Fuel Cell Vehicle Learning Demonstration: Spring 2007 Results

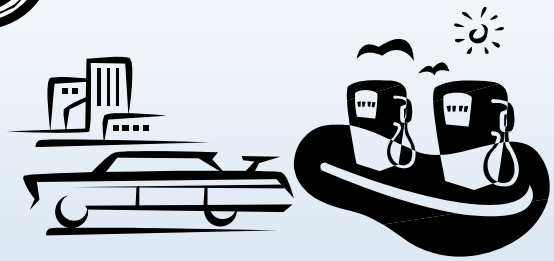
Keith Wipke, Sam Sprik, Holly Thomas, Cory Welch[1]
Sigmund Gronich, John Garbak[2]

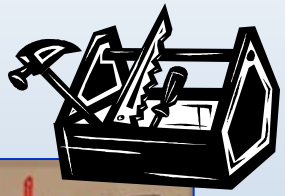
NHA Conference, San Antonio, TX
March 20, 2007

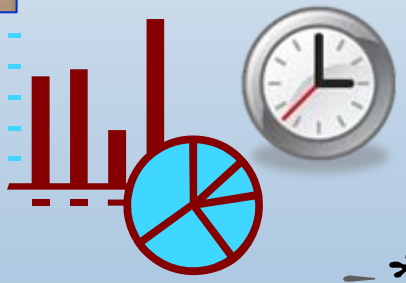
[1]NREL, [2]US Dept. of Energy

This presentation does not contain any proprietary or confidential information

Outline







Fuel Cell Vehicle Learning Demonstration Project Objectives and Targets

- Objectives
  - Validate H_2 FC Vehicles and Infrastructure in Parallel
  - Identify Current Status and Evolution of the Technology
    - Assess Progress Toward Technology Readiness
    - Provide Feedback to H_2 Research and Development

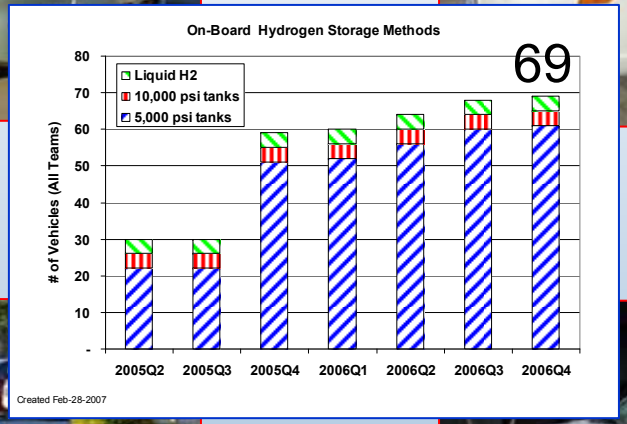
Key Targets

Performance Measure	2009*	2015**
Fuel Cell Stack Durability	2000 hours	5000 hours
Vehicle Range	250+ miles	300+ miles
Hydrogen Cost at Station	$3/gge	$2-3/gge

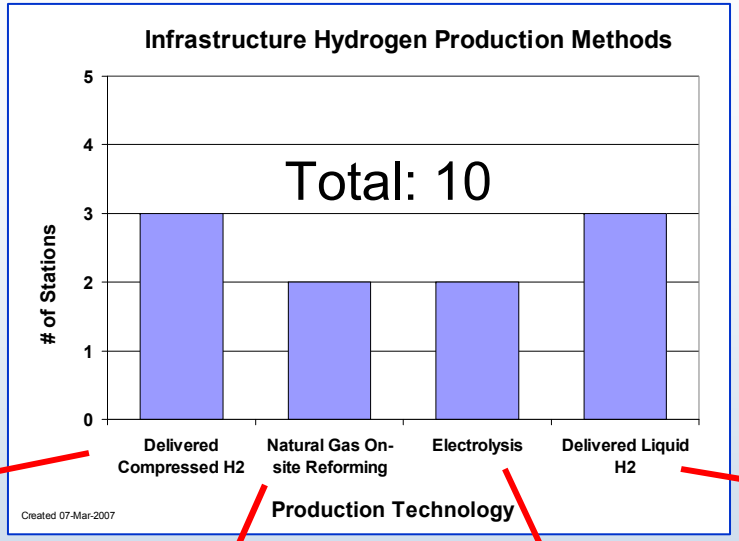
* To verify progress toward 2015 targets
** Subsequent projects to validate 2015 targets

Hydrogen refueling station, Chino, CA Photo: NREL

Over Half of Project Vehicles Now Deployed, First-Generation Predominantly Uses 5000 psi Tanks



~Half of the Project's Infrastructure to Refuel Vehicles Has Been Installed – 4 Types



