

## Europe's CO<sub>2</sub> emission performance standards for new passenger cars: Lessons from 2020 and future prospects

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**Keywords:** CO<sub>2</sub> regulation for passenger cars, European passenger car market, European electric passenger car market

### Introduction

The European Union's (EU) carbon dioxide (CO<sub>2</sub>) emission standards set mandatory targets for fleet-wide average type approval CO<sub>2</sub> emissions of new passenger cars registered in the European Economic Area (EEA). In addition to the 27 Member States of the EU itself, the standards may also apply to new cars in Norway, Iceland, and Liechtenstein. Until 2020, the United Kingdom (UK) also fell under this regulation. The current standard is 95 g CO<sub>2</sub>/km, phased in for 95% of vehicles in 2020 and for 100% of vehicles in 2021, according to the former New European Driving Cycle (NEDC).<sup>1</sup> On July 14, 2021, the European Commission proposed more ambitious targets from 2030 as part of the European Green Deal. Compared to the 2021 baseline, average CO<sub>2</sub> emissions from new passenger cars registered in 2025 and 2030 would have to decrease by 15% (no change) and 55% (formerly 37.5%), respectively. The proposal also suggests that new cars will be required to have zero emissions by 2035 in a de facto phase-out of the internal combustion engine.<sup>2</sup> The future targets set for 2025 and 2030 will be translated into the Worldwide Harmonized Light Vehicles Test Procedure (WLTP) terms based on the average ratio of the WLTP and NEDC CO<sub>2</sub> emission values in 2021.<sup>3</sup>

In light of the recent proposal, we aim through this paper to analyze the development of the European passenger car market. Specifically, we review the uptake of battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), as well as effects on type approval CO<sub>2</sub> emission fleet levels over the past two decades.

1 European Parliament and Council, "Regulation (EU) 2019/631 of the European Parliament and Council of 17 April 2019 setting CO<sub>2</sub> emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011" (April 17, 2019), <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32019R0631&from=EN>.

2 European Commission, "Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) 2019/631 as regards strengthening the CO<sub>2</sub> emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition" (July 14, 2021), [https://ec.europa.eu/info/sites/default/files/amendment-regulation-co2-emission-standards-cars-vans-with-annexes\\_en.pdf](https://ec.europa.eu/info/sites/default/files/amendment-regulation-co2-emission-standards-cars-vans-with-annexes_en.pdf).

3 The EU started transitioning from the NEDC to the WLTP for new vehicle emissions certification in September 2017. The percentage reduction targets in the CO<sub>2</sub> regulation are fixed, while the absolute CO<sub>2</sub> emission level to be met in 2025 and 2030 depends on the fleet average WLTP starting point of all manufacturers in 2021. This starting point, in turn, depends on the NEDC-WLTP adjustment factor, which is determined for the 2020 new vehicle fleet for each manufacturer individually.

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The analysis highlights developments in selected countries and of selected car manufacturers, taking into consideration the EEA-wide CO<sub>2</sub> emission targets for new passenger cars as well as national policies. We assess the effects of the economic crisis caused by the COVID-19 pandemic, as well as respective recovery packages, on the passenger car and electric vehicle market. Finally, we compare developments in China and the United States, which lead global car markets by sales.

## Analysis of the European passenger car market

Figure 1 provides an overview of the analysis steps we apply. The analysis includes an assessment of new passenger car registrations and of new electric passenger car registrations specifically, as well as the effects on CO<sub>2</sub> emission levels of the new passenger car fleet up to December 2020. We derive the data from the annually updated European Vehicle Market Statistics Pocketbook<sup>4</sup> and monthly Market Monitors<sup>5</sup> on European passenger car registrations unless stated otherwise.

The geographic scope of the analysis varies depending on data availability. Generally, the analysis covers all countries of the EEA (27 Member States of the European Union plus Iceland, Liechtenstein, Norway) and the UK. For each section, we specify the geographic scope.

The evaluation of manufacturer performance is based on manufacturer pool. We use the definition of pool from the European Commission, “M1 pooling list” from October 30, 2020. This list includes the following manufacturer pools and vehicle brands: BMW (BMW, Mini), Daimler (Mercedes-Benz, Smart), FCA-Tesla-Honda (Alfa Romeo, Fiat, Honda, Jeep, Lancia, Tesla), Ford-Volvo (Ford, Volvo), Hyundai (Hyundai), JLR (Jaguar, Land Rover), Kia (Kia), Mitsubishi (Mitsubishi), PSA-Opel (Citroën, DS Automobiles, Opel, Peugeot, Vauxhall), Renault (Dacia, Renault), Suzuki (Suzuki), Toyota-Mazda (Lexus, Mazda, Toyota), and Volkswagen Group (Audi, Porsche, SEAT, Škoda, Volkswagen). In addition, one manufacturer not forming a pool (Nissan) is included in our analysis.

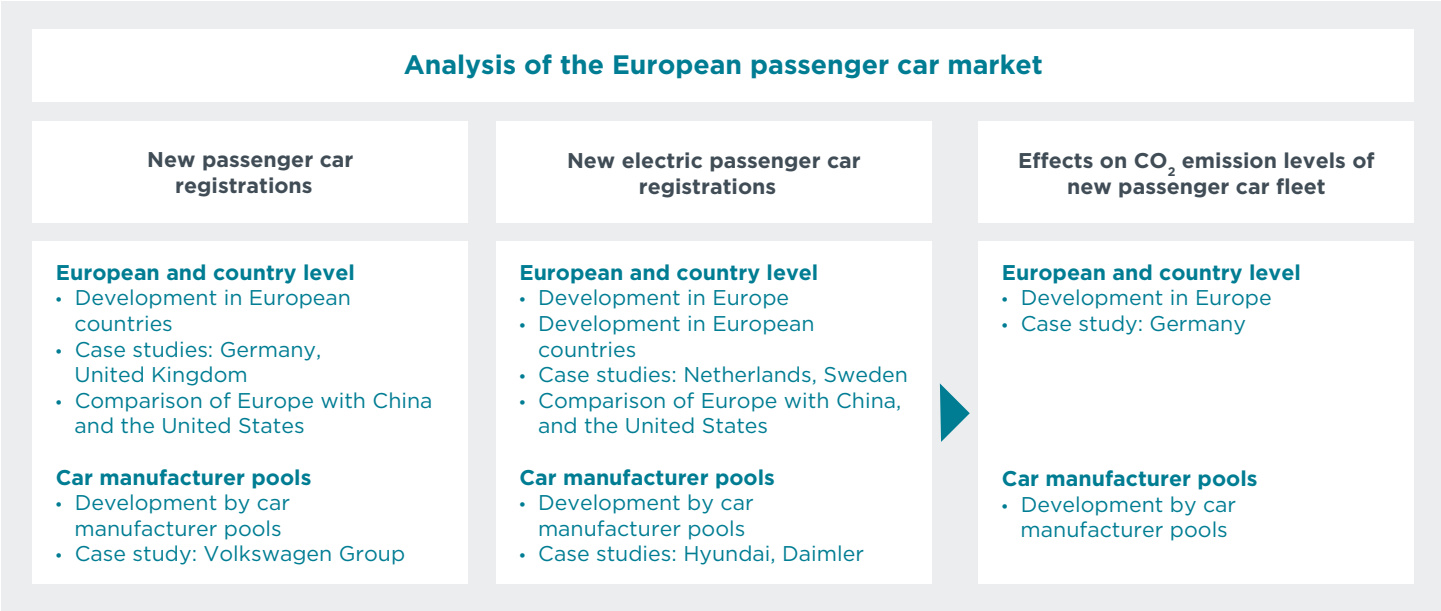


Figure 1. Overview of the analysis of the European passenger car market.

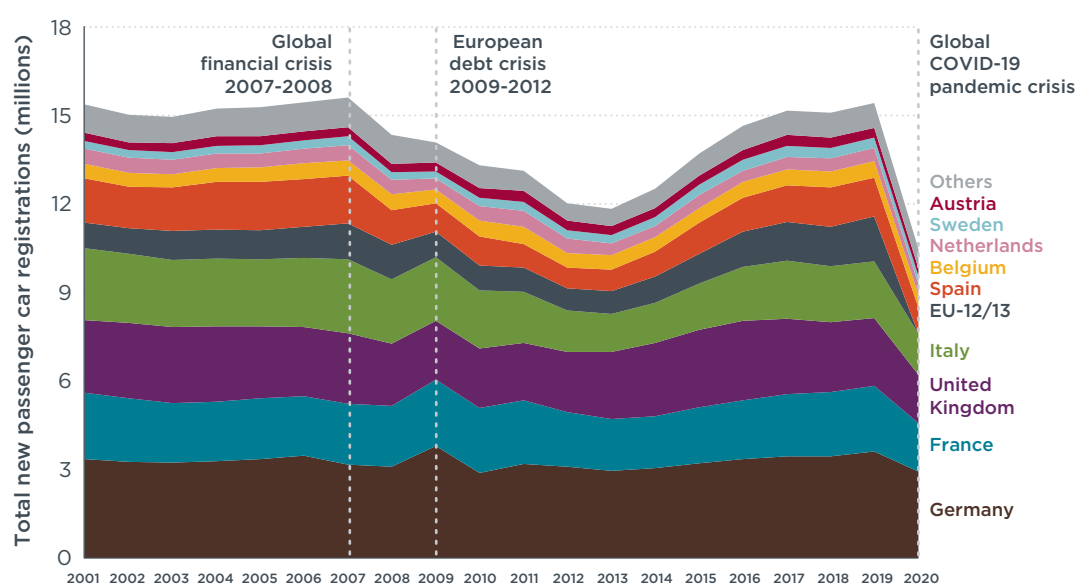
4 The International Council on Clean Transportation, “Topics / EU vehicle market statistical pocketbook” (2021), <https://theicct.org/series/eu-vehicle-market-statistical-pocketbook>.

5 The International Council on Clean Transportation, “Topics / Market monitors” (2021), <https://theicct.org/series/market-monitors>.

## New passenger car registrations

In 2020, 11.6 million new passenger cars were registered in the 27 Member States of the EU and the UK, 25% fewer than were registered in 2019. The sharp drop in 2020 registrations is attributable to the global COVID-19 outbreak in early 2020.

During the 2020 pandemic, new passenger car registrations collapsed more than they had during the global financial crisis between 2007 and 2008 and the European debt crisis between 2009 and 2012 (Figure 2). Starting in 2007, new passenger car registrations fell gradually from 15.6 million by the end of 2007 to 11.8 million in 2013. In 2014, the new passenger car market began recovering gradually, peaking in 2019 to pre-financial-crises registration figures (15.4 million). In addition, the 2020 total of new passenger car registrations of 11.6 million surpassed the previous low point of 11.8 million in 2013.



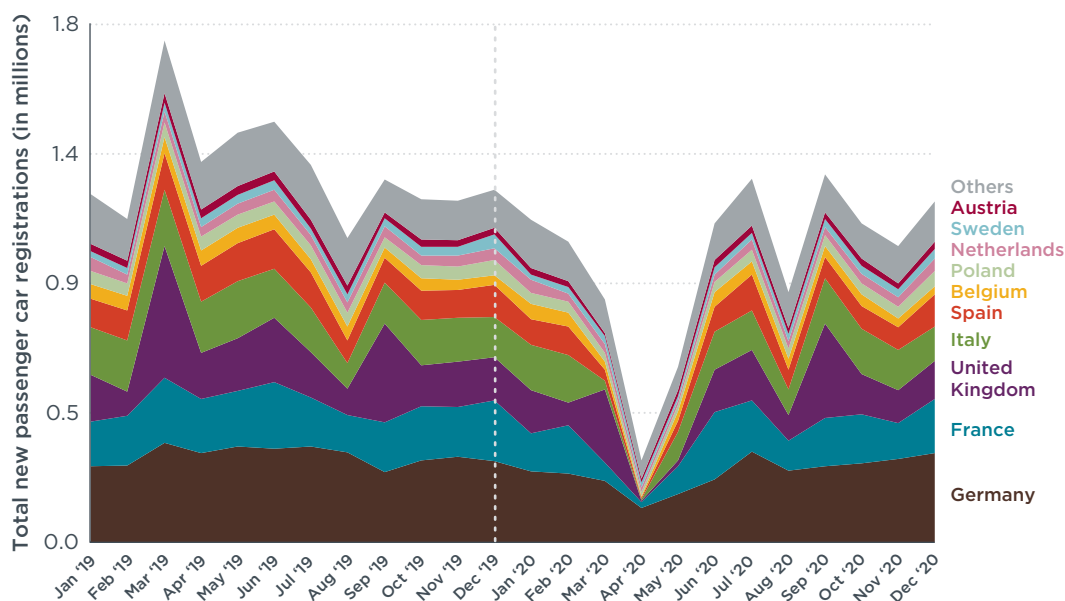
**Figure 2.** New passenger car registrations in the 27 European Member States and the UK from 2001 to 2020. “EU-12/13” includes countries which have joined the European Union between 2004 and 2014, i.e., Bulgaria, Croatia, Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia. “Others” encompasses Denmark, Finland, Greece, Ireland, Luxembourg, and Portugal. The figure excludes Malta for the year 2020 due to lack of data.

