Steel and Automotive Industry

Strategic opportunities in a transforming ecosystem

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Introduction

The automotive and steel industries are undergoing a profound transformation driven by three structural forces: electrification, lightweighting, and decarbonization. These trends are not only reshaping the material composition of vehicles but are also redefining value chains, cost structures, and competitive dynamics across the broader industrial ecosystem.

In this evolving landscape, steel—long the backbone of vehicle manufacturing—is transitioning from a volume-driven commodity to a high-performance, innovation-led material. At the same time, the increasing adoption of alternative materials, such as aluminium and critical minerals, is accelerating the shift toward multi-material vehicle architectures. Concurrently, the emergence of low-carbon emission or green steel introduces new economic considerations, requiring stakeholders to balance sustainability commitments with cost efficiency and operational resilience.

Against this backdrop, the relationship between automotive manufacturers (OEMs) and steel producers is becoming increasingly strategic. Traditional transactional interactions are giving way to deeper, partnership-driven models aimed at securing sustainable material supply, mitigating risk, and enabling innovation at scale.

This document provides a structured analysis of these dynamics, highlighting key trends in material evolution, the impact of electrification on resource demand, the economic implications of the green premium, and the growing importance of cross-industry collaboration. It ultimately outlines the strategic opportunities available to both sectors to jointly build a more competitive, resilient, and sustainable industrial ecosystem.

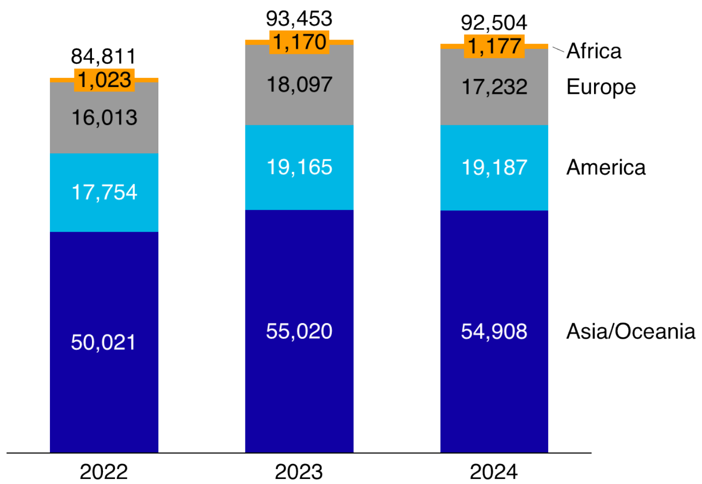
01 Steel in the global automotive industry

In 2024, global steel consumption reached approximately 1,742 million tonnes of finished steel, with the automotive industry accounting for around 209 million tonnes. This makes automotive the third largest consumer of steel worldwide, behind construction and infrastructure which together absorb 52% of total demand . As one of the largest steel-using sector it plays an important role in shaping the evolution of steel grades, production technologies, and sustainability strategies.

Steel accounts for roughly half to two thirds of the total mass in most passenger cars, with the exact proportion varying based on the vehicle's design, class, and type of engine or powertrain. It is used extensively across key components such as the chassis, bodywork, engine, gearbox, and drive systems. The widespread use of steel in automotive manufacturing is due to its affordability, adaptability for shaping and joining processes, and the high level of strength it provides, which is essential for ensuring vehicle safety . In 2024, global vehicle production rebounded to 92.5 million units , approaching pre-pandemic levels. However, the nature of steel demand in the automotive sector is undergoing a profound transformation.

Electrification, lightweighting, and decarbonization are reshaping the material mix in vehicles, with advanced high-strength steels (AHSS), aluminium, and green steel gaining prominence. Regional dynamics further influence this shift: while China leads in absolute volume, Europe and Japan exhibit higher steel intensity per vehicle and stronger regulatory pressure for low-carbon materials. The automotive sector's scale, technological sophistication, and capacity to absorb marginal cost increases its position as a strategic anchor for the global transition toward cleaner steel.

About 60% of the world's car production is in Asia with China, Japan and India as the top 3
Car production by region (' 000 units; 2022 – 2024)



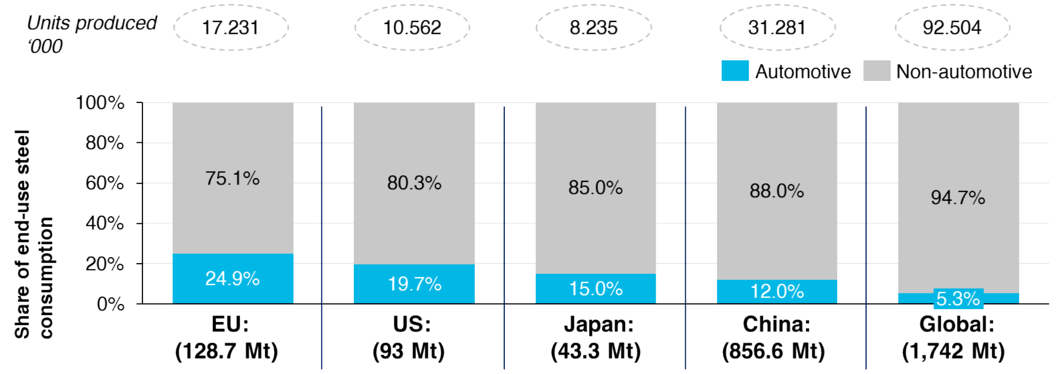
Source: International Organization of Motor Vehicle Manufacturers(OICA)

Acknowledging the significance of steel decarbonisation in mitigating the sector's environmental impacts, as well as the influential position of automakers in driving this transition, this paper presents a summary of: 1) the utilisation of steel within the automotive industry, 2) the ongoing lightweighting movement favouring reduced steel usage, 3) shifts in mineral demand due to vehicle electrification, 4) the emergence of the green premium, and 5) recent collaborations between original equipment manufacturers (OEMs) and steel producers as well as 6) strategic new opportunities for both parties.

