Backfire on emissions:

how are European auto firms doing at reducing CO_2 emissions (and how can they accelerate their journey to Paris)?

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January 2021

Federated Hermes International

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Executive summary

- Over the last few months there has been a huge amount of scrutiny over whether European Union (EU) auto manufacturers will reach the long-anticipated 2020 emissions standards. While the big groups are expected to largely comply, this has been facilitated by multiple perfectly legal regulatory loopholes rather than due to a fundamental shift in the emissions of the fleet of vehicles sold to EU consumers.
- As a means to better support our climate change-related engagement work with this sector, we wanted to understand what is actually happening at the fleet level, once what we term 'regulatory compliance enablers' are removed from the assessment of fleet CO_2 performance. The starting point for our analysis was 2019 data, as disclosed by manufacturers to the EU monitoring system (2020 data are not available to us yet since it has not yet been publicly disclosed via the EU monitoring system).
- As a hypothetical exercise, to inform our understanding of sector trends, we have looked at how the industry would have fared in 2019 in meeting the 2020 standards. What we found raises significant concerns about the pace at which the industry is delivering the transformative technology solutions needed to the market.
- While noting there has been a change in the emission calculation methodology, in response to the emissions cheating scandal, the average emissions of the European fleet in the period to 2017-2019 has slightly increased overall. In 2019, the majority of the models sold were in the range of 100-150g CO_2/km, significantly exceeding the 95g CO_2/km regulatory 'touchpoint' set for 2020.
- The top 10 auto groups are responsible for 90% of EU-wide auto emissions and hold the keys to change. Yet we found erratic progress being made across these groups. Across petrol and diesel internal combustion engine (ICE) categories, while the weights of diesel and petrol vehicles have stayed more-or-less constant throughout 2010-2018 (with an increase in one cohort of more powerful diesel vehicles), hybrids have been getting heavier. This latter point is a significant concern, given the reputational position hybrids hold as a 'bridging technology'. From our analysis, we conclude that while hybrids are likely to reduce emissions in the short term, they risk locking in emissions over the medium term if vehicles are, in parallel, also getting heavier. This, combined with concerns that plug-in hybrid electric vehicles (PHEVs), a subset of hybrid vehicles seen as a stepping-stone to fully electric vehicles, often remain uncharged due to low charge rates and limited range and so run on the ICE, means they are likely to be making real world pollution worse.
- Against this backdrop, vehicles were available that meet the 95 g CO_2/km target in 2019, however, across the board, companies continued to focus on selling much higher emitting options.
- While it is likely that most firms will reach the 95g CO_2/km target in 2020, the pollution legacy left by all companies falling back on enablers such as EV offsets and pooling is significant. This also means much more needs to be done by firms to meet 2021 regulatory requirements (given that many of the enablers will not be available to them in 2021) – but also to roll out a Paris Agreement-aligned fleet in the coming years, which is our particular concern.
- A step change is now needed in terms of the technology developed but also the range of vehicles marketed and sold by the industry. While PHEVs in particular are in theory a reasonable bridging technology, their real-world performance in cutting emissions is poor and their size is worsening the climate problem.
- According to the Committee of Climate Change's analysis, Paris Agreement sector level alignment means achieving 100% battery electric vehicle (BEV) sales by 2030 ideally and 2035 at the latest – up from 2% in 2019 and an estimated 6% in 2020[1]. This faster adoption of BEVs must be a priority for auto companies – alongside a plan to retrain the millions of workers skilled in ICE technology, so as to deliver a just transition to a net zero economy. The low levels of EV-related patent registrations by the majority of the top 10 auto groups (Toyota excepted) is therefore a major concern.

[1] Sources: https://www.eea.europa.eu/data-and-maps/indicators/proportion-of-vehicle-fleet-meeting-5/assessment and T&E (2019) Mission (almost) Accomplished: Carmakers' race to meet the 2020/21 CO2 targets and EU electric cars market. Note that 2020 figures are still in flux and that our analysis of 2019 data used provisional filings, which accounts for our slightly lower figure of 1% for BEVs in 2019.

- Looking ahead at possible transition pathways needed to meet the 2030 EU CO_2 targets for autos, a fast transition out of ICEs is the first step. We modelled what this might need to look like and found for example a 59g CO_2/km 2030 target would require a 12%/11%/30%/47% mix of diesel, petrol, hybrid and EV respectively across the fleet. A 47.5 g CO_2/km 2030 target (which is on the table) would require for example a 62% EV/20% hybrid and 9%/9% diesel and petrol mix. The fast and significant tilt needed toward EVs indicates to us that significant further investment by manufacturers in hybrids may not be the optimal return on capital for shareholders.
- R&D is going to be key to positioning companies to thrive through the transition. Our analysis of patent registration as a proxy for R&D investment indicates a recent uptick in R&D investment. However, given the significant structural changes required in the auto industry to ensure it helps not hinders the transition to a Paris Agreement-aligned 1.5°C world, there will likely need to be significantly more investment into R&D – and this will be a key topic of our ongoing engagement with companies.
- As the auto sector continues to consolidate, and develop technology partnerships, so does its power to influence and deliver sustainable options to customers. We urge them to use that power to ensure the auto sector is a leader in harnessing its capability and reach to keep the world on track to a no more than 1.5°C future. This includes working with policy-makers to ensure future regulation, covering support for high-speed and ubiquitous EV charging infrastructure, provides a glide-path for an orderly transition of the sector to net zero – not a set of rules ripe to be gamed.

1. Introduction

In the EU, road transport emissions, and passenger car emissions in particular, have been growing; this is due both to rising numbers of cars and also the size and weight of vehicles on the road. In 2017, passenger car emissions accounted for about 12% of EU greenhouse gas (GHG) emissions overall[2]. It is with the aim of reducing emissions from this sector that the EU introduced vehicle emissions standards. Given that the average lifespan of vehicles is around 12 years,[3] the speed with which vehicle manufacturers move to put their fleets onto a sustainable footing matters. It is also why the last ICE and even hybrid vehicles need to be sold so much earlier than the usual 2050 net zero deadline.

Fast forward to 2020 and the EU regulatory target of 95 gCO_2/km across manufacturer fleets is now in place. As a hypothetical exercise, to inform our understanding of sector trends, we have looked at how the industry would have fared in 2019 in meeting the 2020 standards.

Our goal was to better support our climate change-related engagement work with this sector, through understanding what is actually happening at the fleet level.

The starting point for our analysis was 2019 data, as disclosed by manufacturers to the EU monitoring system (2020 data are not available to us yet since it has not yet been publicly disclosed via the EU monitoring system). We used these data points as a snapshot to evaluate the plausibility of firms meeting the fleet-based emission requirements of approximately 95 gCO_2/km by 2020 and whether this would be possible if the initial regulatory enablers had not been put in place. We find – in common with others – that while in 2020 there is celebration of the fact most of the manufacturers are likely to meet targets and largely avoid the hefty fines that some predicted, much of this will have been achieved through making extensive use of the short-term 'enablers' in the regulation – such as the generous intra- and inter-business electric vehicle offset schemes allowed alongside a concession to the industry that allows them to exclude the 5% most-polluting vehicles – rather than a massive shift in business operations. When we look past the use of such 'regulatory enablers', we can see that the overall 'pollution legacy' of the fleet of vehicles actually sold to end 2019 is significant and that in 2020 it is the use of 'regulatory enablers' rather than the real-world emission reductions climate action demands that will enable manufacturers to meet the targets.

In terms of how we assess how well-positioned auto manufacturers are in transitioning their product offerings onto a Paris-aligned pathway, we have used as our end reference point the science-based approach set out by the UK Committee on Climate Change. This states that sales of fossil powered vehicles (including hybrids) will need to be phased out not by 2050 – as is widely cited – but by 2035 and ideally 2030.[4]

According to our analysis in 2019, petrol passenger cars remained the best-selling option for EU consumers, constituting 63% of sales (up from almost 60% in 2018). Diesel cars made up 32% of new passenger car registrations (down from 36% in 2018) – showing the positive effect of government and city policies aiming to reduce demand for diesel in particular[5]. Sales of battery electric (BEV) and hybrids (including PHEV) were at 1% and 2%, respectively.

Our analysis raises significant concerns about whether the pace at which the industry is delivering transformative technology solutions to the market matches what the climate science – including the UK Committee on Climate Change – says is required. There is a strong argument that auto manufacturers need to move much faster in shifting their operations and sales to help not hinder the terms of the Paris Agreement on Climate Change.

