Automotive World MAGAZINE

Issue 34 | October 2022

Fisker: creating the world's most sustainable car

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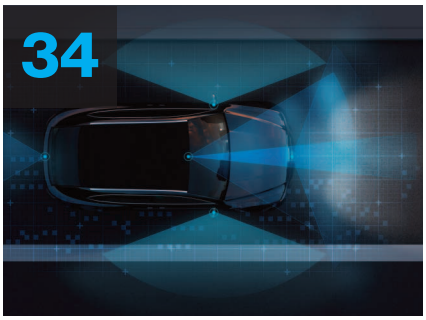

Published in October 2022 by:

Automotive World est. 1992

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ISSN: 2634-9531
Registered number: 04242884
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Cover image courtesy of Fisker

Fisker: creating the world's most sustainable car

Fisker's Chief Executive explains why electrification is just the beginning of building a more sustainable automotive industry. By Will Girling

As the automotive industry strives to usher in a new era of sustainability, tailpipe emissions have received the lion's share of attention. Indeed, with these accounting for 65 to 80% of a vehicle's total lifetime emissions, this focus is not unwarranted. The EU, UK, and the US state of California have all subsequently set deadlines for the sale of new internal combustion engines (ICEs) in the early to mid 2030s.

However, the battle for greater sustainability cannot be fought on one front; the end-to-end vehicle production processes themselves will have to change. In its September 2020 analysis of ICE manufacturing, McKinsey & Co found that 18 to 22% of emissions came from material production, 4 to 6% logistics, and 4 to 8% assembly. Electric vehicles (EVs) are no better–the Massachusetts Institute of Technology (MIT) estimated that the Tesla Model 3's 80 kWh lithium-ion battery alone produces between 2.5 and 16 metric tonnes of CO2 per vehicle.

The opportunities for green optimisation are abundant and require a truly granular way of thinking. Henrik Fisker, Chief Executive of Fisker, tells *Automotive World* that his company's new all-electric SUV, the Ocean, exemplifies this philosophy. "We're on a mission to create the world's most sustainable car," he says.

EVs are only the start

The Ocean's origins, explains Fisker, started following the release of the company's 2011 hybrid sport sedan

model, Karma. “It was among the most sustainable cars at the time, but it came out too early–it was a year before the Tesla Model S.” Praised upon release for its design, which incorporated materials such as vegan leather for its upholstery and reclaimed wood for its dashboard, supplier issues meant that fewer than 2,500 Karmas were ultimately delivered.

Currently scheduled for production in Q4 of 2022, the Ocean is entering a new, EV-focused market that has surpassed all predictions made a decade earlier. With prices starting at US$37,499 in the US, it is significantly below the average US$66,000 cost of a brand-new EV. This, Fisker says, is because electrification is only one part of the transformation: “As long as people aspire to individual ownership, automakers have an obligation to make cars more sustainable.” The company does this by examining its entire supply chain for optimisation opportunities, scrutinising vehicle performance and production, and carefully considering the materials or processes used.

The car will feature a solar PV roof that generates enough energy for up to 2,000 miles annually in ideal test conditions; its smart traction system distributes torque equally, improves stability and boosts traction to minimise energy loss; and a bidirectional onboard charger can power a house for up to 3.5 days from the car’s battery. Meanwhile, the interior will be crafted entirely from vegan, ethically sourced, and

Images © Fisker

Henrik Fisker
Chief Executive and Founder of Fisker

upcycled materials, including plastic bottles, old t-shirts, and repurposed fishing nets.

Changing supply chains

"To understand the challenge, we had to figure out what other OEMs were doing," states Fisker. "A lot of companies don't release this kind of information about their supply chain." Having surveyed the industry, he reveals that the highest amount of recycled material used in a production car was 27kg. By comparison, the Ocean has 50kg.

The challenge for Fisker is finding a way to measure and contextualise all the environmental benefits of its approach. Patrick Newson, ESG Director, states that the company has five main areas of focus: supply chain, inbound/outbound logistics, manufacturing, use phase, and end-of-life recycling. "The biggest challenges are upstream sourcing and the use phase," he explains. "The Ocean is a zero-emission vehicle, but its overall sustainability is still linked to the type of electricity used to charge it." As such, production for the Ocean will take place in a carbon-neutral factory in Austria powered by hydroelectricity.

Fisker expects its suppliers to show a comparable commitment to clean energy. This mentality is backed up by findings from Centre for Climate and Energy Solutions: 31% of supply chain emissions come from electricity generation, with another 15% from transport logistics. To reduce the latter, Fisker sources 83% of its materials from a 1,000-mile radius of its headquarters. "Increasing the proximity and reducing the number of miles travelled can have a significant impact, as well as exploring other modes of logistic transport. For example, rail transport is four times less carbon intensive than trucking," says Newson.

The innovation challenge

Ultimately, the company's goal is to create a completely carbon neutral vehicle by 2027–its Pear model, another electric SUV, which is still in development and has a range spec of over 310 miles. In the meantime, Fisker will also be developing the other aspects of ESG within its business.

"The intersection of environmental and social is becoming increasingly apparent," says Newson. He suggests that researching and incorporating international labour standards like the OECD (Organisation for Economic Co-operation and Development) and the UN Sustainable Development Goals will ensure automotive stakeholders can understand and quantify the actions they need to take.

Established and transparent measurements for ESG, Newson adds, are what the industry is currently missing and what it must urgently address. The company published its full, pre-production ESG report in August 2022–something he claims is uncommon in the automotive industry, but which needs to become a regular practice. "It's not apples to apples in the industry today. What Fisker is trying to do is create a foundation for transparency on sustainability," says Newson. By doing so, he concludes, automakers can begin to engage with their suppliers and innovate beyond manufacturing's "traditional methodologies." Until such an approach is adopted more broadly, Fisker's dedication to building the world's most sustainable car could laying the foundation for a truly eco-friendly industry.

> "Modern infotainment has evolved into a safety critical system and must be treated as such by designers and developers

What does California's ICE ban mean for the US?

This pivotal market has passed ground-breaking legislation in its fight against climate change. By Megan Lampinen

California is accelerating the US' fight against climate change as it pushes ahead with plans to phase out internal combustion engines (ICEs) with the Advanced Clean Cars II rule. While other markets around the world have also set targets to phase out the sale of ICE vehicles, California's move marks a first for the US. Transportation represents the single largest source of global warming emissions and air pollution in the state.

Back in September 2020, California Governor Gavin Newsom signed an executive order to end the sale of new diesel or gasoline cars in the state by 2035. Now, the California Air Resources Board (CARB) has voted to finalise that rule and put the state on a path to zero emissions. The new regulation sets out a roadmap with various milestones. By 2026, 35% of all new cars by an automaker would need to be either zero-emission or plug-in hybrid vehicles. That increases to 68% in 2030 and 100% by 2035. So far in 2022, zero-emissions vehicles (ZEVs) have made up about 15% of new cars sold in the state.

CARB Chair Liane Randolph has described the regulation as setting "ambitious but achievable targets for ZEV sales." California is by far the largest market in the US for ZEVs. In the first half of 2022 it accounted for 36.9% of all new electric vehicle (EV) registrations in the US. It also accounts for the bulk of all fuel cell vehicles. Even so, the targets represent a substantial acceleration in the uptake rate. Randolph notes that the regulation includes "ground-breaking strategies to bring ZEVs to more

ChargePoint and Charge Across Town are working with California Energy Commission to build hundreds of EV chargers at apartment buildings and condo complexes across the state

© ChargePoint

communities and is supported by the Governor's ZEV budget which provides incentives to make ZEVs available to the widest number of economic groups in California, including low- and moderate-income consumers."

California is not just the leading market for ZEV sales in the US; it's also the largest market for new car sales as a whole. In the first half of 2022 the state accounted for 11.7% of the total US new car market. Cleaning up emissions in this one state could have a notable impact, and others will likely follow.

To date, 17 states have adopted all or part of California's existing low-emission and zero-emission vehicle regulations. Altogether, more than 35% of national new light-duty vehicle sales meet California automotive emissions standards. "California's move could accelerate the adoption of EVs across the country," notes Michelle Krebs, Executive Analyst at Cox Automotive. The governor of Washington has said his state will fall in with California, and other states such as Massachusetts, New York and Virginia are also likely to follow suit.

However, politics will inevitably shape the discourse. "Beyond very blue California, the ban of gas-powered vehicles can be fraught politically, particularly in red states and states with automotive assembly plants and a large auto supply base for gas-powered vehicles," Krebs notes. "They may be hesitant to make such a move due to the potential loss of jobs. Already, there are rumblings in Virginia, which generally follows California but now has a Republican governor, that such a ban would create conflict."

Brand impact

While the rulemaking is new, the prospects of an electric future are not and automakers have been making hefty investments in both battery electric and hydrogen fuel cells over

Tesla is in one of the stronger positions in the wake of the regulatory change

© Ford

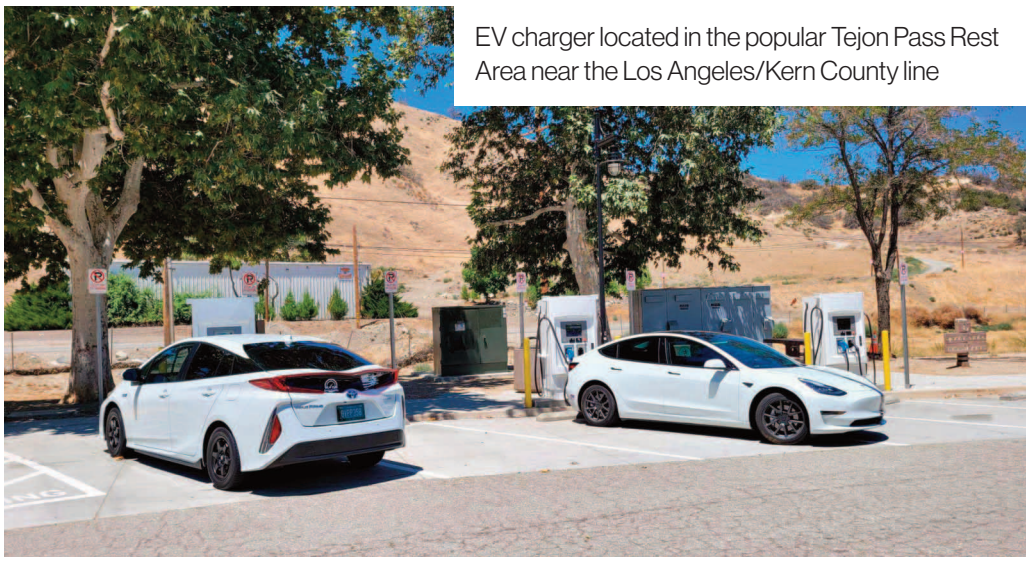
the years. Overall, the early-movers on EVs and plug-in hybrids should fare well under the revised regulations, and Krebs points to Tesla has having a distinct advantage: "It is already the nation's number one seller of EVs–and luxury cars generally. California sells the most EVs, and the bulk of Tesla's sales are there." She also flags Hyundai and Kia as likely to benefit from the move, as well as those players with a strong hold in California, especially Asian imports.

As for the Big Three, California's timeline ties in with GM's plans to offer a full range of ZEVs by 2035. Buick and Cadillac are aiming to become all-electric brands by 2030. Stellantis recently committed US$35bn into vehicle electrification and associated software. The company plans to launch 25 EVs in the US by 2030.

Ford is also on track. As part of its participation in the global RouteZero initiative, Ford aims to make more than half its new car and van sales EVs globally by 2040, and by 2035 in leading markets like the US. "At Ford, combatting climate change is a strategic priority, and we're proud of our partnership with California for stronger vehicle emissions standards, forged during a time when climate action was under attack," said Ford's Chief Sustainability Officer Bob Holycross. "We're committed to building a zero-emissions transportation future that includes everyone, backed by our own investments of more than US$50bn by 2026 in EVs and batteries." He goes on to describe the CARB Advanced Clean Cars II rule as "a landmark standard that will define clean transportation and set an example for the US."

Headwinds

While environmental groups have welcomed CARB's move, it has met with resistance and concern in other corners. The Alliance for Automotive Innovation, for instance, believes it is



EV charger located in the popular Tejon Pass Rest Area near the Los Angeles/Kern County line

overly ambitious and does not take into account external factors that will impact EV uptake and production, such as inflation, charging and hydrogen infrastructure, supply chains, mineral availability, pricing, and the semiconductor shortage. “These are complex, intertwined and global issues well beyond the control of either CARB or the auto industry,” observes Chief Executive John Bozzella. “What we’ve said to CARB and others is that getting more EVs on the road (a goal we unequivocally share and work every day to advance) must go hand-in-hand with other policies that together will ultimately determine the success of this transition.”