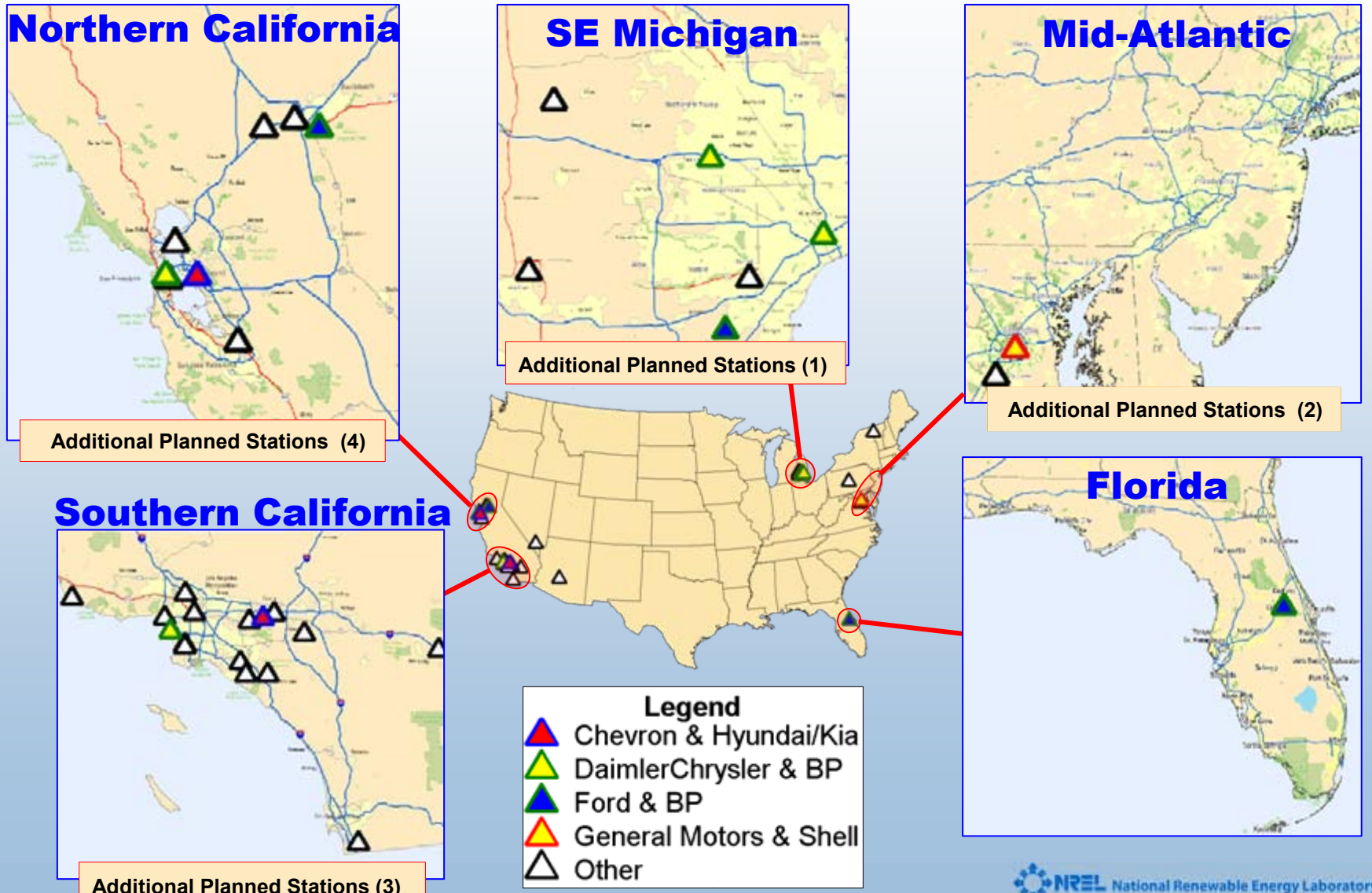
Mobile Refueler
San Francisco, CA

Hydrogen and gasoline station
Washington, DC

Autothermal Reformer
Chino, CA

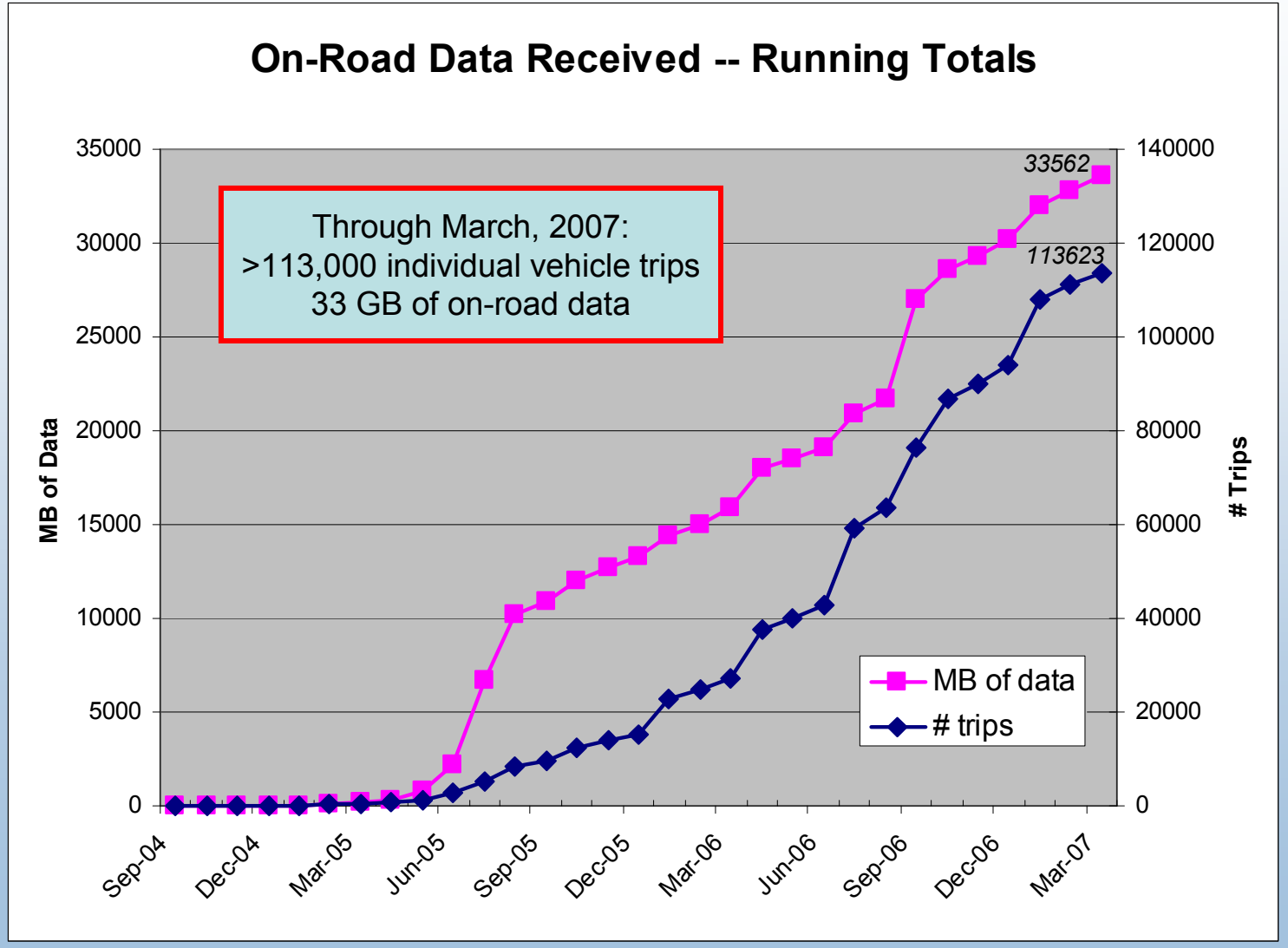
DTE/BP Power Park,
Southfield, MI

Refueling Stations from All Four Teams Test Vehicle/Infrastructure Performance in Various Climates

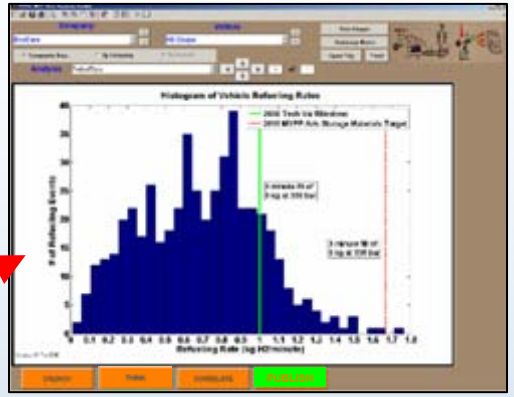


Seven Quarters of Data Analyzed To-Date

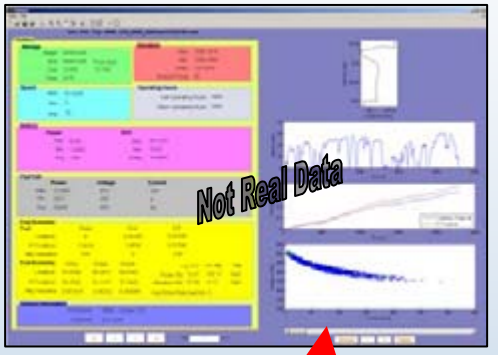
Current Status of Data Reporting to the Hydrogen Secure Data Center at NREL

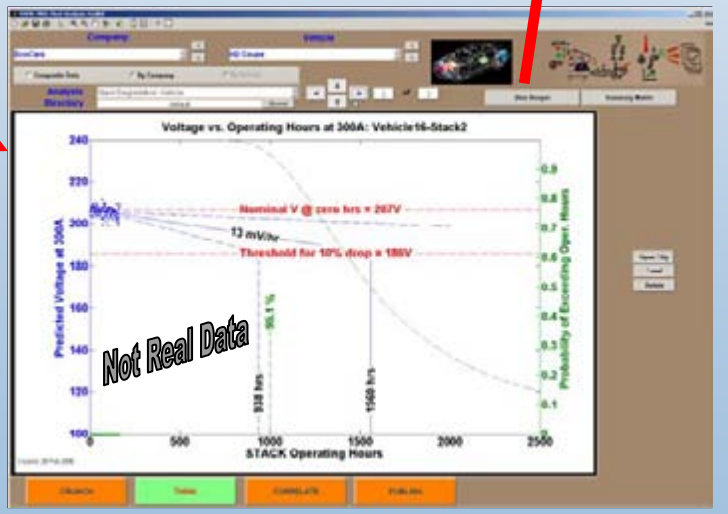


Analysis Calculations and Results are from NREL-Developed GUI – Fleet Analysis Toolkit (FAT)



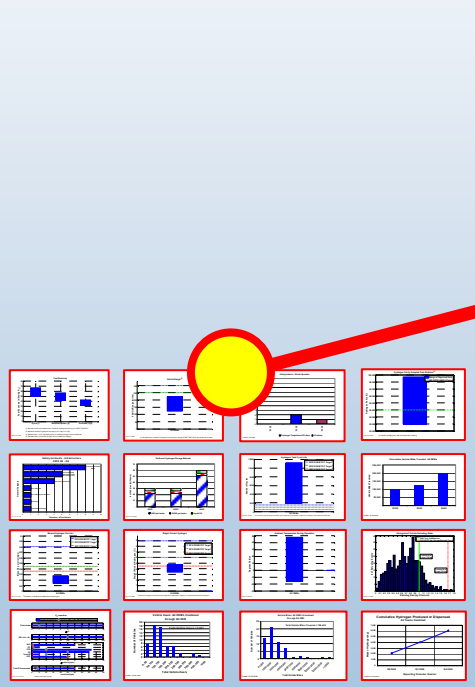
TripView



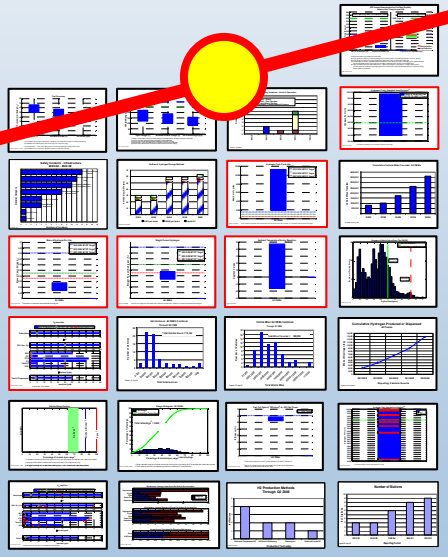


3rd Set of Composite Data Products Published; Updates/Additions Every Six Months

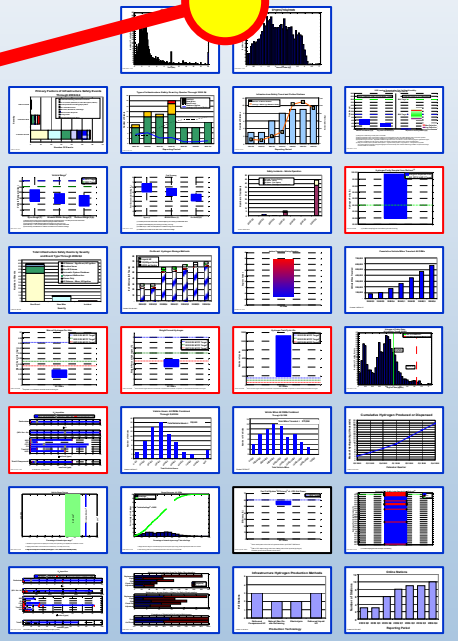
30 Composite Data Products Have Now Been Published



