Steel E-Motive Q&A

What is Steel E-Motive?

Steel E-Motive is a virtual vehicle concept that showcases the suitability of Advanced High-Strength Steel products and technologies for use in future sustainable and autonomous battery electric vehicles.

What is the aim of the project?

Ultimately, it is to advance and enable the journey to zero emissions. By providing a roadmap of innovations, the Steel E-Motive concept can be immediately utilised by global manufacturers at attractive cost levels using existing supply infrastructure, resulting in affordable and accessible autonomous vehicles. This will accelerate the key cultural shift in cities from vehicle ownership to ride hailing, where the use of renewable energy and shared occupancy will drastically cut the emissions per passenger.

The Steel E-Motive project aims to inspire a generation of vehicle design engineers to select Advanced High-Strength Steels (AHSS) as the leading material of choice for autonomous battery electric vehicles operating in the Mobility as a Service (MaaS) sphere.

Why has WorldAutoSteel developed Steel E-Motive?

Net Zero emissions by 2050 is a goal that can seem distant and daunting. But over the past five years, WorldAutoSteel's global automotive steel suppliers have conducted extensive research that illuminates a path forward. The Steel E-Motive concept – borne of this research – represents a significant enabler for reaching the Net Zero goal.

Urbanisation and waning interest in vehicle ownership point to new transport opportunities in megacities around the world. Mobility as a Service (MaaS) – characterised by autonomous, ride-sharing-friendly EVs – can be the comfortable, economical, sustainable transport solution of choice thanks to the benefits that today's steel offers, which will foster the higher vehicle occupancy critical to Net Zero ambitions. Steel E-Motive matters because it fulfils key user, manufacturer, service provider, and societal demands.

What are the vehicle concepts within Steel E-Motive?

Steel E-Motive (SEM) includes two vehicle concepts based on a single modular platform. SEM1 is a short wheelbase 4-passenger urban version for inter-city travel. It has a compact design and vehicle footprint and front-wheel electric drive. SEM2 is a longer wheelbase 6-passenger extra urban version. It has front and rear wheel electric drive and an extended wheelbase. It maximises SEM1 carryover parts to minimise overall costs and optimise the existing manufacturing infrastructure.

What are the key features of Steel E-Motive?

- Conceived for Level 5 Autonomy. Void of driver interfaces, SEM architecture affords a spacious, airy and comfortable cabin for occupants.

- Designed to meet or exceed stringent high-speed crashworthiness standards, enabled by innovations in modern Advanced High-Strength Steels.

- Engineered to be affordable, in terms of not only production but also life-cycle emissions. Steel exploits existing manufacturing infrastructures to deliver low ownership costs – critical for broad adoption. Steel E-Motive is a fully engineered vehicle programme that start-up companies can use to significantly reduce their cost and time to market.

- Planned for sustainability. The viability of any MaaS disrupter is contingent on cost competitiveness versus existing solutions, such as private ownership or taxis. Steel thicknesses are minimised for lower mass, and material utilisation is maximised for lower steel production and emissions. Autonomy further reduces operating emissions due to drive cycle smoothing. High-occupancy vehicle usage – critical to a Net Zero future – must represent enticing (for riders) and profitable (for providers) alternatives to traditional vehicles. Therefore, Steel E-Motive is designed to meet stringent global crash requirements while maintaining low-cost advantages.

Who developed Steel E-Motive?

Steel E-Motive has been developed by WorldAutoSteel, a global consortium of 18 companies that works together on programmes to enhance and communicate advanced material applications in the automotive industry. The project is led by George Coates, WorldAutoSteel's Technical Director, and Neil McGregor, Chief Engineer at Ricardo for the Steel E-Motive project. Key partners are Ricardo (UK), the global engineering and environmental consulting firm, and ARRK Engineering (Germany), a globally active development partner for the automotive and mobility industry.

How is the concept going to be used?

WorldAutoSteel will make the Steel E-Motive portfolio of materials and trademarkable innovations, engineering data and CAD available freely and transparently to the industry without restrictions.

Both concepts (SEM1 and SEM2) are manufacturable using the world's existing infrastructure at costs that support profitable margins for manufacturers and service providers supplying affordable transportation. Mobility-as-a-Service fleet owners and service providers can reduce time to start-up operations with fully engineered, ready-made, fit for purpose designs.

The innovations offer significant learning opportunities for the world's automotive engineering community that can influence new steel architectures for safer, affordable and sustainable vehicles. Many structures, such as the side structure hex beam energy absorber and battery carrier frame, can be adopted for conventional vehicle architectures for efficiency improvements today.

