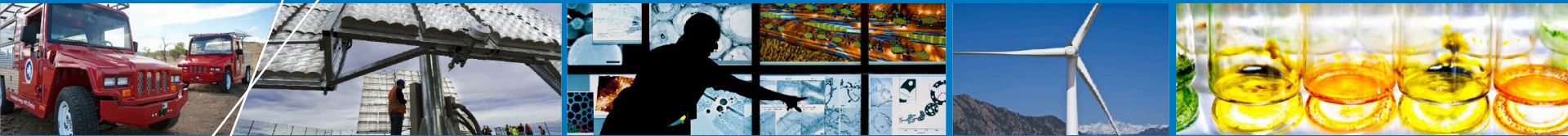


Performance Status of Hydrogen Stations and Fuel Cell Vehicles



2015 Fuel Cell Seminar & Energy Exposition

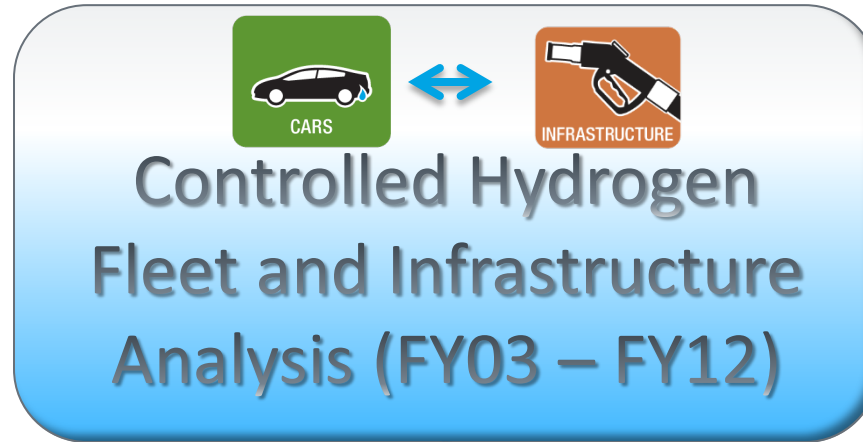
Sam Sprik, Jennifer Kurtz, Chris Ainscough, Michael Peters, Matt Jeffers, Genevieve Saur

Los Angeles, California

November 18, 2015

IND32-3

Technology Validation Progression



FCEV Evaluation Project



6 Data Providers¹



Range of FCEV Model Years

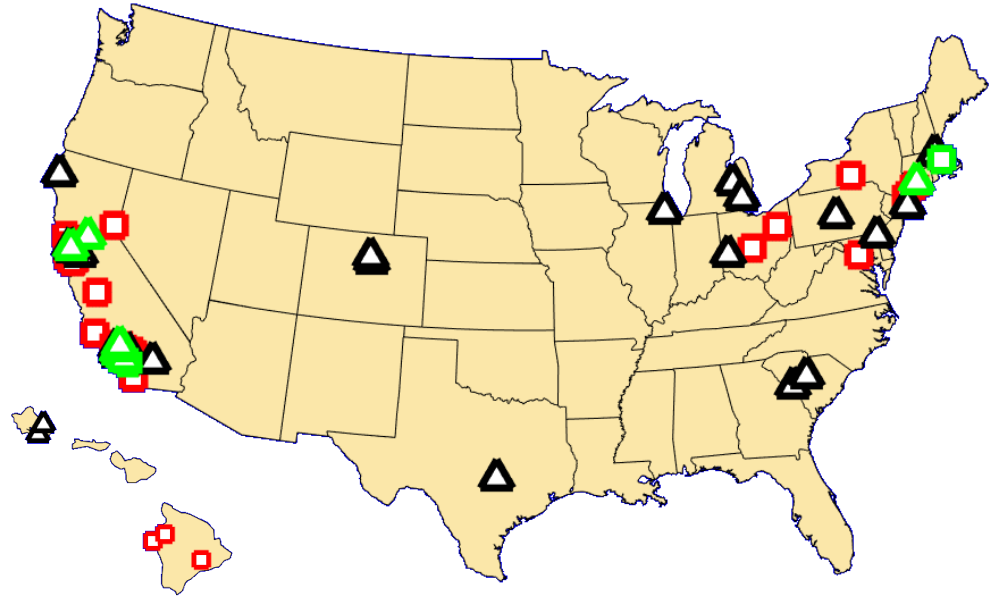


¹DOE Project Overview
\$5.5 million DOE funding
Data collected from up to ~90 vehicles

²Project managed by Electricore

Hydrogen Stations

N. California



37 Operational
53 Planned
4 Retail - Open
45 Retail - Planned

Los Angeles Area



Station Project Partners



Current

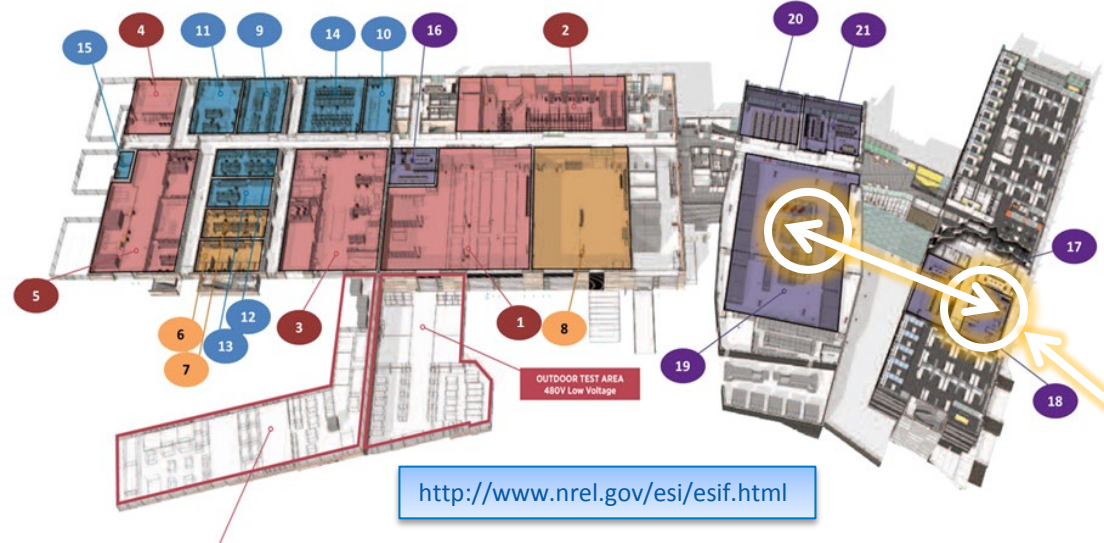
- California Air Resources Board
- California Energy Commission
- California State University Los Angeles
- Gas Technologies Institute
- Linde
- H2 Frontier
- Proton OnSite
- Shell
- IPHE and HySUT
 - Initiating partnership







NFCTEC @ Energy Systems Integration Facility



National Fuel Cell Technology Evaluation Center (NFCTEC)

Bundled data (operation & maintenance/safety) delivered to NREL quarterly

Internal analysis completed quarterly

NREL's National Fuel Cell Technology Evaluation Center

Results

DDPs

Confidential

Public

CDPs

Detailed Data Products (DDPs)

- Individual data analyses
- Identify individual contribution to CDPs
- Only shared with partner who supplied data every 6 months¹

Composite Data Products (CDPs)

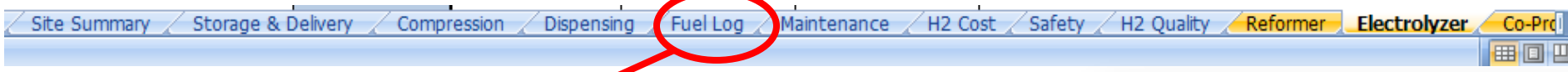
- Aggregated data across multiple systems, sites, and teams
- Publish analysis results without revealing proprietary data every 6 months²

1) Data exchange may happen more frequently based on data, analysis, and collaboration

2) Results published via NREL Tech Val website, conferences, and reports

Data Templates and Tools

Templates enable collection of similar data from all the projects



Infr Template Rev Dec02 2011 (company date).xlsx - Microsoft Excel

Home Insert Page Layout Formulas Data Review View Acrobat

Clipboard Font Alignment Number Editing

B5 insert calendar quarter

1 **Fuel Log**

2 Template last updated on December 02, 2011 (NREL)

3 Data should be from reporting quarter

4

5 Calendar Quarter insert calendar quarter

6 Site Name insert site name

7

Date/Time (m/d/yy HH:MM:SS)	Fuel Price (\$/kg)	Dispenser ID (if multiple)	H2 Filled (kg)	Fill Time (s)	Final Pressure (bar)	Fill Type	Veh Name or Type	Comments	Fill Rate (kg/min) (kg H2/Fill Time)
5/1/01 15:30:24	\$5.00	Disp350A	2.5	180					
5/1/01 15:30:24	\$5.00	Disp700B	15	480					
5/1/01 15:30:24	\$5.00	Disp350B	2	120					

Footnotes:

(1) Refueling Rate: The capability of the on-site refueling system (from storage tank to on the vehicle) shall be tested to determine the hydrogen flow rate and reported qua Refueling time starts and stops upon fuel flow starting and stopping (i.e., set-up exc

NREL HSDC Hydrogen Secure Data Center

NREL Fleet Analysis Toolkit

Application: Vehicle

Company: EcoCars

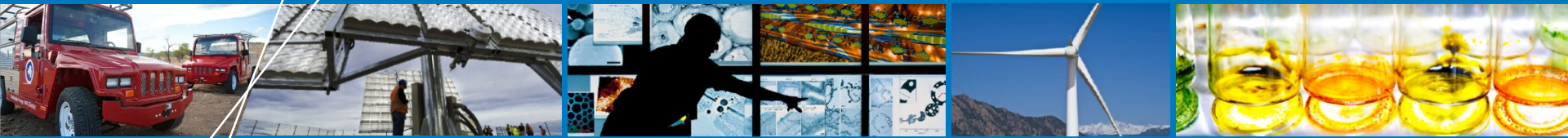
Project: H2 Coupe

CRUNCH THINK CORRELATE PUBLISH

Utility: MASTER: GIT SCC RUN BATCH TRANSMIT ARCHIVE CDP

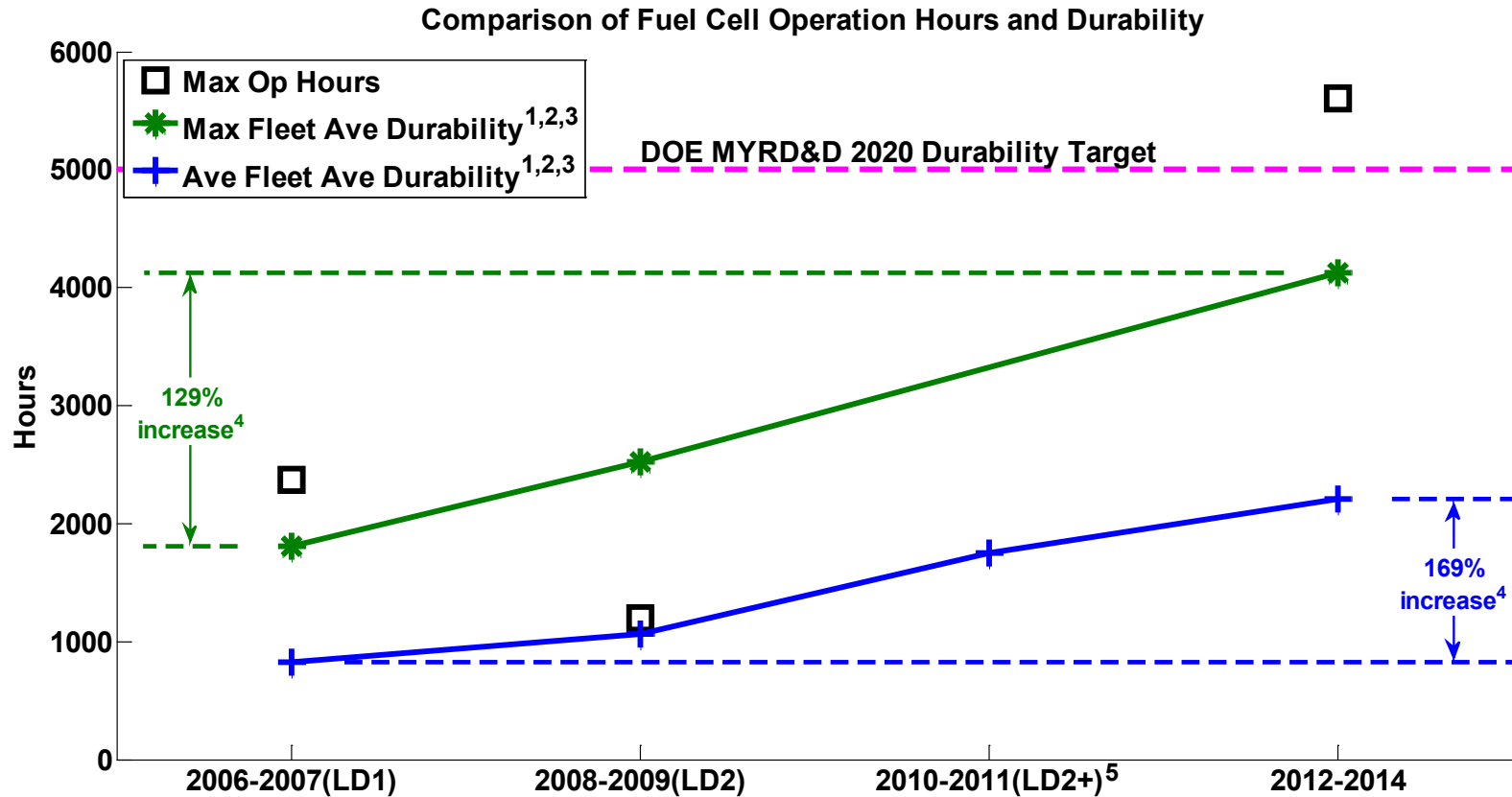
Analysis: Processing to Perform New CD

- ProcessRaw
- GetTripInfo
- StackInfoFromExcel
- FuelEconomyRaw
- FuelEconomy
- DataCompleteRaw
- DataComplete
- RangeRaw
- Range
- FCDegRaw
- FCDeg
- TripData
- StackSummary
- DriveDetails