Spring 2006

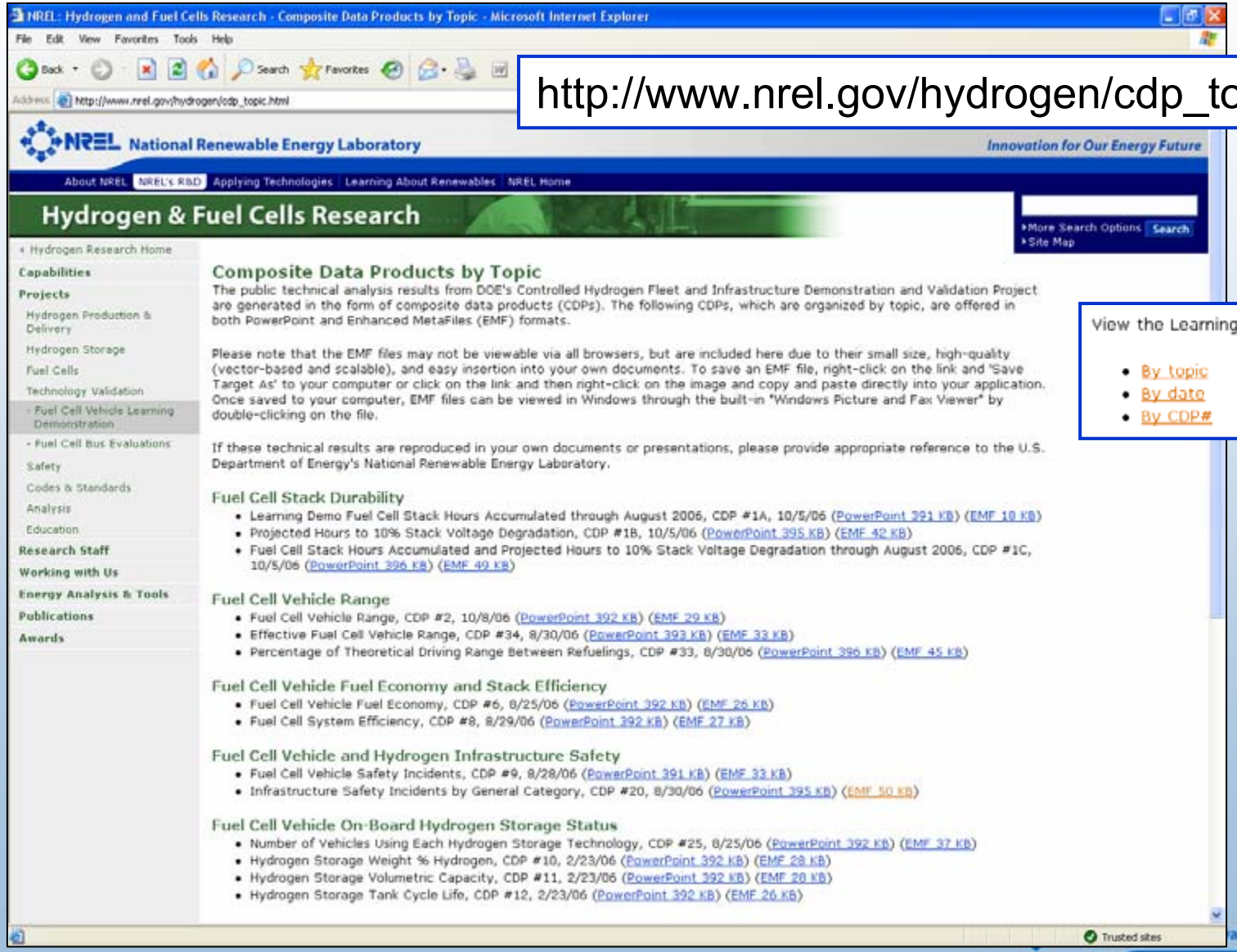


Fall 2006



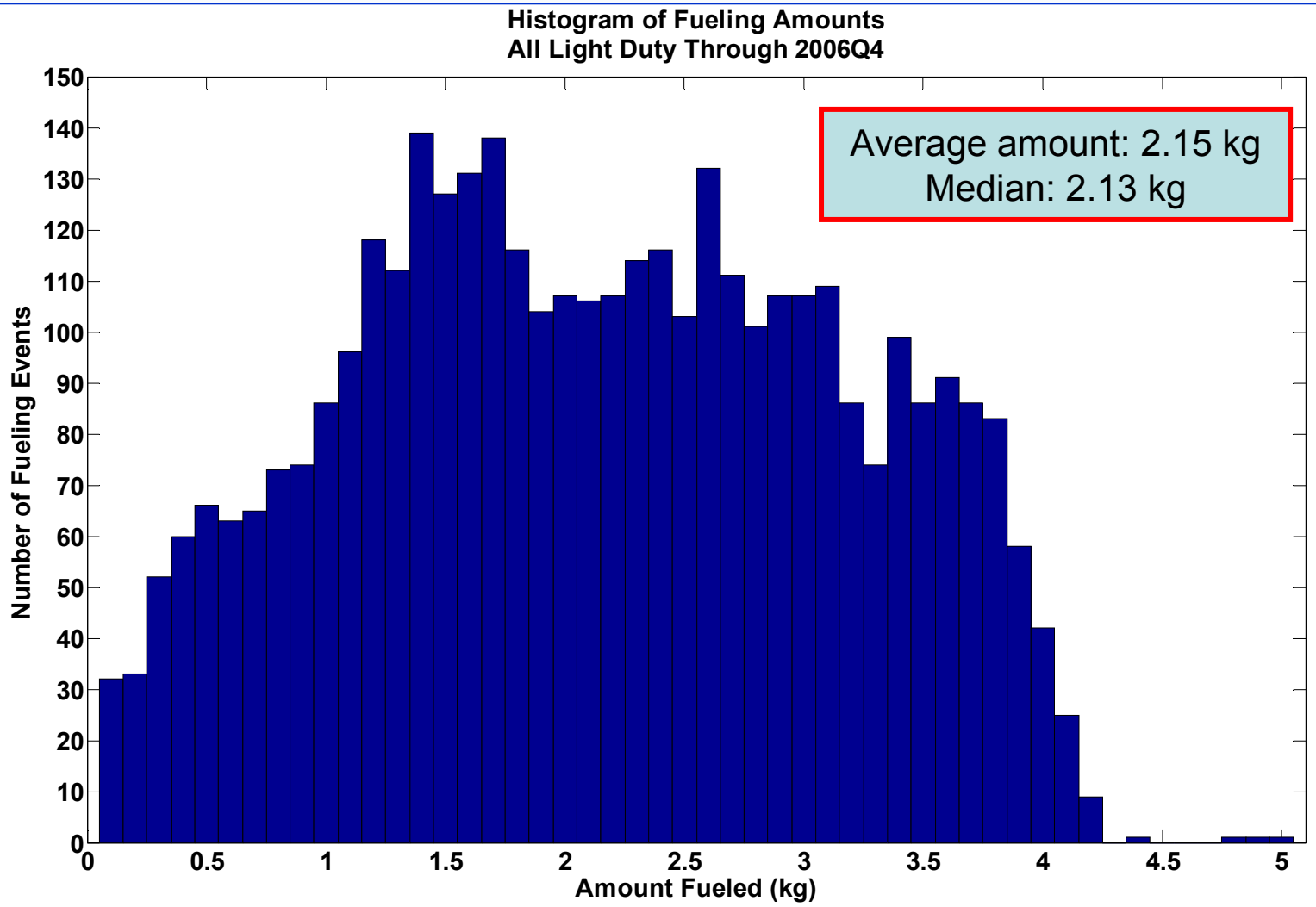
Spring 2007

New Web Site Now Provides Direct Access to Latest Composite Data Products



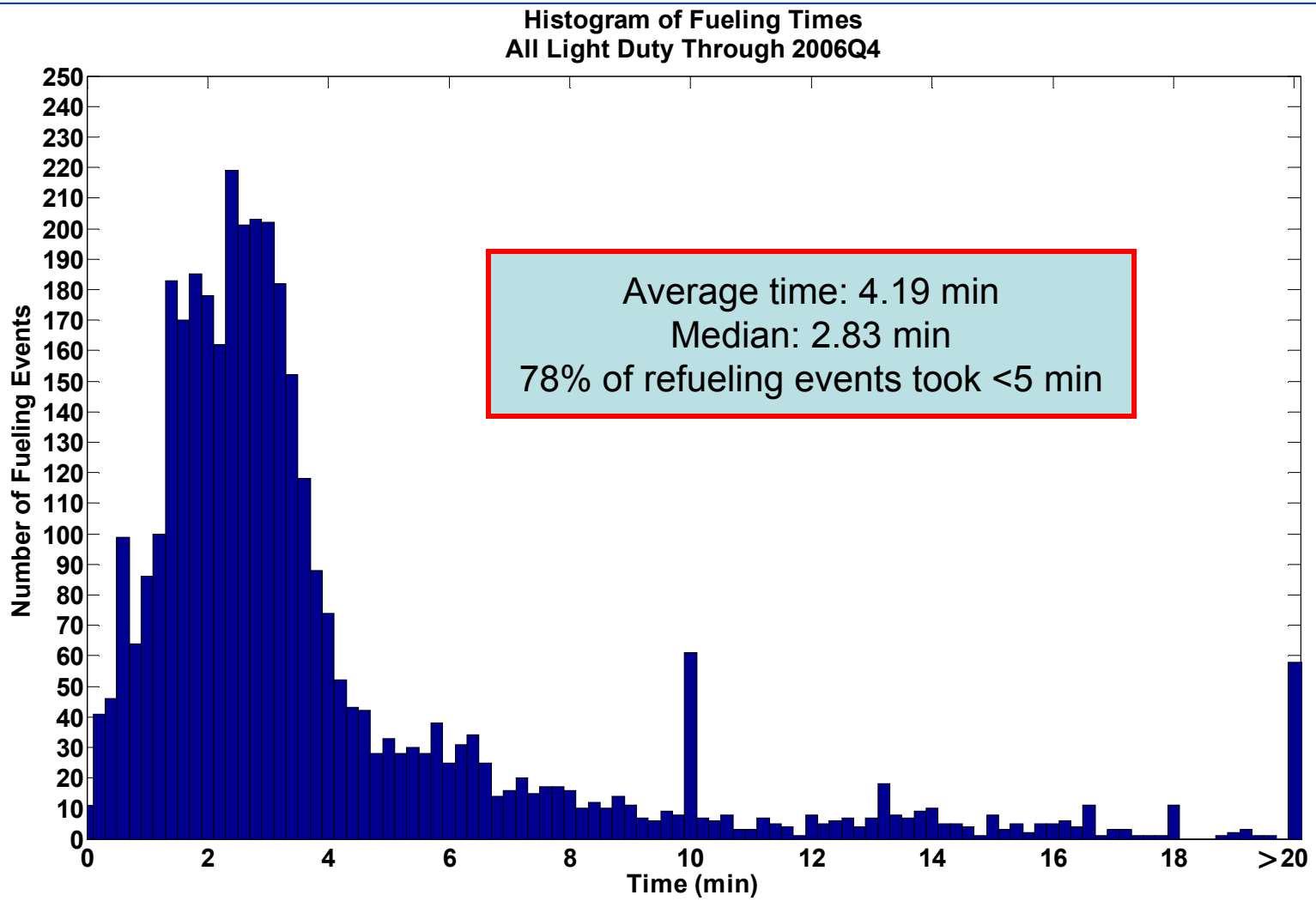
Select New and Updated Learning Demo Results

Actual Vehicle Refueling Amounts from >3700 Events: Measured by Stations or by Vehicles

