SIGNAL
CLIMATE ANALYTICS

Charging up for the EV race

Are automotive companies ready for the climate transition?

November 2022

Authors: Emma Amadi, Carole Ferguson, Oliver Weber, Jules Rouvillois

SIGNALCLIMATEANALYTICS.COM

Signal Climate Analytics is a fundamental research and analytics group at the forefront of systems-level strategic analysis. We provide the market with systemic and company-level insights on the challenges and opportunities of the transition to a post-carbon economy, focusing on the companies, sectors and technologies that matter most. Signal Climate Analytics is part of Signal ESG Limited, which is registered in the UK at Companies House, registration number: 14053210. Signal ESG Limited is a subsidiary of Signal ESG Inc, a Delaware company.

Data for this report was collected up to the end of October 2022.

AUTHORS:
Emma Amadi
Carole Ferguson
Dr Oliver Weber
Jules Rouvillois

Glossary

CAFC: Corporate Average Fuel Consumption

CAFE: Corporate Average Fuel Economy

CAGR: Compound Annual Growth Rate

CAPEX: Capital Expenditures

CO_2: Carbon dioxide

EBITDA: Earnings Before Interest, Taxes, Depreciation, and Amortization

EEA: European Environment Agency

EU: European Union

EV: Electric Vehicle

FCEVs: Fuel-cell electric vehicles

gCO_2/km: grammes of carbon dioxide per kilometre

gCO_2/mile: grammes of carbon dioxide per mile

GHG: Greenhouse Gases

GWh: gigawatt-hour

HEV: Hybrid electric vehicles

ICCT: International Council on Clean Transportation

IEA: International Energy Agency

JV: Joint Venture

L/100km: litres per 100 kilometres

LFP: lithium-ion phosphate batteries

METI: Ministry of Economy, Trade and Industry (Japan)

NCA: lithium nickel cobalt aluminium oxide batteries

NEDC: New European Driving Cycle

NEVs: New Energy Vehicles

NMC: nickel manganese cobalt

NZE: Net Zero Emissions by 2050 Scenario

R&D: Research and Development

TCFD: Taskforce on Climate-Related Financial Disclosures

tCO_2: tonne of carbon dioxide

tCO_2e: tonne of carbon dioxide equivalent

CONTENTS

Assessing the automotive sector transition to net zero

This report initiates Signal Climate Analytics coverage of the global Automotive sector. It includes 29 of the largest global automobile original equipment manufacturers (OEMs), selected based on market capitalisation and passenger vehicle sales coverage in major markets – the US, China, Europe, Japan and the emerging Indian market. The companies selected together represent 96% of global sales units for passenger vehicles and all companies are publicly listed. The aim of the report is to assess which automotive companies are best positioned to transition to a post-carbon economy through electrification of their fleets.

The automotive sector has gone through significant change since 2018 driven by disruptive technology from battery electric vehicles (BEVs) and other low emissions vehicles such as plug-in hybrids (PHEVs) and hybrids (HEVs) from pure play electric vehicle (EV) companies such as Tesla and BYD. Incumbent OEMs have been forced to adopt low emission vehicles, driven by tightening fleet emissions regulation across all major markets with European countries and states such as California introducing outright bans of Internal Combustion Engines (ICE) drivetrains from 2035.

Figure 1: Summary of selected companies

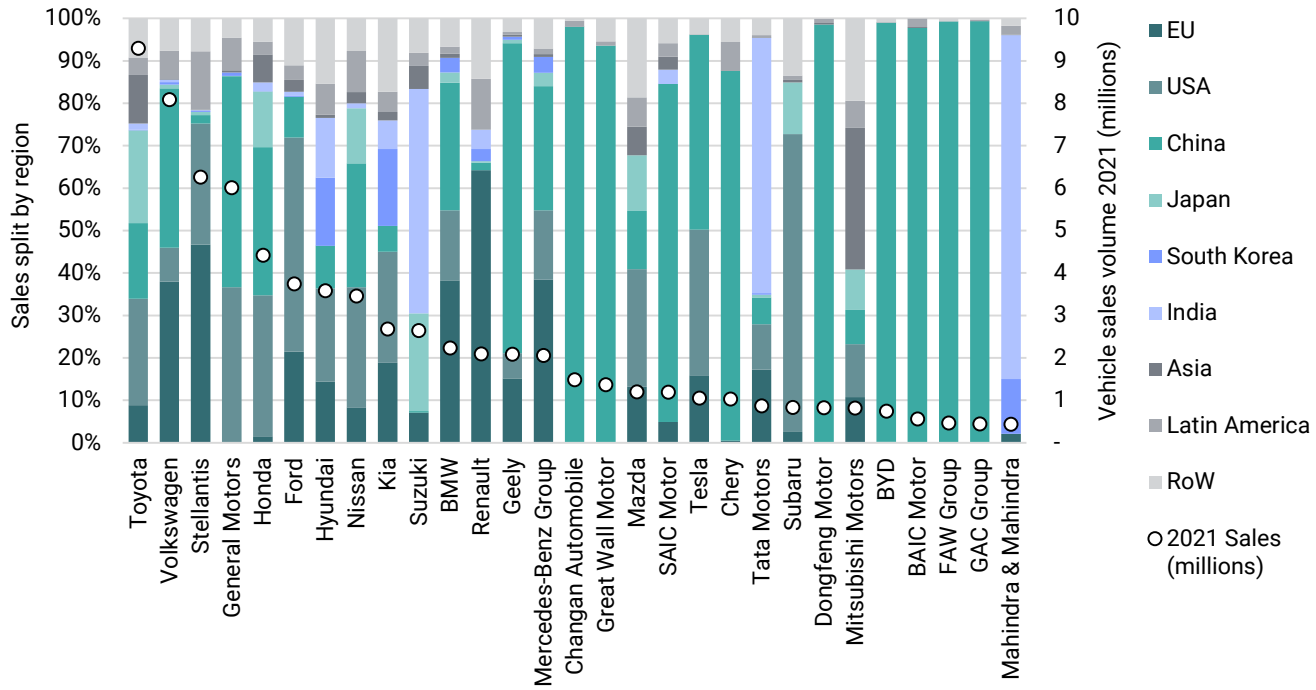
Company	Ticker	Country	Market capitalisation (US$bn) (i)	Unit sales global market share 2021 (ii)
Toyota	7203 JP	Japan	225	12.4%
Volkswagen	VOW GR	Germany	85	10.8%
Stellantis	STLA US	Netherlands	45	8.3%
General Motors	GM US	US	57	8.0%
Honda	7267 JP	Japan	42	5.9%
Ford	F US	US	57	5.0%
Hyundai	005380 KS	South Korea	27	4.8%
Nissan	7201 JP	Japan	15	4.6%
Kia	000270 KS	South Korea	20	3.6%
Suzuki	7269 JP	Japan	18	3.5%
BMW	BMW GR	Germany	56	3.0%
Reanult	RNO FP	France	9	2.8%
Geely	175 HK	China	12	2.8%
Mercedes-Benz Group	MBG GR	Germany	69	2.7%
Changan Automobile	200625 CH	China	15	2.0%
Great Wall Motor	2333 HK	China	29	1.8%
Mazda	7261 JP	Japan	5	1.6%
SAIC Motor	600104 CH	China	23	1.6%
Tesla	TSLA US	US	598	1.4%
Chery	CACTZ CH	China	-	1.4%
Tata Motors	TTMT IN	India	18	1.2%
Subaru	7270 JP	Japan	13	1.1%
Dongfeng Motor	489 HK	China	4	1.1%
Mitsubishi Motors	7211 JP	Japan	7	1.1%
BYD	1211 HK	China	91	1.0%
BAIC Motor	1958 HK	China	2	0.7%
FAW Group	CHFAWZ CH	China	-	0.6%
GAC Group	2238 HK	China	14	0.6%
Mahindra & Mahindra	MM IN	India	20	0.6%