Regional perspectives of steel use in automotive sector is depicted below:

With over 30 million vehicles produced, China is the world's largest automotive market. Its sector consumed 48.4 Mt of steel in 2024, representing roughly 5% of the country's total steel demand. While this share is relatively low due to China's massive construction and infrastructure sectors, the absolute demand is unmatched. The EU's automotive sector constitutes almost 20% of the region's finished steel demand with European automakers at the forefront of adopting advanced high-strength steels and leading the push for green steel, supported by regulatory frameworks such as the EU Green Deal and the Carbon Border Adjustment Mechanism (CBAM). The US automotive industry represents 15% of national steel consumption with recent policy shifts such as the Inflation Reduction Act (IRA) accelerating investments in Low-carbon emission steel production. Japan's automotive sector accounts for around 25% of national steel consumption. This high intensity reflects the country's mature industrial base and strong integration between automakers and domestic steelmakers.

The automotive sector can be segmented into the four leading producing regions
Share of the automotive sector in total steel consumption of finished steel products and number of vehicles produced by region (%; units; 2024)



Sources: World Steel Association, EUROFER, US Geological Survey, SEAISI, Steel Orbis, Fastener World

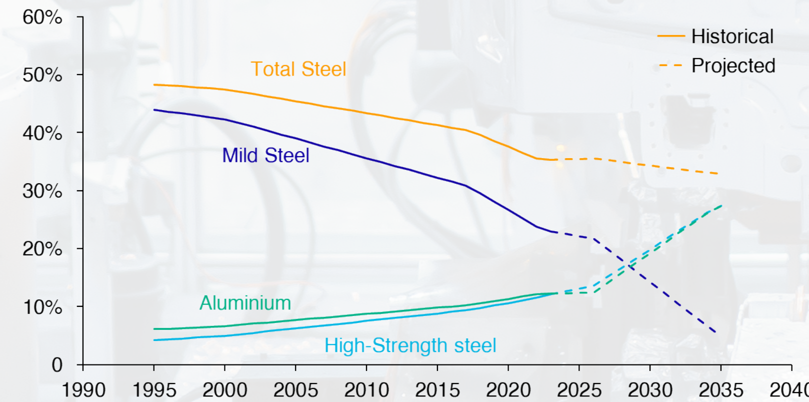
02 Less steel, more aluminium: evolution of materials in automobiles

Over the past few decades, the material mix in automobiles has shifted dramatically as manufacturers pursue lighter vehicles for better efficiency and performance. The share of conventional steel in a typical car has declined from roughly half (43.8%) of the vehicle's weight in the mid-1990s to about one third by the mid-2010s and to 25% by 2020 . In its place, automakers have increasingly used high-strength steels and aluminum alloys, alongside plastics and composites, to reduce mass without compromising safety. This multi-material approach, combining advanced steels, light metals, and occasionally carbon fiber enables a typical new car to be 100–150 kg lighter than it would be using 20th-century all-steel designs. A 10% reduction in vehicle weight can improve fuel economy by roughly 6–8% for combustion vehicles, underscoring why "light-weighting" has become a strategic priority . In reflection on that strategy the historical and projected steel and aluminium mass share per vehicle outlines the increased importance of light-weighting.

Nevertheless, steel continues to be the primary material in current light vehicle structures and its presence in vehicles today is of different types depending on the specific function. Mild steel is often chosen for vehicle body structures and trunk closures because it's less expensive, has lower tensile strength, and is easier to shape during manufacturing. When energy absorption is critical, high-strength steel (HSS) is typically used. Advanced high-strength steel (AHSS) and ultra-high strength steel (UHSS) are even stronger for their weight and help make vehicles lighter, which in turn lowers fuel use and greenhouse gas emissions. While AHSS was initially limited to components like chassis, suspension, frames, and body parts, it's now commonly used for doors and other exterior panels as well. To cut down on the overall emissions from steel in vehicles, manufacturers focus on using fewer and lighter materials, incorporating more recycled steel, and opting for production methods that generate less greenhouse gas.

