TREND
ROAD TRANSPORT

2020: A Smooth Ride for the Electric Car Market, Despite the Pandemic

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Despite the severe slump affecting the automobile industry following measures to stem Covid-19, the progress of electric cars carries on unabated and continues to attract both carmakers and consumers. Boosted by national recovery plans, stricter local regulations, and manufacturers' decarbonization programmes, the penetration of electric vehicles is nevertheless subject to another trend that undermines both climate targets and low-energy carbon-free transportation: the SUV boom.

DATA OVERVIEW

The auto-industry's electrification resists the dip in global sales

Road emissions increased by 0.8% in 2019 compared to 2018, to reach 6.1 $GtCO_2e$, slower than the 1.8% average growth per year from 2011-2018.[1] Emissions resulting from car traffic alone amounted to 3.2 $GtCO_2e$ in 2019. In 2020, following the economic and health crisis triggered by the Covid-19 pandemic, these figures went down for the first time, by 6%, totaling 3 $GtCO_2e$ according to the International Energy Agency (IEA).[2] Data consolidation by Enerdata even estimates this drop to be 10%.[3]

Restrictions on movement imposed as a response to the health crisis had a particularly strong impact on road transport, generating a 10% decrease in oil demand in the sector compared to 2019. At the height of restrictions, road transport activity plunged historically low, by over 80% in some countries (**fig. 1**).[4] In the second half of 2020, activity picked up again in emerging economies, but remained low in developed nations in comparison to 2019 levels.

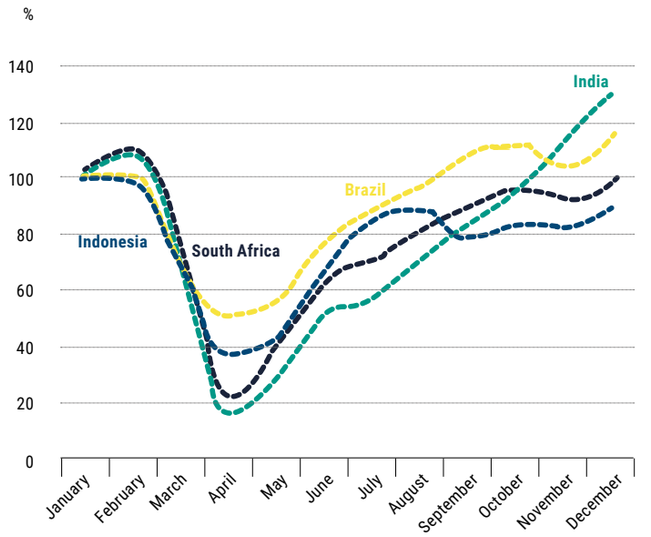
The pandemic has had an even greater impact on car sales. The automobile market was already shrinking, with global sales successively dropping by 2.9% and 6.3% in 2018 and 2019, despite an upswing in some regions (+1% in Europe in 2019). In 2020, the global downturn exceeded 15% and affected all of the leading markets (-21% in Europe, -28% in the United States and -6% in China).[5] Despite these record drops, electric vehicles (EV) performed well: sales reached a new record and the global fleet topped 10 million vehicles.[a] The 2020 Sector-based Report already pointed to encouraging sales of electric vehicles, up by 42% in the first half of 2020 in Europe. This trend was strongly confirmed with an increase of +137% over the whole of 2020 in the European market.[6] For the first time since 2015, sales in Europe (1,417,880 units) were even higher than in China (1,160,764 units). The EV market share rose sharply from 3.2% in 2019 to 10% in 2020, while it grew from 4.8% to 5.7%

a Including Battery Electric Vehicles (*BEV*) and Plug-In Hybrid Electric Vehicles (*PHEV*).

in China during the same period. In the space of one year, the Battery Electric Vehicle (BEV) market share more than doubled in Europe, from 3.5% in the second quarter of 2020 to 7.5% in 2021. Sales of plug-in hybrid electric vehicles (PHEVs) did even better, with 8.4% of the market, representing over half of the sales of all electric vehicles.[7] In the United States, sales are taking off slowly (only 10% of global sales), and EVs only represent 2% of the US market (**fig. 2**).[8]