He specifically flags questions around critical mineral and battery supply chains, EV affordability and access to home charging. “Resolving these questions will determine the ultimate success of the California regulations and the EV transformation,” adds Bozzella.

Similarly, the California Hydrogen Coalition has raised concerns about the ability of the current hydrogen fuelling network to meet increased demand in the wake of the rule changes. “This decision underscores the need to invest in fuelling infrastructure for the growing market for hydrogen vehicles, a critical option for those living in multi-family dwellings, ‘supercommuters’, and single-vehicle households where battery charging doesn’t make sense,” a spokesperson tells *Automotive World*. “It’s time for the Legislature to invest in hydrogen fuelling stations or the state won’t be able to comply with this order.”

Krebs raises questions around whether or not automakers can build enough vehicles to fulfil demand: “Do they have a robust enough supply chain, most notably for the critical minerals used in batteries, and is there enough battery capacity? Automakers are scrambling to make deals for steady sources of metals and build battery plants.”

Just as importantly, will consumers buy EVs and will they be able to afford them? The 2021 Cox Automotive Path to EV Adoption study found that price was the leading obstacle to EV adoption. “Even before the pandemic and the global chip shortage that constrained production and inventory and caused prices to soar, the US was facing an affordability crisis,” Krebs tells Automotive World. Kelley Blue

Book puts the average cost of a new ICE vehicle at US$48,000, while EVs average US$67,000.

Players in the aftermarket sector have raised objections around the focus on EVs in particular. “While EV technology expands clean transportation options, the Specialty Equipment Market Association (SEMA) will continue to advocate on behalf of the industry that has helped make the ICE a reliable, affordable and clean option for millions of consumers,” comments Chief Executive Mike Spagnola.

He is keen to point out that the combined emissions from the six most common air pollutants dropped 78% between 1980 and 2020, which he attributes “in large part to advancements in cleaner ICE technology, which continues to improve. SEMA supports marketplace solutions that guarantee affordable consumer choice, preserve jobs and enjoy widespread consensus within industry, government and the general public,” Spagnola adds.

Susanna Gotsch, Senior Director and Industry Analyst at insurance software specialist CCC Intelligent Solutions, warns that the ICE phase out could have a tremendous impact on the insurance and repair sectors. According to recent data from CCC, EVs that have sustained damage from a collision have a higher average repair cost than their non-EV counterparts. Additionally, EVs take longer to repair, requiring additional scans and calibrations. “Once repairers are fully up to speed on EV servicing, greater efficiencies may help bring EV repair costs more in line with non-electric vehicles, but that won’t happen overnight,” says Gotsch.

Can they do it?

Any new standard puts pressure on the established ecosystem, and change is never without discomfort. Clearly CARB thinks it’s feasible, but do others? Krebs describes the plan as one that is “bold, ambitious and comes with challenges.” She specifically warns that infrastructure investment “will be critical to California’s success with the ban and EV adoption in general beyond California.”

“Kelley Blue Book puts the average cost of a new ICE vehicle at US$48,000, while EVs average US$67,000

Jessica Caldwell, Edmunds’ Executive Director of insights, is more optimistic in her outlook: “Given that EV purchases already make up 15% of sales in California, reaching the 35% interim target by 2026 isn’t too far of a stretch, especially since buying conditions are less than ideal right now due to shortages. If automakers can pick up production, sufficient investments are made in charging infrastructure and the power grid, and the availability of financial incentives is enhanced, this milestone should be achievable—if not surpassable.”

Mexico's vehicle manufacturing market could match China

The USMCA's trade deals and fewer restrictions mean Mexico could stand tall during the manufacturing migration. By Elle Farrell-Kingsley

With its origins dating back to the early 1900s, Mexico's automotive industry has since made impressive progress towards establishing itself as a globally competitive manufacturer. In 2021, the country's passenger car market recorded revenue of more than US$51.4bn, up by over a quarter of its 2020 revenue, according to Statista.

Despite recent production shortages caused by the COVID-19 pandemic, Mexico was among the largest motor vehicle producers in the world, and the leader across the Latin American region. Many economies have suffered due to the semiconductor crisis, and some have blamed the shrinking supplier base and manufacturing consolidation for the current chip shortage. Approximately 75% the world's semiconductors are manufactured in East Asia. According to TACNA Manufacturing, the problem will only worsen unless companies expand their supplier network size and outsource to other countries such as Mexico.

Mexico already has a strong semiconductor manufacturing industry that turns out nearly 12% of the global supply annually–on par with US production, according to the market researchers Tetakawi. As the fourth largest automotive manufacturer and eighth largest electronics manufacturer in the world, Mexico offers US companies a cost-effective and resilient option for diversifying their manufacturing.

© Audi

> “Mexico has been well positioned to win a larger share of manufacturing work

Furthermore, its manufacturing capacity could present a promising future: “Mexico has always been an attractive manufacturing market compared to the US and Europe,” says Misha Govshteyn, MacroFab’s Chief Executive. MacroFab is a digital platform for electronics manufacturing from prototype to high-scale production, with a network of factories across North America. “Contrary to public perception, manufacturing labour rates in Mexico became lower than in China a decade ago and have remained lower into the 2020s as large multinational OEMs and industrial companies have major operations in Mexico for that reason.” He cites recent transportation challenges, particularly ocean freight delays, as having made the cost difference even starker when fully landed costs are factored in.

Can Mexico remain a top manufacturing location in the wake of new mobility trends?

© Bosch

Market

With 21 million residents and 33.4 million vehicles, Mexico City is the world's fifth-most populous city. Sales of electric and hybrid vehicles have surged among Mexican consumers, according to industry analysts Maximize Research. However, In April 2022, the Mexican government raised concerns about the sizable increase in travel times for individuals and greater levels of air pollution generated by the everyday transit of millions of vehicles across Mexico City. With so many vehicles on the road, it's no surprise that so many OEMs have been making the move to Mexico.

Leading automakers in this market include Ford, Stellantis, General Motors, Nissan, Volkswagen, Kia, Toyota, Honda and BMW. "Mexico is key to the strategies of European and Asian firms as they compete in the larger North American market," says John Tuman, Professor at the University of Nevada. As such, the move to make Mexico an integral competitor in the automotive market will be a crucial one.

Trade deals

There are many challenges ahead in building Mexico's manufacturing market. The first, says Professor Tuman, is accelerating the transition of electric vehicle (EV) production. "The North American automotive industry has reached a tipping point. Firms have announced some planned investments in EV production in Mexico, but thus far, the bulk of the new investment in EVs is in the US and Canada." Before reaching that point, Tuman stresses the importance of short- to medium-term planning, "Mexico will continue to serve as an important production base for

combustion engine vehicles. However, once EV production spreads to Mexico, it will undoubtedly lead to restructuring across Tier 1 supply chains and within plants."

Mexico's OEM and automotive parts industries, he continues, are highly integrated within the North American automotive market. "The structure of production in Mexico has been shaped by the North America Free Trade Agreement (NAFTA) and, more recently, the United States-Mexico-Canada Agreement (USMCA)," says Tuman. USMCA came into effect on 1 July 2020, replacing NAFTA. The agreement creates more balanced, reciprocal trade supporting the growth of the North American economy, with a particular focus on the automotive industry.

Wages

An additional and overlapping challenge is the new wage rules for North American content incorporated into the USMCA, which specify that 40% to 45% of vehicles must be made by workers earning at least US$16 per hour. "It remains unclear if European and Asian firms producing in Mexico can meet the wage rules," says Tuman. "The trade war with China is ongoing, and Mexico once again stands out with fewer trade restrictions than the US, EU, or China." Simply put–the easiest way to avoid trade tariffs is to source materials from the supply chain in Mexico, assemble finished goods, and import them into the US or Canada with little to no tariff load.

Beyond staff wages lie further challenges for manufacturers looking to relocate to Mexico: "Large companies find it relatively easy to work in Mexico, but they are increasingly competing for employees. Recruiting and retaining staff are challenges in all countries benefiting from manufacturing migration from China, Mexico included," says Govshteyn.

> "Manufacturing labour rates in Mexico became lower than in China a decade ago

"Finding manufacturing and supply chain partners is more difficult than in heavily concentrated regions in China, so working with the right partner with regional expertise should be a top priority," he highlights. "Since most production in Mexico is oriented towards larger US and European customers, ensuring that smaller customers get equal attention and care is a real challenge."

Nevertheless, these challenges could be overcome due to Mexico's potential workforce and manufacturing capabilities–which could be enough to rival China's manufacturing. "Mexico has been well positioned to win a larger share of manufacturing work simply by its proximity to the US, large population, and reasonable labour costs," concludes Govshteyn.

What is the ROI of fleet telematics?

Digital services promise improvements in safety, efficiency and emissions, but putting a number on that is tricky. Megan Lampinen hears more

Telematics services have been growing rapidly over the years, helping commercial fleets with everything from route planning and vehicle diagnostics to regulatory compliance and business transparency. The pressure is on to deliver ever more functionality and in real-time.

Some of the more popular forms of freight business digitisation include load-matching apps, electronic logging devices, paperless bills of lading, blockchain for documentation, and visibility into fleet health and location. The potential benefits are significant: load matching could theoretically slash empty miles, while fleet management insights would allow operators to track parameters that affect vehicle performance through constant updates, yielding increased efficiency, productivity and safety.

The ultimate outcome of all these individual activities, suggests Doug Haebig, Senior Product Manager at Teletrac Navman, is a connected freight ecosystem. “Visibility is the critical attribute of this connected ecosystem, and it allows multiple stakeholders to apply technology and processes to manage disruptions proactively and improve efficiency and outcomes.”

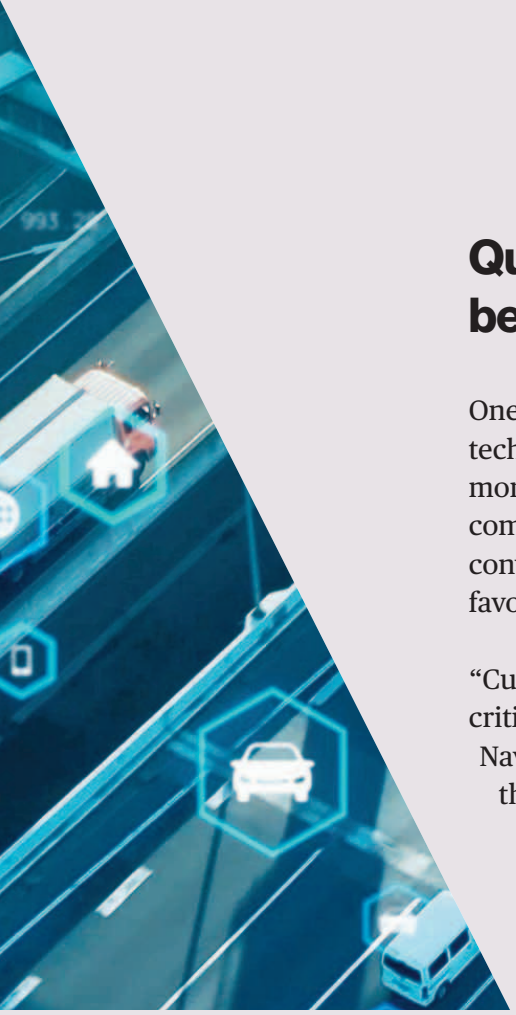
Teletrac Navman is a company at the forefront of the digital freight movement. The telematics specialist offers software that draws on artificial intelligence (AI), scalable cloud technology and real-time computer vision sensors to collect and analyse data. With this input it can then produce insights on safety, efficiency and regulatory compliance.

Informed actions

According to forecasts from Global Market Insight, the global fleet management market is heading to a value of US$45bn by 2027, spurred on by growing adoption of AI technology in vehicle telematics, consumer demand, government regulations and the need to cut costs. “There are several macro reasons to go digital–sustainability, labour availability, and consumer expectations–but the most tangible benefit for companies is that technology helps their employees,” Haebig tells Automotive World.

Features like automated Records of Duty Status, route optimisation and predictive ETAs all allow employees to do more by automating and simplifying tasks. “Effective freight tech allows employees to take action faster and with greater accuracy because the tools have already gathered the data they need–and it’s the insertion of technology at the correct point in the decision-making process that has progressed so well over the last decade,” Haebig elaborates.

While the freight sector has long been criticised as a technology laggard, that’s starting to change. A big part of that comes from consumer expectations in the wake of the pandemic. “COVID-19 changed the way we worked and how we managed our time. Knowing that you have to be at home at a certain time to take delivery of something allows the consumer to plan around work and family commitments; the efficiency gain impacts both the consumer and supplier,” he explains. “Freight companies that haven’t transferred to digital processes and automation are likely at a competitive disadvantage.”



Quantifying the benefits

One of the big benefits from digital technology is that it can save fleets money in the long run, but it still comes with a price tag. Just how convincing are the arguments in favour of a hefty initial outlay?