Car manufacturers are adopting multi-material approaches that achieve weight reduction by increasing the use of high-strength steel and aluminum

Steel and aluminium proportions per vehicle in North America: past and future trends (%; 1995 – 2035)



Source: International Council on Clean Transportation

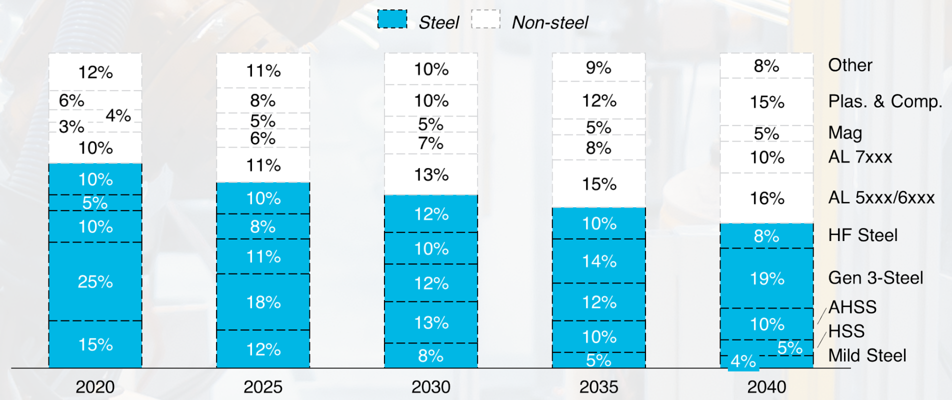
The greatest reduction in emissions comes from combining these approaches . Projections on material mix continue to indicate decreases in usage of conventional steel while increasing the share of both aluminium and lighter steel grades.

At the same time, as the industry transitions to electric vehicles (EVs), which carry heavy battery packs, the imperative for lighter materials is even greater: an electric SUV built in 2022 contains on average 283 kg of aluminium, versus 169 kg in a gasoline car. This trend is expected to continue with the average aluminium content in an EV increasing by 9.5% to 310 kg by 2026 . In summary, automakers globally are using less mild steel and more aluminium and advanced steel per vehicle than ever before, unlocking efficiencies and cutting emissions in the manufacturing and use of automobiles.

In conclusion, the automobile is no longer a simple steel on wheels proposition. It's a high-tech product of metals and materials, each carefully chosen, steel in many different grades for its strength, aluminum for its lightness, plus a supporting cast of plastics, glass, rubber, and more. The trend of "less steel, more aluminum" is set to continue, but it's not about one material winning over another. Rather, it's about using each material smarter. This means steel companies must innovate, the era of bulk commodity steel is shifting to specialty grades tailored for auto needs, and aluminum producers will see growing opportunities, especially if they can produce low-carbon emission aluminum.

Steel is the primary material in vehicle structure, while the overall quantity is expected to decrease, the number of grades will increase

Average vehicle structure (BIW and Closures) material percentage (%; 2020 – 2040)



Source: Center for Automotive Research (CAR)
Notes: 100% includes vehicle structure only which encompasses Body-in-White and Closures. Not included are powertrain/chassis, interiors, windshields and dynamic sealers. (2) 3rd Gen-Steel (AHSS) are multi-phase steels engineered to develop enhanced formability, have improved ductility in cold forming operations compared with other steels, according to World Auto Steel. (3) HF steel or Hot forming is a manufacturing process in which metal is heated above its recrystallization temperature to plastically deform it. This process allows the production of complex geometries while simultaneously enhancing the material properties.

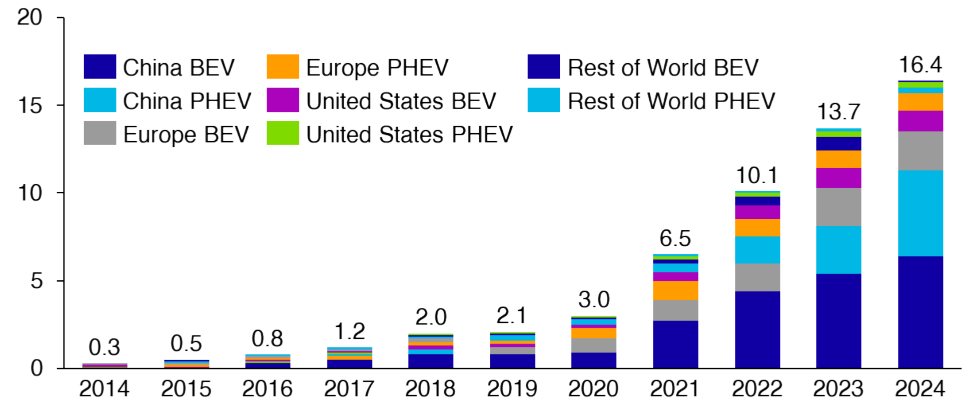
03 Electrification and rare earths: new material challenges

The electrification of vehicles is reshaping automotive material demand, introducing new strategic dependencies. As combustion engines give way to electric motors and battery packs, materials like rare earth elements have surged in importance. Roughly 95% of electric vehicles (EVs) rely on rare-earth permanent magnets in their motors. These magnets – primarily composed of neodymium (Nd) combined with iron and boron, and often doped with dysprosium (Dy) and terbium (Tb) for high-temperature stability – enable efficient and compact motors that significantly extend EV range and performance . The result of this has lead to a global rare earth demand for EV motors jumping to 37,000 tonnes in 2024 (a 32% YoY increase) and is projected to reach ~43,000 tonnes in 2025 . (For perspective, this was only about 5,000 tonnes in 2019). This growth is expected to continue with up to 70,000 tonnes per year by 2030. However, this exponential growth has exposed a strategic vulnerability in which the supply chain for rare earths is heavily concentrated, with China controlling ~70% of rare earth mining and nearly 90% of refining capacity.

