EUROPEAN REGULATIONS FOR AN AFFORDABLE SUSTAINABLE (BATTERY) ELECTRIC VEHICLE

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European regulations for an Affordable Sustainable (Battery) Electric Vehicle

EXECUTIVE SUMMARY

Why do we need a small, affordable, sustainable electric vehicle (ASEV)?

- Europe is not on track to meet the Fit for 55 targets for new car sales because of the lack of affordable offer to support rapid ZEV adoption;
- Europe is still very far from achieving carbon neutrality for the European car fleet in 2050, because actual ZEVs are not sustainable in production;
- Electro-mobility and the 2035 ban on non-ZEVs are increasingly unpopular and contested;
- Without more production volumes, the European automotive industry is facing significant short-term factory closures and massive restructuring, as Chinese FDI increase overcapacity;
- Increasing Chinese price competition on EVs represents a major threat for the European automotive industry;
- In 2025, European automakers need to sell at least one ZEV for every four ICEVs to meet their CAFE threshold and avoid penalties. This ratio should increase to one ZEV for every ICEV in 2030. ASEVs, because of their low price, could contribute significantly to meeting these targets while keeping the European automotive industry competitive and profitable.

Why do we not have an ASEV in Europe?

We identify three main causes that need to be addressed if we want to bring back affordable and sustainable vehicles:

- Increasing uncoordinated regulatory pressure that makes the production of smaller and lighter vehicles unprofitable;
- The absence of policies aimed at preserving/promoting AS(E)Vs for environmental and social reasons;
- The upmarket drift of new car sales and oriented towards exports and global markets, rather than the average European consumer.

What can we learn from countries where such AS(E)V exist?

JAPAN: In Japan, Kei cars - small vehicles typically weighing less than 900 kg - are playing an increasingly critical environmental and social role in Japan's green growth strategy by providing rapid improvements in fuel economy, affordable access to clean and safe personal mobility for low-income populations particularly dependent on cars for mobility, and maintaining domestic manufacturing (in 2023, around 1,7 – 2,2 million vehicles, more than the current joint car production of France and Italy).

à **HOW?**

- Key role of a caped vehicle category that prevented the “upmarket” drift” relative to compact and standard cars and attracted significant fiscal and non-fiscal advantages for its buyers, drastically reducing Kei cars acquisition and use costs compared to other vehicle categories;
- Preservation and development of a large dynamic market driven by the proliferation of new different models and marked by regular product and technology innovations;

- Above all, a long-term social, political, and industrial compromise between consumers/citizens (who want to buy Kei cars), automakers (who have a protected, dynamic, and profitable market), and regulators (who can articulate industrial development, transportation, and energy efficiency policies).

CHINA: The New Energy mini-Vehicles' segment has been the fastest growing BEV segment in the Chinese market, providing extremely affordable access to electric mobility in large urban agglomerations, and generating significant production volumes for NEV Chinese manufacturers.

à HOW?

- The dynamic and flexible articulation of national policies promoting a NEV industry producing at scale, regional policies supporting local manufacturers, and major cities' regulations providing both the dense recharging network infrastructure needed by such mini-vehicles and strong fiscal and non-fiscal incentives to promote their diffusion;
- A strong demand for personal affordable mobility from middle-class populations living in the prioritized areas of deployment of NEVs.

How can we promote a European made ASEV?

Our proposal to bring back ASVs in Europe via an ASEV is articulated on 5 complementary measures:

1) **Create a sub-M1 category (M1 ASEV)** caped in dimensions, mass and power, relatively easy to implement in the EU regulatory framework, with a large market but not taking advantage of an immediate correction of the regulatory pressure;
   <OR>
   Create a new-M0 category (M0 ASEV) caped in dimensions, mass and power and limited in use (speed <110 km/h), providing room for reduction and modification of regulatory pressure (to be estimated), but more complicated to implement in the EU regulatory framework (creating the M0 ASEV category would probably take about three to four more years than creating the M1 ASEV) and smaller market size compared to M1 ASEV.

2) **Adjust the CO2 regulation for ASEV and more efficient decarbonisation:**
   a. Introduction of a degressive ASEV Multiplier (similar to "Supercredits") (2026-2030) to support ASEV take-off;
   b. "Long term" shift towards LCA based CO2 targets for all segments of BEVs progressively starting in 2030.

3) **Introduction of a dedicated financial framework to support production take-off:**
   a. The IPCEI framework could be used to accelerate the establishment of the European value chain needed to produce ASEVs.
   b. Temporary production credits could be introduced following the example of the Inflation Reduction Act in the USA.

4) **Introduction of a European Eco score for cars:**
   a. Based on the European proposed LCA (2025);
   b. To provide transparent and clear information to consumers;
   c. Acting as a transversal activator of a "true" decarbonisation strategy across currently siloed DGs;
   d. Providing a flexible political tool for different national and cities policies and priorities through financial / non-financial incentives;
   e. To influence, in a longer term, OEMs design and manufacturing strategies toward ASEV.

5) **Promotion of a European ASEV toolkit for Member States, regions and cities:**
   a. National/Regional Policies: Numerous financial/non-financial incentives to support ASEV deployment, similar to what is currently underway for BEVs;

b. ASEVs are a very good tool for local authorities to improve their mobility system and can efficiently contribute to achieving significant performance according to the Urban Mobility Indicators associated to SUMPs;
c. ASEVs incentives must be embodied in a systemic definition of a mobility system to ensure an excellent complementarity between all its components, be it ASEVs and non-ASEVs, public transport or scooters, bikes, etc.

What would be the impact of ASEV on decarbonisation, just transition and European industry competitiveness?

- It will provide an immediate boost to new car sales of BEVs replacing Europe on an efficient, realistic and sustainable trajectory of decarbonisation in line with the Fit for 55 and 2050 carbon neutrality targets while helping European automakers to meet both CAFE and profitability targets;
- It will foster a market proliferation of ASEVs addressing the current limited or non-existing access of middle-classes and low revenue social groups to electric cars;
- It will reconcile the average European citizen and consumer with the accelerated path towards electro-mobility needed to achieve our Green Deal's targets;
- It will restore automotive production at a level compatible with a just transition;
- It will reactivate an "innovation playing field" (the "small car") where the European automotive industry has been historically extremely competitive;
- It will favour the emergence of smart local mobility systems taking full advantage of their intrinsic performances.

1. Introduction. Why do we need a European made small, affordable, sustainable electric vehicle (ASEV)?

Promulgated in 2022, the 2035 ban on the sale of non-zero emissions vehicles has set the European Union (EU) on the fastest track globally towards fully electrification of cars. While the measure represented a required correction to the past failures of the EU regulations in reducing road transport emissions (Pardi 2024), it appears increasingly problematic despite the strong commitment of European OEMs towards full electrification of their offer by 2030-2035. The last two years have seen an increasing number of converging evidences suggesting that the Green Deal for the automotive sector is turning into a green wall against which both the European Union and its automotive industry are hitting.

First, the rate of growth in the sales of BEVs has slowed down since 2021 by 30% each year and is expected to further slow down in 2024 (Knapp 2024). BEVs sales have been hauled by average high prices (over 65,000 € in 2023 (JATO 2024)), concerns over autonomy for cheaper models with smaller batteries coupled with inadequate charging infrastructure, the end of public subsidies in Germany, the main European BEVs market, and growing uncertainty on after-sale costs and residual values (Knapp 2024; Autovista Group 2024). As a result, the European automotive industry is not on track yet to meet the Fit for 55 CO2 targets for new car sales in 2025 (Transport & Environment 2024), and the perspectives for 2030 are clearly worse.