"Customer ROI transparency is critical," asserts Haebig. Teletrac Navman has developed several tools that allow it to predict customer benefits early in the sales process and then validate these benefits post implementation. The exact impact will vary by customer, but there are some general estimates that offer a ballpark figure. For instance, Teletrac estimates a 5% improvement for equipment utilisation rate and the reduction of unnecessary equipment; a 50% reduction in downtime due to maintenance; a 10% reduction in road incidents; a whopping 90% reduction in lost or stolen equipment; and a 50% reduction in time spent collecting and entering data.

In addition to these cost-savings, fleets can also expect a drop in the initial cost of the systems. As Sudip Saha, Managing Director and Co-founder of research and consulting firm Future Market Insights (FMI), points out: "The general trend with pricing is that as a technology becomes more accessible it becomes more affordable: the market's landscape favours competitive pricing and volume-based profits."

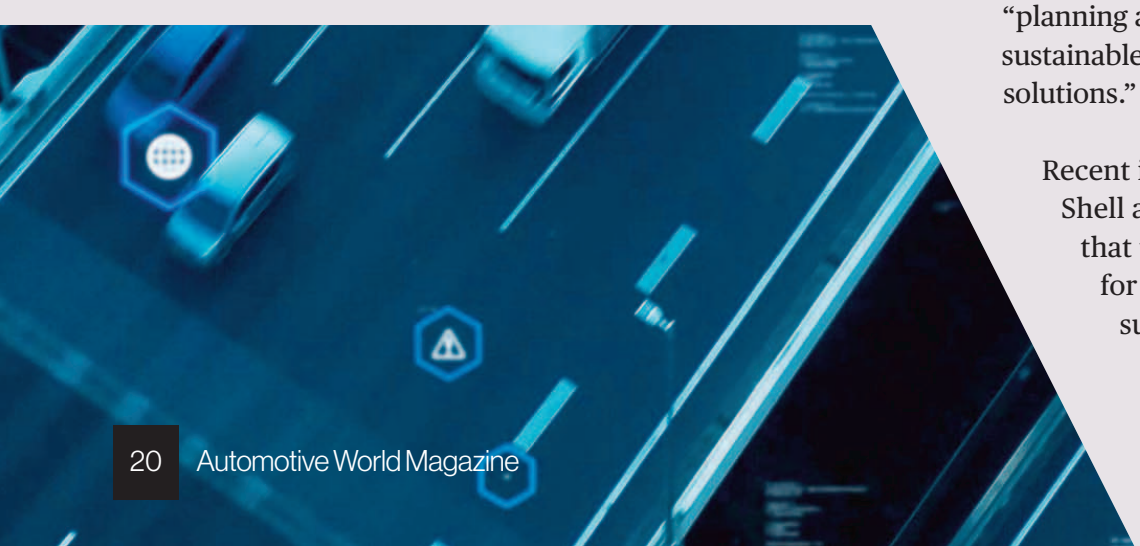
© Teletrac Navman

Fleet management services tackle safety and efficiency from numerous angles

Up next

All sorts of fleets can benefit from a move to digital. Teletrac Navman's customer base, for example, covers transportation, construction, government and general services fleets. All of them face increasing pressure to not only cut costs but also emissions. Among other priority areas, Haebig notes that Teletrac's journey forward will include "planning and transitioning fleets to sustainable and alternative energy solutions."

Recent industry research from Shell and Frost & Sullivan found that this is indeed a focus area for many players. In its survey, more than 70% of



respondents said decarbonisation was either their organisations' leading priority or one of their top three priorities. Telematics and digital freight brokerage can both play a big role on this front. Speaking to Automotive World on the report's findings, Patrick Carre, Vice President of Commercial Road Transport at Shell, asserted: "Technology is our friend in this space and can help us increase the carbon efficiency of the existing diesel truck fleet that's out there."

> "Customer ROI transparency is critical

The years ahead will only see increased uptake of digital features as fleets scramble to address various headwinds, be it on the environmental, cost or safety front, or even somewhere completely new. "The freight industry faces constant, diverse, and evolving challenges," notes Haebig. Luckily, technology can help.

Hailing the net-zero revolution: taxi fleets harness electric and hydrogen power

With more than 250,000 licensed taxis and private hire vehicles in the UK alone, the decarbonisation of the sector could have a major impact on lowering transport emissions. By Tom Mason

With more than 250,000 licensed taxis and private hire vehicles in the UK, the decarbonisation of the taxi fleet industry could have a major impact on lowering emissions in the transport sector—which altogether is responsible for almost one-quarter of all UK emissions.

Taxis or private hire cars drive four times the average vehicle, but diesel still reigns supreme in taxi fleets, fuelling over half (54%) of taxi vehicles across 25 of the UK's largest cities. Carbon emissions from taxis have more than doubled compared with 1990 levels, producing 3.5 million metric tons of carbon dioxide emissions in 2019.

With the government target of ending sales of new gasoline and diesel vehicles less than eight years away, and the fuel market continuing to be hit by several crises (including shortages and incredibly high costs), it is essential that the industry finds a clean, reliable and cost-effective way of powering their fleets that will stand the test of time. With considerable access to private investment resources—and the potential to positively influence thousands of vehicles on UK roads—the taxi fleet industry could shape the future of zero emission.

The rise of fully electric fleets

Several firms are already planning for how they will operate in a net zero manner. Last year, Addison Lee– London's largest taxi fleet– made an investment commitment of £160m with a pledge to make its passenger fleet fully electric by 2023. Uber's Green Future Programme provides access to resources valued at US$800m to help hundreds of thousands of drivers transition to fully electric vehicles by 2025, and its £5m investment will see EV chargers installed in the areas that need them the most.

Taxis and private licensed vehicles (PHVs) are very much at the forefront of the EV revolution, and it's easy to understand why. Low emission zones in large towns and cities—where many fleets operate—is driving many EV purchases. But so too is the lower cost of fuelling an EV, and the fact that EVs can enjoy a lower maintenance cost and exemption from London's congestion charge.

"We have seen the positive impact of having 450 EVs on our fleet. Since November 2021, we have covered over 2.5 million EV miles and saved over 600,000kg of carbon from polluting London's air," explains Andrew Westcott, Director of Sustainability and Regulation at Addison Lee. For end users and customers looking to reduce their own carbon footprints, completing their journey with an all-electric taxi fleet is an obvious choice.

Fast refuel, zero emission hydrogen power

The success of a taxi fleet business requires vehicles to be on the road as much as possible, clocking up miles. There are however, significant challenges around the infrastructure desperately needed to serve large numbers of battery electric vehicles (BEVs). So does electric truly offer the best solution for a net-zero taxi fleet?

Chief Commercial Officer at Bramble Energy, Vidal Bharath, believes the industry needs to look beyond simply electric. “For short trips in and around a city or town, BEVs are a great zero emission alternative–so long as drivers can easily and regularly access a charging point,” he says. “But the focus on solely electric alternatives as the only solution for net zero mobility industry is a fallacy. The real need is for a hybrid approach, leveraging both electric and hydrogen fuel cell technologies to provide the most optimised solution.”

The use of hydrogen-powered taxis is accelerating across Europe. Following trials with BEVs, Hype Taxis in Paris adopted hydrogen power in 2015, as the solution appeared to be well-adapted to the needs of a fleet service. Today, the business is aiming to reach 10,000 zero-emission taxis in Paris, and at least 26 public hydrogen fuelling stations by the end of 2024. “The particularity of FCEV infrastructure is that it offers an acceleration capacity that BEV infrastructure does not have,” explains Mathieu Gardies, Hype’s President and Founder. “In fact, with hydrogen, the more volumes increase, the easier it is to deploy.”

Hydrogen fuel cells offer a whole host of potential benefits to taxi fleets. They can replace or complement (range extender) an existing battery drivetrain, and provide fast refuel, zero emission power. A hydrogen fuel cell vehicle (FCEV) refuels in the typical time frame as its diesel counterpart, offering the no downtime requirement needed by taxi fleets–and no need for taxi drivers to change their work habits. FCEVs also enjoy the added benefit of a longer driving range for those extended customer journeys (such as airport runs), and have operating costs similar to that of a Prius. For taxi fleets that work with depots for their drivers, hydrogen power will enable them to refill vehicles and be back on the road again in minutes.

Addison Lee began its journey to be fully electric by 2023 by partnering with Volkswagen to roll out the ID.4 SUV. This marked the largest UK purchase of EVs by a private hire provider and the start of a £160m investment

© Addison Lee

Driving change with improved infrastructure

The main issue of deploying either electric or hydrogen fuel cell at scale and speed is infrastructure. When it comes to BEVs, there are currently 480,000 battery-electric cars on UK roads, plus a further 790,000 plug-in models. Yet the charging infrastructure stands at just 32,312 charging points across the UK–far from the target of 300,000 public chargers minimum by 2030, set out by the government in the EV infrastructure Strategy. “Even if the infrastructure could allow for every vehicle on UK roads to be powered by electricity, the grid would be unlikely to handle such excess demand, fuelling more problems in the long run. Realistically, a transition of all vehicles to electric simply can’t be done,” explains Bharath.

Gardies adds that “with BEVs, the more volumes increase, the more difficult it becomes; this is why the hydrogen infrastructure is a necessary and relevant complementary network to succeed in zero emission mobility efficiently.”

The installation of charging points remains a complex process and for the amount of BEV charging points the UK would need, the industry is looking at a very long road. “Being at the vanguard of the shift to electrification does not come without its challenges. Charging remains the number

Hype has been running hydrogen taxis

© Hype

one issue for plug-in vehicle drivers, and with only about 10% having the ability to charge at home, the majority are relying on the charging network," says Westcott. "We are working with multiple charging operators to provide Addison Lee drivers with cheap and accessible charging options, and have offered our knowledge and experience to Transport for London and London's Boroughs to inform the next stage."

Hydrogen has similar issues, which is why Hype chose to develop its own network of production and distribution of green hydrogen. The hydrogen installation problem may have a simpler fix than that for BEVs. There are currently only 14 hydrogen refuelling points across the UK. But with more than 8,000 gasoline stations in the country, there is potential for many of them–if not most–to comfortably house an electrolyser on site for the production of hydrogen. This could be done in a much timelier and efficient manner, but would require significant initial investment in order to remove the chicken-and-egg conundrum that plagues the roll out of both BEVs and FCEVs.

Equal access and a hybrid approach

The focus for the future of clean transport needs to be equal access to BEVs, FCEVs and hybrid options, which will mean a much cleaner and more secure future for taxi fleets. But without the correct policies in place–such as incentivisation, which can be a real driving force behind uptake and deployment–the transport sector runs the risk of missing out on viable net zero solutions for the movement

About the author: Tom Mason is Founder and Chief Executive of hydrogen fuel cell company Bramble Energy

China's regulatory environment fosters Level 4 AV innovation

The challenge of making SAE Level 4 autonomous vehicles affordable, reliable, and safe is being met by new Chinese legislation. By Will Girling

Images © DeepRoute.ai

China is on course to overtake the US in the autonomous vehicle (AV) market, despite the latter claiming an early lead in 2020. Worth only US$1.5bn in 2021, MarketResearch.com forecasts a 2030 valuation of US$98.9bn for the Chinese AV sector, a dramatic 6,433% increase. For comparison, the US is currently expected to barely exceed US$10bn by the same year.

In China, US$2.5bn worth of AV-related financing occurred in Q1 of 2021 alone. One of the primary reasons for this growth is China's increasingly favourable regulatory environment. Upon drafting new rules for AV development and operations in August 2022, the Ministry of Transport made clear its intention to encourage AV use in low-traffic areas. However, it also cautioned that "vehicles should stick to safety as the top priority."

This isn't surprising when fatal accidents involving partial self-driving and driver assistance system tech still regularly make headlines worldwide– the US National Highway Traffic Safety Administration estimated 392 incidents on the nation's roads between July 2021 and May 2022. Building public trust in the capabilities of self-driving cars will be essential, particularly as companies strive to employ SAE Level 4 vehicles in public transport services.

New legislation

On 1 August 2022, the Chinese government introduced new legislation for vehicles with self-driving capabilities operating within the city of Shenzhen. For the first time, the use of such cars became legal in an attempt to stimulate their commercial potential. According to the new rules, AVs are divided into one of three tiers depending on whether they are capable of conditional, high, or full autonomy.

> "How autonomous capabilities are marketed to customers must be accurate

The legislation also serves to resolve issues relating to Level 3 vehicles operating in Shenzhen, such as stipulating how a vehicle must be registered before entering service and clarifying insurance liability concerns. For instance, a driver will be held liable for all traffic breaches that occur while they are seated in the cockpit. However, the vehicle's owner and operator must answer for any violations or accidents that occur while it is vacant. Crucially, this development also made Shenzhen the first Chinese city to allow road tests of high-level self-driving (Level 4) vehicles on public roads.

