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*

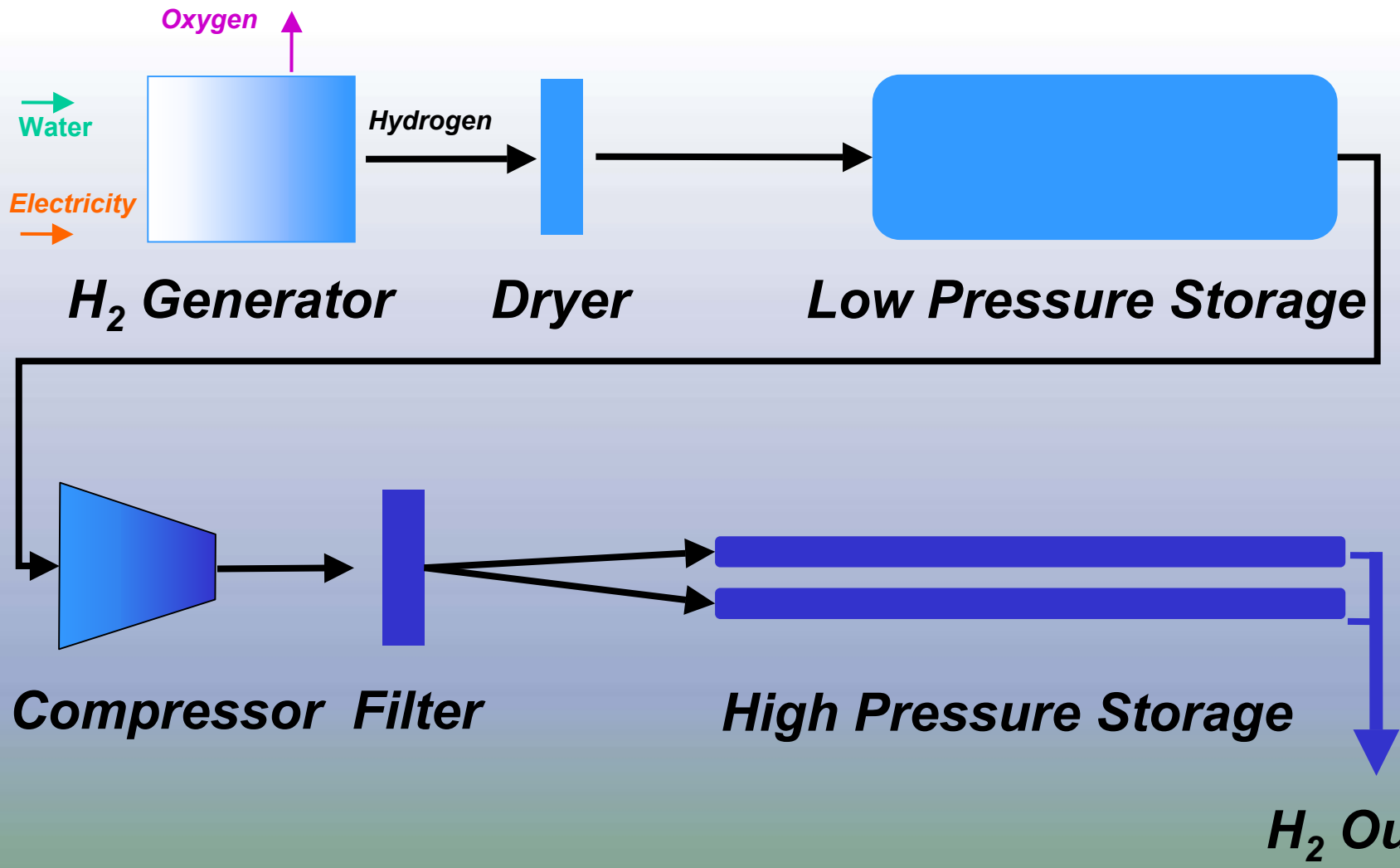
Hydrogen/CNG Fueling Station

- *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



