



**Technical Report**  
NREL/TP-5600-49603  
April 2011

# **Fall 2010 Composite Data Products ARRA Material Handling Equipment**

**Quarter 3 of 2010**

**Composite Data Products  
Final Version September 30, 2010**

Jennifer Kurtz, Keith Wipke, Sam Sprik, and Todd Ramsden

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# Fall 2010 Composite Data Products

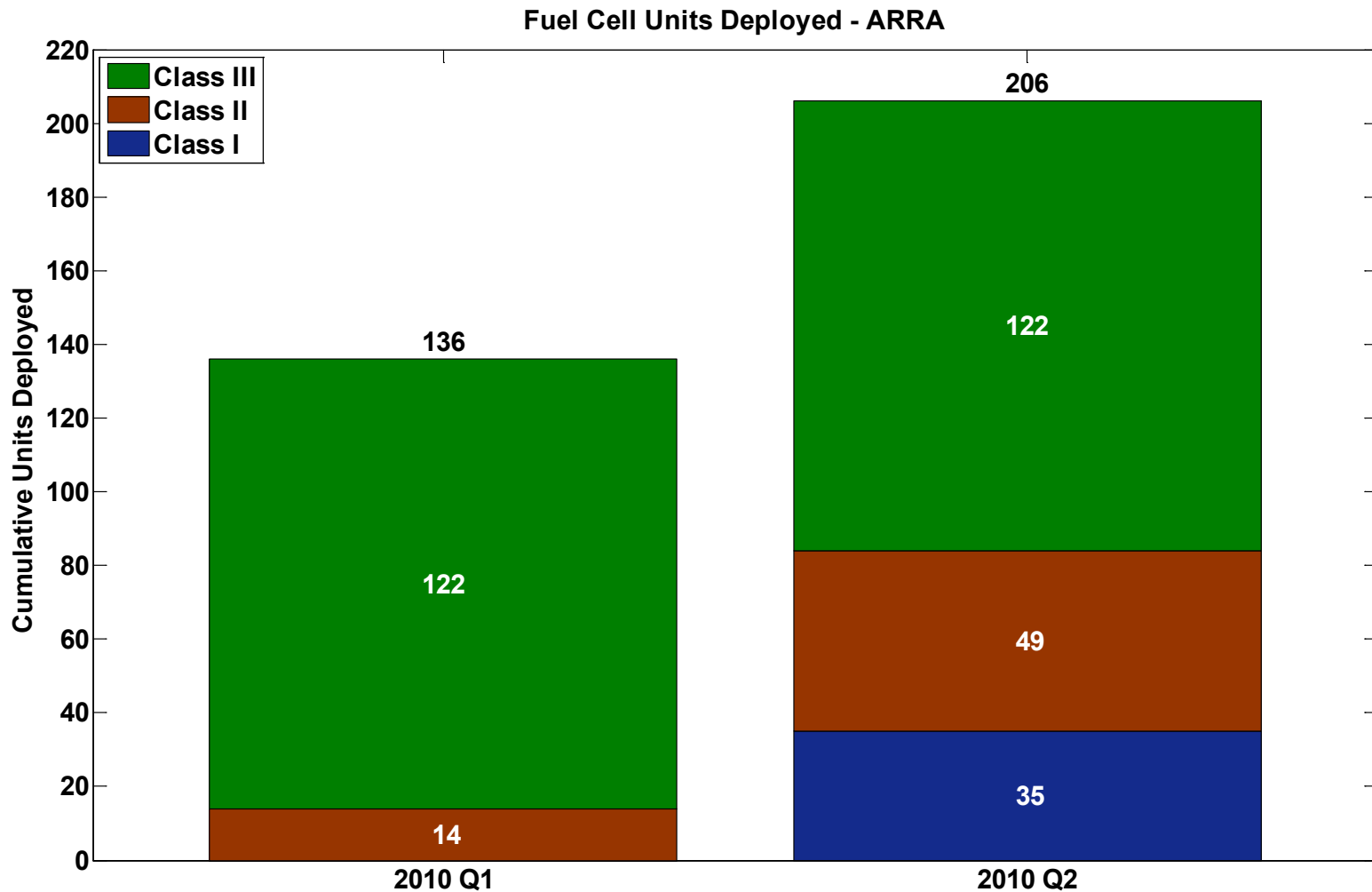
## ARRA Material Handling Equipment



**J. Kurtz, K. Wipke, S.  
Sprik, T. Ramsden**

**September 30<sup>th</sup>, 2010**

## Fuel Cell MHE Systems Deployed

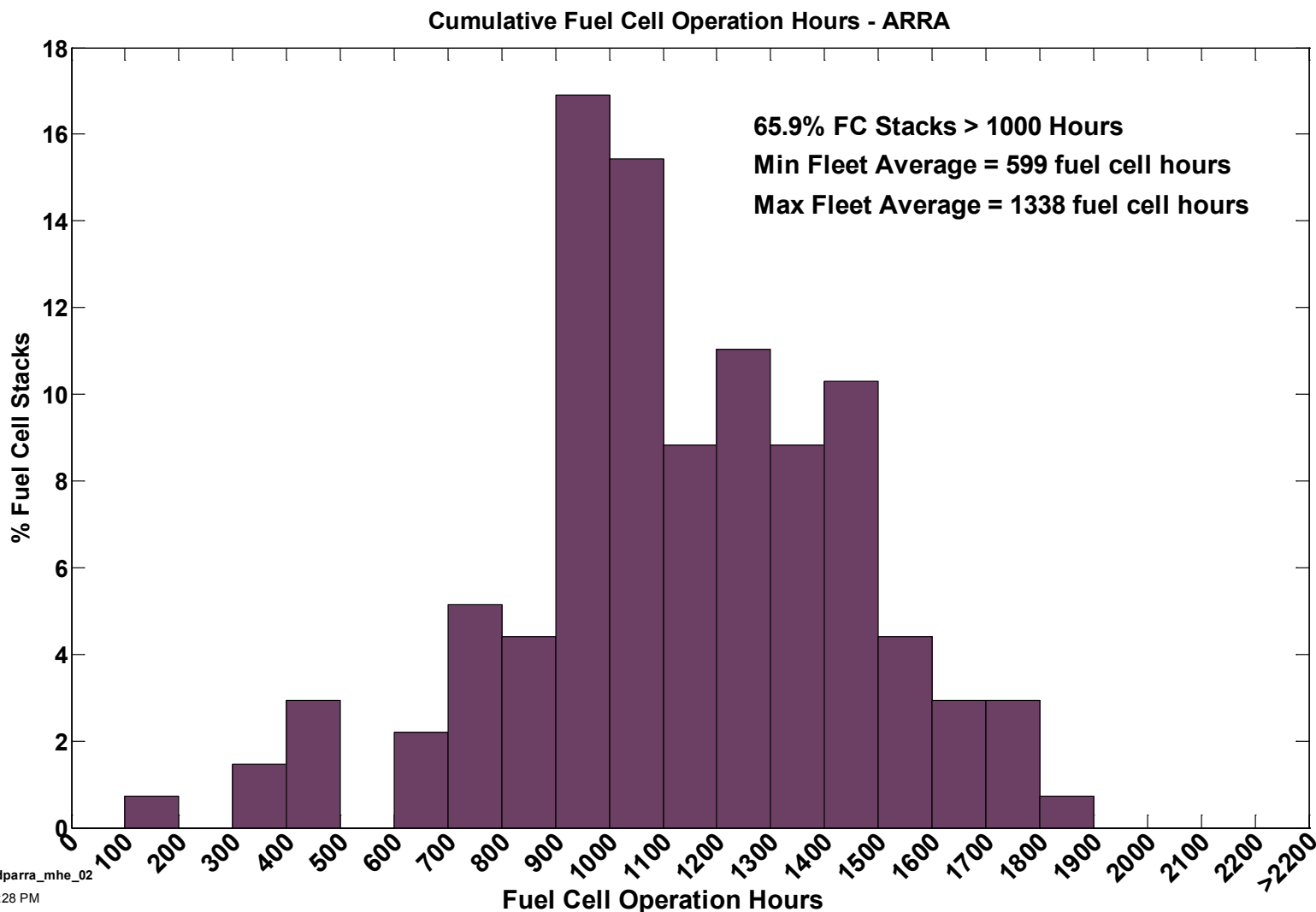