This is a significant regulatory milestone for the progression of AVs generally. However, Maxwell Zhou, Chief Executive of DeepRoute.ai, believes this is also the start of AVs' broader profitability in China. "It indicates that commercial deployment will be allowed soon. Currently, we're offering public-facing robotaxi services for free in the central

A fleet of robotaxis integrated with DeepRoute.ai's SAE Level 4 Driver 2.0 solution

business district (CBD) areas of Shenzhen. By obtaining a commercial license, we can start charging fares," he tells Automotive World. Furthermore, as a world-renowned technology hub, he reasons that expansion into Shenzhen's other districts is likely: district governments have the authority to set zones for AV testing, meaning success in the CBD could provide rich opportunities for scaling up.

Creating a Level 4 experience

Despite this, success is far from assured. In the US, Tesla is facing legal challenges from California's Department of Motor Vehicles (DMV) concerning the nomenclature of its Autopilot and Full Self-Driving technology. The DMV claimed on 28 July 2022 that Tesla "made or disseminated statements that are untrue or misleading, and not based on facts." How autonomous capabilities are marketed to customers must be accurate, and with the majority of vehicles with self-driving capabilities in China attaining only Level 3–conditional autonomy–companies must be cautious.

Nevertheless, Zhou explains that the Shenzhen is approved for "driverless autonomous driving in the city, as opposed to regulations that require the presence of an operator for safety." This suggests that regulators are setting Level 4 as an aspirational goal, and it's one towards which DeepRoute.ai has been working since 2019.

With an established presence in five cities (Beijing, Hangzhou, Shenzhen, Silicon Valley, and Wuhan), and over 300 patents, the company released its production-ready Level 4 solution 'Driver 2.0' in December 2021. "For sensors, we use two to five solid-state LiDARs and eight HDR cameras," explains Zhou. This sensor solution can perceive objects over a distance of 200m, the accuracy of which was achieved by creating an optimisation algorithm to fuse solid-state LiDAR and camera data for a better result. "This is necessary because solid-state LiDAR by itself has too much data interference: objects around 80m to 100m in the distance become distorted. Our algorithm fusion achieves a much more accurate perception."

The algorithm facilitates a true Level 4 experience by allowing the vehicle to make real-time decisions as a human driver would. Traffic dynamics are analysed, and optimal trajectories for overtaking are selected, maximising safety and efficiency while also producing a comfortable ride.

Constraints: technology and regulation

This ready-to-go, sophisticated system puts DeepRoute.ai at the front of the Chinese industry's race for commercialised Level 4 AVs. In June 2022, CNBC reported that Geely's ambition is to bring Level 4 to the broader market by 2025. In terms of taking autonomy even further to Level 5, Zhou informs Automotive World that DeepRoute.ai doesn't have a similarly specific timeline. Also, despite the positive progression that Chinese regulators are exhibiting, he is certain that future challenges will be on the regulatory and technological fronts simultaneously.

"Legal frameworks will regulate market access and lay the foundation for industry development. However, we need to collect more corner cases and continuously improve the algorithms before offering a fully autonomous robotaxi service to the public." The maturity and stability of AVs are predicated on establishing trust in both customers and authorities with hard data. At the same time, he adds, the financial feasibility of operating a Level 4 service must also be considered. "The cost of autonomous driving solutions needs to decrease, because it's just not sustainable to operate robotaxis at the current level of expense." Indeed, McKinsey & Co calculates that early robotaxi services, such as those hinted at by Geely, could be up to 225% more expensive than a comparable ride-hailing service with human drivers. The consultancy's report considered factors such as empty miles, service provisioning, and maintenance.

Notably, the report also determined that these same services are likely to become cheaper in a relatively short timeframe, perhaps as little as five years. High usage rates and longer operational lifespans were cited as the primary reasons, but Zhou believes lower upfront hardware and software costs will also be major contributors. "Only when these components are affordable, can automakers start mass producing AVs ready for robotaxi services. In the case of DeepRoute.ai, we've priced Driver 2.0 at US$10,000 and can further reduce the cost to US$3,000 for automakers in mass production."

> "Only when... components are affordable, can automakers start mass producing AVs ready for robotaxi services

Although the full realisation of Level 4 AVs on the streets of China remains merely an ambition, the sector is clearly gaining momentum as a direct result of new legislation. On 7 August, Baidu announced that it was launching limited robotaxi routes in special areas of Chongqing and Wuhan. Continuing to combine technological innovation with China's favourable regulatory environment could soon make the broader deployment of such services an affordable reality.

Flying high: could drones help address the delivery crisis?

Mark Rutherford puts forward the case for using drones as a solution to the current delivery driver shortage

Key markets around the world have been experiencing a shortage of delivery drivers in recent years. So much so, in the UK Amazon enticed part-time workers with up to £3,000 (US$3,600) in incentives to ensure this didn't affect profits during the festive period.

According to the Road Haulage Association, the UK industry alone was short of more than 100,000 HGV drivers in June 2021. This was due to a number of factors, from barriers to obtaining a licence to the introduction of Brexit, but similar shortages are seen in other regions as well. In order to address these shortages, companies around the world are coming up with innovative alternatives. This includes the introduction of unmanned aerial vehicles (UAVs). Alphabet, for example, has successfully used these to deliver over 10,000 cups of coffee and 1,000 loaves of bread in Logan, Australia alone. Are UAVs the solution?

Can we rely on UAVs?

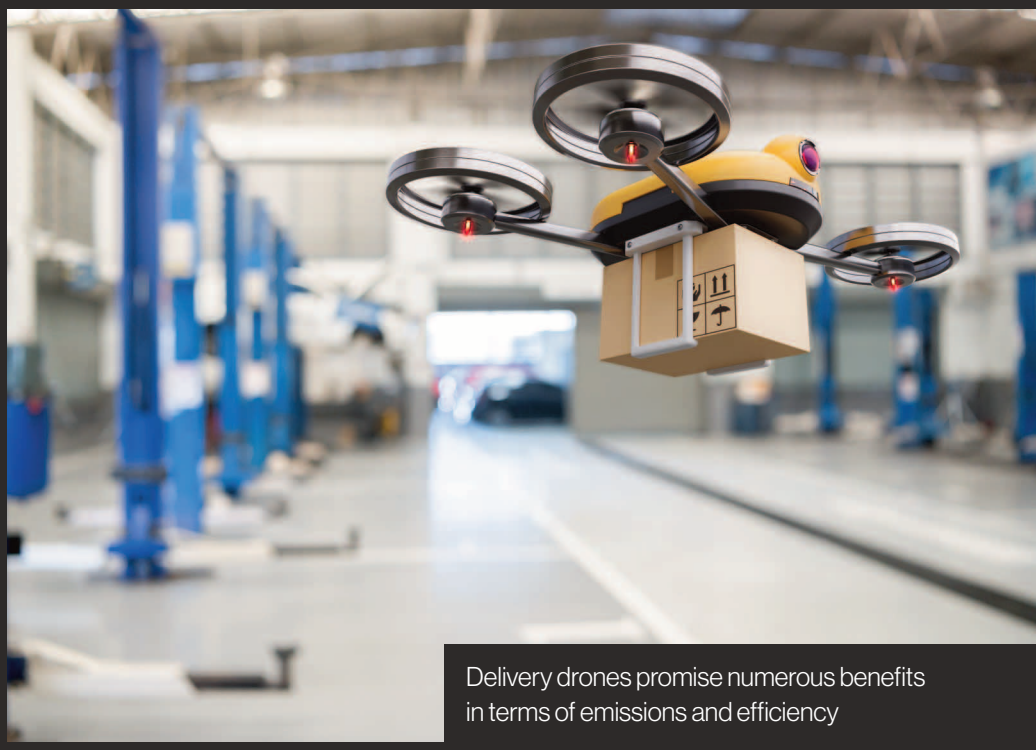
Commercial UAVs are leading the way for innovative research. In addition to delivery services, drones are being utilised for wildlife protection and research, historical preservation, and the improvement of renewable energy resources. However, before the mass distribution of delivery drones, businesses and customers alike must decide if they are reliable. The thought of unmanned vehicles might seem concerning at first, but technological innovations are ensuring this is a safe and dependable process.

Alex Stapleton, Sales Director at Alexander Technologies, a leading provider of customised lithium-ion batteries and chargers, shines a light on the use of UAVs: "The question of how to power a UAV or drone is influenced significantly by the nature of the application. In some cases, particularly for the largest equipment, combustion engines are still designed into this market, but more and more models are being designed to run on lithium-ion batteries."

Lithium-ion battery packs are powerful, comparatively small and light and can be charged quickly. More recently, some have started to use efficient solar panels within the design to extend the range and preclude the need for a dedicated charger at both ends of a flight path. Silent running, vertical take-off and landing (VTOL) capabilities

are attractive, as is the environmental benefit of designing away from the combustion solution.

"Batteries are particularly effective at the moment for short-range missions, similar to the last-mile delivery solutions, to increase bandwidth at the local delivery hub," says Stapleton. "They are more practical when delivering small-sized payloads. Perfecting the design of this solution is critical to a successful new development, and this is usually best achieved through iterative discussions around the application itself and key challenges–such as charging time, operating temperature or capacity."



Delivery drones promise numerous benefits in terms of emissions and efficiency

What are the benefits?

UAVs are becoming the next futuristic piece of technology to dominate the delivery market. Vikram Singh, Chief Executive of TechEagle, a company that has delivered over a thousand packages in India, believes that delivery drones are the future: "Drones are autonomous, faster, more reliable, and more economical than conventional delivery methods."

There are multiple benefits to using a drone delivery service, including environmental perks. In fact, research shows that drones use less energy per kilometre than traditional delivery trucks. They are smaller and powered by batteries, after all, reducing the amount of carbon dioxide entering the atmosphere.

In addition to any ecological benefits, delivery drones are a more efficient service. So much so, the owner of TechEagle has gone on to argue that his company's drones have the ability to deliver parcels 20 times faster than any ground-based method of transportation. Over time, this will build a long-lasting relationship between customers and businesses.

Finally, drones are proving to be a more cost-effective delivery service. Due to the fact that drones can deliver seven to eight packages within an hour, considerably more than standard ground-based services, businesses will save money on both wages and fuel

To summarise

UAVs are on their way to becoming the solution to delivery shortages. Companies around the world are adopting this approach, from Alphabet in Australia to TechEagle in India. In Ireland, drone company Manna is trialling processes in Galway, according to Chief Executive Bobby Healy. Over time, this can reduce company costs and environmental emissions.

About the author: Mark Rutherford is Managing Director at Alexander Technology

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Cleaner cars need not mean more congested cities

Andy Marchant explores ways to simultaneously combat both urban traffic emissions and congestion

While we have all enjoyed the benefits of a world with less traffic congestion during the pandemic, traffic levels are unfortunately steadily increasing again as citizens slowly but surely return to the office as part of their new working patterns.

As a result, local governments and city planners are therefore doing everything possible to reduce transport-related pollutants that are hazardous to the environment and human health. Many cities have implemented low-emissions zones designed to keep carbon-intensive vehicles out of city centres to improve overall air quality. For example, the Mayor of London has proposed plans for the expansion of London's Ultra Low Emission Zone (ULEZ), extending the catchment area to the Kent border. Meanwhile, Aberdeen, Dundee, Edinburgh and Glasgow introduced their own Low Emission Zones earlier this year.

When you consider the environmental cost of traffic congestion, which is alarmingly high, these are encouraging developments. For example, in 2021, 14.8 megatonnes (Mt) of CO2 was emitted in London due to road traffic, of which 15% (2.2Mt) was a direct result of congestion. To capture London's 2021 traffic-related emissions from the

atmosphere, the UK would need to grow a forest nearly the size of Northern Ireland in one year.

The impact of EVs on low emissions zones

With governments aiming to cease the sale of gasoline and diesel cars by 2030, low emission zones would ultimately become redundant in a few decades, with UK citizens and businesses required to switch to more sustainable vehicles.

Taking London as an example, TomTom estimates that increasing the EV ratio by just 1% within the capital's traffic mix would write off 155,000t of CO2 emissions—equivalent to a forest the size of Manchester (125km) to remove this amount of CO2 from the atmosphere. Based on this, it is clear that accelerating the switch to EV mobility will be essential for the UK to achieve its goal of net zero emissions by 2050.

Increased demand for charging stations must also be met. In the long-term, gas stations should be replaced with charging stations, where vehicles can take turns to charge before resuming their journeys. By then, technologies will likely be advanced enough that it takes less time to charge vehicles, taking minutes instead of hours.

Yet, this will result in more vehicles being welcomed back into city centres. While they would be free from harmful emissions, we cannot ignore that traffic congestion would increase enormously. Where certain vehicles previously had to bypass the city, they would once again be allowed to pass through it with ease.

