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FEATURES

ON THE COVER

Experts believe that eventually every EV will have bi-directional charging capability, turning vehicles into mobile power sources that can even power homes during lights-out emergencies. Ford is among the current leaders in this technology, as our cover feature on page 14 explains. (Ford)

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REGULARS

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EDITORIAL

Optimizing EV platforms for pickup trucks

Pickups are the industry's most popular and profitable product because they offer individualized vehicles for nearly every customer and use case. American pickups wrote the book on mass customization long before the German luxury brands discovered carbon fiber armrests and color-matched seat stitching. Need a long-box diesel dually with 3.42 axles, full leather interior, set up for 5th-wheel towing? A short-bed, extended-cab work truck? Or the 4-door/short-bed/4x4 combo that dominates the light-truck landscape? Step right up for any configuration; the OEMs will build your truck.

Chalk that up to the pickup's body-on-frame architecture. Its "old school" ladder frame supports the easy cab, bed, and driveline mix-n'-match that the truck market loves and expects. That proven platform approach, however, also drives nightmarish complexity in the assembly plant. Even with a focus in recent years on reducing build combinations and consolidating options, the hypothetical bills-of-material for F-Series, Ram and Silverado are staggering. Myriad drivelines, frames, cabs, cargo beds, axle capacities, cooling systems, wheel-and-tire combos, towing packages, wiring harnesses, paint schemes, work/fleet models! Throw in scores of trim and accessory choices and the potential permutations of any given model can run into the hundreds of thousands (it was in the millions during the late 1990s). It also can make spec'ing out a new pickup daunting.

Electric propulsion, of course, offers new architecture solutions and reduced BoM. And therein lies a strategic question: What is the optimum structure for future electric pickup trucks that will best satisfy the segment's diverse use cases? As 2022 unfolds, we see Ford with one approach on F-Series and GM with another for Silverado EV (see page 12).

What structure for future electric pickups will best satisfy the segment's diverse users?

Specifics regarding the electric Ram's underpinnings are not yet public.

In developing the F-150 Lightning, Ford decided to stick with the familiar steel ladder frame incorporating the battery pack and other EV hardware. This is the no-compromise, low-risk approach that still can easily deliver the less popular cab/bed configurations that Ford-loyalist farmers, tradespeople and other practical users demand.

Conversely, GM has taken the risky approach that I reckon may test the loyalty of some Chevy and GMC die-hards. Like its Hummer EV cousin, the electric Silverado uses an all-new architecture based on GM's skateboard-influenced Ultium battery platform. "It's not a unibody structure, and it's not body-on-frame," Silverado EV chief engineer Nicole Kraatz told me. "It's... in between them," she said. The overall design is not amenable to easy cab/bed mix n' match. It means Silverado EV buyers, at least initially, can only get a 4-door cab and short bed. To mitigate this, the cab features a "midgate" that opens to allow long-but-narrow cargo to pass through, thus extending the small bed's length.

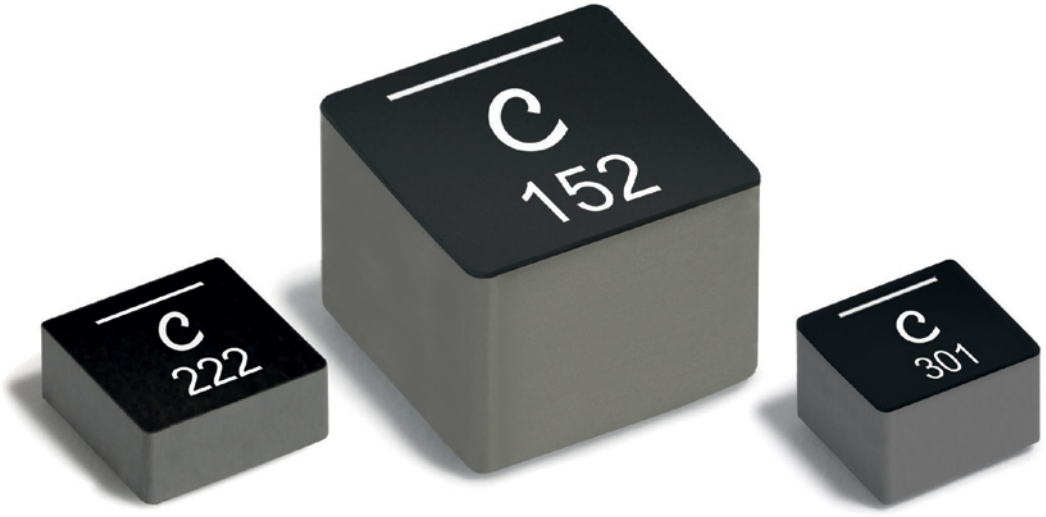
It's a configuration that my friend Dave, whose landscaping business rides exclusively on Chevies, says is a non-starter.

"First, EV pickups can't do the jobs I need them to do, like pushing snow for 10 hours without refueling, as my Duramax trucks can do," he told me recently over a beer. "Now you're saying if I wanted an electric truck, I can't get a regular cab or extended cab...or longer beds!" I told Dave about Silverado EV's midgate feature. He called it fine for carrying long lumber, but not for hauling his big spraying tanks and mowers.

"Will I have to start driving *Fords* now?" Dave asked me with a smirk. He was only half joking.

Lindsay Brooke, Editor-in-Chief

The (lowest) Loss Leaders



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SUPPLIER EYE

Time to turn 'BEV' into a verb

Happy trails to 2021! While vehicle dealers made record profits, most of the industry is overjoyed to place this chip-starved, labor-deprived, and cost-escalated year in the rearview mirror. Despite the constant supply line interruptions and the erratic schedules impacting vehicle output the world over, it was a critical year for the future of the battery-electric vehicle.

Virtually every global vehicle OEM significantly built upon or upwardly revised investment plans for future propulsion battery and BEV production and development. Billions in capital are now devoted to the foundation for the BEV's future.

Though my Grade 2 (that's Canadian for 2nd grade) teacher would surely cringe, I'm officially turning 'BEV' into a verb. To 'BEV' is the activity of increasing Battery Electric Vehicle production or building components/systems for this emerging propulsion format. BEVing is more than just increasing capacity to build BEVs, batteries and e-drive systems. It entails a wholesale shift in the value chain, the cadence/lifecycles, skills and alliances required, how the dealer network fits into this complex equation, and downstream revenue opportunities for all players within the ecosystem.

In light of this shift, virtually every supplier now must determine its trajectory from a perspective within the electrified propulsion supply chain. Strategically, each supplier has or will need to establish whether its technology, relationships and processes are BEV-Negative, BEV-Agnostic or BEV-Positive. Now more than ever before, ensuring that strategy is optimized for the growth of BEV volume and the commensurate shifts in value-add and lifecycles is key to future competitiveness. OEMs are using this transformation to ensure they control those aspects of the BEV which can truly differentiate, and bolster value.

Michael Robinet
Executive Director, IHS Markit
SAE Foundation Trustee
michael.robinet@ihsmarkit.com

Virtually every supplier now must determine its trajectory from a perspective within the electrified-propulsion supply chain.

Let's delve into this further. The classic BEV-Negative sectors are fuel, exhaust and powertrain/ driveline. While there are other sectors heavily impacted by this new propulsion format these are either eliminated or altered substantially as an organization BEVs.

Basic questions emerge: What is the trajectory of the remaining ICE volumes? Will the lifecycles lengthen, and the associated technologies stagnate? Can the production processes or material capabilities transfer to BEV associated systems?

In the end, all suppliers need to understand their prospective role in the new ecosystem. Specifically, those in BEV-Negative sectors need to establish if 1) they are going to shift to a new, more BEV-focused system; 2) sustain the current path and limit capital/new resources to 'cash cow' their position for the next few cycles; 3) become a consolidator in their space by eliminating capacity and reducing the number of players, or 4) or simply sell off or close up shop when the volumes and or financial returns become unsustainable. These considerations will determine their long-term fate.

While the true trajectory of BEV volume through the balance of the decade will surely be debated, we are well past a simple small investment or skunk-works-level initiative when BEVs are considered. Massive investments, structural shifts in development capabilities, new alliances and commitments underscore that we are past the point of no return for many participants.

