


Automotive World

Electric mobility MAGAZINE

Issue 6 | July / August 2025



**Nio: industry
approaching
"a pivotal moment"
for battery swap**

Mercedes fast-tracks solid-state batteries | What's the best way to reduce EV production costs? | **Magna** highlights importance of e-drive efficiency | **Flint Engineering** extends battery lifetimes | EREVs hit range/cost sweet spot, says **McKinsey** | **Dincă Lab** helps lay foundation for sodium-ion

Automotive World

Automotive World
71-75 Shelton Street,
Covent Garden, London,
WC2H 9JQ, UK

www.automotiveworld.com
support@automotiveworld.com

Registered number:

04242884

VAT number:

GB 815 220 173

CEO & Managing Director:

Gareth Davies

Contributors:

Will Girling
Megan Lampinen
Stewart Burnett

Production:

Anmol Mothy

© Automotive World Ltd 2025

Cover image courtesy of Nio

In this issue

3 Editorial summary

4 News in brief

6 Question of the month

What's the best way to reduce EV production costs?

10 Magna: e-drive efficiency results in superior off-roaders

13 New thermal transfer tech extends EV battery life

17 Sion Power: lithium-metal solves energy, cost, safety issues

20 Industry approaches "a pivotal moment" for battery swap—Nio

24 Mercedes hits the road with a prototype solid-state EQS

28 EREVs tap existing tech to target new buyers

32 Dincă Lab reconciles cost and performance in sodium-ion

35 In case you missed it...

OEMs increasingly back away from BEVs in favour of hybrids

Copyright statement

© 2025 All content copyright Automotive World Ltd. All rights reserved.

This publication - in whole or in part - may not be shared, copied, reproduced, stored in a retrieval system, or be transmitted in any form by any means electronic, mechanical, photocopying, recording or otherwise without the prior permission of Automotive World Ltd.

Editorial summary

Consumers now have access to a wider variety of battery electric vehicles (BEVs) than ever before, with options to suit practically every need and price point.

By focusing on power/drivetrain efficiency, automakers and suppliers are producing BEVs that drive further and faster while using less power. For those unable or unwilling to commit to fully electric, innovations in extended-range EVs are providing a hybrid option that taps the range-to-cost sweet spot.

However, manufacturing EVs remains far from profitable for many OEMs, and new innovations to bring down costs will be essential for sustaining the segment's momentum. Unsurprisingly, a lot of emphasis is placed on the single most expensive component: the battery.

For some, lithium-ion batteries still have a lot to offer, albeit with alterations to chemistry and construction. Options include new anode materials and thermal transfer solutions, which not only solve energy and cost issues but also safety concerns.

Other companies are pushing for new chemistries entirely, including solid-state and sodium-ion. Both of these address performance, durability and supply chain issues affecting lithium-ion, although the market might need to wait until the 2030s for their commercial realisation.

The concept of fully integrated batteries is also facing growing competition from swap stations and battery-as-a-service business models, which help mitigate concerns about vehicle longevity and residual value. Their acceleration in markets like China could provide evidence that high BEV penetration and battery swapping go hand-in-hand.

At the same time, the automotive industry must not be myopic: the avenues to explore BEV production cost reduction are limited only by imagination.

If OEMs want to boost profit margins per vehicle, they must be willing to reimagine everything from R&D to manufacturing and re-use. As always, it will be the companies that prioritise quality and efficiency across their organisation that reap the greatest and most enduring rewards.

News in brief

Toyota aims for 20% PHEV sales volume by 2030 in US

May 29 2025

Toyota plans to increase plug-in hybrid (PHEV) sales volume in the US from 2.4% in 2024 to 20% by 2030, according to a 28 May 2025 report by CNBC. However, this goal is contingent on favourable regulatory conditions and ongoing consumer acceptance.

Backlash against BYD's Chinese EV price war worsens

June 4 2025

BYD's aggressive price cuts of up to 34% are drawing the ire of both industry players and regulators in China, with the automaker's Hong Kong-listed shares falling 17% over the last week alone. One critic, the powerful lobbying group, China Association of Automobile Manufacturers, criticised the "vicious competition" and "disorderly price wars" that threaten the electric vehicle sector's sustainability.

Tesla's China-made EVs sales dip 15% YoY in May

June 5 2025

Tesla's sales of China-made electric vehicles (EV) dropped 15% year-on-year in May, marking the eighth consecutive month of decline as local competition intensifies and overseas demand

wanes. Deliveries from Tesla's Shanghai Gigafactory totaled 61,662 vehicles, including domestic sales and exports, according to the China Passenger Car Association (CPCA).

Chery launches US\$11k 2025 Fengyun A8 in China

June 6 2025

Chinese new energy vehicle (NEV) maker Chery has launched its 2025 Fengyun A8 plug-in hybrid sedan with prices starting at CN¥79,900 (US\$11,100), introducing a new 70 km pure electric range variant to expand the model lineup. The five-model range tops out at CN¥109,900 and offers a maximum range of over 1,400 km.

Maruti Suzuki's EV debut hit by rare earth shortage

June 11 2025

Maruti Suzuki has slashed production targets for its first-ever electric vehicle (EV) by two-thirds, planning just 8,200 e-Vitara units between April and September versus 26,500 as originally planned. The cutback stems from China's rare earth export restrictions first imposed in April, which is sowing more and more havoc on global automotive as critical shortages of e-motor magnet metals continue to mount.

Windrose R700 challenges Tesla Semi with 578-mile haul

June 12 2025

In a new video shared on its official YouTube channel, Chinese truck manufacturer Windrose has demonstrated its R700 semi e-truck's capabilities with a 578-mile round-trip hauling 75,000 pounds across California's I-10 corridor. Showcasing technology that rivals or exceeds Western competitors, the Class-8 truck's 729 KW/h battery pack and 1,045 hp e-motors completed the Colton-to-Buckeye route without incident.

Neta Auto enters bankruptcy as worker wages go unpaid

June 12 2025

Struggling Chinese automaker Neta Auto has entered bankruptcy reorganisation proceedings following months of unpaid wages and mounting debts. More than 100 employees confronted Chairman Fang Yunzhou at the company's Shanghai office on 11 June, demanding salaries owed since November 2024.

Ford starts battery production amid Cologne plant crisis

June 12 2025

Ford has begun battery pack assembly at its Cologne facility, producing 52 kWh, 77 kWh and 79 kWh units for its Explorer and Capri electric vehicles. The move ends reliance on Skoda's Czech factory for battery supply, bringing production in-house where both EVs are assembled on Volkswagen's MEB platform.

Leapmotor fights EU's proposed €35,000 EV price floor

June 12 2025

Stellantis-backed Chinese automaker Leapmotor has warned that proposed minimum prices for Chinese electric vehicles (EVs) would prevent it from bringing its affordable small cars to Europe, even if such measures replace existing tariffs. According to statements made on 11 June by Senior Vice President Cao Li, Leapmotor's models are "definitely" priced less than €35,000 (US\$37,100) threshold being discussed by Beijing and Brussels.

Ford faces daily struggle with rare earth magnet supplies

June 13 2025

Ford Motor continues to reckon with severe supply constraints for rare earth magnets essential to EV production, forcing some

temporary factory closures. In a new interview with Bloomberg, Chief Executive Jim Farley described the situation as "hand to mouth", while ongoing Chinese export restrictions continue to dramatically affect Western manufacturers.

Fiat trials five-minute battery swap technology in Madrid

June 13 2025

Fiat has launched a battery-swapping trial in Madrid using 40 modified Fiat 500e vehicles that can achieve full recharging in under five minutes. The Italian manufacturer partnered with battery-swapping firm Ample to test the technology as an alternative to traditional charging infrastructure, often criticised for its slow wait times compared to gasoline refuelling.

Trump scraps California EV mandate as states launch legal fight

June 13 2025

President Trump's termination of California's 2035 electric vehicle (EV) mandate is triggering substantial backlash. California immediately responded to the news with a legal challenge alongside 10 co-signatory states, filing a federal lawsuit that argues the administration's actions violate established regulatory procedures.

Tesla lays groundwork to sell the Semi truck in Europe

June 17 2025

Tesla has appointed Usuf Schermo as Head of Business Development EMEA for Tesla Semi, signalling that it is preparing for a European market entry following years of production delays. The electric vehicle manufacturer expects to begin volume production in the US by late 2025 before pursuing European homologation.

All news articles by Stewart Burnett

What's the best way to reduce EV production costs?

