TransitionAsia

ACCELERATING EAST ASIAN CORPORATE CLIMATE ACTION

GREEN STEEL SUBSIDY ACCELERATES CHINA'S AUTO DECARBONISATION

Case study of China's leading automaker - Geely Automobile

5 Septembert 2023

CONTENTS

KEY TAKEAWAYS

- Geely Automobile has demonstrated an awareness of climate change through active carbon reduction action in the past two years, evidenced by its target of reducing the life cycle carbon emissions per vehicle by 25% by 2025. The shift to battery electric vehicles (BEV) provides an effective method to reach this target; however, the use of green steel provides a lower cost and lower emissions option in the short-term.

- Green steel procurement can be regarded as an excellent method for automobile companies to reduce carbon emissions. The production cost of BEVs is projected to be 9%–45% higher than that of ICE vehicles, while green steel procurement offers a significant economic advantage in terms of per unit carbon reduction, with a unit decarbonisation cost ($/tCO$_2$) at least 50% lower than converting ICE to BEVs. Beyond 2030, as ICE vehicles phase out, the carbon reduction potential of shifting to BEVs reaches its highest potential. Meanwhile, the decreasing green steel premium ensures that green steel procurement continues to deliver long-term, stable, and cost-effective carbon reduction.

- Policy instruments in the form of subsidies can help transform the Chinese auto industry and drive the country forward in becoming a world leader in the low carbon industry. This can also provide valuable emission trajectories for corporations and stimulate economic growth.

- The procurement of green steel would require relatively low government subsidies, estimated at approximately an average of $100 per vehicle before 2035, then reduce by half to $50 per vehicle by 2050, providing on average 1.9 tons CO_2 reduction per vehicle.

INTRODUCTION

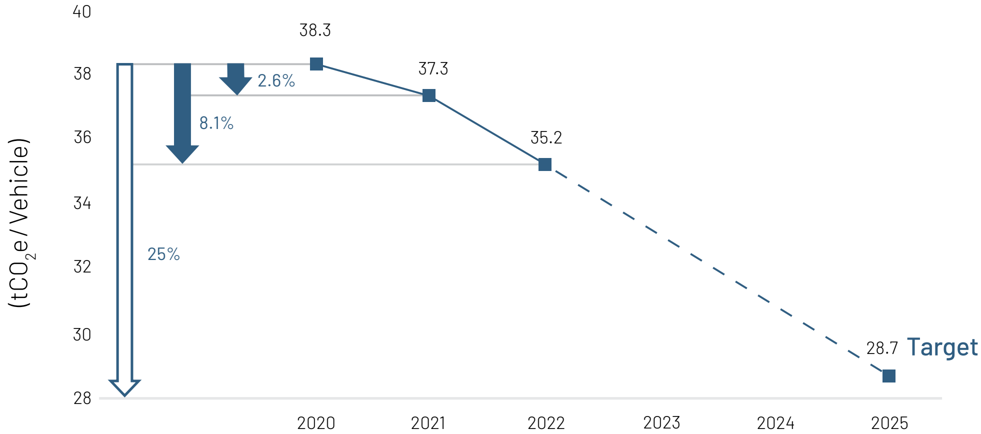
Shifting from internal combustion engine (ICE) vehicles to battery electric vehicles (BEVs) is the most effective decarbonisation strategy in the auto industry. At this stage, in terms of the full life cycle carbon emission of a vehicle, the average emission level of an ICE is 39.7 tons of CO_2, while a BEV is about 22.4 tons, which means that 17.3 tons of CO_2 (43.6%) are expected to be reduced if an auto company replaces one ICE with a BEV[1]. However, shifting to BEVs also means much higher expenditures for automobile companies because the production cost of BEVs is currently 45% higher than ICE. This unsubsidised cost difference is still expected to be 9% in 2030[2].

1 Zhang Bing, et al. 'New Beijing News and Ke.com Finance Jointly Release | The 'Dual Carbon' Journey of a Car.'Beike Caijin, 20 July 2022, www.bkeconomy.com/detail-165828428014924.html.

2 Ruffo, Gustavo Henrique. "EVs Are Still 45% More Expensive to Make than Combustion-Engined Cars." InsideEVs, 17 Sept. 2020, insideevs.com/news/444542/evs-45-percent-more-expensive-make-ice/.

