Powering the Future: 7 Reasons to Upgrade Your Operations to Hydrogen and Fuel Cells

1. Fuel cells boost productivity
2. Fuel cells are cost effective
3. Fuel cells slash electricity use
4. Fuel cells can handle extreme temperatures
5. Fuel cells can meet the needs of any sized facility
6. Fuel cells have seen growing commercial adoption
7. Fuel cells decrease carbon footprint

Today's Fuel Cells for Proven, Reliable Power

Hydrogen fuel cells are rapidly 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 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 a reduced carbon footprint.

Around the world, manufacturing, operations and logistics executives at leading cold chain storage and transportation, automotive manufacturing, retail warehousing and food distribution companies are moving to green technologies to improve their bottom line. At an increasing rate, these companies are choosing environmentally friendly fuel cell power solutions because they not only show customers that they are committed to sustainable business practices, but they also save companies money. The return on investment is undeniable, and it's leading to an expansion of hydrogen and fuel cell use into other motive technologies including ground support equipment and other electric vehicles.

To logistics professionals who are on the cusp of switching to hydrogen for their material handling needs, here are seven reasons now is the time to transition to hydrogen fuel cells.

1. Fuel Cells Boost Productivity

Warehouse labor drives approximately 70% of the overall cost of doing business in a warehouse. Professionals using fuel cells report seeing productivity increase by up to 15%. Not only do 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 a loss in sales (as much as $7,000 per minute in profits for auto manufacturers), as they cannot get back the lost time. By using hydrogen fuel cells, facilities are able to operate at increased efficiency, ultimately protecting companies from losses.

Forklift batteries, whether lead acid or lithium, require changing or charging once per shift – an activity that consumes approximately 60 minutes to 1.5 hours of working time. Whereas, hydrogen refueling takes less than three minutes. Over the course of a year, the amount of time that could be saved on workforce productivity is significant.

When it comes to productivity, predictability is key. Fuel cells operate at full power for an entire shift, regardless of the pallet weight being moved. Each forklift driver also knows exactly when it's time to refuel – the fuel gauge makes it simple – and the operator can refuel in under three minutes before returning to work. In other words, you can count on fuel cells to be consistent with power and performance 100% of the time.

In comparison, power output from lead-acid batteries declines by up to 14% in one shift in ambient temperatures – in a cold or freezer storage facility, that jumps to between 25% and 50%. This severely impacts the predictability of the industrial processes in a factory like this. Moreover, 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 fuel cells solve all of these problems.

2. Fuel Cells are Cost Effective

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 or fast charging occur multiple times each day.

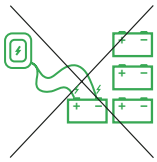
Using fuel cells instead of lead-acid batteries as the power source for electric lift truck fleets offers substantial financial and performance benefits to the company. Traditionally, electric material handling vehicles have run almost exclusively on lead-acid batteries. However, vehicles employing this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

Lithium batteries also require one-to-one charger to battery ratios that do not scale as efficiently as hydrogen refueling infrastructure and takes away from warehouse space, thus increasing charging costs, and reducing racks and profits for customers.

On the flip side, the cost of hydrogen and its infrastructure is declining. 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.

Hydrogen Fuel Cells Make a Positive Impact in **2** Ways

1 Reduce Overall Energy Consumption

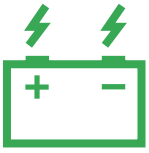


Eliminate Electricity Charging
Eliminating the electricity required for battery charging by shifting to a non-battery solution reduces the total amount of electricity used.

Reduce Electricity Bills
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.

Reduce Peak Power Demand 2

¥ $ = Peak Usage x $ / kW max
¥ Increased costs associated with meeting peak loads.
¥ Fuel Cells avoid Peak Costing at Peak Demand



¥ Battery charging is 20% to 30% of the distribution center's electricity usage
¥ Battery charging represents 50% of peak demand charges
¥ Fuel Cells significantly offset these demands and associated costs

3. Fuel cells slash electricity use

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 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% of a distribution center's electricity usage and approximately 50% of the peak demand charges, due to the spike in electricity usage when batteries are charged. Lithium batteries rely on opportunity charging, which leads to increased electricity usage and rates.

4. Fuel cells can handle extreme temperatures

Working in a cold chain environment? No problem. 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% of Plug customers who have a freezer space in their facility, fuel cells maintain consistent performance even these environments as low as -22 degrees F.

In comparison, both lead-acid and lithium-ion battery performance degradations are amplified in cold environments – a lead-acid battery rated for an eight-hour shift in 77 degree temperatures may only last four to six hours in a cold or frozen environment and a lithium-ion battery with see reduced performance levels of up to 20%. 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.

5. Fuel cells can meet the needs of any sized facility

Fuel cells are an ideal solution for material handling operations both large and small, as evidenced by the Fortune 500 companies that have deployed hundreds of fuel cells, and smaller regional facilities that have deployed as few as 25. Whether a warehouse is laid out in standard or very narrow aisle format, after upgrading to fuel cells, customers can use extra warehouse space to generate more revenue for the business, because they no longer need to support a battery room.

For smaller material handling businesses, the cost of deploying hydrogen fuel cells is feasible through the work Plug 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’s sustainable solutions that allow enhanced operations and a clean competitive advantage in the market.

