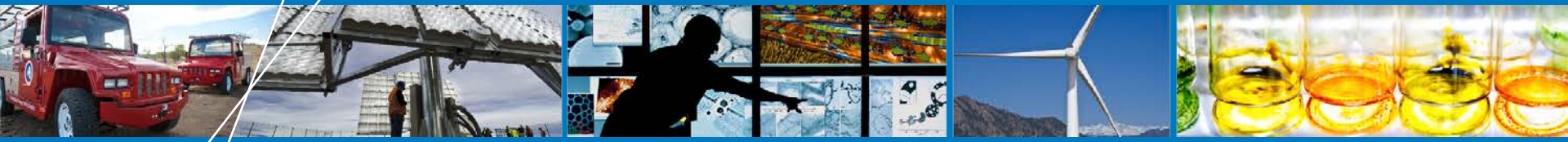
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

National Fuel Cell Technology Evaluation Center



HTAC

October 29, 2013

Jennifer Kurtz

NFCTEC Launch – September 12, 2013

Energy Department Launches National Fuel Cell Technology Evaluation Center to Advance Fuel Cell Technologies

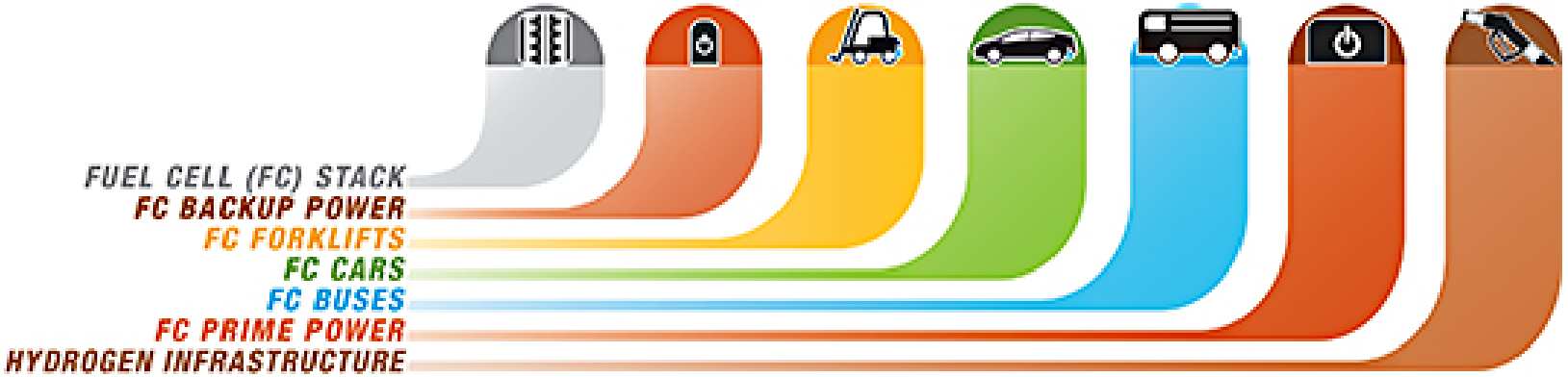
Following Energy Secretary Ernest Moniz's visit to the National Renewable Energy Laboratory (NREL), the Energy Department today announced the unveiling of a one-of-its-kind national secure data center dedicated to the independent analysis of advanced hydrogen and fuel cell technologies at the Energy Department's Energy Systems Integration Facility (ESIF) located at NREL in Golden, Colorado.

The National Fuel Cell Technology Evaluation Center (NFCTEC) allows industry, academia, and government organizations to submit and review data gathered from projects to advance cost-effective fuel cell technology. NFCTEC will also help accelerate the commercialization of fuel cell technologies by strengthening data collection from fuel cell systems and components operating under real-world conditions, and analysis of these detailed data that can be compared to technical targets. The NFCTEC is housed within an ESIF area specifically designed for the secure management, storage, and processing of proprietary data from industry and other stakeholders. Aggregated analysis results that show the status and progress of the technology, but do not identify individual companies, are available to the public.

Source: http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=19607

Rebranding of HSDC to NFCTEC

National Fuel Cell Technology Evaluation Center



a national resource for hydrogen and fuel cell stakeholders

Analysis and Reporting of Real-World Operation Data

Bundled data (operation & maintenance/safety) delivered to NREL quarterly

Internal analysis completed quarterly in NFCTEC

NREL's National Fuel Cell Technology Evaluation Center

Results

DDPs

Confidential

Public

CDPs

Detailed Data Products (DDPs)

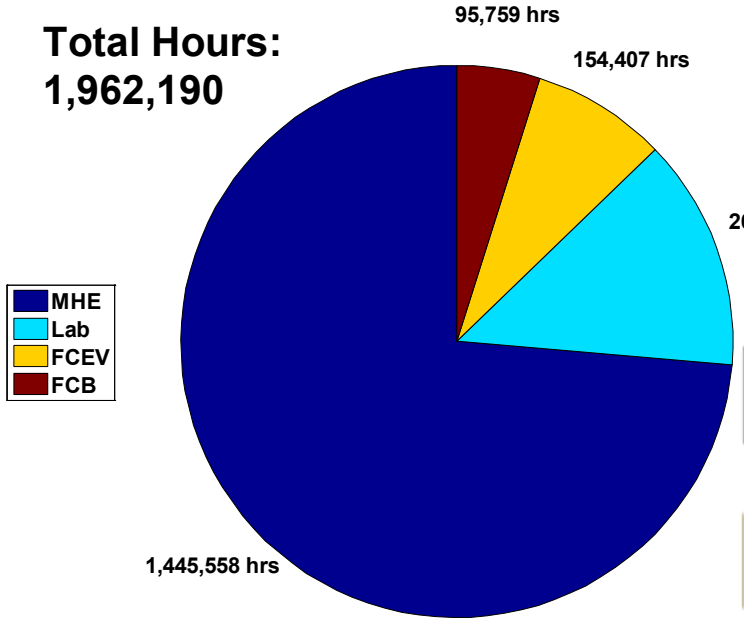
- Individual data analyses
- Identify individual contribution to CDPs
- Shared every six months only with the partner who supplied the data[1]