Subject experts and industry stakeholders outline some effective methods for bringing down the cost of electric vehicle production. By Will Girling

Electric vehicles (EVs) are arguably better than they've ever been: consumers now have access to a greater variety of models at different price points and range capabilities to suit their needs. However, manufacturing these products profitably has been an ongoing challenge for automakers. Few are operating in the black, and some are seeing mounting losses from their EV activities.

Trade wars, geopolitical shifts, and slower-than-anticipated uptake have all conspired to make EV production more difficult and expensive than many initially expected. Q1 2025 reports from

Volkswagen and Ford indicate they still lose thousands of dollars per EV sold. Meanwhile, even those that have made progress face worsening conditions: General Motors' EV line-up was finally "variable profit positive" in Q4 2024, but US import tariffs could reshape key supply chains and push costs back up again.

In an increasingly volatile global market, all automakers need to know where and how they can save money throughout the EV production process. *Automotive World* asked industry stakeholders and subject experts to identify some of the best opportunities for cost reductions.

Reimagine manufacturing

Giacomo Margiotta-Mills, Transportation & Mobility Industry Director for Northern Europe at simulation software company Dassault Systèmes, says: “The total production cost of an EV can be segmented into R&D, manufacturing, and re-use. While separate, they are also inherently interconnected.

“R&D for EVs is currently very expensive and time-consuming for many Western automakers, sometimes three to five years, and there’s discussion about how to learn from Chinese brands accomplishing it in 18-24 months. That’s a massive cost saving in itself, and modularity through multi-vehicle platform architectures can help reign in the manufacturing costs of EVs and software-defined vehicles even further. It brings economies of scale, efficiency, and the ability to re-use resources across a wide range of vehicles.

“Virtual twins combined with artificial intelligence (AI) are the common threads that can bring all of this together in EV production. The battery is sometimes up to 40% of a vehicle’s total cost, so using virtualisation to optimise according to specific strategic goals—safety, sourcing, performance—mitigates the high expense of real-world testing. With AI trained to identify the easiest chemistries to manufacture and how a cell will perform throughout its life, including second-life applications, automakers can produce EVs cheaper but also better.

“Those cost savings will originate in battery manufacturing initially, but I expect to see the same thinking applied everywhere eventually. Companies using our 3DEXperience platform, such



as Jaguar Land Rover, are using virtual twins in a much broader and more ambitious way than manufacturers have done before.”

Consider new materials

Vincent Ledoux Pedailles, Chief Commercial Officer at battery anode producer CarbonScape, says:

“As automakers look to cut EV production costs, many are still struggling to do so in a way that’s both financially viable and environmentally sustainable. Much of the challenge stems from costly battery materials and complex global supply chains heavily dominated by China, yet few companies are exploring alternative ways to source the critical minerals needed for EV batteries.

“Biographite, a carbon-negative alternative for the lithium-ion anode market, which can be made locally from woodchips, could be key to solving this challenge. Beyond the environmental benefits, it offers manufacturers a chance to lower production costs thanks to a readily available, low-cost biomass feedstock. Without compromising on performance, biographite also helps

QUESTION OF THE MONTH

automakers avoid trade risks and reduce import and freight expenses.

“Ultimately, by embracing domestically sourced battery materials, automakers won’t just boost long-term resilience and cost efficiency, they’ll also bring key components of EV production back home, contributing to a more sustainable future.”

Boost quality control

Philippe Arsonneau, Senior Vice President of Infrastructure and Power Systems at energy management and automation specialist Schneider Electric, says: “Historically, the battery pack represents the lion’s share of an EV’s cost. Compounding this, current mature battery factories face significant scrap rates, ranging from 6% to 15%, due to quality issues detected late in the process. For newer entrants, these figures can be considerably higher. Addressing this head-on offers a direct and substantial lever for cost reduction.

“Integrating advanced AI-powered quality control throughout the battery production process can enable real-time defect detection and prevention. This means fewer faulty cells, reduced material waste, and ultimately, lower battery costs. This focus on ‘first-time-right’ manufacturing is paramount in making EVs more affordable.

“Beyond optimising the production process itself, another critical area for OEMs to prioritise is implementing advanced predictive maintenance strategies across their manufacturing operations. Unplanned downtime is a significant cost driver in any industrial setting, and EV manufacturing is no exception.

“Remote monitoring, expert analysis, and predictive algorithms can anticipate potential equipment failures before they occur. This condition-based maintenance approach can drastically reduce electrical failure risks by up to 75% and cut unplanned downtime and on-site activities significantly—by as much as 40%. By ensuring continuous operation and minimising disruptions, OEMs can achieve substantial cost savings and improve overall efficiency.”

Prioritise efficient production

Emile Naus, Partner at management consultancy BearingPoint, says:

“Manufacturers need to do everything they can to make more EVs more efficiently. The number one cost factor is still batteries, so reducing their weight and expense while improving performance will yield the quickest savings. Achieving these could mean rethinking entire EV designs, but the positive is that even minor tweaks can snowball. For example, altering aerodynamics slightly could mean reduced overall power consumption and therefore smaller, lighter, and cheaper batteries.

“Efficiency also applies to how automakers leverage partnerships with their suppliers. Put simply, if something isn’t critical to the customer’s direct experience of a brand, OEMs should explore opportunities for collaboration. Fundamental options include the chassis, battery, and drivetrain. The more costs can be shared across an ecosystem, the cheaper each vehicle will be to produce, particularly if developed on multi-vehicle platforms.

“In terms of streamlining manufacturing itself, gigacasting has



Manufacturers need to do everything they can to make more EVs more efficiently

promise but it's not the only solution available. EVs have fewer components and can therefore be made on simplified production lines that are easier to automate. Some of the segment leaders offer limited personalisation options, opting to focus more on software-driven differentiation instead of hardware. This opens up plenty of new revenue opportunities, and EVs that are designed to last longer through regular software updates could reduce manufacturing costs simply by producing fewer vehicles.

“However, while software might help automakers save money producing EVs, there is a big cultural challenge attached. They will need to accept a new normal of selling fewer vehicles at a higher price and with a longer lifespan, during which brands can continuously generate new value. Messaging to shareholders would need to be carefully considered.”

Focus on energy

James Crosby-Wrigley, Head of Sustainability at energy specialist Advantage Utilities, says: “OEMs are experiencing a lot of problems beyond their direct control, including import tariffs and the wholesale costs of raw materials. It's important for companies

to focus on what they can influence directly; not necessarily manufacturing processes, but rather the overall efficiency of factory infrastructure.

“Energy—electricity, gas, etc.—is typically the third-highest cost of production, and audits can be carried out to determine where savings can be made. For example, has factory lighting been switched to LEDs, or can the implemented metering solutions effectively determine how energy is distributed around the site? Asking these kinds of questions can identify low-hanging fruit in the first instance, like out-of-hours energy wastage and opportunities for reducing idle time. Going forward, companies can pursue greater energy self-sufficiency by incorporating proximate solar panels, wind turbines, and hydrogen electrolyzers. Current estimates suggest approximately 25-30% of an OEM's energy could be self-generated using renewable energy.

“Following these solutions will always help make manufacturing cheaper, particularly during times of volatile energy prices. A relatively inefficient site could see improvements of 35-40%. As more automakers focus on energy efficiency, I think we could see more activity in self-generated clean energy projects for factories.”

Magna: e-drive efficiency results in superior off-roaders

Magna Powertrain's collaboration with Mercedes-Benz highlights the importance of continuous e-drive innovation and optimised value chains. By Will Girling

Regardless of whether an off-road vehicle runs on an internal combustion engine (ICE) or a battery, engineers must consider the same factors: traction, gradeability, and manoeuvrability in rough and rugged terrain. However, new drivetrain innovations could soon elevate the performance of electric vehicles (EVs) far beyond their gas-powered equivalents.

Daniel Lindvai-Soos, Director of Product Management at Magna Powertrain, tells *Automotive World* that electric drivetrains present a number of advantages over

ICE. These include instant torque, better weight distribution for improved handling, and fewer moving parts requiring less maintenance. Magna Powertrain has been working with automakers to help realise these benefits in the off-roading segment.

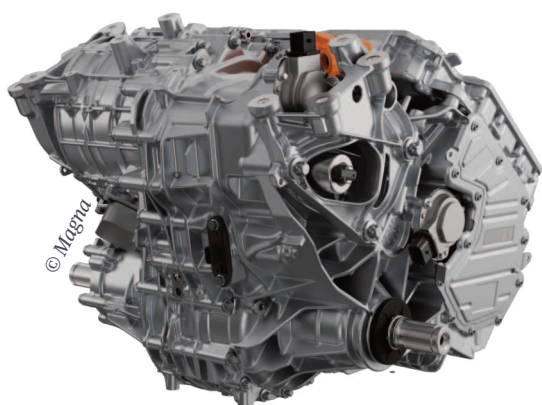
Back in 2024, production for Mercedes-Benz's G 580 with EQ technology—the electric version of its G-Class SUV off-roader—commenced at Magna's factory in Graz, Austria. Lindvai-Soos highlights the eDS Duo e-motor as an example of that collaboration, as well as the broader importance of electric drivetrain innovation in next-gen EVs.

