



Technical Report
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Spring 2014 Composite Data Products: Backup Power

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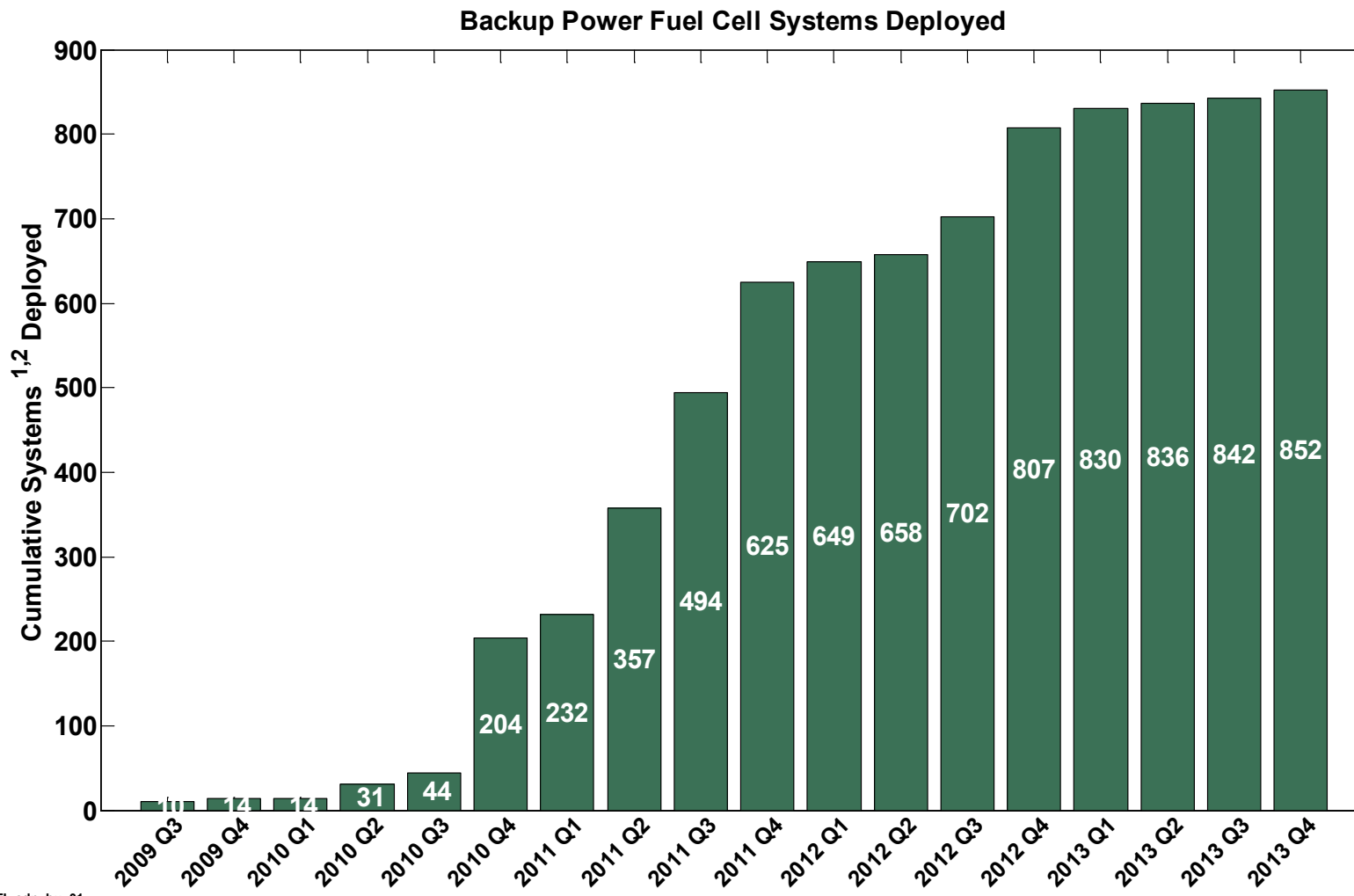
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Backup Power Fuel Cell Systems Deployed

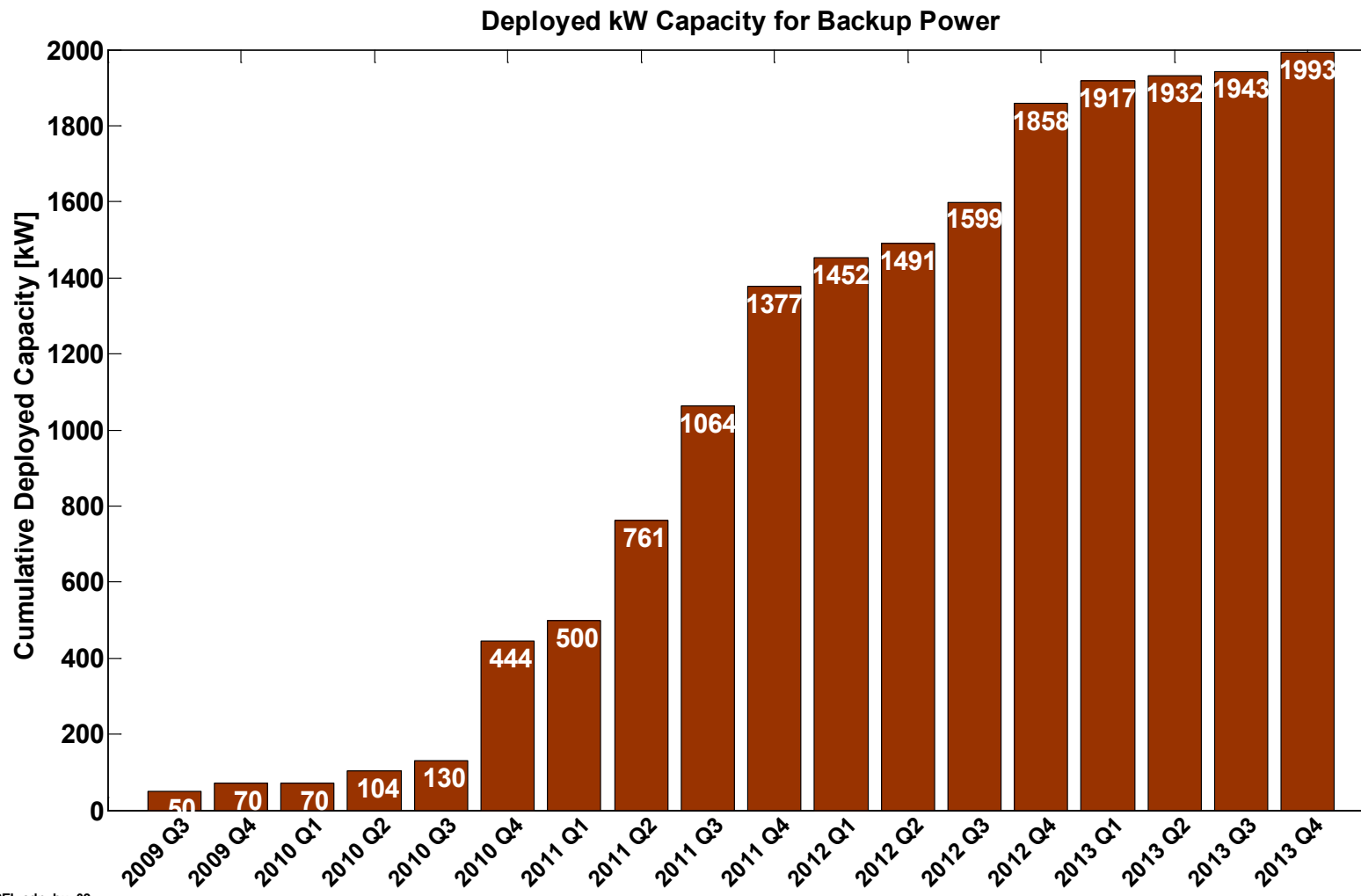


NREL cdp_bu_01

Created: Apr-16-14 5:02 PM | Data Range: 2010Q1-2013Q4

- 1) Sites may have more than one FC system
- 2) Not all FC systems are supplying operation data

Deployed kW Capacity for Backup Power



NREL cdp_bu_02

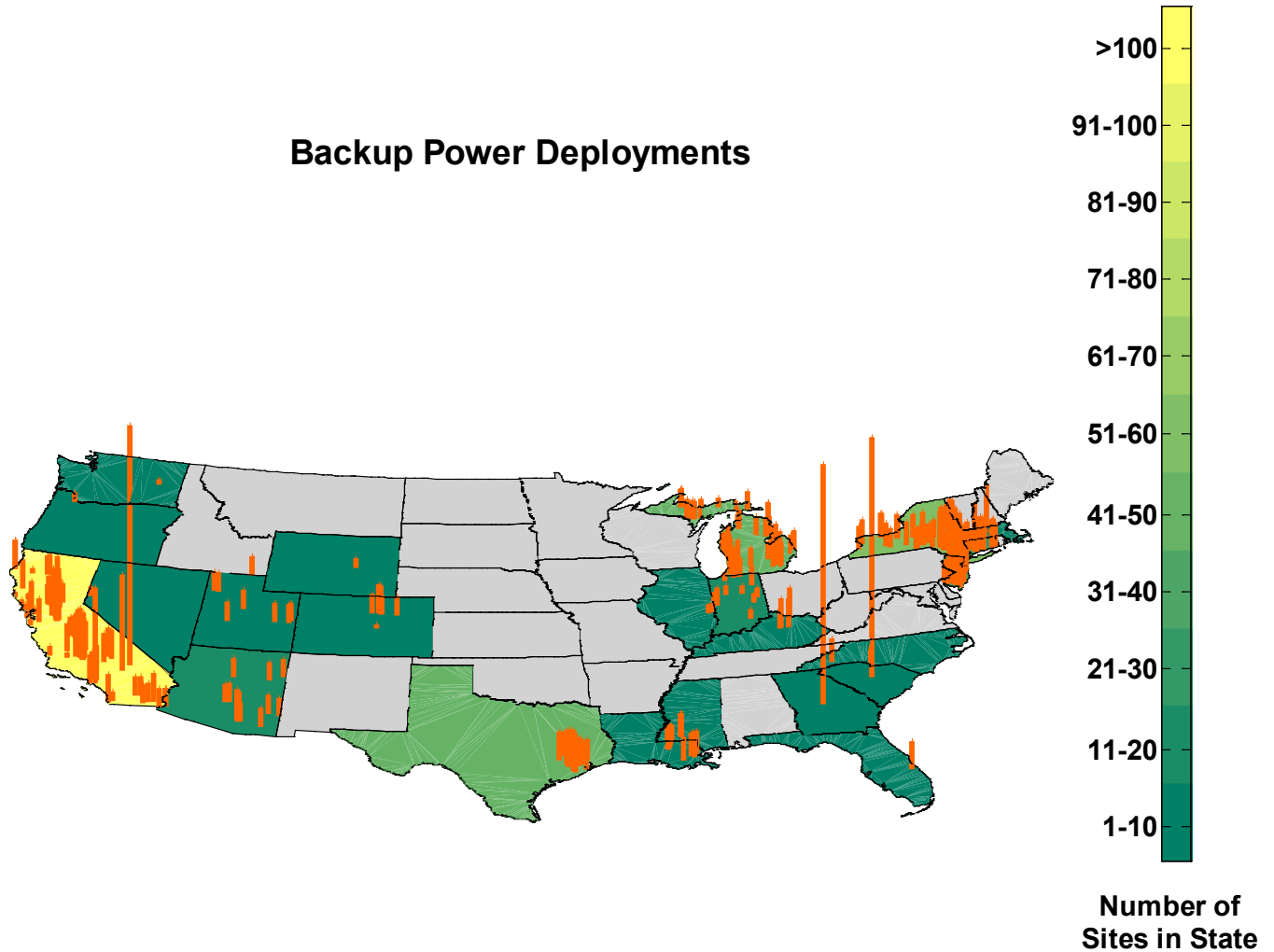
Created: Apr-16-14 5:05 PM | Data Range: 2010Q1-2013Q4

CDP-BU-03

Backup Power Deployments

State	kW	Sites
Arizona	84	19
California	635	130
Colorado	25	6
Connecticut	130	28
Florida	6	1
Georgia	50	1
Illinois	4	2
Indiana	50	16
Kentucky	22	4
Louisiana	40	8
Massachusetts	10	1
Michigan	168	41
Mississippi	10	2
Nevada	2	1
New Jersey	181	40
New York	238	55
North Carolina	10	2
Oregon	2	1
South Carolina	50	1
Texas	238	48
Utah	36	9
Washington	1	1
Wyoming	2	1

Backup Power Deployments



Totals	1993	418
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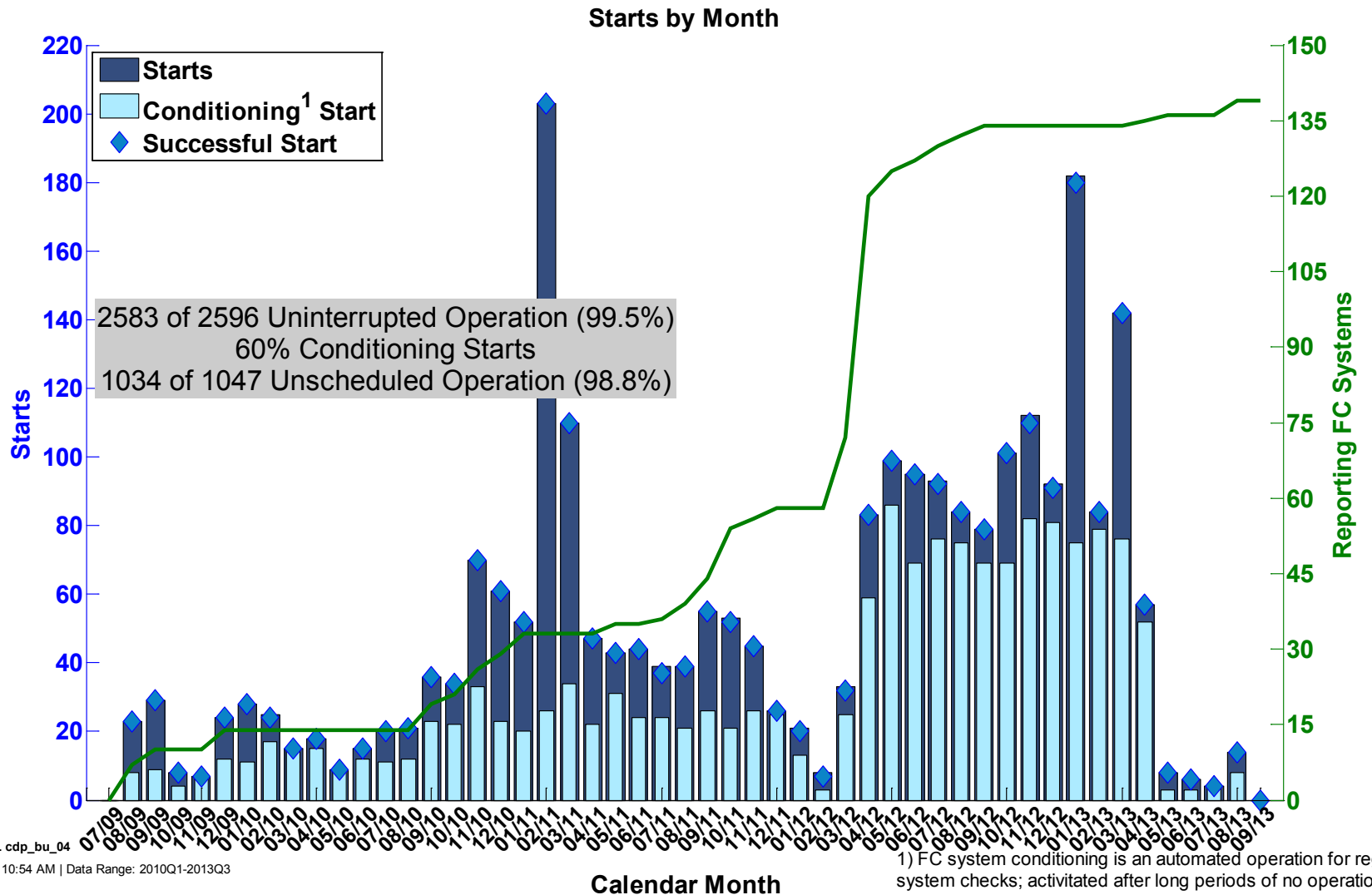


