2007 DOE Hydrogen, Fuel Cells & Infrastructure Technologies
Program Review

Controlled Hydrogen Fleet and Infrastructure Analysis

Keith Wipke, Senior Engineer II
NREL
May 17, 2007

Project ID# TV-5

This presentation does not contain any proprietary, confidential, or otherwise restricted information

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

Project Overview

Timeline

- Project start: FY03
- Project end: FY09
- ~50% of Task III complete (see timeline slide)

Budget

- Context: Overall DOE project is ~$170M project over 5 years
  - Equal investment by industry
- NREL funding prior to FY06 : $1380K
- NREL FY06 funding: $812K
- NREL FY07 funding: $850K

Partners

- See partner slide

Tech. Val. Barriers

A. **Vehicles** – lack of controlled & on-road H_2 vehicle and FC system data

B. **Storage** – technology does not yet provide necessary 300+ mile range

C. **Hydrogen Refueling Infrastructure** – cost and availability

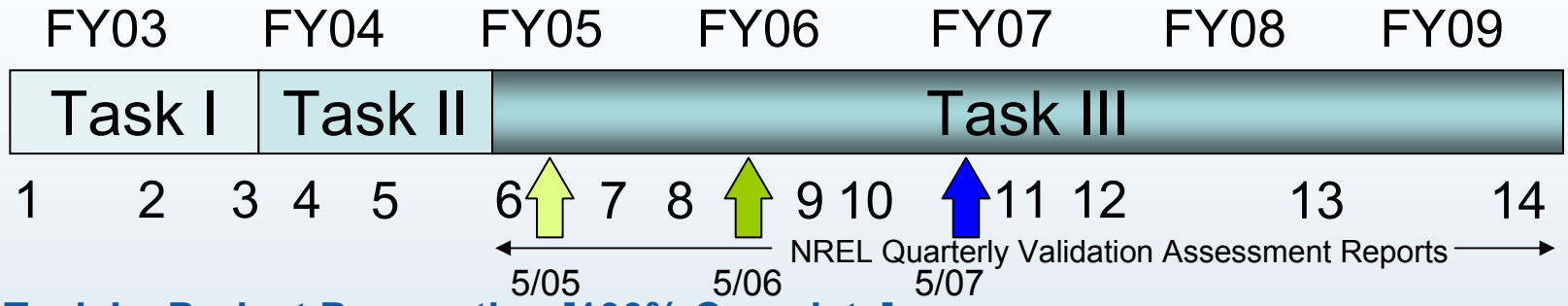
D. **Maintenance and Training Facilities** – lack of facilities and trained personnel

E. **Codes and Standards** – lack of adoption/validation

H. **Hydrogen Production from Renewables** – need for cost, durability, efficiency data for vehicular application

I. **H_2 and Electricity Co-Production** – cost and durability

Project Timeline

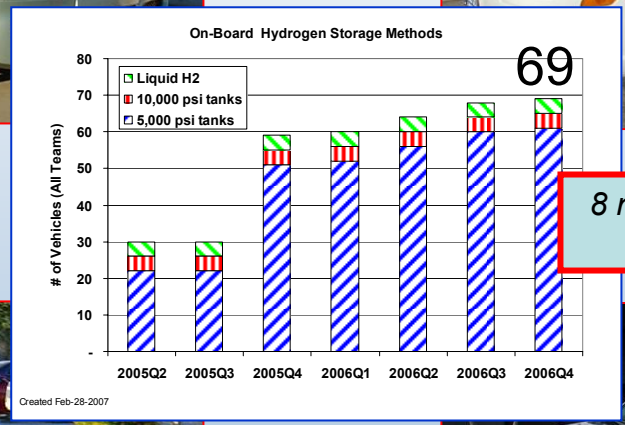


- **Task I – Project Preparation [100% Complete]**
  - 1 Support development of RFP, statement of objectives (Appendix C)
  - 2 Bidder's meeting in Detroit – launch of RFP
  - 3 Create data analysis plan and presentation for discussion with industry
- **Task II – Project Launch [100% Complete]**
  - 4 Announcement of successful bidders (4/04)
  - 5 Kick-off meetings and cooperative agreement awards
- **Task III – Data Analysis and Feedback to R&D activities (partial list) [50% Complete]**
  - 6 Preliminary data collection, analysis, and first quarterly assessment report
  - 7 Demonstrate FCVs that achieve 50% higher fuel economy than gasoline vehicles
  - 8 Publication of first "composite data products"
  - 9 Evaluate FC stack time to 10% voltage degradation relative to 1000-hour target
  - 10 Decision for purchase of additional vehicles based on performance, durability, cost
  - 11 Preliminary evaluation of dominant real-world factors influencing FC degradation
  - 12 Introduction of 2nd generation FC systems into vehicles
  - 13 FCVs demonstrate 250-mile range without impacting passenger cargo compartment
  - 14 Validate FCVs with 2,000 hour durability and $3.00/gge (based on volume production)

Industry Partners: 4 Automaker/Energy-Supplier Teams; Rollout: More than Half Project Vehicles Now Deployed

DaimlerChrysler bp

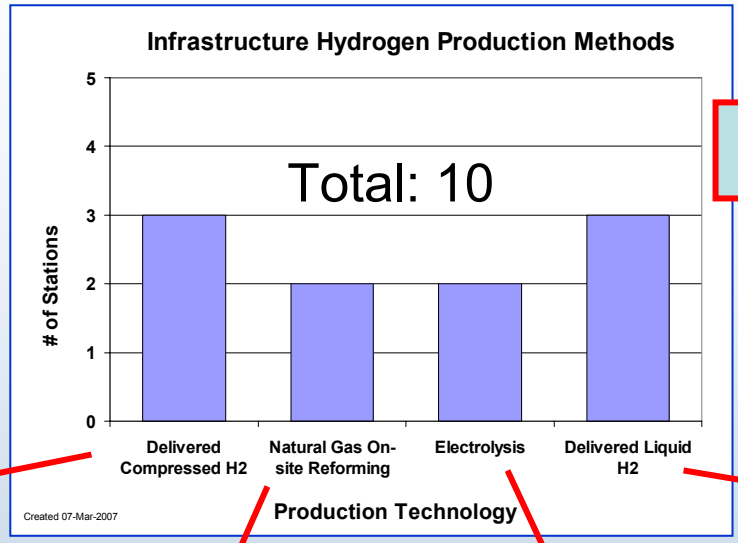
Ford bp



*8 new vehicles added since 12/06 for total of **77***

GM Shell Chevron Hyundai KIA

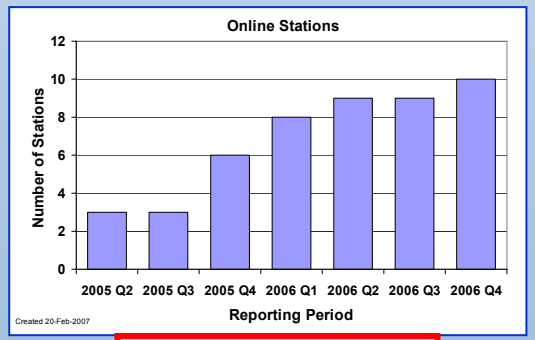
~Half of the Project's Infrastructure to Refuel Vehicles Has Been Installed – 4 Types (examples)



*2 new stations added since 12/06 for a total of **12***

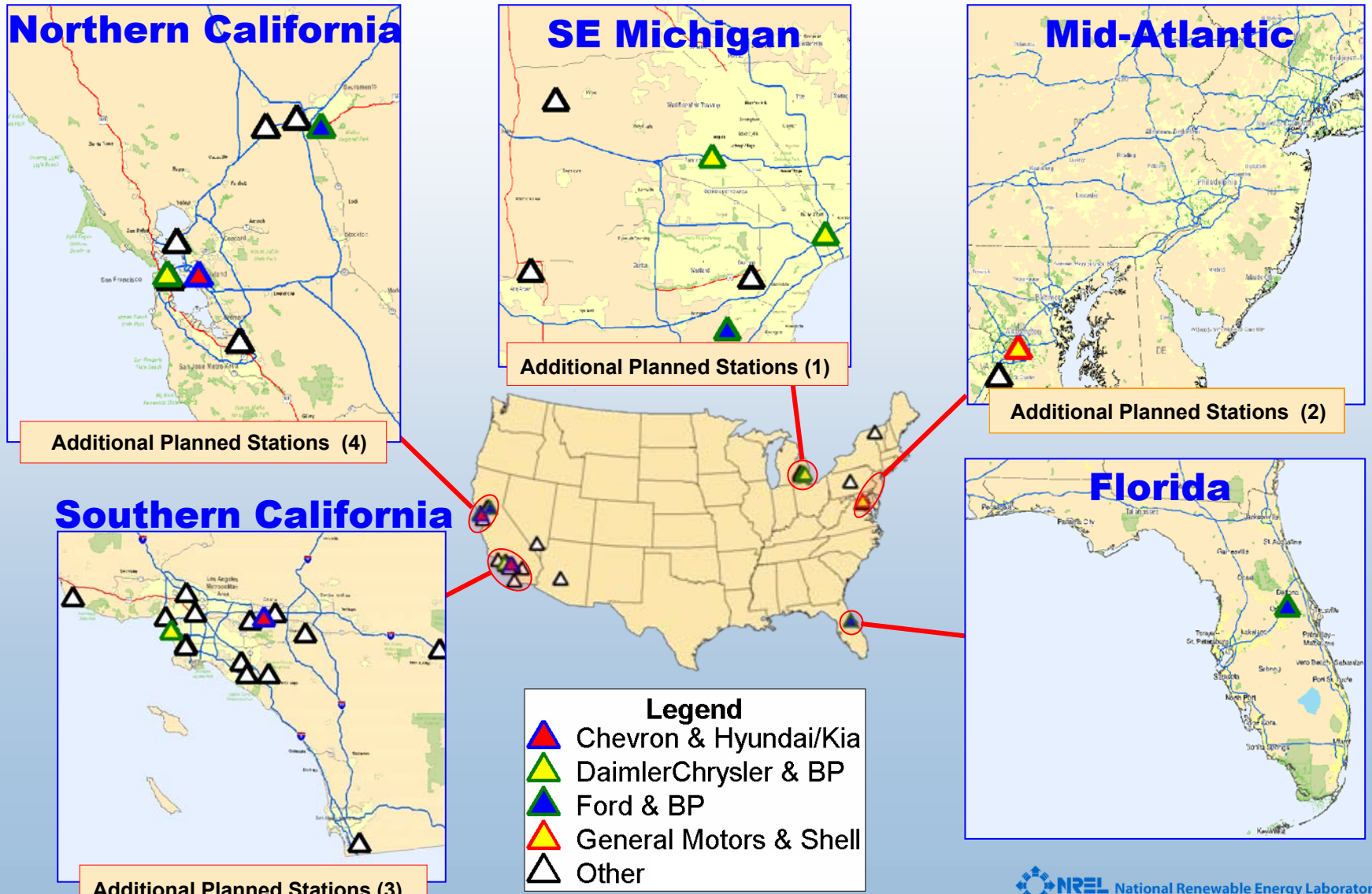
Mobile Refueler
San Francisco, CA

Hydrogen and gasoline station
Washington, DC



4 stations added in 2006

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



Project Approach

- Provide facility and staff for securing and analyzing industry sensitive data
  - NREL Hydrogen Secure Data Center (HSDC)
- Perform analysis and simulation using detailed data in HSDC to:
  - Evaluate current status and progress toward targets
  - Feedback current technical challenges and opportunities into DOE H_2 R&D program
  - Provide analytical results to originating companies on their own data (detailed data products)
- Publish/present progress of project to public and stakeholders (composite data products)

Approach: Providing Data Analysis and Results for Both the Public and the Industry Project Teams

Raw Data, Reports

Hydrogen Secure Data Center (HSDC)

- Located at NREL: Strictly Controlled Access
- Detailed Analyses, Data Products, Internal Reports

Composite Data Products

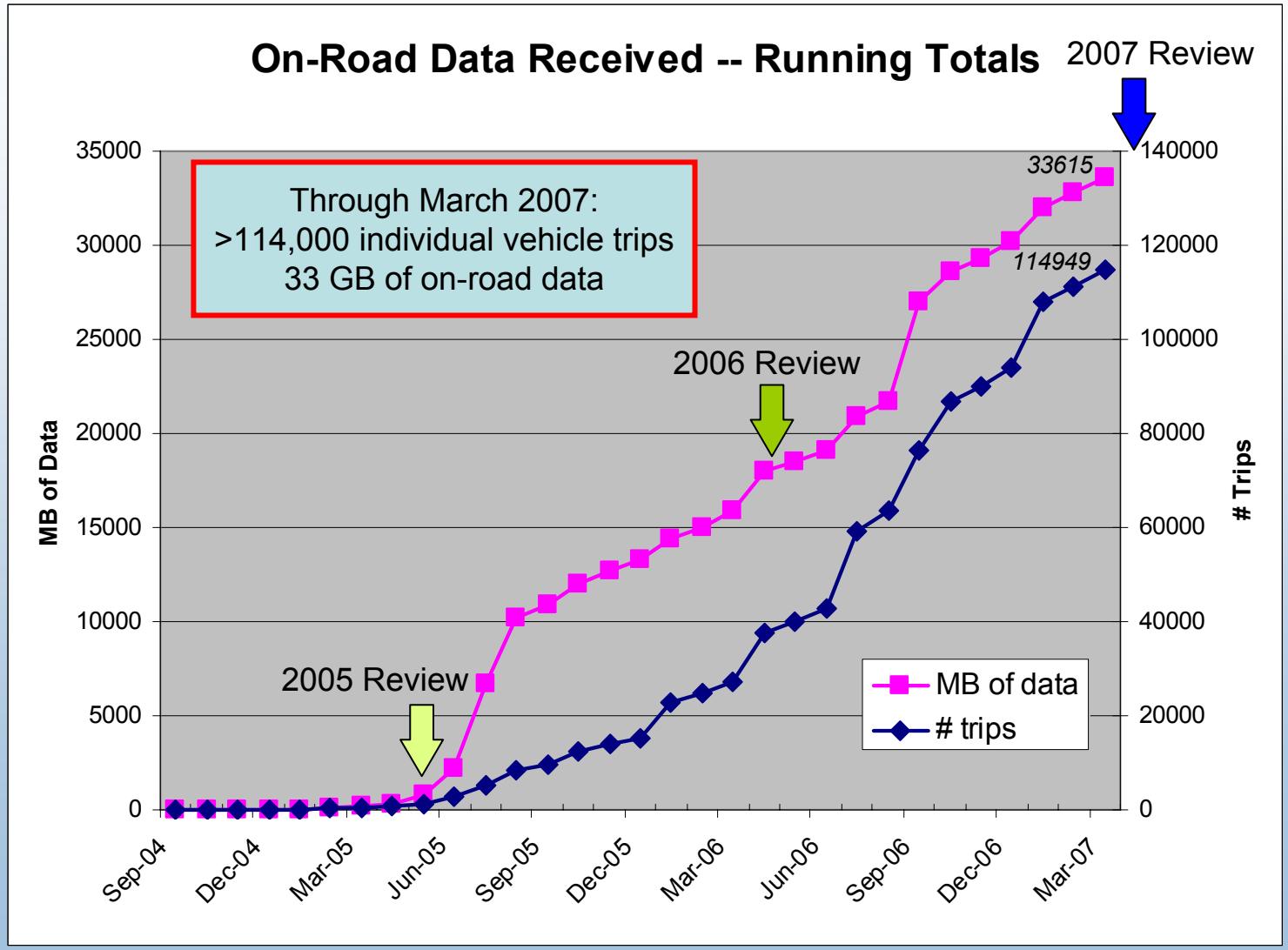
- Pre-agreed upon aggregate data results for public
- No confidential information

Detailed Data Products

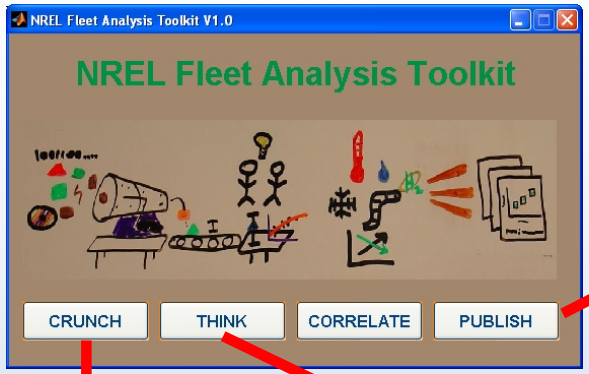
- Only shared with company which originated the data

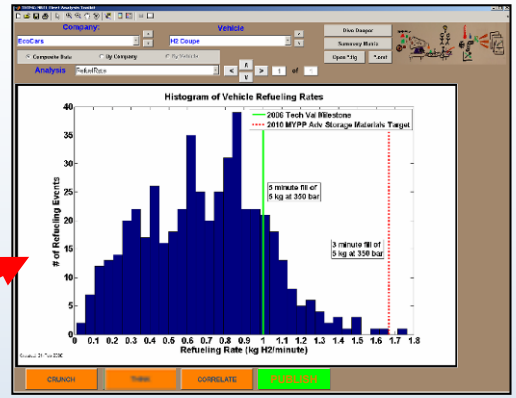
Accomplishment: Seven Quarters of Data Analyzed to Date