[2] This is the latest year for which verified data is available – see https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-12#:~:text=In%202017%2C%20transport%20(including%20aviation,increased%20by%200.7%20%25%20in%202018.
[3] "How Today's Cars are Built to Last," published by AARP in November 2018.
[4] "Net Zero - The UK's Contribution to Stopping Global Warming," published by the Committee on Climate Change in May 2019.
[5] Low and ultra low emission zones exist in cities across the EU including but not limited to Paris, Ghent, Stuttgart, Copenhagen and Strasbourg.

Covid-19 and its economic impact

We are of course aware that 2020 will look very different to 2019 in terms of vehicle sales. According to ACEA, the EU auto manufacturers' association, in the first eight months of 2020 there has been a significant contraction (–32%[6]) in the number of new car registrations in Europe. This contrasts with previous dynamics: prior to that sales had been growing steadily since 2013, albeit with a slight tail-off in 2017/2018. In addition, various national incentives have helped kick start sales of BEVs in 2020. This is already having a very positive effect, aiding regulatory compliance: the think-tank T&E predicts that 9% of EU27 auto sales will be PHEV/BEV in 2020, for example, rising to 14% in 2021. Nonetheless, much uncertainty remains over sales of PHEVs and BEVs and we think our overall approach to the analysis remains useful as we start to track trends in this sector on an ongoing basis to support our engagement work in the sector.

2. Regulatory context

Regulation 2019/631 was agreed back in 2009 after voluntary commitments from the auto industry failed to deliver results. This target was set with a long advance timeline to give clear guidance to the industry on the necessary trajectory for reducing the growing emissions from the European transport sector. The 2009 regulation set a 2015 target of 130 grams per kilometre (g/km) for the fleet average. A similar regulation for light-commercial vehicles (also known as 'vans') followed in 2011, setting a mandatory target of 175 g/km for 2017. Vehicle manufacturers met both targets several years in advance.
A second set of regulations, passed in 2014, required average CO_2 emissions of new cars to fall to 95 g/km by 2021 – with obligations phased in in 2020. The regulation specifies the target CO_2 emissions per vehicle, as well as offsets, derogations and penalties applied for the excess emissions, which are applied from January 1, 2020, if the targets are not met.

2a. Mass-based targets

For each manufacturer pool a specific 2020/21 CO_2 target value applies, depending on the average mass of new cars registered – the heavier the car the more lenient the target. The current mass used as a reference M_0 is 1,379.88 kg. Above this value the target is, in effect, higher than 95g CO_2/km and below is lower. The mass-adjustment was originally designed to ensure the targets are met even if the average mass of all manufacturers increases, as heavier conventional cars emit more CO_2. However, with the mass deployment of hybridisation and electrification technologies heavy cars should no longer have to emit more CO_2 since their engines should in theory be more carbon efficient. The fact PHEVs, in particular, are emitting more CO_2 than expected indicates PHEV technology is being put into large heavy cars. The technology, instead of reducing emissions is increasing them meaning this mass-adjustment factor has created a perverse incentive to increase vehicle mass across the fleet. According to T&E, it is one of the key regulatory design flaws that is favouring the current shift to SUVs.

2b. Portion of fleet counted in 2020

Only 95% of autos count toward the target in 2020, with all cars included in 2021. Auto firms can therefore exclude the 5% most-polluting vehicles, again enabling the production and sale of vehicles that are significantly higher than the 95g CO_2/km target – in some cases twice as high or more.

2c. Eco-innovation and supercredits

Firms can claim credits for fitting technologies to cars that deliver emissions reductions on the road – such as LED headlamps. They can also claim supercredits for the sale of cars with emissions below 50g CO_2/km.

2d. Derogations

Smaller producers (10,000-300,000 autos per year) can apply for niche volume derogations, which sets a different target based on 45% of 2007 emissions. Producers below 10,000 set their own targets; those below 1,000 have none. Jaguar Land Rover (not analysed here) has a much higher target under these derogations, for example, at 132g/km. But by mid-2020, they were still not at this target. In October 2020, Jaguar Land Rover announced that it expects around $118m in penalties for autos sold in 2020.

2e. Pooling

Firms are allowed to form pools jointly to comply with targets. In a pool, emissions across the groups in the pool are averaged-out. This regulatory enabler has been widely relied upon by manufacturers that had not done enough to reduce emissions from their own fleets, including but not limited to FCA, VW and Ford.

2f. Penalties

The penalties, in euros, that will be enforced are equal to 95 * (Excess emissions) * (Number of cars).

3. Data sources

Data for the car registrations and emissions were obtained from https://www.eea.europa.eu/data-and-maps/data/co2-cars-emission-18, which lists data since 2010.

[6] See https://www.acea.be/press-releases/article/passenger-car-registrations-32.0-eight-months-into-2020-5.7-in-july-and-18.

4. Assumptions/Caveats

As with all research, there are a number of factors around the assumptions that should be borne in mind. These are:

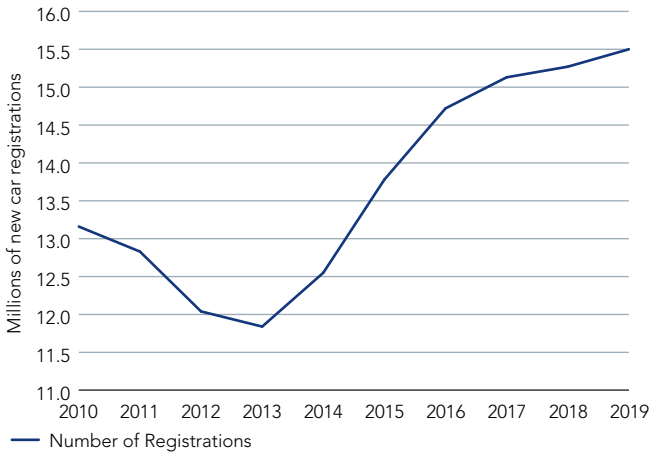
- While best efforts have been made to map the ownership structure of the groups, it may not be completely accurate. As we use this analysis to engage groups and manufacturers on the issues we identify, we will also consult them to verify and address any inaccuracies found.
- The data for 2018 are final as it was updated in early June 2020. Data for 2019 are provisional.
- The number of data points for 2019 (15.5m) is three-times more than 2017 (5m), and 30-times more than the ones of 2010-2016 (~500K, so there could be duplicates).
- A new car registration for BMW in 2018, with ID of 7249984, is removed from the dataset as it appears to be an outlier for the statistics, emitting 2,810 gr of CO_2 per km.

5. Analysis

Figures 1 and 2 show the number of cars registered in the EU, looking out to 2019 only (and we reiterate that we note the significant contraction in 2020). Car registrations had been growing steadily since 2013, with a slight tail-off in the growth rate in 2017/2018. 2019 saw a sharper increase in new vehicle sales, resulting in higher aggregate emissions. Growth was seen across all fuel types: pure petrol; diesel; battery electric (BEV) and hybrid electric. **While noting there has been a change in the emission calculation methodology, in response to the emissions cheating scandal, the average emissions of the European fleet in the period to 2017-2019 has slightly increased overall**.

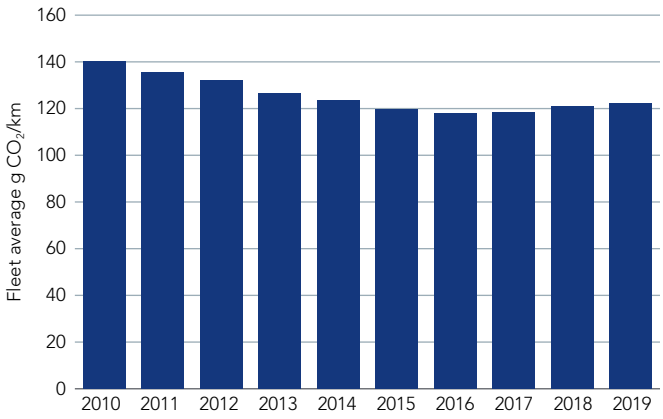
To 2019, numbers of vehicles sold and emissions of those vehicles have been on the rise

Figure 1: Number of new cars registered in millions



Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

Figure 2: Average emissions of the European fleet from the newly registered vehicles as g/km



Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

The auto sector is highly consolidated. This consolidation has continued into 2021, with the recently approved merger of FCA and Groupe PSA to create Stellantis N.V.[7] For that reason, a few groups dominate the European auto market. The top 10 are shown in Table 1 and in visual form in Figure 3 and are the focus of our analysis. **In total these 10 groups have a market share of ~90%, with Volkswagen and PSA Group dominating**.