Chinese automaker Geely Automobile, whose brands include Geely Auto, Volvo, Zeekr and Proton among others, has demonstrated awareness and action towards reducing carbon emissions in recent years. Most notably, it has committed to setting targets with the Science Based Targets initiative (SBTi) and in 2022, Geely Automobile witnessed a rapid increase of 300% in the sales of new energy vehicles (NEVs)[3] in a single year from 2021. Based on the life cycle emission level per vehicle in 2020, Geely Automobile has completed an 8.1% emission reduction from 2020 to 2022. However, Geely Automobile is still facing the challenge of its internal near-term carbon reduction path because it needs to complete 16.9% in vehicle intensity emissions reduction in the coming three years to achieve its 2025 carbon reduction target. Meanwhile, Geely Automobile's ICE sales still account for 77% of its total sales, and its proportion of renewable energy (RE) in vehicle plants' energy consumption only stands at 18.5%, indicating the potential for future development. Notably, Geely Automobile has not shown any indication of purchasing and utilising green steel. Green steel is steel produced via scrap steel+EAF or H_2-DRI-EAF where energy and hydrogen are produced via renewable energy, which, if incorporated into their decarbonisation strategy, would provide fast and effective emission reductions[4].

Figure 1 - Geely's Target on Lifecycle Carbon Emissions per Vehicle



Source: Geely Automobile 2022 ESG Report

Although Geely Automobile's transition pathway in the short-, medium- and long-term would likely involve significant effort to further reduce the proportion of ICE vehicles in their sales, it is crucial for Geely Automobile to prioritise sustainable materials and practices throughout their supply chain and manufacturing processes, mainly through the adoption and use of green steel. Through the adoption of green steel, Geely Automobile can contribute to the decarbonisation of the steel industry in China and simultaneously achieve a substantial positive climate impact from multiple angles.

Subsidies for green steel would both significantly contribute to growth and future economic supremacy in China's steel and automotive industries. Implementing subsidies for the automotive sector in China holds the potential to foster a dual-purpose revolution, effectively addressing the need to decarbonise while maintaining the nation's economic and strategic stronghold.

3 This includes battery electric and plug-in hybrid vehicles. Geely Auto , Geely ESG Report 2022, https://global.geely.com/-/media/project/web-portal/2023/esg/geely-esg-report-2022.pdf.
4 For more information see: https://transitionasia.org/wp-content/uploads/2023/02/TA-Steel-Explainer2023-1.pdf

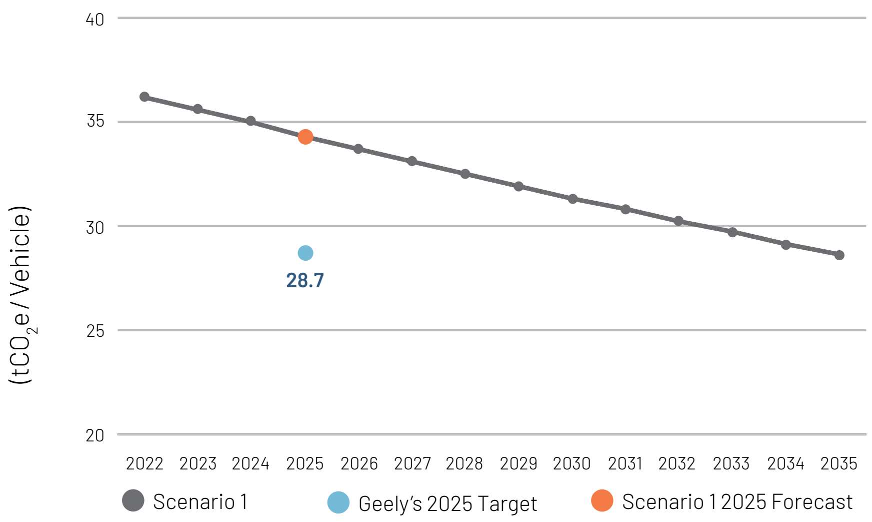
In this paper, we have conducted a comprehensive analysis and developed recommendations regarding Geely Automobile's current situation to help facilitate its target achievement for the short-term (2025) and the long-term (2050), and also proposed the introduction of government subsidies to further support the company's goals.

GEELY AUTOMOBILE 'S DECARBONISATION PATHWAY

To assess the potential transition pathways for Geely Automobile, we have simulated two scenarios: Scenario 1 and Scenario 2[5]. In Scenario 1, Geely Automobile gradually shifts all its production from internal combustion engine (ICE) vehicles and plug-in hybrid electric vehicles (PHEVs) to battery electric vehicles (BEVs) by 2050 in a linear fashion. In Scenario 2, Geely Automobile aims to align with its 2025 target and the European Union's policy banning ICE vehicles by 2035, reflected in our model as a rapid phase out of ICE and PHEVs by 2035[6]. In both scenarios, we set the same linear green steel procurement path, as suggested by Steel Zero, buy and use 50% low emission steel by 2030, and to use 100% net zero steel by 2050[7].