The industry is going to BEV. The question is at what pace and how all the players conform to this new reality. ■

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TECHNOLOGY REPORT

SENSORS

Valeo debuts new lidars, EV tech at CES 2022

It may look like a full-size commercial van, but Valeo's eDeliver4U droid for last-mile routes is actually a small robot.

The breadth of **Valeo**'s news announcements during CES 2022 effectively showcased just how much the show has turned into an automotive tech event. From autonomous driving technologies to powertrain electrification to adapting to a world with too much COVID in it, Valeo had something to offer vehicle makers through its sensors and software.

Third-gen lidar

Valeo's big introduction at CES was the world premiere of its third-generation lidar scanner. Valeo deputy CEO Christophe Périllat said during his company's digital press conference that lidar tech is required to move automated driver assistance systems (ADAS) beyond SAE Level 2. Valeo has experience here; Périllat claimed that one in three new cars produced worldwide today is fitted with the company's driving assistance technologies.

"The overall ADAS market is set to grow three times by 2030," he said. "What is the challenge of ADAS? It's to make mobility safer and lidar is a key part of it. There will be no [SAE] Level 3 autonomy without a lidar sensor."

One of the first production vehicles capable of Level 3 autonomy is the Mercedes-Benz S-Class; it uses Valeo's current (second-gen) SCALA lidar technology. Valeo's third-gen lidar adds a predictive algorithm to track objects – vehicles, cyclists and pedestrians – when they move out of sight, anticipating their trajectories, even at speeds up to 130 km/h (81 mph). The scanner is also able to use the cloud to alert nearby cars of potential road hazards. Périllat said the third-gen lidar could be on the road in new "autonomous" cars starting in 2024.

Near-field lidar (NFL)

Valeo also unveiled a new solid-state flash lidar for near-field application. This NFL provides 360-degree near-field vision for autonomous delivery droids or robotaxis. The idea for these driverless vehicles is to create a "safety cocoon" around the vehicle, Périllat said, using unparalleled vertical and horizontal views and image resolution. Valeo said that using this kind of NFL provides redundancy with other sensors, making automated driving safer by eliminating blind spots.

Powering new EVs

On the powertrain side, the most exciting new electric passenger car with Valeo components is the **Mercedes-Benz** EQS, which uses a Valeo-**Siemens** eAutomotive electric powertrain with two motors. The rear eAxle provides 300 kW of power, while the front axle contributes 170 kW.

At CES, Valeo also displayed an all-electric 48V motorcycle and a 48V electric cycle-assistance setup called the Valeo Smart eBike System. The new e-bike weighs less than 38 lb. (17 kg) and its overall performance is roughly equivalent to that of a 125-cc IC-engine machine, the company said.

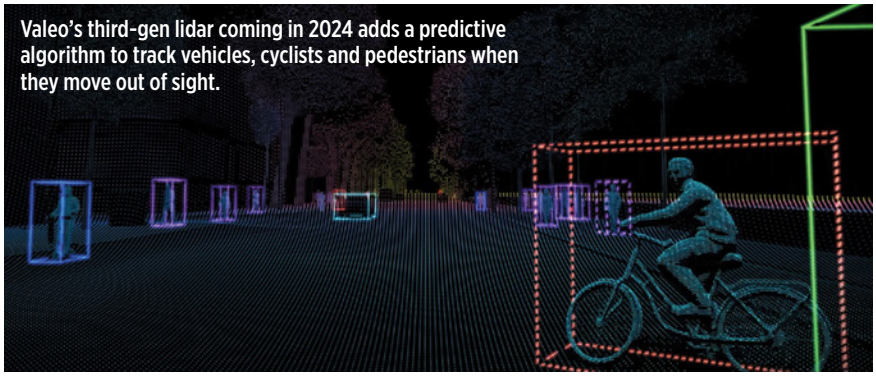
Valeo also showed off an autonomous, intelligent last-mile delivery robot called the eDeliver4U. This droid uses Valeo's electric portrait systems sensors, software, sensor cleaning systems and lighting systems to move on its own and communicate with its environment. The eDeliver4U also uses a 48-V system and can travel at around 7.5 mph (12 km/h) with about 60 miles' range (96.5 km) between charges.

Valeo said a 48-V system is particularly well suited to small urban vehicles (its 2018 48-V

VALEO

system was installed in a small city car), and it offers a cost-effective way of electrifying vehicles. One reason is that so much more of the on-board energy gets used, with over 90% of the power generated by the electric motor reaching the rear wheel compared to about a third from an IC engine.

During Valeo's CES media briefing, Périllat noted that by the end of 2022, nearly 100 electric and plug-in hybrid models will be fitted with the company's powertrain systems, which will be a growing source of revenue in the coming years. "For Valeo, electrification means greater value," he said.



Valeo's third-gen lidar coming in 2024 adds a predictive algorithm to track vehicles, cyclists and pedestrians when they move out of sight.

VALEO

Intelligent interiors

Valeo at CES demonstrated a number of technologies that make the in-vehicle experience more comfortable and convenient. An intelligent lighting system not only lights up the road in front of the car, but also uses augmented-reality (AR) alerts on the windshield to alert the driver to potential hazards by pointing out cyclists on the side of the road or known potholes.

The Valeo Safe Insight technology is meant to keep vehicle occupants safe as well, combining a driver monitoring system with interior sensors to detect if someone is left inside a parked car (a child, for example). Valeo also won a CES 2022 Innovation Award for its UV Air Purifier, which was designed to sterilize the air in buses and other public transportation vehicles. The company said its system can eliminate bacteria, germs and more than 95% of viruses, including COVID-19. Over 2,000 buses around the world have already been equipped with this system.

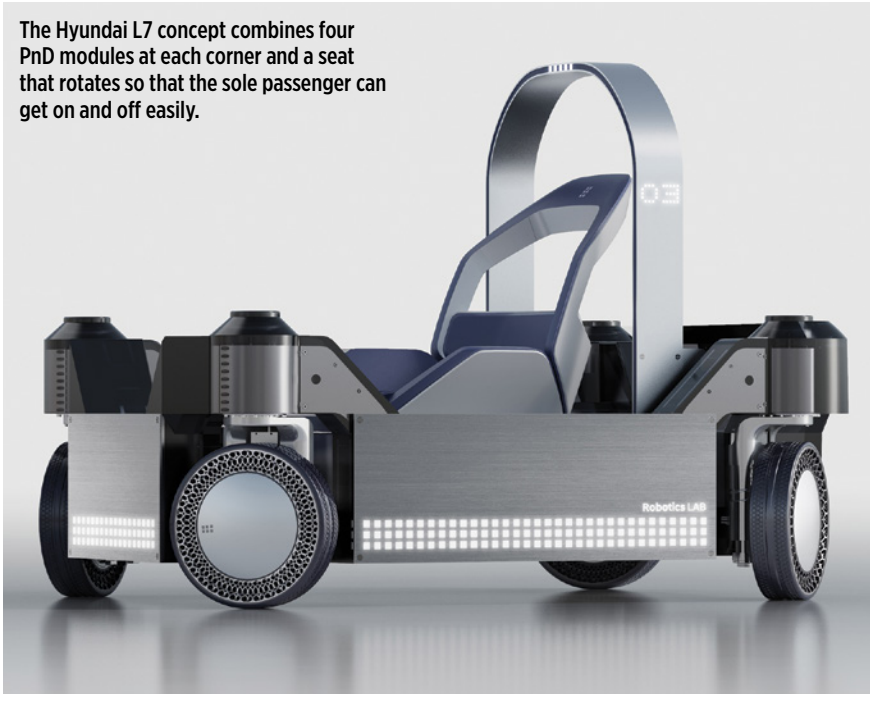
Sebastian Blanco

NEW MOBILITY

Hyundai enters the metaverse via its PnD technology

When **Facebook** announced last October that it was changing its name to **Meta**, most wondered whether people would want to spend as much time in a virtual world as they do on the platforms browsing pics, posts and political rants. At CES 2022, **Hyundai Motor Group** announced that it is jumping into the metaverse for what it calls "Metamobility" purposes, which potentially could be much more beneficial for transportation, manufacturing and society at large than Facebook's digital playground.