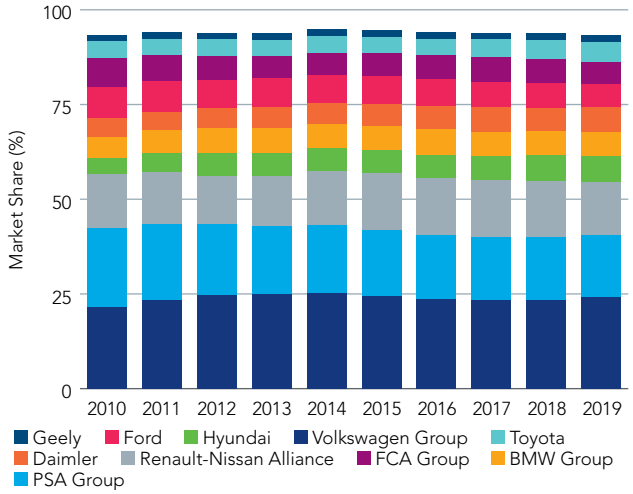
The top ten auto groups are responsible for 90% of emissions and hold the keys to change

Table 1: Number of car registrations per group

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Volkswagen Group	2.8M	3M	3M	3M	3.2M	3.4M	3.5M	3.5M	3.6M	3.7M
PSA Group	2.8M	2.6M	2.2M	2.1M	2.2M	2.4M	2.5M	2.5M	2.5M	2.5M
Renault-Nissan Alliance*	1.9M	1.8M	1.5M	1.6M	1.8M	2M	2.2M	2.3M	2.3M	2.2M
Hyundai**	0.6M	0.6M	0.7M	0.7M	0.8M	0.8M	0.9M	1M	1M	1.1M
BMW Group	0.7M	0.8M	0.8M	0.8M	0.8M	0.9M	1M	1M	1M	1M
Daimler	0.6M	0.6M	0.6M	0.7M	0.7M	0.8M	0.9M	1M	0.9M	1M
Ford	1.1M	1M	0.9M	0.9M	0.9M	1M	1M	1M	1M	1M
FCA Group	1M	0.9M	0.8M	0.7M	0.7M	0.8M	0.9M	1M	1M	0.9M
Toyota	0.6M	0.5M	0.5M	0.5M	0.5M	0.6M	0.6M	0.7M	0.7M	0.8M
Geely	0.2M	0.2M	0.2M	0.2M	0.2M	0.3M	0.3M	0.3M	0.3M	0.3M
Top 10 Total	**12.3M**	**12.1M**	**11.3M**	**11.1M**	**11.9M**	**13.1M**	**13.9M**	**14.2M**	**14.3M**	**14.3M**
As % Of Total	**93%**	**94%**	**94%**	**94%**	**95%**	**95%**	**94%**	**94%**	**94%**	**93%**

Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional. *Shortened throughout this paper from Renault-Nissan-Mitsubishi Alliance for brevity. **Shortened throughout this paper from Hyundai-Kia for brevity.

Figure 3: Market share of the top 10 groups 2010-2019



Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

The aggregate total emissions that these car registrations are emitting annually is shown, group by group, in Table 2a. All emissions volumes were up in 2019, save for Renault-Nissan Alliance and FCA – who we can see from Table 1 also saw reduced sales in 2019.

Of the top 10 only Renault-Nissan Alliance and FCA saw a decline in emissions in 2019 – however this was most likely due to falling sales not a significant technology shift

Table 2a: Total emissions for the group fleet as only the newly registered vehicles are listed in Table 1

GROUP	2017	2018	2019
Volkswagen Group	431.7 m	435.5 m	464.6 m
PSA Group	278.3 m	288.2 m	288.4 m
Renault-Nissan Alliance	257.2 m	260.6 m	256.6 m
Daimler	122.1 m	125.3 m	134.3 m
Hyundai	116 m	124.3 m	129.4 m
Ford	123.9 m	122.1 m	127.6 m
BMW Group	119.9 m	123.9 m	127.1 m
FCA Group	118.3 m	125.1 m	116.1 m
Toyota	71.4 m	75.1 m	78.2 m
Geely	34.9 m	38.5 m	43.3 m

Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

[7] Source: FCA, as at January 2021. See https://www.fcagroup.com/en-US/media_center/fca_press_release/FiatDocuments/2021/January/Merger_of_FCA_and_Groupe_PSA_approved_by_shareholders.pdf for more information.

Table 2b: Group fleets and the car brands associated with them

ASTON MARTIN	GEELY	CATERHAM GROUP	DAIMLER	TATA MOTORS
Aston Martin	Volvo Lotus	Caterham	Mercedes-Benz Smart Daimler	Jaguar Land Rover Tata
HONDA	**FORD**	**EXOR**	**SUBARU**	**SUZUKI**
Honda	Ford	Ferrari	Subaru	Suzuki
SAIC MOTOR UK	**HYUNDAI**	**ISUZU**	**MAZDA**	**MCLAREN GROUP**
MG	Kia Huyndai	Isuzu	Mazda	McLaren
GENERAL MOTORS	**TOYOTA**	**TESLA MOTORS**	**RANGE ROVER**	**MAHINDRA GROUP**
Daewoo Cadillac Chevrolet Buick	Toyota Lexus	Tesla Motors	Range Rover	Ssangyong Mahindra
VOLKSWAGEN GROUP	**PSA GROUP**	**BMW GROUP**	**RENAULT-NISSAN ALLIANCE**	**FCA GROUP**
Volkswagen Skoda Seat Audi Porsche Bentley Bugatti Lamborghini	Peugeot Citroen Vauxhall Opel DS Automobiles	BMW Mini Alpina Rolls Royce	Renault Dacia Nissan Mitsubishi Infiniti Lada	Alfa Romeo Fiat Jeep Maserati Lancia Abarth Chrysler Dodge

Source: Federated Hermes, as at December 2020.

Table 3 shows the average car emissions profiles for the top 10 manufacturers. This is broken down into the lowest 25%, median, and top 75% (as well as the minimum and maximum). Note: this table does not take into consideration the number of cars registered by each group, but looks at the models made available by each group. The table shows that **the majority of the models sold were in the range of 100 – 150g CO_2/km, i.e. exceeding the 95g CO_2/km regulatory 'touchpoint' set for 2020**.

Most of the auto models sold in 2019 were way off the 95g CO_2/km regulatory 'touchpoint' set for 2020

Table 3: Groups' fleet emissions profiles (g CO_2/km)

OWNER	AVERAGE EMISSIONS	MINIMUM	LOWER 25%	MEDIAN	TOP 25%	MAXIMUM
Volkswagen Group	124.34	0	116	131	154	575
PSA Group	114.87	0	109	119	130	286
Renault-Nissan Alliance	117.44	0	115	127	142	455
Hyundai	123.55	0	117	128	146	284
BMW Group	126.91	0	121	133	151	504
Daimler	137.36	0	129	152	174	453
Ford	130.97	0	116	132	161	435
FCA Group	130.83	13	124	143	162	427
Toyota	99.76	0	95	116	138	391
Geely	132.51	0	128	144	160	313

Percent of fleet whose emissions fall in the below groupings (0 g/km, 0-95, 95-110, 110-130, 130-150, and ≥150).

OWNER	AVERAGE EMISSIONS	0-95	95-110	110-130	130-150	≥ 150
Volkswagen Group	124.34	1.73	11.42	35.72	23.66	27.04
PSA Group	114.87	4.48	25.73	44.98	17.28	7.39
Renault-Nissan Alliance	117.44	2.39	13.64	40.51	24.41	17.76
Hyundai	123.55	2.6	11.59	40.15	22.57	21.55
BMW Group	126.91	3.61	3.94	37.46	29.37	25.28
Daimler	137.36	1.89	3.99	19.95	21.44	52.31
Ford	130.97	2.53	14.03	31.07	20.12	32.24
FCA Group	130.83	0.5	5.77	28.87	24.88	39.99
Toyota	99.76	26.34	19.82	17.07	23.79	12.9
Geely	132.51	9.63	0.31	18.71	29.28	42.07

Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional. Analysis undertaken by Federated Hermes.

Figure 4 shows the trajectory of average EU fleet emissions group by group in visual form. This shows that with the exception of Toyota, aggregate fleet emissions have been increasing in recent years – including in 2019. Conversely, in 2019 the average vehicle emissions fell for most groups, the exceptions being BMW, FCA Group, Renault-Nissan Alliance and VW. Figure 4 highlights other interesting trends – notably that the groups' fleets have lower average emissions than the average vehicle within that fleet.