NREL cdparra\_mhe\_01

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# CDPARRA-MHE-02

## Fuel Cell Operation Hours

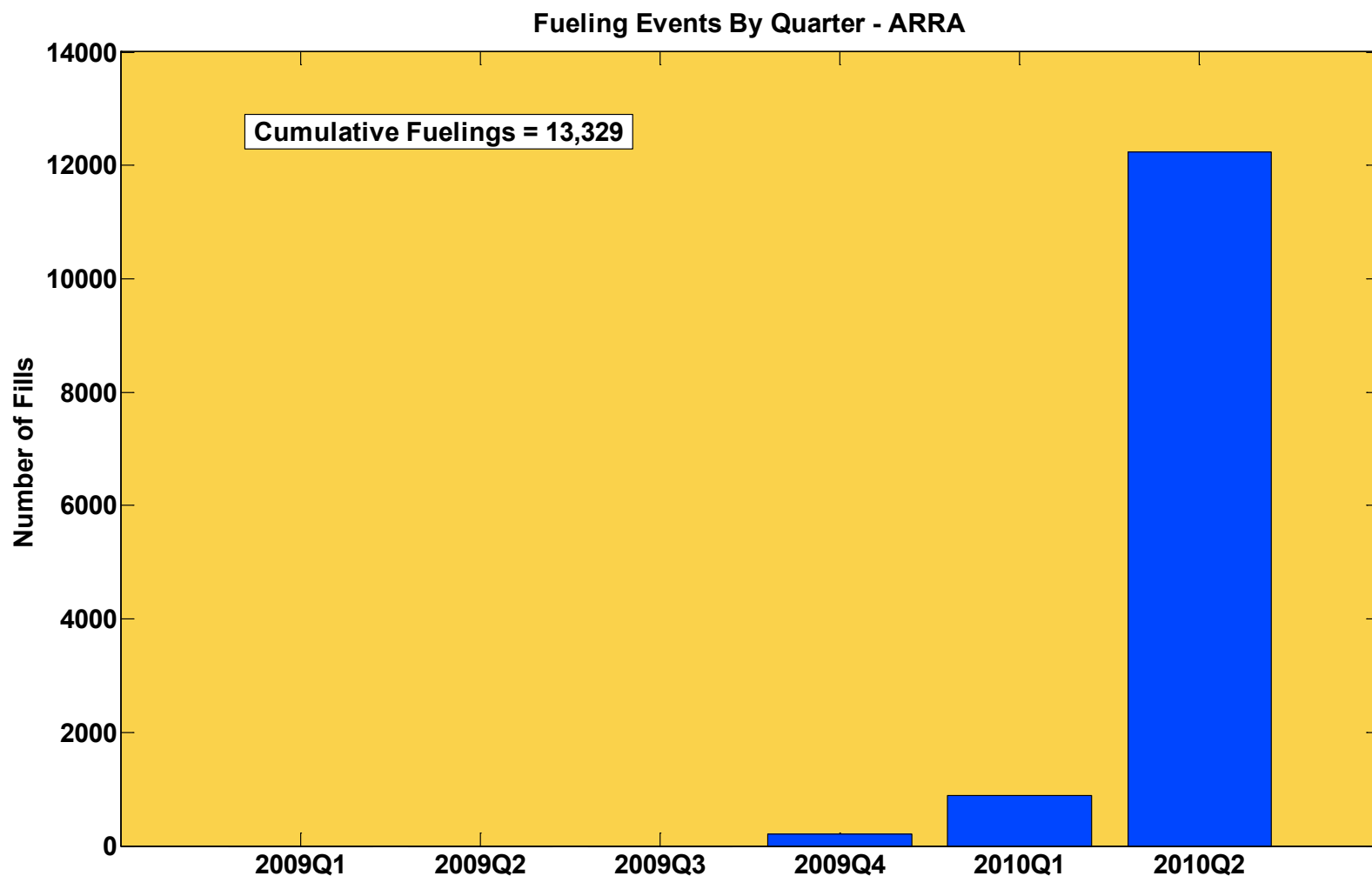


NREL cdparrar\_mhe\_02

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# CDPARRA-MHE-03

## Fueling Events by Quarter

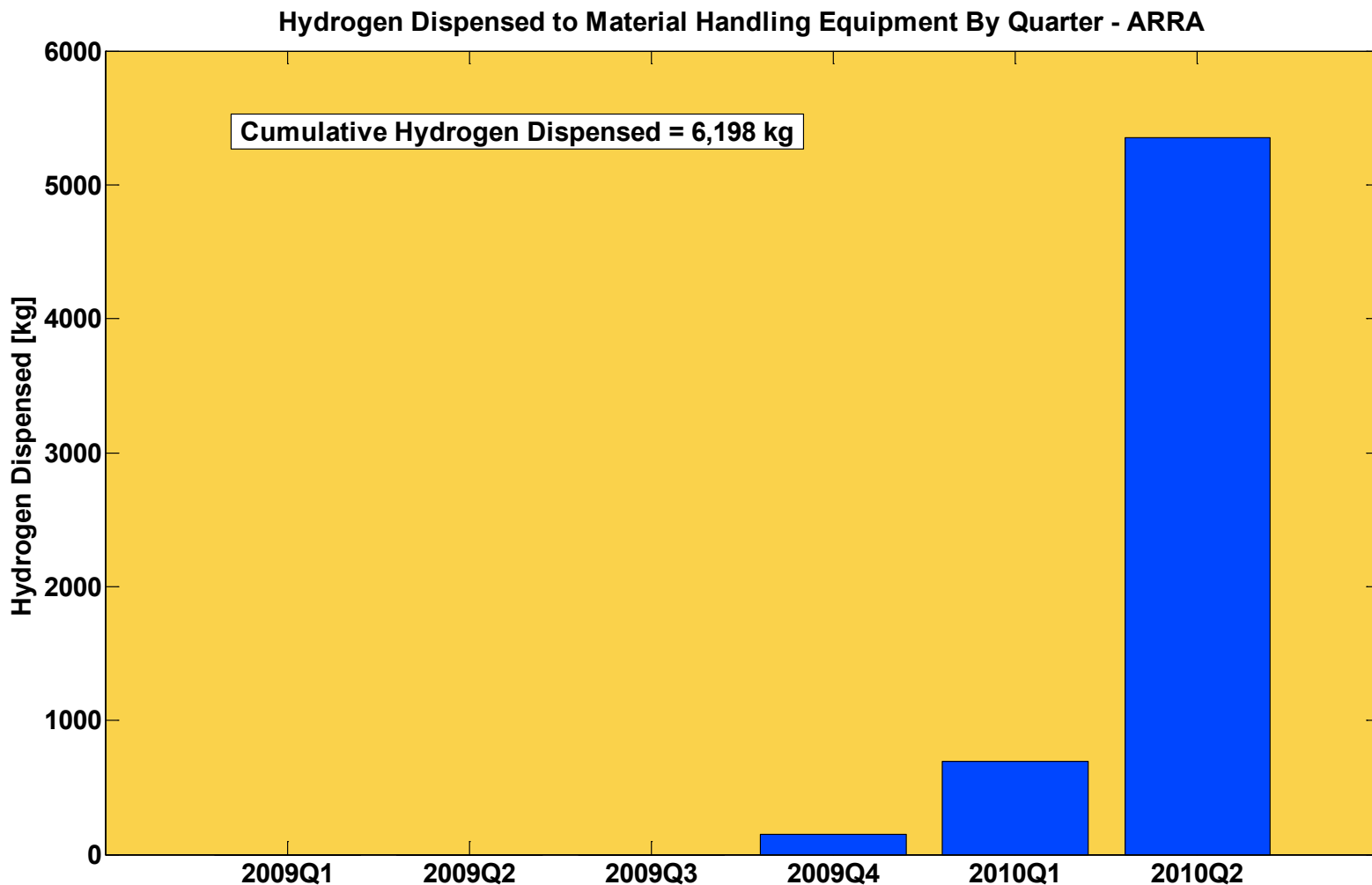


NREL cdparra\_mhe\_03

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# CDPARRA-MHE-04

## Hydrogen Dispensed by Quarter

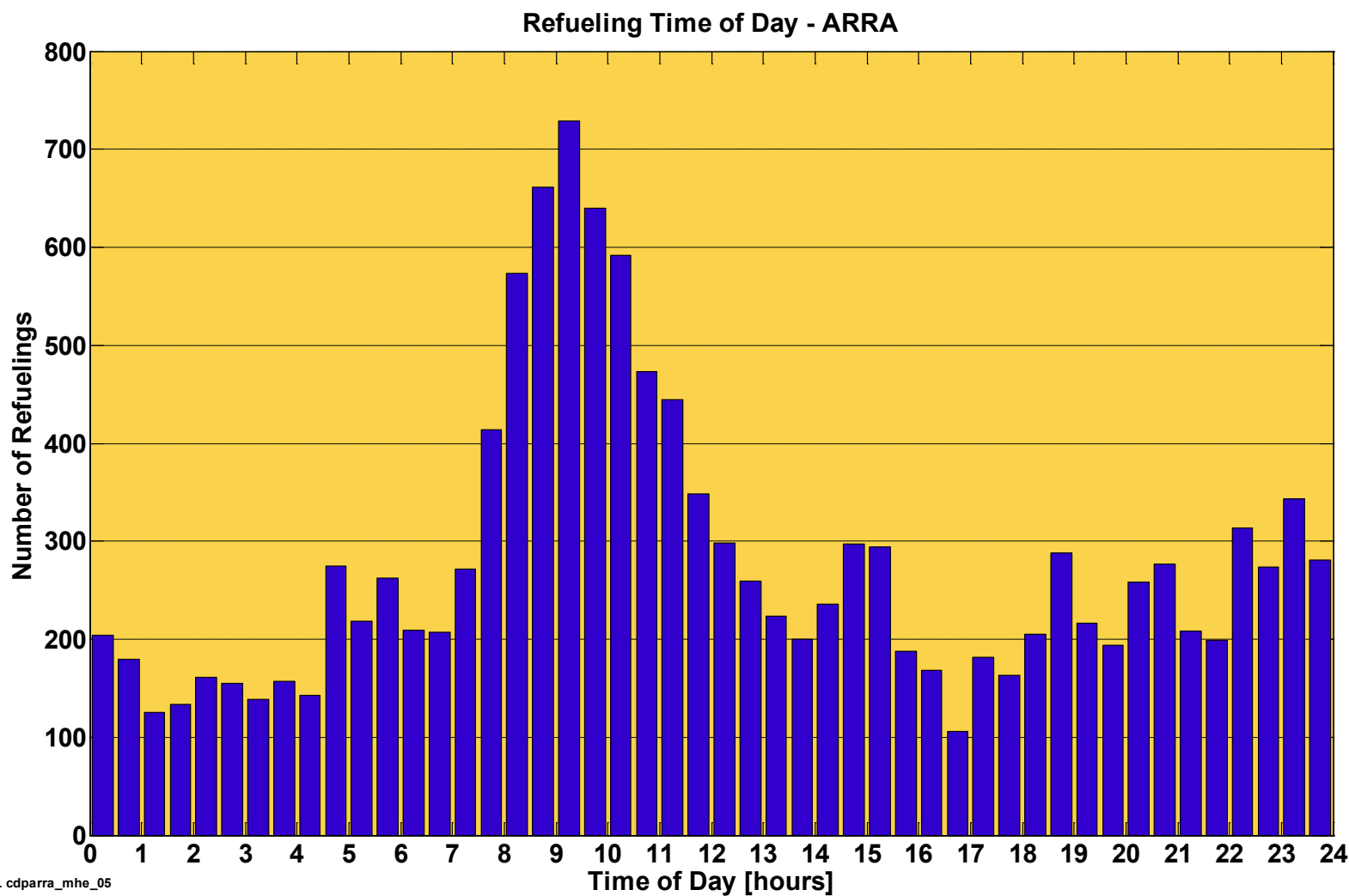


NREL cdparra\_mhe\_04

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# CDPARRA-MHE-05