(i) Market caputalisation: 10 November 2022
(ii) Market share of passenger vehicles and light trucks
Source: Signal Climate Analytics, Bloomberg, MarkLines

This report assesses the winners and losers in the race to deploy EVs looking at three areas aligned with the Task Force on Climate-related Financial Disclosure (TCFD) framework: transition risks, transition opportunities and climate governance and strategy. The report contains a number of metrics in these three areas which aim to capture performance rather than disclosure.

We take a critical look at current positioning of company fleets relative to their regulatory benchmarks in the four major markets, access to supply chains for critical battery materials, current market share ratios for zero emission vehicles (ZEVs) and ZEV sales targets. We also look at a number of other metrics to assess companies' alignment with the IEA Net Zero Emissions (NZE) Scenario which would require the auto sector to have achieved 60% electrified new car sales by 2030.

Figure 2: Vehicle sales split by region (2021)



Source: Signal Climate Analytics, MarkLines

Overview

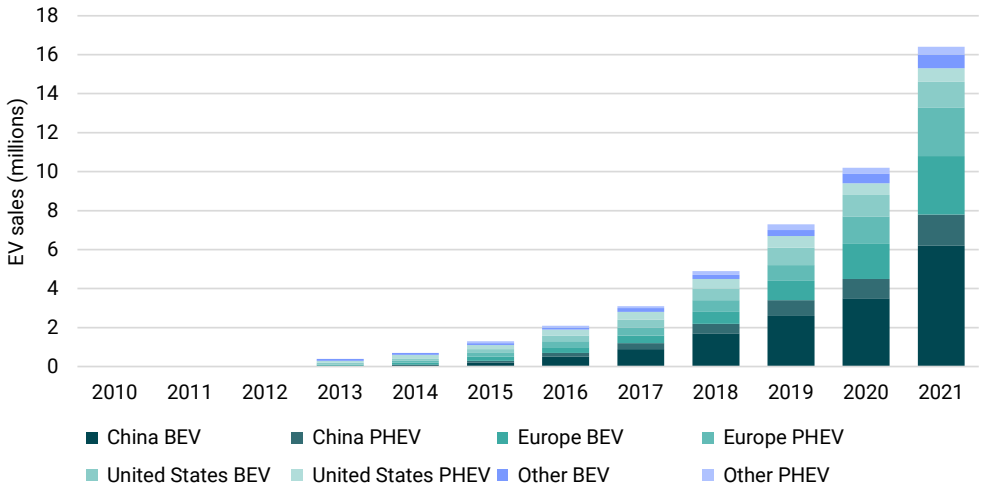
The automotive sector is undergoing profound change as the global transition to electric vehicles (EVs) continues to accelerate. Electric car sales doubled from 2020 to 2021, to an all-time record of 6.6 million[1] vehicles, nearly 9% of global car sales. 2022 is set to see this record exceeded, with 2 million EVs sold in the first quarter of the year alone, 75% higher than the same period in 2021.

The rapid market penetration rate of EVs has been driven by a variety of factors, most notably public policy support. In 2021, public spending on subsidies and incentives for EVs reached nearly US$ 30 billion[1], almost double the spend in 2020. A growing number of governments have set EV sales targets or are pledging to phase out traditional internal combustion engine (ICE) vehicles. EV sales have been further boosted by a reduction in battery costs, which have declined by around 90%[2] in the last decade, along with increasing choice in the variety of EV models available to customers.

Decarbonising the transport sector requires deep cuts in light-duty vehicle emissions