Power and efficiency

Off-road vehicles must be able to navigate challenging terrain with power and precision at low speeds, making an e-motor's continuous performance—meaning its ability to operate at full power without overheating and degrading the unit—paramount.

The crucial differentiator between Magna's eDS Duo and other 'on-road' units, explains Lindvai-Soos, is its two-gear design enabling two speeds. "That provides high continuous performance without affecting its durability." The eDS Duo also exhibits the company's combined emphasis on power and energy efficiency. It delivers 240kW peak power per axle, incorporating two motors in a unique "wheel-individual propulsion system", which enables the G 580 with EQ technology to spin 360 degrees from a stationary position—called a 'G-Turn' or 'tank turn'. However, this is only half the story.

"We introduced silicon-carbide (SiC) semiconductors in the inverter to reduce switching losses, as well as decoupling unused motors to conserve battery power," says Lindvai-Soos. SiC devices are increasingly favoured in EVs for their enhanced conductivity and thermal



Magna claims its eDS Duo allows off-roaders to navigate challenging terrain with power and precision at low speeds



Mercedes-Benz G 580 with EQ technology

management. For the off-road vehicle market, where customer concerns over range are no less prevalent than on-road, these qualities combine with EVs' quieter drivetrain to produce a superior product experience. Lindvai-Soos highlights that reducing noise pollution allows for a far more "immersive" experience when driving in nature.

Continuous innovation

While several OEMs are now releasing entry-level electric models priced less than US\$30,000 to capture opportunities in the mass market, the off-road segment typically attracts premium and luxury consumers. Nonetheless, the initial cost of EVs can still be appreciably higher than ICE equivalents, and this creates a barrier to widespread adoption. However, innovation is gradually bringing costs down—for example, the most affordable SUV from new Volkswagen brand Scout Motors starts at US\$50,000.

Lindvai-Soos is convinced that continuous innovation will be necessary to sustain momentum for off-road vehicle electrification. Among the most

important engineering considerations going forward will be performance, reliability, and sustainability.

“Off-road vehicles require high torque, robust power delivery, and precise control while still being able to drive long distances in remote locations, where charging infrastructure may be limited,” he says. “And these environments can be harsh, with exposure to water, mud, dust, and extreme temperatures.” Increased durability and reduced weight of batteries and e-drive units will be essential for meeting customers’ efficiency and handling requirements. The flexibility of an electric architecture also enables e-drives to be customised and adapted to specific use cases and a broader range of vehicle designs.

A fully optimised value chain

Going forward, Lindvai-Soos echoes a recurring industry sentiment: focusing on e-drive efficiency will ultimately produce more sustainable EVs, and he extends this to include off-roaders.

“Advanced energy management systems and more efficient power electronics can optimise the use of available energy. As environmental regulations become stricter and the demand for sustainable solutions grows, innovations in this area can help reduce the environmental impact of off-road vehicles.”

Sustainability through e-drive efficiency can also mean improved total cost of ownership, and there are studies to corroborate this. An April 2024 whitepaper by the Electric Power Research Institute and Natural Resources Defense Council modelled

the effect of prioritising EV efficiency in the US automotive industry over a 30-year period. It concluded that increasing power/drivetrain efficiency combined with lightweighting could more than double EV range limits without also needing to increase battery sizes. This scenario reduced national energy consumption by 53% and subsequently saved consumers US\$200bn in charging costs.



Innovation is important for automakers and suppliers, but it’s never just limited to product technology

Continuing to improve individual components in the electric drivetrain and proving EVs’ performance superiority in segments like off-roading will contribute to a stronger e-mobility market. However, Lindvai-Soos also takes a broader perspective on the deeper significance of Magna’s collaboration with its customers.

“Innovation is important for automakers and suppliers, but it’s never just limited to product technology. It also includes processes, operations, raw material processing, and more,” he concludes. “The target is to incorporate a fully optimised, cradle-to-grave value chain.”

New thermal transfer tech extends EV battery life

Flint Engineering's isothermal innovation could slash EV charging time and herald an age of million-mile battery packs. By Megan Lampinen

Electric vehicle (EV) battery life and charging times are two of the biggest concerns among consumers today. Nobody wants to wait hours for their EV to charge; even 30 minutes can seem unreasonable when it interrupts a long road trip. And while most new EV batteries are covered by a 100,000-mile warranty, imagine the peace of mind that could come if this ran to a million miles. One UK company believes its innovative approach to thermal transfer could provide a step-change in both battery charging and longevity.

Flint Engineering has developed a multi-channel flat heat pipe called IsoMat. Drawing on isothermal principles, it provides a constant temperature across the material. While traditional heat pipe technology transfers heat from point to point in one dimension, IsoMat moves heat in both the x and y dimensions. The sealed structure features an internal network of interconnected cavities and is charged with a calculated amount of saturated fluid. When any part of the IsoMat is exposed to a thermal energy source, the liquid immediately boils, becoming a vapour and quickly absorbing energy. By manipulating thermal energy at the molecular level in this way, IsoMat opens up many new applications.

“If you take this into situations where heat is a problem or could be used elsewhere, you have thousands of potential applications,” says Chief Executive Mark Robinson.

A range of use cases

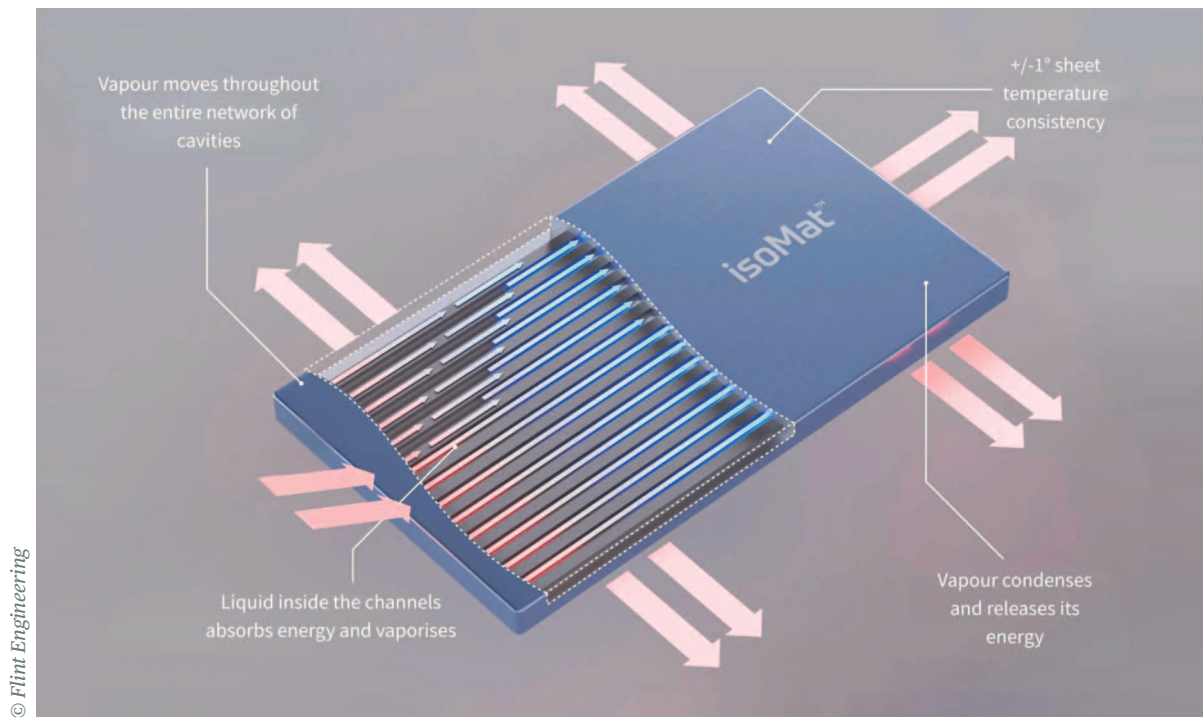
Over the past ten years, Flint Engineering has been exploring the use of IsoMat in various applications,

including building materials and commercial refrigeration. Up next could be EV batteries, where it promises to maintain all battery cells in a pack at a stable temperature, generally about 25 degrees Celsius. “We’ve done a lot of development on EVs, from small cars to big trucks,” Robinson tells *Automotive World*. “That covers battery systems as small as a couple of feet square to systems 12 times bigger.”