Hyundai's Metamobility vision marries emerging trends such as robotics, virtual reality and "digital twin" technology with the company's traditional competencies in personal mobility and manufacturing, while revealing how it will leverage its acquisition last year of robot developer **Boston Dynamics**. The Korean automaker unveiled several new hardware solutions that will help it achieve its overarching goal of "Expanding Human Reach," including a linchpin Plug & Drive (PnD) modular platform that can autonomously move people and goods.



The Hyundai L7 concept combines four PnD modules at each corner and a seat that rotates so that the sole passenger can get on and off easily.

Hyundai's PnD module is an automated, electric-powered single-wheel design incorporating in-wheel motors, suspension components, lidar sensors and cameras.

The PnD module is an automated, electric-powered, single-wheel design that incorporates motors and suspension components as well as lidar sensors and cameras. Hyundai says the PnD modules "can be scaled up or down, for any purpose, size or application," and use "a steering actuator for infinite wheel rotation, meaning it can turn 360 degrees, which enables holonomic movement, like a figure skater."

Multiple applications

At CES, Hyundai showed four primary application concepts enabled by the PnD platform: Personal Mobility, Service Mobility, Logistics Mobility and L7. The Personal Mobility concept is equipped with four 5.5-inch (14-cm) PnD modules and is intended to provide mobility for a single passenger. It uses rotary doors to save space and operates via a joystick. The PnD-powered Personal Mobility modules can also attach to a "mother shuttle" to form bus-like transport but detach to take occupants directly to their final destination.

Using the same PnD platform, the Service Mobility and Logistic Mobility concepts have drawer-like storage bins. Hyundai envisions the Service Mobility unit as being used for "diverse applications, such as transporting customers' luggage in hotels," while the Logistics Mobility is designed for moving materials and goods in industrial environments. The L7 combines four larger 12-inch (30-cm) PnD modules at each corner and a seat that rotates so that passengers can get on and off easily. It is operated with a joystick and can also be reconfigured sans seat to carry packages or equipment for logistic applications.

In addition, Hyundai unveiled a Drive

BOTH IMAGES: HYUNDAI

Hyundai's Personal Mobility concept is intended to provide mobility for a single passenger, uses rotary doors to save space and operates via a joystick.

HYUNDAI

and Lift (DnL) modular mobility system that, like PnD, integrates drive, steering and braking systems into a single module, but with a rotating arm that allows each wheel to articulate and lift independently. This allows for mobility on uneven terrain while keeping a load level or even the ability to climb small steps. One application for DnL Hyundai showed at CES is MobED, a bot with a 2-kWh battery and a tabletlike screen on an articulating arm that could be used as a robotic tour guide or assistant.

Time and place irrelevant

While Hyundai's "Mobility of Things" vision sounds like something out of science fiction – and perhaps CES "vaporware" – the underlying technology has immediate real-world applications when tied together with virtual reality and digital-twin tech. (During Hyundai's CES press conference, Boston Dynamics founder and chairman Marc Raibert came up with a prefect analogy to explain the concept of a digital twin: a car's in-dash navigation system that displays a digital version of the real world outside.)

For example, using a robot with Hyundai's PnD platform and leveraging virtual reality and digital-twin technology, a person could access their home from halfway around the globe to check in and interact with family members or care and feed a pet.

Raibert also gave the example of a robot being able to assist an elderly person in getting dressed, rather than placing the burden on family members or paying for in-home human care. He added that such robots could also be used in nursing homes, which will be a growing – and lucrative – market as the aging population grows.

Perhaps the most immediate application and payoff of the technology will be for industrial applications. For example, a team of engineers in the U.S. could be virtually onsite at a factory in Korea – or anywhere in the word – to evaluate a design or diagnose an issue. By setting up a metauniverse, people will be able to move freely between the physical and virtual worlds, according to Chang Song, president and head of Hyundai's transportation-as-a-service division. "Time and place become irrelevant," he said, "and we'll be able to move people and resources in a whole new way, expanding human reach."

Real application coming soon

Beyond the PnD-based forward-looking mobility concepts Hyundai showed at CES, company executives who spoke were less clear about how the new technology will be used in the company's bread-and-butter vehicle-manufacturing and sales business. Song mentioned that the technology eventually will be applied to Hyundai "cars, robots and UAVs," the unmanned aerial vehicles that the company is developing and plans to deploy through its Supernal division.

Raibert was candid when he mentioned in the CES press briefing that "it's still a question on how to integrate the technology with automotive and we're tasked with figuring it out." But he added that industrial duties can be done more efficiently using PnD and related technologies. "It will be much more applicable in manufacturing," he said. "That's almost a no-brainer."

Hyundai Motor Group chairman Euisun Chung said during the CES press conference that he sees metamobility as a "natural extension of our mobility services".

Song added that while the PnD technology is conceptual at this point, Hyundai is "thinking about mass production and we'll show the real application soon."

Doug Newcomb

ELECTRIFICATION

GM unveils 2024 Chevrolet Silverado EV

The 2024 Silverado EV uses a unique vehicle architecture that limits its cab/chassis configurations to one.

General Motors has fired its first salvo in the high-volume electric vehicle wars, unveiling two versions of the 2024 **Chevrolet** Silverado EV that bring formidable feature content, evolutionary style and impressive performance claims – along with some questions – to what will eventually be GM's most important product. The new pickup's January 5 online debut, also the start of customer reservations, disappointed those who had expected to see the truck live at CES 2022, on the Las Vegas stage with CEO Mary Barra.

SAE Media attended an in-person preview of the $105,000 RST-First Edition version and the decontented $39,900 WT (work truck) in Warren, Michigan, hosted by the program's engineering, design and marketing leads. While not all of Silverado EV's technical specs have yet been announced – and EPA testing won't be completed until closer to the vehicle's mid-2023 production – the long list of details as we know them include:

Range: GM estimates 400-mile (644-km) range capability for both the RST and WT models, under ideal thermal conditions and duty cycle. The estimate, based on analytical projections consistent with SAE J1634 revision 2017-MCT, is roughly 33% greater than Ford's electric F-150 Lightning.

Barra promises $30K EV SUV by fall 2023; automated driving by mid-decade

In a January 5 keynote presentation at CES 2022, General Motors CEO Mary Barra did more than unveil an electric version of one of the company's profit powerhouses, the Chevrolet Silverado pickup truck. She also pledged GM will build an EV variant of Chevy's Equinox compact SUV that will be in showrooms by fall 2023 for a base MSRP of "around $30,000."

That price point that would make the 2024 Equinox EV only marginally more expensive than today's conventionally powered model, which starts at $26,995. "As our most popular vehicle brand," Barra said, "Chevy will be front and center in our mission to provide EVs for everyone. We're at the tipping point of electrification and we expect this to be a massive year for Chevrolet's EV future."

The 2024 Equinox EV's projected starting price suggests GM projects considerable cost-efficiency from scaling its Ultium lithium-ion battery architecture, as well as vehicle platforms optimized to use the new battery technology. The company currently has large Ultium manufacturing sites under construction in Ohio and Tennessee, in collaboration with partner **LG Chem**. Barra also confirmed GM will build an EV variant of the Blazer SUV which will precede the Equinox EV by coming to market in Spring 2023. The company has pledged to have 30 EV models available globally by 2025 and transform its entire light-duty vehicle lineup to EVs by 2035.

She also detailed the **Cadillac** luxury unit's ambitions to offer a range of premium, expressive EVs that include the "hand-built and hand-crafted" Celestiq – and presumably an eventual EV variant of the brand's signature Escalade fullsize SUV. "No other automaker today matches the depth and range of GM's EV portfolio," Barra asserted, adding about the company's ambitious strategy: "Make no mistake – this is a movement."

Barra didn't stop with electrification. Speaking of GM's ongoing and varied initiatives to develop high-level (SAE Level 3-4) driving automation. "We are looking further down the road at opportunities to extend fully-autonomous vehicle technology to personal transportation with the safety and quality our consumers expect." She said GM and **Cruise** – the company's unit developing high-level driving automation for rideshare or "robo-taxi" applications – "are gaining significant technological expertise and experience. We are working to be fastest to market with a retail personal autonomous vehicle. In fact, we aim to deliver our first personal autonomous vehicles as soon as the middle of this decade."