"With governments aiming to cease the sale of gasoline and diesel cars by 2030, low emission zones would ultimately become redundant in a few decades

Planning for a less congested future

Fortunately, there are several ways to simultaneously combat both urban traffic emissions and congestion. For public authorities and city planners, knowing how to influence traffic to ensure viable traffic flows and the efficient use of the infrastructure is essential. Using location technology will continue to change how people move around their cities because it is connected to transportation, commerce, and a strong economy.

Better traffic management, however, can only improve traffic flow by 10%. Therefore, the modal split needs to be altered to effectively combat congestion and permanently end the traditional rush hour peaks in cities. There needs to be more emphasis on using bicycles, public transportation, and other modes of transportation. These are straightforward fixes that are currently underutilised.

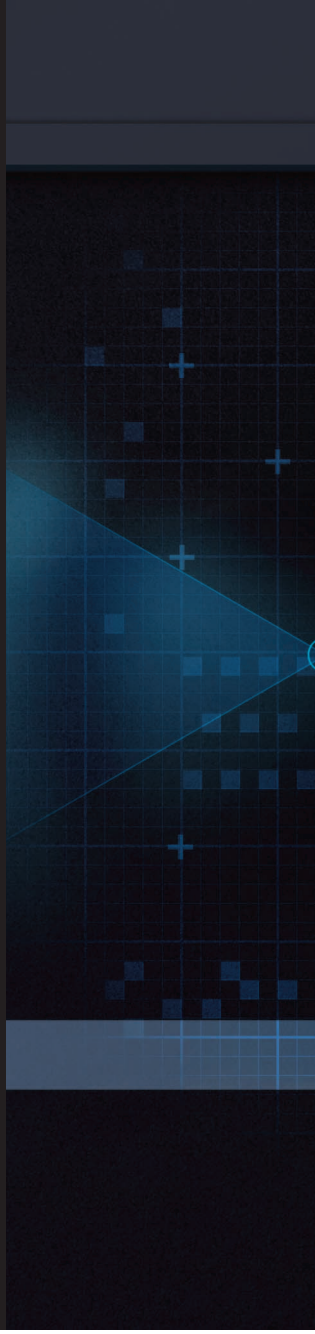
Congestion charges or zones where only a select number of cars are permitted to drive during peak hours may also be implemented by cities. Greater collaboration between city planners, policymakers, employers, and drivers is necessary for this reorientation, but it will take time. However, this change is critical to truly reduce transport-related emissions, while still ensuring that we resolve urban traffic congestion in a future wherein the low emission zones become redundant.

The opinions expressed here are those of the author and do not necessarily reflect the positions of Automotive World Ltd.

Andy Marchant is Traffic Expert at TomTom

The Automotive World Comment column is open to automotive industry decision makers and influencers. If you would like to contribute a Comment article, please contact editorial@automotiveworld.com

Better AV performance in the last 50-feet is crucial

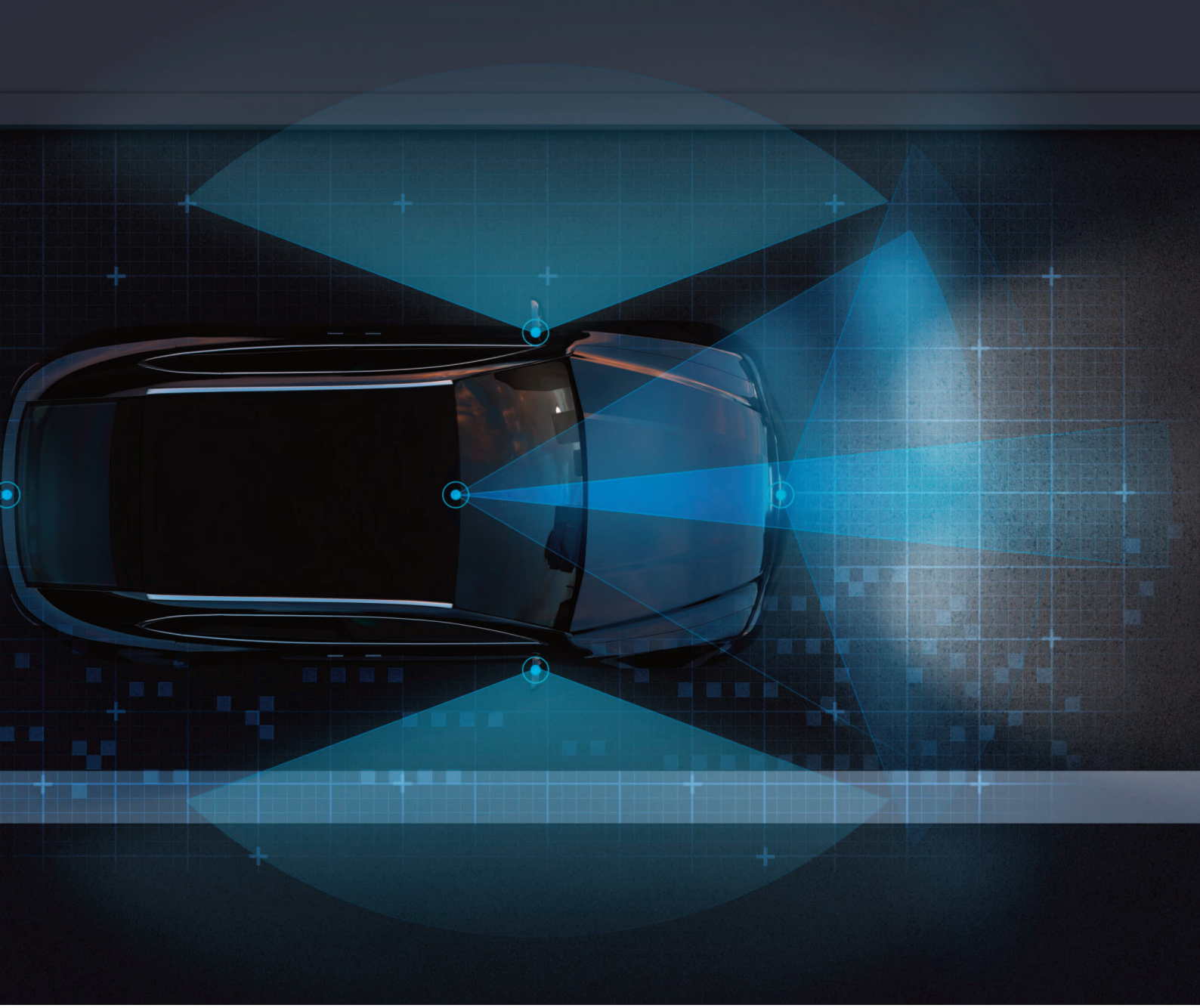


More focus should be placed on delivering a smooth beginning and end to the autonomous vehicle ride experience. By Will Girling

The market for vehicle sensors is growing–Verified Market Research calculated its 2021 value at US$26.9bn globally, with the potential to reach US$46.3bn by 2030. The broader adoption of electric vehicles (EVs) and increasing consumer awareness of sensors' safety benefits are key motivators for this growth. However, the concurrent development of autonomous vehicles (AVs) is putting the full potential of sensor technology to the test.

The ultimate goal of this ongoing industry research–SAE Level 5, or fully autonomous vehicle self-driving–is being facilitated by one key piece of technology: LiDAR. The 3D environment mapping capabilities of these sensors make them ideal for helping a vehicle make sense of and safely navigate its environment. In fact, the 'arms race' to develop LiDAR has been joined by a plurality of OEMs and transport service providers, including Mercedes-Benz, BMW, Toyota, Waymo and Uber.

One notable exception is Tesla, with Chief Executive Elon Musk even calling LiDAR a "fool's errand." However, Paul Drysch, Chief



Executive and Co-founder of PreAct Technologies, does not agree. He tells Automotive World that the secret to better AV motion control could still depend on LiDAR, but with a different approach.

Ripe for disruption

Originally a contractor in Washington DC supplying high-speed sensors to the defence industry, PreAct spun-off in 2018 to bring similar technology to automotive. "Traditional sensors like ultrasound and radar are very old-school and haven't changed much in 50 years. We knew that it was a huge market, and it was ripe for disruption," says Drysch. Taking knowledge and IP of "active protection systems" capable of detecting incoming missile attacks, the company developed "near-field LiDAR sensing" for use in vehicles.

"Initially, we were trying to perform imminent collision detection using just cameras, like the Tesla approach. It was all about exploring how to mitigate injuries or fatalities in a vehicle in the microseconds before impact." However, PreAct soon realised that this approach alone,

An example of PreAct's near-field LiDAR sensor technology

even when augmented by AI and neural networks, was not satisfactory for the task. Easily distorted by weather and environmental conditions, and with inadequate processing power, cameras could not reliably prevent collisions.

Drysch explains that the solution came by combining a new approach with an older technology called time-of-flight (ToF) sensors: "ToF is common today in simple things like supermarket doors. What we did was take these low-cost, off-the-shelf components and enhance them with software to operate in a new way." Software upgrades included improving sensor function in brightly lit areas and boosting range capacity beyond the standard three metre limit.

Lower cost, higher frame rate

Near-fielding LiDAR combines with cameras to produce an optimal safety result—Drysch emphasises that "there is no one-size-fits-all solution for self-driving vehicle sensors. Tesla and Waymo both use a range of radars, and they still have lots of issues." In fact, a large quantity of sensors may even be counterintuitive for good AV motion control. By reducing the number of ultrasonic sensors, short-range radar, and even some cameras, he believes a better result can be achieved. Also, because the sensors are software-defined, new features can be added iteratively to "future-proof" cars and move in-step with AV progression.

"Near-field LiDAR is low-cost, and its high-resolution point cloud is more accurate than ultrasound and radar." Savings can be made on manufacturing because PreAct's software mitigates the lasers and split arrays of traditional LiDAR set-ups. Overall, Drysch claims the frame rate for near-field LiDAR can be up to 15-times faster—picture capturing speed is essential for self-driving systems, as it helps determine whether an object is accelerating or decelerating while being tracked.

Slow ADAS

In terms of near-field LiDAR's use cases in self-driving cars, PreAct has been working with a number of automakers and Tier 1s on "slow ADAS" (advanced driver-assistance system). Focusing on what Drysch calls "the last 50-feet", the company has been focusing on slow-speed applications instead of faster, highway-based motion. "Performance in the last 50-feet of a journey is honestly the most important aspect of self-driving vehicles," he states. "The industry has focused on the broader journey and done very little on when the vehicle has almost arrived, but that's where vehicles interact with customers the most."

If fully self-driving vehicle services are to be realised, the cars will need to safely stop and allow the passenger to get in or out. Vehicle fleets such as

Waymo in San Francisco have laid the foundation for future AV development, yet operations are far from perfect. Slow ADAS can add value by making the beginning and finishing stages of a journey feel smoother, like a human driver. "Waymo cars generally stop in the middle of the street when they should actually find an open parking or safe spot to pick somebody up. That's the next phase of AV technology," says Drysch. It's a phase that the AV sector urgently needs to reach—with the veracity of high-profile systems like Tesla's Autopilot facing scrutiny, building a solid safety profile for self-driving technology is imperative.

Incremental change

In terms of AV motion control's overall progression, Drysch is optimistic for the long term but believes there are still challenges to overcome. Human-driven and self-driving cars will need to coexist for the foreseeable future, and he reasons that incidents could be more frequent as the two interact with each other in unexpected ways.

"The good thing is that, because self-driving vehicles are taking longer to develop than everybody thought, a lot of innovative technology is being developed and integrated into traditional cars," Drysch says. Level 2 features such as steering and acceleration control in Cadillac's Super Cruise system, or the Level 3 environment detection capabilities of the Audi A8, are notable examples. Safety, he continues, is likely to improve incrementally, as will vehicle autonomy generally. Customers will be introduced to new, convenience-based features on a gradual basis so that "when the time comes for Level 5, they'll be comfortable with it."

As far as AV motion control is concerned, it's clear that little details can make the difference. When customers become accustomed to enhanced ride performance and better end-to-end self-driving experiences, PreAct reasons that autonomous features will become table stakes in the same way as power steering and adjustable seats decades earlier.

Where is the US headed with its CASE journey?