### Developments at the country level

Looking at monthly new passenger car registration figures, we find that the effects of the COVID-19 pandemic on registrations were most pronounced in April 2020, after the World Health Organization had declared Europe an active center of the COVID-19 pandemic in mid-March 2020. Figure 3 illustrates monthly new passenger car registrations for the countries of the EEA (excluding the small markets of Bulgaria, Liechtenstein, and Malta due to lack of data) and the UK in 2019 and 2020, displaying the top 10 countries which recorded the highest total new passenger car registrations in 2020; the remaining 18 countries are collated under “Others.”

Germany, France, the UK, Italy, and Spain dominated new passenger car registrations in 2020, accounting for 73% of the total. By month, new passenger car registrations across the countries of the EEA and the UK peaked in March 2019 with over 1.7 million total new registrations. That month, the UK accounted for more than a quarter of registrations, while Germany accounted for 20%. April 2020 marked the low point of monthly new passenger car registrations between 2019 and 2020. Just 285,000 new passenger cars were registered that month—78% fewer than one year earlier in April 2019 and 66% fewer compared to March 2020. At this low point in April 2020, 42% of new passenger

car registrations were captured in Germany and 58% in the remaining 27 markets. All markets recovered quickly in the following months; new passenger car registrations across all EEA markets and the UK increased by 114% between April and May 2020, and by 81% between May and June 2020. The decrease in August in both 2019 and 2020 reflects typically lower registrations numbers during summer months.



**Figure 3.** Total new passenger car registrations in the countries of the European Economic Area and the UK. Excludes the small markets of Bulgaria, Liechtenstein, and Malta due to lack of data.

By individual countries, the UK experienced the highest relative decrease in new passenger car registrations between March and April 2020 of 98%, with registrations falling from almost 255,000 in March to just over 4,300 in April. The relative decrease over the same period was also high in Ireland (-94%), Spain (-88%), and Italy (-84%). Austria was the only country where new passenger car registrations increased between March and April 2020 (+6%), but this boost followed a drop in new passenger car registrations of 49% between February and March of the same year. Almost all markets partially recovered between April and May 2020 with increasing new passenger car registrations and relative growth rates. The greatest recovery occurred in Spain, which experienced a 701% growth from almost 4,600 registrations in April to 37,000 in May 2020. An exception was Finland, which took another month to regain growth rates (+57% between May and June 2020).

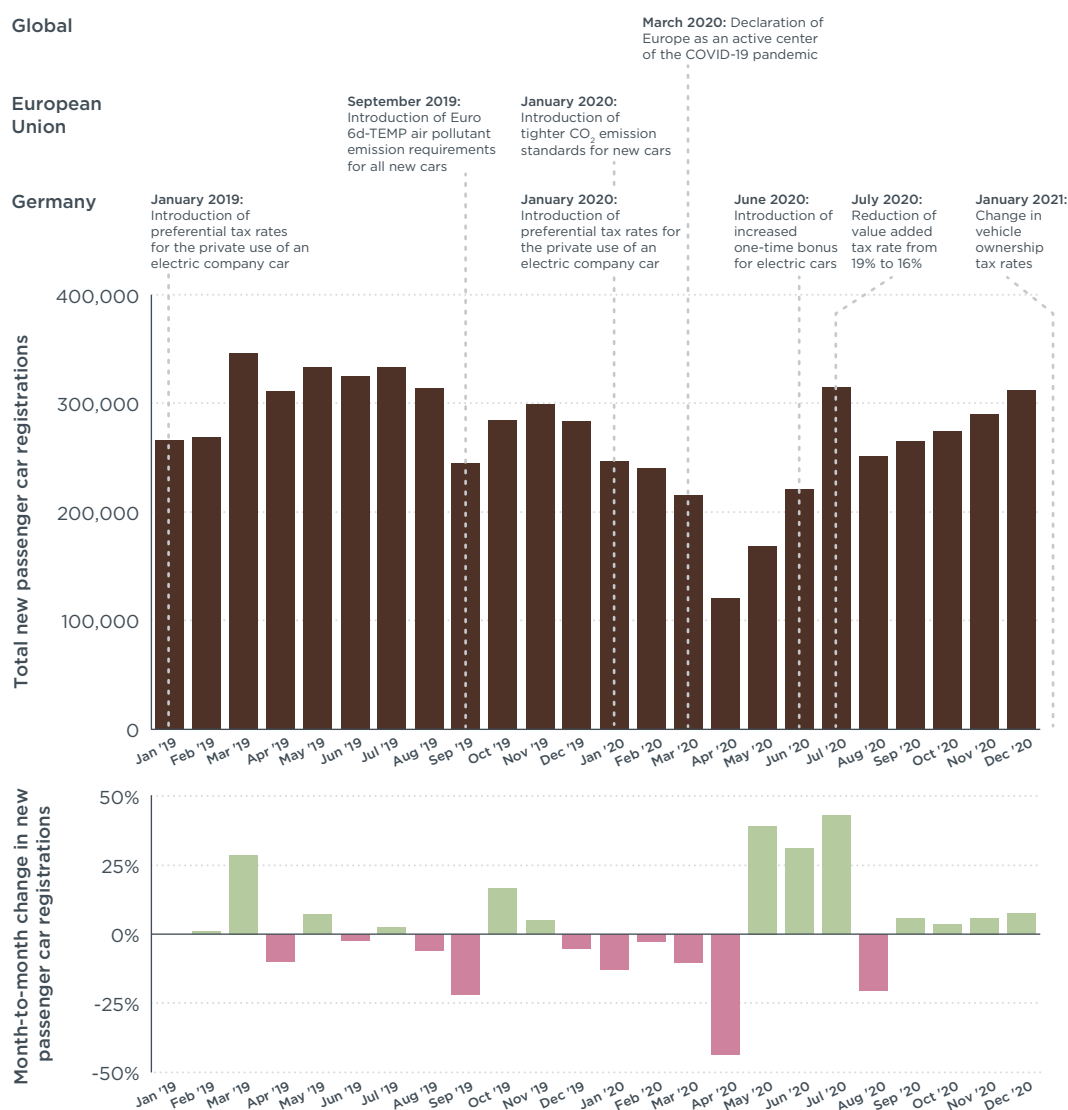
In Germany, the largest European passenger car market by registrations, total monthly registration figures in 2019 and 2020 ranged from almost 121,000 in April 2020 to about 346,000 in March 2019 (Figure 4). Its most pronounced decline was from March to April 2020, when total new passenger car registrations decreased by 44% compared to the previous month. Declines also occurred in September 2019 (-22%) and August 2020 (-20%). Conversely, monthly growth rates were the highest in May, June, and July 2020, with relative increases of 39%, 31%, and 43%, respectively.

## Germany

Global

European Union

Germany



**Figure 4.** Total monthly new passenger car registrations in Germany in 2019 and 2020 with selected policy measures (top) and month-to-month change (bottom).

Policy changes at the EU and national levels and pandemic emergency measures triggered by the COVID-19 outbreak can partially explain Germany's monthly changes in total and relative new passenger car registrations in 2019 and 2020. In September 2019, tighter air pollutant emission requirements came into effect in the EU and the Euro 6d-TEMP emission standard began applying to all newly registered cars.<sup>6</sup> Prior to the introduction of Euro 6d-TEMP and the WLTP,<sup>7</sup> new passenger car registrations in August 2019 (almost 314,000) were unusually high, indicating that a large number of vehicles were registered before the tightened requirements came into effect.<sup>8</sup> New car registrations then fell by 22% from August to September 2019. From January 2020 onwards, vehicle manufacturers had to comply with an average CO<sub>2</sub> emission level of 95 g/km in NEDC applied to 95% of their new car registrations in that year, which may explain the 13% drop in new passenger car registrations that occurred in January 2020.

<sup>6</sup> Prior to September 2019, the Euro 6d-TEMP emission standard only applied to the type approval of new models.

<sup>7</sup> WLTP applied to all new cars from September 2018 onwards, though some exceptions existed until September 2019.

<sup>8</sup> By comparison, August registrations for the years 2015–2017 were between 226,000 and 254,000. WLTP entering into force for new vehicle types impacted registrations in August 2018.

At the national level, the introduction of preferential tax rates for employees privately using an electric company car in January 2019 showed little effect on the overall passenger car market. Meanwhile, the recovery package introduced by the German government in June 2020 in response to the COVID-19 outbreak likely resulted in a strong uptake of vehicle sales: Right after the stimulus program came into effect, new passenger car registrations increased by 43% in July 2020 compared to the previous month. The recovery package aimed to stimulate new electric vehicle sales by doubling the one-time governmental bonus (from €3,000 to €6,000 for BEVs and from to €2,250 to €4,500 for PHEVs).<sup>9</sup> Yet the recovery package can only partially explain the increase: New BEV and PHEV registrations increased by only 2 percentage points, from 9% in June to 11% in July. The recovery package also temporarily reduced the value added tax rate from 19% to 16% until the end of 2020 starting in July 2020,<sup>10</sup> which might have stimulated overall vehicle purchases due to reduced acquisition costs independent of the technology. In addition, prior to the release of the recovery package, the German government discussed various scrappage bonus proposals for vehicles with an internal combustion engine but ultimately opted instead for a larger one-time bonus for electric vehicles. This might also have delayed vehicle purchases and consequently negatively impacted total new passenger car registrations in May and June 2020, which were higher compared to April 2020 but significantly lower compared to the previous year. In May 2019, new passenger cars registrations almost doubled from May 2020 (333,000 versus 168,000). Similarly, new registrations in June 2020 of 220,000 marked a significant drop from the registrations in June 2019 of 325,000,

In the UK, which in 2020 was Europe's third-largest passenger car market by new registrations, monthly registration patterns in 2019 and 2020 were characterized by extreme peaks (Figure 5). Total registration numbers ranged from just over 4,300 in April 2020 to 458,000 in March 2019 and were particularly high in March and September each year. Relative changes to the previous month ranged from -98% in April 2020 and +618% in June 2020. Month-to-month growth rates were also high in March 2019 (+459%), May 2020 (+369%), September 2020 (+276%), September 2019 (+271%), and March 2020 (+220%).

9 Federal Ministry for Economy and Energy, "Questions and answers about the increased purchase premium for electric vehicles" (2021), <https://www.bmw.de/Redaktion/DE/FAQ/Elektromobilitaet/faq-elektromobilitaet.html>.

10 Federal Ministry for Economy and Energy, "Unbureaucratic implementation of the VAT reduction for price information possible through flat-rate discounts introduction" (June 12, 2020), <https://www.bmw.de/Redaktion/DE/Pressemitteilungen/2020/20200612-unbuerokratische-umsetzung-der-mehrwertsteuersenkung-bei-preisangaben-durch-pauschale-rabatte-moeglich.html>.

## United Kingdom

Global

European Union

United Kingdom



**Figure 5.** Total monthly new passenger car registrations in the UK in 2019 and 2020 with selected policy measures (top) and month-to-month change (bottom).

National policy measures primarily help to explain why new registrations of passenger cars in the UK significantly increased in March and September in 2019 and 2020. The UK releases new number plates twice per year at the beginning of March and September. The number plates include an age identifier to assess the quality of a car and its insurance costs. The regular change in number plates typically results in higher registration numbers compared to the immediate months prior, February and August. This also because purchasers of new cars are often opting for the very latest models. Furthermore, annual March peaks can also be explained by yearly vehicle tax changes in the month of April: zero-emission BEVs and fuel cell electric vehicles (FCEVs) receive favorable rates or exemptions, while others pay higher taxes, which depend on a vehicle's fuel type and CO<sub>2</sub> emission levels. Tax changes usually affect excise duty on new car registration, regularly payable ownership tax, and the taxable rate for the private use of a company car. These changes may have pushed consumers to opt for a new car in March 2019 and 2020 before higher taxes came into effect for vehicles that are non-zero-emission.

