Electric car boom at risk:

Why the current EU car CO_2 rules will do little to accelerate the switch to zero-emissions mobility

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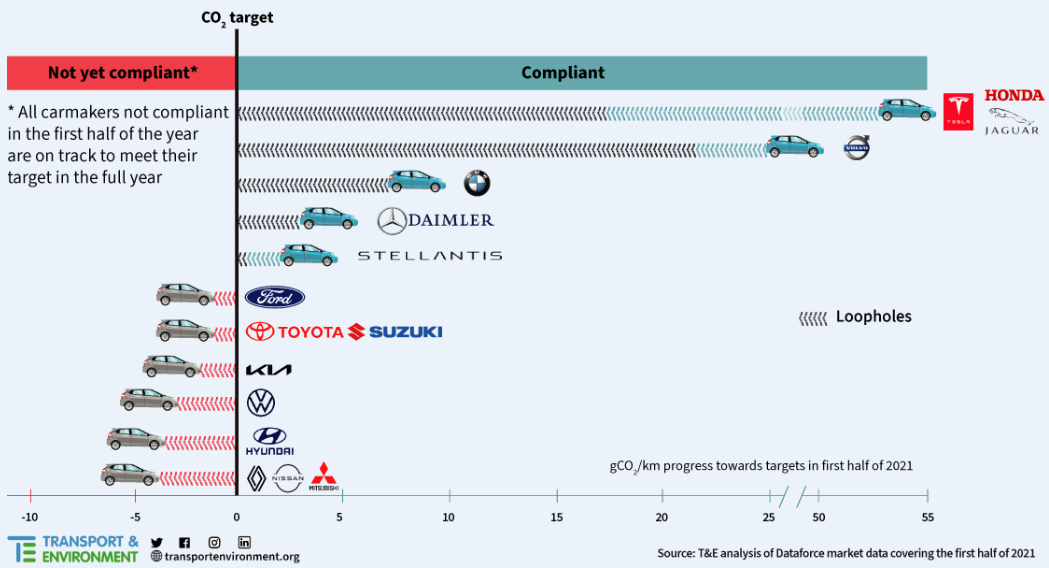
Executive Summary

The EU clean car rules - or car CO_2 standards - have driven the boom in electric car sales across Europe. The standards are phased in over 2020-2021 and require carmakers to reduce CO_2 emissions from the new cars they sell. In 2020, the sales share of plug-in vehicles more than tripled resulting in a significant drop in CO_2 emissions. In this report T&E looks at the situation in 2021, analysing CO_2 emissions from new cars sold in the first half of the year and looking at the performance of individual carmakers. Beyond 2021, the transition to zero emissions must accelerate as the European Commission recently announced proposals to go to 100% zero emission (electric) cars sales across Europe from 2035. As regulators in the European parliament and across governments consider the newly proposed rules from the Commission proposal, this report looks at the new car CO_2 and zero emission vehicle trends and compares them against the proposals. Will the new rules scale up electric car models quick enough so that all Europeans can access them?

CO_2 emissions from new cars dropped by almost one fifth from 2019

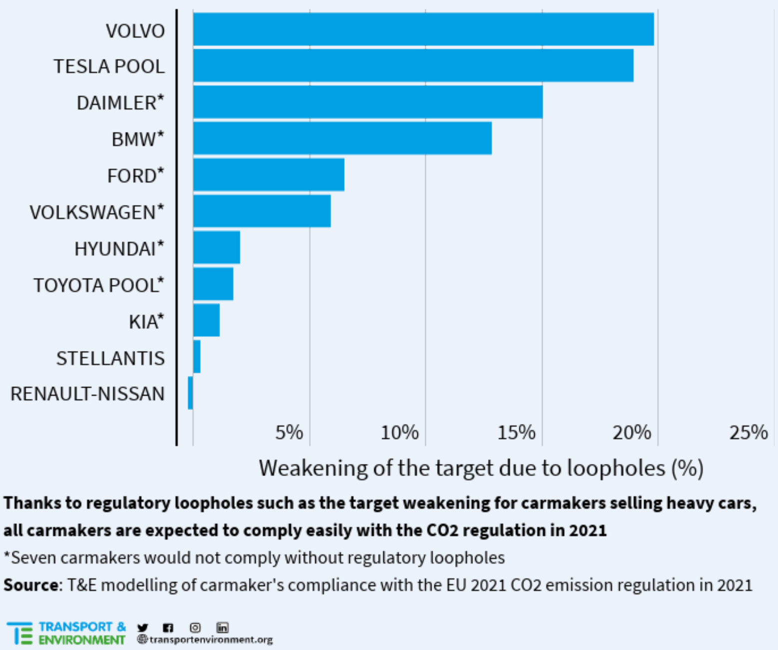
The sales of plug-ins models - battery electric cars, BEV and plug-in hybrid cars, PHEV - have surged with the entry into force of the 2020/21 CO_2 target requiring carmakers' average CO_2 emissions to stay below 95 gCO_2 per km. This report shows that the sales of plug-ins have multiplied by four across Europe, and by five in the EU, in two years: from 3% in the first half of 2019 to 16% in the first half of 2021 (7.5% BEV). This has led to the second largest annual drop in CO_2 emissions from new cars (after last year): an 8% reduction compared to 2020. This results in a total reduction of CO_2 emissions of 18% since the entry into force of the 2020/21 car CO_2 regulation, or the equivalent of all car emissions of Slovenia in 2019.

Majority of carmakers already compliant, but 840,000 electric sales missing due to loopholes



Some carmakers already compliant in the first half of the year thanks to loopholes

Five groupings of carmakers (or "pools" as referred to in the law): Tesla-JLR-Honda, Volvo, BMW, Daimler and Stellantis are already compliant with the 2021 target as of July, six months before the deadline. Ford, Toyota-Mazda-Suzuki-Subaru and Kia are close with a gap of less than 2 g/km while Volkswagen, Hyundai and Renault-Nissan-Mitsubishi have gaps around 3 g/km. This shows carmakers are once again on track to meet their CO_2 targets and will all comply at the end of the year.



Carmakers CO_2 targets weakened by regulatory loopholes

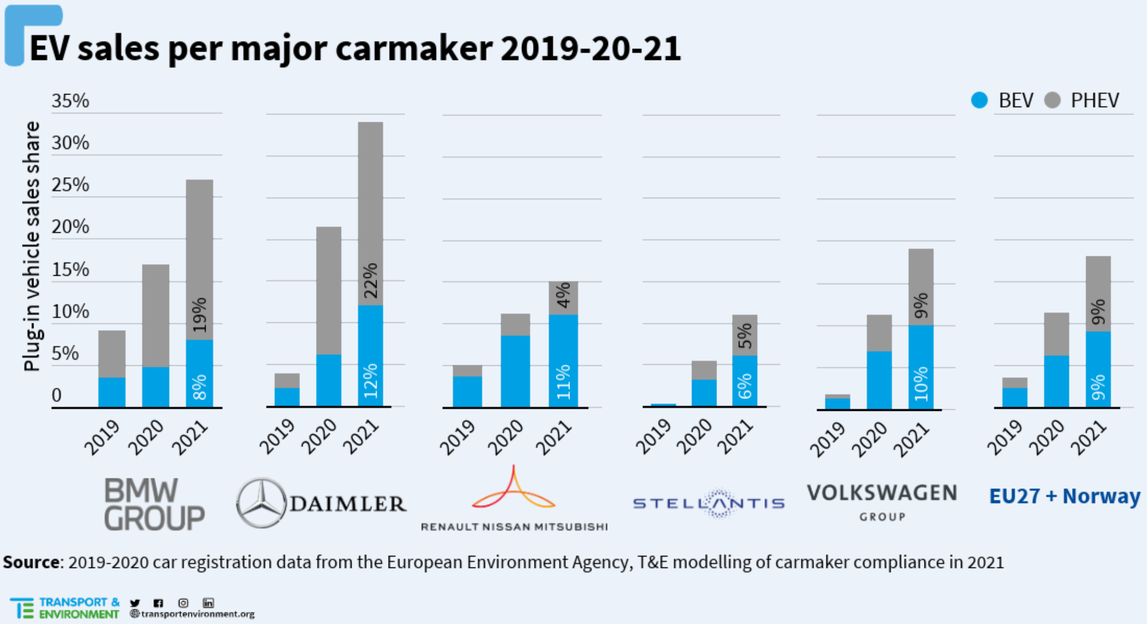
Carmakers have different compliance strategies to reach CO_2 targets: Kia, Renault and Volkswagen rely on growing battery electric sales while Daimler, Volvo or BMW mainly focus on PHEVs. Others such as the Toyota OEM grouping, Ford and Stellantis have a stronger focus on engine efficiency and hybridisation. BMW and Daimler are among carmakers benefitting the most from flexibilities and would not comply without them. For more information on carmakers performance, see T&E OEM dashboard.

On average, over half of the gap to 2021 target is closed by sales of full electric and plug-in hybrid cars. Improving efficiency of conventional models comes second. On top, four regulatory flexibilities - adjusting CO_2 targets for heavier cars, eco-innovation credits, super-credits multiplying sales of plug-ins, and pooling sales with other carmakers - allow carmakers to close 16% of the gap. T&E calculates that these regulatory flexibilities, as well as the unrealistic CO_2 rating of PHEVs, will prevent the sale of 840,000 battery electric cars across Europe in 2021. This is the climate cost of the flawed design of the regulation.

18% plug-in share expected in 2021, but polluting conventional models and hybrids pose problems

The T&E modelling[1] forecasts 18% plug-in share across Europe (EEA) at the end of the year, including 9% fully electric cars. T&E expects that the number of plug-ins sold in Europe would exceed 1.9 million in 2021.

[1] The expected share of plug-in vehicles for the full year 2021 was calculated by assuming all carmakers are compliant by the end of the year and included the impact from flexibilities.

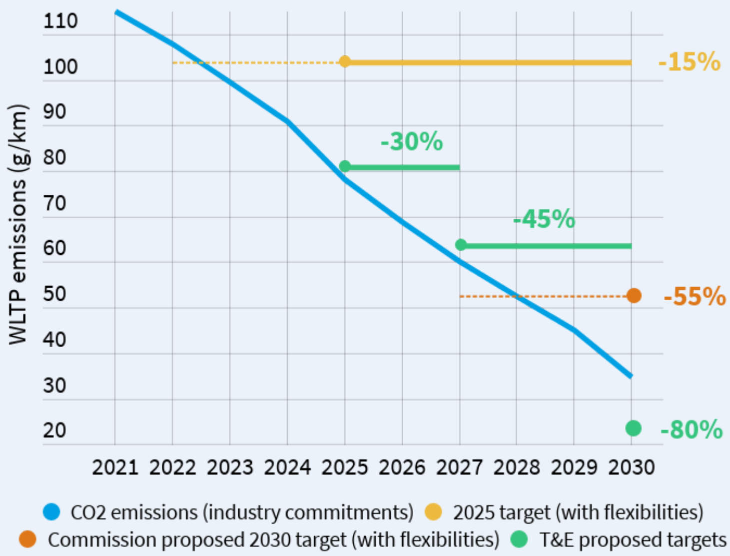


However, PHEV share of the plug-in market (55%) is now higher than in 2019 or 2020 and starts to eat into the share of zero emissions electric sales. Despite being classified as low emissions vehicles with test measurements mostly below 50 g/km, PHEV road emissions are estimated to be two to four times higher than lab results. This means that a large part of the official emissions drop is not occurring on the road.

In addition, CO_2 emissions of conventional (petrol and diesel) models have been stagnating with a mere 2% reduction from their 2016 level. Three carmakers - JLR, Volvo and Daimler - have engine emissions above their 2016 levels. Every 8th car sold in the first half of this year was a high emitting model with CO_2 above 157 g/km, predominantly an SUV.

Regulation lags behind carmakers' emobility potential & is full of loopholes

Looking beyond 2021, the analysis shows that because of the weak CO_2 standards for the period 2022-2029 the ongoing EV boom will taper off from 2022 onwards.



Source: T&E modelling of carmakers emissions in the 2020s

T&E projection of emissions in the 2020s

The current CO_2 targets for 2025 and 2030 lag behind carmakers' own plans for electrification. T&E estimates that if carmakers deliver on their voluntary plans, the CO_2 from new cars would be reduced by as much as 30-35% by 2025. In comparison, the regulation asks for a mere 15% reduction that would be reached as soon as 2023. The CO_2 emissions would be further reduced by 45-50% in 2027, and 65-70% by 2030. This is double the 2030 target currently in force and is significantly above even the newly proposed 55% reduction.

From 2025-2029, a new flexibility will also enter into force: the zero and low emissions vehicles (ZLEV) benchmark that gives credits to sales of full electric and hydrogen cars (1 credit each) as well as plug-in hybrids (less than 1). This will reduce carmakers' CO_2 target by up to 5% if they sell more than 15% ZLEV share in the period 2025-2029. Analysis of the planned electric car production shows that many carmakers would reach this level of sales already in 2023, or two years prior to the flexibility entering force (so all are projected to benefit from at least the partial CO_2 bonus in 2025). Despite this fact, the Commission has left the benchmark untouched until 2030 in its July proposals.

All the regulatory flexibilities will result in new cars emitting 6% more CO_2 than they would otherwise be allowed to over the coming decade, just as we should be accelerating our climate action. This will also make it very hard for member states to reach their national effort-sharing (ESR) targets by 2030. T&E estimates that in the absence of these regulatory loopholes, 11.5 million more battery electric cars would be sold across Europe between 2021-2030.

Carmakers delivering on their EV promises could increase conventional car CO_2 by 60%

Historically, EV sales have closely matched regulatory requirements, jumping from 3% in 2019 to 18% in 2021. We expect this will remain the case, and in 2025 battery electric car sales will be around half of what could be expected based on industry announcements. The weak targets between 2025-2029 could jeopardize the sales of 18 million battery electric vehicles. It will result in 55 Mt of CO_2 pollution – more than the annual emissions of all the cars in Spain.

There is a theoretical possibility carmakers deliver on their EV promises without a tighter regulation. But this would not necessarily be good news for the climate. Indeed, the car CO_2 regulation imposes a cap on the average emissions of new cars sold. Selling high shares of EVs - which are counted as zero emission cars - creates space to sell higher emitting vehicles such as SUVs. In 2020 several carmakers constrained or altogether ended the sales of very polluting cars. For example, Volkswagen ended the sales of the Amarok pick-up truck. T&E modelling shows that if carmakers meet their own EV sales targets, they could increase the emissions of their conventional models by 60% in the second part of the decade compared to 2021 and still comply with the regulation.

Policy recommendations

T&E analysis highlights that the ambition and design of the current and proposed revision of the car CO_2 regulation are not fit for the zero emissions acceleration and industrial preparation required in the next decade. With competitive zero and low emission models now on the market, the next task of the regulation is to scale up their production. This is needed to make them affordable and accessible to all Europeans as well as to build the EV supply chains be it charging or battery materials on time. But the regulation's lack of ambition in the 2020s will not bring the planning certainty for the ZEV sales to ramp up and the new EV industries to scale up on time. This is bad news for Europe for three reasons:

- **Bad news for the climate** as less CO_2 will be reduced from cars in the coming decade and fewer clean models replacing polluting ones, undermining our chance of avoiding a climate catastrophe.
- **Bad news for consumers** as slower scaling up of electric car production in the 2020s will delay the point when the price of zero emission cars reaches that of conventional models. This means electric cars will be less affordable and accessible when the world has to accelerate and transition fully to zero emissions vehicles.
- **Bad news for European industry**, as the EU automotive industry risks not moving quickly enough in the 2020s and conceding the lead in future-proof technology to other regions of the world. Catching up by 2030 is too late as Asian, American and other companies are already taking a growing share of the European market and wooing consumers today.

A combination of excessive flexibilities and inadequate emission reduction targets underscores the need to strengthen the car CO_2 standards in the 2020s when the ramp of electric vehicles is needed to put Europe on a credible path to zero emissions. This is how T&E recommends the regulation is amended by the European Parliament and the European governments:

Increase the current level of the targets:

- To ensure an effective CO_2 reduction and optimal supply of BEVs, **Europe needs at least a 30% CO_2 reduction from new cars from 2025 and 45% from 2027**.
- For the entire car fleet to be zero emission in 2050, the **last new car with any CO_2 emitting engine must be sold no later than 2035**. To be on the feasible path to 100% zero emission sales in 2035, sales of ZEVs will need to hit at least 67% in 2030, which corresponds to a **CO_2 reduction target of -80%**.

Flexibilities are weakening the CO_2 standards by allowing carmakers to cut planned BEV production and/or increase ICE vehicle emissions and remain compliant with the targets. **T&E therefore recommends to improve the design of the regulation** by:

- Removing the ZLEV benchmark and corresponding CO_2 bonus from 2025.
- Stopping the free CO_2 pass for heavier cars by removing the mass adjustment factor as well as limiting the CO_2 savings that can be claimed from eco innovations.
- Reforming the tests to provide realistic CO_2 rating of PHEVs, with the help of real-world data from fuel consumption meters.

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1. Introduction

The car CO_2 emission standards are the main regulatory driver for emission reductions from new cars in the EU. The latest regulatory changes that entered into force in 2020 aim to limit average emissions from the new car fleet to 95 g/km[2]. The entry into force of this standard has sparked the transition to electromobility by forcing carmakers to sell cleaner cars.

Published on an annual basis, T&E's car CO_2 report tracks the compliance of carmakers (OEMs) with this regulation and analyses their various strategies to do so. While some carmakers are primarily looking to reduce their emissions by switching to electric vehicles, all carmakers are benefitting to a certain extent from the considerable flexibilities in the regulation. However, there are some in particular who are exploiting these flexibilities to limit their efforts to roll out zero emission vehicles.

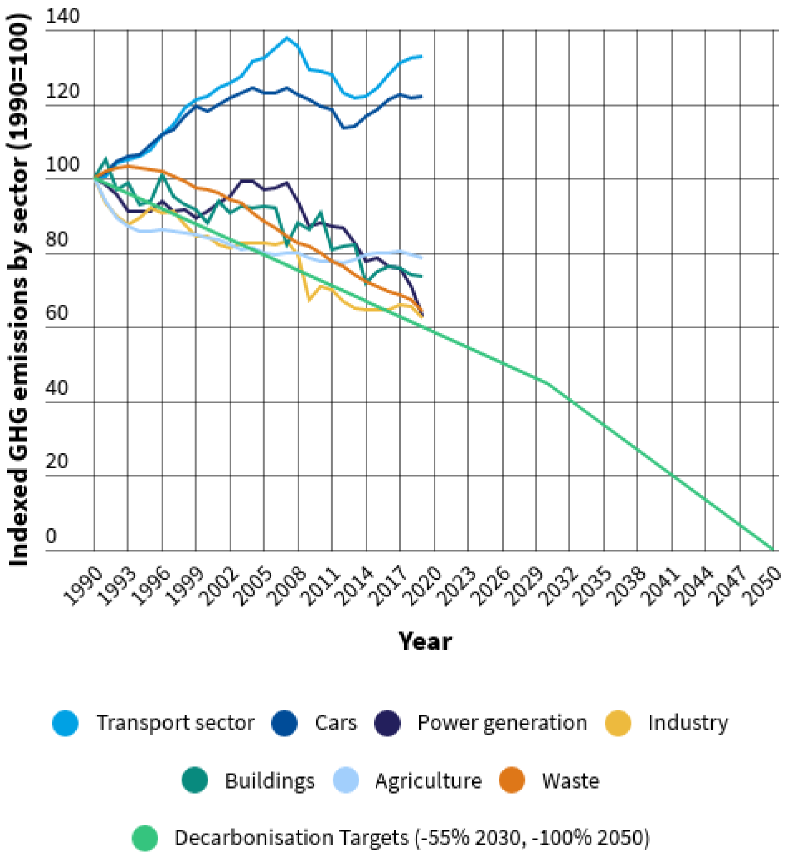
This introduction section provides an overview of CO_2 emission trends in the transport sector in the EU and looks at the 2020/21 car CO_2 regulation as well as the flexibilities it allows to carmakers. The main analysis is based on car registration data from the first half of 2021 and includes projections made for the whole year. The CO_2 emissions of new cars are analysed in section 2, and section 3 focuses on plug-in vehicle sales during the first half of 2021. Section 4 presents T&E's forecast of the remaining plug-ins sales required for OEMs to meet their targets for the whole year 2021. Section 5 analyses in more depth the impact of flexibilities on the stringency of the target beyond 2021. Finally, section 6 presents T&E's recommendations to enhance the car CO_2 regulation and make it fit for purpose for the emobility era. In addition to this report, T&E has published a more comprehensive Technical Annex focused on trends in the past decades as well as carmakers compliance in 2020.

1.1. Transport emissions: Europe's biggest climate problem

Emissions from the transport sector have kept increasing since 1990 thus making transport the biggest source of carbon emissions: in 2018, the transport sector contributed to 28% of the EU's total CO_2 emissions (with aviation and shipping included).

With CO_2 emissions 22% higher than in 1990, cars are the second biggest contributor to the increase of transport emissions after aviation. In total, passenger cars are responsible for around 12.5% of Europe's annual emissions and account for 43% of total transport sector emissions.

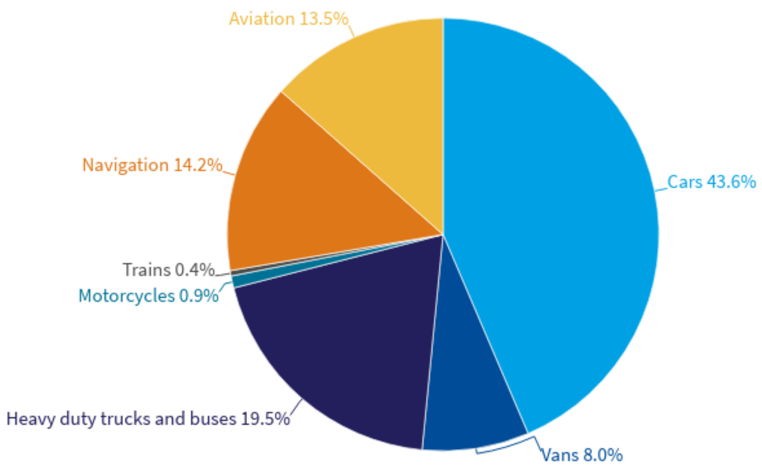
[2] In this report, the unit g/km refers to CO_2 emissions per kilometer (gCO_2/km)



Scope: EU27

Source: T&E from EEA 2019 GHG proxy database

Figure 1 - Evolution of EU GHG emissions per sector 1990-2019



Source: Transport & Environment from Member States' reporting to the UNFCCC (1990-2019 data)

Figure 2 - EU27 transport greenhouse gas (GHG) emissions per sector in 2019

In order to meet the European Green Deal's ambition of net zero CO_2 emissions by 2050, CO_2 emissions from passenger cars have to drop quickly, requiring that all new cars need to be zero emission by 2035 at the latest. Indeed, the average car in Europe drives for 15 years, thus necessitating the last ICE to be sold in 2035 for the total on road fleet to be zero-emission in 2050. The EU car CO_2 standards regulation - Europe's only law regulating the climate impact of new cars - therefore has a crucial importance to incentivise the uptake of zero emissions vehicles during this decade.

1.2. Current 2020/2021 car CO_2 emissions regulation

The current European 2020/21 CO_2 emissions regulation for passenger car manufacturers was adopted in 2014 and implemented starting in 2020. The current CO_2 standard targets limit carmakers average fleet emissions to 95 g/km measured using the New European Drive Cycle (NEDC) test cycle[3] in 2020. From 2021, equivalent targets are set as emissions are measured using the Worldwide Harmonised Light Vehicle Test Procedure (WLTP)[4]. Compared to 2019, the average CO_2 emissions from new passenger cars in Europe in 2020 dropped by 12% while the share of plug-ins (EVs) tripled.

Nevertheless, the regulation also includes several flexibilities [1] to help carmakers reach compliance with the targets:

1. **95% phase-in (2020 only)**: 2020 was a phase-in year, meaning the 95 g/km target only applied to the 95% least emitting new cars in a carmaker's fleet. This favored OEMs producing high-emitting models.
2. **Mass-based target**: Each carmaker's target[5] is adjusted in function of the average mass of their fleet: a carmaker selling heavier cars has a less stringent target compared to one selling lighter cars. Therefore, it discourages the use of lightweighting to reduce emissions and weakens the stringency of the target because of the growing mass of vehicles (see section 4.3). In 2020 and 2021, the reference value used to adjust carmakers' targets is the average mass between 2014 and 2016 (1379.88 kg). But, in 2020, the average mass of the European new fleet had increased to 1462 kg [2], meaning that the average 2020 target is 97.7 g/km instead of 95 g/km.
3. **Pooling**: OEMs are allowed to form pools to jointly comply with CO_2 targets. In a pool, emissions across manufacturer groups included in it are averaged out. Manufacturers who don't sell enough plug-ins can benefit through such collaborations (such as JLR and Honda in the Tesla pool). The list of pools currently declared[6] can be found in Annex 7.1.

[3] The NEDC is a driving cycle designed to assess the emission levels of car engines and fuel economy in passenger cars under lab conditions.
[4] The WLTP is the new vehicle homologation procedure replacing the NEDC in 2021. In order to convert previous OEM NEDC specific emissions targets into new WLTP targets for 2021, the regulation is using an uplift factor calculated according to the ratio of an OEM's average WLTP emissions in 2020 over its average NEDC emissions.
[5] This adjustment does not apply for carmakers benefiting from a derogation on their CO_2 target.
[6] OEMs have to notify the commission of the pool creation before the 31st December 2021 and submit a declaration of interest before 31 October in the case of a pool formed by OEM from different groups of connected undertakings ('open pool').

4. **Eco-innovations**: OEMs can also claim credits, called eco-innovation credits, for fitting technology to the car that delivers emissions reductions on the road but not during the test (such as LED headlamps that are not switched on during the test or during coasting). Eco-innovation credits are given based on theoretical calculations and lab measurements, but their actual use and contribution on the road is unknown. The eco-innovation savings are capped at 7 g/km but no OEM reached this cap yet as the highest contribution was BMW with 1.9 g/km in 2020. The use of eco-innovations and the distribution among technologies are detailed in the Technical Annex.
5. **Super-credits**: These are credits given for sales of cars with emissions below 50 g/km. Each carmaker can use up to 7.5 g/km cumulatively between 2020 and 2022. Most carmakers used all their credits in 2020 (see the Technical Annex) and the only major OEMs having remaining credits in 2021 are Stellantis and the Toyota-Mazda-Suzuki-Subaru pool (1.8 and 5.8 g/km in NEDC respectively). Each car below 50 g/km was double counted in 2020 and 1.67 times in 2021[7].
6. **Derogations for certain carmakers**: Carmakers selling between 10,000 and 300,000 cars can apply for 'niche volume' derogations, which sets a target based on a 45% reduction of 2007 average fleet levels. Carmakers selling less than 10,000 cars effectively set their own targets ('small volume' derogation), while carmakers that sell fewer than 1,000 cars are fully exempt.

