TOP 7 REASONS TO CONVERT TO HYDROGEN FUEL CELL POWER IN YOUR MATERIAL HANDLING OPERATIONS

PLUG POWER

Today's fuel cells for proven, reliable power.

SEVEN REASONS, ONE AT A TIME:

REASON 1:
Fuel cells enable productivity, now more than ever.

REASON 2:
Fleet predictability can't be overstated.

REASON 3:
Hydrogen fuel cells are a cost effective, valuable component to a thriving material handling facility.

REASON 4:
Hydrogen fuel cells enable better management of facility utility costs.

REASON 5:
Fuel cells operate superbly in extreme temperatures.

REASON 6:
Fuel cells can meet the needs of any size distribution center.

REASON 7:
Hydrogen and fuel cells have been adopted and proven effective by material handling organizations large and small.

TODAY'S FUEL CELLS FOR PROVEN, RELIABLE POWER.

Hydrogen fuel cells are changing the way the world works and plays. The first professionals to see the dramatic improvements from fuel cells are in the distribution, manufacturing and warehouse industries. Today, fleet managers are replacing the lead-acid batteries in electric forklift trucks with hydrogen fuel cells at record rates and, in the process, are seeing operational improvements like increased productivity, lower operating costs and reduced carbon footprint.

Throughout North America, manufacturing, operations and logistics executives at leading cold chain storage and transportation, automotive manufacturing, retail warehousing and food distribution companies are making the decision to incorporate green technologies into their business plans. At an increasing rate, these organizations are choosing environmentally friendly fuel cell power solutions because they not only show customers that they are committed to sustainable business practices, but also save these organizations money. The return on investment is undeniable and is leading to an expansion of hydrogen and fuel cell use into other motive technologies including ground support equipment, range extenders and other electric vehicles.

For cold chain storage and transportation, automotive manufacturing, retail warehousing and food distribution companies that are on the cusp of switching to hydrogen for their material handling needs, here are seven reasons now is a better time than ever to adopt hydrogen fuel cells.

REASON 1: FUEL CELLS ENABLE PRODUCTIVITY, NOW MORE THAN EVER.

Warehouse labor drives approximately 70 percent of the overall cost of doing business in a warehouse[9]. Professionals using GenDrive fuel cells report seeing productivity improvements up to 15 percent. Not only do GenDrive fuel cells outperform lead-acid batteries, they also improve lift truck uptime.

For high-throughput facilities, uptime is critical. Facility managers tell us that when a production facility is operating 24/7, any downtime means lost sales (as much as $7,000 per minute in profits for auto manufacturers), as they cannot get back the lost time. By using GenDrive, facilities are able to operate at an elevated efficiency level, protecting revenue for the organization.

Lead-acid batteries require changing once per shift – an activity that consumes approximately 15 minutes of worker time. This compares to an average of two minutes required for the hydrogen refueling of a GenDrive unit. Over the course of one year, those 13 extra minutes needed per shift for the battery

change amounts to over 234 hours of lost productive time per forklift truck in a 3-shift operation. The recaptured time by a GenDrive fuel cell, in a 100 truck fleet, operating three shifts a day for 360 days, represents over 23,400 hours each year that can be put back into the business through a more productive workforce.

REASON 2: FLEET PREDICTABILITY CAN'T BE OVERSTATED.

Hydrogen fuel cells have proven to be of enormous value because of the predictability they provide. GenDrive fuel cells remain at full power for an entire shift, regardless of the pallet weight being moved. In other words, consistent, expected power and performance, 100% of the time. Also, each forklift driver knows exactly when it's time to refuel – the forklift fuel gauge makes it simple. The operator can refuel in under three minutes before returning to work.

In comparison, power output from lead-acid batteries declines by up to 14 percent in one shift in ambient temperatures – in a cold or freezer storage facility, that jumps to between 25 percent and 50 percent. This severely impacts the predictability of the industrial processes in a factory like this. More so, lift truck drivers must go to a centrally located battery room to change the depleted battery – which weighs up to three tons, making this a potentially dangerous activity that distorts the ability to establish a predictable process. Material handling professionals have discovered that Plug Power fuel cells solve all of these problems.