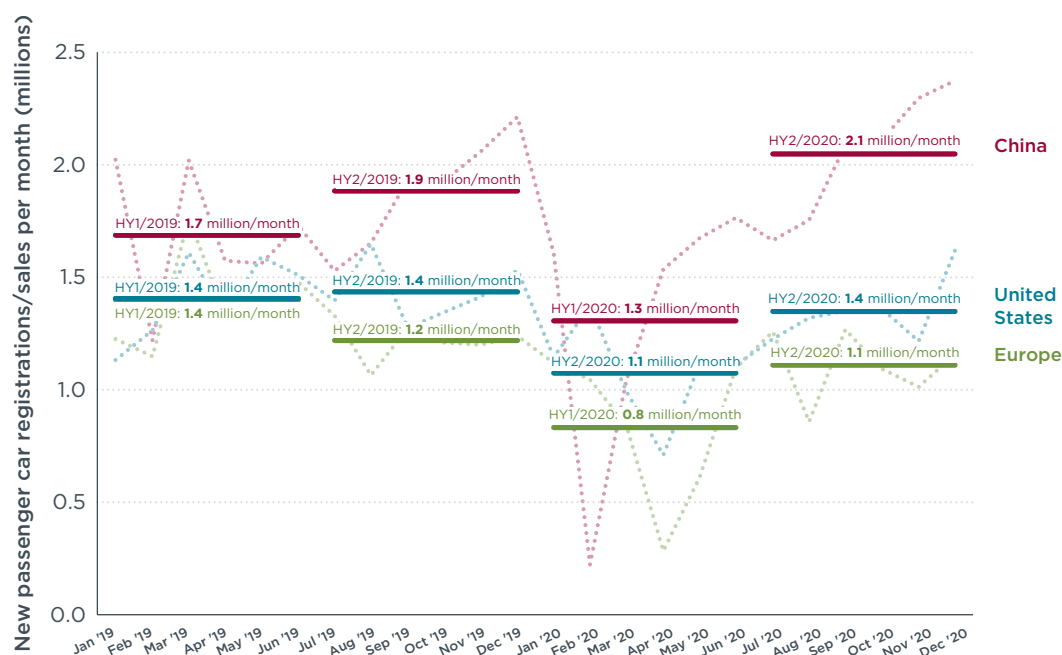
### Comparison with China and the United States

The development of the European passenger car market—the third largest worldwide—illustrates how the first wave of the COVID-19 outbreak has temporarily slowed the



market, which started to recover in the aftermath despite the ongoing pandemic. China and the United States, the largest and second-largest global automotive markets, have had similar experiences. Figure 6 illustrates monthly and half-year new passenger car registrations or sales for all three markets—Europe (i.e., the EEA), China, and the United States—in 2019 and 2020.<sup>11</sup> In China, where COVID-19 first broke out in late 2019 and early 2020, passenger car sales dropped significantly (86%, from 1.6 million to 224,000) between January and February 2020. In Europe and the United States, where the COVID-19 outbreak arrived a few weeks later, monthly passenger car registrations or sales reached their low point in April 2020. In Europe, new passenger registrations dropped from 842,000 in March to 285,000 in April 2020 (-66%), and in the United States from 993,000 to 711,000 (-28%) in the same timeframe. New passenger car registrations and sales increased in the following months. In China, new car sales increased by 366% between February and March 2020. In Europe and the United States, new passenger car registrations/sales increased by 114% and 56%, respectively, in May 2020, following the low point in April 2020.

Consequently, average half-year registrations/sales dropped in the first half of 2020 compared to the second half of 2019 and rose again in the second half of 2020 as all markets recovered, yet at a different pace. In China, new passenger car sales increased from an average 1.3 million per month in the first half 2020 to 2.1 million per month in the second half 2020 (+57%). In the United States and Europe, the increase was less pronounced. In the United States during the second half of 2020, an average of 1.4 million new passenger cars per month were sold, an increase of 26% compared to an average monthly 1.1 million sales in the first half of 2020. In Europe, new passenger car registrations increased by 33% from an average 0.8 million per month in the first half of 2020 to 1.1 million per month in the second half of 2020.



**Figure 6.** Monthly and half-year new passenger car registrations/sales for Europe (countries of the European Economic Area plus United Kingdom), China, and the United States in 2019 and 2020. Note: HY = half-year; data for the United States includes light trucks, data for China and Europe only passenger cars. (Sources: Dataforce, AAA Data, Society of Motor Manufacturers and Traders (SMMT), European Automobile Manufacturers' Association (ACEA), MarkLines).

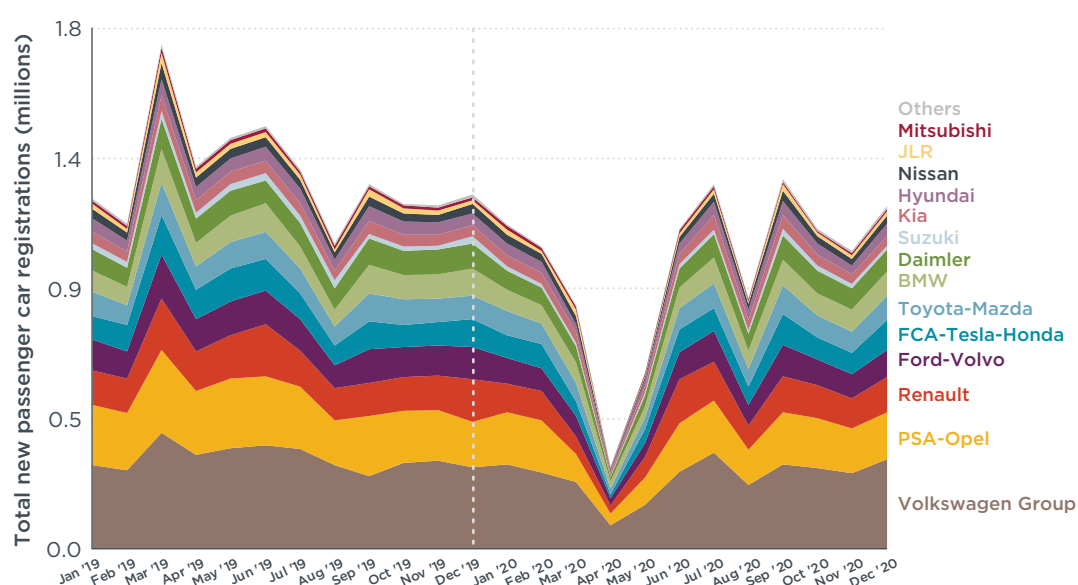
<sup>11</sup> Peter Mock, Zifei Yang, and Uwe Tietge, "The impact of COVID-19 on new car markets in China, Europe, and the United States: V, U, W, or L?" (2020), <https://theicct.org/blog/staff/impact-covid-19-new-car-markets-china-europe-and-united-states-v-u-w-or-l>.



### Development by car manufacturer pool

Total registration figures of new passenger cars by car manufacturer pool across the 27 EU Member States and the UK reflect the general trends identified above (Figure 7). The Volkswagen Group recorded the highest number of new passenger car registrations in 2020, accounting for almost 3 million. PSA-Opel and Renault accounted for 1.7 million and 1.2 million registrations, respectively. These three manufacturer pools together with Ford-Volvo and FCA-Tesla-Honda, made up 64% of new passenger car registrations in Europe in 2020.

Total monthly new passenger car registrations dropped most significantly (66%) in April 2020 for all manufacturer pools, to a total of 285,000. This relative decrease was most pronounced for Jaguar Land Rover (JLR) (from 22,400 in March 2020 to 3,300 in April 2020) and Nissan (from 28,400 in March 2020 to 4,100 in April 2020), in each case reflecting a drop of 85%. Despite a decline in total new passenger car registrations from 61,800 to 28,200 between March and April 2020, Renault was least affected in relative terms (-54%).



**Figure 7.** Monthly new passenger car registrations by car manufacturer pool in the 27 EU Member States and the UK in 2019 and 2020.

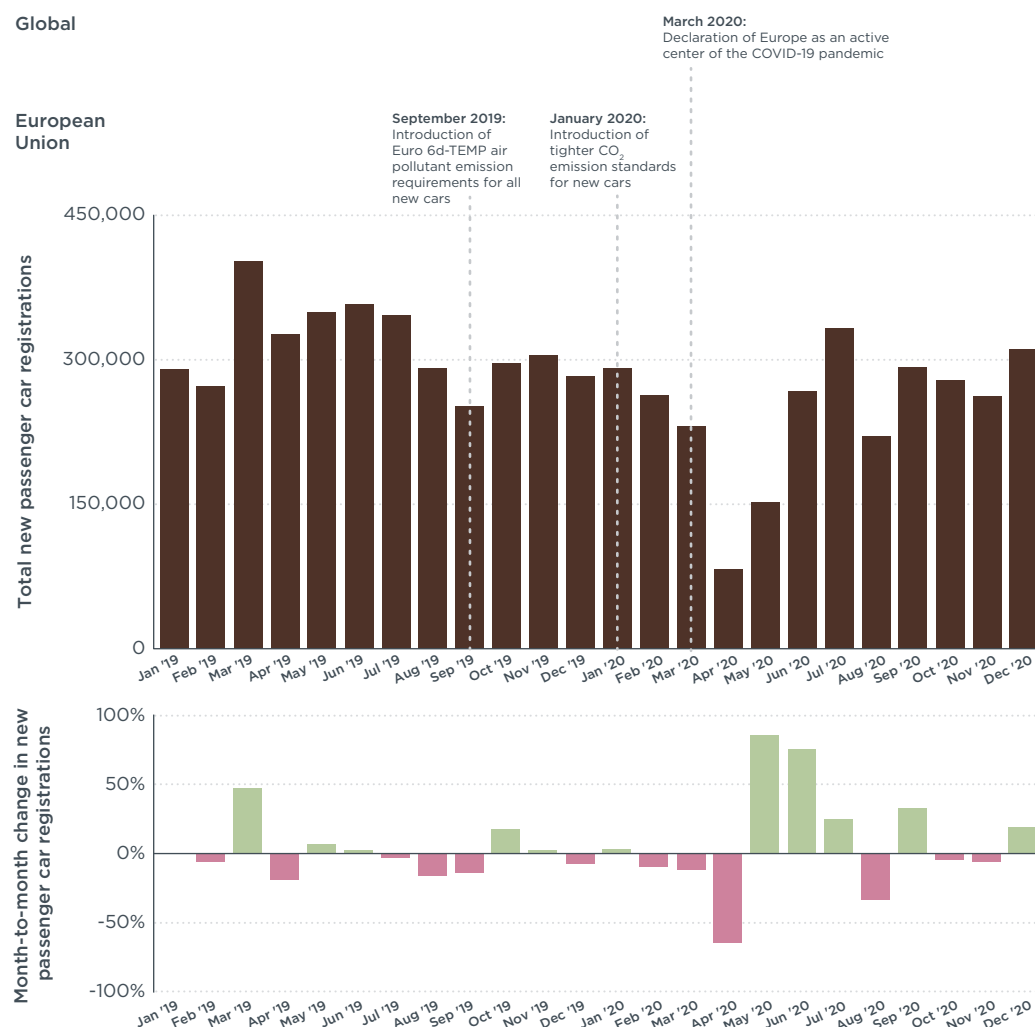
As noted, in September 2019 the EU implemented tighter air pollutant emission requirements and applied the Euro 6d-TEMP emission standard to all newly registered cars. At the European level, this action did not affect total new passenger car registrations by manufacturers, which in September 2019 increased by 19% from the previous month to reach almost 1.3 million. Almost all manufacturer pools recorded growth rates between August and September 2019. JLR reported the highest growth rate, with an increase of 145% in new passenger car registrations. Sales of JLR are particularly strong in its home market in the UK, where the months of March and September traditionally see increased new car registrations as explained previously. Three manufacturer pools experienced lower registrations in September 2019 compared to a month earlier: -14% by the Volkswagen Group, -20% by Mitsubishi and -37% for the “Others” category, which includes Subaru and Polestar.

After the April 2020 monthly low, the fewest total new passenger car registrations occurred in August in both years: 1.1 million in August 2019 and 870,000 in August 2020. This decline is typical for summer months and has also occurred in previous years.