Second, electro-mobility, in general, and the 2035 ban on non zero emission vehicles, more in particular, are increasingly unpopular and contested in Europe. A 15,000 people survey carried out in 2024 by the Hertie School Jacques Delors Centre in Germany, France and Poland shows that the only Green Deal environmental measure taken by the European Union that attracts unanimous discontent amongst all type of voters in all three countries (from extreme left to extreme right) is the 2035 ban on non-zero emissions vehicles (Abou-Chadi et al. 2024). The ban is notably perceived as a driver of unsustainable increase in mobility costs. The results of the 2024 European elections also show that all parties that have taken stance against the 2035 ban have gained votes, in particular far-right parties that have more than doubled the number of seats in the European parliament (from 49 to 109), while Green and Renew parties that have defended the ban as it stands have both lost seats (from 162 to 132).

Third, the European trend towards increasingly expensive BEVs has opened the Single Market to fast growing imports and sales from pure BEV makers, and in particular from Chinese New Energy Vehicles (NEV) makers. As shown by Alochet (2023) and Pardi (2024), the competitive advantage acquired by Chinese NEV makers is substantial and embodied in far cheaper, more energy efficient and better quality BEVs than those offered so far by European OEMs. The 2024 DG Trade anti-subsidy investigation on the Chinese BEV value chain shows that a significant part of this competitive advantage is due to illegal state aids. The proposed trade restrictions, which amount to 20-38% extra duties for Chinese imports of BEVs, are certainly a welcome change in European trade policies towards a more strategic approach to protect key European industries and guarantee a level playing field with foreign competitors. But they are also problematic, because they may entail trade retaliations, which European OEMs clearly fear given the industry's increasing reliance on Chinese refined materials, technologies and batteries to meet the 2025 and 2030 CO2 reduction targets.

Fourth, due to both the increasing average price of new car sales (between 30% and 40% between 2018 and 2023 against an average HCIP Euro inflation of 20%) and the increasing penetration of Chinese imports, the production volumes in 2023 are still 20% below their pre-Covid level. With an increasing number of Chinese carmakers announcing the creation of new car factories or the start of production in Europe (BYD in Hungary, Chery in Spain, Leapmotor and Geely in Poland), there is a further risk of creating significant overcapacities. Electrification per se already entails an important reduction in automotive employment, in particular in the supply chain (Palliet et al. 2021; Strategy& 2021), but if production volumes of European carmakers does not recover, or even worse, if they drop further due to the shift towards more expensive EVs, then the amount of factory closures and restructuring could be much more important and problematic than initially anticipated (European Commission 2021).

Fifth, European automakers are currently profitable thanks to the sales of ICEVs, while BEVs are not yet profitable (European Union 2024, 174). With stricter regulations on the horizon (tightening of CAFE targets, upcoming increase in the utility factor for PHEVs[1], both from 2025), automakers will need to achieve a minimum sales ratio of 1 BEV for every 4 ICEVs to meet their 2025 CAFE target and avoid penalties for several billion €[2]. With BEV sales stagnating at 12,5% (2024) there is currently no clear way forward: one option would consist in reducing the sales of ICEVs to reach the 20% ratio for BEVs, but this would severely impact production volumes, employment, revenues and profitability; another option would consist in pooling together with pure-BEV brands, but this would result in European automakers subsidising more Chinese imports to Europe.

While there is no silver bullet to solve all these problems and keep the European automotive industry on track with the “Fit for 55” targets without major economic and social crises, we believe that one key missing piece in the Green Deal puzzle is a small Affordable and Sustainable Electric Vehicle (ASEV) made in Europe.
In this report we will argue that the development of a European ASEV via the creation of a dedicated new vehicle category and the deployment of a coherent set of policies including an ad-hoc financial framework to support its development, production and diffusion will address several of these issues:

- It will make BEVs more accessible and boost sales and production volumes;
- It will reconcile the average European consumer, worker and citizen with electro-mobility, by showing that the green transition towards BEVs can be compatible with both the preservation and creation of jobs and with affordable and sustainable mobility for all;
- It will contribute in reactivating a strategic playing field – the “small car” – where the European automotive industry was historically particularly strong and innovative and where it could regain a competitive edge over its rivals.

The report is organised around four key questions:

- Why do we not have an ASEV in Europe?
- What can we learn from countries where such AS(E)V exist?
- How can we promote a European made ASEV?
- What would be the impact of ASEV on decarbonisation, just transition and European industry competitiveness?

[1] A recent report from the European Commission (COM (2024) 122 final) shows that for new plug-in hybrid electric vehicles registered in 2021, the real-world CO2 emissions were on average 3.5 times (100 g CO2/km) higher than the WLTP ones.
[2] Avoiding penalties is also a key condition to giving them the capacity to invest heavily in BEVs that are affordable enough to meet mass market conditions and put them on track to meet the 2030 CAFE target.

Chapter 2.
Why do we not have AS(E)V in Europe?

The market share of cars below 1100 kg in Europe has constantly declined since the 1990s and represents today less than 5% of the market.
In the table below we list all the new models of less than 900 kg and less than 1100 kg launched in Europe by decade since the 1980s, their ratio on the total number of new models launched, and also the ratio of models launched by European brands (including Opel and Ford) in the less than 1100 kg category.

Table 1. New models launched in Europe and the relative share of less than 1100 kg models (1980s-2020s)

	<900 kg new models	<1100 kg new models	Total new models	Ratio of <1100kg on total new models	Ratio of EU brands (including Opel and Ford) in <1100 kg models
1980s	13	36	77	47%	92% EU
1990s	14	56	259	22%	79% EU
2000s	17	70	578	12%	46% EU
2010s	7	53	580	9%	59% EU
2020s	1	5	207	2%	40% EU

Source: INOVEV. Authors treatment.

We can see that the total number of new models of less than 1100 kg introduced per decade increased from the 1980s up to the 2000s (from 36 to 70) even though their ratio on total new models constantly declined (from 47% to 12%). Their total number started to decrease in 2010s and dropped to only 5 in the period 2020-2024 for a ratio on total new models of 2%. We can also see that the share of these small-light vehicles manufactured by European brands declined regularly, from 92% in the 1980s to 40% in the 2000s.
What have been the causes of the disappearance of the small car in Europe?
In this chapter we identify and discuss three main causes that can explain this decline of A-B segments small/compact cars from 1990s onward:

- Increasing regulatory pressure making the production of smaller and lighter vehicles non-competitive relative to heavier, more powerful and more expensive ones;
- The absence of transversal criteria and policies to preserve this type of vehicles for environmental (energy efficiency, lower pollution, less congestion) and social reasons (affordable access to personal green and safe mobility);
- The upmarket drift of new car sales characterised by a regular shift towards heavier, more powerful and less affordable cars to the detriment of smaller, more sustainable and affordable cars.

1. The regulatory framework at the origin of the upmarket drift

The automotive internal market is built on the basis of the European reception system. Since 1992, no parallel national certification can compete with the European one.

The reception means the approval of the type of the vehicle and its sub-system (type-approval), by national authorities. Once a national authority certifies the compliance with the technical regulations, the vehicle is accepted on the European market thanks to mutual recognition among national authorities and the Commission.

First, we will describe the basic elements of the reception framework. in second section, we will insist on how technical regulations (safety, emissions) and the way they are conceived are pushing the market toward heavy and expensive vehicles. In a third section, we focus on the CO2 emissions (CAFE regulations). Finally, we discuss the opportunities to coordinate the regulations and to better articulate public authorities, industry and market.

