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The Transformation of the European Car Industry
Electrification and Its Challenges

The European automotive industry faces many 21st-century challenges, with sustainability and climate protection as key objectives. Among these, the European Parliament's decision to mandate zero emission passenger cars and light commercial vehicles from 2035 marks a transformative shift. This cornerstone of the "Fit for 55" climate package carries broad economic, social and political implications, requiring significant adjustments across the automotive value chain and presenting major hurdles for stakeholders.

This manuscript explores the sector's electrification efforts, focusing on the tension between sustainability goals and economic impacts. It highlights disparities in electric vehicle affordability and accessibility across Europe, which risk deepening socio-economic inequalities, and questions the environmental and equity outcomes of weight-based regulatory incentives favouring premium models.

Beyond assessing the feasibility of emissions targets, the study critically examines whether the EU's focus on electric vehicles aligns with broader climate goals or creates new challenges. Addressing these issues aims to illuminate the immediate and long-term implications for the evolution of the automotive industry and Europe's socio-economic landscape.

Keywords: electric cars, automotive industry, sustainability, CO_2 emissions, NO_x emissions, premium models, charging infrastructure, alternative fuels, electrification

Introduction

For Hungary as a member of the European Union, it will be essential to adapt to modern economic and environmental challenges in the future. The European Union's Climate Change Directive and the European Union's Greenhouse Gas Emission Reduction

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Directive for 2030 [Directive (EU) 2018/410], adopted in 2018, requires that EU member states reduce greenhouse gas emissions by at least 55% by 2030. This commitment aims for the EU to achieve climate neutrality by 2050.[2]

The EU's decision comes as the result of the latest scientific reports showing that the world's climate is undergoing highly unusual and significant changes. Global warming is accelerating and is already causing irreversible changes in ocean currents, precipitation patterns and wind patterns.

Increased average temperatures and extreme weather events have a significant economic cost for the European Union,[3] and often affect countries' ability to produce food.[4]

The aim of my study is therefore to explore which EU regulatory instruments can help to achieve this climate neutrality goal, and to examine which policy measures can help the economic competitiveness of Europe and Hungary in the future, especially concerning the rise of electric cars after the diesel scandal and the EU's climate neutrality objectives, and to examine whether electric cars can be the solution to reduce carbon dioxide emissions in the EU Member States.

I deem the rise of electric cars necessary mainly because this trend will bring about inevitable changes in the automotive industry, which is a crucial sector for the EU and our economy. For example, according to the Hungarian Central Statistical Office (KSH) data, it is the most important sector of the Hungarian manufacturing industry, accounting for 25% of domestic manufacturing output in November 2024.[5]

The Hungarian automotive industry already plays a prominent role in the Hungarian economy, and it is expected to continue to develop and dominate the sector, together with the growing importance of battery production and related investments.[6]

My article aims to provide a comprehensive analysis of the challenges of electrification of the European automotive industry to achieve sustainability and climate neutrality goals. This raises critical questions about the reality of the regulation and offers a nuanced perspective on whether this transition is a step in the right direction and whether the take-up of electric cars can only be beneficial.

The article's methodology is based on reports and statistics from the European Commission and the European Court of Auditors, the European Automobile Manufacturers' Association (ACEA), together with a range of relevant literature on the subject.

The entire transfer for electric cars: Solution or additional problem?

Since 1998, the European Commission has been trying to reduce greenhouse gas emissions from cars by regulating the average CO_2 emissions of new cars. This started from

2 Council of the European Union 2024.
3 Hungarian Academy of Sciences 2014.
4 Council of the European Union 2024.
5 KSH 2025.
6 WEINHARDT 2023.

186 g CO_2/km on average in 1995, to 130 g in 2015.[7] Then a target of 95 g/km was set for the period 2020–2021 (although the measurement method changed from NEDC to WLTP, the 95 g/km target corresponds to approximately 115 g/km under the WLTP system between 2021 and 2024, reducing to 93.6 g/km between 2025 and 2029, with a target of 49.5 g/km between 2030 and 2034 and 0 g/km from 2035).[8] Each vehicle manufacturer's target is adjusted to the average mass of the models in its range.[9]

However, this policy has not been effective so far, as emissions from the transport sector have increased (the transport sector accounted for 23% of total EU GHG emissions in 2021[10]), accounting for a quarter of total emissions and cars account for 60% of total transport emissions.[11]