Looking at the monthly new passenger car registrations for the largest manufacturer pool by total registrations in 2020, the Volkswagen Group, we find that the car

manufacturer was greatly affected by the COVID-19 outbreak (Figure 8). The effect was most significant in April 2020 when registrations dropped by 64%, from 231,000 in March 2020 to 82,000 in April 2020. The Volkswagen Group experienced the highest growth rates in the following two months: +85% in May 2020 (from 82,000 to 152,000 new passenger car registrations) and +75% between May 2020 and June 2020 (152,000 to 267,000). In 2019, totals were lowest in September; 251,000 new passenger cars were registered when the EU introduced tighter air pollutant test regulations for all new cars.

## Volkswagen Group



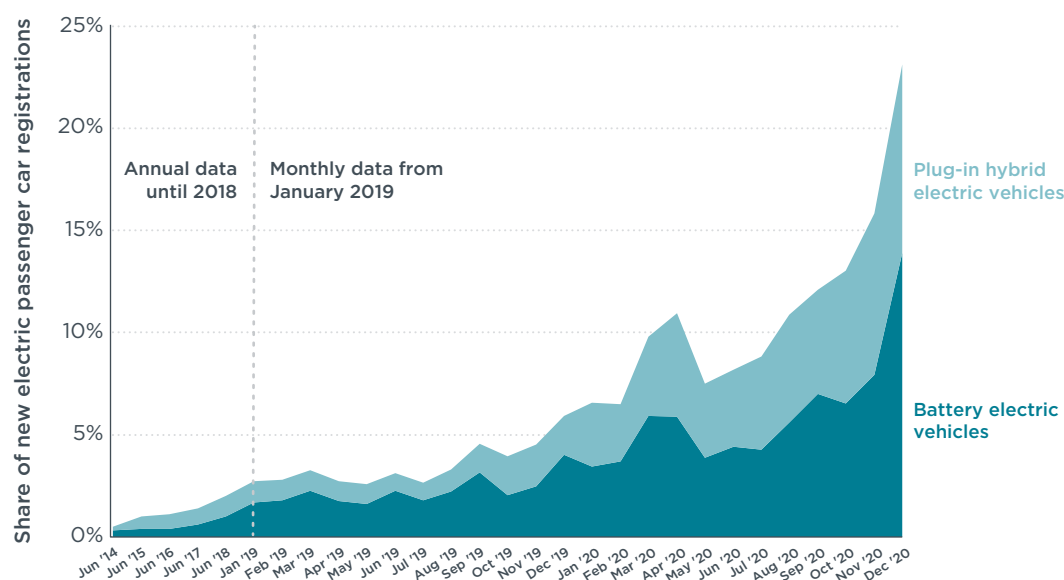
**Figure 8.** Total monthly new passenger car registrations by the Volkswagen Group in the 27 EU Member States and the UK in 2019 and 2020 with selected policy measures (top) and month-to-month change (bottom).

## New electric passenger car registrations

The development of the passenger car market, as illustrated in the previous section, has been shaped by a growing number of electric vehicle registrations in the 27 EU Member States and the UK over the past years (Figure 9). While the combined share of BEVs and PHEVs accounted for 0.5% of all new passenger car registrations in 2014, the share increased steadily to 2.0% by the end of 2018. Monthly registrations in 2019 and 2020 also showed an upward trend. Despite the pandemic emergency measures related to the COVID-19 outbreak resulting in a temporary decline of overall new passenger car registrations, shares of new electric passenger car registrations increased steadily, initially peaking in April 2020 at 11% (6% BEVs and 5% PHEVs). After a slight drop to 8% in May 2020 (4% BEVs and 4% PHEVs), the proportion of new electric passenger car

registrations gradually increased again, reaching a second peak in December 2020 of 23% (14% BEVs, 9% PHEVs).

The strong growth rate of BEVs and PHEVs in comparison to all new passenger car registrations is mainly attributable to the phase-in of tighter CO<sub>2</sub> emission standards beginning in January 2020. Manufacturers' new car fleets were previously subject to a CO<sub>2</sub> emission target of 130 g/km in NEDC, which in January 2020 tightened to the new target value of 95 g CO<sub>2</sub>/km. Supportive fiscal policies at the national level also positively influenced the uptake of electric vehicles, as shown in the following paragraphs.



**Figure 9.** Share of electric vehicles in new passenger car registrations in the 27 EU Member States and the UK from 2014 to 2020. Depicts annual data prior to January 2019 and monthly data from January 2019 onwards.

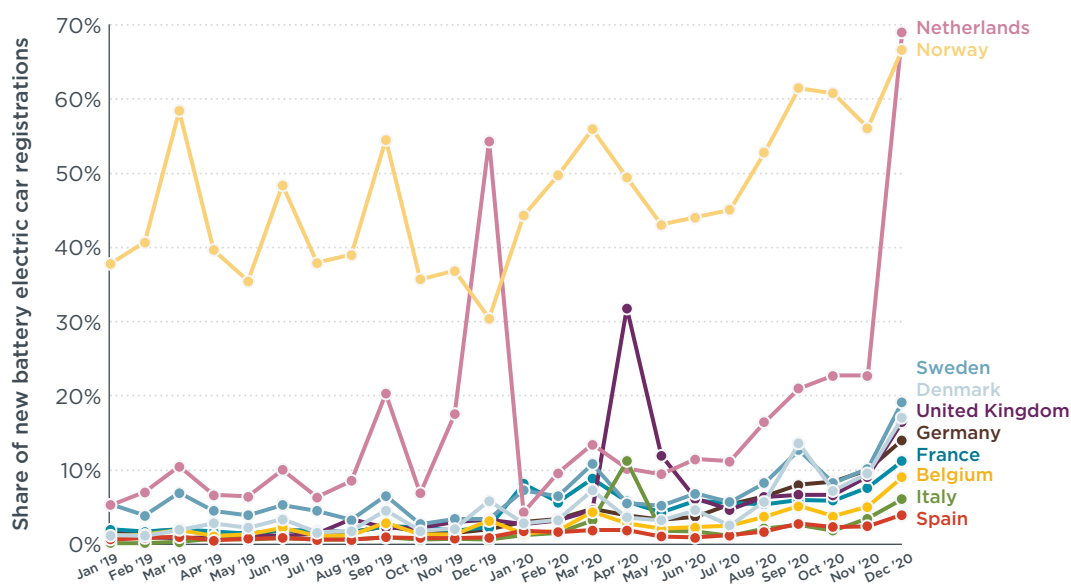
### Developments at country level

Total registrations of new electric passenger cars, including BEVs and PHEVs, were highest in Germany in 2020 at almost 395,000, followed by France (186,000 total) and the UK (over 175,000). In descending order followed Norway, Sweden, the Netherlands, Italy, Belgium, Spain, and Denmark, whose new electric passenger car registrations ranged from 106,000 (Norway) to almost 33,000 (Denmark). The least number of new electric vehicles were registered in Cyprus (over 100) and Latvia (over 400).

Figure 10 shows the share of monthly new BEV registrations in 2019 and 2020 for the 10 markets of the 27 European Member States and the UK, which recorded the highest number of BEV and PHEV registrations. In the 24 months of 2019 and 2020, registration shares of BEVs were highest in Norway, ranging between 30% of all new passenger car registrations in December 2019 and 67% in December 2020. In December 2019 and 2020, BEV registration shares in the Netherlands surpassed those in Norway with shares of 54% and 69%, respectively. In all top 10 countries, new BEV registration shares were highest in December 2020, ranging between 4% in Spain and 69% in the Netherlands.

April 2020, the low point of total new passenger car registrations across the 27 European Member States and the UK as illustrated above, also marked lower BEV registrations shares in most markets. One exception included the UK, where new BEV registrations peaked, increasing by 27 percentage points from 5% in March 2020 to 32% in April 2020. This development can likely be linked to tax changes: The UK had reduced the taxable rate for employees privately using a BEV company car from 16% of a vehicle's purchase price to 0% (by comparison, the rate is 13% to 37% for cars with

emissions greater than 50 g CO<sub>2</sub>/km). Together, these policies likely resulted in the postponement of BEV company car purchases to April.



**Figure 10.** Monthly share of BEVs in new passenger car registrations in 2019 and 2020 for the top 10 electric vehicle markets in the 27 EU Member States and the UK.

Figure 11 takes the example of the Netherlands' monthly BEV shares, which peaked in December 2019 and December 2020. In these two months, BEVs represented 54% and 69% of all new passenger car registrations in the Netherlands, respectively. These high uptakes preceded a steep drop in the following months. In January 2020, new BEV registrations were 50 percentage points lower compared to one month earlier. During the COVID-19 outbreak, new BEV registrations dropped slightly in April and May 2020, yet about 10% of new cars registered were BEVs. Starting in June 2020, their share increased steadily, reaching the historic share of 69% in December 2020.

Existing or newly introduced national fiscal policies can explain some of the monthly registration peaks in the Netherlands. In January 2020, tighter annual added income tax rates for employees privately using a battery electric company car were introduced, increasing from 4% to 8% of a vehicle's purchase price compared to 22% for cars with emissions above 0 g CO<sub>2</sub>/km.<sup>12</sup> In January 2021, the additional rate for company cars with emissions of 0 g CO<sub>2</sub>/km was further increased by 4 percentage points to 12%. These January tax changes can help to explain why new BEV registrations have peaked in December in the last two years, followed by steep drops in January. Tax policy changes for company cars are particularly relevant in the Netherlands: In 2020, companies owned 73% of new electric cars registered in the Netherlands of which 86% were BEVs. Specifically targeted at private new BEV purchases, the Dutch government introduced a new bonus scheme in June 2020, providing a one-time grant of €4,000. The funds made available by the government—€10 million serving subsidies for 2,500 BEVs<sup>13</sup>—were exhausted within a few days. In June 2020 alone, more than 2,800 BEVs were newly registered. Still, this policy helps to explain the increasing number of BEV registrations in the second half of 2020, as the bonus grants were provided at the time of purchase, but delivery and registration of the vehicle are often delayed by a few months.

<sup>12</sup> Business.gov.nl, "Private use of a company car," accessed August 24, 2021, <https://business.gov.nl/regulation/private-use-company-car/>.

<sup>13</sup> Government.nl, "Regulation of the State Secretary for Infrastructure and Water Management, of 25 May 2020, no. IENW/BSK-91099, containing rules for encouraging the purchase and lease of electric passenger cars by private individuals (Subsidy Scheme for private electric passenger cars)" (May 25, 2020), <https://zoek.officielebekendmakingen.nl/stcrt-2020-28162.html>.

## Netherlands

Global

European Union

Netherlands

March 2020:  
Declaration of Europe as an active center of the COVID-19 pandemic

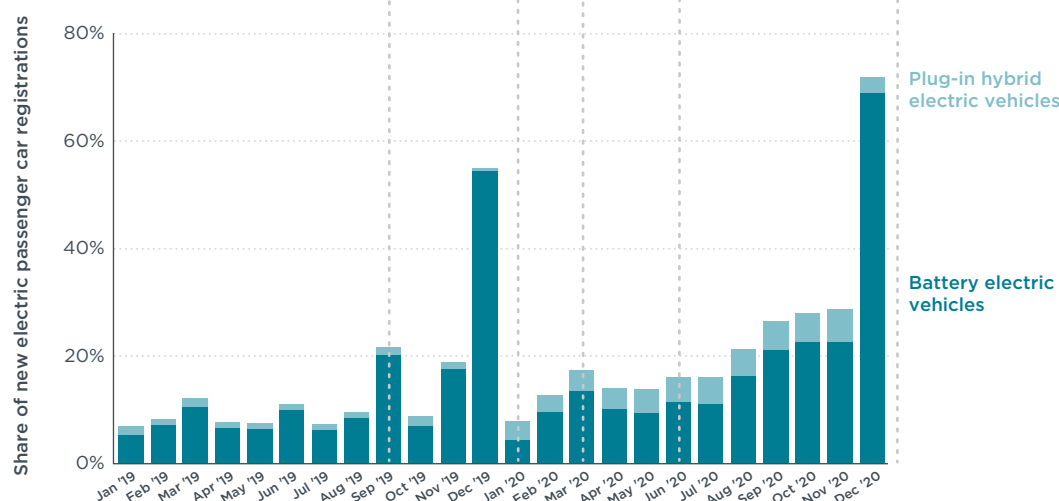
September 2019:  
Introduction of Euro 6d-TEMP air pollutant emission requirements for all new cars