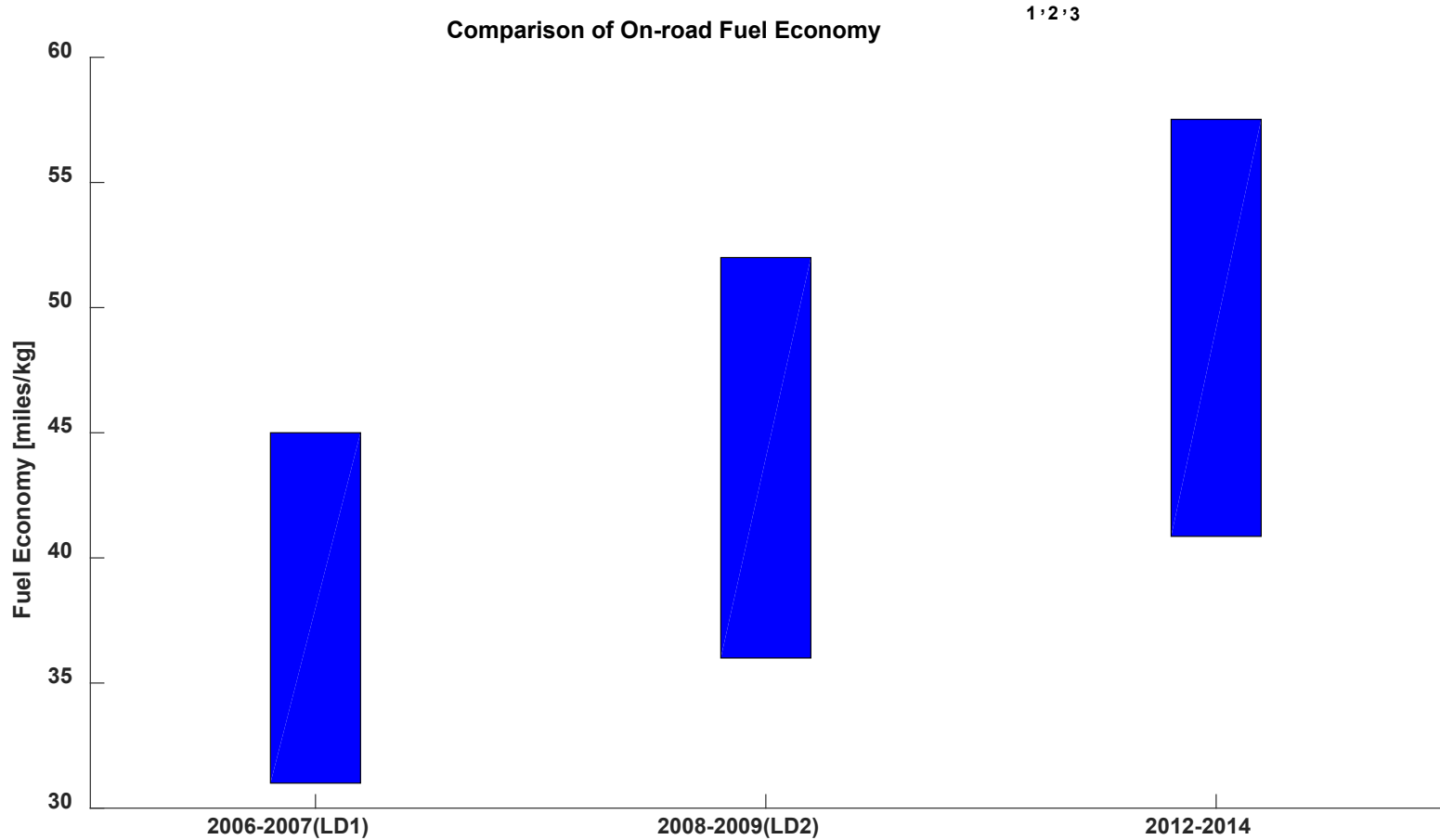
FCEV Results

Durability – Projected Hours to 10% Voltage Drop

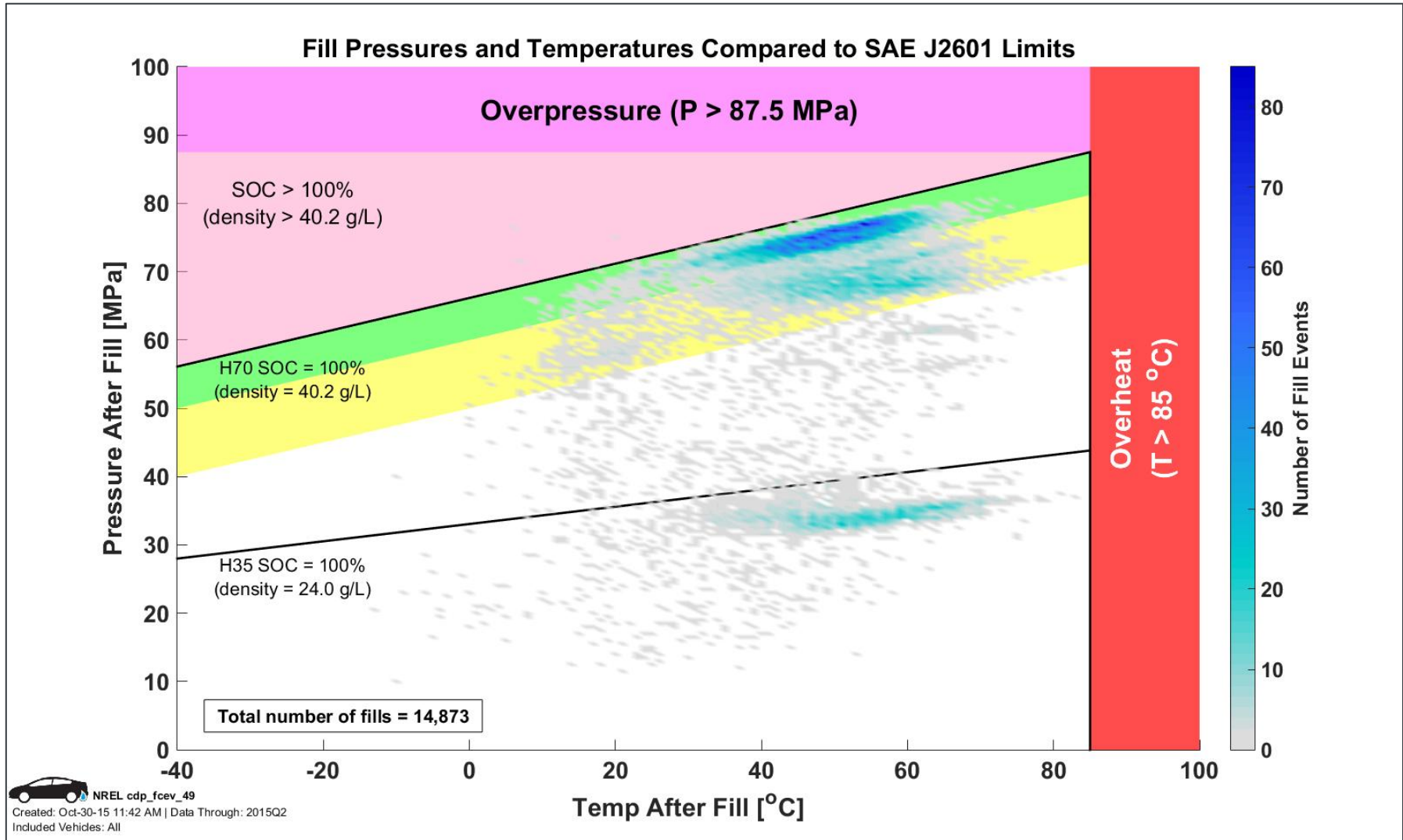


- 1) Durability based on voltage degradation to 10% lower than beginning of life voltage. 10% voltage drop level is a DOE metric for assessing fuel cell durability.
- 2) Projections using on-road data are calculated at approximately 55 - 65% rated stack current.
- 3) 10% voltage drop is NOT an indication of an OEM's end-of-life criteria and projections do not address catastrophic stack failure.
- 4) Percent increases are calculated relative to LD1 (2006-2007).
- 5) Maximum operational hours not reported in LD2+ (2010-2011).