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

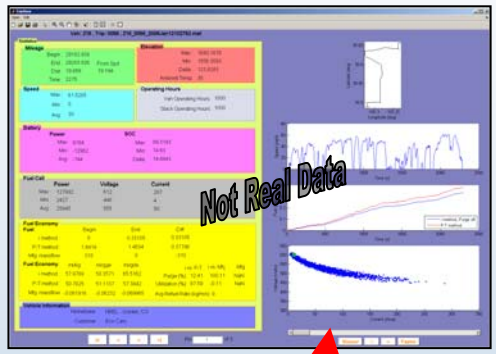


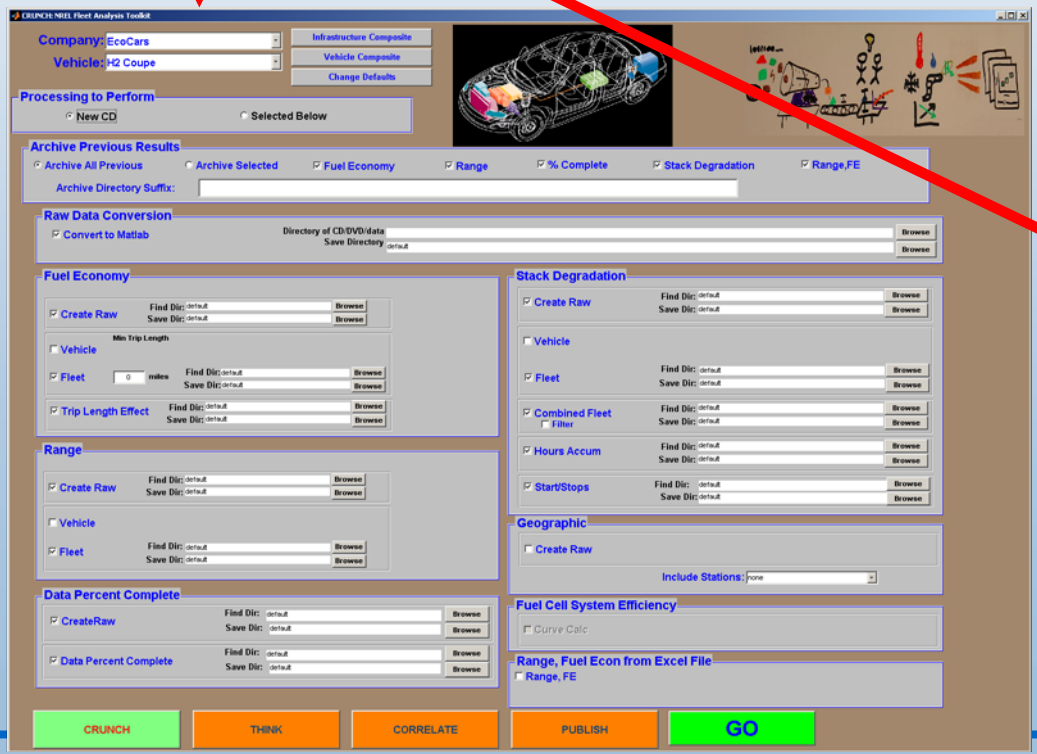
Accomplishment: Generated All Results Using NREL-Developed GUI – Fleet Analysis Toolkit (FAT)

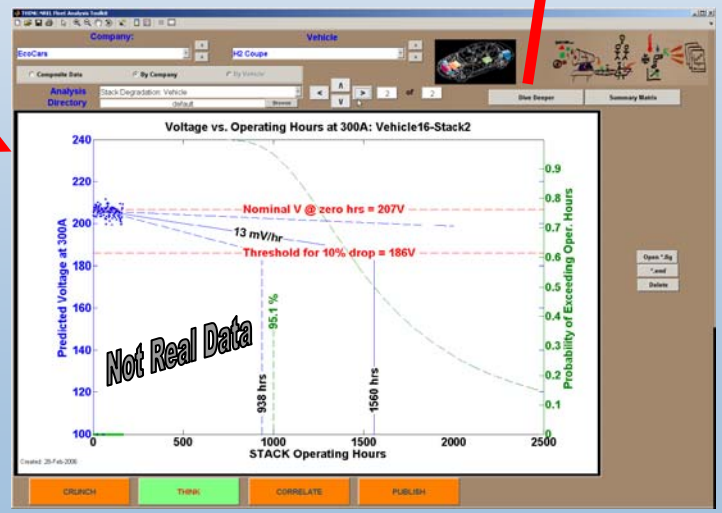




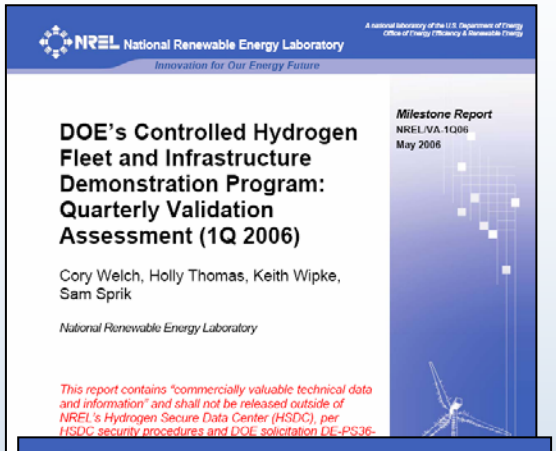
TripView

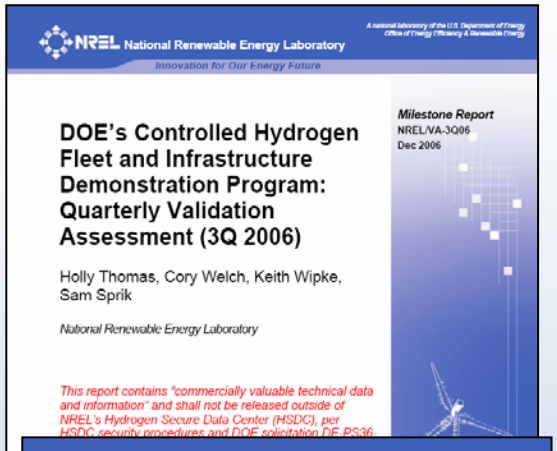


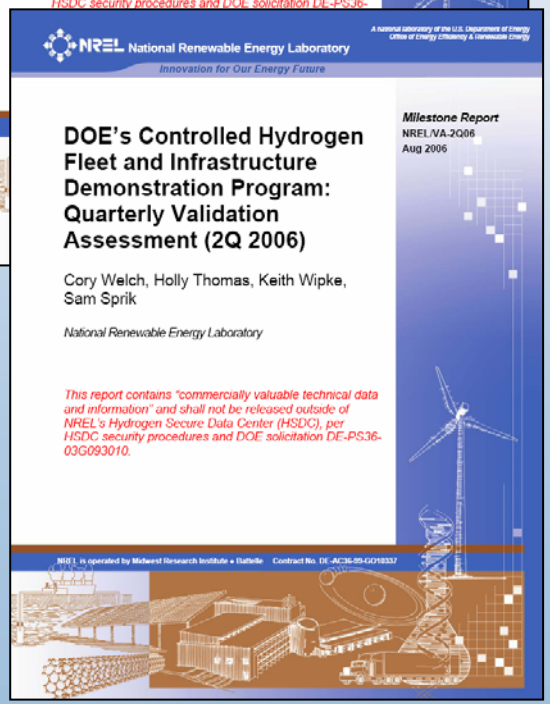


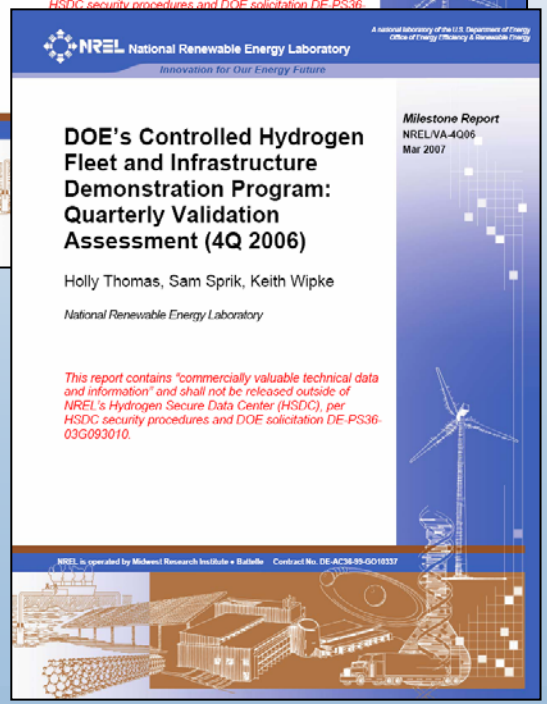


Accomplishment: Completion of Four New Quarterly Technology Validation Assessment Reports









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(Typical TOC)

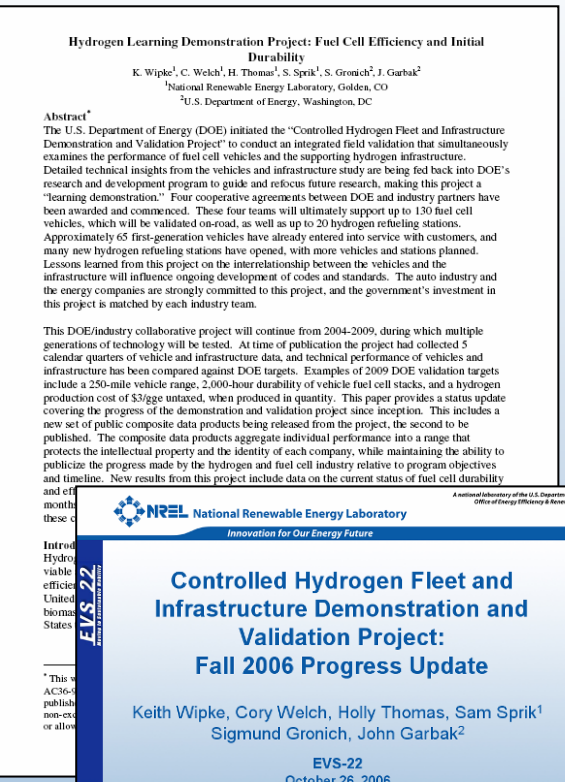
- Internal reports document detailed methodology and results (called detailed data products)
- Shared only with DOE in HSDC
- Used to help guide DOE H_2 R&D

Accomplishment: 2nd Set of Composite Data Products Published at EVS-22 and FC Seminar

FC Seminar

EVS-22 Conf.

WEVA Journal



Hydrogen Learning Demonstration Project: Fuel Cell Efficiency and Initial Durability

K. Wipke[1], C. Welch[1], H. Thomas[1], S. Sprik[1], S. Gronich[2], J. Garbak[2]

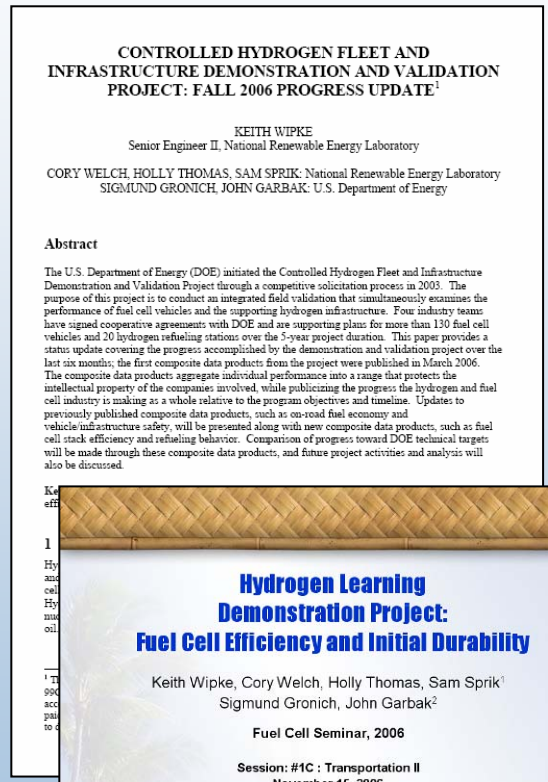
[1]National Renewable Energy Laboratory, Golden, CO

[2]U.S. Department of Energy, Washington, DC

Abstract*

The U.S. Department of Energy (DOE) initiated the "Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project" to conduct an integrated field validation that simultaneously examines the performance of fuel cell vehicles and the supporting hydrogen infrastructure. Detailed technical insights from the vehicles and infrastructure study are being fed back into DOE's research and development program to guide and refocus future research, making this project a "learning demonstration." Four cooperative agreements between DOE and industry partners have been awarded and commenced. These four teams will ultimately support up to 130 fuel cell vehicles, which will be validated on-road, as well as up to 20 hydrogen refueling stations. Approximately 65 first-generation vehicles have already entered into service with customers, and many new hydrogen refueling stations have opened, with more vehicles and stations planned. Lessons learned from this project on the interrelationship between the vehicles and the infrastructure will influence ongoing development of codes and standards. The auto industry and the energy companies are strongly committed to this project, and the government's investment in this project is matched by each industry team.

This DOE/industry collaborative project will continue from 2004-2009, during which multiple generations of technology will be tested. At time of publication the project had collected 5 calendar quarters of vehicle and infrastructure data, and technical performance of vehicles and infrastructure has been compared against DOE targets. Examples of 2009 DOE validation targets include a 250-mile vehicle range, 2,000-hour durability of vehicle fuel cell stacks, and a hydrogen production cost of $3/gge untaxed, when produced in quantity. This paper provides a status update covering the progress of the demonstration and validation project since inception. This includes a new set of public composite data products being released from the project, the second to be published. The composite data products aggregate individual performance into a range that protects the intellectual property and the identity of each company, while maintaining the ability to publicize the progress made by the hydrogen and fuel cell industry relative to program objectives and timeline. New results from this project include data on the current status of fuel cell durability



CONTROLLED HYDROGEN FLEET AND INFRASTRUCTURE DEMONSTRATION AND VALIDATION PROJECT: FALL 2006 PROGRESS UPDATE[1]

KEITH WIPKE
Senior Engineer II, National Renewable Energy Laboratory

CORY WELCH, HOLLY THOMAS, SAM SPRIK: National Renewable Energy Laboratory
SIGMUND GRONICH, JOHN GARBAK: U.S. Department of Energy

Abstract

The U.S. Department of Energy (DOE) initiated the Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project through a competitive solicitation process in 2003. The purpose of this project is to conduct an integrated field validation that simultaneously examines the performance of fuel cell vehicles and the supporting hydrogen infrastructure. Four industry teams have signed cooperative agreements with DOE and are supporting plans for more than 130 fuel cell vehicles and 20 hydrogen refueling stations over the 5-year project duration. This paper provides a status update covering the progress accomplished by the demonstration and validation project over the last six months; the first composite data products from the project were published in March 2006. The composite data products aggregate individual performance into a range that protects the intellectual property of the companies involved, while publicizing the progress the hydrogen and fuel cell industry is making as a whole relative to the program objectives and timeline. Updates to previously published composite data products, such as on-road fuel economy and vehicle/infrastructure safety, will be presented along with new composite data products, such as fuel cell stack efficiency and refueling behavior. Comparison of progress toward DOE technical targets will be made through these composite data products, and future project activities and analysis will also be discussed.

WEVA-2006-001

Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

Initial Fuel Cell Efficiency and Durability Results

Keith Wipke*, Cory Welch*, Holly Thomas*, Sam Sprik*, Sigmund Gronich**, John Garbak**

The objective of the U.S. Department of Energy's "Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project" is to conduct an integrated field validation that simultaneously examines the performance of fuel cell vehicles and the supporting hydrogen infrastructure. This paper provides initial results in the form of composite data products, which aggregate individual performance into a range that protects the intellectual property and the identity of each industry team, while showing overall industry progress toward technology readiness. Technical insights from the project are fed back into DOE's research and development program, making this project a "learning demonstration." Key results to-date include fuel economy, driving range, fuel cell efficiency, and initial fuel cell durability projections based on voltage degradation.

Keywords: fuel cell vehicles, FC stack, vehicle performance, hydrogen infrastructure, energy efficiency.

1. INTRODUCTION***

Hydrogen fuel cell vehicles are being developed and tested for their potential as commercially viable and highly efficient zero-tailpipe-emission vehicles. Using hydrogen fuel and high-efficiency fuel cell vehicles provides environmental and fuel feedstock diversity benefits to the United States. Hydrogen can be derived from a mixture of renewable sources, natural gas, biomass, coal, and nuclear energy. Many of the potential feedstocks would enable the United States to reduce emissions and decrease its dependence on foreign oil. However, numerous technical barriers remain before hydrogen fuel cell vehicles are commercially viable. Significant resources from private industry and government are being devoted to overcoming these barriers.

The U.S. Department of Energy (DOE) is working with industry to further develop hydrogen technologies through its Hydrogen, Fuel Cells & Infrastructure Technologies (HFCIT) Program. This multi-faceted program simultaneously addresses hydrogen production, storage, delivery, conversion (fuel cells), technology validation, education, safety, and codes and standards. Many key technical barriers, such as hydrogen storage and fuel cell durability, have been identified and are being addressed. Additional challenges may become apparent through integrated, real-world application of hydrogen technologies. Prior to this project, the number of fuel cell vehicles in service was small, and vehicle operation was focused primarily in California, limiting the quantity and geographic diversity of data collected. To address vehicle and refueling infrastructure issues simultaneously, DOE is conducting a large-scale "learning demonstration" involving automotive manufacturers and fuel providers that is called the "Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project."