Our analysis suggests that if Geely Automobile follows Scenario 1, the 2025 emission reduction target cannot be met until 2035, as the carbon intensity is expected to remain higher than 30 tCO_2e per vehicle in 2025, which is 58% behind the expected emissions reduction trajectory.

Figure 2 - Scenario 1: Lifecycle Carbon Intensity and 2025 Target



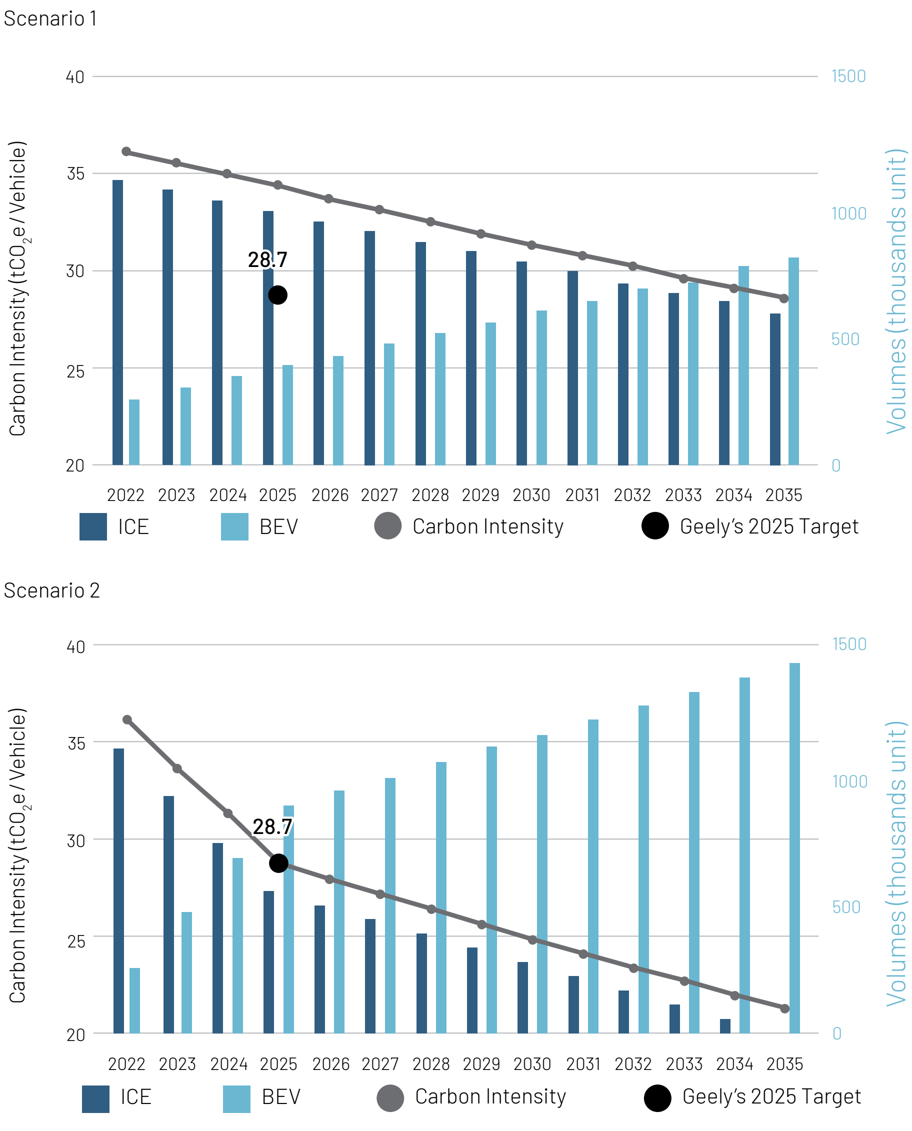
Source: TA analysis

In contrast, Scenario 2 provides significant emissions reduction but requires a more rapid and radical transformation. If Geely Automobile wants to achieve its 2025 target, as a minimum, Geely Automobile has to reduce all PHEV production and halve its ICE vehicles

5 Please refer to the Appendix for more information.
6 We have assumed that sales volumes equal to production volumes in the analysis over the period studied. The unit cost of a vehicle is predicted based on the International Energy Agency (IEA) and Oliver Wyman. Carbon intensity data for the carbon footprint per vehicle lifetime is referred to the Chinese Auto industry data.
7 "Building Demand for NET Zero Steel." Climate Group, www.theclimategroup.org/steelzero. Accessed 14 Aug. 2023.

production by 2025. Additionally, the production of BEV would need to increase by 236% from its 2022 level by 2025, and the proportion of green steel consumption should reach 20%. Following this rapid decrease in ICE and PHEV production, a slightly slower, albeit still aggressive, phase out of ICE vehicles and PHEVs will result in zero production in 2035. Subsequently, large quantities of BEVs are produced, accounting for the majority of vehicle production in 2025 and all vehicles produced by 2035.