In these applications, the IsoMat acts as a plate on which the individual battery cells sit. “Hundreds of cells may be sitting on one of our plates, and all of them are maintained at exactly the same temperature,” he adds. Cooling manifolds running down the end of the plate enable close thermal management of every individual cell. This means the cells can be worked harder and discharged faster. On EVs, that opens the door to faster charging times, and because all the cells are maintained at a stable unified temperature, their lifetime increases. “You don’t end up with rogue cells starting to fail,” Robinson points out. “That’s one of the key reasons that packs degrade over time.”

In comparison, traditional battery cooling systems deploy a serpentine pipe with coolant running between two pressed plates of aluminium. While the initial cells are cooled very well, the effectiveness can fade as the liquid travels through the pack. The result is inconsistent cooling. “We were able to fix that,” he emphasises. “There is no other way to maintain every cell at the same temperature, depending on the application.”

IsoMat won’t replace current thermal management systems but rather serves as a modification to them. While it has



Flint Engineering's IsoMat reinvents traditional heat pipe technology using a revolutionary new heat transfer design

potential in any EV, it really comes into its own for applications within extreme conditions. This includes cold weather regions, where EV range can take a big hit. “IsoMat can heat as well as cool,” says Robinson. A small heating mechanism in the corner of the pack allows for rapid heating of cells to an even temperature, effectively extending range in colder climates.

There's a similar impact on the opposite end of the environmental spectrum. Heavy autonomous mining trucks working around the clock in Australia's extreme heat can exhaust a battery quickly. “In these circumstances, thermal management is difficult. These packs should last ten years, but some of the trucks are burning through them in just two. That's because they don't have a way of evenly managing the temperature. This is a perfect example where the IsoMat can make a really big win.”

Quantifying the impact

Flint Engineering's technical development is based at Brunel University in the UK. It previously conducted a four-year development project with US company Allison Transmission, which produces drivetrains for trucks. Since then, Flint has continued to develop the IsoMat and hopes to quantify some of its claims over the coming years.

“The IsoMat is almost unlimited in the amount of energy it can shift,” says Robinson. “The energy is taken from the cells to our condenser sections. Since carrying out the work with Allison, we've put all of our development effort into coming up with some really clever and high-performing condenser sections for the IsoMat. We are now going through initial trials with those, with a view to specifying performance.” That trial



What we are talking about with IsoMat is mind boggling, ground-breaking core technology

work will run over the course of 2025, after which time the Flint team may resume development work with Allison. In commercial refrigeration systems, IsoMat can cut energy use by nearly one-third. In EV batteries, it could go even further. “It’s difficult to get the metrics because the EV industry is a bit cloak and dagger when it comes to battery longevity and performance. We know that we can extract two to three times more heat from a battery pack than you can using traditional methods. What that will mean in terms of battery longevity, charge times or range, we don’t yet know. That’s where we really need to engage with application-specific partners.”

While IsoMat promises significant benefits, it will likely weigh in slightly heavier than the pressed aluminium plates currently used and cost “a bit more”. The system should be more robust, however, with generally superior performance. At the end of the day, drivers of all sorts of EVs are

looking for extended range, improve safety, reduced charging times and longer lifespans. Because of this, Robinson is optimistic IsoMat could find its way into everything from mining trucks in Australia to family cars in Europe.

“Consumer demand will drive this,” he concludes. “EV owners are frustrated by the promised range not matching what they see every day. There is growing pressure to increase EV mileage and EV adoption...What we are talking about with IsoMat is mind boggling, ground-breaking core technology.”

Commercial production for non-automotive applications launches later in 2025, and development work in automotive is gaining pace. With Flint Engineering reporting strong interest from UK, North American and Middle Eastern markets, this thermal management breakthrough could help to shape the future of electric transportation.

Sion Power: lithium-metal solves energy, cost, safety issues

Lithium-metal anodes could resolve prominent issues with current generation battery tech and bring EVs to a wider audience. By Will Girling

Most industry commentators conclude that improved battery technology is likely to be the lynchpin that takes electric vehicles (EVs) firmly into the mainstream. But this poses an important question: should automakers and suppliers focus on developing a game-changing new chemistry or improve the technology they already have?

Tracy Kelley, President and Chief Science Officer at Sion Power, believes lithium-ion batteries still have a lot to offer. However, the technology cannot progress without some significant alterations. Through more than 20 years of R&D, Sion Power has developed a high-energy battery using a lithium-metal anode that resolves historical durability issues associated with the chemistry. The company calls this product Licerion.



Tracy Kelley,
President and Chief Science
Officer, Sion Power

Kelley discusses with *Automotive World* why current automotive industry challenges make lithium-ion improvements essential, how Licerion can boost EV performance, and the role anode innovation could play in boosting EV adoption over the long term.



Sion Power envisages Licerion as the intermediate step between conventional lithium-ion and anode-free batteries

What constraining factors make next-gen lithium-ion necessary?

Energy is a big problem, and that's mainly due to material limitations. Lithium-ion technology saw gradual increases in energy capacity for a long time, but then it started to plateau around five or six years ago. That made it difficult to optimise cell designs and translate them into cost savings or other crucial performance characteristics, such as driving range and charge times.

How does Sion Power address this plateau with Licerion?

If EVs are going to progress as products, increasing energy density needs to go hand-in-hand with durability when developing new battery tech.

With Licerion, we take out a graphite anode, which is commonly used in lithium-ion batteries, and replace it with a thin-film lithium-metal anode. This is advantageous because it's both much lighter and thinner than graphite, increasing the battery's energy-to-weight and energy-to-volume ratios simultaneously.

Furthermore, Licerion enables us to stabilise lithium-metal across the entire lifetime of a lithium-ion battery. Sion Power developed an novel approach to address this issue: without our IP and know-how, charging and discharging a lithium-metal battery creates dendrites that can reduce cycle life and eventually short out the cell. That could be extremely dangerous for the people driving in that EV.

Are any OEMs currently utilising lithium-metal batteries?

At the moment, there are no applications of scale, but Sion Power is endeavouring to help realise this first. We have partnerships with two major automakers and two large battery makers to scale lithium-metal technology sufficiently for commercial use in vehicles. By H1 2025, we aim to produce the first EV-viable cell sizes and commence validation.

What could automakers expect in terms of improved EV performance?

Sion Power can double the energy delivery of lithium-ion today. If a state-of-the-art battery is 250kWh per



Consumers need to feel they're not sacrificing anything in order to gain access [to EVs]

kilogram, we can approach 450kWh/kg with Licerion. In the first instance, that extra power can dramatically increase EV range. On the other hand, an automaker could use that boost to reduce the number of cells in an energy storage system and produce the same size battery at a lower cost.

A key advantage of Licerion is that it's material agnostic for the most widely used lithium-ion chemistries. For high-performance vehicle applications, it can enhance cells using a nickel-manganese-cobalt cathode. In lithium-iron-phosphate batteries, which are typically targeted at more affordable EVs, Licerion can reduce unit cost while still delivering the same amount of energy.

Why is it better to improve lithium-ion than invest in alternative chemistries?

Solid-state batteries are still under development and manufacturing them will be very different. Licerion technology draws on the same supply chains and processing techniques already in place for standard lithium-ion, so those billions of dollars already invested in current infrastructure won't go to waste.

Sion Power has worked on lithium-sulphur batteries for aerospace applications over the last

two decades. However, we were unable to bridge the performance gap that would make it applicable for automotive, and that's one of the reasons we pivoted to lithium-metal instead.

Given enough time and effort, I believe both these alternative technologies could eventually work. But the main advantage of the Licerion battery system is its faster time-to-market: the further you deviate from the norm, particularly in a risk-averse industry like automotive, the longer introductory engineering periods will be. Taking a pragmatic view and changing only what's essential for addressing the shortfalls of lithium-ion—range, charge times, etc.—will help OEMs bring better EVs to market faster.

Overall, what role do you hope lithium-metal could play in broadening EV adoption?

Cost is still a huge impediment to mass EV uptake: the industry needs to aim for US\$35,000 or less. At the same time, consumers need to feel they're not sacrificing anything in order to gain access. A high-energy system can deliver the performance customers want at a price that's compelling, and Licerion addresses those two needs while keeping safety paramount.