FIGURE 1

ROAD TRANSPORT ACTIVITY IN SELECTED EMERGING COUNTRIES IN 2020 - *Source : IEA, 2021*



While these signs are encouraging, EVs still only represent a small share of the world's automobile fleet: only 0.9% of the vehicles circulating in the world are electric, compared to 0.7% in 2019. The results are only slightly better in the leading markets of China and Europe (1.7% and 1.1% respectively).[12] The transport sector is therefore still highly dependent on fossil fuels[9]: all modes of transport combined represent 60% of oil demand[10], and 97% of the energy used by transportation is of fossil origin[11]. In its road map entitled *Net Zero by 2050*, the trajectory promoted by the IEA to reach carbon neutrality in the sector is based on a rapid switch to electric mobility: by 2030, over 60% of new car sales will need to be those of electric vehicles (compared to under 5% in 2020 – **fig. 2**) and the automobile fleet will need to be almost entirely electric by 2050, amounting to two billion electric vehicles (i.e. 200 times more than the current figure).[12] Other key points in the road map include reduced transport demand, modal shifts, and improved energy efficiency.

As a result, states, local governments and carmakers are working to rapidly establish a market that was almost inexistent a few years ago. Yet, overshadowed by growth strategies and strict regulations, climate issues still take a back seat in this race for innovation. Auto-manufacturers are finding it fairly easy to adapt to incentive and regulation-based policies and continue to focus their sales strategies on images of power.

THE OBSERVATORY'S LENS

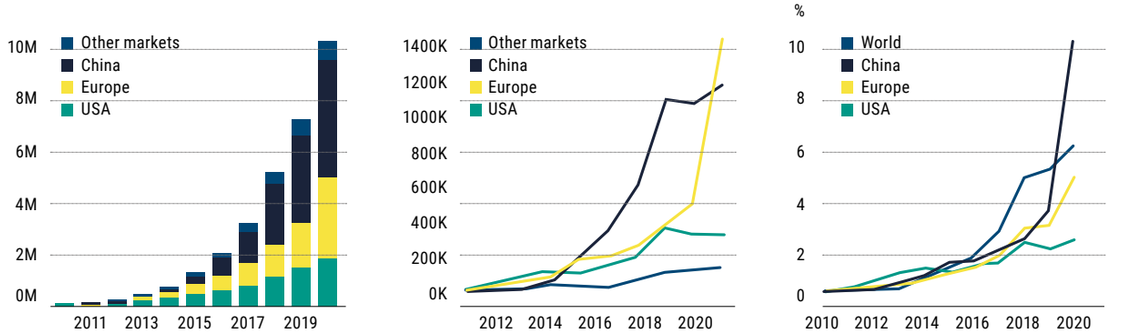
Accelerated electrification of the automarket: a winning hand for carmakers but not for climate

Along with the reduced cost of batteries (-13% in 2020),[13] the growth of electric car sales despite a flagging automobile market is largely thanks to policy support from the European Union and recovery measures in China. The establishment of numerous policies to boost electric vehicles in recent years has contributed to a rapid progression in their sales. Starting

FIGURE 2

EVOLUTION OF THE FLEET (LEFT), SALES (CENTRE) AND MARKET-SHARE (RIGHT) OF ELECTRIC AND HYBRID VEHICLES

Source : Compiled by the author using IEA database.



in 2009, the Chinese government set up a programme to subsidize purchases of EVs and compensate their high price compared to internal combustion engine vehicles. The cost of these subsidies is extremely high, and China was due to bring the programme to an end in 2020.[14] Yet, faced with a sharp drop in sales in the first half of 2020 (-42%), the country decided to extend the subsidies until 2022 to support the sector during the pandemic. These support measures will be progressively reduced and then replaced by a mandate applied to carmakers, obliging them to improve the energy efficiency of EVs and imposing a percentage of EV sales. The aim of this roadmap is that EVs will constitute a 20% market share by 2025.[15]

On the European market, recovery plans have been set up to support the sector, and in 2020 financial aid for purchasing EVs was increased in several countries. Germany has earmarked one billion euros to extend its financial aid programme for purchases of electric vehicles[16]. The French economic recovery plan devotes 1.9 billion euros to maintaining the "ecological bonus" (financial purchasing aid of up to 7,000 euros) and the conversion incentive from 2020 to 2022. The government has also set a target of creating 100,000 charging stations by the end of 2021[17]. In Italy, the budget earmarked for financial aid to purchase EVs was increased by 500 million euros in August 2020[18]. These different support mechanisms are largely responsible for record sales in the European market despite a morose economic environment (+137% over the year compared to 2019[5]).