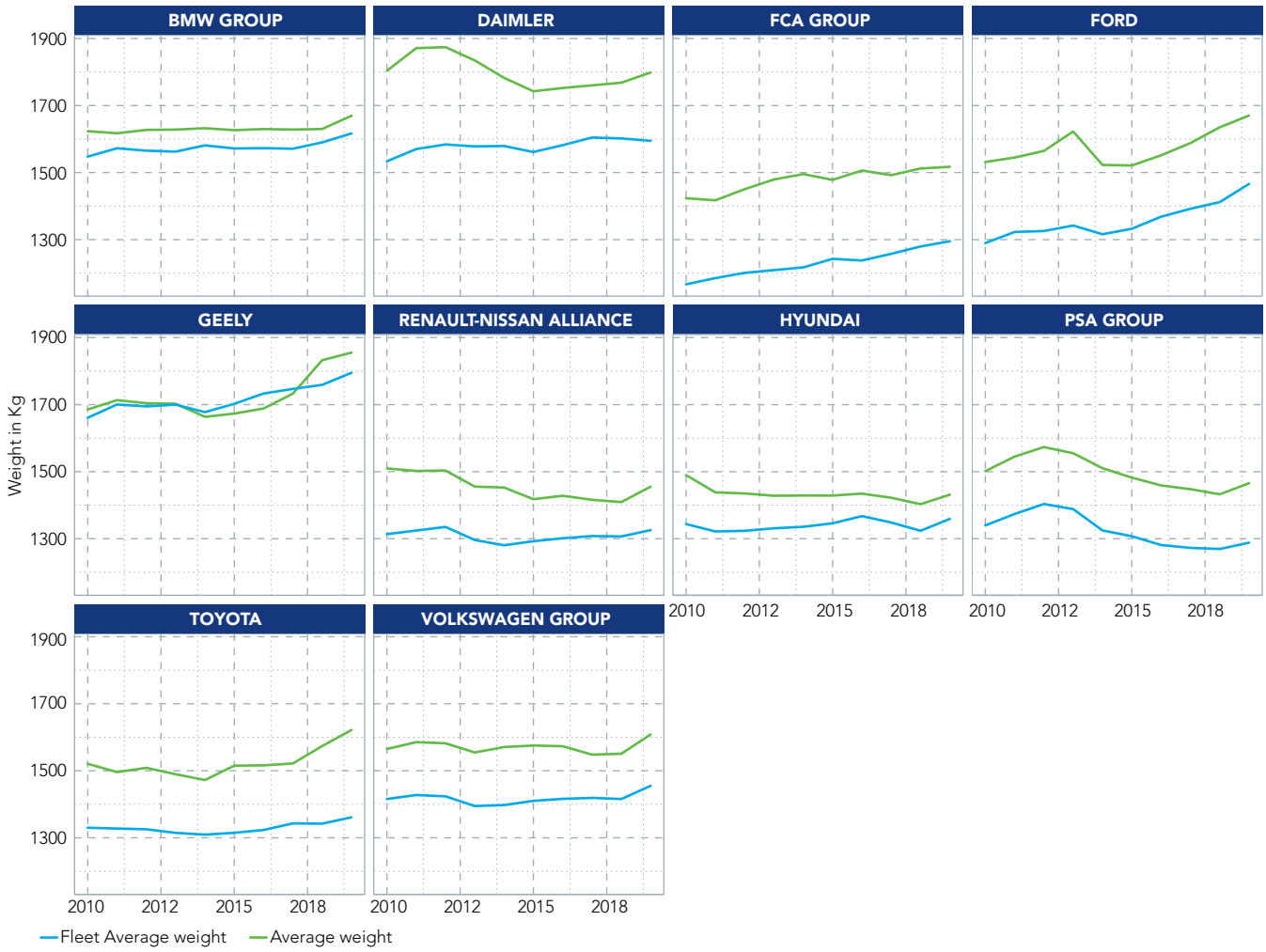
While the majority of fleet sales appears to generally trend toward lighter and smaller-engined vehicles, manufacturers continue to produce and sell cars with high-emitting profiles that take the average up

Figure 4: Average vehicle (dark blue line) vs average for the fleet (bar charts), group by group

Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

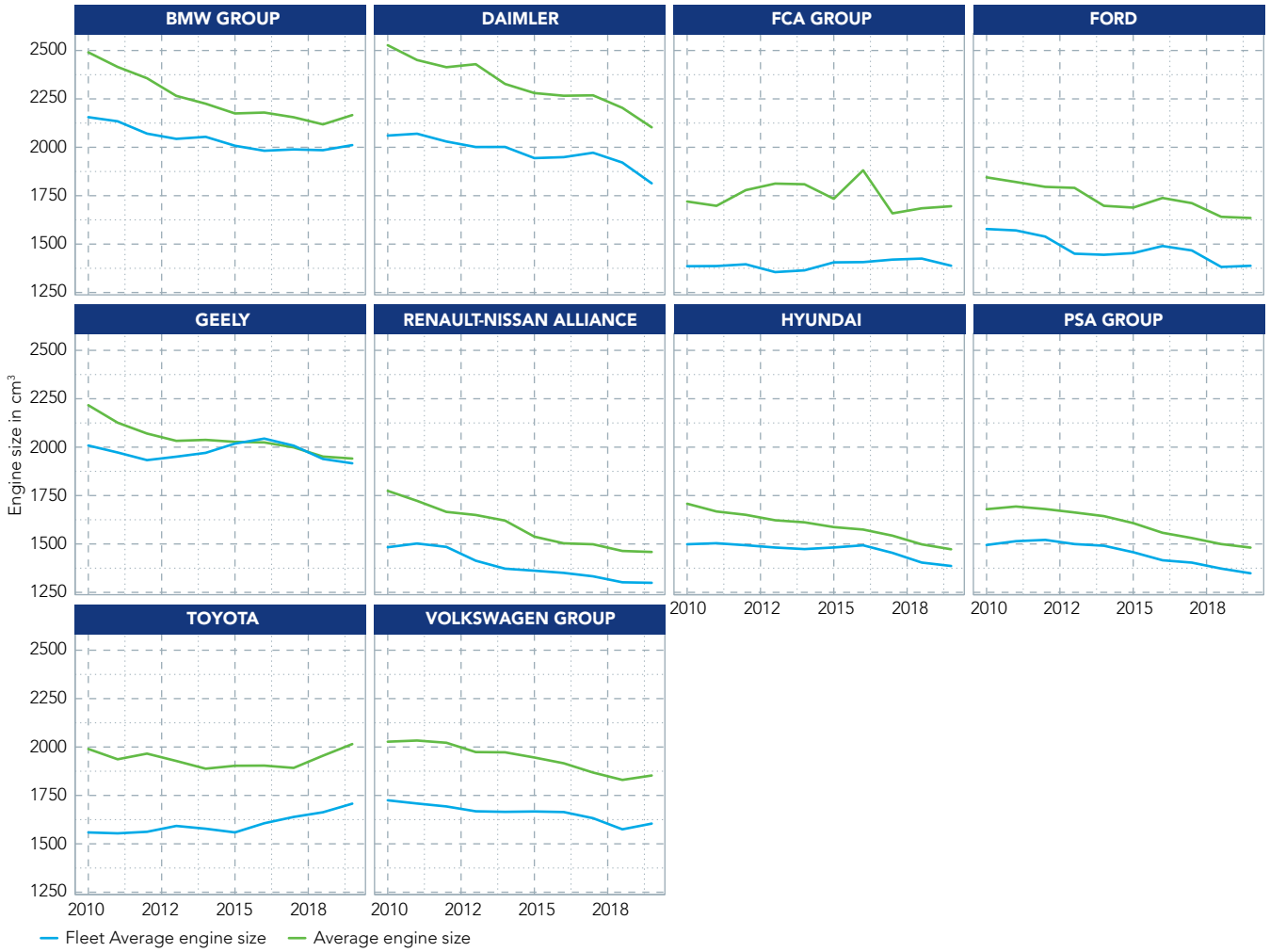
The cause of this discrepancy, as shown in Figures 5 and 6 below, is that the average of the emissions of *all the models* sold by each group is higher than the average across the *different models* sold within each group. So, **auto manufacturers are continuing to produce, market and sell vehicles with high-emitting profiles, despite the fact that the majority of sales are of lighter and smaller-engined vehicles – indicating the majority of customers tend to prefer such models**. Some exceptions to this trend exist such as the case of Geely Automobile Holdings, which manufactures specialised sports cars, where customers prefer heavier cars (Figure 5).