The US, Europe, and Japan now face a materials-security challenge, scrambling to diversify sources, invest in rare earth mining and magnet production outside China, and even redesign motors to reduce or eliminate rare earth content . The transition from internal combustion engine (ICE) vehicles to electric vehicles (EVs) is a paradigm shift not only in drivetrain technology but also in the raw materials required to manufacture a car. Traditional ICE powertrains are composed of majorly of steel (engine block, crankshaft, pistons, transmission), among others. EV powertrains, by contrast, consist mainly of an electric motor (plus power electronics) and a battery pack, which means copper, lithium, nickel, cobalt, graphite, and rare earth elements largely supplant the materials used in engines and fuel systems. In fact, the move toward electric vehicles will significantly boost the demand for these minerals.

Electric car sales have soared to nearly 58 million vehicles by the end of 2024, accounting for approximately 4% of the global passenger car fleet

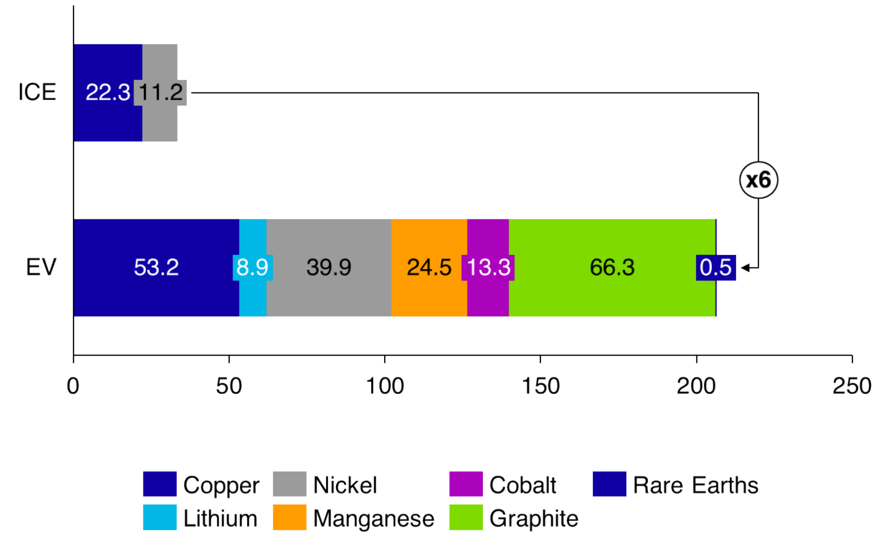
Global electrical vehicle sales (Million Units; 2014 – 2024)



Source: International Energy Agency (IEA)

An EV requires six times the mineral inputs of a conventional car. Lithium, nickel, cobalt, manganese and graphite are crucial in battery performance

Minerals used in electric cars compared to conventional cars (Kg/Vehicle)



Source: Fuels Europe

From a mining & metals industry perspective, these trends signal emerging opportunities where the rare earth sector, long a niche, is becoming mainstream and investable due to EVs. Mining companies that can develop rare earth projects (or extract rare earths as byproducts of other mining) stand to benefit from robust demand and supportive policies. However, challenges arise in raising capital for mines, building costly separation plants, ensuring environmental safeguards, and contending with a market where China can influence prices.

For automakers and suppliers, we may see interesting partnerships, such as automakers directly investing in mines similar to how they've invested in lithium projects. For example, General Motors invested in Controlled Thermal Resources for lithium ; one could envision alike deals in rare earths if supply tightens further.

Other key recommendation is to embed material strategy into product strategy. Whereas in the past materials like steel or aluminum were taken as a given, with supply assured by a broad market, now materials like Nd, Dy, Li, Co require strategic sourcing, partnerships, and even involvement in R&D of alternatives. The most resilient companies will be those that proactively secure their supply chains and invest in material innovation. This might mean long-term contracts or equity stakes in mines, qualifying multiple sources, and designing flexibility into products.

04 Concept of “Green Premium” in green steel

The “green premium” in steel refers to the current cost difference between low-carbon emission steel and conventional steel produced via coal-based methods. It captures the cost gap between traditional blast furnace-basic oxygen furnace (BF-BOF) steel which relies on coal and emits 2.34 tons of CO_2 per ton of steel according to the GHG emissions intensity in 2024 from the World Steel Association and “green steel” made via innovative low-carbon emission routes, like using green hydrogen instead of coal, or using 100% renewable electricity in recycling scrap. All in all, it quantifies how much more expensive it is to make steel with near-zero emissions.

