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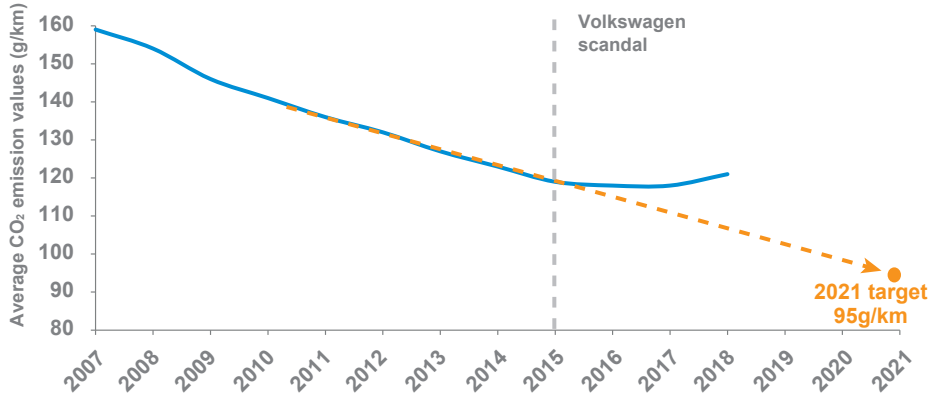
How can we now reduce CO_2 emissions from cars?

Confronted by the climate emergency, the European Union has established that by 2021 the CO_2 emissions from new cars will be 95 grams per kilometre. In April 2019, the European Union set a goal of a further 37.5% reduction by 2030. Yet, these carbon emissions far from diminishing have increased over the last two years. Hence, automobile manufacturers have their backs to the wall: they must reach a level of performance over the next three years never realized in the last twenty years, notably by reducing average CO_2 emissions from new car sales by 10 grams per year. And by 2030, manufacturers also need to cut emissions in half compared with those in 2018. Is this possible? What measures can public authorities implement to support these efforts?

Manufacturers have already accomplished a great deal of work over the last ten years to improve the efficiency of combustion engines and aerodynamics, and to make cars lighter in construction. The two most promising approaches today involve reducing the size of cars and electrification.

To achieve these aims, a bonus/malus calculated by weight as well as the use of cars in electric mode could be applied on a general European level. The introduction of a standard limiting the carbon footprint associated with the production of these cars, moreover, would ensure that low-emission cars, and their batteries are manufactured with low-carbon electricity. Clearly, for the European Union, the stakes are not only environmental, but economic and social.

Average CO_2 emissions measured in the laboratory and targets for new cars in the European Union



Source: France Stratégie, according to Jato data

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Nicolas Meilhan

Scientific Advisor, Department for Sustainable and Digital Development

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INTRODUCTION

Transport is the black sheep of the Kyoto Protocol. Since 1990, most economic sectors have reduced their greenhouse gas (GHG) emissions in the European Union. Transport alone[1], which accounts for more than a quarter of this geographical zone's emissions, has seen its record worsen: +28% in 2017 compared with 1990. While the financial crisis of 2008 halted the continuing increase in emissions, the fall in oil prices in 2014, and economic recovery stopped this downward trend (see Figure 1).

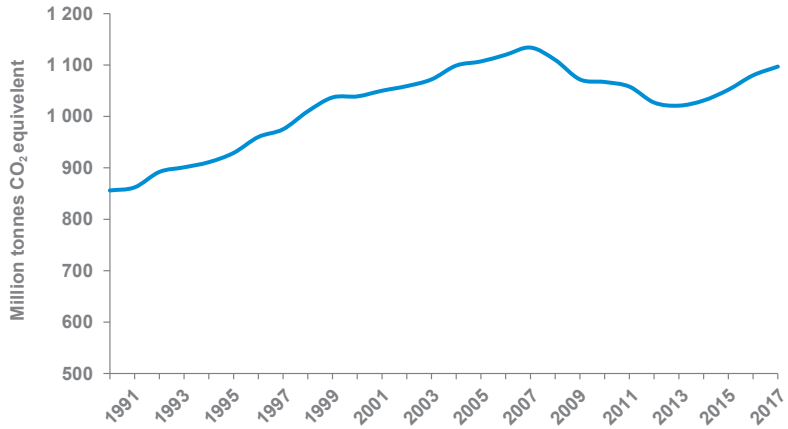
Passenger cars are responsible for nearly half of GHG emissions from transport, and thus are the subject of special attention by the European Commission, whose goal is to achieve a 60% reduction in GHG emissions from the transport sector by 2050 compared with 1990.

By 2021, European automobile manufacturers will be compelled to reduce average emissions from new car sales from more than 120 grams of CO_2 per km in 2018 to 95 grams, which corresponds to about 4 litres of fuel consumption per 100km. Measurements are taken in the certification cycle – that is, in the laboratory on a chassis dynamometer. Manufacturers who fail to attain this standard will be fined 95 euros per gram of excess CO_2 per car sold, a fine that could amount to billions of euros for the least compliant among them[2].

In April 2019, Europe also committed itself to a further 37.5% reduction in average CO_2 emissions for new cars by the year 2030 compared with that in 2021[3]. This is a new threshold of 60 g/km that involves cutting emissions in half compared with those in 2018. According to the International Council on Clean Transportation (ICCT) – a non-governmental organisation specialising in environmental regulation – adherence to the Paris Agreement would essentially require a redoubling of efforts, with a 70% reduction in CO_2 emissions for new cars by 2030[4]. France, with the National Low-Carbon Strategy[5] (SNBC) and the Multiannual Energy Programme[6] (PPE), seeks to achieve a 50% intermediate reduction in CO_2 emissions from new cars by 2030 compared with those in 2021; fuel consumption will be set at under real-world driving conditions of 4 litres per 100km for new cars with combustion engines and a 45% share of the market for electric cars (of which 35% will be battery electric vehicles (BEV) and 10% plug-in hybrids (PHEV).

As CO_2 emissions from new cars have risen over the past two years because of a reduction in the share of diesel engines and an increase in that of SUVs[7], will automobile manufacturers manage to reach the 95 g/km threshold by 2021? And what about the additional 37.5% reduction by 2030? What tools need to be implemented to ensure that France can fulfil commitments made under the Paris Agreement, the SNBC and the PPE, and at the same time reduce the fuel bill for French people?

Figure 1 – Greenhouse gas emissions from the transport sector in the European Union, 1990-2017



Interpretation: air transport is included; maritime transport is not. CO_2 emissions are expressed in millions of tonnes of CO_2 equivalent.

