U.S. Department of Energy

Field Operations Program

Electric and Hybrid Vehicle Testing

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Presentation Overview

• Program Goal
• Program Testing Partners
• Neighborhood Electric Vehicle (NEV) Testing
• Urban Electric Vehicles (UEV) Testing
• Hybrid Electric Vehicle (HEV) Testing
• Hydrogen Fueling Station and Vehicle Testing Activities
  – Hydrogen Production / CNG Compression
  – Hydrogen/CNG Fueling System
• Summary
Program Goal

• Provide fleet managers and other potential advanced technology vehicle (ATV) users with accurate and unbiased information on vehicle performance

• ATVs include
  – Hybrid electric vehicles
  – Hydrogen ICE vehicles
  – Pure EVs (full size, urban, neighborhood)
  – Fuel cell vehicles

• Emphasis placed on supporting the National Energy Policy, DOE’s Mission and Priorities, and testing vehicles incorporating emerging technologies developed by DOE and its industry partners
Program Testing Partners

• Electric Transportation Applications (lead)
  – American Red Cross
  – Arizona Public Service
  – Bank One of Arizona
  – Luke Air Force Base
  – New York Power Authority
  – Salt River Project
  – Southern California Edison
  – Cities of Palm Springs, Palm Valley, & Phoenix
Neighborhood Electric Vehicle (NEV) Testing

- Recently completed NEV America testing of 10 NEVs
  - Frazier Nash, GEM, ParCar, TH!NK
  - Technical specifications and test procedures developed with NEV manufacturer & fleet input
  - Based on NHTSA FMVSS No. 500 - Low-speed vehicles

- 60+ NEVs in fleet testing FY-02
NEV Acceleration Testing (0 to 20 mph)

- Average @ 100% SOC - 8.7 seconds & @ 50% SOC 14.2 seconds
NEV Range Testing - (brick test)

- Minimum 28.4, maximum 52.9, average 36.7 miles
NEV Maximum Speed Tests

- FMVSS No. 500 testing: min 20.5, max 25.6, average 23.8 mph
NEV Energy Efficiency

- Average - 7.8 miles/kWh
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**NEV kWh Capacity & Energy Use**

- Rated average 6.23 kWh & Used average 5.08 kWh
**NEV Charge Times**

- Vehicles 3-10 average charge time - 10.3 hours
- Vehicles 1 & 2 fast charged
NEV America Testing Results

- Some structural flaws found during rough road testing
- Poor SOC meters can result in over-discharge of batteries and false low-charge indication
- NEV America testing demonstrated manufacturers have created an efficient means of zero emissions transportation using low speed vehicles
Urban Electric Vehicle (UEV) Testing

- **Th!nk** city in UEV America baseline performance testing
- 100 **TH!NK** cities in New York train commuter fleet demonstration program
- **TH!NK** city in accelerated reliability testing
- 12 UEVs in 3 fleet tests in California, FY-02 (TH!NK cities, Nissan Hyper-Minis, Toyota e-coms)
Hybrid Electric Vehicle (HEV) Testing

- 2 HEVs Pomona Loop tested as part of testing development process (Insight, Prius)
- 3 HEVs in HEV America baseline performance testing (Insight, Prius, Civic)
- 6 HEVs in accelerated reliability testing (100,000 miles per vehicle) (Insight, Prius, Civic)
- 7 HEVs in fleet testing (Insight, Prius, Civic)
Honda Insight HEV Testing

- Pomona Loop average 52.2 mpg (1,550 miles)
- Accelerated reliability and fleet testing average 48.7 mpg (73,000 miles)
- EPA 61 mpg city / 70 mpg highway
**Toyota Prius HEV Testing**

- *Pomona Loop average 44.4 mpg (1,650 miles)*
- *Accelerated reliability and fleet testing average 44.2 mpg (59,000 miles)*
- *EPA 52 mpg city / 45 mpg highway*
Hydrogen Fueling Station and Vehicle Testing Activities

• Construction of hydrogen production and hydrogen / CNG fueling station with Arizona Public Service
• Current hydrogen test vehicles (19,700 miles)
  – Ford ICE F150 at up to 30% hydrogen / CNG blend
  – Ford ICE F150 at up to 60% hydrogen / CNG blend
    with DOE / Quantum hydrogen tanks
  – 100% hydrogen-powered Mercedes Benz ICE van
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Hydrogen Test Vehicles
Hydrogen Production / CNG Compression

- Electrolytic hydrogen production on site, Proton Energy Systems’ HOGEN PEM stationary fuel cell operating in reverse
- Produce fuel-cell quality hydrogen
- Interconnects to dispense delivered hydrogen fuel
- Compress natural gas from low pressure service
- Delivers pure hydrogen or CNG fuel
- Arizona Public Service
Hydrogen Sub-System

- Water
- Electricity
- Oxygen

H₂ Generator → Dryer → Low Pressure Storage

Compressor → Filter → High Pressure Storage → H₂ Out
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Hydrogen Sub-System (cont’d)

• 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 Sub-System (cont’d)

• 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

Low Pressure Natural Gas Supply → Boost Compressor → Main Compressor → High Pressure Storage → CNG Output
CNG Sub-System (cont’d)

- **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

CNG Sub-System

Delivered Hydrogen

Hydrogen Sub-System

CNG Dispenser

H₂/CNG Dispenser
Hydrogen/CNG Fueling System

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

• Long-term relationships with vehicle manufacturers and private sector testing partners / fleet operators (trust)

• Looking forward towards emerging technologies to identify testing candidates
  – Hydrogen ICEs and fuel cell vehicles
  – Niche-market (NEVs & UEVs) pure electric vehicles
  – HEVs in light, medium and heavy applications

• Testing procedures designed for emerging technologies
Summary (cont’d)

- Only DOE / private sector hydrogen production and fueling station in operation
- Experience gained siting, permitting, constructing, and operating Hydrogen/CNG Station in downtown Phoenix
- Development of hydrogen production and fueling station in-a-box concept

- http://ev.inel.gov/fop