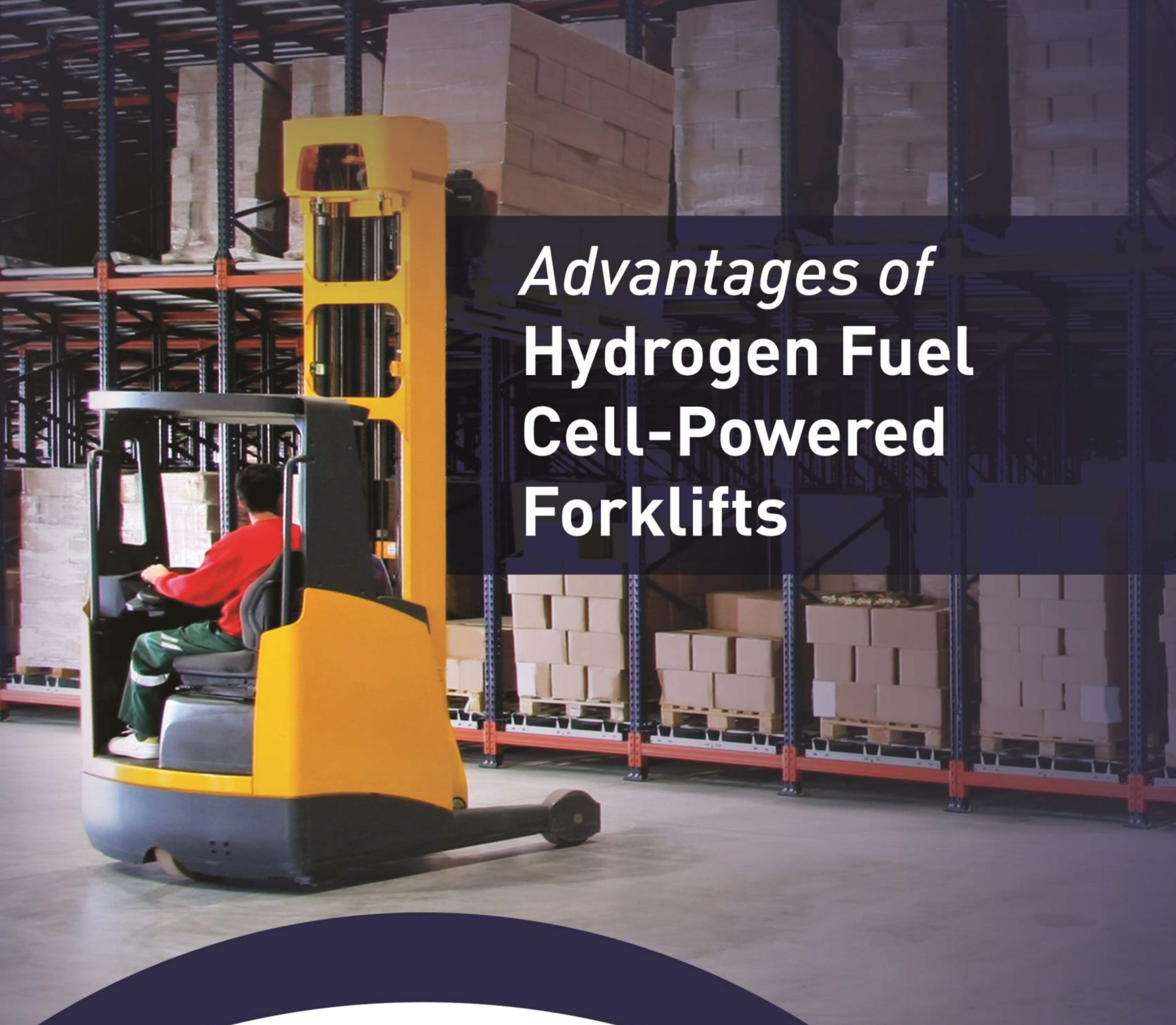

Advantages of Hydrogen Fuel Cell-Powered Forklifts

HandyTube
A STEEL PARTNERS COMPANY

This white paper will discuss the many advantages of converting material handling equipment from batteries to hydrogen fuel cells. Hydrogen fuel cell technology has been slow to gain adoption in the United States, but there is clear data now that the movement is gaining strong momentum. In the realm of material handling equipment in manufacturing, warehousing and distribution businesses, using this technology versus traditional batteries for a fleet of lift trucks shows great promise for gaining operating efficiencies and cost savings.