Source: European Environment Agency

1. European Environment Agency indicator (2018): "Greenhouse gas emissions from transport".
2. MSCI (2017), "Death of diesel: a scenario analysis of which auto makers will pay higher emissions fines", November.
3. Council of the European Union (2019), " CO_2 emission standards for cars and vans: Council confirms agreement on stricter limits", press release, 16 January.
4. International Council for Clean Transportation-ICCT (2018), "Recommendations for the proposed heavy-duty vehicle CO_2 standards in the European Union", Position Brief, July.
5. Ministry for the Ecological and Inclusive Transition (2018), *Draft National Low-Carbon Strategy. The ecological and inclusive transition towards carbon neutrality,* December.
6. Ministry for the Ecological and Inclusive Transition (2018), *French Climate and Energy Strategy. Multiannual Energy Programme, 2019-2023, 2024-2028*, draft for consultation.
7. A SUV or Sport Utility Vehicle is a hatchback recreational vehicle, which may have some off-road or towing capabilities.

REDUCING CO_2 EMISSIONS IN THE AUTOMOTIVE SECTOR: A EUROPEAN FAILURE

An ambitious but incomplete and ineffective policy

From the 1990s onward, the European Commission has introduced a strategy to reduce CO_2 emissions in the automotive sector constructed on three pillars: reducing emissions from new cars, tax incentives, and labelling to inform consumers.

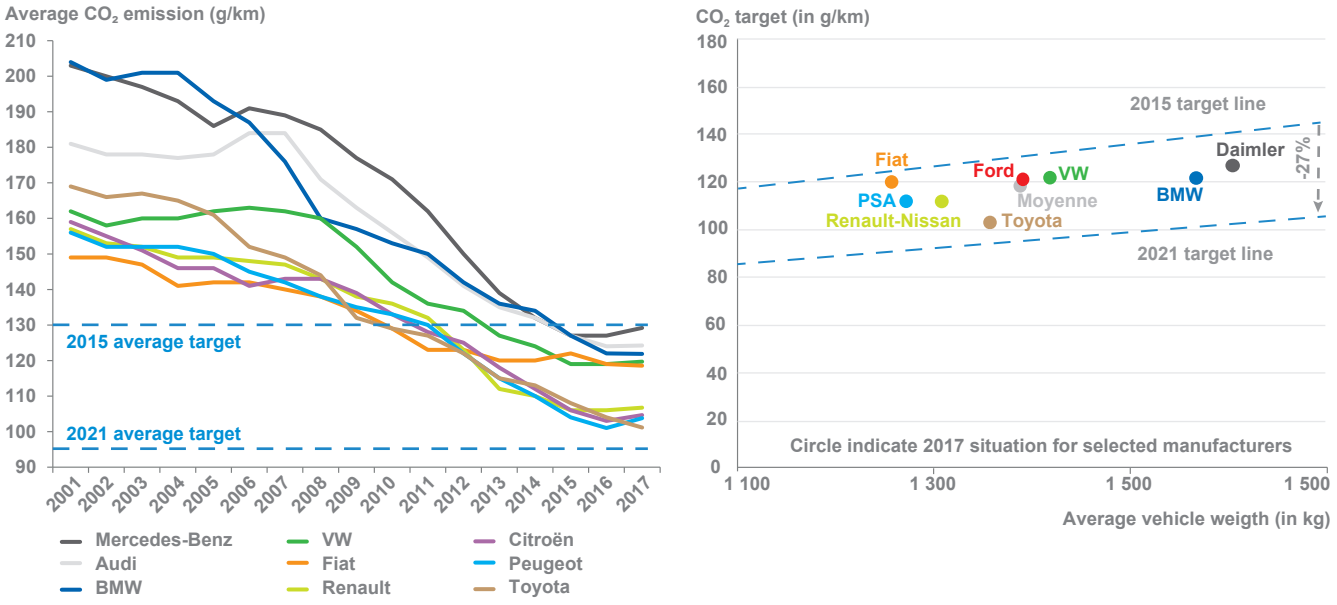
With the first pillar, the European Commission relied at first on voluntary agreement: in 1998, European automobile manufacturers committed themselves to reducing CO_2 emissions from their new cars by 25% compared with 1995 to reach a level of 140 g/km by 2008[8]. Yet in 2005, the Commission had to face the facts: the target was not going to be attained[9]. The European Commission, then, shifted the emphasis from a voluntary initiative to a more coercive obligation – an initial limit of 130 g/km was imposed on automobile manufacturers in 2009 to be achieved by 2015 and was reached by most of them two years ahead of schedule. A second limit of 95 g/km was imposed in 2013 to be achieved by 2021, which means reducing emissions by another 35 g/km (see Figure 2). Unlike the voluntary commitments, which were the same for everyone, these restrictive limits vary from one manufacturer to another. In 2008[10], under the auspices of the European Union, Germany pushed through a method of calculation that favoured heavy cars manufacturers as the CO_2 target is proportional to the average weight of manufacturer's new car sales[11].

Daimler, for instance, whose CO_2 emissions in 2017 approached the 130 g/km limit of 2015, with new cars having an average weight of 1,607 kg, is only required to achieve an average of 103 g/km by 2021, which is equivalent to the CO2 emissions of the most efficient manufacturer in 2017. Toyota, on the other hand, will have to make a further reduction of 9 grams by 2021, since the average weight of its cars is "only" 1,359 kg.

This consideration has important implications for both car sales and manufacturing costs. Lighter cars usually cost less, but like larger cars are obliged to install these emission reduction technologies, which can substantially increase the manufacturing cost of a car, and thereby reduce the manufacturer's margin.

As for the second pillar, Member States have blocked any initiative to standardize vehicle taxation, which they regard as a prerogative. Still, several Member States have implemented, at the national level, taxation based on CO_2 emissions from cars, as France did with the bonus/malus in force since 1st January 2008.

Figure 2 – Average CO_2 emissions from new cars in the EU from 2001 to 2017, and reduction targets for 2021, by automobile manufacturer



Source: ICCT (2018)

8. See "EU: Light-duty: GHG Emissions" (2018), on the TransportPolicy.net website.
9. Commission Communication (2005), *Implementing the Community Strategy to reduce CO_2 emissions from cars: Fifth annual Communication on the Effectiveness of the Strategy*, June.
10. See the Joint Declaration of the Franco-German Council of Ministers of 8 June 2008.
11. The weight is used here for simplicity, but refers to the mass of the vehicle in kilos.