Figure 3 - Auto Volumes and Carbon Intensity by Scenario



Source: TA analysis

Transitioning from ICE to BEV offers a rapid and significant impact on carbon reduction, particularly before 2030. This transition aligns with the broader goal of reducing greenhouse gas emissions in the auto industry, however, it is crucial to note that traditional automobile companies, including Geely Automobile, cannot avoid the substantial costs when shifting to BEV. The cost difference between ICE vehicles and BEVs is expected to remain high before 2030, with BEVs ranging from 9% to 45%[8] more than ICE vehicles.

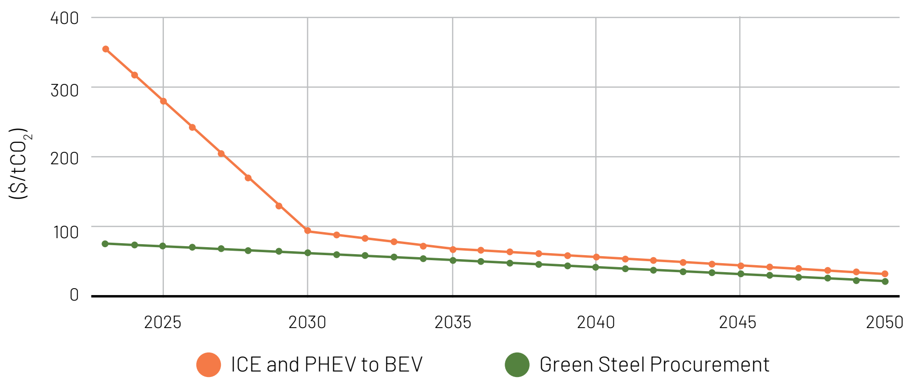
BEV vs. GREEN STEEL: UNIT DECARBONISATION COST

Transition Asia has evaluated which parameters can provide more cost efficient emissions reduction, particularly in regard to the benefits of incorporating green steel. Using our Green Steel Premium (GSP) Model, the GSP delta with BF-BOF steel is projected to decrease annually, indicating the cost of green steel becoming more affordable over time. This model provides the additional potential cost advantages associated with transitioning to green steel, under the trend of increasing numbers of development of NEVs in China.

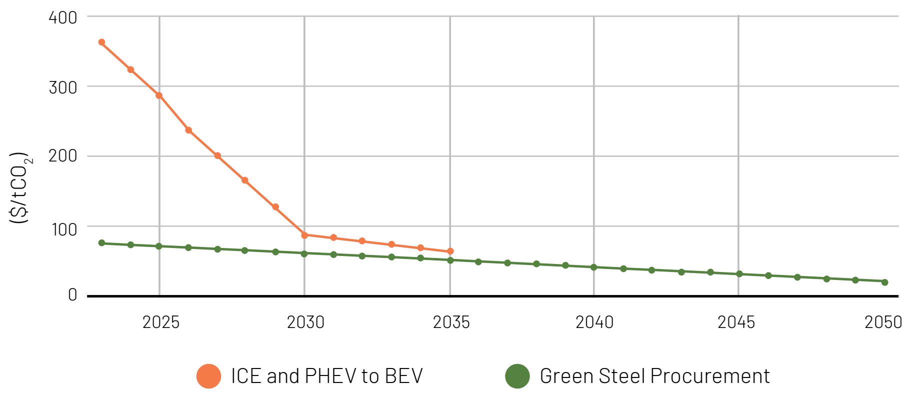
We consider the indicator of increased cost spent per carbon emission reduced to provide a comprehensive comparison of the results. We examine and compare the unit decarbonisation cost of the following two options: only shifting ICE and PHEV to BEV and only conducting green steel procurement. In our analysis, the decarbonisation cost of each option is divided by the carbon reduction of this option. By using this approach, we can effectively evaluate the cost-effectiveness of the green steel transition without relying on uncertain factors such as sales volume, production units, or the proportion of green steel supply. This methodology allows for a fair and accurate assessment of the economic implications of adopting green steel in relation to the reduction of carbon emissions.