2. A steady decrease in car CO_2 emissions

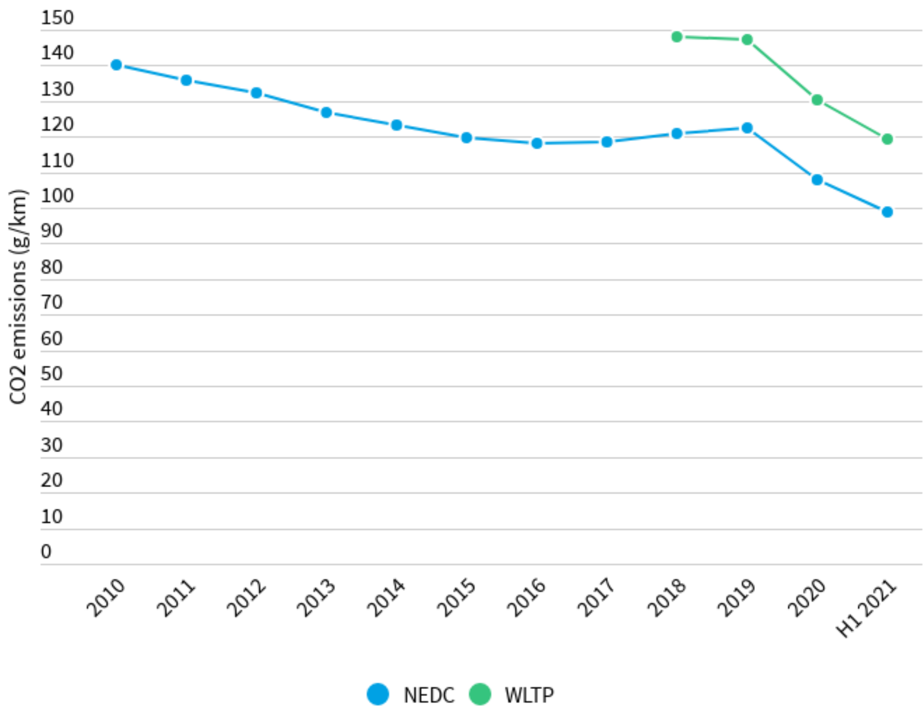
T&E acquired car registration data for the first half of 2021 from Dataforce[8] in August 2021. The dataset contains the registration country, registration numbers, emissions values (NEDC and/or WLTP), powertrain types, and segment information for all car models registered in the European Union (EU27), Norway (NO) and the United Kingdom (UK). As the UK left the European Economic Area (EEA) in 2021, it is not part of the CO_2 regulation from 2021, and cars registered in the UK in 2021 will thus not count towards the carmaker compliance calculations [3]. This report will therefore focus on EU27+NO[9].

The WLTP is the new test procedure that will be used in 2021 for compliance calculations. Unless specified otherwise, emissions values used in this report are obtained from the WLTP data. Registration data from 2020 is based on provisional data from the European Environment Agency [2]. For more details on the data, methodology and comparison of scopes and homologation cycle emissions please see the Annex 7.2.

[7] In 2021, NEDC measurements are still required in order to identify which car is below 50 g/km.
[8] Includes content supplied by Dataforce, based on IRIS® (International Registration Information System), August 2021. The permission to use Dataforce reports, data and information does not constitute an endorsement by Dataforce of the manner, format, context, content, conclusion, opinion or viewpoint in which Datafoce reports, data and information or its derivations are used or referenced herein.
[9] The UK is only included when a comparison with past data is needed.

2.1. Emissions trends analysis (H1 2021)

Continuing the trend of emission reductions initiated in 2020 by the entry into force of the 2020/2021 CO_2 standard, emissions from the first half of 2021 further decreased by 8.1% compared to 2020: from 129.8 g/km to 119.3 g/km (EU27+NO scope, WLTP). This decrease is smaller than the 9.2% obtained in the first half of 2020 compared to 2019, but this is nonetheless the second largest drop in emissions since records began in 2010. The CO_2 regulation is stricter in 2021 compared to 2020 because some of the flexibilities are no longer applicable (e.g. the 95% phase-in has ended and super-credits were mostly exhausted in 2020). Therefore, the regulation continues to drive emission reductions as OEMs need to comply with the higher stringency in 2021. When 2021 is compared with 2019 (EU27+NO), emissions decreased by 18.4%.



Scope: Registration data in the regulation scope applicable for each year (EU27+UK from 2010 to 2018, then EU27+NO+UK from 2019 to 2020 and EU27+NO in H1 2021).
Source: T&E analysis of passenger car registration data from the first half of 2021 from Dataforce, and 2010-2020 from the European Environment Agency.

Figure 3 - NEDC and WLTP emissions in the EEA

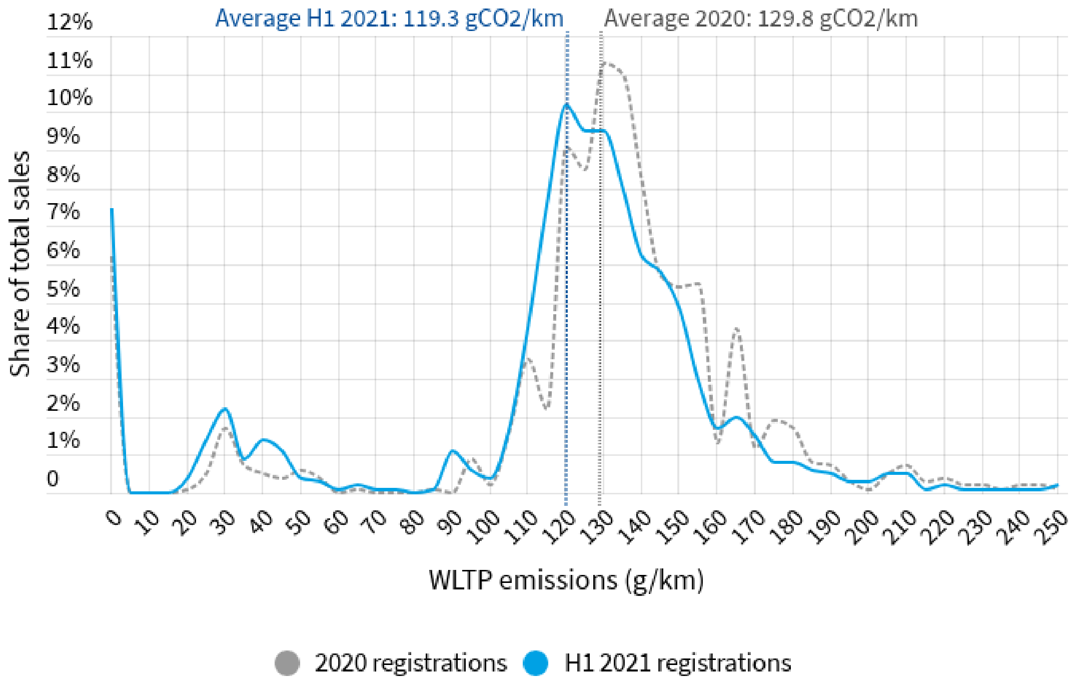
INFO BOX: The largest emissions decrease occurred in 2020

Provisional 2020 data from the European Environment Agency shows that NEDC emissions dropped from 122.3 g CO_2/km in 2019 to 107.8 g CO_2/km in 2020 [4]. This -12% decrease is the largest decrease in emissions since the monitoring of CO_2 emissions from new registrations started in 2010.

This major reduction in CO_2 emissions is mainly due to the large increase in plug-in sales from 3.5% in 2019 to 11.2% in 2020. In this way, the new standard effectively drove zero and low emissions vehicles to the market with 6.2% battery electric vehicles (BEVs) and 5.0% plug-in hybrid electric vehicles (PHEVs) shares of new sales in 2020.
In comparison, T&E analysis carried out using data for the first half of 2020 [5] and assuming that all carmakers would meet their target, led to a forecast of 5.6% BEV and 4.9% PHEV for the whole year 2020. This highlights that plug-in sales are driven almost exclusively by the stringency of the CO_2 regulation, but it also shows that the success of BEVs slightly exceeded T&E's projections (by 0.6 percentage points).

A comprehensive analysis of the full 2020 car registration data is available in the Technical Annex attached to this report.

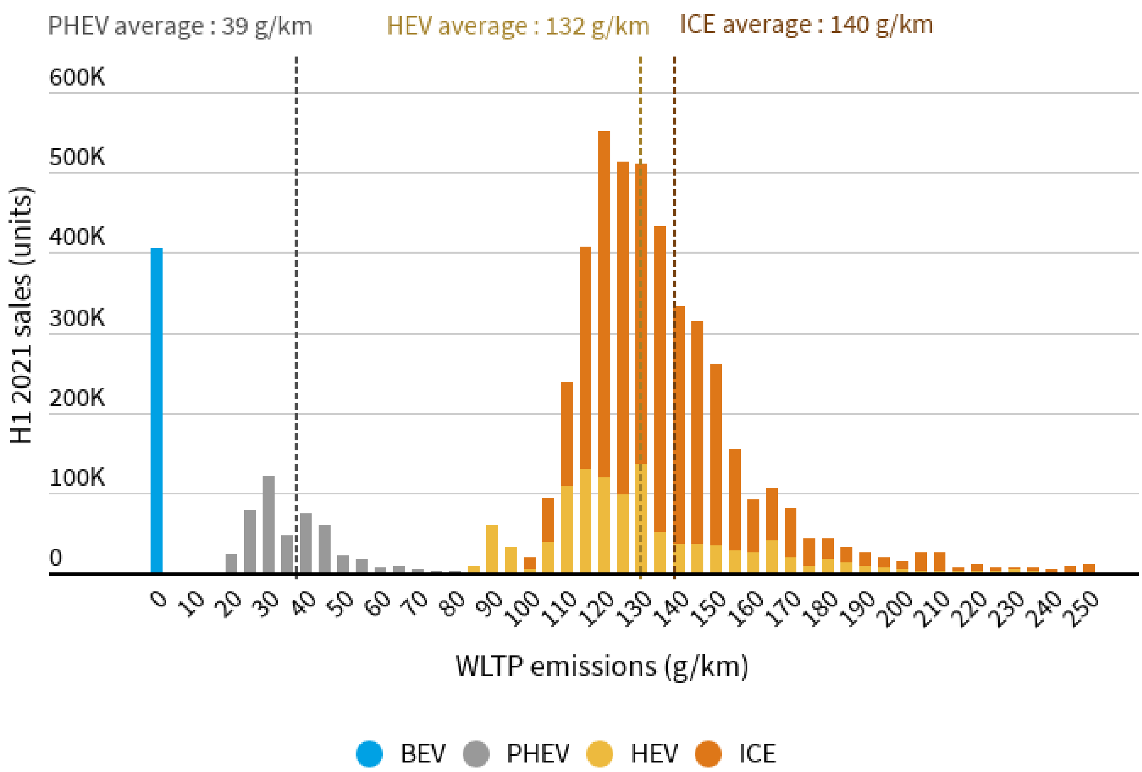
Figure 4 below shows the distribution of car sales depending on their CO_2 emissions for both 2020 and H1 2021 and maps the shift between these two dates. Fewer high-emitting cars were registered as the right part of the curve is below the one from 2020. The figure also depicts a shift of the emissions with the largest sales: the biggest proportion of sales is now at around 120 g/km instead of 130 g/km. The number of registrations of zero and low emission vehicles below 50 g/km also increased as the left part of the curve is above the 2020 level.



Scope: Registration data for the EU27 and Norway. Emissions measured with WLTP.
Source: T&E analysis of passenger car registration data from the first half of 2021 from Dataforce, and 2020 from the European Environment Agency.

Figure 4 - Distribution of WLTP emissions in 2020 and H1 2021

Figure 5 highlights the emission range of different powertrains. Most PHEVs range from 20 g/km to 80 g/km with an average at 39 g/km. Hybrid electric vehicles (HEV[10]) emission range starts from 85 g/km with an average at 132 g/km and pure ICE vehicles have emissions starting from 100g/km with a 140 g/km average.



Scope: Registration data for the EU27 and Norway. Emissions measured with the WLTP.
Source: T&E analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

Figure 5 - Emission distribution by powertrain in H1 2021

Compared to 2020, the average CO_2 emissions for each powertrain type has reduced, with PHEVs undergoing the biggest improvement:

- PHEV emissions decreased from 42.7 g/km in 2020 to 38.6 g/km in the first half of 2021 (9.7% decrease).
- HEV emissions decreased from 135.9 g/km in 2020 to 132.4 g/km (2.6% decrease)
- Pure internal combustion engine vehicles (ICEs) emissions decreased from 144.9 g/km in 2020 to 140.1 g/km in 2021 (3.4% decrease)

Electric vehicles are responsible for almost 60% of emissions reductions

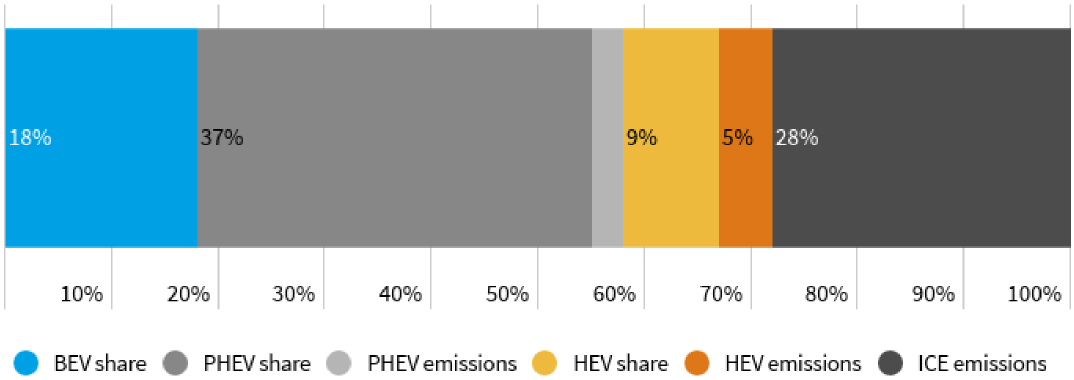
The overall reduction in emissions is driven by both the improvement of each specific powertrain type (see above) and the increase of the market share of BEVs, PHEVs, and HEVs (see section 3). The contribution of each of these factors is shown in Figure 6 below. Together, the decrease of ICE and HEV

[10] In this report, HEV is used to qualify the group of full and mild hybrids.

emissions and the growing share of HEVs amounts to 40% of the emission reduction since 2020. However, ICE and HEV still have relatively large emissions: 138.3 g/km average.

Regarding PHEVs, their theoretical contribution totaled 40% of the emission reductions witnessed in the first half of the year. But this contribution on paper does not reflect emission savings on the road where they actually matter. As outlined in section 3.1.1, the real world emissions of PHEVs is two to four times larger than the emission results delivered in the lab [6]. It means that more than a third of the emission reductions in the first half of the year may not have actually been delivered on the road.

Finally, the increase in BEV sales has contributed to a reduction in CO_2 emissions of 18% compared to 2020. This shows there is still a very large potential to reduce emissions further on the road and that the sales of BEVs must continue to grow in order to achieve our climate goals.



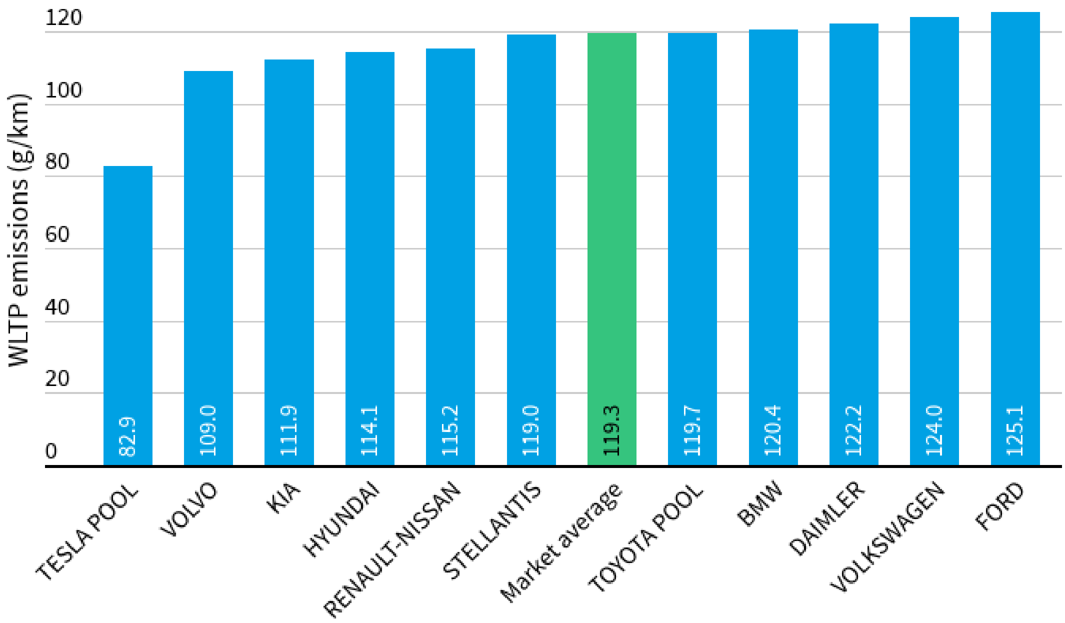
Scope: Registration data for the EU27 and Norway.
Source: T&E analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

Figure 6 - Factors contributing to official emission reductions between 2020 and H1 2021

2.2. Carmakers' CO_2 emissions: where are we today?

This section focuses on carmakers' emissions by pool during the first half of 2021 using the database provided by Dataforce. The results include 11 OEM pools without a derogation, which together cover 99.6% of registrations over the first half of 2021. Compared to 2020, pooling strategies have changed: FCA left the Tesla-Honda open pool and merged with PSA to form Stellantis, which declared it would no longer need Tesla to comply with the regulation in 2021 [7]. The Ford-Volvo pool from 2020 has not been continued. The Toyota-Mazda pool was joined by Suzuki and Subaru. Volkswagen's pool will be continued in 2021 including all brands from the VW Group with the addition of small-scale carmakers such as MG and SAIC.

Average CO_2 emissions (without regulatory flexibilities) are shown in the Figure 7 below:

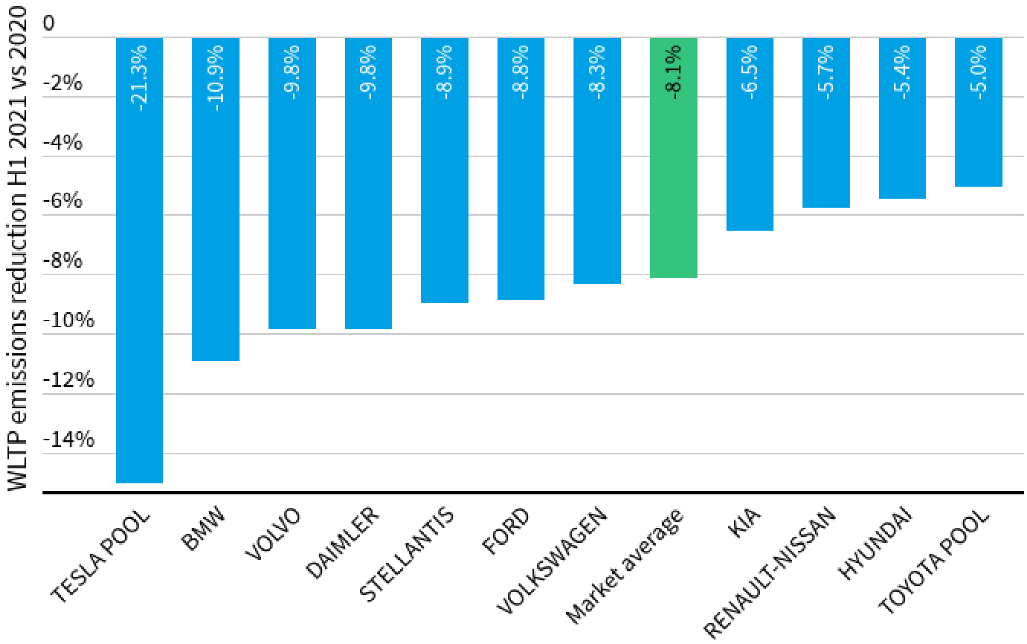


Scope: Registration data for the EU27 and Norway. Emissions measured with the WLTP.

Source: T&E analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

Figure 7 - Average WLTP emissions by carmaker in H1 2021

With a very high fully-electric car share in its registrations (half), the Tesla-JLR-Honda pool is logically the leading pool in terms of emissions with 82.9 g/km. It is followed by Volvo that made a significant improvement from its 125.7 g/km in 2020, to 109.0 g/km in the first half of 2021 mainly thanks to a major ramp-up of PHEVs that now make up 36.8% of its overall sales. With a still limited share of plug-ins in its mix, Ford is now among the highest emitters with 125.1 g/km. Daimler, VW and BMW are still among the highest polluters with 124.0 g/km for VW, and 122.2 g/km for Daimler. Stellantis has emissions close to the market average (119.0 g/km) in the first half of 2021, despite PSA having emitted the least in 2020, and FCA being formerly well ranked due to its pool with Tesla and Honda.



Scope: Registration data for the EU27 and Norway. Emissions measured with the WLTP.
Source: T&E analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

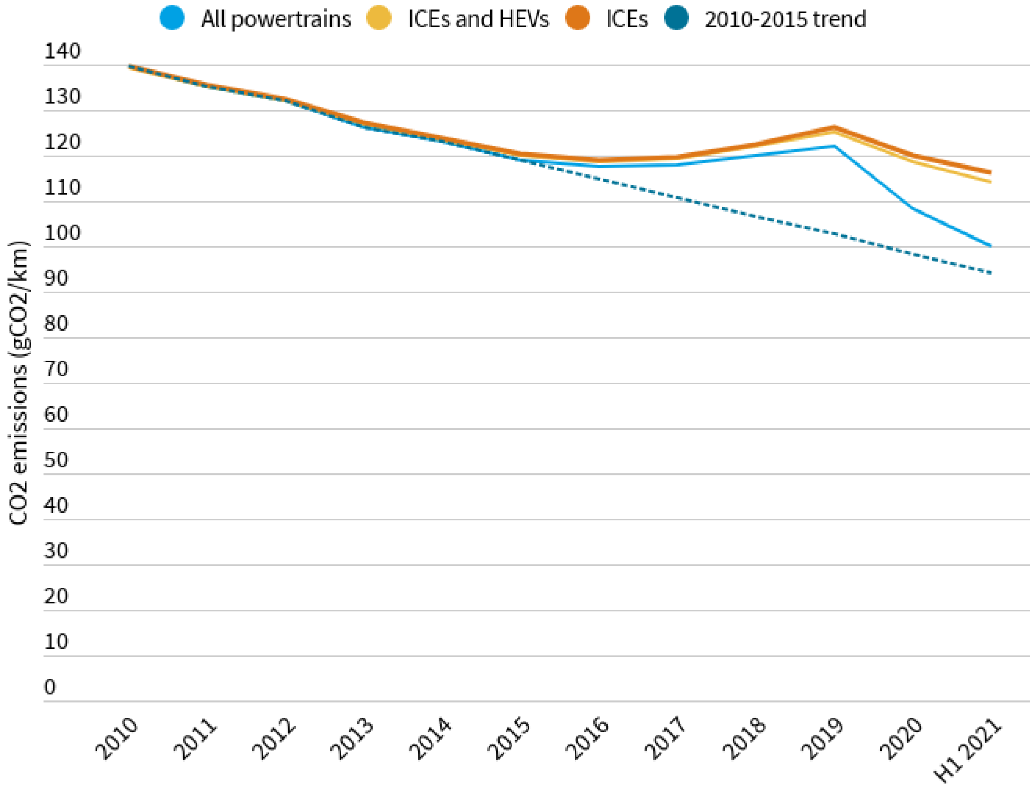
Figure 8 - Emission reduction between 2020 and H1 2021 by pool

Driven by CO_2 targets, carmakers have achieved significant emission reductions
The difference in emissions between H1 2021 and 2020 displayed in Figure 8 shows that some OEMs achieved very large reductions in the first half of the year. The Tesla-JLR-Honda pool has the largest cut in emissions because of the still growing number of BEV sold by Tesla that increase its share in the pool. BMW and Volvo have the second and third largest reductions with 10.9% and 9.8% cut in emissions respectively. Among the OEMs with the smallest changes compared to 2020, Toyota-Mazda and Hyundai have achieved the smallest emission reductions with around -5%. As Toyota's strategy has been historically focused on the development of HEVs, the Japanese OEM is now late to roll out a more ambitious electrification strategy needed to drastically cut its emissions. Hyundai suffered from a small decrease of its BEV sales share from 14% in 2020 to 11% in the first half of the year, leading to slowdown of its emission reduction despite a still large BEV share.

2.3. But ICEs still emit as much as 5 years ago

Despite a major fall in average market emissions, ICE and hybrid emissions have not markedly improved. As depicted in Figure 9, ICEs and HEVs have been much slower to cut their emissions as a proportion of overall emission reductions. While the overall market emissions measured in NEDC decreased by 8.2% from 2020 (EU27), the emissions from ICEs and hybrids decreased by 3.9% (non-hybrid ICEs decreased by only 3.1%). In 2020, average ICE emissions were actually higher than five years ago. In the first half of

2021, emissions of ICEs are only 2% lower than their 2016 level. Had emission reductions continued along the 2010-2015 trend, ICE emissions would be 19% lower than today at around 94 g/km.



Scope: Registration data for the EU27

Source: T&E analysis of passenger car registration data from the first half of 2021 from Dataforce, and 2010-2020 from the European Environment Agency.

Figure 9 - Comparison of NEDC emissions between ICE and the average

As the emissions of many carmakers went up during the 2016-2019 period, the 2020/21 ICE emissions reduction is sometimes not sufficient for carmakers to improve on or even match their previous historical low. To put carmakers' performance on ICE emissions in perspective, Table 1 compares carmakers' pure ICE emissions in H1 2021 with their previous historical low. If H1 2021 emissions were still above the historical low, the last year with recorded emissions closest to today's level are identified. Among the laggards, Volvo even had ICE emissions above their 2013 levels and 16 g/km higher than their previous minimum from 2016, while Daimler and JLR are still above their 2014 level (Daimler emissions were 10g/km higher than in 2016). Other carmakers have barely decreased their ICE emissions since 2016, for instance, BMW and Volkswagen Group's emissions were only 1 g/km and 2 g/km lower.