On the theme of consumer information, the wide latitude granted to Member States for introducing labels has resulted in different rules from one country to another. In Germany, for instance, CO_2 emissions are based on the weight of the car when calculating its environmental rating[12], which allows an Audi Q7 weighing the equivalent of more than two Smart ForTwo, equipped with an engine three times more powerful and emitting one and a half times more CO_2 per km, to receive a "B" rating, whereas the small Smart ForTwo gets an "E" rating[13]. In France, to determine this environmental rating, only CO_2 emissions per km in absolute terms count: the Smart ForTwo therefore receives the highest "A" rating, while the Audi Q7 gets an "E" rating.

Of these three pillars, only the first – the goal of reducing emissions from new cars – has thus been implemented in a uniform way at the European level. CO_2 emissions from new cars have indeed decreased... but mostly on paper.

Emissions under real-world driving conditions have barely decreased in twenty years

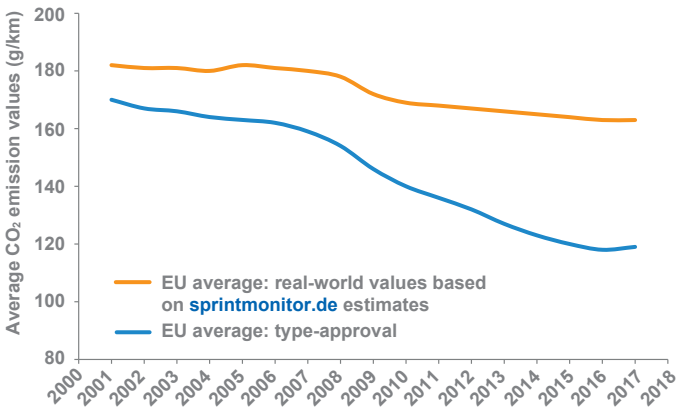
Between 2001 and 2017, CO_2 emissions from new cars measured in the laboratory, during certification testing, fell by 30% (see Figure 3). But under real-world driving conditions, they only decreased by 10%. In other words, two thirds of reductions since 2001 are artificial.

From 2001 to 2008, the dieselisation of new car sales served to offset the increase in the mass, size, and power of cars, while the four-fold increase in sales of SUVs since 2010 has completely negated the efforts made by manufacturers to reduce CO_2 emissions from new cars (see Figures 4 and 5). These efforts include weight reduction measures to stabilise the weight of larger cars, optimising the efficiency of combustion engines and improving aerodynamics.

The only significant decrease in real CO_2 emissions from new cars – 6 grams less in 2009 –was caused by a peak in small car sales, combined with a decrease in SUV sales (see Figure 5). Reduced purchasing power following by the financial crisis in 2008, together with scrappage schemes started in some member states, like France, did much to encourage the sale of lighter cars.

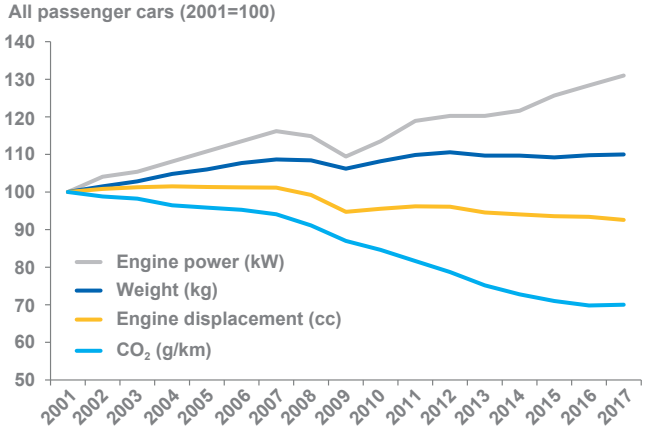
A recent study of more than 1.3 million cars in eight European countries[14] has demonstrated that the gap between "official" CO2 emissions measured in the laboratory in the NEDC certification cycle, compared with those

Figure 3 – Average CO_2 emissions from new cars measured under real-world driving conditions and in the laboratory in Europe



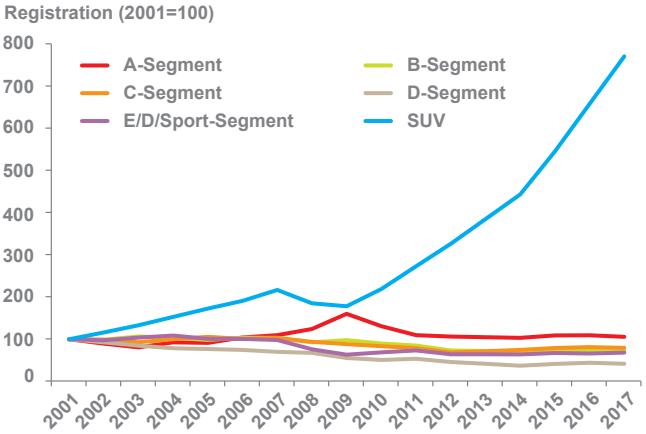
Source: ICCT (2019)

Figure 4 – Evolution of technical characteristics for the certification of new car sales in the European Union, 2001-2017



Source: ICCT (2018)

Figure 5 – New car sales in the European Union, by segment, 2001-2017



Source: ICCT (2018)

12. Haq G. and Weiss M. (2016), "CO_2 labelling of passenger cars in Europe: Status, challenges, and future prospects", Energy Policy, vol. 95, p. 324-335, August.
13. Based on information from the websites of the manufacturers Audi and Smart.
14. TNO / ICCT (2019), "From laboratory to road. A 2018 update of official and "real-world" fuel consumption and CO_2 values for passenger cars in Europe", White Paper, January.

measured under real-world driving conditions increased from 9% in 2001 to 39% in 2017. More than half of this discrepancy is a consequence of the latitude in testing procedure, where manufacturers can alter the charge status of the battery, the non-representativeness of tested vehicles, and the tolerance of measuring instruments (see Figure 6)[15].

With consumption, the discrepancy between the performance stated by manufacturers and the reality has critically inflated household fuel budgets, with an estimated additional annual cost of 400 euros for each car according to the ICCT[16]. In France, this represents a total additional cost of 20 billion euros on household fuel expenditure since the early 2000s.

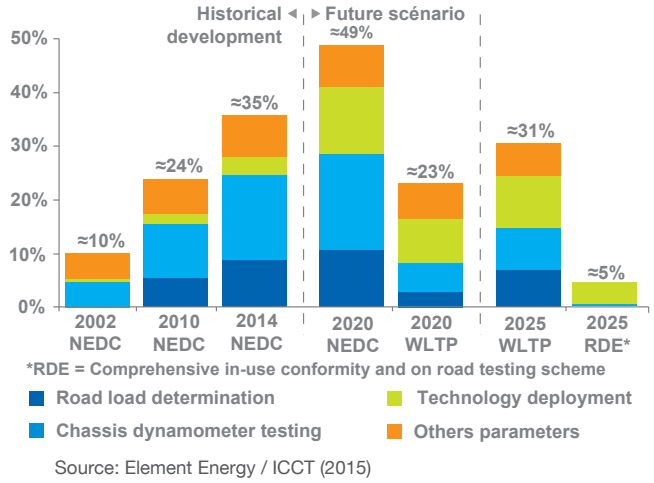
A difficult goal to achieve without electrification.