General Motors CEO Mary Barra said the 2024 Equinox EV is targeted for a base price of around $30,000, little more than today's ICE-powered Equinox. Watch for a pickup spinoff.

Barra said today's efforts and the subsequent automated models targeted for both commercial and personal use will help create economies of scale to help lower the cost and increase the quality of rideshare experiences and bring the advance of driving automation "to a much larger audience." Teams from GM and Cruise, she added, will continue to work together to create a range of personal autonomous vehicles.

Bill Visnic

FROM TOP: CHEVROLET; GM

Silverado EV's flexible Midgate cab helps mitigate hauling longer cargo.

CHEVROLET

Propulsion: Silverado EV shares its 200-kWh Ultium lithium-ion battery pack with the **GMC** Hummer EV, according to chief engineer Nicole Kraatz. Packaging of the drive units and DC inverter (one traction motor for each axle on AWD variants) is unique to the Chevy pickup for a more compact layout than on the Hummer.

Output: RST models will deliver SAE-rated 664 hp (495 kW) and more than 780 lb-ft (1,057 Nm) in what GM calls 'Wide Open Watts Mode' enabled by unique control software. Kraatz said simulations show RST models to be capable of 0-60 mph acceleration in less than 4.5 seconds. WT models will generate 510 hp (380 kW) and 615 lb-ft (833 Nm).

Charging: Standard DC fast charging using 800-V public chargers will deliver up to 350 kW, adding about 100 miles (161 km) of range in 10 minutes, GM claims. Both Silverado EV models can produce up to 10.2 kW of off-board power, distributed across 10 outlets (two of them each provide 240V) on the vehicle.

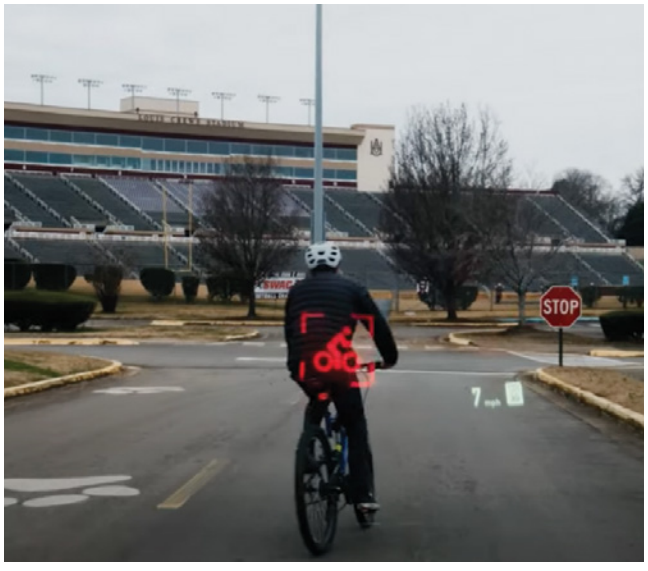
Towing: Estimated up to 10,000 lb. (4,336 kg) of maximum trailering with up to 1,300 lb (590 kg) of payload on RST, and 8,000 lb. (3,629 kg) and 1,200 lb. (544 kg) payload on WT. The ground-to-tailgate load height on the RST 4WD Silverado EV at our preview measured 35.5 in. (901 mm).

At the truck's Jan. 5 reveal during CES, GM CEO Mary Barra added that there will be a Trail Boss trim available for the Silverado EV. The raised-suspension Trail Boss package "taps into our strong foundation of capable, factory-lifted trucks," Barra said. Super Cruise, GM's SAE Level 2 ADAS package with trailer-control will deploy as standard on RST-First Edition models, as will a hefty 24-inch wheel/tire combination. WT models ride on 18-in. wheels. A towing package rated at up to 20,000 lb (9,071 kg) is being readied for WT models after initial launch.

Lindsay Brooke

SAFETY

Panasonic augments driver safety with new HUD tech



Panasonic's AR HUD expands the display viewing rectangle far beyond the windshield, placing information into the driver's world (such as an alert that a bicycle lane is approaching) that will enhance it.

At CES 2022 **Panasonic** Automotive Systems Company of America unveiled AR HUD 2.0 (Augmented Reality Head-Up Display 2.0), the first system to include a new, patented eye-tracking system (ETS).

If you've ever thought about what exists beyond the limits of a HUD and the small rectangular box it displays on the windshield, welcome to the world of AR. And note that AR is not VR, Virtual Reality; VR is a space in which headsets or special glasses allow the wearer to experience a 3D world that doesn't exist except in this technology. It's increasingly used in automotive interior design.

Panasonic's AR HUD expands that small viewing rectangle far beyond the windshield out into the real world, placing information into your world that will not change your world but will enhance it. For example, it's raining and you can't see a traffic light. AR can add that stop light to the field of view.

"2.0," explained Andrew Poliak, Panasonic Automotive Systems Company of America's CTO, "is the patented ETS technology that identifies the individual driver's height and head movement behind the wheel and dynamically adjusts and compensates the images in the 'eye box.'"

Drivers constantly shift their head and change their line of sight, but with parallax alignment and dynamic autofocus working together in the Panasonic HUD system, drivers will see only accurately positioned, crisp, high-resolution overlays and icons. The driver's experience is powered by AI (Augmented Intelligence, a sub-category of artificial intelligence) navigation software which intelligently matches the changing environment with 3D AR overlays, icons and mapping, providing an intuitive awareness of the situation and surrounding environment. The 3D is simulated using a tilted, dual-image plane – providing 3D at what Panasonic claims is the cost of 2D.

As Poliak explained: "Today we are just mapping the virtual world over the real world."

Even in its latest iteration, AR HUD 2.0 is a benign technology. It is not connected to a vehicle's ADAS (advanced driver-assistance system). Instead, it enhances the driving experience and helps drivers make more intelligent decisions regarding navigation and safety related issues, the company said.

However, as the auto industry moves to more automated driving, Panasonic's technology will evolve to integrate with a vehicle's ADAS.

What makes Panasonic's AR HUD 2.0 technology different? According to Hans Troemel Jr., the company's advanced engineering vision & sensing group manager, "We are unique in having experience right down to the component level with every technology required to design these systems. Our breath and our depth are a big advantage over the competition."

Panasonic employs a user-experience group that surveys customers for answers to such questions as, "How much and what types of information do customers want displayed and when?"

"For example," Troemel continues, "Driver distraction is a major safety issue today. Based on feedback we've received, we are starting to enable machine learning functions in the vehicle so that the system learns what info the driver wants displayed and when. Reducing the cognitive load is critical to the driver. We can customize the experience for each driver.

"We've gotten a lot of good feedback from our user-experience groups telling us that once you experience this technology, you really don't want to go back."

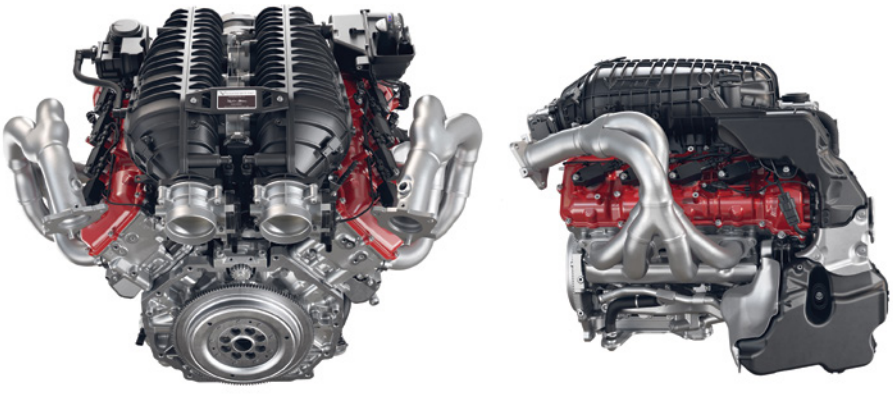
John Dinkel

PANASONIC

PROPULSION

Unique Helmholtz induction for new GM LT6 V8

The 2023 Corvette Z06 recently arrived, powered by a 5.5-L LT6 V8 spinning a radical flat-plane crankshaft. Now that additional engineering details have emerged, the LT6's top hat has supplanted its crankshaft as this engine's most interesting feature. That topper – an active induction system – is capable of filling this DOHC V8 with the air needed to produce SAE-certified 670 hp (499 kW; 121.8 hp/L) at 8400 rpm without any kind of supercharging.