1.1 The reception

The fundamental pillar of the regulatory framework is the modality of the type-approval system. The last version of the regulation is the Regulation (EU) 2018/858 (30 may 2018). This regulation has 3 functions. It defines the competences of each actor, it normalizes the documents and procedures, and it defines what is considered as a car.

Here are the definition of the category M1. “Category M consists of motor vehicles designed and constructed primarily for the carriage of passengers and their luggage, divided into:

- Category M1: motor vehicles with not more than eight seating positions in addition to the driver's seating position and without space for standing passengers, regardless of whether the number of seating positions is restricted to the driver's seating position;”

Some categories may be capped by characteristics, like the weight. For example, vehicles in the category N1 (light duty vehicles) must not exceed 3.5 tons.

From this basic block, other regulations will specify the technical requirements (see below). For example, the Regulation (EU) 2019/2144 normalises the official documents and the technical procurements, which will be detailed in others regulation (on safety, pollutant, noise...).

Another regulation of interest for our study is the Regulation (EU) 168/2013, which proposes the type-approval method for two-, three-wheelers motor vehicles and quadricycle. Here are the definitions of four-wheelers which can correspond to our study:

“Category L6e vehicle (light quadricycle), sub-categorised into:

- L6e-B vehicle (light quadri-mobile), further sub-categorised into:
    - L6e-BP vehicle (light quadri-mobile for passenger transport): vehicle mainly designed for passenger transport; enclosed driving and passenger compartment accessible by maximum three sides and maximum continuous rated or net power (1) ≤ 6 000 W

Category L7e vehicle (heavy quadricycles), sub-categorised into:

- L7e-C vehicle (heavy quadri-mobile), sub-categorised into:

- L7e-CP vehicle (heavy quadri-mobile for passenger transport): vehicle mainly designed for passenger transport, maximum continuous rated or net power (1) ≤ 15 kW and maximum design vehicle speed ≤ 90 km/h and (10), enclosed driving and passenger compartment accessible via maximum three sides.

Such vehicles have to comply with several regulatory procurements. Some of them, like the air pollutant emissions, are similar to the M1, but, as these vehicles have limited speed, many safety regulations are less challenging than the ones over the category M1 (see Annex II of the Regulation 168/2013 for the list of regulation).

1.2. The technical regulations and the upmarket drift

In this section, we will review the different regulations that are defining the European vehicles. For safety and emissions, we illustrate how they participate to the upmarket drift. We quote other regulations as they reveal importance for the EVs, and could be opportunities for ASEVs (see chapter 4).

One of the most striking example of regulation accumulation is the regulations on safety. One regulation (2019/2144) – nicknamed GSR2 (General Safety Regulations 2) – regroups all the technical requirements that vehicles (M and above) should comply.

It is important to note that most of the requirements come from the UN-ECE (WP.29), and are transposed, sometimes without adaptation, in the European legislation.

We must distinguish between passive and active safety. According to our enquiry, passive safety requirements are the most important factor of weight increasing (body reinforcement, lengthening of interior space, front bumper, hard windscreen...). The growth in vehicle weight changed also the perception of consumers regarding safety. In terms of individual interactions where, in order not to be crushed or dominated by other drivers and their vehicles, it becomes "reasonable" to have a vehicle that is at least as heavy and as high as that of others. In economics, this is a fairly classic no-bridge problem, implying that individually optimal decisions are collectively suboptimal or even catastrophic. Heavier vehicles are more dangerous for others, but if we do nothing to prevent them from multiplying, we encourage everyone to equip themselves with them and we end up forcing the smallest and most virtuous vehicles to become heavier in their turn so that they can withstand the shocks that would pit them against the obese vehicles that we have refused to prevent from putting on weight. In Economics, the Gresham's law shows that bad money drives out good money. Now we see that vehicles that are heavy from every point of view end up driving out those that are light and virtuous: first, in new car sales, where the average mass of the European car has taken 277 kg since 2021; then, progressively, in the car fleet. The negative consequences of what has been also called the "vehicle weigh arm race" (White 2004) have been well documented in the US where it has been calculated that the 240 kg taken by the average US car on the road between 1998 and 2008 increased by 25% the risk of fatalities in the struck vehicle due to car accidents (Anderson and Auffhammer 2014, 536).

The active safety, for its part, has only marginal impact on the vehicle weight, but a huge incidence on the vehicle costs, as carmakers have to integrate more and more sophisticated technologies, especially in electronics and software[3]. For example, the GSR2 compels carmakers to include many Advanced Driver

[3] The oldest vehicles in a manufacturer's lineup may not have the hardware, software, and wiring capacity to integrate these new features at an acceptable cost. As a result, OEMs may introduce new platforms to recapture this capacity, resulting in costs that are much higher than the marginal introduction of additional hardware and software components and the retirement of these legacy vehicles.

Assistance Systems (ADAS) in their new cars. Often the issue is not only the additional cost of these technologies, but also the limits of the existing models' architectures in terms of cable integration and computing power that force carmakers to introduce new models' architectures. For obvious reasons, the new models' architectures tend to increase the dimensions of the vehicles, and therefore further increase their mass and their cost.

There is a politico-philosophical meaning behind the introduction of mandatory ADAS. Instead of impeaching the use of phone while driving[4], regulators prefer to introduce nudge and alert system to avoid fatalities. The preferred approach here, in Geneva as in Brussels, is called "techno-solutionism". This can be explained by the fact that carmakers and equipment manufacturers saw this as in their interest: a regulatory tool to make new technologies mandatory and increase their diffusion in new car sales.

On a more technical level, in the regulatory edifice, as it appears from reading reports such as the TRL report, the various systems are assessed by IARs (impact assessment reports) which calculate BCRs (benefits-to-cost ratios) which are supposed to check that society really does gain when one or other of these ADAS is made compulsory. The prevailing approach is very much a "silo" one, and the question of emissions (for which you would like to have lighter and cheaper cars) is not raised at the same time as that of road safety, just as neither of them has to worry about the cost of vehicles or their weight, width or length. As far as road safety is concerned, this very fragmented logic is exemplified by the case of GSR2. While there are good reasons to believe that an ADAS-by-ADAS examination can minimise the impact that these obligations have on vehicle costs, this time it was a question of negotiating a "package", and this should have prompted more global reasoning and more willingness to raise the question of the effects of the measure taken on the "system object" that is the car and/or the alternatives to these purely technological solutions that could have been compared.

In fact, when only a device such as a tyre pressure check is added, the additional cost appears to be modest and, since the BCR is then almost systematically favourable, it is difficult to oppose the principle of making it compulsory for new types and then for all types of vehicles. Even e-Call, which posed far more problems because its adoption involved not only adding equipment but also organising a system for receiving (and filtering) calls and activating emergency services, ended up being accepted because it was not compared with other systems that might be cheaper or easier to implement. Active safety is thus improved using an incremental approach, and the overall effect of the sum of the obligations is not examined. This habit is so ingrained that, even in the case of GSR2, the BCR is carried out for each of the devices and eventually makes it possible to propose the right "package" by agreeing not to include provisions with a worse BCR. The TRL report provides this table:

Table 2. Initial cost at mandatory introduction of policy options per vehicle (best estimate) inflated to year-2021 Euros

Initial cost per vehicle	P01	P02	P03
Passenger cars (M1)	€201	€360	€516
Buses and coaches (M2&M3)	€6	€607	€907
Vans (N1)	€131	€206	€521
Trucks (N2&N3)	€6	€607	€1,013

Reproduced from (Seidl et al. 2018).

