



INEEL-Based Office of FreedomCAR & Vehicle Technologies Program Activities

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Principle Investigator

Advanced Vehicle Testing Activity

IMEAC - Portland, Oregon

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Outline

- *INEEL Overview*
- *Energy Storage Technology Laboratory*
- *Heavy Vehicle Technology Support*
- *Advanced Vehicle Testing Activity (AVTA)*
- *Hydrogen/CNG Fueling Station*
- *Vehicle Testing*
- *Summary*

INEEL Overview

INEEL

- *890 Square mile U.S. Department of Energy Laboratory in eastern Idaho*
- *7,000 DOE and contractor employees*
- *1,600+ vehicles*
- *110 Light-duty CNG vehicles*
- *40 Light-duty LNG vehicles*
- *6 LNG motor coach buses*
- *5 Light-duty propane vehicles*
- *LNG/CNG station at “site” and CNG station 50+ miles distance in Idaho Falls*

INEEL

- *Upgrading Idaho Falls CNG dispenser to 3,600 psi*
- *Adding second 9 g.g.e. CNG tanks to 36 F250 pickups*
- *Replacing 4 g.g.e. 3,000 psi tanks on 13 Ford Contours with 7.2 g.g.e. 3,600 psi tanks*



INEEL Objective

- *Support DOE's efforts to reduce the nation's dependency on foreign oil:*
 - *Technology & Infrastructure Development*
 - *Increasing vehicle propulsion system efficiencies*
 - *Reducing or eliminating petroleum use*
 - *Enable regional integration of transportation, energy, facility, and information systems*
 - *Provide support to: DOE-EE&RE*
 - *FreedomCAR & Vehicle Technologies Program*
 - *Hydrogen, Fuel Cells, and Infrastructure Program*

Energy Storage Technology Laboratory

Energy Storage Technology Laboratory

- *Develop national standards and procedures for performance testing of EV and HEV batteries and ultracapacitors*
- *World leader in the testing of advanced battery technologies for automotive applications*
 - *INEEL procedures manuals used world wide*
 - *Developed standard data analysis procedures*
 - *Only national laboratory to document measurement uncertainty procedures for data quality*
- *Lead DOE lab for Hybrid Electric Vehicle battery testing*

Energy Storage Technology Laboratory

- *Advanced batteries and capacitors*
 - *Procedures development*
 - *Test and Evaluation*
 - *Data Analysis and Reporting*
 - *Development Tasks and Diagnostics*
 - *Program Management, Reporting*
 - *Modeling*
 - *Industry support*



Energy Storage Technology Laboratory

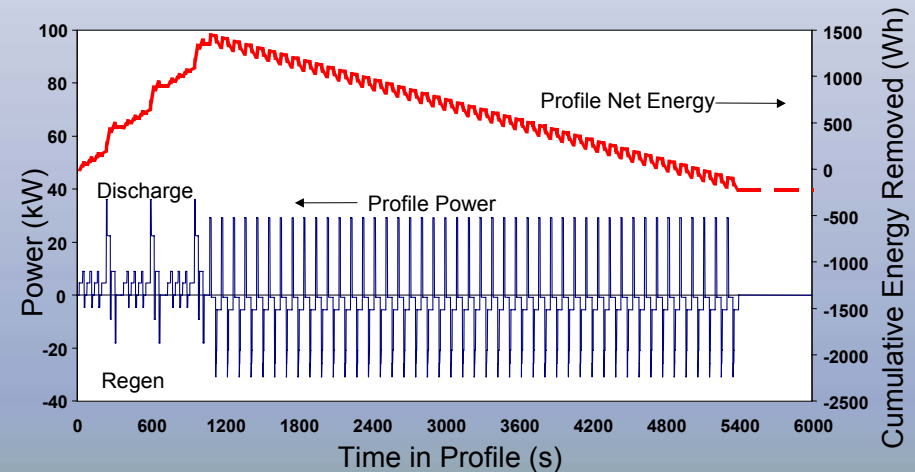
- *Tests small lab fixtures, full-size cells, modules, and battery packs ranging from a few mAh's to hundreds of Ah's and one volt up to hundreds of volts. Including:*
 - *lithium-ion*
 - *lithium-polymer*
 - *nickel metal-hydride*
 - *nickel cadmium*
 - *lead-acid*
 - *zinc-air*
 - *iron-air*
 - *sodium sulfur*
 - *sodium nickel chloride*