In creating the LT6's sophisticated intake manifold, GM powertrain engineers optimized both volumetric efficiency and package efficiency.

Let the record show that the LT6 is the most powerful naturally aspirated V8 ever produced. The 6.6-L 622-hp (94.2 hp/L) M159 engine energizing the Mercedes-Benz SLS AMG Black Series coupe has been bumped down to second place. While exemplary output qualifies the Z06 as a legitimate supercar, bountiful torque is what owners will most appreciate on the street.

To maximize twist, GM engineers tapped a phenomenon discovered in the 19th century by German physicist Hermann von Helmholtz: that air vibrating inside a closed chamber at a pressure slightly above atmospheric produces the sounds emanating from guitars and whistles. What we now call Helmholtz resonance is the technology underlying the positive intake manifold pressures that inflate the LT6's torque curve over a broad rpm range.

Standing tall between this V8's red-painted cam covers, the LT6's induction system consists of two molded-nylon chambers. Two 87-mm throttle bodies admit air to these manifolds, each of which has an internal volume of 5.5 liters. The extensively ribbed, mirror-image plenums are joined along their lengths by three 'communicator' valves. While the driver's right foot operates the throttles (by wire), the servo-operated communicator valves are commanded by the LT6's electronic control module.

Two of the communicators open and close in tandem while the third operates on a separate schedule. Inside each plenum, there are four molded-plastic trumpets feeding the cylinders with utmost efficiency. Downstream, each intake runner splits in two to feed a pair of titanium intake valves per cylinder. The mass of the air stream causes pressure waves to reverberate throughout the induction system every time an intake valve closes at the beginning of the compression stroke.

At wide open throttle, the communicators remain closed until 2000 rpm when the paired set opens to foster resonance between the two plenums. As rpm and air flow surge, the third valve snaps open at 5800 rpm. The benefit of optimizing induction resonance is that pressure within the plenums rises to help overfill the cylinders with air.

Instead of the usual arched torque curve, LT6 output is a nearly flat line comprised of three short-duration humps blended by the active induction system. The apogee is a muscular SAE-certified 460 lb-ft at 6300 rpm. Volumetric efficiency – the measure of how well air and exhaust flow through an engine – tops 110%. In addition to the above WOT strategy for Sport driving, the LT6's control module offers five additional collaborator-opening programs for the Z06's Tour, Stealth, and Track driving modes.

Herr von Helmholtz, born two centuries ago, clearly deserves a respectful tip of the hat to celebrate his birthday, and to acknowledge those contributions that enabled the small-block V8's latest leap forward.

Don Sherman

CHEVROLET

The bi-directional bonus for EVs

Ford's 2022 F-150 Lightning can be equipped to power a home's typical energy needs for up to three days.

Bi-directional charging is a value-added feature that seems certain to help accelerate EV adoption.

by Bill Visnic

Although other automakers have talked about the potential for electric vehicles (EVs) to use their increasingly powerful batteries for purposes beyond propelling the vehicle, it was **Ford** that brought the capability known as bi-directional charging to prominence when it revealed details of its new F-150 Lightning last May. A subsequent high-visibility marketing campaign dramatically showed the Lightning using its bi-directional charging capability to power a sizeable home during a power outage.

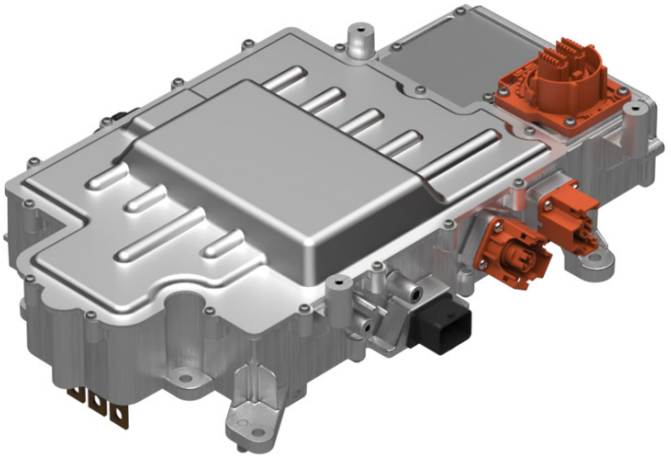
Now, just months before the Lightning hits dealer showrooms, the outsized response to the Lightning – Ford has twice doubled the truck's projected annual production volume to a current 150,000 units – and the gee-whiz nature of its Intelligent Backup Power capability may accelerate the industry's march toward bi-directional charging as a standard feature for most EVs. Although there is specific hardware and software required on both sides of the charging cable to derive the benefits of the so-called vehicle-to-grid (V2G) capability, none of it requires a deal-breaking investment for either OEMs or consumers. And fast-moving innovations in onboard power electronics – particularly the vital AC/DC inverters that are at the heart of bi-directional capability – promise to reduce costs and broaden possibilities.

"I think every electric vehicle, eventually, will be bi-directional capable – it's really only a matter of time," maintained Matt Londre, president of **Willow Glen Electric** and regional leader of Northern California for **Qmerit**, which manages a national network of certified electricians that help ensure EV buyers receive safe, reliable home-charging installations. Qmerit currently collaborates with Ford, **GM**, **Audi**, **BMW**, **Lucid**, **Rivian**, **Volvo** and **Mercedes-Benz** as a preferred installer of home chargers.

"Once the F-150 Lightning comes out with it, kind of bringing the bi-directional capabilities even more mainstream," Londre added, "it's going be a very large and popular thing. Almost 'table stakes.'"

FORD

With its seminal Leaf EV, Nissan was an early advocate of bi-directional charging for a variety of V2G functions.



Semiconductor innovations such as those in this BorgWarner silicon-carbide inverter promise to speed advanced features such as bi-directional charging.

Unlocking EV value

The potential to use an EV's onboard battery energy presents opportunities to help maximize the vehicle purchase, said Ryan O'Gorman, Ford electric vehicle manager, Strategic Partnerships, in an interview with **SAE Media**. "I think this is probably the most game-changing product for our customer in the way of mobility – because it goes beyond mobility. It's just going to be really cool to see how customers use it; it'll be really exciting to see it market."

Ford set an alluring benchmark for the Intelligent Backup Power system: power the entire electrical needs of the "typical" home for three days. Estimates vary regarding a typical home's daily usage, but Ford press material mentioned an "average of 30 kWh per day" – likely a conservative estimate, particularly in unusually hot or cold weather. "You'll hear about the extreme power outages people will bring up where they've been out for a week or two weeks or something like that. But for the majority of power outages, three full days is going to cover it," O'Gorman said.

Ford will be the first mainstream automaker to offer bi-directional charging to consumers when the F-150 Lightning will start arriving in showrooms in mid-2022. The company is confident enough that Intelligent Backup Power is such a compelling "bonus" feature of ownership that it's structured an intriguing go-to-market strategy: Every customer who opts for a Lightning with the extended-range battery (estimated max driving range of 300 miles/483 km) will receive the 80-amp Charge Station Pro, the Level 2 home charger required for Intelligent Backup Power, included in the purchase. The Lightning's lower-level chargers input into the 400V vehicle system at 48 amps or 32 amps.

O'Gorman explained that onboard Intelligent Backup Power capability is enabled through the inverter and associated power electronics, which channels the battery pack's DC power through the charge cord, "then it's provided to an inverter that's external to the Charge Station Pro installed in the house. That inverter then takes the DC power that's come from the battery, converts it to AC and plumbs that into your main panel, effectively," he said. On the home side, the wiring would include a transfer switch and a critical-loads panel that O'Gorman said might be standard with a backup installation. Typically, the inverter allows 9.6 kW of flow into the residence, he said.