Figure 4 - Unit Decarbonisation Cost Comparison by Decarbonisation Option

Scenario 1



Scenario 2



Source: TA analysis. All figures are unsubsidised

8 IEA (2022), World Energy Outlook 2022, IEA, Paris https://www.iea.org/reports/world-energy-outlook-2022, License: CC BY 4.0 (report); CC BY NC SA 4.0 (Annex A)

In both scenarios, the unit decarbonisation cost of green steel procurement is lower than shifting to BEV, and would decrease over time. Based on Transition Asia's existing study on green steel premiums, the China specific unit decarbonisation cost ($\$/tCO_2$) of scrap-EAF and green hydrogen DRI-EAF in 2023 is around $75 and $89, respectively, whereas the unit decarbonisation cost of shifting to BEVs in 2023 exceeds $350. Before 2030, the unit decarbonisation cost of green steel procurement is at least 50% lower than moving production from ICE and PHEV to BEV.

With the reduction of RE prices and green hydrogen prices, the economic advantages of green steel procurement can be sustainably maintained. This presents a promising opportunity for Geely Automobile to invest in green steel and become an industry leader of sustainability in the sector by 2030. It is also even more economical for Geely Automobile to develop supplier partnerships in order to control the total manufacturing costs.

After 2030, assuming ICE vehicles gradually phase out from most of Geely Automobile's markets, the carbon reduction effect of shifting from ICE to BEV will reach its upper limit. Especially under Scenario 2, ICE is expected to be phased out in 2035, so shifting to BEV production to reduce emissions loses its competitiveness. Simultaneously, with the decline of the GSP year over year, its carbon reduction effect and cost efficiency will become more obvious.

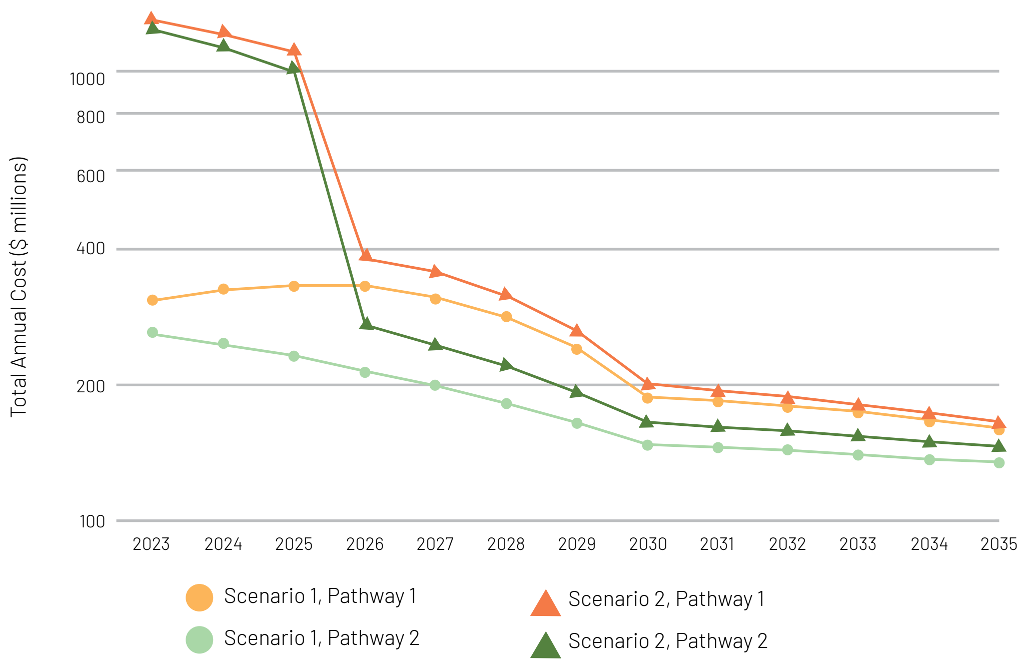
TOTAL COST OF DECARBONISATION PATHWAYS

We examine the effect of green steel procurement on Geely Automobile's overall decarbonisation cost, building upon the previous analysis and comparison of the unit decarbonisation cost for transitioning to BEVs. We have established two pathways: Pathway 1 involves exclusively shifting ICE and PHEV models to BEVs, while Pathway 2 encompasses the integration of green steel procurement alongside the shift to BEVs. We evaluate the total cost of both pathways while maintaining the same level of carbon reduction in each scenario.

