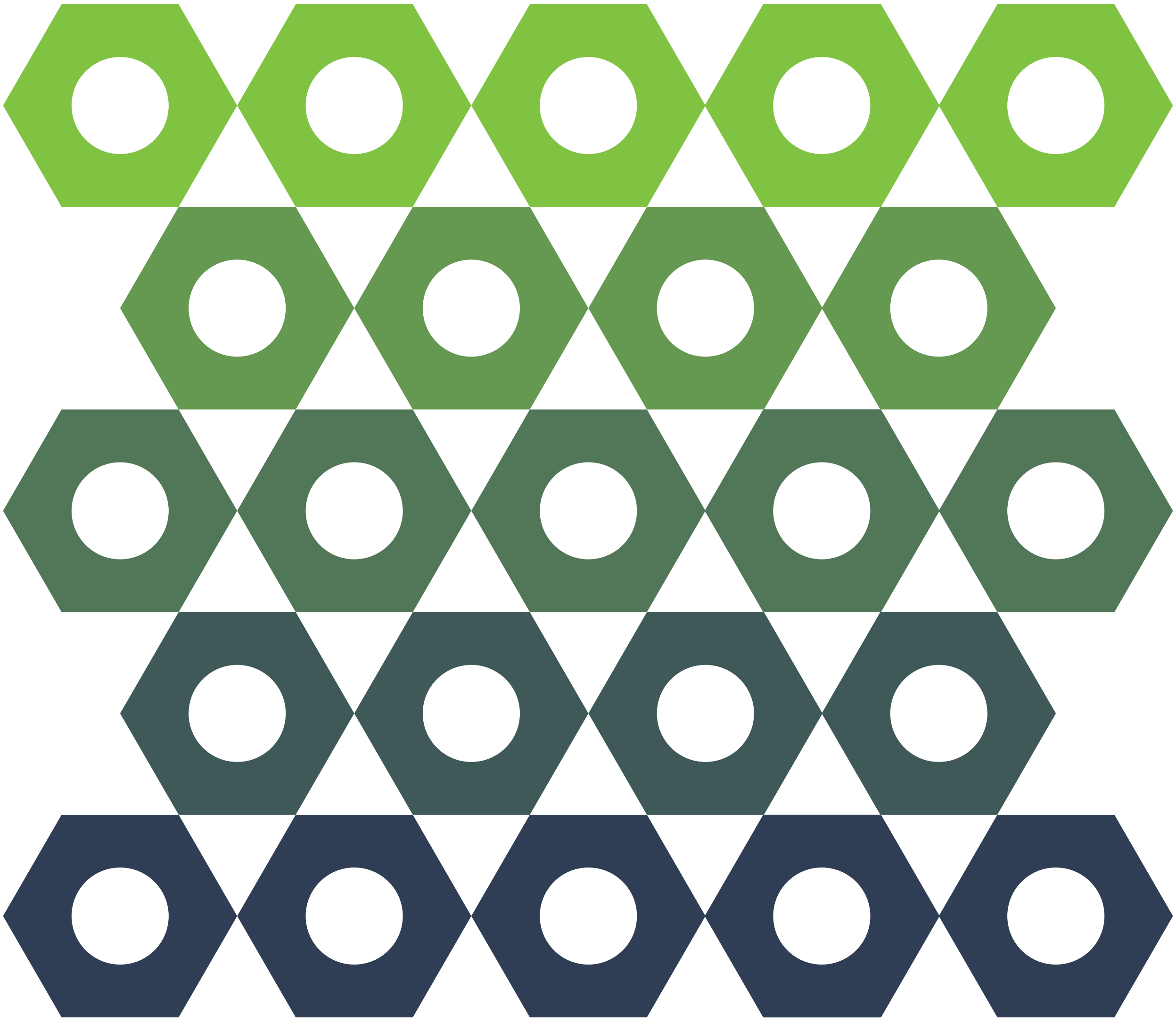
Breaking The Mold: The Role of Automakers In Steel Decarbonisation



If you have any questions or comments, please contact GPEA: enquiry.hk@greenpeace.org

Authors

Wenjie Liu, Jiangbei Hao, Ada Kong

Valuable comments and input were provided by

Benjamin Stephan, Belinda Fletcher, Chan Yang, Carolin Grüning, David Santillo, Daniel Read, Esther Haerim Heo, Elli Newman, Eric Lau, Erin Choi, Erin Newport, Gyorgy Dallos, Hang Bao, Kevin Brigden, Kelly Huang, Matianne Kropf, Meng Tian, Mingyang Zheng, Qianru Ma, Sanghoon Cho, and Zhibin Chen.

May 2023

Executive summary

There is a long way to go before the transport sector is on a path to limit global temperature rise to 1.5 degrees. Several steps need to be taken to drive the change, such as rapidly accelerating the phase-out of internal combustion engine vehicles, reducing the number of cars on the road, prioritising and promoting public transportation, biking and walking, with all remaining vehicles using electric power run from renewable energy sources. Moreover, there is increasing recognition of the need to decarbonise the entire automotive supply chain, including steel materials.

Automakers must drive demand for zero-carbon steel to initiate industry transition

Decarbonising automotive steel is imperative for automakers to achieve carbon neutrality. The average passenger vehicle comprises approximately 50% - 65% steel by weight, making steel a crucial component for automotive manufacturing.[1,2] At the same time, steel is responsible for 30% - 40% of an average vehicle's material emissions.[2] With a transition to battery electric vehicles (BEVs) which brings down the GHG emissions during the usage phase of the product, it is projected that more than 60% of automotive life-cycle emissions will be from materials by 2040.[3] Automakers must go beyond electrification, but also rapidly decarbonise their steel supply. Therefore, we call upon all automakers to:

- Commit to reducing 50% of the carbon footprint from steel supply by 2030 and transition to 100% zero-carbon steel no later than the year they have committed to achieving their carbon-neutral goals or by 2050
- Curb and reduce steel consumption by reducing the size of vehicle models, particularly SUVs and other large models
- Publicly disclose data of steel consumption and associated GHG emissions
- Rethink the business model to reduce the number of cars and develop mobility services

The top 16 automakers use at least 40 million tonnes of steel per year, but their significant environmental footprint remains unaddressed. Our estimation shows that the world's top 16 automakers consumed 40 to 67 million tonnes of steel in 2021 and 39 to 65 million tonnes of steel in 2022. The top three automakers that consumed the most steel were Toyota, Volkswagen, and Hyundai-Kia because of their sales volumes. We estimate that the carbon footprint of the steel materials used by the top 16 automakers was at least 77 million tonnes of carbon dioxide (CO_2) in 2021, and 74 million tonnes of CO_2 in 2022.[i] Despite their net-zero commitments, automakers lack measurable objectives to reduce steel consumption and concrete actions to decarbonise their steel. None of these companies disclosed the carbon footprint of the steel materials they used. The marketing strategy by the automakers to boost the sales of SUVs exacerbates the problem. In our minimum level estimation, the CO_2 emissions from SUVs' automotive steel accounted for more than half of the total auto steel emissions[ii] in 2021.

Automakers should pioneer in creating demand for zero-carbon steel. The automotive industry is one of the largest end-users of steel, representing about 16% of global steel consumption[4], and is best positioned to be the first mover in steel decarbonisation. Automobile production has a relatively less complex supply chain than other steel-consuming industries, which allows a more stable relationship with steelmakers. Moreover, there is a relatively insignificant incremental cost of a vehicle if made with low-carbon steel. Therefore, the automobile industry could stimulate the advancement in decarbonising the steelmaking process. Automakers' commitment to

i. Due to the lack of data transparency, our estimation of the total carbon footprint of the steel materials used by the top 16 automakers fell on a range of 77 to 128 million tonnes of CO_2 in 2021, and 74 to 124 million tonnes of CO_2 in 2022. It is based on the average weight of 13 types of cars sold by each company and the global average CO_2 emission of 1.91 tonne per tonne of steel produced in 2021.

ii. Unless otherwise mentioned, 'emissions' refers to carbon dioxide (CO_2) emissions.

procuring decarbonized steel would signal the future for steel producers to invest in the transition. However, low-carbon steel partnerships are emerging with very limited procurement commitments.

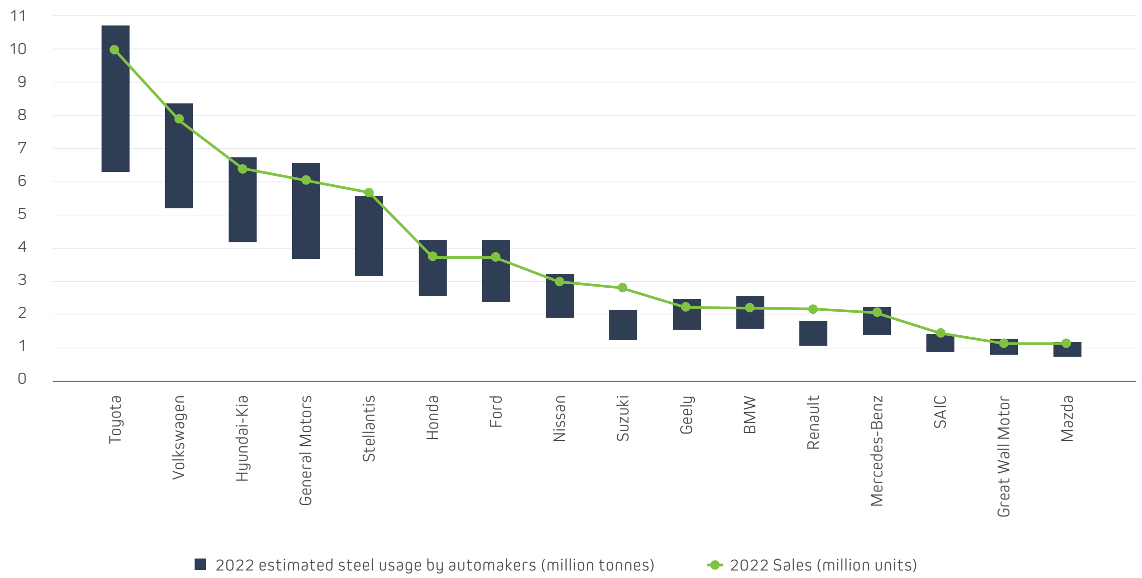
Steelmakers in China, Japan and South Korea serve as vital players in the industry, yet lag behind in the decarbonisation

The transition to a larger share of scrap-based steel production can proceed smoothly as economies mature and scrap availability increases. However, rapid implementation of cutting-edge, early-stage technologies will be required to support this shift. The iron and steel sector is energy and carbon-intensive, accounting for 8% of global final energy use[5] and 11% of global CO_2 emissions[6]. Despite high emissions, the key parts of steelmaking technology have not been renewed for decades. Increased steel recycling, using green hydrogen-based direct reduction, and electrification all constitute avenues for achieving deep emission reductions in steelmaking. Challenges in the supply of renewable energy, scaling up green hydrogen, and scrap steel recycling have to be addressed.