NREL cdp_bu_03

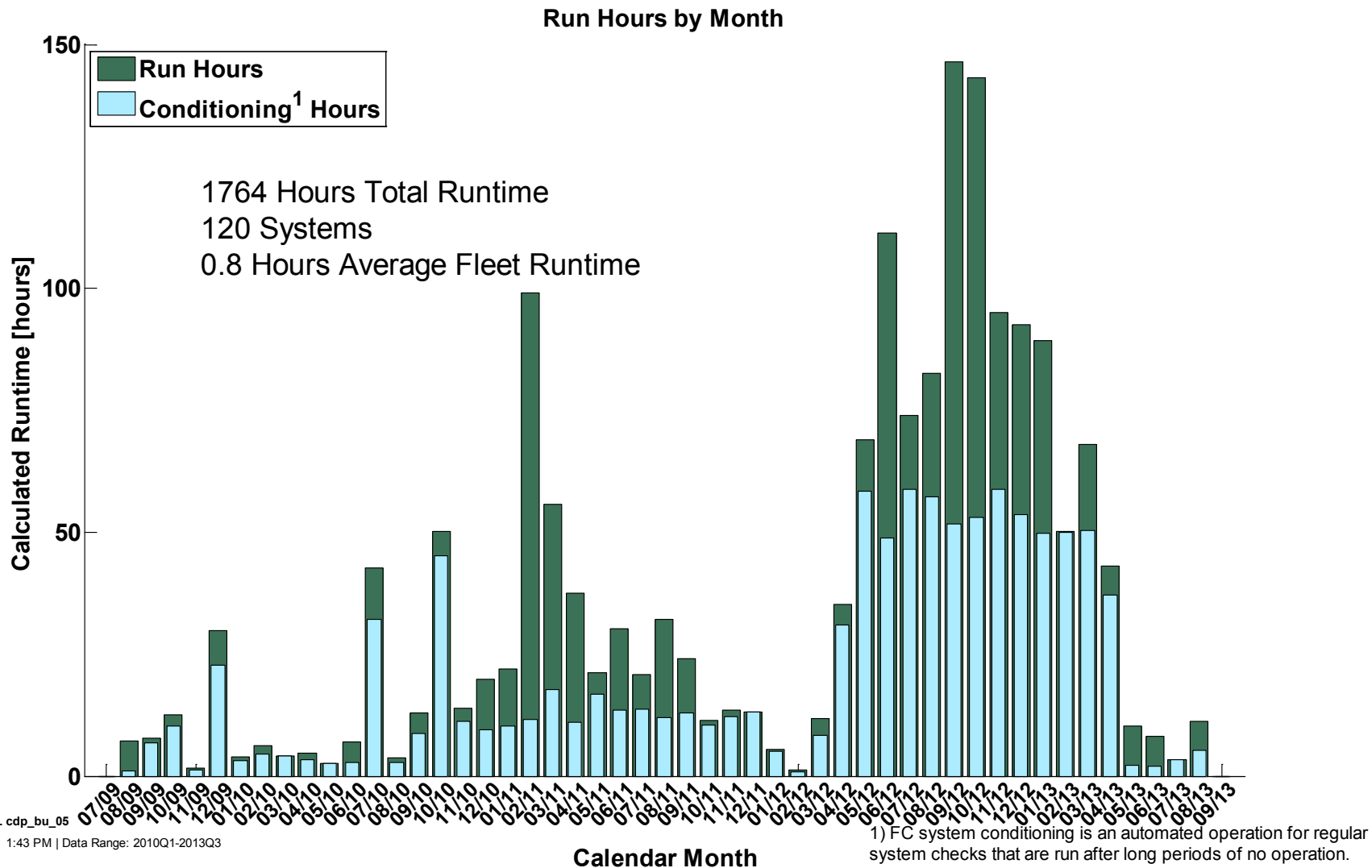
Created: Apr-18-14 7:50 AM | Data Range: 2010Q1-2013Q4

| Site Capacity (line height proportional to installed site kW capacity)

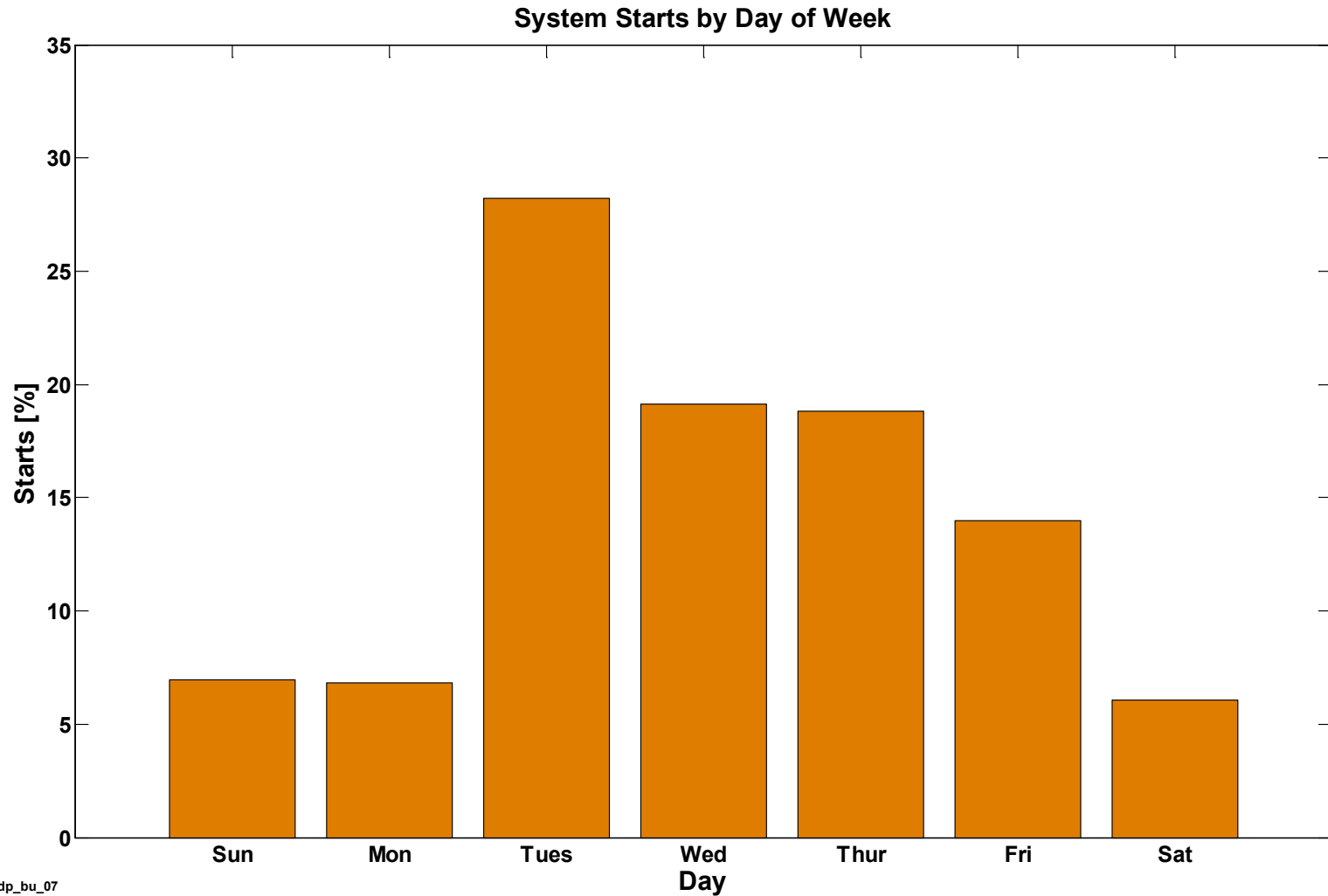
Fuel Cell System Starts by Month



Fuel Cell System Run Hours by Month



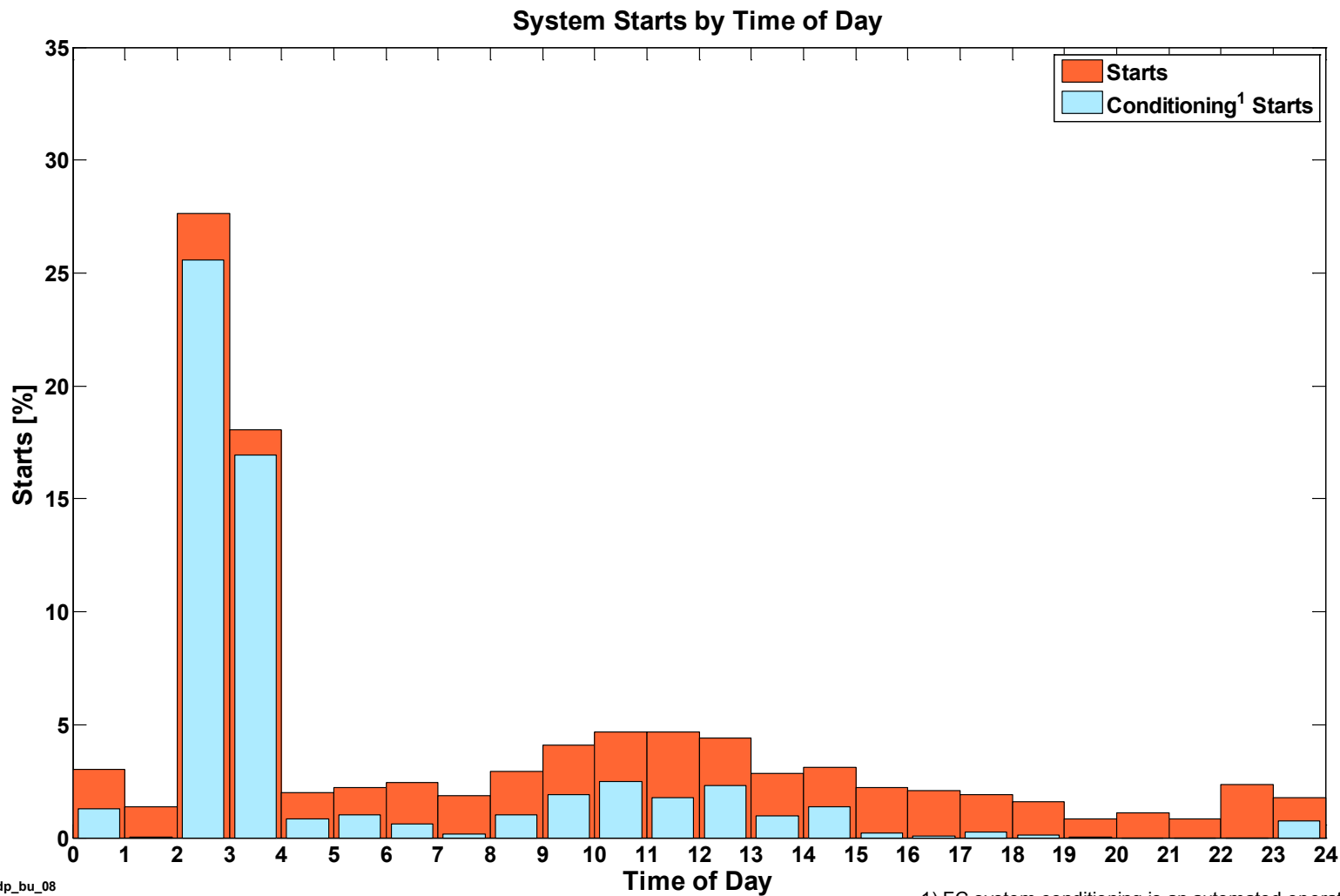
Fuel Cell System Starts by Day of Week



NREL cdp_bu_07

Created: Apr-02-14 1:42 PM | Data Range: 2010Q1-2013Q3

Fuel Cell System Starts by Time of Day



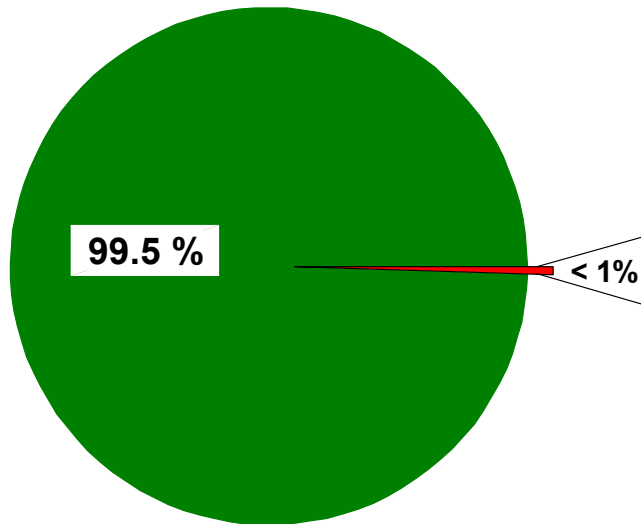
NREL cdp_bu_08

Created: Apr-02-14 1:42 PM | Data Range: 2010Q1-2013Q3

1) FC system conditioning is an automated operation for regular system checks; activated after long periods of no operation.