In the United States, President Joe Biden is currently pushing for an envelope of 174 billion dollars to stimulate the adoption of electric vehicles and make up the gap with China. The programme includes tax rebates and incentives for the purchase of US-made electric vehicles, and subsidies to build a national network of 500,000 charging stations by 2030.[19] In an executive order signed at the White House in early August 2021 in the presence of US automobile manufacturers, Joe Biden established a non-binding target of increasing the share of electric vehicles to 50% of sales by 2030.[20]

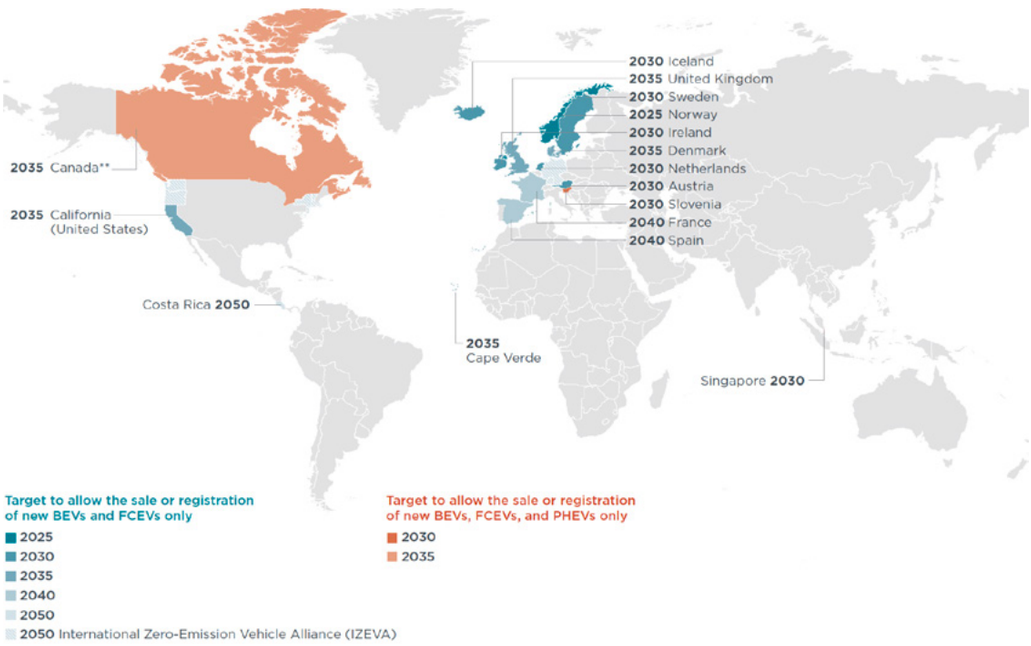
Beyond these incentive mechanisms, an increasing number of regulatory instruments are devised to encourage carmakers and consumers to make low carbon choices. More and more countries are setting objectives to phase out sales of internal combustion engine cars, sending out a clear message to consumers and automobile manufacturers. While most of these countries are in Europe, Cabo Verde is aiming to prohibit imports of gasoline and diesel cars from 2035, and Costa Rica has set a goal of banning sales of internal combustion engine cars within 30 years (**fig. 3**). In July 2021, the European Commission proposed prohibiting sales of gasoline and diesel cars by 2035.[21]

At the local level, sub-national states and regions continue to develop coherent policies to support electric vehicles: in California, the decree issued by Governor Gavin Newsom in September 2020 establishes an objective of 100% sales of "zero emission" vehicles by 2035.[22] Prior to this objective, California had already adopted a Zero Emission Vehicle (ZEV) programme, which obliges car manufacturers to sell a specific number of electric or plug-in hybrid electric vehicles every year and gradually increase their share. To date, nine other federal states (Connecticut, Maine, Maryland, Massachusetts,