This project will ultimately support more than 130 fuel cell vehicles, which will be validated on-road, as well as about 19 hydrogen refueling stations. Sixty-three first-generation vehicles have already entered into service with customers, and are currently supported by 10 hydrogen refueling stations with more vehicles and stations planned. Estimated government investment in this 5-year project will be about $170 million; including cost-share from industry total projected expenditures are over $350 million.

2. PROJECT OBJECTIVES AND TARGETS

One of the HFCIT Program's key objectives is to conduct parallel learning demonstrations of hydrogen infrastructure and fuel cell vehicles to evaluate the status of the technology and identify remaining

* National Renewable Energy Laboratory, 1617 Cole Blvd., Golden, CO. 80401; e-mail: keith_wipke@nrel.gov
** U.S. Dept. of Energy, 1000 Independence Ave. SW, Washington, DC. 20585, e-mail: Sigmund.Gronich@hq.doe.gov
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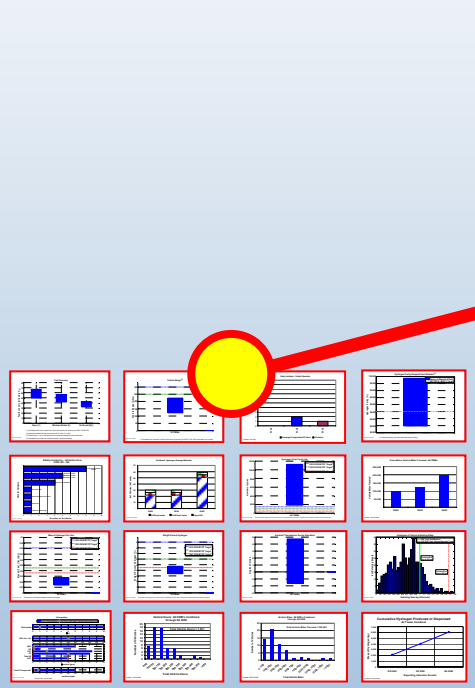
WEVA Journal, Vol. 1, 2006 1

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

Accomplishment: 3rd Set of Composite Data Products Published at NHA; Updates/Additions Every Six Months

30 Composite Data Products Have Now Been Published



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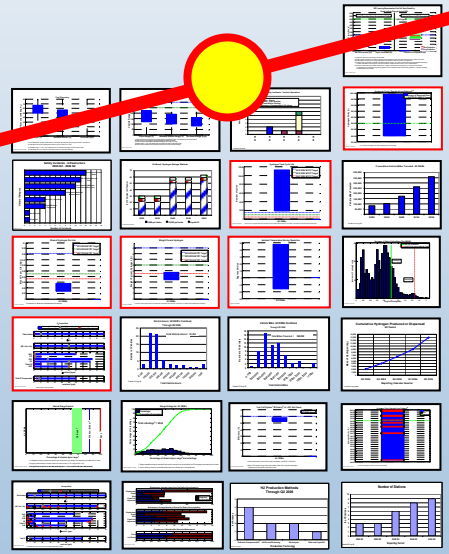
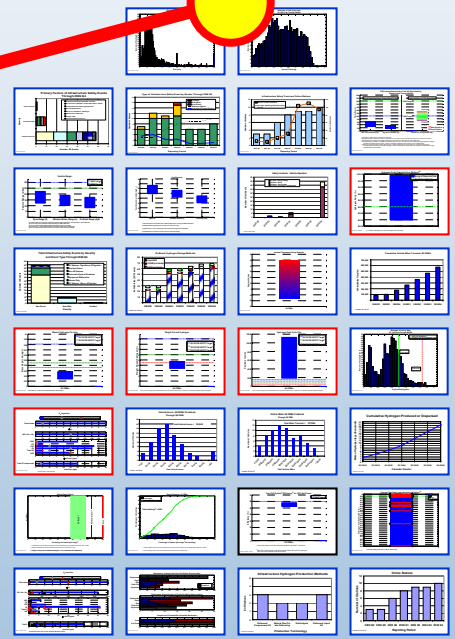


EVS-22, FC Seminar,
WEVA Journal



NHA Conf,
DOE Annual Review

Spring 2006 **Fall 2006** **Spring 2007**

Accomplishment: Created Web Pages to Provide Direct Access to Latest Composite Data Products

NREL: Hydrogen and Fuel Cells Research - Composite Data Products by Topic - Microsoft Internet Explorer

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Address http://www.nrel.gov/hydrogen/cdp_topic.html

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Composite Data Products by Topic

The public technical analysis results from DOE's Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project are generated in the form of composite data products (CDPs). The following CDPs, which are organized by topic, are offered in both PowerPoint and Enhanced MetaFiles (EMF) formats.

Please note that the EMF files may not be viewable via all browsers, but are included here due to their small size, high-quality (vector-based and scalable), and easy insertion into your own documents. To save an EMF file, right-click on the link and 'Save Target As' to your computer or click on the link and then right-click on the image and copy and paste directly into your application. Once saved to your computer, EMF files can be viewed in Windows through the built-in "Windows Picture and Fax Viewer" by double-clicking on the file.

If these technical results are reproduced in your own documents or presentations, please provide appropriate reference to the U.S. Department of Energy's National Renewable Energy Laboratory.

View the Learning Demonstration CDPs:

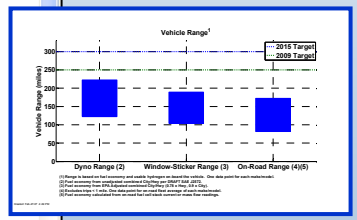
- By topic
- By date
- By CDP#

Fuel Cell Stack Durability

- Learning Demo Fuel Cell Stack Hours Accumulated through August 2006, CDP #1A, 10/5/06 (PowerPoint 391 KB) (EMF 18 KB)
- Projected Hours to 10% Stack Voltage Degradation, CDP #1B, 10/5/06 (PowerPoint 395 KB) (EMF 42 KB)
- Fuel Cell Stack Hours Accumulated and Projected Hours to 10% Stack Voltage Degradation through August 2006, CDP #1C, 10/5/06 (PowerPoint 396 KB) (EMF 49 KB)

Fuel Cell Vehicle Range

- Fuel Cell Vehicle Range, CDP #2, 10/8/06 (PowerPoint 392 KB) (EMF 29 KB)
- Effective Fuel Cell Vehicle Range, CDP #34, 8/30/06 (PowerPoint 393 KB) (EMF 33 KB)
- Percentage of Theoretical Driving Range Between Refuelings, CDP #33, 8/30/06 (PowerPoint 396 KB) (EMF 45 KB)



Fuel Cell Vehicle Fuel Economy and Stack Efficiency

- Fuel Cell Vehicle Fuel Economy, CDP #6, 8/25/06 (PowerPoint 392 KB) (EMF 26 KB)
- Fuel Cell System Efficiency, CDP #8, 8/29/06 (PowerPoint 392 KB) (EMF 27 KB)

Fuel Cell Vehicle and Hydrogen Infrastructure Safety

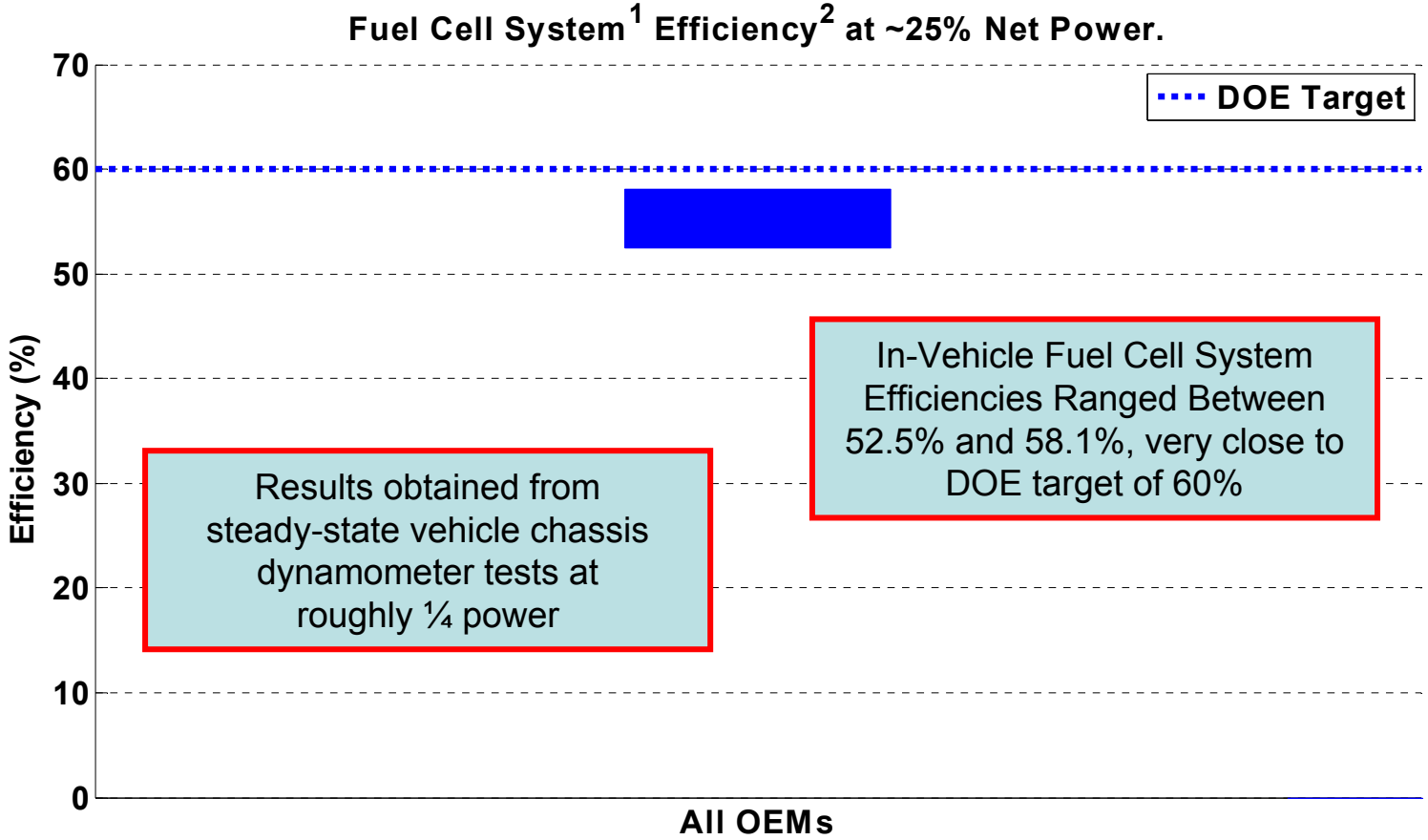
- Fuel Cell Vehicle Safety Incidents, CDP #9, 8/28/06 (PowerPoint 391 KB) (EMF 33 KB)
- Infrastructure Safety Incidents by General Category, CDP #20, 8/30/06 (PowerPoint 395 KB) (EMF 50 KB)

Fuel Cell Vehicle On-Board Hydrogen Storage Status

- Number of Vehicles Using Each Hydrogen Storage Technology, CDP #25, 8/25/06 (PowerPoint 392 KB) (EMF 37 KB)
- Hydrogen Storage Weight % Hydrogen, CDP #10, 2/23/06 (PowerPoint 392 KB) (EMF 28 KB)
- Hydrogen Storage Volumetric Capacity, CDP #11, 2/23/06 (PowerPoint 392 KB) (EMF 28 KB)
- Hydrogen Storage Tank Cycle Life, CDP #12, 2/23/06 (PowerPoint 392 KB) (EMF 26 KB)

The Following Slides are the Latest Composite Data Products

Controlled System Tests Verify High Fuel Cell System Conversion Efficiency



[1] Gross stack power minus fuel cell system auxiliaries, per DRAFT SAEJ2615.

[2] Ratio of DC output energy to the lower heating value of the input fuel (hydrogen). Excludes power electronics and electric drive.

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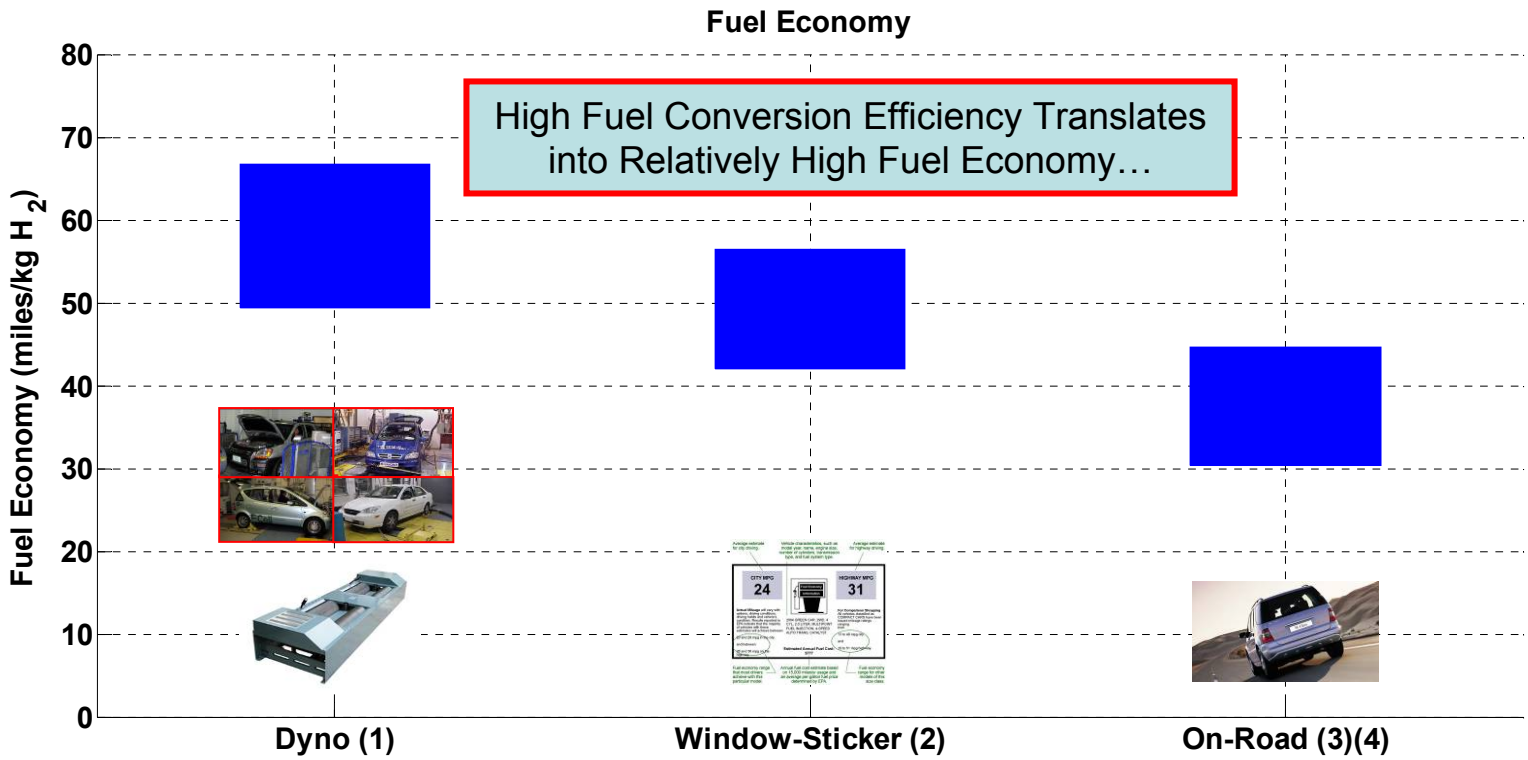
Dynamometer and On-Road Fuel Economy from Learning Demonstration Vehicles



(1) One data point for each make/model. Combined City/Hwy fuel economy per DRAFT SAE J2572.

(2) Adjusted combined City/Hwy fuel economy (0.78 x Hwy, 0.9 x City).

(3) Excludes trips < 1 mile. One data point for on-road fleet average of each make/model.

(4) Calculated from on-road fuel cell stack current or mass flow readings.