Industry approaches “a pivotal moment” for battery swap—Nio

Nio is setting the bar for EV battery swap technology,
and a new partnership with CATL offers further
momentum. By Megan Lampinen

Chinese automaker Nio is taking a multi-pronged approach to electric mobility with a range of electric vehicles (EVs), plug-in charging networks, and battery swap stations. While both its charging and swapping locations are growing across China, Europe and the Middle East, swapping accounts for 60% of its vehicles' global energy consumption. Looking exclusively at highway use, 83% of the energy going into Nio's EVs comes from swapping.

Today, Nio operates more than 3,200 power swap stations (PSS): 3,172 in China, 59 in Europe, and one in Abu Dhabi. As EVs move beyond the early adopter demographic, swapping could play an increasingly important role and end up reshaping EV battery requirements along the way.

Battery-as-a-Service

Nio owners have the choice to buy their car's battery outright at the time of purchase or lease it. In Europe, the latter opens up a host of additional options, most importantly access to swapping. In China, users have access to swapping even if they have bought the battery. "Our cars are chargeable, swappable, and upgradeable, so users can decide which is the most convenient for them," says Nio's Kajsa Ivansson Sognefur, Head of Power Europe.

In China, where many EV owners live in apartment blocks and don't have access to home charging, convenience often means swapping. Nio's latest generation PSS can replace a used battery with a fresh one in just three minutes. "This is a fully automated process, so it's even more convenient than conventional refuelling," Sognefur tells *Automotive*



Nio swap station

World. "It requires minimal effort from the driver." Nio's stations perform a battery health check, drawing on various sensors and AI-powered cameras, before slow charging the batteries. All of these steps are designed to optimise the battery lifetime.

During any visit to a PSS, a driver may opt to upgrade the capacity of their battery, choosing between the standard 75kWh battery or a 100kWh option in Europe, with a further option of upgrading to 150kWh in China only. This is particularly popular ahead of holiday periods, when many owners are heading off on road trips. The upgrade service has been offered in China since 2021 but only came to Europe in December 2024. Here, a similar pattern is playing out.

"We're seeing the same consumer swapping trends in Europe as in China," notes Sognefur. "For instance, there was a lot of activity ahead of the



Christmas holidays as drivers headed off on family get togethers or ski trips.” In Europe, upgrades can be activated for one month with the option to extend. The offer in China is more flexible, with daily upgrades the most popular and dominant preference for users there. Switching to a smaller battery is possible as an ad hoc service.

Notably, the use of flexible upgrades has prompted greater interest in smaller batteries for day-to-day use, as drivers realise they require less range outside of road trips. “Some years ago, before we had flexible upgrade and the extensive PSS network, half of our users in China would select the smaller battery when they bought their car, and half would select the bigger option,” says Sognefur. “Now, with the extensive network and the ability to do flexible upgrades, 95% of our users

chose the smaller battery when they purchase the car because it’s cheaper. They generally only upgrade when they go on holiday.”

For the wider EV industry, a move towards smaller batteries as standard could improve sustainability across many fronts, reducing the vehicle’s lifetime energy consumption and greenhouse gas emissions. It also reduces materials demand; a report commissioned by Climate and Community Project found that limiting the size of EV batteries could reduce lithium demand by 42%.

A pivotal moment

The idea of battery swapping has been around for many years, with many failed endeavours. Today China is the

only country with an extensive swapping network in place. Part of the problem has been a lack of standards, as the EV, the battery, and the swap stations all need to be aligned. Working with a number of other brands on this front, Nio now has agreements with Changan, Geely, Chery, JAC, GAC, FAW, and Lotus.

In March 2025, it outlined a partnership with Chinese EV battery supplier CATL to establish the largest and most advanced swapping network in the world. Speaking at the time of the announcement, Nio Founder, Chairman and Chief Executive William Li described the collaboration as one that “marks a pivotal moment, propelling battery swapping into a brand-new phase.”

CATL is also investing CN¥2.5bn (US\$346m) in Nio Power, the automaker’s energy management division that oversees both swapping and the plug-in charging networks. Nio will introduce CATL’s Choco-Swap technical standards and network for its upcoming models under the Firefly brand. The networks of both parties will operate in parallel, with the promise of a more seamless and efficient swapping experience for drivers. According to the partners, the arrangement should produce a synergy effect in which “the whole is greater than the sum of its parts.”

The partnership with CATL is focussed exclusively on China, which continues to lead the global charging push. Europe is progressing, but slower than expected. Nio had originally targeted 1,000 PSS in Europe by 2025. The current total of 59 is woefully short of that. “We are still opening stations, but not at the pace to reach 1,000

stations this year. We have completed more than 140,000 swaps in Europe, so we are achieving solid milestones,” notes Sognefur.

Arange of solutions

While Nio is directing considerable attention and resources into battery swap, it remains equally committing to plug-in charging, and Sognefur refuses to put her bets on one technology dominating in the future. “To ensure users can choose whatever kind of energy provider they would like, we will keep investing in both over the long term.”

There is plenty of scope for innovation within plug-in charging, and Nio is currently exploring bidirectional charging in its home market of China. A recent report by EY and Eurelectric found that smart charging and vehicle-to-grid technologies “are critical for cost savings, grid stability and renewables integration.” It’s very early days for Nio on this front, with Sognefur describing bidirectional efforts as “experience and data gathering” at the moment.

Whether it involves plugging in or swapping out, automakers like Nio are actively investing in the energy ecosystem underpinning EVs. As Sognefur points out, the two are very much connected. “OEMs have to consider the impact of their models on the energy network,” she concludes. “How we support the ecosystem is super important. Instead of posing a problem for the grid, we can be a part of the solution, and I think there are many different solutions available to support the transition into green mobility.”

Mercedes hits the road with a prototype solid-state EQS

Mercedes taps Factorial cells and F1 specialists to fast-track solid-state developments. By Megan Lampinen



Solid-state batteries promise a step change in electric vehicle (EV) safety and performance, once they finally make it into mass production. While research efforts have been underway for many years, pretty much all applications remain in the prototype and trial stage. Recent developments at Mercedes-Benz, however, point to promising progress. The automaker aims to launch an EV with solid-state batteries by the end of the decade, and is currently road testing the technology in a modified EQS.