Composite Data Products (CDPs)

- Aggregated data across multiple systems, sites, and teams
- Publish analysis results every six months without revealing proprietary data[2]

http://www.nrel.gov/hydrogen/proj_learning_demo.html

Leveraging Data Process and Analysis Capabilities Across Technology Validation Projects



PRIME POWER

BACKUP POWER

STACK

FORKLIFTS

INFRASTRUCTURE

CARS

BUSES

Project Renewing

Prehistory...2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013

Published performance reports

Fuel Cell Electric Bus Evaluation

Three types of fuel cell dominant, FCEBs at three transit sites:

- AC Transit, Oakland, CA
  - 40-foot Van Hool buses with ClearEdge Power* FC (ZEBA)
- CTTRANSIT, Hartford, CT
  - 40-foot Van Hool buses with ClearEdge Power FC (Nutmeg)
- SunLine, Thousand Palms, CA
  - 40-foot New Flyer bus with Ballard FC and Bluways hybrid system (AT)
  - 40-foot ElDorado bus with Ballard FC and BAE Systems Hybrid drive (AFCB)

ACT ZEBA

CTT Nutmeg

SL AT

SL AFCB

*Formerly UTC Power

Fuel Cell Electric Vehicle Evaluation

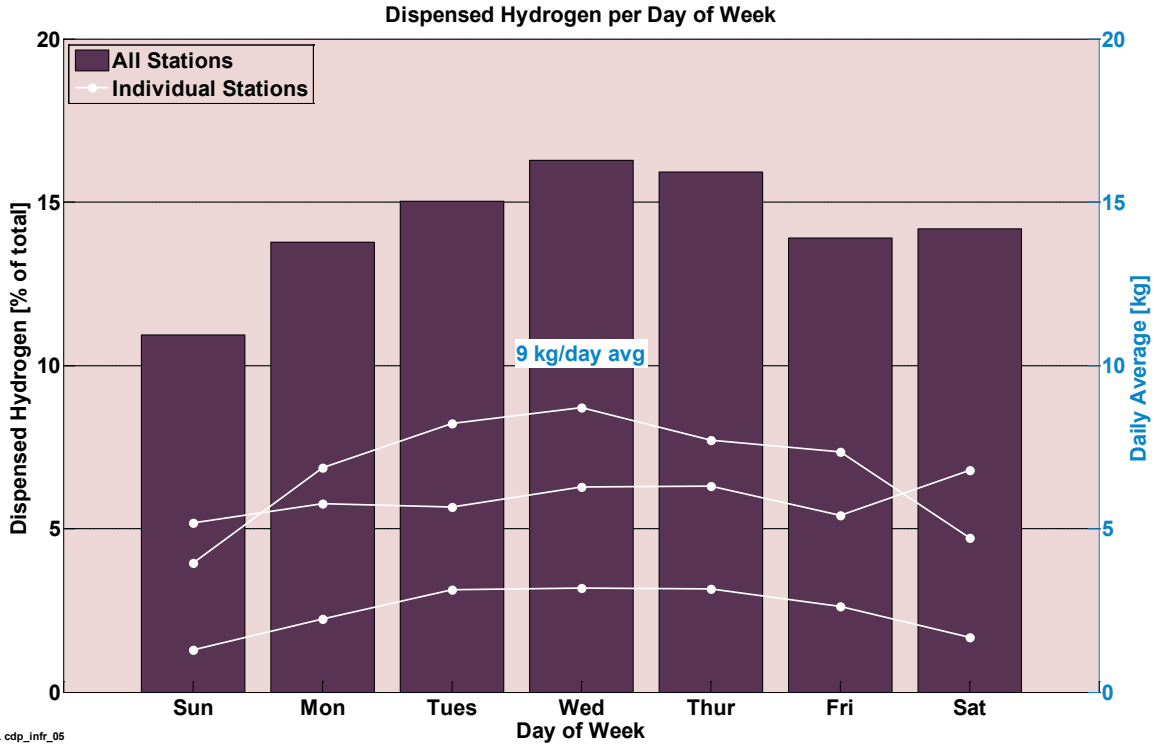
CARS

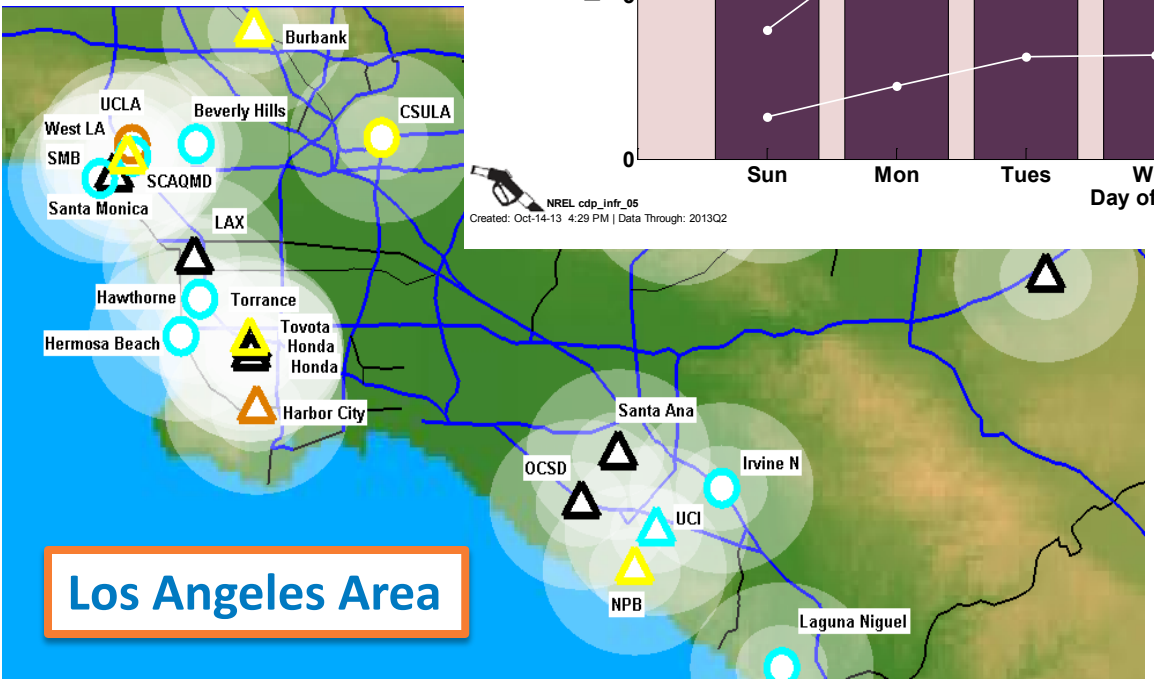
Objectively assess progress toward targets and market needs

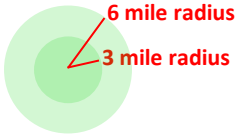
Key Targets		
Performance Measure	**Status***	**Ultimate (2020)**
Fuel Cell Stack Durability	2,500 hours	5,000 hours
Vehicle Range	254+ miles	300+ miles
Fill Rate	0.77 kg/min	1.0 kg/min
Efficiency	59% at 25% Power	60% at 25% Power

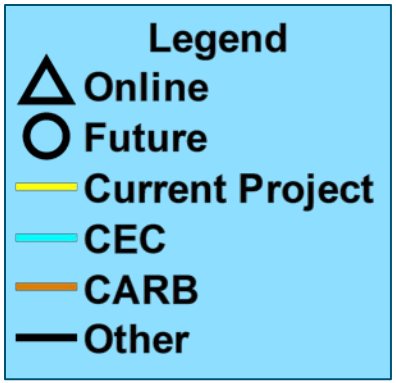
*As reported in previous Learning Demonstration results