FIGURE 3

NATIONAL AND LOCAL GOVERNMENTS WITH A TARGET TO BAN SALES OF INTERNAL COMBUSTION ENGINE CARS

Source : ICCT, 2020



New York, New Jersey, Oregon, Rhode Island, and Vermont) have adopted regulatory policies along the same lines.[23] Massachusetts, for example, has committed to ban sales of new internal combustion engine cars by 2035.[24] Several states have also created financial incentives, like Colorado, which offers a tax credit of 4,000 US dollars for the purchase of an electric vehicle, or Connecticut, which reduces registration fees for electric vehicles. Other incentives include tax credits for installing charging stations, subsidies for research projects, and low-carbon requirements for public vehicle fleets.[25] In France, the Bouches-du-Rhône Department offers financial aid of up to 25% of the cost of a new electric vehicle, capped at 5,000 euros and cumulable with the state ecological bonus. Six months after its launch, this measure has seen sales triple in the area. Due to its success, the programme's initial limit of covering 1,000 vehicles has been cancelled.[26] In China, the government of the Hainan province announced in 2020 that it would provide financial aid of 10,000 yuan (~€1,315) for the purchase of an electric vehicle.[27]

Cities employ various policies to encourage the adoption of electric vehicles. With the goal of reducing air pollution, big Chinese cities like Zhengzhou, Chongqing, Shenzhen and Guangzhou have set up their own subsidies for electric vehicle purchases. At least ten Chinese cities impose traffic restrictions from which electric vehicles are exempt.[28] To cushion the impacts of the pandemic on the automobile sector, some Chinese cities eased restrictions for purchasing vehicles in the second quarter of 2020. The combination of these local measures was the main driver of growth of EV sales in 2020 in China.[27] Cities also play a key role in the deployment of charging facilities: Berne, Liège and Tampere have introduced new subsidies to accelerate the creation of stations, and Malaga is installing stations in all of its municipal parking lots.[29]

In its analysis of the 22 metropolitan regions in Europe with the fastest progression in new electric vehicle registrations, the International Council on Clean Transportation (ICCT) underlines the role of coercive measures: half of these cities have created low emission zones (LEZ), and several are planning to introduce zero emission zones (ZEZ),[29] thus encouraging electric vehicles. On a global scale, REN21 lists over 225 cities that have at least partially restricted the circulation of internal combustion engine vehicles, and six that have adopted ZEZs.[9] Bergen, in Norway, also intends to create a ZEZ in 2023. The city of Lausanne recently committed to abolish internal combustion engine vehicles from its streets by 2030.[30] These restrictive measures are largely supported by urban residents: a survey of the inhabitants of 15 major cities in Western Europe showed that almost two-thirds of them were favorable to prohibiting sales of new gasoline and diesel cars in Europe after 2030.[31]

In contrast to these measures to support EVs, sometimes local governments create obstacles instead. In 28 US states, the registration fees for an electric vehicle are higher than for combustion engine cars, and 17 states have banned Tesla and other manufacturers from directly selling their cars to private individuals. The residents of these states have to pick up their electric vehicle from another state or have it delivered by a third party.[32] In Texas, a bill is under examination that aims at taxing the owners of electric vehicles, based on the justification that they do not pay the gasoline taxes that feed into the budget for investment in highway infrastructure.[33]

For car manufacturers, electrification makes it easier to respect emissions standards

The European regulation aimed at reducing CO_2 emissions from new cars came into force on 1 January 2020 (EU regulation 2019/631[34]). Rather than imposing sales targets for electric vehicles, it sets a limit of 95 gCO_2/km for emissions from all new vehicles sold from 2021 onwards. That means that the average emissions from all of the vehicles commercialized by an individual carmaker over one year must be lower than 95 gCO_2/km. As a result, it is always possible to produce and sell a vehicle that exceeds that limit, provided that the sale is compensated by a vehicle with lower emissions.