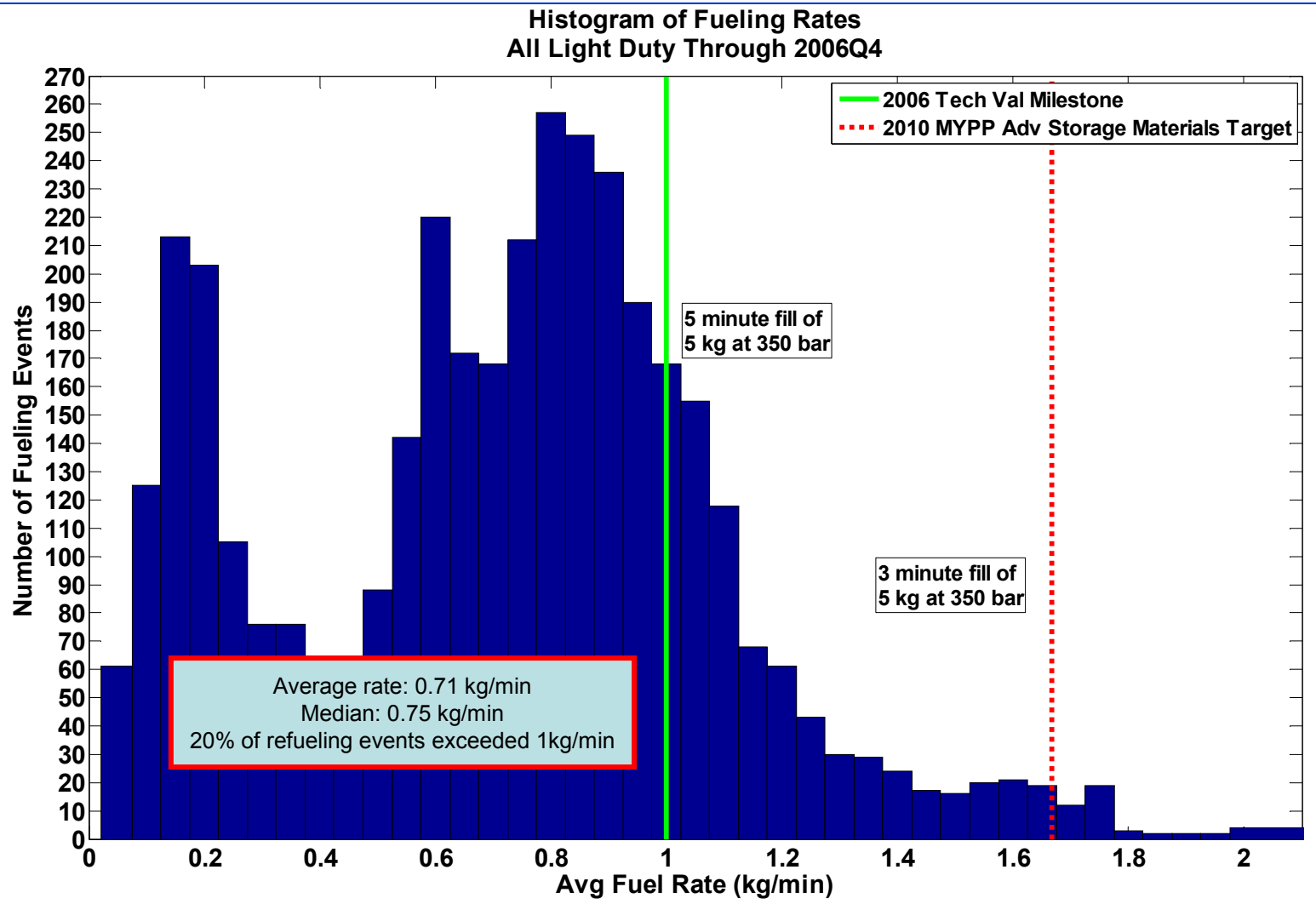


Created: Feb-28-07 1:43 PM

Actual Vehicle Refueling Times from >3700 Events: Measured by Stations or by Vehicles

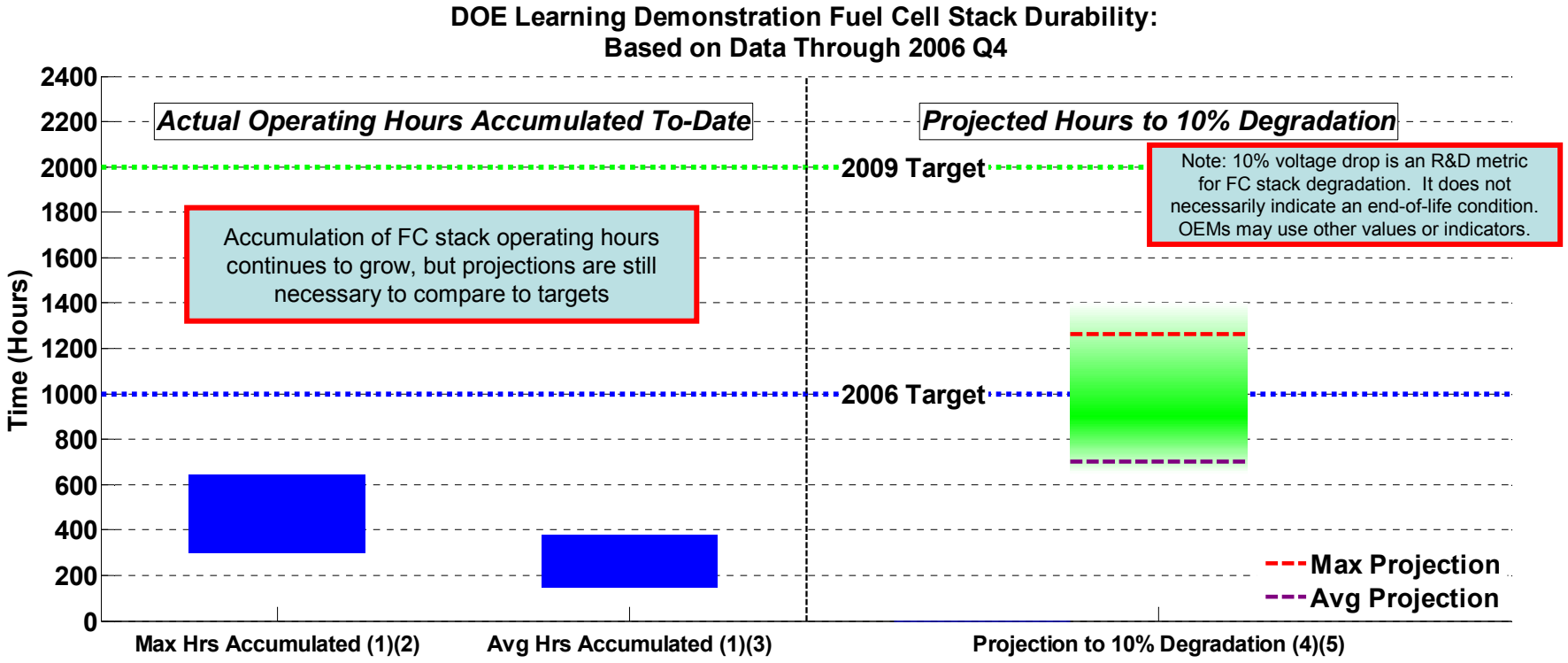


Actual Vehicle Refueling Rates from >3700 Events: Measured by Stations or by Vehicles