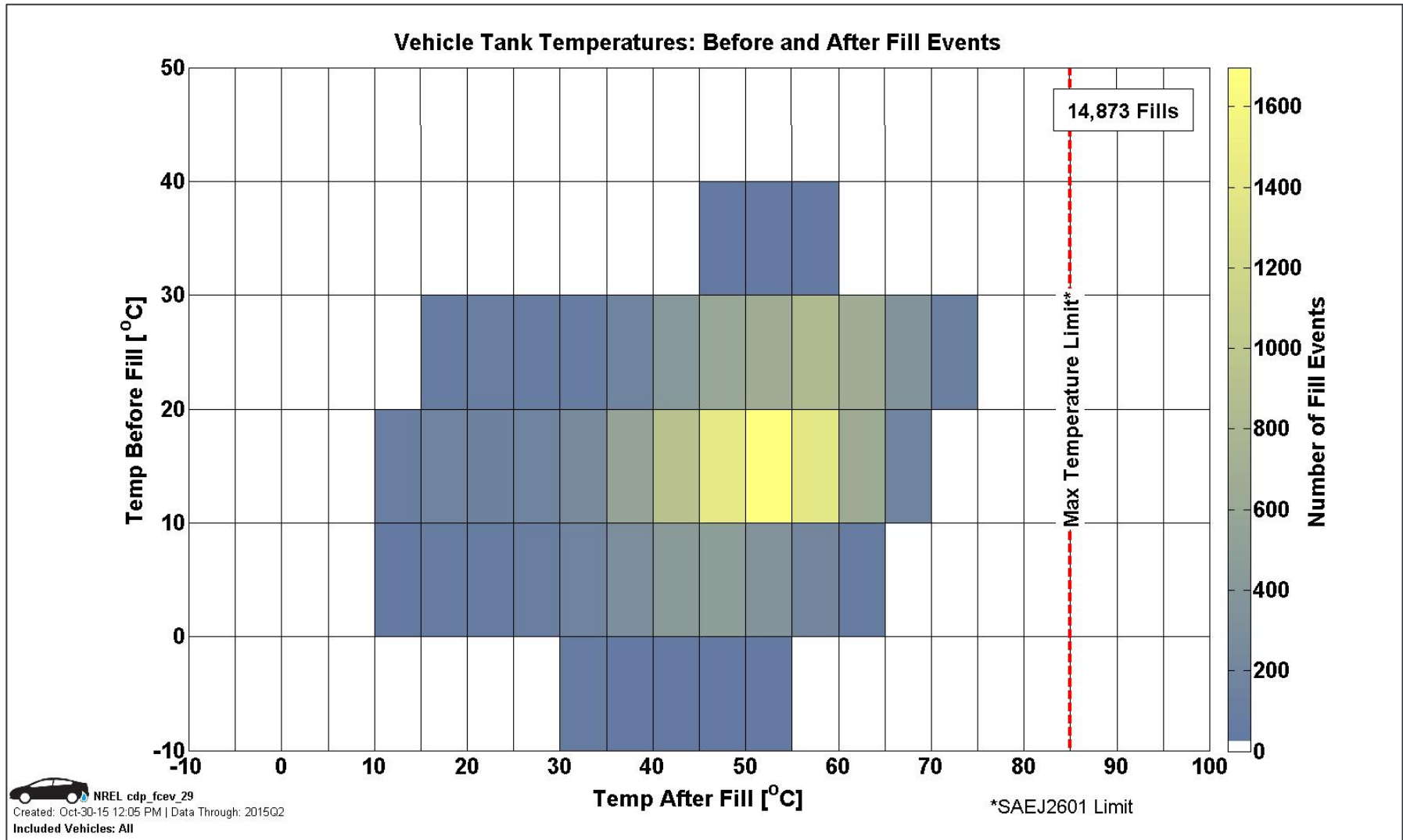
On-Road Fuel Economy Comparison



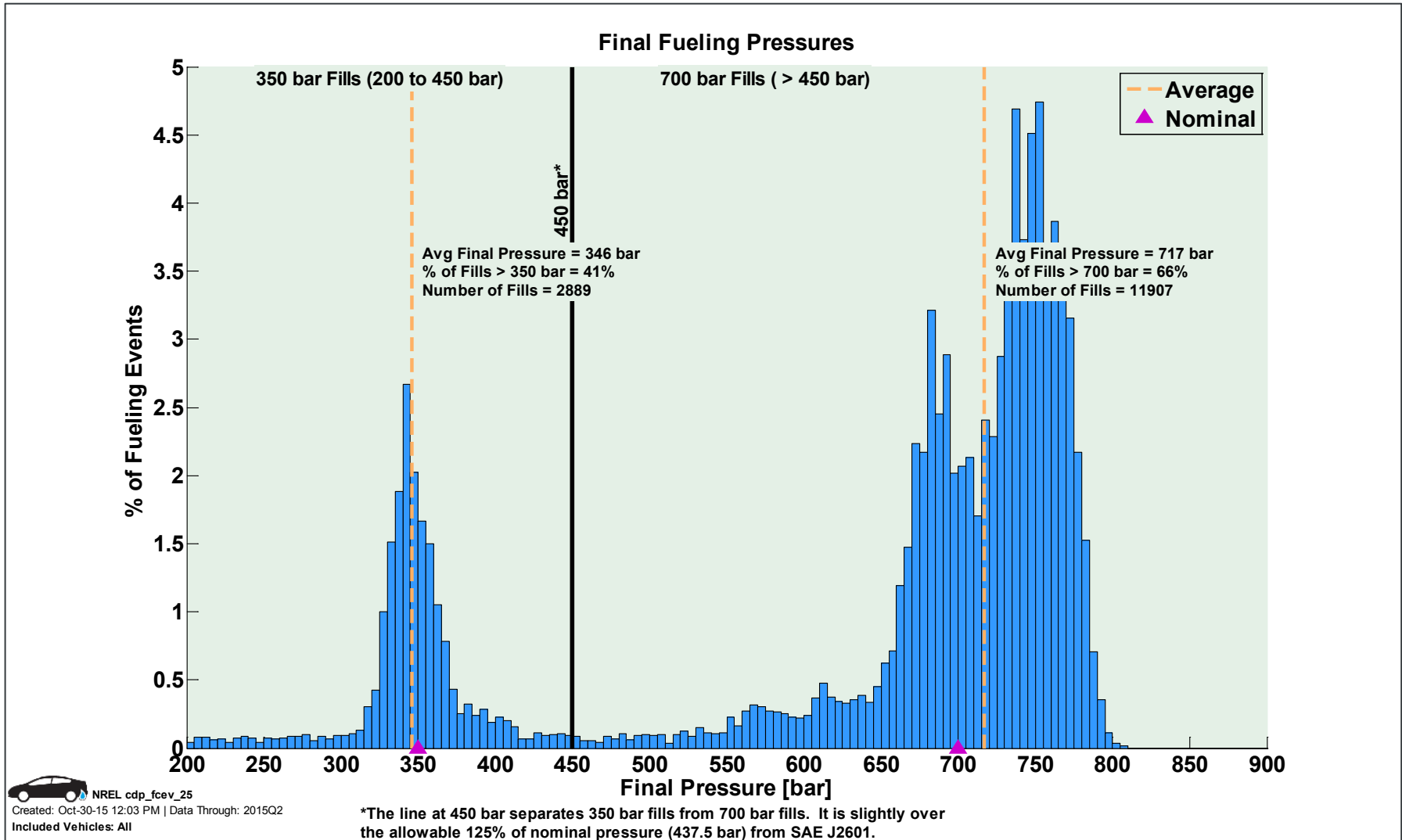
Fill Pressures and Temperatures



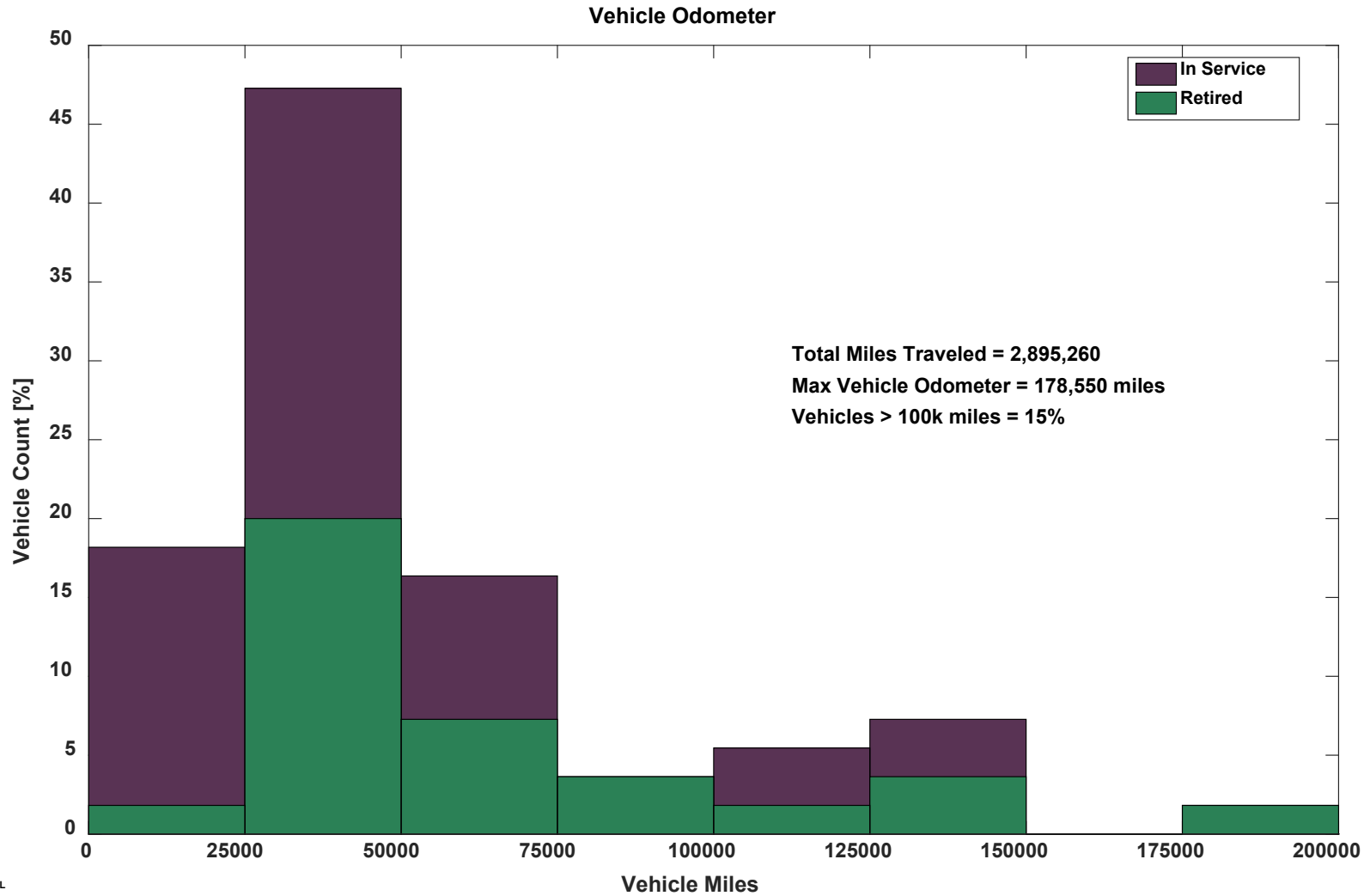
Fueling: Temperature Before and After



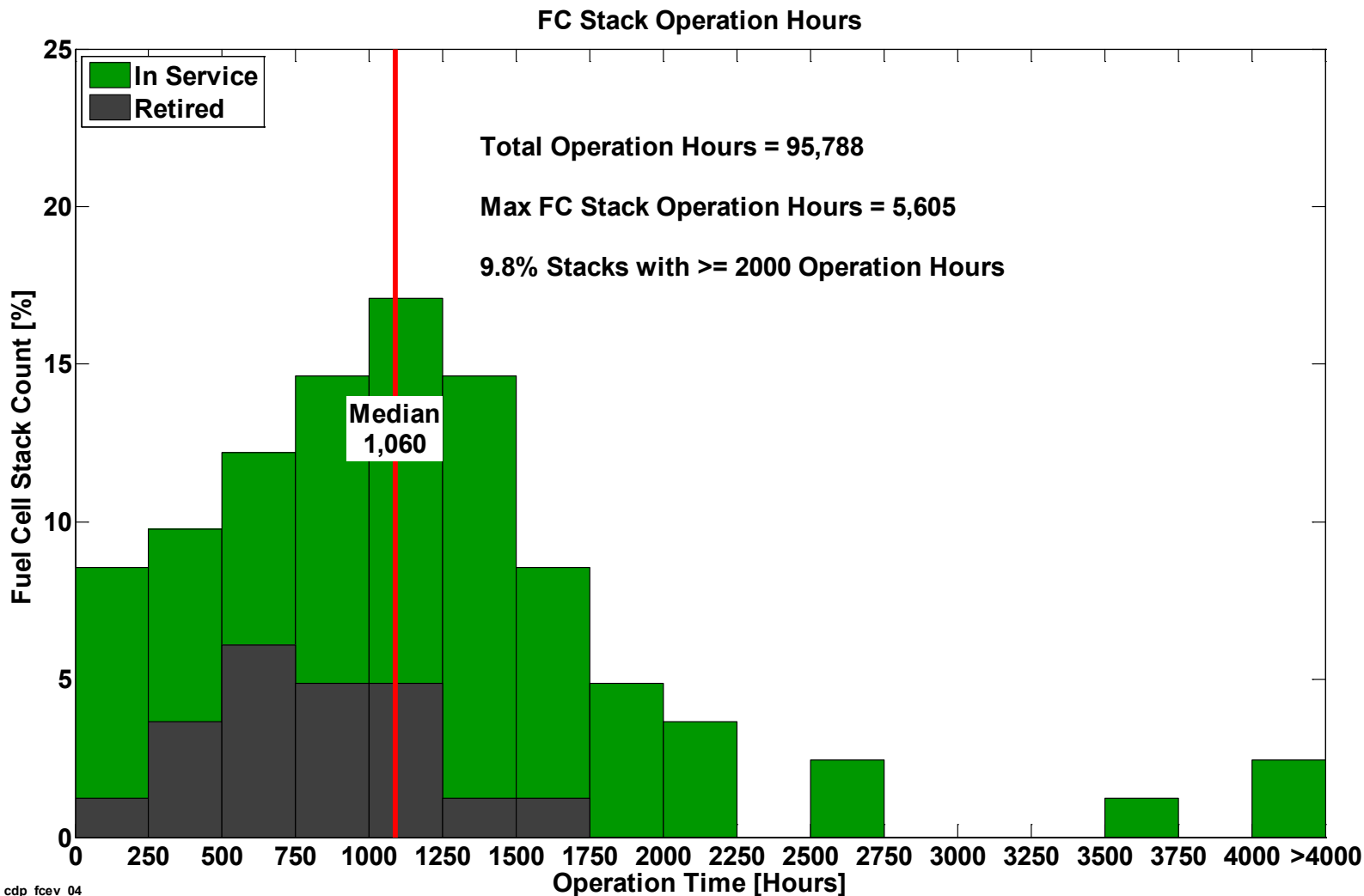
Final Pressures

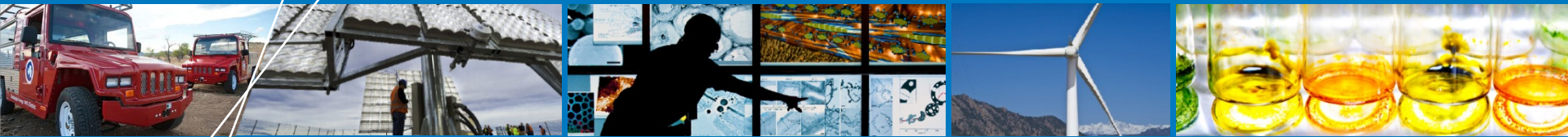