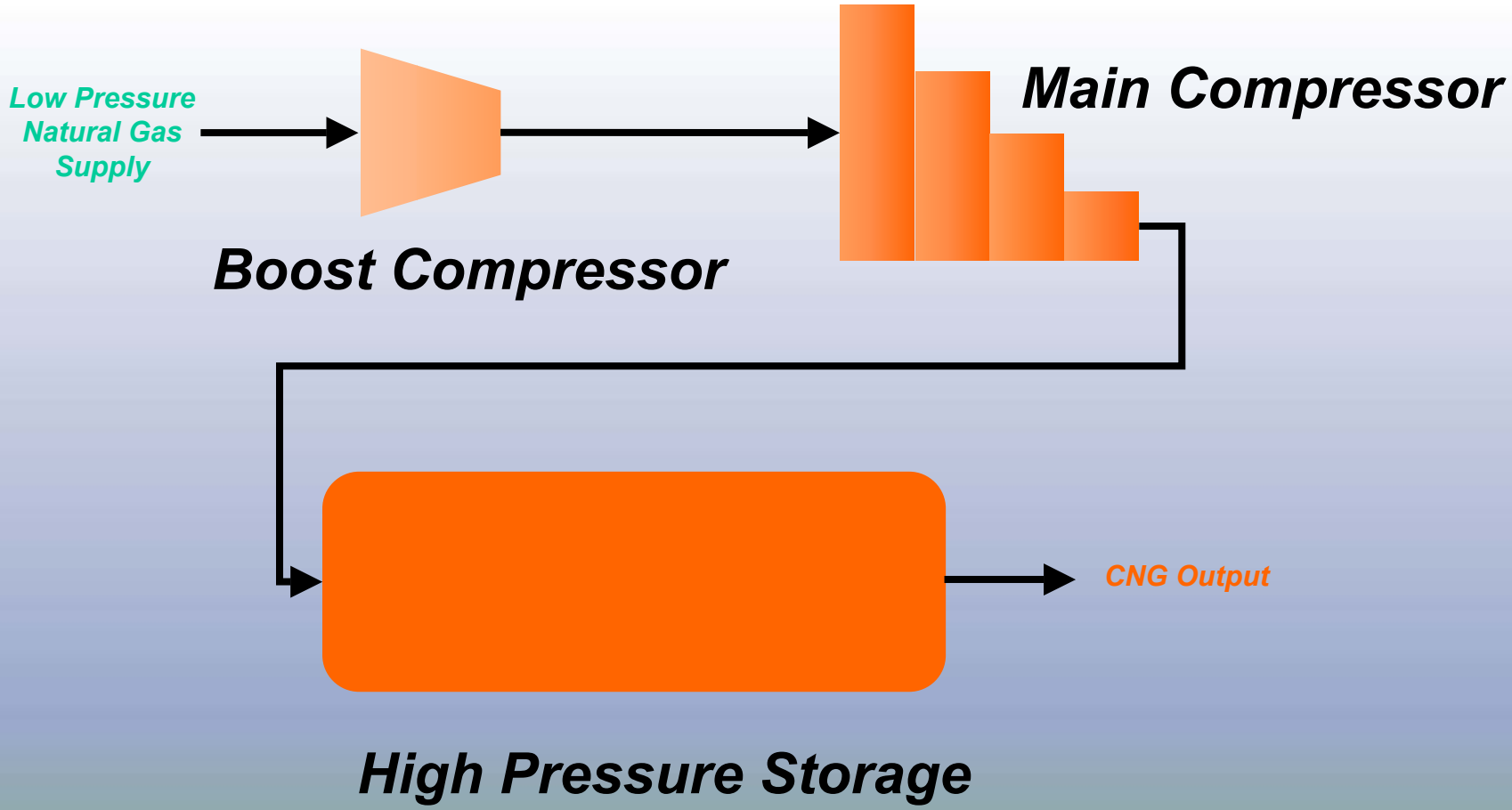
Hydrogen Sub-System

- *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*

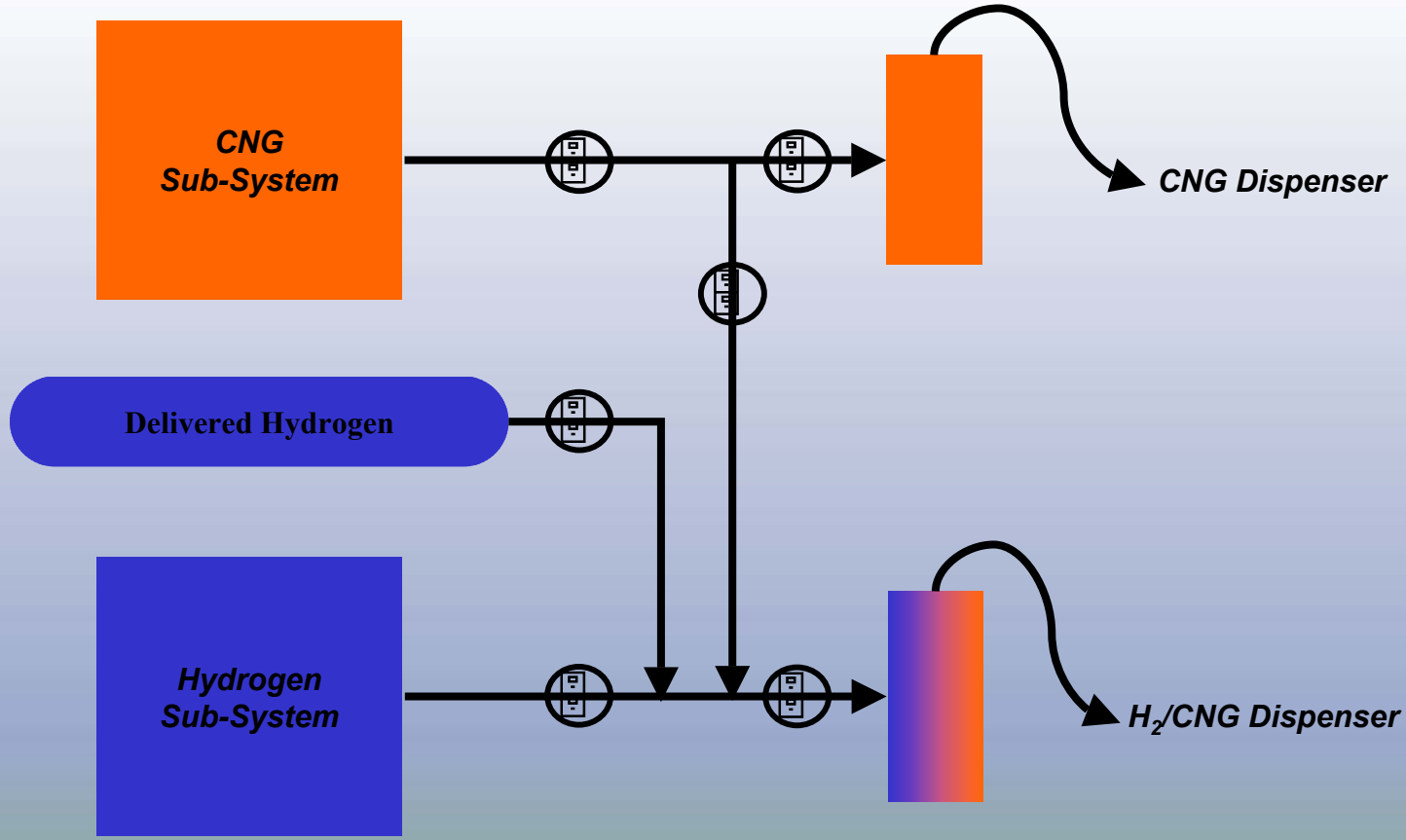
CNG Sub-System



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*