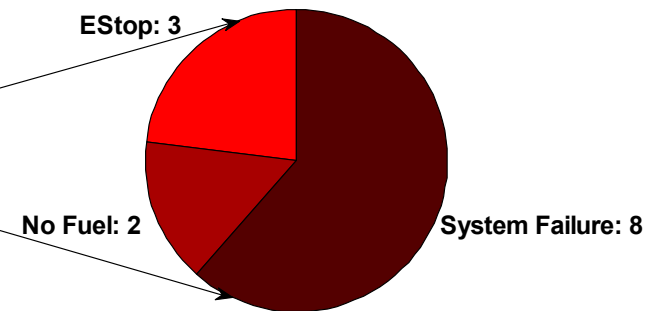
Interrupted Operation Categories

Uninterrupted Operation



2583 out of 2596 uninterrupted operation

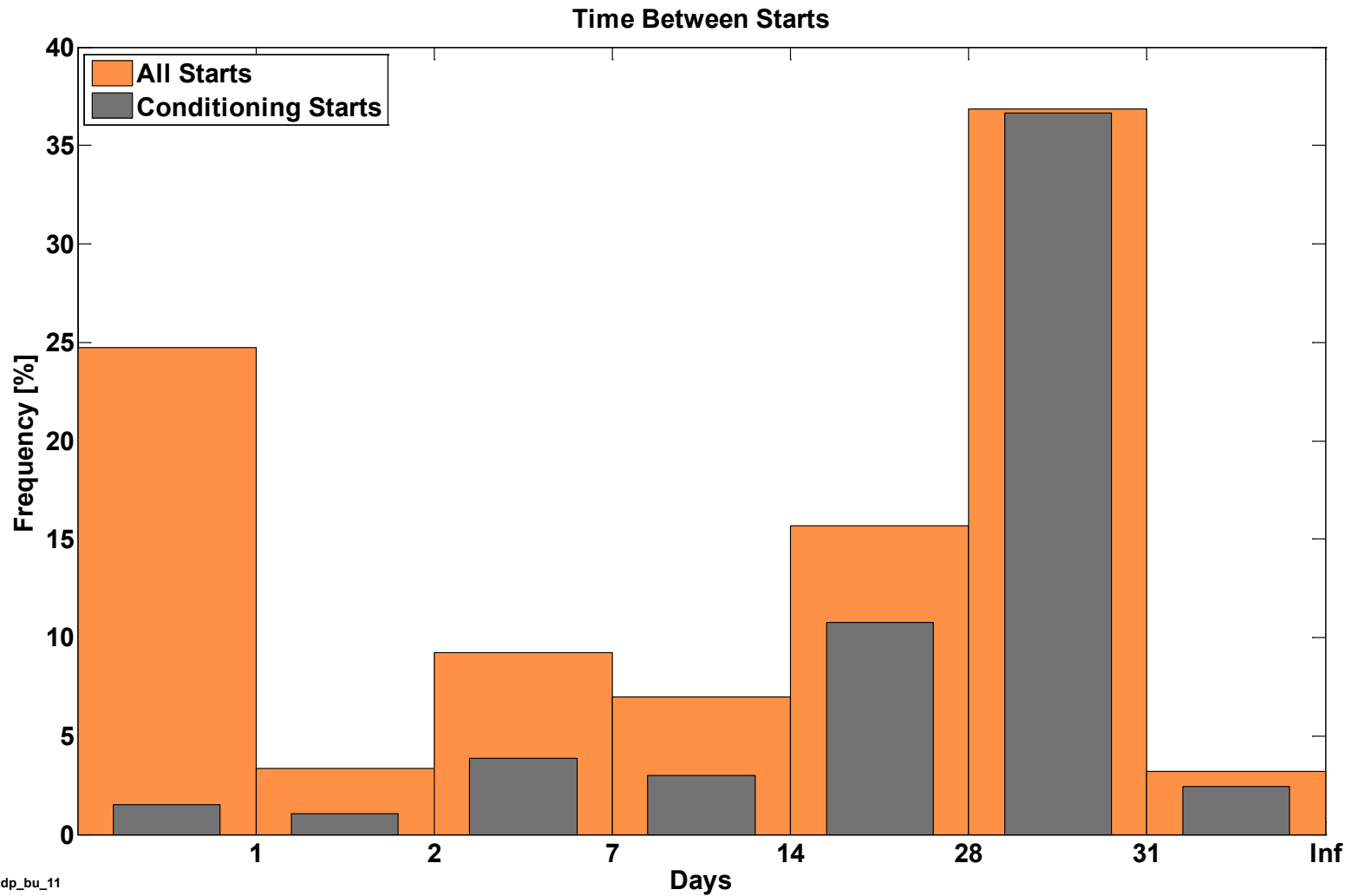
Interrupted Operation Categories



13 interrupted operations



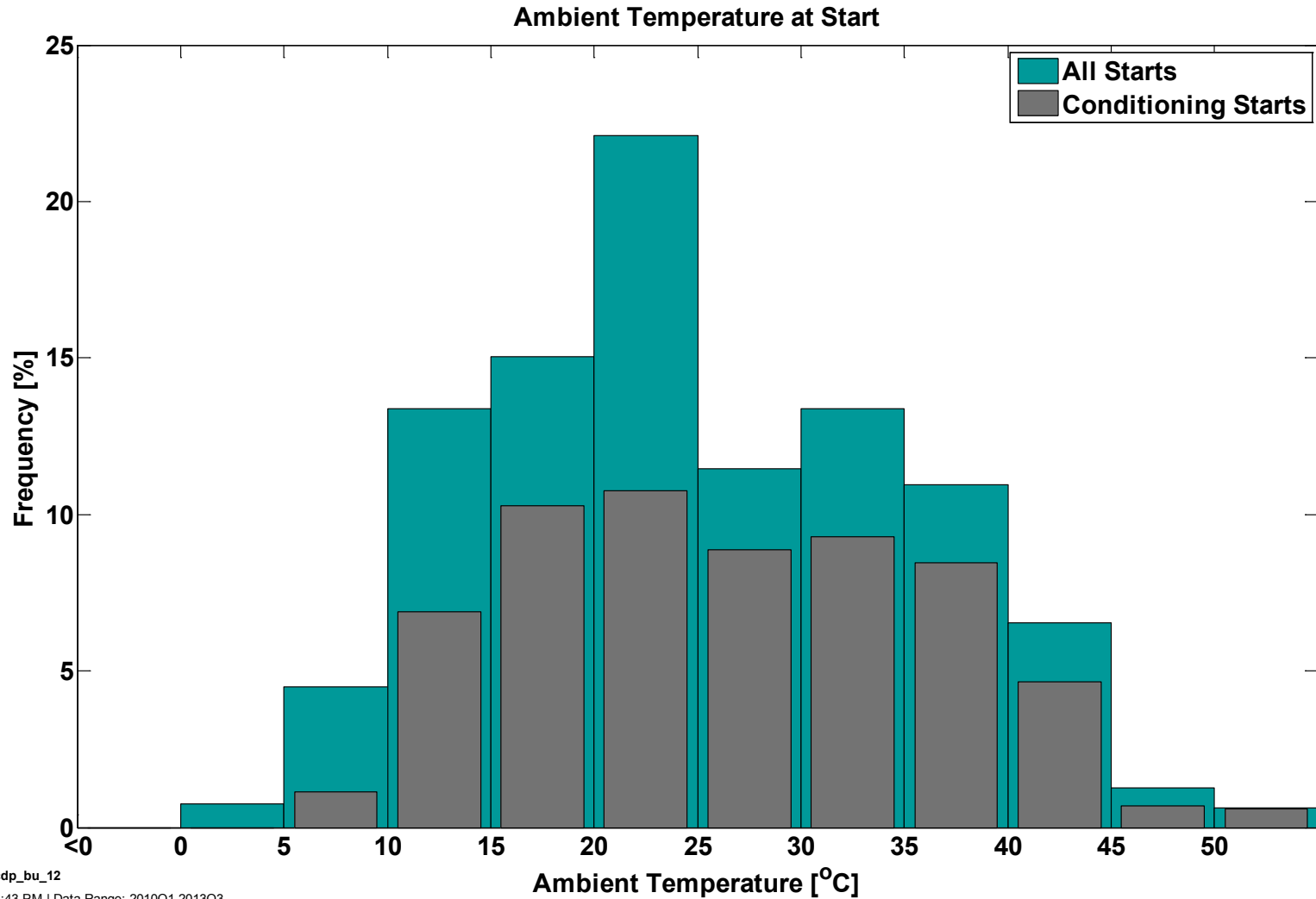
Time Between System Starts



NREL cdp_bu_11

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System Start Ambient Temperature

