ELECTRIFICATION IS COMING TO PORTS. IS HYDROGEN RIGHT FOR YOUR CONTAINER HANDLING OPERATION?

Your port terminal operation is going electric. The main question is how.

With supply chains accounting for more than 90% of most organizations' greenhouse gas (GHG) emissions, ports play an important role in meeting emissions reduction targets. But as terminals consider technologies like hydrogen fuel cells and lithium-ion batteries to replace tried-and-true internal combustion engines (ICE), how can they evaluate emerging electrification options?

Ports are fast-paced environments that require enough power to support fleets of vehicles, cranes, container handlers and more as they carry heavy loads continuously with minimal downtime. So, when evaluating electrification options, factors like performance, cost and reliability are critically important. Unlike ICE power, which depends on well-established fossil fuel supplies, local electrical infrastructure and hydrogen fuel supply require special attention to determine the best solution.

// WHAT ABOUT LITHIUM-ION BATTERIES?

Battery electric power has a long history powering smaller equipment like forklift trucks in warehouse and manufacturing environments. How does this approach stack up to the realities of powering large container handling equipment at ports?

Battery-powered electric vehicles rely heavily on the electrical grid. The same grid brings electricity to homes and businesses daily, with the average household using 28.9 kWh and the average business using 70 kWh per day. Charging a single container handler with, for instance, a 260 kWh battery pack, uses significantly more. If a fleet has 100 vehicles and they each get charged once a day, that's over 20,000 kWh – enough demand that could overload grid capacity.

In addition, port terminals use almost every square inch of space to maximize storage capacity, accommodate cranes and provide pathways for container handling equipment. But battery charging stations can be bulky and finding the right place for them in terminal layout is key – especially for larger fleets that require more space, power and a consistent charging schedule.

An opportunity charging strategy requires strategically locating several charging stations all around the port to allow for easy charging on breaks. But even with the right charging infrastructure, operators can still forget to charge equipment when they take a break.

It can take anywhere from one and a half to five hours to fully recharge a battery for a large container handler, depending on the charging setup. Not only that, a fully charged battery typically only lasts four to eight hours. The need to frequently recharge and the hours required to fully recharge requires equipment to spend significant time out of service. For operations used to ICE power with run times that last the equivalent of several 8-hour shifts, a switch to battery electric power could require purchasing more units to have the same level of equipment availability to meet demand.

// HYDROGEN FUEL CELLS FOR HEAVY-DUTY FLEETS

Compared to lithium-ion battery power, hydrogen fuel cells possess key differences, along with an important similarity. Fuel cells do not need to be recharged. Instead, operators refuel a tank of hydrogen, more similar to the process and time spent refueling an ICE than lengthy battery charging. But while diesel-powered vehicles produce GHG emissions during operation, equipment powered by hydrogen fuel cells only emits water and heat.

The space requirements for hydrogen refueling stations are in part determined by the time necessary to refuel and the associated run time. For large equipment with big tanks, it takes up to 15 minutes to fill an empty tank – enough for eight to 10 hours of continuous run time. This means that hydrogen-powered units do not need to refuel as frequently as their battery electric counterparts need to recharge, nor do they spend nearly as much time parked at refueling stations. In general, powering equipment with hydrogen requires less infrastructure and space than relying solely on battery power in many applications.

// HOW DO HYDROGEN FUEL CELLS ACTUALLY WORK?

Hydrogen fuel cells work in tandem with an onboard lithium-ion battery. The fuel cell can power equipment directly or charge the onboard lithium-ion battery, which can also power equipment and capture regenerative energy from braking and load lowering.

In practice, the goal is to draw power from the path of least resistance, prioritize efficiency, avoid drivetrain loss and extend the life of the fuel cells and batteries. To maximize the useful life of the fuel cell, it should run continuously, rather than cycling on and off intermittently.

For example, take a setup with two 45 kW onboard fuel cells. Avoiding the burden of maximum output means drawing 35 kW from each for 70 kW total. If the vehicle requires more than 70 kW at a given time, the battery power activates, too. Or, if less than 30 kW is required, the battery provides power, but the fuel cell stays on to avoid cycling intermittently – instead, it charges the lithium-ion battery.

// SOURCING HYDROGEN FUEL

Hydrogen fuel can be generated on-site or delivered to storage and fueling stations. The amount of hydrogen an operation uses is a critical factor to determine what method of hydrogen sourcing makes sense. For a single truck, using a bundle of hydrogen tanks is sufficient, but when consumption hits 200 kg per day, delivery with a tube trailer is appropriate. When consumption passes 800 kg per day, on-site generation starts to make more sense. Location can also dictate the economics of trucking in hydrogen, as on-site generation becomes increasingly attractive with greater delivery distance.

Finally, note that neither hydrogen nor electricity are primary fuels, so understanding the complete carbon impact requires looking at the feedstocks from which it is produced. Two examples of hydrogen production processes are thermochemical and electrochemical. Thermochemical processes use natural gas, coal or biomass to extract hydrogen molecules. Electrochemical processes like electrolysis use electricity to split water into hydrogen and oxygen. There are even some electrolytic systems in development that use renewable energy. Currently, fossil fuels account for 96% of hydrogen production, with the remaining 4% produced through a wide variety of alternative sources.

// THE FULL POTENTIAL OF HYDROGEN AT PORTS

The application of hydrogen in port settings can go beyond upgrading fleets of reach stackers and container handlers. Hydrogen fuel cells can also power the terminal tractors ports use to transport shipping containers inside the yard.

Hamburger Hafen und Logistik AG (HHLA) recently agreed to be a real-world test center for an empty container handler and terminal tractor powered by hydrogen fuel cells. The equipment will be deployed at HHLA Container Terminal Tollerort (CTT) in Hamburg in late 2022 and early 2023. Future plans include equipping CTT with hydrogen refueling infrastructure and connecting it to the future Hamburg hydrogen grid. Fuel cell-powered equipment is a key component of the Clean Port and Logistics program, a joint initiative of HHLA and other European companies, and HHLA's H2LOAD project that aims to achieve climate neutrality across the HHLA group by 2040.

Efforts to implement hydrogen fuel cells are also underway at U.S. ports. The California Air Resources Board awarded a grant to support the development of a zero-emission container handler for use in the Port of Los Angeles. Powered by a hydrogen fuel cell, the top-pick container handler is scheduled to begin testing at the Fenix Marine terminal in the second half of 2022.

// LOOKING TO THE FUTURE

The development of hydrogen infrastructure and hydrogen fuel cell-powered equipment is happening now. Not only are real-world deployments of port equipment powered by hydrogen fuel cells planned for the near future, major companies are joining forces to build a regional hydrogen network to produce and distribute hydrogen fuel at scale.

As ports consider how best to electrify, consult with an expert to understand whether hydrogen is the right long-term fit. To learn more, visit **Hyster.com**.