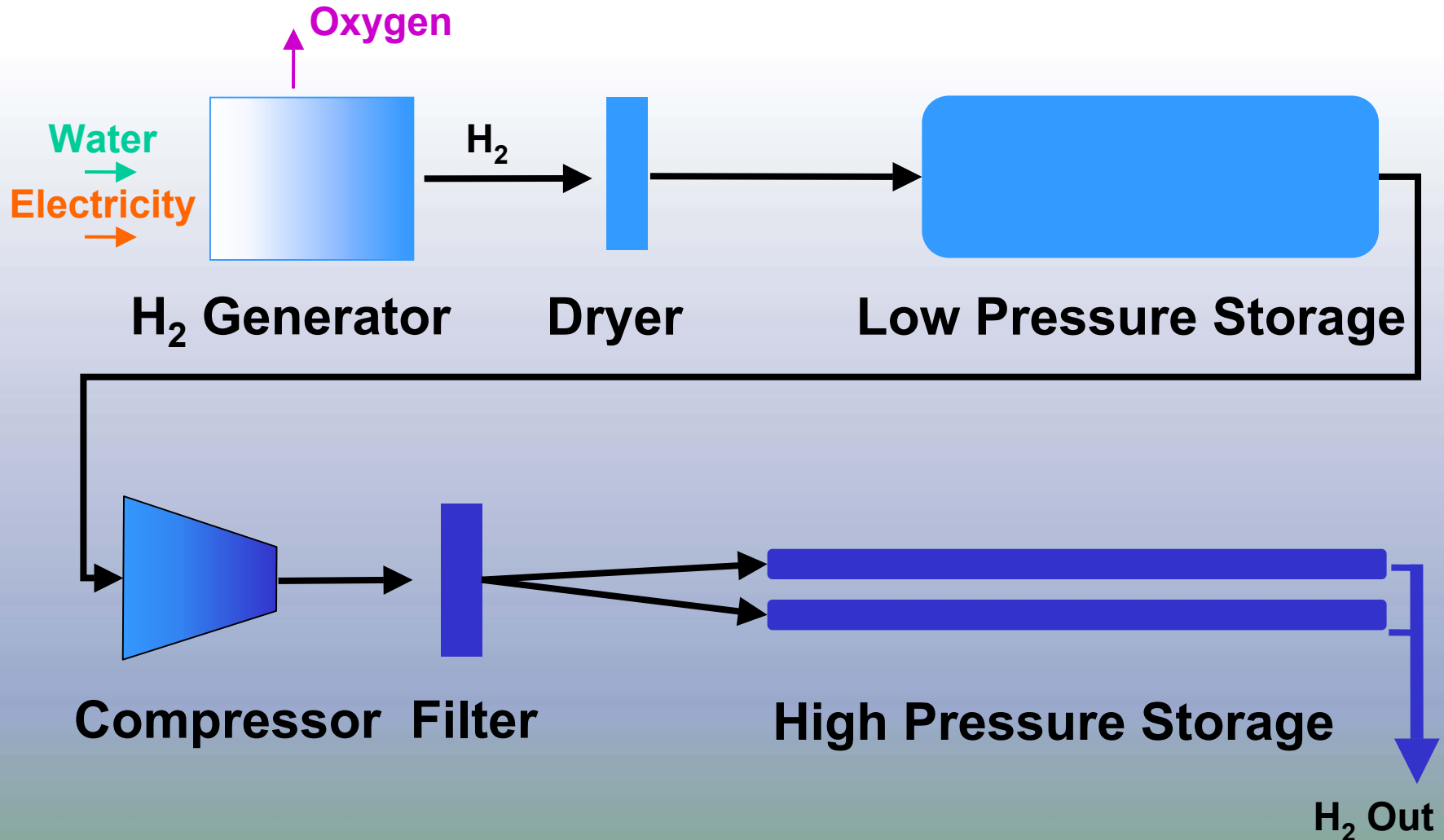
- **Partners:**
 - **Arizona Public Service**
 - **Electric Transportation Applications**
- **Onsite hydrogen production, and hydrogen / CNG compression and fueling**
- **Objectives:**
 - **Evaluate the safety and reliability of operating ICE vehicles on hydrogen and blended hydrogen fuels**
 - **Evaluate the ICE vehicle fueling infrastructure**
 - **Quantify ICE vehicle costs, performance and emissions**