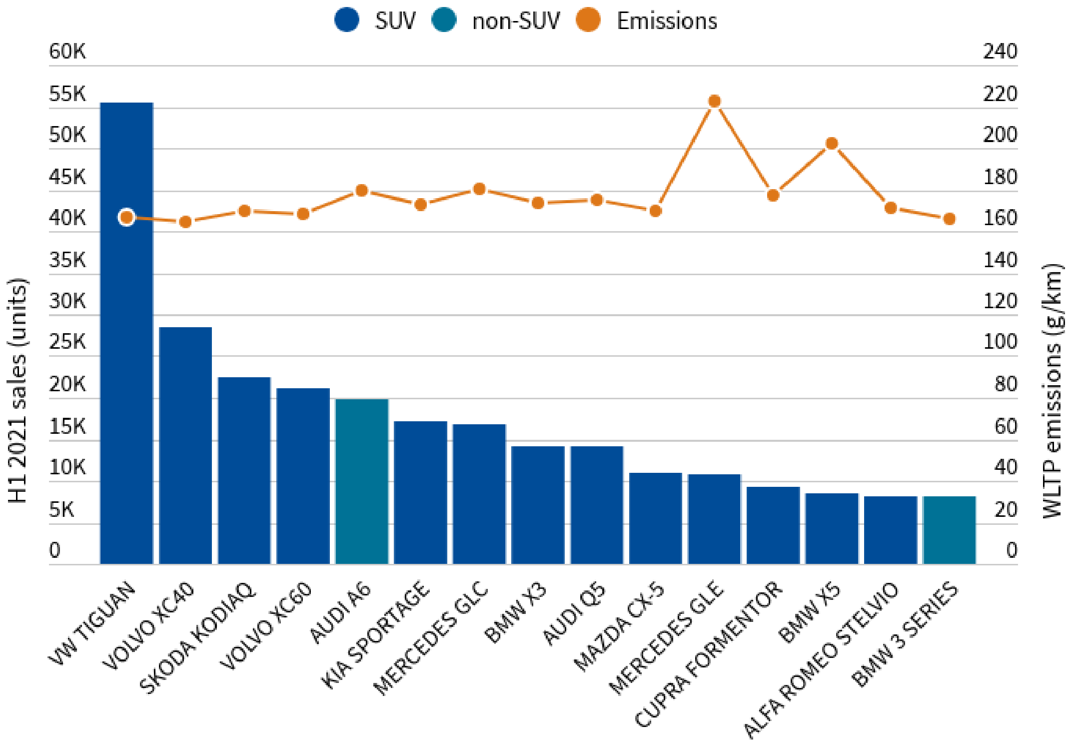
Table 1 - Carmakers' pure ICE emissions in H1 2021 compared with their past minimum (EU27 scope)

Carmaker	Emissions in H1 2021 (g/km)	Previous minimum ICE emission (g/km)	Previous minimum ICE emission reached in	Year closest to the current emissions
BMW	124	125	2016	
DAIMLER	**137**	127	2015	**2014**
FORD	116	119	2015	
HYUNDAI	113	124	2017	
JLR	**178**	149	2016	**2014**
KIA	117	122	2017	
RENAULT	112	110	2016	
STELLANTIS	107	112	2016	
TOYOTA	112	103	2018	
VOLKSWAGEN	118	120	2016	
VOLVO	**140**	124	2016	**2013**

High emitting vehicles

In this section, a high emitting vehicle is defined as a vehicle with emissions above the 2015 emission target that was defined at 130 g/km and would translate into a 157 g/km in WLTP. In the past decade, the share of high emitting vehicles decreased from 58% in 2010 to 24% in 2016 before rising again to 33% in 2019. In H1 2021, 12% of cars sold are above this limit showing that the regulation drove a cut in polluting vehicle sales. Among these vehicles, more than half are SUVs (63%), 16% are utility vehicles registered as passenger vehicles, and most of the others are high-end vehicles from segment D and E+ as well as sports cars.

The VW Group has the highest number of these polluting vehicles as the OEM registrations account for the third of these high-emitting vehicles. For instance, the Volkswagen Tiguan, the Skoda Kodiaq or the Audi Q5 are included in this category, as well as high end Porsche and Audi models. The second largest contributor is Daimler with 14% of the high emitting vehicles with a large number of SUVs such as the GLC, GLE or G-class. Among the other brands, JLR has lower registration numbers but three out of four cars sold by the British OEM emit more than 157 g/km. Moreover, even if Volvo has made good progress toward electrification, 43% of its registrations are still heavy and polluting combustion engine SUVs. Figure 10 below compares the emissions and sales volumes of the 15 most popular high emitting cars. Among this top 15, only two models are not SUVs, and the Mercedes GLE and the BMW X5 have the largest emissions, reaching above 200 g/km. In addition to these high emitting cars, another category of vehicles is problematic: as detailed in Technical Annex, pick-up trucks emit 73% more than cars and some models have extremely high emissions such as the Ram pick-up (323 g/km in NEDC).



Scope: Registration data for the EU27 and Norway. Emissions measured with the WLTP.

Source: T&E analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

Figure 10 - Top 15 of high-emitting vehicles

Carmakers' communication about electric cars often hides the fact that a lot of carmakers still have a significant proportion of high emitting models in their lineup - permitted and even incentivised under the current design of the regulation. Electrification technologies are now largely mature across all vehicle segments and carmakers should be actively replacing high polluting vehicles with zero emission models to achieve high climate benefit in a short time.

2.4. CO_2 emissions per country

As the CO_2 regulation is applied to the whole EEA, emissions are averaged across all countries, but data shows that countries have performed differently. Figure 11 displays the average emissions per country and highlights that most countries have emissions in the range 110-140 g/km (WLTP) with six countries already compliant with the EU fleet-wide target (Norway, Sweden, Denmark, Finland, the Netherlands and France). Norway is still the country with the lowest emissions with only 34 g/km, thanks to the highest plug-in share in Europe (83%). The lowest emitting EU country is Sweden with 98 g/km, it is followed by Denmark with 103 g/km. With regard to the highest emitting countries, four exceeded 140 g/km: the Czech Republic with 141 g/km, Latvia with 142 g/km, Estonia with 145 g/km, and Slovakia with 155 g/km.

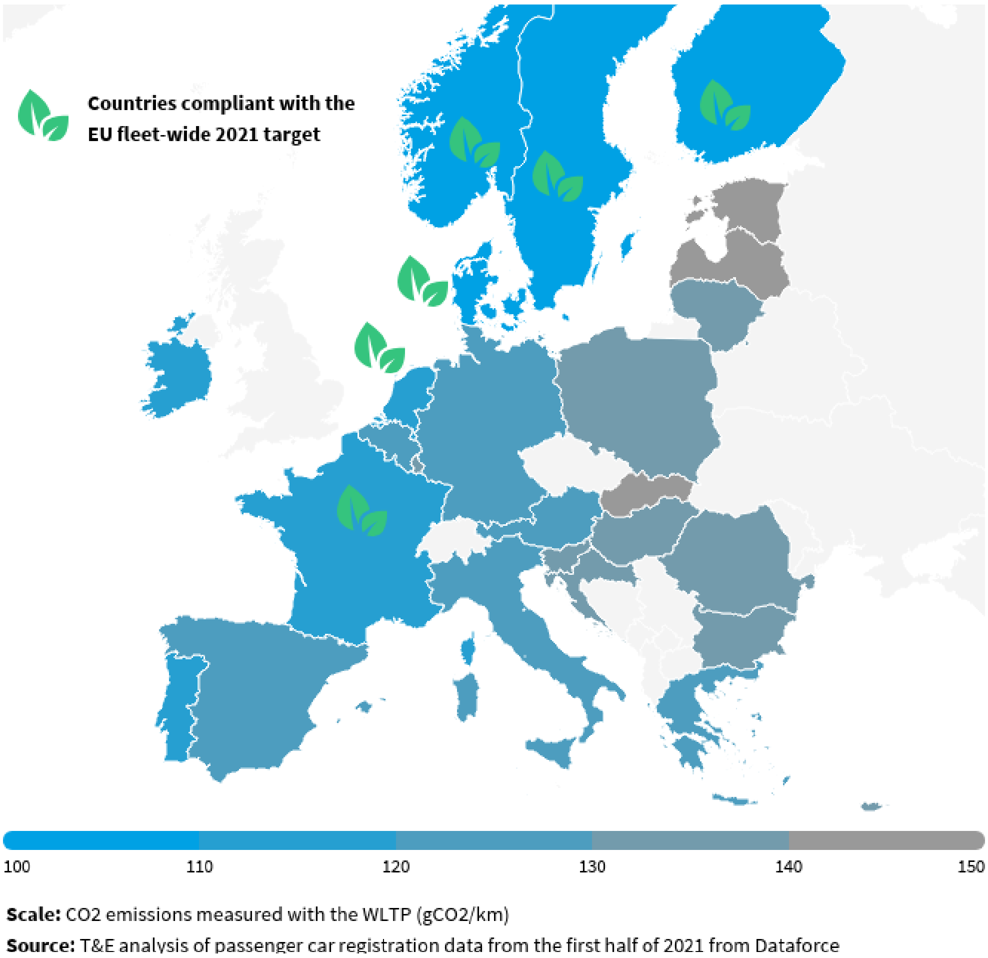
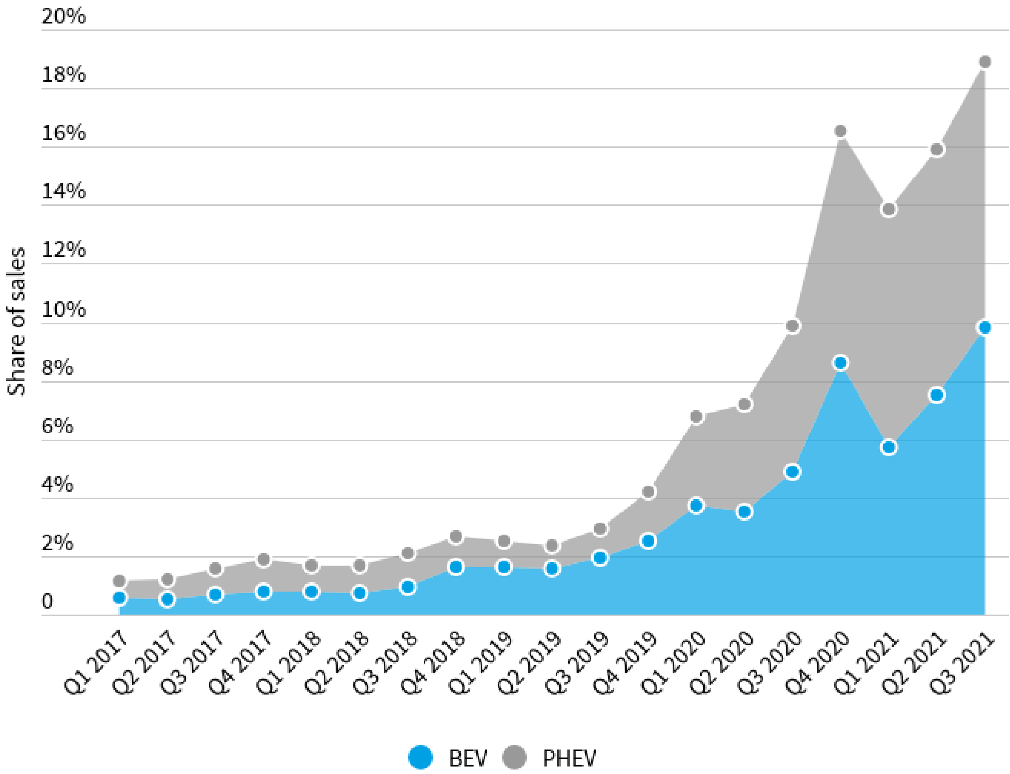


Figure 11 - Average emissions by countries in H1 2021

3. Electric car sales continue to rise

3.1. Plug-in sales trend analysis

This section analyses historic plug-in sales based on ACEA's quarterly registration data [8] and presented for the EU27. Figure 12 shows the strong growth of plug-in sales that occurred as a result of the entry into force of the EU CO_2 targets in 2020. In the third quarter of 2021, plug-ins reached 18.9% of the market with 9.8% BEV and 9.1% PHEV. For the first time, plug-in sales exceeded diesel cars sales. This means that plug-in share doubled compared to the third quarter of 2020 and grew more than sixfold compared to 2019. Looking at sales for the three quarters of the year, plug-ins reached a 16% share of the EU27 market and plug-in sales were multiplied by five compared to Q1-Q3 2019 (the EV share was multiplied by six). When Norway is included, plug-ins sales were multiplied by four and they amounted to 17.2% of the market in the three quarters of 2021 (compared to 3% in Q1-Q3 2019). This shows an increase compared to the first half of the year alone when plug-ins amounted to 15% of sales in the EU27 market with 6.7% BEV (16% of sales in the EU27+NO with 7.5% BEV).



Scope: EU27 registrations

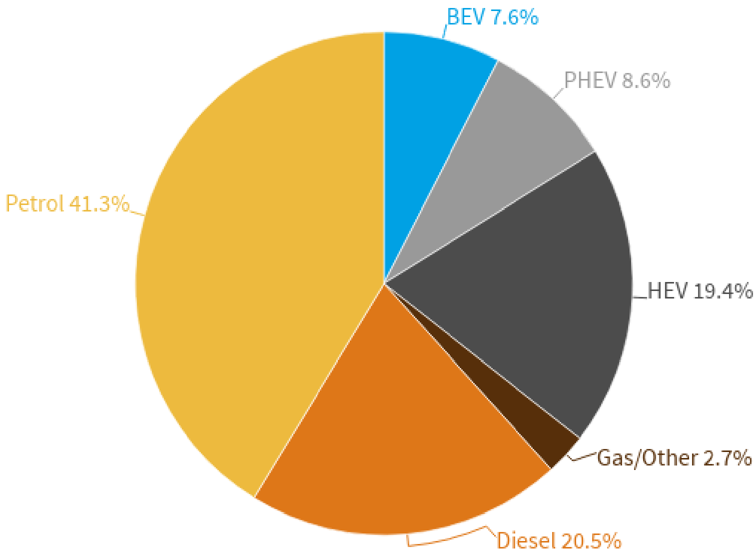
Source: ACEA (2021) Quarterly AFV registrations

Figure 12 - Plug-in share of sales in the EU27

Sales in the third quarter of 2021 exceeded the historical high that happened in the last quarter of 2020 when carmakers focused their efforts to reach compliance at the last minute by boosting their plug-in sales. Evidence suggests that some carmakers were able to pre-register many plug-ins with their dealerships, to register some for their internal fleets, or to deliver company cars to their Business-to-business customers at the end of the year. For instance, Greenpeace [9] calculated that almost every fourth registration of the ID.3 model (24%) in Europe was attributable to VW and its dealers.

The share of each powertrain as a proportion of total new vehicle sales in the three quarters of 2021 is displayed in Figure 13. Over Q1-Q3 2021, BEVs accounted for 7.6% of the EU27 registrations and PHEVs

8.6%. Hybrid vehicles, including full and mild hybrids, reached 19.4% of the market. Other alternative powertrains account for a negligible share of the market (2.7%) with only 0.5% of compressed natural gas vehicles (CNG) and 2.3% of liquefied petroleum gas vehicles (LPG). Regarding pure ICE cars, the share of diesel continues to decrease and reached 20.5% (an 8.5 percentage points drop of the market share compared to Q1-Q3 2020).



Scope: Registrations data for the EU27 in Q1-Q3 2021
Source: ACEA (2021) Quarterly AFV registrations

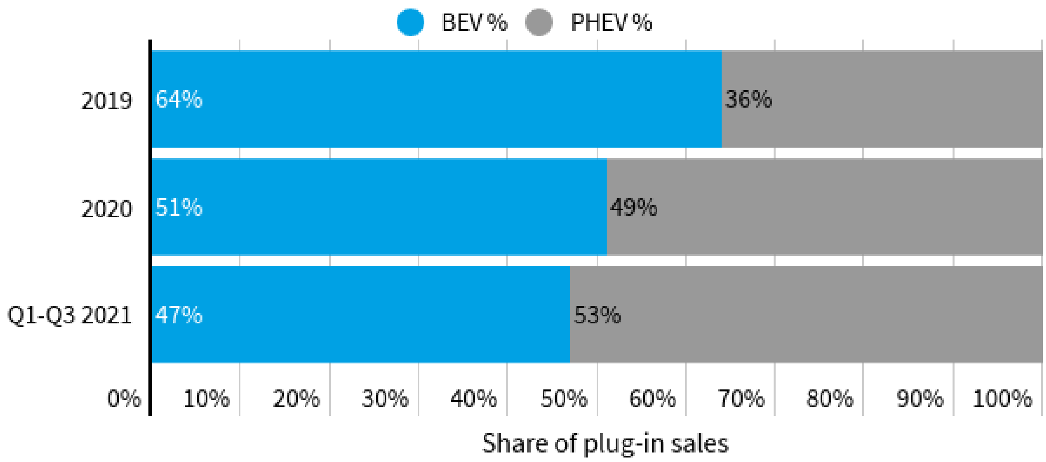
Figure 13 - Powertrain sales share in the three quarters of 2021 in the EU27

3.1.1. 2021: The PHEV problem

The share of PHEVs amongst all plug-in (BEV+PHEV) sales was 36% in 2019 but rose to 53% in the three quarters of 2021 (55% in the first half of the year), thus overtaking BEVs which have performed better than PHEVs in 2019 and 2020.

Regarding the distribution of PHEV sales in the different European countries, the majority now sells more PHEV than BEV (12 countries are selling more BEV). In France, the second largest plug-in market, BEV were preferred to PHEV in the past (70% of new plug-ins were BEVs in 2017-2019, 60% in 2020) but the trend reversed with almost an equal share of BEV and PHEV in the three quarter of 2021 (51% BEV). Finland and Belgium have the lowest share of BEV as only 29% of plug-in registered are fully electric. Greece has 31% BEV, Spain 33%, and Denmark 35%. Regarding carmakers, the largest contributors to the PHEV growth are VW, Stellantis, BMW, Daimler and Ford (more details in section 3.2).

Despite being classified as low emissions vehicles with a theoretical emissions average of 38.6 g/km, PHEVs' real emissions on the road are much higher than the lab results.



Scope: EU27 registrations
Source: ACEA Quarterly AFV registrations

Figure 14 - Split between of BEV and PHEV among electric vehicles sales

PHEVs emit two to four times more on the road than in the lab
As shown by the ICCT [10], PHEV real world utility factors (UF) - i.e. the share of the distance that is driven in the electric mode - are about half of those assumed for calculating official PHEV CO_2 figures. The private car official average UF is 69% compared to 37% for real-world driving. The gap for company cars, which accounted for 74%[11] of PHEV sales in the EU in 2020, is even wider with 63% officially but just 20% for real-world driving. This means that the current methodology used to calculate PHEV emissions does not take into account the real life use of these cars and significantly overestimates the distance that is driven in electric mode. As a result, WLTP CO_2 emissions are largely underestimated for PHEVs. The ICCT calculated that the average real world PHEV emissions are in reality two to four times higher (for private and company cars respectively) than official figures suggest. According to WLTP measurements, PHEVs emit 72% less than ICE vehicles, but it would be only 37% less[12] on the road. In other words, PHEV emission savings would be halved in the real world compared to lab measurements.

Analysis of the registrations from the first half of 2021 shows that most PHEVs are SUVs (64.3%). This is an additional issue because, once the battery is exhausted, the combustion engine alone is relied upon to power the vehicle. In the case of large SUVs, which are heavier and have poorer aerodynamics, this results in higher CO_2 emissions and fuel consumption than a smaller car. Tests on three popular models conducted by Emissions Analytics for T&E [11] in 2020 showed that, when not charged, PHEVs' CO_2 emissions are up to eight times higher than the official figures. Moreover, PHEVs are responsible for a 1.7

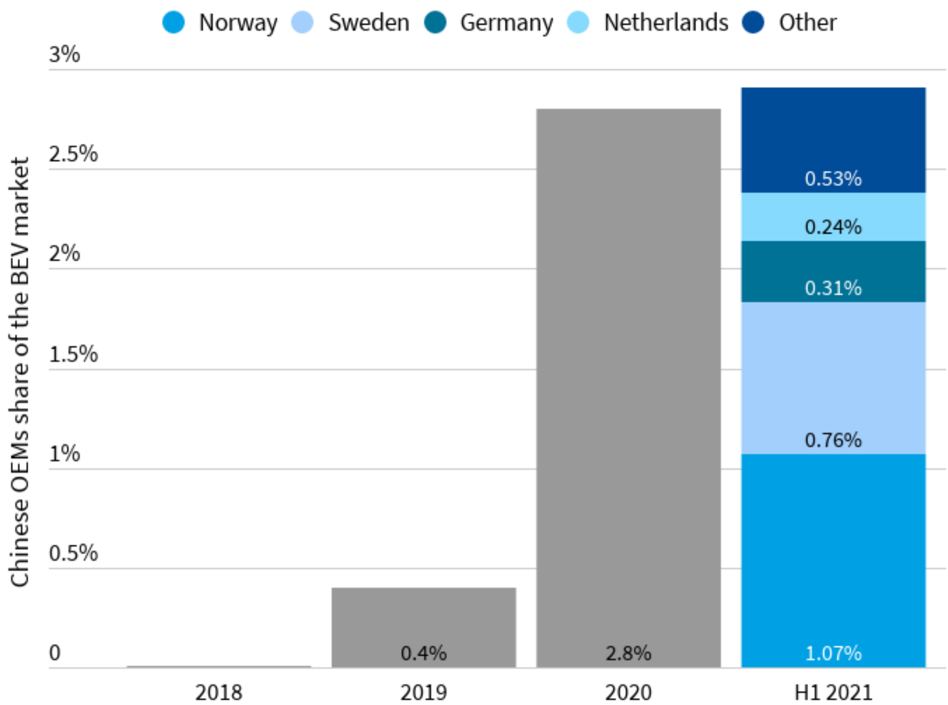
[11] Author's calculations based on Dataforce. (2021). New passenger car registrations.
[12] On average in H1 2021, ICEs emit 140 g/km (WLTP) and PHEV emits 39 g/km (WLTP). With an estimated real-world uplift (real-world over WLTP ratio 1.14 and 2.6 for ICE and PHEV respectively), ICEs would emit 160 g/km and PHEVs 100 g/km.

g/km weakening of the CO_2 target (WLTP) due to the CO_2 target mass adjustment (PHEVs are 30% heavier than an average car).

These findings highlight that carmakers are mainly building PHEVs to benefit from regulatory incentives for low emission vehicles, while failing to deliver the expected CO_2 reductions on the road. This trend towards PHEVs is consequently concerning and is delaying the uptake of zero emission solutions such as BEVs. By allowing large mass adjustments to carmakers' CO_2 targets and by rewarding PHEVs with much lower emissions than what is achieved on the road, the regulation currently promotes suboptimal emission reduction strategies from carmakers.

3.1.2. A growing market share for Chinese OEMs

In 2018, Chinese carmakers were absent from the European plug-in market with less than 10 BEV models registered and a 0.01% market share. Since then, several carmakers succeeded in introducing their models in the EU market and their volume reached 16,800 units in 2020 (2.8% of the BEV market) and at least 11,800 in the first half of 2021 (2.9%). 17 models (from 12 Chinese OEMs) were available in the first half of 2021 in Europe but most of the sales came from two models: the Polestar 2 and the MG ZS both exceeded 5,000 sales. Geely's Polestar brand accounts for 48% of Chinese OEM sales and SAIC's MG brand is 44%. In addition, three other brands exceeded 200 registrations: Aiways, Xpeng and Maxus.



Scope: Registration data for the EU27 and Norway.
Source: T&E analysis of passenger car registration data from the first half of 2021 from Dataforce, and 2018-2020 from the European Environment Agency.

Figure 15 - Rising Chinese carmaker BEV sales

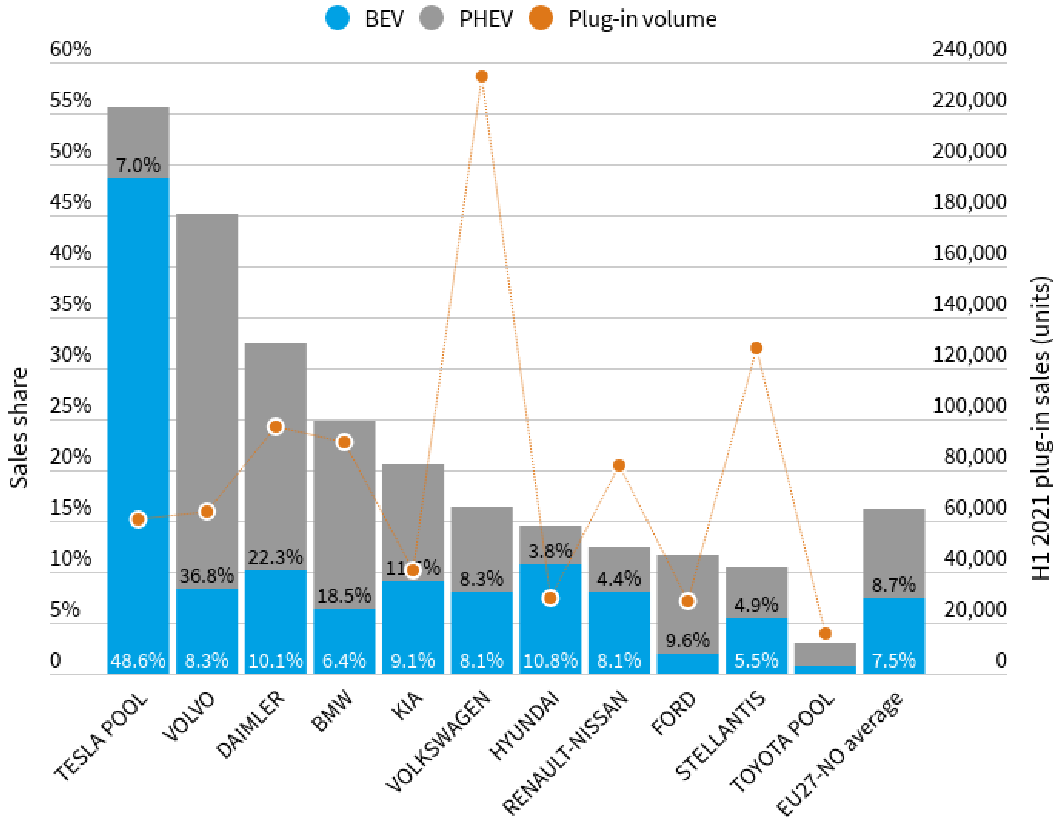
As shown in Figure 15, Chinese BEVs are mainly sold in Norway (37% of Chinese BEV registrations in Europe) and Sweden (26% of registrations). As a result, Chinese BEVs amount to 9% of the local BEV market in Norway and 13.5% in Sweden. It shows that Chinese carmakers focus as a priority on the most mature BEV markets and thus have potential to expand to other countries as the BEV market share increases across the EU. Many other carmakers have plans to enter the European market: Nio [12] started its delivery in Norway in September, BYD [13] plans to deliver 1,500 electric SUVs in Norway by the end of 2021 and Great Wall [14] launched its Ora brand in Europe with deliveries starting in 2022.