It's quite simple – GenDrive fuel cells allow facilities to operate with more precise knowledge of their operational capabilities. Predictability of fleet movement can now be measured in dollars. Because fuel cells guarantee constant power to the vehicle, truck operators can now be allocated to maximize efficiency and activities can be streamlined. Labor dedicated to changing batteries is thus better utilized elsewhere in the facility.

REASON 3: HYDROGEN FUEL CELLS ARE A COST EFFECTIVE, VALUABLE COMPONENT TO A THRIVING MATERIAL HANDLING FACILITY.

GenDrive fuel cells provide immediate savings in new facilities. Fuel cells save end users hundreds of thousands of dollars, especially in multi-shift environments where battery change-outs occur multiple times each day.

Using fuel cells instead of lead-acid batteries as the power source for electric lift truck fleets offers substantial financial and performance benefits to the company. Traditionally, electric material handling vehicles have run almost exclusively on lead-acid batteries. However, vehicles employing this source of power require up to three, time-consuming battery changes during

GENDRIVE PROVIDES POWERFUL BENEFITS:

• Increased Productivity — A hydrogen fuel cell forklift can operate for up to eight hours at maximum power before needing to be quickly refueled, whereas lead-acid batteries degrade in power over six-hour shifts before needing to be recharged. By switching to fuel cells, companies can reduce wasted time changing batteries. Instead, workers can use the time more productively on the floor picking goods, moving pallets, and loading and unloading trucks — the key activities of any thriving distribution hub.

• Reduced Operational Costs — Fuel cells operate like a fully charged lead-acid battery 100 percent of the time, resulting in less wear and tear on the forklift's components. Each fuel cell lasts eight to ten years, that's double the life of a lead-acid battery.

• Undiminished Power — Battery-powered lift trucks lose approximately 14 percent of their speed over the last half of the battery charge. On the other hand, fuel cells run at full speed throughout the entire shift and lifetime, enabling businesses to move more goods through the production facility. And, in cold storage facilities with sub-zero temperatures, an environment in which batteries experience significant power degradation, fuel cells meet or exceed performance requirements.

• Quick and Easy Fueling — Fuel cells are refueled in under three minutes by the forklift operator, compared to approximately 15 minutes for each lead-acid battery swap. The in-building fueling infrastructure is extremely compact, especially when compared to battery charging rooms, leaving more valuable warehouse space for operational activities. There is no need to invest in battery swapping and charging equipment, extra batteries and battery storage, or personnel dedicated to this task.

• Decreased Carbon Footprint — Fuel cells produce zero harmful emissions and eliminate the costs associated with handling and storing toxic materials. Sites can reduce "wells-to-wheels" greenhouse gas emissions by up to 80 percent. And, by transitioning to fuel cells, Plug Power's customers see their net and peak energy consumption reduced, resulting in significantly lower electricity bills.

• Sound Investment — Fuel cells offer an efficient, clean and cost-effective source of power for motive applications. They provide instantaneous savings that enable business professionals to do more with their existing fleet. Reductions in long term maintenance multiply the savings over time.

ELECTRICITY BILLS

The positive impact to the electrical grid is two-fold: (1) fuel cells reduce overall energy consumption and (2) fuel cells reduce peak power demand.

Electricity bills are built on two main cost drivers:

1. Electricity Usage ($ = Total Usage x $ / kWh)

2. Peak Demand ($ = Peak Usage x $ / kWmax) Cost associated with meeting peak loads. This is typically based on the maximum amount of power used during any 15-minute to 30-minute time window throughout the month.

Eliminating electricity required for battery charging by shifting to a non-battery solution reduces the total amount of electricity used. This reduces the rate of the remaining electricity consumption (the more used, the higher the incremental cost).