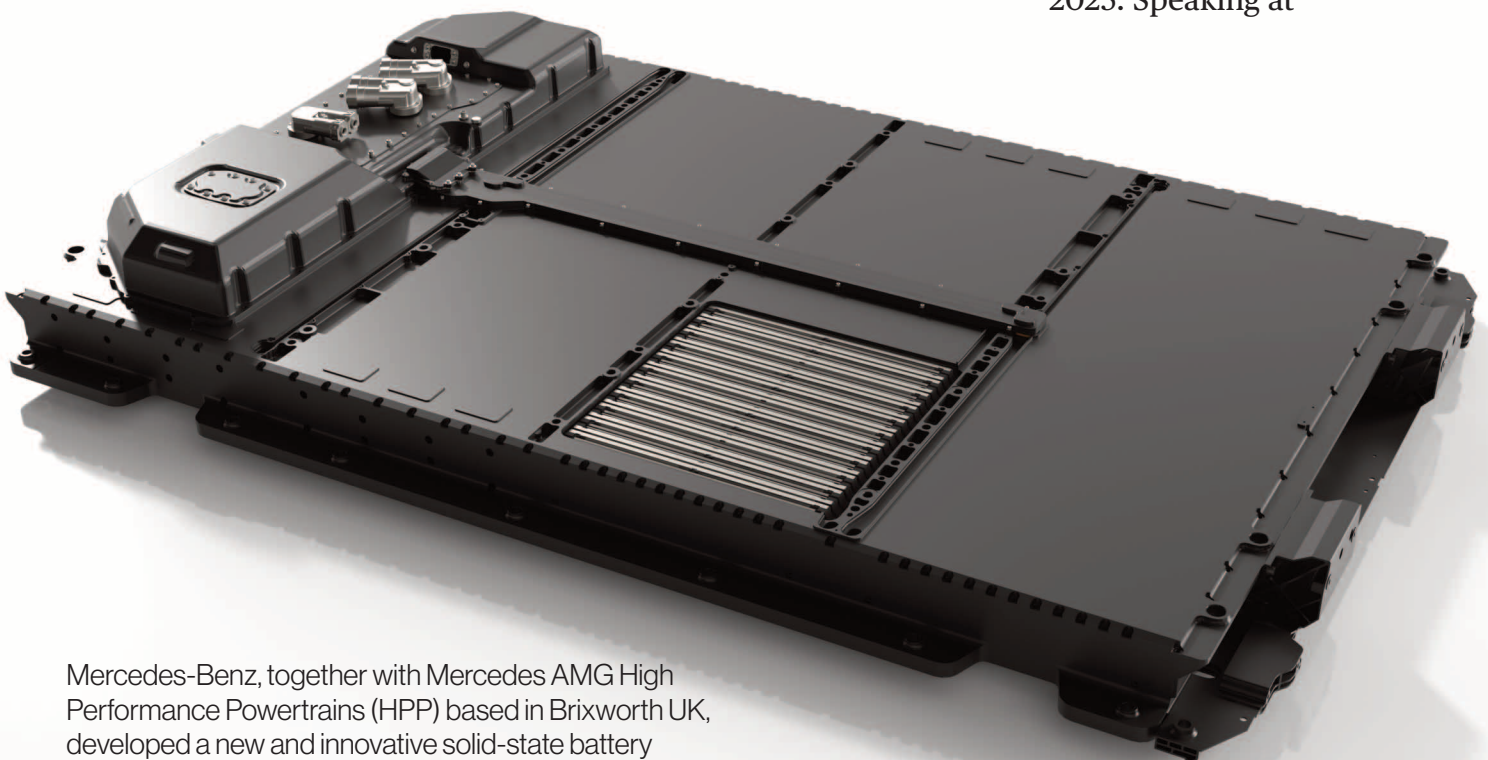
Towards series integration

Mercedes has been developing batteries of one sort or another since the 1970s and working on lithium-ion for nearly 20 years. The move to a solid-state chemistry could be a game changer. It's been working on this front together with US solid-state battery developer

Factorial Energy since 2021 and took delivery of the first lithium metal solid-state battery B sample shipment in summer of 2024.

“Solid-state brings a huge increase in cell energy density,” explains Uwe Keller, Head of Mercedes-Benz Battery Development. “With today’s lithium-ion batteries, you get a gravimetric energy density of 200-300 Wh/kg. With solid-state, we’re going up to 450 Wh/kg. That means we can get 25% more range from the same size and weight battery.”

Drawing on Factorial’s cells and engineering input from the racing experts at Mercedes AMG High Performance Powertrains (HPP), the automaker has integrated a new solid-state battery pack into an EQS. The vehicle was modified to accommodate the battery and equipped with the necessary accessories to operate it. Laboratory tests began in Stuttgart at the end of 2024 ahead of road testing, which kicked off in February 2025. Speaking at



Mercedes-Benz, together with Mercedes AMG High Performance Powertrains (HPP) based in Brixworth UK, developed a new and innovative solid-state battery

the time, Mercedes-Benz Chief Technology Officer Markus Schäfer commented on how the testing will provide “crucial insights into possible series integration of this cutting-edge battery technology.”

Innovations

Initial feedback points to a 621-mile range—25% more than a corresponding standard EQS battery—along with notable safety advances. “We replace the liquid electrolyte with a solid material that has a higher flammable temperature,” Keller tells *Automotive World*. “And because solid-state cells normally work at higher temperatures, we switch from active to passive cooling.” This opens the door to additional weight and energy efficiency. The new chemistry also allows for the use of new anodes, like lithium-metal, which carry more energy. “For the first time, we are using a lithium metal foil anode, not the usual graphite or silicon anode,” he notes

Another innovation within the new battery pack addresses battery pressure. In solid-state batteries, pressure is pivotal to maintaining good solid-solid ionic interface contact during charging and discharging. “You don’t have the liquid there helping the lithium ions move from the anode to the cathode, or the other way around,” observes Keller. “The interfaces between them have to be attached very thoroughly, and this is done via pressure—really high pressure. There are systems up to 3MPa and beyond.” In comparison, an average bicycle tyre will be pumped up to roughly 0.2MPa. “This is more than ten times that

pressure. To maintain that in a battery is quite difficult.”

Together with colleagues at Mercedes AMG HPP, his team developed a floating cell carrier system with a pneumatic actuator that helps maintain a constant pressure on the cells while allowing movement at the same time. “This is very unique, and patented,” he emphasises.

Non-negotiable

Cost and efficiency are at the heart of battery innovation, but it’s also about sustainability, reliability, and safety for Keller and his battery development team. Sustainability encompasses CO2 footprint, repairability and recycling, while reliability looks to ensure the battery performance over the vehicle’s lifetime and beyond. Safety encompasses not just the battery but the whole vehicle, going above and beyond official regulations. He describes these three metrics as “non-negotiable”.

Within these guiding principles, there is room for multiple solutions and chemistries that can be used off the same or similar basic platforms. “We think there will be more than one solution for consumers, and solid-state can play a role within this,” says Keller.

For now, the focus is on road testing the solid-state EQS and evaluating its performance in the real world. “You cannot control conditions outside the lab; the real challenge is understanding the performance you can bring there. You test and analyse results, then you make improvements to the software or the hardware.” This stage will last a year or longer, though



Road tests with the new solid-state battery in an EQS development car started in February 2025

the participation of the HPP group should help. As Keller notes: “These F1 guys are very fast in prototyping.”

Mercedes is by no means the only brand racing to put a solid-state vehicle on the market. Factorial has solid-state development contracts with Stellantis, Hyundai and Kia, all of which have similar ambitions. Stellantis is gearing up to launch a demonstration fleet of Dodge Charger Daytona models incorporating Factorial’s solid-state batteries in 2026. The batteries to be used in the Charger Daytona offer a specific energy density of more than

390Wh/kg. CATL, BYD, QuantumScape, and ProLogium are just a few of the other companies developing solid-state technology, each with their own illustrious list of automaker partners.

By 2030, Mercedes hopes to have solid-state technology powering a production passenger car and hopefully attracting new buyers. “From the consumer side there’s been some hesitation about adopting EVs, but a technology like solid-state and the performance benefits it brings can really help with that,” concludes Keller.

EREVs tap existing tech to target new buyers

The latest industry disruptor combines BEV and PHEV to tap the range/cost sweet spot.

By Megan Lampinen

Range anxiety remains one of the biggest obstacles in the shift to electric vehicles (EVs). For drivers without access to a home charger or those that travel long distances, lack of public charging is a huge deterrent. Add to that continued price premiums over gasoline and diesel models and it's understandable why EV volumes have fallen short of projections. Recently, an alternative approach to electrification has been gaining ground and could prove a major industry disruptor.

2024 saw a number of global automakers dial back or postpone EV launch plans in favour of extended-

range EVs (EREVs). This is a form of plug-in hybrid EV (PHEV) in which a small combustion engine is used solely as a generator for the battery, with no connection to the drivetrain. Like a traditional PHEV, an EREV can be plugged in to charge the battery while the engine is refuelled with gasoline. But unlike traditional PHEVs, EREVs can travel long distances on battery power alone: an average PHEV will offer an all-electric range of 20-40 miles, while an EREV could offer something closer to 200 miles. Supported by the engine, a model's total range could easily be double that—Li Auto offers EREV models boasting total ranges in excess of 800 miles.



The Li L9 EREV offers a total range of more than 1,000km

EREV technology is not new. A handful of models debuted alongside the initial mass market EVs about a decade ago, but they failed to gain traction among the wave of tech-savvy, eco-driven early adopters. However, EREVs are now undergoing a renaissance as an alternative to pure BEVs while the world comes to grips with charging requirements and affordability.

China leads the way

China is the world's largest EV market and leads the charge on EREVs. Boston Consulting Group reports that both PHEVs and EREVs combined recorded a CAGR of 104% in China between 2020 and 2024, compared to a 55% for battery EVs. Bloomberg figures show that EREV sales alone more than doubled in China over the past year and currently account for roughly 30% of the country's PHEV market.

Several brands have been competing in this space, though Li Auto is the global EREV leader in terms of sales. Many more are set to join the trend,

and not just in China. The past year alone has seen the likes of Xpeng, Volkswagen SAIC, Stellantis, Lotus, Hyundai, Ford, Mazda, and Scout Motors all announce new or additional EREV production launch plans for China, the US, and Europe.

Boston Consulting Group predicts that EREVs “will likely play a greater role going forward in the US and, before long, in the EU.” McKinsey makes a similar conclusion. “In the short term, we expect EREVs to be concentrated in China, but the expansion of Chinese OEMs into new markets and EREV investment by [other] OEMs means we will likely see EREVs taking more market share globally in the medium term,” says Paul Hackert, Senior Expert, Product Development & Procurement at McKinsey. That said, regulatory differences could hold back the segment's potential in Europe. “In the US, current regulations give partial zero emissions credits for EREVs,” Hackert tells *Automotive World*. “In Europe, existing regulations require pure battery electric vehicles (BEVs) by 2035, limiting the long-term advantages

of EREVs in that market.” China’s broader New Energy Vehicle policy recognises EREVs equally alongside PHEVs and BEVs.