Vehicle Odometer



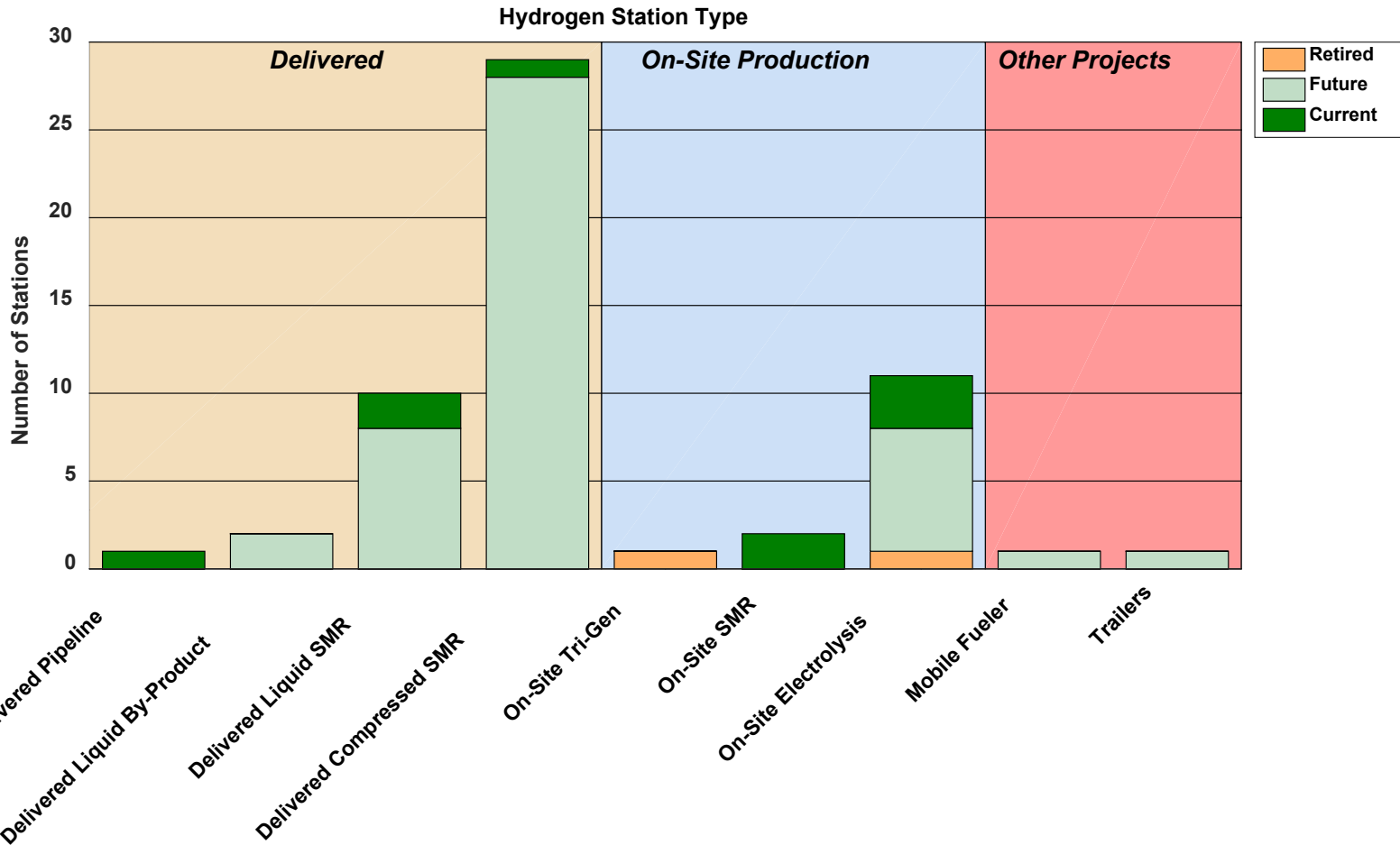
Fuel Cell Stack Hours



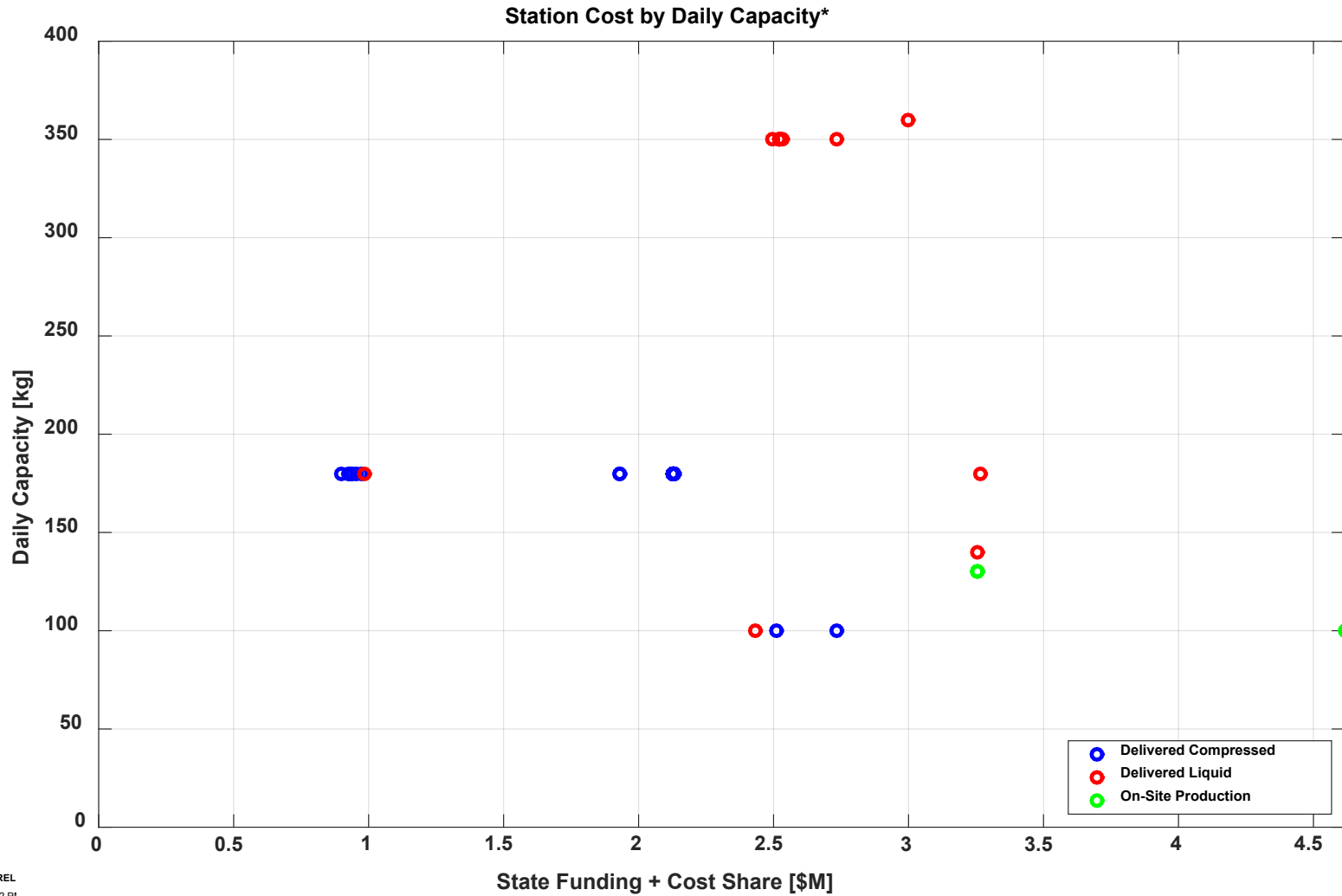


H2 Infrastructure Results

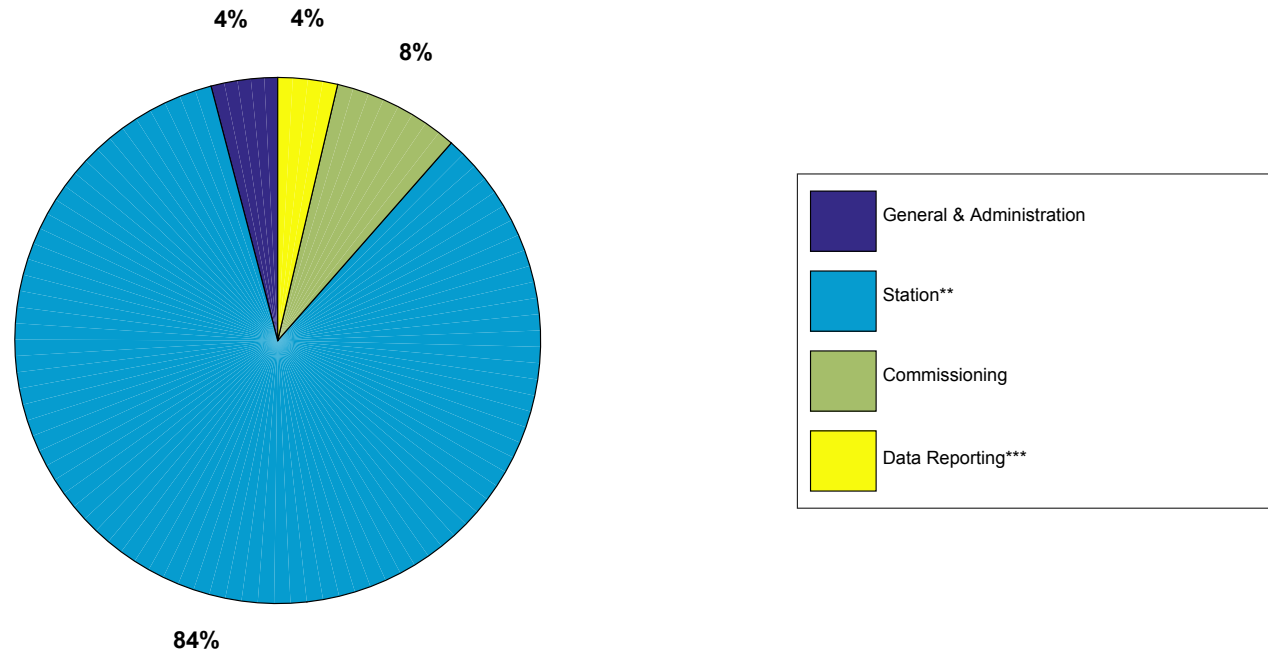
Hydrogen Station Types



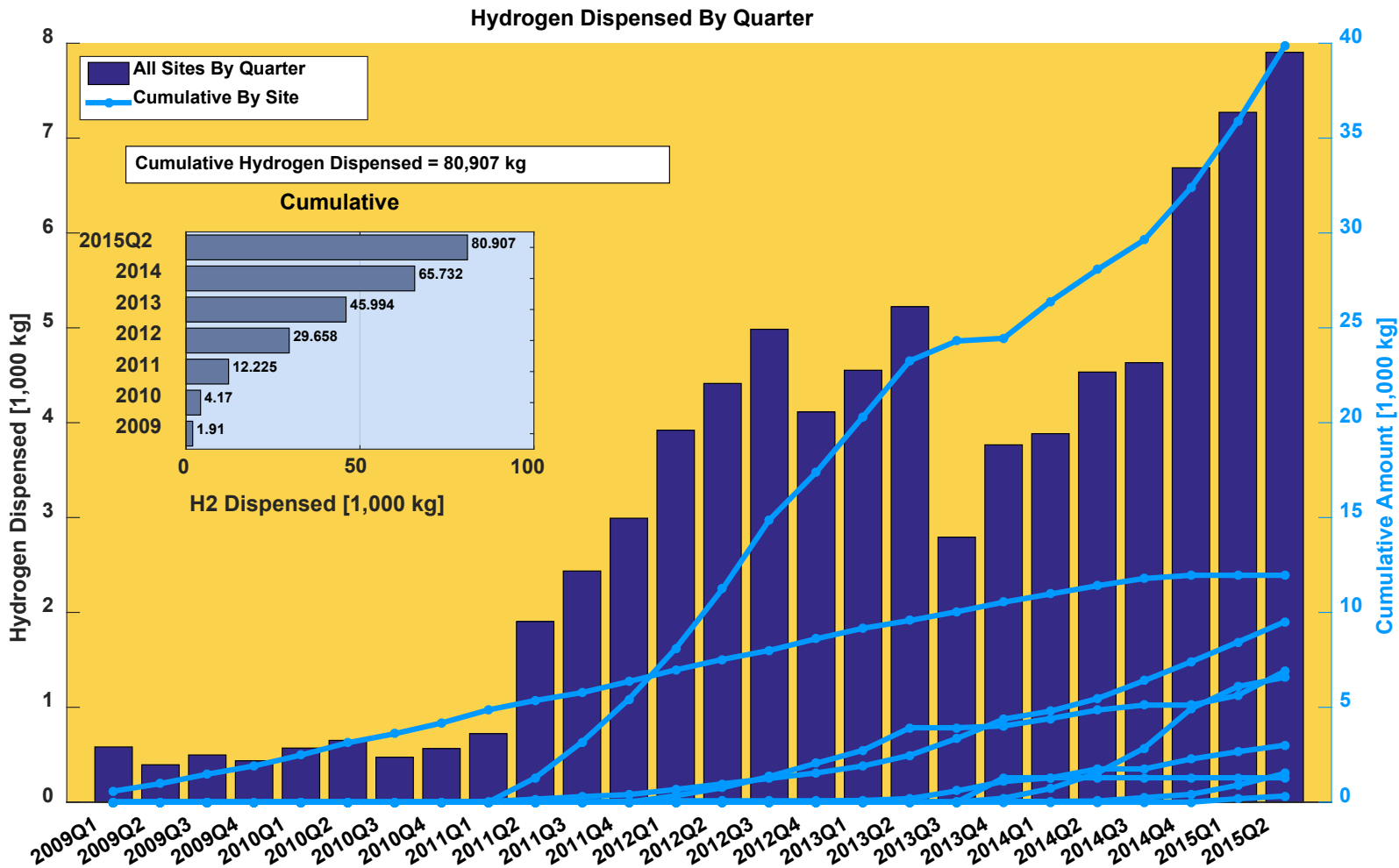
Station Cost and Daily Capacity