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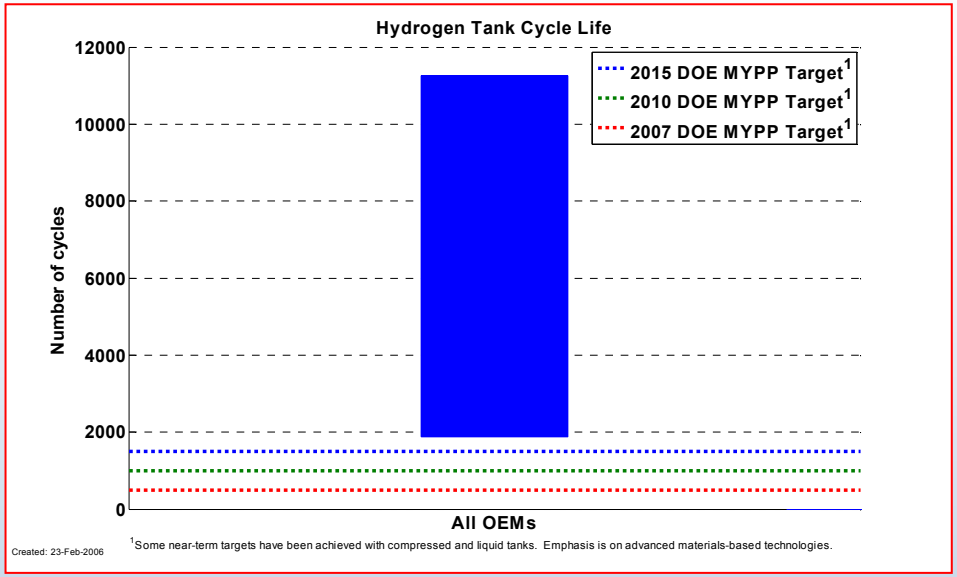
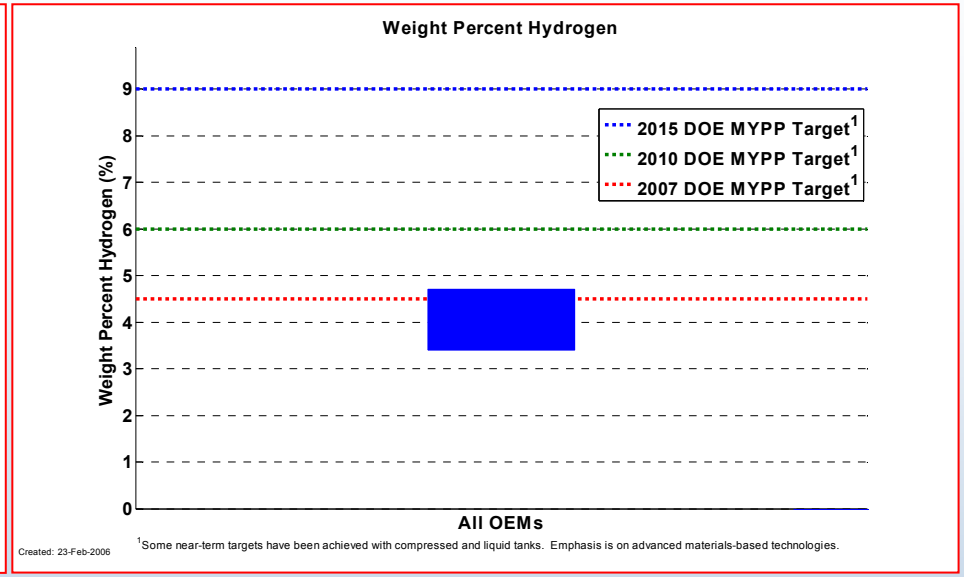
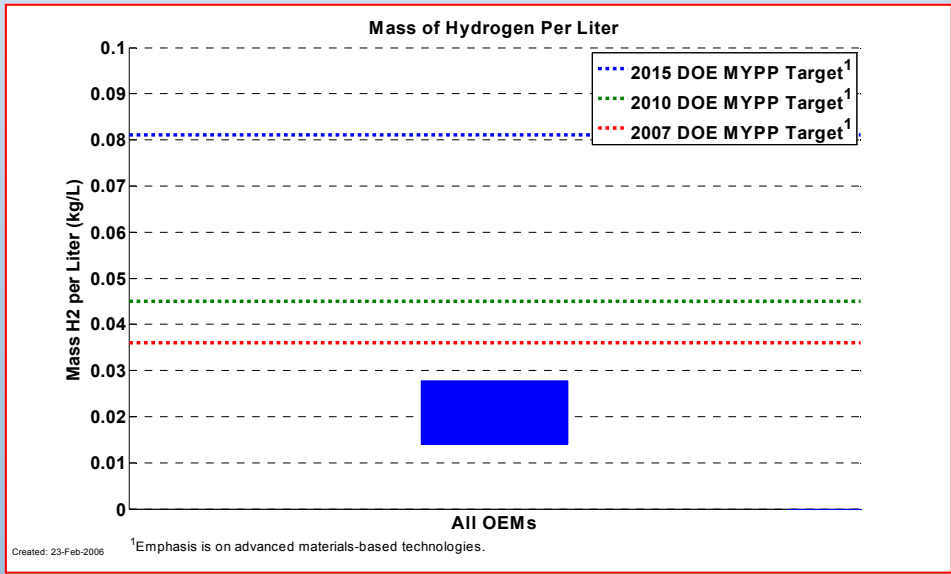
Technical Status of On-Board H_2 Storage Technologies Being Validated

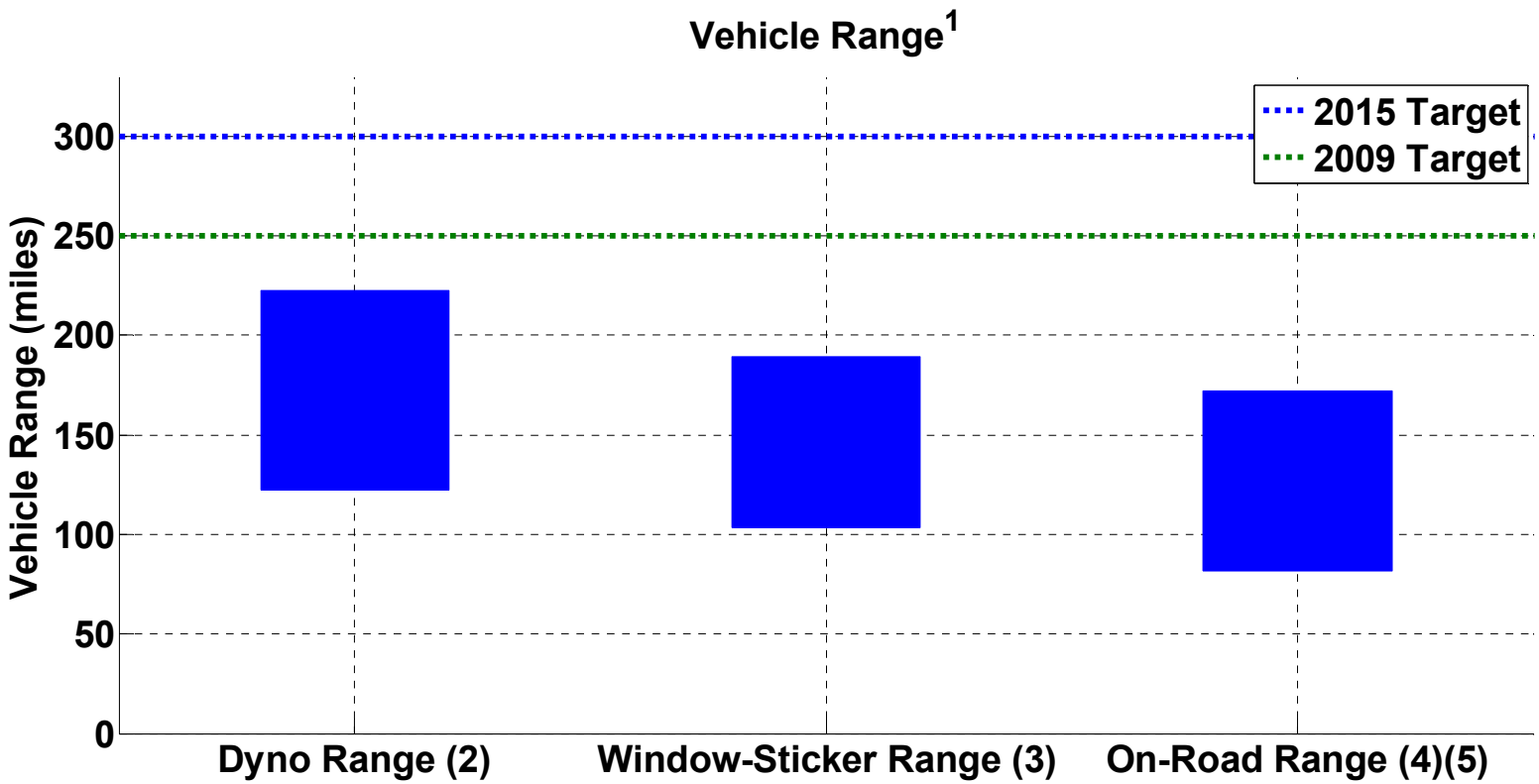






Compressed and liquid H_2 tanks meet durability and short-term weight %, but don't meet long-term weight % or volumetric capacity targets for vehicles

Vehicle Range Based on Dyno Results and Usable H_2 Fuel Stored On-Board



(1) Range is based on fuel economy and usable hydrogen on-board the vehicle. One data point for each make/model.
(2) Fuel economy from unadjusted combined City/Hwy per DRAFT SAE J2572.
(3) Fuel economy from EPA Adjusted combined City/Hwy (0.78 x Hwy, 0.9 x City).
(4) Excludes trips < 1 mile. One data point for on-road fleet average of each make/model.
(5) Fuel economy calculated from on-road fuel cell stack current or mass flow readings.

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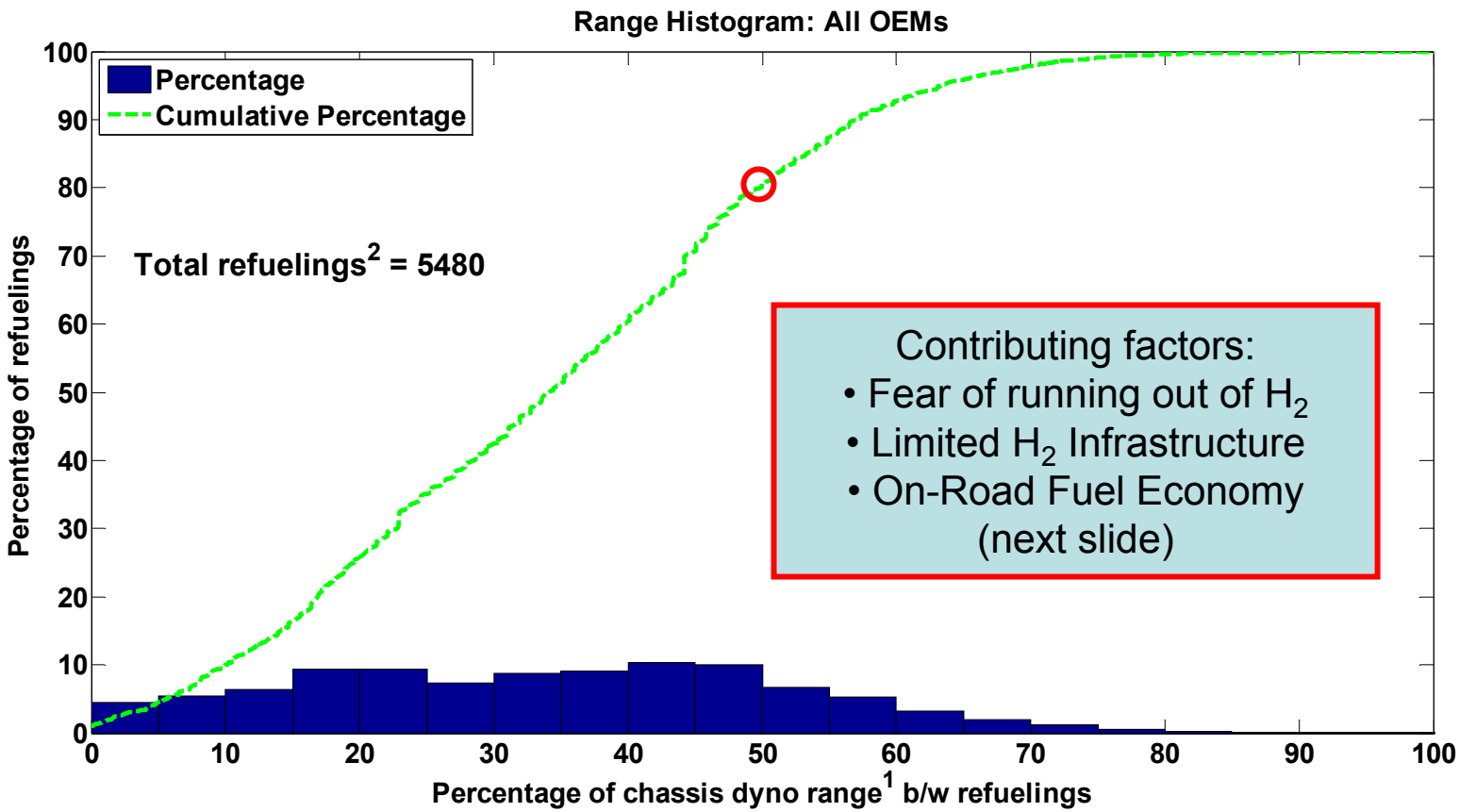
Majority (80%) of Vehicles Travel <50% of Dyno Range Between Refuelings



1. Range calculated using the combined City/Hwy fuel economy from dyno testing (not EPA adjusted) and usable fuel on board.

2. Some refueling events are not detected/reported due to data noise or incompleteness.

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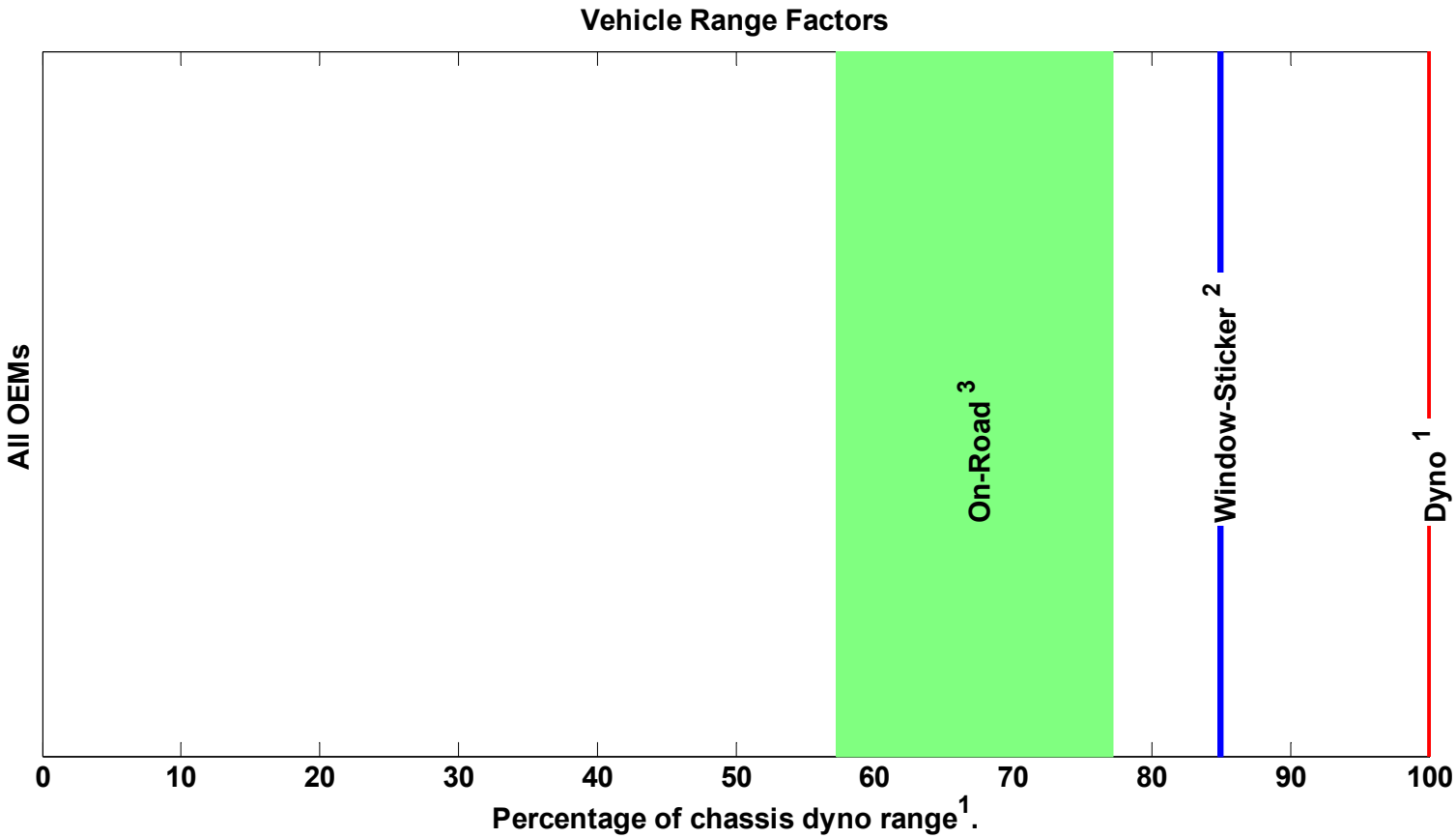
Large Spread of On-Road Range from Four Teams as a % of Dyno Range