Lightning pickup buyers who choose the standard-range battery (230 miles/370 km max driving range) also can install the Charge Station Pro and get Intelligent Backup Power, O'Gorman added. The only substantive difference, he said, is that pickups with the standard-range battery don't have the dual onboard chargers (19.2-kW total) fitted to extended-range models, meaning the maximum recharging rate is 9.6 kW.

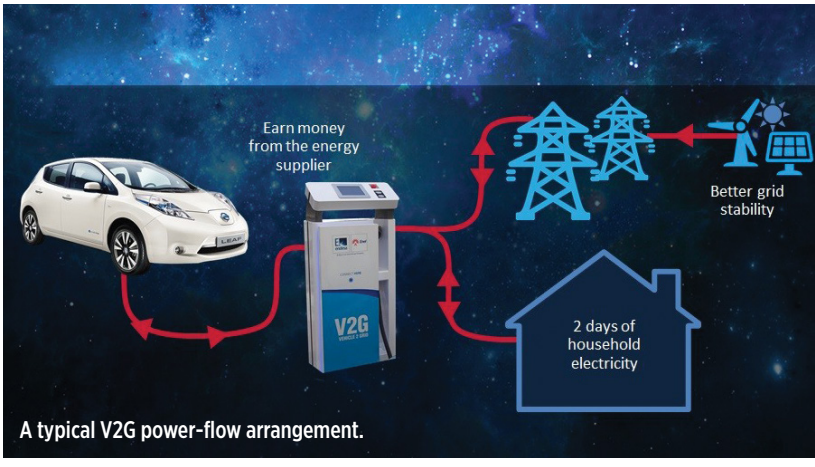
Because electrician labor and other costs vary widely, O'Gorman declined to speculate regarding installation costs. Ford has selected established nationwide solar/electrical installer **Sunrun** as its installation partner for Intelligent Backup Power, although the customer is free to choose another installer, he added. "We're not force-feeding the customers anything, we're leaving it to them to take the best path. But we are providing really good resources to make it easy. So, it should be relatively painless," he said.

The Charge Station Pro, like nearly all other home chargers, uses the **SAE** standard J1772 combined charging system (CCS) connector, which was presciently designed to enable bi-directional power flow for both AC and DC current. Londre from Qmerit, which is the preferred installer for the bi-directional Connected Home Charging Station offered by Lucid

FROM LEFT: NISSAN; BORGWARNER

The bi-directional bonus for EVs

Advanced inverter is the heart of eLeapPower's Smart Inverter System.



A typical V2G power-flow arrangement.

Motors for its ultra-premium Air sedan, said that in addition to nearly all home chargers incorporating bi-directional capability, the industry could evolve like the mobile phone sector, with just a few manufacturers taking the lead.

"If there's a company making a fantastic charger, let's standardize on that one. And let other companies also try to find some amazing ways to differentiate their chargers," he asserted. "Right now, if you can offer bi-directional charging in your charger, like the Lucid Connected will offer, that is one of the best product differentiators I've ever heard of in my career." And powering the home is just one trick in bi-directional charging's repertoire.

Londre forsees "many options in the future with powering the house, with powering your neighborhood, with powering the grid for everybody around. "In the future, I anticipate there being a time when, rather than paying 50 bucks at a garage, at airport long-term parking, they'll be paying you 50 bucks a day for access to your battery for the week when you're gone."

Others quickly joining

That was the vision at **Nissan**, one of the earliest players in the contemporary EV market with its groundbreaking Leaf, introduced in 2010. As early as 2015, Nissan was engaged with demonstrations of vehicle-to-grid bi-directional charging as a load- and cost-balancing solution. In 2018, the company initiated a pilot program in which the Leaf was grid-connected to help manage power at its headquarters in Franklin, Tenn. and its design center in San Diego. A similar pilot program, on a fleet scale, was in installed in Europe.

And in January, 2022, **Volkswagen** announced that all models in its new ID model range with 77-kWh battery packs will be built with bi-directional charging capability – and over-the-air (OTA) software updating will enable the function for "vehicles already delivered, as well." The company said a specific home charger will be required and it was unclear whether or when the bi-directional charging capability would be available in the North American market. Rivian CEO RJ Scaringe also has said his company's premium electric vehicles will at some point offer bi-directional charging. It seems inevitable that more OEMs are soon follow to that point at which Qmerit's Londre believes the feature effectively will be standard.

The onboard essentials

Although there are certain equipment requirements on the home side of the charging cable, the necessary hardware to make an EV bi-directional-capable is limited largely to equipment that already is required, specifically the inverter. As demonstrated by Volkswagen's intent to enable the function strictly through a software update, it appears that in many situations, little about an inverter's silicon platform need be altered to impart bi-directional charging functionality.

Moreover, inverters and other EV power electronics are rapidly evolving. Electronic-components suppliers such as **BorgWarner**, **Bosch**, **Continental** and **ZF** are turning to innovations such as silicon-carbide (SiC) and gallium-nitride (GaN) power and field-effect transistors (FETs)

FROM LEFT: eLEAPPOWER; NISSAN

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The bi-directional bonus for EVs

Matt Londre, president of Willow Glen Electric and regional leader of Northern California for Qmerit.

QMERIT

and semiconductors, which promise substantial near-term performance and efficiency upgrades – and perhaps cost reductions on a systems basis.

One startup, **eLeapPower**, which spoke with SAE Media about bi-directional charging, said its pending Smart Inverter System is "a really powerful, very differently configured inverter," according to CEO Russell Pullan. With investor funding that includes a multimillion-dollar, multiyear award from the **Bill Gates' Breakthrough Energy**, as well as funding from **Natural Resources Canada**. The Smart Inverter System uses the capabilities of the EV's traction motor and other hardware to, among other things, eliminate the need for an onboard charger, which Pullan calls a serious EV system energy "bottleneck."

Pullan also said his is the only system the company is aware of that can take DC power directly into the inverter. "Fleets who have their own solar power on site can now make their fleets completely green." He said the technology currently is going into trials in Canada and is slated for production with a Chinese commercial-vehicle partner in 2023. He said the technology is open to potential advances from SiC and GaN semiconductors, depending on a customer's cost requirements.

And at CES 2022, ZF announced a new scalable and modular e-motor inverter architecture that can be used in powertrain systems ranging from 400V to 800V. Critically, the inverter features a design that isn't dependent on predefined semiconductors, the company said. The next-generation inverter, called the Modular eDrive Kit, "[optimizes] the link between the power semiconductor boundary conditions and control software in order to gain the full potential from the semiconductor configuration," ZF said, particularly when employing SiC chips. ■

Ouster exhibited its new DF series solid-state lidar sensors (complete suite above) and displayed its OS series scanning lidar powered by its new L2X chip.

OUSTER

Lidar tech illuminates CES 2022

Lidar suppliers tout increased perception, smaller form factors and mass-production capabilities as the sensors begin moving to mainstream applications.

by Doug Newcomb

While marquee automakers and suppliers ditched CES 2022 due to a COVID surge, more than a dozen lidar suppliers unveiled their latest products and innovations during the show. The following is a highlight of sensor companies' CES announcements and how they fit into the ever-changing automated/autonomous-vehicle (AV) and mobility landscape.

Blickfeld

This German startup called its Qb2 sensor unveiled at CES "the next generation of lidar" due to capturing and processing of 3D data being performed by a single-unit integrated system and requiring no additional compute, servers, or adaptor boxes — a world first, the company said. The device combines MEMS (microelectromechanical systems) hardware with a compute module that runs **Blickfeld**'s Percept software stack, which the company also announced at CES. Beyond AV and mobility applications, Percept software can be used for crowd analytics, traffic management, smart industry and security solutions, with the Frankfurt, Germany, airport already deploying the software in a people-counting application.

Hesai Technology

This Chinese supplier showed its new AT128 lidar sensor at CES, a directional long-range hybrid solid-state solution designed for ADAS applications in mass-production vehicles. **Hesai** said the AT128 provides consistent resolution over a full field of view and has a small form factor for easy integration onto production passenger and commercial vehicles. The AT128 provides an ultra-high measurement frequency of over 1.53 million points per second (single return) and range of more than 200 meters (656 feet) with 10% reflectivity and effective object detection as far as almost 70 meters (230 feet). Hesai said the AT128 has been subjected to more than 50 validation tests conducted according to OEM standards such as electrical, mechanical, environmental, sealing, material and EMC tests.