[4] Or to touch the screen to select some function of their on-board computer for example

In the columns, policy options involving more or less extensive sets of measures are compared, as if the maximum option were being used to provide a sort of guarantee of success for the one immediately below it. In order to calculate these BCRs, we obviously need to agree on the additional costs associated with the measures we are considering making compulsory, the fatal or serious accidents avoided and the costs of each. At each level, the methodological debates could be endless, and the only salvation lies in the "all other things being equal" approach that is customary in economics but obviously contrary to any holistic reasoning. Incidentally, the costing of ADAS to be added appears to be truncated three times over.

- The extra cost is, by definition, zero for vehicles already fitted with the system, whereas it is maximum for vehicles that previously did without it. The average cost is therefore underestimated and, above all, the differentiated effects that the measure will have for vehicles and manufacturers depending on their mix are overlooked.
- The extra cost is calculated element by element or ADAS by ADAS, and the questions of sizing the electronic architecture or software that will eventually arise are not on the agenda because reasoning in silos allows us to keep to an incrementalistic vision. It seems that the decision not to renew the range of certain A-segment vehicles, such as the C1 and 108 at Stellantis, relates to these issues.
- The additional cost as observed at the time of the impact study is considered by convention to be significantly reduced by betting that the massification of the market for the ADAS concerned will lead to very significant reductions in the prices charged by equipment manufacturers.

Another factor that plays in favour of the upmarket drift is Euro NCAP. Compared to the technical regulations mentioned above, Euro NCAP is an independent, non-mandatory norm provider. In testing the safety of vehicle, Euro NCAP provide a score, which is widely diffuse to consumers. Obtaining a good score in the Euro NCAP tests is an important step to make the vehicle attractive to consumers.

However, even if Euro NCAP is basing its tests on the European regulation, it appears that their level of exigence overpasses the basic requirement. Therefore, in order to get a good score, carmakers have to go beyond the basic regulation in adding up-to-date safety technologies.

In addition, another package of technical regulations concerns the externalities, in terms of noise and pollution. However, it appears that the control of noise is marginal in the vehicle cost and weight, and the air pollutant emissions regulation, which played a very important role in the up-market drift during the 90s and 2000s (advanced catalytic convertors, particulate matters filters...), is not relevant for electric vehicles. Indeed, even if the Euro 7 regulation incorporate the emissions from brake and tyres in its scope, the impact of electrification is very limited thanks to regenerative brakes and adapted tyres.

Finally, there are growing regulations over the environmental performance of production, especially on batteries production. The EU has adopted, or is in the process of adopting, regulations concerning environmental requirements for batteries. For example, a delegated act (Ares (2024)3131389) defines the methodology for calculating the carbon footprint of batteries. However, most of these regulations are still under discussion, leading to a number of proposals which we will discuss later. Other regulations impose requirements in terms of battery recyclability (2023/1542), repairability and durability. These last regulations are important for our case study, as it challenged the cheapest battery technologies.

In a context of its quest for strategic autonomy, the European Commission updated its Critical raw material Act (Regulation (EU) 2024/1252), to include the materials needed for the production of battery. The

European Commission can now monitor the market, in order to ensure the supply and the circulation of these materials, and to limit their exportation by improving the recycling.

Finally, as steel industry will have to pay progressively the full price of carbon on the ETS by 2026, the European Union introduce the Carbon Border Adjustment Mechanism (CBAM) (Regulation (EU) 2023/956). In brief, importers of steel will have to pay the carbon price if the steel is produced in a country where there is no carbon market. To do so, traceability of steel and its carbon content is necessary.

1.3. The CO2 emissions

Alongside the technical requirements, the European Commission published since 2009 the CO2 targets. In 1999, carmakers agreed on voluntary targets to reach 140g of CO2 in average. However, as the targets were not reached, the DG CLIMA promulgated in 2009 mandatory targets for 2015 (130gCO2/km) and 2021 (95gCO2/km, in 2020 initially).

During this period, specific emissions targets were calculated thanks to a linear equation implying a positive weight adjustment parameter. At this time, selling an average vehicle of 100kg more than the average market weight leads to a target 4.5g higher than 95g. Conversely, 100kg less lead to a target of 4.5g below 95g. In short, the logic for generalist automakers was to increase the weight of their vehicles at least as much as their premium competitors in order not to be at a serious disadvantage in meeting CAFE targets, while maintaining a contained amount of CO2 emissions. It was then a direct catalyst for the upmarket drift.

This equation was (partially) solved thanks to the engine downsizing – at least until the Euro 6b standards – allowing to reducing the amount of CO2 emission per kg of vehicle transported. However, the main technological solution was the substitution of petrol powertrains with diesel powertrains that provided much better fuel economy (27-37%) over equivalent petrol engines (IEA 2019, 46). Diesel powertrains had nevertheless two major problems:

- First, they were heavier and more expensive, contributing to the upmarket drift (more mass and more engine power) which significantly reduced the overall CO2 benefits of dieselization (based on real-drive consumption the net CO2 reduction between 2001 and 2019 of CO2 gr/km of new cars was only of 5% (Pardi 2022));
- Second, they were expensive and difficult to depollute, in particular for NOx. Even if the Euro standards for air pollutants were much less strict than US standards for Diesels, they eventually led some European OEMs to cross the red line of test “optimization” and cheat using deceit devices during homologation tests.

The Dieselgate scandal of 2015 disqualified the diesel technology, whose sales collapsed, and forced OEMs to rapidly increase the electrification of their new car sales to meet the new 95 CO2/gr target of 2020 (on 95% of sales) and 2021 (100% of sales) and avoid expensive fines. Their capability of reaching a significant market share of 18% for EVs (including PHEVs) in 2021 from 3% in 2019 showed that an accelerated process of electrification was possible and technological feasible, setting the tone for the negotiation of the “fit for 55” update of the CO2 regulation in 2022.

After several discussions in the Commission, at the parliament and at the Council, the European Union finally agreed on targets for 2025 (-15%) and 2030 (-55%) (Regulation (EU) 2023/851), in coherence with the Fit for 55% package. Meantime, the targets are now calculated with the new testing procedure (combining WLTP and RDE) and real-drive emissions are recorded by OEMs via compulsory on-board

devices, transmitted to the Commission, and made published on-line by the European Environmental Agency.

In line with these objectives, the Parliament asked for the ban of new “non-zero emissions” cars by 2035. After a difficult discussion at the Council, Germany managed to include in the definition of non-zero emissions car fitted with e-fuels engine. A review clause indicates that the debate will be reopen by 2026. In the meantime, traditional right-wing parties in Germany, France and Italy have expressed their opposition to the 2035 ban. Also, the far-right, which displays an even fiercer opposition to the ban of ICEs, has grown significantly at the parliament following the 2024 European elections. While the re-election of Ursula von der Leyen as President of the European Commission guarantees some degree of continuity in Green Deal policies, preserving the 2035 ICE ban will require rapid decisions on additional regulatory and financial frameworks to support both industry and market uptake.

Another important change that has been introduced in 2023 is the adoption of a negative slope for calculating CO2 targets relative to the average mass of new car sales by group (See the figure below for a summary of the calculation rules for a given automaker's annual CAFE target since 2012). The negative slope will start to be applied from 2025 onward. Due to the massive electrification in the early 2020s, the Joint Research Center calculated that the correlation between CO2 emissions and vehicle weight is now negative (because zero emissions BEVs and less than 50 CO2 gr/km PHEVS are significantly heavier than the average European car sold in the market). As it was written in the regulation, this new negative slope will be enforced by 2025. In short, this mean that the heavier the average car is, the most important the effort to reduce CO2 emissions is.