APS Alternative Fuel Pilot Plant

- **Electrolytic hydrogen production on site**
- **Proton Energy Systems' HOGEN PEM stationary fuel cell operating in reverse**
- **Compresses natural gas from low pressure street service**
- **Vehicle fueling**



Hydrogen Sub-System



Hydrogen Sub-System

- Hydrogen generator
 - PEM fuel cell, 57 kW, 20 cells
 - 300 SCFH hydrogen output
 - 17 kWh per 100 SCF hydrogen
- Hydrogen dryer
 - 300 SCFH
- Hydrogen compressor
 - Oil free diaphragm compressor
 - Three stage compression
 - 6,100 PSI output
- Hydrogen - 99.9997% purity

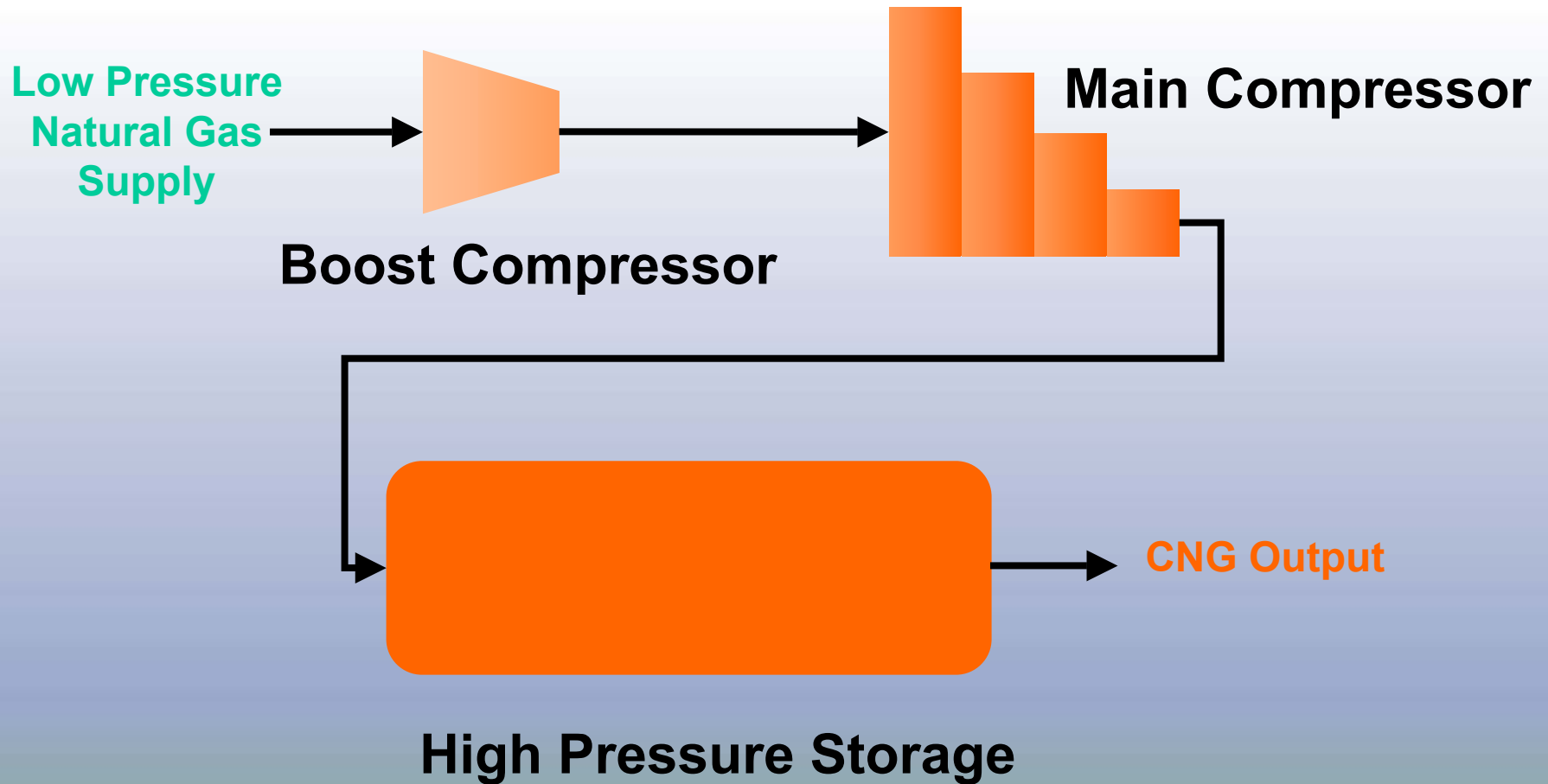


Hydrogen Sub-System

- Low pressure hydrogen storage (lower tank)
 - 8,955 SCF @ 150 PSIG
- High pressure hydrogen storage (upper 2 tanks)
 - 17,386 SCF @ 6,000 PSIG
- Hydrogen monitoring system (150 nodes instrumented) - examining production tradeoffs