A new demographic

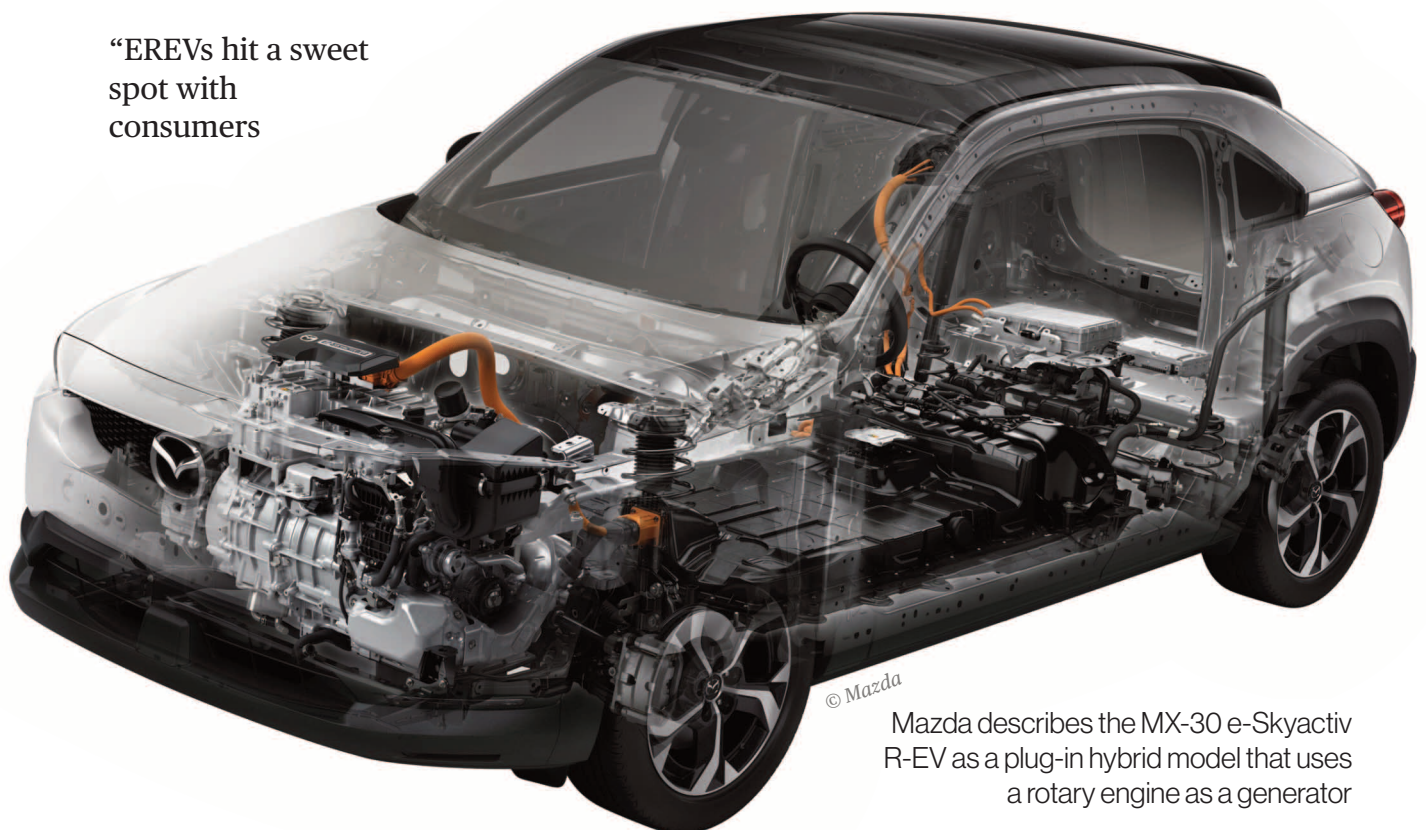
A late-2024 survey from McKinsey found that a sizeable percentage of respondents would consider an EREV for their next vehicle purchase if one were available. Among the 2,800 new-car buyers surveyed in the US, 18% were “very interested in purchasing EREVs” once the technology was explained to them. “That was a lot higher than I expected,” notes Hackert. Across the US consumer group and the 2,300 buyers surveyed in Germany and the UK, two-thirds noted an intent to purchase an internal combustion engine (ICE) or hybrid vehicle in the absence of an EREV option. McKinsey concludes from this that EREVs could motivate more ICE vehicle owners to move to electric.

“EREVs hit a sweet spot with consumers

when it comes to electrification,” observes Anna-Sophie Smith, Leader for Mobility Consumer Insights at McKinsey. “They appeal to this group that is open to electrification but may have range anxiety or may not have the opportunity to charge at home. Fast charging and the longer ranges possible with the EREV’s backup generator really hit some of the existing concerns. That is an important consideration, especially in Europe, which faces a 2035 deadline for zero emission vehicle-only sales. An EREV on the market now can help people transition to electric.”

The sweet spot

EREV technology could potentially apply to almost any vehicle segment, but it has primarily been used with SUVs and pick-ups so far. “Some vehicle segments that have a greater



© Mazda

Mazda describes the MX-30 e-Skyactiv R-EV as a plug-in hybrid model that uses a rotary engine as a generator

percentage of longer distance driving customers—such as full-size work pick-ups or vans making multiple daily customer stops—may have a higher than average demand for EREVs,” suggests Hackert. “We are seeing more pick-ups in the EREV space, perhaps because it’s easier to package a larger battery and an engine in this vehicle class.”

Stellantis intends to introduce EREV technology on the Ram 1500 Ramcharger pick-up, while VW’s Scout Motors will use it for an upcoming range of rugged SUVs and pick-ups. Ford Chief Executive Jim Farley has also thrown his support behind the technology for certain vehicle segments. Speaking to analysts in the company’s Q4 2024 earnings call in February 2025, Farley noted that EREVs could be the key to electrifying affordably the big trucks that American consumers favour. “They love big trucks and they love the feeling of electric, but they just can’t get it,” he told analysts. “It’s US\$30,000 or US\$40,000 too expensive for these big vehicles. This technology gives them the electric experience without the range anxiety.”

That’s down to using a smaller battery than BEVs. There will always be a compromise between range and cost, but McKinsey suggests that there could be a sweet spot. By targeting 100-200 miles of EV-only range and total range of 350-600 miles depending on customer segment, it believes EREV costs should fall between a similar sized ICE and a BEV. “That would satisfy almost all customers’ daily commute and some longer commute requirements,” asserts Hackert. McKinsey’s Madhumitha Aravanan, an Asset Leader and Portfolio Manager, points out that there is “no real convergence yet on what the capacity

of the battery plus the engine should look like.”

In the future, EREVs could potentially lose some of that cost benefit as battery costs decrease. They could also take a hit should the industry see any other major advances in battery technology that somehow reduce their advantage over PHEV.

Outlook

McKinsey believes that EREVs could grab a 2.5% share of the global passenger vehicle market by 2030, though Hackert stipulates this figure is “actively changing as automakers shift production plans.” Market Research Intellect predicts that the global EREV market could be worth US\$518bn by 2031. While the potential is there, lack of consumer awareness and a scarcity of models are major constraints to uptake.

“People are still very confused,” cautions Smith. In McKinsey’s US consumer survey, 27% of respondents thought ICE was a more sustainable option than EREV, BEV or other hybrid forms. 48% agreed with the statement ‘I’m overwhelmed by the number of powertrains currently available to choose from’. Moving forward, automakers will need to put in a concerted effort to educate consumers and clearly communicate the benefits of the technology.

“The industry has come to the realisation that public charging systems aren’t where we want them to be,” concludes Hackert. “EVs are still priced at a significant premium over ICE...It could be an interesting time to invest and make EREVs available. There are trade-offs and risks.”

Dincă Lab reconciles cost and performance in sodium-ion

Through a breakthrough new cathode material, Dincă Lab could lay the foundation for commercially viable sodium-ion batteries. By Will Girling

As geopolitical tensions challenge and constrain established lithium-ion (Li-ion) battery supply chains, which are primarily consolidated in China, sodium-ion (Na-ion) is gaining attention in the automotive industry. Sodium is both 1,300-times more plentiful and 90% cheaper than lithium, making the batteries theoretically easier to scale around the world.