Budget Amounts* (Avg Total = \$2.2M), 46 Stations

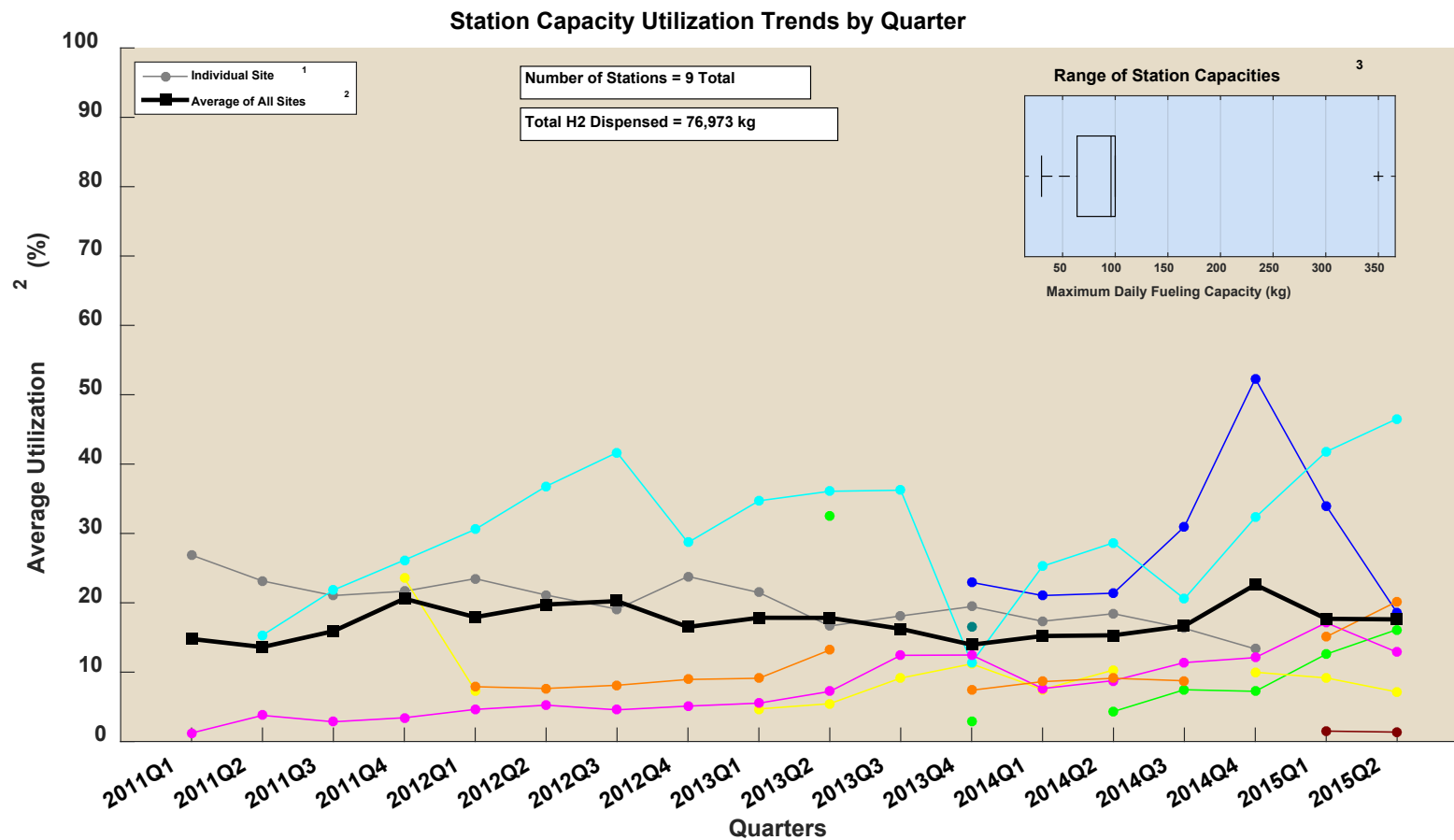


Hydrogen Dispensed by Quarter

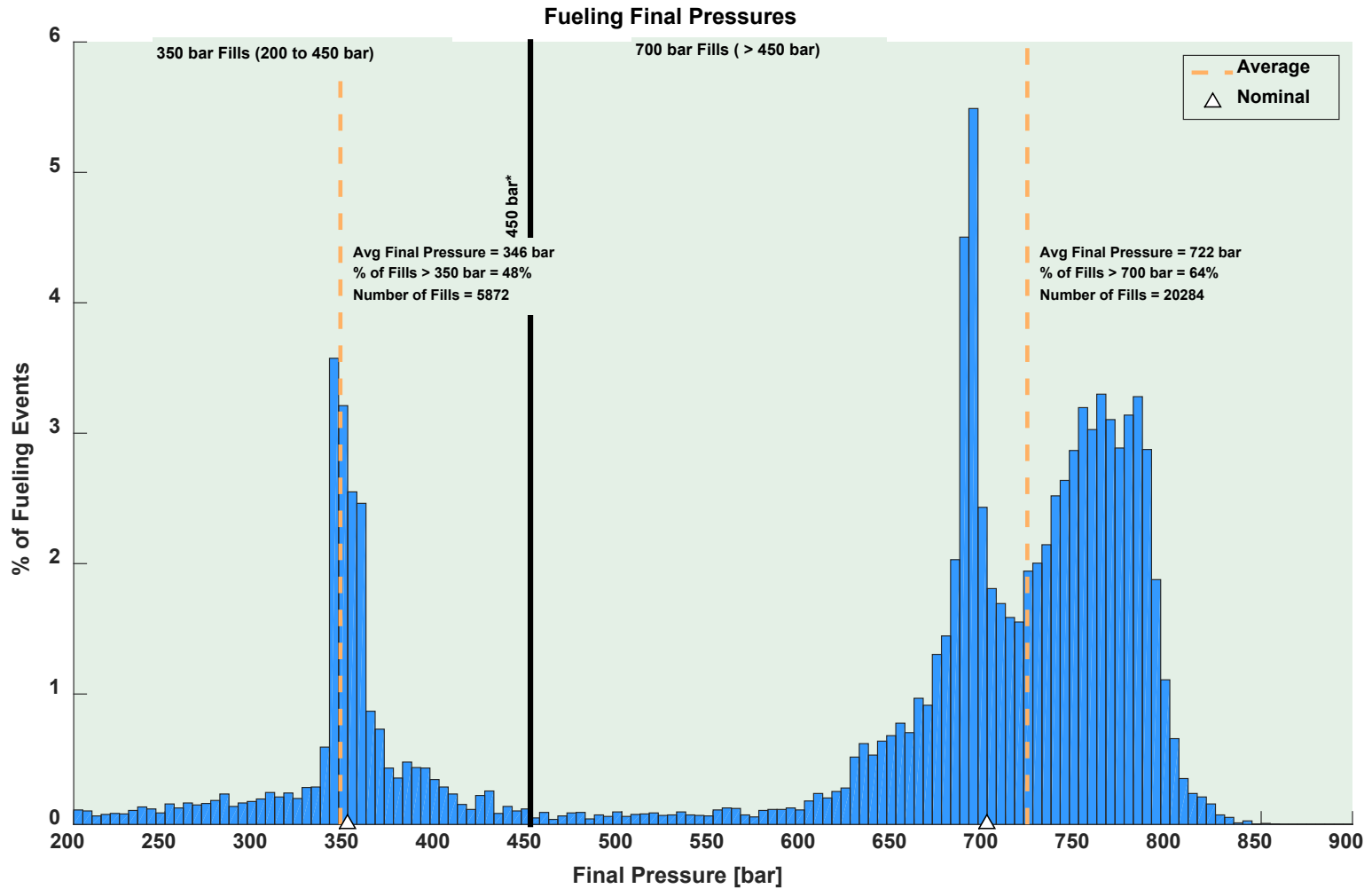


Created: Oct-19-15 4:00 PM

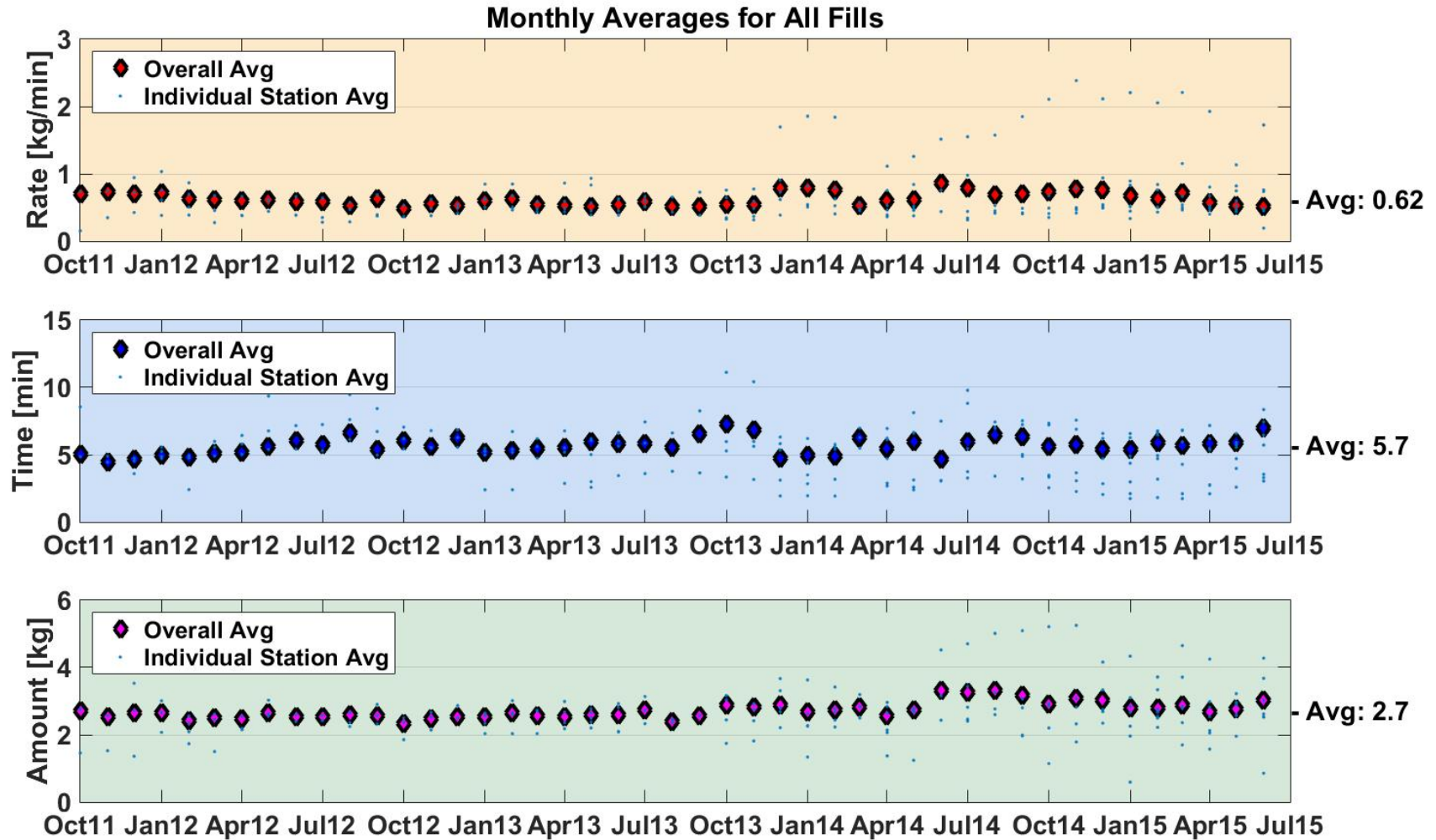
Station Capacity Utilization



Fueling Final Pressures



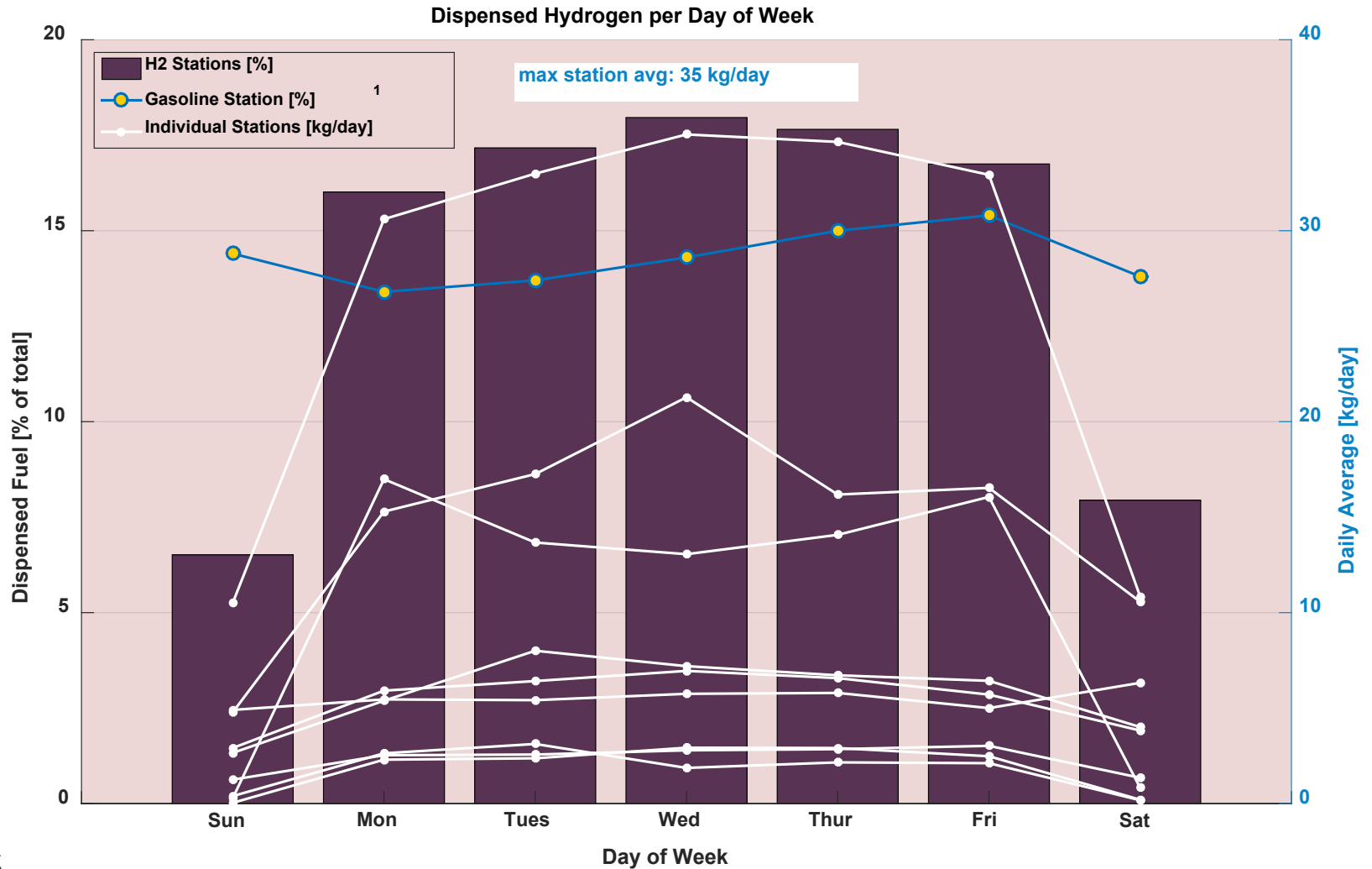