The target of reducing emissions of CO_2 per km to 95 grams by 2021 seems hard to achieve by relying solely on incremental improvements in the fuel efficiency of combustion-engine cars. Indeed, after twenty-five years of steady reduction, CO_2 emissions measured in the laboratory increased for the second consecutive year in 2018[17] – the combined effect of the success of SUVs, which have continued to increase their market share, and the fall in diesel car sales since 2015 (see Figure 7).

Following the Volkswagen scandal and the rigged assessments of nitrogen oxide (NOx) emissions in September 2015[18], several major European cities such as Paris, Berlin, Madrid and Rome declared their intention to restrict the use of the highest polluting diesel cars. These announcements caused a decline in the market share of diesel for new vehicles (see Figure 8); consumers anticipated access restrictions to city centres in the medium term, and a drop in their car's residual resale value, not to mention a possible rise in fuel price at the pump in some countries like France.

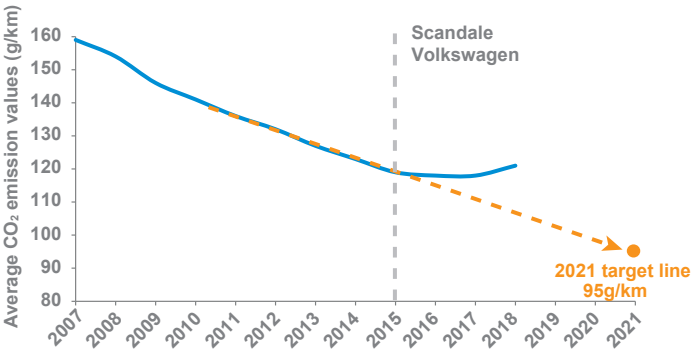
This 15 to 25 basis point reduction in diesel market shares in the main European automotive markets has not been offset – for the moment – by a significant increase in sales of electric cars, as in Norway (see below). Whether in France, Germany or the United Kingdom, sales of electric cars still made up less than 3% of the new car market in 2018.

Figure 6 – Gaps between official and real-world CO_2 emissions from new cars in the European Union, as a percentage



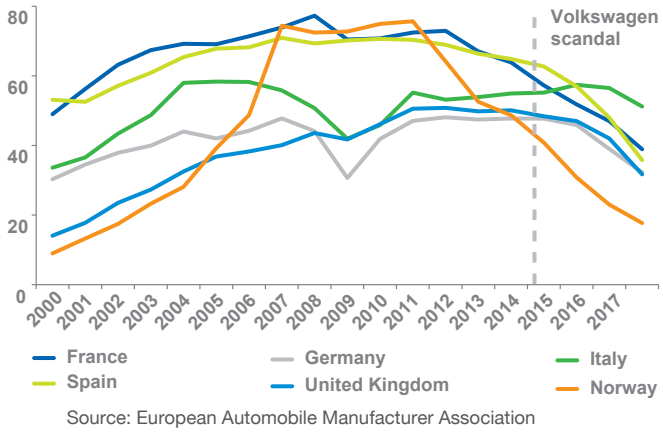
Source: Element Energy / ICCT (2015)

Figure 7 – Average CO_2 emissions measured in the laboratory and targets for new cars in the EU



Source: France Stratégieaccording Jato

Figure 8 – Market share of diesel cars in new car sales in Europe, as a percentage



Source: European Automobile Manufacturer Association

15. Element Energy / ICCT (2015), "Quantifying the impact of real-world driving on total CO_2 emissions from UK cars and vans", Final report for the Committee on Climate Change, September. In addition, automobile manufacturers underestimate the load factor they provide to laboratories to represent the rolling resistance as well as the aerodynamic drag of the car during certification testing, which explains a further third of the disparities. See Külwein J. (2016), "The impact of official versus real-world road loads on CO_2 emissions and fuel consumption of European passenger cars", ICCT, White Paper, May.
16. ICCT (2017), "Real-world vehicle fuel consumption gap in Europe at all-time high", Press release, 5 November.
17. Jato (2019), "CO_2 emissions rise to highest average since 2014, as the shift from diesel to gasoline continues", Press release, 4 March.
18. The German manufacturer admitted to fitting some of its cars with software capable of cheating emissions tests, thereby violating anti-pollution regulations.

In addition, the growing popularity of SUVs since 2010, which in the early 2000s represented less than 5% of new car sales, has shown no sign of waning, totalling more than 1 in 3 new cars registered in Europe in 2018[19].

Since the year 2000, the dieselisation of new car sales has compensated for the rise in emissions linked to the increase in weight, size and power. Today, the fall in sales of diesel engines has combined with the negative effects of this SUV trend, to cause an increase in CO_2 emissions. By 2021, this combined effect could add 5 to 10 grams of CO_2 to the average emissions of new cars. Manufacturers must, therefore, lower their CO_2 emissions by 30 g/km (25%) over the next three years-- or 10 grams per year-- something that has not occurred in the last twenty years.

WHAT MEASURES CAN REDUCE CO_2 EMISSIONS AND CAR ENERGY CONSUMPTION?

Manufacturers have undertaken a considerable amount of work during the last ten years to improve the efficiency of combustion engines, to make cars lighter, and to improve their aerodynamics. Today, the two most promising methods for achieving a decrease of 10 grams per year are the reduction in car size and electrification.

