Evaluation of Stationary Fuel Cell Deployments, Costs, and Fuels

2013 Fuel Cell Seminar and Energy Exposition

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NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.
Technology Validation at NREL

- Confirmation of component and system technical targets
- Evaluation, optimization, and demonstration in integrated energy systems
- National Fuel Cell Technology Evaluation Center (*NFCTEC*)

Photo by Dennis Schroeder, NREL
Figures and illustrations: NREL
NFCTEC Analysis Approach

Analysis and reporting of real-world operation data

Operational and Performance Data

NREL Data Analysis

NFCTEC

National Fuel Cell Technology Evaluation Center

Results

DDPs

Confidential

Detailed Data Products (DDPs)
- Individual data analyses, shared only with partner supplying data
- Identify individual contribution to CDPs

Composite Data Products (CDPs)
- Aggregated data across multiple systems, sites, and teams
- Publicly available analyses, published without revealing proprietary data

www.nrel.gov/hydrogen/proj_tech_validation.html
Major Ramp-Up of Fuel Cell Stationary System Deployments Began in 2010

Cumulative Deployment Count by Year*

Total = 295 units

Cumulative Capacity by Year*

Total = 121 MW

Majority of deployments and nearly all capacity is electric only

*NREL cdp_stat_01
Created: Sep-25-13  9:08 AM | Data Range: 2001Q2-2013Q2
*Data from the California SGIP.
Contractual Status of Stationary Fuel Cell Systems in Deployment

New projects since 2011 receiving the performance-based incentive

Definitions:
- RRF = Reservation Request Form, is the first step in the SGIP incentive claim process.
- PPM = Proof of Project Milestone; the applicant must prove progress and commitment to the project.
- ICF = Incentive Claim Form is the step where the applicant, after meeting all SGIP requirements requests payment of the incentive.
- PBI = Performance Based Incentive is the way in which the incentive is paid out over time based on performance of the system.

Other Categories:
- ICF Review
- ICF Inspection
- RRF Technical Review
- RRF Reserved
- PPM Technical Review
- ICF Technical Review

*Data from the California SGIP.
Natural gas is the most-used fuel. However, renewable fuels make up one-third of capacity.
Nearly all CHP systems use natural gas.

**Site Count by Fuel Type***

- **Digester Gas**: 1%
- **Natural Gas**: 99%

**Installed Capacity by Fuel Type**

- **Digester Gas**: 18%
- **Natural Gas**: 82%

**Total Sites**: 71

**Total Capacity**: 8 MW

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*Data from the California SGIP.*
Natural gas systems have a wide range of sizes. Digester systems tend to be the largest.
Natural gas CHP has a few large deployments (large mean, small 25–75 percentiles)
Fuel Cell Stationary Capacity and Average Eligible Costs (All Systems)—Incentive Range $3K–$4K/kW

Eligible costs slightly decrease in larger sizes, yet are far from DOE long-term 2020 targets.
Distribution of Capacity and Eligible Cost (CHP FC Only)

Distribution of Capacity and Average Eligible Cost $2010/kW (CHP Fuel Cell)*

Capacity (kW)

% of systems

$/kW w/o Incentive

$/kW w/ Incentive

2020 DOE Target†

Avg. $/kW

0

2,000

4,000

6,000

8,000

10,000

12,000

0

200

400

600

800

1000

>1000

Economies of scale are better for CHP systems


†for the year 2020, operating on natural gas.

*Data from the California SGIP.
Distribution of Stationary Fuel Cell Install Cost With and Without Incentives

Installed Eligible Cost Per kW*
Adjusted To 2010 Dollars

Average incentives are $3,500/kW historically; fuel cell incentives are now set to decrease 10% per year.
Stationary Fuel Cell Install Cost Over Time With and Without Incentives

Average Eligible Cost $2010/W Trend for Overall Deployments*

Eligible costs are generally **increasing** over time (inflation adjusted), driven by the sub-MW size range


*Data from the California SGIP.
Stationary Fuel Cell Install Cost by Fuel Type With and Without Incentives

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Eligible Costs ($2010/kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass</td>
<td>Avg. Without Incentive: 6000, Avg. With Incentive: 7500</td>
</tr>
<tr>
<td>Digester Gas</td>
<td>Avg. Without Incentive: 4000, Avg. With Incentive: 4750</td>
</tr>
<tr>
<td>Landfill Gas</td>
<td>Avg. Without Incentive: 8000, Avg. With Incentive: 9250</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Avg. Without Incentive: 10000, Avg. With Incentive: 11750</td>
</tr>
</tbody>
</table>

Digester systems have the lowest costs in both mean and 25 percentile.


*Data from the California SGIP.
Deployments are continuing to increase in an era of decreasing incentives

*Data from the California SGIP.*
Average System Size Installed Per Year (kW)

Overall Average Capacity = 471 kW

2013 has seen the third largest average system size

*Data from the California SGIP.*
Rule change in 2011 requiring directed biogas to be in state, and a lack of its availability (it’s all being used already) has led to dominance of natural gas.
Comparing FC to Other Distributed Generation (DG): Distribution of Capacity by Equipment Type

Distribution of Capacity by Equipment Type*

- Fuel Cell CHP
- Fuel Cell Electric
- Gas Turbine
- Internal Combustion
- Microturbine
- Pressure Reduction Turbine

Fuel cells represent about one-third of installed generation capacity in most size bins in SGIP

*Data from the California SGIP.
Comparing FC to Other DG: Average Eligible Cost by Equipment Type

Average Eligible Cost $2010/W Trend for Overall Deployments*

Without Incentives

With Incentives

Without incentives, fuel cells have a cost disadvantage compared to other technologies


*Data from the California SGIP.
Directed biogas systems tend to cost more than onsite sources.

Mean Time Between Stoppage (For Any Reason)

Overall Mean = 2742 hours

*Data from outside the SGIP.
Mean Unit Lifetime Electrical Efficiency (%HHV)

Overall Mean = 27%

Efficiency includes startup, shutdown, transients, and part load

†Includes startup, shutdown, transient and partial power operation

*Data from outside the SGIP.
Mean Unit Lifetime Availability

Unit Mean Availability*

Overall Mean = 93 %

Availability includes stoppages for all reasons, including customer request

*NData from outside the SGIP.
Conclusions

• Stationary fuel cell deployments are accelerating despite decreasing incentives

• Current SGIP incentives make FC systems more competitive with other distributed generation systems

• Lack of available directed biogas in CA has caused new SGIP installations to be natural gas

• Cost curves need to begin going down (not up) to accommodate decreasing incentives

• NREL will continue to update results as new data are available
Acknowledgements

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