

**STEEL SOLUTIONS IN THE GREEN ECONOMY**

FutureSteelVehicle



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The World Steel Association (worldsteel) is one of the largest and most dynamic industry associations in the world. worldsteel represents approximately 170 steel producers (including 16 of the world's 20 largest steel companies), national and regional steel industry associations, and steel research institutes. worldsteel members represent around 85% of world steel production.

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The environmental 'footprint' of next-generation car bodies can now be shrunk by up to 70% with the use of new steels, latest design-optimisation techniques and electric 'powertrains' – the group of components that generate power and deliver it to the road surface, which includes the engine, transmission, drive shafts, differentials and the final drive (drive wheels).

WorldAutoSteel, the automotive group of the World Steel Association, recently completed a three-year programme that delivers fully engineered, steel intensive designs for electric vehicles. Known as the FutureSteelVehicle (FSV), the project features steel body structure designs that reduce the mass of the body-in-white to 188 kg and reduce total life cycle greenhouse gas (GHG) emissions by almost 70%.

The FSV study commenced in 2007 and concentrated on solutions for cars that would be produced from 2015-2020.

Three different models were studied:

- Battery electric vehicles (BEV)
- Plug-in hybrid electric vehicles (PHEV)
- Fuel cell electric vehicles (FCEV)

The engineering team chose a B-class BEV as its focus. The prototype draws on a broad portfolio of steel types and grades in a range of properties, and applies a wide range of manufacturing processes.

The results point the way towards a full range of more efficient designs not only for electrics, but conventional internal combustion engine (ICE) powered vehicles as well.

### Lower-emission vehicles

FSV is a global steel industry investment to advance the state-of-the-art of automobile bodies to contribute to lower emission vehicles. It explores wide-ranging research into the practical use of advanced high-strength steels and innovative design and manufacturing technologies, and proposes specific examples for electrified vehicles. The latest developments in advanced high-strength steels that are stronger and more flexible are also being implemented, with a design approach that applies the latest computer-aided techniques to fully exploit steel's exceptional design flexibility.

In addition, for the first time, Life Cycle Assessment (LCA) is being used to select techniques that result in the lowest total carbon footprint, beyond accounting only for emissions in the use phase. Launched in 2008, FSV is the latest technology-demonstration project

from the global steel industry, building on 13 years' pioneering work to find ways to decrease vehicle mass, reduce costs and meet comprehensive crash safety standards, in pursuit of a smaller environmental footprint.

The use of advanced high-strength steels and sophisticated manufacturing technologies trims body weight and cost and enables compliance with global five-star safety standards.

Steel is the only material to achieve emissions reductions in all life cycle phases, including raw material manufacture, product use and disposal.

## FSV's vehicle variants

<b>FSV 1</b> A-B Class 4-door hatchback 3700 mm long	<b>Plug-In Hybrid</b>  PHEV20 Electric Range: 32km Total: 500km Max Speed: 150km/h 0-100 km/h 11-13 s
	<b>Battery Electric</b>  BEV Total Range: 250km Max Speed: 150km/h 0-100 km/h 11-13 s
<b>FSV 2</b> C-D Class 4-door sedan 4350 mm long	<b>Plug-In Hybrid</b>  PHEV40 Electric Range: 64km Total: 500km Max Speed: 161km/h 0-100 km/h 10-12 s
	<b>Fuel Cell</b>  FCEV Total Range: 500km Max Speed: 161km/h 0-100 km/h 10-12 s

FSV PHEV-20



FSV PHEV-40  
& Fuel Cell



FSV BEV



## Lower weight

The extensive use of a broad portfolio of advanced high-strength steels provides strength and formability at a lower mass. This, coupled with an optimised design that takes full advantage of steel's inherent flexibility for structural efficiency, is responsible for body masses of:

- 176.8 kg - BEV
- 176 kg - PHEV20
- 201 kg - PHEV40, FCEV

In addition, there is a 39% mass reduction, compared to the benchmark.

A lower weight, mass-efficient body creates opportunities for downsizing sub-systems, including the powertrain, and promotes reductions in overall vehicle mass.

## Lower cost

Steel is the most cost-competitive material for car bodies. It is economical to fabricate into



components and sub-systems, and assemble into the total body-structure assembly.

The resulting cost estimate of US\$1,115 to manufacture and assemble the complete FSV body competes very well with construction costs for other modern vehicles.

## **Reduced carbon footprint**

FSV lowers total life cycle GHG emissions by 50-70%, compared with conventional gasoline ICE vehicles, depending on the electricity energy source. In addition, steel is the world's most recycled material, with recycling infrastructures well established around the globe.

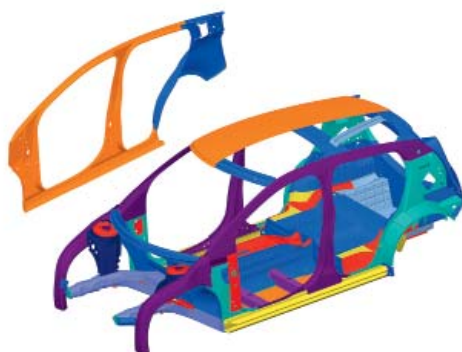
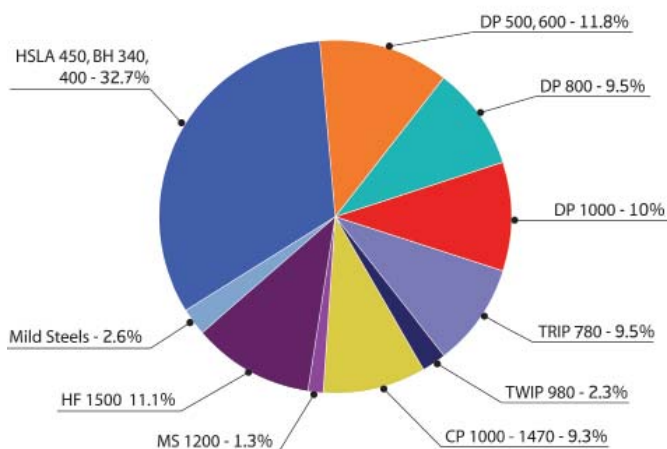
## **Safe**