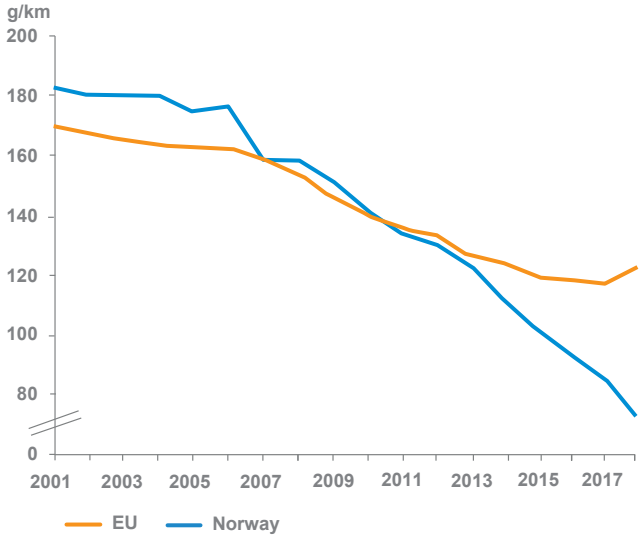
Implementing a proactive policy in favour of electric cars

To meet the 95 g/km target by 2021, manufacturers should sell a large number of electric cars, as is in Norway, where average emissions from new cars attained this threshold in 2016[20] (see Figure 9). Indeed, in Norway, unlike other European countries, the drop in diesel sales has unequivocally benefited electric cars (see Figure 10); virtually half the new cars sold in 2018 were electric.

For more than twenty-five years, Norway has implemented a range of direct and indirect incentives highly favourable to the development of electric mobility,[21] and at the same time strictly applied the "polluter pays" principle. It is one of the few countries in which an electric car is less costly than its combustion-engine equivalent. Electric cars were granted exemption from import tax at the beginning of the 1990s, followed by a 50% tax reduction on company cars in 2000, and finally exemption from VAT in 2001. In addition, many indirect incentives have been introduced at both national and local levels: exemption from annual road tax in 1996, free tolls in 1997 (motorways, bridges, tunnels); free parking in 1999; access to bus lanes in Oslo in 2003, and throughout the country in 2005; and free ferry transport beginning in 2009.

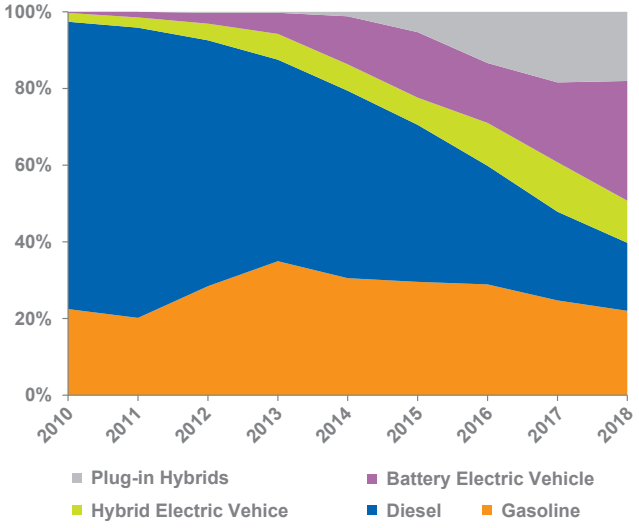
Following the example of London, European cities could also create zones where only ultra-low emission vehicles are to be used. The electric vehicle, though still not adapted to long distances, would have an immediate benefit for users, because combustion-engine vehicles, banned from city centres, would no longer satisfy all day-to-day mobility needs.

Figure 9 – emissions from new cars in Norway and the European Union



Source: Norwegian State Budget and Jato (2019)

Figure 10 – New car sales in Norway by engine type as a percentage



Source: Opplysningsrådet for veitrafikken (OFV)

19. Jato (2019), *op. cit*. In France, SUVs represented 36.2% of new car sales in 2018, according to the French Environment and Energy Management Agency (ADEME).
20. ICCT (2019), *European vehicle market statistics. Pocketbook 2018/19*.
21. Auverlot D., Meilhan N., Mesqui B. and Pommeret A. (2018), *Government Policy in Favour of Ultra-low Emission Vehicles*, France Stratégie, report, May.

In France, the target for electric cars sales on the new car market is 35% by 2030, and 100% by 2040. Yet if all types of decarbonised "vehicles" are used, the "factor four" goal in the transport sector could be reached as early as 2030[22] --that is, with 80% of day-to-day mobility needs being decarbonised: walking, cycling, scootering, carpooling, electric bicycles, electric scooters, electric vans, taxis, driver on-demand services equipped with electric vehicles, electric buses, electric trams, electric metro and electric trains.

Adding a weight component to the bonus/malus to discourage the purchase of SUVs

Weight is a factor in three of the four reasons affecting driving resistance for car: rolling drag, potential energy (on climbs), and inertia (during acceleration)[23]. Whether a car uses combustion or electric powertrain, its weight should be maintained to a minimum to keep its energy consumption as low as possible. This will reduce the battery capacity required to cover day-to-day mobility needs, making electric cars more affordable, limiting their environmental impact during production.

A bonus/malus based not only on CO_2 emissions, as today, but also on the weight of the vehicle, as in Norway, would help to dissuade households from buying larger and heavier cars, particularly since usually they are operated as single occupancy vehicles: in France 90% of trips from home to work and back are made with only one person in the car[24].

In addition, a bonus/malus based on weight would have a direct effect on the principal cause of car energy consumption, and would impede manufacturers' efforts to circumvent regulations ("cycle beating"), and this without waiting for 2027 and the hypothetical implementation of a mechanism by the European Commission to readjust their 2030 targets (see Inset 1).

Consider, again, the example in Germany of the Audi Q7 and the Smart ForTwo, with their environmental ratings of "B" and "E" respectively. In Norway, the weight component of car registration tax amounts to 20,000 euros for the Audi Q7 compared with only 1,000 euros for the Smart ForTwo-- 20 times less.

Inset 1 – Measuring real-world CO_2 emissions from new cars

The introduction of a new WLTP (Worldwide Harmonised Light-Duty Vehicles Test Procedure) certification cycle should reduce the 40% gap between "official" CO_2 emissions as measured in the laboratory in the NEDC certification cycle, compared with those measured under real-world driving conditions. Still, on-road measurements will need to be performed in parallel to ensure that the reduction in CO_2 emissions observed in the laboratory is not artificial.

To achieve this purpose, the European Commission intends to use aggregate data from all new cars, to be fitted with "black boxes" for measuring their actual fuel consumption[25] from 2021 onwards. If significant variations with laboratory measurements are detected in the period 2021 to 2026[26], the Commission may decide to introduce a mechanism for reassessing the 2030 CO_2 emission reduction goals imposed on manufacturers to make sure that the decrease measured in the laboratory corresponds to an equivalent decrease under real-world driving conditions.

No regulatory restrictions are currently associated with these consumption measurements under real-world driving conditions, despite requests from some NGOs[27].

In recent years, Norway has gradually lowered the tax burden on cars weighing less than 1.4 tonnes, and maintained high taxation on heavier cars (see Figure 11). In 2019, this weight component amounts to 1,250 euros for a 1-tonne car, ten times less than for a 1.8-tonne car, three times less than for the same car in 2014.