Following the "Dieselgate" scandal,[12] the European Commission has decided to tighten its emissions policy further. It has tightened up penalties for non-compliance with the new Worldwide Harmonised Light Vehicles Test (WLTP)[13] driving cycle and the introduction of the Real Driving Emissions (RDE) test[14] and has also tightened up the emission values to the levels as mentioned above. By comparison, CO_2 emissions are directly proportional to the amount of fuel burned. On average, 1 litre of petrol burns 2.33 kilograms of CO_2, compared to 2.64 kilograms for 1 litre of diesel. To meet the 95 g CO_2/km (2021–2025) target, a diesel vehicle would need to consume an average of 3.6 litres per 100 kilometres, compared to 4.1 litres for a petrol vehicle. This is the average amount that all cars sold in the EU would have to aim for to reach the 95 g CO_2/km target, and 93.6 g CO_2/km from 2025.

7 Mock 2018.
8 European Court of Auditors 2024.
9 Regulation (EU) 2014/333.
10 European Court of Auditors 2024.
11 European Parliament 2023.
12 The diesel scandal is one of the biggest industrial scandals, which erupted in 2015 when it was revealed that some car manufacturers, notably the Volkswagen group, had manipulated emissions data for their diesel vehicles. Volkswagen deliberately programmed its direct-injection turbocharged diesel (TDI) engines to activate certain emission control systems only during laboratory tests. The system reduced the car's power output during the test and created a richer mixture in the combustion chamber, resulting in less nitrogen being released into the air. In reality, nitrogen oxide emissions were 40 times the legal limit in real conditions.
13 The Worldwide Harmonised Light Vehicles Test (WLTP) was designed to replace the outdated European Driving Cycle (NEDC) and was adopted on 1 June 2017. The WLTP measures all air pollutants and greenhouse gas emissions already regulated by the NEDC. The aim was to ensure that the WLTP cycle more accurately reflects real road driving conditions.
14 The Real Driving Emissions (RDE) test is carried out in real traffic on public roads, covering a wide range of driving conditions experienced by drivers across the EU. The RDE test is designed to cover normal driving conditions. It consists of three parts (urban, rural and motorway), determined by the speed at which the car is travelling. In order to pass the RDE test, the vehicle must have average NO_x emissions below the limit value for the full test and the urban part.

Table 1: Carbon dioxide emission targets for the EU car fleet since 1998

Year	Target (g CO_2/km)
1995–2010*	186
2010–2019	130
2020	95
2021–2024**	115.1
2025–2029	93.6
2030–2034	49.5
2035–	0

*Note: * voluntary targets based on agreements with the EU; ** measurement method changed from NEDC to WLTP.*
Source: European Court of Auditors 2024

Obviously, meeting such a target will only be possible if car manufacturers increase sales of electric vehicles (EVs). Otherwise, they will face annual penalties for the whole industry. If a manufacturer exceeds the 95-gram limit (which will be 93.6 g CO_2/km from 2025), it will have to pay a penalty of €95 per gram multiplied by the number of cars it sells in the EU, estimated at €14.2 billion in 2021.[15] If carmakers do not reduce their average emissions below 93.6 g CO_2/km from 2025, the total industry penalty could rise to around €13 billion for cars and a further €3 billion for vans (to avoid penalties, carmakers will have to sell at least 20% all-electric vehicles, even if EV sales growth stagnates). Therefore, the European Union's automotive lobby is seeking to postpone the 2025 emissions targets by two years. The industry group is proposing that the EU should introduce emergency legislation to ensure that car manufacturers avoid drastic fines of up to €13 billion or face the possibility of having to stop production of around 2 million cars and threatening millions of jobs in the EU.[16]

Returning to the Dieselgate,[17] another important consequence was that the main technology developed by the European industry to reduce CO_2 emissions, diesel engines, was phased out. Although diesel cars in Europe emit on average 15–25% less CO_2 than petrol cars, this benefit comes at the cost of four times higher air pollutant emissions. The drive to dieselise new car sales was aimed at reducing CO_2 emissions and complying with regulations. The market share of diesel cars has increased from 35% in the early 2000s to 52% in 2015, but has been steadily declining since the scandal broke, falling to 30% in 2019. This sharp decline has seen average measured CO_2 emissions from new cars in Europe rise after more than 20 years of steady decline, reaching 122 grams in 2019, 27 grams above the 2021 target, but falling to 108 g/km in 2020,[18] which is also further away from the target. Furthermore, according to a report by the European Court of Auditors for 2024, the EU has failed to reduce car emissions from cars with internal combustion engines over the past 10 years, due to their greater weight and power.[19]

15 VÁRKONYI 2020.
16 Automotive News Europe 2024a.
17 SZEGEDI 2018, 2022.
18 KSH 2022.
19 European Court of Auditors 2024.