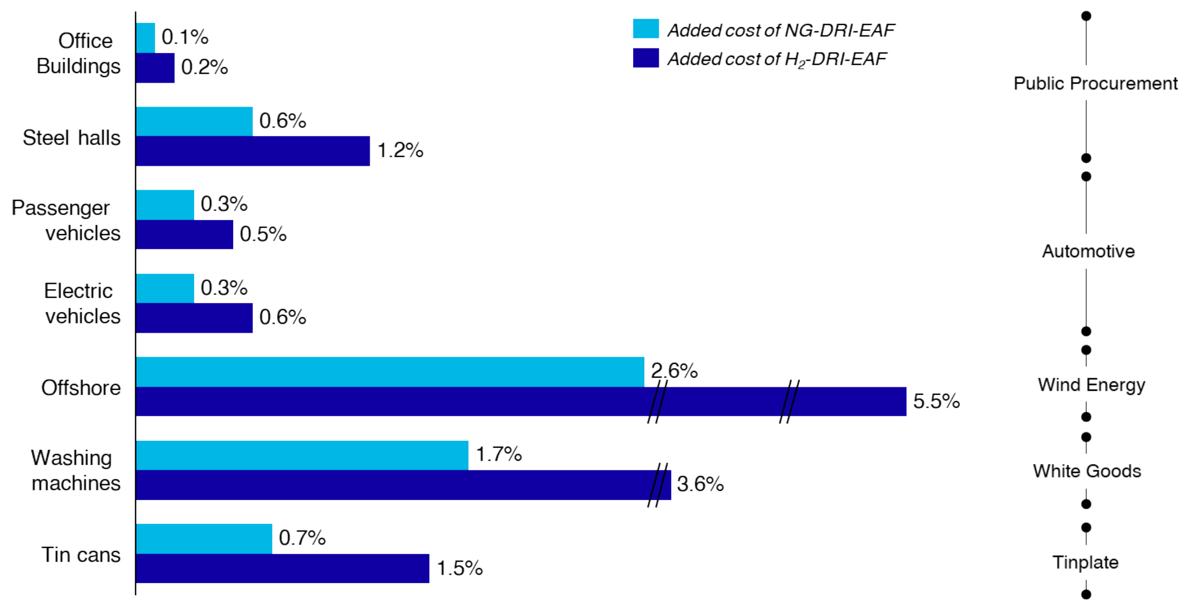
According to an analysis by the International Council for Clean Transportation , that calculated the green steel premium by averaging projections from 13 different studies, the resulting premium for green steel is about 42% higher than conventional steel, both for 2024 and for projected costs in 2030. However, it is expected that this premium will decrease as renewable energy, hydrogen technologies, and green steel production advance. This is the essence of the green premium, if conventional hot-rolled steel costs, say, $1,000 per ton , according to the average net selling price per ton of the largest supplier of steel to the automotive industry in North America (Cleveland-cliffs), the green equivalent might cost $1,400–1,450 per ton under current conditions. The difference (roughly $400–$450) is the premium that someone in the value chain must be willing to pay for the environmental benefit of near-zero CO_2 steel if the whole vehicle were to be produced with green steel.

It’s important to note that green steel doesn’t need to match the cost of today’s steel to be viable, because the increment on final products is very small. Steel is usually only a fraction of the total input cost of a product. In an automobile, steel might account for less than 10% of manufacturing costs. Therefore, even a significant percentage increase on steel translates to a minor percent increase on the car. Let’s say a $400 increase per ton of steel as our base case adds roughly $400 to the car’s cost, since approximately 1 tonne of steel per car is needed. On a $35,000 car, that just 1.15% increase.

According to the article “Transforming the Steel Industry May Be the Ultimate Climate Challenge”, the cost impact of green steel on final products is minimal across multiple industries, not just automotive. This means that decarbonizing steel supply chains is economically viable on a broad scale, since a significant increase in steel cost only results in a very small uptick in end-product prices (often well under 2% in sectors like automotive, construction, and consumer goods).

Strategically, this underpins a strong business case for accelerating the transition to low-carbon steel beyond the auto industry, firms in construction, machinery, appliances, and other steel-intensive sectors can adopt green steel with negligible impact on their product competitiveness as presented in the below figure.

Demand for green steel comes first from the Automotive sector where costs can be absorbed as vehicle production cost would raise by ~0.5%
Added cost in EU by steel process type (%; 2030)

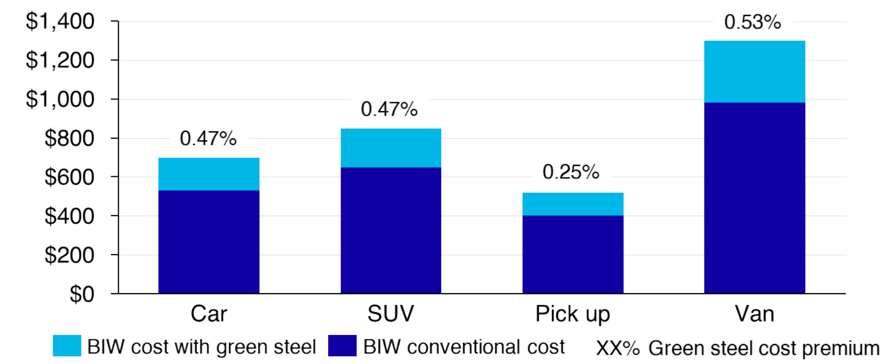


Source: “Transforming the Steel Industry May Be the Ultimate Climate Challenge”
Notes: Added cost assumes adding the cost of DRI-EAF (NG) or DRI-EAF (H2) compared to BF-BOF in 2030.