6. Fuel cells have seen growing commercial adoption

After more than a decade of development and refinement, hydrogen fuel cells have proven viable for the commercial market, as evidenced by more than 52,000 material handling vehicles powered by Plug at more than 165 operations sites. These sites have more than 820 million hours of operations. Many of these companies are repeat customers that have either expanded their current fleet or deployed additional sites elsewhere. Furthermore, Plug includes infrastructure, service and de-commissioning costs, whereas lithium service is fragmented with recycling costs stunningly high.

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:

Amazon made a bold promise: To be net carbon zero by 2040. To reach that goal, the technology company is relying on Plug's technology to power its distribution centers around the world. Amazon is using more than 15,000 fuel cells to power 70 sites with plans to add additional sites in 2022.

Walmart is committed to its partnership with Plug, 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. With new Walmart distribution centers already operating with Plug's turnkey 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%, compared to batteries charged from the grid, fuel cells are helping the company become a more sustainable operation. As of January 2022, there are 10,000 fuel cells operating at 41 hydrogen fuel sites across Walmart distribution centers, with more planned for the year.

Home Depot, the largest home improvement retailer in the U.S., came to Plug with the plan to standardized fuel cells to save money while increasing productivity across its distribution network. By the end of 2021, Plug was powering 22 sites nationwide using 2,100 fuel cells. After seeing rapid success as these distribution centers, Home Depot agreed to use fuel cells to power an additional 30 centers by the end of 2025.

Carrefour, the leading retailer in Europe and the second-largest retailer in the world, purchased more than 150 fuel cells, to be deployed in the company's distribution center located in Vendin-les-Bethune, France. 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 corporation, was the first logistics center in Europe operating solely on fuel cell-powered material handling vehicles, signing up in 2015 to use 200 fuel cell 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 fuel cell solution enhances this initiative – Colruyt Group increases efficiency of its workers in a safer environment by removing lead-acid batteries from the workplace. Fuel cells are powered by clean hydrogen fuel, generating only heat and water as byproducts.

BMW purchased fuel cells to power the 275 forklifts, tuggers and stackers inside its automotive manufacturing facility in Greer, S.C. The units have enabled the German auto manufacturing giant to use its D.C. space more efficiently and with fuel cell refueling times of just 60 to180 seconds (versus 20 minutes to change out a depleted lead-acid battery for a charged battery or 60-to 90-minutes to fully charge a lithium-ion battery). BMW is also realizing significant gains in workforce productivity and has expanded fuel cell use to their Leipzig facility.

In addition to these recognizable industry giants, Plug 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.

7. Fuel cells decrease carbon footprint

From a business standpoint, there are at least six reasons to upgrade your operations to hydrogen fuel cells. From a sustainability standpoint, there's one clear reason: Plug's innovative fuel cells help businesses decarbonize.

When companies adopt hydrogen fuel cells, replacing the batteries they formerly used in material handling equipment, they eliminate the costs associated with handling and storing toxic materials, while reducing greenhouse gas emissions by up to 80%. With the realization that we need to reduce our carbon footprint in order to maintain a healthy planet, there's been a growing adoption of hydrogen. Hydrogen is used safely in many different industries, including food manufacturing (hydrogenation), food production (ammonia in fertilizer), welding, cryogenics, weather balloons, oil refining, household use as hydrogen peroxide and fuel for transportation and stationary power.

When it comes to decarbonization, customers turn to Plug to provide a full ecosystem of products. Because of the growing customer demand, Plug has committed to producing 500 tons per day of green hydrogen by 2025. By 2028, we expect to produce 1,000 tons.

State and federal governments, realizing the need for renewable energy, have increasingly offered companies incentives to upgrade their operations, while the cost of commercial electricity has skyrocketed to record prices.

The convenient availability of hydrogen allows our customers to meet their sustainability goals, while promoting environmentally friendly business practices to the public.

Turnkey Solutions

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

Plug offers the following for one-stop shopping:

- Fuel cell power
- Hydrogen infrastruction and fueling
- Aftermarket customer service and support

Plug provides full integration and deployment of the entire solution for customers to ensure seamless transition to hydrogen fuel cell-based power. Plug 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 – turnkey services are an important advancement in the industry because it offers a dramatically simplified path to a cost-effective, complete hydrogen fuel cell systems. Customers have a single-source vendor to enable a smooth transition away from traditional power sources to hydrogen fuel cell power solutions.

Join the Hydrogen Movement

Fuel cells are powering our world, including material handling operations, in a smoother and a smarter way. The world's leading companies have made them an integral component in maintain-ing their global competitiveness. Since being introduced to the material handling sector, Plug's hydrogen fuel cells have proven themselves to be a more reliable product at a lower overall cost than batteries. The world is quickly moving in the direction of renewable, smart energy. Join us in this movement and let's pow-er your operations with the energy of the future. Contact us to learn how Plug can help you move your business into the future.

About Plug

Plug is building an end-to-end green hydrogen ecosystem, from production, storage and delivery to energy generation, to help its customers meet their business goals and decarbonize the economy. In creating the first commercially viable market for hydrogen fuel cell technology, the company has deployed more than 50,000 fuel cell systems and over 165 fueling stations, more than anyone else in the world, and is the largest buyer of liquid hydrogen. With plans to build and operate a green hydrogen highway across North America and Europe, Plug is building a state-of-the-art Gigafactory to produce electrolyzers and fuel cells and multiple green hydrogen production plants that will yield 500 tons of liquid green hydrogen daily by 2025. Plug will deliver its green hydrogen solutions directly to its customers and through joint venture partners into multiple environments, including material handling, e-mobility, power generation, and industrial applications. For more information, visit www.plugpower.com.

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