The implications of this change are far reaching. Before, carmakers were incited to increase the mass of their new car sales in particular with heavier EVs that had a double advantage: increasing the average mass of new cars sold making CO2 targets less demanding while reducing the average CO2 gr/km emitted (see in particular (T&E 2021). With the new negative slope, carmakers are incited to reduce the mass, and the heavier is their average new car sold, the more they are incited to reduce its mass. In other terms, if before the overall regulatory framework was hostile to small cars, now the CO2 regulation becomes finally coherent with its purpose – driving down CO2 emissions in the most efficient and convenient way. The question however is now how to make the whole regulatory framework coherent with this new welcome direction and support the required efforts of carmakers to move towards lighter and smaller EVs.

Table 3. Summary of the calculation rules for a given automaker's annual CAFE target since 2012

Years	2012 – 2019	2020	2021 – 2024	2025 - 2029	2030 - 2034
Regulation	(EC) No 443/2009		(EU) 2019/631 amended by (EU) 2023/851		
Cycle test	NEDC		WLTP		
EU fleet target (g CO2 / Km)	130 (100% vehicles 2025 onwards)	95 (95% of vehicles, 100% in 2021)	Specific target per OEM refiWLTP$_{(2021)}$ = Target$_{(2020)}$ X [WLTP average CO2 emission 2020] / [NEDC average CO2 emission 2020] Both values **declared** by the OEM	The 2021 WLTP reference value is the weighted average of the individual targets of all OEMs based on the **measured** average 2021 WLTP CO2 emissions = 110,1 EU target = 93,6 (-15% vs 2021 WLTP reference)	49,5 (-55% vs 2021 WLTP reference)
Calculation rule of the target for OEM i in year (yy)	Target =130+$a(M_{i(yy)}-M_{0(yy)})$ a = 0.0457	Target$_{(2020)}$ = 95+a(M_{i2020}−1379.88) a = 0.0333 (-27% / 2012-2019)	TargetWLTP(yy)=refiWLTP(2021)+ $a[(M_{i(yy)}-M_{0(yy)})-(M_{i(2020)}-M_{0(2020)}]$ a = 0.0333	Target(yy) = 93,6 + a2025($TM_{i(yy)}-TM_{0(yy)}$) ZLEVi a2025 = -0.0144 a2025 is derived from the slope of the best fitting straight line for the CO2 emissions vs test mass for the 2021 EU fleet (-0,0175).	Target(yy) =49,5+ a2030($TM_{i(yy)}-TM_{0(yy)}$) a2030 = -0.0076 a2030 is calculated similarly to a2025
Parameters	$M_{i(yy)}$ is the average mass in running order of all passenger cars of manufacturer i in kg in the year yy (M_i in 2020). $M_{0(yy)}$ is the EU-fleet average mass value a priori defined in the Regulation for the year yy. $M_{0(yy)}$ is 1,379.88 in 2020, 2021 and 1,398.50 in 2022, 2023 and 2024			$TM_{i(yy)}$ is the average **test mass (i.e., measured)** of all new passenger cars of the manufacturer registered in year yy $TM_{0(yy)}$ is the EU-fleet average reference test mass Calculated as 1,609.6 kg for 2025, to be calculated for 2030	

Source: Authors' summary of 2025 and 2030 CO2 emission targets for Light Duty Vehicles (based on JRC133502)

1.4. A single crossing point?

Our survey reveals notably a lack of coordination within the European bodies, what many describe as "work in silos". On the one hand, several DGs and several parliamentary committees deal with regulatory texts. But on the other hand, the timetable for the adoption of regulatory texts, even when they are adopted within the same DG, is difficult to read. Moreover, there is no holistic approach of the regulation.

The introduction of EVs could have been the moment for rethinking what is a sustainable European car based on new holistic approach, but it has been built on the same siloed regulatory methods as ICEVs. If in the first half of the 2010s, when BEVs' market share was still below 1%, the first BEVs launched in Europe – mostly by Renault and Nissan – represented an attempt to move away from this logic with small cars with relative small autonomy (the Zoe and the Leaf), the second half of the 2010s, and even more the beginning of the 2020s coincided with an accelerated upmarket drift of the BEVs. Most of the BEVs launched during this period have been designed all the more willingly in this way because manufacturers in Europe, and in particular "premium" brands following the Tesla template, have attacked the market 'from above' and wanted to give their customers with very high willingness-to-pay the feeling that they were being served at least as well as buyers of combustion-powered vehicles acquired at comparable price levels. The result is vehicles that are much heavier than their internal combustion counterparts, and it so happens that when we want to limit the extra cost, we opt for slightly less efficient battery chemistries, which means that in order to have equivalent range, we have to make the vehicles even heavier. Eventually, when it comes to upgrading the passive safety of vehicles, they will have to be protected against collisions with vehicles weighing 2 tonnes or more, which will account for a major proportion of registrations and the vehicle fleet. Electrification managed without systemic management - and therefore without regulation - of this cumulative logic, which implies that mass begets mass, is highly counterproductive, and there is an urgent need to break the silos.

From this perspective a single point of passage that articulates and arbitrates between different regulatory priorities in favour of a more coherent and holistic approach would be needed. However, we believe that a single point of passage would be complex to enact, due to the structural division of competencies inside the Commission. On the one hand, the European edifice has been built around functional divisions, and

with such a political organization it would be difficult to take away from DG ENVI or DG CLIMA their prerogatives concerning vehicles. All the more so since the adoption of the Green Deal, the Net Zero Industrial Act, etc., have strengthened the position of these DGs.

Since the 90s, DG ENTR/GROW has tried to keep a firm grip on automotive regulation (Klebaner 2020). Several attempts, such as the Auto-emission 2000 symposium, the Auto-oil initiative, and the various High-Level Groups of Expertise (Cars 21, Cars 2020, GEAR 2030), can be seen as attempts by DG GROW to remove automotive regulations from the political arena, by referring directly and exclusively to the expertise of stakeholders. But these attempts have failed, either because the Parliament has established itself as a major player (the Auto-oil initiative was abrogated by the Parliament), or because DG CLIMA and ENVI follow different agendas - and different ways of consulting stakeholders.

These political contradictions are compounded by regulatory contradictions. Regulatory texts follow one another without any real concatenation. As a result, the dense and confusing regulatory calendar complicates the work of product definition teams.

These regulatory contradictions can lead to technical contradictions. For example, requirements concerning carbon emissions may conflict with those limiting pollutant emissions. Or safety regulations may imply greater mass, and therefore more powerful braking technologies, a stronger chassis, and therefore more mass, etc.

Finally, these political, regulatory and technological contradictions lead to the last contradiction, that of profitability. Because of regulatory requirements, many ranges are becoming unprofitable due to regulatory costs. Many manufacturers are abandoning the A segments, as their selling price far exceeds the purchasing capacity of potential customers. In the B and especially C segments, regulatory costs mean that vehicles are priced so high that they occupy a higher range, and must therefore include more sophisticated technologies to attract more exigent customers. Although our report does not concern these vehicle segments, we believe it would be necessary to extend our proposals and lower regulatory costs in these categories as well.

All these regulatory constraints and technological contradictions between different norms apply to all types of motorization, but become particularly salient for BEVs due to their current structural unprofitability. According to the EU enquiry on the economic situation of the European automotive industry (carried out in the context of the investigation on Chinese illegal state aid (European Union 2024, 174)), BEV sales made by European OEMs generated on average a negative profit rate of -10,8% between the 30th of September 2022 and the 1st of October 2023. This means that BEVs are priced at even higher levels than the already increasingly expensive ICEVs to contain these losses, preventing however the growth of sales that would be needed to achieve profitability via higher economies of scale. This is also why we advocate in this report the introduction of dedicated regulatory and financial measures to support the production and sales of ASEVs to break free from this vicious circle.