Infrastructure Evaluation

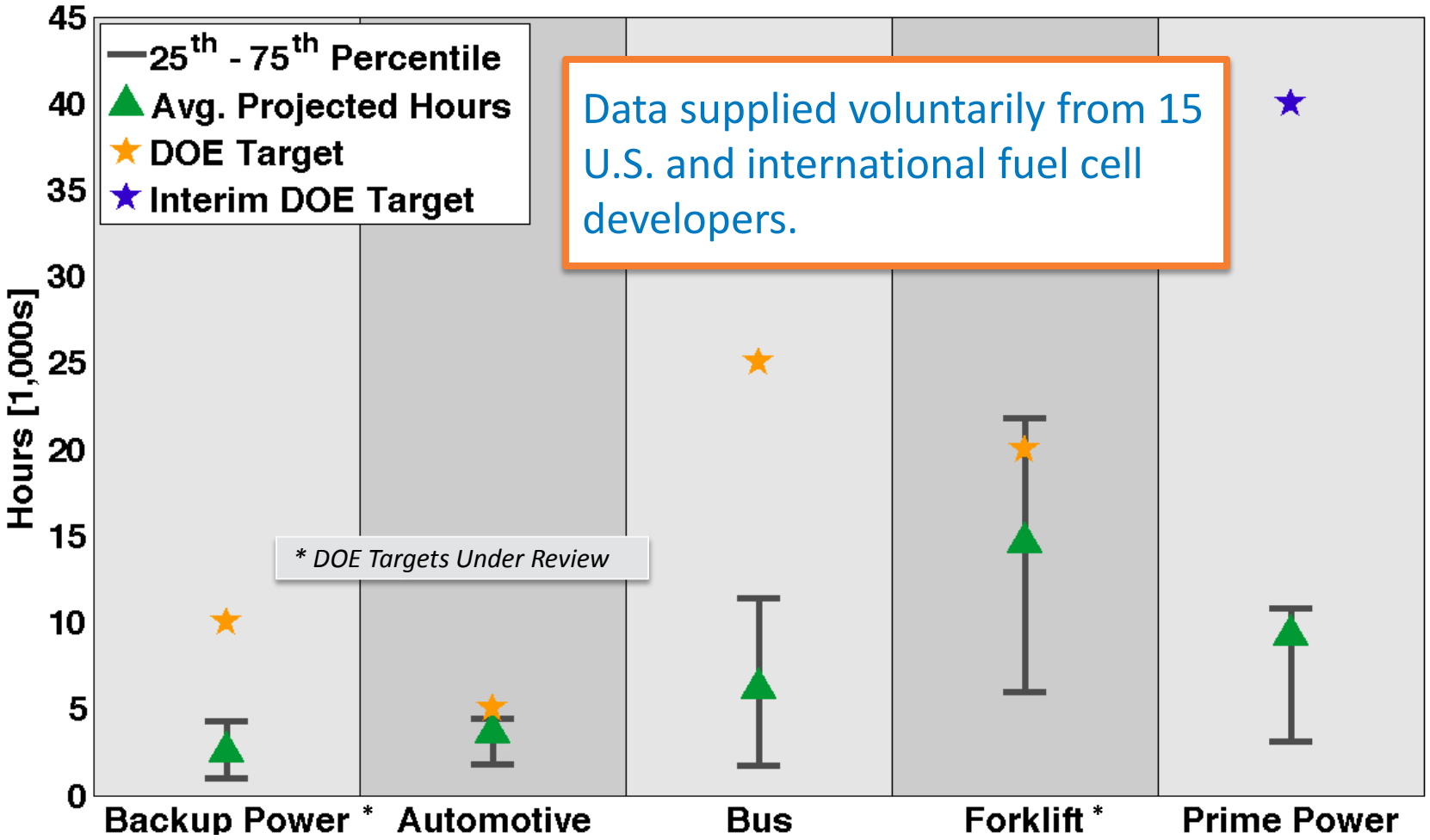








Fuel Cell Technology Status



Data supplied voluntarily from 15 U.S. and international fuel cell developers.