However, sodium has a larger molecular mass than lithium, making movement of ions between the cathode and anode during charge/discharge cycles slower. Furthermore, the voltage of a sodium chemistry cell is generally lower than lithium. These factors combine to halve

Na-ion's energy density relative to Li-ion, making it impractical for electric vehicle (EV) applications where range is a core customer purchase consideration.

For now, the race to create a commercial-scale Na-ion battery that can compete with Li-ion is still on. However, the finishing line might be closer than ever before.

'Blank slate' thinking

Mircea Dincă, Alexander Stewart 1886 Professor of Chemistry at Princeton University and leader of the Dincă Lab research group, has been exploring battery technology since 2015. Dincă Lab

consists of around 20 staff, including PhD students and post-doctoral associates. Its focus on energy storage started with supercapacitors, devising new classes of materials previously unused in such applications. “We were outsiders to the community, but that was our advantage: we didn’t have decades of baggage to constrain us,” Dincă tells *Automotive World*.

It was this ‘blank slate’ that attracted Lamborghini to Dincă Lab, and the two began a relationship in 2017, while the latter was still part of the Massachusetts Institute of Technology’s (MIT) chemistry department. This subsequently transferred with the research group’s move to Princeton. Lamborghini was interested in new battery solutions for EVs and offered a broad remit for Dincă to explore options that would hit key metrics like power, energy density, and stability.

Other companies have investigated how to retain Na-ion’s low cost while boosting its performance. For example, California-based start-up Unigrid claims replacing carbon with tin in the anode can triple capacity and shrink its size by 1,500%. On the other side, Dincă Lab researched how new cathodes could improve Na-ion performance. “Finding solutions with multi-electron redox behaviour that enables multiple sodium ions per unit of cathode material was really difficult,” says Dincă. Nonetheless, in February 2025, this is exactly what his team demonstrated.

Solving performance issues

The solution’s foundation came in 2024 with the development of a new layered organic solid called bis-tetraaminobenzoquinone (TAQ). Dincă



The sodium used in Na-ion batteries is essentially salt from sea water

credits the achievement to the “educated guesses” of his staff and the “wide research latitude” facilitated by Lamborghini’s funding. The researchers published their findings in *ACS Central Science*, originally citing its potential in Li-ion applications. The TAQ molecule is both insoluble and highly conductive, qualities that make it well suited for use in cathodes, and this eventually shifted focus over to its prospects for solving Na-ion’s perennial performance issues.

Over the next year, Dincă Lab researchers—Tianyang Chen, et al—used carbon nanotubes to bind TAQ crystallites with carbon black particles. This yielded an interconnected and homogenous cathode that enables up to 100% utilisation of the active material. Importantly, the material has high cycling stability and is durable to air, moisture, and heat.

The research group’s 2025 paper on its findings, published in *Journal of the American Chemical Society*, claimed an electrode-level energy density of 606 watt-hours per kilogram at 90% weight of active material. A Na-ion cell had a cathode energy density of 472 Wh/kg when charged/discharged in 90 seconds. Theoretically, this could give it almost a



Talking about a battery's cost or performance doesn't mean anything if they aren't in balance with each other

60% performance advantage over Li-ion cells using nickel-manganese-cobalt (NMC) cathodes, which generally achieve up to 300 Wh/kg. However, it should be noted that this comparison is currently based on lab scale versus manufactured products.

A true breakthrough?

Dincă believes TAQ cathodes in Na-ion batteries could enable the automotive industry to “hit all its battery performance targets at once.” The improved rate performance increases overall gravimetric and volumetric density, meaning batteries can be smaller and store the same amount of energy as current generation cells or be scaled up to store more. “How much space a battery takes up in a car is an important consideration. On top of that, automakers improve other aspects that customers will care about, like safety and cost.”

Exact pricing will be difficult to determine until Daqus Energy, a start-up spun out from MIT, of which Dincă is also a co-founder, has scaled TAQ production sufficiently for industrial manufacturing. However, the potential benefits for OEMs like Lamborghini are clear, and the company can afford to wait—it has pushed back the release of its first EV to

2029, expecting the market to mature further during the interim. A slight delay could save money and produce a better and wider variety of battery options in the long term.

“In principle, TAQ can replace cathodes in some of the higher-end but geopolitically problematic Li-ion battery chemistries like NMC,” states Dincă. “TAQ comes from commodity chemicals derived from petroleum, and access to those downstream products is very secure compared to metals. Wouldn't it be better to make smart materials from petroleum instead of burning it?” In addition to allowing automakers to build more secure supply chains, synthesising TAQ is also less carbon intensive (involving heating up to 120 degrees Celsius) than NMC (up to 800 degrees Celsius).

By then replacing lithium with sodium—which is basically sea water—Dincă says that automotive can rid itself of all the “problematic minerals” that continue to plague battery production. “Talking about a battery's cost or performance doesn't mean anything if they aren't in balance with each other. TAQ reconciles both in an environmentally friendly solution that complements broader electrification efforts.” This, he concludes, could be the true breakthrough of TAQ-based batteries.

OEMs increasingly back away from BEVs in favour of hybrids

A confluence of low demand, high costs and regulatory changes is making the future of mobility seem more electrified than electric.

By Will Girling

In many ways, the global battery electric vehicle (BEV) market is in the best shape it's ever been. For Q1 2025, sales were up 11% and 24% year-on-year in the US and Europe, respectively. This is to say nothing of the 55% growth achieved in China during the same quarter. And yet, automakers are increasingly hedging their bets on full electrification.

Brands have been dialling back highly ambitious BEV sales targets since mid-2024,

when it became apparent that uptake was slower than anticipated and concessions on emission regulations would be necessary to avoid crippling fines. So far in 2025, these trends don't show any signs of stopping.

In the EU, the European Commission's Action Plan pushed back compliance with tightening CO2 regulations to 2027. Meanwhile, the US government has aggressively sought to end the 'green agenda' of previous administrations. It argues

that emissions regulations, combined with the promotion of BEVs without comprehensive and reliable charger infrastructure, raise prices and restrict consumer choice.

Automakers' substantial investment in BEVs globally—more than US\$275bn between 2022 and 2023 alone, according to the International Energy Agency—makes abandonment of the technology unlikely. However, for many, a pivot back to internal combustion



IN CASE YOU MISSED IT...

engines (ICE) and hybrids is a financial necessity over the medium term.

At a factory in Tonawanda near Buffalo in New York state, General Motors has switched a US\$300m investment in electric drive units for US\$888m in V8 engines. This is likely to support the company's best-selling SUV and pick-up model lines. Stellantis has also pushed back its electric Ram 1500 programme again. The BEV version will now be released in 2027, with the extended-range EV Ramcharger now in 2026. Alfa Romeo is also reportedly delaying release of its new Stelvio SUV to late 2026 and changed it from BEV to hybrid.

Similar reversals are happening for manufacturers of smaller passenger vehicle models. Honda has slashed its BEV investments through 2030 by 30%—from JP¥10tr (US\$69.3bn) down to JP¥7tr—in order to capitalise on demand for hybrids. Toyota is also hoping to grow plug-in hybrid sales volume in the US from 2.4% in 2024 to 20% by 2030. Wards Intelligence forecasts 28% year-on-year growth (to 409,000 units) in the country's overall segment during 2025.

While not discounting BEVs, Geely Chairman Li Shufu believes there's still plenty of



General Motors Tonawanda
Propulsion plant

life left in ICE and hybrids. He characterised maintaining investment in all three powertrains as particularly necessary amid the BEV pricing wars initiated in China by BYD. The automaker is pursuing this strategy to bring down stock inventory levels, which reached 3.5 million units in April 2025—the highest since December 2023.

In addition to demand and associated regulatory issues, a big problem for BEVs in the near term is that they simply do not offer attractive margins. Ford alone expects to lose US\$5.5bn from its Model e division in 2025. However, the needs of automakers and customers are at odds: the former need higher prices to make BEVs profitable, while the latter are calling for greater affordability. This causes a 'chicken and egg' scenario in which scaling production would bring down costs and

attract buyers, but OEMs won't move until demand increases.

Volkswagen and Renault are attempting to reconcile these positions—with the ID. Every1 and R5 E-Tech, respectively—but high-margin segment leaders like Tesla have apparently given up. Some reports state the much-anticipated US\$25,000 'Model 2' has been cancelled internally, though the company has not officially confirmed this.

If H1 2025 has proved anything, it's that hybrids will almost certainly factor into the electrification timeline for longer than previously thought, and cost efficiency will need to be a core production goal moving forward. As high prices exclude customers and cause stagnation in crucial auto markets, affordability will need to be addressed sooner rather than later.