


DOE Hydrogen and Fuel Cells Program Record		
Record #: 17003	Date: 4/30/2017	
Title: 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).

	DOE Funded¹ (ARRA) as of Record Date	DOE Funded²⁻⁴ (Appropriations) as of Record Date	DOE Total	Industry-Funded Fuel Cell Shipments and Units On Order (U.S.)^{2-9, 13-21} from 2009 – Record Date	DOE and Industry Total from 2009 – Record Date
Number of MHE Deployments (current and planned)	524	189	713	15,805	16,518

The successful deployment of more than 700 MHE fuel cell units with U.S. Department of Energy (DOE) funds has led to more than 15,800 MHE fuel cell shipments and units on order with no DOE funding. The 16,518 MHE fuel cell shipments and units on order equate to more than 105,000 kW of fuel cell systems.ⁱ

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.ⁱⁱ The DOE Fuel Cell Technologies Office (FCTO) has estimated that the more than 700 fuel cell powered lift trucks

ⁱ 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>

ⁱⁱ 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.

deployed with DOE cost-share led to more than 15,800 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	Toshiba
Hyster-Yale/Nuvera Fuel Cells	Toyota Industries
Plug Power, Inc.	

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.¹⁰ 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.¹¹

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.¹²

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.¹⁸ Nuvera began shipping its fuel cell MHE to customers in mid-2016.

As of March 2017, 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	Lowes	United Natural Foods, Inc. (UNFI)
Coca-Cola	Martin-Brower	U.S. Foodservice

CVS	Mercedes	Walmart
EARP Distribution	Nestle Waters	Wegmans
East Penn Manufacturing	Nissan North America	Whole Foods Market
FedEx Freight	Proctor and Gamble	WinCo Foods, LLC

Fuel cell forklift deployments are growing 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.¹⁹ 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.²⁰

In July 2016, Carrefour, Europe's largest retailer and the second largest retailer in the world behind Wal-Mart, will buy more than 150 fuel cell units from Plug Power for its distribution center outside of Paris.²² In November 2016, Toshiba announced its Fuchu Complex in western Tokyo will be using fuel-cell powered forklifts, based on its new H2One hydrogen power system and developed at its new Hydrogen Application Center.²³ In January 2017, Toyota announced its plans to replace existing lead acid battery forklifts with fuel-cell powered forklifts at its Motomachi plant, beginning with two units in 2017 and eventually reaching a goal of 170–180 units by 2020.²⁴ These fuel cell forklifts will be manufactured by Toyota Industries Corporation. In March 2017, the Canadian Tire Corporation announced it has selected Nuvera's fuel cell systems to replace lead acid battery power systems in two distribution centers in Ontario, Canada.²⁵

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.

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