1. Calculated using the combined City/Hwy fuel economy from dyno testing (non-adjusted) and usable fuel on board.

2. Applying window-sticker correction factors for fuel economy: 0.78 x Hwy and 0.9 x City.

3. Using fuel economy from on-road data (excluding trips > 1 mile, consistent with other data products).

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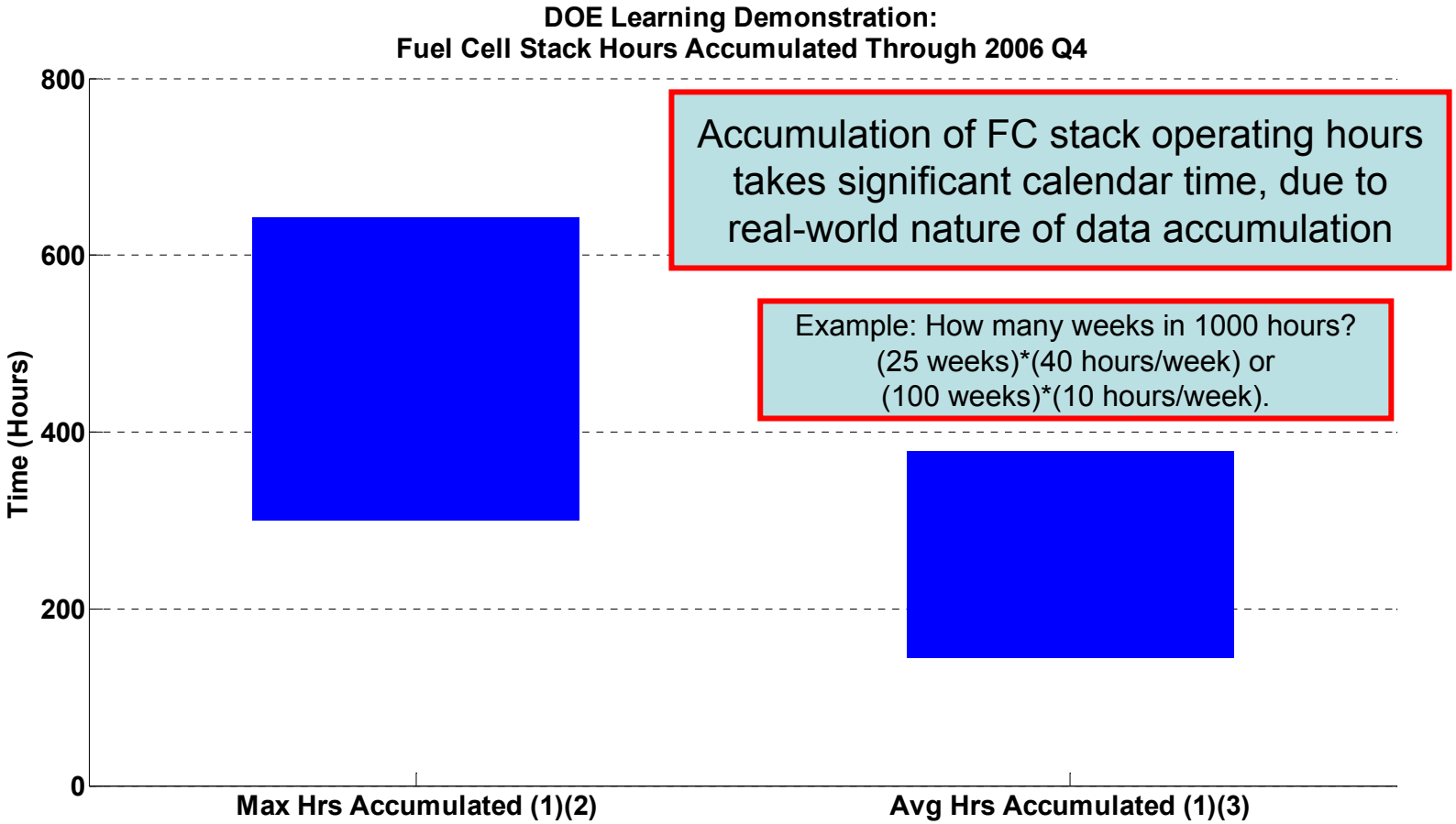
Learning Demo Fuel Cell Stack Hours Accumulated Through December 2006



(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.

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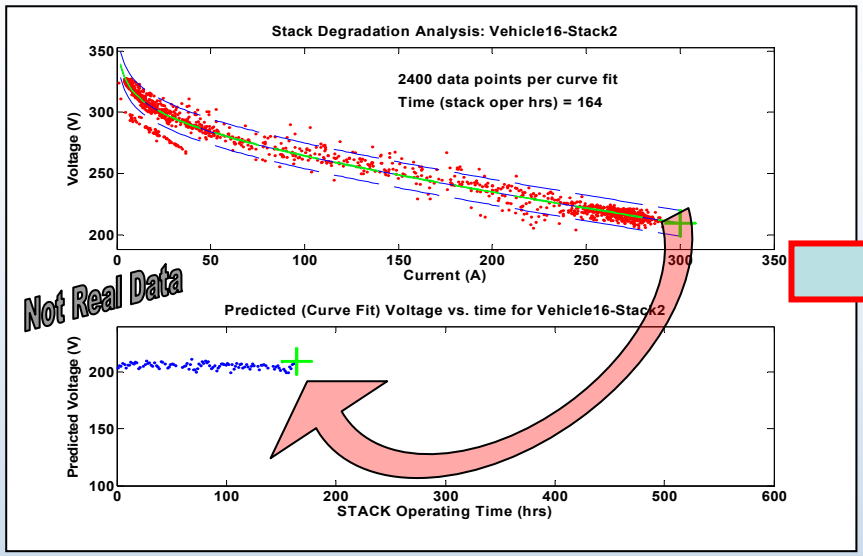
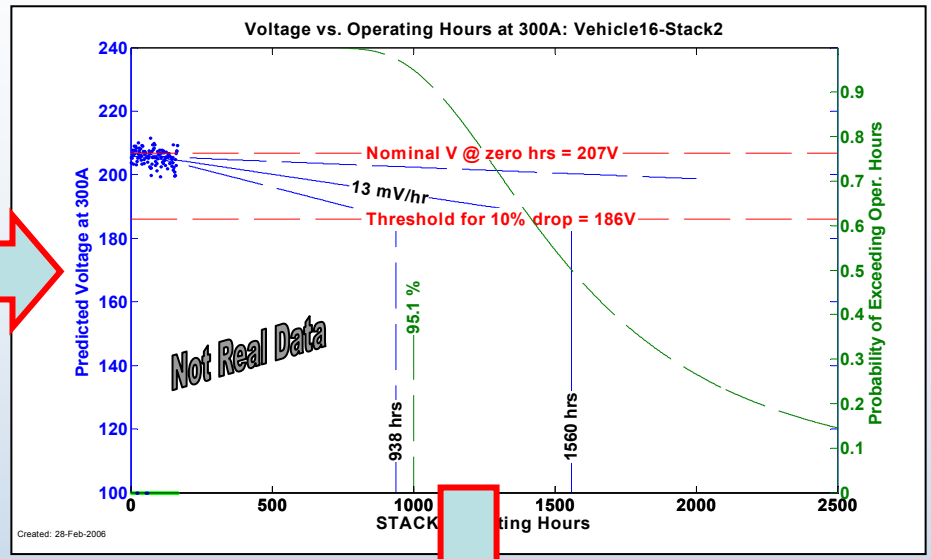
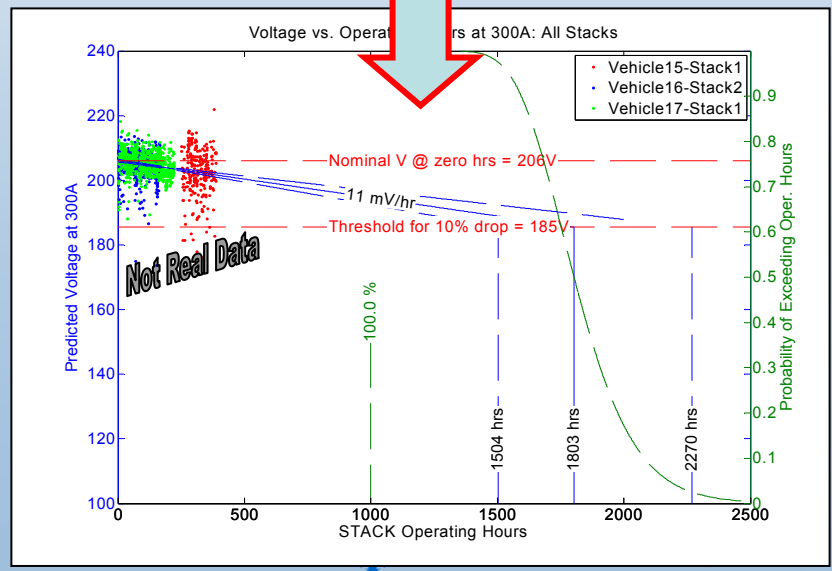
Limited Data Necessitates Projecting the Time to 10% Fuel Cell Stack Voltage Degradation



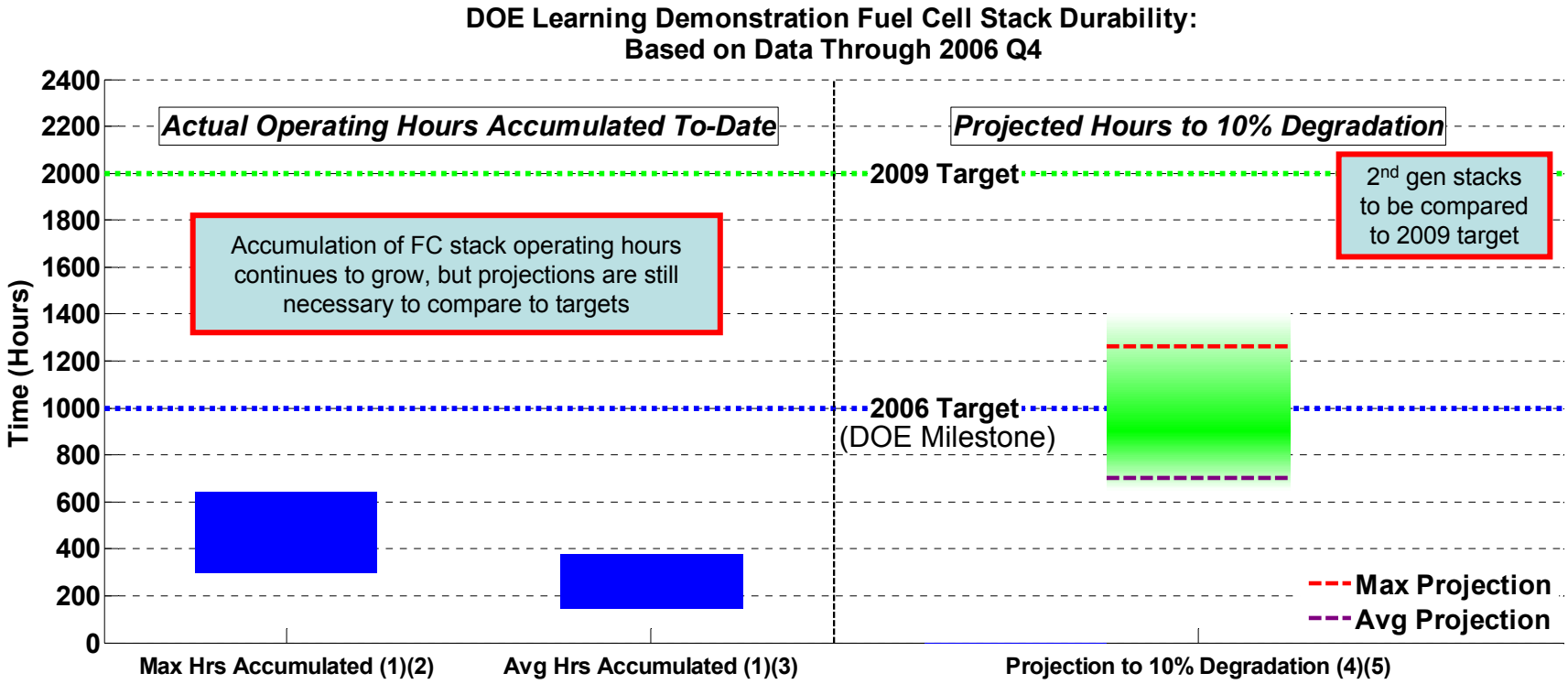


Note: 10% is an R&D metric for FC stack degradation. It does not necessarily indicate an end-of-life condition. OEMs may use other values or indicators.

Technique makes performance projection based on all available FC data; Includes reporting confidence in results



Sept. 2006 MYPP Milestone Satisfied Through Project Results: 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.

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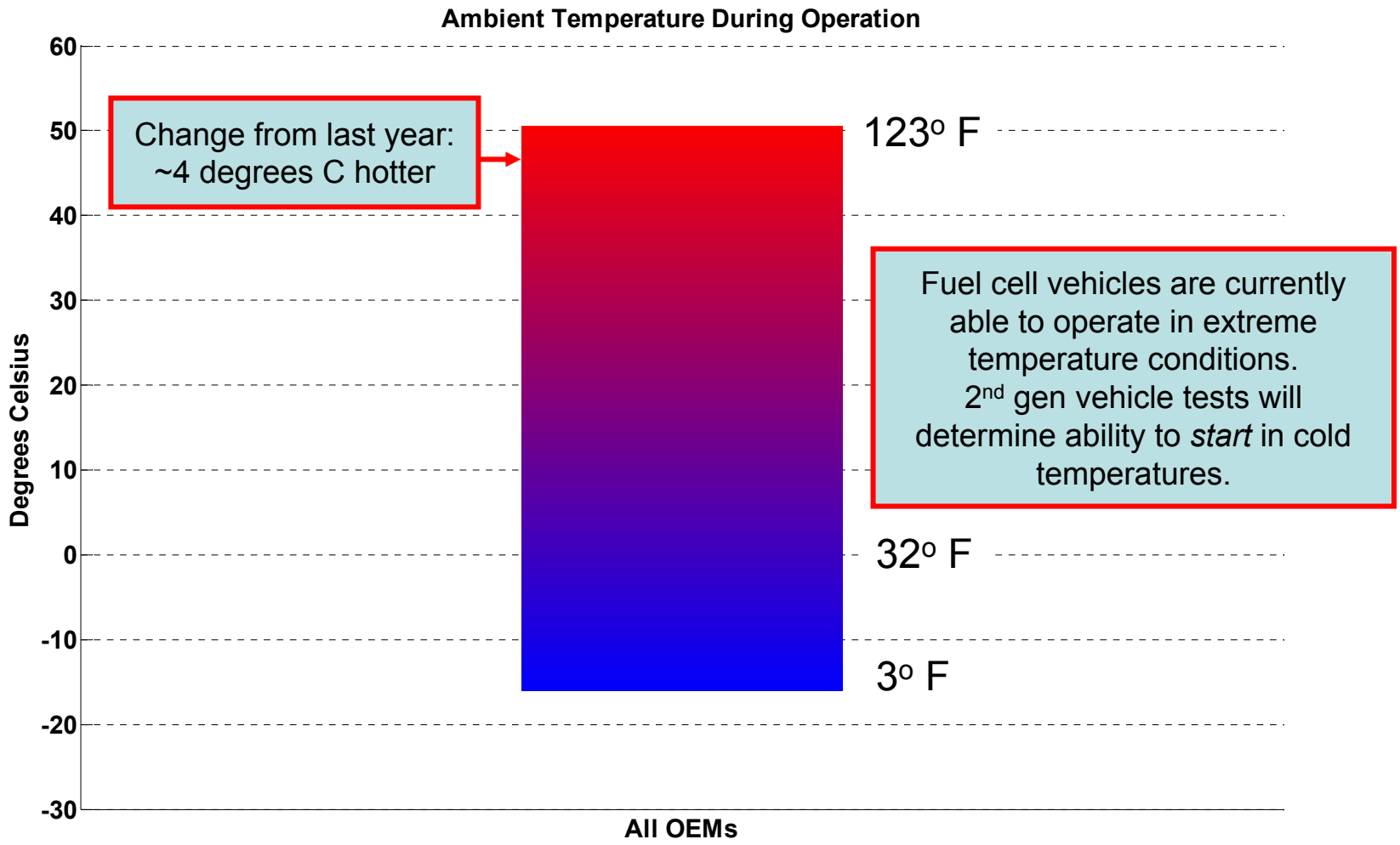
Range of Ambient Temperature During Vehicle Operation