Other studies highlight that by switching to 40% green steel would add just €57 to the price of an electric vehicle in 2030. Switching to 100% green steel by 2040 will cost only €8 compared to using conventional steel due to CO2 pricing as well as the falling costs of green steel production . According to “Making Net-Zero Steel Possible” study from the MPP , the price difference of products containing steel produced by an average DRI-EAF fed with 100% green hydrogen compared to steel produced by an average BF-BOF only increase by 0.5% the cost of a $37.500 passenger car by 2030, 0.4% by 2040 and 0.3% by 2050. In other words, an automaker could virtually decarbonize the steel in its cars for about five dollars on every $1,000 of vehicle cost, a trade-off that looks more than reasonable when framed in those terms. Also, the International Council on Clean Transportation made this exact study with different type of vehicles, including from standard passenger cars to pick-ups & vans . The green steel premium forms a small share of a vehicle’s total price, even for larger vehicles. For 2024, cars saw a $167 premium, SUVs $206, and trucks $124. This is because overall vehicle costs rise faster than the green steel premium as vehicle size increases.

In conclusion, the existence of a green premium in steel is not just an economic footnote; it is the central obstacle to decarbonizing one of the world’s largest industries. Strategically, how it gets resolved will shape competitive dynamics in both the steel sector and downstream industries like automotive. The next few years we will see the first cars built with significant volumes of green steel, and we will see whether the presumed cost trajectories hold true. If they do, the narrative by 2030 might shift from “how do we pay the green premium?” to “remember when green steel used to cost more?”. But for now, the key strategic takeaway is that the cost of inaction will far outweigh the cost of action, where leading players in the automotive and steel industries will be acting accordingly, turning green premium into a bridge of collaboration.

The average MSRP in 2024 for cars is $35,724, with an additional cost premium of $167, representing 0.47%
Costs of body-in-white steel per vehicle and the additional cost of green steel by vehicle category ($/vehicle unit)



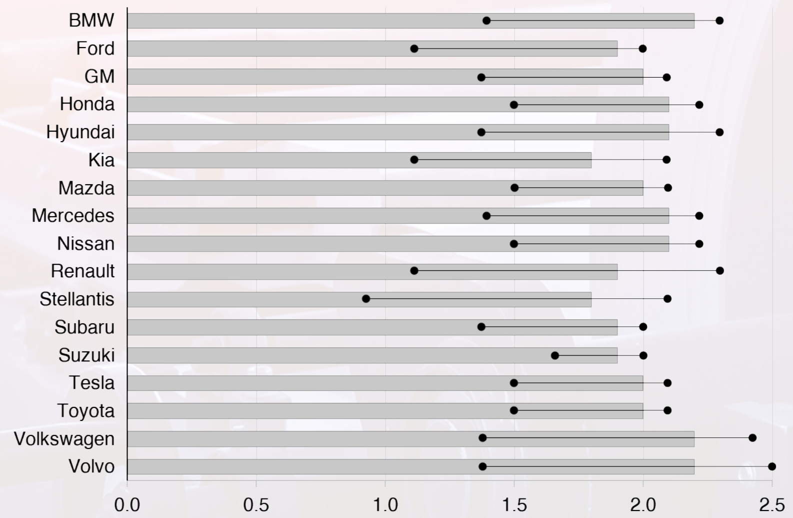
Source: ICCT
Notes: MSRP: Manufacturer’s Suggested Retail Price

05 Recent alliances between car manufacturers and steelmakers

In light of the above, a wave of strategic alliances has emerged between major automakers and steel producers, driven by the urgent need to decarbonize automotive steel supply chains. These partnerships typically aim to secure a future supply of low-carbon emission or "green" steel for vehicle production, helping carmakers cut Scope 3 (supply chain) emissions and meet climate targets. They range from equity investments in new green-steel ventures to long-term offtake agreements for delivering fossil-free steel (made via hydrogen-based processes) or recycled-content steel with lower emissions. As demonstrated in the illustration below, notably, nearly all big car manufacturers still rely on conventional steel today, where the average steel used in vehicles carries ~2.1–2.3 tons of CO_2 per ton, as high as the industry norm.

The majority of automakers exhibit a greater greenhouse gas emissions intensity compared to the average level in the steel industry.

Global average greenhouse gas emissions intensity of steel utilized by car manufacturers (t CO2 e/t steel)



Source: ICCT
Notes: Gray lines indicate the lowest and highest emissions intensity scenarios

These alliances are designed to dramatically lower that carbon footprint, in some cases targeting a >90% reduction. European automakers have led with bold commitments: for example, Mercedes-Benz, BMW, and Volvo Cars have all struck deals to incorporate near-zero steel by mid-decade. U.S. automakers General Motors and Ford have also begun locking in greener steel supplies and joined initiatives, these alliances are shaping a new market for green steel. The table below summarizes some of the most significant carmaker-steelmaker partnerships to date, illustrating how the auto industry is actively

#	Carmaker–Steelmaker	Type of Agreement
1	Mercedes-Benz – Stegra; Steel Dynamics Inc.	Mercedes-Benz has entered into a supply agreement with the Swedish start-up Stegra (Former H2 Green Steel (H2GS)) to receive around 50,000 tonnes of nearly CO_2-free steel per year for its European press shops. The company has also strengthened its partnership with Stegra by signing a Memorandum of Understanding (MoU) aimed at creating a more sustainable steel supply chain in North America. Mercedes-Benz has reached an agreement with Steel Dynamics, Inc. (SDI) to supply over 50,000 tonnes of CO2-reduced steel each year to its Tuscaloosa, Alabama plant, representing a significant step forward in decarbonizing its worldwide steel supply chain.
2	BMW Group – Salzgitter AG; Stegra	Starting in 2026, Salzgitter AG will supply low-CO2 steel to every BMW Group plant across Europe, significantly supporting its customer's efforts to meet climate goals. The BMW Group has entered into an agreement with Stegra. Starting in 2025, Stegra will provide steel made solely with hydrogen and renewable energy to BMW Group's European factories. This method is expected to lower CO2 emissions by about 95%.