## Refueling Time of Day



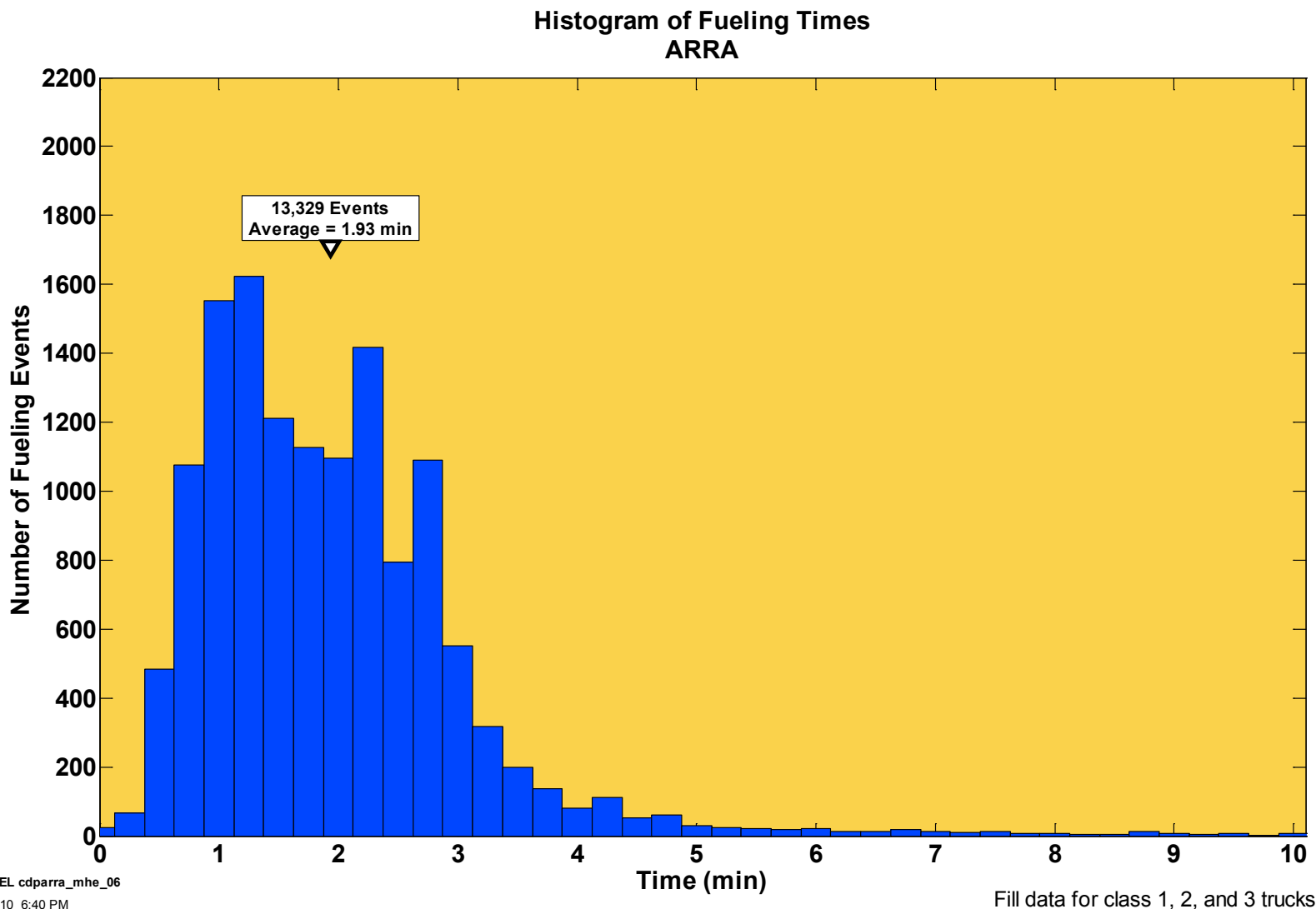
NREL cdparramhe\_05

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# CDPARRA-MHE-06

## Histogram of Fueling Times

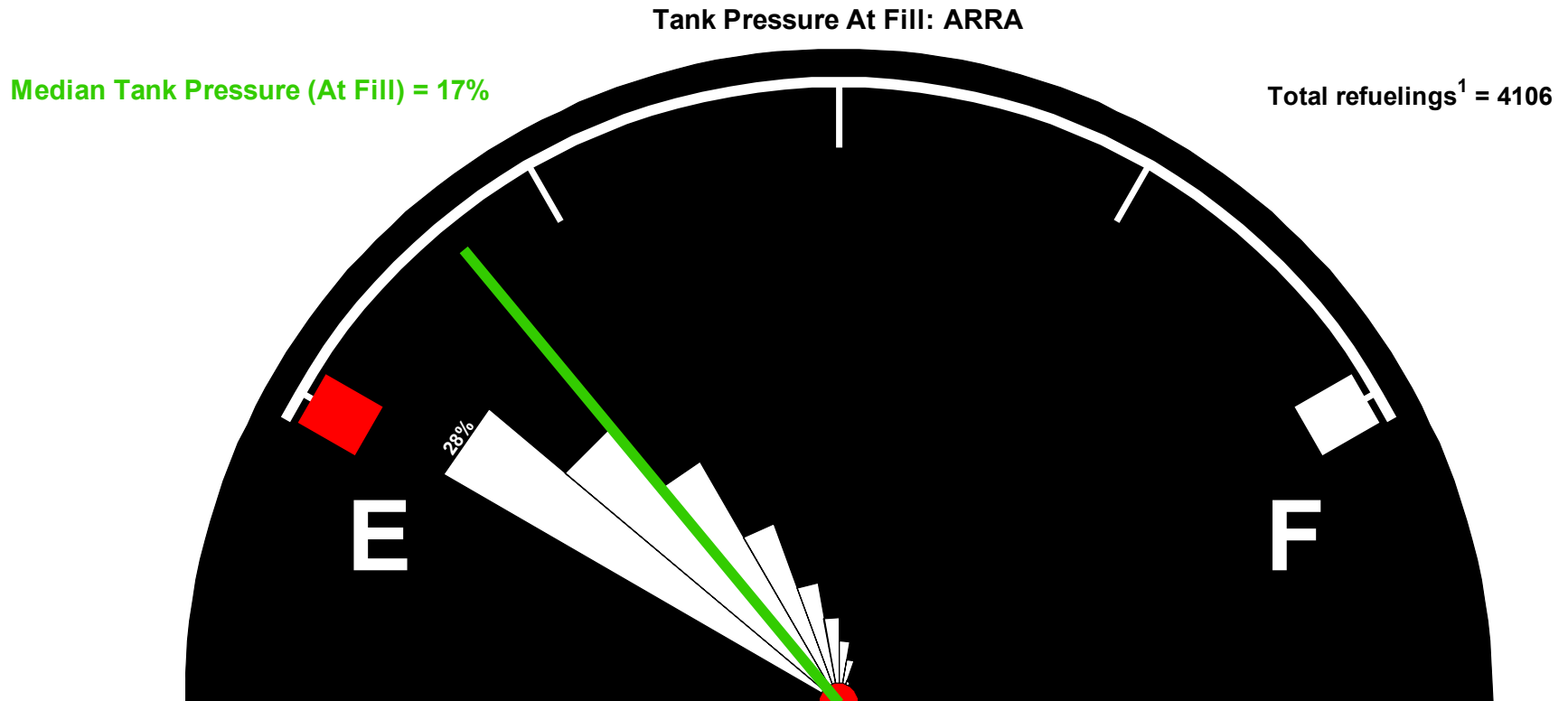


NREL cdparra\_mhe\_06

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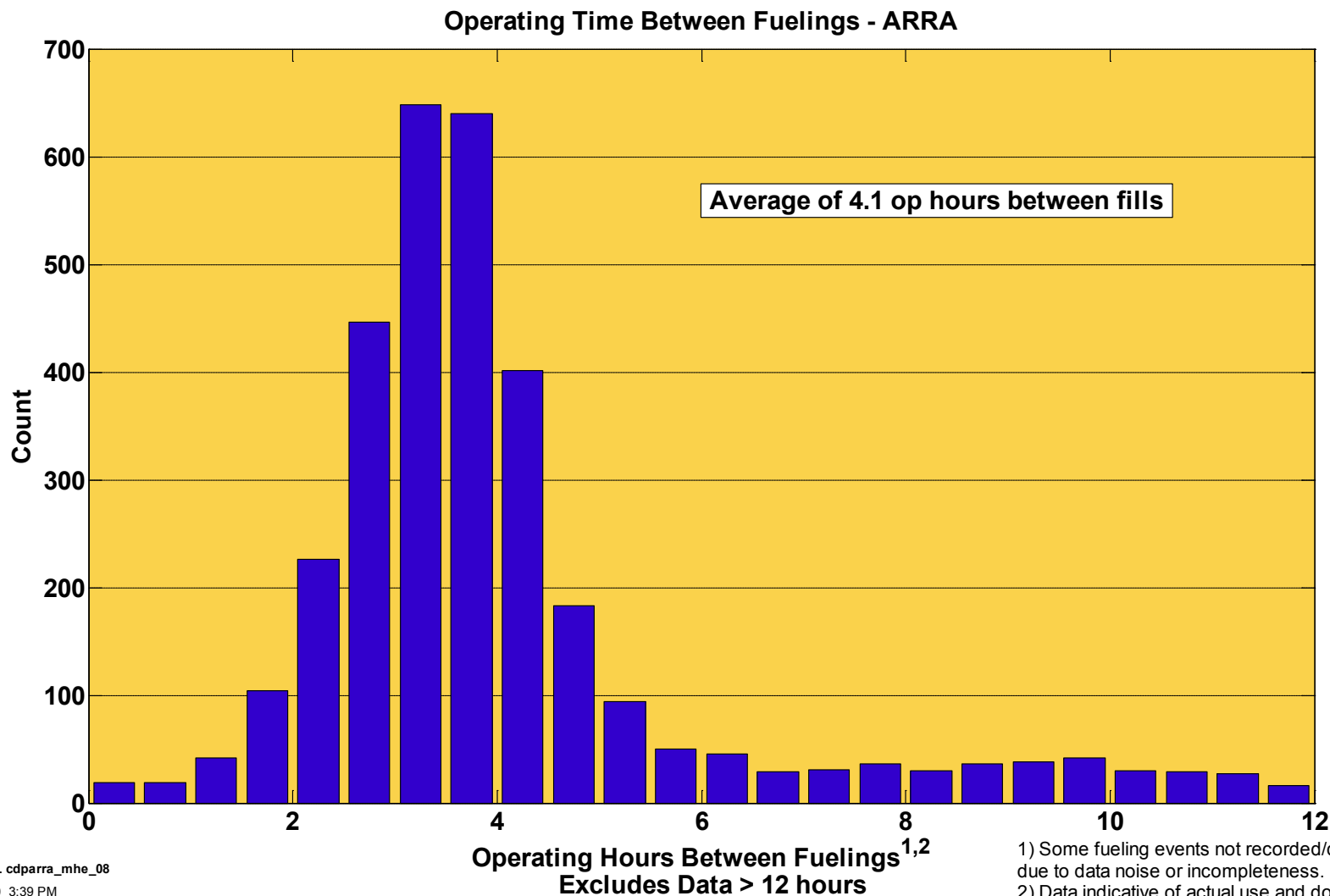
# CDPARRA-MHE-07

## Tank Pressure Level at Fueling



1. Some refueling events not recorded/detected due to data noise or incompleteness.
2. The outer arc is set at 40% total refuelings.
3. Full Pressure is either 3600 psi or 5000 psi.