Figure 5: Difference between the average (absolute) weight vs the fleet average



Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

Figure 6: Average engine size vs fleet average engine size



Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

Erratic progress being made to 2019 weights of diesel and petrol engines and vehicles have stayed more or less constant – however, hybrids engines and vehicles are getting heavier

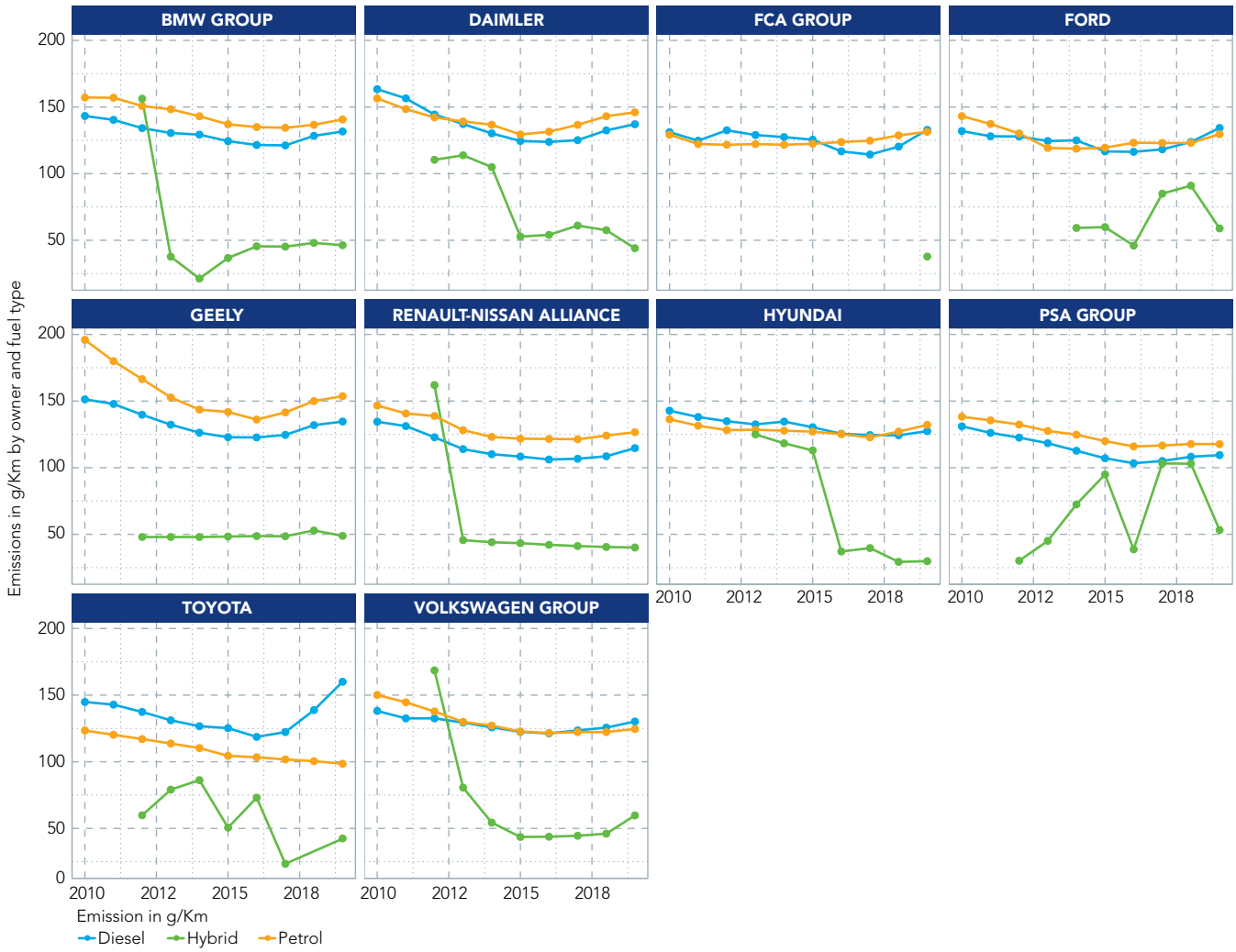
We can also see from Figure 7 that **while the weights of diesel and petrol have stayed more or less constant throughout 2010-2018 (with an increase in the cohort of diesel vehicles with more powerful engines), hybrid engines (including plug-ins) have been gradually increasing in weight**. Vehicle weight is a function of the engine size in terms of cm^3 and as Figure 7 shows the larger the engine, the heavier the vehicle. **Thus, we conclude that the engines of hybrids vehicles as a group are getting larger – and that instead of acting as a bridging technology to reduce emissions from the passenger car sector, hybrids are adding to the problem of rising emissions from the sector**. This combined with concerns that PHEVs in particular often remain uncharged due to low charge rates and limited range and so run on the ICE means they are likely to be making real-world pollution worse.

Figure 7: Average weight of vehicle vs fuel type and engine size in cm^3 across the EU fleet to 2018

Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

To understand more about what is going on, Figure 8 breaks down the weighted average emissions for the top 10 manufacturers by fuel type. We have grouped all the non-pure diesel and non-pure petrol in the 'other fuel type' (i.e. EV and hybrids). **What we see is insufficient real progress being made in 2019 across petrol and diesel categories with any gains in reduction of average engine size being offset by the rising weight of vehicles. In the hybrid category, BMW, Daimler, Renault-Nissan Alliance, Hyundai and VW are generally reducing average emissions – but the performance of Ford, PSA and Toyota has been erratic to say the least**.

Figure 8: Average emissions per manufacturer (most popular brands) vs fuel type

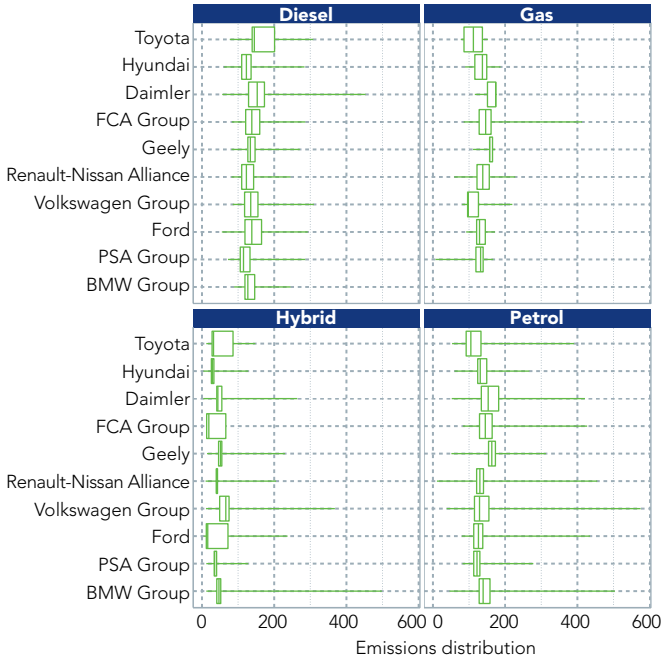


Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

Vehicles were available that meet the 95g CO_2/km target in 2019, however, across the board the focus continued to be on selling much heavier options

As noted earlier, the average fleet and model emissions per manufacturer are well above the 95g CO_2/km target that the EU has set. Figure 9 shows the distribution of emissions per manufacturer in 2019 by fuel type. It is a boxplot, which has at the left end of the line the lower number, the leftmost part of the box, being the bottom 25%, the line in the middle of the box being the median, the rightmost part of the box the 75%, and the right end of the line is the highest value. **It shows that, particularly within the hybrid category – but also in a few cases within the petrol category – there are vehicles that were already compliant with the 95g CO_2/km target. However, in 2019, these were not marketed as aggressively as the higher-emitting options, even among the hybrid range**.

Figure 9: Distribution of emissions for the most popular brands per fuel type, as at 2019



Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

5a. If hypothetical fines were applied to the entire 2019 fleet – without regulatory enablers – how would manufacturers perform?

When Regulation 2019/631 was agreed, fines for non-compliance were also set in place. As noted, generous regulatory enablers have been built into the rules. The following analysis sets out what fines would have become due on the fleet as reported for 2019, based on 2020 targets and had the regulations been applied as originally envisaged (i.e. without offsets for electric vehicles, environmental improvements and pooling offsets). **The aim is to give a snapshot of how on or off-course firms were in 2019**. The hypothetical penalty implications are calculated in the following table. The cost is calculated in euros as 95 * (excess emissions) * (number of vehicles). In Table 4 we show the hypothetical fines that would have applied to the top 10 manufacturers in 2019.