Fuel Cell Material Handling Evaluation

FORKLIFTS

Validation of MHE is based on real-world operation data from high-use facilities

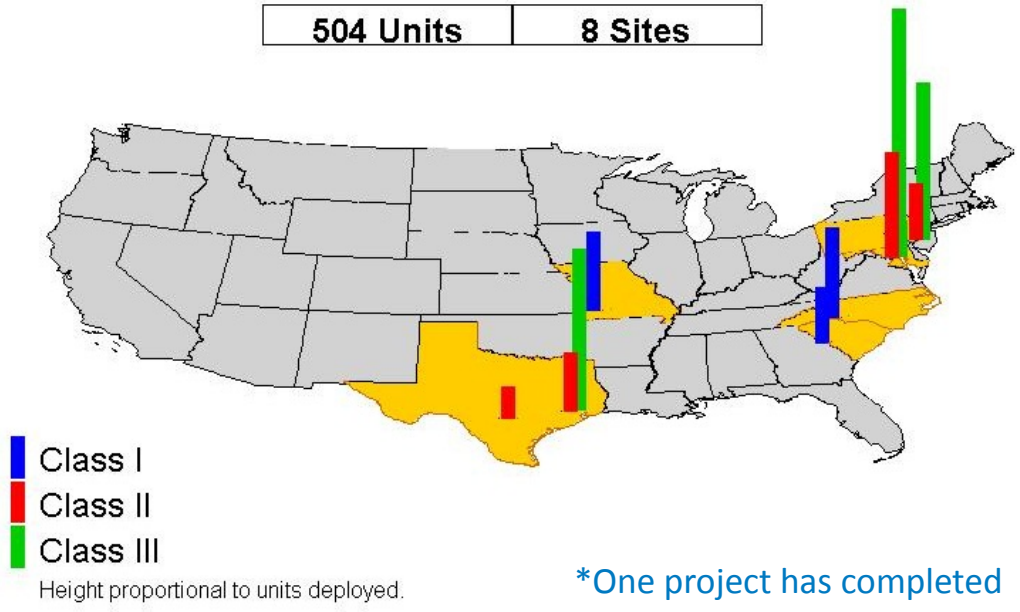
1,859,616
Operation hours

291,114
Hydrogen fills

490
Units in operation*

4.4
Average operation hours between fills

232,551
Hydrogen dispensed in kg

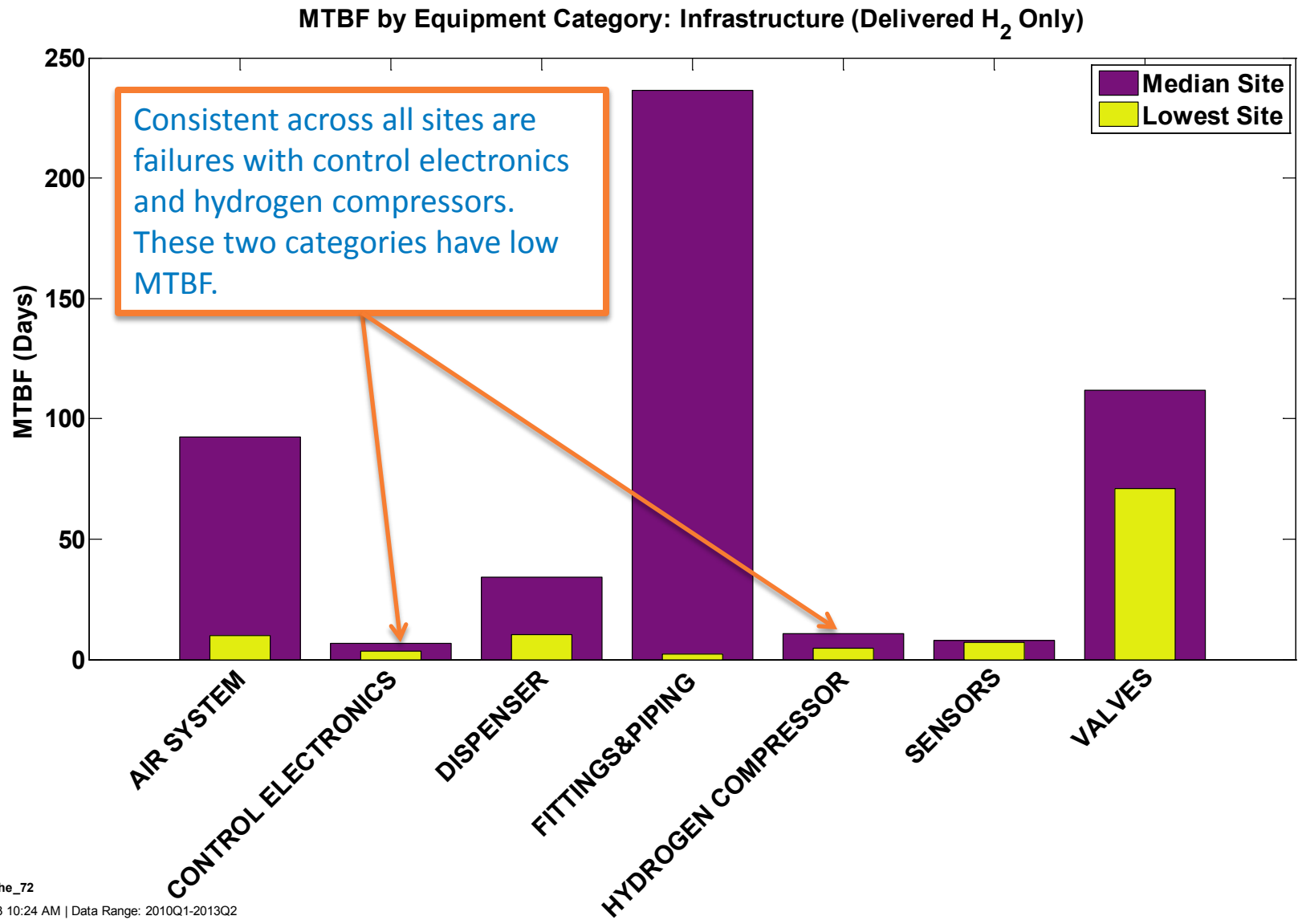


0.6
Average fill amount in kg

2.3
Average fill time in minutes