The company said the AT128 is developed based on Hesai's proprietary lidar application-specific integrated circuits (ASICs), which it said greatly simplify the assembly process and increases manufacturing efficiency and consistency for mass production. Hesai's AT128 has secured contracts for multiple ADAS programs, mainly from Chinese mobility companies, including Li Auto, HiPhi and JiDU, an electric vehicle venture between China tech giant Baidu and Chinese automaker Geely. Hesai said the contracts call for several million units and that the sensor begins mass production in 2022.

Innoviz

This Israeli company is considered one of the leaders in automotive lidar and was one of the first to develop lidar that uses a MEMS-based sensor. Its first volume commercial sensor, the InnovizOne, is scheduled to launch on BMW vehicles later this year and includes four lasers, detectors and MEMS units. **Innoviz** also debuted a pair of

Lidar tech illuminates CES 2022

The Innoviz360 uses a new single laser, detector and custom processing chip.

Quanergy's M-series 3D lidar will be used on EV charging robots in South Korea.

its next-generation sensors at CES, the lower-cost InnovizTwo and the Innoviz360. The InnovizTwo is slated to be produced in 2023 and has a single laser, detector and MEMS unit, which the company said will reduce the sensor's cost by 70%. The Innoviz360 uses most of the hardware from the InnovizTwo including the new single laser, detector and custom processing chip but contains a different beam-steering system.

Innovusion

At CES, **Innovusion** revealed production-ready versions of its Falcon and Robin lidar sensors designed

Luminar announced its lidar sensors will be standard equipment on Volvo's new line of EVs.

for use in AVs, smart mobility and industrial automation. The company said once production starts it will be able to produce lidar sensors in high volume, reaching 100,000 units per year. The Falcon system is an image-grade lidar with a detection range of more than 500 meters (1640 feet), and the company said it can be customized and integrated into any consumer vehicle. The lidar is scheduled for delivery in early 2022 and Chinese electric automaker NIO is using the Falcon Lidar as the standard configuration for its flagship ET7 autonomous sedan. The Robin system is a short-to-midrange lidar that's 1.3 in. (35 mm) high, a compact and lightweight form factor featuring low power consumption. Innovusion said the Robin sensor can be integrated onto a vehicle's fenders, headlights, rear lights or bumpers to provide 360-degree vehicle coverage.

Lumotive and ZKW Group

In another nod to integrating lidar sensors into vehicles in a low-key configuration, at CES lidar maker **Lumotive** and lighting systems and electronics developer **ZKW Group** unveiled a golf-ball-sized lidar that fits inside a vehicle headlight. The concept couples Lumotive's compact, solid-state M30 lidar with ZKW's innovative vehicle lighting, while Lumotive said its Light Control Metasurface solid-state beam steering chip reduces complexity, cost and size of its lidar systems. It added that the use of LCM chips eliminates the need for large mechanical moving parts of traditional lidar sensors and enables what it calls the industry's first "software-defined" lidar, allowing the lidar scan pattern, frame rate and resolution to be customized for specific use cases in real time.

Luminar

Luminar announced at CES that its lidar sensors will be standard equipment in Volvo's new line of electrified vehicles that also will be capable of autonomous highway driving via the automaker's Ride

CLOCKWISE FROM TOP LEFT: INNOVIZ; LUMINAR; QUANERGY

Pilot feature. While initial availability will be in California, Volvo did not announce a timeframe. The Swedish carmaker displayed the Concept Recharge electric crossover at Luminar's CES booth and said it will also apply for an autonomous test permit in California, where the vehicle will launch. Luminar said its Iris sensor detects objects nearly 250 meters (820 feet) ahead of a vehicle at highway speed. The company expects per-sensor cost to be between $500 and $1,000 per vehicle, depending on production volume.

Opsys

Israeli startup **Opsys** announced that it inked a deal to provide full production solid-state lidar sensors to South Korea-based automotive supplier **SL**, with delivery beginning in 2024. The company's technology is based on vertical-cavity surface-emitting laser (VCSEL) microchips that it said are easier to produce and therefore less costly than those based on the edge-emitting laser technology used in most solid-state or semi-solid-state lidars available today. **Apple** uses VCSELs in its latest iPhones for face recognition and because suppliers are rapidly ramping up to meet demand for the chips, availability should increase and prices decrease. The Opsys lidar will be packaged into lighting modules produced by SL, the Korean supplier said.

Ouster

Ouster exhibited its recently unveiled DF series solid-state lidar sensors for high-volume automotive production and showed its OS series scanning lidar powered by its new L2X chip. Ouster customers showcased applications at CES leveraging the company's lidar across automotive, industrial and robotics use cases. These included Vecna Robotics' autonomous mobile robot for warehouse and logistics operations and **Robotic Research**'s commercial autonomous driving technology. **Perrone Robotics** offered rides in **GreenPower Motor Company**'s AV Star shuttle that's designed for cargo, delivery, shuttle, transit and school bus markets and uses Ouster lidar.

Quanergy Systems

One of the obstacles to electric-vehicle adoption is access to charging, which is why a coalition of South Korean government agencies is working with companies to develop a mobile, autonomous EV-charging robot, with plans to deploy the units throughout the country by the end of 2022. Together with system integrator iCent, **Quanergy** is supplying its M-series 3D lidar and Qortex 3D perception software for the EV charging robots

Every year, established and emerging lidar suppliers vie for media attention, tech supremacy and, most importantly, contracts from automakers and major OEM suppliers.

to enable their safe, efficient navigation. Each robot will be equipped with three lidar sensors: one M8 sensor to detect and classify objects in "stop" mode, and two M1 Edge sensors for collision avoidance. The sensor detection zones are monitored dynamically based on the robot's movement to and from a charging location.

RoboSense

The Chinese company showed its RS-LiDAR-M1 sensor, which it said is "the world's first mass-produced automotive-grade MEMS solid-state lidar," and Ruby Plus, a new 128-beam mechanical lidar sensor. **RoboSense** said it completed its first mass production and delivery of the M1 as part of a project with an unnamed vehicle manufacturer and the company has also received orders from Chinese automakers, including **BYD**, **GAC**, **WM Motor**, Geely subsidiary **Zeekr** and **Inceptio Technology**. RoboSens said the new Ruby Plus not only has a longer detection range and higher detection accuracy than its predecessor, but it has also reduced the sensor's overall weight and volume by more than 50% and power consumption by 40%.

Velodyne

Lidar pioneer **Velodyne** used CES to show its Alpha Prime long-range sensor that the company debuted in November 2021 and said generates a high-quality point cloud in a wide variety of light conditions, with advanced sensor-to-sensor interference mitigation, power efficiency and thermal performance. Velodyne also showed off its solid-state sensors and its Intelligent Infrastructure Solution at CES, which creates a real-time 3D map of roads and intersections and provides traffic monitoring and analytics in any lighting or weather condition, according to the company. Velodyne also demonstrated its Vella Development Kit (VDK) that provide access to Velodyne's Vella perception software paired with the company's lidar sensors, allowing customers to plug in lidar with an off-the-shelf library of functions to help accelerate time to market for autonomous vehicles, ADAS, mobile delivery devices, industrial robotics and drones. ■

SPOTLIGHT: POWER ELECTRONICS

Compact power module for hybrids, EVs

Infineon Technologies (Neubiberg, Germany) has introduced its EasyPACK 2B EDT2 750 V power module. The device can provide a power supply of up to 50 kW and 230 A rms and is intended for inverter applications in hybrid and electric vehicles. A key feature of Infineon's EDT2 (Electric Drive Train) technology is higher efficiency in low-load conditions. The EDT2 chip ensures significantly lower energy loss and is claimed to outperform Infineon's previous-generation chips by 20%. The unit also features a "plug-and-play" capability, which simplifies module integration. The EasyPACK 2B's packaging requires 30% less surface area than Infineon's HybridPACK 1 and is fully certified to AQG324 standards.