CNG Sub-System

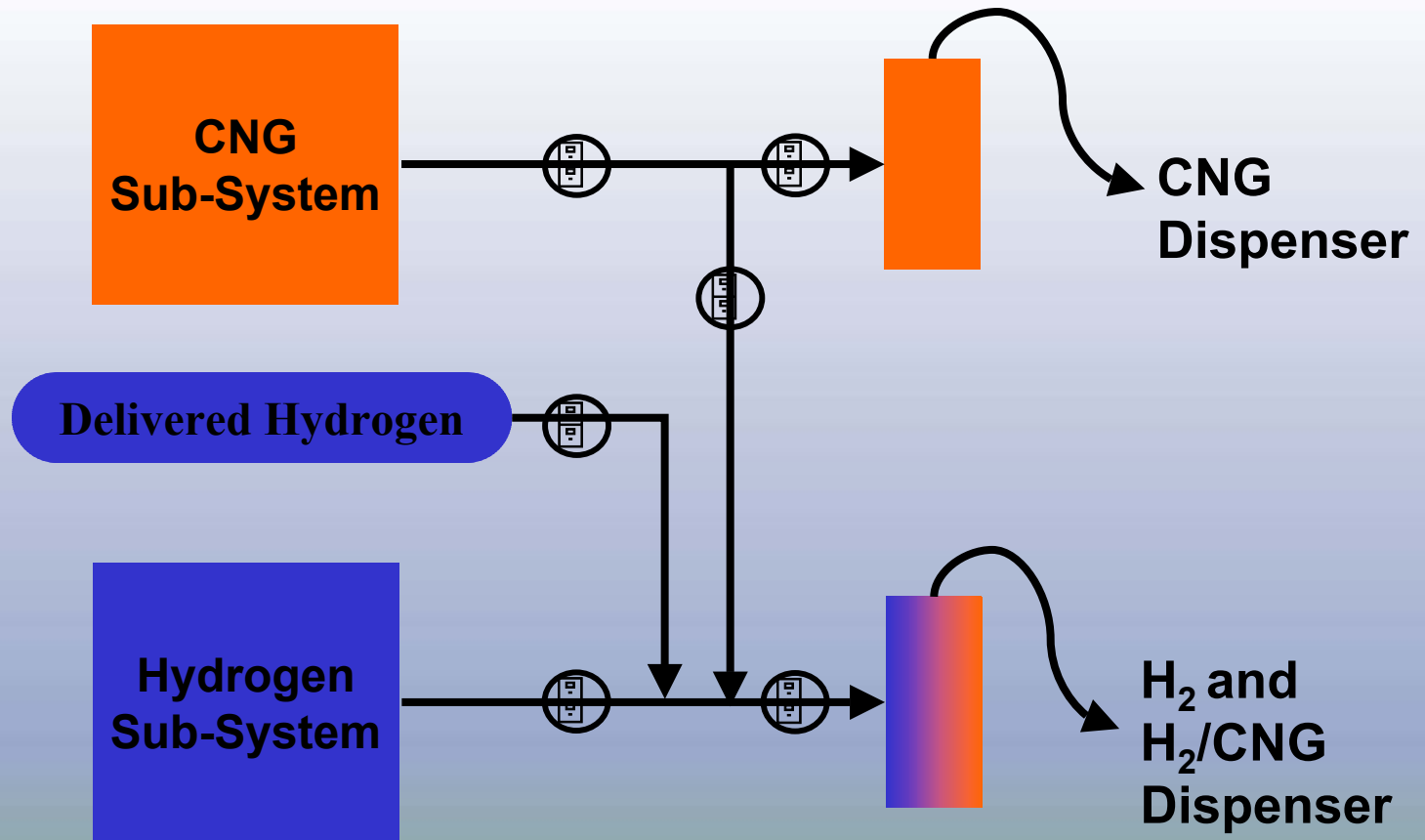


CNG Sub-System

- **CNG Boost Compressor**
 - 300 SCFM @ 60 PSI
- **CNG Main Compressor**
 - 350 SCFM @ 4,500 PSI
 - Multi-Stage Piston
- **High Pressure CNG Storage**
 - 50,000 SCF @ 4,000 PSI
 - ASME Vessels



APS Alternative Fuel Pilot Plant Fueling System



APS Alternative Fuel Pilot Plant Fueling Station

- Dispense pure hydrogen or pure CNG fuel
- Blend and dispense hydrogen/CNG (H/CNG) blended fuels
- Includes metering and electronic billing Interface



Hydrogen/CNG ICE Vehicle Testing

- Initial ICE Hydrogen Vehicle Testing
 - Ford F150 up to 30% H/CNG (continues testing)
 - Ford F150 up to 50% H/CNG
 - 100% hydrogen Mercedes Benz van
- Fuel provided to DaimlerChrysler fuel cell NECAR & other hydrogen fuel cell vehicles



Hydrogen/CNG ICE Vehicle Testing

- **Ongoing ICE Hydrogen Vehicle Testing**
 - **8 vehicles 15% H/CNG (APS meter readers) S-10s, Sierra pickups, Blazers**
 - **10 vehicles 15% H/CNG (Phoenix Fire Department) Sierra pickups**