To ensure they do not continue to lose ground in their domestic market, European carmakers should commit to a faster transition toward BEVs, by ramping up their investments and line-up.

3.2. Electric car sales by OEM

Most carmakers increased their share of fully electric cars sales in the first half of 2021. The pool Tesla-JLR-Honda leads with 49% BEV share and Hyundai has the second largest BEV sales share but this share is down to 10.8% from 14.4% in 2020, amidst the growing competition. Daimler closely follows it with 10.1% BEV sales thanks mainly to its new EQ model series or the Smart brand models.

Among the laggards, Stellantis BEV models (such as the Peugeot 208 or the Fiat 500) amount to only 5.5% of its registrations although the carmaker has seen one of the largest growth in BEV sales (72% increase compared to a low 2020 BEV share). Ford launched its first major BEV model, the Mach-E, which reached 2% of its sales in H1 2021. The Toyota pool comes last as Toyota brand first BEV model will only be sold in 2022 (the current 0.8% BEV share includes Lexus and Mazda models) and FCEV sales are still at a very low level (only 300 Mirai were registered in the first half of 2021, or 0.08% of the brand sales).

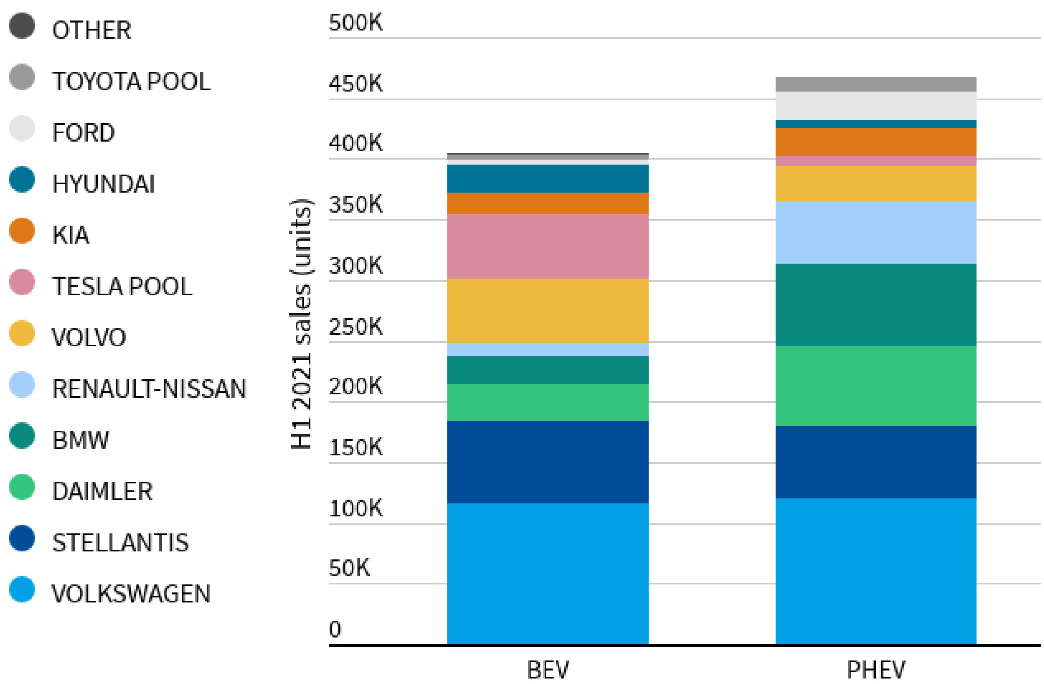


Scope: Registration data for the EU27 and Norway.
Source: T&E analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

Figure 16 - Plug-in sales share and volume by carmaker in H1 2021

When PHEV are included, Volvo, Daimler and BMW rank second, third and fourth respectively in terms of plug-in share (still behind the Tesla pool). Although most carmakers have a strong focus on direct electrification, some also sell a lot of hybrid vehicles. For instance, the Toyota pool relies mainly on HEVs for its compliance, which amount to 72% of its sales, and Hyundai reached 38% with a large increase of mild hybrids models.

In terms of total plug-in sales volume, the VW pool consolidated its leader position with 235,000 plug-ins sold (29% of the total BEV sales and 26% of PHEV sales) thanks to its ID models and multiple models in PHEV versions. Stellantis comes second with 128,000 plug-ins sold and Daimler is third with 97,000 units. BMW is demoted to the fourth position with 91,000 plug-ins whereas it was close to the second position in 2020. When looking at BEVs only, VW is first, Stellantis comes second and the Renault pool is third.

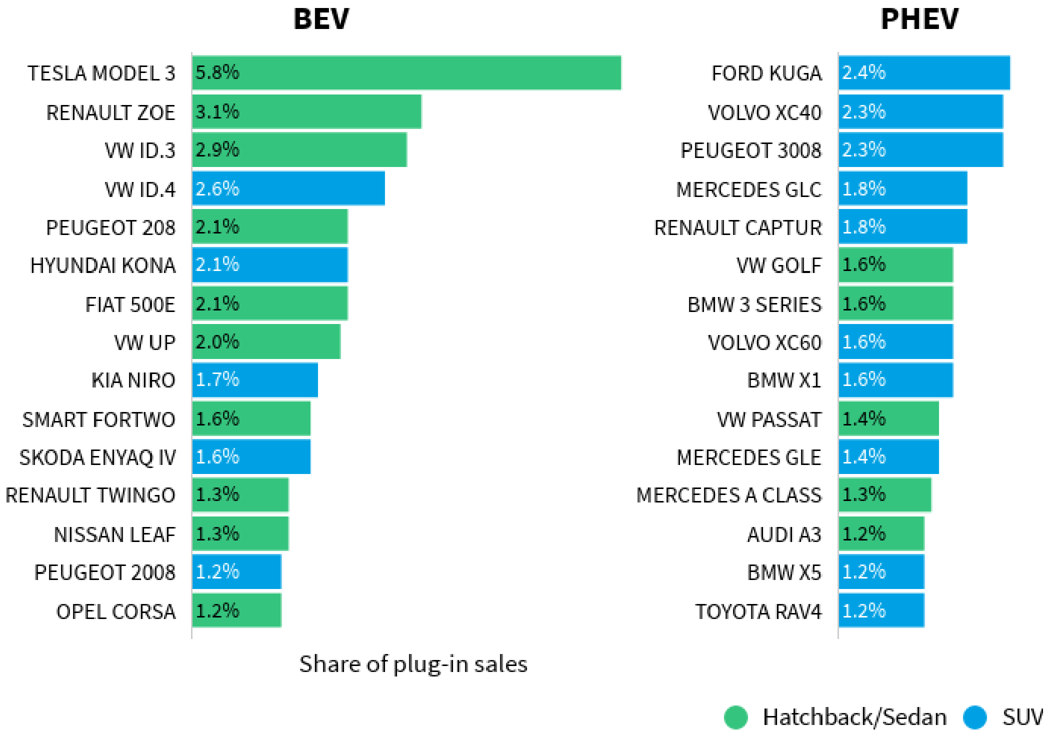


Scope: Registration data for the EU27 and Norway.
Source: T&E analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

Figure 17 - BEV and PHEV volumes in H1 2021

3.2.1. Most popular plug-in models

Using sales data for the first half of 2021, the most successful BEV and PHEV models are ranked according to their share of the total plug-in sales in Figure 18. Four BEV models top the plug-in ranking (with sales accounting for more than one plug-in out of 40) while the best selling PHEV comes in fifth position. The successful Tesla Model 3 accounts for 5.8% of the plug-in market, the Renault Zoe loses steam and is downgraded to the second position (the Zoe was by far the most sold plug-in in 2020), the VW ID.3 and ID.4 are ranked at the third and fourth position (2.9% and 2.6% of all plug-ins). On the PHEV side, the Ford Kuga, the Volvo XC40 and the Peugeot 3008 are on the podium with 2.3%-2.4% of all plug-in sales (and are fifth, sixth and seventh respectively when ordered with all plug-ins). A striking difference between BEV and PHEV top models is that PHEVs are predominantly SUVs: two thirds of the top 15 PHEV models are SUVs when they are only a third of the top 15 BEV models. As shown in part 3.1.1, this predominance of large SUVs among PHEVs is a problem with regards to their real world emissions that are often much larger than what is advertised by OEMs. The comparison of the sales share between BEV and PHEV highlights that popular BEV models have a larger share of the whole plug-in market (both BEVs and PHEVs).



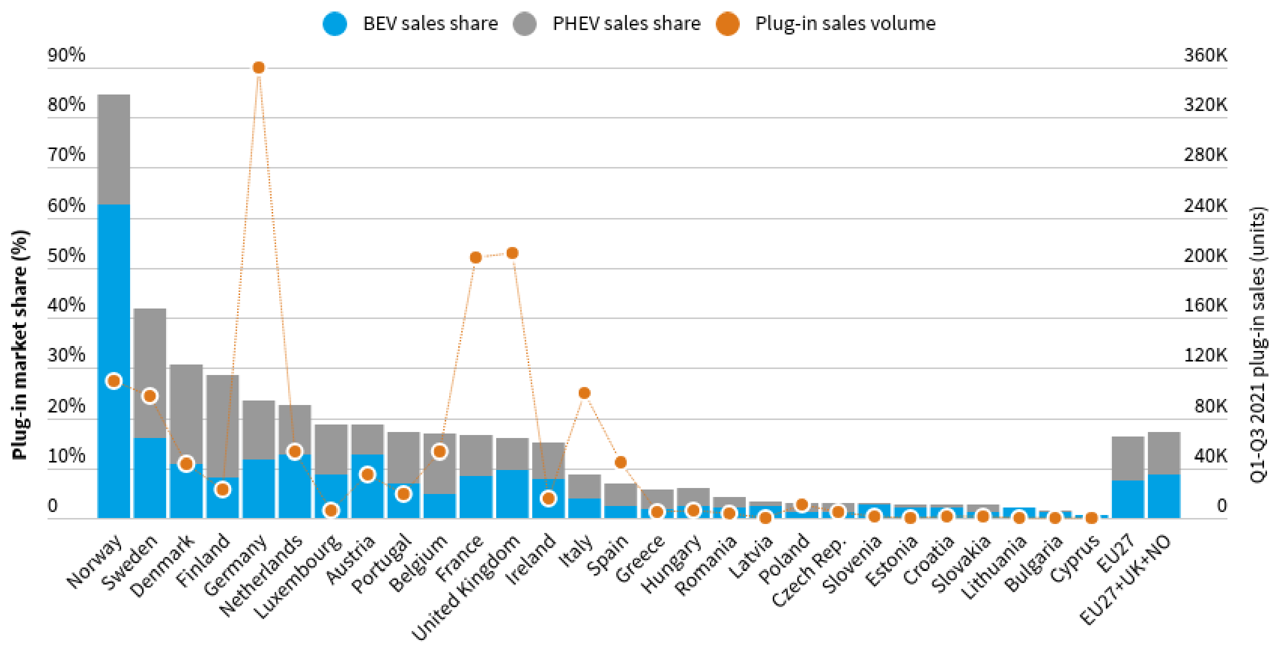
Scope: Registration data for the EU27 and Norway.
Source: T&E analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

Figure 18 - Top 15 of BEV and PHEV best-selling models

3.3. Plug-in sales by country

The CO_2 targets are applied to carmakers' sales across Europe, which means that the ability of an individual member state to attract sales of plug-ins depends mostly on the national incentives that are in place, as well as the charging infrastructure network. But the overall supply of zero and low emission vehicles is limited by the ambition set in the car CO_2 regulation, meaning that, as long as supply is limited, selling significantly more plug-ins in one country will result in selling fewer in another country. Any individual country therefore has little impact on carmakers' overall production plans or volumes.

The country with the largest plug-in share of sales is still Norway with 84.7% plug-ins (with 62.5% BEV). With an efficient charging infrastructure deployment, favorable taxation and an ICE phase-out planned in 2025, Norway is one of the world leaders for emobility. Two other Nordic countries complete the podium: Sweden reaches a 41.7% plug-in share (including 16.1% BEV) and Denmark has a 30.7% plug-in share. When looking at fully electric cars only, Norway and Sweden keep the lead but the Netherlands takes the third position with 12.7% BEV, closely followed by Austria (12.7% BEV) and Germany (11.7% BEV).



Source: T&E analysis of ACEA quarterly registration statistics

Figure 19 - Plug-in sales by country in H1 2021

Focusing on plug-in sales volume, Germany accounts for 39.4% of the EU27 plug-in market with 480,000 units in the three quarters of 2021. France registered 210,000 units (17.2% of EU27 plug-ins) and with 8.5% BEV and 8.1% PHEV. In third and fourth position, Italy and Sweden account for 8.3% and 8.0% of the plug-in market each but Italy settles for a relatively low plug-in share of its domestic sales (4% BEV and 4.6% PHEV). Among the other large markets, Spain also has a limited share of plug-ins with only 2.3% BEV and 4.6% PHEV.

4. Carmakers to easily meet CO_2 targets in 2021

This section analyses carmakers' compliance with the 2021 CO_2 target. First, we present an analysis that is based on registrations and emissions for the first half of 2021 - i.e. assessing carmakers' compliance gap as of July 1st 2021. A deeper analysis then follows looking at compliance for the full year by forecasting the plug-in sales needed over the full year 2021 with details of each carmaker's compliance strategy.

4.1. Overview of the current compliance gap per OEM

The registration data for the first half of the year 2021 acquired from Dataforce is used to calculate the average emissions of each carmaker pool in the scope of the regulation (EU27+NO).

Methodology

The analysis of 2020 EEA registration data detailed in the Technical Annex is used in order to define the remaining super-credits of each carmaker[13]. The expected mass of the 2021 fleets is also defined using known mass data by nameplate (from provisional 2020 data). The expected average mass of each OEM is used to calculate the 2021 targets after adding the mass adjustments. The potential savings from eco-innovations are calculated assuming that the eco-innovations used in 2020 in the Lights and Alternator category (previously approved with the NEDC) are replaced by the equivalent eco-innovations approved with the WLTP. More detail about the methodology can be found in Annex 7.2 and carmakers' detailed status is presented in Annex 7.3.

Five carmaker pools already compliant as of July 1

With sales from the first half of the year, five pools are already compliant with their targets thanks to a combination of strategies including increased plug-in sales, more efficient ICEs and/or a reliance on regulatory flexibilities.

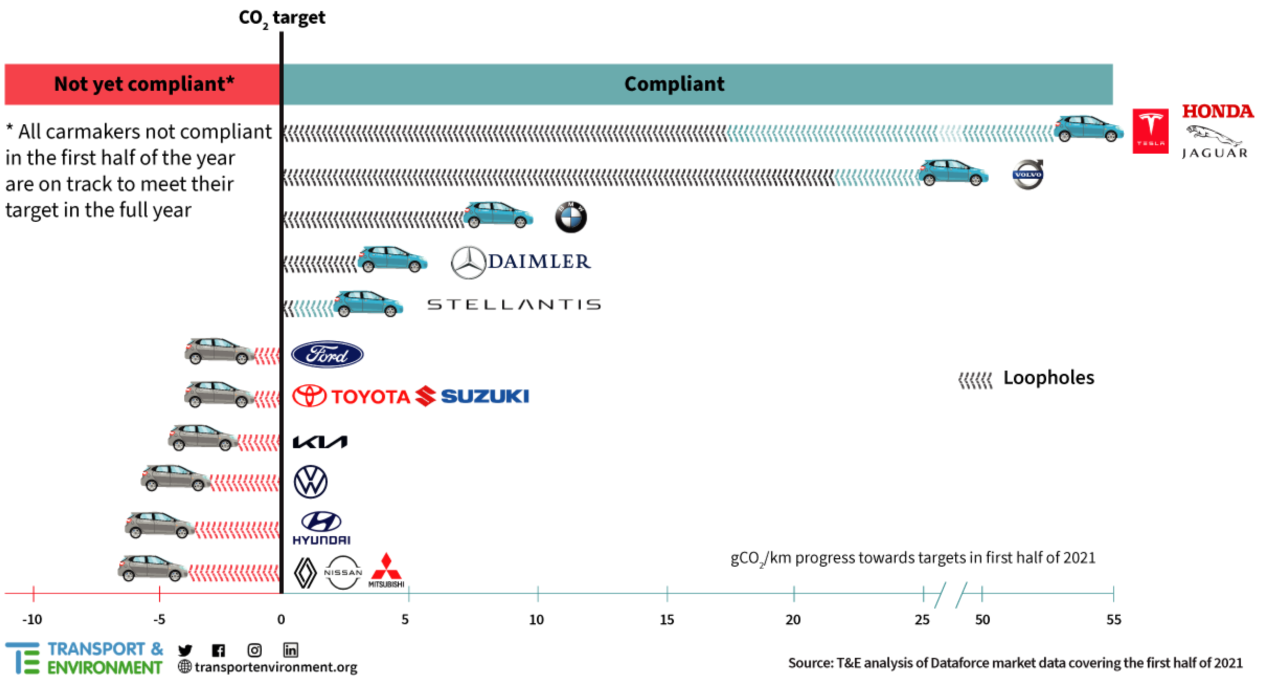


Figure 20 - OEM's compliance gap in the first half of 2021

Tesla-JLR-Honda is largely over-compliant (53 g/km) as most of its sales are already fully electric cars (49%). As Volvo increased both its plug-in sales (to reach 45% EV) and its overall fleet mass (expected at around 1930kg, which leads to a 21.4 g/km weakening of its target), the Swedish carmaker now has the second largest overcompliance compared to its target (25 g/km). BMW has a 7 g/km overcompliance, mainly thanks to an increase of PHEVs that amount to 18.5% of its registrations. Daimler relied on a large

[13] According to the analysis, only the Toyota pool and Stellantis have super-credits remaining to be used in 2021.

increase of both BEV and PHEV sales to exceed its target by 3 g/km (32% plug-ins). But Daimler's very heavy PHEVs also contributed to a major increase of its fleet mass and thus to a weakening of its target by 15.6 g/km). Without these large benefits from regulatory flexibilities, Daimler and BMW would not comply with their targets. Stellantis complies with the smaller margin of 2.1 g/km. As most of these carmakers are still expected to keep increasing their plug-in sales in the second part of the year, and given they already have a relatively large advance on their target, they are expected to easily meet their targets at the end of the year.

Six pools are not yet compliant as of July 1

Ford, the Toyota pool and Kia are very close to their targets with a gap lower than 2 g/km. After a good launch in the first part of the year, the Mach-E BEV model would be the main compliance tool that could help Ford to close the remaining 0.9 g/km gap and meet its target by the end of the year. Despite a comparatively good performance from the Toyota brand alone, the Toyota pool is penalised from high emission from other pool members (mainly Suzuki and Subaru) and has a 1 g/km gap with its target. With a current 1.6g/km gap to its target, Kia would need to increase its plug-in and hybrid sales in the second part of the year in order to comply.

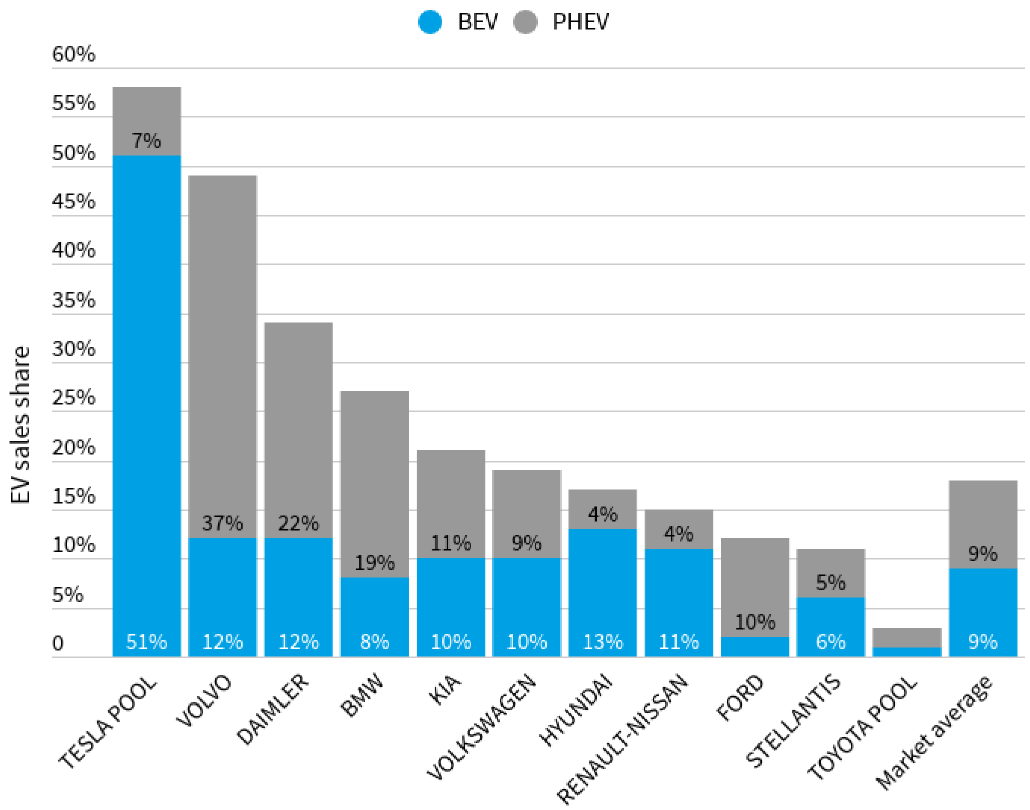
With a compliance gap larger than 2 g/km, three carmakers will need to undertake a bigger push than others to comply by the end of the year. Volkswagen, which did not comply in 2020 (more details about carmaker compliance in 2020 can be found in the Technical Annex), is still at risk of falling short in 2021 with a 2.7 g/km gap to make up, and Hyundai will need to increase its BEV share to close its 3.3 g/km gap. Close behind, the Renault pool has a 3.4 g/km gap to its target that will be easily closed as the pool is expected to sell a much larger amount of BEVs (Dacia Spring, Nissan Leaf, ...) to recover in the second half of the year.

All carmakers are either already over-compliant in the first half of the year or have many levers to close the relatively small remaining gap to their targets in the full year (as explained in the next two sections). Therefore, all carmakers are on track to comply with the CO_2 regulation in 2021.

4.2. 2021 plug-in sales per OEM

T&E projected the share of plug-in that OEMs would need to sell in the full year 2021 to comply with their targets (methodology detailed in section 4.2.1 below and carmakers strategies detailed in Annex 7.3). According to this model, average plug-in sales across Europe are projected to reach 17.7% in 2021 with around 8.9% BEVs and 8.8% PHEVs.

T&E's 2021 compliance projection modelling finds the following OEM plug-in sales share: the Tesla pool would achieve 51% BEV sales, Volvo is expected to sell up to 49% plug-ins (with 12% BEVs), followed by Daimler with 34% plug-ins (15% BEVs) and BMW is projected at 27% plug-ins (but its BEV share would stay at a low 8%). Kia would increase its BEV share up to 10% and reach 21% plug-ins. The VW pool is projected to reach a 18% plug-in share with its BEV share increased to around 10%. Hyundai BEV share is projected to recover from H1 and reach 13% for the whole year with a 17% plug-in share. The Renault-Nissan-Mitsubishi pool is expected to reach 11% BEV (15% plug-ins). Ford is projected to comply with at least a 2.4% BEV share but a higher PHEV share leading to 12% plug-ins. Stellantis is projected to finish the year with 11% including 6% BEV. Finally, the Toyota pool would settle for only 4% plug-ins.



Scope: forecast for the EU27 and Norway in the whole 2021 year.
Source: T&E modelling of carmaker's compliance with the EU 2021 CO2 emission regulation. Partly based on the analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

Figure 21 - Projected plug-in share in the full 2021

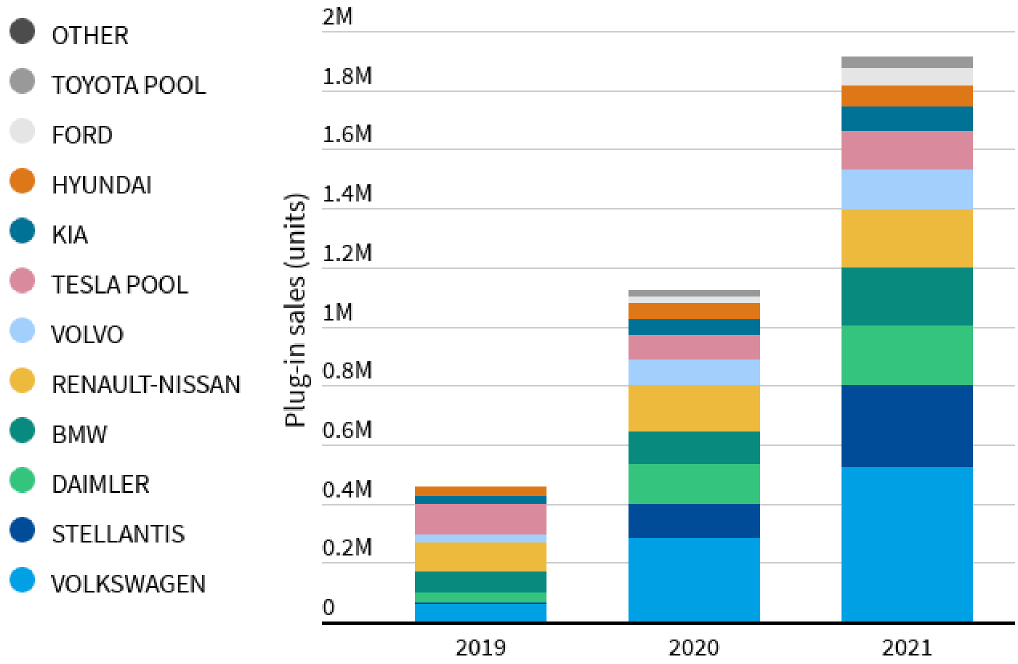
Close to 2 million plug-ins will be sold in 2021

In 2021, 1.9 million plug-ins are projected to be sold made up of 960,000 BEVs and 955,000 PHEVs[14]. While the market share of plug-ins is expected to be multiplied by 5 from 3.5% in 2019 to 18% in 2021, the number of plug-in sold is multiplied by 4.1 (from 460,000 units in 2019 to 1.9 million in 2021) due to lower overall car sales.