Asian steel companies have the potential to play a significant part in steel decarbonisation, but have yet to make substantial efforts in doing so. The steel output of China, Japan, and South Korea represents more than 60% of the global production, however, their production, on average, is more carbon intensive than that in North America and Europe. Automotive steel, a high-end product with a high technical threshold, is produced by only a few steelmakers in the region. Baosteel and Shougang Steel from China, Nippon Steel and JFE from Japan, and POSCO and Hyundai Steel from South Korea supply many automakers, accounting for 23.8% of the global automotive steel market. However, their steel production relies heavily on the blast furnace-basic oxygen furnace (BF-BOF) route, which heavily depends on coal to produce crude steel. Only 10% - 30% of their steelmaking capacity is the electric arc furnace (EAF) route, which is much lower compared to 40% in the EU and 70% in the United States.[7, 8, 9] The technical roadmaps of the six companies show a lot of uncertainty in decarbonising their steel production. All six companies committed to carbon neutrality by 2050 but their visions require carbon capture and storage (CCS), a false solution, and carbon off-setting to realise carbon neutrality, instead of mitigating the emissions from production.

Huge gaps exist in the financing of the decarbonisation of steel and policies that provide incentives. Significant investment should be channeled to enable the zero-carbon transition. Most green finance frameworks and instruments provide support for green economic activities and green equity, leaving the low-carbon transition activities from high-emission industries such as steel behind. Even though governments have provided subsidies and funds for low-carbon technology development, current financial support is inadequate, and some funding resources have been directed towards false solutions, such as CCS.

Vehicle sales and estimated steel usage by automakers in 2022



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Automakers should race for steel decarbonisation

1

1.1
Automakers are in the hot seat to curb the greenhouse gas emissions from steel

More than 30 countries have pledged to phase out internal combustion engine (ICE) vehicles, but there is a long way to go before the transport sector is on a path to limit global temperature rise to 1.5 degrees. The largest lever to reduce greenhouse gas (GHG) emissions of a car is the electrification of the powertrain, but it is not enough to achieve carbon neutrality within the automotive sector. Specifically, the car industry needs to decarbonise the upstream raw materials used for auto production, of which steel makes up the largest proportion.[10]

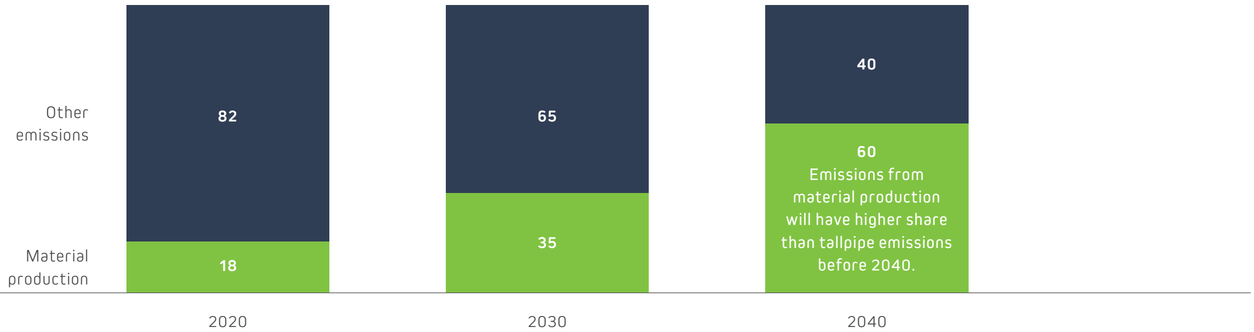
The average vehicle contains about 50% - 65% iron and steel by weight, making steel a crucial component for automotive manufacturing.[1, 2] Each vehicle contains, on average, approximately 0.9 tonnes of steel[11], a value that is higher for sport utility vehicles (SUVs) and pickup trucks.

Steel is responsible for 30% - 40% of an average vehicle's emissions from material production.[2] Current life cycle analyses of a typical ICE vehicle attribute about 18% of emissions to the production of the vehicle.[3] With a mass-market transition to battery electric vehicles (BEVs), it is projected that by 2040, more than 60% of automotive life cycle emissions will be from materials.[3]

Reducing steel consumption in the automotive industry is critical to improving fuel efficiency. A 10% reduction in vehicle weight results in a 5% - 7% improvement in fuel economy.[12] By reducing steel consumption, automakers can reduce the GHG emissions associated with the production and use of their vehicles.

The material emissions of a car depend upon the availability of low-carbon steel and other materials. Automakers must look beyond electrification, and both reduce the amount of steel they use by producing smaller and more efficient cars as well as ensuring the use of low-carbon steel in their products.[13]

Figure 1. Projected greenhouse gas emissions from material production in the automotive sector.



Sources: McKinsey, 2020[3]

1.2
Automakers have a great potential to lead the demand for low-carbon steel

The automotive industry is one of the largest end-users of steel, representing about 16% of global steel consumption.[4] With a huge demand for high-quality steel, automakers are well-positioned to be early adopters of low-carbon steel in their products. In 2021, 1839 million tonnes of steel were used across all industries[14], with about 300 million tonnes going to the automobile industry alone and emitting approximately 573 million tonnes of CO_2.[iii] The automotive steel market was valued at USD 112.93 billion in 2021 and is expected to grow at a rate of over 3% in terms of revenue from 2022 to 2030.[15] The rising adoption of electric vehicles is expected to further increase demand for steel.

Automobile production has a relatively less complex supply chain than other steel-consuming industries, which allows a stable relationship with steelmakers. Compared with other large consumers of steel, there is a relatively insignificant incremental cost of a vehicle if made with low-carbon steel. A study estimated that the incremental cost of the finished vehicles would be less than 1% of the retail price of a new vehicle.[16]

A higher proportion of primary steel is used to make cars than buildings, therefore the automobile industry could stimulate the advancement of decarbonising the ironmaking process. Automakers' commitments to procuring decarbonised steel would signal the future for steel producers to invest in the transition. However, low-carbon steel partnerships are emerging with very limited procurement commitments.

iii. Based on the portion of steel consumed by the automotive industry (16%) and the average CO_2 emissions in 2021 per tonne of steel produced (1.91 tonnes of CO_2). World Steel Association.

The status quo of steel decarbonisation by global automakers

2

This chapter focuses on the current efforts by the automakers on the decarbonisation of steel. The analysis is based on the global passenger vehicle sales figures and other publicly disclosed information of the top 16 automakers.[iv] The results reflect their performance in decarbonisation strategy, disclosure, material efficiency, and low-carbon steel collaborative efforts.

2.1 Obstacles ahead

Inadequate attention and unclear roadmaps

Despite many automakers committing to becoming carbon neutral, actions to decarbonise the supply chain, including steel, have not been progressive enough. Most automakers have set the same timeline for achieving decarbonisation goals in their supply chain as their net-zero commitments, with the notable exceptions of Suzuki, SAIC, and Great Wall Motor, which have not made such promises. Some automakers have set intermediate goals to decarbonise the supply chain while it is unclear whether these current measures align with automakers' overall net-zero commitments or comply with the Paris Agreement due to a lack of evaluation.

Currently, none of the major automakers have set specific goals to reduce steel consumption and associated emissions. While some automakers, including Toyota, Geely, and BMW, have set measurable objectives to reduce their supply chain emissions, it is not clear whether they have included steel in their mitigation approaches. *(Refer to Appendix 1)*

For most automakers, supply chain decarbonisation is still in the early stages, with a focus on gathering information and engaging in climate-related activities. Unfortunately, many have not yet given adequate attention to materials such as steel, nor have they developed clear roadmaps to address this issue.

iv. Data used to analyse the 16 automotive groups are from multiple sources. Marklines' sales data have been collected for all passenger vehicles sold for all brands and models. Other data have been collected from corporate sustainability/CSR/ESG reports and relevant press releases. This report considers Nissan and Renault as independent car manufacturers as the decision-making of these companies is also independent.