Energy Storage Test and Evaluation

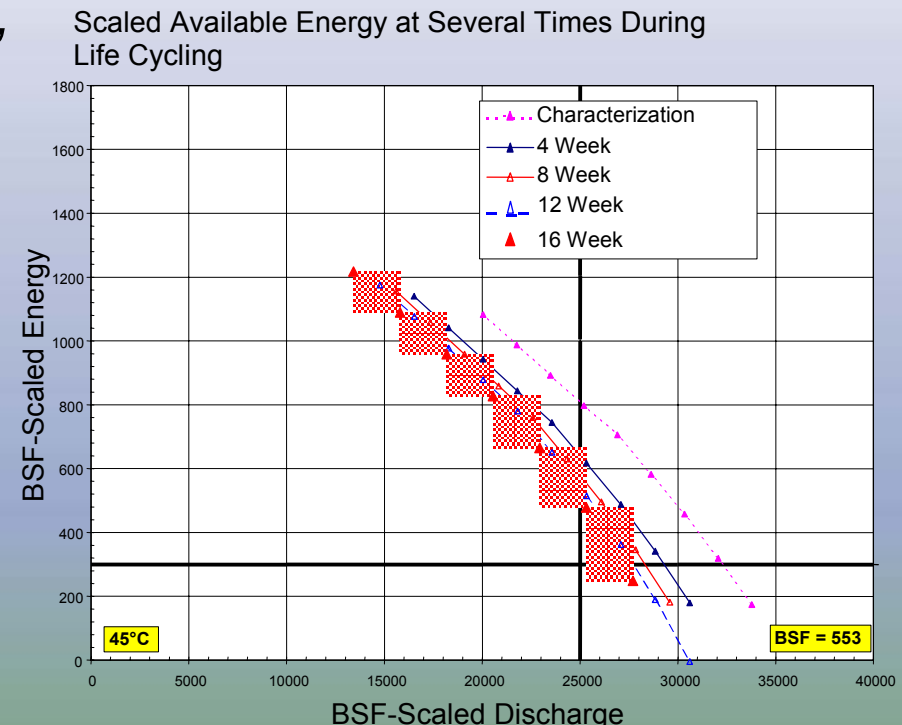
- *The PNGV Battery Test Manual (now FreedomCAR Program) developed by INEEL is the industry standard for testing HEV batteries.*
- *Tests include:*
 - *Static capacity*
 - *Thermal performance*
 - *Self-Discharge*
 - *Cold-cranking power*
 - *Efficiency*
 - *Pulse power*
 - *Calendar life*
 - *Cycle life*

Dual Mode Life Cycle Test Profile



High Power Energy Storage Data Analysis

- The INEEL has pioneered the development of analysis procedures for battery scaling, thermal management, capacity fade, and power fade.*



Heavy Vehicle Technology Support

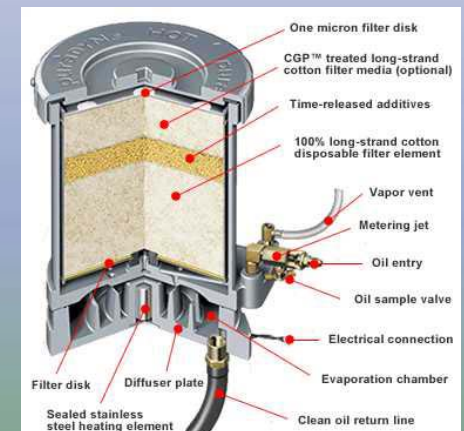
Heavy Vehicle Technology Support, 21st Century Truck Program

- Site Transportation Facility is a unique DOE facility fully equipped to support the development of advanced heavy truck and bus technology*



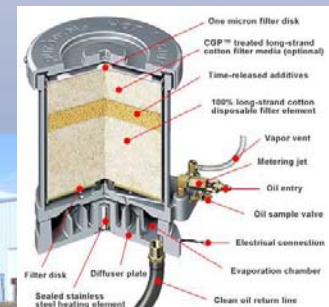
Oil Bypass System Performance Evaluation

- *Goal: Demonstrate & quantify engine oil use reductions*
 - *Phase 1: Demonstrate oil bypass filtration system (puraDYN)*
 - *Phase 2: Demonstrate light-duty vehicle operations*
 - *Phase 3: Economic benefits analysis by vehicle & fleets*
 - *Phase 4: Analysis and dissemination of DOE complex-wide economic and oil-use benefits*