Created: Feb-28-07 1:42 PM

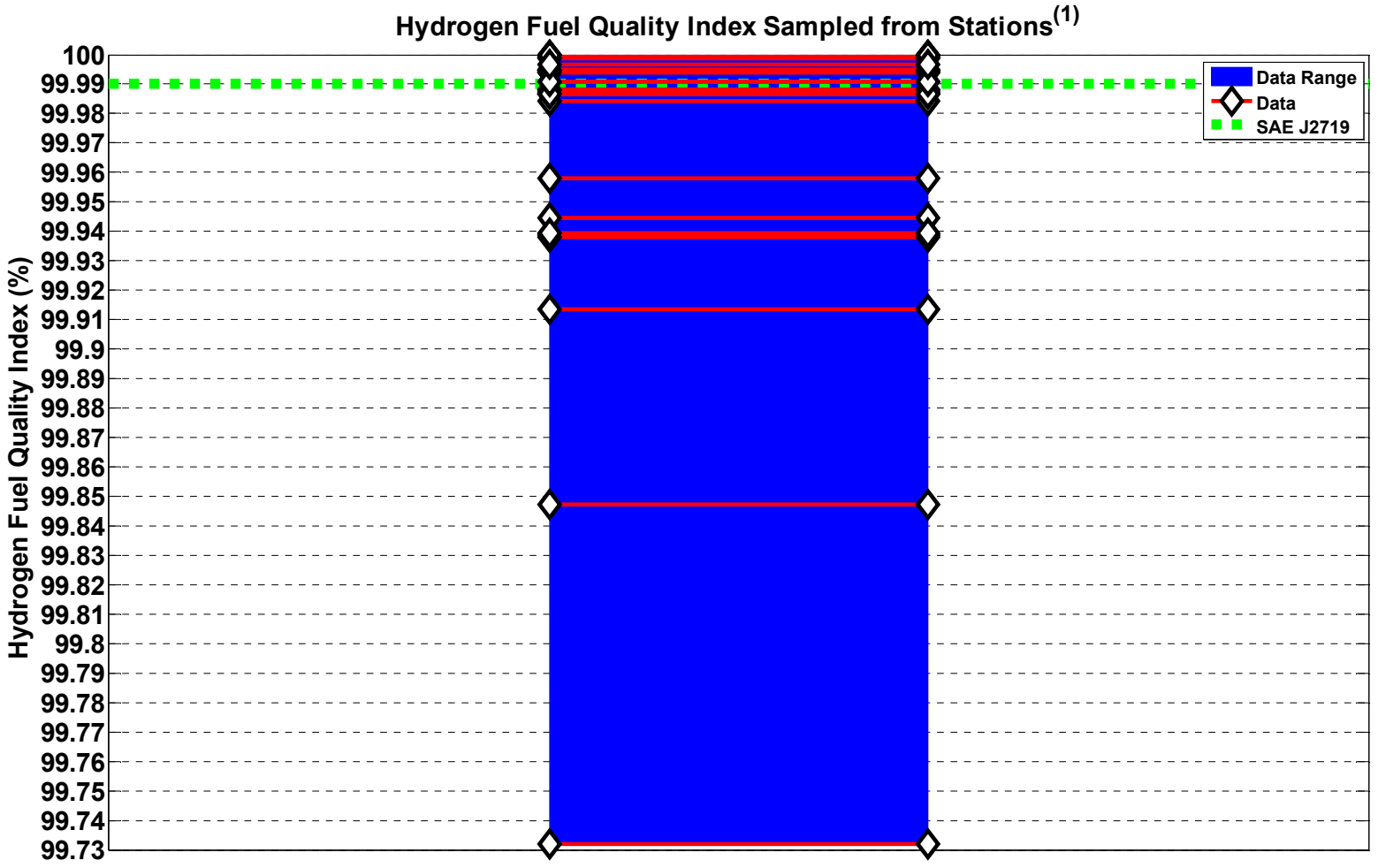
Updated Results for Hours Accumulated and Projected Hours to 10% Stack Voltage Degradation



(1) Range bars created using one data point for each OEM.
(2) Range (highest and lowest) of the maximum operating hours accumulated to-date of any OEM's individual stack in "real-world" operation.
(3) Range (highest and lowest) of the average operating hours accumulated to-date of all stacks in each OEM's fleet.
(4) Projection using on-road data -- degradation calculated at high stack current. This criterion is used for assessing progress against DOE targets, may differ from OEM's end-of-life criterion, and does not address "catastrophic" failure modes, such as membrane failure.
(5) Using one nominal projection per OEM: "Max Projection" = highest nominal projection, "Avg Projection" = average nominal projection. The shaded green bar represents an engineering judgment of the uncertainty due to data and methodology limitations. Projections will change as additional data are accumulated.

Created: Feb-28-07 8:27 PM

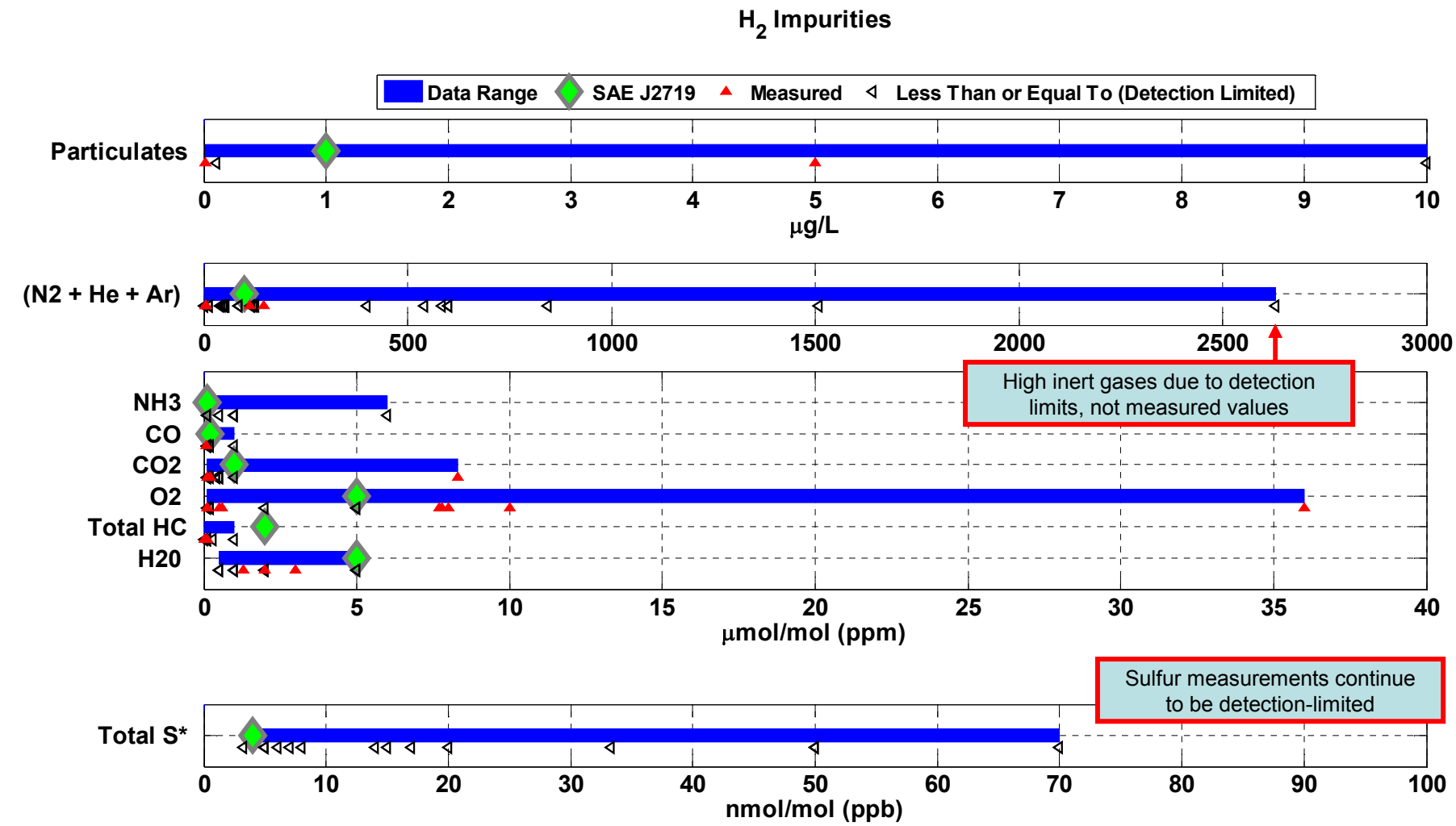
Hydrogen Quality Index Close to Target Except for Some High Inert Gas Measurements