Lack of disclosure on steel consumption and related emissions

Disclosure on steel consumption is insufficient and the boundary of steel consumption (primary materials, auto parts, for example) is not consistent across companies. Toyota, Suzuki, Mazda, Hyundai, Geely, Renault and Stellantis have disclosed their annual steel consumption while others have not. *(Refer to Appendix 1)*

Despite steel accounting for a significant portion of supply chain emissions, none of the companies reported emissions associated with steel. Most companies covered in the analysis have used the GHG Protocol to calculate their emissions and followed the Task Force on Climate-related Financial Disclosures (TCFD) or other international standards to disclose their emissions. Some provided emission specifications on purchased goods and services in Scope 3, which theoretically includes emissions from steel material. Companies such as SAIC and Great Wall Motor follow domestic standards of their place of registration, which makes their reporting difficult to align with international standards.

2.2
Huge steel consumption and associated emissions

Due to the lack of disclosure, we estimated the volume of steel used by automakers in 2021 and 2022, both by company and by car type. Additionally, we have estimated the CO_2 emissions associated with the manufacturing of automotive steel, highlighting the significant carbon footprint and the urgent need to reduce both steel consumption and steel-associated emissions.

Methodology

The estimated steel consumption values were calculated by multiplying the sales[v] values with the assumed vehicle's kerb weight and the share of steel in weight (50% - 65%), then adding up the amounts for each type to give a company total based on the corporate group-level sales data. In the equation I and II, i denotes the 13 car types considered in the analysis: Sedan A,B,C,D,E,F and sports utility vehicle (SUV) A,B,C,D,E, multi-purpose vehicle (MPV) and pickup truck. The parameters used for assuming the vehicle's kerb weight are attached in Appendix 2. The difference in steel consumption reflected the variation in sales among automakers and weight for different segments.

$$\textbf{Total Steel consumption}_{minimum} = \sum_{i=1}^{i} \textbf{Car Sales by type X Weight by type}_{minimum} \textbf{ X 50\% (I)}$$

$$\textbf{Total Steel consumption}_{maximum} = \sum_{i=1}^{i} \textbf{Car Sales by type X Weight by type}_{maximum} \textbf{ X 65\% (II)}$$

The carbon footprint associated with the steel consumption is calculated by multiplying the total steel consumption by the world average carbon intensity for steelmaking. It is based on the World Steel Association's data, which provided that the global average emissions of a tonne of steel produced being 1.91 tonnes of CO_2 in 2021.[17]

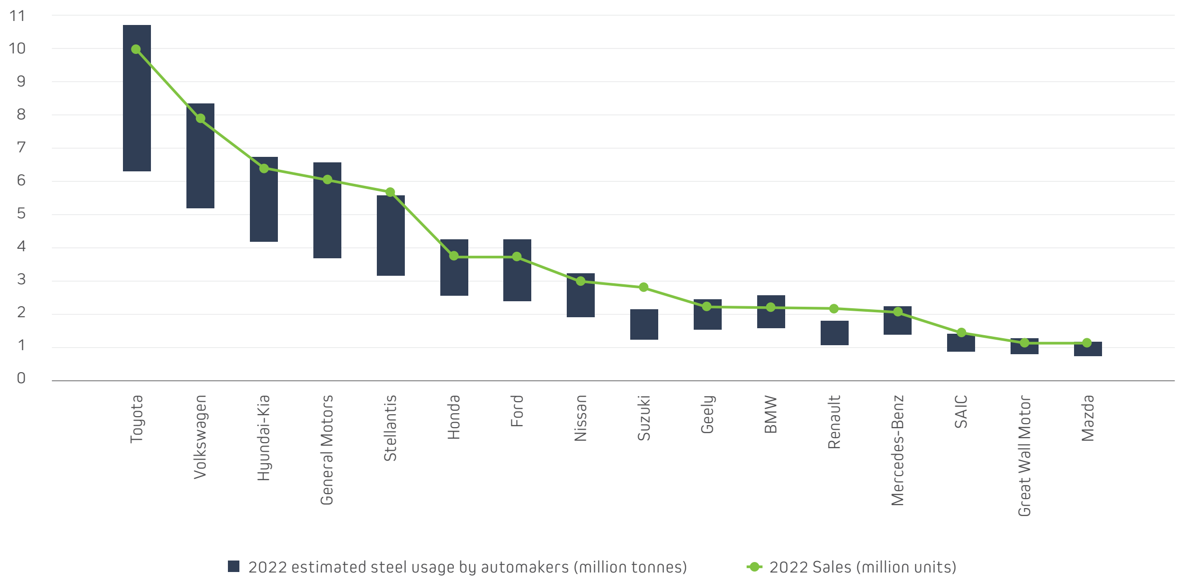
v. The vehicle sales data was retrieved from Marklines in May 2023. The dataset provides sales information at the group level, car type and model level, and the one-year period is based on the calendar year. It's important to note that the estimation of steel consumption does not include sales of unclassified car types or cars produced but not sold. Therefore, the actual steel usage is likely to be higher than our calculated steel usage.

2.2.1

Steel consumption by car makers and associated CO_2 emissions

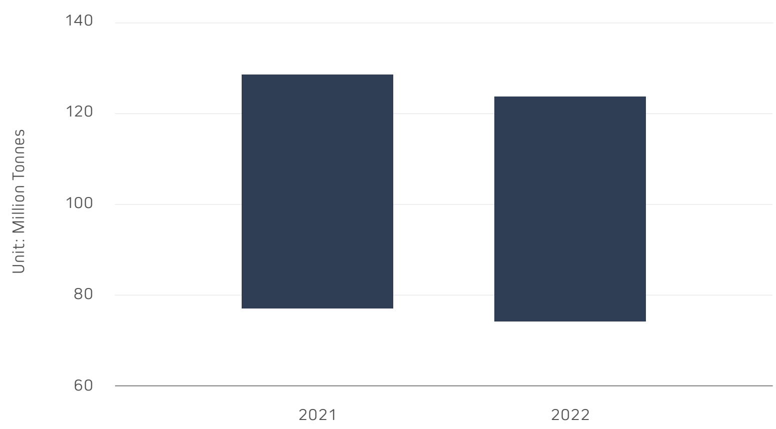
Our estimation shows the top 16 automakers consumed 40 to 67 million tonnes of steel in 2021, and 39 to 65 million tonnes of steel in 2022 to make Sedans, SUVs, MPVs and pickup trucks. In 2021, with the minimum-level estimation as shown in Figure 8, the first tier that consumed the most steel includes Toyota, Volkswagen, and Hyundai-Kia, which used at least 6.31, 5.36, and 4.33 million tonnes of steel materials, respectively. Stellantis, General Motors, Honda, Ford, and Nissan fall into the second tier, with each consuming 2 million tonnes of steel at least. Suzuki, Renault, Mercedes-Benz, BMW, Geely, Great Wall Motor, SAIC, and Mazda went to the third tier with an estimated consumption of fewer than 2 million tonnes. The levels of steel consumptions could be largely explained by the total sales volume and sales by car type.

Figure 2. Vehicle sales and estimated steel usage by automakers in 2022.



In 2022, Toyota, Volkswagen, and Hyundai-Kia remain the top three steel consumers, using at least 6.30, 5.19, and 4.20 million tonnes of steel materials, respectively. Based on the average emissions of 1.91 tonnes of CO_2 per tonne of steel produced in 2021[17], the steel usage by the top 16 automakers could have caused at least an estimated 77 to 128 million tonnes of CO_2 in 2021, and between 74 to 124 million tonnes in 2022.

Figure 3. Estimated CO_2 emissions from automotive steel used by the top 16 automakers.



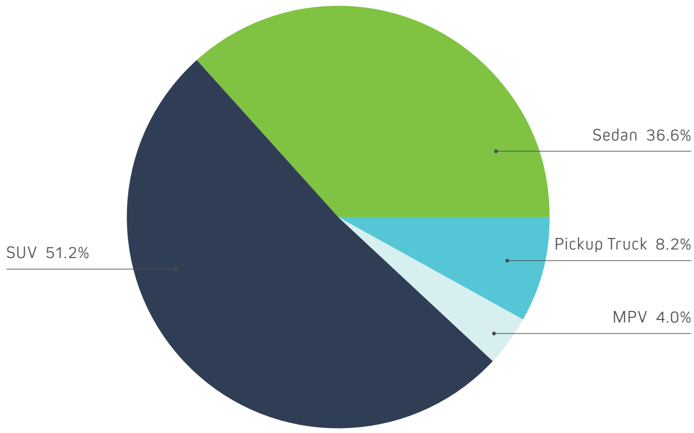
2.2.2

Steel consumption by car type

Steel consumption across car types, including sedan, SUV, MPV and pickup truck, has been estimated. On average, an SUV consumes 20% more steel than a sedan vehicle due to its larger size and kerb weight.[18] In our estimation, SUVs consume 5.9 - 8.2 million tonnes more steel than sedans in 2021 and 6.5 - 9.2 million tonnes in 2022 from the top 16 automakers.

SUVs consume about one-quarter more energy than medium-size cars during use and drive the increase in the automotive industry's demand for steel.[19] SUVs are known to have lower fuel economy than smaller vehicles because they typically have larger engines and are heavier, which requires more fuel. SUVs have an average fuel economy of around 20 - 30 miles per gallon (MPG).[20] **In our minimum level estimation, the CO_2 emissions from SUVs' automotive steel accounted for more than half of the total auto steel emissions in 2021.**

Figure 4. Estimated CO_2 emissions from automotive steel by car type.



On the company level, Toyota, Volkswagen, and Hyundai-Kia sold more than 3 million SUVs each in a single year, accounting for almost 40% of the total SUV sales from the top 16 automakers. As a result, based on the minimum level estimation, these three automakers used more than 2.5 million tonnes of steel each to manufacture SUVs, significantly more than their competitors. Moreover, the estimated steel consumption from SUVs for Ford, Geely, and Great Wall Motor is significantly higher than that from sedans. By reducing their reliance on SUVs and decreasing the size and number of cars, these automakers could significantly reduce their steel consumption.