Oil Bypass System Performance Evaluation

- *Evaluation Status – Phases 1 & 2*
 - *Systems installed on 8 of 99 INEEL motor coach buses*
 - *Ongoing bus operations and oil sampling*
 - *101,000 test miles on 8 buses (4/1/03)*
 - *Motor oil is sampled for 26 additives and contaminants*
 - *Systems being installed on 6 Chevrolet Tahoes*



Heavy Truck Idle Reduction Project

- *Goal: reduce 800+ million gallons of annual fuel use during idling periods*
- *Assess regional and national driver/truck idling needs and practices*
- *Assess idling technology options for heating, air conditioning, and auxiliary loads*
- *Match needs and technology capabilities*
- *Fleet/component demonstration/data collection project*
- *Results analysis and dissemination*
- *Solicitation being reviewed*

Advanced Vehicle Testing Activity (AVTA)

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 is a DOE Activity within the FreedomCAR & Vehicle Technologies Program (Lee Slezak – DOE-HQ Manager)*

AVTA Testing Partners

- *Qualified Vehicle Testers*
 - *Electric Transportation Applications (lead)*
 - *Arizona Public Service*
 - *Bank One*
 - *Luke AFB*
 - *New York Power Authority*
 - *Red Cross*
 - *Southern California Edison*
 - *Salt River Project*
 - *City of Palm Springs*
 - *City of Palm Valley*
 - *City of Vacaville*

Hydrogen/CNG Fueling Station

Hydrogen/CNG Fueling Station

- *Objectives:*
 - *Evaluate the safety and reliability of operating vehicles on hydrogen and blended hydrogen fuels*
 - *Evaluate the vehicle/infrastructure interface*
 - *Quantify vehicle emissions, costs, and performance*
- *Partners:*
 - *Energy Company - Arizona Public Service (APS)*
 - *Vehicle Testing - Electric Transportation Applications (ETA)*
- *Construction of APS Alternative Fuel Pilot Plant - hydrogen production and hydrogen/CNG fueling station*

Hydrogen/CNG Fueling Station

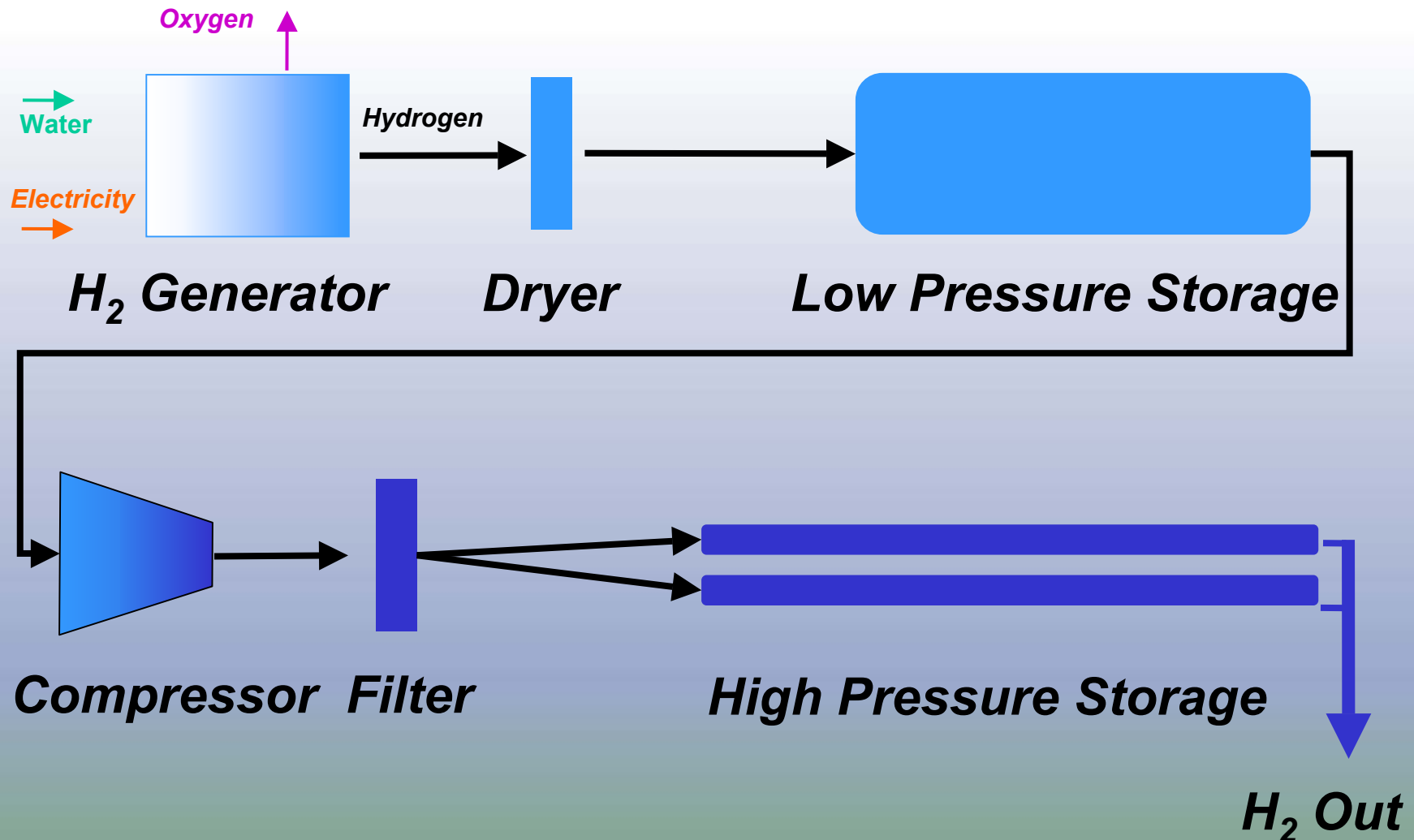
- *Initial hydrogen and H/CNG ICE test vehicles – operated 40,000+ miles, including emissions testing & oil analysis*
 - *Ford ICE F150 up to 30% hydrogen*
 - *Ford ICE F150 up to 50% hydrogen with DOE / Quantum hydrogen tanks*
 - *100% hydrogen-powered Mercedes Benz ICE van*
 - *Dodge Ram ICE Van 100% CNG and 15% H/CNG*
- *Fuel provided to DaimlerChrysler Fuel Cell NECAR & other hydrogen vehicles*