What 'firsts' does Steel E-Motive represent?

Steel E-Motive is the world's first autonomous vehicle engineered to meet the global high-speed crash requirements, with performance in keeping with an Insurance Institute for Highway Safety (IIHS) 'Good' rating.

It contains seven AHSS structural innovations (listed below), with lightweighting designed in: its 282kg body structure represents 25% reduced mass compared to an expected reference vehicle of 374kg. Its steel-enabled battery integration makes its battery carrier frame 37% lighter than the average reference battery packaging, whilst also reducing cost by 27%.

The seven key innovations are made possible by applying Steel E-Motive's steel portfolio of 65 high-strength grades and steel technologies available globally. Many of these innovations do not have to wait for the future. They can be studied and deployed in conventional vehicle architectures for more efficient vehicles on the road to Net Zero.

1. B-pillarless one-box open body structure
2. Globally deployable short front crash zone
3. AHSS extended front passenger protection zone
4. Small offset crash glance beam
5. (Rocker) hex beam energy absorbers
6. Scissor doors with virtual B-pillar
7. Unique coverless battery carrier frame

What safety rating does Steel E-Motive have and what safety features does it incorporate?

Steel E-Motive's performance is in keeping with an Insurance Institute for Highway Safety (IIHS) 'Good' rating. The design team met with representatives of the IIHS to review crash management approaches and simulation results for Level 5 autonomous vehicles, as intrusion targets for these vehicles have not been set. IIHS generally agreed with the approach, calling our targets "reasonable and logical."

The use of AHSS in the roof bow, battery frame and rocker (floor) minimises deformation in crashes. The double-walled bottom cover for the battery pack protects batteries from road debris and jacking errors. The battery packaging achieves stringent global battery electric vehicle requirements, including China's GB 38031-2020, incorporating 100kN crush load. The use of scissor doors, through integrating the B pillars, contribute to crash performance. In the front crash structure, a variety of steels permit crush rails to absorb energy, glance beams to redirect energy, and rigid pieces to prevent cabin intrusion, while maintaining a very short front overhang. In the side structure, AHSS steel in A and C pillars align with front and rear occupant seating areas to provide lateral protection, while the combination of the hex beam absorber innovation, Advanced High-Strength Steel cross members, integrated B-pillars and a robust battery carrier frame provide excellent side intrusion and battery protection.

What emissions reduction does Steel E-Motive promise?

Ride sharing and ride hailing autonomous vehicles increase average passenger occupancy which enables optimisation of CO_2 emissions per mile. A Steel E-Motive mass efficient vehicle using improved battery technology and a renewable energy grid offers life cycle emissions savings of 60% compared to a 2022 benchmarked conventional electric vehicle with a single occupant. With additional steel de-carbonisation, actively pursued by the steel industry, and high passenger capacity (3+ occupants), the benefits of autonomous vehicle drive cycle smoothing, extended vehicle life (due to steel's durability) and battery life, vehicle emissions can reach a reduction of ~86%. Net zero achievement will likely require production carbon capture and a 100% renewable grid supply.

In the production process, emissions are significantly reduced through the design by minimising material thickness and maximising material utilisation.

What challenges in vehicle design has Steel E-Motive overcome?

It shows how AHSS products and technologies can solve unique architectural challenges in lightweighting and safety (see above). It also offers passengers ease of ingress and egress including mobility-challenged access, (eg through the use of AHSS to allow the B-pillar to be removed from the body and integrated into the door system). The high levels of comfort, safety and accessibility will meet the main user and fleet operator requirements for autonomous ride hailing vehicles, fostering user acceptance required to reach high capacity use.

Why is steel considered a sustainable choice for autonomous vehicles?

Steel is required to enable sustainable mobility. Steel's strength, durability, repairability and recyclability give it a strong environmental performance from a life cycle perspective and for its contribution to the circular economy. These characteristics are particularly important in ride hailing vehicles which will need to have a useful life that is at least 2x longer than current passenger vehicles. Steel's characteristics of strength, durability, and repairability are completely aligned with the needs of these next generation vehicles. Steel's primary production emissions are 7 to 20 times less than other automotive materials, and it is infinitely recyclable, with a strong recycling infrastructure throughout the world. The steel industry is actively bringing on line more Electric Arc Furnace steel production, which uses recycled steel to make new steel.

How soon could we see Steel E-Motive turned into reality?

