"In commercial vehicles, there are many things that are specialized," Reeser said. "Instead of using the 12V system everyone designed to with ICE vehicles, you might use 400V for a wheelchair lift or the air conditioner; 400V is more efficient, you just need to develop that wiring harness and the CAN bus."

While moving trucks and buses down the road is a primary design focus, it may not be the only engineering challenge. Battery packs may be enlisted to help support the nation's power grid and avoid brownouts. Executives also noted that California is exploring techniques for using school bus batteries to help utility companies when grids are strained.

Bus battery packs typically can be charged at night, when utility rates and demand both are low, and potentially transfer energy back to the grid on days when demand is high. That's especially effective in summer and on weekends, when buses often sit idle. However, Bettis noted that this program will take a lot of cooperation between vehicle owners and utilities.

Supply-chain challenges

Regardless of how batteries are used, supply-chain issues remain a major challenge for production of both repowered and new vehicles. Getting chassis has been difficult, and many components are in short supply.

"The challenges are multifold," Reeser said. "It's not just the chassis, it's hard to get transmission control modules and chips. It's also hard to get wiring harnesses and connectors. I do think in the next nine months we'll come out of that. We've added new suppliers and we've gone to vertical integration. Making our own components is being done out of necessity, not because we necessarily wanted to."

The need for new designs is fueling expansion at Lightning's 1 million square-foot facility in Loveland, Colorado. The company added 60 engineers and 15 service-team members last year, bringing the total employee count to around 250.

Terry Costlow

FLOW CONTROL

Emerson supports scalability of fuel cell systems

To produce enough hydrogen fuel cell systems to supply fleets, manufacturers need to quickly scale up in terms of resources, factory extension and procurement efficiency.

'Green' hydrogen is a promising fuel on the path to decarbonizing the mobility sector, proven by significant investments in many transportation projects and technologies. New fuel-cell electric vehicle (FCEV) truck designs continue to enter testing stages, with some manufacturers planning to launch fleets as early as this year. The technology is even celebrating big milestones: In January, an electric-hydrogen-powered truck debuted in the 2022 Dakar Rally, and in 2021, a hydrogen-powered fleet drove over 1 million km (620,000 miles) in 11 months using its 46 trucks.

Many in the commercial-vehicle market see hydrogen fuel cells as a viable way to decarbonize transportation around the world. Unlike their battery-electric alternative, hydrogen fuel cells are lightweight and allow commercial trucks to maintain relatively the same haul tonnage as their diesel equivalent. Hydrogen fuel has a high energy density and is stored at high pressures, ensuring an advantage when it comes to onboard storage footprint. Hydrogen tanks can also be refueled in as little as five minutes, minimizing transit time for long-haul routes.

Even with so many advantages, some manufacturers still worry about scalability, while others are concerned about the safety and efficiency of hydrogen as a fuel source. The good news is there are proven ways to scale up production for hydrogen fuel cell technology, as well as available solutions that can improve system safety, reliability and efficiency.

Controlling fuel flow

Due to its low ambient temperature density, hydrogen gas has a low energy-per-unit volume that requires the element to be highly pressurized when used as fuel. In onboard storage tanks, the fuel is typically subject to pressures of either 35 or 70 MPa (5,075 or 10,150 psi). These high pressures, combined with the hydrogen molecule's small size, make the gas very susceptible to leaks. It is critical that fuel cell technology safely, reliably and efficiently controls the flow of the hydrogen fuel within FCEVs. Regulators and proportional valves engineered for hydrogen fuel cell systems are being designed with safety in mind to provide stable pressure

It is critical that fuel cell technology safely, reliably and efficiently controls the flow of the hydrogen fuel within FCEVs, said Emerson's Akilah Doyle.

BOTH IMAGES: EMERSON

The short stroke of the ASCO Series 238 Pilot General Service Solenoid Valve from Emerson increases cycle life, while its compact construction reportedly reduces installation time and simplifies service.

regulation and reliable flow control.

Systems also should be designed with optimal performance and easy manufacturability as concerns. High pressure fluctuations, especially during vehicle starts and stops, result in reduced performance of fuel cell systems. Pressure-reducing regulators, such as **Emerson**'s TESCOM HV-3500 Series hydrogen onboard regulator or the TESCOM 20-1200 Series hydrogen pressure regulator, can help maximize fuel cell efficiency by controlling that high pressure. With high leak integrity, a dual-stage, positive seal design can stabilize outlet pressure to prevent decaying inlet characteristic and leakage, which improves fuel cell operation and maximizes overall energy efficiency. A specially designed rectangular shape and mounting holes also simplify installation and enable OEMs to quickly secure the regulator to existing panels and frames in the fuel cell system.

Long service life also is important for regulators. The 20-1200 Series with a piston-sensing design, for example, has been successfully implemented into systems that have received EC-79 certification and is specifically designed for pressure control onboard hydrogen FCEVs. Suitable for inlet pressures up to 70 MPa, the regulator also includes an integrated 10-micron filter that prevents installation contamination.

In addition to regulators, proportional valves are key to hydrogen fuel cell system designs. It's beneficial to look for proportional valves that can precisely control hydrogen fuel flow rates while remaining lightweight and easy to install. Some suppliers also offer flexible engineering services to supply customized manifold solutions for the fuel cell inlet module, such as a shutoff valve with proportional valve to accompany the pressure regulator or drain modules, such as a drain valve with a water separator and check valve. This level of partnership allows OEMs to obtain high-reliability flow control, pressure regulators, safety junction boxes and flameproof cable glands, as well as educational services and support from a single source, simplifying the supply chain.

Collaborative engineering

Well over 800,000 hydrogen fuel-cell trucks and goods-carrying commercial vehicles will be sold by 2035, according to a September 2021 report by Research and Markets. While this rapid growth makes it a lucrative time to be in the FCEV truck market, it can also make it difficult to scale designs and capacity to meet demand.

Emerson's TESCOM HV-3500 Series hydrogen onboard regulator is specially designed to maximize fuel cell efficiency in commercial fuel-cell vehicles.

To produce enough hydrogen fuel cell systems to supply fleets, manufacturers need to quickly scale up in terms of resources, factory extension and procurement efficiency. One way OEMs can achieve this is by working closely with supplier partners that have successfully adapted their products as needs have grown or changed.

OEMs of all sizes and capabilities are emerging in the hydrogen market. Some may understand all aspects of their unique design process, while others may need help to optimize their current solutions. Educational resources, such as a collaborative engineering workshop, can help OEMs integrate emerging hydrogen technology and design best practices to develop cost-saving strategies and accelerate their new technologies. In such workshops, OEMs work with engineers and product experts to identify performance metrics and requirement definitions, create strategies that integrate findings, learn about application-specific technology options, pilots, and more.

Hydrogen fuel cell systems and FCEV trucks have the potential for exponential growth in carbon-neutral transport. Scalability depends on safe and efficient operation that complies with high regulatory standards while providing long fuel-cell life and reduced downtime. While the transition to alternative fuels will not be instantaneous, a scalable approach will reduce risk while making meaningful progress. Selecting the right technologies, processes and partners is critical as hydrogen fuel cell technology and FCEV truck providers help launch the fleets of the future now.

Akilah Doyle, product marketing manager, TESCOM, at Emerson, wrote this article for *TOHE*. She holds a bachelor's degree in electrical engineering from the Georgia Institute of Technology and an MBA from Emory University.

BOTH IMAGES: EMERSON