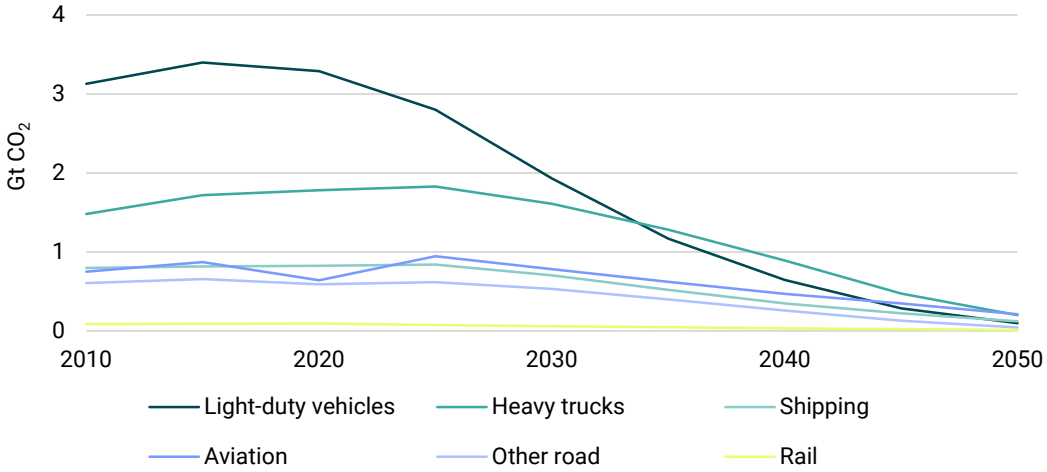
The global transport sector directly emitted 7.7 Gt CO_2[3] in 2021 (nearly 8.5 Gt CO_2 in 2019, pre-Covid-19 pandemic) of which light duty vehicles (including cars and light trucks) accounted for 3.5 Gt CO_2[4], around 8% of global direct CO_2 emissions. Under the IEA's net zero emissions by 2050 scenario (NZE), light-duty vehicle emissions need to fall by 45% by 2030 with a further 95% reduction required by 2050 to reach 0.1 Gt CO_2.

Figure 3: Global electric car stock, 2010-2021



Source: IEA

Figure 4: Evolution of the IEA's NZE scenario



Source: IEA

[1] IEA, 2022, Global EV Outlook 2022 - Securing supplies for an electric future
[2] IEA, 2021, Net Zero by 2050 – A roadmap for the global energy sector
[3] IEA, 2022, World Energy Outlook
[4] IEA, 2022, Cars and Vans
[5] ICCT, 2021, Decarbonizing road transport by 2050: Zero-emission pathways for passenger vehicles

A suite of electrification technologies have been commercialised

A variety of low- and zero-emissions vehicles (ZEV) technologies have been commercialised in recent years. Full battery electric vehicles (BEVs) are currently the main technology enabling a very low GHG emissions pathway for the sector. BEVs have been shown to have ~66%[5] lower lifecycle GHG emissions than ICEs (see Figure 6).

Plug-in hybrid vehicles (PHEVs) are also considered in low carbon scenarios as a bridge technology to achieve full electrification, but only achieve around 28%[5] lower lifecycle GHG emissions than ICEs. Emissions savings from both vehicle types are increased when powered by electricity from renewable energy.

Hybrid electric vehicles (HEV) which do not have a plug-in battery are considered a more fuel-efficient variant of an ICE car, rather than being a true electrification technology. HEV models only result in very minimal emissions savings and will not meaningfully contribute to the significant emissions reduction the sector requires to achieve net zero.

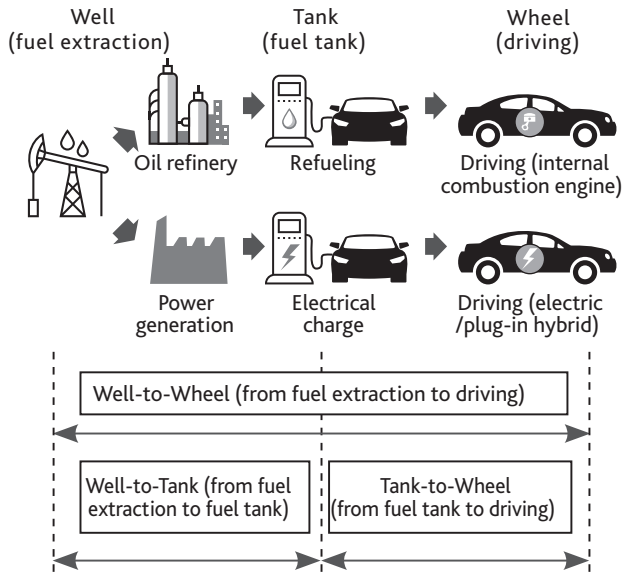
Fuel cell electric vehicles (FCEVs) also feature as a decarbonisation option, particularly in markets like Korea. FCEVs can achieve significant emissions savings when using low carbon 'green' hydrogen produced through electrolysis of water using renewable energy. The uptake of FCEVs remains limited, due partly to the inadequate roll out of hydrogen refuelling stations and higher costs of both vehicles and fuel for customers compared to other EVs.

Shifting from tailpipe to lifecycle emissions

The carbon footprint of traditional ICE vehicles is dominated by greenhouse gas (GHG) emissions from the combustion of fuel, also known as tank-to-wheel (TTW) emissions. For a mid-size ICE car TTW emissions account for around 65%[5] of total lifecycle GHG emissions.

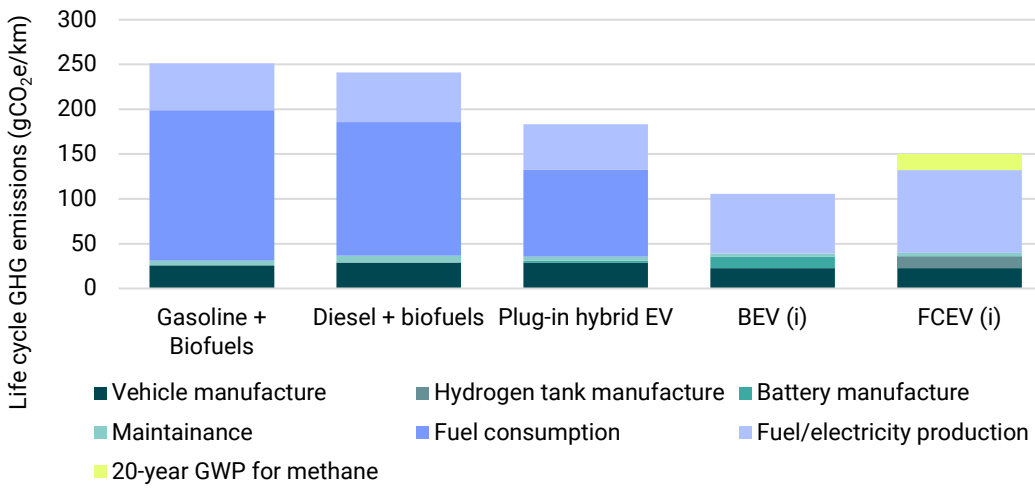
Current emission and fuel efficiency regulation for OEMs therefore focuses on TTW emissions. However, as powertrains shift from ICEs to EVs the whole vehicle lifecycle needs to be considered. Emissions from the production of electricity/fuel used to power vehicles are particularly important to capture as these account for a larger proportion of lifecycle emissions for PHEVs and BEVs.