The design anticipates increasingly stringent crash safety standards over the next decade and meets European and US five-star crash safety performance requirements. It applies the latest holistic

design and material improvement approaches, made possible by more powerful computing capabilities. In this way, the final FSV design comprises state-of-the-art mass-efficient shapes that meet or exceed a global range of crash-safety requirements. Applying a wide range of manufacturing processes, FSV has been able to incorporate hundreds of variables to identify many solutions – this approach accentuates the body structure as an integrated system, creating a template that works in harmony with all vehicle requirements.

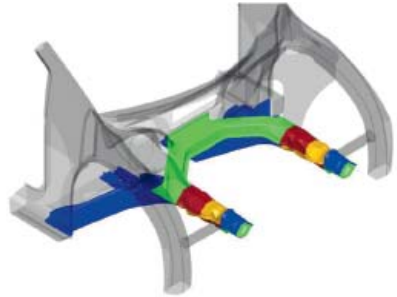
Using steel's extensive selection of grades and gauges to find the right combination of attributes for a particular part function, this design process yields results beyond that which have been possible previously. FSV is leading the way towards a full range of more efficient designs.

### FSV BEV Steel types as % of body structure mass

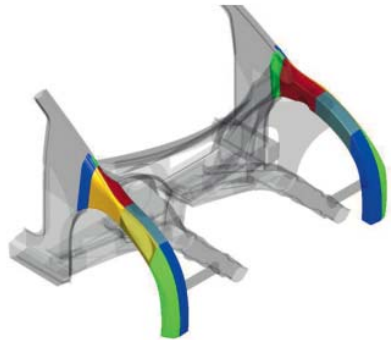




**Front rail sub-system** is a new design for automotive front crash structures. The unusual section shape of the rails is a result of a methodology that improves the effectiveness of each steel element to achieve minimum mass and best crash-management performance.



**Shot-gun sub-system** is traditionally named in some parts of the world for its shape, which resembles a shot-gun. However, it was found that the very light, trunk-like shaped component was more logical to the load paths and consequently provides superior performance in both full-frontal and offset crash simulations.



**Rocker sub-system** features a distinctive cross section. Resembling a skeletal bone, the rocker has enabled excellent results in four different side crash simulations that represent a combination of global requirements.



The technology represents practical use of Life Cycle Assessment (LCA) as an integral element of the vehicle design process. In combination with optimising the design for mass, cost and functionality, FSV integrates full accounting for its complete environmental footprint, as measured in carbon dioxide-equivalent emissions (CO<sub>2</sub>e).

It also incorporates the entire lifetime carbon footprint of the vehicle, not simply the usage phase. This includes the entire fuel-production cycle (well to pump) and fuel-usage cycle (pump to wheels), but also the production of raw materials and disposal/recycling.

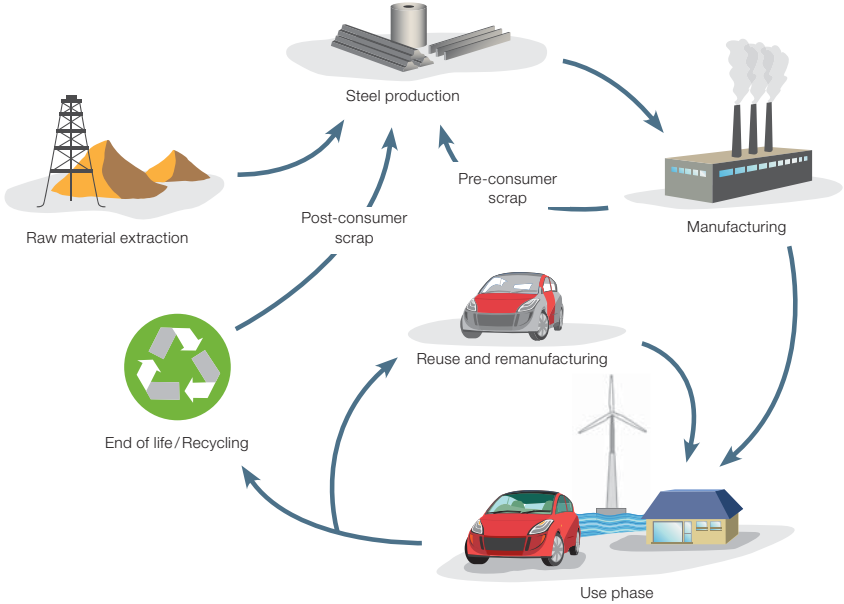
This demonstrates that the coupling of a light-weight, advanced high-strength steel body structure with a battery-electric powertrain results in a 50-70% reduction in total life cycle GHG emissions, compared with equivalent-sized vehicles with conventional gasoline ICEs.

Furthermore, based on new steel's light-weighting capabilities, it is the only material to realise emission reductions in all life cycle phases.

As vehicle manufacturers continue to develop more advanced powertrains and fuel sources, material production will account for a growing proportion of total CO<sub>2</sub>e. As these powertrains reduce use-phase emissions, material-production phase emissions will represent a greater share of total vehicle emissions.

Thus, with steel's relatively low CO<sub>2</sub>e intensity during the material-production phase, its use becomes increasingly beneficial.

# The life cycle of steel



Source: worldsteel

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