When considering overall costs, there is a noticeable decline in annual expenses, which can be attributed to the decreasing costs of BEVs in both scenarios. Before 2025, the pathways in Scenario 2 exhibit costs that are nearly 4.5 times higher compared to those in Scenario 1. This discrepancy arises from the higher initial expenses associated with BEVs in contrast to ICE vehicles, particularly before 2030, and the substantial number of BEVs required before 2025. However, as ICE vehicles are rapidly phased out, annual costs for Scenario 2 experience significant reductions, particularly after 2035.

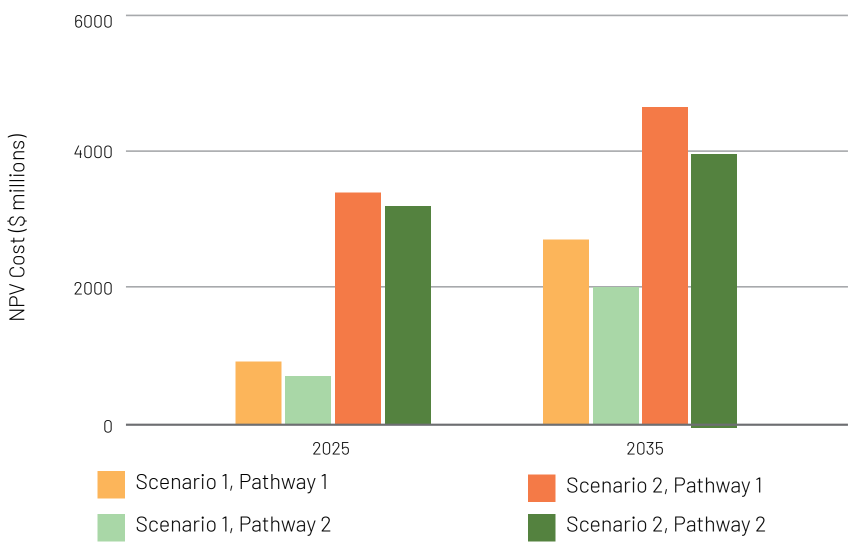
Through a comparison of the Net Present Value (NPV) between the two pathways, it is evident that the integration of green steel procurement (Pathway 2) results in lower costs compared to solely shifting to BEVs (Pathway 1), while achieving the same level of carbon reduction. In Scenario 1, adopting Pathway 2 for decarbonisation leads to savings of $219 million by 2025 and $729 million by 2035. Similarly, in Scenario 2, Geely Automobile can achieve its decarbonisation targets and save $224 million by 2025 and $683 million by 2035, respectively.

Figure 5.1 - Change in Total Annual Cost



Source: TA analysis . All figures are unsubsidised.

Figure 5.2 - NPV by Scenario



Source: TA analysis. All figures are unsubsidised.

Green steel presents Geely Automobile with a cost-effective solution to reduce emissions in either scenario. This is primarily due to the lower unit decarbonisation cost associated with green steel. By incorporating green steel into their operations, automobile companies can achieve equivalent carbon reduction outcomes while also realising cost savings. The extent of cost savings becomes more pronounced as the proportion of green steel purchased increases.

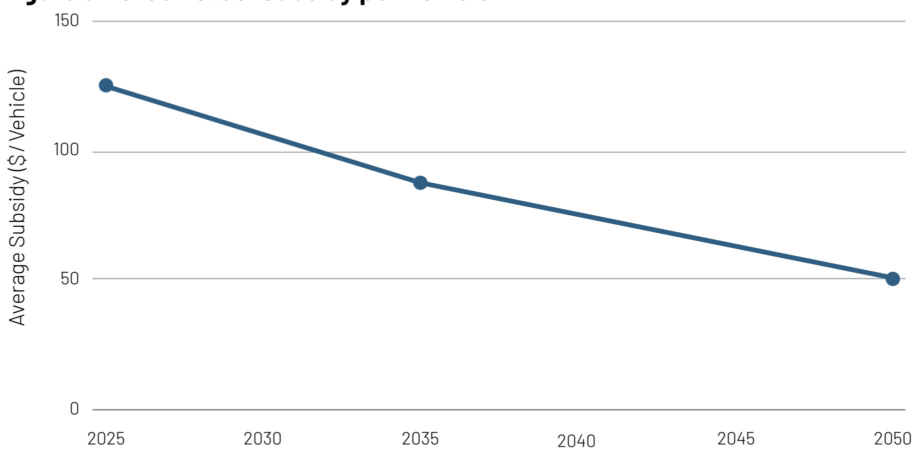
AUTO GREEN STEEL SUBSIDY TO TRANSFORM CHINA'S STEEL SECTOR - AUTO VALUE CHAIN

As the world's largest producer and consumer of steel, China's commitment to mitigating greenhouse gas emissions holds significant global implications. To achieve substantial reductions in carbon emissions within the steel sector, a combination of technological advancements, policy interventions and industry collaboration is essential.