BEV volume is projected to be multiplied by 3 compared to 2019 and PHEV volume by 6. The fact that PHEV sales have grown twice as much as BEVs emphasises the worrying trend toward a less efficient and

[14] Volumes are calculated assuming that sales volumes in H2 stay at the same level as H1, the total sales number would reach 10.8 million at the end of the year in the EU27+NO market. Some uncertainties remain because, despite a growing demand due to the post-covid recovery, the global car production is expected to slow down in the second part of the year due to the current chip crisis [15].

more polluting technological solution (PHEVs). Assuming BEV share would have grown as much as PHEVs, the share of BEV would reach 17% today and the market average emissions would be 10% lower.



Scope: Registration data for the EU27 and Norway (2019, 2020) and 2021 forecast.
Source: T&E modelling of carmaker's compliance with the EU 2021 CO2 emission regulation, and 2019-2020 registrations from the European Environment Agency.

Figure 22 - Projected plug-in volumes in 2021 compared to 2019 and 2020

The VW pool is expected to keep its leading position with regards to plug-in sales volumes with around 520,000 plug-ins, followed by Stellantis with 270,000 units and Daimler with 195,000 units. When looking at fully electric cars, the podium is expected to be: VW first with 275,000 BEVs, Stellantis second with 150,000 units and the Renault pool third with 140,000 units.

Methodology

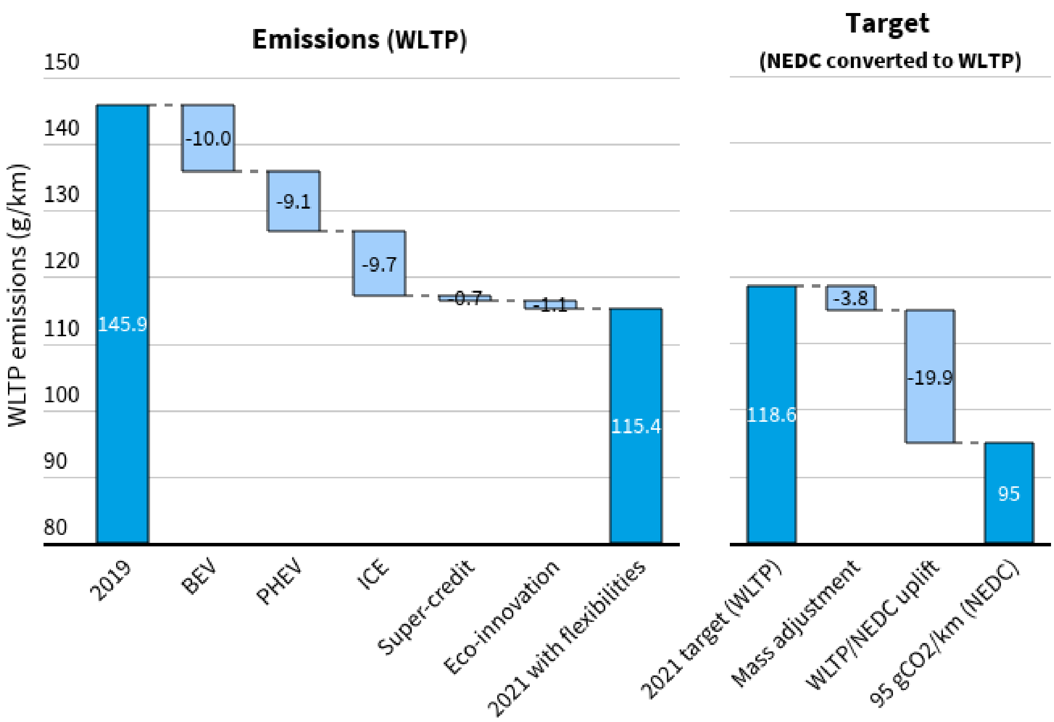
For OEMs that are already compliant with the regulatory targets, a likely scenario was defined based on production forecasts[15] and new models coming to the market. This is a conservative scenario that does not reach the maximum sales potential of each OEM. For OEMs that are not compliant after the first half of the year, BEV, PHEV and HEV shares are increased in order to reduce the emission average down to the level needed for compliance. A two-step approach (detailed in Annex 7.2) ensures that any increase in the relative share of a powertrain can be justified by carmakers' sales and production strategies. First, T&E assumes a carmaker cannot reach sales that are significantly above its production forecast. In cases where a compliance gap remains, powertrain shares are increased accordingly and depending on new models available, assuming these models perform better than projected.

[15] Carmakers production forecast were analysed in T&E's 2021 EV report [16]

The full year analysis is carried out assuming carmakers will keep the same market share as H1 2021. Only the distribution of powertrain inside each OEM market share is modified. Emissions for each specific powertrain are also kept constant at H1 2021 levels in the analysis. The average mass of each OEM over the full year 2021 is calculated by taking into account the new calculated powertrain shares for each powertrain. Eco-innovations savings are derived from 2020 Alternator and Lights eco-innovation savings approved under WLTP.

4.2.1. How has the full 95 g/km target been reached?

This section looks at how the compliance gap was closed in 2021 compared to 2019 in order to understand how carmakers chose to comply with the 95 g/km target once it was fully phased in. Indeed, 2021 is the first year with the full application of the target as OEMs benefitted from the 95% phase-in in 2020 (which meant the target didn't apply to the 5% most polluting vehicles). Moreover, the widespread use of super-credits in 2020 creates a distorted picture for that year. Therefore, 2021 is compared directly with 2019 (without 2020 flexibilities) and Figure 23 below show the contribution of each vehicle type and regulatory flexibility towards reaching compliance in 2021.



Improvements compared to 2019 emissions to show how carmakers comply with the 95 g/km once fully-phased in.

Scope: forecast for the EU27 and Norway in the whole year 2021.

Source: T&E modelling of carmaker's compliance with the EU 2021 CO2 emission regulation. 2019 emissions from the European Environment Agency.

Figure 23 - Breakdown of emission reduction and flexibilities

Starting from 145.9 g/km WLTP emissions in 2019, a 10.0 g/km reduction was achieved by the BEV ramp-up and a 9.1 g/km was achieved by both the increase of PHEV share and their emission reductions. As described above, PHEV sales increased more than BEV sales but their contribution to the emission reduction is still lower than for BEVs - thus highlighting that BEVs are a much more effective emission reduction strategy.

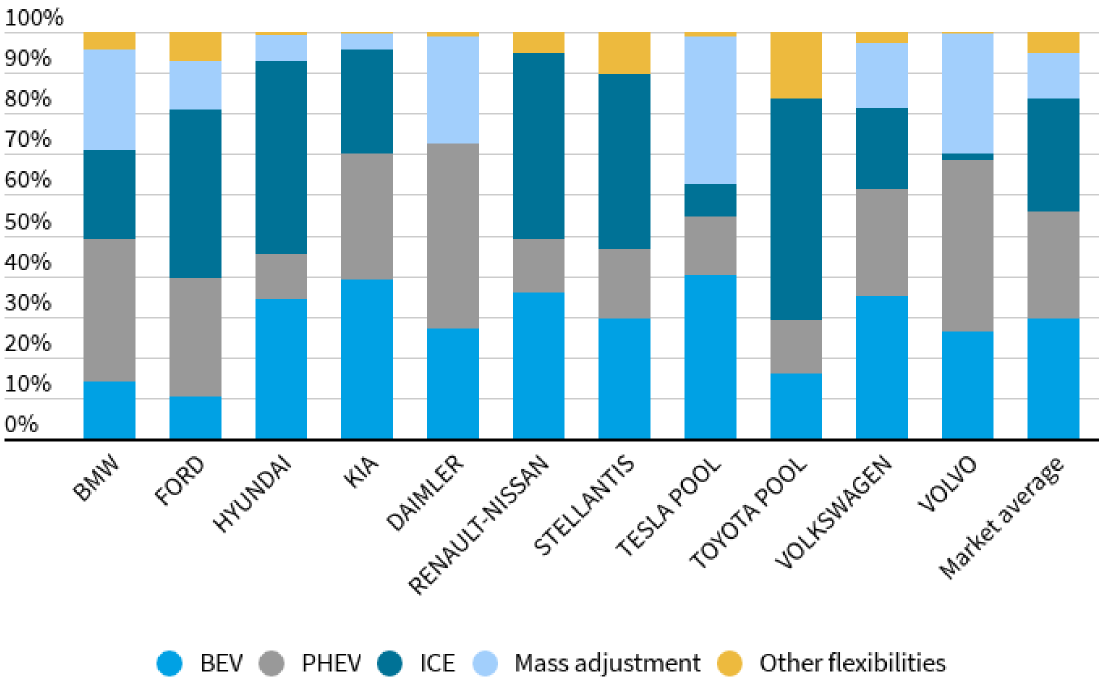
A similar contribution of 9.7 g/km was achieved from the increase of HEV sales and the overall emission reduction of combustion engines. Two flexibilities also directly lower the average emissions: -0.7 g/km from the remaining super credits and -1.1 g/km from eco-innovation credits. This gives a 2021 emission average with flexibilities of 115.4 g/km which is 3.3 g/km below the 2021 overall target at 118.6g/km. This overcompliance is explained by the share of carmakers that are already over-compliant in the first half of the year and are expected to remain largely in advance of the regulation for the full year 2021.
The right part of figure 23 describes how the 95 g/km target becomes a 118.6 g/km target in practice. Starting from the right, the 95 g/km target under NEDC is converted to WLTP by applying the average 2020 WLTP/NEDC uplift (21%). More details about the WLTP/NEDC uplift are presented in the Technical Annex. Then, 3.8 g/km are added to the target because of the mass adjustment[16].

Looking at the different contributions in relative terms compared to the compliance gap, 56% of the emission reduction is achieved thanks to the ramp-up of plug-in vehicles, 28% from ICE improvements (including HEVs), with flexibilities amounting to 16% (11% due to the target mass adjustment and 5% from eco-innovation and super-credits).

4.2.2. Overview of OEMs 2021 compliance strategies

This section focuses on the strategies that carmakers have implemented to reduce their emissions. Figure 24 below summarises the contribution of the different emission reduction factors for each carmaker when 2021 expected emissions are compared to 2019.

[16] This adjustment is the aggregation of the 2020 mass adjustment, the WLTP/NEDC uplift applied to this 2020 adjustment and the impact of the difference between the 2021 and 2020 masses.



* Other flexibilities includes super-credits and eco-innovation credits

Improvements compared to 2019 emissions to show how carmakers comply with the 95 g/km once fully-phased in.

Scope: forecast for the EU27 and Norway in the whole year 2021.

Source: T&E modelling of carmaker's compliance with the EU 2021 CO2 emission regulation.

Figure 24 - Carmakers 2021 compliance strategies

The contribution of the increased BEV share to the emission reduction compared to 2019 can be observed from this figure: after the Tesla-JLR-Honda pool that achieved 40% of its improvement with BEV, Kia has a 39% contribution of BEV, then the Renault pool with 36%, the VW pool with 35% and Hyundai with 34%. Regarding PHEVs, Daimler records the largest benefit from the powertrain with 46% of its improvement. It is followed by Volvo with 42% and BMW with 35%. Directly related to their high PHEV share, Volvo, Daimler and BMW are also among the largest beneficiaries from the mass adjustment with 30%, 26% and 24% respectively. The Toyota pool relies the most on ICE improvement with 54% of its improvement coming from its hybridisation strategy, then Hyundai with 48% due to a large share of mild hybrids, and the Renault pool with 46%. The compliance strategy of each carmaker is detailed in Annex 7.3.

A growing fully electric car line-up

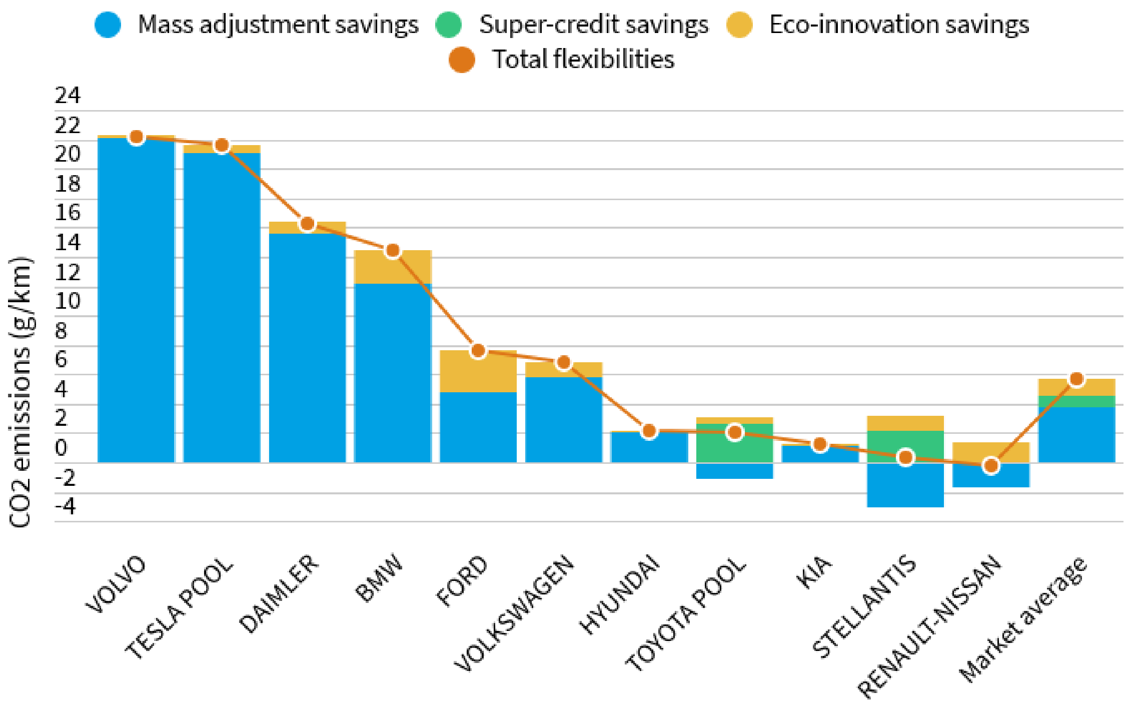
Regarding battery electric cars, emission reductions are achieved both by increased sales of existing models (successful models available before 2021 and new models released in H1 2021) and the launch of new models (10 new models will be available in H2 2021 from major carmakers). Table 2 below details the BEV product portfolio with the main nameplates sold by carmakers. Nameplates identified in *italic* are expected to have at least a 10% production growth in H2 compared to H1 and would contribute to the full year BEV growth in addition to new nameplates available in the second part of the year.

Table 2 - BEV models lineup

Pool 2021	Main pre-2021 models	H1 2021	H2 2021
BMW	i3, Mini	iX3	iX, i4
DAIMLER	*EQC, Smart Fotwo, Forfour*	*EQA*	EQS, EQB
FORD		*Mach-E*	
HYUNDAI	Ioniq, *Kona*		Ioniq 5
KIA	e-Soul, e-Niro		EV6
RENAULT-NISSAN	Renault Zoe, Renault Twingo*, Nissan Leaf*	*Dacia Spring*	
STELLANTIS	e208, e2008, Corsa-e, DS3 Crossback, Fiat 500e, C-zero, iOn	Citroen e-C4, *Mokka-e*	
TESLA POOL	*Model 3*, S, X, *Honda e, Jaguar I-Pace*		Model Y
TOYOTA POOL	Mazda MX-30, Lexus UX		
VOLKSWAGEN	*VW ID.3*, *VW ID.4,* Audi e-tron Sportback, *Porsche Taycan*, VW eUp!, Seat Mii	*Skoda Enyaq*	Q4 e-tron, Cupra Born
VOLVO	*XC40, Polestar 2*		C40

4.3. CO_2 regulation flexibilities

In 2021, carmakers benefitted from four flexibilities in the CO_2 standards regulation: the CO_2 target mass adjustment, eco-innovation savings, remaining super-credits, pooling. On average, the savings from flexibilities helped carmakers close a third of the remaining compliance gap from 2020 (not taking into account the flexibilities in 2020). On average, flexibilities are expected to reach 5.7 g/km with two thirds for the mass adjustment (3.8 g/km), 1.1 g/km for eco-innovations and 0.8 g/km for the remaining super-credits. Figure 25 below details the contribution from flexibilities for each carmaker.



Scope: Forecast for the EU27 and Norway in the whole year 2021.

Source: T&E modelling of carmaker's compliance with the EU 2021 CO2 emission regulation. Partly based on the analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

Figure 25 - Expected flexibility savings by carmakers in 2021

Most carmakers would not meet their CO_2 target without these flexibilities. Figure 26 shows the compliance status of carmakers expected in the full year 2021 compared to their hypothetical status without any flexibilities. As described in the methodology in section 4.2, all carmakers are expected to comply in the full year (the blue car symbol on the compliant side of Figure 26). However, when the benefits from regulatory flexibilities are removed (orange bar), carmakers' compliance is more mixed. Indeed, only Renault-Nissan, Stellantis, the Tesla pool and Volvo would comply without flexibilities (green car symbol). All seven remaining carmakers would not comply without flexibilities (grey car symbol). Some carmakers would even end up far from meeting their targets: for instance, Daimler would have a 10.9 g/km gap with its target, Ford would have a 7.5 g/km gap, the VW pool a 6.8g/km gap and BMW a 4.5 g/km gap.

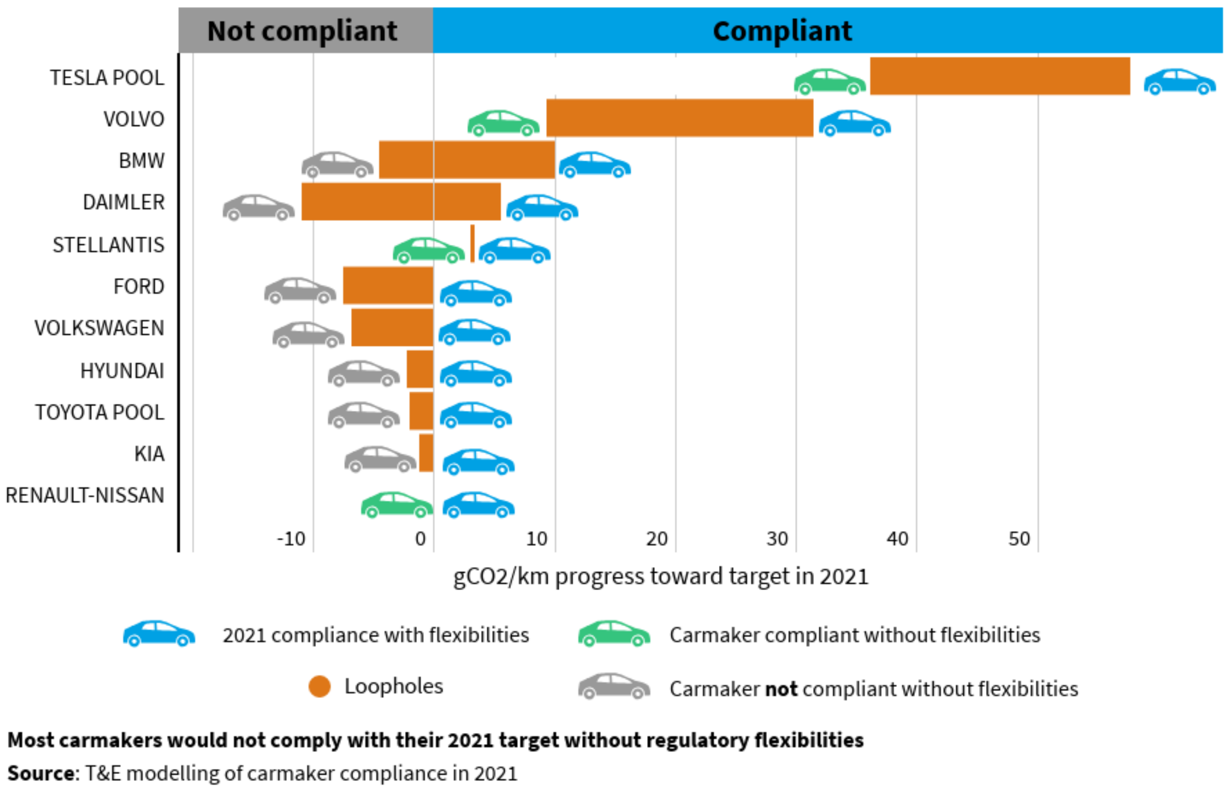


Figure 26 - Thanks to flexibilities, all carmakers are set to comply with the 2021 car CO_2 targets

Mass adjustment

Volvo, Daimler, Tesla-Honda and BMW are expected to benefit the most from the CO_2 target mass adjustment provisions as they produce much heavier cars than the average. This is partly due to the high share of heavy plug-ins given that PHEVs weigh on average 1907 kg[17] while a BEV weighs 1725 kg. Conversely, carmakers with a high share of small vehicles are burdened by the mass adjustment via a more stringent target: Stellantis' target is lowered by 2.9 g/km and the Renault pool by 1.6 g/km.

Assuming that the mass adjustment mechanism is removed and that carmakers would reduce their emissions by the same amount, OEMs would need to produce 280,000 additional BEVs to comply (2.6% of the market). In other words, the current flexibility prevents a 29% increase of the total number of BEV.

Super-credits

Stellantis is expected to exhaust its remaining super-credits of 2.2 g/km[18] remaining while the Toyota pool would use 2.6 g/km without using all its remaining super-credits[19]. Consequently, all carmakers are expected to have used all their available credits in 2021 and this flexibility will not be available anymore

[17] Volvo is expected to have a 37% share of PHEV weighing 2030 kg, Daimler 22% at 2034 kg and BMW a 19% at 1974 kg.

[18] The calculation of the remaining supercredit for Stellantis is based on the relative share of vehicles below 50 g/km between PSA and FCA brand in H1 2021. The remaining super-credit of 1.8 g/km in NEDC is inflated to 2.2 g/km in WLTP (based on a 27% WLTP/NEDC uplift from 2020 super-credits)

[19] Using the relative share H1 2021, the Toyota pool would have a 7.4 g/km super-credit cap (5.8g/km remaining in NEDC inflated by a 27% WLTP/NEDC uplift from 2020 super-credit).

in 2022. If Toyota-Mazda and Stellantis would sell more BEVs to ensure an emission reduction equivalent to their remaining super credits, the market share of BEVs would increase by 0.5 percentage points.

Eco-innovation credits

Assessing the CO_2 savings from eco-innovations is more challenging as only official EEA registration data includes this information (which would be available around June 2022 for 2021 registrations). Moreover, the change from NEDC to WLTP cancels all eco-innovations approved under NEDC and carmakers will have to approve new WLTP eco-innovations on all cars previously fitted with NEDC eco-innovations. In 2020, while 46% of cars were fitted with NEDC-approved eco-innovations, only 3% were approved with WLTP eco-innovation. Eco-innovations approved under WLTP also bring lower savings on paper than when approved under NEDC. On average, by comparing WLTP-approved and NEDC-approved eco-innovations in the Alternator and Lights category in 2020, the WLTP-approved eco-innovations provide 28% less CO_2 savings. This difference is likely due to WLTP measurements that are more representative of real-world savings than NEDC (which potentially overestimated the savings resulting from eco-innovations). Moreover, some types of eco-innovation such as coasting functions are available under NEDC in 2020 but not yet approved under the WLTP. Because of the lower expected savings from WLTP in 2021 compared to NEDC in 2020, and in order to grant carmakers a generous phase-in of the WLTP measurement of the contribution of eco-innovation technologies, the regulation will apply a 1.9 factor to WLTP savings. Assuming carmakers approve as many vehicles with Alternator and Lights eco-innovation under WLTP in 2021 as they did in 2020 the average eco-innovation saving is expected to reach 1 g/km in 2021 (0.55 g/km without the 1.9 adjustment factor).

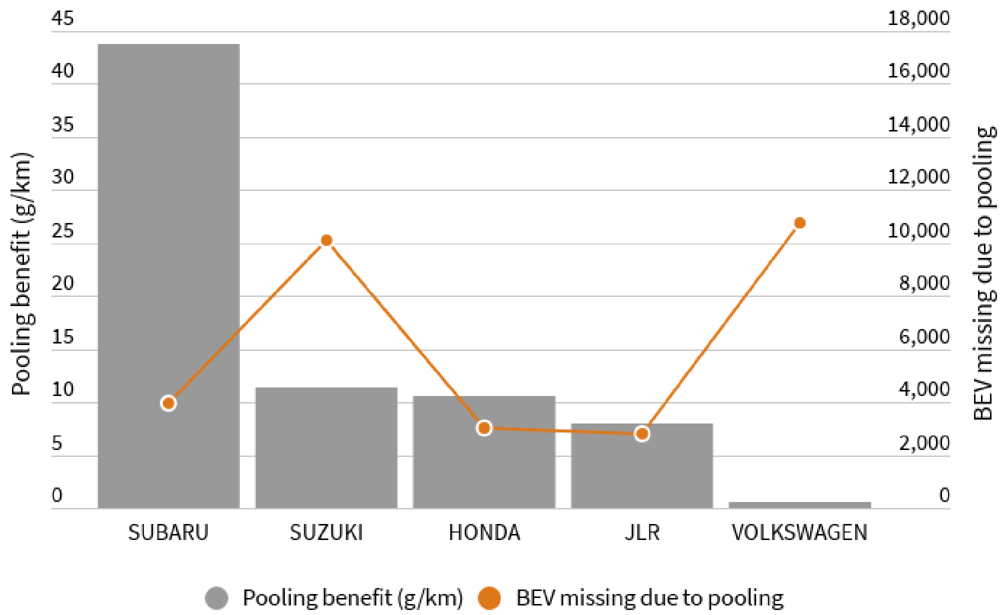
Ford is expected to benefit the most from eco-innovation technologies with a 2.8 g/km saving. BMW was the largest beneficiary in 2020 but the German carmaker is expected to be limited to 2.2 g/km in 2021 as thermal and kinetic eco-innovation technologies[20] - which BMW relied on to a great extent in 2020 - are not yet approved under WLTP.

T&E calculates that the contribution of the eco-innovation flexibility is equivalent to the sale of 77,000 additional BEVs. So, eco-innovations credits would be equivalent to a 0.7 percentage points increase of the BEV share.

Pooling

At the time of writing, open pools are Tesla-JLR-Honda, Toyota-Mazda-Suzuki-Subaru, Renault-Nissan-Mitsubishi and the Volkswagen pool that includes small-scale carmakers such as SAIC or MG Motors. Based on T&E's analysis of the current compliance status of each carmaker, we have analysed the potential implication of the creation of new pools between the leaders and laggards over the first half of the year. Subaru and Suzuki are expected to be the main laggards in the Toyota pool, and Honda and JLR will benefit from Tesla performance. Figure 27 details the benefits that carmakers would draw from pooling with a frontrunner and the number of BEVs that would not have to be sold because of these pools (as carmakers would not need to increase their plug-in sales anymore).