Figure 5: Well-to-wheel and tank-to-wheel emissions



Source: Mazda

Figure 6: Life-cycle GHG emissions for medium-size cars in 2021



(i) 2021-2038 grid/hydrogen mix
Source: ICCT

[5] ICCT, 2021, Decarbonizing road transport by 2050: Zero-emission pathways for passenger vehicles

The deployment of EVs depends on battery costs, technologies and material supplies

Batteries are the biggest part of the cost differential between ICEs and BEVs and a key part of the deployment challenge facing OEMs. The IEA's Announced Pledges Scenario projects an increase in battery demand from 340 GWh in 2020 to 3,500 GWh in 2030 [6]. Battery supply chains today already face pressure from increasing demand. The price of raw materials such as cobalt, lithium and nickel have surged causing a reversal in battery costs which have risen from $132/kWh in 2021 to $135/kWh in 2022[6]. Significant investment is needed in the supply of battery materials and these projects have a long lead time.

There are currently a wide range of battery technologies in use. Most electric vehicles rely on lithium-ion technology in combination with other chemistries which determine range capacity. Lithium combined with nickel and cobalt provide the highest ranges and form the largest part of current vehicle sales. Lithium iron phosphate batteries are growing market share due to lower costs and less supply chain risks. A key innovation advantage for auto companies is the development and adoption of battery technologies with new chemistries.

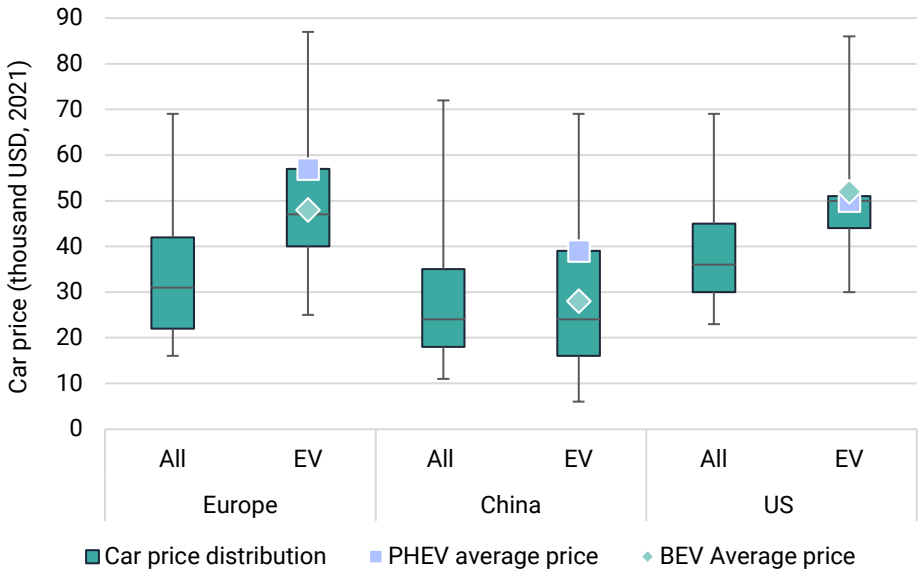
The Chinese OEMs are taking the lead in EV development

China has emerged as the leader in EV sales globally - more EVs were sold in China in 2021 (3.3 million) than in the entire world in 2020 (3 million)[7]. Chinese OEMs are breaking away at home and beginning to expand sales internationally, including Europe, another major EV market. This poses a huge challenge to the incumbent multinational European and American OEMs, many of which are yet to meaningfully invest in developing EVs. Japanese companies like Toyota are also falling behind on the ZEV transition after investing heavily in HEVs.

Charging up for the EV race

While the rapid growth in EV sales is encouraging, the sector faces several barriers in reaching full-scale electrification including constrained battery supply chains and the roll out of charging infrastructure. Despite these challenges, the market for ZEVs, charging services and infrastructure and advanced driver assistance systems is expected to grow 23% annually from today to reach US$ 2.5 trillion in value by 2030[8]. There is a race to capture a share of these new markets and companies already leading in the EV transition will be well-positioned to take advantage of new low-carbon business opportunities, while others may struggle to keep pace.

Figure 7: Price distribution of EVs compared to overall car market, 2021



Source: IEA

[6] IEA, 2022, Global Supply Chains of EV Batteries
[7] IEA, 2022, Global EV Outlook 2022 - Securing supplies for an electric future
[8] PWC, 2022, Next in auto: Automotive industry trends

Size matters

SUVs have captured a significant portion of the consumer passenger car market as their share has grown from 2010-2021. This trend driven in part by consumer taste, has counterbalanced other emissions reductions as SUVs are heavier and consume 20% more energy than an average size car. The increasing size of passenger vehicles has added to average new vehicle weight. In the USA, where this trend in most pronounced, average weight dropped 21% from 1975-1981 to a minimum of 1452 kg but has since risen steadily to reach 1865 kg in 2020.[9] This overall market trend is captured within the sample set of companies in this report.

Breaking down sales by drivetrain reveals that the percentage market share of ICE SUVs peaked in 2020 and remained stable at ±0.3% from 2019-2021, while ICEs market share declined -24% in the same period.[10] In absolute sales terms from 2016-2021, ICE SUV sales first rose then declined for an average rate of change of -0.9%, while ICE cars sales declined by -12.9%.

BEVs and PHEVs grew their market share for both SUVs and cars from less than 1 % to over 4% from 2019-2021.

The plateauing ICE SUV sales are being replaced by SUVs based on zero carbon technologies. BEV and PHEV SUV sales grew by 55% between 2016-2021, outpacing overall BEV and PHEV car sales which increased 34% in over the period.