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 service*
- *Delivers either pure hydrogen or CNG fuel or hydrogen/CNG blended fuels*



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*
- *Fuel-cell quality hydrogen - 99.9997% pure*

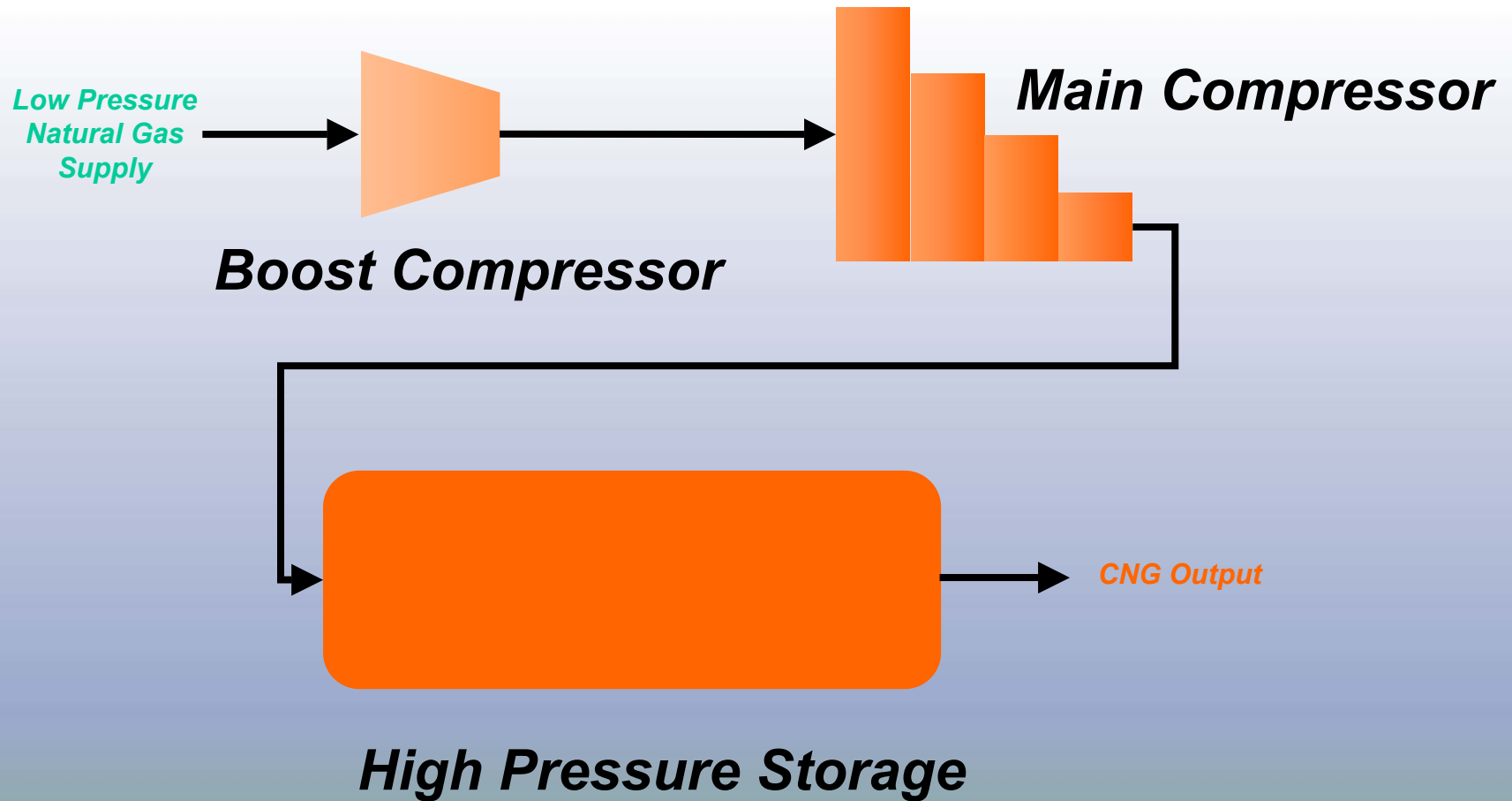


Hydrogen Sub-System

- *Low pressure hydrogen storage (lower tank)*
 - 8,955 SCF @ 150 PSIG
- *High pressure hydrogen storage (upper 2 tanks)*
 - 17,386 SCF @ 6,000 PSIG