*One project has completed

Breakdown of MTBF by Key Delivered Hydrogen Infrastructure Categories



NREL cdparra_mhe_72

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Fuel Cell Backup Power Evaluation

BACKUP POWER

1.94
Installed capacity in MW

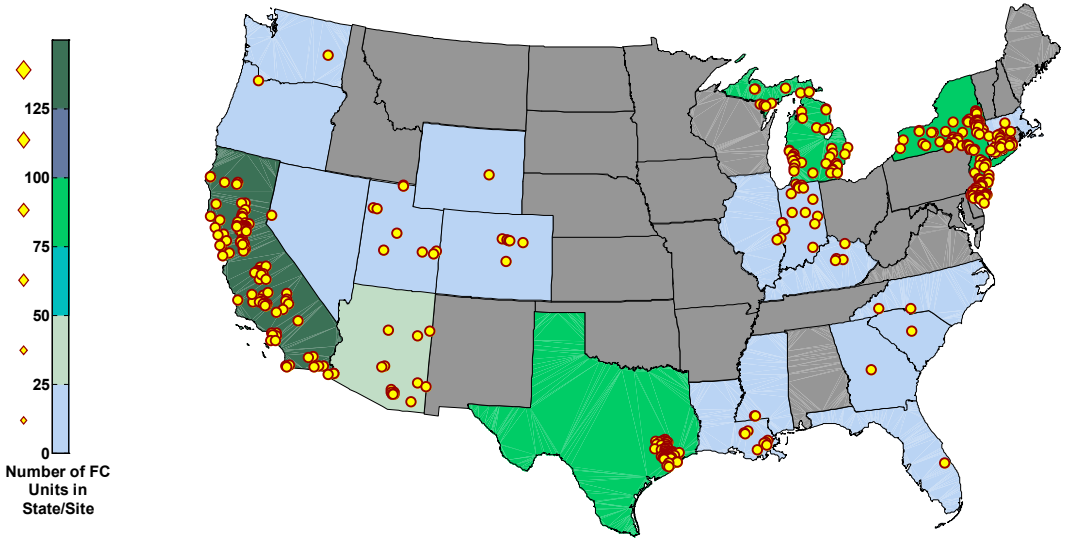
Systems are operating reliably in 23 states. Reasons for unsuccessful starts include an e-stop signal, no fuel, and other system failures.