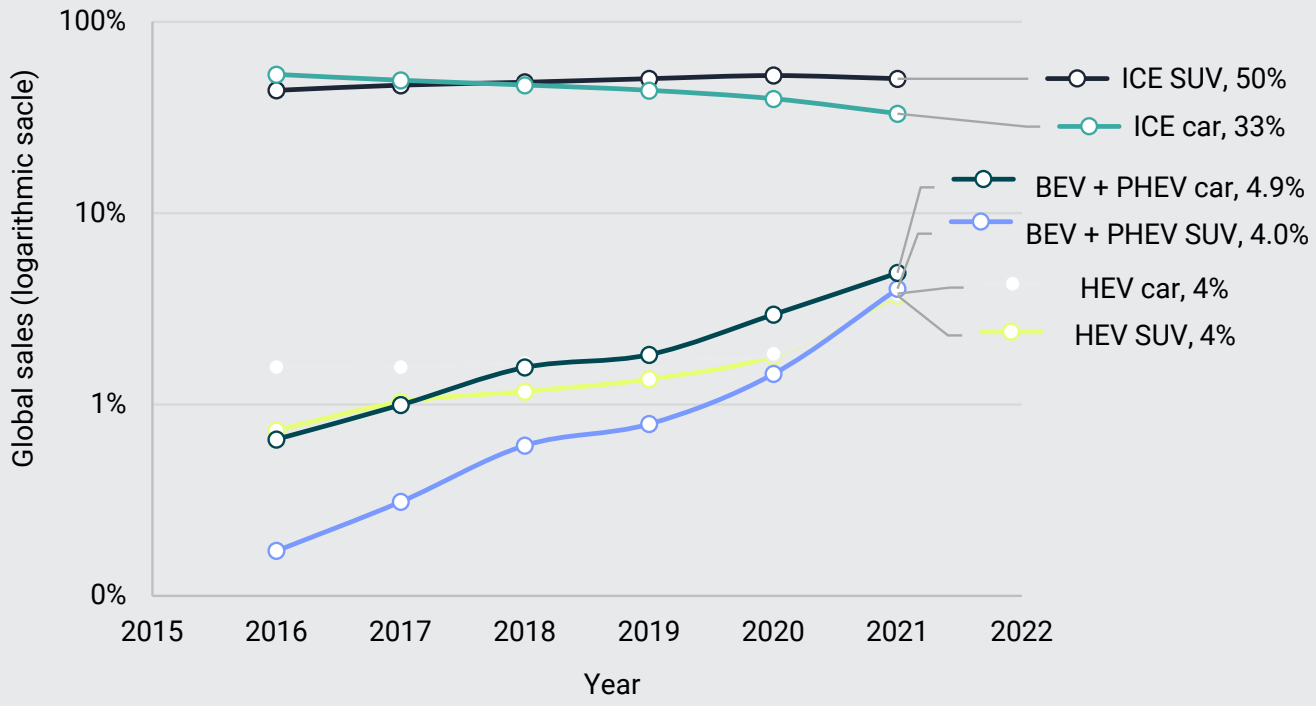
Substituting ICE SUVs with BEV and PHEV SUVs has a net carbon benefit as estimated by ADEME[11] and ICCT[12] and if this fulfils market demand by consumers, OEMs with ZEV SUV models could argue they are providing consumer choice.

However, continuing to roll out ICE and HEV SUVs will hinder progress on achieving the emissions cuts needed to decarbonise the sector.

It is interesting to note that Chinese regulation has been particularly well structured to benefit new energy vehicles through their credit system, resulting in compact, low-cost new energy vehicles that maximise credit value per vehicle. This report has found that Chinese companies in the Chinese market produced passenger vehicles that were on average 200kg lighter than foreign automakers in China.

The Chinese car companies are now able to produce a competitively priced small EVs putting them in a strong position to capture market share. In China the sales weighted average price of a small/ medium BEV was US$27,000 in 2021 in comparison to $48,000 for the equivalent BEV sold in Europe.[13] Ultimately, lighter ZEVs will have a smaller overall carbon footprint than larger, heavier models.

Figure 8: SUV and Car market share by drivetrain for the companies analysed in this report



Source: Signal Climate Analytics, Company reports

[9] EPA, 2022, The 2021 EPA Automotive Trends Report
[10] Marklines Database, 2022
[11] ADEME, 2022, AVIS de l'ADEME: Voitures électriques et bornes de recharges
[12] ICCT, 2021, A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric passenger cars
[13] IEA, 2022, Global EV Outlook 2022 - Securing supplies for an electric future

Methodology

Absolute scoring

Companies have been scored on an absolute basis in order to measure their risk and resilience against an external constraint rather than an internal industry standard. This external constraint is the limit on GHG emissions set by the Earth's climate system. The scoring in this report is therefore designed to reflect each company's exposure to the risks associated with climate change, rather than their relative position against the "best-in-class" performance for the sector.

Scores from 0 to 100 are assigned across metrics to provide a detailed analysis of company performance across climate indicators which could have a material impact on company performance. In some metrics, the best performer may receive a score well below 100, indicating that they and their peers are at risk.

Scores are then aggregated, with each metric weighted according to its influence on investment risk and opportunity, while taking uncertainty into consideration. Overall, these give an indication of how well companies are positioned to transition to low-carbon business models.

The metrics in this report have been grouped into the following categories based on the TCFD framework: Transition risks, Transition opportunities and Climate governance and strategy.