Figure 5. Vehicle sales and estimated steel usage of SUVs in 2022.

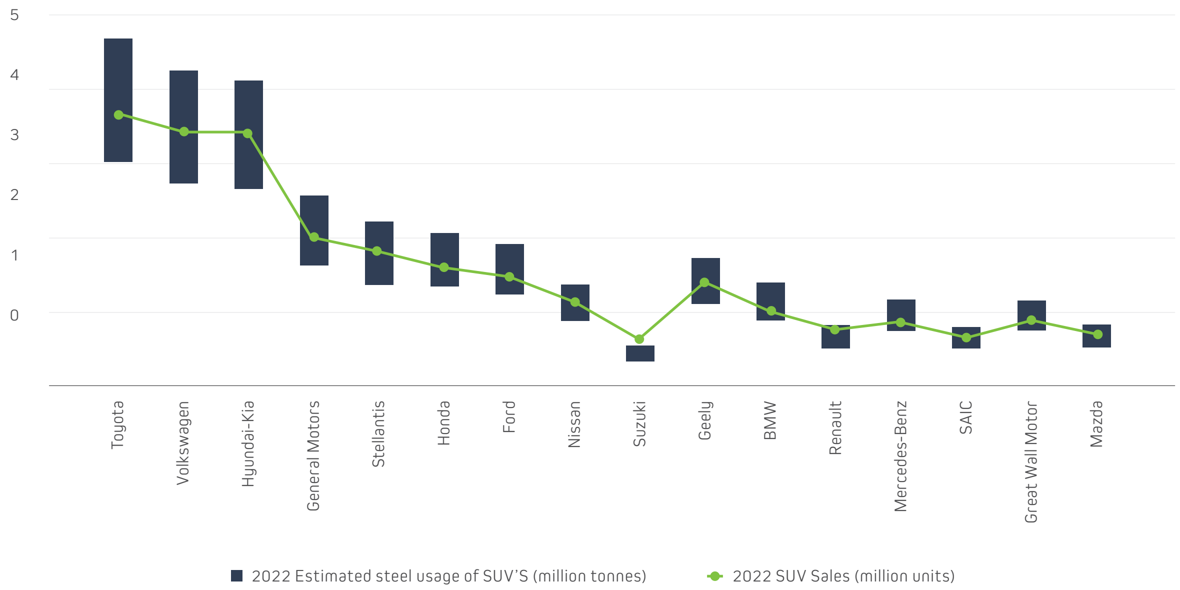
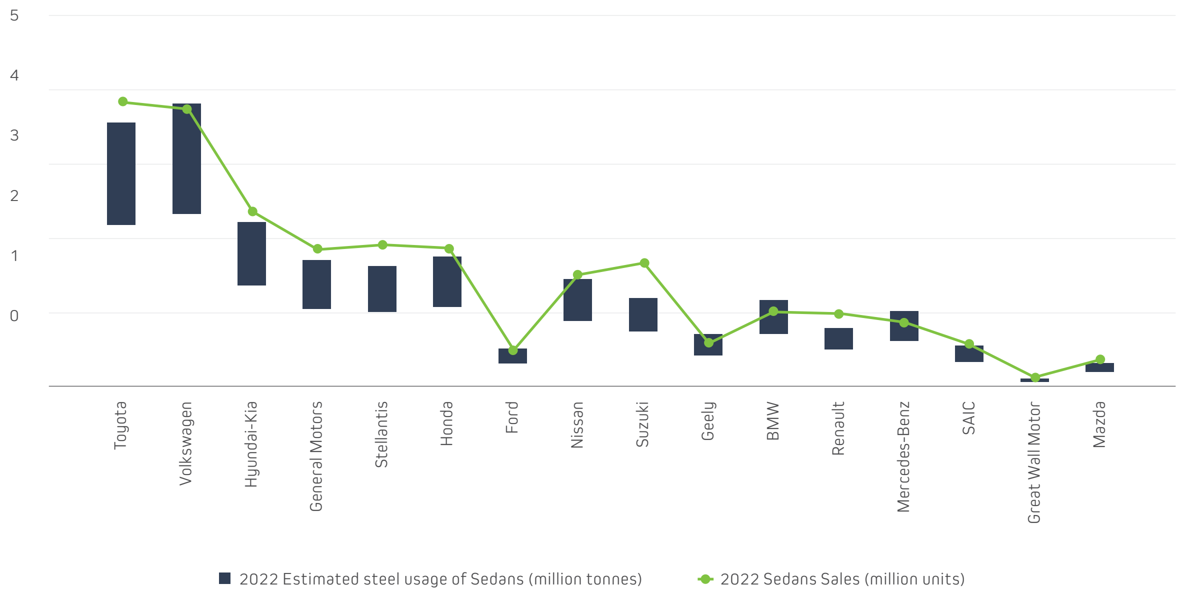


Figure 6. Vehicle sales and estimated steel usage of sedans in 2022.



2.3
How green are the emerging low-carbon steel partnerships?

To reduce the carbon footprint from steel, automakers need to both decrease their steel consumption and find low-carbon steel suppliers. European car makers and steelmakers are leading the way in collaborating and developing low-carbon steel. Some automakers, such as Ford, General Motors and Volvo, have made modest procurement commitments to purchase at least 10% near-zero carbon steel and aluminum by 2030.[21, 22] However, the technological standards for these commitments have not been clarified.

Automakers recognise that low-carbon steel will be a game changer for future competition. However, the development of the low-carbon steel market is in its early stages, and the level of 'greenness' in these emerging low-carbon automotive steel partnerships varies. Most of the factories producing low-carbon steel are located in Europe and are owned by a few European steel companies such as H2 Green Steel, SSAB, and Salzgitter. These companies are currently testing hydrogen-based steel production processes that replace fossil fuels in the direct reduced iron (DRI) production stage with hydrogen produced by renewable energy. These companies claimed to produce low-carbon steel on a commercial scale from 2025. However, scaling up green hydrogen production is a challenging task and the supply volume of the 'low-carbon' steel is not yet specified in most of the emerging collaborations.

In contrast, the progress of promoting low-carbon steel partnerships between automakers and steelmakers is relatively slow in East Asia. Only Hyundai has developed a partnership with POSCO for DRI steel made from hydrogen. Mercedes-Benz and BMW have started collaboration with two steelmakers in China. While Toyota and Nissan claim to use low-carbon steel in car manufacturing, the technologies applied in these projects aren't sufficiently 'low-carbon' enough as the steelmaking is still relying on blast furnaces that heavily relies on coal to produce crude steel.

Table 1. The ambiguous claims of the 'low-carbon' automotive steel partnerships

Automaker	Steel Partner	Partnership Plan	Time to start supplying	Technology claimed to adopt	Scale of supply
Toyota	Kobe Steel	Toyota claimed to employ a steel product with a 100% reduction in CO_2 emissions.[23] However, the steelmaking still relies on BFs[23] and only supplies for one type of racing vehicle.	2022	Charging a large amount of hot briquetted iron (HBI) produced into the blast furnace.	Only for hydrogen engine-equipped racing vehicle Corolla
	Tokyo Steel	Toyota adopted lower arm parts made by using 100% recycled iron scrap for vehicles participating in a race.	2022	100% recycle scrap	N/A

Automaker	Steel Partner	Partnership Plan	Time to start supply	Technology claimed to adopt	Scale of the supply
Volkswagen	H2 Green Steel	The group subsidiary Scania has entered into a cooperation with the start-up H2 Green Steel.[24] The supply volume is not specified.	2024	Using end-to-end digitalisation, electricity from fossil-free sources and green hydrogen instead of coal.	N/A
	Salzgitter	They signed Memorandum of Understanding (MOU) on supply of low-CO_2 steel[25].	From the end of 2025	Using green hydrogen and renewable energies on a new production route to reduce over 95% of CO_2 emissions.	For future projects such as the Trinity1 e-model
Hyundai	POSCO	Hyundai developed a partnership with POSCO for DRI steel made from green hydrogen.[26] The supply time and volume of the low-carbon steel are not specified.	N/A	Using hydrogen gas as a fuel and reducing agent in its blast furnaces to make steel.	N/A
	Hyundai Steel	Hyundai Steel aimed to establish Hyundai Motor Group's hydrogen-based reduction steelmaking process in the long-term.	N/A	H_2- DRI-EAF	N/A
General Motors	United States Steel Corporation	U. S. Steel announced to supply General Motors with steel manufactured with up to 75% fewer emissions compared to traditional blast furnace production[27]. This claimed reduction only includes scope 1 and scope 2 emissions. The supply volume is not disclosed.	2023	Using 90% recycled steel.	N/A
	Nucor Corp	General Motors sourced 'net-zero carbon steel products from Nucor'[28]. They claimed the company would operate at 70 percent below the current steel industry greenhouse gas intensity. However, they still rely on purchasing carbon offsets to eliminate scope 1 emissions[29].	2022	Using recycled scrap-based EAF and using electricity from 100% renewable sources.	N/A