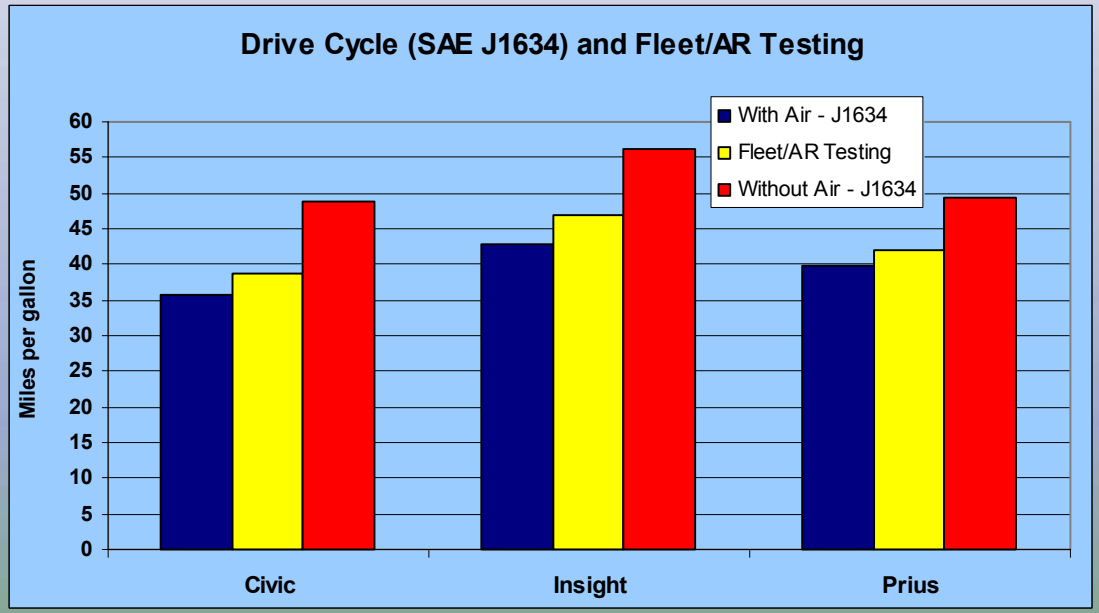
Hydrogen/CNG ICE Vehicle Testing

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*

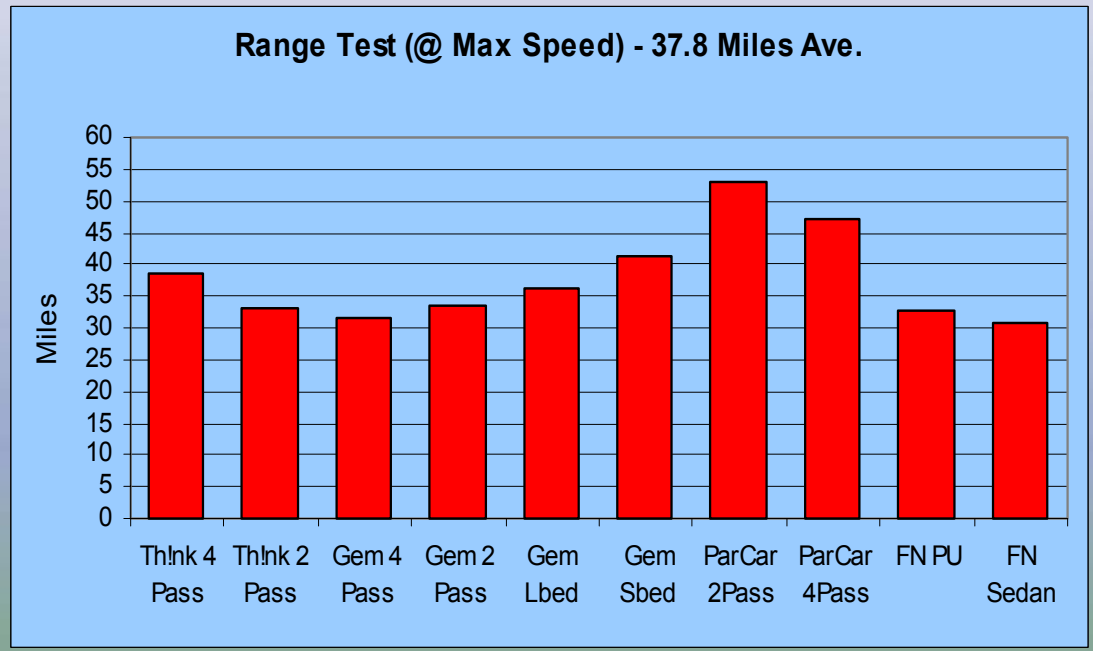