This regulation does, however, provide for "compliance mechanisms" aimed to help carmakers to reach their targets. Manufacturers can form a group, like Fiat-Chrysler which has got together with Tesla to reduce its average emissions, in exchange for a payment of 1.8 billion euros over three years. In addition, the emissions limit takes the mass of cars into account, making it possible to relax the CO_2 target for manufacturers that sell heavier-than-average vehicles, which gives them no incentive to reduce the weight. A bonus system is also applied to electric vehicles, which are counted several times in the average emissions calculations, thus making the emissions limit more flexible (1 EV counted for 2 vehicles in 2020, and 1.67 in 2021). Lastly, automobile manufacturers can win eco-innovation CO_2 bonuses by equipping their vehicles with innovative technologies.[35] Depending on these different adjustments, the emissions limit granted to an individual manufacturer by the EU can be significantly different: for example, it was 103 gCO_2/km for BMW in 2021.[36]

In 2019, manufacturers were still far from reaching their respective targets: average emissions had even gone up by 1 gCO_2/ km to reach 122 gCO_2/km, with wide disparities between carmakers. At that point, the Toyota-Mazda group boasted the lowest emissions per kilometre[37] and was the closest to its targets for 2021, although it had not reached them (**fig. 4**). But thanks to increased sales of electric vehicles in Europe, the average emissions of all manufacturers combined nevertheless dropped considerably in 2020 (for the first time since 2016), reaching 108 gCO_2/km.[38] With the help of compliance mechanisms, derogations and bonuses established by the European standard, the average had decreased to 96 gCO_2/km, and nine manufacturers out of ten (96% of the European market) had managed to reach their emissions targets. Excluding compliance mechanisms, only Volkswagen missed its target, by about 1 gCO_2/km, while the PSA group obtained the best average score (97 gCO_2/km).

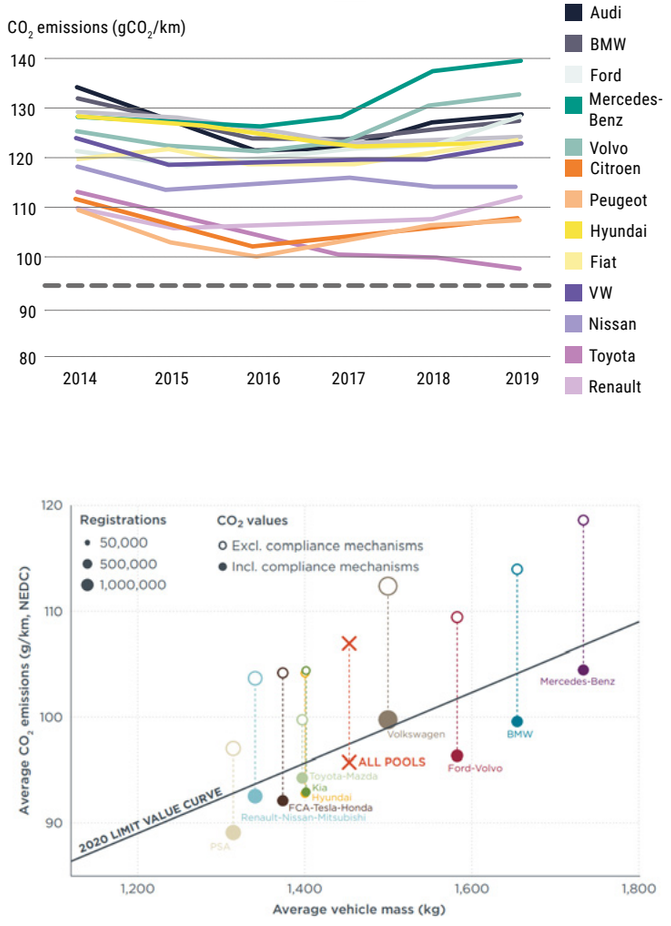
Not taking into account the compliance mechanisms, the figures clearly illustrate a shift, given that average emissions increased by 0.7 gCO_2/km per year from 2015 and 2019. For the first time in five years, electrification has therefore made it possible to reduce the average emissions of European

automobile sales. We can also see a fairly strong correlation between the weight of the vehicles put on the market by manufacturers and average emissions; the lightest vehicle manufacturers perform better than heavy vehicle manufacturers (**fig. 4**).[39] Nevertheless, it should not be forgotten that these figures were measured using New European Driving Cycle (NEDC) protocol, and as "Dieselgate" has shown, laboratory testing conditions for emissions can produce widely different results from real vehicle use on the road (up to 50% in 2020 according to T&E[40]). The data obtained with the new Worldwide Harmonized Light Vehicles Test Procedures (WLTP) international standard applied since 2021 could prove less advantageous to manufacturers.