Figure 9: A summary of key areas, metrics and weights within the League Table

Key area in League Table	Financial impact	Metrics	Metric weighting	Key area weighting
Transition risks	▶ Tightening emissions regulations increase compliance costs for traditional internal combustion engine vehicles. ▶ Risk of reputational damage and financial penalties for missing fleet emissions targets, impacting earnings.	▶ **Fleet emissions performance** (passenger vehicles & Light commercial vehicles/trucks: distance to regulatory target and historical trend) EU, US, China, Japan (weightings normalized by market exposure)	80%	30%
		▶ **Manufacturing emissions intensity** (level and trend)	20%	
Transition opportunities	▶ Growing demand for zero emissions vehicles provides an opportunity to capture share of a nascent market and de-risk revenues. ▶ Ambitious zero emissions vehicle targets indicate strategy to capitalise on low-carbon opportunities. ▶ Resilient supply chains, vertical integration and battery technologies influence company's ability to deliver on low carbon business models.	▶ **Zero emissions vehicle market share ratio** (includes BEV, PHEV and FCEV)	40%	50%
		▶ **Zero emissions vehicle targets**	10%	
		▶ **Supply chain resilience**	40%	
		▶ **Capital flexibility** (gearing and net debt to EBITDA, free cash flow yield and CAPEX ratio)	5%	
		▶ **R&D spend to sales ratio**	5%	
Climate governance & strategy	▶ Ambitious emissions reduction targets and strong governance structures indicate how well companies are positioned to respond to demand disruption from regulation.	▶ **Emissions reduction target disclosure**	25%	20%
		▶ **Emissions reduction target alignment**	35%	
		▶ **Scope 3 fleet emissions accounting**	25%	
		▶ **Board & executive climate management**	10%	
		▶ **Emissions reduction target alignment**	10%	

Source: Signal Climate Analytics

Key findings

- BYD and Tesla benefit from first mover advantage in the EV market. BYD is reducing its exposure to supply chain risk through use of lithium-ion phosphate batteries and its vertically integrated business model, while Tesla is more exposed through its use of nickel and cobalt in its NCA batteries.
- There is a significant gap between the pure play EV leaders Tesla and BYD and the incumbent multinational OEMs. General Motors, Mercedes-Benz Group and BMW lead this group. All three companies are relatively well positioned in terms of battery supply chain resilience which will be critical in enabling the transition from ICEs to ZEVs.
- Chinese companies GAC Group, Changan Automobile and SAIC Motor are emerging as potential disruptors in the automotive sector. All three perform particularly well for battery supply chain resilience and GAC Group and SAIC Motors have significantly increased ZEV market share in recent years.
- Japanese companies Toyota, Honda, Mazda, Nissan and Mitsubishi Motors who were early adopters of hybrid technology lag behind their international peers, with few showing EV supply chain resilience. These companies are late adopters of BEV and PHEV technologies evidenced by low market share ratios for both.
- Large incumbent OEMs will have to accelerate ZEV adoption substantially to meet tightening fleet emissions regulations in major markets which focus on tailpipe emissions as well as their own ambitious ZEV sales targets.
- The European, the US and Japanese based OEMs showing leadership in climate governance have not performed as well in the metrics that evaluate momentum in fleet electrification. By contrast, Chinese companies in this report and Tesla, lag in governance but lead in the EV race.

Figure 10: Summary scores

Company	Transition risk	Transition opportunities	Climate governance & strategy	Weighted score
Tesla	85	70	0	60
BYD	79	72	0	59
General Motors	31	32	57	36
BMW	38	27	58	36
Mercedes-Benz Group	21	25	79	35
Ford	26	26	50	31
Suzuki	58	16	19	30
Renault	23	23	51	29
Volkswagen	27	25	34	28
Toyota	49	13	23	26
Nissan	31	20	33	25
Stellantis	19	26	33	25
GAC Group	26	31	8	25
Geely	26	26	19	25
BAIC Motor	44	21	4	24
Kia	31	20	19	23
Honda	34	20	16	23
SAIC Motor	29	28	0	23
Mazda	28	21	17	22
Hyundai	24	21	22	22
Mitsubishi Motors	32	20	12	22
Subaru	29	19	19	22
Changan Automobile	19	28	0	20
Tata Motors	19	19	19	19
Dongfeng Motor	19	23	3	18
Great Wall Motor	27	19	0	18
Chery	24	17	0	16
Mahindra & Mahindra	10	16	22	15
FAW Group	17	17	0	13
Weighting:	30%	50%	20%	100%