Hybrid Electric Vehicle Testing

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



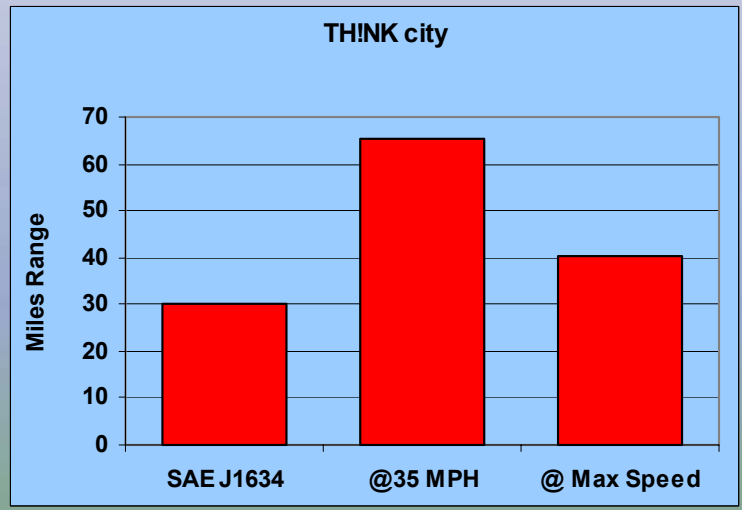
Neighborhood Electric Vehicle Testing

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