For more information, visit http://info.hotims.com/82329-400

SPOTLIGHT: ON-BOARD PROCESSORS

Imaging radar processor

NXP Semiconductors (Eindhoven, Netherlands) has made an update to its imaging radar processor. The update includes 4D imaging radar sensing with up to six front and rear radar sensors in a 360-degree radius. This update ensures the imaging radar can simultaneously measure velocity and classify objects at distances of up to 300 m (985 ft) while distinguishing between fast-moving targets and slower or static obstacles. NXP states that its 4D imaging radar is the first to deliver concurrent 3-in-1 multimode sensing across short-, mid- and long-range operation. This enables simultaneous sensing through a wider field of view around the vehicle.

For more information, visit http://info.hotims.com/82329-401

Internal navigation system for Level 2 ADAS

Aceinna (Tewksbury, Massachusetts) has unveiled its new INS401 high-performance inertial navigation system with an RTK-enabled dual frequency GNSS receiver. The unit promises precise autonomous vehicle positioning through technologies like triple-redundant inertial sensors and a positioning engine. It is designed for use in SAE Level 2 and higher ADAS and other high-volume applications requiring precise position information. It provides cm-level accuracy with enhanced reliability and performance during GNSS outages. The dead-reckoning solution also delivers strong performance in GNSS-challenged urban environments such as areas with tall buildings or underground structures. The company also states that the INS401 system is significantly more cost-effective to produce than comparable systems with a unit price of less than $500.

For more information, visit http://info.hotims.com/82329-402

READER FEEDBACK

Hydrogen springs eternal

Your December article on Faurecia's hydrogen developments was interesting. My company has been a supplier to various hydrogen R&D programs including GM and Mercedes and we've witnessed the technology's steady progress since the 1990s. It appears that generating the fuel and providing a fueling infrastructure are the two remaining challenges for industry, but it's remarkable to see a seating-systems supplier embracing the technology. I have high hopes that hydrogen will emerge as a commercially viable fuel this decade.

Alex Anuda

EV subsidy soundoff

Great piece on EV subsidies ("Let's End the EV Subsidies," October). I completely agree that the government footing the bill in a space where the consumer is a niche clientele is crazy. I see the Teslas lined up in our local town center to "refuel" because their apartment buildings do not have charging stations. I read recently that 54% of the gas stations are minority owned—so we are going to disadvantage those businesses in the name of "green."

I am in the aviation business and the fuel density of JET-A cannot be overcome by hydrogen and batteries. Again, the government has large subsidy programs for this and biofuels. The current subsidy is $1.70/gallon going to over $2 — nuts.

Keeping putting the "common" in sense. It is good reading!

David Downey
Downey Aviation Service
Southlake, Texas

Your October AE editorial caught my eye. Where is the limit of the nonsense of money pits? Google the worldwide lithium-ion battery production, divide that total by an average battery pack of 50 kWh and the result shows the BEV hype and future projections are sustained in "maybes" and assumptions.

Aside from the present raw-materials price rise, it seems the market will suffer a strain between offer and demand in no more than two years because Europe, the U.S., and China want to go electric at the same time. Mother Earth cannot supply in time the amounts required to feed all the mega factories. I´m certain the future will be 100% electric, but the timing cannot be pushed by decree.

Ing. Sergio Ricardo Bellido

What a ridiculous editorial. Why should [EVs] be cost competitive? Cars and trucks are overloaded with gizmos that almost nobody uses but I don't see any criticism of that. American consumers are addicted to buying vehicles with larger engines and bigger bodies than they need. Marketing has been selling them on "lifestyles" and not needed functionality.

Are you a global-warming skeptic then? Electrics are cost competitive now. My Bolt certainly was.

Chris Pollard

Thanks for the excellent points in your October editorial. EVs now have the features and capabilities to sell themselves without a dime of "taxpayer crutch." Enough is enough.

Peter Woods

RE: October AE Editorial: "Where does this madness end?" is a key phrase that people like yourself are ideal to make — take a cut out of the industry here and there and bring the [electrification] discussion to a new, manageable level.

Herb Everss

I'm a design engineer currently working in two EV programs for a supplier and agree with your commentary on subsidies. Tesla's continuing success since its sales total ended the company's purchase-tax rebates proves the point. Tesla's stying, features, performance, cachet and, for many customers, the 'Musk mystique,' sell the cars. No one cares that there is no cash on the hood of a Model 3 or Y.

Melanie Wong

Editor's note: Thanks to all for your feedback. No, I'm not a "global warming skeptic" and it's not up to me or the SAE publications to advocate one technology over another. I simply stated that because EV commercial attributes are now equivalent to IC vehicles then it's time those attributes sell the vehicle, rather than have taxpayers subsidize them.
– Lindsay Brooke

READERS: Let us know what you think about *Automotive Engineering* magazine. Email the Editor at Lindsay.Brooke@sae.org. We appreciate your comments and reserve the right to edit for brevity and clarity.

COMPANIES MENTIONED

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Battery & Electrification Technology

Q&A

Electrons, combustion, and Bosch

As president of the Powertrain Solutions Division at Robert Bosch, veteran engineer Uwe Gackstatter wrestles the challenge of cultivating new electrified technologies while continuing to evolve those that make IC engines cleaner. At the 2021 IAA Munich show, he greeted SAE Media with the news that electrification is moving quickly as a core business of **Bosch**, with more than one billion euros in turnover thanks to electrified drives, e-axles and power electronics. "We expect to reach 5 billion [euros] in a few years," he beamed. "We are well prepared for all the battery-electric vehicles that will be built in the future. Our entire interview can be found at www.SAE.org, while highlights appear here.

Many experts see the ICE continuing through 2045-2050 in various applications. How do you see the ICE evolving during what could be a long transition to electrification?

As a market leader in powertrain in all vehicle segments, our approach is country-by-country and customer-by-customer. In Europe for example, the big bet by the European Commission is on battery-electric vehicles. BEV will be the mainstream of the pass-car segment. It's no longer an 'open technology' approach. By 2035 at the latest, every vehicle has to be a BEV. And from my view, fuel cells if the hydrogen comes from renewables.

We see real differences in other markets: much more of an open-technology approach. The ICE business in Japan, China and the U.S. is still existing and cannot be switched overnight to BEVs or fuel-cell vehicles.

The second path I see is alternative fuels for ICEs, but not in Europe, which has gone all-in on BEVs. But in other regions such as Japan, they want to develop an H2 society. I think we will see all kinds of powertrains there. Same in China. We've seen in China's latest five-year plan a clear commitment in the direction of what are being called "H2 engines;" these are ICEs fueled by hydrogen, and there will be hydrogen fuel cells. Luckily, Bosch is active worldwide, so we can bring all of our solutions to the market.

Bosch global propulsion head Uwe Gackstatter.

We cannot stop developing the ICE, because world-wide they power 99 percent of new vehicles in some countries.

What about hybrids?

In Europe, hybrids are coming under pressure. By 2035, the hybrid solution will disappear due to the CO_2 [vehicle emissions] targets. We as a supplier, and also our customers, have to react. In Europe, plug-in hybrids will come under more pressure. This could be different in other markets where we see different legislation. It also depends on the vehicle range; the BEV is a perfect solution for driving only in urban areas. But hybrids can be the best solution if you need longer range.

And with alternative fuels, the ICE can be CO_2-neutral. Unfortunately, those fuels are not available at scale. We have to consider what can be used in existing fleets.

The politicians are still ignoring the fact that on this planet we have more than 1.3 billion cars and they won't all disappear in the next 20 years! At Bosch for our internal fleet, we use biofuels; this brought our CO_2 balance down. This is also possible worldwide, for existing fleets. We are working with partners on solutions for bringing more alternative fuels to the market.

Does Bosch's development of evolutionary technologies for ICEs continue?

Yes. We cannot stop developing the ICE, because they power 99 percent of new vehicles in some countries and the numbers will remain high for many years. Vehicles run for up to 40 years. Recently, we were awarded by a German agency a prize for the most efficient diesel engine we developed for a Chinese company.

It makes sense to still develop the ICE because we will see many new vehicles to come with a more-efficient engine. ■

Read the full interview with Bosch's Uwe Gackstatter on SAE.org.

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