 - **Dodge Ram van 15% H/CNG**
 - **Ford F150 30% H/CNG (tested at 100% CNG, 15%H/CNG, and 30% H/CNG)**



Hydrogen/CNG ICE Vehicle Testing

- **Ongoing ICE Hydrogen Vehicle Testing**
 - **Ford F150 - 100% hydrogen, 5.4 liter, 32 valve, 35%+ efficiency**
 - **Ford F150 – 100% hydrogen, 5.4 liter 16 valve, production engine**
 - **Developing Hydrogen ICE Baseline Performance testing specifications and procedures**
 - **Emissions testing, oil analysis**
 - **175,000+ hydrogen test miles**



Hydrogen/CNG ICE Vehicle Testing

- F150 ICE testing results

Fuel Blend	Time to 60 mph (seconds)	Fuel Economy (miles/gge)	Range (miles)
CNG	10.10	23.3	122
15% H/CNG	10.97	22.6	110
30% H/CNG	12.68	23.5	102



Hydrogen/CNG ICE Vehicle Testing

- F150 ICE testing results

Fuel Type	Percentage Change in Emissions Testing					
	NMHC	CH ₄	HC	CO	NO _x	CO ₂
Gasoline	Base	Base	Base	Base	Base	Base
CNG	-80	+967	+35	-63	-34	-24
15% H/CNG	-78	+1000	+40	-70	-26	-27
30% H/CNG	-89	+1050	+37	-73	-25	-28