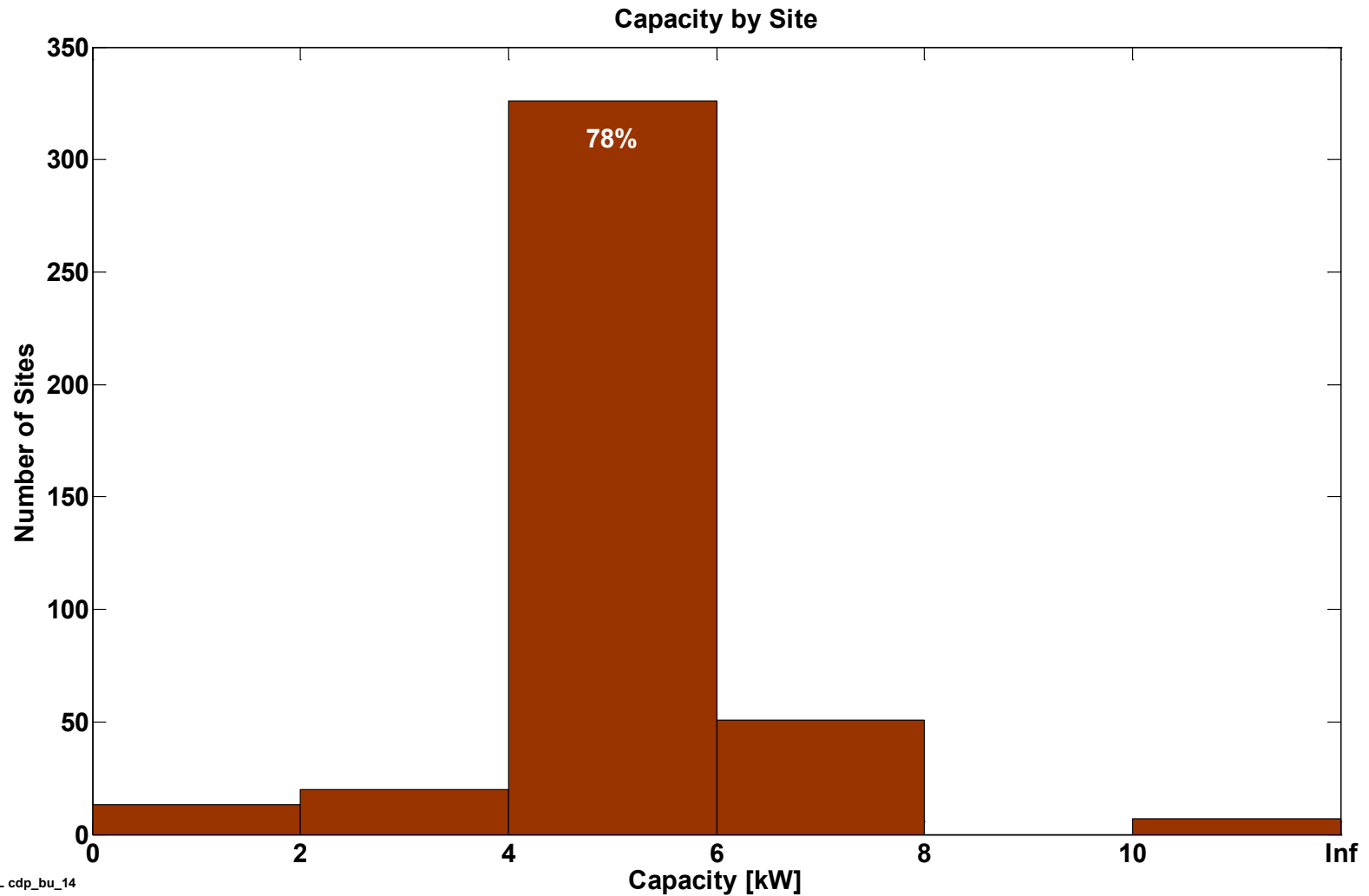


NREL cdp_bu_12

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CDP-BU-14

Site Capacity

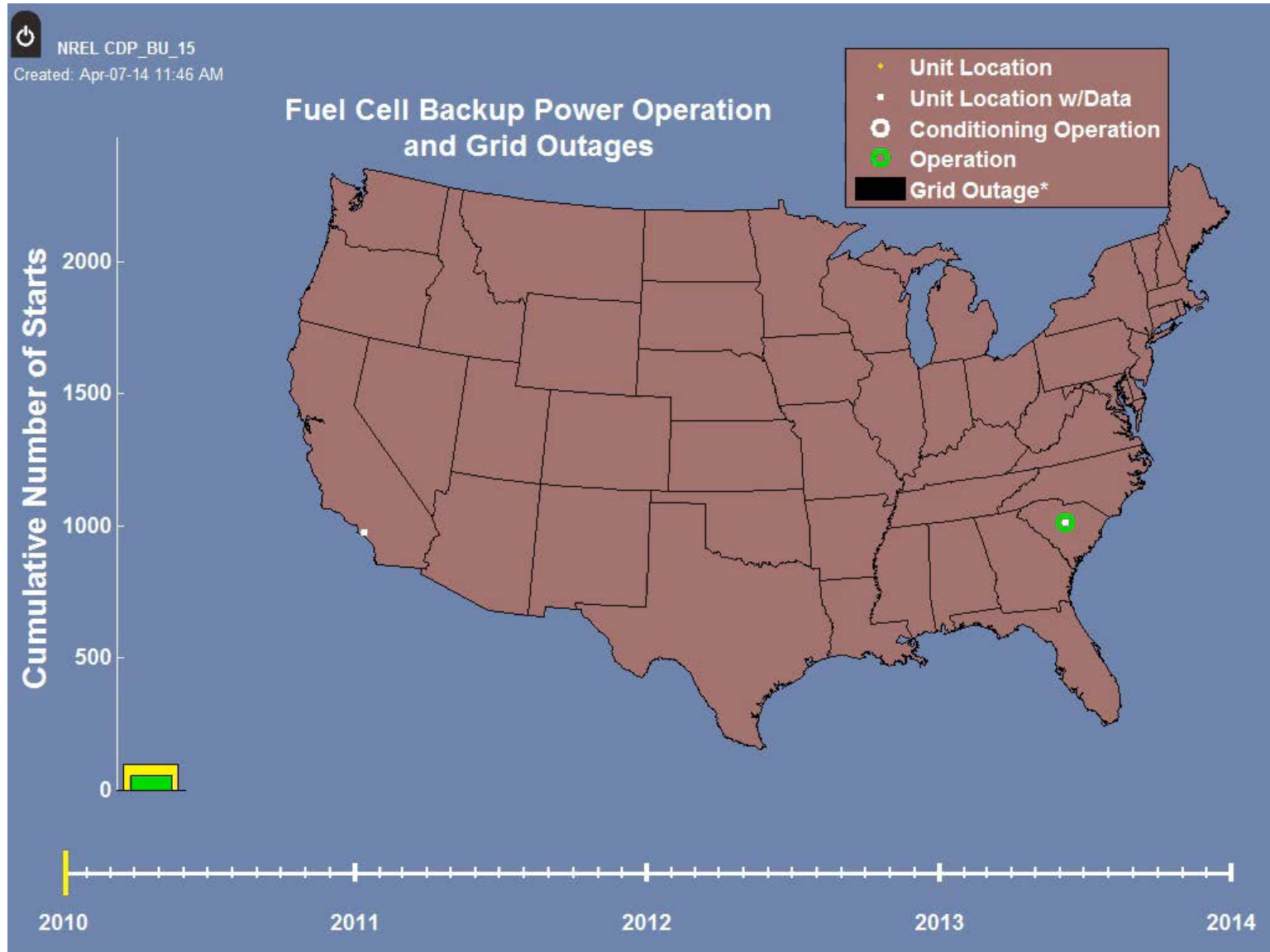


NREL cdp_bu_14

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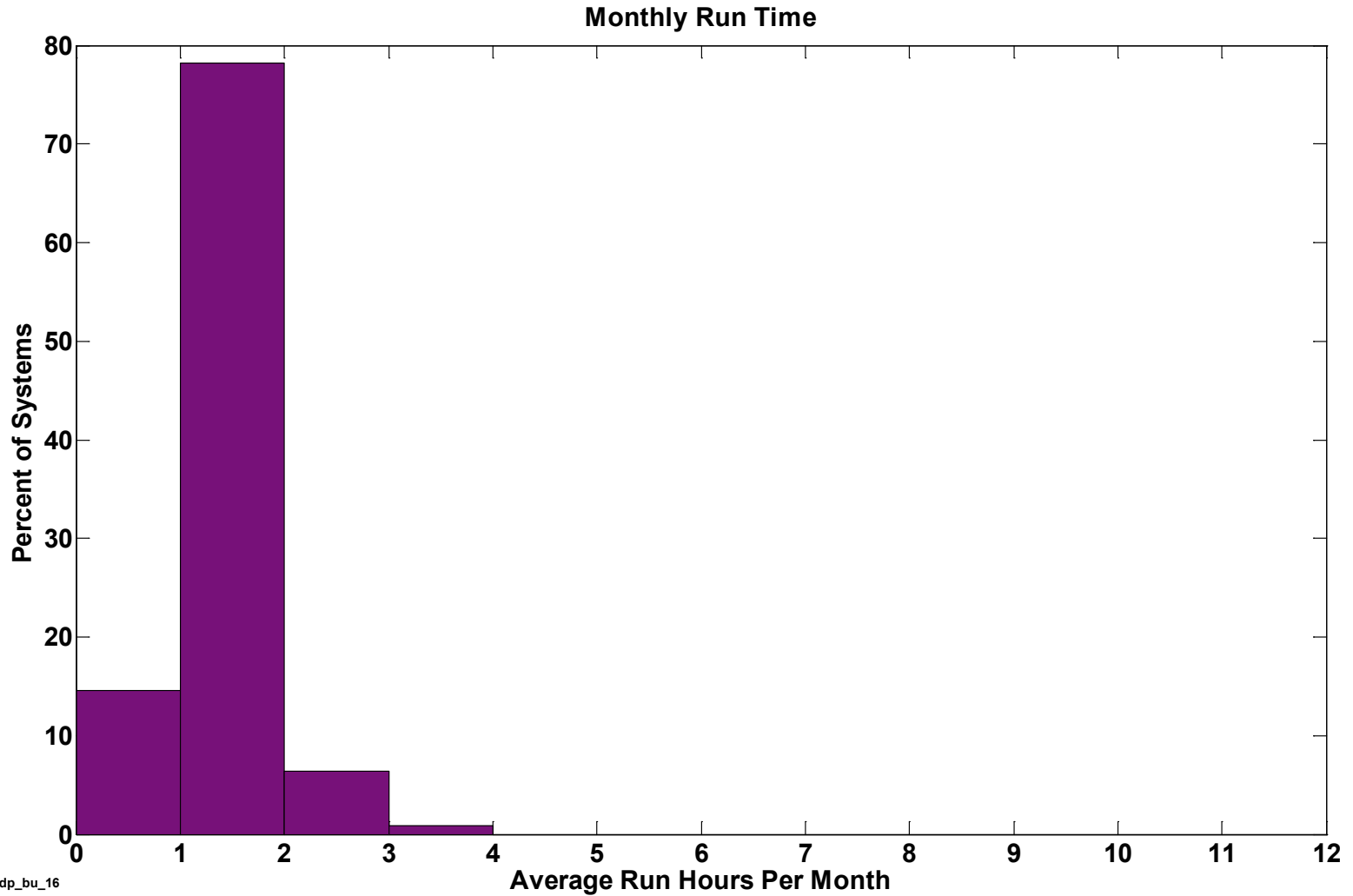
CDP-BU-15