This raises the issue of how the industry can achieve reductions as testing protocols tighten and diesel vehicle sales decline. The only possible answer is the aforementioned electrification, and the European Commission has paved the way to ease the transition by introducing 'super credits' for low-emission vehicles. From 2020, all cars emitting less than 50 grams of CO_2 per kilometre will be counted twice when determining the average emissions of each car manufacturer (until 2022[20]), and only electric vehicles will be able to meet this.[21]

The distortive effect of legislation favouring heavier vehicles

The increase in vehicle weight over the past decades has had a significant impact on fuel consumption and carbon dioxide emissions, which are crucial factors in achieving climate protection goals, as weight growth directly contributes to the rise in CO_2 emissions.

Between 2001 and 2008, the average weight of cars sold in Europe increased by 10%, equivalent to 129 kg. If we go back to 1995, when the European Commission first introduced the regulation to reduce CO_2 emissions in the transport sector, the average European car gained 259 kg, an increase of 20%.[22] A 10% increase in weight corresponds to a nearly 7% increase in CO_2 emissions.[23]

In addition, the performance of heavier vehicles has also increased over the period (by 15% between 2000 and 2008), which is another factor in the increase in emissions. The increase in engine power also has a negative impact on emissions, as the additional energy used during acceleration represents an additional 15% increase in CO_2 emissions, equivalent to an increase of 7–10%.

It is important to mention that, since the CO_2 targets for each car manufacturer are based on the average weight of vehicles sold, which means that as the weight of a vehicle increases, the targets are less stringent than for lighter vehicles. This parameter, which was introduced in European legislation in 2008[24] following considerable lobbying by the German Government,[25] was introduced to protect premium brands [the current Regulation (EU) 2019/631 sets out in its Article 4 the permitted derogations depending on the weight of the vehicles; this article states that the emission targets are adjusted according to the weight of the vehicles, thus allowing higher emission targets for heavier vehicles and stricter standards for lighter vehicles].[26]

Models from these brands are usually several hundred kilos heavier than models from mainstream brands, because heavier cars are easier to comply with regulation. As it is easier to introduce environmentally friendly technologies for more expensive cars, these weight-based targets have driven the whole European car industry upwards

20 Regulation (EU) 2019/631.
21 Szűcs 2022.
22 Pardi 2022: 167.
23 International Council on Clean Transportation 2017: 6.
24 Transport & Environment 2007.
25 Jerome 2007.
26 Regulation (EU) 2019/631.

in terms of price. Therefore, the average car sold in Europe has become more expensive making it harder for families to buy a new car.[27]

Another reason for the rising cost of new cars is the tightening of safety standards. The European Union's General Safety Regulation 2 (GSR2) regulates the general safety requirements for vehicles and the use of Advanced Driver Assistance Systems (ADAS).[28] This regulation has led to cost increases,[29] particularly in the small car category (the second half of the regulation came into force on 7 July 2024, making black box, cyber-attack protection, intelligent cruise control, driver fatigue and alertness detection, reversing radar–camera, advanced emergency braking systems mandatory safety features for all new passenger cars placed on the EU market, and lane-keeping assist), which has led some manufacturers to decide to stop selling these low-consumption models in Europe, which, in addition to increasing costs, could again lead to an increase in fleet-level emissions,[30] since, as we have seen, larger, heavier vehicles emit more pollutants.

In addition to these, the tightening of environmental Euro standards, which manufacturers are building into the price of new cars, will also increase the price of new cars. According to the European Automobile Manufacturers Association (ACEA), the introduction of the Euro 7[31] standard could increase the price of cars by up to €2,000.[32]

It is therefore contradictory that when the car industry voluntarily committed to reduce CO_2 emissions by 25% between 1998 and 2008, car manufacturers made it harder for themselves by increasing the weight and engine power of the cars they sold. Not surprisingly, they failed to meet the 2008 target of 140 CO_2 g/km. The upward drift has not stopped: the average European car has become longer (+9 cm), wider (+4 cm) and taller (+2 cm) between 2008 and 2018; the share of automatic gearboxes and all-wheel drive, which both increase weight and CO_2 emissions, has increased from 13% to 36% and from 9% to 14% of total sales respectively over this period, and engine power has increased by a further 15%. As in the previous period, the net result of these paradoxical trends was that it became increasingly difficult to achieve CO_2 reductions, and the industry's response was to use new technologies to optimise CO_2 performance in homologation testing to meet the 2015 target of 130 CO_2 g/km, as illustrated by the increasing gap between the New European Driving Cycle (NEDC)[33] and real driving CO_2 emissions. Transport & Environment (T&E) also reports in a recent study that the average width of new cars will exceed 180 centimetres in the first half of 2023, up from 177.8 cm in 2018,