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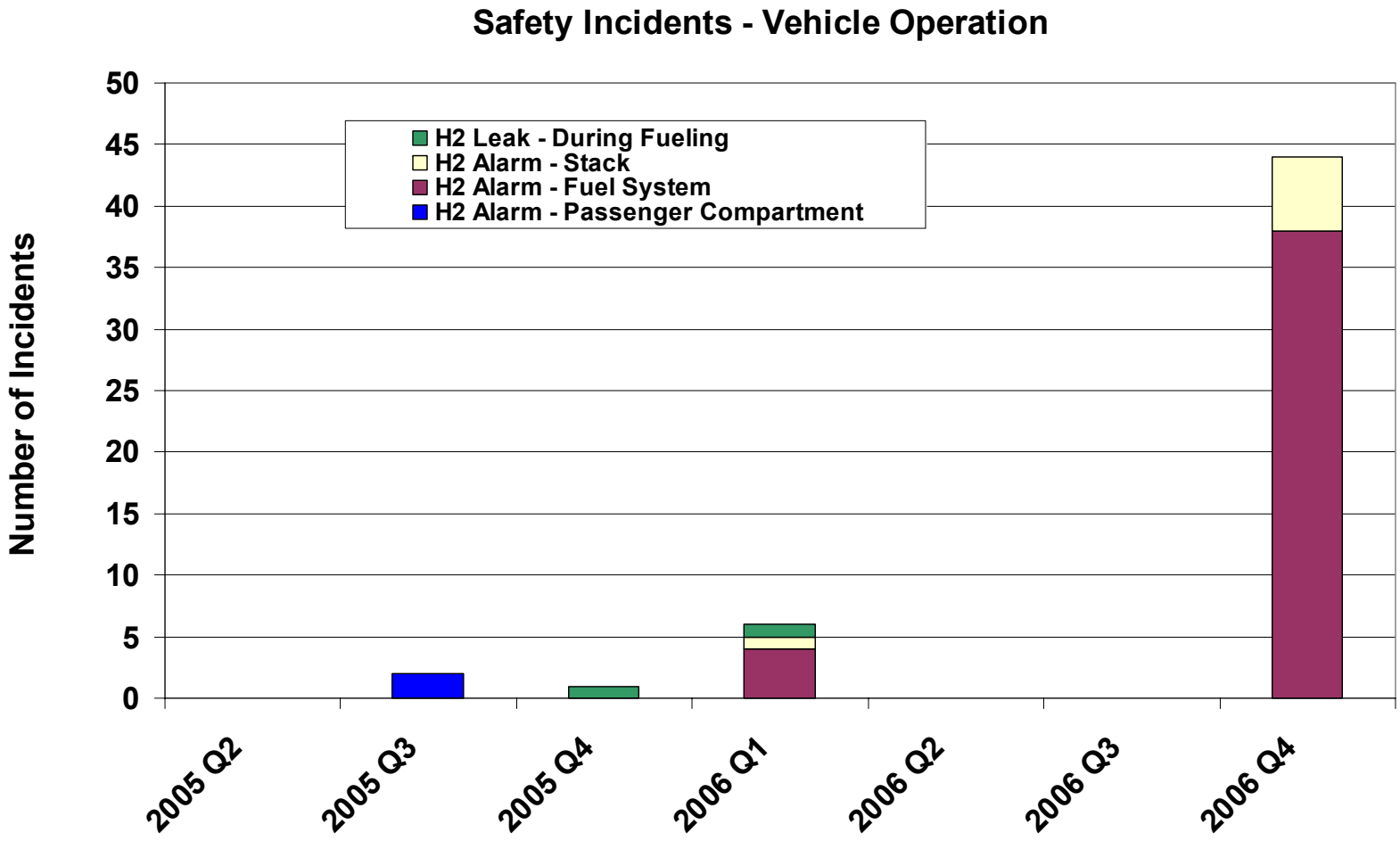
H_2 FCV Safety – An Issue Has Been Identified Relative to H_2 Sensor Alarms and is Currently Being Addressed



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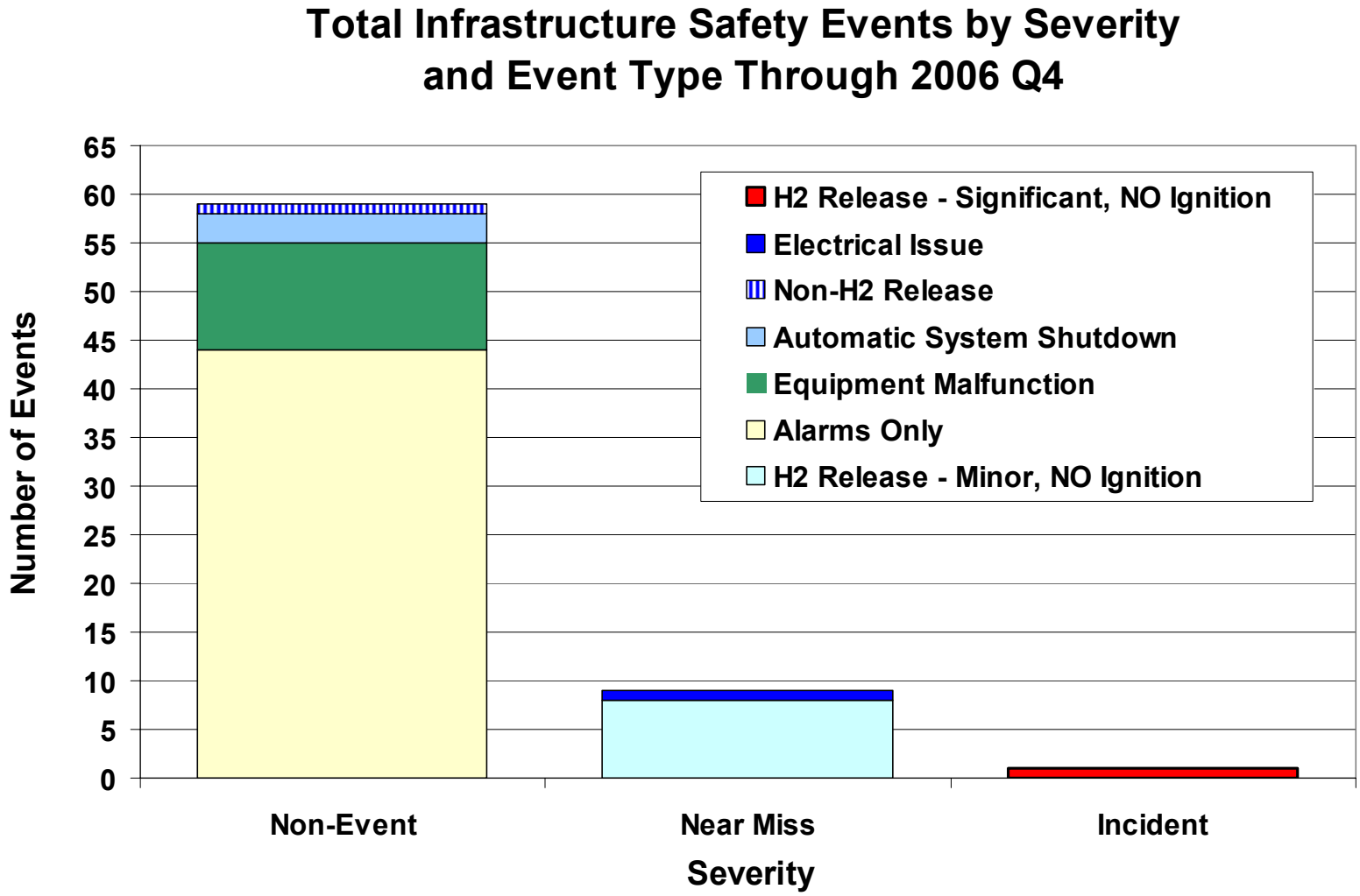
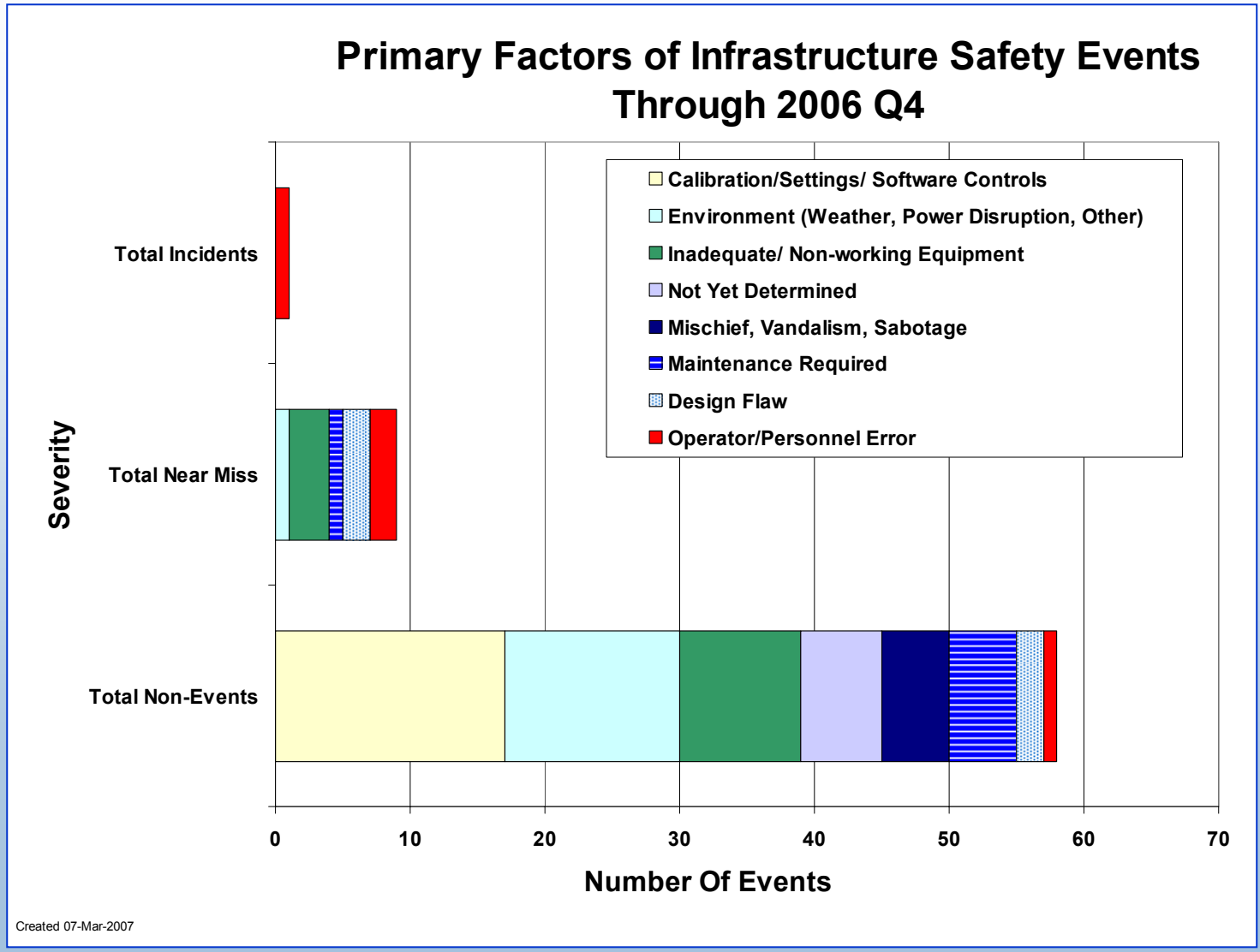
Most of Infrastructure Safety Reports Are Non-Events (and Most of Those, Alarms Only)

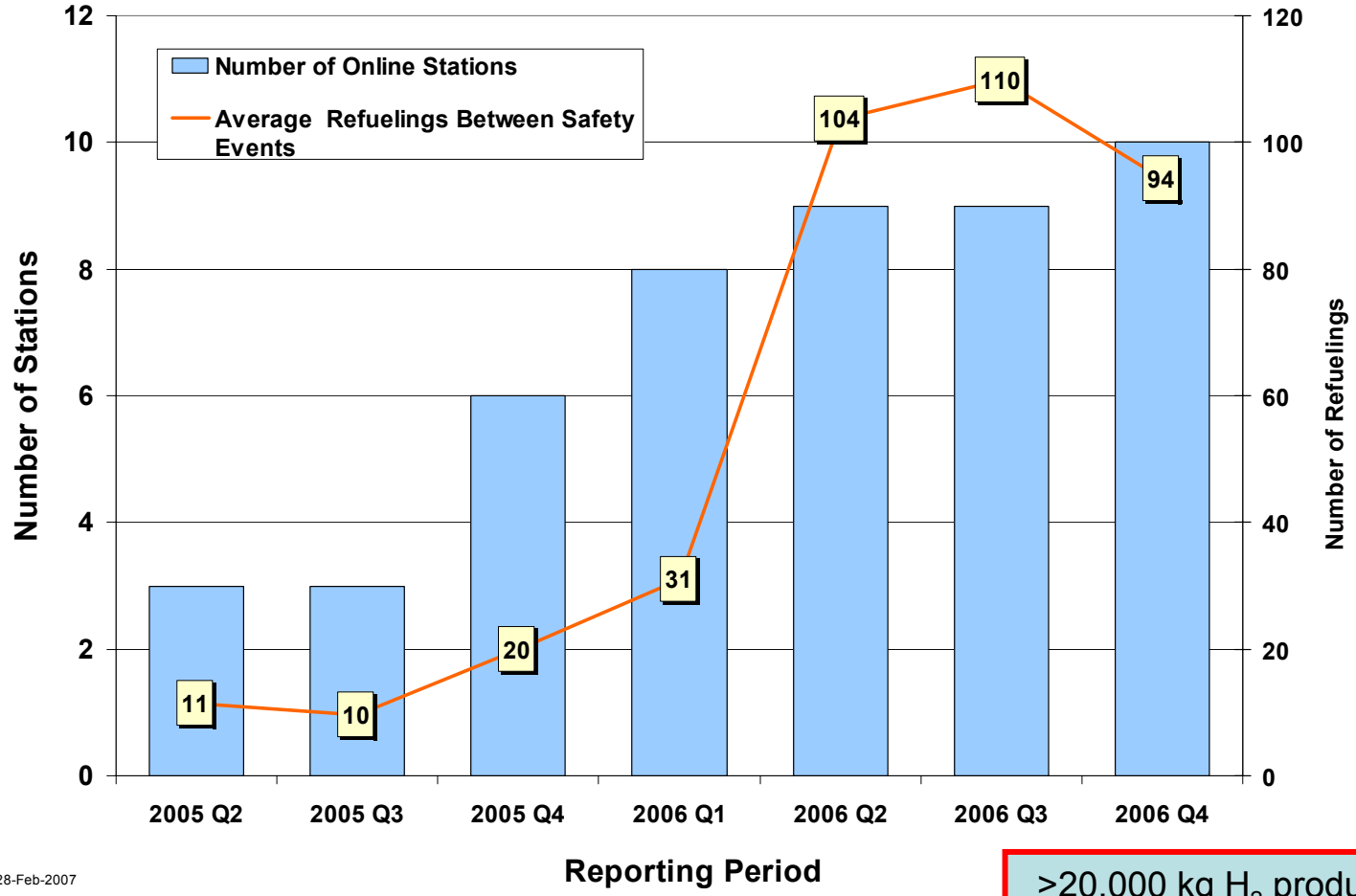


No Single Primary Factor Leading to Majority of Infrastructure Safety Reports



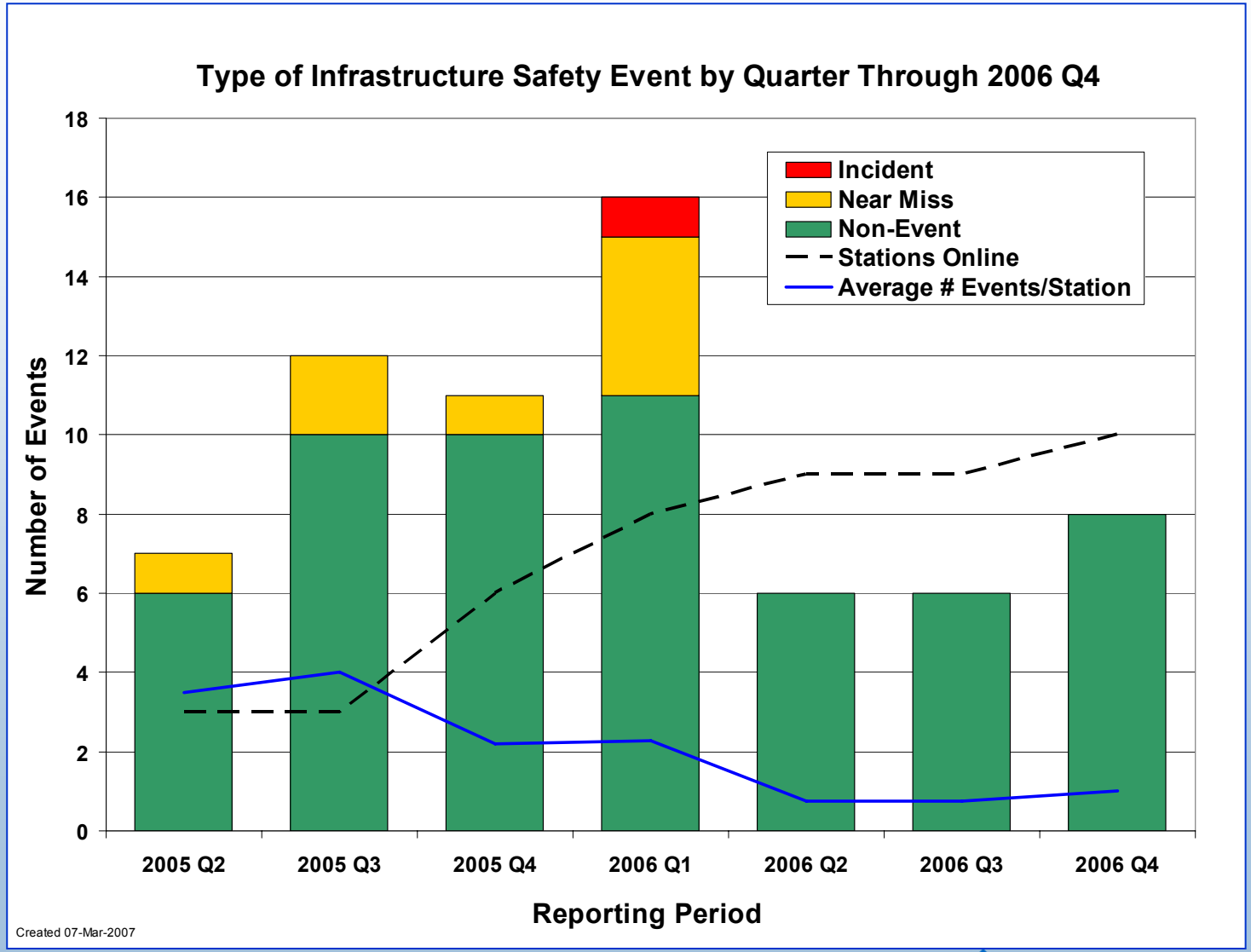
Average Refuelings Between Infrastructure Safety Reports Has Increased by ~10X Since Beginning of Project

Significant improvement in H_2 infrastructure safety!