January 2020:  
Introduction of tighter CO<sub>2</sub> emission standards for new cars

January 2020:  
Introduction of tighter added taxable income rates for privately used battery electric company cars

June 2020:  
Introduction of one-time purchase bonus for new battery electric cars

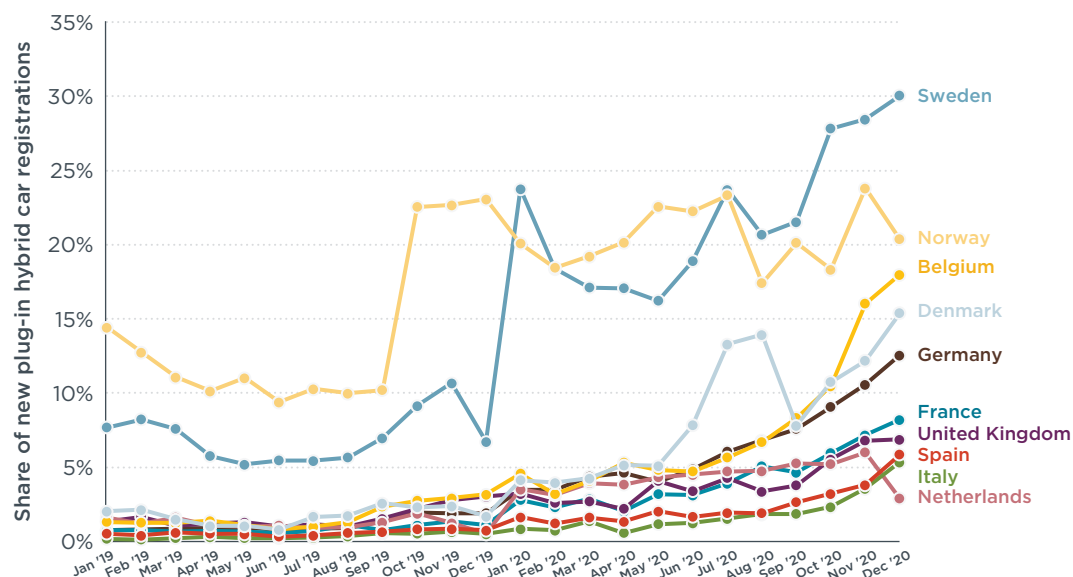
January 2021:  
Introduction of tighter added taxable income rates for privately used battery electric company cars



**Figure 11.** Monthly share of electric vehicles in the new passenger car registrations in the Netherlands in 2019 and 2020 with selected policy measures.

Figure 11 also displays new PHEV registration shares. Due to tax policies favoring BEVs, the PHEV share of monthly new passenger car registrations in the Netherlands was comparably low in 2019 and 2020, ranging between 0.5% in December 2019 and 6.0% in November 2020.

Similar to new BEV registration shares across Europe, PHEVs also showed an upward trend in the top 10 European electric passenger car markets in 2020 by total registrations (Figure 12). Norway initially led on new PHEV registrations, with shares ranging between 9% in June 2019 and 24% in July 2020. Sweden outpaced Norway in the second half of 2020, when its new PHEV registrations ranged between 21% in September 2020 and 30% in December 2020. Since 2020, new PHEV registration shares increased steadily in almost all markets. In the last month of 2020, eight markets recorded their highest monthly shares of new PHEV registrations if looking at monthly figures for 2019 and 2020. Norway and the Netherlands were exceptions, experiencing a decrease in December 2020 of 4 and 3 percentage points, respectively, compared to the previous month.

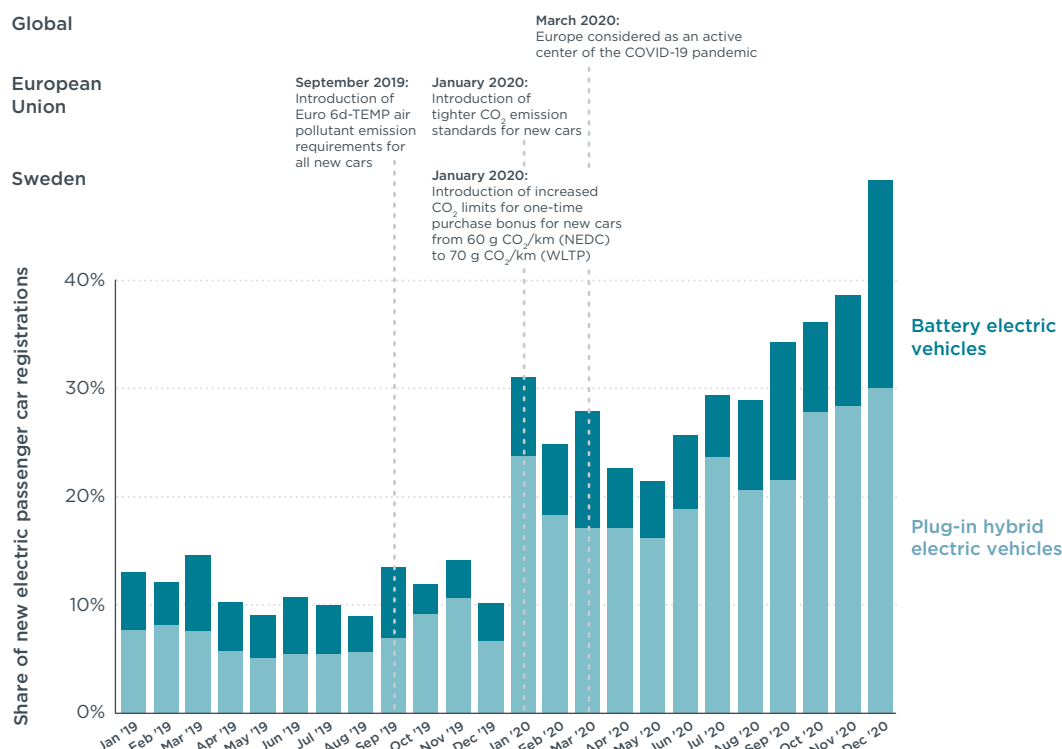


**Figure 12.** Monthly share of plug-in hybrid electric vehicles in new passenger car registrations in 2019 and 2020 for the top 10 electric vehicle markets in the 27 EU Member States and the UK.

Below, we take Sweden as an example to show the potential effects of policies on the progression of PHEV registration shares and display BEV registration shares for comparison. Figure 13 shows that monthly registration shares of new PHEVs outpaced those of BEVs in 2019 as well as in 2020. In 2019, new PHEV registration shares ranged between 5% in May 2019 and 11% in November 2019. Registrations surged in January 2020, with almost one quarter of new passenger car registrations in Sweden being a PHEV. The market in 2020 was also affected by the COVID-19 pandemic; May marked with the lowest monthly 2020 PHEV share of 16%. The market recovered gradually, with a peak in December 2020 (30%).

The high uptake of PHEVs in Sweden can partially be explained by the country's vehicle taxation policy and particularly by the bonus-malus scheme introduced in July 2018. Up to the end of 2019, cars with CO<sub>2</sub> emissions between 0 and 60 g/km (as measured in the NEDC)—typically BEVs, FCEVs, and most PHEV models—received a bonus ranging between €5,700 for zero-emission BEVs and FCEVs, linearly decreasing to €1,000 for vehicles emitting 60 g/km. In January 2020, the CO<sub>2</sub> threshold was increased to 70 g/km, now in WLTP terms. This action may have stimulated additional PHEV purchases in January 2020. In addition, the EU introduced tighter CO<sub>2</sub> emission standards, which might have delayed the introduction of new PHEV models by car manufacturers until January 2020.

## Sweden



**Figure 13.** Monthly share of electric vehicles in new passenger car registrations in Sweden in 2019 and 2020 with selected policy measures.

As illustrated, new registrations of electric vehicles in Europe have shown an upward trend by registration share, surging in 2020 despite the COVID-19 pandemic. While monthly variations among countries exist due to country-specific policy measures, the overall market increase is partially explained by tighter CO<sub>2</sub> performance standards for new passenger cars that the EU introduced in January 2020. As a point of comparison, below we review the development of the electric passenger car market in the United States and China by monthly and half-year registration/sale shares in 2019 and 2020 (Figure 14).<sup>14</sup>

On a monthly basis, new electric passenger car registration/sales shares, including BEVs and PHEVs, were the highest in China between January and August 2019 (ranging between 4.0% and 6.1%), followed by Europe (ranging between 2.5% and 3.3%), and the United States (monthly shares ranging between 1.5% and 2.3%). Starting in September 2019, this trend reversed: Through December 2020, new electric passenger car registration shares in Europe surpassed those in China. European shares ranged between monthly shares of 3.9% and 5.9%, while Chinese shares ranged from 3.4% to 5.6%. With the exception of January 2020, when the monthly new registration/sales share reached 2.6% in China, 2.9% in the United States, and 6.6% in Europe, the United States recorded the lowest share of new electric passenger car shares based on total new passenger car sales for the rest of the year: 1.3% to 2.7%. Between February and December 2020, monthly shares ranged between 4.1% and 9.4% in China and 6.5% to 23.0% in Europe. In December 2020, new electric passenger car registration/sales shares reached 23.0% in Europe, followed by China (9.4%) and the United States (2.7%).

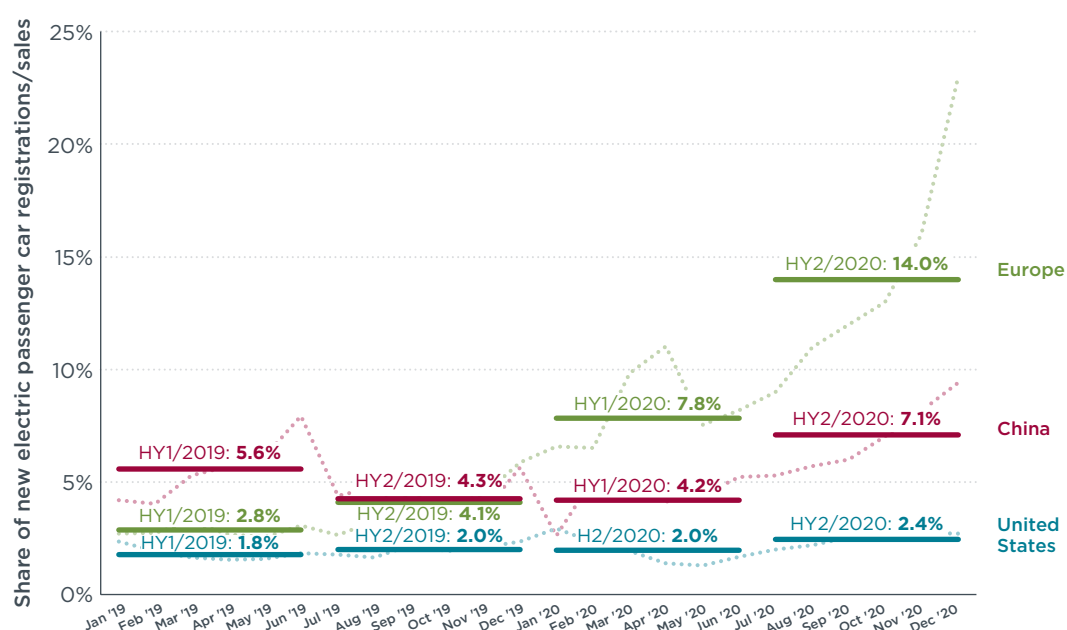
The average new electric passenger car half-year registration/sales shares stagnated in the United States at 2.0% in the second half of 2019 and the first half of 2020. A similar trend occurred in China, where average half-year shares decreased slightly by

<sup>14</sup> Mock, Yang, and Tietge, "The impact of COVID-19."



0.1 percentage points from 4.3% to 4.2%. Meanwhile, new average half-year electric passenger car registrations in Europe increased between the second half of 2019 and the first half of 2020, from 4.1% to 7.8%, despite the COVID-19 outbreak in early 2020, likely as a result of tighter CO<sub>2</sub> emission performance standards for new cars starting January 2020.