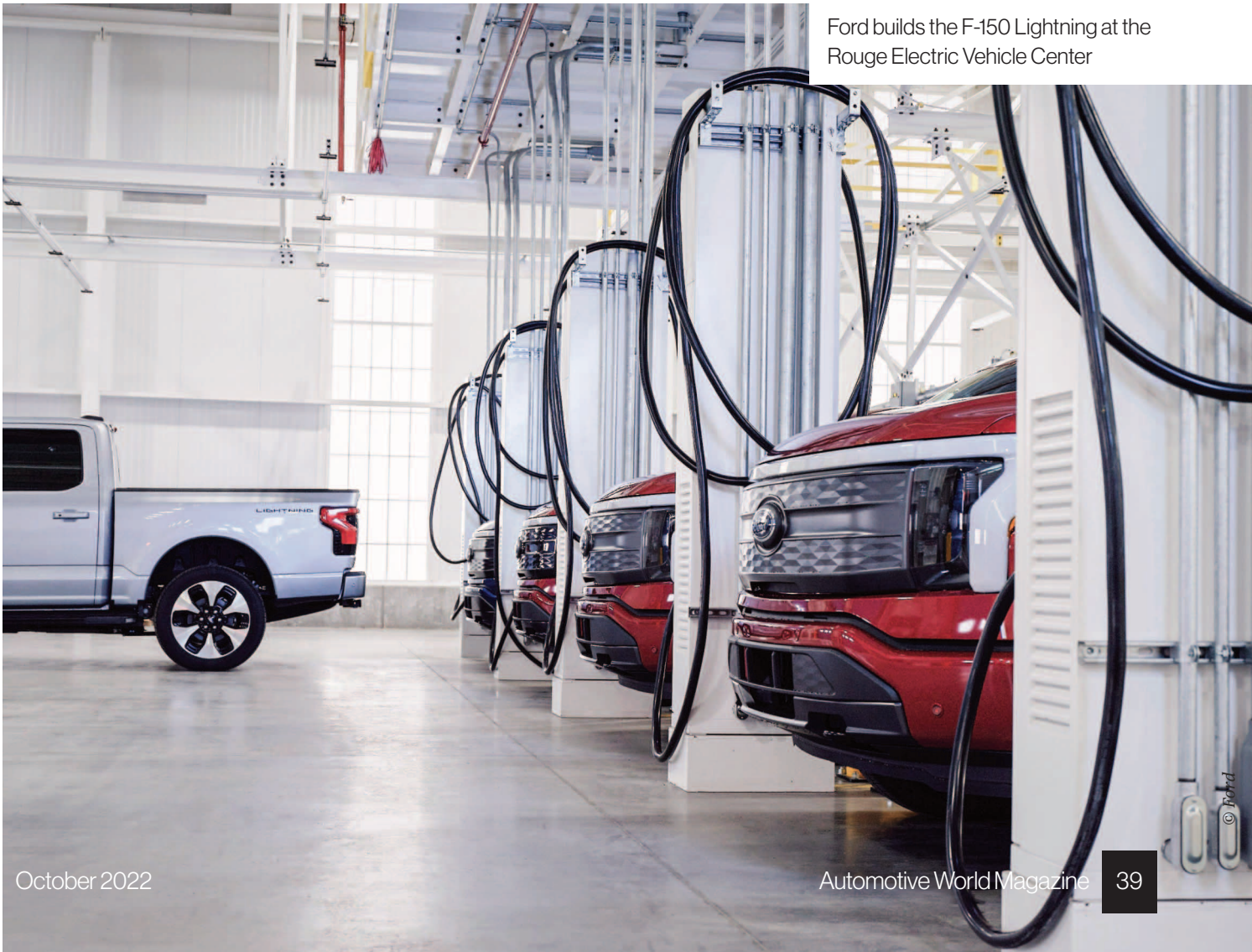
This pivotal market is moving towards a connected, autonomous and electric future, but perhaps not as quickly as expected. By Megan Lampinen

The US is the second largest automotive market in the world, following only China both in terms of vehicle registrations and production. The industry accounts for 3% of the country's GDP. Every year, Americans spend nearly US$800bn on vehicle loans and insurance, and on average more than 90% of households have access to at least one vehicle. It's a pivotal market to understand, and where it heads, others may follow.

Electrification

Like all markets today, it is being reshaped by the rise of connected, autonomous, shared and electric (CASE) vehicles. Sales of new light-duty plug-in electric vehicles, including all-electric vehicles (EVs) and plug-in hybrids (PHEVs), nearly doubled between 2020 and 2021, jumping from 308,000 units to 608,000. 70% of these were pure EVs.

"The North American light vehicle market is at an inflection point as most manufacturers work to add EVs to their line-ups in the next year or two, if they haven't already," observes Edmunds' consumer insights analyst, Joseph Yoon. So far, he adds, EVs in the US have been largely categorised as a "luxurious novelty" for many consumers and account for less than 5% of the market. Moving forward, an increase in offerings from mainstream manufacturers at varying price points should increase that figure. The next couple of years, for instance, will see the launch of an all-electric SUV from



Ford builds the F-150 Lightning at the Rouge Electric Vehicle Center

Acura, the Audi A6 e-tron, an electric Ford Explorer, and electric versions of Chevrolet's Silverado, Blazer and Equinox.

Karl Brauer, Executive Analyst at CarExpert.com and a highly experienced industry veteran, also expects to see more EVs introduced across brands, vehicle categories and price points. However, he suggests these models will continue to struggle with consumer acceptance due to higher costs and limited charging infrastructure outside major cities. "Automakers will attempt to shift production, sales, and revenue toward EVs, but they will face smaller profit margins and capped consumer demand, especially as more models are introduced but the percentage of consumers buying EVs doesn't increase with production and competition," Brauer tells Automotive World. "The ramp up of models from both traditional and new brands like Lucid, Rivian, Fisker, and VinFast will put additional pressure on all automakers to establish a profitable EV business plan."

The market's move to EVs could also see a long-term boost from the recently signed Inflation Reduction Act. The new federal tax credits go into effect in 2023, but their impact

Audi A6 e-tron concept

may be limited; the law has been designed to incentivise only those vehicles that are assembled in the US. At the moment, just a few models qualify. “Considering the scale of the car market in the US, it’s likely that manufacturers are scrambling to align their supply chains so that their vehicles qualify for these tax credits in the coming years,” says Yoon.

Connected and autonomous

Connectivity is another megatrend shaping mobility and the US is leading the pack. In 2020, 91% of new vehicles sold in the country were connected– more than any other market. But the evolution from connected infotainment features to vehicle-to-everything and even autonomous driving could take some time.

Mercedes-Benz is pushing ahead with development work for conditionally automated driving in the US

“Until there’s a clear directive from the federal government, or enough state governments dictate a standard protocol for connected vehicles, I don’t see much happening by 2025,” cautions Yoon. The US Department of Transportation is still in the research phase of evaluating connected vehicles and infrastructure, and so far the research funding has been going into pilot programmes to determine the effectiveness and efficiency of vehicle-to-infrastructure (V2I) programmes. Yoon points to Denver and Pittsburgh as two cities currently researching and integrating these infrastructure upgrades, but notes that “a larger, nationwide adoption of V2I seems much further away than 2030.”

Partially and fully autonomous driving will also take time. Yoon does not expect to see an appreciable portion of vehicles with Level 3 automation available for purchase for “a significant while longer.” Today, the only vehicles with regulation-approved Level 3 capabilities are the Mercedes Benz S-Class and EQS. “Due to the hardware requirements for the autonomous technology, it seems that it will remain a flagship feature for a while,” Yoon observes. “Even if we optimistically look at how quickly the technology can scale both in price decreases and size, I don’t see significant inroads with Level 3 for another five to seven years at the earliest.”

Brauer is more optimistic and anticipates additional Level 3 models on the market by 2025, with most of them either premium brands or EVs from mainstream brands. “We’ll see most new cars available with Level 3 tech by 2027,” he predicts.

Voyage is providing its robotaxi service to residents of The Villages communities

As for driverless vehicles, there are a limited number of applications in use within geofenced areas today, such as Voyage's service within The Villages retirement community in Florida. About half of US states allow on-road testing and there are a small number of commercial pilots. By 2025, Brauer expects to see limited areas where fully self-driving cars can operate. By 2030 this should extend to large stretches of mainstream highways and substantial areas within major metropolitan centres. "But there will be incidents where the technology fails and accidents, injuries, and traffic jams occur," he adds. "It won't be a clean, problem-free transition, and it will take well into the 2030s before self-driving technology works in most areas of the US."

New brands

Ford, General Motors and Chrysler have dominated the US market for decades, though in 2021 Toyota grabbed the top spot from GM, pushing it off the top spot for the first time since 1931. Can these big-name players expect to see competition from new arrivals?

Yoon is doubtful: "I would love to see new, innovative brands make waves in the industry, but we haven't really seen it done successfully at scale yet, outside of Tesla. Vehicle manufacturing is an extremely difficult endeavour, and even the most well-funded and well-marketed brands with all the right people seem to have difficulty scaling up

production to meet the demands their vehicles have created." He suggests that it will be especially difficult now for start-up brands to make inroads as legacy players invest more significantly in EVs and start cranking out vehicles at a pace new entrants will have a tough time matching.

Brauer, however, has his eye on some potential disruptors: "All indications suggest VinFast will be a real player in the US market in the next 24 months. Rivian will also become a serious brand in the US, though cost and profit challenges for all EV models will limit start-up EV brands from taking real market share from traditional automakers–which will also struggle with cost and profit issues for their EV models."

Could Rivian become a big player in the US?

Challenges ahead

The C-Suite has plenty to keep it up at night, but issues around EVs will likely be at the top of their worries. "The cost of raw materials, particularly raw materials needed for large battery packs, will be the biggest challenge for every brand seeking to transition from internal combustion to electric power," says Brauer. He also expects cost and profit issues to plague traditional vehicles as EPA requirements force greater fuel efficiency, which will essentially require the electrification (in the form of hybridisation) of drivetrains for models that aren't fully electric. "Even though hybrid models use smaller battery packs than EVs, they will still cost more to produce and require higher MSRPs that many consumers either can't or won't pay," he warns.

Yoon flags EV charging infrastructure as a future concern, noting: "For brands focused on making strides in consumer adoption of EVs, the biggest challenge will be encouraging consumers that the charging infrastructure is continuing to improve and suitable for their lifestyle, whether they are work commuters or travellers or both. Not only will US highways need to be fully wired for charging, but so will homes, apartments and office buildings."

Government financial support, directed at EV purchases as well as EV manufacturing and infrastructure, could prove pivotal. "It would present a very difficult challenge for an automaker in the US looking to build up EV market share if their vehicles are consistently out of consumers' reach due to an inability to qualify for financial incentives," Yoon warns.

Images © Hyperion

The science of fuel cells beats batteries, says Hyperion

Hyperion's Chief Executive explains why the fuel cell electric vehicle powertrain offers greater long-term value. By Will Girling

Although their price range might put them beyond the reach of most consumers, high-performance vehicles demonstrate the upper limits of powertrain technology. Today, sustainability demands are shifting development from internal combustion engines (ICEs) to the new frontier of battery electric vehicles (BEVs).

The high-torque electric powertrain has already seen BEVs achieve remarkable feats–the Aspark Owl claimed the title of 'fastest accelerating vehicle in the world' in 2022 with a verified 0-60mph in 1.69 seconds; meanwhile, the second-generation Tesla Roadster has a spec that combines fast acceleration (0-60mph in 1.9 seconds) with a 620-mile range. However, the debate on lithium-ion's (Li-ion) overall durability and efficacy, particularly regarding its sensitivity to heat and cold, calls into question whether the future of cleaner light vehicle mobility truly belongs to BEVs.

Angelo Kafantaris, Founder and Chief Executive of Hyperion, believes that the limits of BEV technology have already been reached. Instead, he proposes that hydrogen fuel cell EVs (FCEVs) could be the true successors to ICE.

Intrinsically high-performance

Kafantaris tells Automotive World that, when it comes to performance, most BEV technologies generally have a trade-off such as low range or long recharge times. Indeed, EV charging specialist Pod Point notes that size of a car battery and the speed of a charging point could vary the recharge time from 30 minutes to eight hours. Furthermore, in a 2021 survey by Volvo on the top consumer barriers to purchasing an EV in the US, 58% of drivers cited range anxiety, 49% lack of charging infrastructure, and 20% performance capability.

Hyperion's XP-1 addresses each of these factors. A hydrogen-powered, limited production hypercar announced by the Californian manufacturer in August 2020, it is scheduled to enter production at the company's Columbus, Ohio plant in late 2022. "We built the XP-1 as a way to test several new technologies," Kafantaris explains. "We wanted it to be a test case for the pinnacle of FCEVs' potential, both as a practical vehicle and a showcase for innovation." The performance of the XP-1 could give some previously dissenting voices pause for thought– in 2020, Volkswagen strongly favoured passenger BEVs over FCEVs and cited the contemporary energy efficiency of the former (70 to 80%) as vastly superior to the latter (25 to 35%).

Angelo Kafantaris
Founder and Chief Executive, Hyperion

The US Department of Energy's own research found a much higher efficiency of 40 to 60%. Indeed, Kafantaris states that FCEVs are intrinsically higher performance: "The Hyperion XP-1 has a range of 1,000 miles and can be refuelled in three to five minutes at a station, similar to a gasoline-powered car." Utilising an AWD drivetrain that delivers over 2,000bhp and a top speed of 220mph, the XP-1 has the high torque characteristic of EVs while also dispensing with the encumbrance of a large and heavy battery.