(1) Includes sampling from both electrolysis and reforming

Created: Feb-28-07 12:06 PM

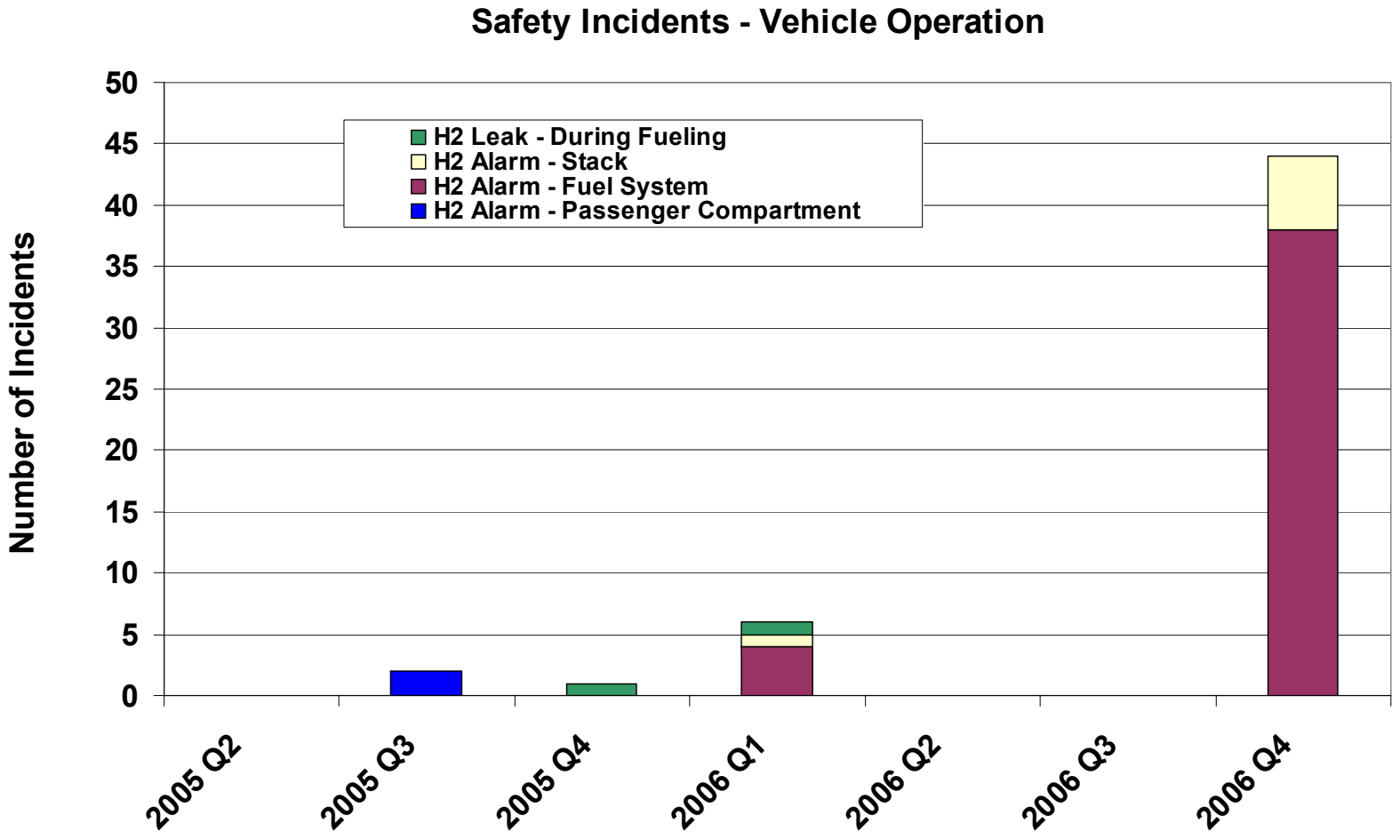
Hydrogen Impurities Sampled from All Stations to Date
In General, Inert Gases and Sulfur Suffer from High Detection Limits



Created: Feb-28-07 12:06 PM

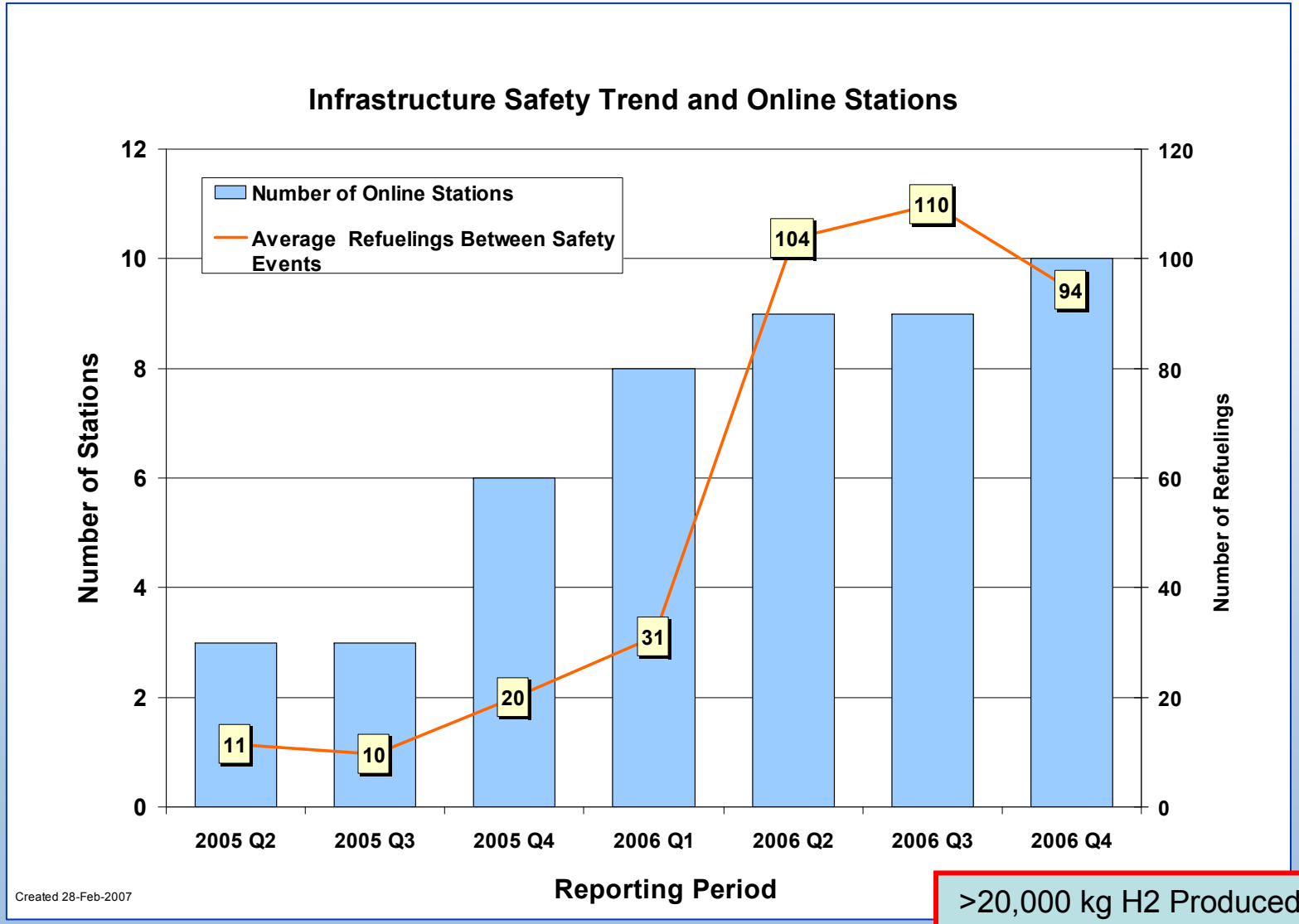
*Calculated from SO2, COS, H2S, CS2, and Methyl Mercaptan (CH3SH).

H2 FCV Safety – An Issue Has Been Identified Relative to H2 Sensor Alarms and is Currently Being Addressed