Powerhouses like Walmart, BMW and Coca-Cola have become early adopters of the technology, so other corporations are taking notice. Such large facilities depend on fleets of lift trucks to keep operations going around the clock. To remain competitive, these companies must operate efficiently, and hydrogen fuel cell technology offers an opportunity.

Fleet Battery Usage in Context

Equipment that utilizes hydrogen fuel cell technology is proving to be less costly in terms of manpower, warehouse space and battery disposal.

A standard battery must be replaced once its charge runs out, typically twice per eight-hour shift. So, each lift truck usually has a dedicated backup battery at a charging station located within the warehouse. Depending on travel time to and from the charging station, battery replacement could create 30 minutes of downtime per operator. By contrast, fuel-cell powered forklifts only need to be refueled once per eight-hour shift and can be refueled in less than five minutes.

Warehouses operating hundreds of lift trucks must have massive charging stations, which rob the company of valuable floor space. Switching to hydrogen eliminates the need for battery charging stations, freeing up space for revenue-generating activities and allowing this space to be used more productively.

Finally, batteries have serious issues with power degradation over time and disposing of them poses environmental and storage challenges until the batteries can be properly discarded or recycled.

By converting battery-powered fleets to hydrogen fuel cell technology, fleet managers can harness significant productivity gains while seeing economic benefits. In addition, numerous case studies illustrate that businesses can realize significant ROI from forklift fleet conversion to fuel cells.

Hydrogen Supply

As popularity for hydrogen fuel cell technology grows, key providers in the supply chain are ramping up to service the needs of this expanding segment. In particular, the industrial gas suppliers are expanding their offerings to include turnkey fueling solutions focused around the needs of the material handling industry.

Pilot hydrogen supply solutions are available to make it easy and cost effective to evaluate fuel cell technology at a facility. Once the ROI is demonstrated, permanent fuel cell solutions can be implemented into the material handling fleet.

For low-volume requirements, hydrogen supply is available via tube trailer. For higher volume users, hydrogen can be delivered to the site and transferred into the operations holding vessels. In areas where availability or delivery of industrial hydrogen is limited, on-site generation using natural gas reforming (the process of converting natural gas into hydrogen using thermal processes), can provide a viable alternative for end users.

As part of its cost of ownership assessment, the National Renewable Energy Laboratory[1] assessed a range of costs associated with MHE (material handling equipment) operation. This captured the capital costs of battery and fuel cell systems, the cost of supporting infrastructure, maintenance costs, warehouse space costs, and labor costs.

Considering all these costs, the results of the NREL study found that fuel cell MHE can have a lower overall cost of ownership than comparable battery-powered MHE. The total cost assessment represented an analysis of the average of the deployment sites evaluated, which in turn reflects a fairly intensive warehouse and distribution application—a deployment of about 60 fuel cell lifts for two to three shifts per day, six to seven days per week. The analysis found that for Class I and Class II forklifts (three- and four-wheel, sit-down, counter-balanced forklifts) used in multi-shift operations, fuel cells reduced the overall cost of ownership by 10 percent per lift, per annum. The cost of ownership of Class III forklifts (also known as pallet jacks) can be reduced by five percent, i.e., from $12,400 per year to $11,700 per year, on average, for each lift truck.

Productivity Gains

In the MHE category, fuel cell-powered lift fleets offer a compelling economic business case. This is driven primarily by productivity gains. Increased productivity comes through:

Continuous movement: Within the duty cycle, fuel cell-driven lifts are able to move more goods in a given period of time.

More uptime: With battery-powered forklifts, within an eight-hour shift there is typically a requirement to change out the batteries at least once, requiring the operator to leave the work area and drive to a centralized battery change-out station for replacement. This creates up to 30 minutes of downtime.

More runtime: By contrast, a fuel cell lift will run up to three times longer than its battery driven counterpart, eliminating lost productivity. During that time, the fuel cell produces constant voltage and maintains constant power output capacity throughout the shift.

Quicker refueling access: By strategically locating the hydrogen dispensing stations throughout the warehouse, operators can refuel their lifts in five minutes or less.