Monthly Averages – All Fills



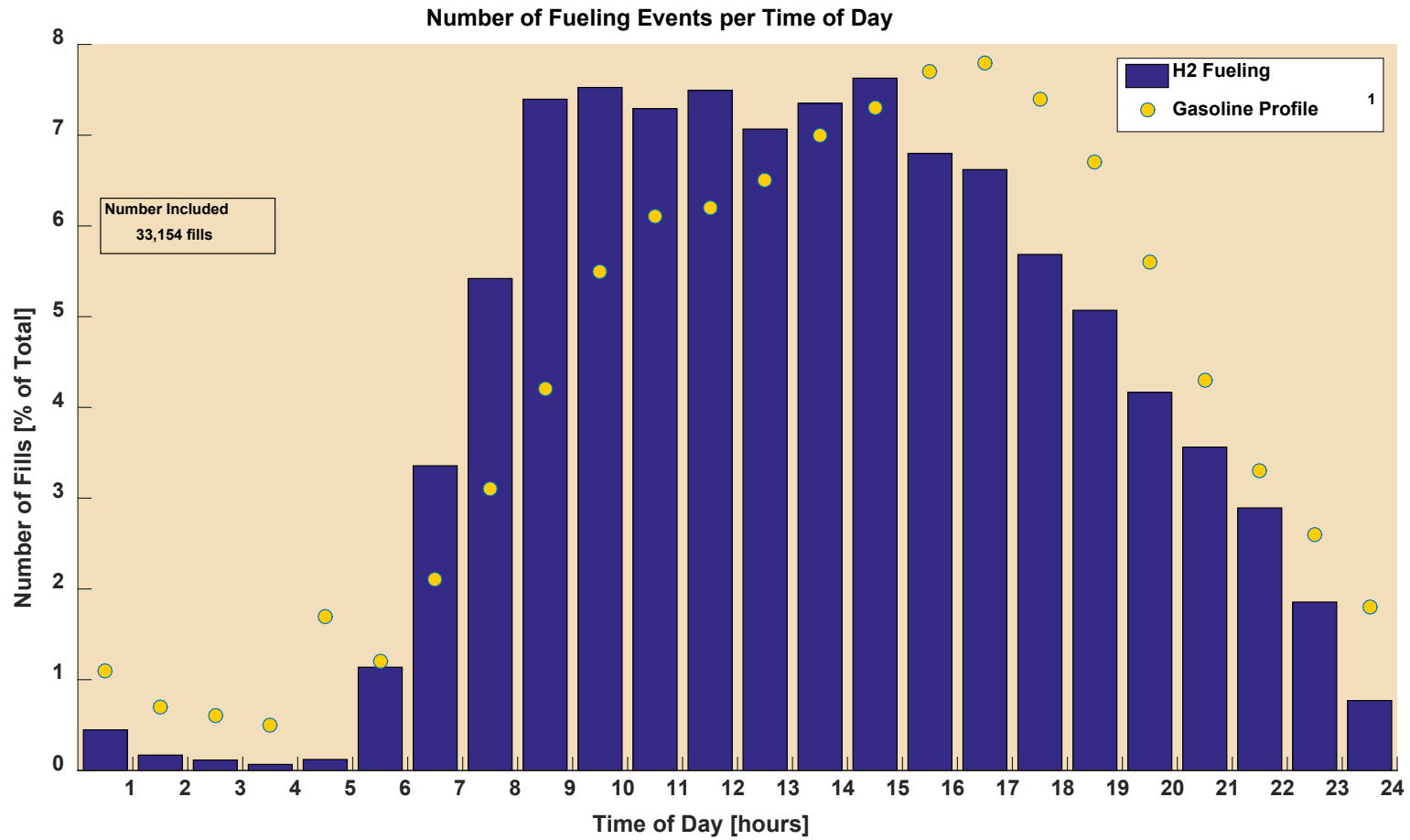
NREL cdp_infr_55

Created: Nov-04-15 2:59 PM | Data Range: 2009Q1-2015Q2

Dispensed Hydrogen per Day of Week



Dispensed Hydrogen per Day of Week

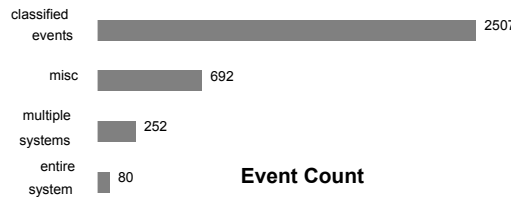
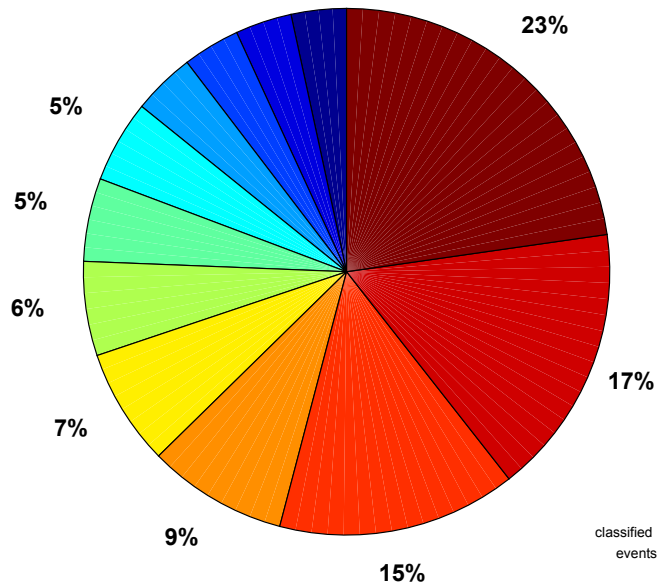