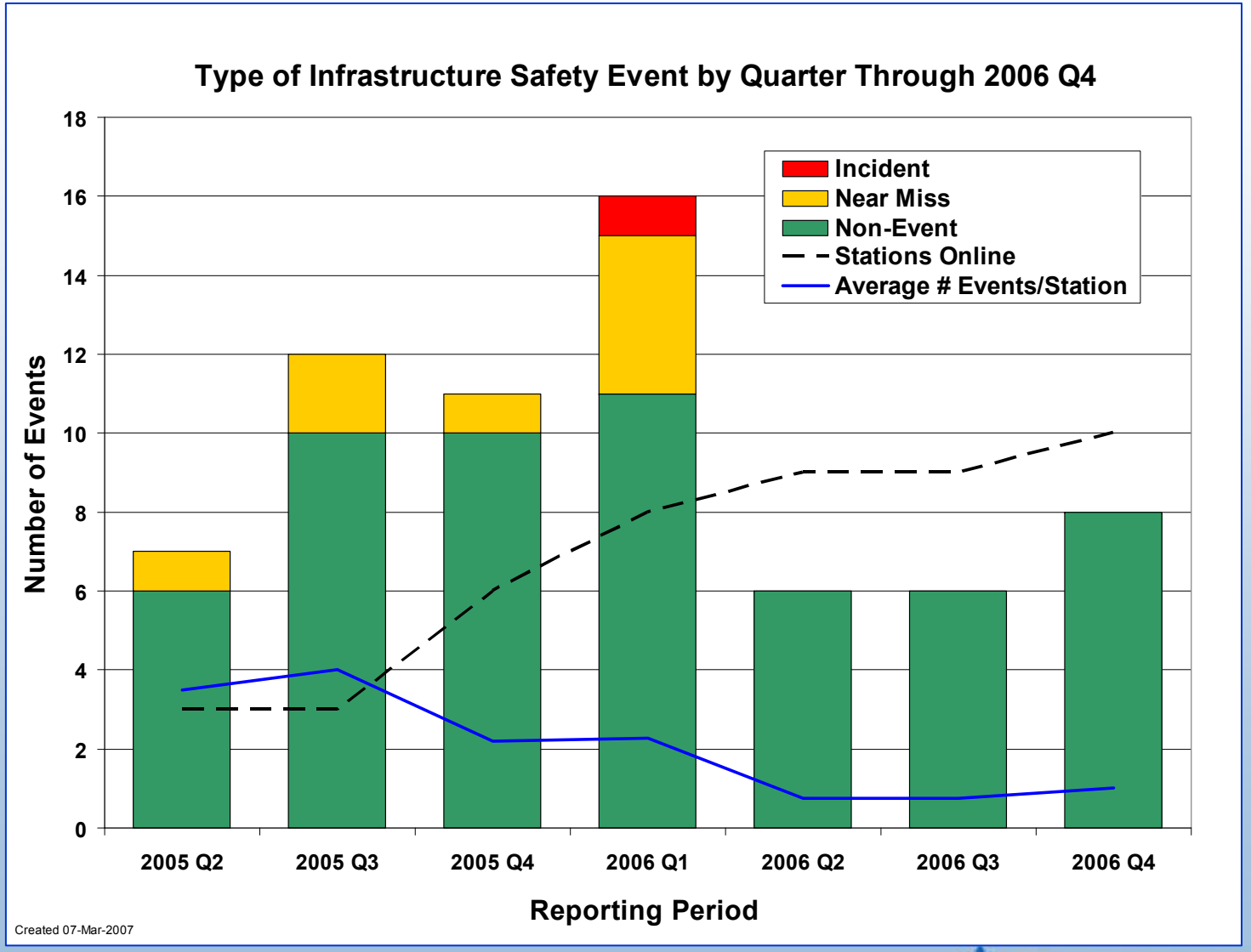
Created: 2/28/07 8:45AM

Average Refuelings Between Infrastructure Safety Events Has Increased by ~10X Since Beginning of Project

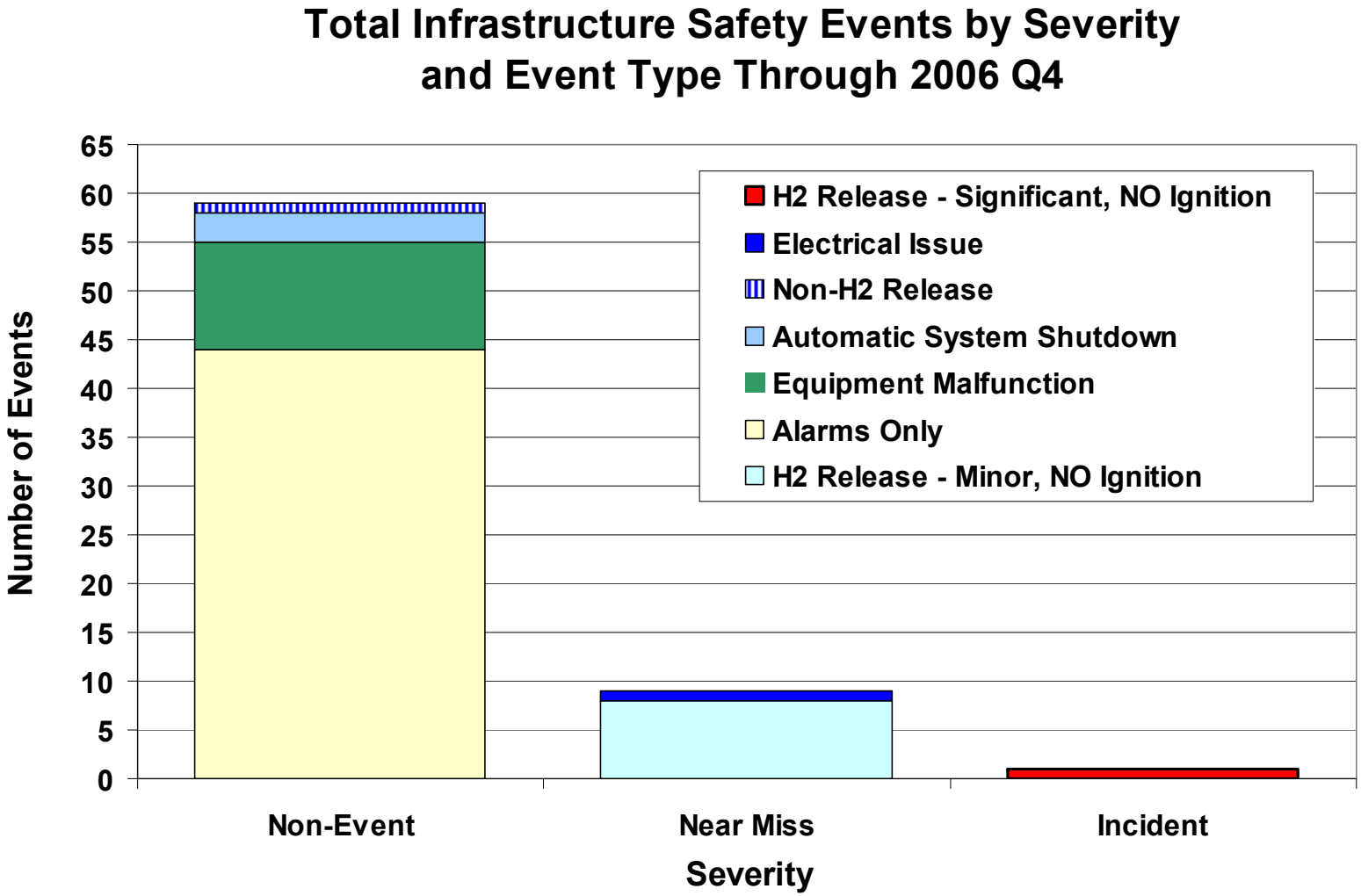


>20,000 kg H2 Produced or Dispensed from this Project

Severity Decreased: Only Infrastructure *Non-Events* Have Been Reported in Last 3 Quarters

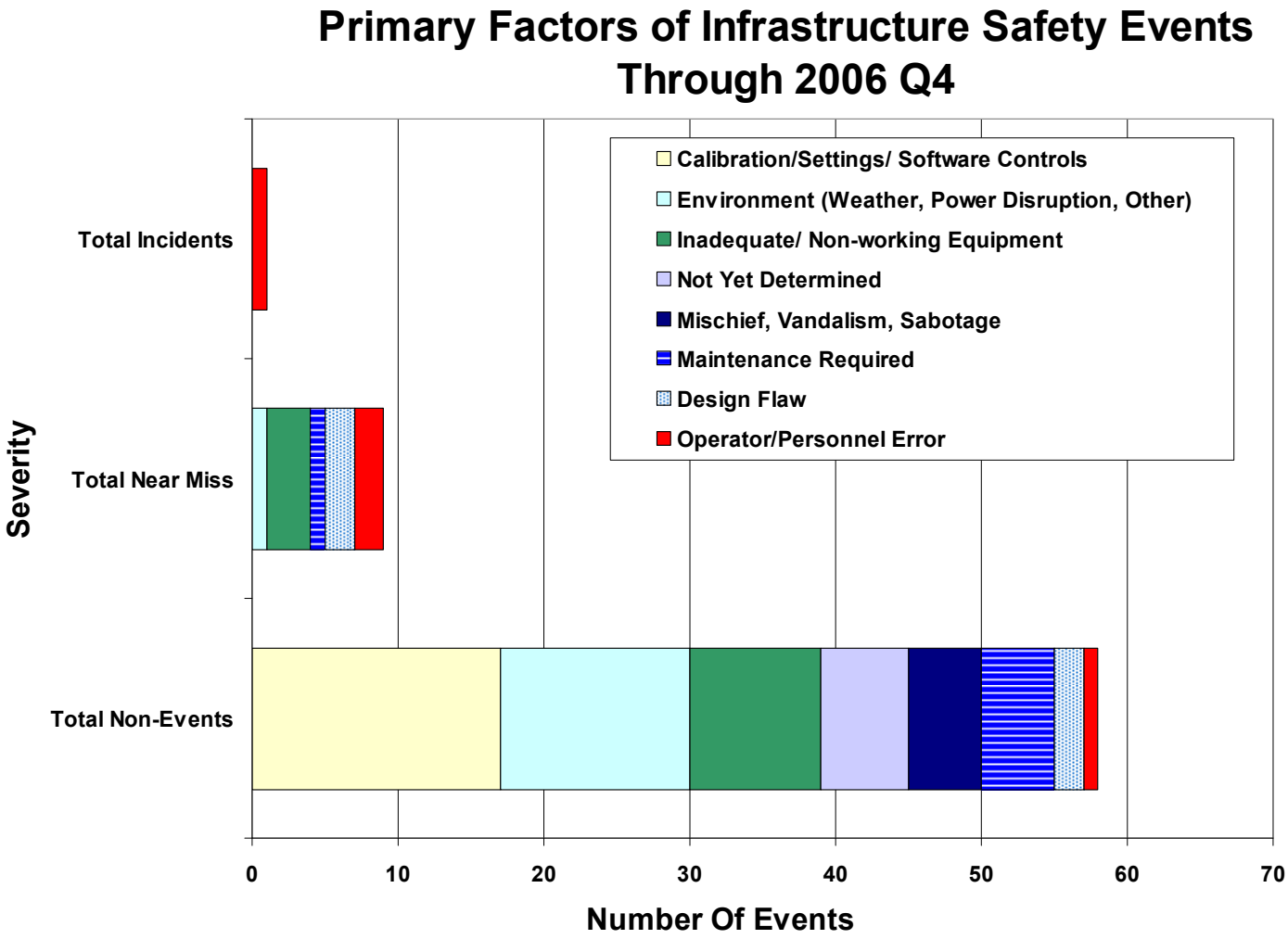


Most of Infrastructure Safety Reports are Non-Events (and Most of Those, Alarms Only)