Automaker	Steel Partner	Partnership Plan	Time to start supply	Technology claimed to adopt	Scale of the supply
Ford	Tata Steel	Ford Signed MOU with Tata Steel's Dutch arm for low-carbon steel[30] without clarifying the emission reduction effects. However, the company is being criticised for heavy pollution.[31,32]	After 2030	Without using fossil fuels.	Only supply Ford plants in Europe
	Salzgitter	Salzgitter will supply Ford with its green steel and plans to gradually convert its steel production to hydrogen-based processes starting from 2025.[33] The supply volume is not specified.	2033	Using green hydrogen and renewable energies on a new production route to reduce over 95% of CO_2 emissions.	N/A
	Thyssenkrupp	Ford signed MOU with Thyssenkrupp for low-carbon steel.[34] The steelmaking technology and supply time are not specified.	N/A	N/A	Ford Europe
Nissan	Kobe Steel	Nissan claimed to use steel that eliminates CO_2 emissions from the manufacturing process in domestic car manufacture. However, the steelmaking still relies on BF[35] and only supplies for one type of vehicle.	2023	Charging a large amount of hot briquetted iron (HBI) produced into the blast furnace.	Only for Serena minivans
Mercedes-Benz	H2 Green Steel	Mercedes-Benz participated in the Swedish startup H2 Green Steel.[36] The supply volume is not specified.	2025	Using electricity from fossil-free sources and green hydrogen instead of coal.	N/A
	Kloeckner	Klöckner & Co delivered the first roughly 20 tons of significantly carbon-reduced green steel to Mercedes-Benz.[37]	2022	BF-BOF EAF DRI-EAF	20 tons
	SSAB	Mercedes-Benz formed a partnership with the Swedish manufacturer SSAB for the delivery of CO_2-free steel. The first prototype parts for body shells were already planned for 2022 but the fossil-free steel will only be launched in 2026. The supply volume is not specified.	2026	Replace coking coal with fossil-free electricity and hydrogen.	N/A

Automaker	Steel Partner	Partnership Plan	Time to start supply	Technology claimed to adopt	Scale of the supply
Mercedes-Benz	Salzgitter	Salzgitter AG delivered green strip steel products with a CO_2 footprint reduced by more than 66% to four German plants of Mercedes-Benz AG.[38] The supply volume is not specified.	N/A	Using green hydrogen and renewable energies on a new production route to reduce over 95% of CO_2 emissions	N/A
Mercedes-Benz	Baosteel	Mercedes-Benz signed MOU with Baosteel to supply the carbon-reduced steel.[39] The supply volume is not specified.	2025	H_2- DRI-EAF	N/A
BMW	H2 Green Steel	BMW entered into an agreement with H2 Green Steel to purchase hydrogen steel produced using green electricity.[40] The supply volume is in validation.	2025	Using electricity from fossil-free sources and green hydrogen instead of coal	N/A
BMW	HBIS	BMW's production at its Shenyang, China plant will gradually incorporate automotive steel which is claimed to be 10% to 30% less carbon intensive from mid-2023, and will start using 'green steel' produced by HBIS in the vehicle production process and it will gradually cut 95% of carbon emissions.[41]	2026	Based on technologies such as green electricity and electric furnace.	Shenyang plant
BMW	Salzgitter	Salzgitter AG will be supplying all the European plants of the BMW Group with low-CO_2 steel from 2026, with the steel scrap from the BMW plants to be returned and directly reused. The supply volume is not specified.	2026	Using green hydrogen and renewable energies on a new production route to reduce over 95% of CO_2 emissions	European plants of the BMW Group
BMW	SDI, Nucor, Big River Steel	BMW reached agreement with Steel Dynamics (SDI), Nucor and Big River Steel to use renewable energy sources in the scrap-based steel production.	Active	Electric Arc Furnace with steel scrap and renewable energy	Half of the flat steel used by the US and Mexico plants of BMW Group
SAIC	Baosteel	SAIC said to develop low-carbon steel products with Baosteel Group[42]. The specific steelmaking technology, and supply time and volume were not disclosed.	N/A	N/A	N/A

Decarbonisation efforts by steelmakers in China, Japan and South Korea

3

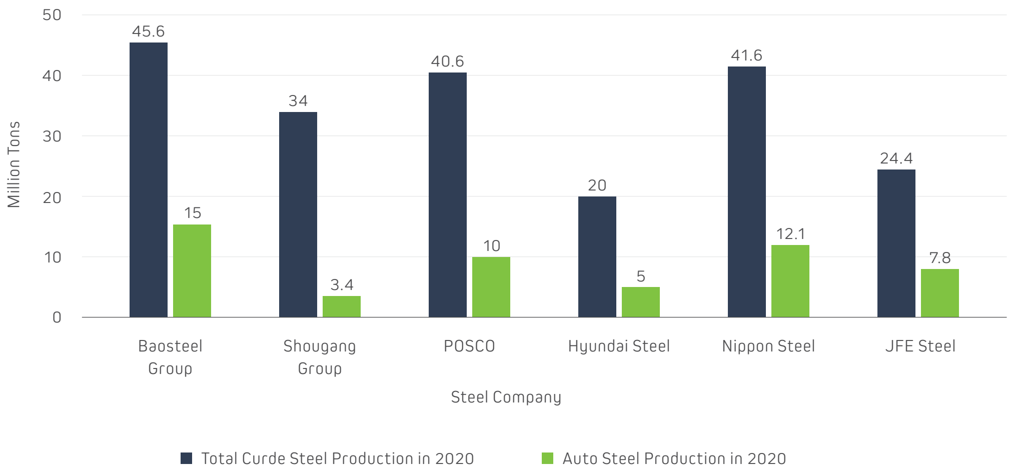
In 2021, the steel output from China, Japan and South Korea represents more than 60% of the world's production, with China representing more than 50%.[43] Six steelmakers cover the majority of the automotive steel market in the region: Baosteel Group and Shougang Group in China; Nippon Steel and JFE in Japan; and POSCO and Hyundai Steel in South Korea, and accounting for more than one-fifth of the global automotive steel market. This chapter presents an analysis of the six steel producers in regard to automotive steel, including their progress and obstacles in decarbonisation. The data used for this analysis is primarily sourced from the financial and corporate social responsibility (CSR) reports of the six companies, as well as third-party sources such as BloombergNEF.

3.1 A growing market

Automotive steel has a higher profit margin than other steel applications and has long been a key market for the top steelmakers. In our investigation[vi], all six companies demonstrate a high share in the automotive steel market. In fact, their total crude steel output accounts for 11.3% of global steel production while their automotive steel production is more than double that, at 23.8% of the global market. Specifically, Baosteel automotive steel production accounted for 33% of its crude steel production in 2020, which is the highest among the six companies. The six companies are expected to invest in production capacity and technology development for the continued growth of the automotive steel market. (See Figure 7.)

vi. The automotive steel in this report includes cold-rolled steel sheets, hot-rolled steel sheets, hot dip galvanised steel sheets and electrogalvanized steel sheets.

Figure 7. Crude steel and automotive steel production of the six steelmakers in 2020.



Sources: World Steel Association and market data[44, 45, 46, 47, 48]

3.2 Carbon-intensive steelmaking in the near future

Steelmaking by all six featured companies is dominated by the blast furnace-basic oxygen Furnace (BF–BOF) route that heavily relies on coal to produce crude steel. Hyundai Steel demonstrates a much lower carbon intensity in crude steel because of a higher percentage of output from EAF. However, its automotive sheets are primarily made using the BF–BOF route, which has similar carbon intensity compared with other steelmakers. Even though the China-based steel producers have a higher proportion of BF-BOF output, they still achieve a lower crude steel carbon intensity because of the younger facilities.

The age of steelmaking facilities is a major factor that contributes to carbon intensity. Baosteel Group and Shougang Group, which have both demonstrated lower carbon intensity, have relatively newer production lines. Although newer facilities are more efficient in the short term, they may generate high sunk costs during the transition to low-carbon steel in the long term. Steelmakers in Japan are running production in facilities that were established decades ago. Nippon Steel has started to close its aged production lines and replace them with facilities that utilise EAF production technology, forecasted to be completed before the end of 2023. Other steelmakers also made commitments to develop large-scale electric arc furnace (EAF) facilities in the future.

All six companies have committed to carbon neutrality by 2050 but have different mid-term decarbonisation plans and allocation of the base-year, while Shougang does not have a mid-term goal. Company visions heavily rely on carbon capture and storage (CCS), a false solution, and carbon off-setting to realise carbon neutrality, instead of mitigating the emissions from production. Overall, before 2030, steelmaking of these six companies will be still carbon-intensive. *(See Table 2)*

Table 2. Technologies and carbon intensity of the six steelmakers in 2020.

Steel Company	Output in 2021 (million tonnes)	Number of BF	Output by BF+BOF	Output by EAF	2020 Carbon Intensity (tCO_2/ t Crude Steel)	Mid-term Decarbonisation Target
Baosteel Group	119.95	11	97%	3%	1.96	Peak CO_2 emissions by 2023 Reduce 30% by 2035
Shougang Group	44.23	10	98%	2%	1.98	Reduce 35% by 2035
POSCO	42.96	6	86%	14%	2.11	Reduce 10% by 2030 Reduce 50% by 2040
Hyundai Steel	19.64	3	58%	42%	1.35	Reduce 12% by 2030
Nippon Steel	49.46	9	94%	6%	2.06	Reduce 30% by 2030
JFE Holdings	26.85	8	84%	16%	2.08	Reduce 30% by 2030

Sources: Global Steel Plant Tracker[49], Worldsteel Association[50], companies' CSR reports and news[51, 52, 53, 54, 55, 56]

3.3
Tough transition to zero-carbon steel

Companies developing zero-carbon steel face many challenges and the technical roadmaps from the six steelmakers demonstrate uncertainty. In the short term, they have outlined two major pathways to decarbonisation.