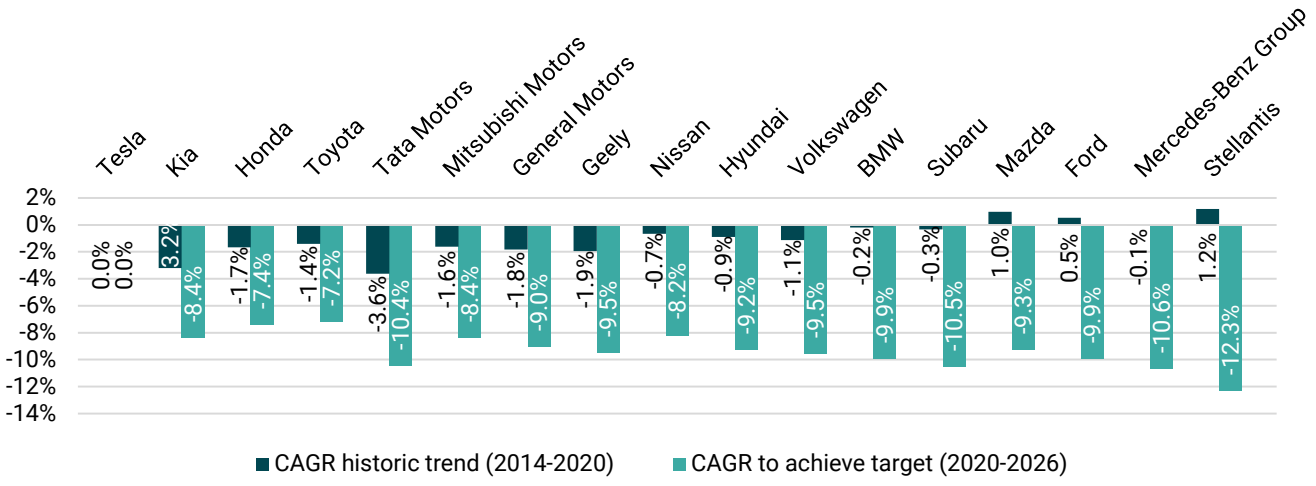
Source: Signal Climate Analytics

Highlights

Transition risks

- Companies are at risk of falling behind regulators' fleet emissions targets, with most OEMs requiring a significant reduction in fleet emissions or improvement in fuel economy to meet future regulatory targets. This is particularly pronounced in the US where companies have been slow to reduce emissions and more stringent regulation is coming into play.
- Tesla performs best overall for fleet emissions with its 100% BEV fleet. BYD ranks a close second overall, with its BEV/PHEV fleet. Both companies outperform regulator targets in all markets they have exposure to.
- Several companies perform strongly in their domestic markets, where they can optimise their fleets to meet local regulatory requirements. Suzuki performs well in Japan, its biggest market, making fuel-efficient lightweight ICE vehicles. BAIC Motor ranks third in China, having rapidly expanded BEV and PHEV sales.
- Chinese manufacturers BYD and BAIC Motor have rapidly developed small EVs in China, incentivised by the new energy vehicle credits system – part of China's fleet emissions regulation.
- Large multinational OEMs Stellantis, Mercedes-Benz Group, Renault, Volkswagen and BMW perform poorly overall against fleet emissions regulation. These companies have low historical emissions reduction rates and require a step up in emissions reductions and EV deployment to meet future regulatory targets.
- Scope 1 and 2 manufacturing emissions have increased by 1.7% on average across the sample from 2016-2020, reaching an average of 0.57 tCO_2e per vehicle in 2020.

Figure 11: US Passenger vehicles GHG emissions: past trend and future performance needed to meet 2026 target

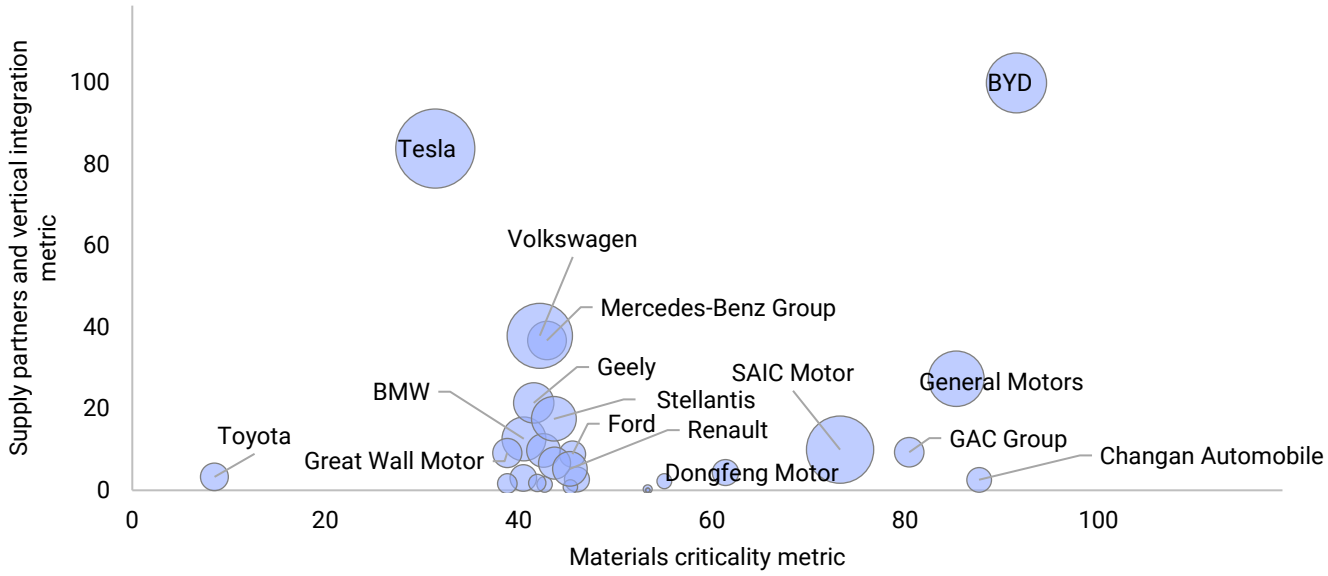


Source: Signal Climate Analytics, EPA

Transition opportunities

- BYD leads overall for transition opportunities, with its uniquely vertically integrated EV supply chain and early adoption of lower-risk lithium-ion phosphate batteries. The company has rapidly grown BEV and PHEV sales and announced it would no longer produce ICEs in 2022.
- Tesla ranks a close second overall for opportunities with well-established supply chain partnerships and ambitious aims to sell 20 million BEVs by 2030. However, its use of NCA batteries leaves it more exposed to supply chain risks from cobalt and nickel.
- Tesla's BEV market dominance is being eroded by increased sales across the market and from new entrants: Chinese companies BYD and GAC Group.
- Japanese companies perform poorly in terms of ZEV market share ratio and supply chain resilience. These OEMs were early adopters of HEV technology but have failed to develop BEV and PHEV sales or supply chains.
- Large global OEMs General Motors and Volkswagen have built up some of the highest absolute BEV sales, but this remains below 10% of each companies' total vehicle sales, presenting a challenge to scaling fleet electrification.
- General Motors and Chinese companies BYD, Changan Automobile, GAC Group are well positioned in terms of access to critical battery materials as early adopters of lithium-ion phosphate batteries which do not contain cobalt or nickel and their associated supply chain risks.
- Large global players Stellantis and Ford and Korean companies Kia and Hyundai provide detailed and ambitious ZEV sales targets but have historically failed to develop BEV and PHEV sales.
- Chinese companies, apart from BYD and Geely, fail to disclose detailed ZEV sales targets, but have rapidly increased BEV and PHEV sales since 2019 and are well placed to continue this trend.