To ensure the predictability of regulatory developments, we recommend insisting on the adoption of a medium- to long-term schedule of requirements. This could be the subject of a detailed roadmap, indicating the dates of adoption of future requirements, but also the dates of revision of automotive standards.

We propose the organisation of Automotive Roundtables (ART) every 4-5 years, which will discuss during one year on what would be the regulations implemented in the following 3_4 years. For example, the Commission could take advantage of the review clause of the CAFE regulation in 2026 to organise ART1, which will discuss the 2030 new regulatory packages. The ART2 will come in 2031 to define regulations for

2035 and so on. We recommend also to publish impact assessment before the adoption of the regulation, and also an evaluation of the regulation effects to prepare the next roundtables.

In order to make ART a strong place for regulation, we recommend to invite every stakeholder and policymaker. The idea would be to bring every actor (Commission, Parliament, industry, trade union, NGOs…) around a table. Each actor can bring their own expertise, field of competences, but the final discussion must end with a coherent regulatory framework, considering the car – and mobility – as a complex system.

We believe that one way to achieve better coordination of standards would be to adopt transversal principles. The adoption of principles such as BATNEEC (Best available technology not entailing excessive costs) would also make the adoption of new requirements more predictable, but at the condition of adopting a holistic approach (what is considered is the whole package, and not each technology separately) where the desirability of achieving higher sustainability (CO_2 reduction via inter alia mass reduction) and affordability will also be taken into account. As a second principle, we can add that of environmental performance/ecological footprint, in order to limit “transversally” the environmental impact of regulations.

Also, differentiated urban policies are another obstacle to the definition of a "single crossing point", since legally speaking, European regulations are primarily aimed at member states, and not at local authorities. The adoption of a new vehicle category – what we propose in chapter 4 of this report – would, however, open up numerous possibilities, such as the creation of dedicated infrastructures. But other cities or regulators could also restrict use, by prohibiting access to certain lanes. Concerted action with major cities and national road safety authorities will therefore be needed to harmonize and coordinate the arrival of this new vehicle category.

2. Clio, an emblematic example of the upmarket drift

Analyzing Clio's weight trends from the 1st model, which appeared in the early 90s, to the upcoming Clio 6, expected for 2026, is interesting for several reasons. Firstly, because this vehicle is very representative of the B-segment range, which is part of the focus of this study.

Secondly, because this vehicle has gone through all the regulatory changes of the last 30 yea:

a) Clio1 was subject to the first regulation addressing pollutants emissions, i.e., Euro1, shortly after its commercial launch, while Clio6 is designed to comply with Euro7;
b) In 2012, Clio4 was subject to a CAFE target of 130g C02 / km (NEDC), Clio5 is now subject to a CAFE target of 95g C02 / km (NEDC), while Clio6 will have to contribute to a target of 93.6g C02 / km (WLTP) from 2025 and 49.5g C02 / km (WLTP) from 2030;
c) In terms of safety, Clio1 had to deal with many regulations addressing a (relatively) limited number of issues, while Regulation (EU) 2019/2144 now addresses a more comprehensive scope and introduces new requirements for general safety and protection of vehicle occupants and vulnerable road users (GSR2).
d) In addition, Clio3 was the first car in its segment to achieve a 5* Euro NCAP rating for occupant protection in 2005 and the Clio4 and Clio5 have also been awarded 5* Euro NCAP while, at the same time, rating methodology has been constantly tightened.

Thirdly, in stark contrast to its predecessor, the Super 5, the Clio was positioned at the top of its segment from the outset, with its advertising proudly proclaiming "Elle a tout d'une grande!".

The figure below shows three main periods in the evolution of Clio's weight [5] :

1. Whereas the Super Five had a contained weight of less than 750 kilograms, there was a clear increase in weight between Clio1 and Super 5 and between Clio1 and Clio3;
2. From the launch of the Clio4 until the middle of the Clio5 marketing phase, a period of relative stabilization of weight can be observed;
3. A further increase in the weight of the Clio5 following the introduction of Euro6 DFull-compliant diesel engines and the HEV version, and this situation should continue for the Clio6.

The important increase in weight of the Clio1 compared to the Super 5 is a direct result of the vehicle's new positioning in the B-segment, with larger dimensions[6], a higher level of equipment and more powerful engines, while the regulatory framework in terms of safety was relatively stable.

The most significant increase occurs first with Clio2 and then with Clio3. It is related to four main factors (listed by order of importance):

1. Safety: Passive safety requirements to improve occupant protection are met through additional structural reinforcements and equipment while the first active safety requirements are introduced during this period (ABS becoming mandatory in 2004). Both active and passive requirements result

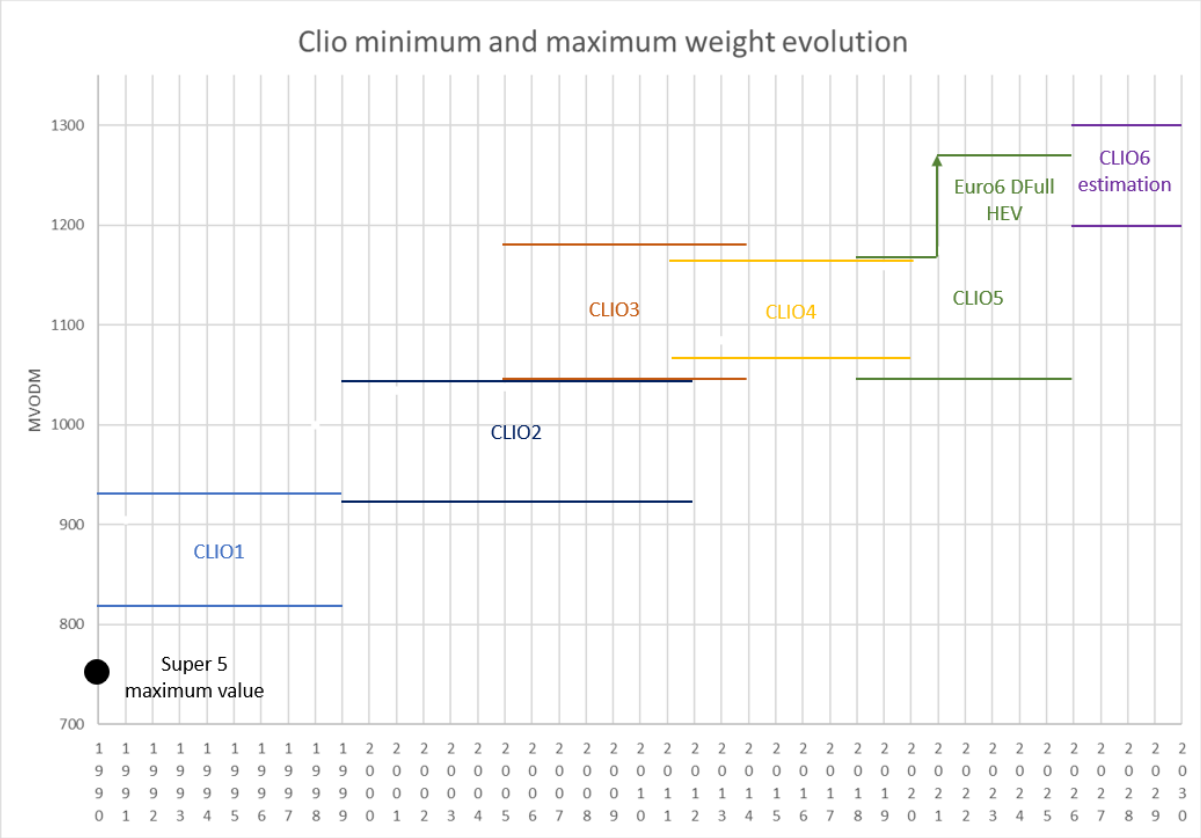
[5] This analysis does not include the various sporty versions of Clio. Vehicle weights are public data obtained from Wikipedia, Autotitre, Paru Vendu and Caradisiac for Clio1 to Clio 4, data from Renault's online comparator for Clio5 and the authors' estimates for Clio6. The magnitudes used in this figure and in the discussion of this evolution were confirmed through access to confidential manufacturer data and through interviews with experts from the manufacturer.