Electricity bills may also be reduced because the amount of power needed during peak demand times is smaller without the need for energy-intensive battery charging stations.

each 24-hour period, greatly diminishing a driver's productivity. Even facilities employing opportunity-charging or fast-charging stations are impacted by battery issues including premature replacement as well as safety issues like acid spills or battery flareups due to heat buildup.

As the cost of hydrogen and its infrastructure continues to decline, a growing number of global corporations are discovering they can obtain an immediate payback on their investments by establishing a hydrogen infrastructure in new-construction warehouse facilities. These "greenfield" sites eliminate the need to earmark funds for costly battery charging and changing infrastructure, including expensive copper wire, battery watering, maintenance equipment and space-consuming racks.

As a result, valuable real estate is not occupied by large battery rooms and, instead, this space is used to generate revenue within the business, specifically by moving more products with an efficient forklift fleet. Compact fueling dispensers are installed in the facility to facilitate a quick refuel of the fuel cell with hydrogen in under three minutes, before returning to the floor to move product. When constructing a new facility, the use of fuel cells can reduce a customer's capital investment by approximately $1 million dollars before they even break ground.

At existing sites, customers may switch from a battery room to hydrogen infrastructure to support a growing fleet, expanding business or sustainability initiatives. Companies have experienced paybacks on the order of 12–18 months. These customers seek to increase overall productivity, lower operational costs, recapture much needed facility space, and eliminate or reduce electricity charges.

REASON 4: HYDROGEN FUEL CELLS ENABLE BETTER MANAGEMENT OF FACILITY UTILITY COSTS.

Until now, the costly financial implications of lead-acid battery use were accepted by material handling managers as a cost of doing business. A paradigm shift has brought electricity surcharges, cost of labor, truck downtime and the value of productivity into the limelight. Significant business improvements as a result of hydrogen fuel cell solutions, like Plug Power's GenDrive, have allowed decision makers to re-evaluate their power solution options.

Using fuel cell systems not only lowers a company's electricity bill through the elimination of battery charging; it reduces electricity costs for the remaining operations. Lead-acid battery charging represents 25 to 30 percent of a distribution center's electricity usage and approximately 50 percent of the peak demand charges, due to the spike in electricity usage when batteries are charged. Implementation of fuel cells significantly reduces this peak demand and the facility's electricity load profile.

REASON 5: FUEL CELLS OPERATE SUPERBLY IN EXTREME TEMPERATURES.

GenDrive fuel cells power material handling vehicles the same way gasoline powers cars: If the system has fuel, it has full power. For the more than 70 percent of Plug Power customers who have a freezer space in their facility, GenDrive fuel cells maintain consistent performance even these environments as low as -22 degrees F.

In comparison, lead-acid battery performance degradations are amplified in cold environments – a battery rated for an eight hour shift in 77 degree temperatures may only last four to six hours in a cold or frozen environment. This leads to inconsistent power levels, more frequent battery change-outs, more batteries needing to be purchased in order to accommodate the frequent change-outs and more downtime, all of which impacts productivity and profits.

The difference is dramatic to cold storage professionals - hydrogen fuel cells are not affected by cold operations, and they run up to twice as long per fill-up compared to battery-powered units. This allows operators to stay productive moving goods around longer, because fuel cell-powered lift trucks can remain in the cold storage facility for longer periods of time.

REASON 6: FUEL CELLS CAN MEET THE NEEDS OF ANY SIZE DISTRIBUTION CENTER.

Fuel cells are an ideal solution for material handling operations both large and small, as evidenced by the Fortune 500 companies who have deployed hundreds of GenDrive fuel cells, and smaller regional facilities who have deployed as few as 25.

For smaller material handling businesses, the cost of deploying hydrogen fuel cells is feasible through the work Plug Power has done with its partners and smaller customers to develop a downsized fueling infrastructure scaled to economically meet the needs of these smaller businesses. Additionally, customers with modest-sized fleets have committed to investing in and adopting Plug Power's sustainable solutions that allow enhanced operations and a clean competitive advantage in the market.