In light of this, we propose that the shift to green steel should be backed by government subsidies. There is currently no government subsidy focussed on green steel for the auto industry whereas subsidies for BEVs and other NEVs have existed for many years. Historically, state subsidies to the steel industry have benefitted BF-BOF steel production with energy and raw materials, including coking coal, being the target of government subsidies. Transition Asia encourages a shift in state steel subsidisation from fossil fuels to the supply and demand side of green steel, providing on average 1.9 tons CO_2 reduction per vehicle.

For the procurement of green steel produced via scrap steel+EAF or H2-DRI-EAF where energy and hydrogen are produced via renewable energy, government subsidies would be relatively low, estimated at around $126 per vehicle by 2025 and $88 per vehicle towards 2035. By 2050, due to the declining price of green steel, the average green steel subsidy has been reduced to an inconsequential $50 per vehicle.

Figure 6 - Green Steel Subsidy per Vehicle



Source: TA analysis. All figures are unsubsidised.

For the auto industry, following SteelZero's recommendations and setting green steel procurement ambitions of 50% by 2030 and 100% by 2050 would be unprecedented. Such an action would place Geely Automobile firmly as a sector leader and send a clear demand side signal to Chinese steel companies that green steel is in demand and will remain so.

China introducing subsidies for the automotive sector and expanding its economic growth in the industry further rests on several pivotal factors. First, the relationship between the automotive and steel sectors must be acknowledged. With the automotive industry constituting approximately 7% of Chinese steel consumption, targeted support for this sector would inherently drive demand for steel, spurring the adoption of greener technologies in steel production.[9] By incentivising the automotive sector's shift towards green steel, a cascading effect of decreased emissions throughout the entire value chain could be achieved.

Second, recognising that the automotive sector contributes significantly to the nation's GDP, accounting for around 10%, it becomes evident that substantial investments in sustainable practices within this sector can catalyse economic growth and innovation while concurrently mitigating environmental impacts[10]. Subsidies can serve as a robust instrument to accelerate the transition to cleaner mobility solutions, encouraging research and development, production scale-up, and consumer adoption of lower carbon vehicles.

Furthermore, the potential for emissions reduction becomes even more pronounced when considering the iron and steel sector's role as a major contributor to greenhouse gas emissions, accounting for approximately 17% of China's total emissions[11]. Integrating subsidies into this sector can trigger a domino effect, whereby increased demand for steel, driven by the transitioning automotive sector from ICE to BEVs and increased global market share, pushes the steel industry towards producing low carbon steel. The resulting reduction in emissions can substantially aid China in meeting its climate goals and enhancing its global reputation as a responsible and sustainable player.

This strategy aligns with China's overarching ambitions to lead the global green revolution and solidify its dominance in economic and strategic sectors. By channelling subsidies towards decarbonising the automotive sector, China can not only maintain its strong position in manufacturing and innovation but also position itself as a leader in sustainable technologies related to steel. This multi-faceted approach showcases China's commitment to tackling the urgent challenges of climate change while simultaneously bolstering its economic resilience and influence on the global stage. Subsidies for the Chinese automotive sector represent a golden opportunity to harmonise environmental stewardship, economic advancement and strategic leadership.

9 Meng, Ke. "Overview of China's Steel Industry in 2020." LeadLeo Research , June 2020, www.leadleo.com/report/details?id=5f1f-cb72a21c56636552d519.

10 Linguerri, Lorenzo. "Inside Chinese Car Market: The Rise of Homegrown Players and the Impact of Covid-19." Daxue Consulting - Market Research and Consulting China, 2 Mar. 2023,http://daxueconsulting.com/chinese-automakers-compete-for-first-place/#:~:text=China%20contributed%20to%20more%2hthan,of%20the%20%20total%20%20Chinese%20%20GDP.

11 Ji Chen, Shuyi Li, Xiangyi Li, Ye (Agnes) Li, Pursuing Zero-Carbon Steel in China: A Critical Pillar to Reach Carbon Neutrality, RMI, 2021, http://www.rmi.org/insight/pursuing-zero- carbon-steel-in-china.