The first is relevant for those companies that are heavily reliant on BF–BOF. The main solutions for these companies involve hydrogen injection into BF. The two Japan-based companies, Nippon Steel and JFE Steel demonstrate this as they jointly develop the technology to cut emissions from the BF process, which will reduce CO_2 emissions by 30% but only 10% from hydrogen where the additional 20% relies on carbon capture. They claimed that technology will be further improved to maximise hydrogen use but coal is still used in the process. The second pathway is the new generation EAF, plus hydrogen-based direction reduction. Hyundai Steel, which has a large EAF fleet, is installing the new generation EAF and announced an electric furnace-based steel production system, which will produce low-carbon steel by converting it to a hydrogen-based steel production system by 2030.[57] The technology seems to be an early version of hydrogen-based steelmaking but still needs to mix pig iron from the BF process, so the level of emissions reduction is unclear. POSCO has started its demonstration project of hydrogen-based ironmaking and plans to verify the commercial feasibility of hydrogen-reduced steelmaking by 2030.[58] Baosteel also kicked off its pilot hydrogen-based steelmaking projects in 2022, aiming to produce 1 million DRI steel upon finishing the projects. In 2023, Baosteel produced the very first low-carbon auto sheet.[59]

However, the real challenge is the availability of green electricity and green hydrogen. The current supply of green electricity is still limited, which also limits the supply of green hydrogen. The steel companies would need to commit to promoting renewable energy to realise their grand roadmaps and stay competitive in the automotive steel market.

The potential of scrap steel

Technologies exist that claim to produce low-carbon steel, the first of which involves using scrap steel. Unlike the BF–BOF route, the EAF process can accommodate up to 100% scrap steel. Recycled steel accounts for significant energy and raw material savings: over 1.4 tonnes of iron ore, 0.74 tonnes of coal, and 0.12 tonnes of limestone are saved for every tonne of steel scrap made into new steel compared to primary steel production.[60] However, both technical and economic barriers exist. In 2019, only 22% of globally produced steel was made using scrap steel with electric arc furnaces.[61] The full potential of reused and recycled steel is currently unfulfilled, especially in manufacturing specially shaped steel, such as for a car body, because of the unstable quality.[16] A well-designed recycling system is the premise to control the quality of scrap steel, which will also contribute to carbon reduction in the EAF process.

The steel industry will need different combinations of technologies to reach net zero emissions. Widespread steel recycling, the use of green hydrogen and electrification all constitute avenues for achieving deep emissions reductions in steelmaking. The transition to a larger share of scrap-based steel production can proceed smoothly as economies mature and scrap availability increases. However, rapid implementation of cutting-edge, early-stage technologies will also be required to support this shift.

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Emerging drivers for automotive steel decarbonisation

4

Policies and finance both play critical roles in the transition to zero-carbon steelmaking. Policies can create incentives for steelmakers to reduce their carbon emissions while finance can provide funding for the development and commercialization of low-carbon technologies. Examples of emerging public policies, financial instruments and trends in low-carbon automotive steel demand which might accelerate auto steel decarbonisation in China, Japan and South Korea are examined in this chapter.

4.1 Public Policy

Since 2020, China, Japan and South Korea have committed to achieving carbon neutrality and tightened their policies on GHG emissions. However, while the concept of 'carbon constraint' has been just introduced to the regulations applying to the steel and the automotive industries, the policies in these three countries still merely focus on emissions accounting and reporting. There is a need for more progressive policies to effectively address 'carbon constraint' in the high-emission industries.

China

China has implemented several policies aimed at decarbonising the auto supply chain. In 2022, the central government issued a plan to achieve peak carbon in the industrial sector, which ordered the sub-national governments and state-owned enterprises to build a low-carbon supply chain, that includes the automobile and steel industries.[62] However, there is still no regulation to mandate life cycle emission accounting and reporting for automakers. In terms of carbon trading, the steel industry will be included in the national emission trading system (ETS) later.[63] Carbon prices are expected to keep rising after the eight high-emission industries are included in the ETS.[64] The increased cost of production for steel companies is expected to encourage the adoption of low-carbon technologies. Discussions are underway to connect the corporate average fuel consumption–new energy vehicle (CAFC-NEV) credits regulation[65] (a mechanism that provides an incentive to automakers to electrify their fleets) with the ETS, which might give further pressure to automakers to decarbonise the entire value chain.[66]

Japan

The Ministry of the Environment Government of Japan has published guidelines on supply chain GHG emission accounting but has not specified the requirements for either the automotive industry or the steel industry. To bring total lifetime auto emissions down to zero, a carbon credit trading market among automakers in conjunction with sales quotas for green vehicles has been under consideration.[67] Other policy instruments such as carbon tax or carbon credit markets have limited effects on pushing the automotive and steel industry to move forward in the low-carbon transition because the carbon price is too low.[68] The Japanese government has provided financial support for industries that are involved in steel decarbonisation and establishment of hydrogen supply chains, aiming to cut 30% of CO_2 emissions in the steel industry by 2030 mentioned in the GX (Green Transformation) Policy.[69, 70] However, considering Japan's unambitious renewable target, it remains to be seen how these measures will affect the production of low-carbon steel.

South Korea

The Korean government has addressed investing in technology innovations in vehicle production in the 2050 carbon-neutral strategy. The 4th Act on Promotion of Development and Distribution of Environmental-Friendly Motor Vehicles has accelerated the transition into vehicle life cycle analysis (LCA) based GHG emissions management and the first Korean vehicle LCA tool has been introduced.[71] The policies implied a strong demand for low-carbon materials, including automotive steel, in the near future. With regards to the steel decarbonisation side, the Korean Emissions Trading Scheme (K-ETS) has covered direct and indirect emissions from electricity consumption by 684 of the country's largest emitters,[72] among which 85 are steelmakers. However, the cost has not been significant enough to induce companies to make investments in low-carbon options, and the free allowances also bring the big challenge of K-ETS accounting.[73]

On top of domestic regulations and policies, there is a requirement from the cross-border trade market to address carbon leakage.[vii] The EU Carbon Border Adjustment Mechanism (CBAM) could bring the extra costs associated with decarbonisation to steelmakers. CBAM will initially apply to a selected number of goods at high risk of carbon leakage including iron and steel. China, Japan and South Korea all had a significant increase in iron and steel exports to the EU from 2021 to 2022 by 88%, 68%, and 32%, respectively. As big iron and steel exporters to the EU, these three countries would be severely affected by CBAM if they don't take immediate actions to decarbonise steel.

Starting in 2026, the cost of purchasing CBAM certificates will be based on the actual CO_2 emissions from product manufacturing and the free allowances allocated to these products, which means that steelmakers with higher carbon intensity will face higher costs. As a result, downstream producers will need to search for suppliers with lower carbon intensity to avoid paying the additional fees.[74] In this scenario, China and South Korea-based steelmakers should pay attention because of their high exports to EU countries. *(See Table 3.)*

Table 3. Estimated cost for iron and steel industry under the Carbon Border Adjustment Mechanism (CBAM)[viii]

Country	Iron and Steel Export to EU in 2021 (tonne)[75]	Iron and Steel Export to EU in 2022 (tonne)[75]	Total Estimated CBAM Cost	CBAM Cost intensity[ix]
China	1,983,444	3,742,330	377 - 406 million USD (2.6 - 2.8 billion RMB)[76]	100 - 108 USD/tonne of iron and steel
Japan	892,936	1,501,385	95 million USD[x]	58 USD/tonne of iron and steel
South Korea	2,351,323	3,122,265	194 million USD (258.3 billion won)[77]	62 USD/tonne of iron and steel

vii. Carbon leakage refers to the situation that may occur if, for reasons of costs related to climate policies, businesses were to transfer production to other countries with laxer emission constraints. European Commission. "Carbon Leakage." Accessed May 9, 2023. https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/free-allocation/carbon-leakage_en.

viii. The findings are from different research, which may use different assumptions and research boundaries.

ix. Dividing the estimated total cost by the export volume in 2022.

x. This is a rough estimation based on several assumptions: a) Assuming the EU ETS allowances are around 60 EUR per tonne of CO_2 and no free allowances; b) Carbon rate in Japan is equivalent to 31 EUR (including a carbon tax equivalent to 2.29 EUR and an average fuel excise tax equivalent to 29.3 EUR per tonne of CO_2 emissions); c) The average steelmaking carbon intensity in Japan is 2 tonne CO_2 per ton steel. Camille Van der Vorst. "Carbon border adjustment in the EU - the implications for Japanese exports". EIJS Policy Brief. February 21, 2022. https://www.hhs.se/en/about-us/news/eijs/2022/eijs-policy-brief-carbon-border-adjustment-in-the-eu---the-implications-for-japanese-exports/

4.2 Financial Instruments

The low-carbon transition will require vast public and private investment. Research from Wood Mackenzie shows that decarbonising the steel and iron ore industry by 2050, in line with the Paris Agreement, will require US$1.4trn of funding and revolution across every stage of the value chain including but not limited to switching to renewable energy, supplying green hydrogen and increasing steel scrap recycling.[78] Several regulatory bodies, including the US, Canada, and the EU, have allocated significant funds for the development of low-carbon steel technology. In China, Japan and South Korea, governments have provided substantial financial support to the steel industry, particularly for hydrogen production and use in steelmaking. Despite these efforts, there remains a significant financing gap. Current financial support is inadequate, and some resources have been directed towards false solutions, such as carbon capture and storage.