## Operation Time between Fueling

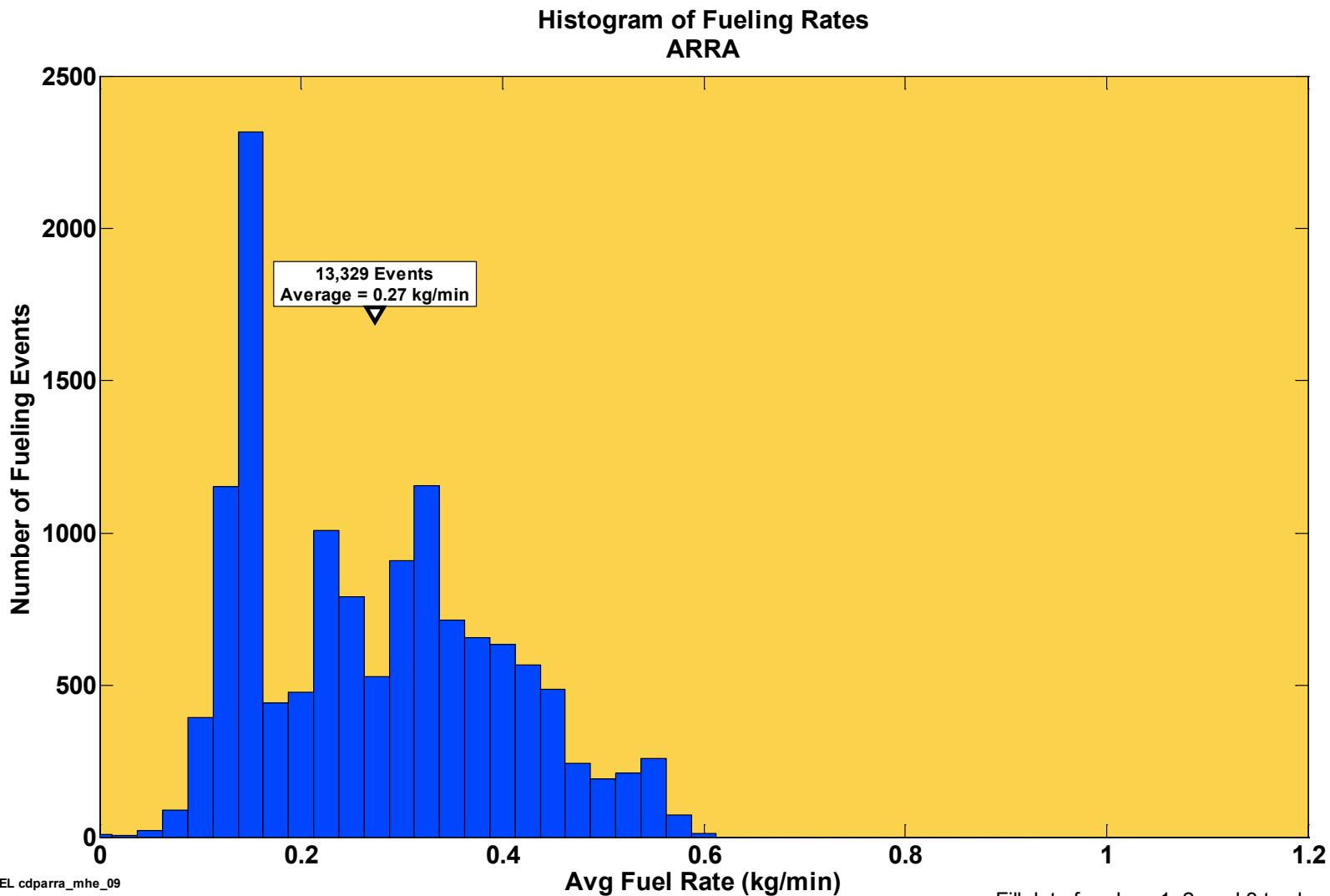


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# CDPARRA-MHE-09

## Histogram of Fueling Rates

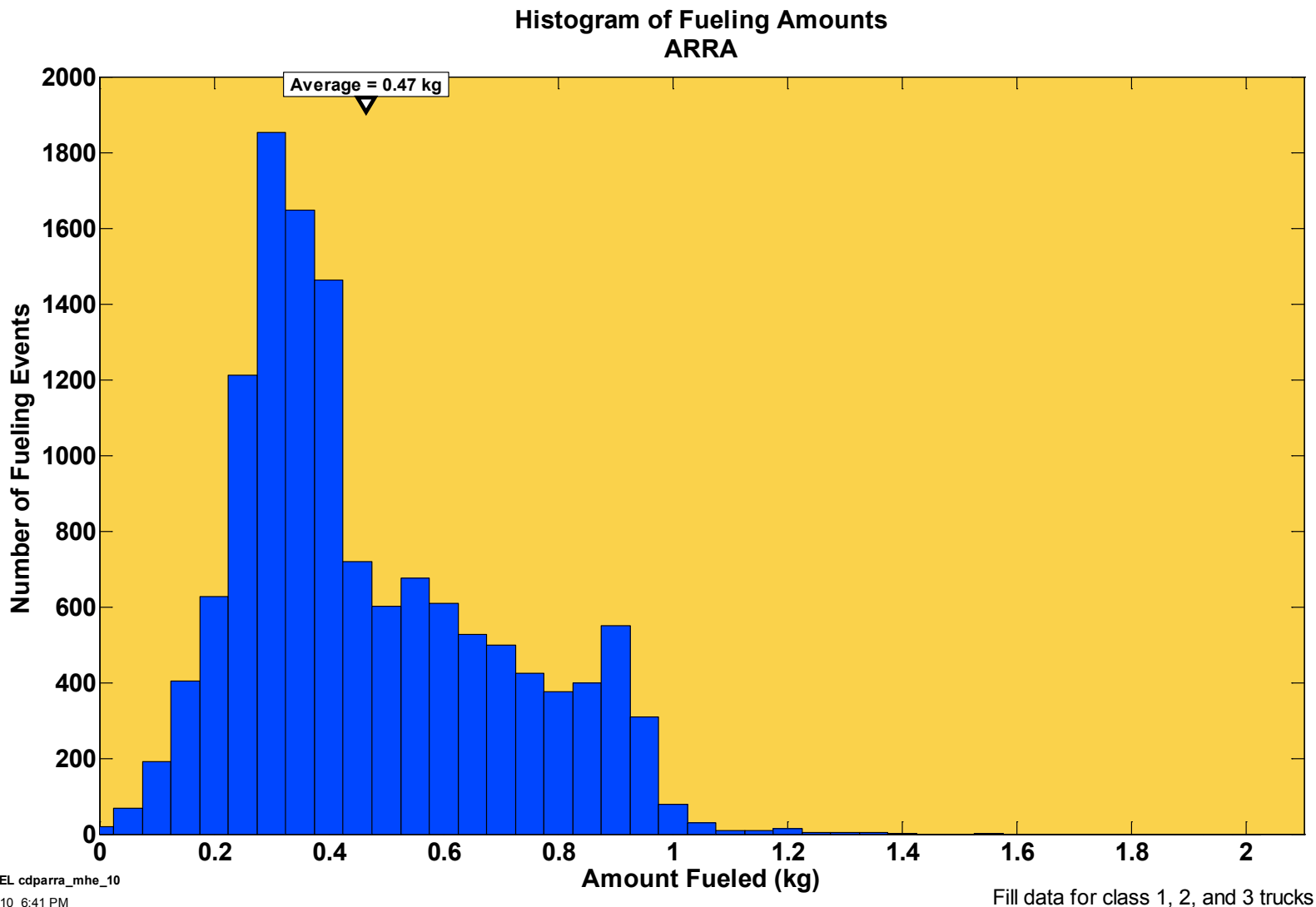


NREL cdparra\_mhe\_09

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Fill data for class 1, 2, and 3 trucks

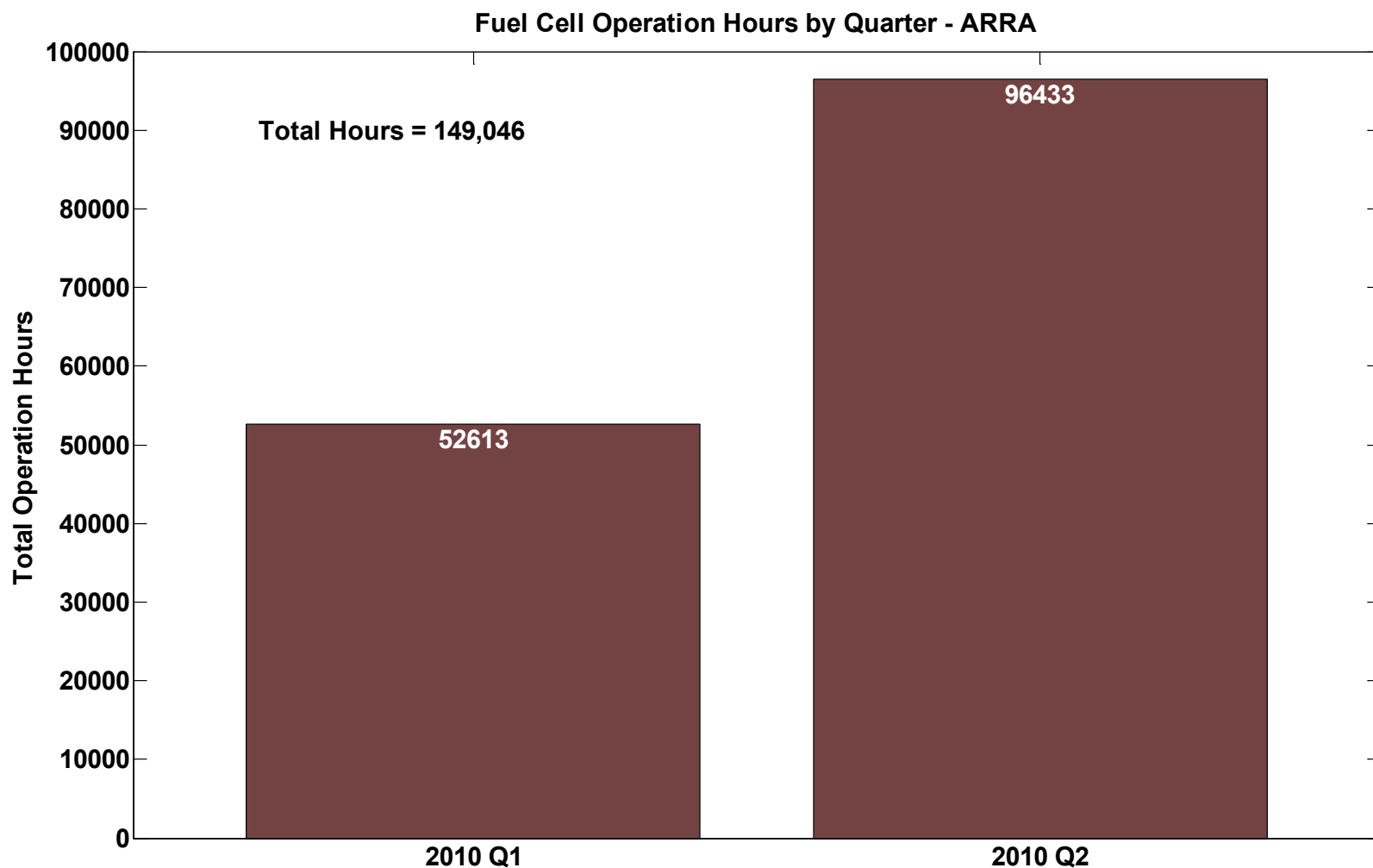
## Histogram of Fueling Amounts



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## Fuel Cell Operation Hours by Quarter