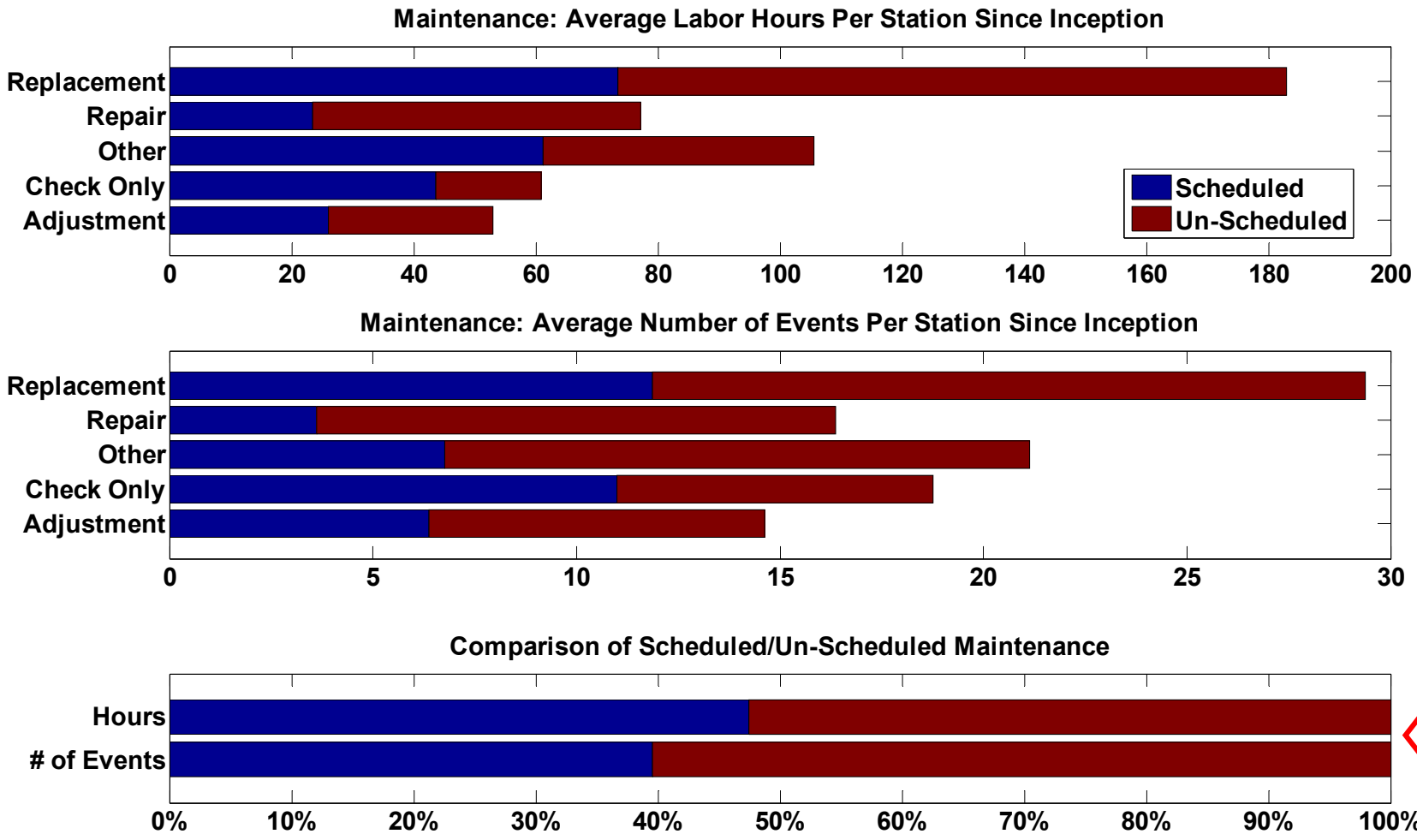


>20,000 kg H_2 produced or dispensed from this project

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



Infrastructure Maintenance – ½ Labor Hours are Unplanned (60% of events)



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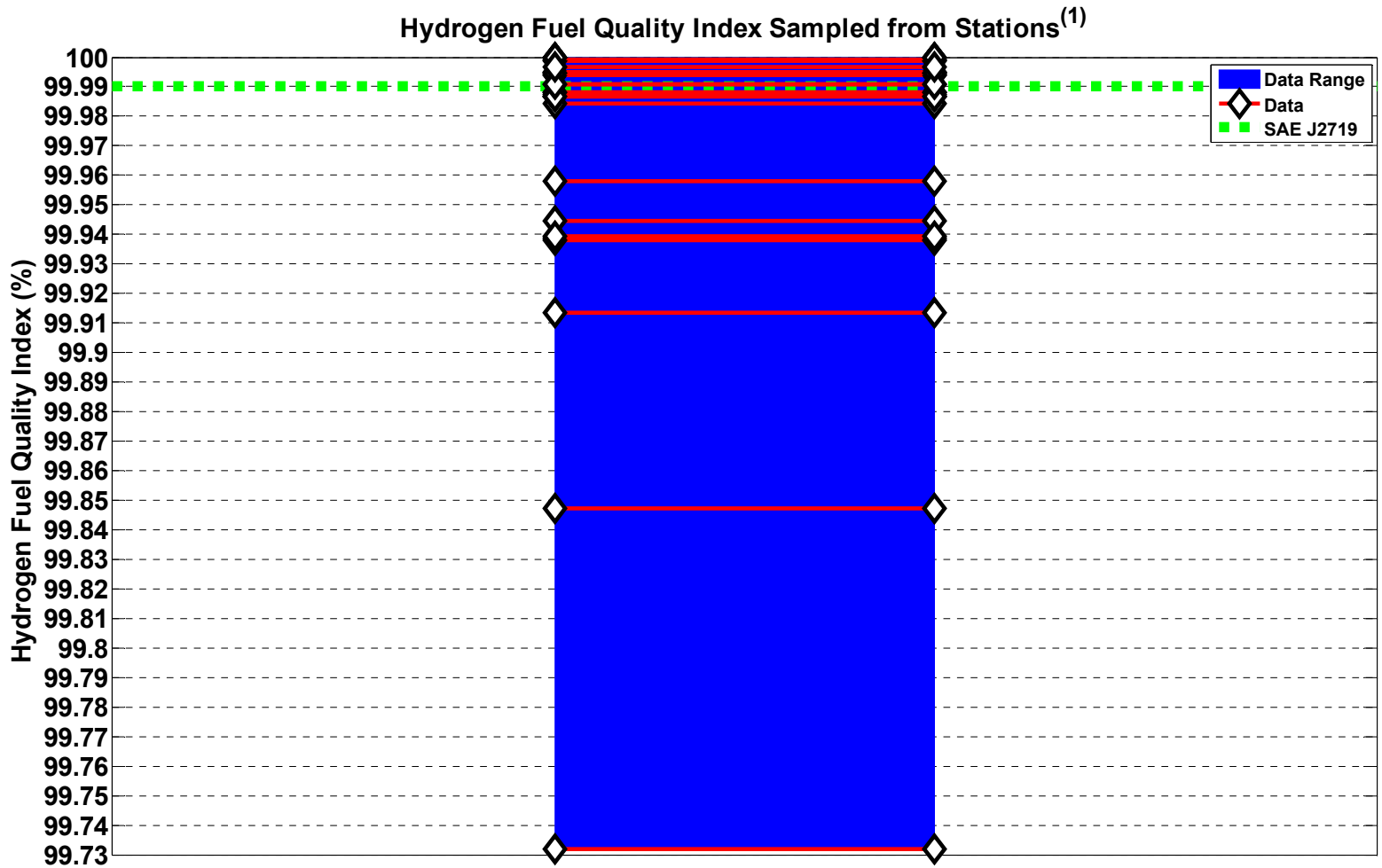
Hydrogen Quality Index Close to Target Except for Some High Inert Gas Measurements



(1) Includes sampling from both electrolysis and reforming

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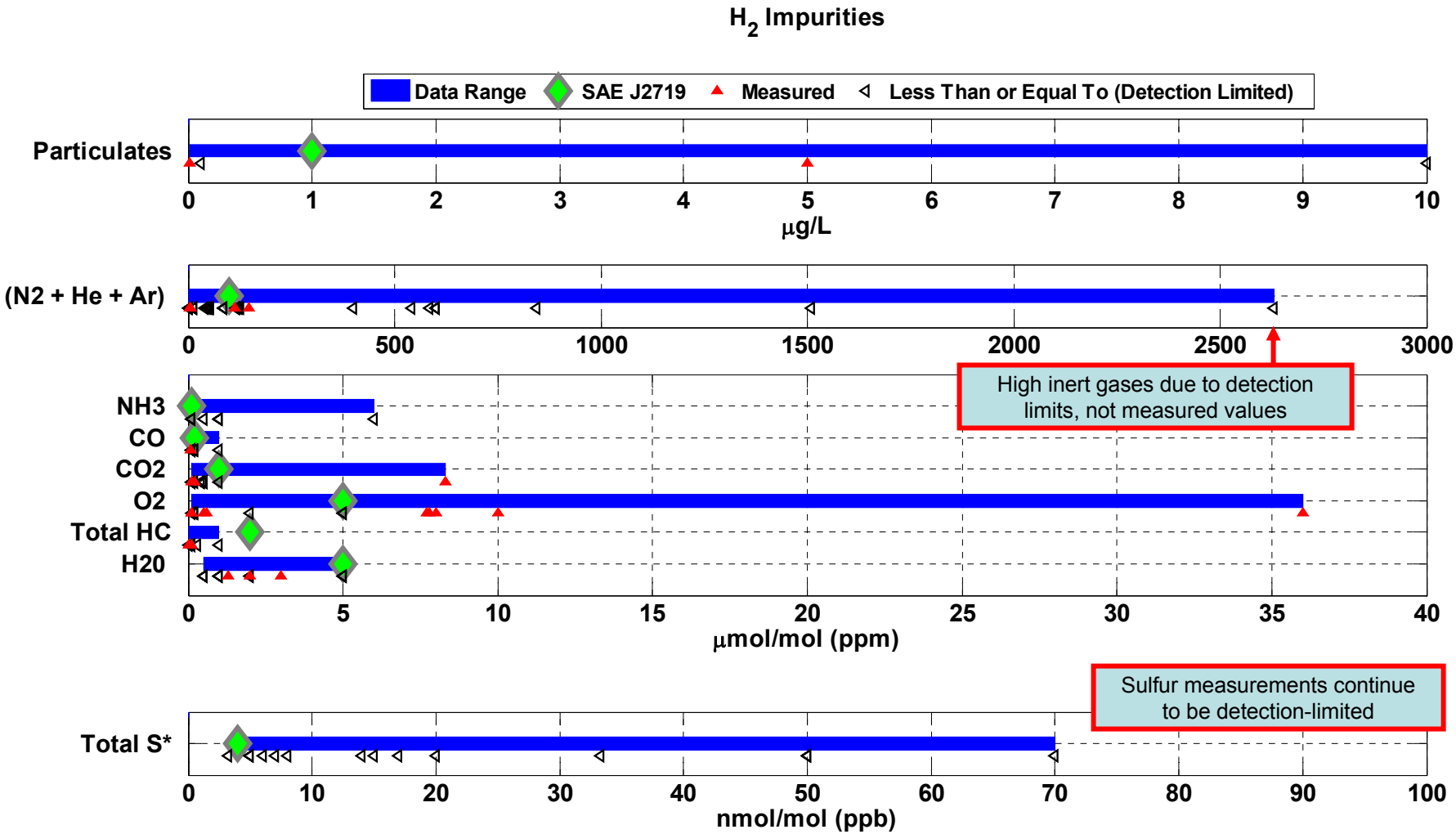
Hydrogen Impurities Sampled from All Stations to Date
In General, Inert Gases and Sulfur Suffer from High Detection Limits



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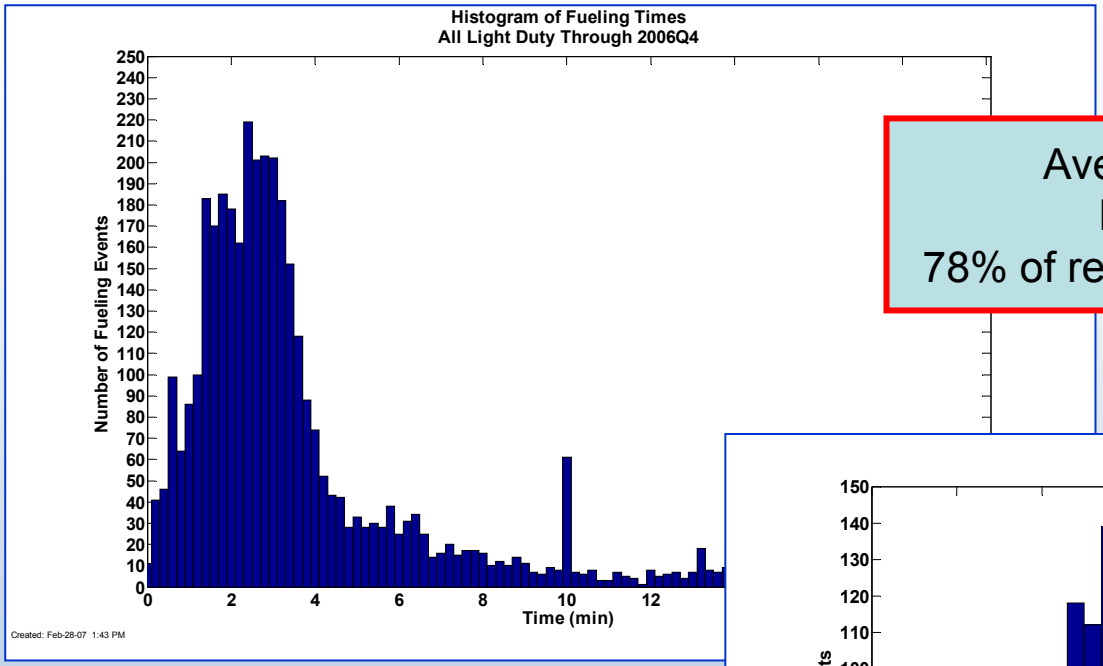
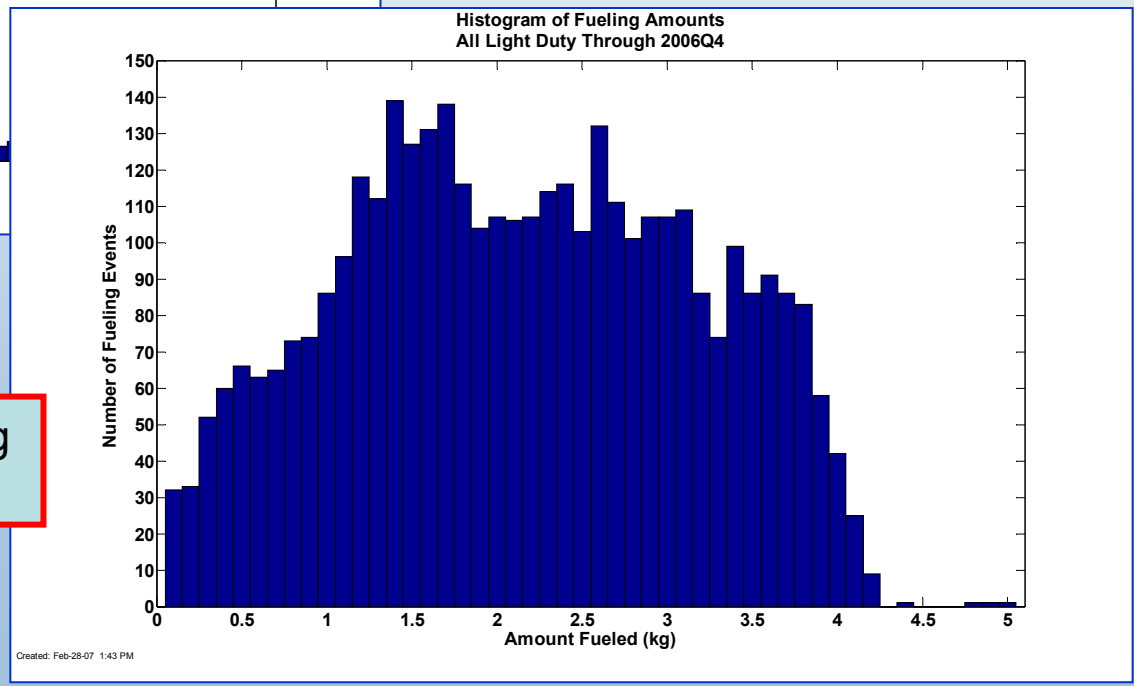
*Calculated from SO2, COS, H2S, CS2, and Methyl Mercaptan (CH3SH).

