Next Generation H2 Station
Fall 2014 CDPS (Thru 2014Q2)

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CDP-INFR-01
Hydrogen Dispensed by Quarter

Cumulative Hydrogen Dispensed = 52,662 kg
CDP-INFR-02
Histogram of Fueling Rates

Histogram of Fueling Rates

- 17,012 Events
- Average = 0.57 kg/min
- 14% > 1 kg/min
- 3% > 1.67 kg/min

3 minute fill of 5 kg

Reference Line at 1 kg/min
2012 MYPP Tech Val Milestone
Histogram of Fueling Times

Average = 5.65 min
48% < 5 min
18% < 3 min

Reference Line at 5 min
2012 MYPP Tech Val Milestone (5 kg in 3 min)
CDP-INFR-04
Histogram of Fueling Amounts
CDP-INFR-06
Station Capacity Utilization

Station Capacity Utilization

- Maximum Daily Utilization
- Maximum Quarterly Utilization
- Average Daily Utilization

Note: The focus for early stations is geographic coverage.

$\text{Station nameplate capacity reflects a variety of system design considerations including system capacity, throughput, system reliability and durability, and maintenance. Actual daily usage may exceed nameplate capacity.}$

$\text{Maximum quarterly utilization considers all days; average daily utilization considers only days when at least one filling occurred.}$
Station Usage

- Maximum Daily Fills
- Average Daily Fills

Note: The focus for early stations is geographic coverage.

1 Excludes hydrogen fills of < 0.5 kg
2 Average daily fills considers only days when at least one fill occurred
CDP-INFR-08
Time Between Fueling

Histogram of Time Between Fuelings

- Back-to-Back Fills
- Simultaneous Fills

8% of fills are within 0-5 minutes of each other
74% of fills have more than 20 minutes between them
17077 Total Fills

Final Pressures for Fills with <5 Minutes in Between

- Previous Fill
- Next Fill

*Time is from end of fill to start of next fill.
Fueling Final Pressures

Avg Final Pressure = 346 bar
% of Fills > 350 bar = 46%
Number of Fills = 4581

Avg Final Pressure = 722 bar
% of Fills > 700 bar = 62%
Number of Fills = 12242

*The line at 450 bar separates 350 bar fills from 700 bar fills. It is slightly over the allowable 125% of nominal pressure (437.5 bar) from SAE J2601.
Cumulative Number of Stations

Cumulative Stations

Number of Stations

Reporting Period


CDP-INFR-10

Created Oct-07-14 8:09 AM

NREL cdp_infr_10
CDP-INFR-11
Hydrogen Stations by Type

![Graph showing hydrogen stations by type: Delivered and On-Site Production categories. The bars indicate the number of stations for each type—Compressed, Liquid, Pipeline, Reforming, and Electrolysis.]
CDP-INFR-12
Fueling Rates 350 Vs. 700 bar

Histogram of Fueling Rates 350 vs 700 bar Fills

<table>
<thead>
<tr>
<th>Fill Type</th>
<th>Avg</th>
<th>%&gt;1</th>
<th>%&gt;1.67</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>350 bar</td>
<td>0.49</td>
<td>4</td>
<td>1%</td>
<td>4631</td>
</tr>
<tr>
<td>700 bar</td>
<td>0.60</td>
<td>18</td>
<td>4%</td>
<td>12380</td>
</tr>
</tbody>
</table>

3 minute fill of 5 kg
CDP-INFR-13
Number of Fueling Events per Hour

Average: 1.7 per hour
Median: 1.0 per hour
Max: 23.0 per hour
Number of Fills by Time of Day
CDP-INFR-16

Fueling Amounts per Time of Day

[Graph showing fueling amounts per time of day with bars for total, lines for max and average, and a note indicating 54,862 kg included.]
CDP-INFR-17
Fueling Rates by Amount Filled

Histogram of Fueling Rates by Amounts

Number of Fueling Events

Average Fuel Rate [kg/min]

0 to 0.5 kg
0.5 to 1 kg
1 to 2 kg
2 to 4 kg
4 to 6 kg
Reference Line at 1 kg/min
2012 MYPP Tech Val Milestone
CDP-INFR-18

Fueling Amount vs. Time to Fill

Histogram of Fueling Amount Vs Time

1/1/2011 Through 7/1/2011

7/1/2011 Through 1/1/2012

1/1/2012 Through 7/1/2012

7/1/2012 Through 1/1/2013

1/1/2013 Through 7/1/2013

7/1/2013 Through 1/1/2014

1/1/2014 Through 7/1/2014

NREL cdp_infr_18
Created: Oct-29-14 4:26 PM | Data Range: 2009Q1-2014Q2
CDP-INFR-19
Hydrogen Dispensed by Month
CDP-INFR-20
Number of Fills by Month
CDP-INFR-21
Maintenance by Equipment Type

Total Events = 2,318
38% unscheduled

- Hydrogen compressor: 21%
- Dispenser: 18%
- Safety: 15%
- Thermal management: 8%
- Reformer: 6%
- Electrolyzer: 6%
- Feedwater system: 5%
- Sensors: 5%
- Purifier: 9%
- Electrical: 8%
- Software: 6%

Total Hours = 20,081
16% unscheduled

- Hydrogen compressor: 31%
- Dispenser: 15%
- Safety: 7%
- Thermal management: 6%
- Reformer: 5%
- Electrolyzer: 5%
- Feedwater system: 5%
- Sensors: 4%
- Purifier: 4%
- Electrical: 3%
- Software: 2%

Event Count:
- Classified events: 1,566
  - Misc: 489
  - Multiple systems: 217
  - Entire system: 46

MISC includes the following failure modes: seal, nitrogen system, storage, hydrogen chiller, valves, fittings & piping, air system, control electronics, fuel system, other
CDP-INFR-22
Maintenance Labor Hours per Event

92% of repairs require less than the mean of 9.8 hours of labor.
Median labor hours: 2.5
CDP-INFR-23

Equipment Category Repair Time
CDP-INFR-24

Failure Modes for Top Equipment Categories

- **Thermal Management**: 9%
- **Safety**: 18%
- **Dispenser**: 19%
- **Hydrogen Compressor**: 21%

*Percentage of total events or hours.*

**Legend**:
- Fluid Leak (Non-Hydrogen)
- Hydrogen Leak
- Improper Installation
- Inspect Trouble Alarm or Report
- Manufacturing Defect
- Replace Failed Parts
- Software Bug
- Misc
- Scheduled (Prev Maint, Upgrades)

Created: Oct-23-14 3:39 PM | Data Range: 2009Q1-2014Q2
39 of 50 samples (78%) met the SAE J2719 guidelines. Consecutive samples may be for a single issue.

Values are in micromole/mole, except for particulate size (Psize) in micrometer. Only values that exceed SAE J2719 guideline are shown in text. Left edge of text box aligns with date.
CDP-INFR-26
Compressor Monthly Maintenance

Overall Average:
28 hours per station per month.

Overall Average:
10 events per station per month.
CDP-INFR-27
Hydrogen Site Summary
Maintenance Hours by Month

Overall Average:
33 hours per station per month.

Stars represent individual station maintenance hours in a given month.
CDP-INFR-29
Monthly Averages for 700bar Fills >1kg with Pre-Cool of -20C

- Rate [kg/min]: Avg 0.61
- Time [min]: Avg 6.1
- Amount [kg]: Avg 2.9