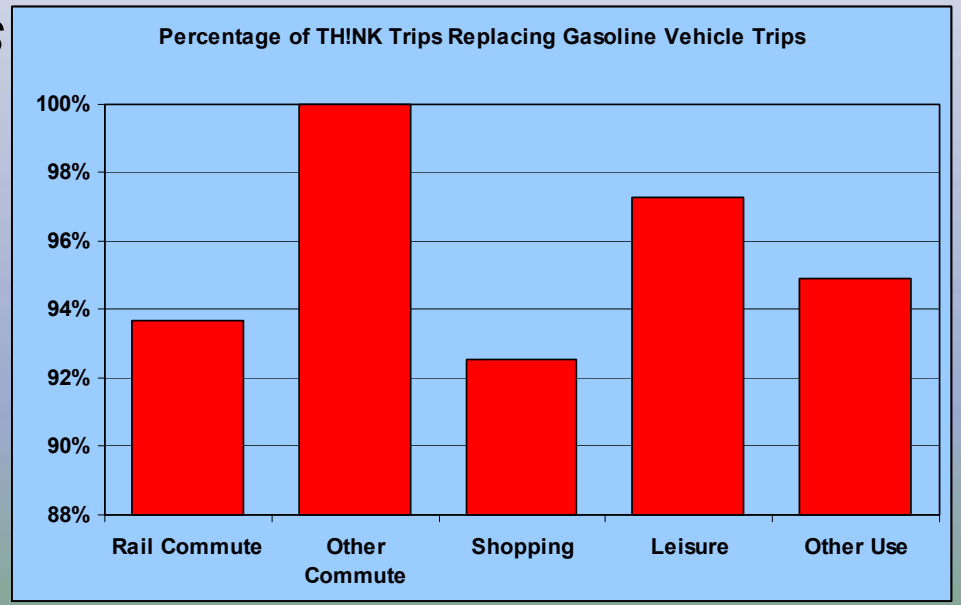
Urban Electric Vehicle Testing

- *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*



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*