Hydrogen shapes design

In an age of mobility defined by environmental sustainability, a vehicle cannot sacrifice green principles for performance. Kafantaris emphasises that hydrogen fuel cells are not a problematic, combustion-based technology. "The fuel cells essentially pull the electrons out of hydrogen molecules," he says. The XP-1 is designed to utilise a hydrogen system invented by NASA to store the large quantities of energy needed to achieve its high range in a small volumetric area. In fact, this space

Hyperion's XP-1. Limited to 299 production models, the hydrogen fuel cell powered sports car has a range of over 1,000 miles

flight technology permeates the XP-1's design and powertrain—from a high-voltage fuel cell, ultracapacitors, and four motors placed on each wheel, to a carbon fibre frame reinforced with titanium and adjustable wings that create a greater surface area for solar-panel recharging.

Although the XP-1's production run will be limited to 299 vehicles, it demonstrates FCEVs' ability to combine speed, convenience, and sustainability in a single package. "It's great for the environment because the only by-product is clean water," he points out. The "jet stream" of expelled water even serves as a coolant for several of the vehicle's components.

The problem of refuelling

Bringing several new technologies together into a recognisable two-seater sportscar package was the biggest challenge of creating the XP-1. However, when considering how to scale FCEVs into the broader mass market, Kafantaris adds that hydrogen infrastructure remains the most significant hurdle.

In its report 'The green hydrogen economy', PricewaterhouseCoopers (PwC) noted two immediate issues: the fact that 'grey' or fossil-fuel generated hydrogen is the most widely available today, and the difficulty of building infrastructure essentially from the ground up. Building a pipeline suitable for hydrogen transmission, for example, could take up to 12 years to be realised. Therefore, even if large-scale work commenced immediately in 2022, a hydrogen economy would only become a real prospect by the mid-2030s. Nonetheless, PwC noted that uptake could accelerate at that point—coinciding with new ICE sales cut-offs in several markets—and begin gaining traction by 2050.

In terms of public infrastructure, Kafantaris is encouraged by the state of California's goal to build 200 hydrogen refuelling stations by 2025. However, Hyperion is going one step further to mitigate the problem for its customers by including a plug-in home fuel cell refueller with each XP-1. Kafantaris notes that the home refuelling time is ten to 15 minutes, slower than a hydrogen station but still substantially faster than "an overnight, eight-hour charge common for BEVs."

"This charger is low-cost and uses a house's water supply," he continues. "Our technology electrolyses water, or separates the hydrogen from oxygen to create fuel." The hydrogen is transferred to the vehicle's fuel cells while the oxygen is released as an environmentally safe by-product. Combined with solar power at home, he states that FCEV technology could effectively alleviate the issue of electric grid strain that increased BEV uptake threatens.

A better value proposition

In a March 2020 report, BloombergNEF concluded that passenger cars would ultimately favour battery-electric powertrains instead of fuel cells as the most cost-effective option. Kafantaris strongly disagrees with this assessment: "Li-ion batteries started out in small consumer electronics applications, and manufacturers have tried to enhance the same technology for high performance in vehicles. I think we've now reached the limit of that development." This, he adds, is why so much innovation exploring alternative battery configurations has emerged in recent times.

An indicator for the ultimate trajectory of light vehicle powertrains could be developments taking place in heavy commercial vehicles. Feedback received by Hyperion from truck manufacturers testing BEVs suggested that battery lifespans can be up to three times shorter than advertised. "If you push a battery every day, the charge-discharge cycle will degrade capacity quickly," Kafantaris explains. FCEV powertrains do not have this problem, and some OEMs like Volvo Trucks have even announced tests for hydrogen-powered vehicles with a comparable range to the XP-1. Furthermore, if more road freight vehicles incorporated fuel cells, he reasons, their use would subsequently boost hydrogen refuelling infrastructure and lay the foundation for the broader rollout of passenger FCEVs.

> "FCEV technology could effectively sidestep the entire issue of electric grid strain that increased BEV uptake threatens

"At that point, consumers would probably have the option of choosing a BEV or FCEV version of a vehicle model at purchase." Between the two, Kafantaris is confident that the higher range, longer operational lifespan, and easier refuelling experience of a hydrogen-powered car will convince most that it has a better overall value proposition. "At that point, FCEVs will overtake BEVs in the electrification race," he concludes. "The science of hydrogen beats Li-ion hands down."

Mineral wealth is the key to Canadian EV sector's success

With the global EV market dependant on the availability of battery materials, Canada's vast mineral resources could give it an advantage. By Will Girling

In 2021 Canada was ranked the 11th largest light vehicle market in the world–approximately 1.64 million units sold–and the automotive industry contributed CA$16bn (US$12.2bn) to the nation's GDP. According to market researcher IBISWorld, it is expected to grow 11% in 2022.

While Canada is currently the second-largest car producer in North America, its main competitor–the US–holds a commanding lead on the region: it secured sales of almost 15 million in 2021, making it second only to China in global terms. However, the move towards electrification is providing Canada with a significant opportunity to increase its standing.

According to the Canadian government's Innovation, Science and Economic Development (ISED) department, this opportunity is presented on three fronts: investment in manufacturing, availability of battery materials, and incentivising ownership. "Canada's strength in automotive manufacturing, combined with its world-class information technology cluster and natural resources, positions Canada to lead in battery electric vehicle (BEV) R&D," an ISED spokesperson tells Automotive World.

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> Canada's substantial mineral wealth is primed to secure it a larger share of the global automotive market

Concentrating investment

Underpinning the Government of Canada's focus on electrification has been targeted investment in manufacturers building zero-emission vehicles (ZEVs). "Since 2015, the government has invested nearly CA$2.2bn in the automotive sector, leveraging over CA$20bn in announced investments," states the ISED.

Areas for investment have involved several notable collaborations with OEMs, including US$2.8bn to help Stellantis expand EV manufacturing at its Windsor and Brampton assembly plants; US$1.4bn with General Motors to produce electric commercial delivery vehicles in Ingersoll and resume production in Oshawa; and US$1.4bn for Ford to produce BEVs in Oakville. In addition, the government gave US$1.1bn each to Toyota and Honda to assist in the production of their new hybrid models.

"The government is always looking at the bigger picture," adds the ISED. "Conversations are happening on regular basis with a number of stakeholders in an effort to make Canada a worldwide leader in the

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Pictured: The Honourable Doug Ford, Ontario Premier; The Honourable François-Philippe Champagne, Minister of Innovation, Science and Industry; Scott Bell, Vice President, Global Chevrolet; The Honourable Vic Fedeli, Ontario's Minister of Economic Development, Job Creation and Trade; Mr. Ryan Turnbull, Member of Parliament for Whitby, Ontario; and Marissa West, President and Managing Director, GM Canada. Photo Credit: Ryan Bolton

automotive industry." Indeed, the Honourable François-Philippe Champagne, Minister of Innovation, Science and Industry, met with senior executives of the German and Japanese automotive industries during spring and summer 2022. On the agenda were the benefits of decarbonisation and–most notably–promoting Canada as a hub for battery production.

A lead on battery materials

According to market analyst Fact.MR, the global EV battery market could be worth US$900bn by 2031–an exponential rise from its 2021 valuation of US$91bn. However, in May 2022, CNBC reported that global raw material shortages for these batteries are unlikely to be resolved before 2026. In this climate of strained supply chains, Canada's substantial mineral wealth is primed to secure it a larger share of the global automotive market.

As of 2020, mines in Canada produce over 60 minerals and metals at a total value of US$33.8bn. A spokesperson from Naturel Resource Canada (NRC) reveals to Automotive World that the country has either existing production or reserves for "nickel, graphite, cobalt, copper and manganese," as well as "an abundance of rare earth elements to make permanent magnets for EV traction motors."

In fact, the country's natural resources are large enough for NRC to forecast enough capacity to produce 186% of the nickel and 109% of the lithium required for Canada's EV market by 2035. In addition to its domestic requirements the nation is also forging strong mineral supplier relationships with the US, which accounts for 43% of nickel exports, 10% of cobalt, and 50% of copper as of 2022.

> "The objective will undoubtedly be for Canada to become a global leader in the production of batteries

The NRC highlights that Canada's "resource wealth, industrial know-how and trade relations" are adding value while simultaneously meeting its own sustainability targets. "Our low-cost green electricity allows for low-carbon processing of these minerals into materials." Above all, adds the NRC, Canada's existing automotive and supply chain capabilities provide a solid foundation upon which new, BEV-centric value chains can be built. "By 2025, we expect Canada to have mid- and downstream battery capacity," it states.

Incentivising ownership

With BEVs accounting for 5.6% of new car sales–barely trailing the US' 5.8%–Canada is not ignoring the need to increase uptake and create a more favourable manufacturing environment. As of 2022, Transport Canada operates two purchase grants: one for light vehicles (Incentive for Zero-Emissions Vehicles–iZEV) and another for the medium- and heavy-duty zero-emission vehicles (iMHZEV).

"The iZEV programme is one of the Government of Canada's key measures to help meet its target of 100% light-duty vehicle sales by 2035," a Transport Canada spokesperson informs Automotive World. "The programme offers point-of-sale (POS) incentive of up to CA$5,000 on the purchase or lease of eligible vehicles." The programme has assisted the purchase or lease of 159,000 ZEVs since it was introduced in 2019. Meanwhile, the iMHZEV programme launched in July 2022 offers businesses up to ten CA$200,000 POS incentives for commercial vehicles per year.

The duration of iZEV has been extended to the end of Q1 2025 through CA$1.7bn of additional government funding, with MHZEV expected to terminate in 2026. This should help support domestic uptake

and production in the near term. However, developments in the US could serve to boost Canadian automotive industry even further.

"Once-in-a-generation" chance

In July 2022, US President Joe Biden introduced new material point-of-origin specifications as conditions to the receipt of EV tax credits. Notably, Canada is no longer listed among the exempted assembler countries–a drawback of the original bill introduced by President Donald Trump. In July 2022, CBC quoted Flavio Volpe, Chief Executive of Canada's Automotive Parts Manufacturers' Association, as stating that this would prove highly advantageous by providing new opportunities to increase EV and battery export operations. "This couldn't be a bigger vote of confidence in the North American auto sector. All of these new investments in Canada now have an incredible runway to have this rebirth of Canada's auto sector," he said.

ISED Canada agrees: despite the challenges of large-scale EV manufacturing, which it concedes is still "a couple of years away," and the need to continue investing in value chains, the department called the situation a "once-in-a-generation" opportunity. "Transitioning Canada's automotive sector towards the production of ZEVs offers significant economic benefits," it said. With government investment high and new markets emerging, the objective will undoubtedly be for Canada to become a global leader in the production of batteries. By doing so, the country could emerge at the forefront of North American vehicle manufacturing in the electric era.