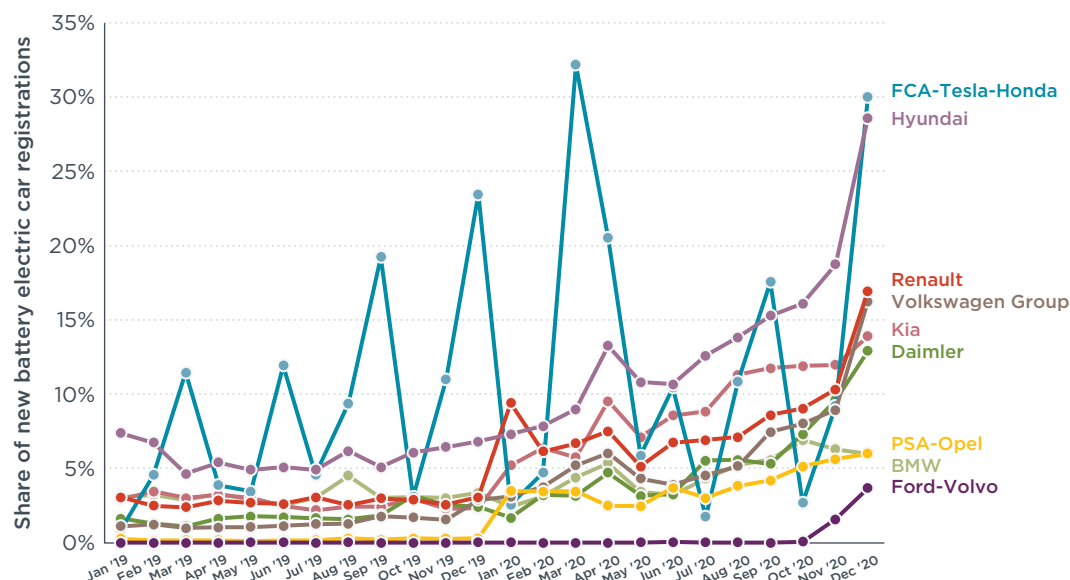
The high uptake of electric vehicles in Europe began at the same time that tighter CO<sub>2</sub> emission standards came into effect from January 2020 onwards. While stimulus packages in some European markets responding to COVID-19 have likely encouraged more consumers to opt for an electric car starting mid-2020, the CO<sub>2</sub> standards' inclusive credits for electric vehicles are likely the driving force behind this development, as car manufacturers have faced penalties when they have failed to reach the standards. All three markets saw an increase of new average half-year electric passenger car registration shares between the first and second half of 2020, most pronounced in Europe (+6.2 percentage points), followed by China (+2.9 percentage points) and the United States (+0.4 percentage points).



**Figure 14.** Monthly and half-year share of electric vehicles in new passenger car/light truck registrations/sales in Europe (European Economic Area plus United Kingdom), China, and the United States in 2019 and 2020. Note: HY = half-year; data for the United States includes light trucks, data for China and Europe only passenger cars. (Sources: Dataforce, AAA Data, Society of Motor Manufacturers and Traders (SMMT), European Automobile Manufacturers' Association (ACEA), MarkLines).

### Developments by car manufacturer pools

Figure 15 shows monthly BEV shares of the top nine manufacturer pools by total 2020 electric passenger car registrations (BEVs and PHEVs combined) in the 27 EU Member States and the UK between 2019 and 2020. While mostly stagnating on a monthly basis in 2019, almost all car manufacturer pools recorded increasing monthly BEV shares in 2020. Most pronounced was the uptake for Renault (Renault, Dacia) in January 2020, with BEVs constituting 9% of all new passenger cars registered in that month, up from 3% in December 2019. While most car manufacturers saw a gradual increase of BEV shares, the BEV share fluctuated in the case of the FCA-Tesla-Honda pool. About every two to three months, the pool recorded peaks in its BEV share, ratcheting up to 32% in April 2020 and falling to 5% two months later. These fluctuations in BEV shares may be attributable to all new Tesla vehicles to date being imported to Europe and subject to fixed shipment schedules.



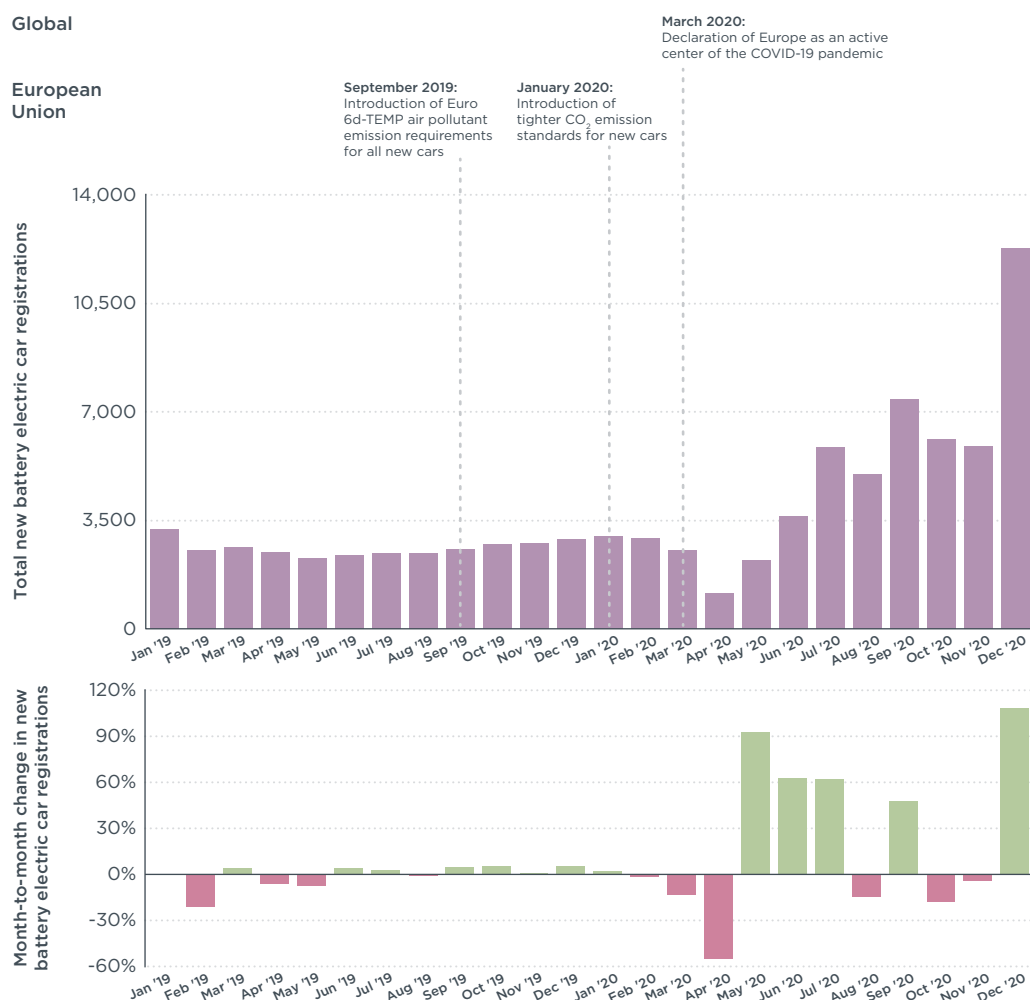
**Figure 15.** Monthly share of battery electric vehicles in new passenger car registrations in 2019 and 2020 for the top nine car manufacturer pools by registrations in the 27 EU Member States and the UK.

Hyundai saw the largest and most stably increasing shares of BEVs in new car registrations among the 27 EU Member States and the UK compared to the other top eight car manufacturer pools by electric passenger car sales in 2020. Between January and December 2019, Hyundai's registrations did not show any extreme peaks, ranging between 2,300 in May and 3,200 in January (Figure 16). Rather, relative changes between the previous months ranged between -21% in January 2019 and +6% in October 2019. With the introduction of tighter CO<sub>2</sub> emission standards for new passenger cars in Europe in January 2020, total and relative new month-on-month BEV registrations increased slightly by +2% and fell by -1% in February 2020, -13% in March 2020, and -55% in April 2020. After the first wave of the pandemic, total new BEV registrations increased steadily by 93% in May 2020 and by 63% and 62% in June and July 2020, respectively. The most BEVs were registered in December 2020 (more than 12,000), with a relative increase of 108% compared to November 2020—the highest figures over two years.

# Hyundai

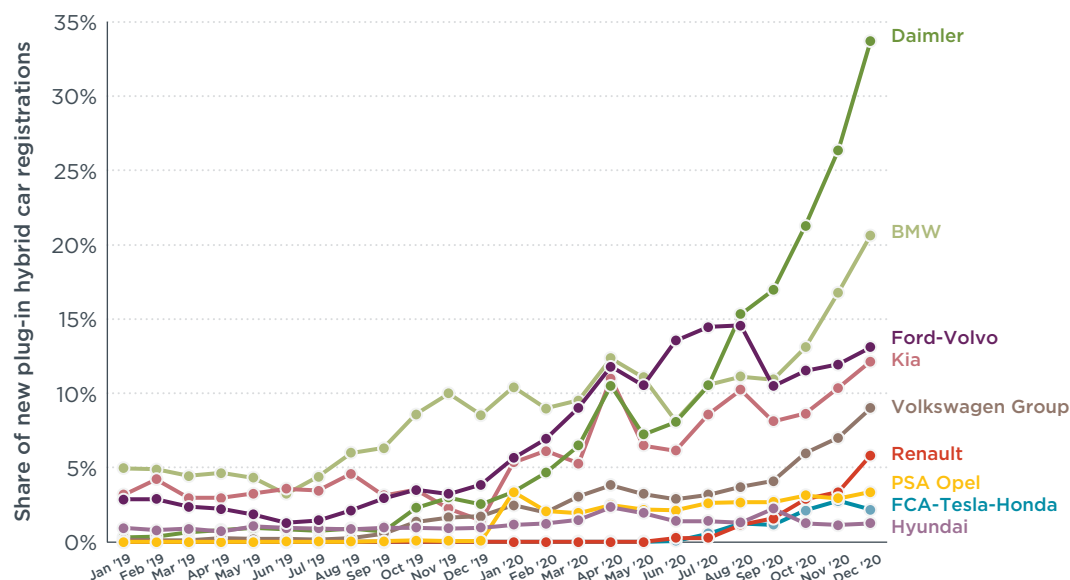
Global

European Union



**Figure 16.** Total monthly new passenger car registrations by Hyundai in the 27 EU Member States and the UK in 2019 and 2020 with selected policy measures (top) and month-to-month change (bottom).

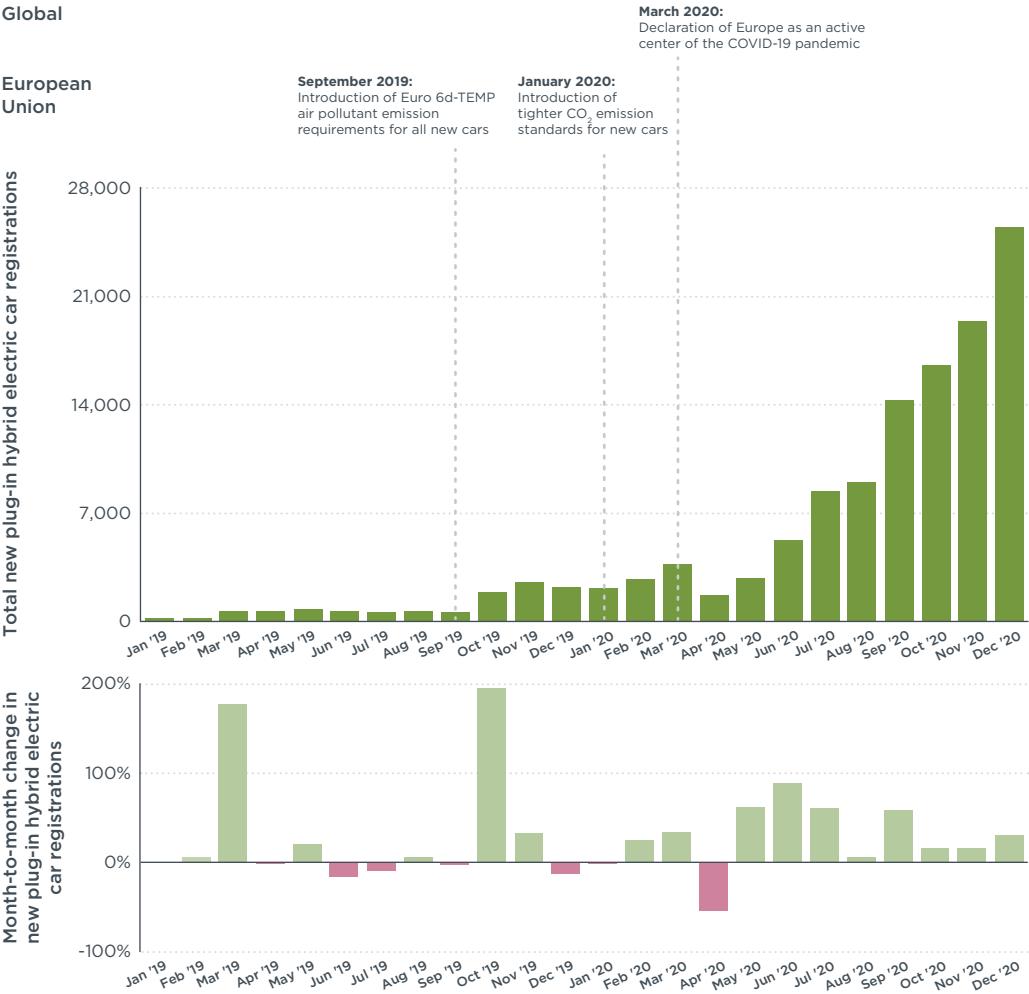
The share of PHEV in new car registrations has also gradually increased on a monthly basis for the nine top car manufacturer pools (Figure 17). Between January 2019 and May 2020, monthly shares were the highest for the BMW pool (BMW, Mini), ranging between 3% in June 2019 and 12% in April 2020. In June 2020, Daimler (Mercedes, Smart) and BMW both reached a share of 8% of new PHEV registrations. In August 2020, Daimler surpassed BMW's PHEV registration figures, reaching an all-time PHEV registration high of 34% of new passenger cars in December 2020. After a peak in April 2020 recorded by all car manufacturer pools with the exception of Renault (Renault, Dacia) and FCA-Tesla-Honda, registrations dropped temporarily in May 2020 and recovered in June or July 2020, depending on the manufacturer pool.