Backup Power Operation With Grid Outage from 01/2010 to 12/2013



CDP-BU-16

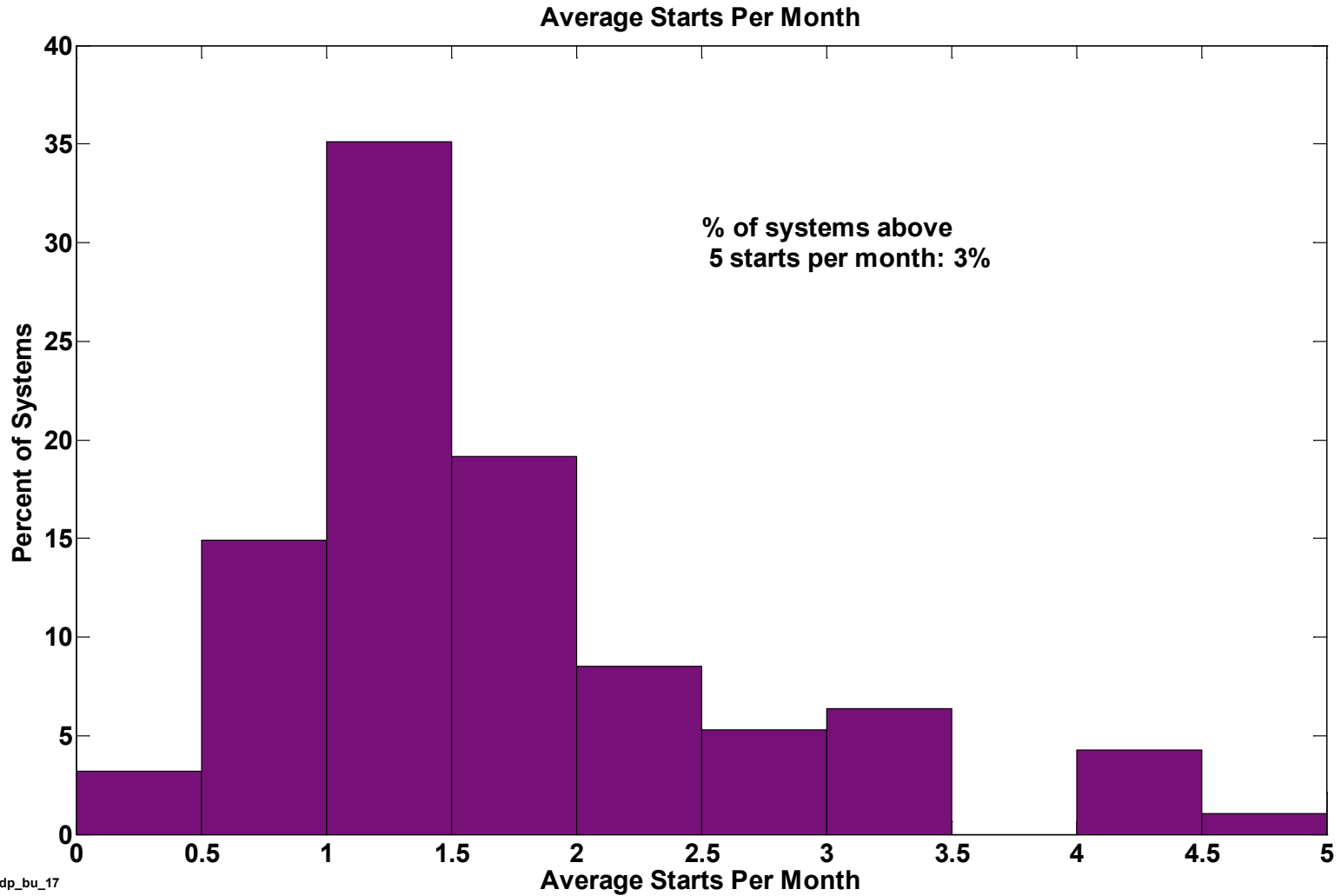
Operation Hours Per Month



NREL cdp_bu_16

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Average Starts Per Month



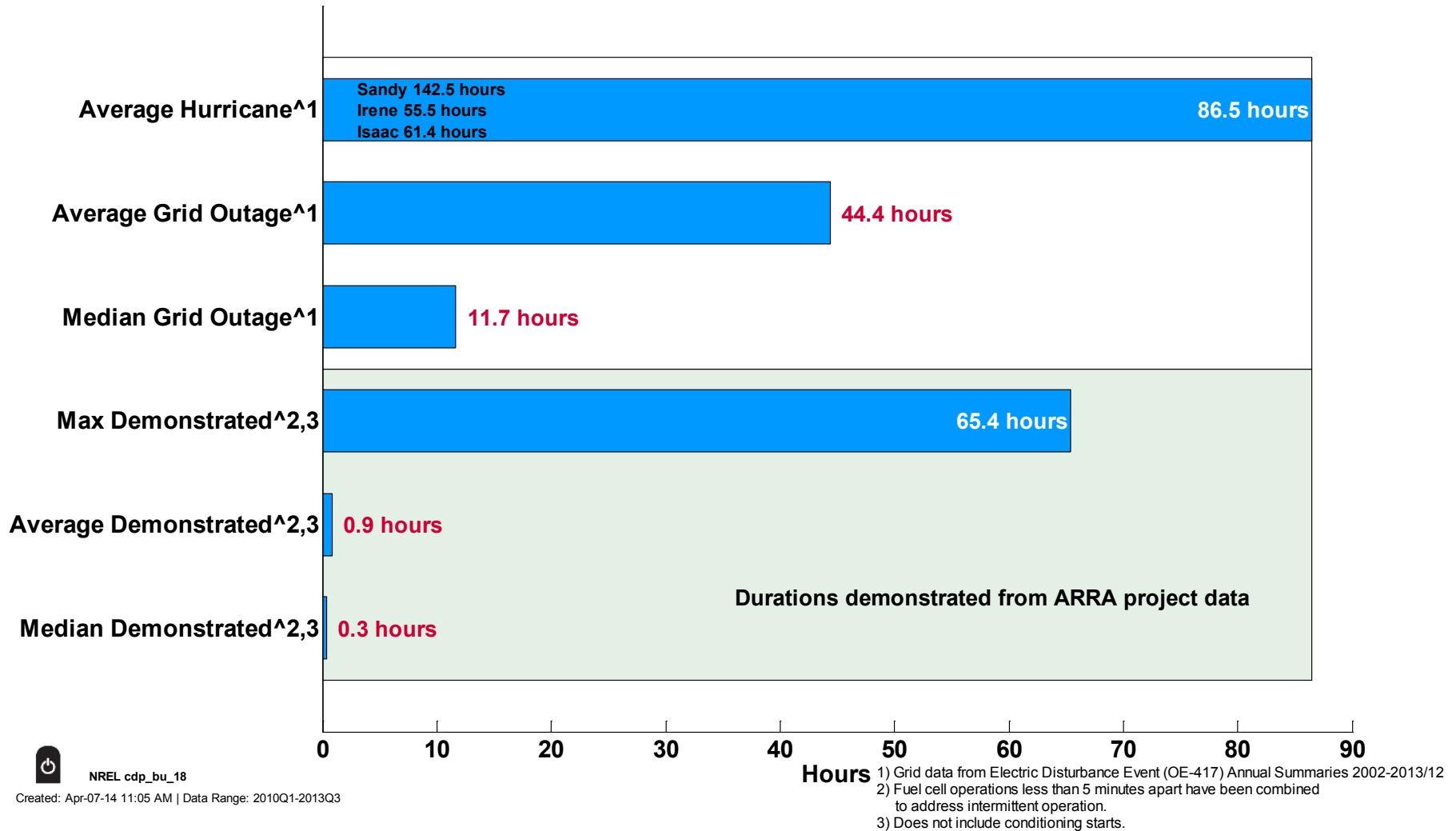
NREL cdp_bu_17

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CDP-BU-18

Site Capacity

Continuous System Run Time



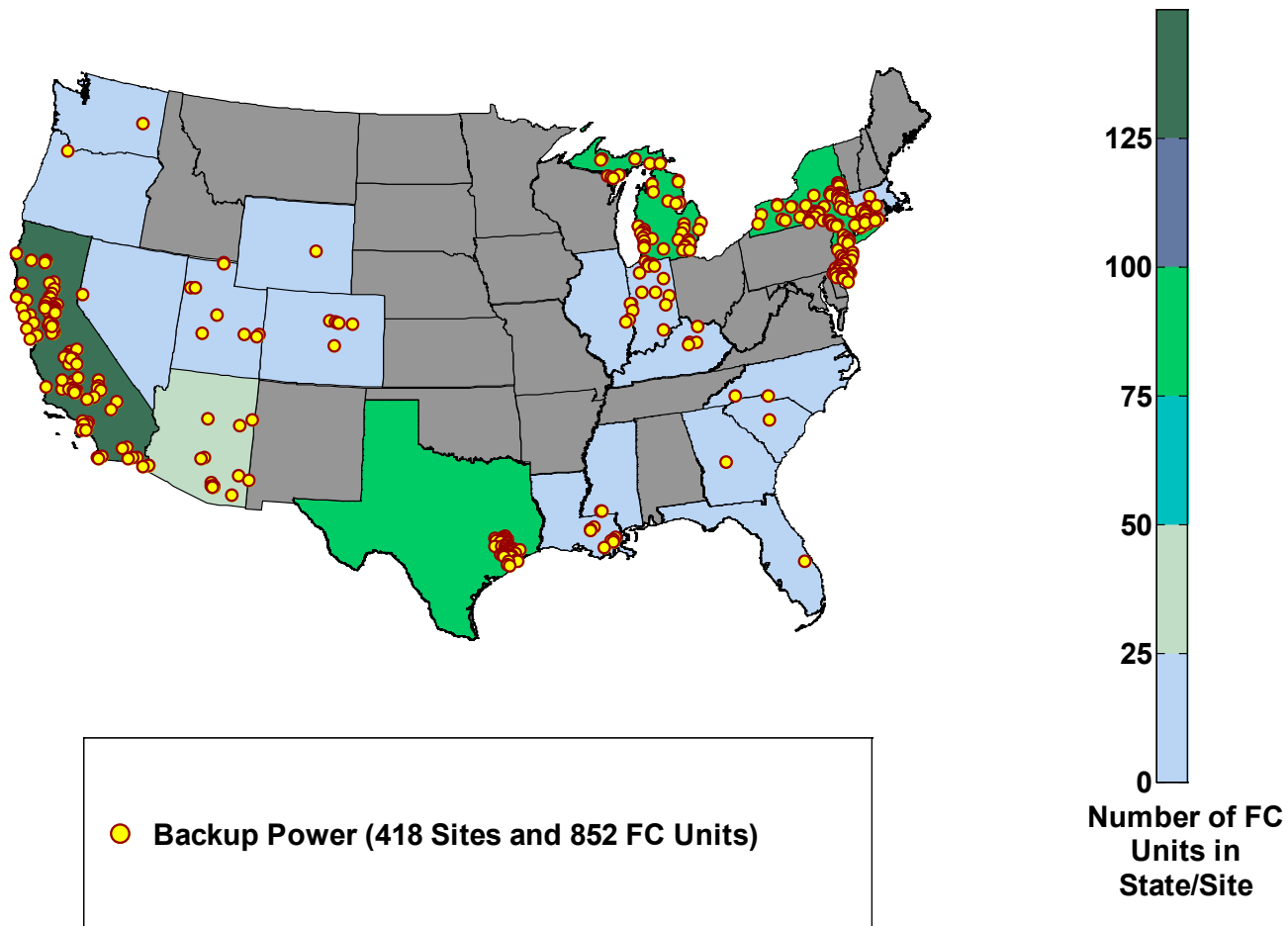
NREL cdp_bu_18

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CDP-BU-19

Unit Locations

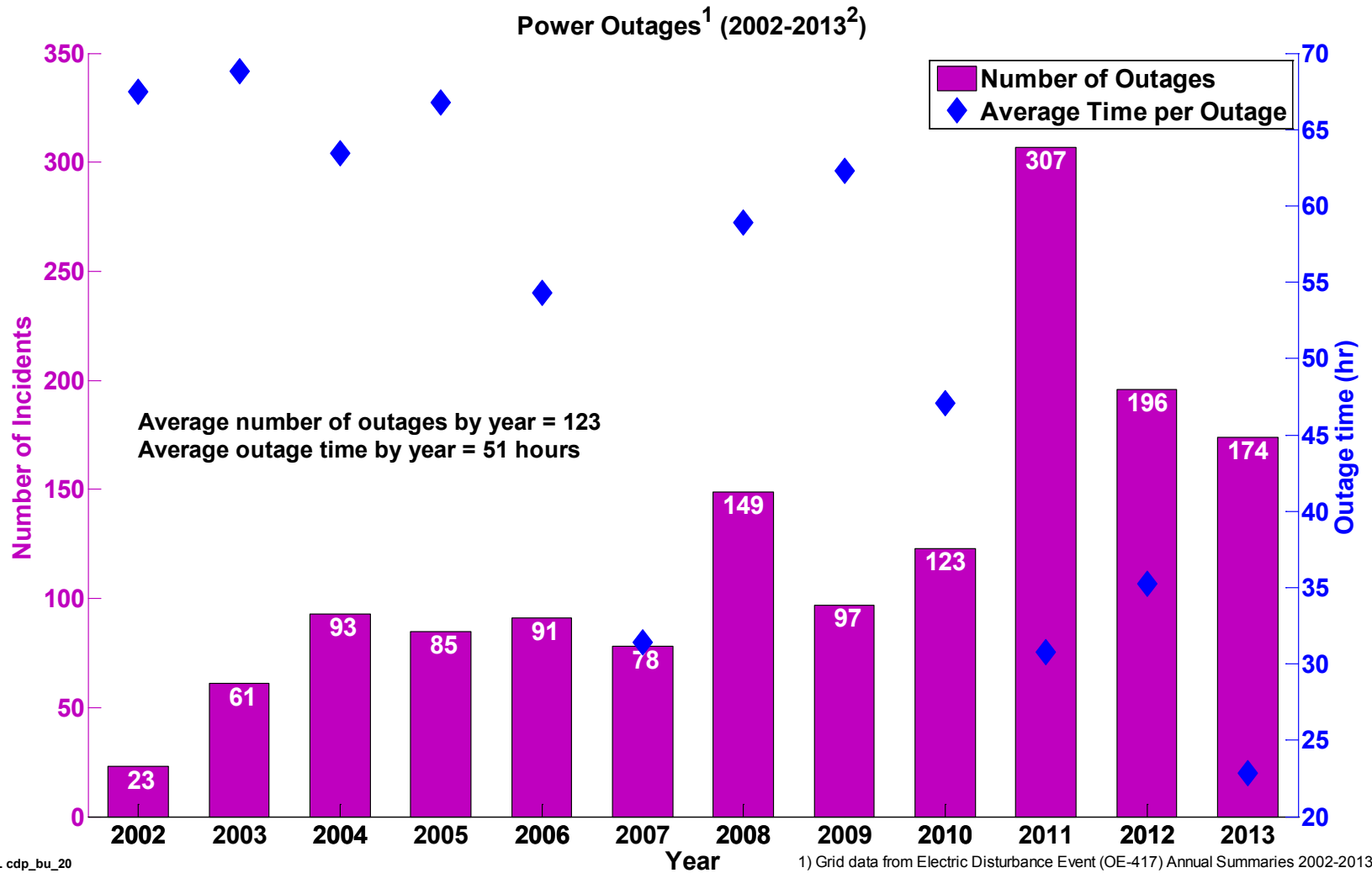
FC Unit Locations - Backup Power



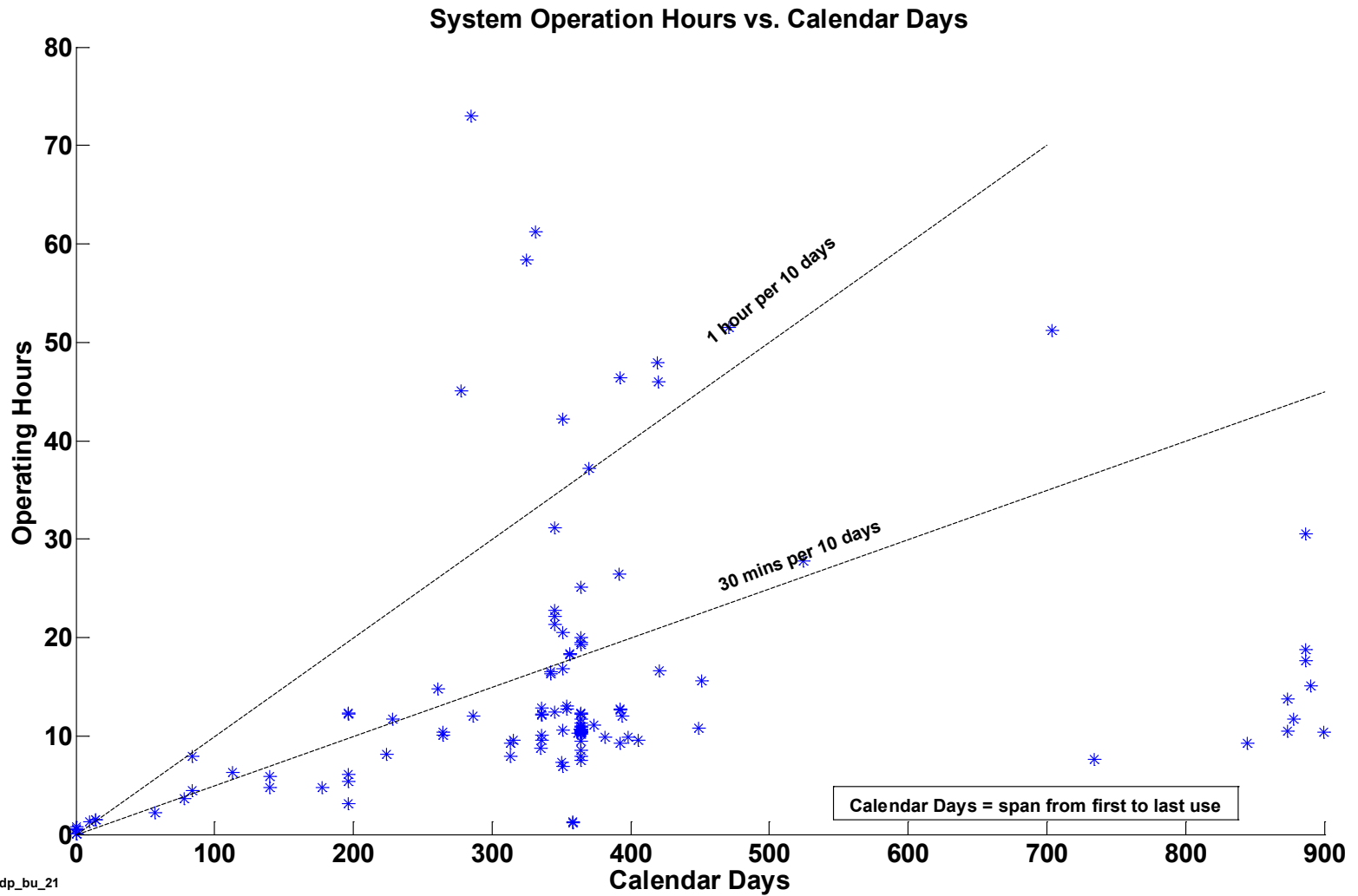
NREL cdp_bu_19

Created: Apr-24-14 11:13 AM | Data Range: 2010Q1-2013Q4

Power Outages per Year



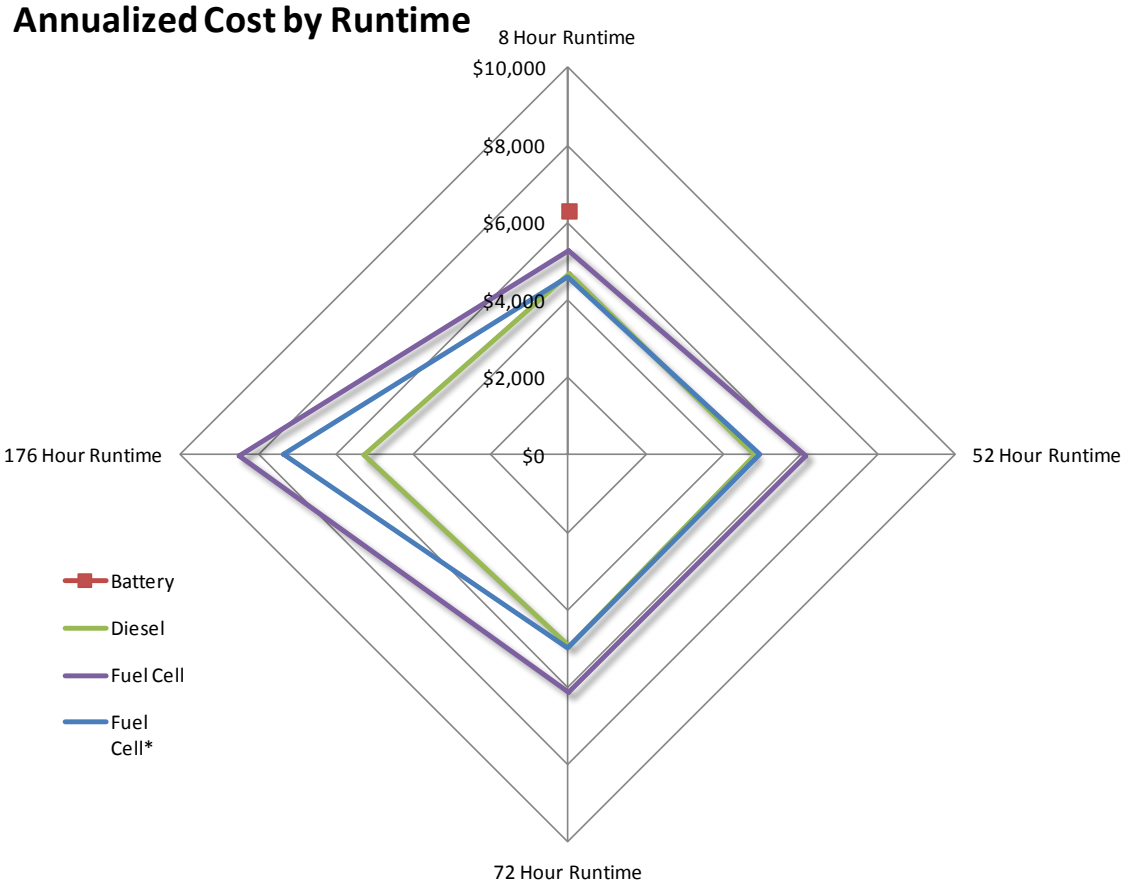
Operation Hours vs. Calendar Days



NREL cdp_bu_21