CNG Sub-System

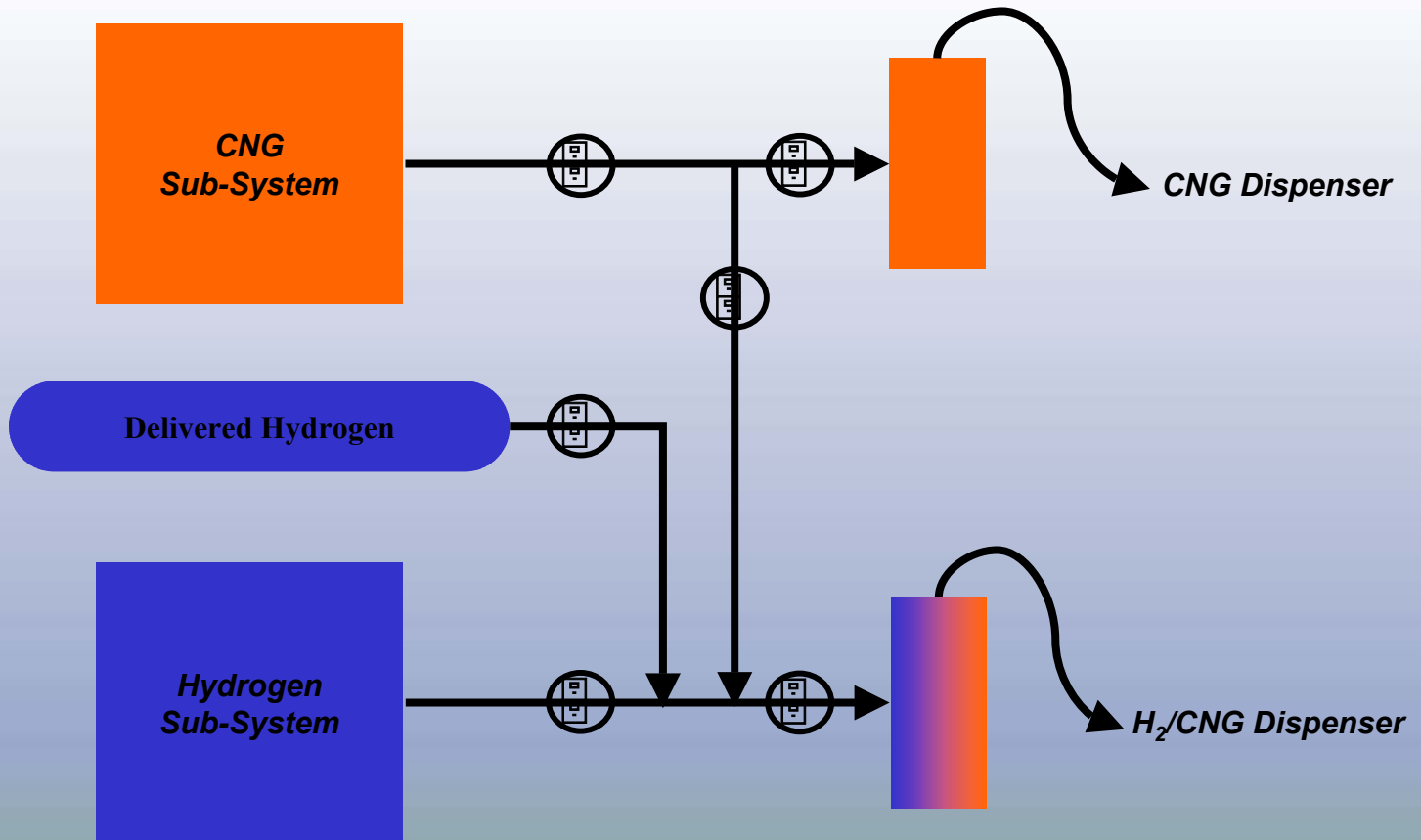


CNG Sub-System

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



Hydrogen/CNG Fueling System



Hydrogen/CNG Fueling Station

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



Vehicle Testing

Vehicle Testing Methods

- *Hydrogen, HEV, UEV, NEV, full-size EVs*
 - *Baseline Performance: Closed track and dynamometer testing, with highly repeatable results, allowing year-to-year and vehicle-to-vehicle comparisons. Industry input into test specifications and test procedures. (21 full-size EV models tested)*
 - *Accelerated Reliability Testing: 25,000 miles in 12 months (EVs, UEVs, Hydrogen) & 100,000 miles in 15 months (HEVs) of operations experience. Includes energy use and fuel economy, maintenance requirements, vehicle performance*
 - *Fleet Testing: fleet operations data collection*

Hydrogen/CNG ICE Vehicle Testing

- *Fleet Testing - ongoing*
 - *8 vehicles 15% H / 85% CNG (APS meter reader fleet) S-10s, Sierra pickups, Blazers*
 - *Adding 10 vehicles 15% H / 85% CNG (Phoenix Fire Department fleet) Sierra pickups*
 - *Ford F150 30% H / 70% CNG (APS)*
- *Developing Baseline Performance Hydrogen ICE testing specifications and procedures*
- *Baseline performance and accelerated reliability testing*
 - *Ford F150 - 100% hydrogen (Fall 2003)*
- *Emissions testing, oil analysis*
 - *Various vehicles*