TRANSITION ASIA'S RECOMMENDATIONS FOR GEELY AUTOMOBILE

To achieve Geely Automobile's 2025 target, a swift shift from ICE to BEV is necessary following the trajectory outlined in Scenario 2. This scenario will not only ensure a reduction of CO_2 in line with internal targets but also facilitate the navigation of the increasing rigour of international carbon borders such as CBAM. Procurement of green steel in line with SteelZero's target recommendations also optimises stakeholder value and extends decarbonisation further up the supply chain. Value is amplified with greater proportions of green steel purchased, providing Geely with the opportunity to maximise green steel within its vehicles to a great extent.

Geely Automobile already has major strategic shareholdings and subsidiaries that have already demonstrated an appetite for green steel procurement: Volvo Group and Volvo Cars. They have become the first automakers to venture into the realm of fossil-free steel in collaboration with Swedish steel company SSAB[12]. Transition Asia recommends that Geely builds on these strategic partnerships and cooperates closely with the steel plant suppliers to develop and implement green steel technology into the vehicle manufacturing process.

By embracing green steel, both Geely Automobile and its steel suppliers can make meaningful contributions to reducing the climate impact of the automotive industry. We believe that this can position Geely Automobile as an industry leader globally in promoting greener solutions and enabling the same change for the industry.

A SHORT NOTE ON SCRAP QUALITY CONCERNS

Scrap steel is more often than not associated with lower quality steel. This stems from the use of obsolete scrap in EAFs that has been contaminated with tramp elements, reducing the quality of the steel and compromising the structural integrity of the finished product. However, for years the American steel industry has been supplying autos with scrap-based steel for their manufacturing processes. For example, the steel used to make the shell of American manufactured car, including the doors, hood, trunk and quarter panels, contains a minimum of 25% recycled content[13]. Now, steel mills have improved quality through increasing the ratios of prompt and home scrap; new steel that is a by-product from the steel manufacturing process, and incorporating virgin iron in the form of DRI and pig iron. [14][15]Scrap-EAF steel accounts for around 70% of steel production in the US showing quality concerns can be alleviated through procuring higher grade raw materials. For the lowest carbon footprint, these are prompt and home scrap, and low carbon DRI/HBI.

12 "Volvo Cars Is First Car Maker to Explore Fossil-Free Steel with SSAB." Volvo Car Global Newsroom, 16 June 2021,https://www.media.volvocars.com/global/en-gb/media/pressreleases/282789/volvo-cars-is-first-car-maker-to-explore-fossil-free-steel-with-ssab. Accessed 14 Aug. 2023.

13 Recycling Steel and Iron Use in Automobiles ." WorldAutoSteel, 13 Sept. 2021, www.worldautosteel.org/life-cycle-thinking/recycling/.

14 Tolomeo, Nicholas, et al. "US Steel Sector Thrives as Mills Move Up Quality Ladder." S&P Global Commodity Insights, 9 May 2019, www.spglobal.com/commodityinsights/en/market-insights/blogs/metals/050919-us-steel-sector-thrives-as-mills-move-up-quality-ladder.

15 "Advanced High Strength Steel Grades: Big River Steel." BRS, 3 Apr. 2020, bigriversteel.com/products/ahss/.

GLOSSARY

BEV Battery electric vehicle
NEV New energy vehicle
ICE Internal combustion engine
PHEV Plug-in hybrid vehicle, powered by both gasoline and electricity
RE Renewable Energy
GSP Green Steel Premium
DRI Direct Reduced Iron
EAF Electric Arc Furnace
HBI Hot Briquetted Iron

APPENDIX:SPECIAL TERMS

Scenario 1: A smooth decarbonisation scenario in which Geely Automobile gradually shifts all its production from internal combustion engine (ICE) vehicles and plug-in hybrid electric vehicles (PHEVs) to battery electric vehicles (BEVs) by 2050 in a linear fashion, together with green steel procurement growth aligned to Steel Zero's suggestion.

Scenario 2: An aggressive decarbonisation scenario where Geely Automobile aims to align with its 2025 target and the European Union's policy banning ICE vehicles by 2035, reflected in our model as a rapid phase out of ICE and PHEVs by 2035, together with green steel procurement growth aligned to Steel Zero's suggestion.

Pathway 1: Only shifting ICE and PHEV to BEV

Pathway 2: Shifting ICE and PHEV to BEV with the integration of green steel

DATA AND DISCLAIMER

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Founded in 2021, Transition Asia is a Hong Kong-based non-profit think tank that focuses on driving 1.5°C-aligned corporate climate action in East Asia through in-depth sectoral and policy analysis, investor insights, and strategic engagement. Transition Asia works with corporate, finance, and policy stakeholders across the globe to achieve transformative change for a net-zero, resilient future. Visit transitionasia.org to learn more.