#	Carmaker–Steelmaker	Type of Agreement
3	Volvo Cars – SSAB	Volvo Cars will be the first car maker to secure SSAB steel made from hydrogen-reduced iron from HYBRIT's pilot plant in Luleå, Sweden.
4	General Motors – US Steel; Nucor	U. S. Steel (NYSE: X) will supply General Motors with verdeX steel, an advanced, sustainable steel made with up to 90% recycled content and produced with up to 75% fewer emissions than traditional methods. The steel is also endlessly recyclable without loss of quality. Nucor Corporation has introduced Econiq, a range of steel products with net-zero carbon emissions. General Motors, a leading American manufacturer, will be the initial purchaser of **Econiq**.
5	Volkswagen Group – Salzgitter; Vulcan/Oman	Volkswagen Group and Salzgitter AG sing a MoU on the purchase of low-CO2 steel starting in late 2025, using hydrogen and renewable energy to reduce emissions by over 95%. Volkswagen AG and Vulcan Green Steel have signed an MoU for a partnership on low-carbon steel, supporting Volkswagen's green steel strategy. From 2027, a significant share of the Group's steel needs will be supplied by Vulcan Green Steel.
6	Toyota Motor Corp. – JFE Steel, Nippon Steel & Kobe Steel	Toyota Motor has begun sourcing low-emission "green" steel, a move that may encourage other steelmakers to adopt cleaner production methods such as electric furnaces. By the end of last year, Toyota started buying green steel from Nippon Steel, JFE Steel, and Kobe Steel. Like other companies, Toyota receives certification proving how much carbon dioxide was reduced during the steel-making process. This data enables Toyota to highlight the carbon savings in its own products. Electric furnaces can lower CO2 emissions by approximately 75% compared to traditional coal-fired blast furnaces.

Almost all automakers have similar, high emissions intensity in their steel supply today (roughly 2.1–2.3 tCO_2 per ton, as the figure above illustrates). This means a typical car built now contains several tonnes of CO_2 embedded in its steel. Procuring steel made with clean energy and new processes is one of the few ways automakers can directly reduce their value-chain (Scope 3) emissions. These alliances provide steelmakers with the guaranteed demand needed to justify huge investments in decarbonization. From the automaker perspective, the partnerships ensure early access to greener materials, which can become a competitive advantage as consumers and regulators demand low-carbon emission products.

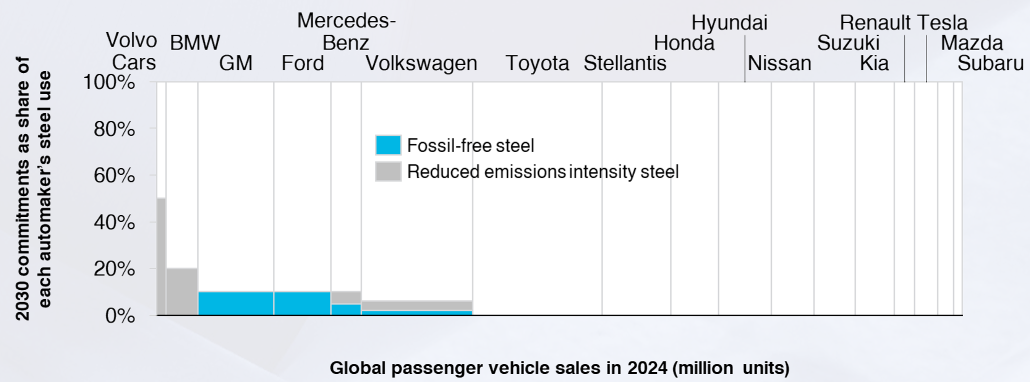
It is important to note that even that momentum is being built, the overall impact of these commitments is still modest relative to the industry's size. According to the 2024 ICCT study, the announced "fossil-free" steel purchase commitments by automakers account for only 2% of the steel they collectively consume (rising to ~4% if including lower-carbon but not fully fossil-free steel) .

In other words, the bulk of automotive steel will remain high-carbon through this decade unless many more such alliances are formed or expanded. The following illustration, adapted from the referenced study, demonstrates this point.

Having said that, the trend is clear, and it is accelerating, while some years ago, no automaker had any green-steel strategy envisioned, leaders like Volvo or Mercedes-Benz are setting the example with new partnerships. These partnerships are also exemplifying a new paradigm of supply chain collaboration in which automakers are extending their influence beyond the factory to jointly innovate with raw material suppliers on sustainability. As these alliances start delivering results, they are likely to spur the effect into the whole industry, where markets such as China where policy drivers are still emerging, will have to adopt similar agreements to keep up in the market. In the future, partnerships with steelmakers for decarbonization may become as important as traditional metrics like quality in the automotive industry.

