


<b>DOE Hydrogen and Fuel Cells Program Record</b>		
<b>Record #:</b> 16012	<b>Date:</b> 05/27/2016	
<b>Title:</b> Industry Deployed Fuel Cell-Powered Lift Trucks		
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**Item:**

Table 1: Number of fuel cell deployments (shipped and on-order) for applications in material handling equipment (MHE).

	<b>DOE-Funded<sup>1</sup> (ARRA) as of Record Date</b>	<b>DOE-Funded<sup>2-4</sup> (Appropriations) as of Record Date</b>	<b>DOE Total</b>	<b>Industry-Funded Fuel Cell Shipments and Units on Order (U.S.)<sup>2-9, 13-21</sup> from 2009 – Record Date</b>	<b>DOE and Industry Total from 2009 – Record Date</b>
<b>Number of MHE Deployments (current and planned)</b>	524	189	713	11,022	11,715

The successful deployment of more than 700 MHE fuel cell units with U.S. Department of Energy (DOE) funds has led to more than 11,000 MHE fuel cell shipments and units on order with no DOE funding. The 11,715 MHE fuel cell shipments and units on order equate to more than 76,000 kW of fuel cell systems.<sup>i</sup>

**Data/Assumptions/Calculations:**

Total DOE American Recovery and Reinvestment Act (ARRA) investment for these fuel cell-powered lift trucks is about \$9.7M, with an industry cost share of \$11.8M.<sup>ii</sup> The DOE Fuel Cell

<sup>i</sup> Estimated total kW of fuel cell systems deployed assumes a capacity of 6.5 kW for each MHE unit. This is the average of 3 kW and 10 kW system sizes based on [NREL analysis](#) indicating that the distribution of MHE units is evenly split between Type I/II (10 kW) and Type III (3 kW) units. Information on system sizes is supported by the NREL report, *An Evaluation of the Total Cost of Ownership of Fuel Cell-Powered Material Handling Equipment*: <http://www.nrel.gov/docs/fy13osti/56408.pdf>

<sup>ii</sup> ARRA funding supported deployments in MHE for: FedEx Freight East; GENCO with deployments at Coca-Cola, Kimberly Clark, Sysco Philadelphia, Wegmans, and Whole Foods Market; and Nuvera Fuel Cells with deployments at H-E-B Grocery. Funds included units as well as other aspects of the projects such as infrastructure, training, installation, data collection, analysis, and reporting.

Technologies Office (FCTO) has estimated that the more than 700 fuel cell-powered lift trucks deployed with DOE cost-share led to more than 11,000 orders/deployments with no DOE funding. As industry continues to place orders and deploy units, DOE will revise its records and determine actual orders filled/units commissioned as a result of initial DOE funding (Market Transformation and ARRA projects).

The manufacturers providing the fuel cells for the deployments (installed and on order) mentioned in Table 1 are:

Hydrogenics	Plug Power, Inc.
Hyster-Yale/Nuvera Fuel Cells	Toyota Industries
Oorja Protonics	

In 2011, Plug Power announced the next generation of its GenDrive fuel cell products for electric lift trucks and committed to purchase a minimum of 3,250 fuel cell stacks by the end of 2011 from Ballard Power Systems.<sup>10</sup> Plug Power also announced its intent to partner with Axane, an Air Liquide subsidiary, to better penetrate the European forklift market, which the company estimates to include an installed base of 2,000,000 forklifts and 325,000 annual unit sales.<sup>11</sup>

In January of 2014, Plug Power launched its latest hydrogen fuel cell product, GenKey, the company's first all-inclusive product for material handling sites. GenKey consists of three separate elements: GenDrive fuel cell units, GenFuel hydrogen fuel and infrastructure, and GenCare maintenance service. By providing full integration and deployment of the entire GenKey package, this new offering ensures a seamless transition to hydrogen fuel cell-based power for material handling operations.<sup>12</sup>

In December 2014, Hyster-Yale acquired Nuvera Fuel Cells and announced plans for a ground-up fuel cell MHE product. This acquisition creates a unique capability to integrate fuel cells with MHE units in order to optimize performance and energy efficiency of the combined system.<sup>18</sup> Deliveries are expected by mid-2016 and will be reflected in future records.

As of May 2016, examples of companies that have purchased or ordered fuel cell-powered lift trucks are as follows:

Ace Hardware	Golden State Foods	Stihl
Baldor Specialty Foods	IKEA	Sysco Foods
BMW Manufacturing Co.	Kimberly-Clark/GENCO	Testa Produce
Bridgestone-Firestone	Kroger Co.	Unified Grocers
Central Grocers	Lowe's	United Natural Foods, Inc. (UNFI)
Coca-Cola	Martin Brower	U.S. Foods

CVS	Mercedes	Walmart
EARP Distribution	Nestlé Waters	Wegmans
East Penn Manufacturing	Nissan North America	Whole Foods Market
FedEx Freight	Procter & Gamble	WinCo Foods, LLC

Fuel cell forklift deployments have begun in foreign markets. In February 2015, the Kansai International Airport in Japan announced it will start replacing its fleet of 400 forklifts with hydrogen fuel-cell models as part of efforts to reduce carbon dioxide emissions. These fuel cell forklifts will be manufactured by Toyota Industries Corporation.<sup>19</sup> Plug Power announced in October 2015 its first European full-site deployment of 35 units at a Prelodis distribution center in Saint-Cyr-en-Val near Orleans, France.<sup>20</sup>

Based on original equipment manufacturer (OEM) feedback, it was determined that their purchase orders for deployments were considered either directly or indirectly due to results of the DOE FCTO. This includes both Market Transformation and ARRA deployment funding. In some instances, companies increased the number of purchases beyond those with DOE funds assistance. In other instances, the OEMs were able to show the business case using data collected from DOE projects and obtained purchase orders with no DOE funding. The list only includes deployments that can be traced to DOE FCTO involvement.

**Peer Review:** This record was reviewed by outside experts at the National Renewable Energy Laboratory (Jen Kurtz) and Fuel Cell and Hydrogen Energy Association (Jen Gangi).

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