[20] Kinetic eco-innovations are based on coasting functions while thermal eco-innovations are based on engine complement encapsulation systems or enthalpy storage tanks



Benefits obtained within the following pools: Subaru and Suzuki in the Toyota pool, Honda and JLR in the Tesla pool, VW in the pool with small scale carmakers (SAIC, MG, ...)

Scope: EU27 and Norway in the whole year 2021.

Source: T&E modelling of carmaker's compliance with the EU 2021 CO2 emission regulation. Partly based on the analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

Figure 27 - Pooling benefits and equivalent BEV missing

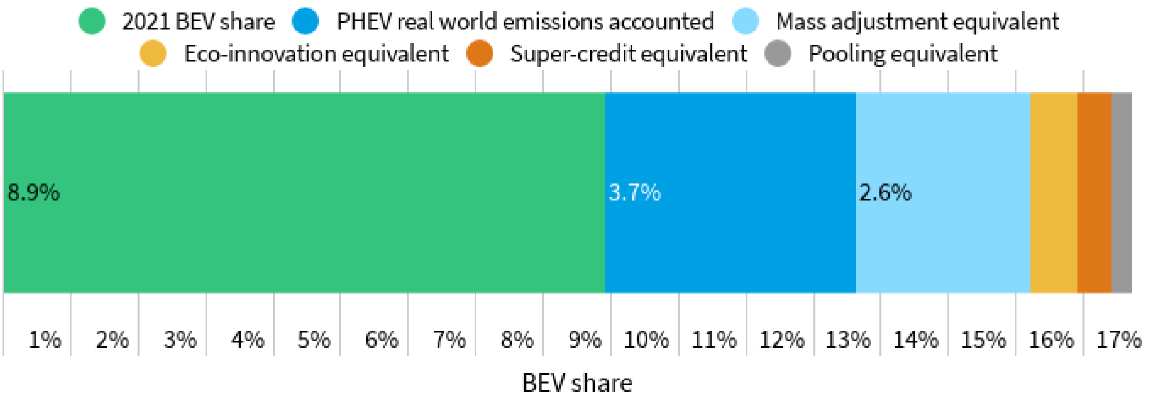
Subaru is the largest beneficiary from pooling with a 44 g/km bonus, Suzuki or Honda would benefit from around 11 g/km and JLR from 8 g/km. Volkswagen benefits from a modest 0.6 g/km as the number of cars produced by other OEMs in the open pool are relatively small compared to VW production (VW accounts for 99.4% of the pool). Overall, the pooling prevents the sales of 31,000 BEV from being sold. As a result, the pooling would reduce by 3% the number of BEVs that would otherwise need to be sold in the whole year 2021.

Total missing BEVs - combined impact of flexibilities and PHEVs

Mass adjustment, eco-innovation, pooling and super-credits prevented potential sales of 450,000 fully electric cars that would be equivalent to the CO_2 savings under these regulatory flexibilities. Moreover, as detailed in section 3.1.1, the regulation favours the sales of PHEVs that increase the mass adjustments benefits due to their mass well above the average car, but that do not achieve any emission reduction on the road. Indeed, real world PHEV emissions (WLTP) could be 2.6 times more than the theoretical measurement[21]. Under the assumption that carmakers increased their BEVs sales to compensate for the higher emissions of PHEVs, around 400,000 additional BEV would be required (3.7% of the market). As detailed in Figure 28, the BEV sales share would be 7.8 percentage points higher (the BEV market share

[21] Assuming PHEV real world average utility factor is half the value used in the WLTP and that PHEVs consume 14% more than theoretical WLTP values in charge-sustaining mode.

would reach 16.6%) without the flexibilities and with the real world utility factor for PHEVs. Overall, around 840,000 BEVs are missing due to these flexibilities which weaken the regulation.



Methodology: BEV share calculated so that the additional BEV share would provide emission reductions equivalent to the flexibilities contributions in 2021. In the case of the PHEV loophole, additional BEV would be required to compensate the accounting of PHEV real world emissions.
Scope: Registration data for the EU27 and Norway.
Source: T&E modelling of carmaker's compliance with the EU 2021 CO2 emission regulation. Partly based on the analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

Figure 28 - Equivalent BEV share without flexibility and the PHEV loophole

5. Post 2021 outlook - carmakers on course for an easy ride

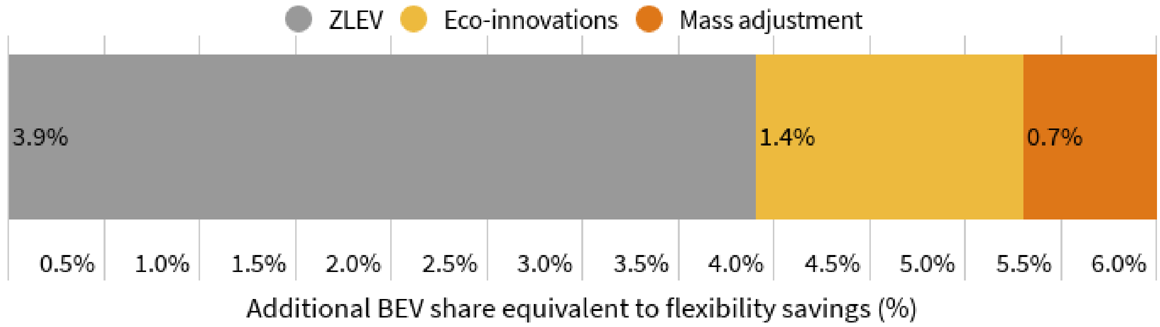
This section analyses the design and ambition of the car CO_2 regulation in the 2020s. The impact of flexibilities is assessed while the ambition of the CO_2 emission reduction targets is compared with the potential of the market. To model carmaker's CO_2 emissions in the 2020s, T&E projected plug-in sales based on the 2021 sales (from the compliance model presented in section 4), industry's production trends [16] and carmakers' voluntary sales targets for 2025 and 2030.

5.1. Flexibilities continue to weaken the regulation

In 2025, 6% BEV are projected to be missing due to regulatory flexibilities
Flexibilities are expected to continue weakening the regulation's ambition in the coming years. T&E projects that flexibilities would amount to a 7.6 g/km weakening of the target in 2025: 1.8 g/km due to eco-innovations, 0.9 g/km due to mass adjustment and 4.9 g/km due to the zero and low-emission vehicles (ZLEV[22]) bonus. Without these flexibilities, OEMs would need to sell an additional 6 percentage points BEV (around 740,000 BEVs) to reach the same emissions levels. As shown in Figure 29, the ZLEV bonus that will be implemented in 2025 is expected to be the largest contributor to the weakening,

[22] ZLEVs are defined as vehicles emitting less than 50 g/km (WLTP)

equivalent to a 3.9 percentage points increase of the BEV share (see more below). The importance of eco-innovations is expected to grow in the decade and their emissions credits would be equivalent to increasing the BEV share by 1.4 percentage points. Regarding the mass adjustment weakening, it is expected to be lower from 2025 but it would still be equivalent to a 0.7 percentage points increase of the BEV share.



Methodology: First, the contribution of each flexibility is calculated. Then, the BEV sales share is increased so that average emissions (without flexibilities) decrease by the same amount as flexibilities' contributions.
Source: T&E modelling of carmaker's compliance in 2025

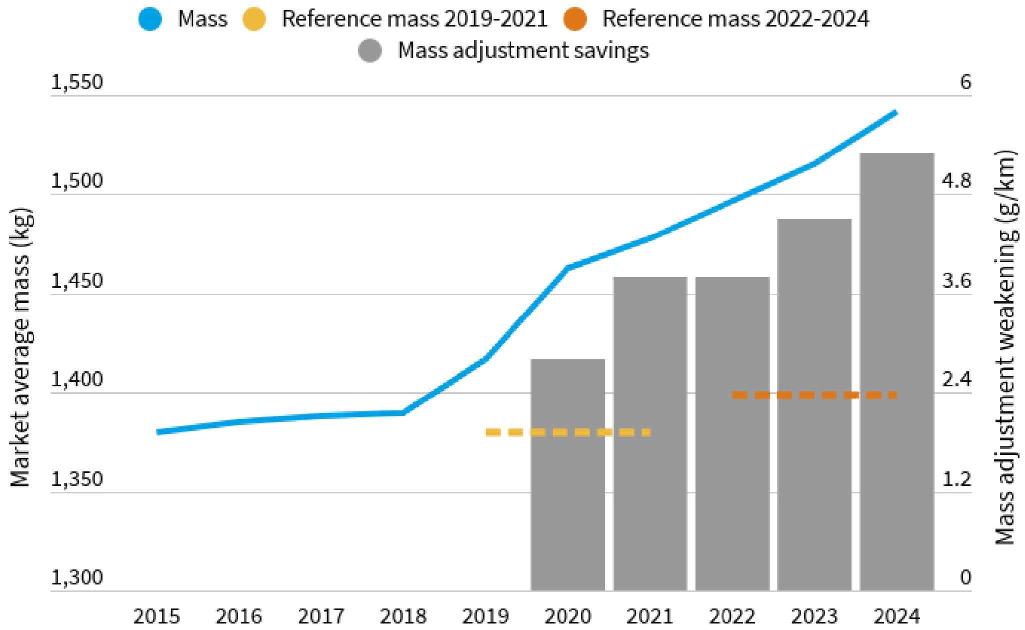
Figure 29 - Additional BEV share required to reach the same CO_2 savings as flexibilities in 2025

The weakening from the mass adjustment is expected to double in 2024 (compared to 2020)

The OEM specific CO_2 targets are adjusted every year based on the difference between the average mass of its vehicles sold in that given year and the EU reference mass (called M0, set every 3 years until 2025). The higher the average mass of vehicles sold, the higher (less strict) the target is (and vice versa).

On average, the mass adjustment weakening is projected to increase by 38%[23] from 2.7 g/km 2020 to 3.8 g/km 2021. The mass increase trend and status in 2020 is further described in the Technical Annex. Based on the compliance modelling for the full year in 2021, the average car sold in 2021 is expected to weigh 1477 kg, a 14 kg increase compared to 2020. In 2022, the reference mass used to compare the OEM-specific mass will be updated to 1398.5 kg (from 1379.9 kg in 2019-2021), but the mass adjustment is expected to remain at the same level as 2021 (3.8 g/km) due to the expected increase of the average mass in 2022[24]. However, as the average mass is expected to continue increasing in 2023 and 2024, the mass adjustment weakening could reach 4.5 and 5.3 g/km respectively. It means that the average contribution from the 2024 mass adjustment is expected to nearly double compared to 2020 (93% increase). On average, the mass adjustment is expected to be 4.4 g/km in the whole 2021-2024 period.

[23] 21% is due to the WLTP/NEDC uplift factor that is also applied to the mass adjustment part of the target, and 16% due to increased mass between 2020 and 2021.
[24] T&E's plug-in vehicles sales forecast was used to model the mass increase in the 2020s.



Scope: Forecast for the EU27 and Norway
Source: T&E modelling based on mass data from EEA Monitoring of CO2 emissions from passenger cars (2015-2020), on the analysis of passenger car registration data from the first half of 2021 from Dataforce, and T&E's plug-in vehicles sales forecast

Figure 30 - Projection of mass adjustment weakening

From 2025, the reference mass is expected to be updated every two years (instead of three years before 2025). This change is expected to reduce the impact of the mass adjustment but the reference mass will always lag behind the average mass of cars observed in the EU fleet. In 2025 and 2026, the reference mass will be the average from 2022-2023, meaning that, in 2026, there will still be a three years difference between the reference and the actual market average.

Another modification of the regulation in 2025 is the update of the factor "a" used in the formula to calculate carmakers specific targets based on the average mass of their sales. Currently, this factor is 0.0333, but it will be updated to fit more closely the correlation between the emissions and the mass of cars registered in 2021. Current calculations, based on 2020 provisional data and carried out by the ICCT [17], suggest that this factor "a" could be around 0.015. Using this assumption and T&E's plug-in vehicles sales forecast to estimate the market average mass, the average mass adjustment in the 2025-2029 period would be around 0.8 g/km.

Eco-innovations to reach a 3 g/km weakening per conventional car in 2025

As detailed in the Technical Annex, the share of cars fitted with eco-innovation technologies grew to 46% of the market in 2020, nearly three times the 2019 number. The change to the WLTP in 2021 is likely to temporarily dampen the increase. However, the use of these technologies is expected to continue to grow in the coming years as the technologies become cheaper and more widespread. Eco-innovation emission savings are correlated with the number of eco-innovations fitted on cars: by fitting two eco-innovations (for instance a combination of light and alternator eco-innovations), savings are increased. As most carmakers were fitting only one eco-innovation in 2020, savings are expected to grow in the future as carmakers are expected to combine multiple technologies. Based on 2020 data, eco-innovation credits would account for 2 g/km per conventional car if OEMs fit the most common available technologies on all cars. Nevertheless, this value is expected to increase further in the future as all eco-innovations are not yet approved under WLTP. For instance, coasting functions were used under NEDC but OEMs still have to apply for the use of this eco-innovation with the WLTP. Additionally, air-conditioning systems will be eligible for eco-innovation savings from 2025. Therefore, an average 3 g/km credit is assumed for all conventional cars (ICE and HEV)[25] from 2025. This leads to a 1.8 g/km saving in 2025 at fleet level as BEVs would not benefit from these credits. As the BEV share will continue growing in the second part of the decade, eco-innovations would amount to a 1.3 g/km on average in the period 2025-2030.

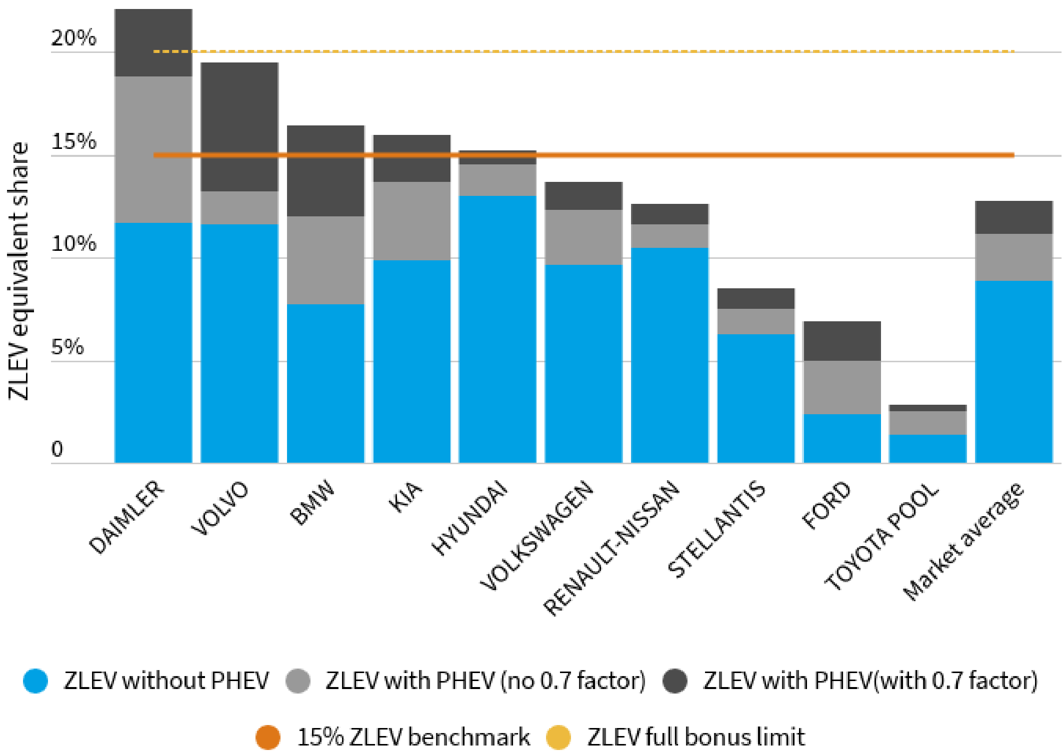
Six carmakers would already meet the requirements for the ZLEV bonus in 2021

From 2025 on, a new incentive mechanism for ZLEVs is introduced, replacing the super-credit mechanism which is phased out after 2022 - the ZLEV benchmark. This crediting system allows a carmaker to relax its specific emissions target if its share of ZLEV sales exceeds the non-binding 15% benchmark from 2025 to 2029[26]. Exceeding the ZLEV benchmark by one percentage point increases the manufacturer's CO_2 target (in g/km) by one percent, making it easier to comply with. Target weakening is capped at 5%, so carmakers benefit from the full bonus by selling at least 20% ZLEV. The ZLEV share of sales is weighted according to a system which counts zero-emission vehicles as one and PHEVs as less than one depending on their WLTP emissions.

The average share of ZLEV equivalent (after weighting) is projected to reach 12.8% of the market in 2021, or 2.2 percentage points below benchmark value (15%). Figure 31 shows that five OEMs would already meet the requirements for the ZLEV bonus in 2021 - or four years before the entry into force of the benchmark. In addition to the Tesla pool (not shown in the figure) which would reach a 52% ZLEV share, Daimler would also benefit from the full bonus as its ZLEV share would exceed 20%. Volvo, Kia, BMW and Hyundai would benefit from bonuses but without reaching the maximum value.

[25] PHEV could theoretically benefit from eco-innovations but current technologies approved under WLTP are not compatible with off-vehicle charging hybrid electric vehicles. Indeed, a given eco-innovation technology needs to provide at least 0,5 g/km savings under WLTP to be eligible (previously 1 g/km under NEDC). The only eco-innovation eligible for PHEV was the navigation-based preconditioning of battery SOC under NEDC but this technology is not approved under WLTP yet.

[26] The ZLEV benchmark and associated bonus initially planned for 2030 is proposed to be removed in the Commission's legislative proposal [18].

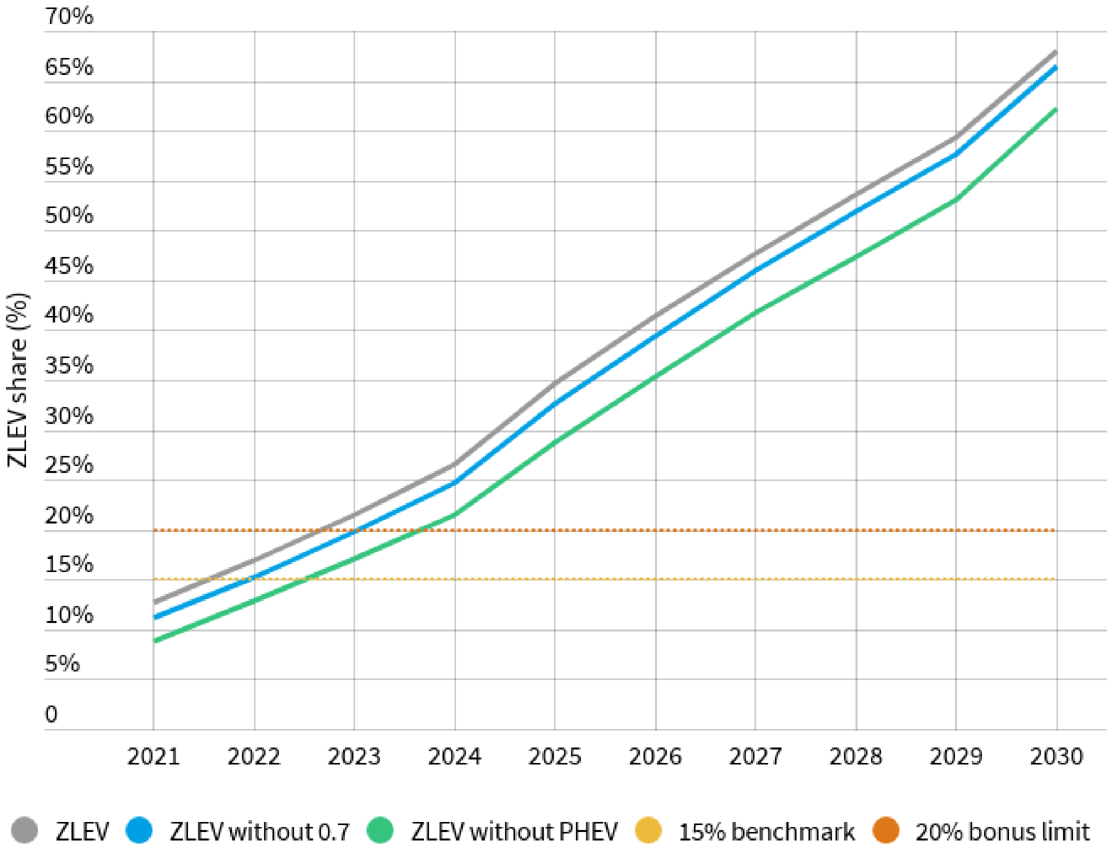


Scope: forecast for the EU27 and Norway in the whole 2021 year.
Source: T&E modelling of carmaker's compliance with the EU 2021 CO2 emission regulation. Partly based on the analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

Figure 31 - Projected ZLEV share in 2021

For low emission vehicles, the weighting system is based on their WLTP emissions, so as to benefit PHEVs which emit less. This emissions-based weighting is, however, inflated by a 0.7 multiplier that gives 0.3 of a credit instead of zero to PHEVs (or low emission vehicles) emitting 50 g/km. Because of this multiplier, on average, the weight of PHEVs in the ZLEV calculation is almost doubled. Removing this additional factor would decrease the market ZLEV equivalent share to 11.1% instead of 12.8%. In that case, the Tesla pool and Daimler would be the only OEMs to already qualify for a ZLEV bonus in 2021.
If PHEVs were simply removed from the calculations, the ZLEV share would effectively be equal to the ZEV share and would reach 8.9% in 2021. Here, Tesla-JLR-Honda would be the only pool to qualify for a bonus already in 2021.

The full ZLEV bonus would be reached on average in 2023
Based on T&E plug-in vehicles sales forecast, the market average ZLEV share is expected to exceed 15% as early as 2022. The 20% threshold of the bonus limit is expected to be reached on average across OEMs in 2023, or two years before the entry into force of the system. Even when removing PHEVs altogether from the mechanism, the date would only be delayed by a year (full bonus in 2024 on average). In all scenarios, the ZLEV market average will be above 20% before 2025, highlighting that the benchmark is already outdated before it has even entered into force.

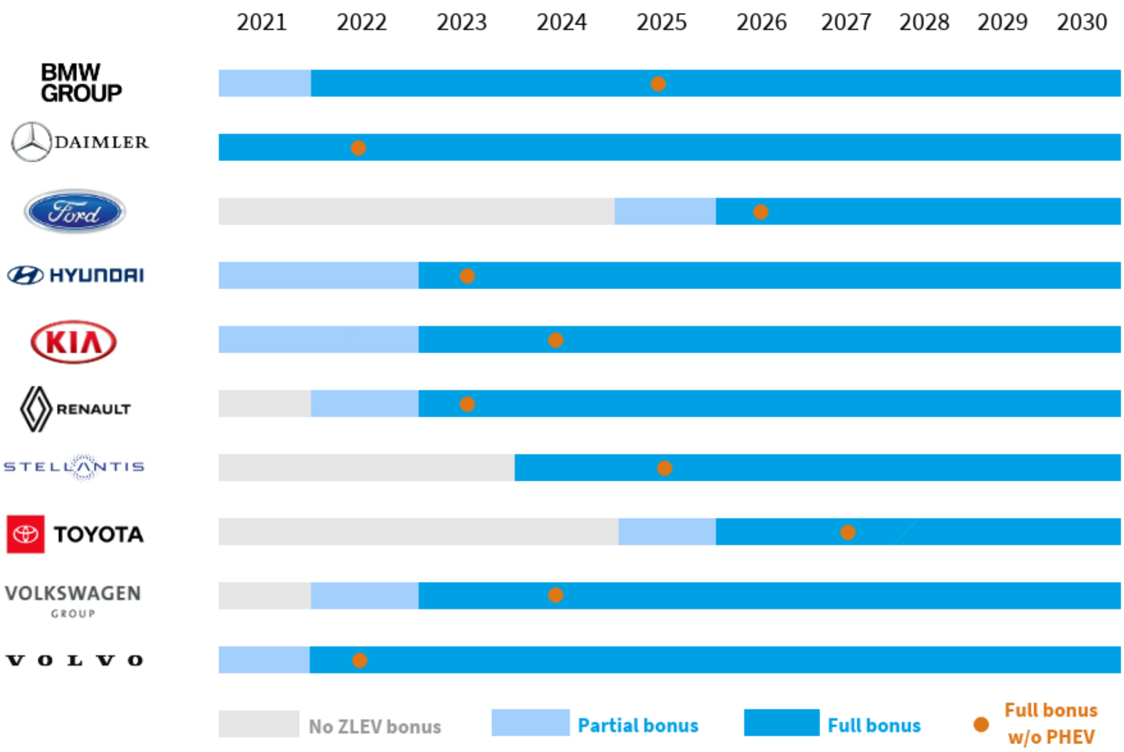


Source: T&E's plug-in vehicles sales forecast modelled from passenger car registration data from the first half of 2021 from Dataforce, carmakers' 2030 sales targets, and EU production data.

Figure 32 - Projection of the market average ZLEV share

All carmakers will benefit from the ZLEV bonus in 2025

Based on T&E's sales forecasts, Figure 33 shows the years where each individual OEM would reach the 15% benchmark limit (light blue), the full bonus limit with the current regulation (dark blue) as well as the full bonus if PHEV are excluded from the ZLEV calculation (orange line).



The period 20210-2024 was included for indicative purposes given no bonus can effectively be achieved over this period.

Scope: Forecast for the EU27 and Norway from 2021 to 2030.

Source: T&E's plug-in vehicles sales forecast modelled from passenger car registration data from the first half of 2021 from Dataforce, carmakers' 2030 sales targets, and EU production data.

Figure 33 - Expected years in which carmakers achieve ZLEV bonuses

All major car manufacturers, with the exception of Toyota-Mazda and Ford, would benefit from a full bonus of 5% from 2025 on (and all of them from 2026 onwards). This amounts to at least 83% of the European market in 2025 that is covered by carmakers benefitting from the full 5% weakening of their CO_2 target. If PHEVs are removed from the ZLEV definition (so that only ZEV are included), the year of the full bonus application is either unchanged for OEMs with high BEV share or just delayed by one year. BMW would be the only OEM with a 3 year delay to reach the 20% BEV level but would still reach it in 2025.

Compared to plug-in market shares already observed in the EU (10.5% in 2020, 16.1% in the first half of 2021), or to carmakers' voluntary commitments (e.g. in 2030, BEVs are expected to make up 100% of Volvo, Daimler, Fiat and Ford's sales, 60% of VW Group's, and 50% of BMW's), the current level of the ZLEV benchmark is remarkably low. The system fails to incentivise or reward carmakers which are leading the plug-in race and instead weakens the stringency of the target of each OEM by 5%, thus allowing carmakers to sell fewer BEVs or more highly polluting SUVs. Under the current system, the ZLEV bonus is expected to weaken the CO_2 savings by 4.9 g/km in 2025 and would be the equivalent of selling 3.9 percentage points additional BEVs.

