Benefits of Forklift Battery Handling Equipment vs. Fuel Cell Technology

Introduction: Hydrogen Fuel Cells and Material Handling Equipment

Hydrogen PEM fuel cells eliminate the need for forklift battery changers and other infrastructure, and the availability of tax incentives have made fuel cells an attractive option for some extremely large operations. However, full utilization of fuel cells is not yet a cost-effective option for most facilities, especially when lead-acid batteries are already in common use.

In most instances, improved battery handling and management practices will result in more substantial improvements for a forklift fleet, both in terms of productivity and long-term profitability. This white paper will discuss the disadvantages of a full-scale switch to hydrogen fuel-cell systems for material handling equipment (MHE) in various settings. It will discuss the factors that can influence a return or loss on investment for a typical operation with a fleet of average to large size.

Figure 1. The BHS Double Stack Battery Extractor (BE-DS) can optimize both floor space and change-out efficiency, reducing costs for fleets of up to 149 batteries.

Infrastructure and Material Requirements

The most immediate and extreme cost of fuel cell conversion is infrastructure. Newer facilities may be able to handle the substantial infrastructure requirements of fuel cells, but for established companies, conversion is prohibitively expensive.

In fact, most proponents of fuel cells accept that infrastructure costs are only viable in a new greenfield site; hydrogen fueling infrastructure is not assumed to be used as a replacement for existing infrastructure. Even in greenfield sites, fuel cells are not necessarily a superior option after considering all associated costs.

Many arguments for fuel cells propose establishing the required infrastructure outdoors. However, this is not a viable option in some instances, even with larger operations. Outdoor fueling stations may be subjected to inefficiencies due to inclement weather, and local zoning laws can affect viability. Even in ideal circumstances, fuel cell infrastructure and maintenance costs roughly $17,000 per month according to an evaluation from the National Renewable Energy Laboratory (NREL).

It is also important to note that well-designed battery handling equipment requires a very limited amount of real estate. BHS can design and install systems to the individual specifications of client operations, installing forklift battery changers, battery wash stations and other products in a way that optimizes available floor space.

Cost Benefits of Lead-Acid Batteries for Class I/II Material Handling Equipment

Technology	Battery	Fuel Cell
Charging or Fueling Infrastructure Capital / Maintenance	$75 per lift / mo.	$17,000 / mo.
Cost of Hydrogen or Electricity (per Truck)	$500 / year	$2,400 / year
Cost of Battery or Fuel Pack (Without Tax Incentives)	$2,300	$3,700
Battery or Fuel Cell Maintenance (Averages)	$150 / mo.	$180 / mo.
Total Warehouse Real Estate Needed (Assumes Availability of Outdoor Space for Fuel Cell Infrastructure)	2,500 - 5,100 ft^2 (indoors)	500 ft^2 (indoors) and 2,500 ft^2 (outdoors)

Figure 2. Infrastructure costs for Class 1 and II MHE. Source: NREL and independent research.

Battery Handling Efficiency and Productivity

Lead acid batteries remain a more efficient choice for the vast majority of operations. The current scale for hydrogen infrastructure is skewed towards organizations that operate large fleets for more than two shifts per day and for six to seven days per week in new facilities, and potential gains in work efficiency may be overstated. Pro-fuel-cell research from the Department of Energy assumes a 2.2 shift / day average and relies on facility manager surveys to measure productivity.

This is problematic for several reasons. First, as fuel cell technology is relatively new, it is primarily utilized in greenfield facilities. Because hydrogen fuel cells are a relatively new technology, most facilities follow best practices to ensure optimal efficiency and safety. This is not true for standard forklift batteries and associated equipment, which are used in a far greater number of operations and aggregated for comparisons with fuel cells. In other words, many proponents of fuel cells compare average costs for lead-acid batteries to optimized costs of fuel cells.

Battery pack inefficiencies can be avoided with proper management. For example:

- Prompt disposal of older batteries -- before natural performance degradation affects shift lengths -- can extend the life of charging equipment and infrastructure.
- Systems like the BHS Fleet Tracker™ can reduce inefficiencies substantially by monitoring battery fleets. Managers can use these technologies to find ways to get more of a return from each individual battery and to avoid the productivity losses caused by the overutilization of older batteries.
- Proper use of forklift battery changers will improve productivity significantly, limiting the time that operators spend switching batteries between shifts. Best practices will also reduce the total cost per lift truck by reducing the annual costs of maintenance and refurbishment for this equipment.
- New battery technologies, deionization systems such as the WDS-1, “smart” battery chargers and similar improvements can reduce consumption of electricity and extend operating life.

