WHITE PAPER

Use case: The benefits of converting electric power to hydrogen

How some busy warehouses realize cost savings, sustainability and productivity with the switch

Yale®
LIFT TRUCK TECHNOLOGIES

Consumers have a growing appetite for the convenience, selection and cost of online retail. E-commerce sales grew 44% in 2020 and a Forrester report projects more than 25% of all retail sales to be online by 2024. With demand continuing to rise, logistics operations are under pressure to support expectations for broad selection and fast delivery, while tightly controlling costs.

The warehouse is ground zero for e-commerce logistics, rife with opportunity to boost efficiency and support greater speed and selection, while keeping costs in check.

Capitalizing on that opportunity may mean making more efficient use of space to house more inventory or upgrading to more efficient equipment and reconfiguring workflows to boost labor productivity.

The hypothetical scenario presented in this piece is meant to illustrate how changing the power source on electric lift trucks can equip e-commerce warehouses to meet benchmarks for productivity and inventory selection, while keeping costs in check.

Online retail warehouse

Large online retailers often operate several regional warehouses and fulfillment centers throughout the United States. A large region may be served by an 850,000-square-foot facility that runs three shifts, seven days a week. An operation of this size depends on a fleet of 100 lead-acid battery-powered lift trucks, including:

- End riders and walkie pallet trucks to load and unload trailers
- Order selector trucks for picking and building orders
- Narrow aisle turret trucks to serve high-level storage and order picking

Opportunity: unnecessary downtime

To improve productivity without increasing logistics costs, an operations manager can target lift trucks. During lead-acid battery charging procedures, lift trucks can experience high levels of regular downtime – capping labor productivity as operators accumulate idle time.

What's more, halfway through each shift, many lift trucks operators start coping with reduced drive and lift speeds due to power degradation as the battery charge drops below 50%, indicating the need to visit the battery storage area for fresh power. The process of driving to that area, swapping a lead-acid battery and getting back to work can take about 20 minutes or even longer, depending on traffic and wait time while other trucks get freshly charged replacements, too.

And that's just the regular, expected downtime.

Local utility capacity can be another, unpredictable variable. Occasional brownouts prevent all batteries from charging and in some cases, higher rates make charging extra expensive during peak demand times. The challenges of lead-acid battery power and local utilities can leave warehouses in an unsavory position, balancing downtime risk with bloated spending on excess lift trucks and power units.

The Yale Emerging Technology team can evaluate the complex lift truck power needs of such a warehouse and recommend a solution without the drawbacks of the old paradigm. The team conducts an application survey to identify the best-fit power solution, considering volatile organic compounds in the air, truck age, lease terminations, attachments, duty cycle, number of shifts, number of batteries and kilowatt-hour rates. In this case? Hydrogen fuel cells.

Fuel cell advantages

Hydrogen fuel cells can be refueled in as little as three to five minutes, enabling operators to get back to work in a fraction of the time it took when swapping out lead-acid batteries. Power degradation is also a thing of the past, so lift trucks operate at full power with maximum travel and lift/lower speeds until full depletion – just like an internal combustion engine. Plus, fuel cells fit easily into the standard battery box of the existing lift trucks, enabling an easy retrofit.

Since lift trucks powered by hydrogen fuel cells have minimal scheduled downtime due to quick refueling, idle time is at a minimum and other operators can use them during breaks. For e-commerce operations with strict deadlines and massive order volumes to move on tight margins, making the most of material handling equipment through high truck utilization is essential.

While fuel cells do not come with the daily maintenance requirements of lead-acid batteries, they do require a limited amount of periodic maintenance, typically about two to three times each year. The same dealer that performs regular lift truck maintenance may also service the fuel cells, enabling both types of service to be scheduled at the same time – minimizing operational disruption.

- Refuel as quickly as 3-5 minutes
- Maximize truck utilization
- Achieve consistent power delivery
- Eliminate daily maintenance requirements

Space savings and simplicity

Since lead-acid batteries require 8 hours to fully charge and 8 hours to cool down before they can be used again, two or three batteries are allocated for every lift truck. Storing and maintaining such a volume of batteries requires a designated area that takes up about 5,000 sq. ft. of floor space.

But by transitioning to hydrogen fuel cells, the warehouse can install four hydrogen fueling dispensers, each the size of a standard gasoline pump, that occupy minimal indoor space. And when it comes to sourcing the hydrogen fuel, the Yale Emerging Technology team provides guidance to help warehouse operations understand the available options and make the best decision based on their needs. Rather than generating hydrogen on-site or getting it delivered as liquid, the Yale team can recommend taking delivery of hydrogen gas in a trailer and parking it outside the facility – the method with the least amount of on-site infrastructure. The trailer even includes telemetry so that operations can monitor supply and schedule deliveries to keep hydrogen flowing to indoor dispensers. These dispensers are located throughout the facility for convenient refueling and relief from the burden of managing and maintaining a massive fleet of lead-acid batteries.

Eventually switching the entire lift truck fleet to fuel cells can completely eliminate the large battery charging and storage area, opening up indoor space for additional racking and SKUs – increasing revenue per square foot without expensive construction to add on to the building.

Hydrogen fueling dispensers are the size of a standard gasoline pump and occupy minimal space.

Going green

In addition to avoiding costs to replace, maintain and dispose of batteries, fuel cells enable sustainability benefits. No harmful emissions while in operation or refueling can enable compliance with tough emissions regulations, help position businesses to take advantage of tax credits and support corporate-level green initiatives. Not only do hydrogen fuel cells avoid the off-gassing necessary to maintain lead-acid batteries, they avoid the environmental impact associated with disposal of old batteries. Hydrogen also produces a lower well-to-wheels carbon footprint compared to electricity, further solidifying the retailer's sustainability commitment.

Based on a potential hydrogen consumption of 300 kw per day, the Yale Emerging Technology team would recommend delivering kilograms of liquid hydrogen based on a lower unit price. After a moderate capital expenditure for a hydrogen storage tank and conversion system, the warehouse just pays for liquid hydrogen deliveries regularly via tanker truck, which is less expensive than having hydrogen gas delivered.

Impact

Switching from lead-acid batteries to hydrogen fuel cells can help the warehouse serve consistent, growing e-commerce demand, thanks to longer lift truck run times, increased throughput, and additional floor space to keep up with SKU proliferation. The success of fuel cells at a single warehouse can also spur further implementations at other warehouses and fulfillment sites an online retailer's supply chain network.

For more information on switching from lead-acid batteries to hydrogen fuel cells, contact the Yale Emerging Technology Team.

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