27 Pardi 2022: 163.

28 Regulation (EU) 2019/2144.

29 Thatcham Research 2024.

30 Horváth 2024.

31 The phasing-in of Euro 7 will vary according to the type of vehicle: new passenger cars and light commercial vehicles will be mandatory from 1 July 2025, and heavy-duty vehicles from 1 July 2027. This standard will require stricter limits and more durable emission conformity and will also cover particulate emissions from brakes and tyres to reduce air pollution.

32 ACEA 2023.

33 The New European Driving Cycle (NEDC) was a standardised testing procedure introduced by the European Union to measure vehicles' fuel consumption, CO_2 emissions and other air pollutants. It was developed in the 1970s and later modified to suit modern vehicles. The cycle aimed to provide comparable data on vehicle consumption and emissions based on laboratory tests. Since 2017, it has been replaced by the WLTP (Worldwide Harmonised Light Vehicles Test Procedure).

making them on average half a centimetre wider each year since 2001, taking up more space and obviously emitting more harmful substances.[34]

Table 2: Growth in car size and performance between 2008 and 2018

Year range	Length increase (cm)	Width increase (cm)	Height increase (cm)	Automatic gearbox share (%)	All-wheel drive share (%)	Engine power increase (%)
2008–2018	9	4	2	13–36	9–14	15

Source: compiled by the author

Yet, because of the aforementioned regulation that makes it easier for heavier cars to comply with the regulation, on paper they have been more successful in reducing CO_2 emissions than lighter cars. The difference between the average CO_2 emissions of premium car brands (Mercedes, BMW, Audi, Volvo) and mainstream car brands (Renault, Peugeot, Citroen, Ford, Opel) has fallen from 40 g/km in 2001 to 16 g/km in 2018, with the average premium car gaining 192 kg and the average mainstream car only 100 kg.

The answer has several components as to how this was possible. Firstly, the mandatory targets set by the 2009 Regulation discussed above [and the current Regulation (EU) 2019/631] are weight-based, so as discussed earlier, car manufacturers selling heavier cars have an easier CO_2 target. For example, in practice, this meant that by 2021, the premium group would comply with the regulation if they achieved 102 CO_2 g/km and the generalist car manufacturers would comply if they achieved 92 CO_2 g/km. This means that carmakers who increase the weight of their cars will not be penalised as their target will be less stringent and, more importantly, carmakers who reduce the weight of their cars will not be rewarded as their target will be more stringent.

As a result, the regulation will push all car manufacturers, including generalist car manufacturers, up the market. This means that the heavier the car, the lighter the rules, which basically benefits four manufacturers: the big three German car makers, Volkswagen, BMW and Mercedes-Benz, and the Ford–Volvo duo. Under this calculation in 2021, these four companies have received a total of €1,670 million in rebates, while all other manufacturers paid €532 million more than if they were all treated the same.[35]

Despite this, by 2025, the Volkswagen group could still face a €1.5 billion penalty due to the aforementioned tightening CO_2 emission limits (but at the same time they have added the cost of having to sell more electric cars, with lower profits, rather than more profitable combustion-engined cars).[36]

Moreover, there is also the possibility of pooled fleet compliance, a mechanism in the EU's CO_2 emissions legislation that allows car manufacturers to meet their emission targets together.[37] This means that several car manufacturers can form a pool and are assessed on their combined emissions rather than individually. If the jointly calculated emissions level complies with the rules, they can avoid or reduce fines. In this way,

34 Transport & Environment 2024a.
35 Bucsky 2021.
36 Automotive News Europe 2025.
37 European Commission s. a.

Stellantis, Ford and Toyota plan to buy credits from Tesla and Mercedes-Benz from Volvo and Polestar, as the emissions rules benefit the U.S. carmaker, which will be compensated for the consolidation of its EV fleet sold this year.