Among these smaller corporations is FreezPak Logistics, who selected Plug Power's full-service GenKey solution for its new cold storage distribution center freezer warehouse in Carteret, New Jersey. The GenKey deployment for this location included a mix of 25 class-3 and class-2 GenDrive fuel cells, a GenFuel outdoor hydrogen storage infrastructure with two indoor GenFuel dispensers, and total GenCare service for both the fuel cells and hydrogen system.

GENKEY

With Plug Power's GenKey, it's never been easier to adopt clean, cost-effective hydrogen and fuel cell power for your business. GenKey delivers a complete range of turnkey services to streamline the entire hydrogen and fuel cell adoption process. Plug Power's GenKey solution removes complexity and links together everything material handling customers will need for an easy conversion.

GenKey includes the following for "one-stop shopping":

- GenDrive fuel cell system
- GenFuel hydrogen infrastructure and fuel
- GenCare aftermarket customer service and support

Plug Power provides full integration and deployment of the entire GenKey solution for customers to ensure seamless transition to hydrogen fuel cell-based power. Plug Power acts as a single-source vendor, handling the infrastructure, fueling, service, integration, deployment and ongoing maintenance, so customers can focus on putting their newfound productivity to use.

It's proven – GenKey is an important advance in the industry because it offers a dramatically simplified path to a cost effective, complete hydrogen fuel cell system. With GenKey, customers have a single-source vendor to enable a smooth transition away from traditional power sources to hydrogen fuel cell power solutions.

HYDROGEN STATISTICS

• About ten million metric tons of hydrogen are produced in the United States annually, enough to power 20-30 million cars or five to eight million homes. (Source: U.S. Energy Information Administration)

• A large hydrogen production site exists today near almost every major U.S. and European city. They are within reach of most major U.S. metropolitan areas, which accounts for roughly 70 percent of the U.S. population. (Source: California Fuel Cell Partnership)

• Hydrogen is used safely today in many different industries: food manufacturing (hydrogenation), food production (ammonia in fertilizer), welding, cryogenics, weather balloons, oil refining, household use as hydrogen peroxide and fuel for transportation & stationary power.

• A Plug Power GenFuel hydrogen refueling into a forklift, industrial vehicle or stationary fuel cell happens every 9 seconds today – that's nearly 9,000 fills each day...and growing. (Source: Plug Power)

REASON 7: HYDROGEN AND FUEL CELLS HAVE BEEN ADOPTED AND PROVEN EFFECTIVE BY MATERIAL HANDLING ORGANIZATIONS LARGE AND SMALL.

After more than a decade of development and refinement, hydrogen and fuel cells have proven viable for the commercial market, as evidenced by more than 12,000 forklift trucks powered by Plug Power GenDrive fuel cells, deployed by more than 40 customers in North America and Europe that have accumulated more than 110 million hours of operations. Many of these companies are repeat customers that have either expanded their current fleet or deployed additional sites elsewhere. No company has ever gone back to lead-acid batteries after a GenDrive purchase.

The following examples provide a snapshot of some of the leading businesses that are experiencing the attractive benefits and savings that using fuel cells provide over battery technologies:

Walmart is committed to its partnership with Plug Power, using hydrogen and fuel cells in its distribution centers across the U.S. and Canada, including many in refrigerated distribution centers with temperatures as low as -29°C, as one of the ways it reduces costs[1]. With new Walmart distribution centers already operating with Plug Power's GenKey power, fuel and service bundle, the Fortune 500 leader has avoided costs associated with installing, maintaining and operating traditional lead-acid battery systems. Furthermore, with potential greenhouse gas emissions reductions of up to 72 percent[2], compared to batteries charged from the grid, fuel cells are helping the company become a more sustainable operation.