NMHC=Non-Methane Hydrocarbons

HC=Total Hydrocarbons

NO_x=Oxides of Nitrogen

CH₄=Methane

CO=Carbon Monoxide

CO₂=Carbon Dioxide

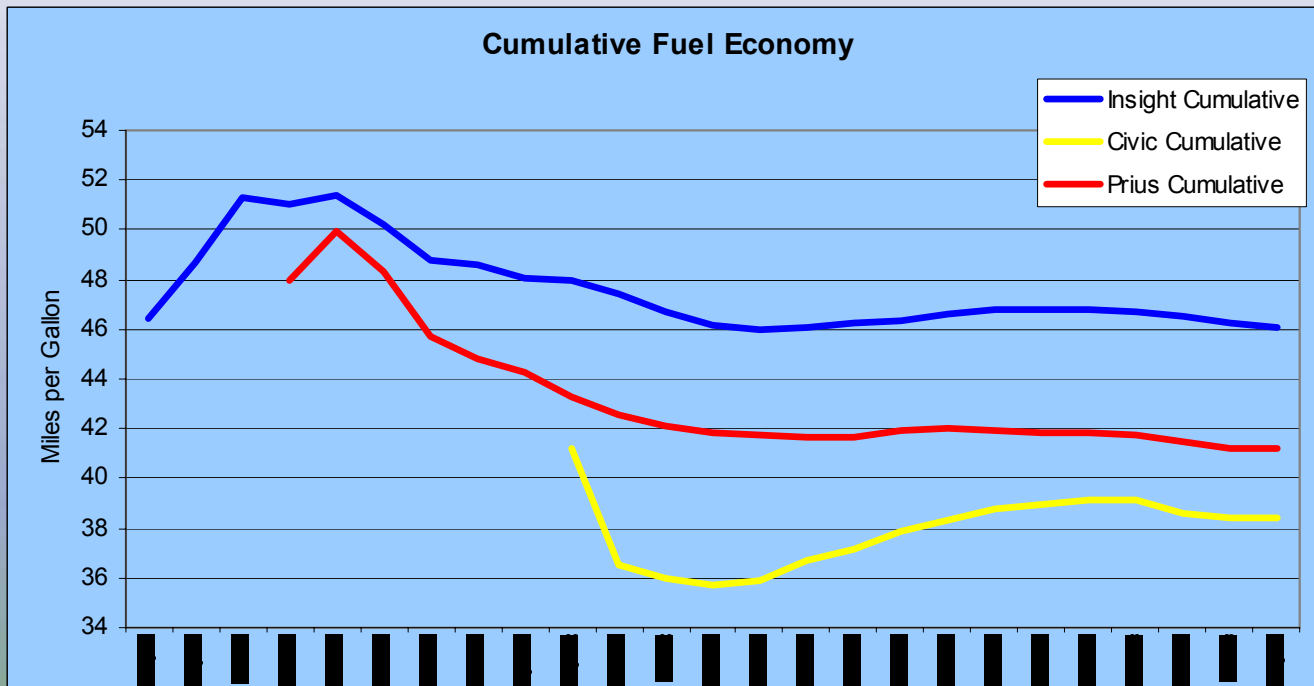
Hybrid Electric Vehicle Testing

- **Honda Insight, Honda Civic, Toyota Prius**
- **Fleet and accelerated reliability testing - 800,000+ miles to date (10/01/03)**
 - **Bank One, Red Cross, Arizona Public Service, ETA**
 - **Fuel use, maintenance, repairs, driver experience**
- **Baseline Performance testing**
 - **Fuel economy, acceleration, max speed, braking, & handling**