Created: Nov-13-15 10:28 A

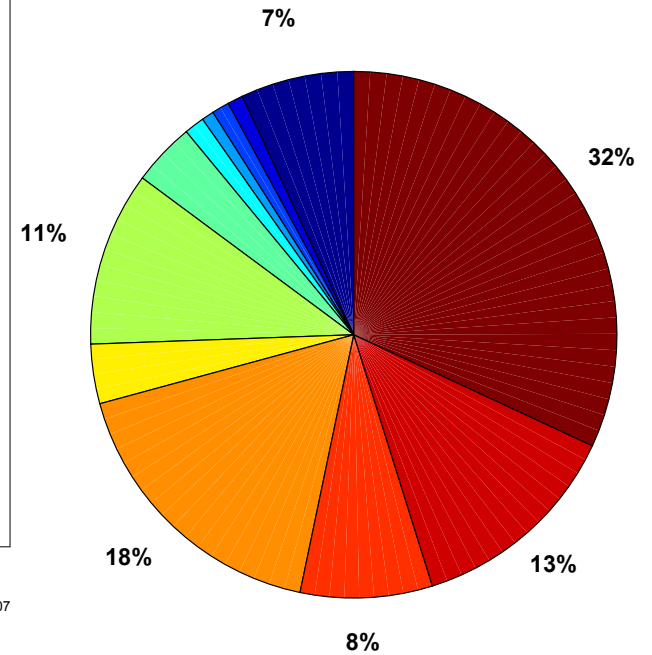
Maintenance by Equipment Type



Total Events ¹ = 3,531
37% unscheduled

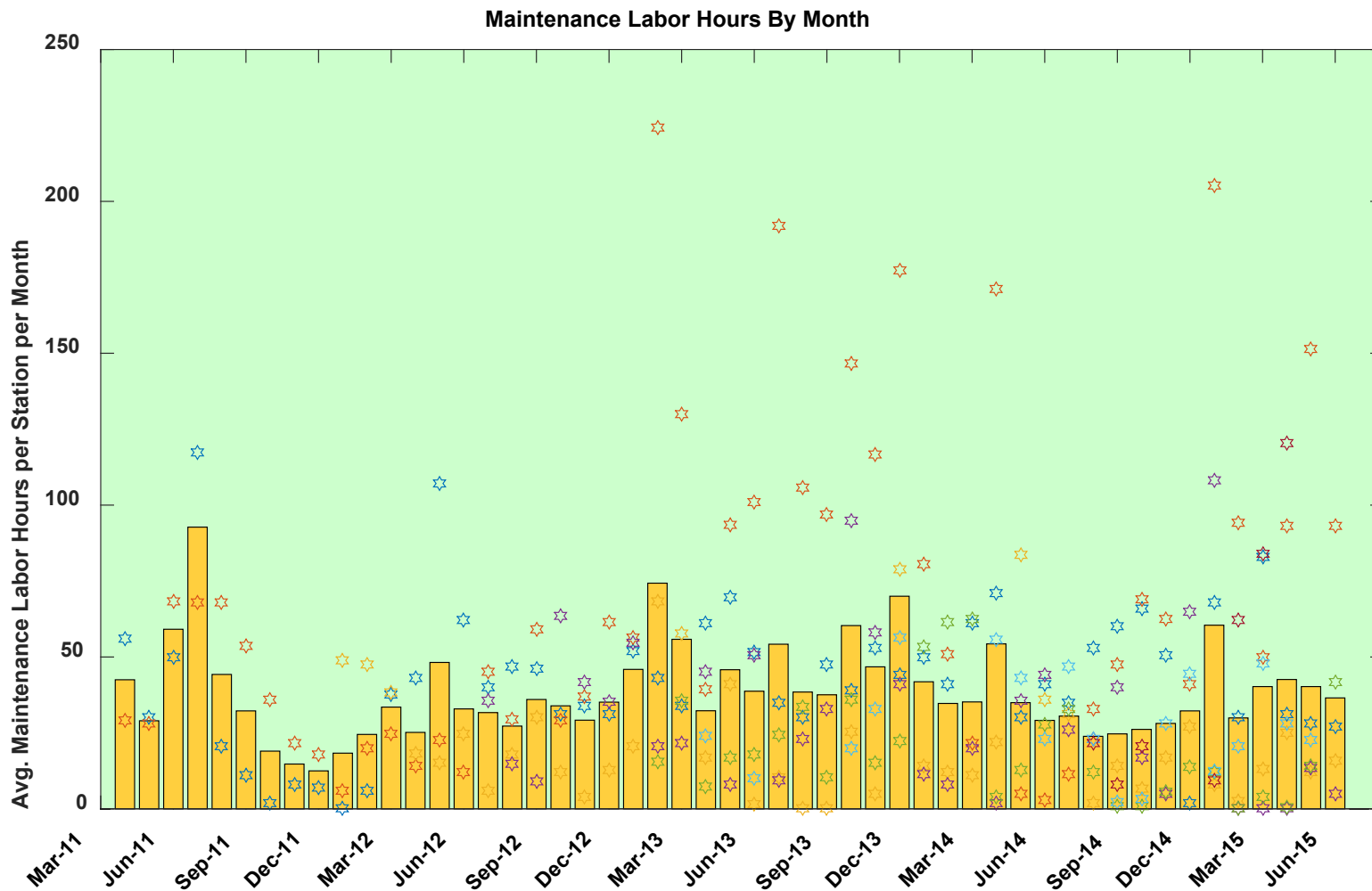


Total Hours ¹ = 24,304
17% unscheduled

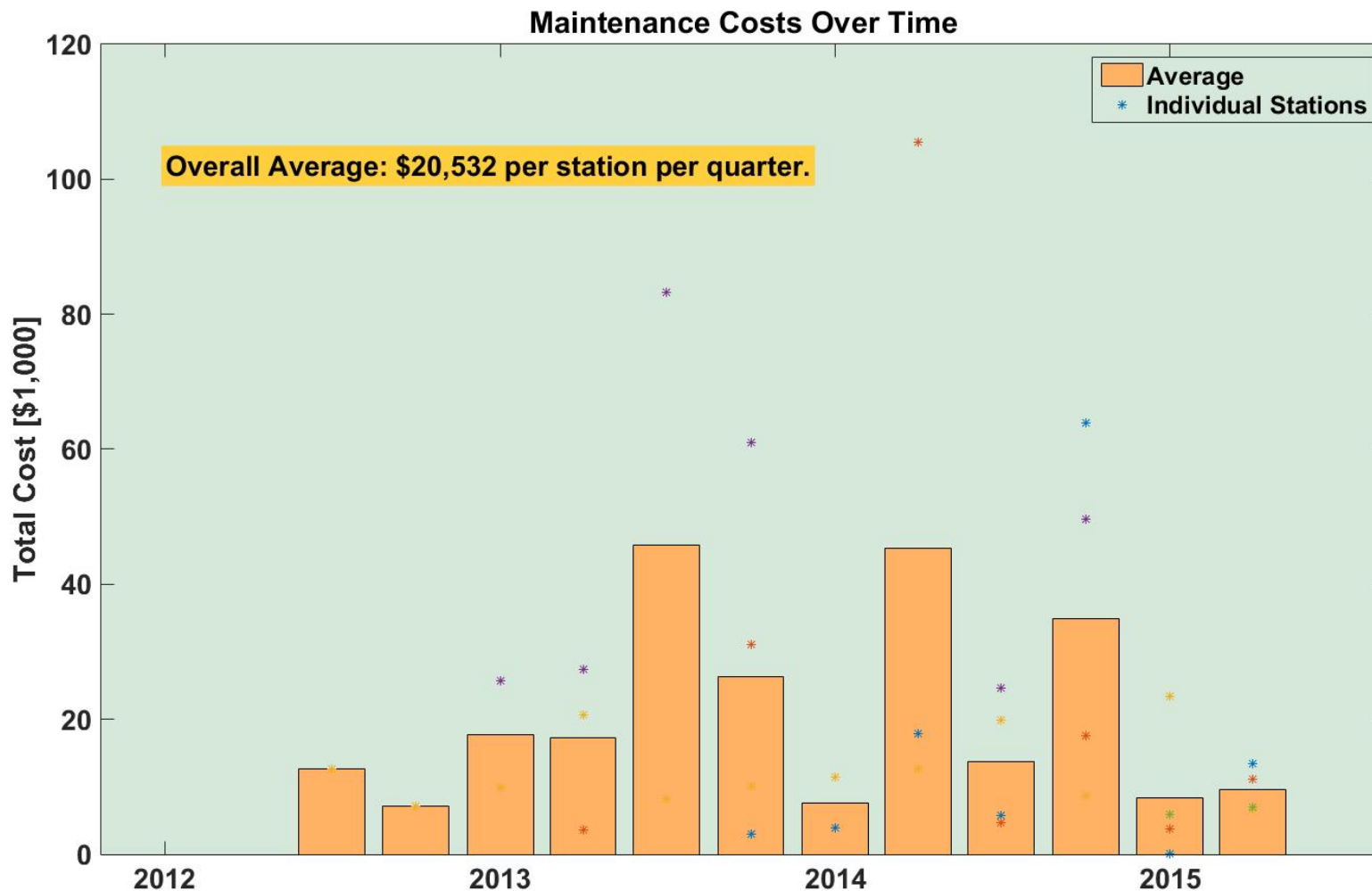


Created: Nov-11-15 12:47 F

Maintenance Hours by Month



Average Maintenance Cost by Quarter

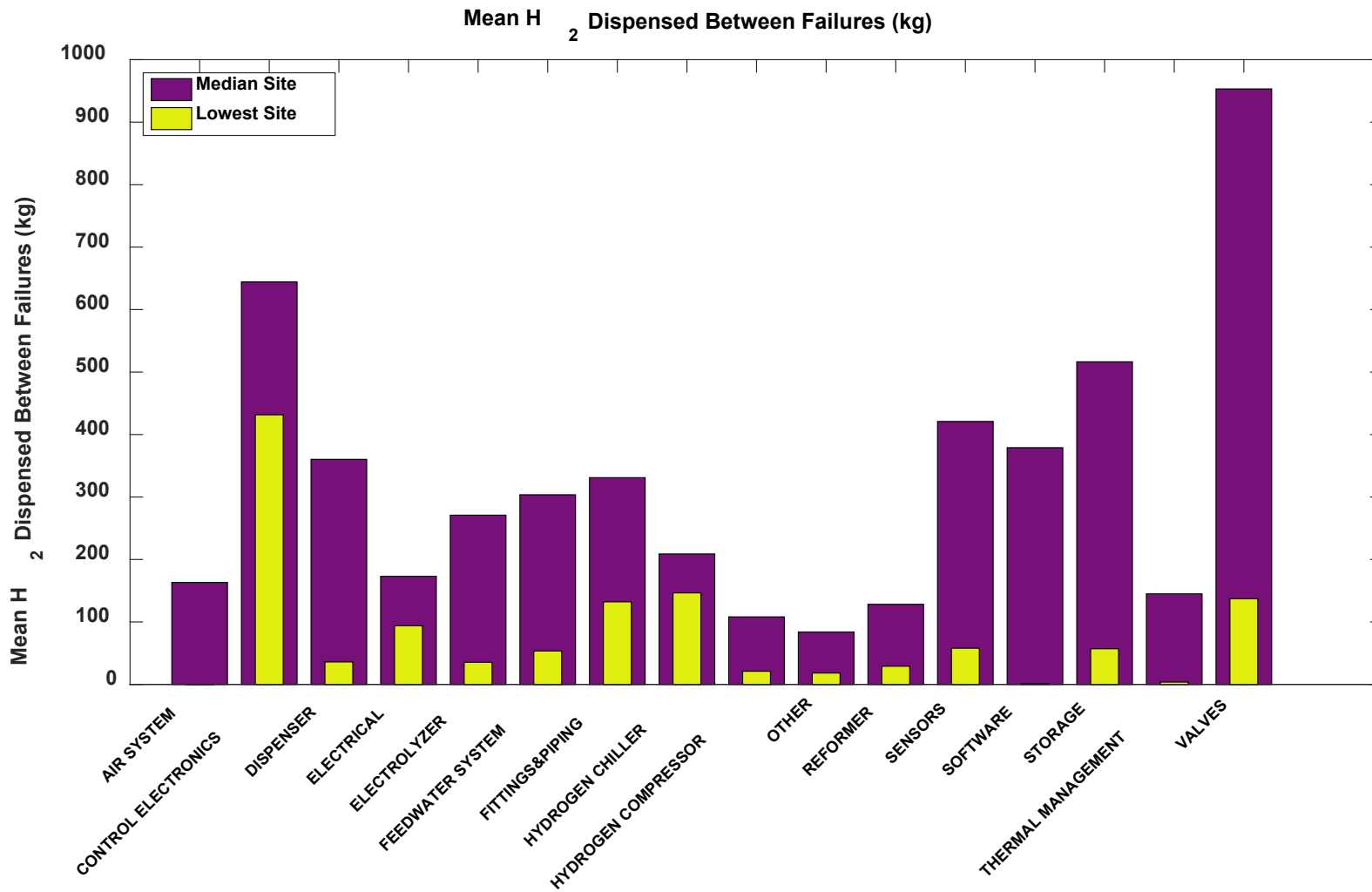


NREL cdp_infr_30

Created: Nov-12-15 11:19 AM | Data Range: 2009Q1-2015Q2

*Each color represents a unique station.