Carrefour, the leading retailer in Europe and the second-largest retailer in the world, purchased more than 150 GenDrive units, to be deployed in the company's brand new distribution center located in Vendin-les-Bethune, France[3]. In new facilities, the use of hydrogen allows companies to avoid the high costs of building a battery room and related upgrades to electrical infrastructure, and instead apply that budget to more cost-effective hydrogen infrastructure.

Colruyt Group, a leading supermarket, was the first logistics center in Europe operating solely on fuel cell-powered material handling vehicles, signing up in 2015 to use 200 GenDrive[4] units in its Halle, Belgium facility. Colruyt Group's sustainability initiatives involve optimizing its own operations and collaborating with others in its supply chain to minimize its impact on the environment. Adoption of the GenDrive fuel cell solution enhances this initiative – Colruyt Group increases efficiency of its workers in a safer environment by removing lead-acid batteries from the work place. GenDrive is powered by clean hydrogen fuel, generating only heat and water as byproducts.

BMW purchased GenDrive fuel cells to power the 275[5] forklifts, tuggers and stackers inside its automotive manufacturing facility in Greer, SC. The units have enabled the German auto manufacturing giant to use its DC space more efficiently and with fuel cell refueling times of just 60–180 seconds (versus 20 minutes to change out a depleted lead-acid battery for a charged battery), BMW is also realizing significant gains in workforce productivity.

Coca-Cola Refreshments USA bought 56 GenDrive fuel cells[6] to power a fleet of lift trucks at its 250,000 square foot bottling and distribution center. By moving to fuel cells, the beverage leader, which had previously relied on lead-acid batteries, gained 2,000-square-feet of battery storage space for other business operations, while also reducing its electrical consumption by an estimated 1.6 million kWh each year. The iconic brand, whose goal is to become an industry leader in energy conservation and climate protection, also reduced its carbon emissions by 15 percent[7].

Procter and Gamble purchased more than 200 GenDrive fuel cell units to use in four different North American distribution centers[8]. Productivity and fleet uptime are very important to this Fortune 500 Company, which is the largest consumer manufacturing company in the world, and using hydrogen fuel cells addresses the depletion issues experienced as lead-acid batteries lose charge.

In addition to these recognizable industry giants, Plug Power routinely provides the same cost-effective hydrogen and fuel cell solutions scaled for customers with smaller-sized fleets, including FreezPak, Newark Farmer's Market, and Dietz & Watson.

CONCLUSION

Fuel cells are indeed viable and this is evident in the decision by many of the world's leading companies to make them an integral component in maintaining their global competitiveness. Since being introduced to the material handling sector, Plug Power's hydrogen fuel cells have proven themselves to be a more reliable product at a lower overall cost than lead-acid batteries.

The facts are clear:

- Fuel cells ARE a feasible solution for material handling operations
- Financially, fuel cells DO make economic sense for growing your business
- Fuel cells ENABLE predictability and productivity of lift truck fleets and your labor
- Fuel cells operate SUPERBLY in extreme temperatures
- Hydrogen and fuel cell solutions CAN be sized for both large and small material handling operations

No wonder so many material handling professionals have turned to Plug Power to Power their Possibilities. The world is moving - join us and move your business forward with Infinite Drive!

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ABOUT PLUG POWER INC.

The architects of modern hydrogen and fuel cell technology, Plug Power has revolutionized the industry with its simple GenKey solution, elements of which are designed to increase productivity, lower operating costs and reduce carbon footprints in a reliable, cost-effective way. Plug Power's GenKey solution couples together all the necessary elements to power, fuel and service a customer. Plug Power is the partner that customers trust to take their businesses into the future.

For more information about Plug Power or to contact a Plug Power sales representative, visit www.plugpower.com, or call 518.738.0320.

Corporate Headquarters
968 Albany Shaker Road
Latham, NY 12110
518.782.4004

West Coast
15913 E. Euclid Ave.
Spokane, WA 99216
509.228.6500

Europe
1 Place Paul Verlaine
92100 Boulogne-Billancourt
France

PLUGPOWER.COM
gendrive@plugpower.com

PLUG POWER®

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