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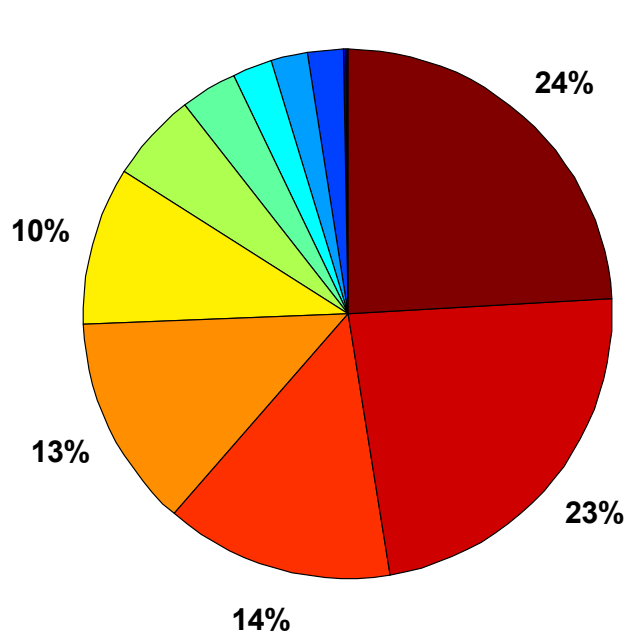
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# CDPARRA-MHE-12

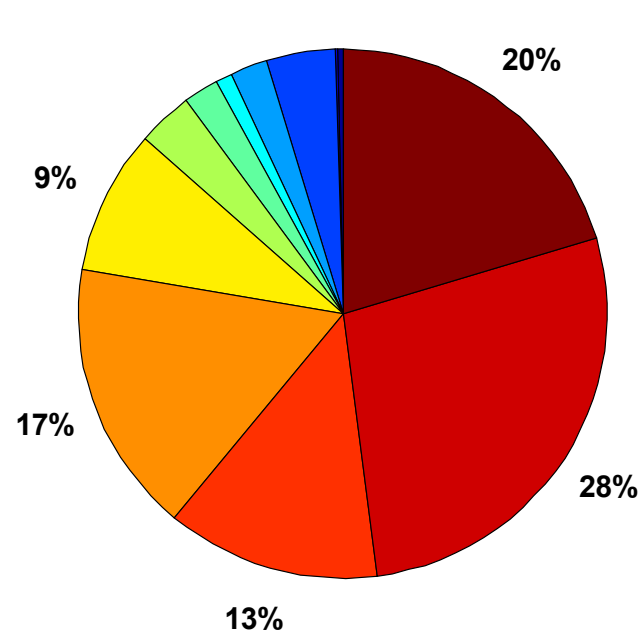
## Fuel Cell System Maintenance by Category

### Forklift Maintenance By Category - ARRA

**Number of Events**  
Total Events = 789  
73% were unscheduled



**Labor Hours**  
Total Hours = 1165  
69% were unscheduled



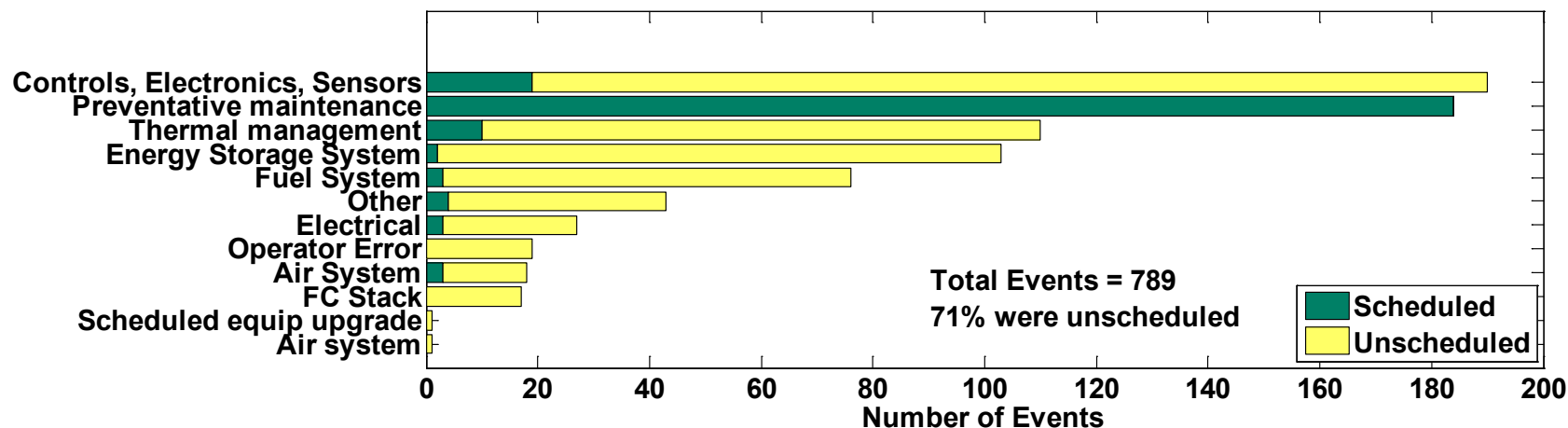
NREL cdparramhe\_12

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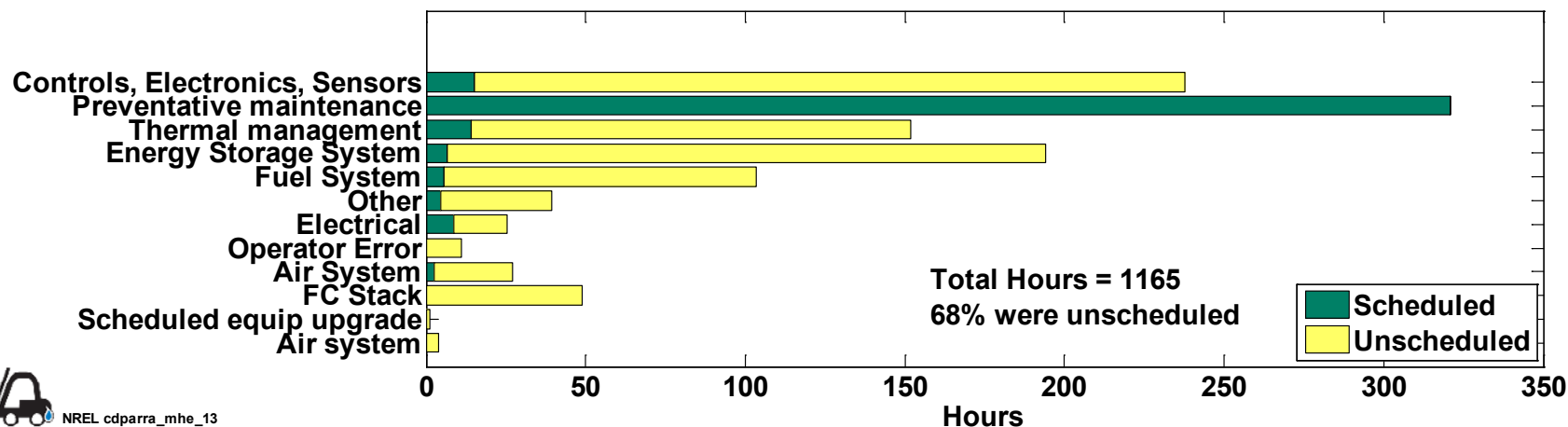
# CDPARRA-MHE-13

## Fuel Cell System Scheduled and Unscheduled Maintenance by Category

Fuel Cell System Maintenance Scheduled vs. Unscheduled - ARRA  
Number of Maintenance Events by Category



Number of Labor Hours by Category



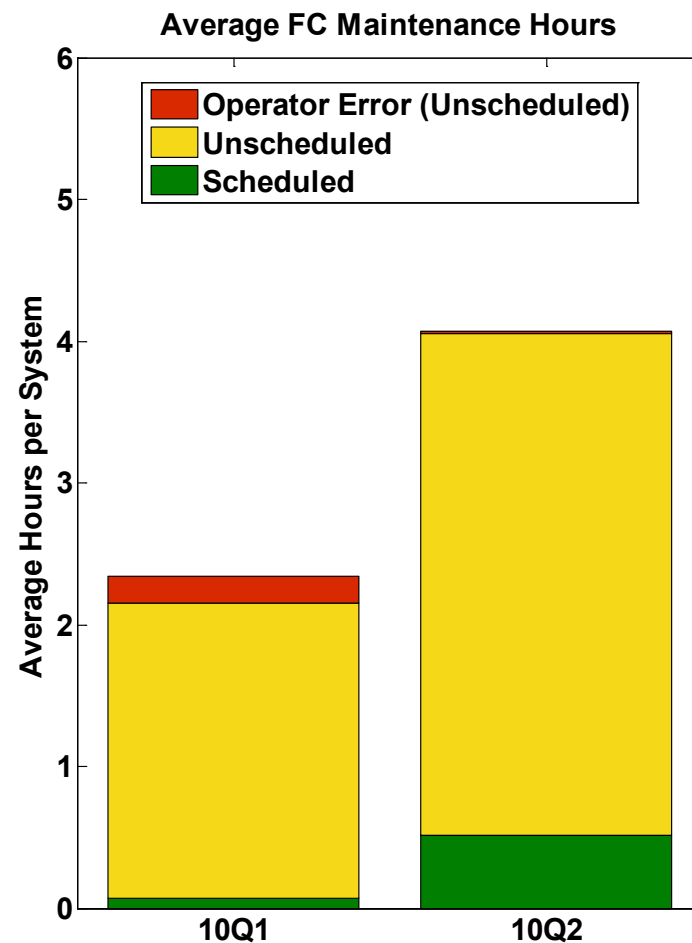
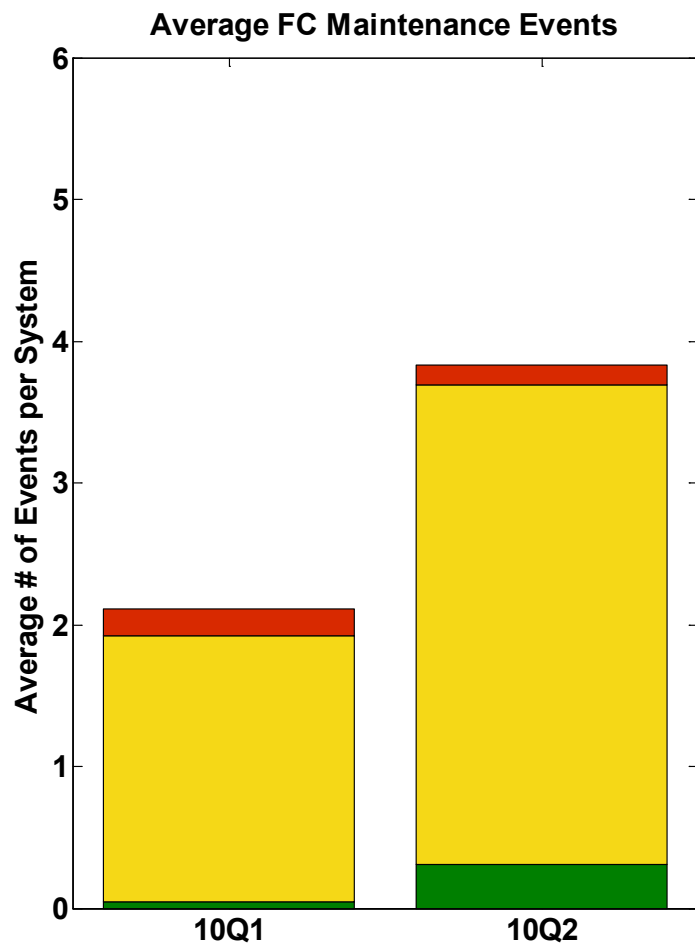
NREL cdparra\_mhe\_13