A sorry legacy of emissions left by 2019 fleet sales

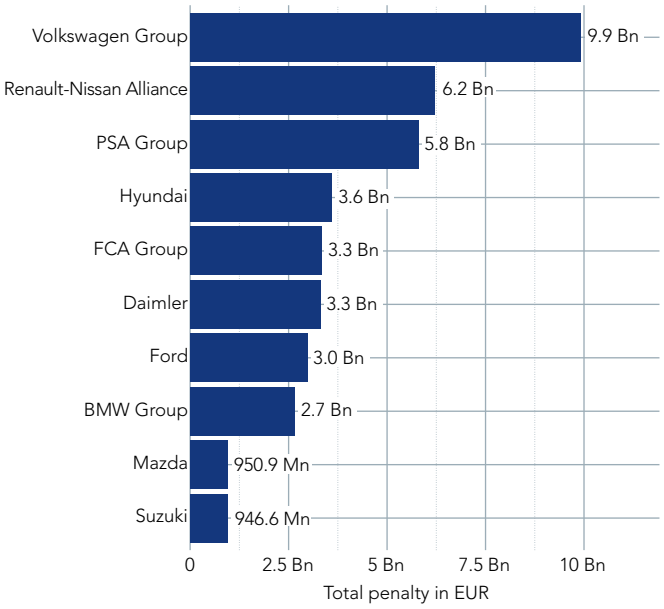
Table 4: Hypothetical fines for companies had regulations been in force, without enablers, in 2019

OWNER	AGGREGATE FINES (EUR)	AVERAGE FINE PER VEHICLE (EUR)
Volkswagen Group	9.9 bn	9.8 K
Renault-Nissan Alliance	6.2 bn	6.3 K
PSA Group	5.8 bn	6.5 K
Hyundai	3.6 bn	3.7 K
FCA Group	3.3 bn	10.2 K
Daimler	3.3 bn	1.5 K
Ford	3 bn	2.8 K
BMW Group	2.7 bn	1.1 K
Geely	825.7 m	1 K
Toyota	823.1 m	0.2 K

Source: Federated Hermes, as at December 2020.

These figures can be viewed as a proxy for the climate damage the legacy of the sale of the vehicles into the market, which last on average 12 years[8], has caused. Table 4 shows that, **for example, in 2019 if hypothetical fines as per Regulation 2019/631 had been in place, to cover the cost of those fines each VW group auto sold should have cost on average approximately €9.8K more at the point of sale to reflect fleet emissions over the desired 95gCO_2/km target. For Toyota the additional cost to cover fines due would have been just €200 per vehicle sold**. Aggregate hypothetical fines are shown in Figure 10.

Figure 10: Estimated total penalty per manufacturer (excluding supercredits)



Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

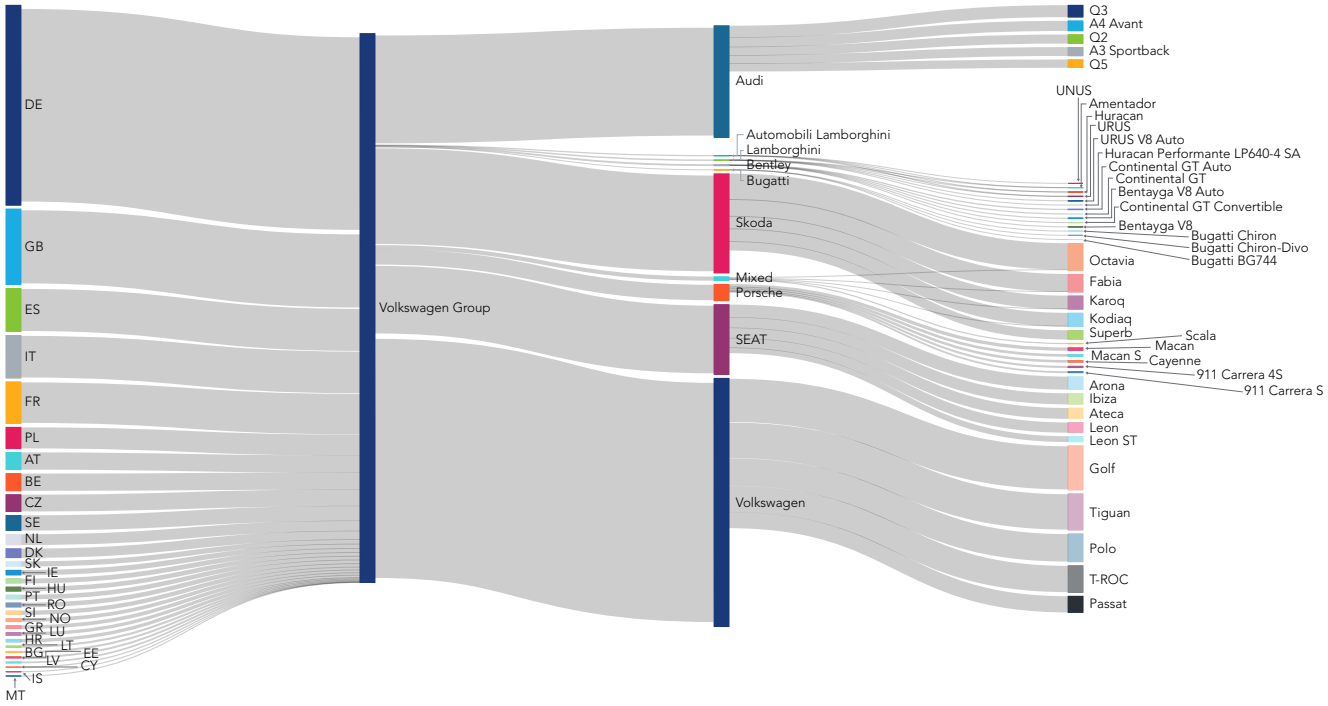
[8] "How Today's Cars Are Built to Last," published by AARP in November 2018.

In the example of Volkswagen, Germany far outweighs other European countries as a source of pollution – helping explain some of the generous incentive schemes put in place by the German government to support firms in their transition

5b. Manufacturers' country and car footprint

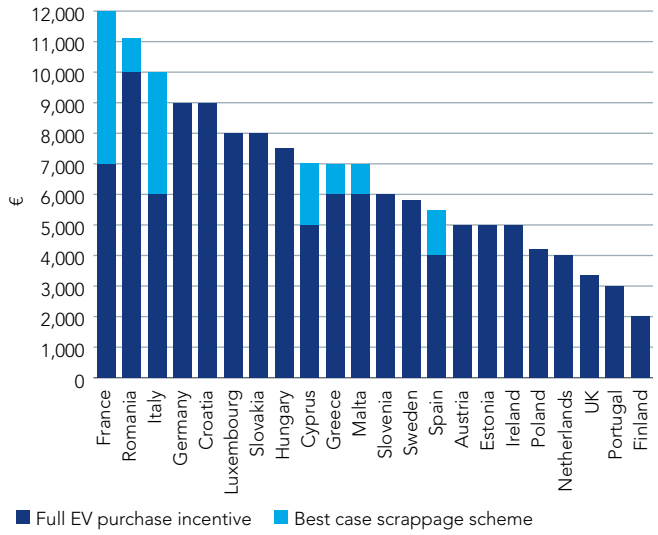
Figure 11 shows an illustrative estimated aggregate hypothetical penalty for Volkswagen, apportioned by country, brand and top five cars, had 2020 rules been in place in 2019 – and without the regulatory enablers. It is interesting to note Germany is the largest contributor, which may help explain why the German government and auto companies increased the most generous jointly funded grants for BEVs in November 2019, which are to be extended to 2025 to drive up demand[9]. (This is one of a plethora of grant/scrappage schemes instituted across European member states to drive up demand – see Figure 12).

Figure 11: Illustrative breakdown of Volkswagen emissions by country, brand, and top 5 cars



Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

Figure 12: BEV purchase subsidies and scrappage schemes in Europe



Source: Transport and Environment, as at September 2020.

6. What next? How feasible is a net zero/ 1.5°C-aligned EU auto industry?

In the past months and years the major European manufacturers have come out with a range of climate and sustainability commitments (as illustrated on page 16). Many, though not all, of the commitments relate to emissions from operations – not from the vehicles themselves. Yet as the analysis has shown the legacy vehicle emissions are huge – and, given that the need to limit global temperature increases is more urgent than ever, they must be a priority for firms.

The industry is not moving as fast as the climate science requires – and greater transparency in how sustainability commitments 'map' existing and future regulatory requirements in relation to emissions is needed.

[9] German government expands subsidies for electric cars," published by DW in November 2019.