**Figure 17.** Monthly share of plug-in hybrid electric vehicles in new passenger car registrations in 2019 and 2020 for the top nine car manufacturer pools by European registrations in 2020.

Daimler showed the steepest increase of total new PHEV registrations in 2020. Of its brands, only Mercedes offers PHEVs while there are no PHEV models on the market for Smart brand. While in 2019 its total monthly PHEV registration numbers ranged between 230 in January 2019 to almost 2,600 in November 2019, they surged in 2020 (Figure 18). Starting in June 2020, total monthly PHEV registration numbers increased from almost 5,300 to over 25,000 in December 2020. The month-to-month growth rate was the highest in October 2019 at +195%. In 2020, with the exception of January and April, when month-to-month PHEV registrations respectively decreased by 1% and 53%, registrations remained strong, peaking in June with +89% compared to the previous month.

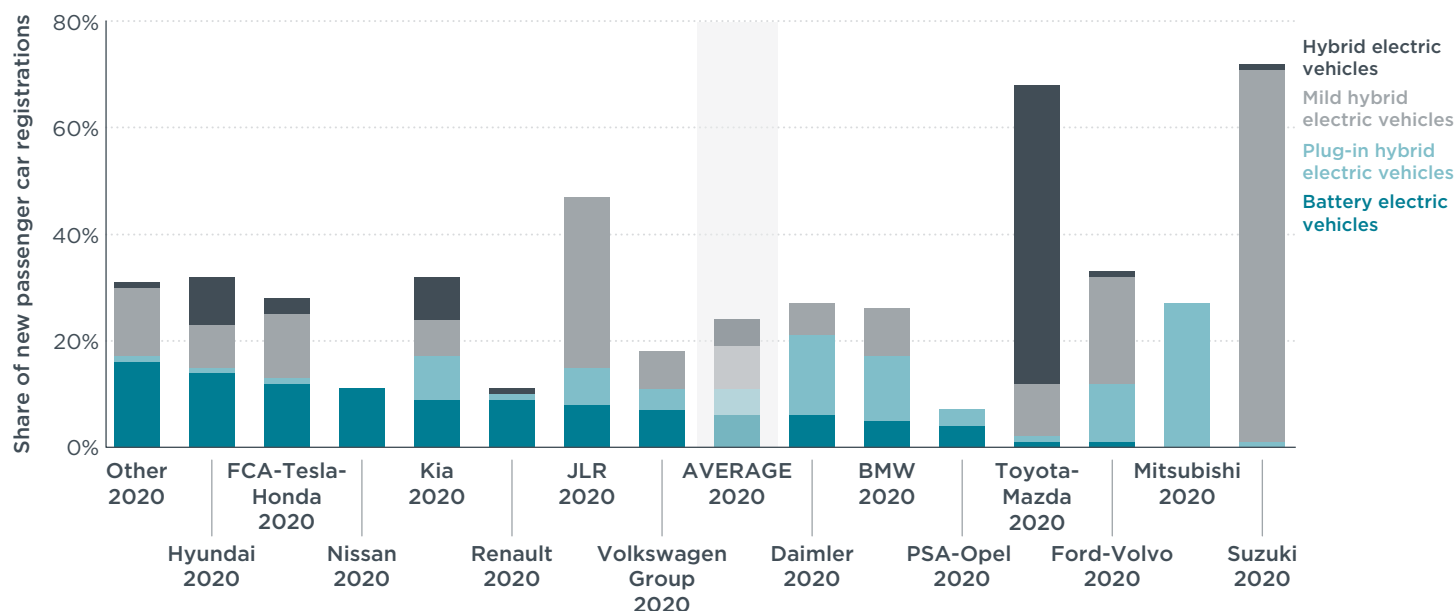
The introduction of tighter air pollutant emission standards for all new cars beginning in September 2019 and the phase-in of a lower CO<sub>2</sub> fleet target from January 2020 onwards have likely boosted new Daimler PHEV registrations. The COVID-19 outbreak affected PHEV registrations of the group temporarily in April 2020.



**Figure 18.** Total monthly new passenger car registrations by Daimler in the 27 EU Member States and the UK in 2019 and 2020 with selected policy measures (top) and month-to-month change (bottom).

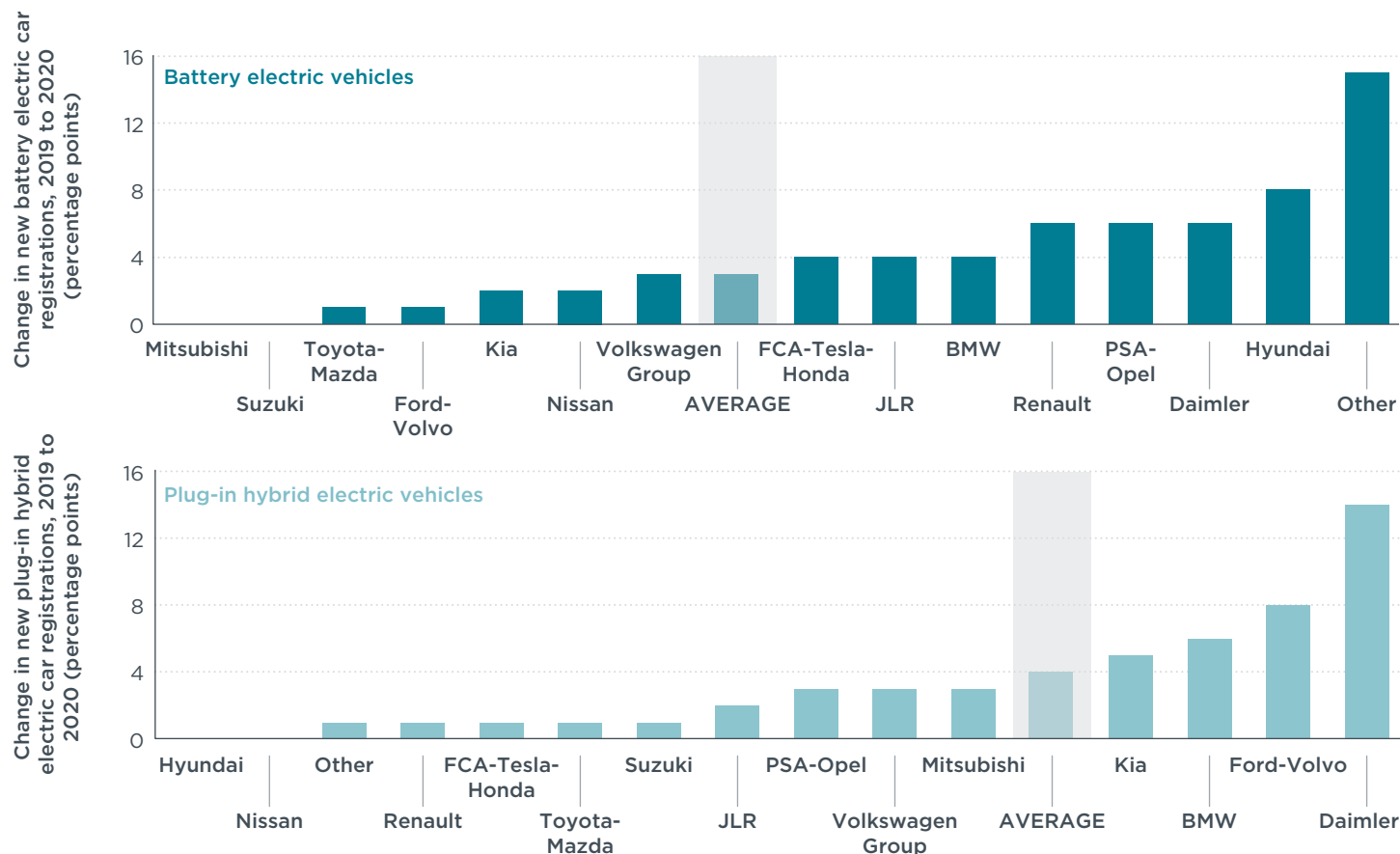
Figure 19 illustrates the share of new passenger car registrations by car manufacturer pools for 2020, differentiated by BEV, PHEV, mild hybrid electric vehicle (MHEV), and hybrid electric vehicle (HEV) shares. Car manufacturers are sorted based on BEV registration shares in 2020, from highest to lowest.

In 2020, the “Others” category, including Subaru and Polestar, recorded the highest share of new BEV registrations (16%), followed by Hyundai (14%), FCA-Tesla-Honda (12%), and Nissan (11%). The pools with the highest PHEV registration shares included Mitsubishi (27%), Daimler (15%), BMW (12%), and Ford-Volvo (11%). For comparison, we also list MHEV and HEV registrations. Suzuki and JLR led on new MHEV registrations in 2020, with 70% and 32% of their pools’ passenger car registrations, respectively. For HEVs, Toyota-Mazda captured 56% of its passenger car market in the 27 EU Member States and the UK.



**Figure 19.** Average market share of electric vehicle types in new passenger car registrations in the 27 EU Member States and the UK in 2020, by manufacturer pool. Sorted by market share of new battery electric vehicle registrations in 2020.

All manufacturer pools increased their new BEV registration shares between 2019 and 2020, with the exception of Mitsubishi and Suzuki, whose respective pools saw 2020 BEV registrations below 100 and less than 10, respectively (Figure 20, top). The average BEV registration share was +3 percentage points, with Toyota-Mazda and Ford-Volvo recording the lowest growth rates of +1 percentage point. Daimler, Renault, and PSA-Opel, each with an increase of +6 percentage points, fell behind Hyundai, whose BEV registrations share increased by +8 percentage points between 2019 and 2020. The highest increase was recorded for the “Other” pool (+15 percentage points). For new PHEV registrations (Figure 20, bottom), the average increase stood at +4 percentage points. Hyundai did not increase its share; Nissan did not register any PHEVs in Europe. The uptake of new PHEV registrations was lowest for the “Other” pool, Renault, FCA-Tesla-Honda, Toyota-Mazda, and Suzuki (+1 percentage point). PHEV registrations for multiple pools surpassed the European average, including Daimler (+14 percentage points), Ford-Volvo (+8 percentage points), BMW (+6 percentage points), and Kia (+5 percentage points).



**Figure 20.** Percentage point change in new battery electric passenger car registrations (top) and plug-in hybrid passenger cars in the 27 EU Member States and the UK by manufacturer pools, 2019 to 2020

## Effects on CO<sub>2</sub> emission levels

Tighter CO<sub>2</sub> emission standards for new passenger cars can help to explain why automakers in Europe pushed more electric vehicles into the market from January 2020 onwards, when average type approval CO<sub>2</sub> emission levels of new passenger cars began to decrease significantly.