Inspired by Norway's example, the European Union could introduce a bonus/malus based on weight that would allow a 900 kg car like the Smart ForTwo to benefit from a 1,500 euro bonus upon purchase, while an Audi Q7 would be subject to a malus of 17,500 euros. In France, this sum could be in addition to the CO_2 malus capped at 10,500 euros for any car emitting more than 190 grams of CO_2/km.

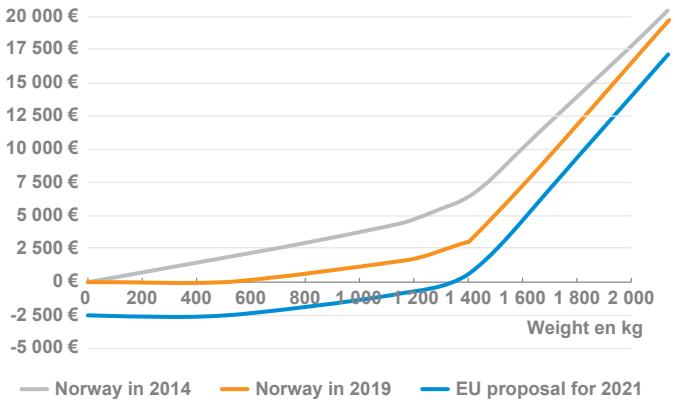
22. General Council for the Environment and Sustainable Development (2013), *Le facteur 4 en France: la division par 4 des émissions de gaz à effet de serre à l'horizon 2050*, Ministry for Ecology, Sustainable Development and Energy, final report, February.
23. Inter Action (2009), *Réflexions sur l'énergétique des véhicules routiers*, by Mathieu Barreau and Laurent Boutin, May.
24. General Commission for Sustainable Development (2014), "Le covoiturage pour les déplacements domicile-travail: quel potentiel?", *Études & Documents*, n° 107, June.
25. Council of the European Union (2019), " *CO_2 emission standards for cars and vans: Council confirms agreement on stricter limits*", *op. cit*.
26. European Commission (2019), "Post-2020 CO_2 emission performance standards for cars and vans", Policy.
27. Transport & Environment / Deutsche Umwelthilfe (2019), "*Get Real testing campaign: why new laboratory tests will do little to improve real-world fuel economy*", March.

A bonus/malus based on CO_2 emissions, and on weight would be more fair socially: it would reduce taxation on the lightest and most fuel-efficient vehicles while seriously increasing taxation on the heaviest vehicles, with large families continuing to benefit from reductions[28]. What is more, this system would give modest households medium-term access to more fuel-efficient, more economical second-hand vehicles.

Such a measure would encourage automobile manufacturers to develop lighter and more energy-efficient cars, to the benefit of the greatest number of people, and would stop the exponential growth of SUVs, including electric "tanks" weighing more than 2 tonnes, whose environmental gains are more than limited. As the ADEME (French Environment and Energy Management Agency) recently pointed out, the electric car offers an environmental gain all the more important, since it is used intensively, and the size of its battery is limited and suited to everyday use[29] --- less than 60 km per day for 80% of French people (see Inset 2 on the following page).

The 75 kWh battery of a Tesla Model 3 would cover 80% of the use of a fleet of five cars if it were divided equally into five 15 kWh batteries, whether in light electric cars (an autonomy of almost 200 km for Valeo's 48V e-City, which only weighs 600 kg and consumes 8 kWh per 100 km[30]) or in plug-in hybrids (with an electric range of 60 km[31]). Used in a single vehicle, this 75 kWh battery only covers 20% of the usage of this fleet. By way of illustration, the first version of the Renault Zoé, fitted with a 22 kWh battery, covers the vast majority of day-to-day journeys and could therefore replace the second, often second-hand, car owned by 30% of French households.

Figure 11 – Bonus/malus based on car weight: evolution in Norway and proposal for the European Union



Source: Norwegian Government and France Stratégie

Promoting decarbonised day-to-day mobility

To achieve an 80% decarbonised day-to-day mobility by 2030, all decarbonised modes of transport are to be encouraged, from walking to cycling, and public transport. However, for much of the population, the private car remains the only way to get around: it is precisely these people who should be encouraged to use electric cars for day-to-day mobility.

For individuals, a low-emission car could receive a discount proportional to its electric mileage. A battery electric vehicle (BEV), operational only in electric mode, would obtain a 100% discount on this weight-based component. Meanwhile, a plug-in hybrid (PHEV) would benefit from a discount proportional to the percentage of daily use covered in electric mode: a battery providing an actual electric autonomy of 60 km covers 80% of day-to-day journeys in electric mode.

For company cars, generally subject to annual taxation (corporate vehicle tax in France) and in which the driver often does not pay for the fuel, a discount on the annual bonus/malus could be calculated each year for plug-in hybrids (PHEV) by using real fuel consumption data from the "black boxes", as set out by the European Commission from 2021[32]. This would ensure that they are regularly recharged, and used in electric mode most of the time. A company car used in electric mode 80% of the time would thus be granted a discount of 80% on the annual bonus/malus. This measure would further encourage manufacturers to develop models with sufficient battery to accommodate most day-to-day journeys in electric mode.

As Norway envisaged in 2017[33] with its "Tesla tax" , electric cars weighing more than 2 tonnes could be excluded from this discount, because the large battery size restricts environmental gains of electric mobility. Rather than benefiting as today from a bonus of 6,000 euros, an Audi e-Tron costing more than 80,000 euros and weighing 2.5 tonnes, including 700 kg in batteries, should be subject to a malus of 10,000 euros, corresponding to the weight component of this bonus/malus applied to its weight, excluding the batteries[34].

28. See service-public.fr for cases where a reduction or exemption from the malus applies.
29. IFP Énergies Nouvelles (2018), "Cross-sector review of the impact of electrification by segment. Project E4T", ADEME, report, April.
30. *Le Parisien* (2018), "Voiture électrique: nous avons testé la e-City de Valeo", 5 December.
31. Hardman S., Plotz P., Tal G., Axsen J., Figenbaum E., Karlsson S. et al. (2019), "Exploring the role of plug-in hybrid electric vehicles in electrifying passenger transportation", UC Davis, Plug-In Hybrid & Electric Vehicle Research Center, *Policy Brief*, April.
32. Transport & Environment (2018), "How fuel consumption meters can be used to deliver real-world CO_2 improvements as part of post-2020 CO_2 standards", Briefing, November.
33. *Financial Times* (2017), "Norway's electric car owners face "Tesla tax"", 12 October.
34. Including the batteries in the calculation would increase the malus by 15,000 euros.