Therefore, exact calculations for 2025 are therefore difficult to establish yet with the new CO_2 standards, as the expected penalties discussed earlier will depend essentially on the percentage of electric cars that car manufacturers can sell. If sales figures are high in terms of electric vehicles, the €13–15 billion penalty mentioned above could be much lower.[38]

The other answer is that since weight reduction is not a solution to meet CO_2 targets due to regulations that "reward" heavier cars, car manufacturers can only rely on greener technologies. However, greener technologies are expensive and easier to introduce in less price-sensitive premium cars. The two main technologies for reducing CO_2 emissions in 2001–2018 were diesel engines and direct gasoline injection (GDI), which are premium technologies. In the European market, the average premium for buying a diesel vehicle over a comparable petrol vehicle is between 9% and 21%.[39] The premium group was particularly successful in selling diesel cars, which accounted for almost 80% of its sales before Dieselgate, compared to only 50% for the generalist group.

The third possible answer is that new technologies already available in a generalist car, such as start–stop systems and cylinder deactivation, help to reduce CO_2 emissions and offer new possibilities for optimising laboratory tests. For example, in 2017, the difference in CO_2 emissions between laboratory tests and real-world conditions averaged 35% for petrol cars, 41% for diesel cars, 47% for hybrid electric cars and 221–225% for plug-in hybrid electric cars, 33% for manual gearbox cars and 40% for automatic gearbox cars, and 46% on average for the premium group and 37% for the generalist group.[40]

Table 3: The difference in CO_2 emissions between laboratory tests and real-world conditions (2017)

Vehicle Type	Difference in CO_2 emissions (lab tests vs. real-world conditions)
Petrol cars	35%
Diesel cars	41%
Hybrid electric cars	47%
Plug-in hybrid electric cars	221–225%
Manual gearbox cars	33%
Automatic gearbox cars	40%
Premium group	46%
Generalist group	37%

Source: compiled by the author

The electric car remains a premium technology: the purchase price is around €10,000–15,000 higher[41] than for a car with an internal combustion engine, which makes it much easier to electrify premium models.[42] An electric vehicle has large and powerful

38 Transport & Environment 2024c.
39 International Council on Clean Transportation 2019: 46.
40 TIETGE et al. 2019: 8–13.
41 Deloitte 2024: 6.
42 Transport & Environment 2024b.

batteries, fantastic acceleration and top speed and very low noise levels. Unsurprisingly, although premium brands were initially hesitant to electrify their models, they swiftly shifted towards electrification once they realised that diesel technology was insufficient to meet the previous 2021 CO_2 targets and the 93.6 g/km target already in place as mentioned earlier.[43]

Electric cars have the potential to become an affordable technological solution, provided they adopt smaller, lighter batteries designed primarily for specific mobility needs, such as urban transport, rather than serving as all-purpose vehicles. However, instead of pursuing this direction, the European automotive industry is increasingly favouring heavier models. This trend, coupled with electrification, is expected to exacerbate the upward trajectory in vehicle weight rather than counteracting it.[44]

The environmental, economic and political costs of electrification

Over a decade ago, when the automotive industry began considering mass production of electric cars and several brands released their first electric models, it was widely accepted that electric vehicles could not compete with conventional cars due to their limited range and long charging times. Rather, it was expected that they would shift the focus from car use to shared mobility, and from multi-purpose vehicles to dedicated service-based vehicles supported by a dense charging network.[45]

One of the first cars of this type was the Bolloré Bluecar, used by the Paris-based car-sharing service Autolib. Unlike the premium models, the Bluecar was extremely small and compact, measuring just 3.3 metres, compared to the average EU car length of 4.2 metres in 2009.[46] It was also only 1.7 metres wide, which is not even comparable to the almost 2 metres width of the new SUVs in the recent T&E survey mentioned earlier. The vehicle's total weight was only 1,070 kg, including the 30 kWh battery, which weighed 300 kg on its own.[47]

By comparison, the Tesla Model Y, Europe's best-selling electric vehicle in 2023,[48] weighs an average of 890 kg more than the Bluecar, depending on battery size and engine power. It is also 1 m longer and has 57 kWh battery capacity, with a range of 455 km.

The Volkswagen E-Up, launched in 2013 as a relatively affordable electric car, illustrates the upward evolution of electric cars in Europe. Between 2013 and 2020, its battery capacity doubled from 18.7 kWh to 36.8 kWh and its range increased from 130–150 km to 250–300 km. Engine power did not increase significantly (from 60 kW to 61 kW). The vehicle's weight has increased by 90 kg thanks to the larger battery, while its price has risen by 11.5%.