Hydrogen/CNG ICE Vehicle Testing

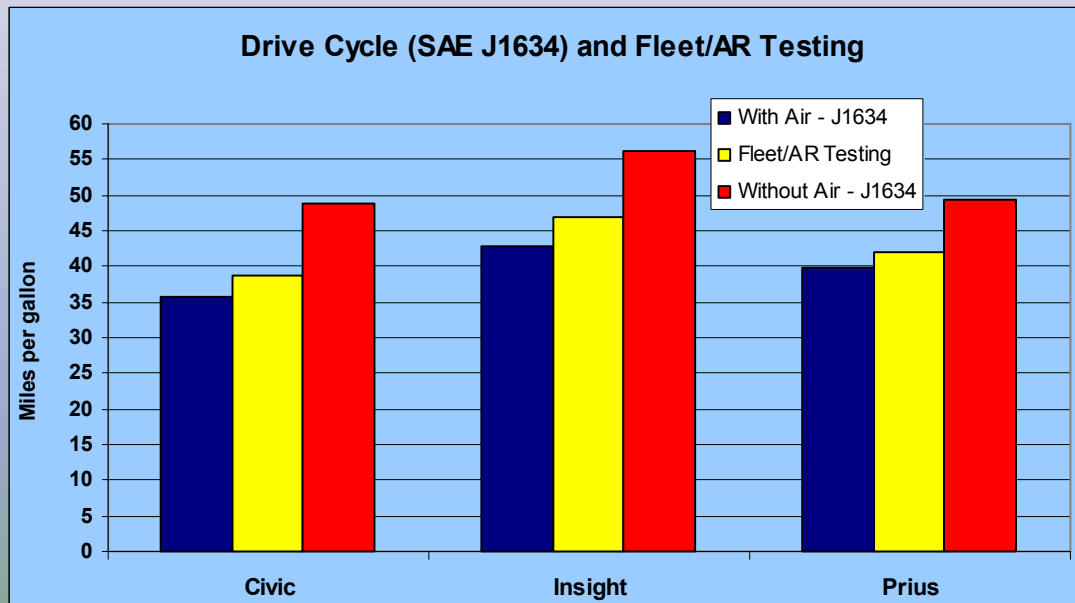


Hybrid Electric Vehicle Testing

- *HEV Accelerated Reliability and Fleet Testing*
 - *Fleet & accelerated reliability testing - 500,000+ HEV miles to date (03/01/03)*
 - *4 Civics (118,000 miles) ~38.7 mpg*
 - *6 Insights (221,000 miles) ~46.8 mpg*
 - *6 Prius (230,000 miles) ~41.9 mpg*
 - *Bank One, Red Cross, Arizona Public Service, ETA fleets*
 - *Fuel use, maintenance, repairs, driver experience*

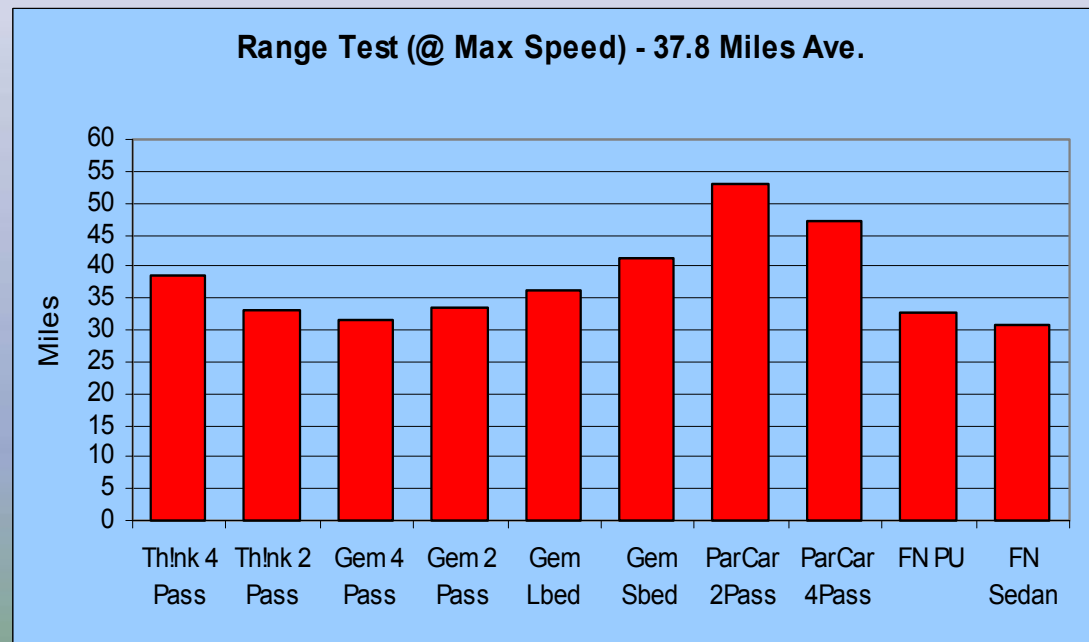
Hybrid Electric Vehicle Testing

- *HEVAmerica Baseline Performance Testing*
 - *Toyota Prius, & Honda Civic & Insight*
 - *Fuel economy, acceleration, max speed, braking, & handling*