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## Average Fuel Cell System Maintenance by Quarter

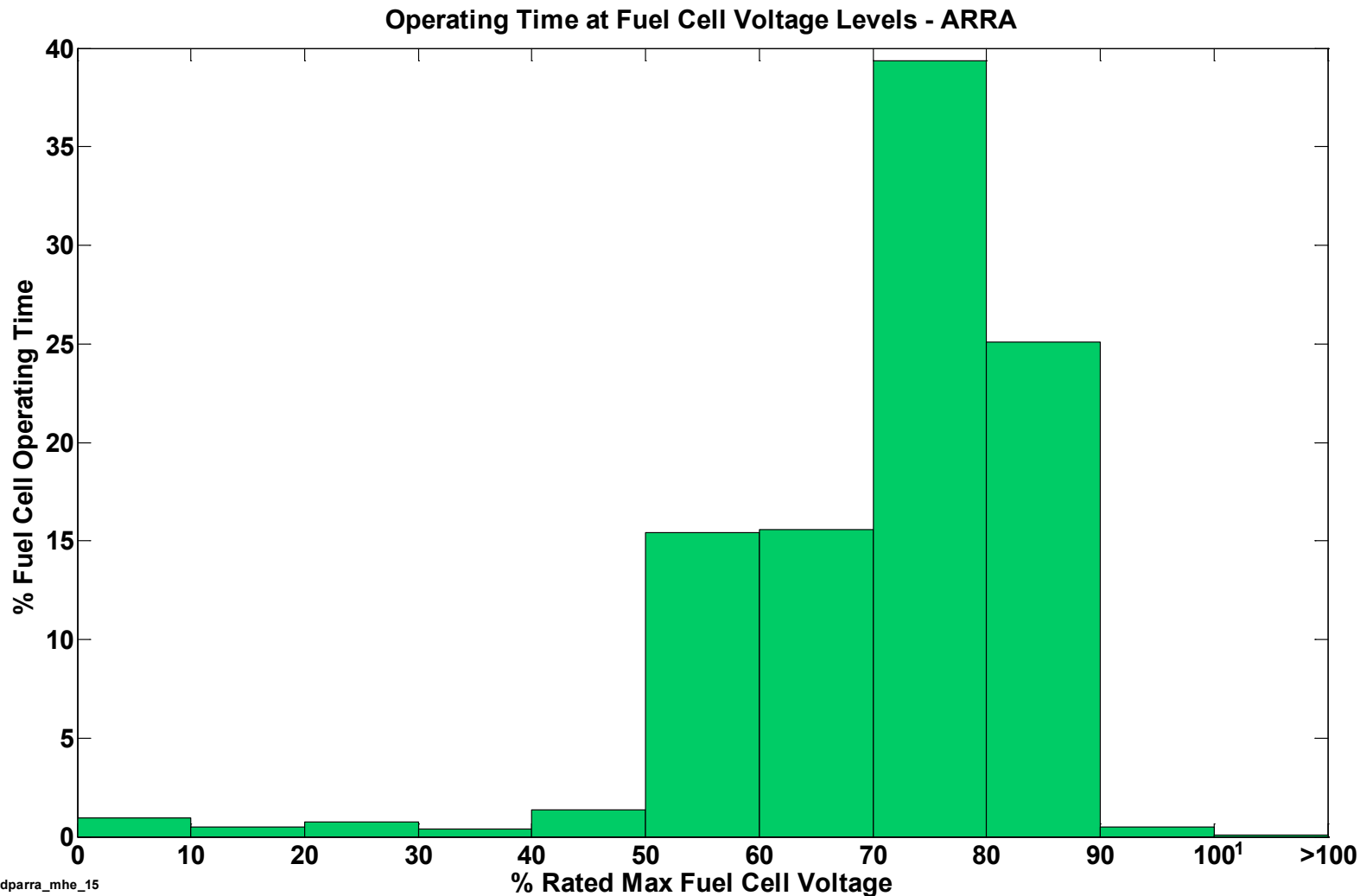
Average Fuel Cell System Quarterly Maintenance - ARRA



NREL cdparra\_mhe\_14

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## Operating Time at Fuel Cell Voltage Levels



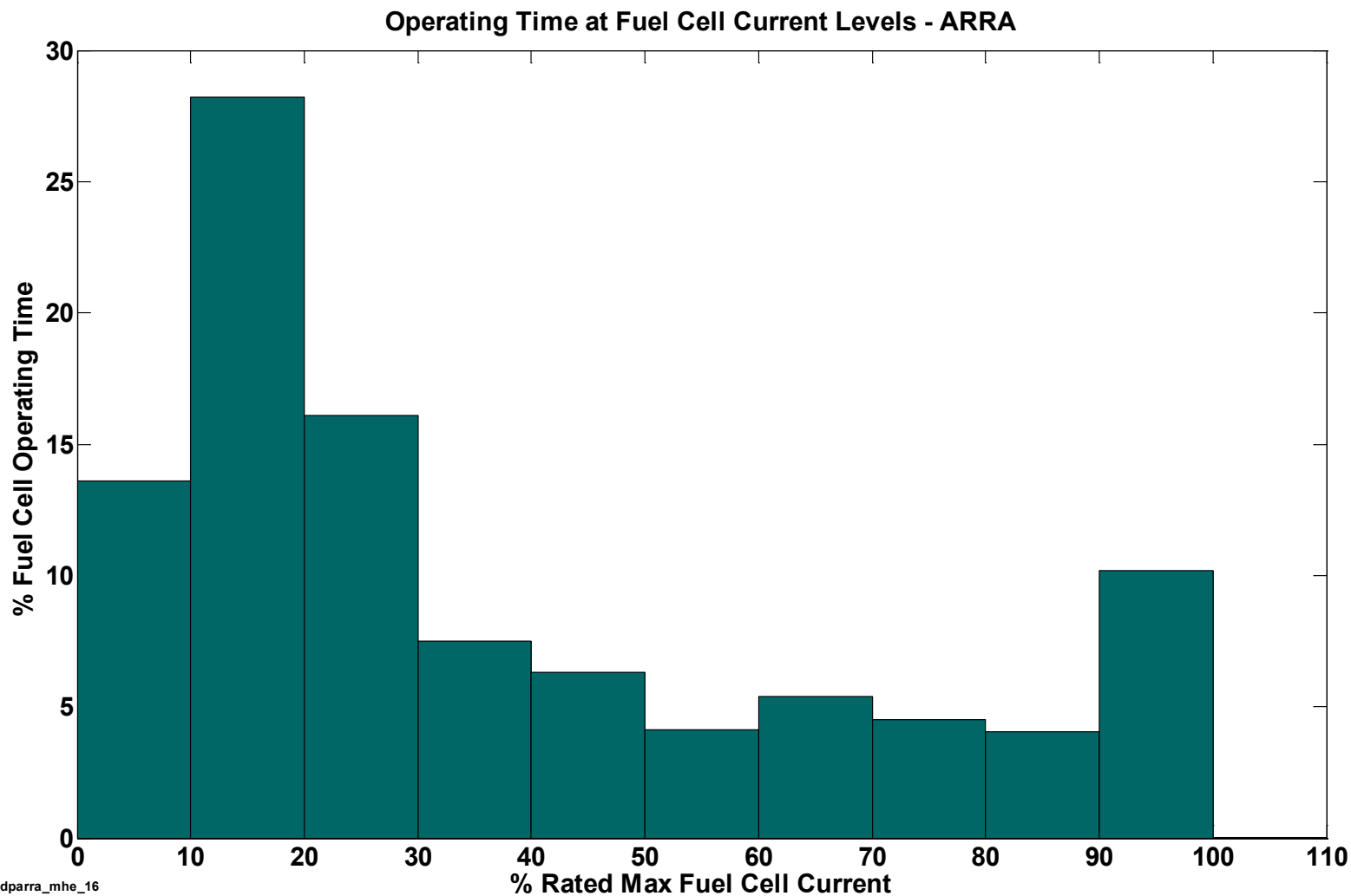
NREL cdparra\_mhe\_15

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1) 100% max fuel cell voltage is approximately open-circuit voltage

# CDPARRA-MHE-16

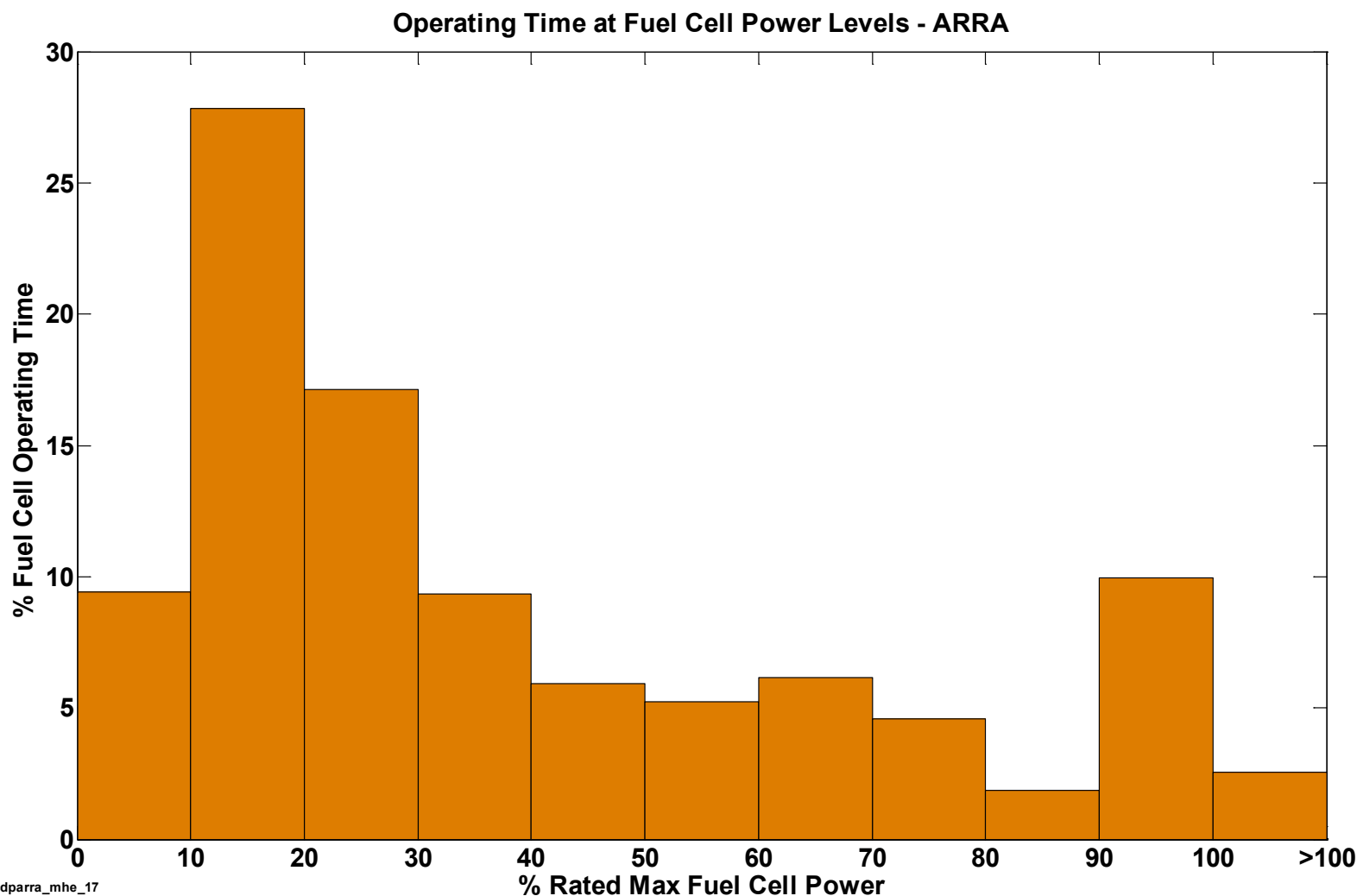
## Operating Time at Fuel Cell Current Levels