6a. Climate change and technology innovation commitment

It is positive to see firms committing to increase BEV sales in particular – but at the same time, it is frustrating that it is often unclear how these high level targets 'map' to existing 2020 regulatory obligations of a fleet average of 95g CO_2/km and new 2030 obligations of 59g CO_2/km or even 47.5g CO_2/km and an end target (in our view) of 100% zero emissions by 2035 at the latest. **Put simply, the car companies need to move faster on R&D by marketing and selling Paris-aligned technology solutions and withdrawing models that worsen the emissions problem**.

	Carbon reduction and electric vehicles commitments
VOLKSWAGEN	Previously, the firm has said that by 2025 it aims to reduce the carbon footprint of cars and light-commercial vehicles across the entire value chain by 30% compared to 2015 – and by 2050 to make the entire group's balance sheet CO_2 neutral. On EVs the company has said by 2025 it intends to sell more than 1 million electric cars per year worldwide. By 2030, it plans to have launched about 70 all-BEV models across the group. Currently, the company sells BEVs (10 models are available) and PHEVs (19 models are available).
PSA GROUP	Target to, by 2035, reduce average CO_2 emissions of vehicles sold worldwide by 55% compared with 2012 levels. By 2034 reduce fleet GHG emissions by 37% from 2018 levels validated by the Science Based Targets initiative (SBTi). By 2050, all plants will be carbon-neutral, which will be achieved through the use of renewable energies and new carbon-free technologies, and by offsetting inevitable emissions. By 2034 reduce absolute GHG emissions from energy consumption (scope 1 and 2) by 20% from the 2018 base year (validated by SBTi). Currently, the company sells BEVs (nine models are available) and PHEVs (six models are available).
RENAULT-NISSAN ALLIANCE	Reducing carbon footprint by 25% by 2022. Scopes 1, 2 and 3 targets for 2030 approved by SBTi in March 2019. Currently, the company sells BEVs (two models are available) and PHEVs (two models are available). By 2022, Renault plans to produce eight 100% electric and 12 hybrid models.
BMW	BMW has a long-term ambition to establish a successful net-zero business model across the full value chain by 2020 at the latest. It has developed a 10-year plan with annual interim goals for the timeframe up to 2030. It will reduce CO_2 emissions per vehicle by at least 33% by 2030 across the entire value chain. It targets to achieve net-zero ambition from 2021 onwards for its own emissions (scope 1 + 2). In the use phase (scope 3 emissions), the objective is to reduce CO_2 emissions by 40% per vehicle-kilometre by 2030. BMW currently sells two BEVs and nine PHEVs. BMW plans for a quarter of its vehicles sold in Europe to have an electric drive train by 2021; a third in 2025 and 50% in 2030. By the end of 2021, BMW will offer five BEVs and it aims to have at least 25 electrified models by 2023 including at least 13 BEVs.
DAIMLER	With 'Ambition 2039', the company has set itself the target of making its fleet of new passenger cars CO_2-neutral over the vehicles' entire life cycle by 2039. Daimler Trucks & Buses Aims to offer only new vehicles that are CO_2-neutral in driving operation ('tank to wheel') in the triad markets of Europe, Japan and NAFTA by 2039. Mercedes-Benz has established science-based medium-term targets to reduce scope 1 and 2 GHG emissions by 50% by 2030 and to reduce scope 3 emissions from use of sold products by 42% per vehicle- kilometre by 2030. By 2039 all of its plants in all of its business units worldwide will be CO_2-neutral. From 2022 on all of its Mercedes-Benz car and van plants worldwide as well as its European plants for Trucks & Buses will be CO_2-neutral. At Mercedes -Benz, the goal is to have plug-in hybrids or all-electric vehicles account for more than 50% of its car sales by 2030. The group currently offer BEVs (three models are available) and PHEVs (eight models are available). Within the group, Mercedes-Benz alone planned by the end of 2020 to have five BEVs and >20 PHEVs in its portfolio, with >20 BEVs and <25 PHEVs by 2030.
FORD	Aspire to achieve carbon neutrality by 2050 and use 100% locally sourced renewable energy for all manufacturing plants globally by 2035. The group currently offer PHEVs (two models are available).
HYUNDAI	Looking just at Hyundai (not Kia), plans to reduce GHG emissions from business sites by 26% compared to the figure in 2016 by 2030. Target to operate over 26 eco-friendly vehicle models (hybrid, PHEV, BEV, FCEV) and 1.03 million units by 2025. Plans to set up a domestic production line capable of rolling out 500,000 fuel cell electric vehicles a year by 2030.
FCA GROUP	No mention of any commitment to the goals of the Paris Agreement or net-zero emissions. The group focuses on BEV (four models are available) and PHEVs (two models are available). Spent €1.8bn on CO_2 credits from Tesla to meet EU emissions targets.[10]
TOYOTA	By 2050, to reduce average CO_2 emissions from new vehicles by 90% compared to 2010 levels and achieve zero CO_2 emissions at global plants. By 2025, to reduce average CO_2 emissions from new vehicles by 30% or more compared to 2010 levels and reduce CO_2 emissions from global plants by 30% from 2013 levels. While Toyota has been the leader in the hybrid space and sold nearly 1.9 million of those globally in 2019, it only started selling BEVs in 2020. It sold 56,000 hybrids and 2,000 fuel cell electric vehicles (FCEVs) in 2019 worldwide. In the EU nine hybrids are available.
GEELY AUTOMOBILE HOLDINGS	Endeavour to achieve zero carbon emissions in all stages of product design, manufacturing, automotive use, shared transport and material recovery (but no time commitment). It currently offers four BEV, 11 hybrid and 10 PHEV models. Likely to publish more concrete targets after the merger with Volvo Cars is complete.

Source: Federated Hermes, as at December 2020.

[10] "Fiat Chrysler pools fleet with Tesla to avoid EU emissions fines," published by the Financial Times in April 2019. See: https://www.ft.com/content/7a3c8d9a-57bb-11e9-a3db-1fe89bedc16e.

Perhaps in response to this inaction, in 2020 in the UK, a new campaign has been established 'Badvertising', which aims to stop adverts fuelling the climate emergency, including those for cars, airline flights and fossil fuels. The campaign initially focused on combating the increasing sales of bigger and more-polluting cars in the UK and globally, which it says risks putting vital climate goals out of reach. The initial Badvertising report states:

- SUVs now make up more than four out of every 10 new cars sold in UK;
- This 'size creep' has led to over 150,000 new cars being sold in the UK in 2019 that are too big to fit in a standard parking space;
- The trend towards ever-larger, more fuel-hungry vehicles is being driven by the corporate marketing strategies of big car brands.

These assertions appear to be borne out by our analysis too. In November 2020 the UK government announced 2030 as the phase-out date for sales of new internal combustion engines and 2035 for sales of hybrids, brought forward from 2040 and then 2035. This sits alongside new commitments to invest £1.3bn in high-speed EV charging infrastructure and £582m in grants for the purchase of zero or ultra-low emission vehicles[11]. In Sweden, Netherlands and Ireland, among others, a 2030 ban on ICE vehicles is in place. Slovenia will allow only PHEVs from that date. From a climate science perspective this would seem to be a sensible way forward, potentially with interim measures to require companies to desist from selling the most-polluting vehicles. For example, governments could introduce an immediate withdrawal from sales of vehicles emitting over 130g CO_2/km, ideally without weight adjustment applied so that real-world benefits from these actions can be fully realised.

Looking ahead we have developed four scenarios to further support our assertion that the industry, based on 2019 figures, is moving too slowly in its transition and why 'bets' on hybrids – and PHEVs in particular – might be the wrong technology to invest in:

- **In scenario A, 'Under pressure'**, we assume an initial more generous 2025 target of 59g CO_2/km and then a fast and steep decline in fleet emissions to phase out of all ICE and hybrids in 2030;
- **In scenario B, 'Ashes to ashes'**, we again assume an initial more generous 2030 target of 59g CO_2/km, followed by a slower and more gradual phase out of all ICE and hybrids in 2035;
- **In scenario C, 'Heroes'**, we assume a more ambitious 2025 target of 47.5g CO_2/km (which we believe the European Commission may well propose in light of its recently increased 2050 climate change ambition), followed followed by a swift phase out of all ICE and hybrids in 2030;
- **In scenario D, 'Where are we now'**, we again assume a more ambitious 2030 target of 47.5g CO_2/km, followed by a swift phase out of all ICE and hybrids in 2035.