FIGURE 4

CO_2 EMISSIONS PER MANUFACTURER IN THE EUROPEAN MARKET FROM 2014 TO 2019 (TOP), AND BY MANUFACTURER GROUPING IN 2020 (BOTTOM)

Source : Compiled by the author using data from ICCT, 2021



To meet with these standards, manufacturers have largely moved towards making electric motors. Battery electric vehicles (BEVs) already represented a significant share of the market in 2019 for some carmakers like Nissan and Hyundai (7% and 5% respectively in Europe – **fig. 5**). The trend accelerated in 2020 with the launch of 65 EV models on the European market, including 35 with all-electric motors (not hybrids).[41] Around one hundred new models have been announced for 2021[42] and registrations of EVs are rising steadily in Europe. In a single year, the market share of BEVs more than doubled, going from 3.5% in the second quarter of 2020 to 7.5% in 2021. Sales of plug-in hybrid electric vehicles (PHEVs) have done even better, with an 8.4% share of the market, representing more than half of all electric vehicle sales.[43]

PHEV sales have risen sharply, spurred on by manufacturers like Volvo and BMW, which have given these vehicles a central place in their strategy to conform with CO_2 standards. In 2019, they thus represented 8% of sales for Volvo (**fig. 5**), which had not yet launched an all-electric model. PHEV technology is well-suited to the vehicle ranges of these manufacturers with larger cars capable of housing both a combustion engine and an electric system. They are also favored by the super credit mechanism: when a PHEV sale takes place, it is counted twice, in the same way as a battery vehicle, allowing the manufacturer to bring down its average emissions score. However, the NGO Transport & Environment has issued a warning about the performances of these vehicles: the low-capacity batteries and the lack of fast charging makes 100% electric usage difficult, so that the real emissions are on average two to four times higher than announced by the manufacturers. According to the NGO, in their current state, sales of PHEVs are simply a compliance tactic that has no real impact on reducing CO_2 emissions from road transport.[44] Volvo recently changed its strategy: following the launch of its first BEV in 2020,[45] the manufacturer has committed to only commercializing battery vehicles by 2030 (**tab. 1**).

TABLE 1

MANUFACTURERS' PUBLIC TARGETS (JUNE 2021)

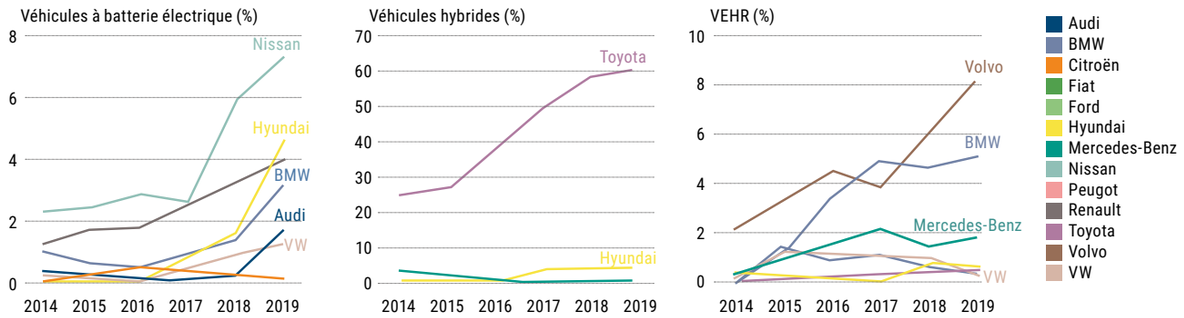
Source: Transport & Environment, 2021

ORIGINAL EQUIPMENT MANUFACTURER	2025 SALES	2030 SALES
BMW	33% BEV+PHEV	50% BEV/Mini Brand: 100%
DAIMLER	Up to 25% BEV	50% BEV + PHEV
FORD		100% BEV
HYUNDAI-KIA	Kia Brand: 20% BEV	Whole group: 25% BEV
JLR	Jaguar Brand: 100% BEV	Land Rover Brand: 25% BEV
RENAULT	Renault Brand: 30% BEV	Renault Brand: 90% BEV + PHEV
STELLANTIS	38% BEV + PHEV	70% BEV + PHEV/ Fiat Brand: 100% BEV
TOYOTA	10% BEV + FCEV	
VOLVO CARS	50% BEV + 50% PHEV	100% BEV
VOLKSWAGEN	20% BEV	Group: 60% BEV/VW Brand: 70% BEV