Here again, the problem comes to the fore that Volkswagen, instead of using the technological advances in batteries and electric powertrains to make the E-Up lighter

43 Pardi 2022: 174.
44 Transport & Environment 2023.
45 Villareal 2011: 326–339.
46 Vervaeke–Calabrese 2015: 245–264.
47 Pardi 2022: 177.
48 De Prez 2024.

and more affordable, has followed an upward trend to improve, presumably for greater profit (and this small city car is no longer available in the range). Thanks to this general trend, it is already clear that the average European electric car will be much heavier and more powerful than the equivalent internal combustion car. According to the International Energy Agency (IEA), the average pure electric vehicle (BEV) and plug-in hybrid (PHEV[49]) sold in Europe in 2017 was 200 kg and 420 kg heavier than the average internal combustion engine car, respectively. Newer models, such as the Volkswagen E-Golf, added an average of 400 kg to the equivalent combustion version.[50] An even larger electric Volkswagen ID.3 model with a 58 kW/h battery pack weighs almost 600 kg more than a Volkswagen Golf VII with an internal combustion engine.[51]

By contrast, the same data for an average Chinese pure electric vehicle, which is 210 kg lighter than a Chinese internal combustion car in the same category and 300 kg lighter than an average European electric vehicle, suggests that a different approach is possible. Electric vehicles are being treated differently from conventional internal combustion models, combining electrification, weight reduction and low prices to offer an affordable, environmentally friendly means of transport for the urban middle class.[52]

In 2023, the best-selling Chinese models were the Wuling Bingo and the BYD Seagull. The Wuling Bingo is a compact city car with a 17 kW/h battery and a range of around 203 km, starting at a price of around $8,200. The car has a maximum speed of around 100 km/h and a length of 3.5 metres, making it ideal for use in urban environments. One of the key figures is that Wuling Bingo weighs around only 830 kg. This light weight contributes to the car's efficiency and relatively low energy consumption, which is particularly important in urban traffic. The BYD Seagull also showed strong sales (with its weight of 990 kg), especially thanks to its affordable pricing and competitive range (300 km with the smaller battery), which starts at around $10,500.

It is a good counter-example to passenger cars from Volkswagen and other European manufacturers. It is also telling that in 2023, the cheapest new electric car available in Europe was 92% more expensive than the cheapest combustion engine car, while in China the affordability problem was solved, with the cheapest electric car available costing 8% less than the cheapest combustion engine car.[53]

Environmental impacts of heavier electric cars

Weight is a decisive factor for electric vehicles, even more so than for internal combustion cars, as heavier electric vehicles either require larger batteries (which are the most expensive component of electric cars, as they can account for 35–40% of the total cost)

[49] A PHEV (Plug-in Hybrid Electric Vehicle) is a hybrid vehicle that combines an internal combustion engine with battery-powered electric drive. Its battery can be charged from an external power source, enabling pure electric operation over shorter distances, while the internal combustion engine provides flexibility for longer journeys.

[50] International Council on Clean Transportation 2019: 53–54.

[51] INGRAM 2023.

[52] PARDI 2022: 177.

[53] DRAGHI 2024: 150.

or have a shorter range, which is the biggest disadvantage of electric vehicles. Furthermore, weight also affects performance, as it reduces acceleration and top speed – and weakens breaking capacity.[54] The upward market trend also means that not only is the weight of these cars increasing, but also their performance, with better acceleration, higher top speed and greater range, which means that cars require ever larger batteries, which in turn create even more weight (for example, a Tesla Model Y with a 75 kW/h battery weighted 770 kg in 2020, a Volkswagen E-Up with a 36.8 kW/h battery weighted 248 kg).[55]

Doubling the average size of electric vehicle batteries negatively affects the whole life cycle. Firstly, some of the materials needed to make batteries, particularly cobalt and lithium, are rare, and their extraction is polluting. By doubling the size of the average electric vehicle battery, the upward trend is likely to increase the price of these materials and undermine the economic viability of batteries in car manufacturing.[56]