Insert 2 – The environmental impact of electric cars

While the electric car does not emit CO_2 "from the exhaust pipe", its environmental gain will be all the more important since the CO_2 emissions associated with its production will be contained and the electricity used to charge and recycle its battery will be decarbonised.

Whether a car is electric, diesel or petrol-fuelled, the same amount of energy goes into its manufacture. On the other hand, manufacturing the battery consumes as much energy as that of the car itself. The energy consumption associated with manufacturing a car doubles with a 50 kWh battery, which most new electric cars should be fitted with by 2020.

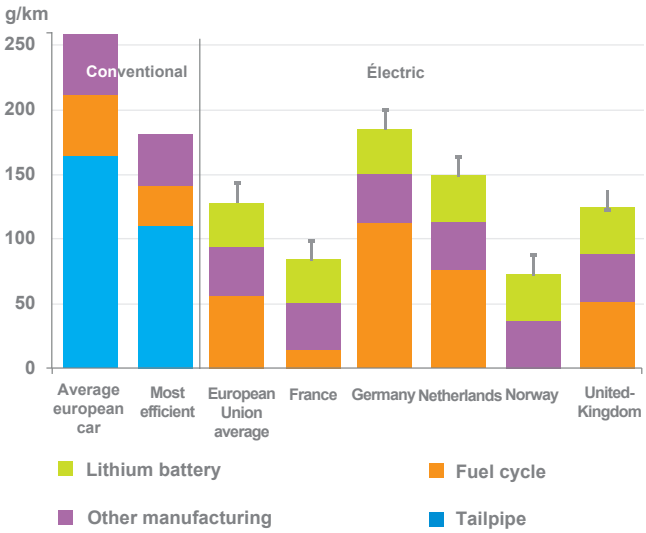
The electricity mix of a country where electric cars are used and manufactured plays an important role in environmental gains calculated over the car life-cycle. This gain will be substantial in countries with highly decarbonised electricity, such as France, but more limited in countries that resort to large quantities of coal for electrical generation, as in Germany, Poland and China.

The benefits in air quality are significant, regardless of the electricity mix, since no particles are emitted by the exhaust. Petrol and diesel vehicles, by contrast, are allowed to emit up to 600 billion particles per kilometre, in addition to their nitrogen dioxide emissions.

Moreover, the development of electric cars fitted with high-capacity batteries could, by 2025, compromise the availability of some rare metals, such as cobalt, essential in batteries offering an autonomy close to that of combustion-engine cars[35].

The risk, then, exists of creating a heavy dependence in Europe on countries that control its supply, notably the Democratic Republic of Congo, which accounts for more than half of cobalt extraction, as well as China, which already controls 80% of cobalt refining for battery applications[36].

Figure 12 – CO_2 emissions over the life-cycle of an electric or combustion-engine vehicle in Europe



Interpretation: due to a lack of available data, carbon emissions are compared over the life-cycle of production and use, and recycling is not included.

Source: ICCT (2018), *Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions*

Producing low-emission cars with low-emission electricity

Battery manufacturing can consume as much energy as manufacturing the car itself; therefore, this production should take place in those countries with low-emission electricity, and not in countries like Poland, the most coal-intensive country in the world, where, for instance, the Korean company LG Chemical[37] established its first European battery plant.

To produce these cars and their batteries with low-carbon electricity, a carbon price floor adjusted at the borders of the European Union could be introduced, as proposed three times by the President of the French Republic[38]. Such a system, which could potentially target a few key sectors such as the automotive industry, would help retain, in France and Europe, a greater share of the value added in manufacturing the cars of the future. It would also encourage manufacturers to produce their low-emission cars and their batteries with decarbonised electricity[39]. As such, it will also be possible to internalise pollution from production in Europe rather than externalising it, which would encourage us to boost our efforts to reduce these emissions.

35. Alves Dias P., Blagoeva D., Pavel C. and Arvanitidis N. (2018), " Cobalt: demand-supply balances in the transition to electric mobility", European Commission, Joint Research Centre, Luxembourg, Publications Office of the European Union.
36. *Financial Times* (2018), "China tightens grip on global cobalt supplies", 14 March.
37. Electrek (2018), "LG is investing half a billion in its Polish battery factory to increase production", 30 November.
38. Speech for a sovereign, united and democratic Europe, 26 September 2017; Speech at the Conference on Sustainable Finance (Brussels), 22 March 2018; Press conference following the Great National Debate, 25 April 2019.
39. Auverlot D., Meilhan N., Mesqui B. and Pommeret A. (2018), *Government Policy in Favour of Ultra-low Emission Vehicles*, *op. cit*.

The probability of achieving unanimity among member States for the creation of a carbon floor price adjusted at the borders of the European Union is highly remote. A standard limiting the carbon footprint associated with the production of low-emission cars and their batteries could be introduced as part of an enhanced cooperation procedure, involving at least nine Member States. A limit on the carbon content of the electricity used in the production process would ensure that these low-emission cars and their batteries are produced using low-carbon electricity.

Establishing an industrial plan for producing these low-emission vehicles

If Europe finally decides to introduce such tools to lower the real CO_2 emissions and fuel consumption for new cars (see summary table on the following page), it must-- together with this environmental plan-- develop a genuine industrial plan to ensure its autonomy of manufacturing these low-emission cars. Specifically, this includes batteries, on which European manufacturers have, so far, failed to compete with the sector's Asian giants, like South Korea's LG Chemical and Samsung SDI, Japan's Panasonic and China's BYD and CATL[40]. If, in the medium term, the European Union were unable to manufacture its own batteries[41], it would be compelled to pay a high import cost for each electric car sold. And it would be dependent on the countries such as China that control the supply of materials required to manufacture them[42] (see Inset 3).

France and Germany announced at the beginning of May 2019 the creation of an "Airbus for batteries", with the construction, by 2023, of two production plants, each employing 1,500 people. The projected figure for investment is between 5 and 6 billion euros[43], including 1.2 billion in public subsidies subject to the approval by the European Commission by the end of 2019. If this initiative succeeds, it will allow European manufacturers to compete with Asian players, but without guaranteeing them access to rare metals such as cobalt.

Research and development must be conducted throughout Europe to develop batteries containing a very low cobalt content: "high-tech" solid electrolyte batteries particularly within the European consortium led by Saft[44], which aims to start production by 2025, or "low-tech" alternative-chemistry batteries such as the lithium iron phosphate (LiFePO4) battery for batteries with a contained capacity (15 kWh) – suitable for lightweight battery electric vehicle like the 48V e-City developed by Valeo[45] or plug-in hybrids.