CHIPS Act could make the US a semiconductor powerhouse

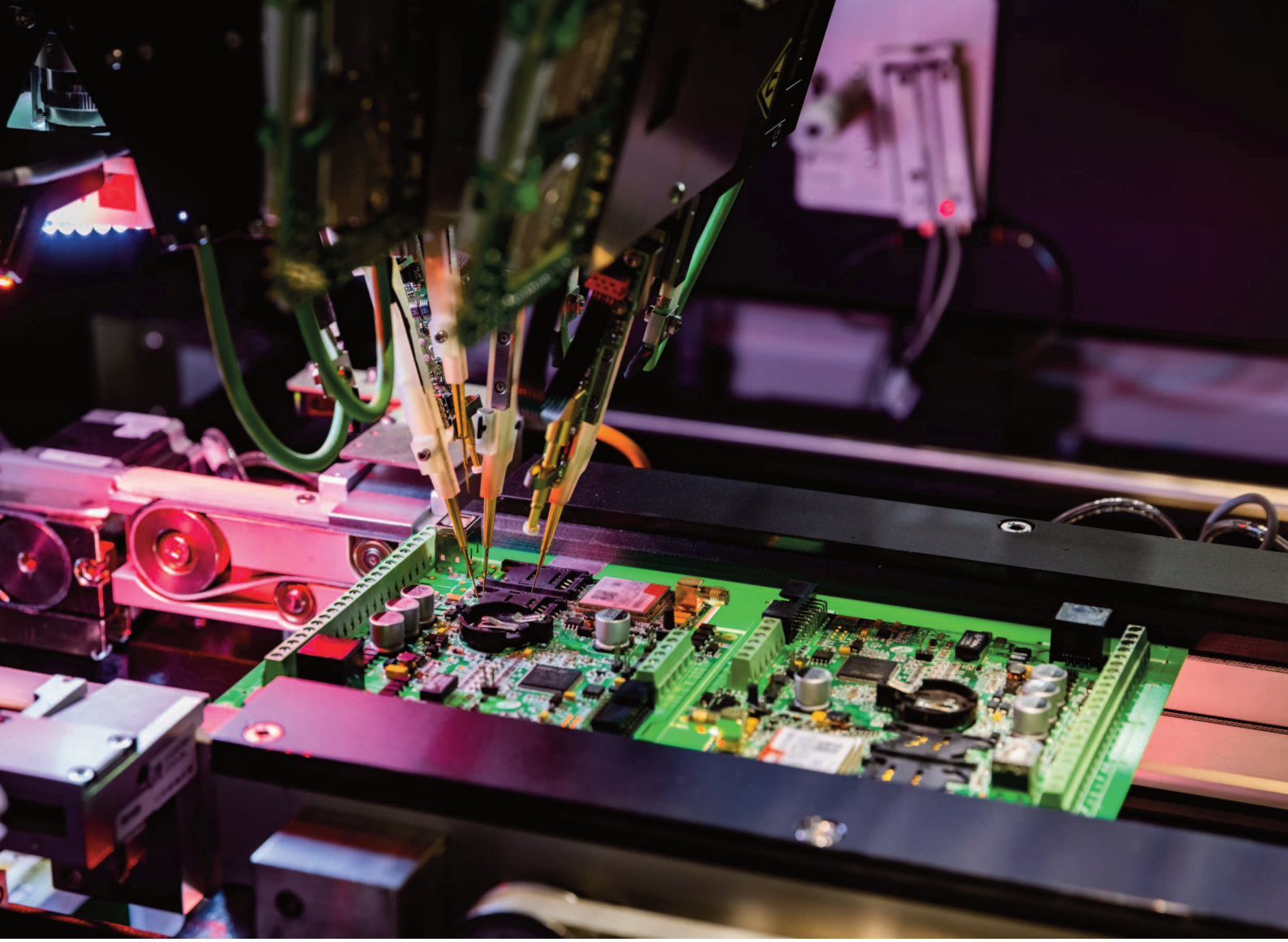
How might this new legislation, passed in August 2022, impact the US automotive market's prospects? By Elle Farrell-Kingsley

Modern vehicles are more reliant on semiconductors than ever before. Most vehicles come fitted with a number of chips to handle onboard functions, power infotainment systems, and monitor and perform driving functions, including advanced driver assistance systems (ADAS) and semi-autonomous operations.

Yet, a semiconductor chip crisis marred the global economy in 2020, causing price hikes and major supply chain disruptions across the automotive industry. The shortage cost the global auto industry roughly US$210bn in lost revenue in 2021, according to market research firm AlixPartners. AutoForecast Solutions estimated that the world lost 11.3 million units of chip production in 2021, creating a major impact on vehicle production. More recently, Russia's 2022 invasion of Ukraine has introduced further uncertainties to the semiconductor supply chain and automotive production. McKinsey reports that Ukraine supplied 25 to 35% of the world's purified neon gas, and Russia supplied 25 to 30% palladium, a rare metal used for semiconductors.

Chips as a commodity

Nevertheless, as demand for new vehicles featuring the latest technology increases, it's forecasted that the global semiconductor industry will increase manufacturing



capacity by 56% in the next decade, according to the Semiconductor Industry Association (SIA). At the moment, 75% of the world's chip manufacturing occurs in East Asia. Much of this production has been supported by government subsidies to keep production costs low.

Now, the US is preparing to rival East Asia with a greater share of semiconductor production through its own government subsidy; the CHIPS and Science Act passed on 9 August 2022. "The CHIPS Act is one of the few in recent history to get true bipartisan support, which says a lot," says Aron Solomon, Head of Strategy and Chief Legal Analyst at legal marketing agency Esquire Digital. "Essentially, we're trying to validate semiconductor chips becoming like oil–a commodity that we desperately need and currently have to rely on others to supply."

This legislation could be crucial in establishing a secure domestic supply of semiconductors. Notably, US semiconductor manufacturing capacity has dropped from nearly 40% of global supply in 1990 to 12% today, according to PWC. This plunge is part of a wider decline in US manufacturing as services have outpaced goods. Paired with the impact of globalisation, the US now accounts for 84% of outsourcing deals globally, according to project management firm Team Stage, as other countries have become production powerhouses.

Constructing enough factories could be challenging

The US$208bn bill contains US$52bn in subsidies for domestic chip manufacturers to help build future infrastructure and remedy the current chip shortage facing producers. This will generally be in the form of grants for both manufacturing and R&D. “The fact that so much of the money (close to US$20bn) is being released in the first year shows how serious legislators are with this,” Solomon tells Automotive World. “That massive cash infusion could allow the US to play catch-up reasonably fast with chip production.”

Factory construction challenges

But even with the funding in place, Solomon believes there will be construction challenges ahead: “Semiconductor factories aren’t the easiest to build. That was the case even before the post-pandemic labour shortages.”

One other key element of this development is the ecosystem surrounding the industry, says Richard Gardner, Chief Executive of tech regulator Modulus. “This is an opportunity to begin designing the labour force of tomorrow, cementing the nation as a long-term powerhouse in the semiconductor arena.”

However, he believes that the biggest challenge will be geopolitical ties. “For a period of ten years, companies accepting funding cannot expand operations in China or other countries deemed a threat to national security. That’s a significant commitment.” The

implication of accepting funding means that most recipients would need to fundamentally realign their business model, including an evaluation on whether it would need to require new investors or partners.

China's competition

The CHIPS and Science Act ultimately proposes to lower costs, create jobs, strengthen supply chains, and counter China. "This is what the act was supposed to do, but there is one major issue that will prevent this from becoming a reality—rare earth materials. Most of these chips have multiple rare earth materials involved in their manufacturing. Rare earths are 90% mined and refined in China. Therefore, no matter the grandiose vision this act puts forward, there really is no way to execute upon it unless we expand our mining operations for such materials here in the US," says Bob Bilbruck, Chief Executive of consulting firm Captjur.

He proposes that to achieve this vision would require expanding mining operations in mines such as The Mountain Pass Mine. The Mountain Pass Mine, owned by MP Materials, is an open-pit mine of rare-earth elements on the south flank of the Clark Mountain Range in California, 53 miles southwest of Las Vegas, Nevada. A US Geological Survey (USGS) revealed that the mine supplied 15.8% of the world's rare-earth production in 2020. "We all know this won't happen as the environmental lobby is too strong to allow this mine to expand, but for the CHIPS Act to succeed, that is exactly what must happen," he says.

"The idea that all vehicles will be electric in ten years and have chips to make them fully autonomous and efficient is a pipe dream," Bilbruck tells Automotive World. He also adds, "There are no plans to expand mining operations to provide the rare earth materials needed to build the chips needed for these vehicles. It's as if everyone forgot about this part of the equation for producing cars. Where we find ourselves in the US car manufacturing sector points to one thing—China's future dominance in the car industry."

> "We can't be held hostage politically by any nation that can control our chip supply

However, this view is not agreed upon across the board, as Solomon highlights: "None of this means that it has to be a zero-sum game with China. There is no reason why the major chip producers there can't keep producing. The global demand for these chips isn't decreasing, and there's no forecast to suggest it will. Nonetheless, it is one more point of tension in increasingly strained China-US relations." Focusing on the US's future, Solomon concludes: "The reality is the CHIPS Act will ensure that with this domestic production, we can't be held hostage politically by any nation that can control our chip supply."

Automotive is on the verge of a quantum computing revolution

The broad applications for quantum computers across automotive value chains make them a perfect fit for an industry already in transition. By Will Girling

Quantum computers are capable of processing speeds over 158 million times faster than a modern 'classical' supercomputer. To put this power into perspective, in 2019 Google's machine performed a calculation in four minutes that would have ordinarily taken over 10,000 years. This problem-solving capacity holds exciting potential in automotive.

The scope of applications, from manufacturing (design, supply chain optimisation and hardware placement) to retail (logistics and data analytics), makes quantum computing a worthwhile investment. However, despite interest from key players like Ford, Volkswagen and BMW, the global market for this burgeoning technology remains relatively small. In June 2022, Industry Research valued it at just US$325.4m, with the potential to rise to just under US$2bn by 2028.

Adding complexity

Classical computing relates to the general-purpose machines used in a variety of daily applications– supercomputers being almost identical, albeit with exponentially higher processing power. By contrast, quantum computing uses the laws of quantum mechanics to facilitate solutions by incorporating complex variables and reactions. According to IBM, this creates "multidimensional spaces where the patterns linking individual data points emerge." Therefore, while a classical supercomputer might eventually come to the same conclusion, a quantum computer will do so at speeds orders of magnitude faster. This is because supercomputers are not intrinsically designed to find and follow intricate patterns in data.

With this emphasis on identifying patterns within disparate variables in large datasets, it's perhaps not surprising that Ford's and Volkswagen's initial forays into quantum computing have focused on route and traffic management. However, BMW's 2021 Quantum Computing Challenge demonstrated

> "Ford's and Volkswagen's initial forays into quantum computing have focused on route and traffic management

As supply chains continue to experience logistical and material issues, the next-gen performance of quantum computers could prove invaluable to OEMs. However, the technology and its use cases must be developed further.

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the technology's broader potential. In collaboration with Amazon Web Services, the automaker crowdsourced innovations for four specific automotive applications: autonomous driving sensor placement, equipment configuration optimisation, material deformation simulation, and quality analysis.

Victor Onofre, Quantum Software Developer for Multiverse Computing (Multiverse), informs Automotive World that the latter application is showing particular promise. Multiverse Computing is a software specialist that applies quantum-inspired solutions to solve complicated problems across several industry verticals, including manufacturing, engineering, and mobility.

Image recognition

In August 2022, Multiverse released a joint research paper–*Quantum artificial vision for defect detection in manufacturing*–with tech centre IKERLAN. Benchmarking algorithms for quantum computer vision against their classical counterparts, the study was the first of its kind to explore the technology's use on an industrial production line. "The challenge a lot of automakers are facing with automation is classification; they need systems to reliably detect defects in vehicle parts, such as wheels and connectors," explains Onofre.

The testing itself utilised noisy intermediate-scale quantum hardware for binary image comparison using quantum machine learning techniques. Using a dataset containing thousands of images of automotive parts–with and without defects–the system was trained to 'see' whether a defect was present and then inspected real-world examples. "What we found was that the quantum model out-performed the classical model," states Onofre. In fact, since the precision and speed of the quantum model are already appreciably better, despite the relative infancy of the technology, "the future potential for this technology in vehicle component classification is significant."

Furthermore, the study concluded that the image recognition model training could be conducted in a quantum system and then deployed in a classical one. “This makes possible the exploitation of quantum-based methods in real industrial manufacturing scenarios in the near future, without requiring the adaptation of an ecosystem to deploy and use them,” it said. Augmented by this technology, the overall quality and safety of vehicle production lines would be notably improved.

An inflection point

In addition to quality control, quantum computers can be used to simulate the deterioration of vehicle components with high fidelity. Moreover, the technology can provide OEMs with insights that were previously inaccessible when using supercomputers. Onofre states that new prediction models like these show a lot of promise for the next generation of automotive development.

For instance, Mercedes-Benz partnered with IBM to learn about the wear and tear of electric vehicle (EV) batteries, the accuracy of which is dependent on simulating the miniscule interactions of individual electrons. This would allow manufacturers to better understand the wear and tear of batteries and how to enhance durability.

However, when it comes to the relatively slow growth of quantum computing within automotive to date, he adds that its novelty is affecting initial uptake: “It’s a new technology and stakeholders don’t know how it fits in with current operations.” As such, Onofre compares it to the obscure status of machine learning at the turn of the 21st century, which Fortune Business Insights now values to be worth US$21.17bn. “Something similar is going to happen with quantum computing; we’re at a critical moment in its development, and the automotive industry is just realising its potential.”

A farewell to classical computing?

If the performance of quantum computers is superior to that of classical computers, does this mean that OEMs will need to gradually phase out their old equipment? Onofre doesn’t think so: “No one is going to work from a laptop fitted with quantum hardware. This technology is designed for specific problems that require a lot more power.” Therefore, the most likely outcome is that both classical and quantum computers will co-exist for the foreseeable future.

In terms of when this new computing paradigm might take hold, McKinsey & Co’s analysis predicts that the necessary quantity of commercially viable use cases may accumulate by 2030. At that time investment is likely to accelerate, with quantum computing providing “a boost to automotive players transitioning into the EV era by notably accelerating research and development of novel technologies.” By 2035, McKinsey estimates that the quantum computer services market will grow to between US$32bn and US$52bn. Such exponential growth in a relatively short amount of time indicates that Onofre’s conviction is sound: automotive could be on the verge of a transformative quantum computing revolution.