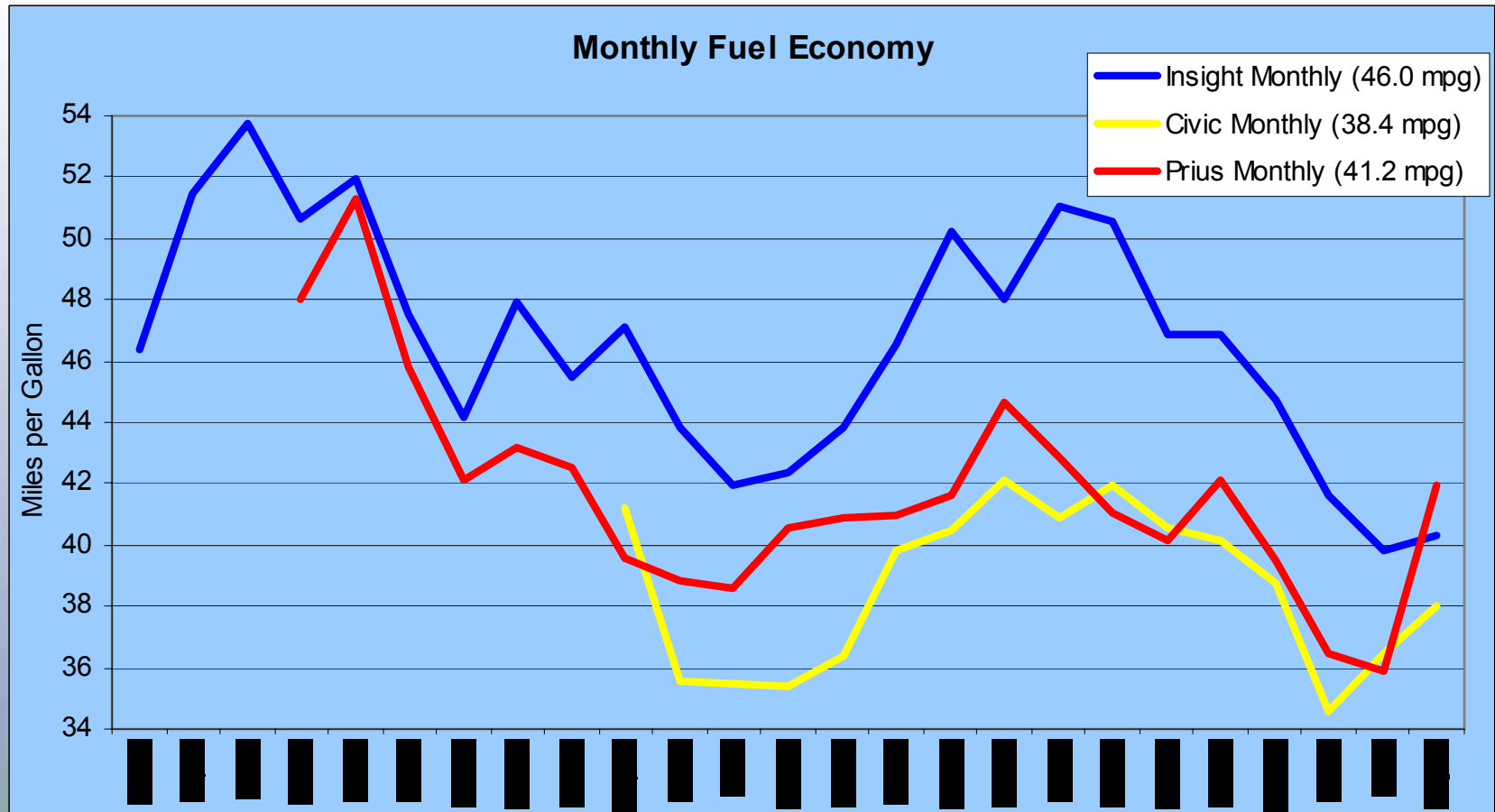
Hybrid Electric Vehicle Testing

- Fleet & accelerated reliability testing – cumulative mpg
 - 4 Civics (223,000 miles) ~38.4 mpg
 - 6 Insights (279,000 miles) ~46.0 mpg
 - 6 Prius (305,000 miles) ~41.2 mpg