Another advantage of hydrogen fuel cell-driven lift fleets is the significant reduction of the carbon footprint, sometimes up to hundreds of metric tons reduced within the operation. In most instances, replacing battery-powered lifts with hydrogen can reduce the carbon footprint by up to 80 percent. Additionally, the use of battery-powered forklifts introduces environmentally unfriendly pollutants into the atmosphere, making it difficult to position it as being a “green,” eco-friendly choice.

Transferring Hydrogen Fuel

In its simplest form, fueling stations typically involve the transfer of hydrogen from storage tanks to dispensers, where it becomes a usable fuel for forklifts. Seamless tubing is transported to the job site in coil form where contractors use state-of-the-art tools and equipment to uncoil and straighten the tubing. The uncoiled tubing can be easily laid in a trench or run up the side of a building to connect storage to dispenser. In many instances, tubing may cover hundreds of feet, incorporating numerous bends to accommodate vertical and horizontal requirements inside and outside the building envelope. This method reduces potential leak paths as well as installation time and manpower, compared to the conventional method of welding pipe together.

Study: Return on Investment Model (all values in USD)

With hydrogen fuel cells there is an investment required to establish a fueling station. While the initial cost of this, including the costs associated with delivering the compressed hydrogen, is not trivial, the long-term return on investment is positive.

An ROI study completed by Ballard Power Sytems[2] created a comprehensive business model that compares the total cost of ownership of a fleet of forklifts, powered either by lead acid batteries or hydrogen fuel cell power packs. Below is a fuel cell vs. battery replacement pack scenario. Key operating parameters, as well as capital and operating costs, make up the analysis to simulate a typical distribution warehouse. (However, each operation is unique and should be evaluated on its own merits). Key assumptions that drive the net present value analysis in the model include:

Fleet Size: The example scenario is representative of a “greenfield facility” for a large grocery distribution center, containing 180 Class III, 40 Class II and 10 Class I lift trucks operating 2.5 shifts per day, 350 days per year.

Productivity Improvements: The labor rates of the forklift driver and battery handler are used to estimate the cost of lost productivity. It is assumed that each battery change will take 20 minutes, occurring two to three times per day. Each hydrogen-refueling event is assumed to take three minutes and occurs 1.3 to 1.5 times per day. In addition, battery-powered lift trucks lose approximately 14 percent of their speed over the last half of the battery charge.

Fuel Cell System Cost: The price of a hydrogen fuel cell power pack depends on a number of factors, including the manufacturer, unit size and volume of units produced. For this scenario, a commercial price of $14,000 to $30,000 per unit is assumed, depending on the class of truck. This is representative of today’s commercial pricing, however, increased demand will reduce this price.

Power System Lifetime: Lead acid batteries are replaced every three years at a cost of $2,600 to $5,500 per battery, depending on the class of truck. The average fuel cell system lifetime is 10 years, with the fuel cell stacks refurbished every three years.

Fueling Cost: The cost of both electricity (for recharging batteries) and hydrogen are factored into the calculations. Hydrogen (including delivery and storage) is priced at $8.00 per kilogram. Typically, fleets with more than 40 forklifts are large enough to make liquid hydrogen-refueling infrastructure practical.

Tax Credit: The U.S. government currently offers incentives for the purchase of fuel cell solutions in the form of tax credits equal to 30 percent of the purchase price (up to $3,000 per kW).

Economic Results

Factoring in the fuel cell tax rebate, this warehouse operation will realize a full payback in less than one year, even with an initial higher capital investment for 230 forklifts. Over 10 years, the operation will realize a 24 percent savings in total lifetime ownership cost, resulting in a Net Present Value of ~$4.0 million. The associated reduction in lost productivity means that over 53,000 hours of work/labor time is recovered per year.

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1) NREL, "Assessment of a range of costs associated with an MHE operation," website (2012).

2) Ballard® Power Systems Incorporated, "A comprehensive business model that compares the total cost of ownership of a fleet of forklifts," website (2010).

Photo & Other Content Sources Include:

- Plug Power, Inc.
- PDC Machines, Inc.
- Italian Hydrogen and Fuel Cell Association

About HandyTube

HandyTube Corporation, a Handy & Harman Company, is a premium manufacturer of long-length hydrogen tubing. HandyTube's seamless, stainless steel coils are also used in applications for the oil and gas, chemical process, shipbuilding, instrumentation, aerospace and defense, process automation and life sciences industries. A recent corporate focus is to expand its proven long-length hydrogen tubing into the hydrogen fuel cell market.

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