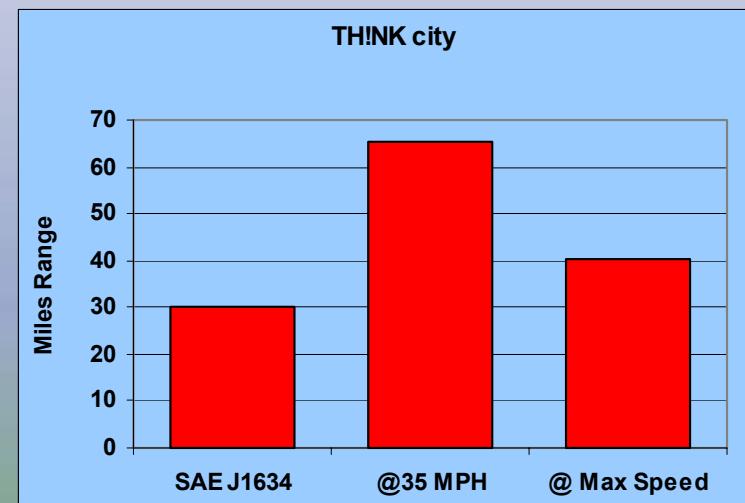
Neighborhood Electric Vehicle Testing

- *NEVAmerica Baseline Performance Testing*
 - *Completed NEVAmerica testing of 10 NEVs*
 - *Acceleration, max speed, range, braking, charging*
- *85+ NEVs in fleet testing including fast charging*



Urban Electric Vehicle Testing

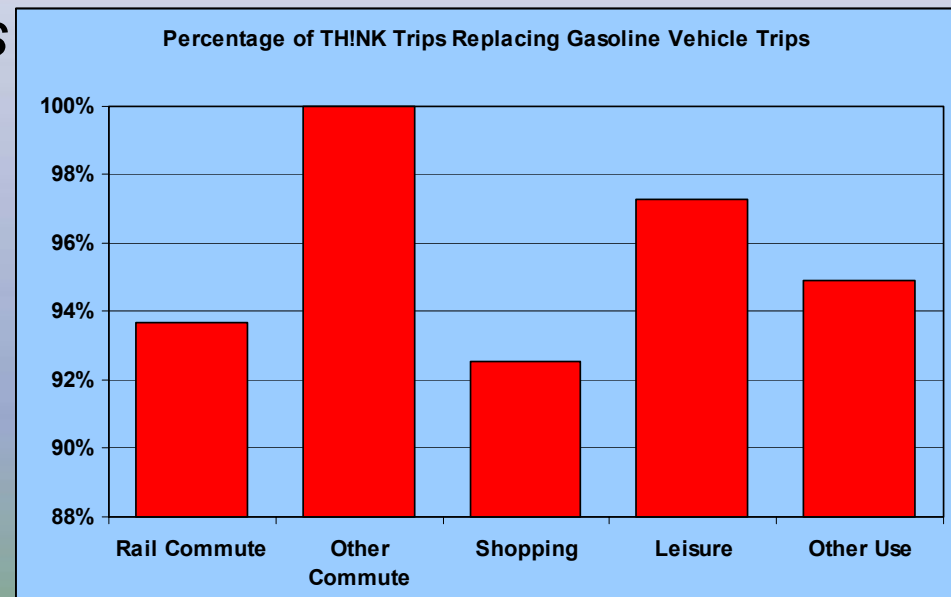
- *UEVAmerica Baseline Performance Testing*
 - *Completed TH!NK city testing*
- *Fleet and accelerated reliability testing*
 - *100 TH!NK cities in NY commuter fleet demonstration*
 - *240 TH!NK cities in national demonstration program*
 - *5 Nissan Hyper-mini and 5 Toyota e-com UEVs in fleet testing*
 - *TH!NK city in AR testing*



Urban Electric Vehicle Testing

- *New York Power Authority fleet demonstration*
 - *Chargers at homes and seven area train stations*
 - *Internet data collection*
 - *Vehicle use (miles driven, energy use, gasoline trips avoided)*
 - *Driver demographics*

NYPA/TH!NK Clean Commute Program



Summary

APS/ETA/INEEL Hydrogen Activities Summary

- *Gen I goals:*
 - *System optimization, component testing, codes analysis, fleet education, and enhanced fueling practices*
 - *Develop business case for regional hydrogen infrastructure*
- *Gen II goals:*
 - *Design/construct hydrogen production/fueling stations*
 - *Develop hydrogen fueling corridor*
 - *Link Phoenix with Las Vegas and California projects*
 - *Support DOE Seattle regional infrastructure meeting*
- *Educate and support hydrogen customers*

AVTA Summary

- *Only DOE/energy company hydrogen/CNG production fueling station supporting DOE test vehicles*
- *Experience gained siting, permitting, constructing, and operating Hydrogen/CNG Station in downtown Phoenix*
- *Continue looking forward towards emerging technologies to identify testing candidates*
 - *Electric ground support (airport) and other electric drive vehicles*
 - *Hydrogen ICEs and other advanced technology vehicles*
- *Hydrogen reports - <http://avt.inel.gov/hydrogen.html>*
- *AVTA - <http://avt.inel.gov>*