Table 4. Policies providing financial support to the steel industry in China, Japan, and South Korea

Country	Supporting areas and size
China	- The research and development in the steel industry strive to reach 1.5% of its annual value added with a focus on technologies such as hydrogen metallurgy, low-carbon metallurgy, clean steel smelting, thin strip casting and rolling, and endless rolling.[79] - A sub-fund of the national green development fund was formed to support the iron and steel industry (approximately 7.2 billion USD).[80]
Japan	- The Green Innovation Fund of METI supports large-scale hydrogen supply chain establishment, hydrogen production, and hydrogen use in steelmaking processes. The funding for each project would be approximately 15 million USD or more.[81] - Technologies targeting decarbonising the iron and steel sector can be supported by transition finance guidelines.[82] - GX (Green Transformation) Policy will invest 3 trillion JPY in 10 years to decarbonise the steel industry with a focus on shifting BF to EAF, introducing H_2 DRI steelmaking technologies, etc.[83]
South Korea	- The Green New Deal supported the transition of infrastructure and innovations in green industries, among other measure.[84] - The steel industry development strategy and plans would create a 150 bn South Korean won (approximately 115.9 million USD) fund to support low-carbon steel production.[85]

While the industry should not rely on taxpayer funds to fulfill their obligation to reduce carbon emissions, innovative financial instruments are needed to channel more resources. Most green finance frameworks and instruments provide support for green economic activities and green equity, leaving the low-carbon transition activities from high-emission industries such as steel. In 2022, the G20 introduced a transition finance framework to guide the future development of both jurisdictional policies and financial services strategies to support the net-zero transition. To date, several global standard groups have developed guidance for the steel sector transition. For example, the world's first climate-aligned finance agreement for steel – Sustainable STEEL Principles (SSP) – was launched in September 2022, and the signatories to the SSP are committed to lending to the steel sector. If it is fully realised, the potential impact of the agreement could be sizable as the signatories represent a combined bank loan portfolio of approximately USD 23 billion.[86]
In addition to bank financing, steel companies have shown increasing interest in sustainability-linked bonds (SLBs) and transition bonds. While the bond market for sustainable finance is still developing, the Steel Criteria from Climate Bonds Initiative can certify bonds for companies that are on a credible transition path, allowing them to issue transition-labelled debt.

Table 5. Sustainable financial instruments examples by the steel industry in China, Japan, and South Korea

Financial Instrument	Introduction	Examples
Green loans/ sustainability-linked loans	Used by companies or other organisations to raise funds for green projects	- H2 Green Steel received finance from banks that align with the Sustainable STEEL Principles (SSP).[87]
Green bond/ sustainability-linked bond/ transition bond	Enable capital-raising and investment for new and existing projects with environmental or social benefits	- HBIS has issued green bonds for energy efficiency improvement projects since 2018 in China.[88] - POSCO issued an ESG bond in an attempt to raise capital for ESG means.[89]
Green equity	Use equity investments or shares in a client to promote environmental sustainability	China Baosteel and National Green Development Fund Co., Ltd. jointly initiated the establishment of Baowu Carbon Neutral Equity Investment Fund.[90]

4.3 Demand drivers

The low-carbon steel market is growing due to increasing support from governments and major consumers in industries such as construction, automotive, and household appliances. The International Energy Agency (IEA) estimates that the market size of low-carbon steel will reach nearly 500 million tons by 2050.[91]

Governments are playing a significant part in the growth of the low-carbon steel market, and public procurement can make up to 20% of local and national demand for steel.[92] The governments of the United Kingdom, India, Germany, the United Arab Emirates, Canada, Japan, and Sweden have pledged under the new Industrial Deep Decarbonisation Initiative (IDDI) to support the production of low-carbon steel and to purchase these products for their own use. The clear message from the public procurement will further support the growth of the low-carbon steel market.[93]

On top of demand drivers from the public sector, many companies are also pledging to procure low-carbon steel as part of their sustainability efforts. By joining initiatives such as SteelZero, companies across industries, from construction to automobile, are publicly committing to purchasing low-emission steel, which drives demand for and production of low-carbon steel. For example, Volvo has signed up for the SteelZero initiative, committing itself to stringent CO_2-based steel sourcing requirements by 2030 and buying only net-zero steel by 2050.

What should the automakers do?

5

To decarbonise the transport sector, various measures need to be taken, such as rapidly accelerating the phase-out of internal combustion engine vehicles, reducing the number of cars on the road, and prioritising and promoting public transportation. The decarbonisation of the automotive supply chain is a crucial part of the effort to limit global temperature rise to 1.5 degrees. Rather than solely relying on electrification, the industry must reduce the consumption of steel and prioritise the incorporation of zero-carbon steel into products. To this end, we call upon all automakers to:

- Commit to reducing 50% of the carbon footprint from steel supply by 2030 and transition to 100% zero-carbon steel no later than the year they have committed to achieving their carbon-neutral goals or by 2050.
- Curb and reduce steel consumption by reducing the size of vehicle models, particularly SUVs and other large models.
- Publicly disclose steel consumption and associated GHG emissions.
- Rethink the business model to reduce the number of cars and develop mobility services.

It is essential to foster close collaboration among automakers, steelmakers, policymakers and investors to decarbonise automotive steel. Steelmakers and investors should immediately stop investing in fossil fuel-based facilities. Investors should also actively engage with automobile companies they invest in and consider the carbon footprint of the whole value chain when making environmental, social, and governance (ESG) investment decisions. Meanwhile, governments and regulators should make automakers liable for the carbon footprint of their steel supply chain.

Appendix 1

Automakers' steel consumption, associated carbon emissions and reduction disclosure practices

Automaker	Supply chain decarbonisation goals	Steel-specific supply chain decarbonisation goals	Steel consumption reduction goals	Disclosed Steel consumption	Disclosed Steel emissions
Toyota	Making its manufacturing plants carbon neutral by 2035 and to eliminate CO_2 emissions from value chain by 2050.[94]	/	/	Iron: 8.83 million tons in 2021[95]	/
Volkswagen	Becoming CO_2-neutral by 2050 including vehicles as well as plants and processes.[96]	/	/	/	/
Hyundai	Becoming zero-emissions in its supply chain by 2045.[97]	/	/	Steel: 1.04 million tons in 2021[98]	/
Kia	Achieving carbon neutrality by 2045, following a reduction of more than 10% to be achieved by 2030 through the energy transition of key suppliers, and a reduction more than 55% by 2040 by extending these efforts to include raw material suppliers.[99]	/	/	/	/
General Motors	Suppliers in carbon-intensive industries providing raw materials or primary resources commit to carbon neutrality by 2038 or sooner.[100]	/	/	/	/
Stellantis	Achieving carbon net zero by 2038 from vehicles to supply chain, and industrial and sites.[101]	/	/	Steel: 8.87 million tons in 2021[102] and 7.87 million tons in 2022[103]	/
Ford	Achieve carbon neutrality no later than 2050 across its vehicles, operations and supply chain.[104]	/	/	/	/
Honda	Engaging with major automotive parts suppliers to achieve net-zero emissions by 2050[105] but no specific supply chain decarbonisasion goal disclosed.	/	/	/	/

Automaker	Supply chain decarbonisation goals	Steel-specific supply chain decarbonisation goals	Steel consumption reduction goals	Disclosed Steel consumption	Disclosed Steel emissions
Nissan	Achieving carbon neutrality in 2050, throughout the vehicle life cycle such as material extraction and manufacturing[106] and asking Tier-1 parts suppliers to set carbon reduction goals and methods by plant and product.[107]	/	/	/	/
Suzuki	Achieving carbon neutrality in Japan and Europe by 2050 and in India by 2070.[108]	/	/	Iron: 0.537 million tons in 2020[109] and 0.48 million tons in 2021[110] for domestic manufacturing	/
Geely	Targeting carbon neutrality across the entire value chain by 2045 and achieving 20% reduction in each product line by 2025 in supply chain.[111]	/	/	Steel: 0.33 million tonnes; 251.5 kg/ vehicle[112]	/
BMW	Aiming to reduce CO_2 emissions throughout a vehicle's entire value chain by 40% by 2030.[113]	/	/	/	/
Renault	30% emissions reduction goal for the parts and materials supply chain by 2030.[114]	/	/	Steel: 2.7 million tonnes for vehicle production in 2022[115]	/
Mercedes-Benz	Making an entire fleet of new vehicles net carbon-neutral along the entire value chain and over the vehicles' entire life cycle by 2039.[116]	/	/	/	/
SAIC Motor	/	/	/	/	/
Great Wall Motor	/	/	/	/	/
Mazda	Achieving carbon neutrality throughout the entire supply chain by 2050.[117]	/	/	Raw materials (steel, aluminium, etc.): 0.721 million tons[118]	/