In these scenarios we assume that the targets apply to the full EU fleet on a per car basis (i.e. no derogations, weight adjustments or super credits etc). The findings are shown in Table 5. **What the scenarios show is a target of either 47.5g or 59g CO_2/km which implies little or no ICE in the mix, although hybrids can help contribute to those targets** (notwithstanding the misgivings we stated earlier in relation whether PHEV emissions really are as low as this when in real world use).

The transition then to net zero emissions from 47.5g or 59g CO_2/km implies a total phase-out of hybrids, with 100% BEV take-up – which raises the question of whether investment in a hybrids to BEV technology transition pathway within the five to 10-year range we lay out delivers the most attractive return on shareholder capital: we are skeptical on this point. Given the step-change trajectories this modelling implies, it is very concerning that Ford, in particular, has no current BEVs in the market. We also note Toyota has no BEVs on the market yet – however, as the data shows in Figure 13 and Figure 14 there has been a significant amount of patent registration by Toyota, with EV patent-filing far outstripping peers, which leaves us less concerned.

Table 5: Mix of diesel, petrol, hybrid and BEV under different scenarios

	Petrol	Diesel	Hybrid	BEV
2019	63%	32%	2%	1%
Scenario A, Under pressure 2025 (59g CO_2/km)	11%	12%	30%	47%
Scenario A, Under pressure, 2030 (net zero)	0%	0%	0%	100%
Scenario B, Ashes to ashes 2025 (illustrative 75g CO_2/km)	30%	10%	30%	30%
Scenario B, Ashes to ashes 2030 (59g CO_2/km)	11%	12%	30%	47%
Scenario B, Ashes to ashes 2035 (net zero)	0%	0%	0%	100%
Scenario C, Heroes 2025 (47.5g CO_2/km)	9%	9%	20%	62%
Scenario C, Heroes 2030	0%	0%	0%	100%
Scenario D, Where are we now 2025 (illustrative 75g CO_2/km)	30%	10%	30%	30%
Scenario D, Where are we now 2030 (47.5g CO_2/km)	9%	9%	20%	62%
Scenario D, Where are we now 2035 (net zero)	0%	0%	0%	100%

Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional. Analysis conducted by Federated Hermes.

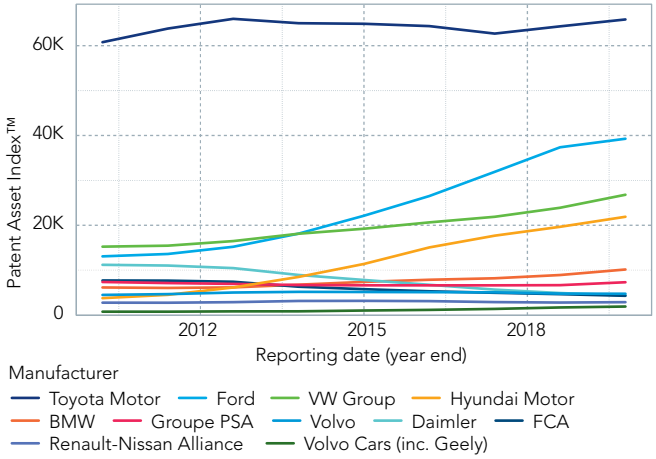
[11] See https://www.thetimes.co.uk/article/charges-for-using-roads-to-fill-40bn-black-hole-t2bz9k6br

This steep trajectory we describe 'maps' to some of the more aggressive timelines for phasing out fossil-based vehicles.

6b. Fortune favours the bold: preparedness for a step change?

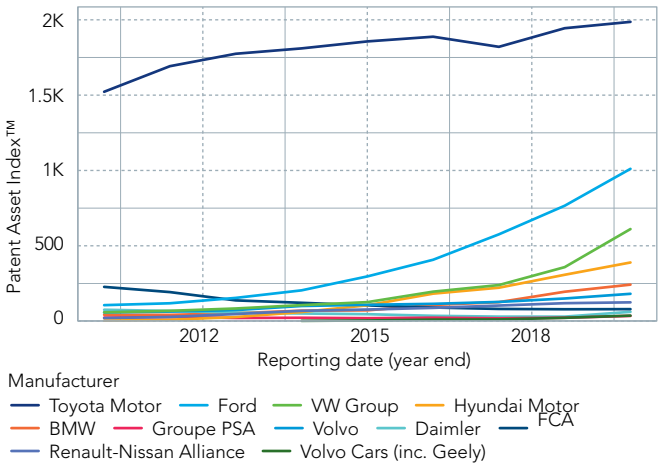
As we have laid out, technology development and deployment will be key to meeting the decarbonisation challenge that the auto sector faces. To understand what is happening within the 10 largest auto groups in Europe we looked at patents filed by auto groups in Europe, which we use as a proxy for R&D spending (see Figure 13 and 14). For all patent filings, Toyota leads the pack by a significant distance, followed by Ford and then VW group. Toyota has clearly placed great significance on R&D over many years, for other groups there has been a substantive increase in activity in recent years that mirrors that of the other groups, except Daimler (Figure 13). When EV patents are looked at in isolation, there is a consistent growth trend – again Toyota leads the pack by a significant distance, followed by Ford and then VW group. (Figure 14).

Figure 13: All EU auto company patent filings (inclusive of EVs)



Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

Figure 14. EU company patent filings (only EVs)



Source: European Environment Agency, as of December 2020. Data until 2018 is final, 2019 is provisional.

While the recent uptick in R&D across the sector looks positive, the significant structural changes required in the auto industry to ensure it helps not hinders the transition to a Paris-aligned 1.5°C world, will likely (with the exception of Toyota, perhaps) need significantly more investment into R&D – and will be a key topic of our engagement with companies

7. Conclusions

We conclude that early progress in meeting the first tranche CO_2 in cars targets (pre-2016) has not been matched in recent years. There seems to have been an industry-wide failure to invest sufficiently in the R&D and, importantly, the marketing and sales needed to shift both technology and sales norms in the auto sector onto the radical transformation pathway needed to keep a 1.5°C temperature increase in reach.

While it is likely that in 2020 most firms will reach regulatory compliance with the 95g CO_2/km target, our view is the pollution legacy left by companies falling back on perfectly legal EV offsets and pooling in 2020 is significant. It also means much more needs to be done by firms to roll out a Paris-aligned fleet in the coming years.

In Table 5, we showed the scale of the challenge if 1.5°C is to remain in reach. The data indicates a fast transition out of ICEs – for example, a 59g CO_2/km target would require a 12%/11%/30%/47% mix of diesel, petrol, hybrids and EV across the fleet. A 47.5 g CO_2/km target (which is on the table) would require for example a 62% EV/20% hybrids and 9%/9% diesel and petrol mix. The fast and significant tilt needed toward EVs indicates to us that substantial further investment in hybrids and PHEVs in particular may not offer the optimal return on capital for shareholders.

Technology change is all well and good – but a just transition is also needed for Europe's 3.7m auto workers

A step change is now needed in terms of the technology developed but also the range of vehicles marketed and sold by the industry. Historical data shows that incremental improvement to petrol/diesel ICE technology – or even hybrid technology – is unlikely to deliver the scale and pace of emissions reductions needed from the auto industry. Improvements will need to be combined with an early phase-out of diesel and petrol vehicles (including hybrids and PHEVs), replaced – if revenues are to be retained – with significant sales of BEVs. While light hybrids can be a reasonable bridging technology, ultimately 100% penetration of BEVs is needed by 2030, ideally, and 2035 at the latest. **This faster adoption of BEV must be a priority for auto companies – alongside a plan to retrain the estimated 3.7m workers (2.7m in direct manufacturing and a further 1m in indirect jobs[12]), whose jobs are at risk of becoming obsolete unless they are retrained in EV technology**.

Ubiquitous and high-speed charging infrastructure, and expansion and reinforcement of the electric grid, is also key to mass uptake of electric autos

We also recognise that **access to widely available and high-speed charging infrastructure is key to accelerating the uptake of electric vehicles. We agree with proposals** from key NGOs such as T&E **that electric-charging infrastructure should be rolled-out faster at work, home and across business premises – and we would welcome more announcements, like that made by the UK government** (notwithstanding Brexit) **to invest £500m plus in growing the EV infrastructure. This needs to sit alongside vehicle tax reform to accelerate electrification and penalise those that buy highly polluting vehicles**.

As the auto sector continues to consolidate through developing technology partnerships, so does its power to influence and deliver sustainable options to customers. **We will engage with companies to urge them to use that power to ensure the auto sector is a leader not a laggard in harnessing its capability and reach to keep the world on track to a no more than 1.5°C future**.

[12] See https://www.acea.be/statistics/article/employment

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