Currently, it seems that no automakers have set sufficiently ambitious targets for 2030 to effectively contribute to the decarbonization of steel sector

Percentage of automakers' global steel demand projected to be fossil-free or have lowered greenhouse gas emissions intensity by 2030, according to their public pledges (%)

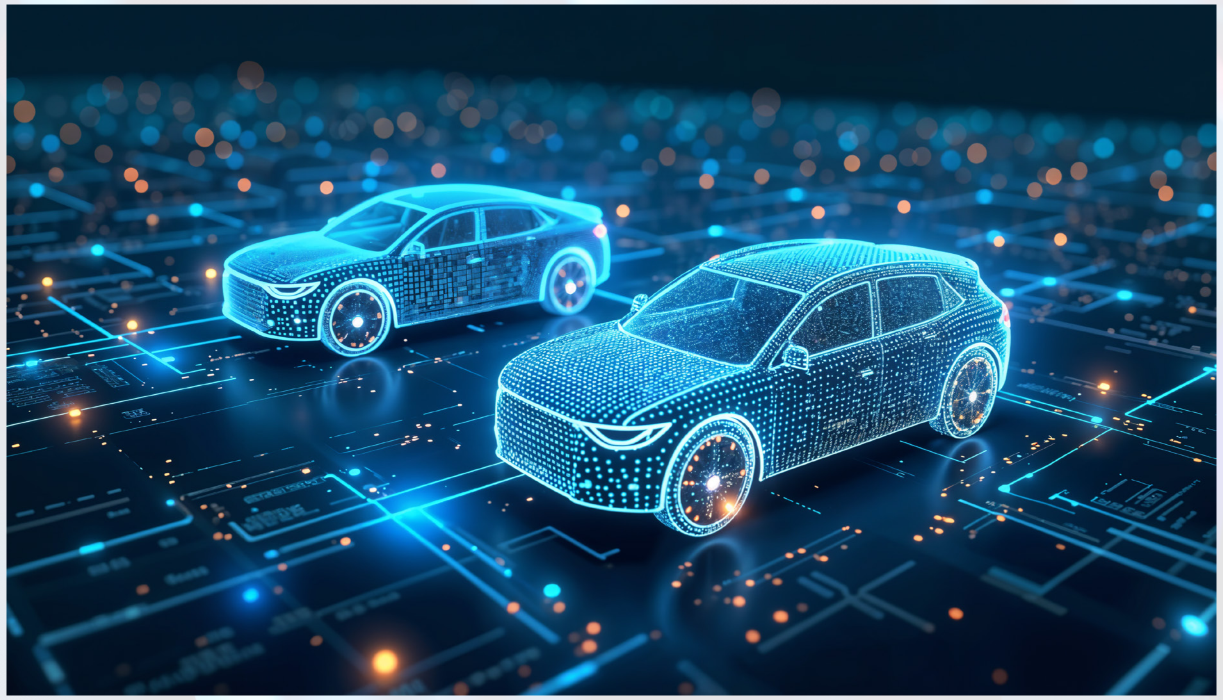


Note: The width of each section reflects global passenger vehicle sales for 2024. Source: ICCT

06 Conclusion, strategic new opportunities for car manufacturers and steel producers

In this transforming ecosystem, car manufacturers and steel producers each have distinct strategic opportunities, yet their success will increasingly stem from a common vision of innovation and sustainability. For automakers, the path forward is about reimagining what goes into a car: adopting greener and lighter materials, securing critical inputs, and fundamentally reshaping their supply chains to be resilient and low-carbon. Seizing these opportunities will allow automotive companies to build vehicles that meet strict future regulations, delight eco-conscious customers, and differentiate their brand in an era when environmental leadership is a competitive advantage. For steelmakers, the opportunities lie in reinventing what they offer and how they operate: from developing cutting-edge steel grades and embracing carbon-free production, to becoming proactive partners in their customers' success through deeper collaboration and service-oriented models. By capitalizing on these avenues, steel companies can ensure they remain indispensable in the value chain, capture new profit pools (like premium green steel), and avoid being commoditized in a decarbonizing economy.

While the opportunities for each sector have unique focuses, it's clear that their strategies must harmonize. An automaker's drive for sustainable, advanced materials creates the market signal for a steelmaker's innovations; a steel producer's breakthrough enables an automaker's goals for lighter, greener cars. In practical terms, this means continued partnership between the two industries. The winners in the next decade will be the companies that not only excel in their own domain but also effectively collaborate across the auto-steel divide to build an integrated, future-ready supply chain. Together, leveraging these strategic opportunities, car manufacturers and steel producers can jointly shape a mobility ecosystem that is competitive, innovative, and sustainable – delivering economic value while driving progress toward global climate objectives. Each must play its part: automakers by demanding and funding the change they wish to see, and steelmakers by delivering the technological and sustainable solutions needed. In the end, those distinct efforts will converge to redefine both industries and set a new benchmark for industrial cooperation in the face of 21st-century challenges.



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