NREL cdparra\_mhe\_16

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## Operating Time at Fuel Cell Power Levels



NREL cdparra\_mhe\_17

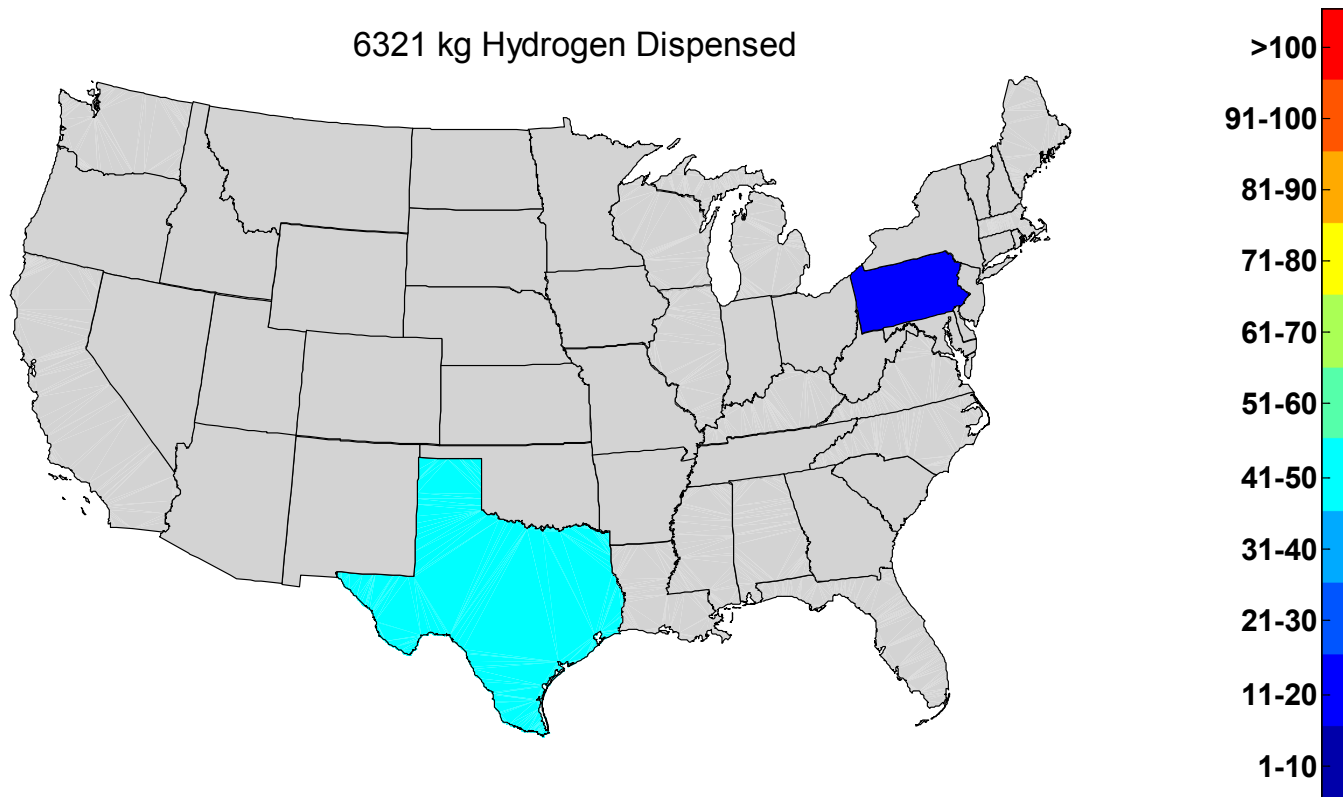
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# CDPARRA-MHE-21

## Average Daily Hydrogen Dispensed by Location

Average Daily Hydrogen Dispensed by Location - ARRA

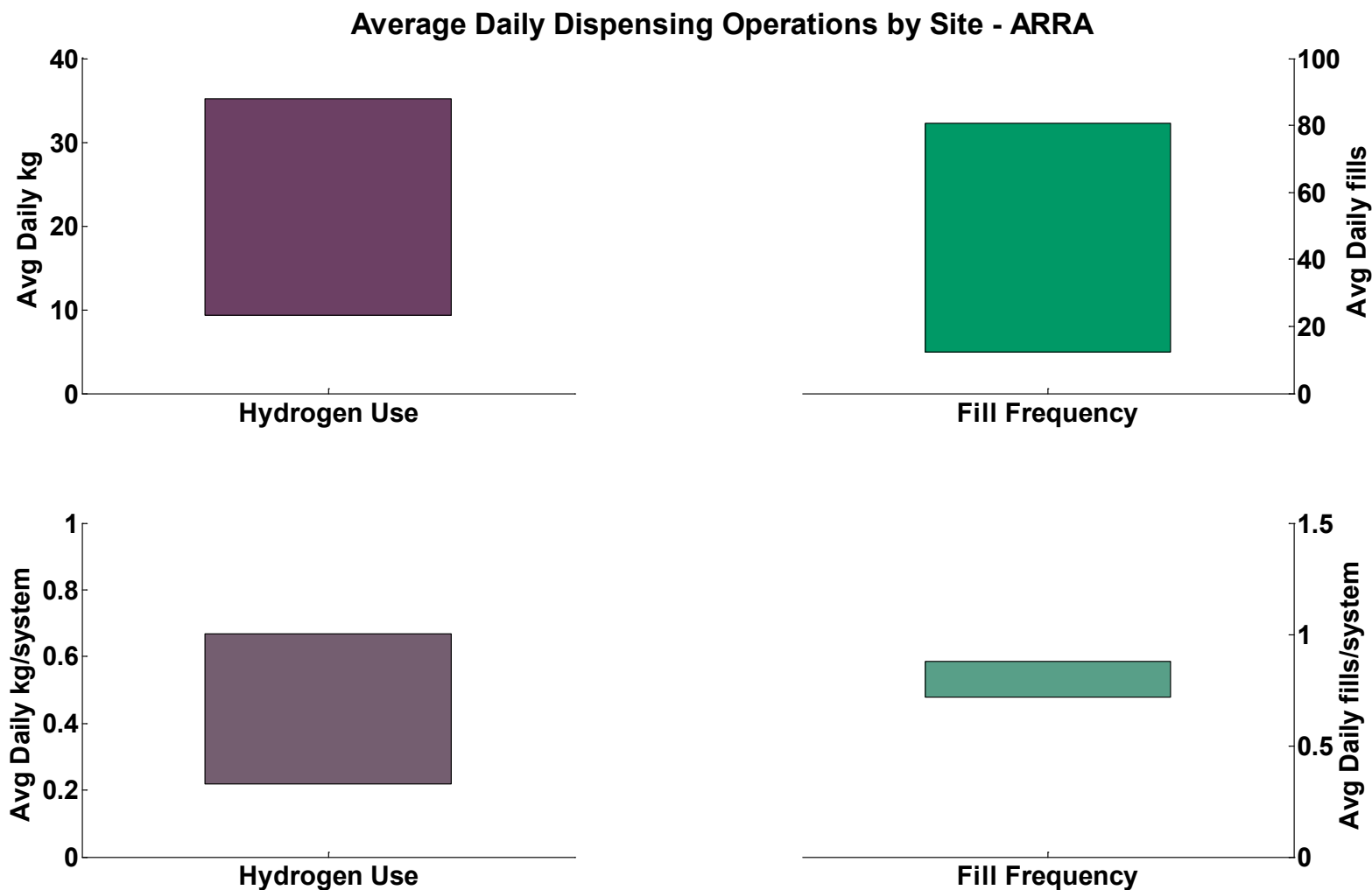
6321 kg Hydrogen Dispensed



NREL cdparramhe\_21

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## Average Daily Dispensing Operations by Site