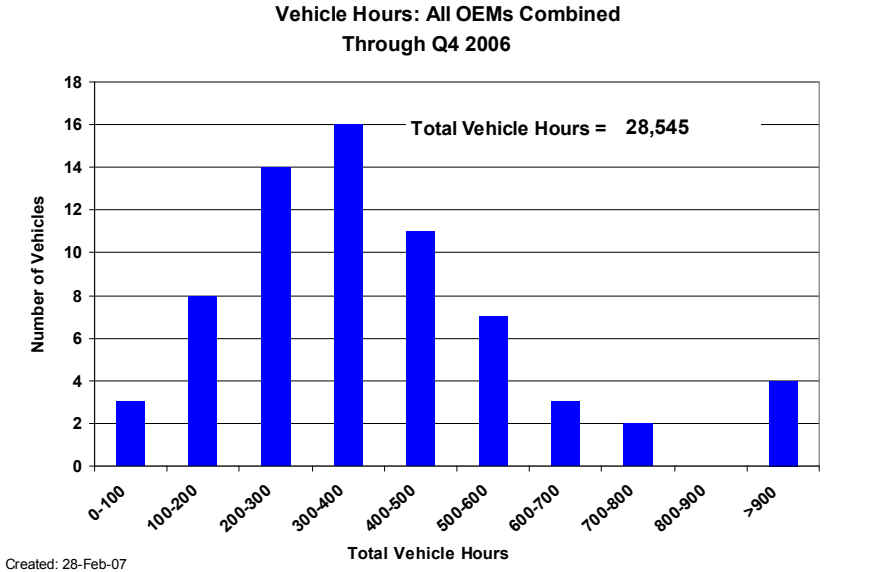


Created 07-Mar-2007

No Single Primary Factor Leading to Majority of Infrastructure Safety Events

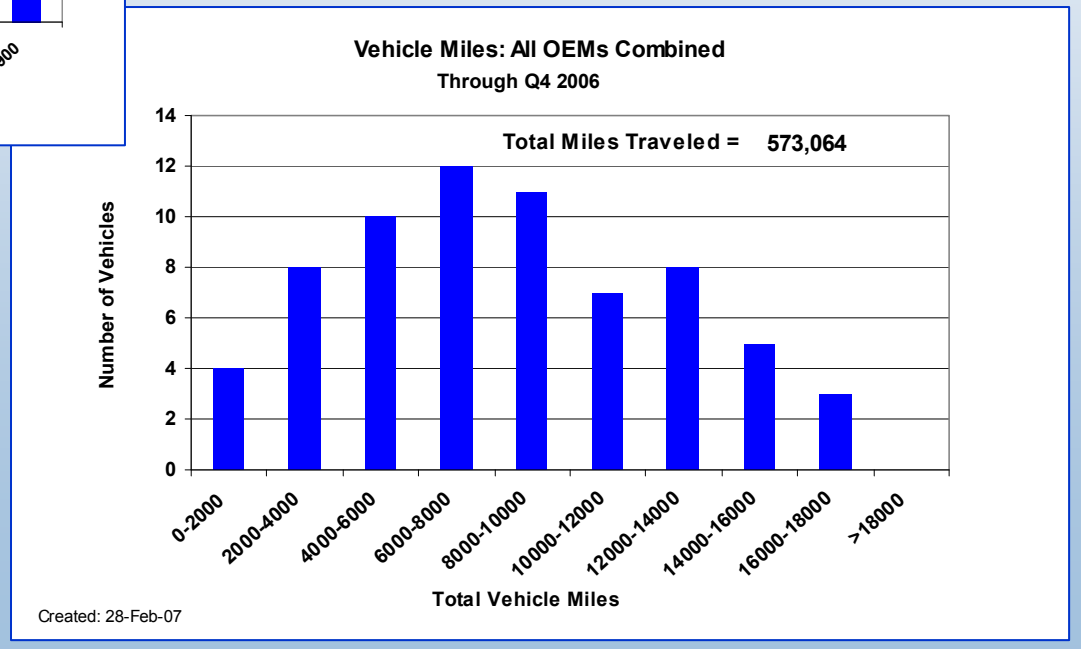


Vehicle Operating Hours and Miles Traveled Distribution



The bulge of operating hours and miles traveled has now shifted to right.

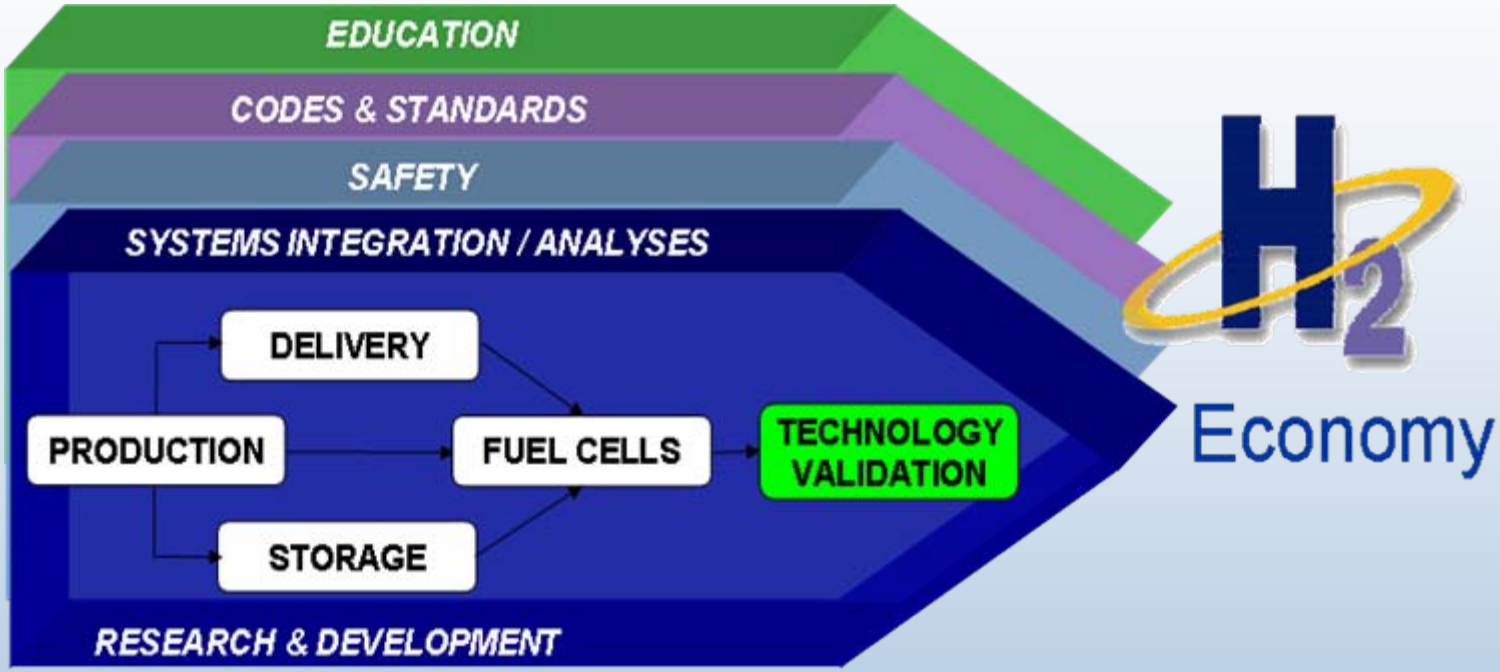
New Gen 1 vehicles continue to be introduced, but 2nd bulge will appear at left with Gen 2 vehicle introduction starting this fall.



Summary

- First half of project completed
  - 69 vehicles and 10 stations deployed
  - 570,000 miles traveled, 20,000 kg H2 produced or dispensed
  - 113,000 individual vehicle trips analyzed
  - Project to continue through 2009
- More detailed examination of project safety now possible
  - Updated data templates allowed more detailed reporting
  - Infrastructure safety has seen dramatic improvement
  - H2 sensor alarm issue being resolved on vehicles
- Compressed H2 refueling time, amount, and rates indicates this technology could meet customer's refueling time expectations
  - Key will be having adequate station coverage
- Total of 30 composite data products published to-date
  - New web site allows direct web access to the most current CDPs

Questions and Discussion



Project Contact: Keith Wipke, National Renewable Energy Lab
303.275.4451 keith_wipke@nrel.gov

All public Learning Demo papers and presentations are available online at http://www.nrel.gov/hydrogen/proj_tech_validation.html