99.7%
Successful starts

842
Systems in operation*

4–6
Average site capacity in kW

2,579
Start attempts



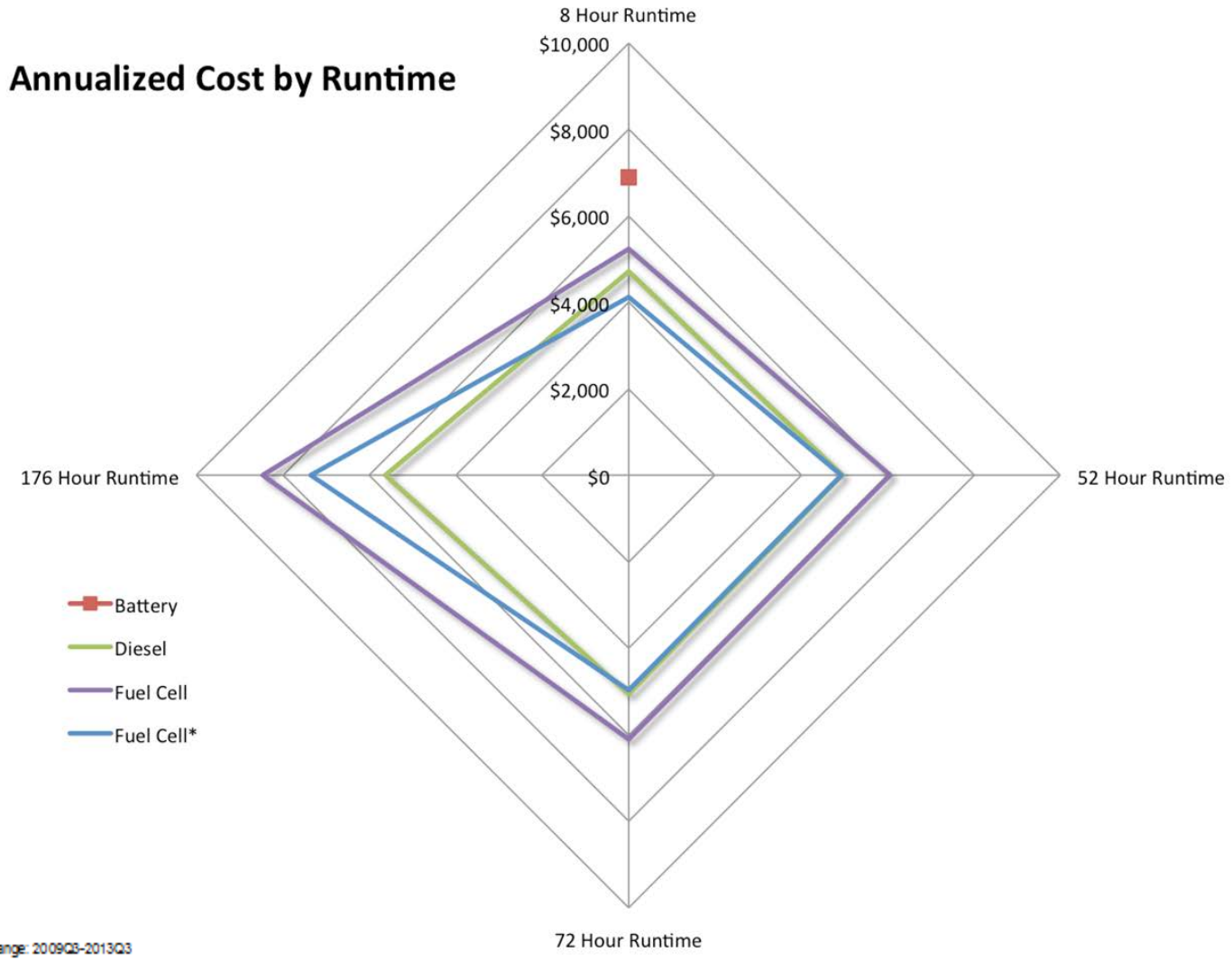
65
Continuous run hours demonstrated

1,683
Operation hours

*Not all systems have detailed data reporting to NREL

FCBP Annualized Cost by Runtime

BACKUP POWER



NREL cdp_bu
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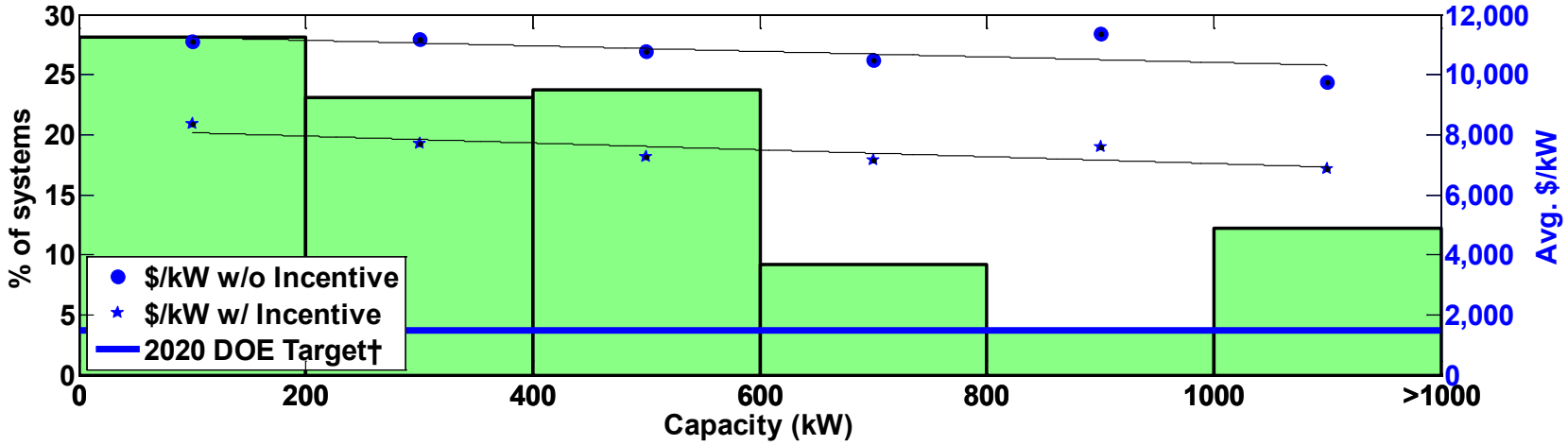
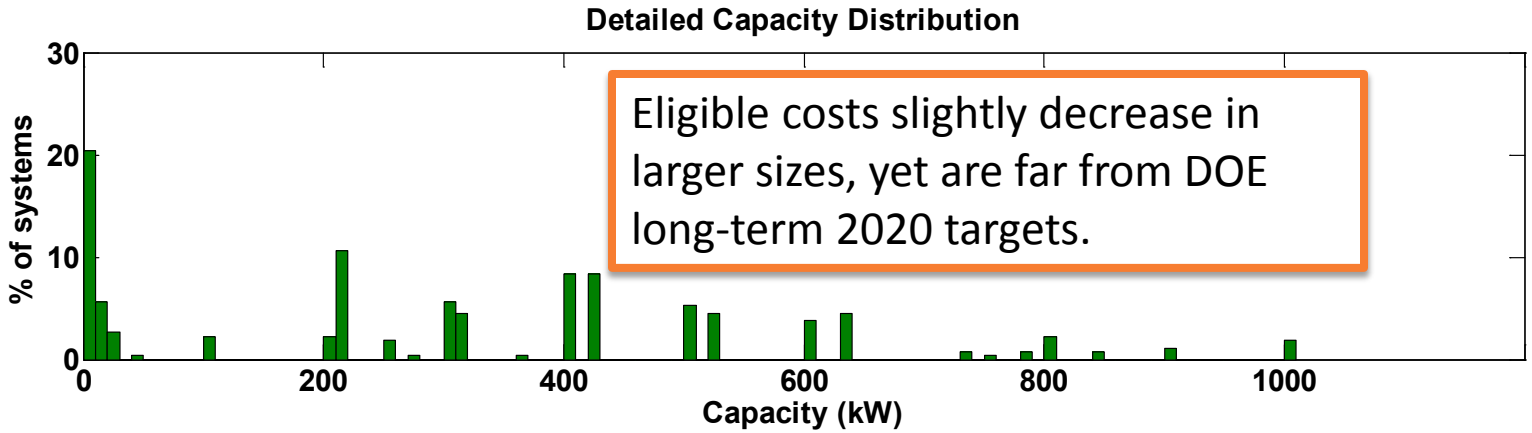
Fuel Cell Prime Stationary Power Evaluation

Fuel Cell Stationary Capacity and Average Eligible Costs
Incentive Range $3K-$4K/kW





Eligible costs slightly decrease in larger sizes, yet are far from DOE long-term 2020 targets.

Eligible Costs May Include: Planning & Feasibility Study, Engineering & Design, Permitting, Self-Generation Equipment Waste Heat Recovery Costs, Construction & Installation Costs, Gas & Electric Interconnection, Warranty, Maintenance Contract Metering, Monitoring & Data Acquisition System, Emission Control Equipment Capital Gasline Installation, Fuel Gas Clean-up Equipment, Electricity Storage Devices, Bond to Certify Renewable Fuel Sales Tax, Fuel Supply (digesters, gas gathering, etc.), Thermal Load, & Other Eligible Costs

†for the year 2020, operating on natural gas.
*Data from the California SGIP.

NREL cdp_stat_06
Created: Sep-27-13 11:23 AM | Data Range: 2001Q2-2013Q2

NREL Technology Validation

Objective: Independent validation of fuel cell and hydrogen technologies in real-world operation providing status, trends, and gaps to key stakeholders.

FCEV Durability

- Generation 1 Fuel Cell Durability Projection (Max Fleet) 1,807 hours
- Generation 2 Fuel Cell Durability Projection (Max Fleet) 2,521 hours
- Next generation evaluation starting

Infrastructure Reliability

- Poor MTBF for infrastructure stations
- Identification of key maintenance categories (e.g. compressors)
- Accelerated life testing for failure mode identification of hydrogen compressors

Cost of Ownership

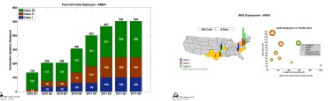
- Value proposition analysis (e.g. fill time < 2.5 mins)
- Comparison with incumbent technologies
- Annual cost savings of ~2,000 per Class I/II fuel cell lift

Results published via NREL technology validation website (http://www.nrel.gov/hydrogen/proj_learning_demo.html)