Figure 3. The Water Deionizing System (WDS-1 can improve battery performance by removing impurities, extending lifespan and providing an improved return on investment.

One report from the Green Manufacturing Initiative found that “improvements in batteries, chargers, and charging practices can reduce the amount consumed by each forklift to approximately 2,400 kWh annually” for a medium-sized facility in Michigan. This represents a 58 percent decrease as compared to existing averages of 5,600 kWh per forklift (for the numbers referenced in Figure 2., NREL notes monthly usage of up to 550 kWh for Class 1 material handling equipment).

When coupled with annual savings for new battery technologies and the productivity benefits of battery handling systems, these practices will exceed any similar benefits from a full-scale switch to hydrogen fuel cells, especially given the costs of high costs of fuel cell materials.

Reporting Methods Used by Proponents of Fuel Cells

The slow acceptance of lift truck fuel cells has prompted a large number of papers on the subject from advocates. However, it should be noted that many of these papers examine individual cases involving larger greenfield sites or rely on self reportage, including manager surveys.

Additionally, some of the current research makes untested assumptions regarding operating efficiency, which can vary greatly between facilities and fleets. For example, one paper estimates an average “lost productivity” of 20 minutes per battery change as opposed to 3 minutes for fuel cell. This follows the assumption that hydrogen refill stations are easily and instantly accessible, when fuel cell infrastructure is often outdoors.

Fuel cell proponents do not assume best practices for battery changes or management.

While NREL estimates a more realistic battery change time of 10.5 minutes, we estimate an average of 3-9 minutes when following best practices and utilizing appropriate equipment. Change times will vary according to fleet size, number of shifts, number of work days and various other factors. Proper use of BHS forklift battery changers and other battery handling equipment can improve efficiency by as much as 12 minutes per change-out.

NREL’s report also notes that “the cost and space required for battery changes generally mean that only one battery changing area is available in the warehouse facility.” In the large facilities mentioned in the report, multiple battery changing rooms could be a viable option; BHS provides custom designs that can limit real estate usage while improving productivity via multiple charging stations and a streamlined battery changing process. In most instances, this type of solution would be far less costly than hydrogen PEM fuel cell infrastructure.

Figure 4. Systems like the BHS Fleet Tracker™ can optimize fleet management, improving efficiency and reducing the annual costs of battery maintenance and replacement.

Likewise, estimates of forklift battery lifespan are often inaccurate. Estimates from fuel cell advocates can be as low as 3 years, which assumes poor practices for charging, handling and use. Warehouses and other facilities with dedicated battery changing equipment and monitoring technologies often report lifespans closer to 4.4 - 5 years per battery.

Conclusion:

While hydrogen fuel cells can be an appropriate choice for large facilities in certain circumstances where tax benefits are substantial, lead-acid batteries and efficient battery handling equipment still provide a superior return on investment in most cases. This is largely due to the significant costs of infrastructure conversion and ongoing material costs as well as misinformation regarding the efficiency of forklift battery pack technology.

The effects of conversion on operational productivity will vary greatly from case to case, and current research may be artificially skewed in favor of fuel cells due to measurement and reporting methods. Likewise, gains in productivity due to fuel cell conversion have been overstated. Before considering a switch to fuel cells, organizations should consider the following:

- Availability of Tax Benefits
- Cost of Conversion for Existing Equipment and Infrastructure
- Cost of Financing (Where Applicable)
- Size of Facility and Workforce
- Number of Shifts per Day/Week
- Efficiency of Current Battery Monitoring Systems and Forklift Battery Changers

It is worth noting that the demand for fuel cells has recently declined, largely due to the high cost of hydrogen fuel and the extreme costs of infrastructure referenced earlier in this paper. The costs of fuel are tied to the demand, and widespread acceptance of hydrogen fuel cells appears unlikely at this time -- while some extremely large operations have converted to hydrogen, these facilities depended on significant tax benefits to limit expenses.

This is not to say that hydrogen fuel cells do not have a future in the material handling industry. Many operations utilize fuel cells for backup power, refrigeration and other secondary forms of energy, and the limited ecological footprint of fuel cells certainly holds promise. However, to improve energy efficiency, reduce costs and limit environmental impact, most operations should invest in improved battery management practices and high-quality battery handling equipment to see the best possible return.

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