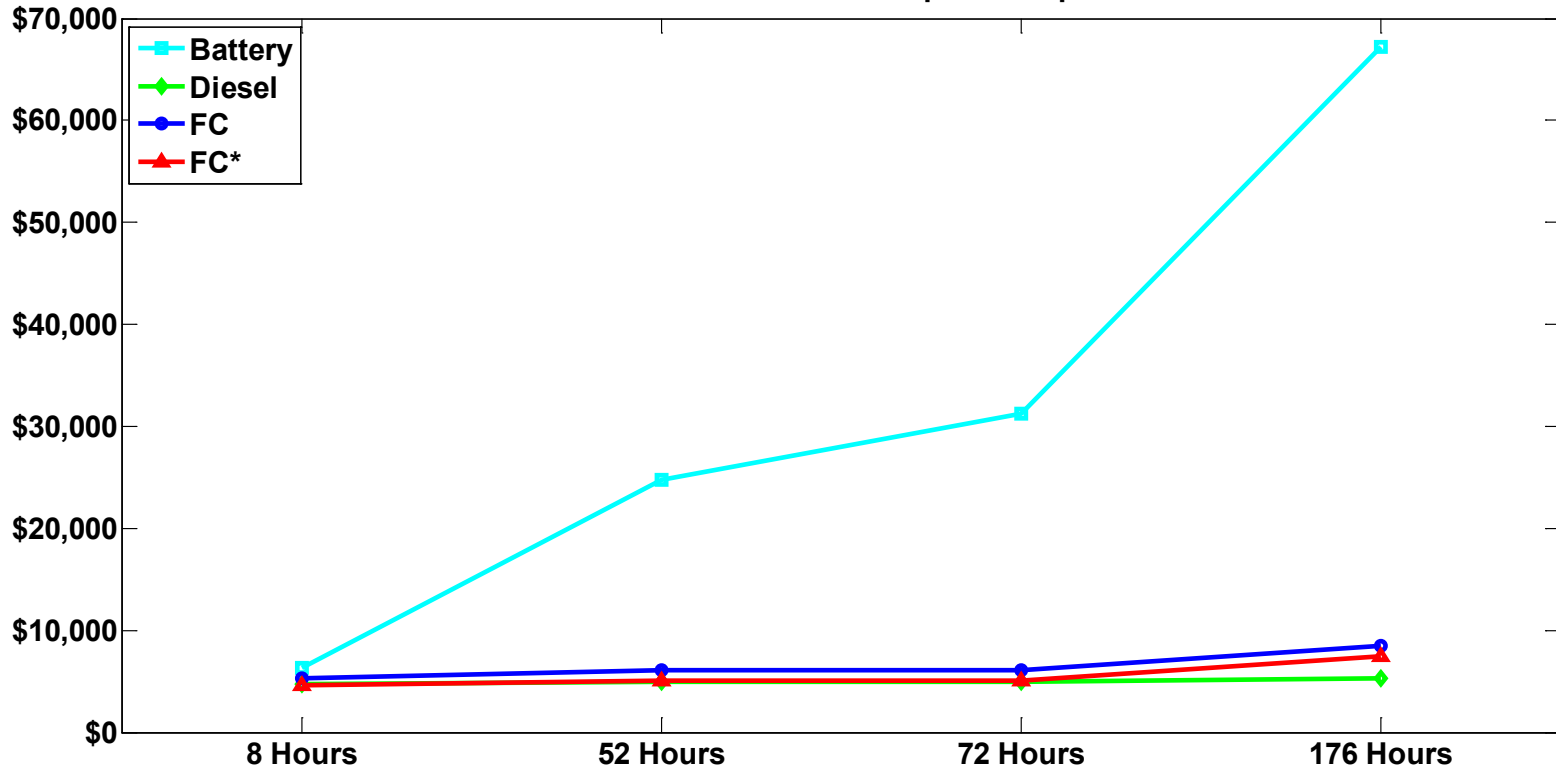
Created: Apr-02-14 1:43 PM | Data Range: 2010Q1-2013Q3

Annualized Cost of Ownership



Annualized Cost of Ownership

Annualized Cost of Ownership - Backup Power



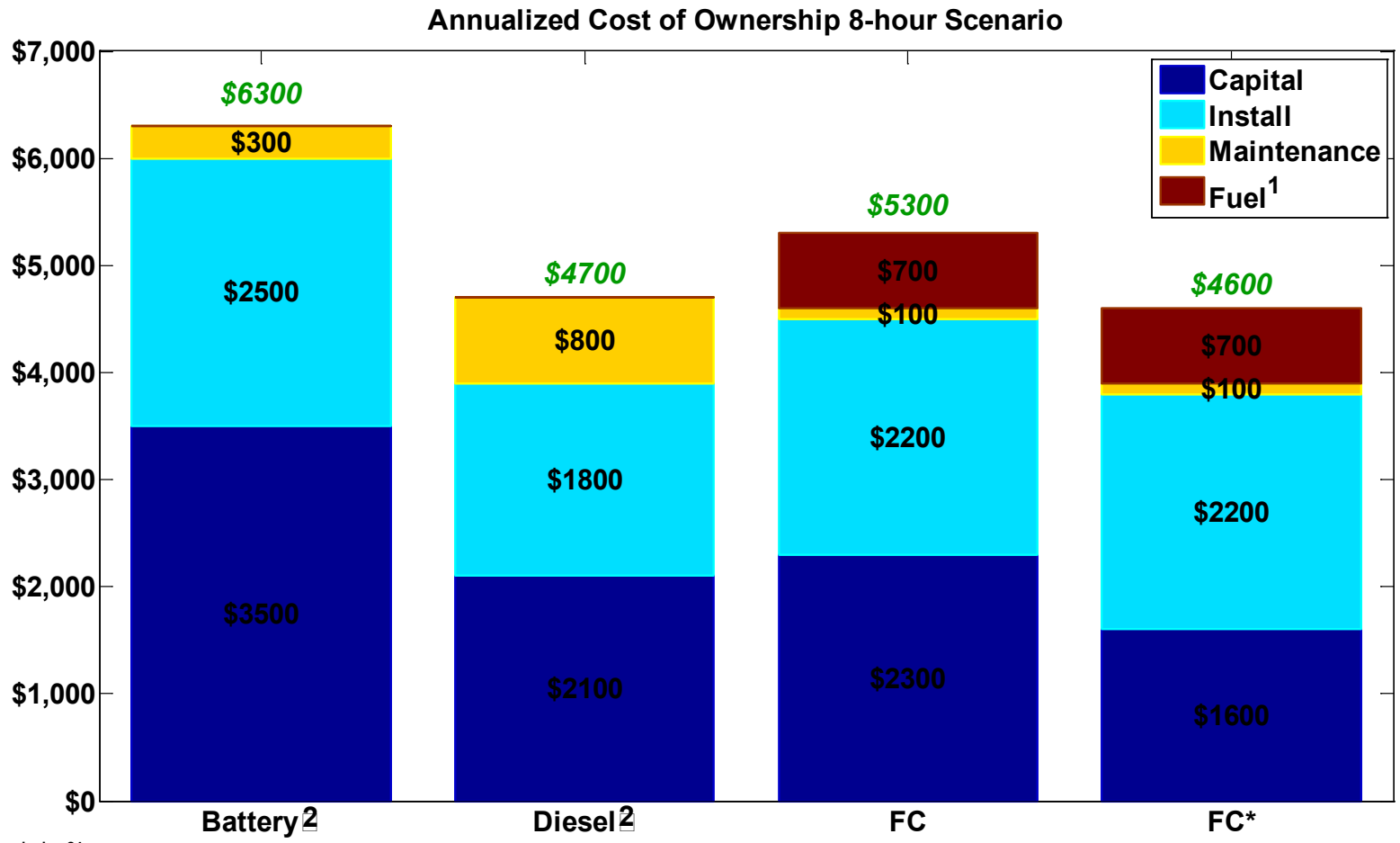
Battery	\$6300	\$24800	\$31300	\$67200
Diesel	\$4700	\$4900	\$4900	\$5300
FC	\$5300	\$6100	\$6100	\$8500
FC*	\$4600	\$5100	\$5100	\$7400



NREL cdp_bu_23

Created: Apr-07-14 10:05 AM | Data Through: 2013Q4

8-hour Annualized Cost of Ownership



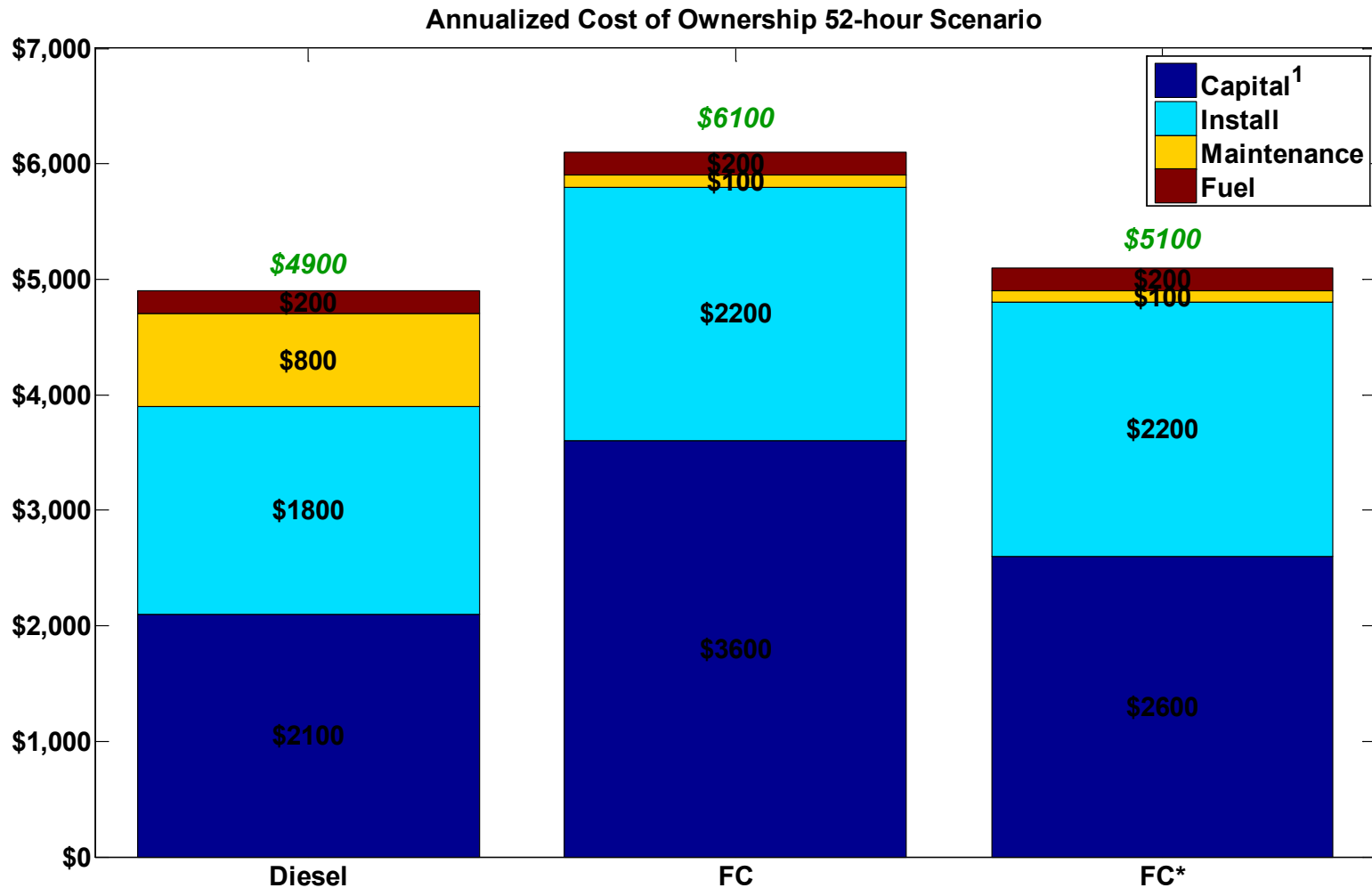
NREL cdp_bu_24

Created: May-13-14 10:35 AM | Data Through: 2013Q4

1. Includes hydrogen storage rent

2. Actual fuel cost negligible when rounded to the nearest hundred

52-hour Annualized Cost of Ownership

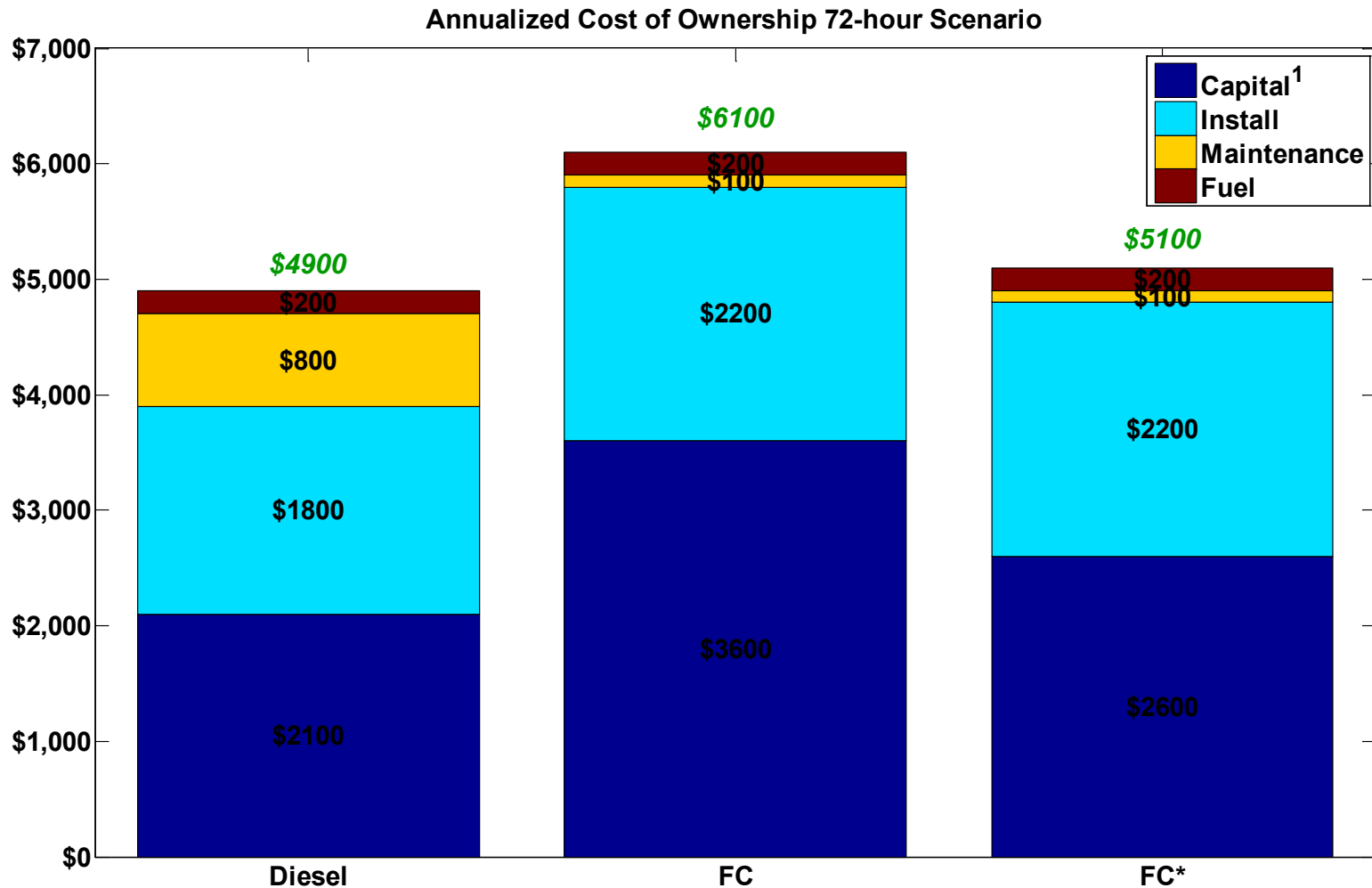


NREL cdp_bu_25

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1. Includes capital costs for fuel storage