Figure 12: Materials criticality score vs partnerships and vertical integration score

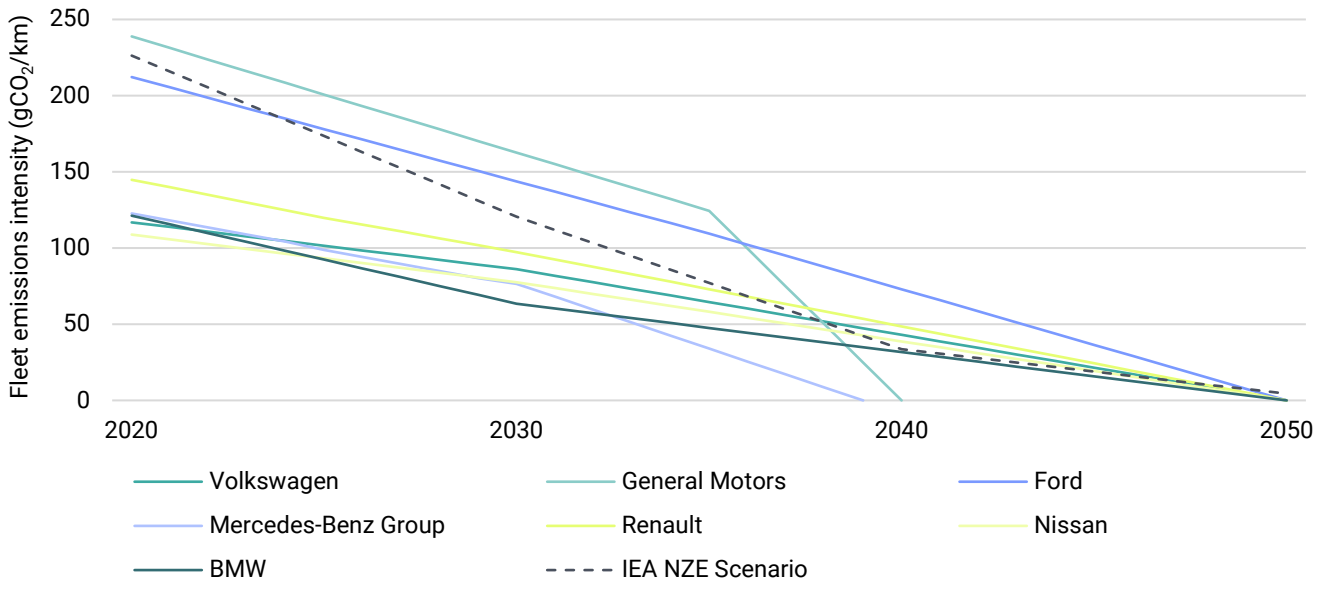


Source: Signal Climate Analytics, MarkLines, Abdelbaky et al. 2022

Climate governance & strategy

- Large multinational European and American OEMs such as Mercedes-Benz Group, BMW, General Motors, Ford and Renault, perform the best in terms of climate governance and strategy. All five companies aim for net zero or carbon neutrality by 2050.
- Tesla and Chinese companies BYD, SAIC Motor, Changan Automobile, Great Wall Motor, Chery and FAW Group rank lowest. These companies do not disclose any targets and do not disclose any evidence of climate-related committees or remuneration.
- The companies showing leadership in climate governance have not performed as well in the metrics that evaluate EV deployment in transition risks and opportunities. By contrast, Chinese companies and Tesla, lag in governance but lead in the EV race.
- 21 companies have set a near- or long-term emissions reduction target. However, the quality of these varies significantly across the group.
- 15 companies disclosed Scope 3 fleet emissions reduction targets. However, only seven provided the base year emission required to assess target alignment with the IEA NZE scenario
- Mercedes-Benz Group is the only company with a fleet emissions reduction target aligned with the IEA NZE scenario emissions budget. However, the company's current ZEV sales are very low, so a significant shift in business model is required to achieve this target.
- 19 companies disclose a long-term target committing to achieve net zero emissions or carbon neutrality. However, only six companies - Toyota, Nissan, Suzuki, Kia, Mazda, and Subaru - have defined quantitative long-term emissions reduction targets, ranging from 90% - 100% emissions reductions.
- Analysis of Scope 3 emissions accounting shows that only eight companies have adopted a more holistic WTW methodology with the large global auto companies Mercedes-Benz Group, Renault, BMW, General Motors and Ford leading with their Japanese peers lagging although Japanese regulators are moving to WTW regulation.

Figure 13: Company Scope 3 use of sold products (well-to-wheel) targets compared to IEA NZE scenario



Source: Signal Climate Analytics, Company reports

Conclusion

This report highlights the leaders and laggards in the EV race. While Tesla and BYD have emerged as two clear leaders, Chinese companies GAC Group, Changan Automobile and SAIC Motor are emerging as potential disruptors. Incumbent multinational OEMs have considerable ground to cover to develop EV sales at scale, although many are better positioned than their Japanese counterparts who have failed to develop the BEV and PHEV technologies needed to drive deep cuts in carbon emissions.

As these results indicate, EV adoption has been faster in some markets than others. Emissions reduction regulations in the EU and China have encouraged many manufacturers to develop BEV and PHEV sales to benefit from favourable credits or fleet emissions accounting. EV adoption rates have been lower in the US and Japan and fleet emissions regulation in these markets has not provided the same incentives as the EU and China.

Fleet emissions regulation is becoming more stringent across all major markets, and many of large incumbent OEMs may struggle to meet new targets. More research is needed to understand the suite of incentives that regulators and companies can provide to develop EV sales in markets where adoption is lagging.

This report identifies several companies who have developed the resilient EV battery supply chains needed to capitalise on new opportunities in the EV market and meet new regulatory targets. Although many of the Chinese OEMs in this report are technically well placed to elevate their position in the global market, the geopolitical landscape is changing radically. Most notably, the US Inflation Reduction act could create barriers to entry for these companies, favouring domestic car manufacturers.

Manufacturers based in the EU and US in particular have heavier fleets with larger carbon footprints. More company-level research is needed to understand how this may negatively impact emissions reductions in the transition to ZEVs.

Further research is needed to understand the extent to which companies are investing in innovative battery technologies that could increase their supply chain resilience and lower costs and range capacity of EVs. An exploration of emerging EV battery leasing business models is also needed, with potential significant advantages for reducing EVs lifecycle carbon footprints and reducing some supply chain risks through material recycling.

Ultimately the shift to EVs will require car manufacturers to develop new business models and cross-sectoral partnerships not just with immediate suppliers, but beyond to the mining companies and chemicals companies critical to their battery supply chains.

Contact us

Hogarth House
136 High Holborn
London WC1V 6PX
United Kingdom

Tel: +44 (0) 203 818 4333
www.signalclimateanalytics.com