FIGURE 5

MOTORIZATION BY MANUFACTURER ON THE EUROPEAN MARKET (2014–2019)

Source : Compiled by the author using ICCT, 2021



Electric or internal combustion, cars are prey to notions of power

The Chinese carmaker Chongqing Changan was the first to announce, back in 2017, that it would stop manufacturing internal combustion engine cars before 2025.[46] Since then, numerous international auto manufacturers have committed to increasing the share of BEVs in their sales (**tab. 1**) with multiple announcements of investments in the production of electric vehicles. BMW has set a target of 50% of electric cars by 2030, and Mini will be 100% electric in 2030.[47] Renault, for which BEVs represented 12.7% of sales in 2020, aims at 90% electric vehicle production by 2030.[48] A production site with an annual capacity of 9 GWh of batteries will see the day in northern France in 2022 to produce the future electric *R5*.[49] The British group Jaguar Land Rover (JLR) has revealed a radical plan to enter into the electric vehicle market. Its strategy involves progressively abandoning diesel from 2026 and transforming Jaguar into a 100% electric brand by 2025. The group hopes to make 60% of its sales from "zero-emission" vehicles by 2030. To achieve this figure, it intends to invest £2.5 billion a year in developing electric and connectivity technologies for its cars. In 2020, JLR had to pay a £35 million fine for failing to meet with its EU emissions targets.[50] Volkswagen intends to make 60% of its European sales electric by 2030 and anticipates producing 240 GWh of batteries in six "gigafactories".[51] General Motors has announced the electrification of its entire range by 2035 and is set to invest $27 billion in electric and autonomous vehicles over the next five years. The US manufacturer has set itself a considerable challenge: electric vehicles only represented 0.8% of its domestic sales in 2020.[52] Announcements from actors in the sector are at times more ambitious than national objectives, going further for example, than France and Spain, which anticipate the end of internal combustion engines by 2040 (**fig. 3**). In total, the cumulative announcements made by car manufacturers amount to investments of about $345 billion.[53]

Lastly, of the main manufacturers, only Toyota, the largest automotive manufacturer by volume,[54] has not presented a clear vision in terms of BEVs. The entire strategy of the Japanese carmaker is currently based on hybrid cars (which represented 60% of its European sales in 2019 – **fig. 5**) and to a lesser extent on fuel-cell electric vehicles (FCEV) powered by hydrogen (**see Tokyo case study**). Despite its recent announcement of the launch of a BEV range,[55] deployment is proving slow. For Transport & Environment, the facts are obvious: "*Toyota has slipped from the leading green car company 10 years ago to being the least prepared for the electrification revolution that is underway.*" [56]

In its analysis of climate action undertaken by the 30 most influential car manufacturers, the World Benchmarking Alliance regrets manufacturers' lack of commitment to positive legislation on climate.[57] In March 2020, at the peak of the Covid-19 crisis in Europe, lobby groups from the European automotive industry even wrote to the president of the European Commission, Ursula von der Leyen, calling for less stringent objectives to reduce CO_2 emissions in the sector.[58]

The World Benchmarking Alliance also observes that the automobile industry makes insufficient efforts to guide consumers towards choosing low-emission vehicles. Higher prices and difficulties accessing charging stations still hold many consumers back, yet manufacturers could help remove these obstacles by making investments and changing the direction of their marketing strategies.[56] Marketing budgets still mostly focus on the heaviest vehicles. In France, the car industry devoted €1.8 billion to promoting SUVs in 2019, which was 42% of its advertising expenditure.[59] Advertising campaigns to launch the Subaru *Ascent* 2021, the manufacturer's biggest SUV to date, put the accent on the vehicle's enormous size.[60] In New Zealand, Ford spends 85% of its marketing budget on pickups, and 8 out of 10 cars sold in the country are SUVs.[61] Globally, it was not just electric vehicles that saw their sales go up in 2020 – SUVs also did well: for the first time, one car in two sold in the United States is now an SUV.[62] In Europe, SUV sales have also broken records, with a 44% market share in January 2021, its highest level following 40% in January 2020.[63]