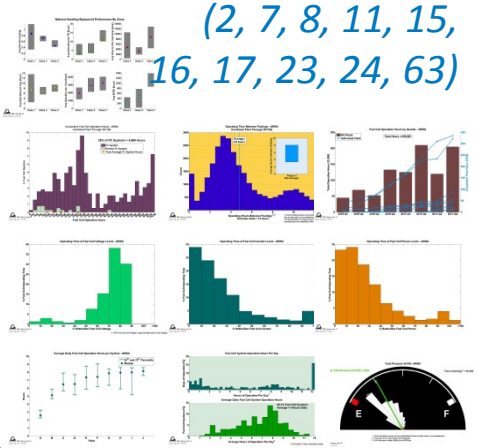
74 MHE CDPs—Count and Category

FORKLIFTS

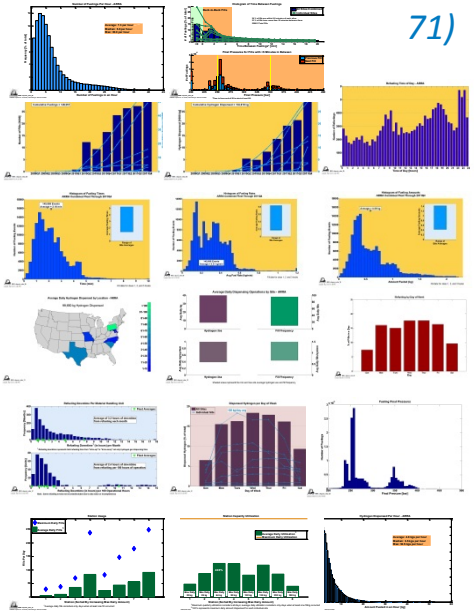
Deployment & Site Overview *(1, 40)*



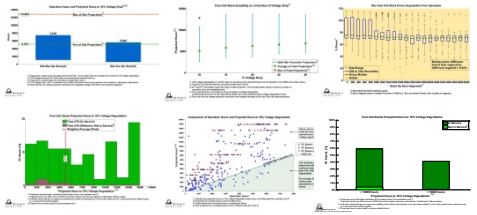
Fuel Cell Operation *(2, 7, 8, 11, 15, 16, 17, 23, 24, 63)*



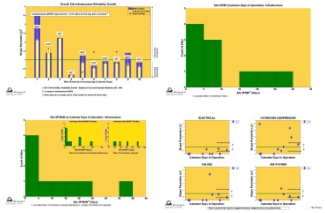
Infra. Operation *(3, 4, 5, 6, 9, 10, 21, 22, 35, 37, 42, 62, 65, 68, 69, 70, 71)*



Fuel Cell Durability *(32, 33, 34, 38, 39, 73)*

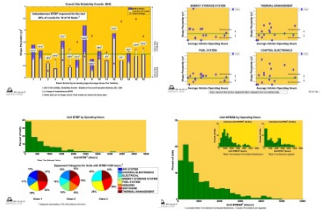


Infra. Reliability *(45, 48, 49, 50)*

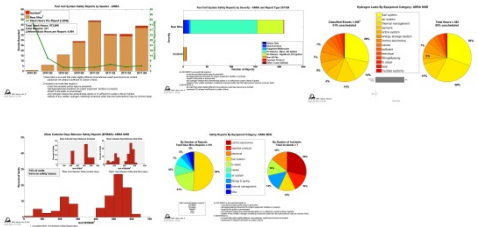


FC Maintenance *(12, 13, 14, 43, 54, 61)*

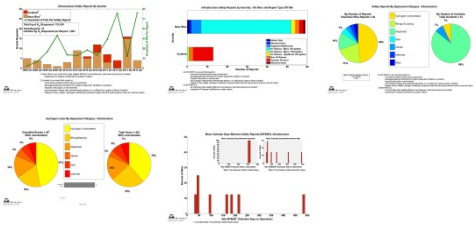
Fuel Cell Reliability *(28, 29, 30, 31)*



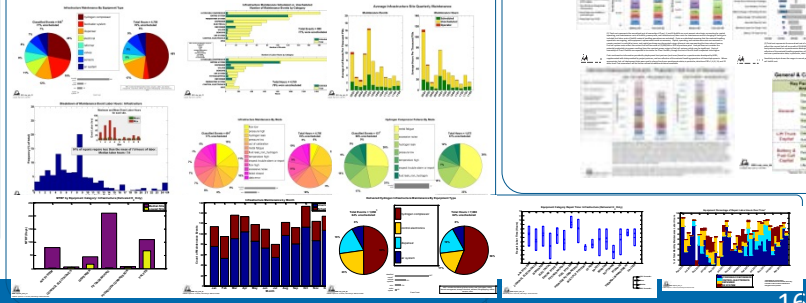
Fuel Cell Safety *(26, 27, 53, 56, 57)*



Infra. Safety *(25, 41, 46, 51, 55)*



Infra. Maintenance *(18, 19, 20, 44, 47, 52, 66, 67, 72,76,77)*



Cost of Ownership *(58, 59, 60,64)*

NFCTEC

- Independent, secure analysis
- Industry collaboration
- Confirmation of component and system technical targets
- Technology validation
- Evaluation, optimization, and demonstration in integrated energy systems and real-world operation

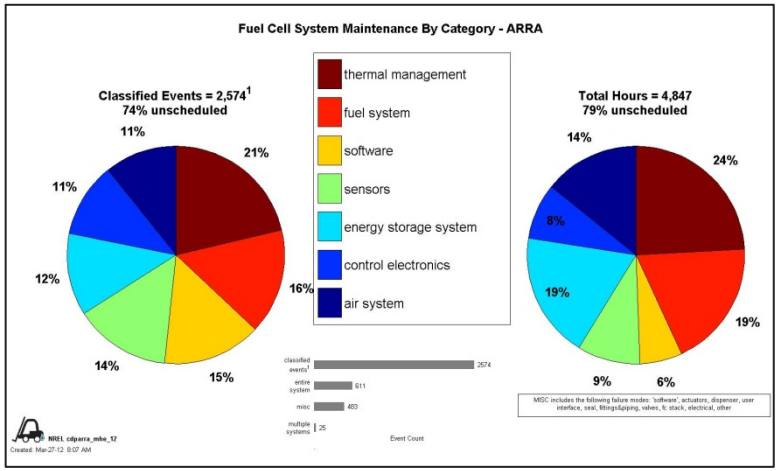


Photo by Dennis Schroeder, NREL
Figures and illustrations: NREL