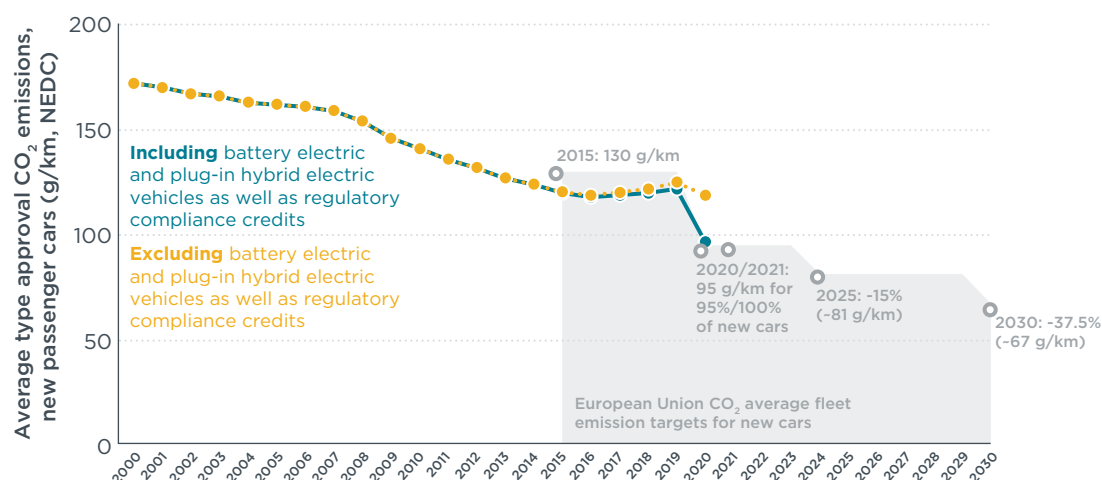
### Developments at European level

The average type approval CO<sub>2</sub> emissions of the new passenger car fleet in the 27 EU Member States, Iceland and Norway, and the UK decreased continuously from 172 g CO<sub>2</sub>/km in 2000 to 120 g CO<sub>2</sub>/km (based on NEDC) in 2015, illustrated as a blue line in Figure 21. Between 2015 and 2019, the CO<sub>2</sub> fleet average ranged between 118 and 122 g CO<sub>2</sub>/km (NEDC), well below the fleet average target for all manufacturers at 130 g CO<sub>2</sub>/km (NEDC) as set by EU regulation but representing an increase from the low point reached in 2016 (118 g/km). In 2020, when a sharply reduced fleet-wide emission standard of 95 g CO<sub>2</sub>/km came into force for 95% of new cars, average CO<sub>2</sub> emission values decreased significantly to 97 g CO<sub>2</sub>/km (NEDC).

This drop in CO<sub>2</sub> emissions for the new passenger car fleet is largely the result of more BEVs and PHEV registrations in 2020, constituting 11% of all new passenger cars compared to 3% in 2019. Previously, the effects of electric cars on the CO<sub>2</sub> fleet average in the 27 EU Member States, Iceland, Norway, and the UK were marginal due to low registration figures. In 2020, excluding BEVs and PHEVs and regulatory compliance credits (super-credits for electric vehicles, eco-innovation credits, and phase-in credits), the average CO<sub>2</sub> emission level of the total new passenger car fleet would have been about 22 g/km higher in 2020 (about 119 g CO<sub>2</sub>/km, NEDC) (yellow

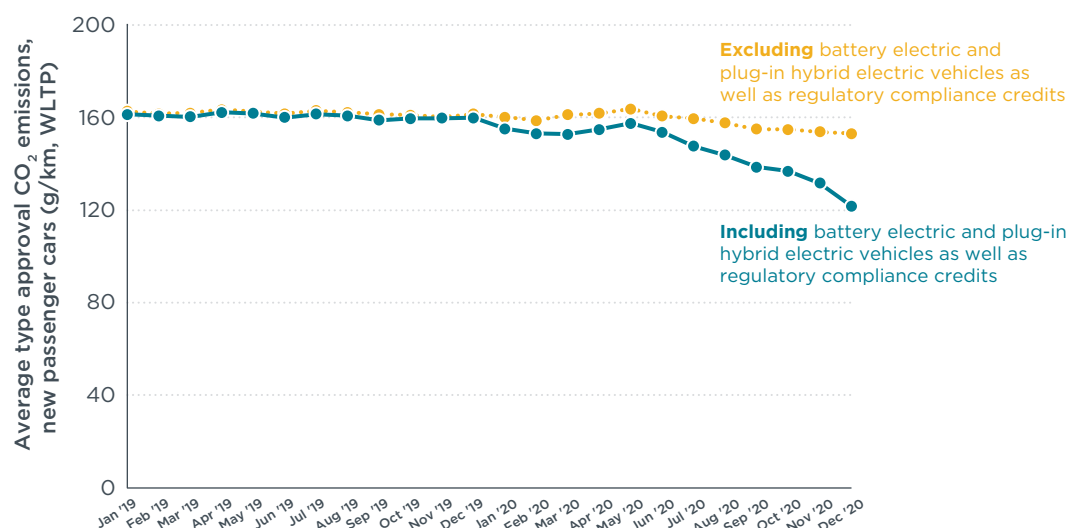


line in Figure 21). By including electric vehicles and regulatory compliance credits, manufacturers were largely able to comply with their respective 2020 CO<sub>2</sub> emission targets and avoid paying penalties.



**Figure 21.** Average type approval CO<sub>2</sub> emission levels (NEDC) of new passenger cars in the 27 EU Member States, Iceland, Norway, and the UK since 2000, including regulatory target values.

Taking the example of Germany, which is the largest European passenger car market by registrations, Figure 22 illustrates its market developments since January 2019 on a monthly basis. Average emission levels stagnated throughout 2019 to a level of about 160 g/km in WLTP terms. From January 2020, CO<sub>2</sub> emission levels began decreasing, particularly during the second half of 2020. Within one year, emissions had decreased by 25% (from 156 g/km in December 2019): By December 2020, the average new car type approval CO<sub>2</sub> level in Germany reached a low of 117 g/km. The drop is an unprecedented decline in emissions of more than 2% per month. Similar to the EU, the introduction of more electric vehicles primarily accounts for this sudden decrease in type approval CO<sub>2</sub> emission levels in Germany. Excluding the effect of electric vehicles and of regulatory compliance credits, the average CO<sub>2</sub> emission level in December 2020 would have stood at about 153 g/km, only slightly lower than in previous months.



**Figure 22.** Monthly average CO<sub>2</sub> emission levels (in WLTP) of new passenger cars in Germany since January 2019. Adapted from Kraftfahrtbundesamt.

## Summary and conclusions

In 2020, the European passenger car market was hit hard by the COVID-19 outbreak. For the total year, new registrations collapsed more than during the global financial crisis between 2007 and 2008 and during the European debt crisis between 2009 and 2012. While monthly registration figures of new passenger cars have not yet returned to pre-COVID levels, these registrations have partially indicated an upward trend, notwithstanding the usual lull during August and another slowdown in November 2020.

In the middle of what turned out to be Europe's most challenging year for the automotive market in more than 20 years, registrations of new electric vehicles reached unprecedented levels. Europe's annual average share of electric passenger car registrations went from 3% in 2019 (2% BEVs, 1% PHEVs) to 11% in 2020 (6% BEVs, 5% PHEVs). Monthly registration shares reached an all-time high of 23% in December 2020 (14% BEVs, 9% PHEVs). The Netherlands led in new BEV registrations with a share of 69% in December 2020. The highest rate of PHEV registrations was recorded for Sweden at 30% that month.

Compared to China and the United States, Europe took the lead in electric vehicle registration and sale shares. In the second half of 2020, an average of 14.0% of new passenger cars registered in Europe was a BEV or PHEV, compared to 7.1% in China and 2.4% in the United States. One year earlier in the second half of 2019, China led electric vehicle sales with a share of 4.3%, compared to 4.1% of all passenger car registrations in Europe and 2.0% of all car sales in the United States.

Manufacturers were quick and decisive in turning around their product portfolio. Renault's share of BEVs at one point tripled from 3% in December 2019 to 9% in January 2020. By December 2020, 29% of Hyundai's new car fleet consisted of BEVs, up from 7% in January that year. Daimler managed to increase its PHEV share tenfold, from 3% in January to 34% in December 2020.

As a result of a strong uptake of electric vehicles, type approval CO<sub>2</sub> figures of manufacturers' fleets dropped at an unprecedented pace throughout 2020. After years of stagnation, since manufacturers had successfully met the previous EU fleet CO<sub>2</sub> target of 130 g/km (in NEDC) in 2015, emission levels on average decreased by more than 1% per month and by 20% within one year, from 2019 to 2020. Taking out the effect of electric vehicles and regulatory compliance credits granted in 2020, the average NEDC type approval CO<sub>2</sub> level would have been about 22 g/km higher, or 119 g CO<sub>2</sub>/km, as non-electric vehicles saw hardly any improvements in CO<sub>2</sub> reduction compared to previous years.

From a regulatory perspective, fully accounting for BEVs and PHEVs, as well as for provided credits, the EU CO<sub>2</sub> standards in 2020 were effective policy instruments. Type approval CO<sub>2</sub> emission levels dropped as intended, and vehicle manufacturers were able to ensure compliance with their respective targets without any substantial fines. Meanwhile, the market share of electric vehicles increased, and Europe was able to secure international market leadership for this key technology area. This strong uptake of electric vehicles in 2020 was triggered not only by the EU-wide CO<sub>2</sub> regulation, but also in many cases by national fiscal policies.

In July 2021, the European Commission came forward with a regulatory proposal for revising the post-2021 CO<sub>2</sub> targets for new passenger cars and vans. While the proposal suggests retaining the 2025 reduction target of 15% compared to the 2021 baseline, CO<sub>2</sub> emissions reductions from cars would have to reach 55% in 2030, up from 37.5% in the current regulation. The proposal also suggests a de facto phase-out of internal combustion engine vehicles by suggesting that new cars registered should have zero-emissions by 2035.

Based on our analysis of 2020 market developments, we conclude with the following observations and recommendations:

- » New vehicle type approval CO<sub>2</sub> emission levels can decrease substantially if the right regulatory framework—including high penalties for non-compliance—is in place. The drop in average CO<sub>2</sub> emission levels in Europe by -21% from 2019 to 2020 provides an impressive case study.
- » Vehicle manufacturers are promptly able to adapt their product portfolio and marketing strategy to ensure compliance with regulatory targets. For example, Daimler managed a tenfold increase in its PHEV market share within one year, from 3% in January to 34% in December 2020, while reducing the average CO<sub>2</sub> emission level of its new car fleet from about 137 g/km in 2019 to about 105 g/km in 2020 (in NEDC).
- » The decrease in average new car type approval fleet CO<sub>2</sub> levels in 2020 was almost entirely due to the strong uptake of electric vehicles, as well as regulatory compliance credits. Meanwhile, the average CO<sub>2</sub> level of non-electric vehicles is estimated to have remained about constant.
- » National fiscal policies can help to leverage the effect of the EU-wide CO<sub>2</sub> regulation by providing incentives for consumers to opt for low- and zero-emission vehicles and reduce average type approval CO<sub>2</sub> emission levels.
- » To ensure compliance with the European Green Deal climate protection targets, CO<sub>2</sub> emission levels will have to decrease at a much faster rate than they have in previous years. The vehicle CO<sub>2</sub> regulation provides an exemplary regulatory instrument to ensure the necessary reductions but must urgently be strengthened and adapted to the climate objectives.
- » Introducing annual interim targets for average new vehicle CO<sub>2</sub> emission levels, rather than relying on 5-year targets as is currently foreseen by the regulation, would help to ensure a continuous decline in CO<sub>2</sub> emission levels and avoid sudden market interruptions, such as the observed yet unprecedented uptake of electric vehicles in 2020.
- » Introducing minimum requirements for internal combustion engine vehicles, along with implementing monitoring and enforcement measures for real driving emissions, would help to ensure that manufacturers focus solely on reducing type approval CO<sub>2</sub> levels and rely almost entirely on electric vehicles and regulatory credits for compliance, as was the case in 2020.
- » Revising fiscal policies at the national level to provide strong incentives for vehicles with zero- or low-emissions, while applying high taxation rates for vehicles with high emissions (i.e., a bonus-malus taxation system), would help to secure a continued and financially sustainable push for zero- and low-emission vehicles. These actions would leverage the effect of the EU-wide CO<sub>2</sub> regulation and help automakers ensure compliance with their respective regulatory target values.