Furthermore, the production of batteries requires a lot of energy, and is mainly done in countries where energy production is highly CO_2-intensive (such as China) and highly polluting. Therefore, electric vehicles have a CO_2 "debt" when they are put into use and it takes several years before they have less CO_2 emissions than equivalent internal combustion engine cars (of course, this may still reduce CO_2 emissions and noise locally, especially in cities, but it is likely to shift emissions globally to other industries and other geographic locations). For another example, a Tesla Model S produced in the United States had a CO_2 footprint of 10 tonnes, so it would need to travel an average of 64,200 km to catch up with its CO_2 footprint. For a Tesla Model S manufactured and used in China, this debt to be recovered increases to 15 tonnes of CO_2 and 139,400 km are required to repay. For a Renault Zoe manufactured and used in France, the debt is 2,100 kg CO_2 compared to an equivalent Renault Clio and only 16,800 km are required to repay.[57] Again, on the one hand, this shows that the cars with the lowest weight and size would be the most viable, and would ultimately have a smaller ecological footprint, on the other hand the ecological footprint can depend to a large extent on where the vehicle is manufactured. Not to mention that the capacity of the batteries will decrease over the years, thus reducing the range that can be covered.[58]

Table 4: CO_2 debts and distance to offset CO_2 (km)

Car model	Manufacturing country	CO_2 footprint (tonnes)	Distance to offset CO_2 (km)
Tesla Model S	USA	10	64,200
Tesla Model S	China	15	139,400
Renault Zoe	France	2.1	16,800

Source: compiled by the author

54 Világgazdaság 2024.
55 Onyango 2024.
56 Jetin 2020: 156–177.
57 Arval Mobility Observatory 2019.
58 Pardi 2022: 178.

Finally, although electric vehicles do not locally emit CO_2, they use energy produced with CO_2 emissions. In 2018, the EU energy sector emitted 3.3 billion tonnes of greenhouse gases, well below the 4.3 billion tonnes in 1990, but still more than the 0.9 billion tonnes emitted by the transport sector in 2018.[59] Doubling the size of the battery can double the amount of energy used by EVs and thus their associated CO_2 emissions.[60]

Passenger cars produce harmful fine particles (PM 2.5 and PM 10) mainly through brake, tyre and pavement wear, which account for 60% of total emissions, and this will not change with the use of electric vehicles.[61] The extra weight increases wear and tear, which adds to the impact of air pollution. Larger cars also take up more space, increasing urban congestion, transport emissions through congestion (which means that internal combustion cars emit even more pollutants), and increasing parking difficulties. In my opinion, France is setting an example to be followed by taking a firm stand against heavy and polluting vehicles and by reducing the weight limit for heavy vehicles from 1.8 tonnes to 1.6 tonnes with the introduction of restrictions on 1 January 2024, which will entail additional taxes on the purchase of a new car.[62]

As a result, most SUVs will also be subject to this extra charge. The additional charge for vehicles up to 2.1 tonnes is €10 per kilogram, while for vehicles heavier than 2.1 tonnes, the amount is €30 per kilogram. This move will encourage people to choose greener vehicles and promote sustainable transport in the country. It is hoped that the higher taxes will discourage people from buying heavy off-road vehicles, which cause more pollution and pose a greater danger to pedestrians or cyclists in the event of a collision.[63]

The potential impact of electric vehicles on the economy and society

The general upward trend in the car market, both in power and weight, is making the average European electric vehicle more expensive, slowing down its uptake. Electric cars are primarily purchased in high-income countries, mainly in Northern and Western Europe, and only if substantial public subsidies are available (between €5,000 and €10,000 on average). At the same time, various tax breaks and discounts on the purchase price are being phased out in many countries (Norway, Germany, France). As we have seen, the upward drift favours premium brands, mainly produced in Germany, and we have seen how this has been to the detriment of generic brands in France and Italy. Electrification is likely to further reinforce this trend by making it more difficult for generic brands to be profitable, leading to further structural transformation and relocation of production to low-wage countries, and raising further problems from a social and political perspective about the sustainability of such a transition. Moreover, as the production of electric vehicles requires fewer workers in production (20–25%), there are, for example, in Germany, a series of mass general restructurings or even factory closures

59 European Environment Agency 2020.
60 BERJOZA–JURGENA 2017: 1391.
61 Aiq Quality Expert Group 2019: 72.
62 FROST 2024.
63 FROST 2024.

due to falling demand.[64] The Volkswagen group could reduce the number of workers in Germany by up to 30,000 in the medium term, which would mean a 10% reduction.[65]

Because of their high price, new electric vehicles are currently only available to wealthier households, who (to a lesser extent) usually benefit from government subsidies, tax breaks, free parking and lower running costs. In contrast, poorer households must contend with the economic and social costs of maintaining outdated internal combustion cars.[66]

Governments are being forced to compensate for the rising costs of electrification and falling revenues from fuel taxes with car user charges, including higher fuel taxes. The case of France has shown how contradictory such policies can be. The 2018 fuel tax hike, justified on environmental grounds, triggered the biggest social movement since 1968, the Yellow Vest Movement.[67] Another good example is the 2024 farmers' demonstration in Brussels, which drew attention to the rising costs of farming, when a crowd of thousands of protesters marched through the centre of Brussels, blocking the streets and drawing attention to the problems.[68] This is another sign of a society very sensitive to costs.