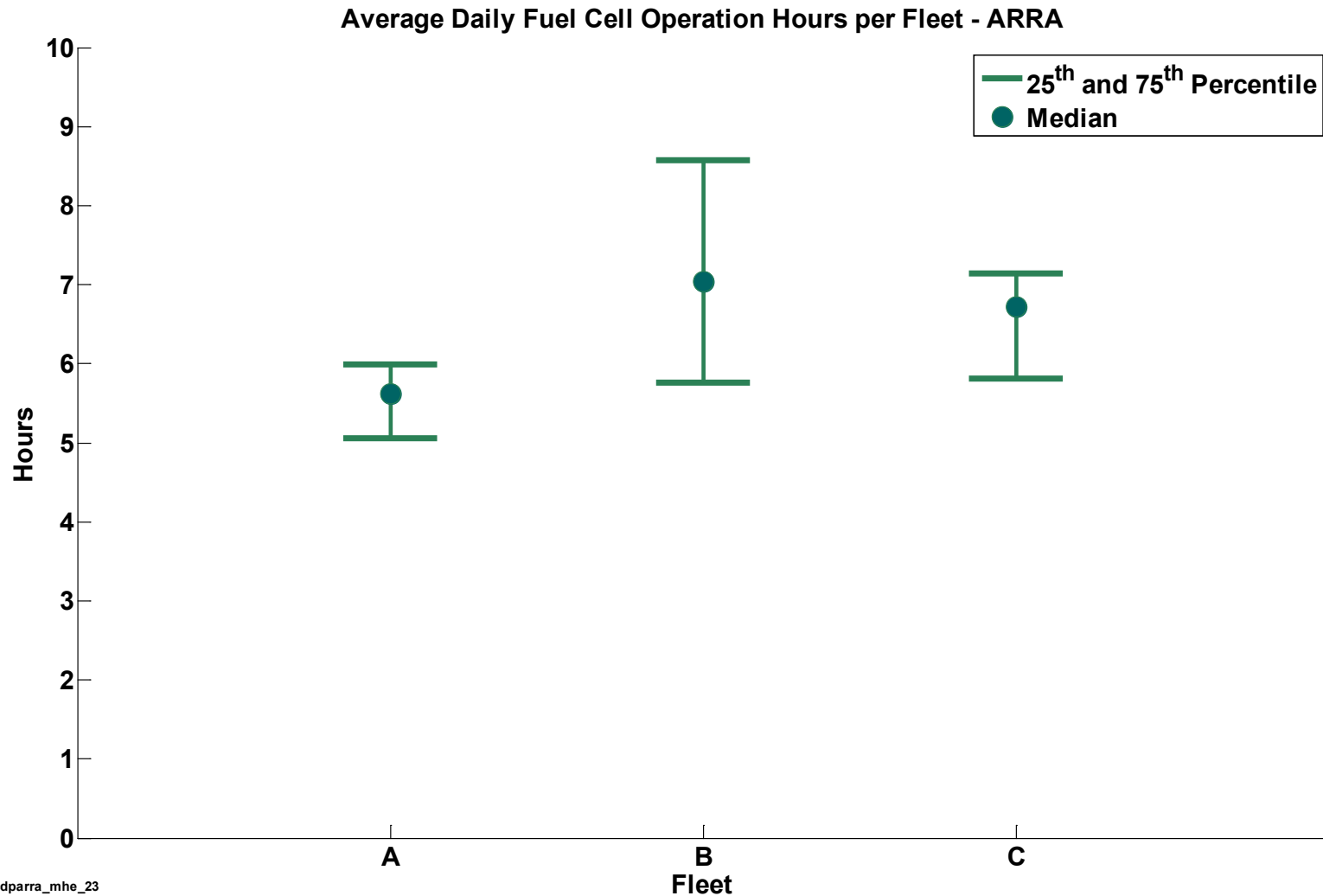
NREL cdparra\_mhe\_22

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Shaded areas represent the min and max site average hydrogen use and fill frequency

# CDPARRA-MHE-23

## Average Daily Fuel Cell Operation Hours per Fleet

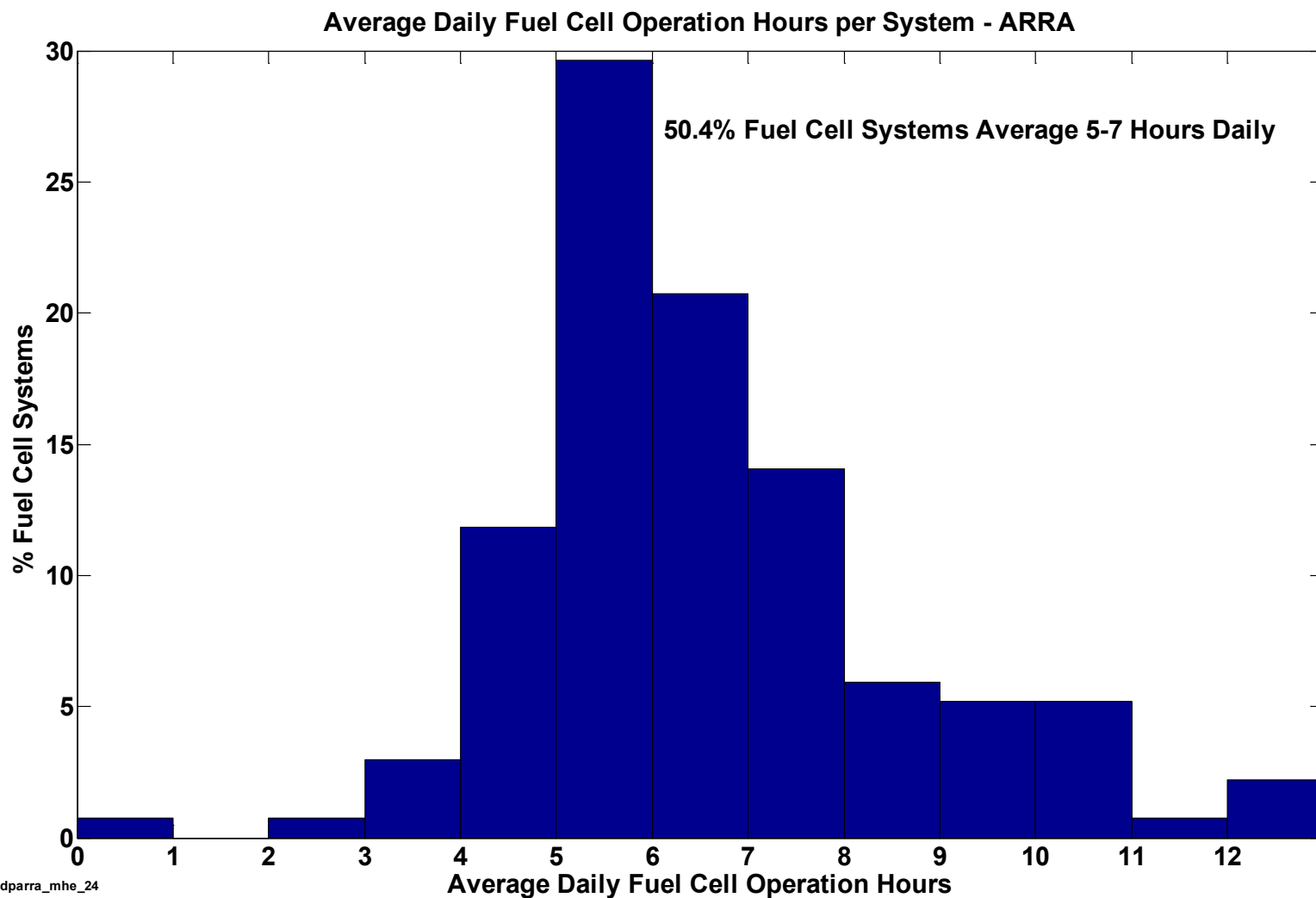


NREL cdparra\_mhe\_23

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# CDPARRA-MHE-24

## Average Daily Fuel Cell Operation Hours per System



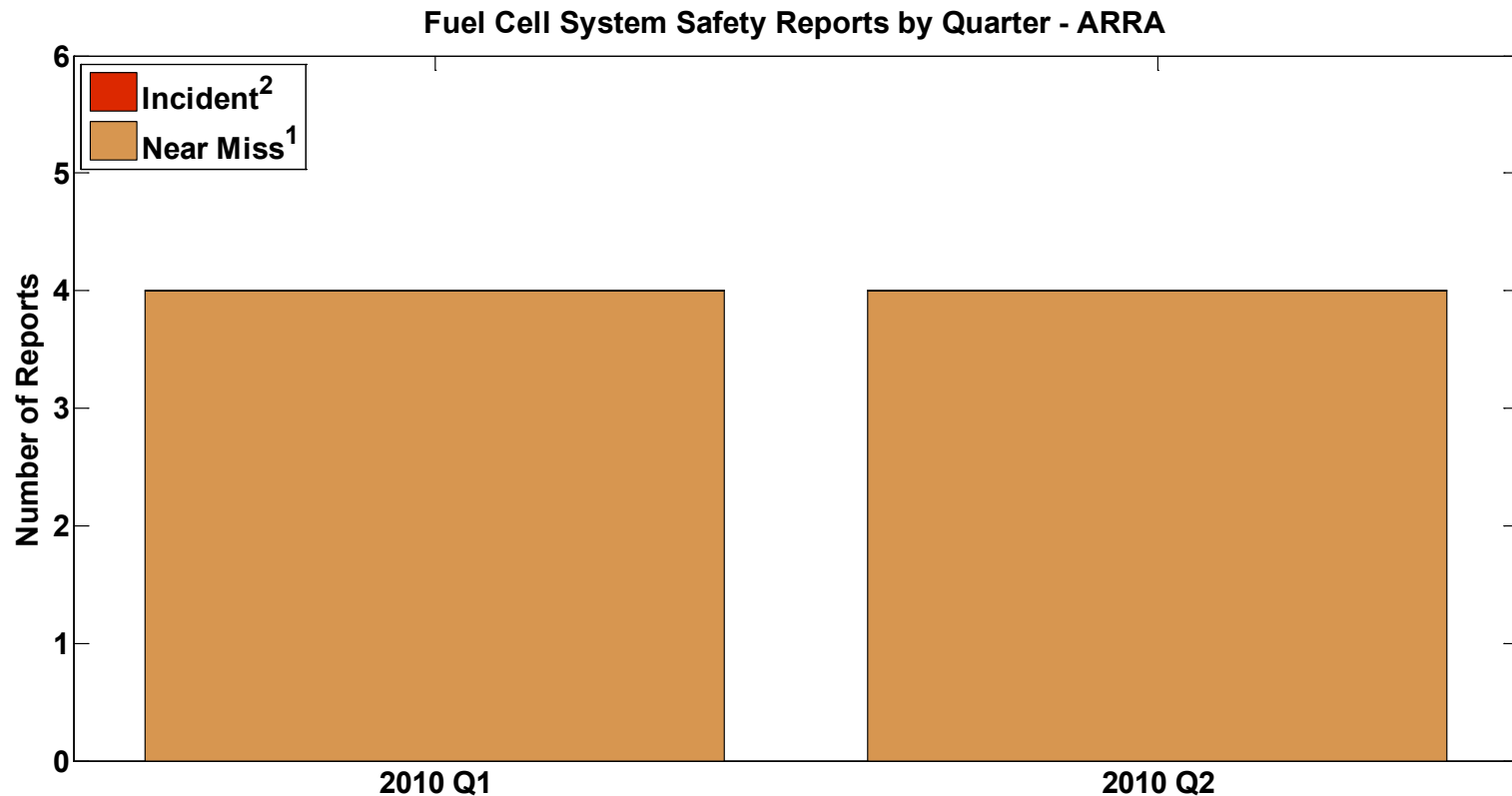
NREL cdparra\_mhe\_24

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# CDPARRA-MHE-26

## Fuel Cell System Safety Reports by Quarter



1) Near Miss is an event that under slightly different circumstances could have become an incident  
-unplanned H<sub>2</sub> release insufficient to sustain a flame

2) 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 or is sufficient to sustain a flame if ignited
- release of any volatile, hydrogen containing compound (other than the hydrocarbons uses as common fuels)



NREL cdparrar\_mhe\_26

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