

# GENCO Fuel Cell Powered Lift Truck Fleet Deployment

Principal Investigator: Jim Klingler  
Presenter: Robert Simon

GENCO Infrastructure Solutions, Inc.  
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Project ID: H2RA011

## Project Overview

### ■ Timeline

Start: October 1, 2009

Finish: September 30, 2013

56% complete (December 31, 2011)

### ■ Budget

- Total project funding
  - DOE share: \$6,057,106
  - Cost share: \$6,057,106
- FY 2009 DOE funding: \$3,231
- FY 2010 DOE funding: \$4,496,674
- FY 2011 DOE funding: \$1,506,551
- FY 2012 DOE funding: \$ 50,650

### ■ Barriers

- Represents a change in technology, which is met with reluctance
- Uncertain power unit reliability due to lack of widespread performance data
- Safety and expense of hydrogen and fueling equipment
- Difficult to obtain permits and approvals for hydrogen fueling stations

### ■ Partners

- Plug Power – GenDrive® power unit and service provider
- Air Products – Hydrogen supplier
- Linde – Hydrogen supplier

# Relevance

## OBJECTIVES

- Support American Recovery and Reinvestment Act goals of long-term economic growth by successfully demonstrating a new technology
- Promoting the economic and environmental benefits of hydrogen fuel cell technology

## TACTICS

- Demonstrate the economic benefits of large fleet conversions of lift trucks from batteries to fuel cell power units by measuring, analyzing and reporting on the performance, operability and safety of the systems that will spur further fuel cell lift truck fleet conversions
- Convert electric-drive fork lift truck fleets to fuel cell use in five large distribution centers and manufacturing facilities
- Provide affordable and reliable hydrogen
- Establish a proving ground for hydrogen fueling technology that will promote the future adoption of fuel cells in other applications, such as cars, and help drive the use of fuel cell technology in the United States

## Approach

### OBJECTIVE

Develop a track record by installing 357 GenDrive power units at five commercial distribution and manufacturing centers

	<b>Wegmans</b>	<b>Whole Foods</b>	<b>Coca-Cola</b>	<b>Sysco Phil.</b>	<b>Kimberly-Clark</b>	<b>TOTAL</b>
<b>Class 1 GenDrive</b>	0	45	40	0	25	<b>110</b>
<b>Class 2 GenDrive</b>	36	14	0	25	0	<b>75</b>
<b>Class 3 GenDrive</b>	100	2	0	70	0	<b>172</b>
<b>TOTAL</b>	<b>136</b>	<b>61</b>	<b>40</b>	<b>95</b>	<b>25</b>	<b>357</b>
<b>Hydrogen Supplier</b>	Air Products	Linde	Linde	Air Products	Air Products	



## Approach

### Critical Path Toward Lift Truck Fleet Conversions

- **Build GenDrive Power Units**
  - Complete the construction of GenDrive fuel cell power units
- **Obtain National Environmental Policy Act (NEPA) Approvals**
- **Install Fueling Stations**
  - Install hydrogen handling and dispensing equipment consistent with merchant liquid hydrogen supply
- **Commission Equipment and Train Personnel**
  - Commission and start up the fueling station and GenDrive power units and train site personnel in their use and maintenance
- **Operate Distribution Centers**
  - Provide operational and maintenance support for the power units and the hydrogen handling and dispensing equipment and evaluate their performance over the duration of the project

## Approach

### Project Milestones (at December 31, 2011)

	Wegmans	Whole Foods	Coca-Cola	Sysco Phil.	Kimberly-Clark
<b>Fueling Station Operational</b>	Completed	Completed	Completed	Completed	Completed
▶ <b>GO/NO GO</b>	GO	GO	GO	GO	GO
<b>GenDrive Power Units Delivered</b>	136 of 136	61 of 61	40 of 40	95 of 95	25 of 25
▶ <b>GO/NO GO</b>	GO	GO	GO	GO	GO
<b>Distribution Center Fully Operational</b>	Completed	Completed	Completed	Completed	Completed
<b>Project Complete</b>	9/30/2013	9/30/2013	9/30/2013	9/30/2013	9/30/2013



## Accomplishments and Progress

### WEGMANS

- Department of Energy (DOE) contract signed in January 2010
- Fueling stations in the produce building completed
- 2 new fueling stations in the grocery building and a second compressor completed
- 100 class-3 power units and 36 class-2 power units operating
- Data cable connector failures resulted in temporary loss of some operational data. Connectors have been replaced with sturdier parts on Wegmans power units and will be replaced on all power units at other sites in 2012.