72-hour Annualized Cost of Ownership

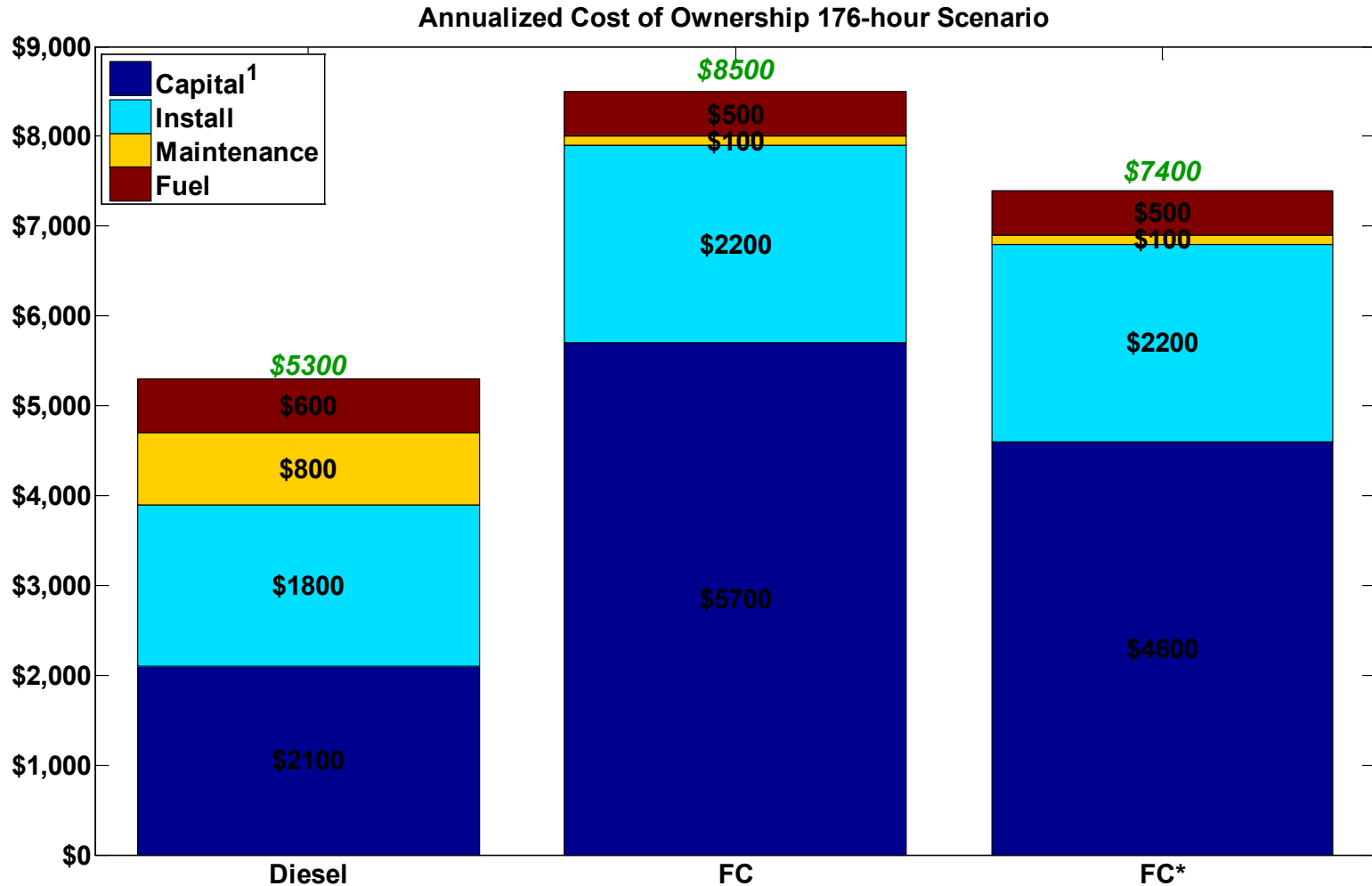


NREL cdp_bu_26

Created: Apr-07-14 10:05 AM | Data Through: 2013Q4

1. Includes capital costs for fuel storage

176-hour Annualized Cost of Ownership



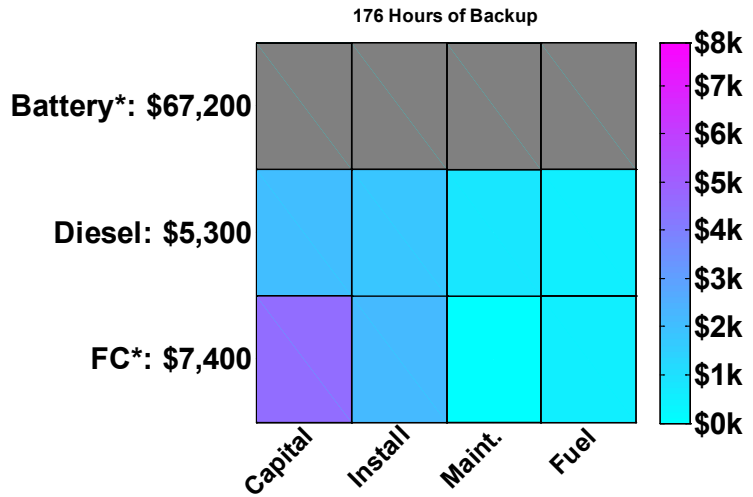
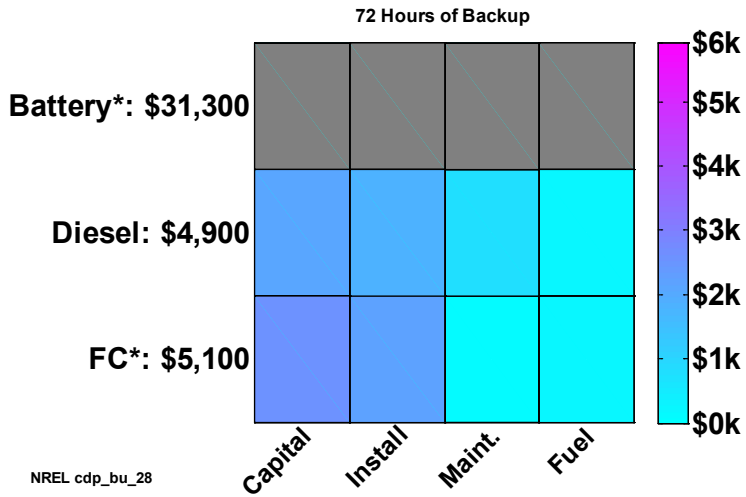
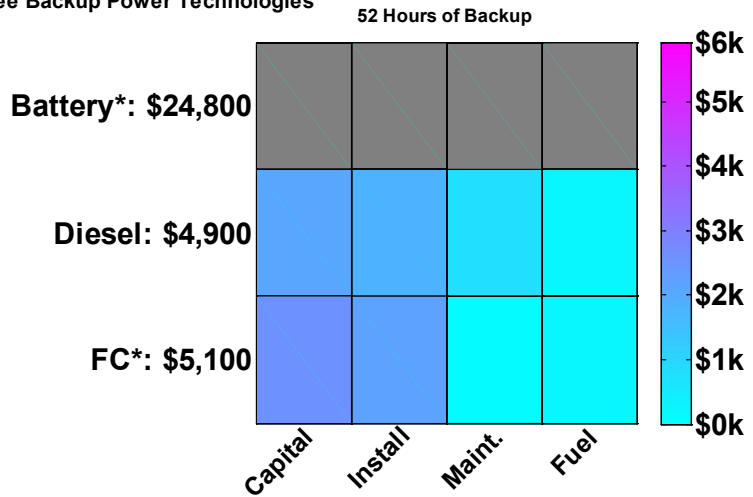
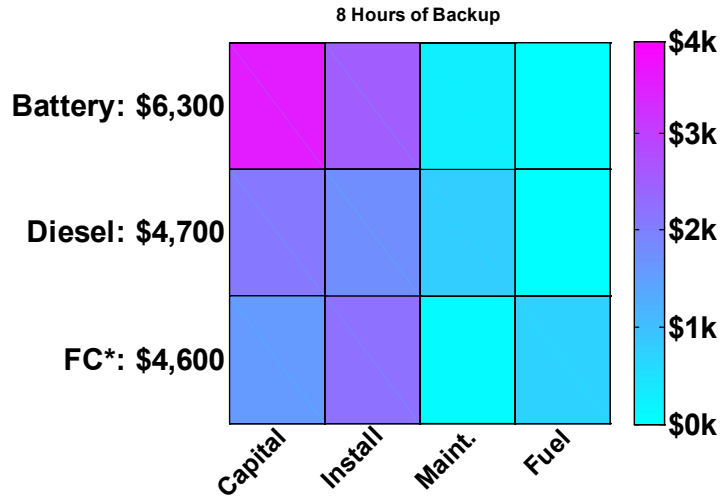
NREL cdp_bu_27