Appendix 2

Car type and assumed average kerb weight

Car Type	Representative Models	Assumed Average Kerb Weight
Sedan-A	Suzuki Alto, Daihatsu Mira, Honda N-BOX, Fiat 500, VW up!, Chevrolet Spark, Ford Ka, Chery QQ, Changan Benni	800-1000kg
Sedan-B	Honda Fit (Jazz), Toyota Vitz (Yaris), Mazda2, VW Polo, Renault Clio, Peugeot 208, Ford Fiesta, Chevrolet Aveo, Changan CX20, Chery A1	1000-1200kg
Sedan-C	Toyota Corolla, Honda Civic, Subaru Impreza, VW Golf, Renault Megane, Peugeot 308, Ford Focus, Chevrolet Cruze, Dodge Dart, BYD F3, Geely Vision	1200-1500kg
Sedan-D	Toyota Camry, Honda Accord, Nissan Altima, VW Passat, BMW 3 Series, Mercedes-Benz C-Class, Ford Mondeo, Chrysler 200 Series, BYD Qin, Geely Borui	1400-1800kg
Sedan-E	Toyota Crown, Nissan Maxima, Honda Legend, Audi A6, BMW 5 Series, Mercedes-Benz E-Class, Chrysler 300 Series, Cadillac XTS, Hongqhi H7	1600-2000kg
Sedan-F	Lexus LS, Acura RLX, Infiniti Q70, Mercedes-Benz S-Class, BMW 7 Series, Jaguar XK	1800-2300kg
SUV-A	Mitsubishi Pajero Mini, Suzuki HUSTLER	800-900kg
SUV-B	Honda Vezel, Mazda CX-3, Nissan Juke,Renault Captur, Peugeot 2008, Opel Mokka, Jeep Renegade, Chevrolet Trax, Haval H2, Changan CS15	1200-1600kg
SUV-C	Honda CR-V, Nissan X-Trail, VW Tiguan, Audi Q3, BMW X1, Ford Escape, Chevrolet Equinox, Jeep Wrangler, Trumpchi GS4, Baojun 560	1500-1800kg
SUV-D	Mitsubishi Outlander, Subaru Outback, Toyota Highlander, Audi Q5, Mercedes-Benz GLC-Class, Ford Explorer, Chevrolet Traverse, GMC Acadia, Haval H6, Zotye T600	1800-2100kg
SUV-E	Lexus RX, Toyota Land Cruiser, Mitsubishi Pajero, BMW X5, Audi Q7, Porsche Cayenne, Chevrolet Tahoe, Jeep Grand Cherokee, Ford Expedition, Haval H9	2100-2600kg
MPV	Toyota Estima, Nissan Serena, Honda Odyssey, VW Touran, Renault Scenic, Ford C-Max, Chrysler Town & Country, Wuling Hongguang, JAC Refine	1100-2000kg
Pickup Truck	Toyota Hilux, Nissan Frontier, Mitsubishi Triton, VW Amarok, Fiat Strada, Ford F-Series, Chevrolet Silverado, Ram Pickup, Foton Tunland, ZX Auto Grand Tiger	1500-2500kg

Appendix 3

Estimated steel consumption and associated emissions in 2021

Figure 8. Vehicle sales and estimated Estimated steel usage by automakers in 2021.

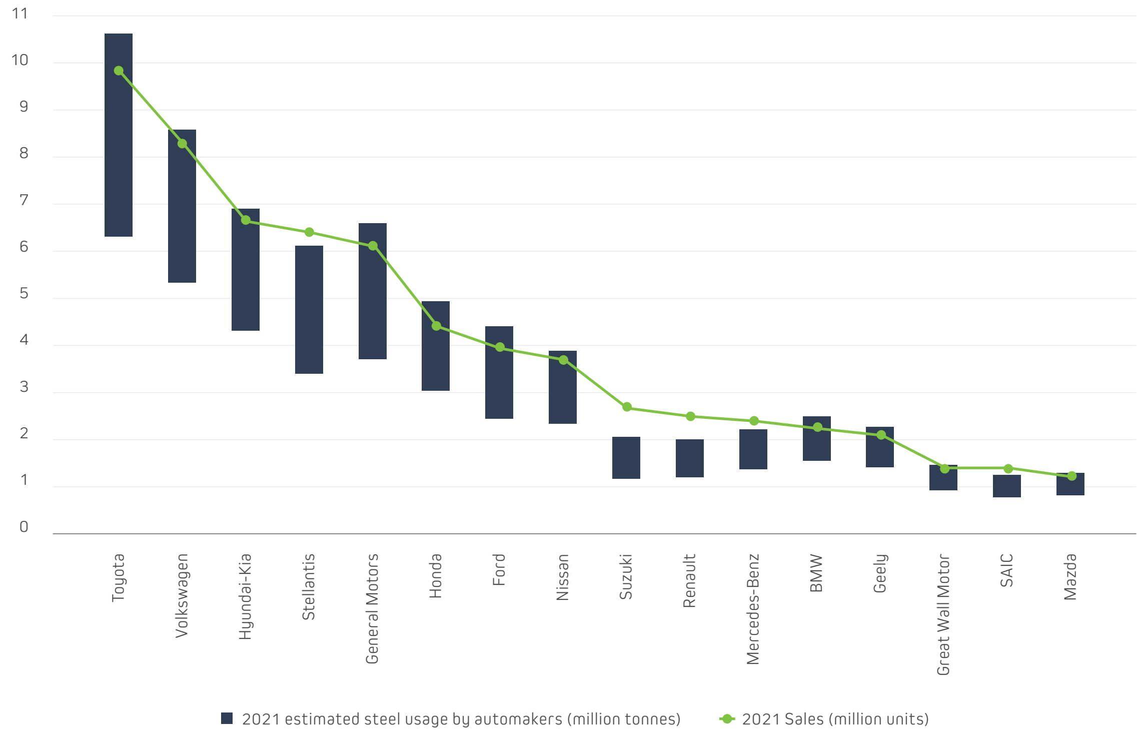


Figure 9. Vehicle sales and estimated steel usage of SUVs in 2021.

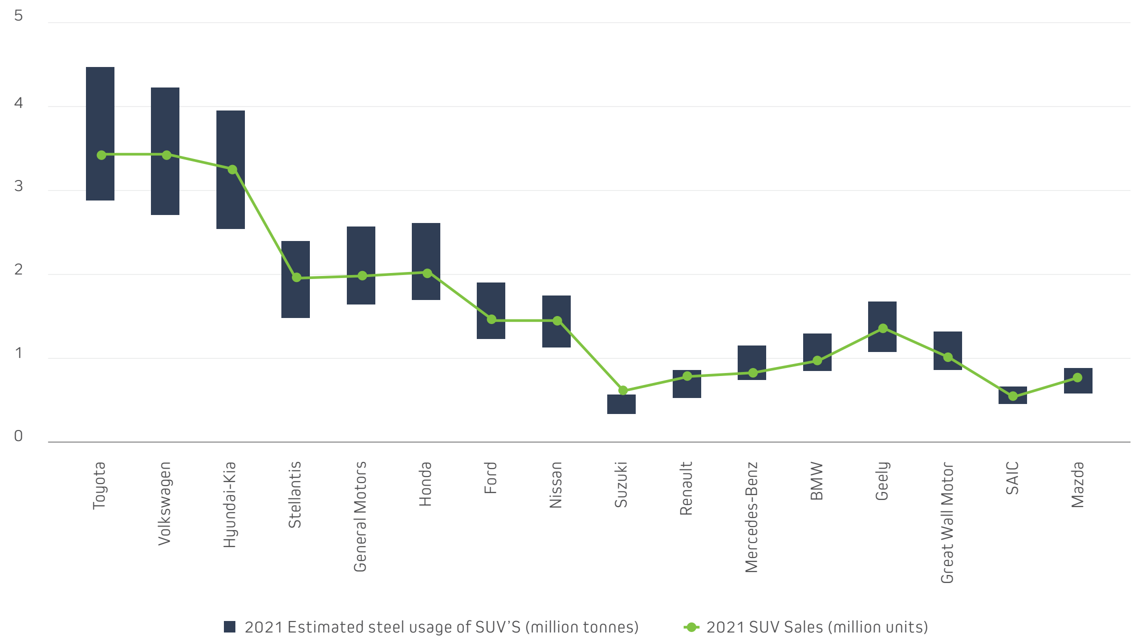
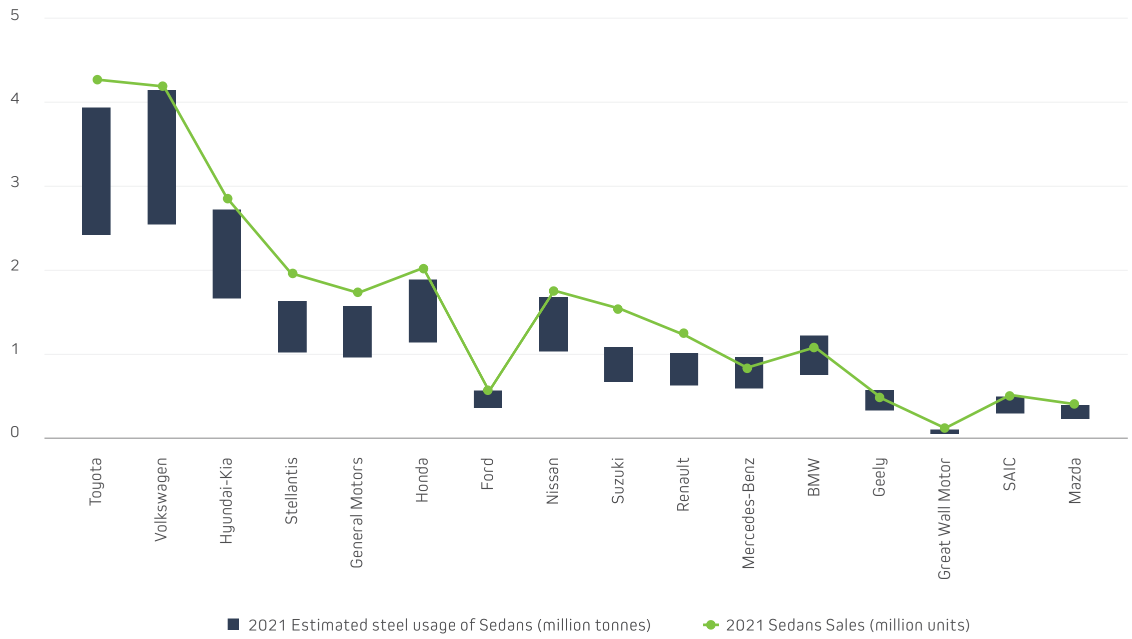


Figure 10. Vehicle sales and estimated steel usage of sedans in 2021.



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