Spring 2013 Composite Data Products – Backup Power

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CDP-BU-01
Backup Power Fuel Cell Systems Deployed

![Backup Power Fuel Cell Systems Deployed](image)

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

Created: Apr-02-13 2:33 PM | Data Range: 2009Q3-2012Q4
Deployed kW Capacity for Backup Power

Cumulative Deployed Capacity [kW]

- 2009 Q3: 50
- 2009 Q4: 70
- 2010 Q1: 70
- 2010 Q2: 104
- 2010 Q3: 130
- 2010 Q4: 444
- 2011 Q1: 500
- 2011 Q2: 761
- 2011 Q3: 1065
- 2011 Q4: 1378
- 2012 Q1: 1453
- 2012 Q2: 1492
- 2012 Q3: 1600
- 2012 Q4: 1860

Created: Apr-02-13  2:33 PM | Data Range: 2009Q3-2012Q4
### Backup Power Deployments

<table>
<thead>
<tr>
<th>State</th>
<th>kW</th>
<th>Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>84</td>
<td>16</td>
</tr>
<tr>
<td>California</td>
<td>576</td>
<td>124</td>
</tr>
<tr>
<td>Colorado</td>
<td>24</td>
<td>5</td>
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<tr>
<td>Connecticut</td>
<td>125</td>
<td>27</td>
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<tr>
<td>Florida</td>
<td>6</td>
<td>1</td>
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<tr>
<td>Georgia</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>Illinois</td>
<td>4</td>
<td>2</td>
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<tr>
<td>Indiana</td>
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<td>16</td>
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<tr>
<td>Kentucky</td>
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<td>4</td>
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<tr>
<td>Louisiana</td>
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<td>7</td>
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<tr>
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<td>New York</td>
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<td>53</td>
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<tr>
<td>North Carolina</td>
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<td>2</td>
</tr>
<tr>
<td>South Carolina</td>
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<td>Texas</td>
<td>200</td>
<td>39</td>
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<tr>
<td>Utah</td>
<td>36</td>
<td>9</td>
</tr>
</tbody>
</table>

**Totals**: 1855, 388

- **Site Capacity**: (line height proportional to installed site kW capacity)

NREL cdp_bu_03

Created: Apr-03-13 11:16 AM | Data Range: 2009Q3-2012Q4

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NATIONAL RENEWABLE ENERGY LABORATORY
Fuel Cell System Starts by Month

1788 of 1796 Starts Successful (99.6%)  
57% Conditioning Starts

1) FC system conditioning is an automated operation for regular system checks; activated after long periods of no operation.
1153 Hours Total Runtime
113 Systems
0.7 Hours Average Fleet Runtime

1) FC system conditioning is an automated operation for regular system checks that are run after long periods of no operation.
CDP-BU-06
Cumulative Hydrogen Consumed by Month

Cumulative Hydrogen Consumed by Month

83.4 kgs Total Consumed H₂
32,777 scf Total Consumed H₂

Calendar Month

Hydrogen kgs Consumed

Created: Apr-03-13  9:52 AM | Data Range: 2009Q3-2012Q4
Fuel Cell System Starts by Day of Week

System Starts by Day of Week

Starts [%]

Sun | Mon | Tues | Wed Day | Thur | Fri | Sat

Created: Apr-02-13  2:40 PM | Data Range: 2009Q3-2012Q4
Fuel Cell System Starts by Time of Day

1) FC system conditioning is an automated operation for regular system checks; activated after long periods of no operation.
Continuous Fuel Cell System Run Time

Max Continuous Run Time = 65 hours
Average Runtime Per System = 0.8 hours
Average Conditioning Run Time Per System = 0.7 hours

1) Fuel cell operations less than 5 minutes apart have been concatenated due to battery interactions that may cause apparently intermittent operation.
Start Reliability

99.6%

Unsuccessful Operation Categories

- EStop: 1
- No Fuel: 2
- System Failure: 5

1788 out of 1796 successful starts

8 failed operations
CDP-BU-11
Time Between System Starts

Days

Frequency [%]

Time Between Starts

All Starts
Conditioning Starts

Created: Apr-02-13 2:42 PM | Data Range: 2009Q3-2012Q4
CDP-BU-12
System Start Ambient Temperature

Ambient Temperature at Start

Frequency [%]

All Starts
Conditioning Starts

Ambient Temperature [°C]

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

<0 0 5 10 15 20 25 30 35 40 45 50

NREL cdp_bu_12
Created: Apr-02-13 2:42 PM | Data Range: 2009Q3-2012Q4

NATIONAL RENEWABLE ENERGY LABORATORY
System Operation Time

Average System Hours = 49.5
Average Fleet Hours = 10.2
Max system hours = 69.9
25% of systems have hours > 12.3
Backup Power Operation with Grid Outage from 01/2010 to 12/2012

Fuel Cell Backup Power Operation and Grid Outages

Cumulative Number of Starts

2010  2011  2012  2013
CDP-BU-16
Operation Hours Per Month

Monthly Run Time

Percent of Systems

Average Run Hours Per Month

Created: Apr-02-13  2:43 PM | Data Range: 2009Q3-2012Q4
CDP-BU-17
Average Starts Per Month

![Average Starts Per Month Chart]

Percent of Systems

Average Starts Per Month

Created: Apr-02-13 2:43 PM | Data Range: 2009Q3-2012Q4
Site Capacity

Continuous System Run Time

- Average Hurricane\(^1\)
  - Sandy: 142.5 hours
  - Irene: 55.5 hours
  - Isaac: 61.4 hours
  - Total: 86.5 hours
- Average Grid Outage\(^1\)
  - Duration: 38.5 hours
- Median Grid Outage\(^1\)
  - Duration: 7.3 hours
- Max Demonstrated\(^2,3\)
  - Duration: 65.5 hours
- Average Demonstrated\(^2,3\)
  - Duration: 0.8 hours
- Median Demonstrated\(^2,3\)
  - Duration: 0.3 hours

Durations demonstrated from ARRA project data

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1) Grid data from Electric Disturbance Event (OE-417) Annual Summaries 2002-2012
2) Fuel cell operations less than 5 minutes apart have been combined to address intermittent operation.
3) Does not include conditioning starts.
FC Unit Locations - Backup Power

Backup Power (393 Sites and 817 FC Units)

Number of FC Units in State/Site

Created: Apr-03-13 11:57 AM | Data Range: 2009Q3-2012Q4
Power Outages per Year (2002-2012)

Average number of outages per year = 118
Average outage time = 42 hours

Number of Outages
Average Time per Outage

1) Grid data from Electric Disturbance Event (OE-417) Annual Summaries 2002-2012