Setting up a recycling eco-system for these batteries – an "Airbus for recycling" based on the European champions Umicore and Valdi (Eramet) – will also be necessary to reduce our dependence on third countries for our rare metal supplies. Recent work by the European Commission[46] estimates that recycling 90% of electric car batteries after eight years of life would cover 10% of the European Union's cobalt requirements for electric cars by 2030.

Just as China has long promoted the development of its local battery champions[47], so, too, European countries could provide adequate financial aid for those electric cars that attain a standard – to be defined – based on the carbon content of the electricity used in their production. Time is of the essence. The first electric cars produced in China are scheduled to arrive on the European market this

Insert 3 – The impact of car electrification on our trade balance

Passenger cars used for private transport consume approximately 23 million tonnes of oil equivalent each year in France, which represents 164 million barrels of oil or the equivalent of 26 billion litres of oil. Since France produces only 1% of what it consumes[48], 10 billion dollars' worth of oil is imported each year, and used for private transport in passenger cars[49].

Achieving carbon neutrality by 2050 – a goal set by the Minister for the Ecological and Inclusive Transition –implies that all cars on the road in France must be electric. Assuming a fleet of 32 million electric cars each fitted with a 50 kWh battery costing 150 $/kWh to produce, the total cost of manufacturing these batteries is 240 billion dollars over thirty years, or 8 billion dollars per year.

If we do not produce these batteries locally, battery imports will cancel out most of the savings made on our oil imports.

40. Ni J. (2018), "Does China hold the Key to the Future of the Electric Car?", France Stratégie, *La Note d'analyse*, n° 70, September.
41. See European battery cell R&I workshop Final report, European Commission, 12 February 2018.
42. Auverlot D., Meilhan N., Mesqui B. and Pommeret A. (2018), *Government Policy in Favour of Ultra-low Emission Vehicles*, *op. cit*.
43. *Libération* (2019), "Airbus des batteries: mieux vaut tard que jamais", 3 May.
44. *L'Usine Nouvelle* (2018), "Saft forme une alliance pour développer une batterie lithium-ion solide", 22 February.
45. *Le Parisien* (2018), "Voiture électrique: nous avons testé la e-City de Valeo", 5 December.
46. Alves Dias P., Blagoeva D., Pavel C. and Arvanitidis N. (2018), "Cobalt: demand-supply balances in the transition to electric mobility", *op. cit*.
47. Ni J. (2018), "Does China hold the Key to the Future of the Electric Car?", *op. cit*.
48. Ministry for the Ecological and Inclusive Transition (2019), "Ressources en hydrocarbures de la France", June.
49. This bill obviously fluctuates according to the price of oil: it amounts to 8 billion dollars for a barrel at 50 dollars and rises to 13 billion dollars for a barrel at 80 dollars.

Summary table of possible levers to finally reduce CO_2 emissions and car energy consumption

			LEVEL OF APPLICATION		
			European Union	**Enhanced Cooperation (9 Member States minimum)**	**National**
REGULATORY LEVERS		37.5% decrease in average emissions from new cars between 2021 and 2030	- Adopted by the European Union in April 2019 - Each manufacturer's reduction target remains proportional to the average mass of cars sold		
		Measurement of CO_2 emissions under real-world driving conditions	- European Commission survey of new car consumption from 2021 - No binding measures planned before 2030		
		Limit on the carbon content of electricity used to produce low-emission cars and their batteries	Qualified majority required but difficult to achieve among Member States with high-carbon electricity	Member States that are not part of the enhanced cooperation should not oppose it	
TAX LEVERS		Introduction of a carbon floor price adjusted at the borders of the European Union	Unanimity required but difficult to achieve among Member States with high-carbon electricity		
	Addition of a weight component to current tax on CO_2 emissions	Discount on the weight component for individuals proportional to the theoretical utility factor in electric mode permitted by the battery	Unanimity required but difficult to achieve		Possible addition to the current bonus/ malus on CO_2 emissions
		Discount on the annual taxation of company vehicles proportional to the actual utility factor in electric mode			
		Discount exemption for electrified cars weighing more than 2 tonnes in 2021 (followed by 1.5 tonnes in 2025)			
		Discount exemption for electrified cars where the carbon content of the electricity used to produce them exceeds the regulatory limit			
R&D		Development of batteries with a very low cobalt content	R&D grants to reduce the amount of cobalt per kWh in batteries: alternative chemistry, solid electrolyte batteries		
		Development of a battery recycling system	Incentives to ensure that battery recycling takes place in Europe		
		Development of a refining system for rare metal: lithium, nickel, cobalt, manganese, rare earths	Implementation of processes to limit pollution during the refining of these metals and strict environmental standards so that refining plants and their pollution can be relocated		

In orange: the levers put in place at the time this report was published

year. Volvo's first electric car, the Polestar 1, will be manufactured in Chengdu and launched in Europe mid-2019[50]. BMW will follow in 2020, with the introduction in Europe of its iX3 electric SUV, produced by its Chinese plant in Shenyang[51]. Meanwhile, Daimler has recently announced that the Smart's production, which has been based in Hambach in Moselle for twenty years, will be moving to China in 2022, under a new partnership with Geely, the Chinese manufacturer that owns Volvo[52].

CONCLUSION: IS IT POSSIBLE TO SIGNIFICANTLY REDUCE CO_2 EMISSION FROM CARS?

If we want to reduce substantially CO2 emissions from passenger cars, it is crucial to reorient the market towards lighter cars that emit less. And if we genuinely want the electric car to be a viable, realistic solution for individual mobility, we must limit the environmental externalities linked with their production. This is the goal of the measures outlined in this report: a bonus/malus based on CO2 emissions and car weight, combined with a carbon footprint standard relating to the production of low-emission cars and their batteries.

These measures must be implemented at the European level to strengthen and enlarge their environmental impact. In this way, the transport sector will at last make a decisive contribution towards achieving the ambitious aims of the Paris Agreement, after being regarded as the black sheep of the Kyoto Protocol.

Key words: greenhouse gas emissions, automobile manufacturer, electric car, bonus/malus, carbon footprint

50. *Challenges* (2019), "Polestar 1: une Volvo sportive fabriquée en Chine à plus de 150 000 €!", 25 April.
51. *Challenges* (2018), "BMW Concept iX3: le SUV électrique s'annonce", 25 April.
52. *Les Échos* (2019), "Smart abandonne la Moselle pour la Chine", 28 April.

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Press contact: Flavio Leoni, Communications Officer, Publishing-Communications-Events Department, +33 (0)1 42 75 60 30, flavio.leoni@strategie.gouv.fr