Actual Vehicle Refueling Times and Amounts from >3,700 Events: Measured by Stations or by Vehicles

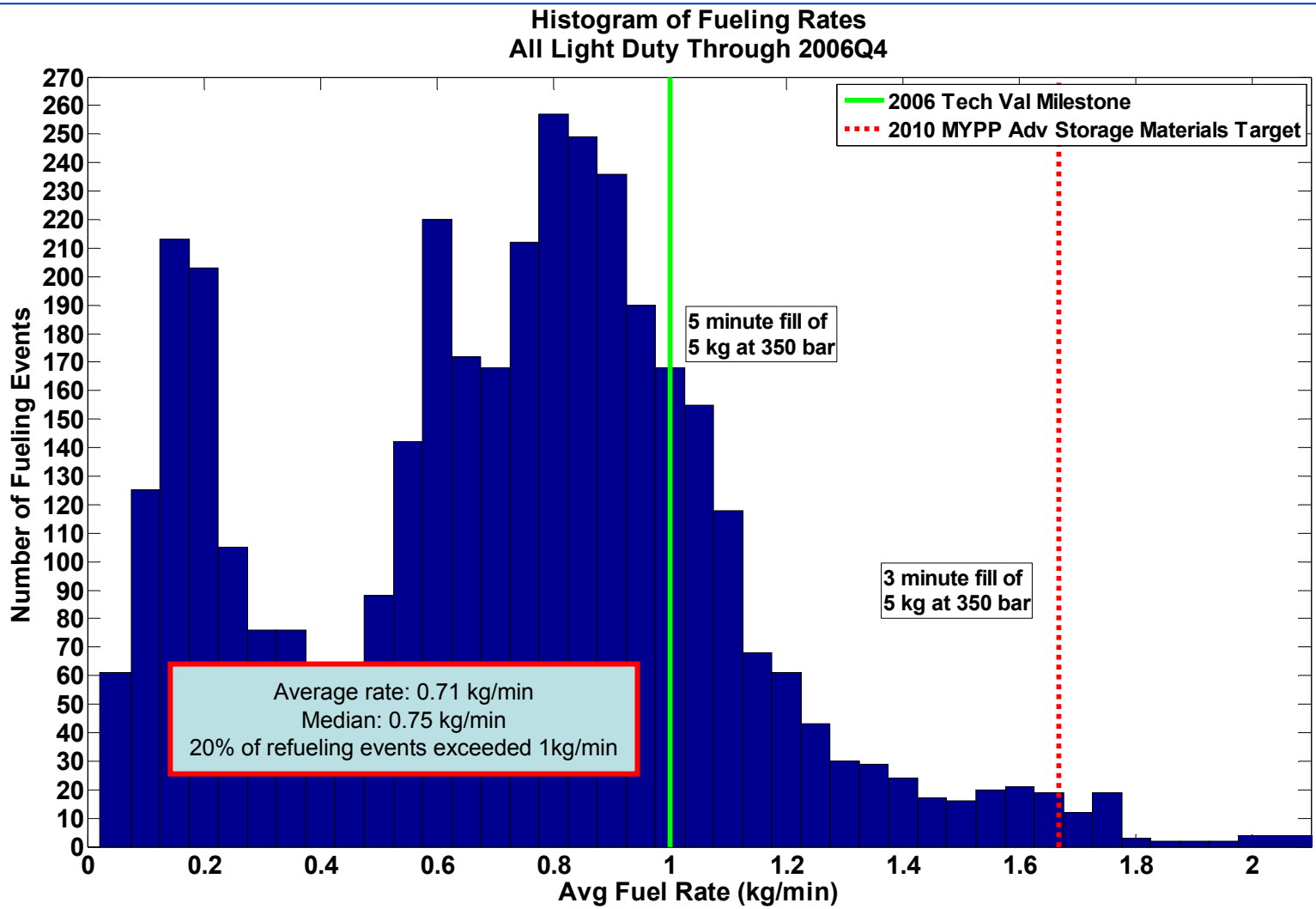


Average time: 4.19 min
Median: 2.83 min
78% of refueling events took <5 min



Average amount: 2.15 kg
Median: 2.13 kg

Actual Vehicle Refueling Rates from >3,700 Events: Measured by Stations or by Vehicles



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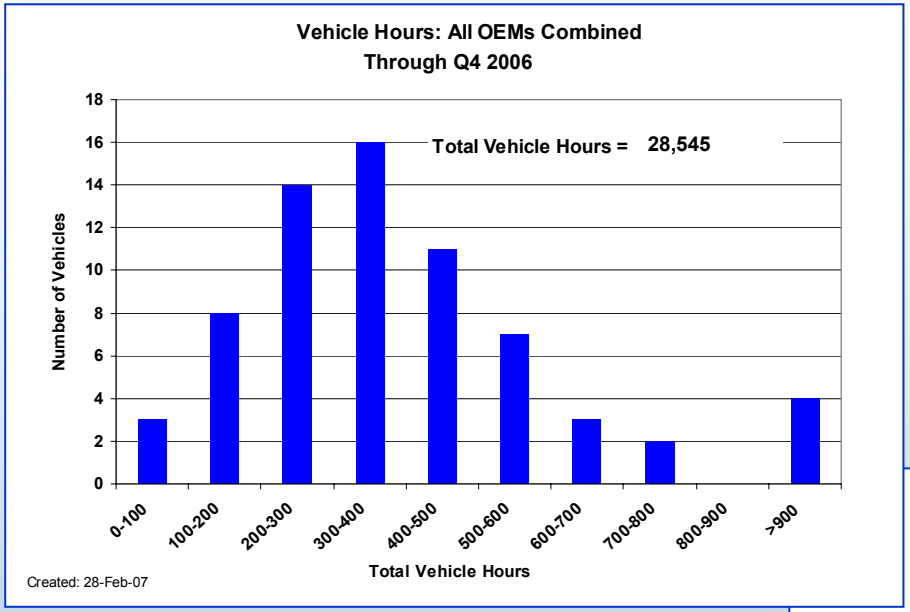
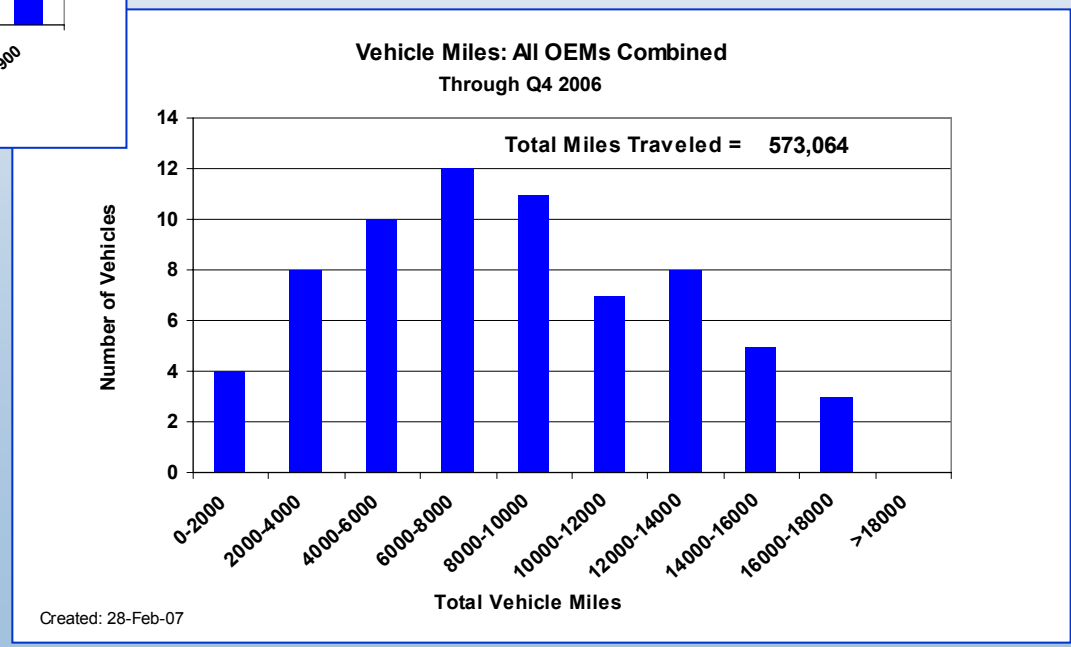
Distribution of Vehicle Operating Hours and Miles Traveled

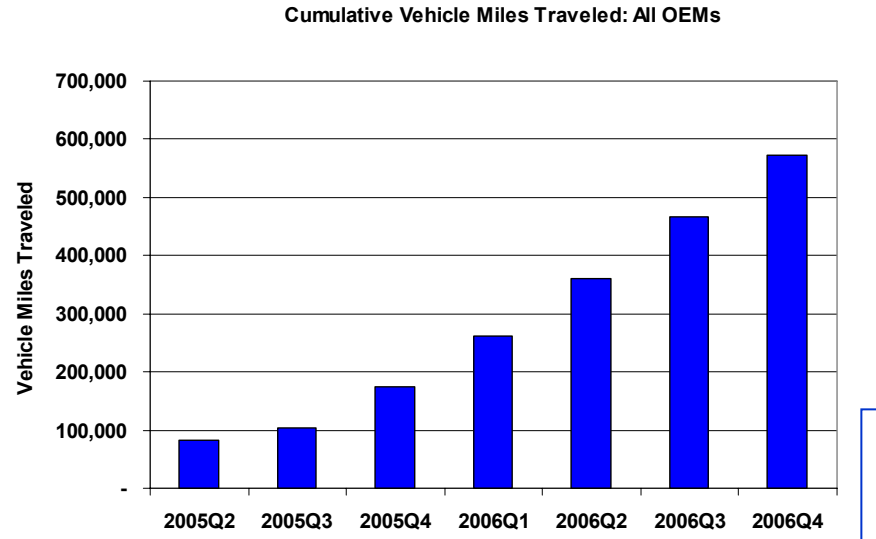


The bulge of operating hours and miles traveled has now shifted to right.

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

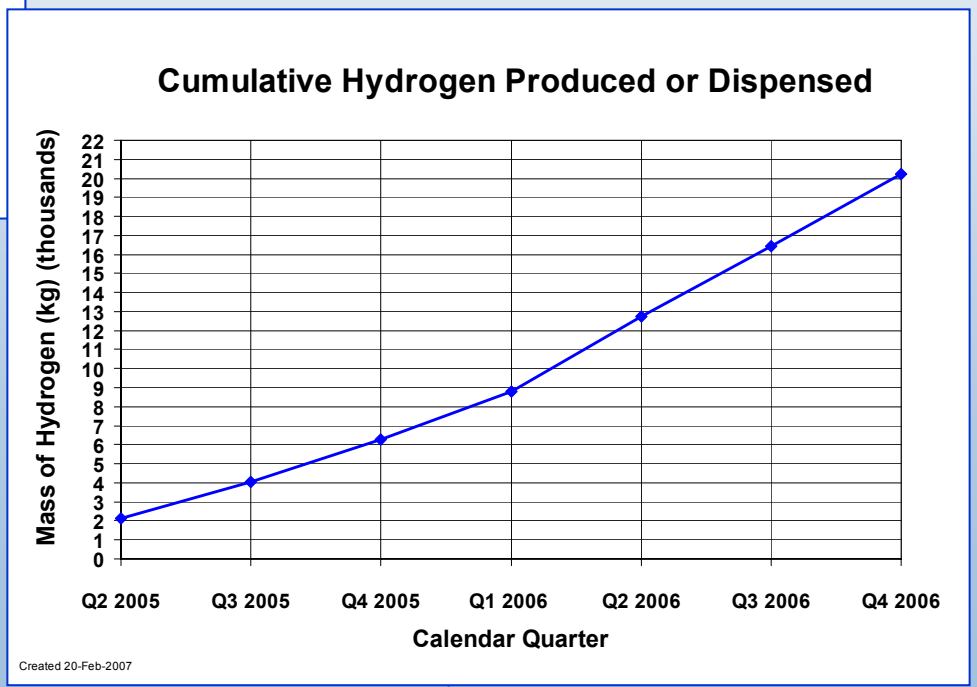


Cumulative Vehicle Miles Traveled and Mass of H_2 Produced or Dispensed



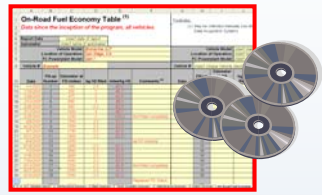
Current deployment of new H_2 refueling stations for this project is about 50% complete

Rate of mileage accumulation stabilizing as initial fleets approach full Gen 1 vehicle deployment



Highlights of Interactions and Collaborations

- Industry Partners
  - Site visits to discuss detailed results and NREL methodology
  - Worked with teams to improve data reporting templates (safety, FC stack)
- DOE H_2 Safety Panel
  - Discussions on safety results, data templates, and H2incidents.org
- FreedomCAR/Fuels Tech Teams (presentations and discussions)
  - Codes and Standards Tech Team (6/5)
  - Systems Analysis Tech Team (7/12, 11/8)
  - H_2 Storage Tech Team (9/21)
  - Fuel Cell Tech Team (10/18)
- H_2 Quality Teams (participating on teams)
  - USFCC "Joint H_2 Quality Task Force"
  - Ad-hoc committee on Technical H_2 Quality Guidance for CA DMS
- CaFCP working groups and meetings (sharing results, experiences)
- States and Other Countries
  - Consulted on data collection protocols/templates (Europe, Canada)



Future Work

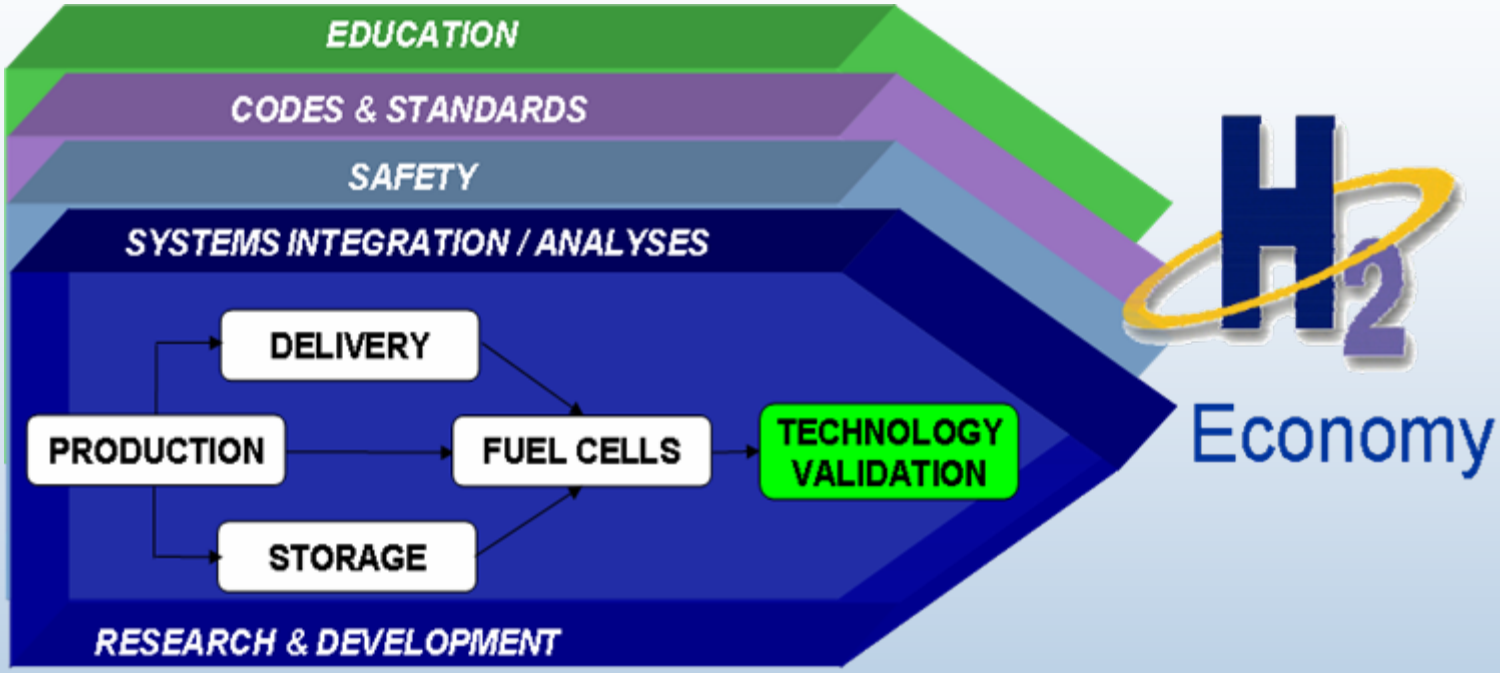
- **Remainder of FY07:**
  - Identify correlations of real-world factors influencing fuel cell degradation
    - Supports June 2007 DOE Joule milestone
    - With feedback and collaboration from industry teams
  - Create additional and updated composite data products (CDPs) based on data through June 2007
    - Prepare results for publication at EVS-23 and 2007 Fuel Cell Seminar
  - Support September 2007 DOE MYPP and Joule milestone on refueling times and rates
  - Write quarterly validation assessment reports (6/07, 9/07)

- **FY08 and beyond:**
  - For 2nd generation vehicles, evaluate improvements in FC durability, range, fuel economy, and safety
  - Semi-annually (spring/fall) compare technical progress to program objectives and targets
    - Provide public outputs through publication at conferences
  - Identify opportunities to feed findings from project back into HFCIT program R&D activities to maintain project as a “learning demonstration”

Summary

- First half of project completed
  - 69 vehicles and 10 stations deployed
  - 570,000 miles traveled, 20,000 kg H_2 produced or dispensed
  - 114,000 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
  - H_2 sensor alarm issue being resolved on vehicles
- Supported major DOE MYPP milestone on evaluating on-road fuel cell durability through voltage degradation
  - Now looking at factors affecting the degradation rates
- 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