Created: Apr-07-14 10:05 AM | Data Through: 2013Q4

1. Includes capital costs for fuel storage

Annualized Cost of Ownership Heat Map

Annualized Cost Breakdown For Three Backup Power Technologies

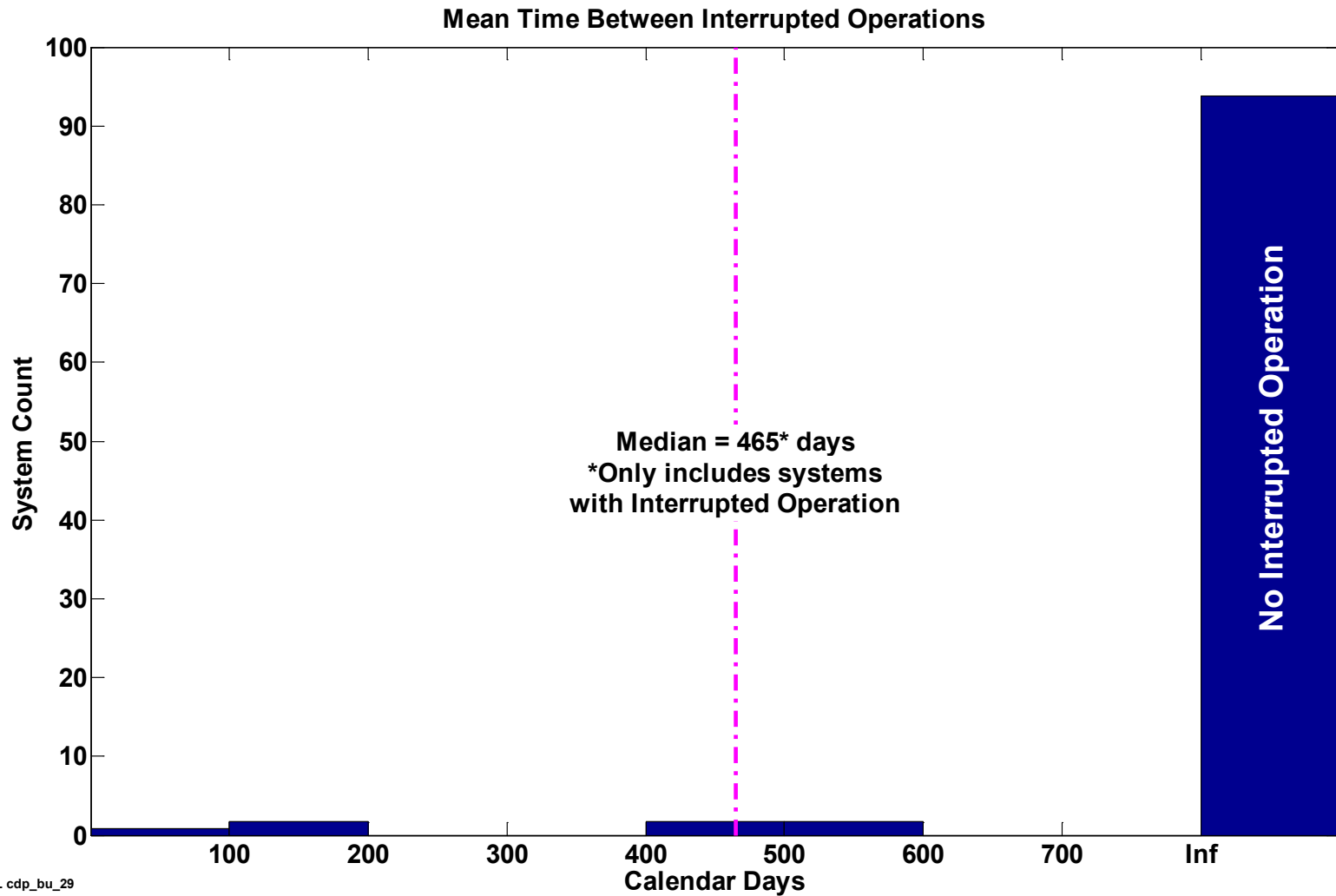


NREL cdp_bu_28

Created: Apr-07-14 10:16 AM | Data Through: 2013Q4

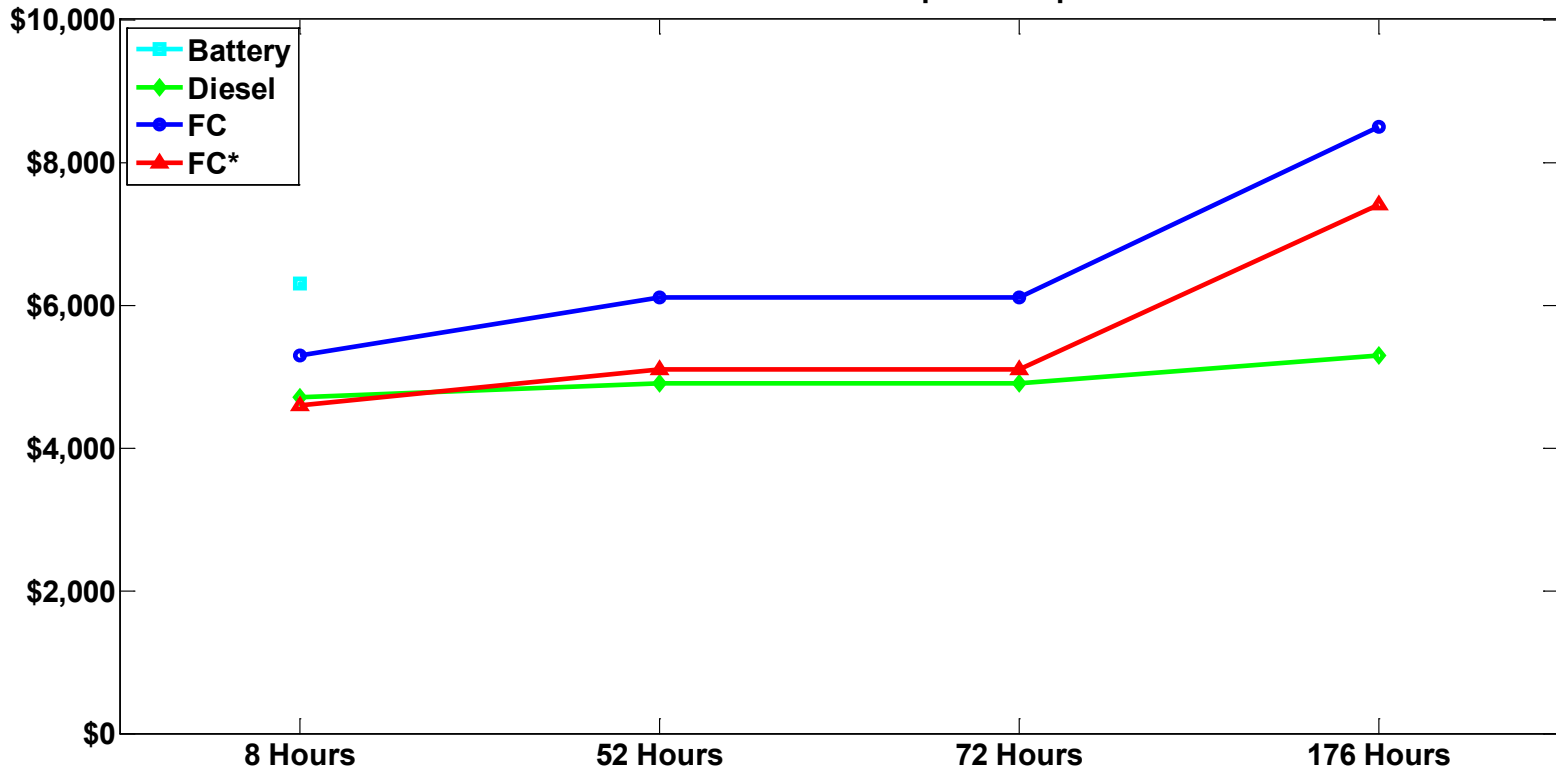
*Battery costs above chart axis limit, not shown.

Mean Time Between Interrupted Operation



Annualized Cost of Ownership—Zoomed In

Annualized Cost of Ownership - Backup Power



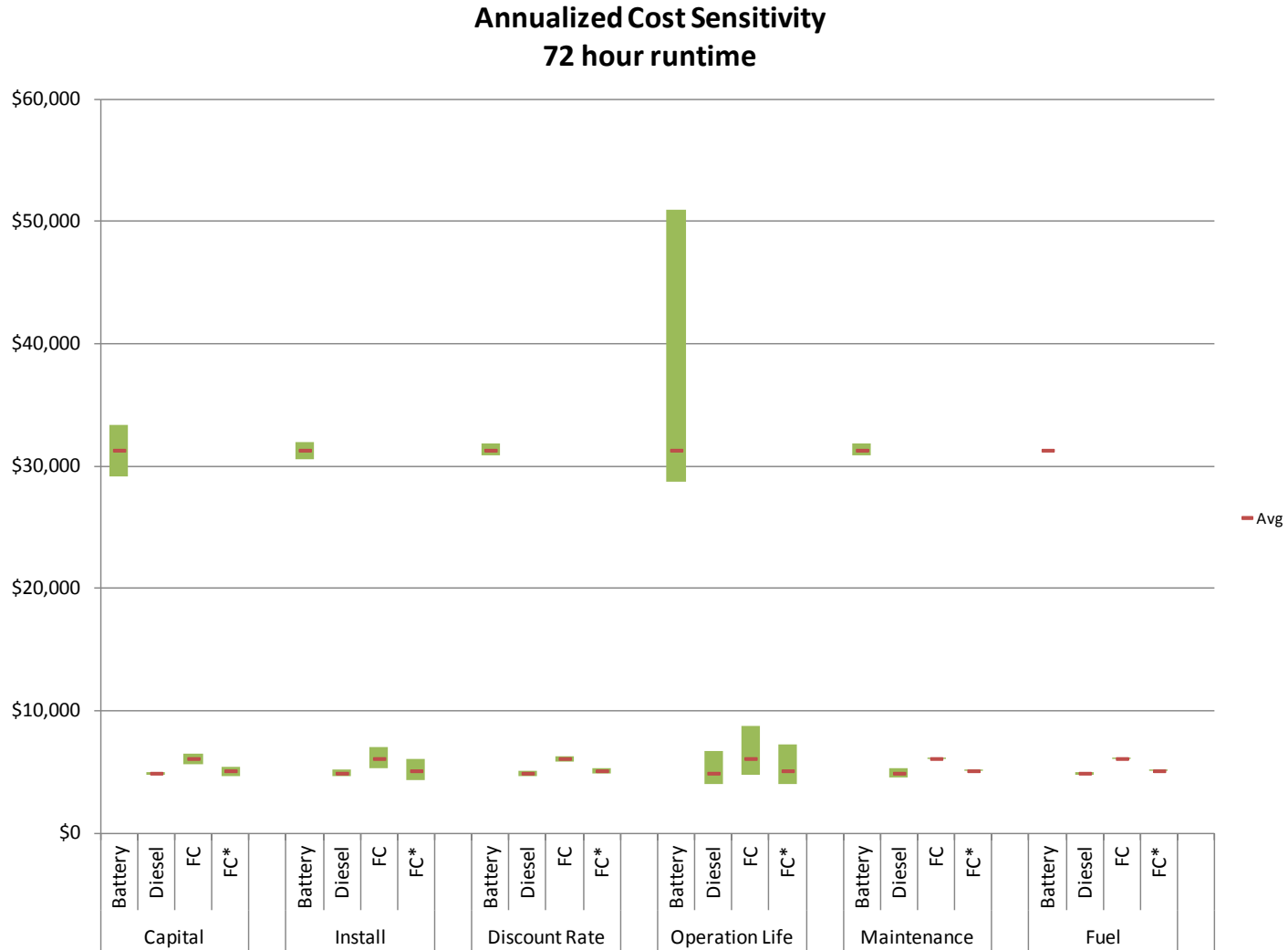
Battery	\$6300	\$24800	\$31300	\$67200
Diesel	\$4700	\$4900	\$4900	\$5300
FC	\$5300	\$6100	\$6100	\$8500
FC*	\$4600	\$5100	\$5100	\$7400



NREL cdp_bu_30

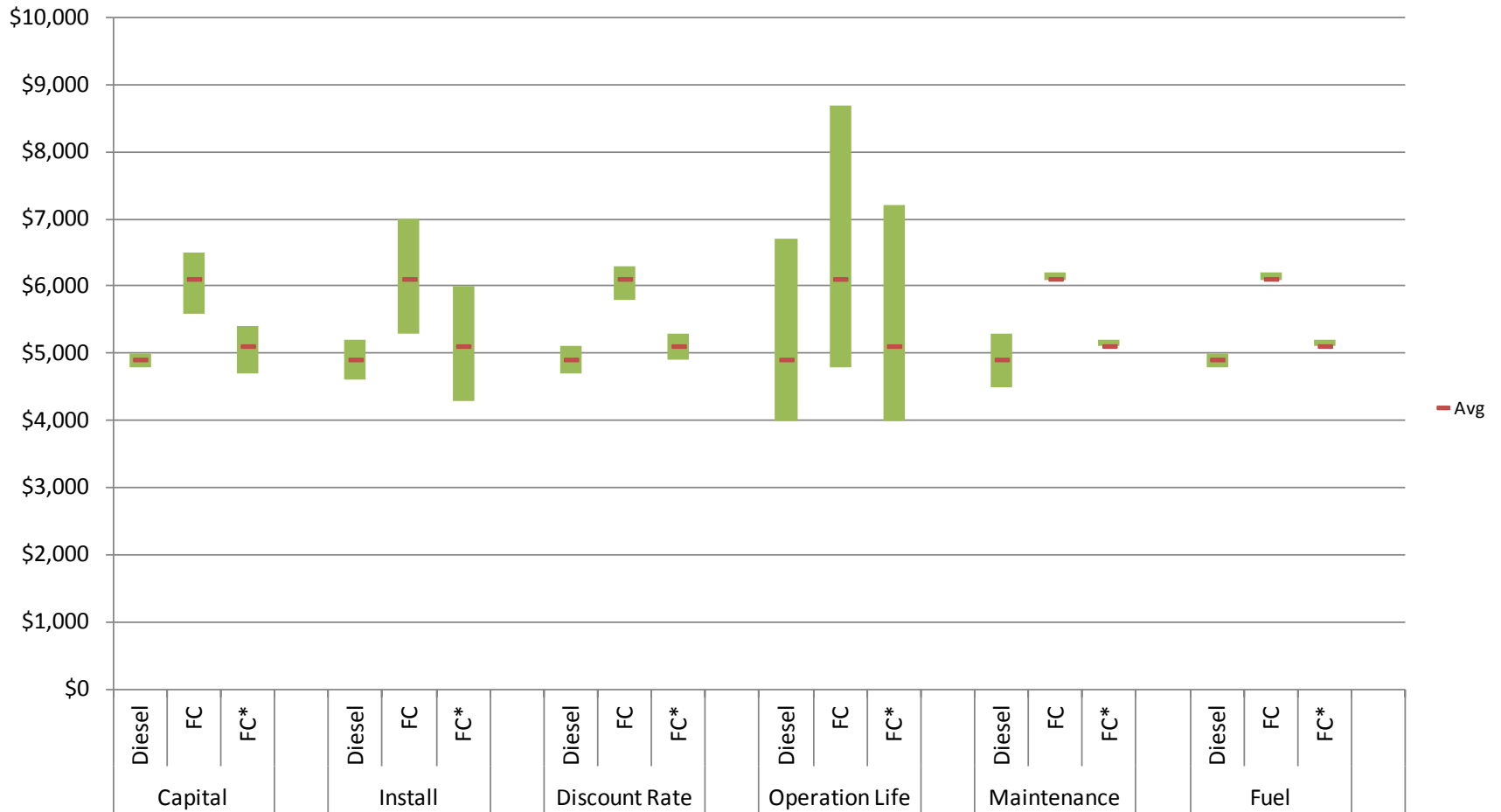
Created: Apr-07-14 10:05 AM | Data Through: 2013Q4

72-hour Annualized Cost of Ownership Sensitivity



72-hour Annualized Cost of Ownership Sensitivity—Zoomed In

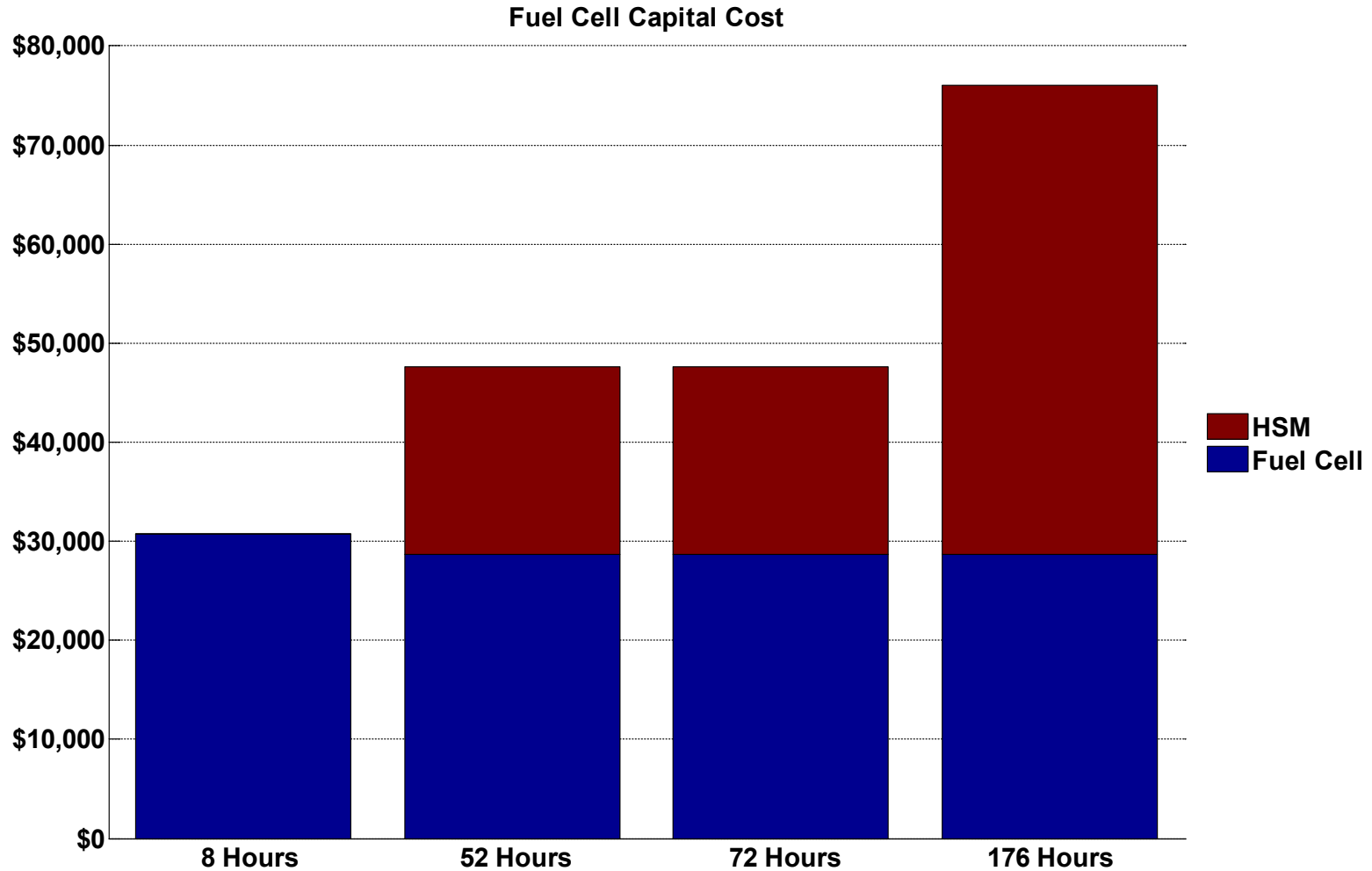
Annualized Cost Sensitivity
72 hour runtime



NREL cdp_bu_32

Created: Apr-15-14 4:32 PM | Data Range: 2010Q1-2013Q3

Fuel Cell Capital Cost Breakdown



HSM = Hydrogen Storage Module



NREL cdp_bu_33

Created: Apr-16-14 8:59 AM | Data Range: 2010Q1-2013Q4