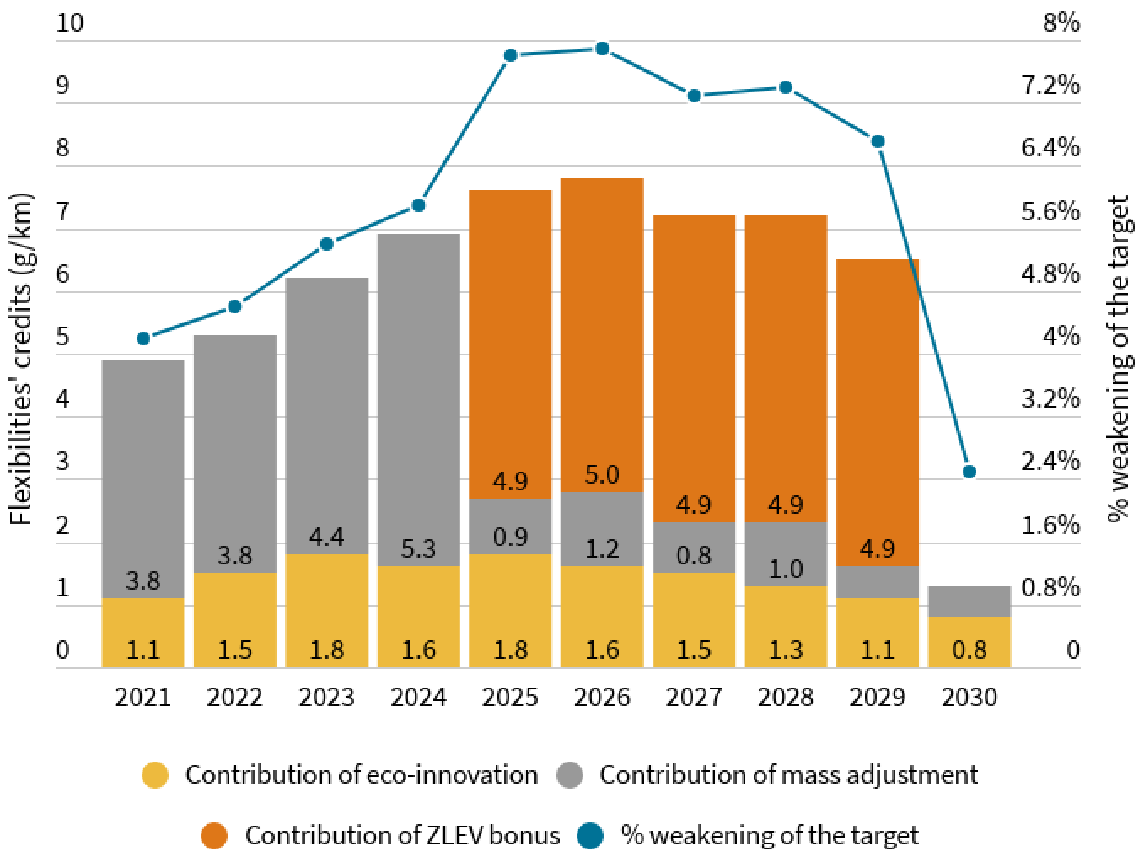
Test manipulations could bring a further artificial emission decrease

The OEM-specific 2021 targets are set first by calculating the mass-adjusted 95 g/km NEDC target multiplied by the 2020 WLTP-NEDC uplift, then by adjusting this to the mass variation of the sales between 2020 and 2021. The bigger the WLTP-NEDC difference in 2020, the higher (and therefore easier to meet) the WLTP derived target in 2021 will be (which also serves as the baseline for the 2025/2030 targets). Carmakers might therefore have made the 2021 target relatively less stringent by inflating the difference between the two values in 2020 through test manipulation and optimisation, and then reducing this gap in 2021. Carmakers were allowed to rely to a large extent on double testing of cars using both the NEDC and WLTP procedures to optimise separately each of the tests. In other words, while complying with the NEDC target in 2020, it is likely that carmakers would have aimed for low NEDC and high (inflated) WLTP values in 2020, and low (realistic) WLTP values in 2021.

The JRC suggested that the ratio between the WLTP/NEDC should be 15% [19] whereas it was observed to be 21% in 2020. This results in a 5% gap between actual and theoretical WLTP emissions that could favor OEMs from 2021 and give them a further decrease in their emissions on paper by 5%, just by test optimisation. The official publication of the 2021 WLTP measurements from the EEA will allow further analysis of this potential loophole.

Flexibilities are responsible for a 6% weakening of the emission reduction targets over 2021-2030

Figure 34 shows the average credits from flexibilities that are expected in the 2021-2030 period. By the end of 2024, flexibilities would amount to an average of 5.8 g/km weakening the 95g/km equivalent target. In relative terms, it means that the target over 2021-2024 is weakened by 5.1%. The 2025-2029 target (15% CO_2 reduction compared to 2021) is expected to be weakened by 7.4% due to an average 7.3 g/km total credit from flexibilities.

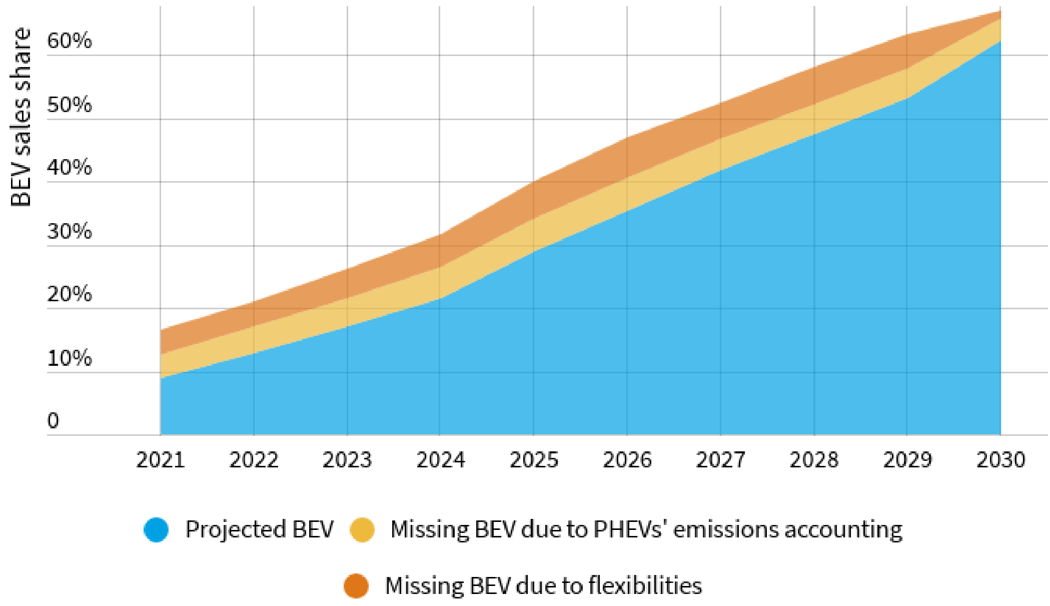


Source: T&E modelling of carmakers' compliance in the 2021-2030 period based on T&E plug-in vehicles sales forecast (production adjusted to take imports/exports and carmaker sales targets into account). Partly based on the analysis of passenger car registration data from the first half of 2021 from Dataforce, August 2021.

Figure 34 - Target weakening due to flexibilities in the 2020s

On average over 2021-2030, regulatory loopholes are responsible for a 9.4% missing BEV sales share

Figure 35 shows the BEV share of sales missing each year due to the target weakening from flexibilities and the unfair accounting of PHEV emissions. On average over the 2021-2030 period, the BEV share could increase by 4.8 percentage points to compensate for the flexibilities' credits. An additional 4.5 percentage points could be added if carmakers would reach the same emissions levels by increasing the BEV share when PHEVs' real world emissions are accounted for. As a result, regulation flexibilities and the PHEV loophole would be responsible for a cumulative 11.5 million missing battery electric cars in 2030.



Methodology: *Projected BEV*: based on production trends adjusted to 2021 sales and OEM 2030 sales targets.
Missing BEV due to PHEVs' emissions accounting: From the average emission accounting PHEVs' real world emissions, BEV sales are increased so that emissions reach the level obtained when theoretical PHEV emission are accounted.
Missing BEV due to flexibilities: BEV share increased so that emissions decrease by the amount of flexibilities' credits.

Figure 35 - Missing BEV due flexibilities and the PHEV loophole in the 2020s

5.2. Emission reduction targets lag behind market dynamics

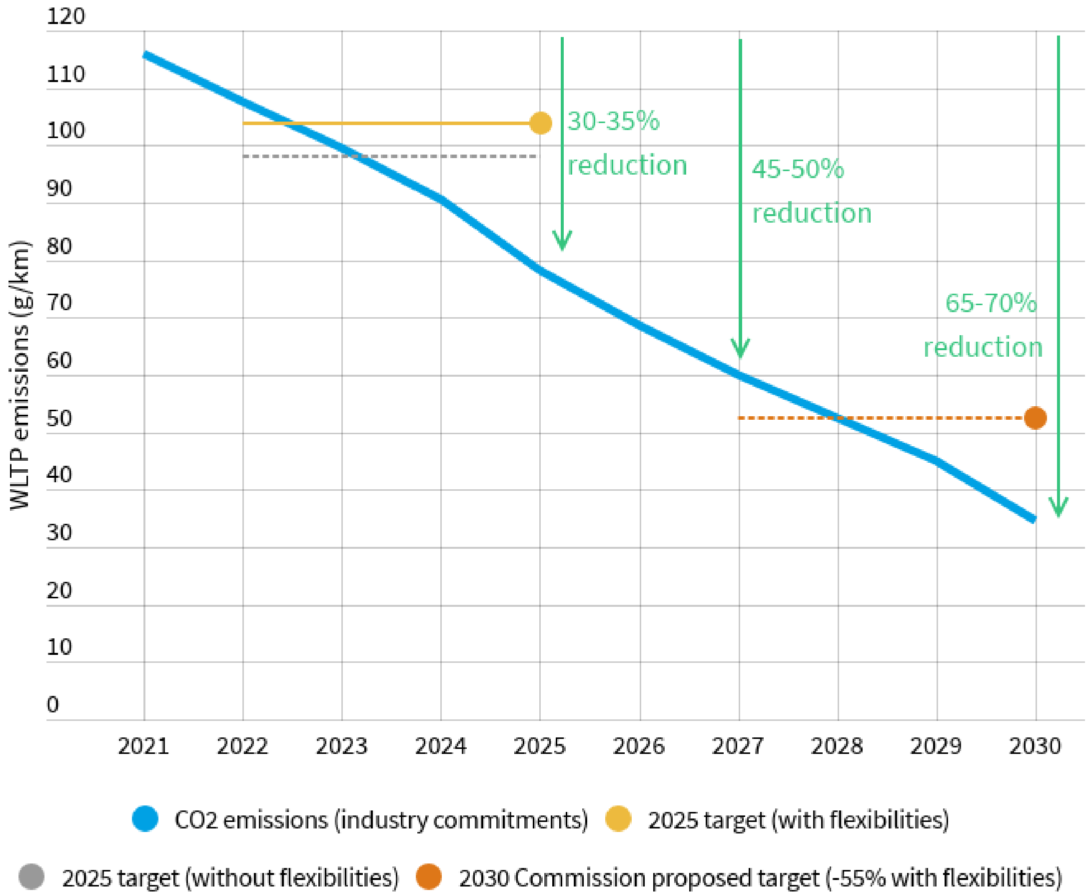
In 2025, the CO_2 target will be 15% lower than the reference emission from 2021 (115 g/km) and would be set at 98 g/km (WLTP). To this fleet-wide target, the mass adjustment and ZLEV bonuses will be added so that the effective average target would likely be relaxed to 104 g/km, a 6% weakening compared to the 2025 reference target (98 g/km). The latest proposal of the European Commission aims for a -55% CO_2 reduction in 2030 [18] that would lead to a 52 g/km fleet-wide target.

Based on T&E's plug-in vehicles sales forecast, plug-ins could reach 41% in 2025 (with 29% BEV) and 72% in 2030 (with 62% BEV). In addition to this growing plug-in sales trend, the expected reduction in ICE emissions would be -2% each year up to 2025, then -1.6% each year in the 2026-2030 period (refer to Annex 7.2 for the details of these assumptions). These scenarios lead to the emission reduction depicted in Figure 36 below.

The 2025 target could be met as soon as 2023

In comparison to the 2025 target, the emission reduction calculated based on expected market trends could be twice as large with a 30-35% reduction. As the emission reductions would continue in the second part of the decade, emissions could be reduced by 45-50% in 2027. In 2030, the reduction potential could reach 65-70%, whereas the European Commission has proposed a target of -55% for the revision of the car CO_2 standards (part of the Fit for 55 legislative package from July 2021).

Moreover, if the 2025 target is simulated in the years prior to its entry into force, the target (including the 5% full ZLEV bonus) would be reached by the market average as soon as 2023, a projection that would still hold even if PHEVs are removed from the ZLEV calculation. In the absence of a ZLEV bonus, the -15% reduction target is expected to be met in 2024 on average. Regarding the new 2030 target proposed by the Commission (-55%), this is expected to be reached one year in advance, in 2029 according to industry forecasts.



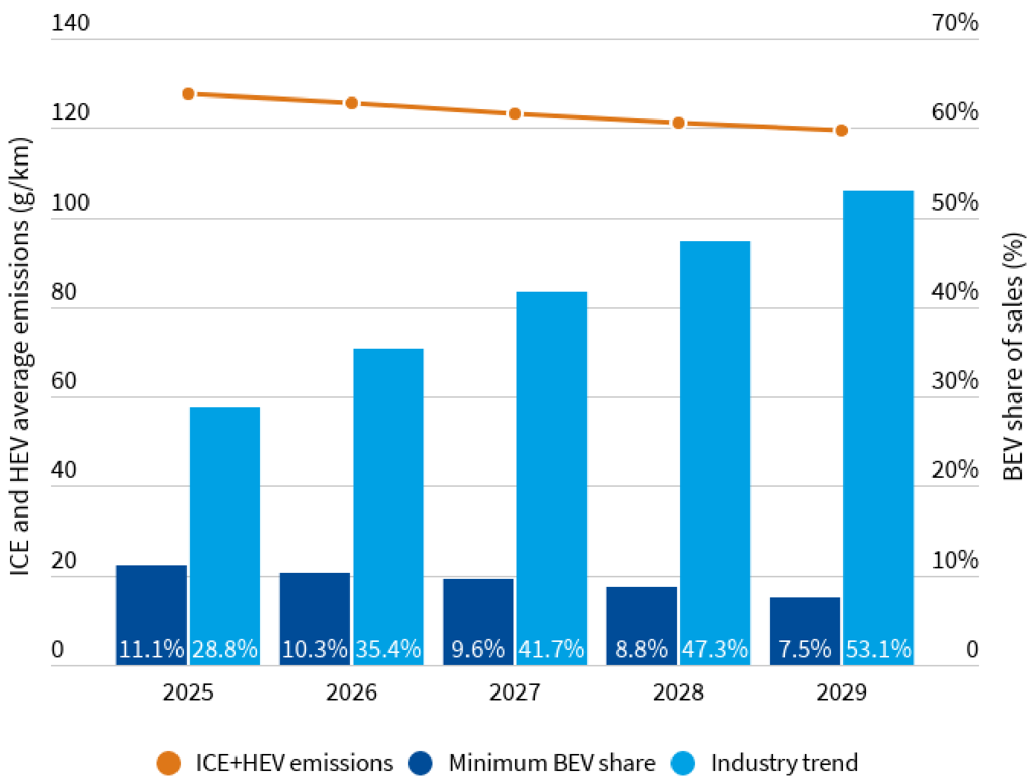
Source: T&E emission modelling derived from passenger car registration data from the first half of 2021 from Dataforce, carmakers' 2030 sales targets, and EU production data.

Figure 36 - Projected emission reduction in the 2020s compared to the regulation targets

The forecasts presented above are based on current industry production trends, and would lead to significant overcompliance from the side of the carmakers. As a result, OEMs have considerable room to maneuver and could divert from current production plans toward less ambitious trajectories and strategies (for example in an attempt to reduce costs). Consequently, there is a risk that carmakers do the strict minimum to comply with the regulation either by suppressing sales of BEVs or stopping all efforts to reduce combustion engines emissions (both trajectories and their impact are presented below).

Carmakers could comply in 2029 with the same BEV sales share as today

In the first scenario shown in Figure 37, carmakers would continue to improve their ICE and HEV emissions but would limit their BEV sales to the minimum. By keeping the same PHEV sales as the production-based forecast, the level of BEV sales was decreased to reach the targets without over-compliance. In this case, the market would settle for 11.1% BEV in 2025. This would be a 61% decrease in the BEV share compared to the initial market sales forecast. As ICE improvements could continue in the second part of the decade, carmakers would need even fewer BEVs to comply and the BEV share could decrease to 7.5%, an 86% decrease compared to the market sales forecast. This means that, in 2029, carmakers could sell the same amount of BEV as in the first half of 2021 in the EU27+NO. On average, if OEMs settle for the minimum BEV level required to meet the regulation target, the number of BEV sold over 2025-2029 would decrease by 75%. It means 18.4 million BEVs would be missing due to a low target over the 2025-2029 period. Finally, in 2030, the plug-in market share could still be 25% lower than the baseline forecast with a 47% BEV share. Overall, if carmakers do the minimum to comply, it could result in an additional pollution of 55 Mt CO_2 – more than the annual emissions of all the cars in Spain (52 Mt CO_2) – compared to a scenario based on industry trends[27].



Scenario 1: ICE and HEV emissions are assumed to decrease in the 2025-2029 period, PHEV sales are kept aligned with industry trends. The minimum BEV sales share is calculated so that the market average is compliant with the 2025 target (-15% emission reduction). Industry trends based on production forecast adjusted to 2021 sales.

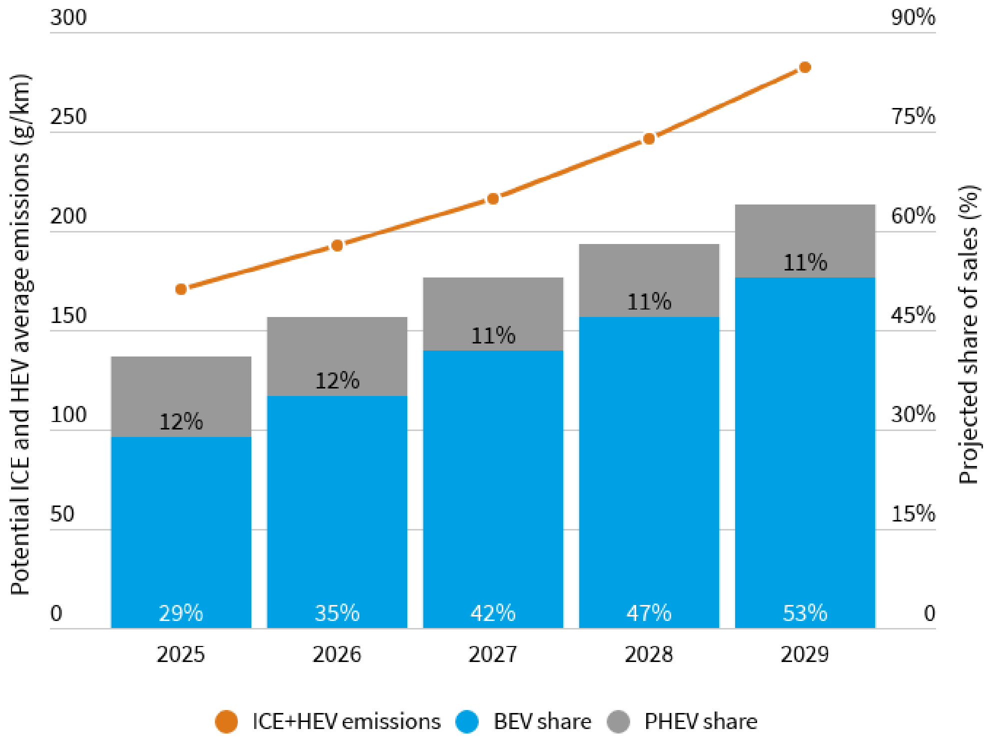
Source: T&E modelling of carmakers' compliance in the 2025-2029 period.

Figure 37 - Minimum BEV sales share needed to comply in the 2025-2029 period

[27] T&E's fleet-wide emission modelling (EUTRM) leads to a 432 Mt CO_2 under the fit for 55 proposal scenario while the plug-in sales derived from industry trends lead to 376 Mt CO_2.

ICE emissions could increase again

In the second scenario shown in Figure 38, emissions from ICEs (including HEVs) would increase by 24% in 2025 compared to 2021 and carmakers would still meet the 2025 target by selling the same amount of plug-ins as currently planned. Furthermore, as the target applies from 2025 to 2029 without any annual increase, the increase in ICE emissions would potentially reach 105% in 2029. Even though this value is only illustrative, it emphasises that carmakers have no interest whatsoever in trying to improve ICE emissions in the second part of the decade. On average over the 2025-2029 period, ICE and HEV emissions could be 61% higher than 2021. In 2030, carmakers could comply with the proposed 55% reduction target with ICE emissions 31% higher than in 2021.



Scenario 2: The plug-in sales share is calculated based on curent production trends adjusted to expected 2021 sales and OEM sales targets. Maximum ICE and HEV emissions increase under a compliance scenario.
Source: T&E modelling of carmakers' compliance in the 2025-2029 period.

Figure 38 - Potential ICE emissions increase under a minimum compliance scenario

6. Recommendations

Any slowdown in the progress towards emobility during the 2020s will put at risk Europe's ability to cut CO_2 emissions in line with a credible pathway toward carbon neutrality. Additionally, Europe could jeopardise an outstanding industrial opportunity: a fast and ambitious transition will allow Europe to secure the leading electromobility supply chain and future jobs. In order to achieve the transition toward zero emission vehicles and reap the full benefits of the promising battery electric industry, T&E suggests to enhance the regulation design with the following recommendations:

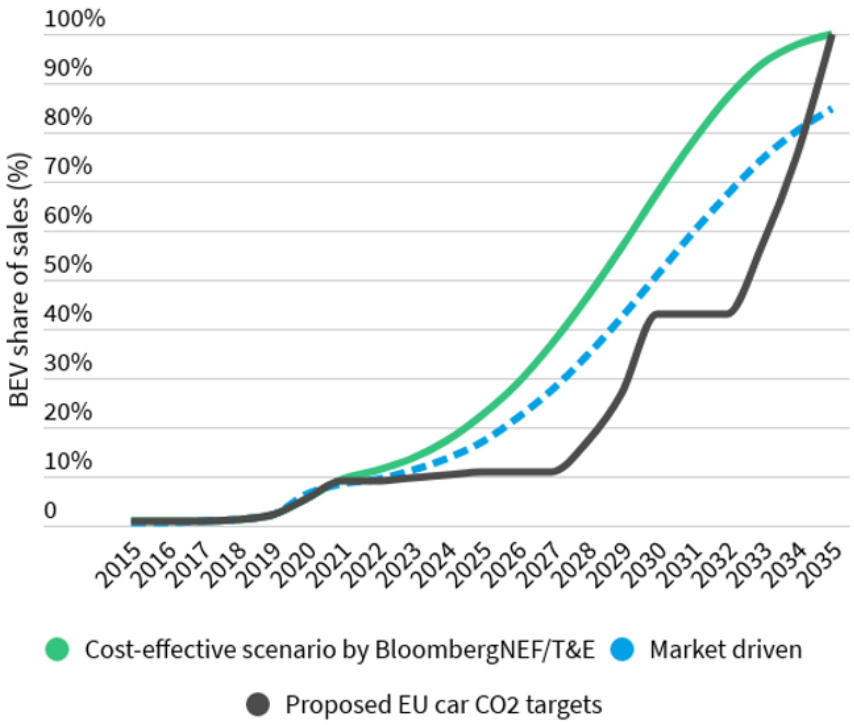
6.1 The EU must set out a Green Deal compatible trajectory to 100% zero emissions

Internal combustion engine vehicles need to be phased out by 2035

For the entire car fleet to be zero emission in 2050 - a requirement for the EU to meet its commitment to reach carbon neutrality - the last new car with any CO_2 emitting engine must be sold no later than 2035. This trajectory is supported by analysis commissioned by the European Commission [20], which shows that the average retirement age of cars in Europe is around 15 years (14 for diesel and 14.4 for petrol).

T&E commissioned a study [21] to BloombergNEF to assess the feasibility of the entire EU going to 100% electric car sales by 2035. The results show that with the right policy support (which T&E refers to as the Green Deal compliant scenario), conventional cars and vans can be phased out in all European countries between 2030 and 2035. To achieve this most optimally, sales of battery electric vehicles need to hit 22% in 2025, 37% in 2027 and 67% in 2030 as shown in Figure 39.

Early action and supply-side targets (set in the car CO_2 regulation) are essential to reach the required ZEV sales volumes to be able to phase out combustion cars by 2035. BNEF analysis highlights the importance of the early build up of ZEV sales volume, as that drives cost reductions and also generates the necessary consumer buy-in for further adoption in the future. The earlier the ZEV market enters the phase of accelerated ZEV sales, the easier it will be to reach the ICE phase-out and related climate goals. Under the Commission's proposed revised post-2021 CO_2 targets, the pace of CO_2 reductions is far too slow to reach zero emissions transport by 2050 and meet the goals of the European Green Deal.



Source: Bloomberg NEF (2021), *Hitting the EV Inflection Point* and T&E modelling of the EU CO2 standards for cars.

Figure 39 - Cost effective pathway compared to the trajectory proposed by the Commission

Some market segments (e.g. high-mileage fleets such as taxis), regions (e.g. EU capitals) and whole countries can and should go 100% zero emissions sooner, as an electric car is already the cheapest option from the total cost of ownership perspective and will reach production price parity with conventional cars in the mid-2020s. But the current EU internal market rules make it difficult for individual member states to restrict registration or circulation of new cars in their territory. Given the urgency of the climate action, individual countries or groups thereof should be allowed to set 100% zero emission sales mandates sooner than 2035, in order to achieve their national climate and air quality goals.