### SYSCO PHILADELPHIA

- Fueling station completed
- 70 class-3 power units and 25 class-2 power units operating
- Start-up and training completed

## Accomplishments and Progress

### COCA-COLA

- Fueling station completed
- 40 class-1 power units operating
- Start-up and training completed

### KIMBLERY-CLARK

- Fueling station completed
- 25 class-1 power units operating
- Start-up and training completed

### WHOLE FOODS

- Fueling station completed
- 45 class-3, 14 “order picker” (modified class-2), and 2 class-2 power units operating
- Start-up and training completed

## Operational Data

(at December 31, 2011)

	Wegmans	Whole Foods	Coca-Cola	Sysco Phil.	Kimberly-Clark
Average operating hours per unit	4,050	3,000	n/a	n/a	n/a
Total operating hours	550,000	183,400	n/a	n/a	n/a
Total hydrogen dispensed (kg)	41,765	11,983	8,266	9,186,	14,137
Average hydrogen dispensed per fill (kg)	n/a	0.85	1.16	n/a	n/a

Note: Some operational data not available at this time due to problems with data collection equipment

## Technical Accomplishments – Fuel Cells



### GenDrive Class-1

**Nominal voltage**

36 – 48 Vdc

**Max. Continuous Power**

8.7 - 10.1 kW

**Weight**

2,260 – 4,000 lbs

**Operating Temperature**

-25 F – 104 F

**Fill Time**

180 seconds



### GenDrive Class-2

**Nominal voltage**

36 Vdc

**Max. Continuous Power**

10.5 kW

**Weight**

2,600 lbs

**Operating Temperature**

-22 F – 104 F

**Fill Time**

70 seconds



### GenDrive Class-3

**Nominal voltage**

24 Vdc

**Max. Continuous Power**

2.6 kW

**Weight**

590 lbs

**Operating Temperature**

-22 F – 104 F

**Fill Time**

60 seconds

## Technical Accomplishments – H2

### Air Products

- **Wegmans:** First and second phases of the fueling station completed, not part of DOE scope of work
- **Sysco Foods:** Fueling station completed
- **Kimberly-Clark:** Fueling station completed

### Linde

- **Coca-Cola:** Fueling station completed
- **Whole Foods:** Fueling station completed



## Collaborations

### ■ Partners

- Plug Power (Industry) – GenDrive power unit and service provider
- Air Products (Industry) – Hydrogen supplier
  - Wegmans (not part of DOE scope of work)
  - Sysco Foods Philadelphia
  - Kimberly-Clark
- Linde (Industry) – Hydrogen supplier
  - Coca Cola
  - Whole Foods (not part of DOE scope of work)

### ■ Technology Transfer

- Collaboration with Plug Power for commissioning of GenDrive power units and service
- Collaboration with Air Products and Linde for installation of hydrogen fueling systems

## Future Work

- Continue monitoring the performance, reliability and safety of power units and fueling equipment at all sites



## Summary

- Relevance:** Develop safe hydrogen material handling operations to demonstrate economic benefits and spur future distribution and manufacturing center conversions
- Approach:** Install Air Products or Linde hydrogen fueling stations at each site, deliver Plug Power GenDrive power units and evaluate operation
- Accomplishments:** All GenDrive power units and fueling stations operational at all sites
- Technology Transfer/Collaborations:** Plug Power, Air Products and Linde
- Future Work:** Continue monitoring the performance, reliability and safety of power units and fueling equipment at all sites