The electric vehicle market does not escape from being associated with an image of power. While it was initially embodied by compact city cars that are still popular, like

Renault's *Zoe* and Nissan's *Leaf*, the EV market has taken advantage of its expansion to extend its ranges to include heavier, more voluminous models. Based on figures published by Clean Technica on the twenty best-selling electric vehicles in the world (BEV + PHEV), the Climate Chance Observatory calculated that 63.4% of electric sales are SUVs or sedans.[64] EVs also constitute a significant share of European sales of sports cars, like Porsche (16.5%) and MG (51.2%). Because their battery makes them heavier, the average weight of an EV on the market is 1,940 kg: one-third of them are over 2,000 kg, and more than half weigh between 1,500 and 2,000 kg,[65] which is a lot heavier than the average new vehicle in France (1,240 kg[66]), and even in the United States (1,857 kg).[67] This is while the energy efficiency of an electric car tends to decrease as its weight increases.[68]

KEYS TO UNDERSTANDING

EXTENDING BATTERY LIFE AND MANAGING END OF LIFE: THE NEW CHALLENGE FOR ELECTRIC MOTORIZATION

Another symptom of the increased power of vehicles, the autonomy of some EVs is starting to match that of traditional combustion engine vehicles. The Chinese automotive manufacturer GAC has announced the wide-scale production of its next electric SUV, the *Aion XL*. It will be the first electric car to run autonomously for 1,000 km, thanks to the introduction of new silicon anode battery technology, which increases the battery's power density while reducing its weight by 14% and its volume by 20%. Up until now, *Tesla S Long-range* held the autonomy record with 652 km.[69] On average, the autonomy of electric vehicles is around 350 km, which is 2.3 times more than in 2015.[28]

The manufacture of these batteries, which are complex alloys of critical metals, and the management of their end of life – in other words recycling the battery components – are two concerns that frequently oppose the development of EVs. In addition, the shortage of semi-conductors and the inflation of metal prices that have struck the globe since late 2020 underline the fragility of supply chains of electronic materials, in a world where the digital shift and the ecological transition have become interdependent[b]. During the last year, manufacturers have responded with a concentration and vertical integration of value chains, by bringing the automobile industry closer to the electronic industry. Reinhard Ploss, CEO of Infineon, the biggest European producer of semi-conductors, has even called on car manufacturers to drop the "just-in-time" management model promoted by Toyotism[c] in order to better plan their supplies.[70] Tesla has announced that it is prepared to make advance purchases of its electronic chips and is researching the production of its own batteries,[71] while at the other end of the chain, the Chinese electronics giant Foxconn, best known for producing *iPhones* in its factories in Shenzhen, is entering the automobile chassis production market for electric vehicles.[72] Volvo has also launched a joint venture with the Swedish start-up Northovolt to open a "gigafactory" with an annual production capacity of 50 GWh, which is enough batteries for 500,000 vehicles,[73] while Mobilize, the Renault subsidiary that specializes in electric hire cars (like *Twizy*), has signed a partnership with the German start-up Betteries, which will recuperate batteries from the cars and make them into mobile electric generators.[74]

KEY TAKEAWAYS

Electric vehicles have largely benefited from the reorganization of the automotive market, prompted by recovery plans, urban policies, and the strategies of car manufacturers waging on electrification and the programmed demise of internal combustion engine cars. Some manufacturers have even announced a move to all-electric that outpaces the strategies established by States.

Boosted by its new emissions standards, Europe has outstripped China as the leading global market for electric cars, while the trend is struggling to take hold in the United States. However, the existing fleet is still largely dominated by combustion engine cars, and electrification is only a drop in the ocean compared to another strong trend in the sector: almost one vehicle in two sold in the world today is an SUV, and the growth of their sales constituted the second source of increased GHG emissions before the pandemic, according to the IEA.

b For example, in its communication on the EU Green Deal, the European Commission talks of the *"twin challenge of the green the digital transformation"*.

c "Toyotism" designates a "lean" method for managing production lines, involving no stock and thus calling for very fast reactions from all stakeholders in the value chain. Initially employed by Toyota, this form of production organization was widely adopted by the entire automotive industry. "Just in time" is one of its components and involves synchronizing the supply of parts with the pace of production.

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