[6] 3.71m x 1.63m for the Clio1 versus 3.59m x 1.58m for the Super 5 resulting in a 10% increase in square footprint

in an increase of approximately 100 kilograms for a B-segment car. The Clio3's achievement of a 5* Euro NCAP rating for occupant protection has also contributed significantly to this increase.

2. Reduction of pollutant emissions: While Clio2 was subject to Euro2 requirements at launch, Euro3, Euro4 and Euro5a followed in quick succession until Clio3 was discontinued, adding about 100 kilograms for modified and / or new engines and various pollution control devices.

Figure 1 : Clio minimum and maximum weight evolution over time



3. Changes in vehicle dimensions and performance: Clio3 is 0.22m longer and 0.16m wider than Clio1, resulting in a 13.4% increase in surface area compared to Clio1[7]. Choice of design and equipment to meet market demand (or driven by the carmakers themselves), with vehicles often tending to be more richly equipped. The cumulated impact is estimated to be a few tens of kilograms, less than either of the above factors.
4. The knock-on effect: "mass begets mass", as experts estimate that an increase of 100 kg to meet (regulatory or market) requirements draws an additional increase of 20 kg to reinforce the vehicle structure, brakes, suspension systems, axles and so on.

The period of relative stabilization of weight observed from the launch of the Clio 4 until the middle of the Clio 5 marketing phase is the combination of diverse actions:

[7] Finally, vehicle sizing must take into account changes in human height (which increased on average up to 2007) and the more recent and persistent phenomenon of increasing average weight.

1. Restrictions on vehicle dimensions: while the Clio4 was even longer than the Clio 3 (4.06m vs. 3.99m), the Clio5's length was reduced to 4m.
2. Engine downsizing: older engines have been gradually replaced by downsized and more modern engines that take advantage of a turbocharger to compensate for the loss of displacement. The introduction of these new engines has helped to reduce the weight increase due to the introduction of additional pollution control devices.
3. Mass reduction by design: the use of lighter materials (thermoplastics, high-strength steels, etc.) and optimized design solutions have helped to reduce the weight of vehicles, all other things being equal.
4. Finally, safety requirements are now much more focused on active safety than passive safety, with a much more limited impact on vehicle weight.

On the whole, these strategies have been effective, especially as the performance offered has continued to improve. For example, Clio4 and Clio5 have all been awarded 5* Euro NCAP ratings, but one with the 2012 rating and the other with the much more stringent 2019 rating.

The further increase in weight of the Clio5 is directly related to the introduction of two powertrains in 2021 to meet Euro6 requirements[8]: a diesel engine, which adds around 50 kilograms to the weight of the Clio5 since its introduction through successive adaptations, and a full hybrid (HEV) engine, which is around 150 kilograms heavier than the equivalent ICE version.

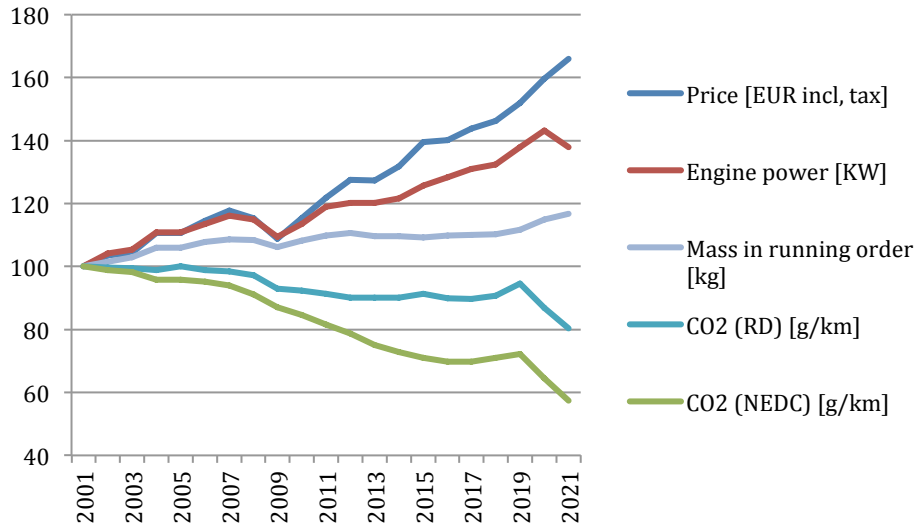
The increase in weight observed on the Clio5 will continue on the Clio6 as this model will comply with the Euro7 regulation. Even if the level of pollutant emissions has been kept at the same level as in Euro6 Dfull, Euro7 brings significant evolution as the durability threshold has been multiplied by 2, the size of particulate matter has been reduced and new On-Board Monitoring (OBM) provisions have been introduced. What's more, a number of articles in automotive magazines have mentioned a new hybrid powertrain with a larger displacement for the internal combustion engine. All in all, our estimation is that Clio6 weight should be between 1,200 kilograms (mechanical gearbox petrol vehicle) and 1,300 kilograms (HEV version).

[8] Downsized engines don't have the capacity to fully achieve all Euro6 requirements

3. The European upmarket drift of new car sales

The upmarket drift concerned all segments, models and brands sold in Europe since the 1990s. The figure 2 below illustrates how the average European car has become heavier, more powerful and more expensive since 2001 and also why this trend was in clear contradiction with the need of reducing CO2 emissions.

Figure 2. The upmarket drift of the average new car (EU, 2001-2021)



Source: ICCT (pocketbook data), EEA data - author treatment.
CO2 Real Drive data is based on (Tietge et al. 2019) until 2018, and on SprintMonitor data by brand for 2018-2021.

On average, a 10 per cent increase in weight leads to a 7 per cent increase in fuel consumption (IEA 2019). Furthermore, heavier cars need more powerful engines that also lead to higher fuel consumption: on average, a 10 per cent increase in engine power leads to a 5 per cent increase in fuel consumption (ICCT 2017; Tietge et al. 2019). The 10% of mass and the 26% of engine power that were added to the average new car sold in the Single Market between 2001 and 2015 were therefore equivalent to a 21% increase of CO_2 emissions. During the same period, the automotive industry was supposed to reduce CO_2 emissions by 20% in order to meet the 2015 target of 130 CO_2 gr/km (as measured by the NEDC homologation test), but in fact, to compensate for this extra mass and extra engine power, a 41% reduction was required.

Part of this upmarket drift was driven by the process of dieselization of new car sales as the main technological solution to reduce CO_2 emissions (diesel vehicles were heavier (+50 kg on average (T&E 2017)) and more expensive (between 9 and 21%) (Tietge et al. 2019). Even with diesels' market share growing from 36% to 52% between 2001 and 2015, and with direct gasoline injection's market share growing from less than 1% to 40% (a technology that delivers a 7% reduction of CO_2 emissions), the total CO_2 reduction was not enough to compensate for the upmarket drift.

The industry delivered in real drive conditions[9] only a 9% decrease of CO_2 emissions between 2001 and 2015, twice less than what was demanded, which is why "optimization" of homologation tests was required to fill the gap and fulfill the target.