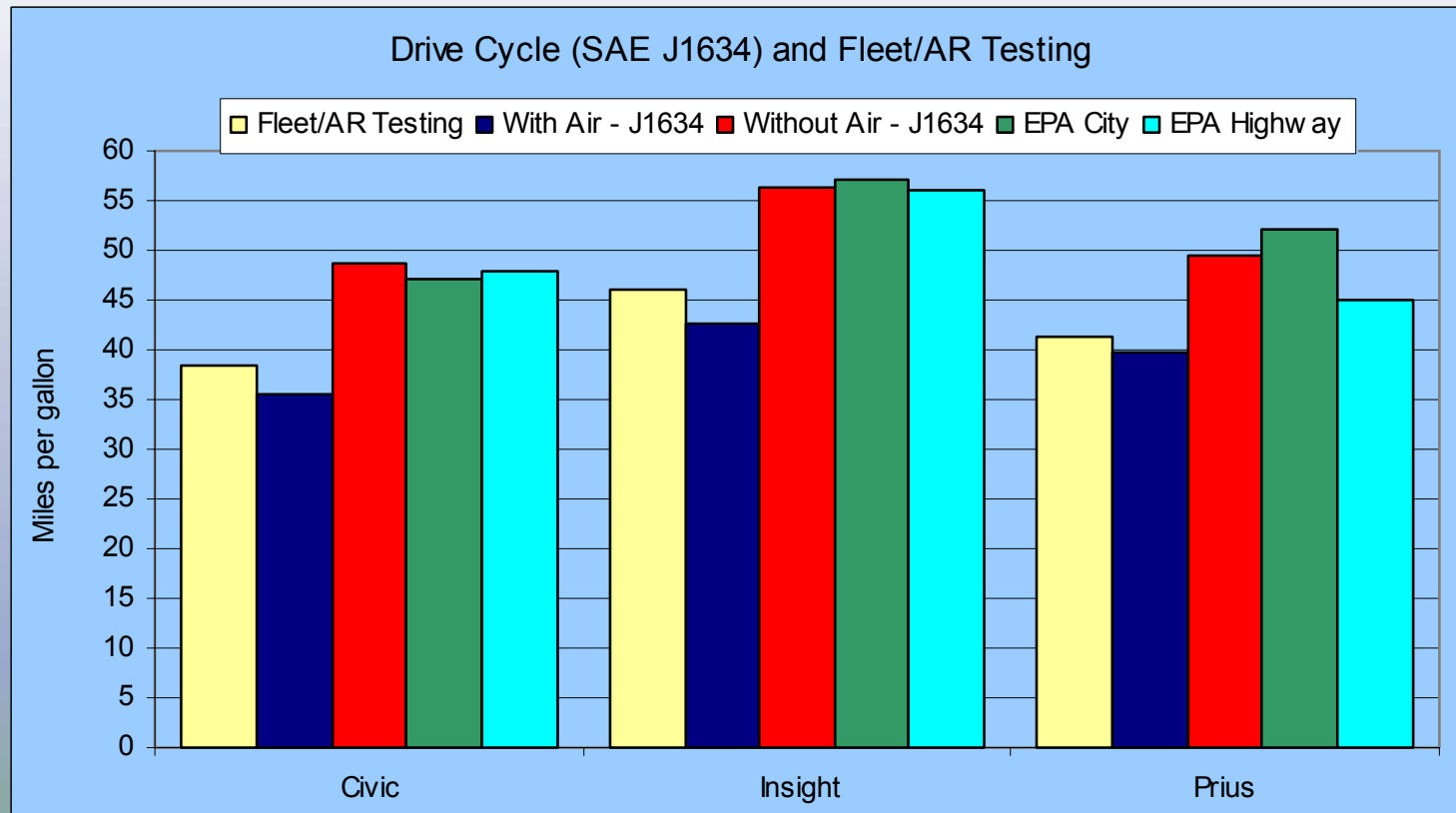
Hybrid Electric Vehicle Testing

- Fleet & accelerated reliability testing – monthly mpg



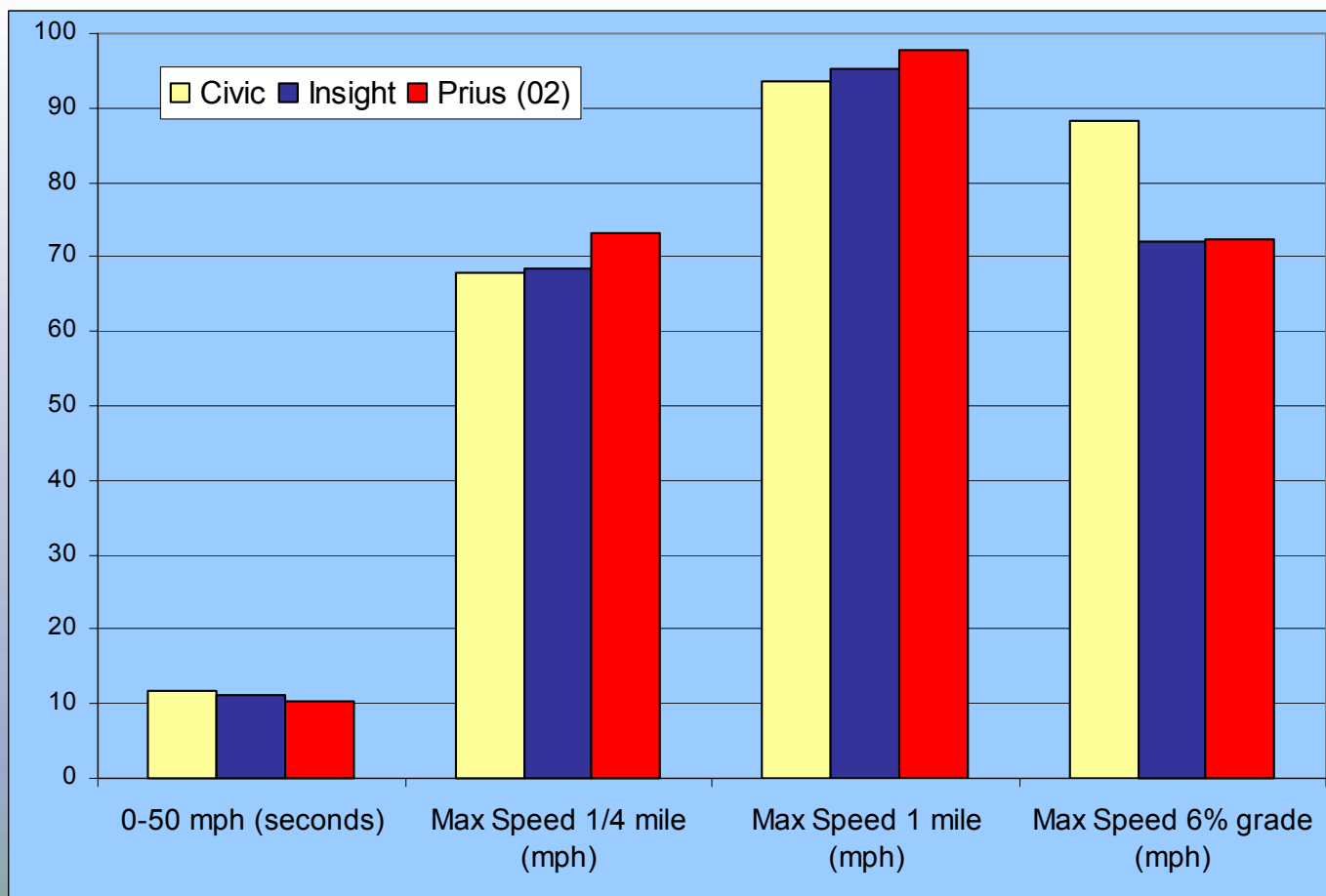
Hybrid Electric Vehicle Testing

- **Baseline Performance, fleet and accelerated reliability, and EPA testing results**



Hybrid Electric Vehicle Testing

- Baseline Performance testing results



Neighborhood Electric Vehicle Testing

- **NEVAmerica Baseline Performance Testing**
 - Completed NEVAmerica testing of 10 NEVs (max speed, acceleration, range, braking, charging)
- **90 NEVs in fleet testing (including fast charging)**
 - San Diego Police Department
 - Luke Air Force Base
 - Palm Valley
 - Palm Springs



Urban Electric Vehicle Testing

- **UEVAmerica Baseline Performance Testing**
 - Completed TH!NK city testing
- **Fleet and accelerated reliability testing**
 - 90 TH!NK cities in New York commuter fleet demonstration (miles driven, energy use, gasoline trips avoided, driver demographics)
 - 240 TH!NK cities in national demonstration
 - 5 Nissan Hyper-mini UEVs in fleet testing
 - TH!NK in accelerated reliability testing
 - Vehicle use 175,000+ miles



NYPA/TH!NK Clean Commute Program

Electric Airport Ground Support Equipment Testing

- **Developing electric GSE specifications and test procedures**
- **Vehicle specifications and test procedures to be adapted by SAE after completing review process**
- **Industry input meeting October 2003**
- **Test GSE (including fast charging) in 2004, including:**
 - **1 electric pushback tractor**
 - **4 electric bag tractors**

All vehicle testing reports and fact sheets available @:

<http://avt.inel.gov>