To be on track for zero emission in 2035, an -80% CO_2 reduction target is needed in 2030

T&E estimates that to be on the feasible path to 100% zero emission sales in 2035 based on the BNEF trajectory, sales of ZEVs will need to hit at least 67% in 2030, which corresponds to a CO_2 reduction target of -80%. The -55% emission reduction target proposed by the Commission for 2030 is way below even the purely market driven trajectory and would guarantee a ZEV share of just 43% (or 50% if carmakers stop producing and selling PHEVs). This would lead to suboptimal ZEV technology development and adoption as the EV market would likely be held back by carmakers looking to recoup investments from the ageing petrol and diesel technologies instead of investing in ZEV technologies. **To stay on track for zero emissions in 2035 therefore, T&E proposes that the -55% target should be increased to -80%**.

Higher targets in the 2020s required for an optimal ZEV supply

Raising the 2030 target alone, however, won't suffice as it will only spur investments towards the very end of the decade and from 2030 onwards. In other words, the long term goal of zero emissions mobility cannot be achieved without much more ambitious short and mid-term targets in the 2020s than the ones the EU has currently set itself. T&E has shown in section 5.2 that, based on the current market trajectory, the 2025 CO_2 target will be met on average by car makers even before 2023.

Moreover, low ambition in the 2020s would also delay investments in the supply of electric vehicles needed for the market to grow, and delay the point at which ZEVs cost the same to make as petrol vehicles. Slow ZEV market growth in the 2020s will also put at risk the current plans for battery gigafactories across Europe, as they might lack the market to sell their product into. Indeed, even with the new proposed 2030 target of -55%, when both the fully and partially financed projects are considered, the planned battery capacity is almost triple the minimum demand up to 2030 [22]. Following the cost optimal pathway, **Europe needs at least a 30% CO_2 reduction from new cars from 2025 and 45% from 2027**.

Polluting ICEs need to be banned as soon as 2030

Given the potential ramp-up of plug-in vehicles sales driving the decrease of emissions, carmakers are expected to make minor efforts to cut ICE emissions or could even take advantage of flexibilities to let these emissions increase (see section 5.2). In order to drive both increased ZEV sales and the continued improvement of ICEs (which will remain on our roads until 2050), stricter measures are required. T&E proposes to ban all new cars with emissions above 120g/km from 2030, as this is the point at which most (94%) non-plug-in SUV models start.

6.2 End the free lunch for carmakers and stop flexibilities weakening the regulation

Adjust the ZLEV benchmark to market potential...by removing it altogether

T&E sales forecast shows that the ZLEV benchmark applicable from 2025 is way below market trends (see section 5.1). Moreover, the ZLEV benchmark incentivises sub-optimal plug-in hybrid technology due to the 0.7 multiplier, which awards more ZLEV credits to each PHEV. This in particular benefits models with emissions close to 50 g/km (many of which are SUVs) as they now get a third of a credit instead of zero. Overall, this weakening almost doubles the number of credits earned by PHEVs. T&E recommends simply removing the ZLEV benchmark already from 2025 (5 years earlier than proposed by the Commission). The benchmark as it is already outdated and agreed when the market for plug-in vehicles was a fraction of what it is today.

PHEVs real-world emissions need to be accounted for

As shown by both ICCT [10] and T&E [11], the assumptions used for how much PHEVs are driven in electric mode are overly optimistic. The problem is that these assumptions - or utility factors (UF) - are used to establish the type approval CO_2 emissions of PHEVs alongside their tested values on the WLTP test procedure. In fact, the average share of the distance that PHEVs are driven in the electric mode is about half of that assumed for calculating official PHEV CO_2 figures and, as a result, their emissions are largely underestimated. In order to avoid another emissions scandal, real-world fuel consumption and CO_2 data (which is being collected as of 2021 in all new vehicles) from on-board fuel consumption meters should be used to set real-world utility factors to calculate the WLTP CO_2 emissions of PHEVs. This should be done via revision of the current WLTP regulation. This will incentivise all carmakers to improve their PHEV offering, as well as promote driver awareness programs to encourage regular charging.

Stop giving heavier cars a free CO_2 pass and remove the mass adjustment factor

Under the current regulation, carmakers that sell heavier premium cars (and the wealthier drivers who can afford to buy them) are allowed to emit more CO_2, via the mass-adjustment of OEM CO_2 targets. This loophole is not justifiable on climate, social justice, or technological grounds and is one of the principal reasons for the surging sales of heavy and highly-polluting SUVs across Europe. **T&E recommends to remove the mass-adjustment part from the specific emissions reference target formula** (effectively setting a_{2025} and a_{2030} at zero) thus requiring all carmakers to achieve the same CO_2 targets regardless of vehicle weight. Removing the target mass-adjustment mechanism has many benefits: it removes the structural weakening of the stringency of the regulation; ensures that all carmakers have the same target therefore pushing the larger and more polluting segments to electrify more rapidly, in line with their potential and heavier climate impact; it simplifies the regulation; and finally, it removes the incentive to sell more SUVs while incentivising carmakers to use lightweighting to reduce ICE emissions.

Limit the impact of eco-innovation credits on weakening the targets

Eco-innovations are becoming increasingly common and carmakers are expected to cumulate the benefits of fitting multiple technologies on their cars. Though driving technological innovations is an important part of the fight against climate change, rewarding carmakers who fit now common technologies on polluting vehicles is not helping to achieve a major cut in emissions. Furthermore, emissions savings on the road due to eco-innovations are not proven. Eco-innovation credits are mainly weakening the regulation instead of promoting significant emission reduction on the road. Therefore, **T&E suggests to decrease the maximum amount of CO_2 savings carmakers can claim from eco-innovations, in line with the proposed CO_2 reduction targets: 5 g/km in 2025, 4 g/km in 2027, and 2 g/km in 2030**. Moreover, the real-world CO_2 reduction contribution of eco-innovations should be verified using fuel consumption meter (FCM) data from 2025 onwards.

Benefits from pooling should be limited

Pooling - or allowing carmakers to join together to be able to meet the car CO_2 targets - allows laggard carmakers the opportunity to limit their efforts to develop EVs and instead form pools with frontrunners. In order to limit an excessive reliance on pooling strategies by certain carmakers and avoid a potential cliff edge scenario for OEMs who have failed to invest sufficiently in ZEV technology before the 100% ZEV target applies (in 2035 as proposed by the Commission), T&E proposes to limit the CO_2 benefits allowed under pooling.

7. Annexes

7.1. Manufacturer pools

For this report, the definition of pools according to the European Commission, "M1 pooling list", version of 22th of June applies [23] with open pool added from the declaration of intent (version of 28 October 2021 [24]). The main brands or pools considered in this report are:

- **BMW**: BMW, Mini, Rolls-Royce
- **Ford**
- **Daimler**: Mercedes-Benz, Smart
- **Hyundai**: Hyundai, Genesis
- **Kia**
- **Renault pool**: Renault, Dacia, Alpine, Lada, Nissan, Mitsubishi
- **Stellantis**: Alfa Romeo, Chrysler, Citroën, Dodge, DS, Fiat, Jeep, Lancia, Opel, Peugeot, RAM
- **Tesla pool**: Tesla, Jaguar, Land Rover, Honda
- **Toyota pool**: Toyota, Lexus, Mazda, Suzuki, Subaru
- **Volvo**: Volvo and Polestar
- **VW pool**: Audi, Bugatti, Cupra, eGo, LEVC, SAIC, MG Motors, Porsche, Seat, Skoda, Volkswagen, Aiways

7.2. Methodology

7.2.1. Filling the data gaps

The data provided by Dataforce includes several small gaps which T&E has addressed and solved to the best extent possible.

The data for Malta are missing but the country was only 0.3% of sales in 2020. In the case of Bulgaria, Hungary, Portugal and Romania (3% of the total EEA registrations), emissions data were missing, so emissions for each model-powertrain combination is calculated from the average of known emissions from other countries (for the specific model-powertrain combination). When the powertrain is unknown in the database, the average of the model emissions is used.

For 11.5% of the registrations provided by Dataforce, WLTP emissions are missing and only NEDC emissions are available. In those cases, for each model-powertrain combination, the ratio WLTP/NEDC is calculated from the data where both WLTP and NEDC emissions are available. This ratio is multiplied to NEDC emission values in order to calculate the estimated WLTP emissions for each model-powertrain combination. If the ratio is not known for a given model-powertrain combination, then the ratio by carmaker-powertrain is used and when that is not feasible the average ratio by carmaker is used.

These adjustments made to compensate for missing data lead to inherent uncertainties regarding the exact value of carmakers average WLTP emissions. In order to improve the accuracy of the statements, some carmakers proactively provided additional information regarding their emissions and vehicle mass in the first half of the year.

7.2.2. Emissions comparison under different scopes

This report uses different geographical scope and emissions measurements methods depending on the type of analysis and comparison required. The Table 3 below allows comparing the order of magnitude of average market emissions under different scopes.

Table 3 - Average emissions under different scopes

	EU+NO+UK		EU+NO	
Emissions (g/km)	**NEDC**	**WLTP**	**NEDC**	**WLTP**
2019	122.3	146.9	121.4	146.2
2020	107.8	130.5	107.3	129.8
H1 2021	99.9	120.4	99.0	119.3

7.2.3. Compliance model

Mass model

Masses are averaged by each combination of nameplate-powertrain from 2020 EEA registrations data and are matched in the H1 2021 database from Dataforce. When this first combination is unknown, masses are averaged either by the combination powertrain-OEM-segment, or powertrain-OEM, or powertrain depending on the data available.

Eco-innovations

From 2020 EEA registration data, the savings from eco-innovations approved under WLTP and measured with WLTP are isolated. For each carmaker, the average savings by category of eco-innovations (alternator, light or combination alternator-light) are calculated. It is assumed that all vehicles fitted with NEDC-approved eco-innovations from the applicable categories would be fitted with WLTP-approved in 2021. Therefore, the number of NEDC eco-innovations are used with average WLTP savings to calculate the expected average savings by carmakers in 2021.

2021 modelling

The following methodology was used in order to forecast OEMs sales at the end of year 2021.

- The starting point is the current H1 status described above for each carmaker. It is assumed that the BEV, PHEV and HEV sales in H1 are the minimum and the sales would not decrease below their H1 level in the full year. It means only the ICE share is expected to decrease in the second part of the year.

- For OEMs that are already compliant, a likely scenario was derived from production forecast [16] and new models coming to the market. This is meant to be a conservative scenario that does not reach the maximum sales potential of each OEM.
- For OEMs that are not compliant after the first half of the year, BEV, PHEV and HEV shares are increased in order to reduce the emission average down to the level of compliance.
- The average mass of each OEM over the full year 2021 is calculated by taking into account the new calculated powertrain shares for each powertrain (constant average mass for each powertrain and each carmaker). Eco-innovations savings are based on 2020 Alternator and Lights eco-innovation savings approved under WLTP.
- In a first step, powertrain shares are increased in line with the expected production. For each powertrain, the achievable share is set depending on 3 scenarios for each carmaker: its production forecast, its sales forecast based on an import/export adjustment[28] and a sales scenario adjusted based on production growth (assuming the sales growth rate is the same as the production growth rate). The maximum value of each scenario is used to limit the sales share of each powertrain. This method ensures that sales growth is balanced between powertrains.
- In a second step, for carmakers where the maximum forecast based on production scenarios are reached, the powertrain shares are adjusted upward based on the portfolio of new models. This second step assumes that carmakers could revise upward their production plans in case new models perform better than expected. Therefore, this two-step approach controls that any increase of a powertrain share can be justified by a component of carmakers' strategies.

7.2.4. Powertrain emission forecast

The following assumptions are used to calculate expected emission reduction by powertrain:

- Pure ICE emissions by body type (hatchback or SUV) are assumed to decrease by -1.5% each year between 2021 and 2025 and would stagnate from 2025. The growth of the SUV share is expected to follow the historical trend and would grow from 43% in 2021 to 63% in 2030. This leads the pure ICE emissions to decrease each year by -1.3% between 2021 and 2025 and to increase by 0.2% every year between 2025 and 2030.
- Full and mild hybrid powertrains are both assumed to see a -1.5% emissions reduction each year between 2021 and 2025 and -1% each year from 2026. The share of full hybrids among all HEVs (full and mild) is expected to grow from 31% in 2021 to 39% based on T&E sales forecast. This would lead HEV emissions to decrease by -1.6% each year between 2021 and 2025, then -1.3% each year.
- Overall, ICE sales share are expected to decrease from 63% in 2021 to 2% in 2030 and HEV sales share would increase from 21% in 2021 to 29% in 2030. This would lead the average ICE+HEV emissions to decrease by -2% each year between 2021 and 2025, then by -1.6%.

[28] The adjustment includes import/export flow on top of the production forecast. This adjustment is calculated between 2020 sales (EEA registration data [2]) and the European production.

- The increase of PHEVs' average utility factor due to the availability of larger batteries is assumed to reduce CO_2 emissions from 39 g/km in 2021 to around 30 g/km in 2030. T&E assumes that, from a 72% utility factor (WLTP) in 2021 obtained with a 13 kWh average battery, the utility factor would increase up to 79% in 2030 with a 19 kWh battery.

7.3. Overview of individual OEM compliance strategies

BMW
Over the first half of 2021, BMW would meet its CO_2 target with around 7 g/km overcompliance. Indeed, the carmaker benefits a lot from the mass adjustment with an average vehicle mass expected to reach 1,690 kg (BMW's PHEVs weigh 1,975 kg) and its savings would reach 12.1 g/km. It means that, without the mass adjustment flexibility, BMW would not comply yet. Regarding its plug-in sales, one out four cars registered by the German carmaker is a plug-in but its plug-in sales mix is largely dominated by PHEVs as 74% of its plug-ins are PHEVs. From early 2020, BMW offered a wide range of PHEV models and the X5 or the 3-series were among its largest sales increase in H1 2021. Both models are ranked in the top 15 best selling PHEVs models in H1 2021 with the 3-series ranked at the 7th position and the X5 at the 14th position. The carmaker relies less on BEV but still has three models available: the new iX3 available in H1 2021 and the i3 and Mini BEV. BMW also doubled its HEV share that reached 20% in the first half of the year and that contributed to the improvement of its ICEs.
In the full year, BMW is expected to increase its BEV share with the new SUV iX and the Gran Coupé i4 and would reach a 7.7% BEV share (26.8% EV) in the whole 2021. When BMW's expected emission level in 2021 with all flexibilities is compared with its 2019 status, PHEVs sales and the mass adjustment are the main components of its compliance strategy with 35% and 25% respectively.

Daimler
Daimler is already compliant with its target in the first half of the year and has a 3 g/km overcompliance. Nevertheless, it benefited from a 15,6 g/km weakening of its target thanks to the heavy mass of its vehicles (estimated at 1797 kg with PHEVs reaching 2034 kg) and would not comply without it. The carmaker achieved a good 52% increase of its plug-in share in H1 with a 62% increase of its BEV share that now reaches 10%. Its BEV sales increase is explained by the success of the Smart fully electric models (the Smart Fortwo is ranked at the tenth position of the best selling BEV in H1 2021) and its EQC and EQA nameplates. Nevertheless, Daimler still relies a lot on PHEVs that reached 22% of its sales, mainly thanks to the growing sales of heavy models such as the GLC (fourth position of the best selling PHEVs), GLE and GLA.
In the full year, Daimler plug-ins are projected to reach 34.1% of its sales with BEV share increased by the launch of the EQS and EQB. Overall, 72% of its compliance strategy since 2019 is achieved by plug-ins (46% by PHEVs and 27% by BEV) while 26% is achieved by the mass adjustment. Daimler does not rely on ICE improvements as its HEV share stagnated and its ICE emissions even increased by 2% in 2021.

Ford

Ford is close to its target in the first half of the year with a missing 0.9 g/km to be saved to reach compliance. The American OEM launched its first BEV model in 2021: the Mustang Mach-E, which already reached 2% of Ford sales in H1 2021. In addition to its BEV model, Ford also relied on PHEVs with the Kuga and Explorer model that reached 9.6% of its sales in H1 2021. The Ford Kuga reached the first position of the best selling PHEVs in the first half of the year. Ford also improved its ICE emissions with the use of mild hybrid technologies: for instance, the Puma mild hybrid version is sold 2.6 times more than the pure ICE version. Ford's hybridisation strategy has enabled a 12% decrease of its combustion engine vehicle emissions since 2019.

In the full year, Ford is expected to keep increasing its Mach-E sales that would need to reach at least 2.4% of its sales to reach compliance with the regulation. Since 2019, the largest part of Ford's compliance strategy is focused on ICE improvements that would amount to 42% of its compliance gap while plug-in ramp-up amounts to 39%.

Hyundai

Hyundai BEV sales declined in the first half of the year to 10.8%, 3.6 percentage points below their high level in 2020 (14.4%). Consequently, the Korean carmaker is not compliant in H1 2021 with a 3.3 g/km gap to its target. PHEVs now amount to 3.8% of its sales mainly with the Tucson SUV. Hyundai's ICE emissions improvements are due to its increase in mild and full hybrids that are now 38.2% of its sales. This strategy has enabled a 12% decrease in ICE and HEV emissions since 2019.

In order to reach compliance in 2021, Hyundai is expected to rely mainly on the sales of the new Ioniq 5. BEV share would need to recover and increase to 13.0% in the full year. The main component of Hyundai's compliance strategy (48%) is ICE improvement while its increased plug-in sales is responsible for 45% of its emission reductions.

Kia

Kia is relatively close to its CO_2 target in the first half of 2021 and will need to decrease its average emissions by 1.6 g/km to reach compliance. Kia's BEV share was stable compared to 2020 at 9.1% with still good performances of the e-Niro model (9th best selling BEV in H1 2021). Its PHEV sales rose to 11.5% with different models such as the Ceed, X-Ceed and Sorento.

In the full year, the main driver of Kia emission reductions would be the sales of the new EV6 model. Kia would need to sell 9.9% BEV in the whole year to meet its CO_2 target. The main part (70%) of Kia's compliance gap since 2019 is filled thanks to its plug-in sales (39% due to BEVs and 31% due to PHEVs) and 26% are also due to its ICE hybridisation strategy.

Renault-Nissan-Mitsubishi

The Renault pool has a 3.4 g/km gap to its target in the first half of the year (2.8 g/km for the Renault Group if it was alone). The sales of its flagship Zoe model slowed down but it is still the second best selling BEV model and the pool sold 8.1% BEV in H1. The Captur (5th best selling PHEV model) and Megane PHEV versions drove the pool PHEV share upward to 4.4%. The pool suffers from the mass adjustment flexibility that gives the pool a 1.6 g/km malus in H1 2021. In terms of ICE improvement, the

pool achieved a -10% emission reduction from 2019 partly due to the launch of new full hybrids such as Renault's E-Tech powertrains.
To reach compliance in 2021, the pool is expected to increase its BEV share up to 10.5%. The Dacia Spring is the main lever that would enable this increase as deliveries to physical customers started in September (first deliveries in H1 2021 were dedicated to company fleets). But the pool is also expected to benefit from a significant improvement of the Nissan Leaf sales in the second half of the year. Regarding Mitsubishi, the Eclipse Cross PHEV is expected to be the core of its sales in 2021. As for the pool compliance strategy since 2019, 49% of its compliance gap was achieved thanks to its plug-in sales growth (36% thanks to BEVs) and 46% with ICE improvements.

Stellantis
Stellantis is expected to have a 2.1 g/km overcompliance in the first half of 2021. Since 2020, the carmaker has increased both its BEV and PHEV share with the success of several models: the Peugeot 208 and Fiat 500 are ranked 5th and 7th in the best selling BEV models while the 3008 is the best selling PHEV model. Stellantis has a 5.5% BEV share and a 4.9% PHEV share in H1 2021. The carmaker will benefit from its 2.2 g/km remaining super-credits that would also ease its compliance efforts. Since 2019, Stellantis has achieved a -10% reduction of its ICE emissions with Fiat mild hybrid powertrains and improvement of PSA combustion engines.
Stellantis is expected to end the year with a 6.3% BEV share (11.3% EV). Plug-in sales are 46% of Stellantis compliance strategy (30% for BEVs) while ICE improvement is also a large part of Stellantis compliance strategy with 43% of its compliance gap since 2019.

Tesla-JLR-Honda
As Tesla accounts for 46% of the pool share, the Tesla pool already met its CO_2 target in H1 2021 with a very large overcompliance of 53 g/km. This is due to both the low 83 g/km emission average allowed by the 49% share of BEV but also by a large mass adjustment of 21 g/km.
At the end of the year, the pool is expected to reach 50.9% BEV and 7.0% PHEV. The difference between the pool emissions with all flexibilities in 2021 and its 2019 emissions is mainly due to the increase of Tesla sales that increase its share in the pool. The compliance strategy would be split with 40% due to BEV and 37% due to the mass adjustment.

Toyota-Mazda-Suzuki-Subaru
The Toyota pool has a 1 g/km gap to its target in the first half of 2021. The pool has a large share of hybrids (72% of its sales) but it did not increase significantly its plug-in share that remains as low as 3.1%. Despite some BEV sales due to the Lexus UX and Mazda MX-30, the pool will need to wait until 2022 to have a higher BEV offer with the bZ4X, the first major model of the Toyota brand. Despite this new model coming, Toyota is expected to keep sales of plug-ins at a low level in the next few years as it considers it is too early to focus on electric cars [25]. Toyota faces the risk of being late compared to its competitors by delaying its plug-in ramp-up, and because of its continuous investments in combustion engines that are slowing down any possible transition to electric cars.
In the full year 2021, the pool is expected to slightly increase its plug-in share to 3.6% with 1.4% BEV. The pool can rely on PHEV models such as the Toyota RAV4 but also on Lexus and Mazda BEV models (Lexus

UX, Mazda MX-30). Toyota pool compliance strategy is mainly based on its hybridization (54% of its emission improvements) while plug-in sales amount to only 29% of its improvements.

Volkswagen pool

After failing to comply in 2020 by a thin margin, Volkswagen is not yet compliant in the first half of 2021 with a 2.7 g/km gap to its target. Both VW's BEVs and PHEVs share increased in the first half of the year with 8.1% BEVs and 8.3% PHEVs. The BEV increase is driven by new models such as the VW ID.4 (4th best selling BEV model) or the Skoda Enyaq, and by existing models such as the ID.3 (third best selling BEV model). The PHEV increase is driven by existing nameplates such as the VW Golf or the Audi A3. The pool also benefits from a large mass adjustment of 5.4 g/km.

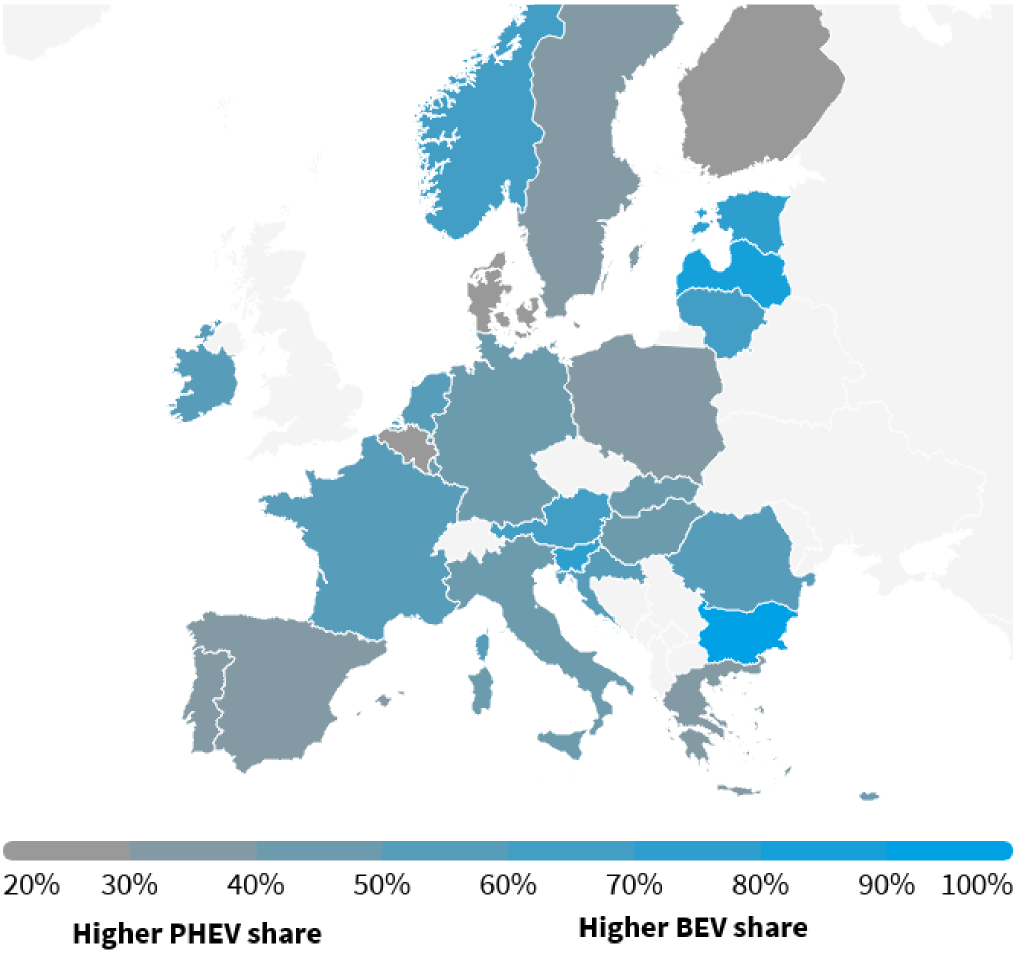
In the full year, the VW pool is expected to comply mainly with an increase of its BEV share to 9.6% thanks to two models (Audi Q4 e-tron and the Cupra Born) and a growth of its existing models (for instance the ID.3 and 4). 61% of VW's compliance gap since 2019 is filled by its plug-in sales with 35% thanks to BEVs. 20% are resulting from ICE improvements and 16% by the mass adjustment flexibility.

Volvo-Polestar

Volvo is the carmaker with the second largest over-compliance (25 g/km) in the first half of the year thanks to its large plug-in share (45% with 8.3% BEV and 36.8% PHEV). But it also benefits from the largest mass adjustment (21 g/km) due to the large mass of its cars (1,931 kg on average). Specifically, its PHEVs models weigh around 2,030kg on average and their high share enables this high mass adjustment saving. Volvo has two cars in the top selling PHEV models: the XC40 is ranked second while the XC60 is 8th. The Volvo pool BEV models include the XC40 and the Polestar 2.

Given sales trends of Volvo and Polestar models, Volvo is expected to reach a 11.6% BEV in the full year 2021. Volvo compliance strategy since 2019 is based predominantly on PHEVs that filled 42% of its compliance gap while the mass adjustment amounts to 30% and BEV sales to 26%.

7.4. BEV-PHEV distribution across Europe



Scale: Ratio BEV over total plug-ins vehicles (BEV+PHEV).

Source: T&E analysis of passenger car registration data from the first half of 2021 from Dataforce

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Figure 40 - BEV-PHEV distribution across Europe

Endnotes

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