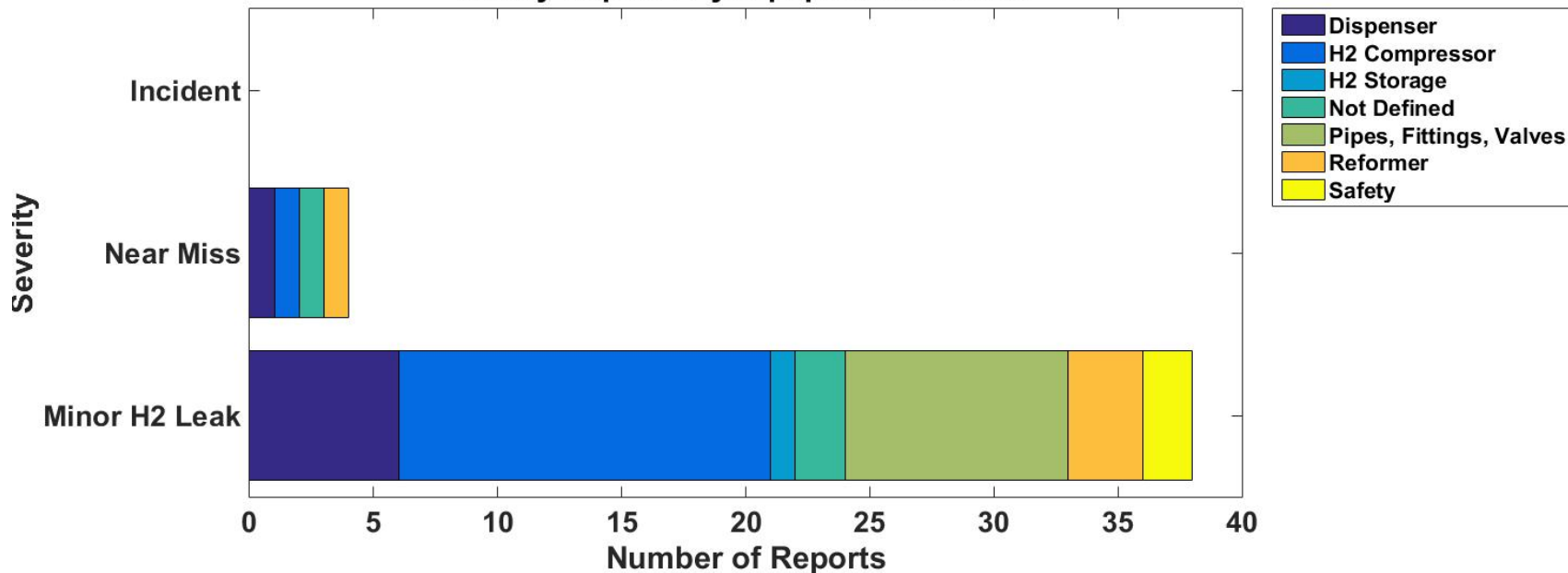
Mean Amount Dispensed Between Failures



Safety Reports by Equipment Involved



Safety Reports By Equipment Involved



An Incident is an event that results in:

- a lost time accident and/or injury to personnel
- damage/unplanned downtime for project equipment, facilities or property
- impact to the public or environment
- any hydrogen release that unintentionally ignites
- release of any volatile, hydrogen containing compound (including the hydrocarbons used as common fuels)

A Near Miss is:

- an event that under slightly different circumstances could have become an incident
- any hydrogen release sufficient to sustain a flame if ignited

A Minor H2 Leak is:

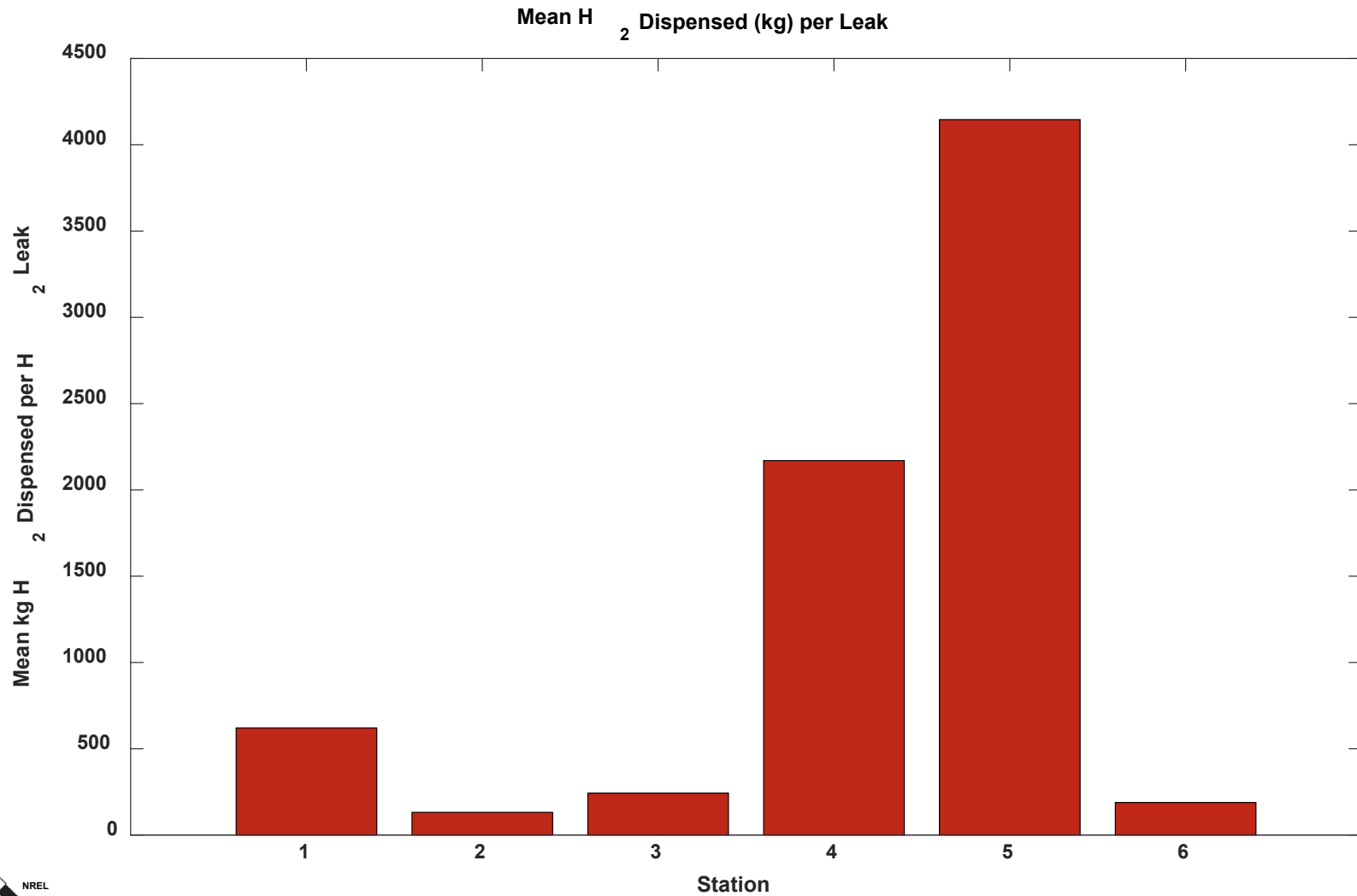
- an unplanned hydrogen release insufficient to sustain a flame, and does not accumulate in sufficient quantity to ignite



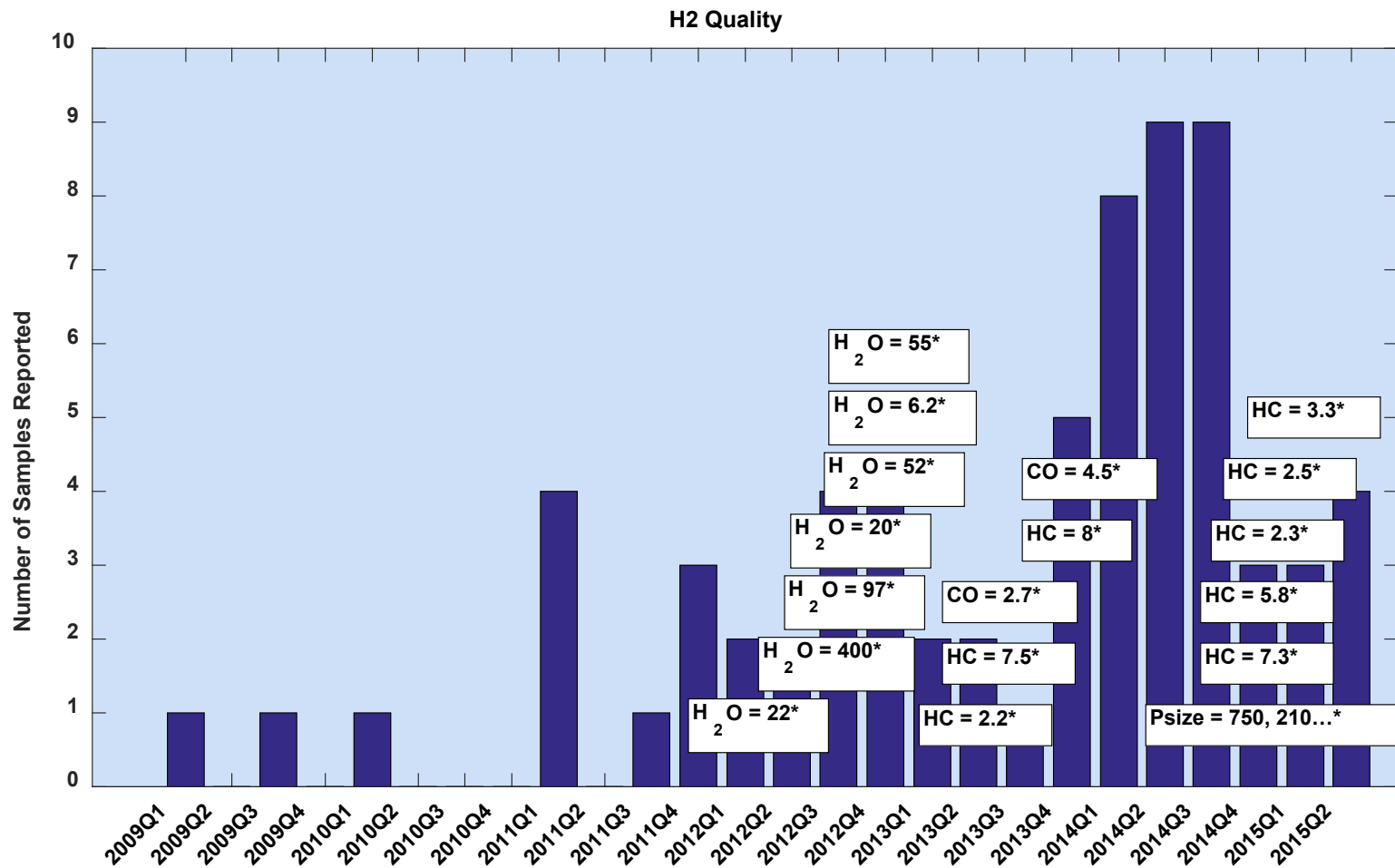
NREL cdp_infr_32

Created: Nov-04-15 1:45 PM | Data Range: 2008Q3-2015Q2

Average Amount Dispensed Between Leaks



H2 Quality



NREL
Created: Oct-06-15 3:30 PM




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Fuel Cell and Hydrogen Technology Validation

Technology validation is defined as confirmation that component and system technical targets have been met under realistic operating conditions. The NREL technology validation team works on validating hydrogen fuel cell electric vehicles; hydrogen fueling infrastructure; and fuel cell use in early market applications such as material handling, backup power, and prime-power applications. The team also analyzes the current status of state-of-the-art laboratory fuel cell technologies, with a focus on performance and durability. This work supports the Department of Energy's hydrogen and fuel cell technology validation activity.

Technology validation projects involve gathering extensive data from the systems and components under real-world conditions, analyzing this detailed data, and then comparing results to technical targets. While the raw data is protected by NREL, analysis results are aggregated into public results called composite data products. These public results show the status and progress of the technology, but don't identify individual companies.

Click on the application type to see project highlights, analysis results, and detailed reports and presentations from the hydrogen and fuel cell technology validation efforts underway at NREL.

Vehicles



CARS

Buses



BUSES

Forklifts



FORKLIFTS

Backup Power



BACKUP POWER

Stationary Power



PRIME POWER

Infrastructure



INFRASTRUCTURE

Laboratory Stacks



STACK

[Printable Version](#)

Animated Map Correlates Fuel Cell Usage for Backup Power with Grid Outages



Learn how NREL developed the [time-lapse geographical visualization map](#) or view the [animation](#), which covers January 2010 to December 2013.

1
2
3
4