In a European context of increasing political instability and the rise of populist parties, it would not be surprising if the growing social disparities in access to sustainable mobility led to further social tensions and even 'class warfare'. It is also worth noting that from 2027 road transport will also be included in the EU Emissions Trading Scheme (ETS2), affecting emissions from transport fuels. Consequently, the running costs of combustion engine vehicles are expected to increase.[69]

One might think that in the long run, expensive electric vehicles will become as affordable as used cars. Still, even in a high-income country like France, this is not the case, where the average used car bought by the average French household is 9 years old and costs less than €4,000. This means it will take well over a decade before the average electric vehicle model available on the European market will be affordable for the average European household, even in high-income countries.[70] It will, therefore, take even longer for poorer families to access these vehicles, leading to an ageing fleet.[71] Not to mention that the uptake of electric vehicles is hindered by their inherently high purchase price, low residual values and typically higher insurance premiums. Electric cars are generally more expensive to insure than internal combustion engines because the average cost of damage is higher, as well as the cost of repair and battery replacement.[72]

Central and Eastern European countries contributed most to increased CO_2 emissions from road transport. Their greenhouse gas emissions from cars increased by 130% between 1990 and 2018.[73] This is partly due to the rapid growth of their car fleets and partly to the fact that this growth was mainly achieved by importing second-hand cars

64 Automotive News Europe 2023.
65 Automotive News Europe 2024b.
66 Ryan 2023.
67 Amiel 2019.
68 Chiappa et al. 2024.
69 Draghi 2024: 146.
70 European Court of Auditors 2024: 46.
71 Demoli 2015: 311–328.
72 Dai–Lechner 2024.
73 National Assembly Office 2021.

from the 17 'Western' EU countries. Given that electrification makes new cars more expensive, it is clear that the 120 million citizens living in these countries under the current regulatory framework question how much they will be included in the new EU green deal. The gap between rich and poor European countries and between rich and poor households will widen and the economic, social and environmental costs of electrification may prove too high to be politically sustainable.

Conclusion

Overall, the EU regulatory framework for reducing CO_2 emissions in the transport sector has played a central role over the past twenty years in driving the industry away from what it should have been doing, namely reducing the weight, mass and size of cars sold to make them less polluting. EU legislation offering more favourable treatment to heavier vehicles pushes car manufacturers towards 'premiumisation'. The continent's car fleet will thus be made up of increasingly heavy and powerful cars, which will harm society in terms of the increase in car prices and the adverse effect on the environment. As it is almost impossible to meet CO_2 standards with ever heavier and heavier cars (mainly internal combustion), emissions will not fall as much as expected, and as shown above, electrification is not the solution to eliminate all emissions. Fortunately, more and more car manufacturers are recognising this negative trend. They are introducing a range of models that better embody the needs of urban transport, with smaller and more affordable electric cars.

Footprint-based targets should replace weight-based targets, as these would not penalise weight reduction but would take into account the utility of cars. In addition, size reduction is a desirable objective to reduce urban congestion and improve environmental protection. Regulation should encourage car manufacturers to reduce the weight and size of vehicles, not the other way around. Adaptation at the national level could also help, as the current legislation is more suited to the needs of Northern and Western European countries but not the fleet structure of Southern and Central and Eastern European countries.

Finally, I think that the increasingly popular strategy of postponing the EU ban on internal combustion passenger cars (or the restriction on synthetic fuels under the latest EU decision[74]) beyond 2035 should also be considered. Many carmakers report that demand for electric cars is falling, or at least not growing at a rate that would satisfy their sales, leaving the European car industry in a difficult situation that is unlikely to be helped by EU safeguard tariffs on Chinese cars.[75] The Commission's new draft strategy paper ("Competitive Compass") – which proposes a technology-neutral approach to achieving climate neutrality targets in the automotive sector under the new Clean Industrial Deal (replacing the former Green Deal) – could be a step forward.[76] This may

74 POSANER 2023.
75 LIBOREIRO 2024.
76 European Commission 2025.

also include allowing the sale of plug-in hybrids after 2035, the use of range-extending technologies after 2035 and relaxing penalties from emission limit values.[77]

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