Because Steel E-Motive can utilise existing global manufacturing and supply resources at attractive cost levels and profit margins, production could start as soon as 2030. Vehicles based on Steel E-Motive concept could be autonomised and in widespread use in urban and suburban environments around the world by 2030-2035. Additionally, Steel E-Motive is a fully engineered vehicle, whose CAD data, provided freely and without restrictions, can help start-up companies significantly shorten their time to market.

What advantages does Steel E-Motive offer vehicle manufacturers?

Steel E-Motive can be produced using existing global manufacturing and supply resources at cost levels that support profitable margins. The minimised material thickness and maximised material utilisation results in an optimised total cost of ownership (TCO).

Steel E-Motive concepts are engineered for high-volume production (>250,000) using conventional vehicle manufacturing facilities and equipment, so minimising investment costs. The stamped and fabricated steel body structure is an inherently low-cost solution through cost saving measures, such as: high elongation and high-strength steel grades enable components with complex geometry to be integrated into single stampings, reducing part count and tooling costs. Lower cost roll forming and roll stamping methods were applied for constant section profiles. The integrated body and battery structure consolidates parts, and the large side doors have enabled the deletion of body side outer panels. The SEM vehicle and body structure cost is competitive with current production BEV vehicles.

What makes Steel E-Motive affordable and why is that important?

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The affordability of Steel E-Motive's shared mobility concept fills in gaps in urban transportation systems. It will make sustainable, affordable transport more widely available and links to the missions of smart cities around the world.

What are the chief characteristics of a Steel E-Motive vehicle?

There are two virtual concepts: SEM1, a 4-passenger urban transport; and SEM2, a 4-6 passenger extra-urban commuter designed for deployment from 2030-35+. Both feature:

- Short front and rear overhangs
- Front wheel drive (SEM1) and four-wheel drive (SEM2)
- Low step-in height for ease of passenger ingress/egress
- Level 5 autonomy with no steering or pedal box
- Flexible, open interior, designed for rear facing front passengers
- Battery agnostic—designed for maximum battery volume
- Designed to carry cargo in off-peak hours
- 4-wheel steering for tight turning circles for navigating inner city roads
- High volume production >250,000.

When will SEM2 be introduced?

Information will be in the engineering report, which will be issued in August 2023 at steelemotive.world for free download.

How long has Steel E-Motive been in development?

In a bold move, WorldAutoSteel started a mobility programme the year the world came to halt during the pandemic (July 2020). The commitment of our members and staff was proved in countless hours of web meetings, virtual white board discussions and in-depth steel technology transfers. Their investment, in time, resources and funding, made Steel E-Motive a reality. The vehicle development process for this fully engineered vehicle took 30 months.

How have auto manufacturers reacted so far?

In developing Steel E-Motive, many major suppliers were consulted, including seat manufacturers, Ricardo powertrain experts and autonomous sensor manufacturers. An OEM Advisory Board was convened, made up of leading global automakers, and consulted at programme milestones to review design direction and feasibility. All along the way they showed their excitement and interest in this vehicle with very positive feedback and engagement with the design, both in presentations and in our virtual reality development rooms. We are expecting that global automakers will study Steel E-Motive, not only for future vehicles, but for application in current vehicle architectures as well, just as they have with all of the steel industry demonstration programmes over the past 20 years.

What is MaaS?

Mobility as a Service (MaaS) is a term used to describe digital transport service platforms that enable users to access, pay for, and get real-time information on a range of public and private transport options.

What is the difference between ride hailing and ride sharing?

They are similar. Both are services for hire. Ride hailing, however, could mean one person in one hired car. Ride sharing indicates more than one person using the same vehicle to get to one or more destinations. To truly reach Net Zero emissions goals, ride sharing vehicles should have an average of three or more occupants per vehicle.

What makes Steel E-Motive different from other autonomous vehicle projects?

There are many companies that are entering the Mobility as a Service space, but when you research those companies, you find that they're all about using technology in active crash avoidance through the use of visual systems, like cameras, radar and lidar. We didn't think that was good enough. We know that these autonomous vehicles will be in mixed driving scenarios, where humans are controlling some of the vehicles. There will still be crashes, so we knew the right solution had to be a vehicle that's developed to be crashworthy. It had to meet all of the global crash requirements and that was the challenge we set out to meet with the Steel E-Motive programme.

We saw an opportunity to utilise this great portfolio of Advanced High-Strength Steels and fabrication processes and to do it in a sustainable way. It was important that these vehicles not only

met the user requirements of safety and comfort, but also the mobility service providers' needs to be durable, repairable, and affordable. The mobility service providers need to have a positive business case to promote and influence their take-up of these services.

For further enquiries please get in touch at steel@worldautosteel.org

https://steelemotive.world/