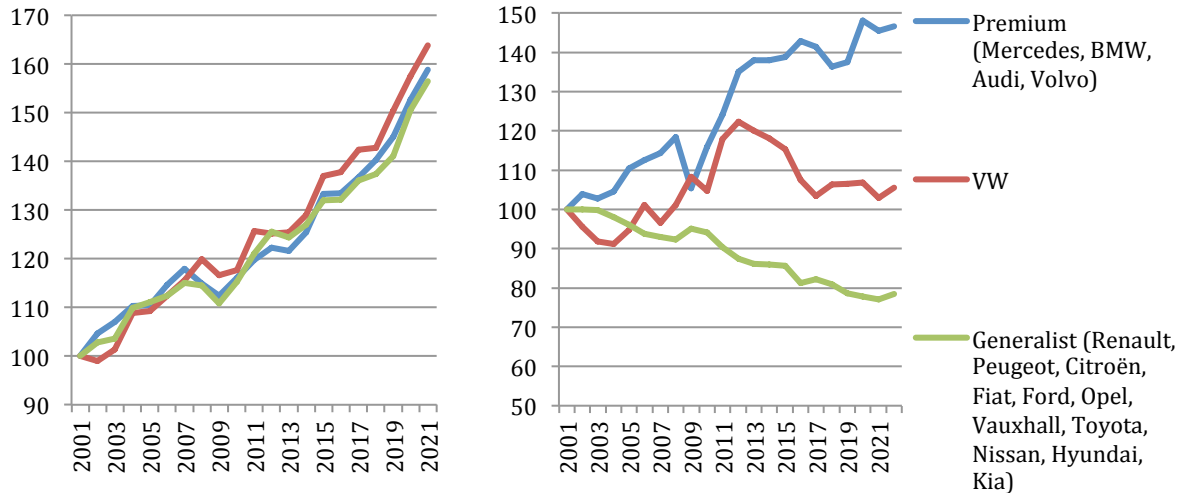
Following the Dieselgate scandal and the collapse of diesels' sales, the average new car sold in 2019 emitted only 5% less CO_2 emissions in real drive conditions than in 2001, while being 12% heavier, 38% more powerful and 52% more expensive: a utter technological and regulatory failure.

This paradoxical outcome was also driven by another direct consequence of the upmarket drift. Historical European generalist brands (Fiat, Renault, Peugeot, Citroën, Opel and Ford in our sample) were forced to follow premium brands upmarket by the regulatory pressure and the weight-based standards. As we have seen in detail with the case of the Renault Clio, their traditional compact cars sold in the A and B segments had to integrate more expensive premium technologies to comply with both sets of regulation (vehicle type approval and CO2). As a result, they moved away from their customer base and lost market share all along the way. Only Volkswagen, the most expensive European generalist brand (33,500 € of average price in 2021 compared with 25,700 € for the generalist group), preserved its market share. The other European generalist brands saw on average their market share halved (-47% between 2001 and 2022). Not surprisingly, almost all employment loss in the European automotive industry during the last twenty years (2000-2020) occurred in the countries where these generalist brands are manufactured: France (-87,000), Italy (-30,000), and Spain (-116,000). This loss of employment was also caused by the increasing relocation of production of A-B segment models to the low-cost new EU member States integrated in 2004 and 2008. In fact, the only non-premium generalist brands that have increased market share during this period were exclusively manufactured in these countries (Hyundai-Kia, Dacia and Skoda). When we include in the generalist sample non-EU brands such as Hyundai-Kia, Toyota and Nissan, the loss of market share is still 21% since 2001.

By contrast, premium brands (BMW, Daimler, Audi and Volvo in our sample) increased their market share by 47%. If we include in this group the brands Mini (owned by the BMW group), Jaguar-Land Rover and Tesla, we see that its overall market share has grown from 16% to 25% of the EU market. The historical EU generalist group has seen its market share dropping from 59% to 28% simultaneously squeezed by the upmarket drift, but also by the increasing market share of Asian brands (in particular Hyundai-Kia, and more recently Chinese brands), via either imports or EU production in Central and Eastern European countries, which has increased substantially since the start of fast electrification in 2020.

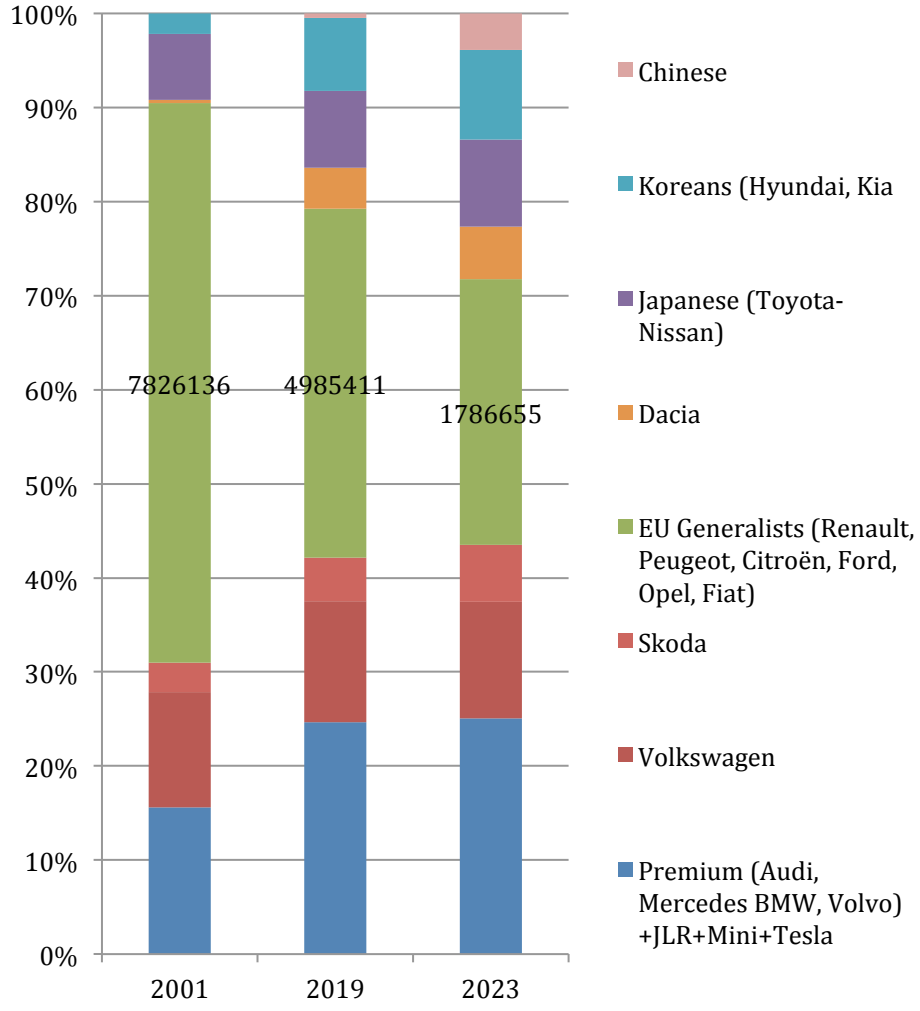
[9] Real drive data is provided either from different consumers' database where consumers report how much fuel the use for driving their cars or from tests in real drive conditions carried on several different models by ONGs or independent laboratories/universities. For a comprehensive list of these databases and tests see (Tietge et al. 2019).

Figure 3. Average price (left) and market share (right) by groups of brands



Source: ICCT, Authors treatment.

Figure 4. Market shares (EU27) by brands and groups of brands (2001-2023)



Source: CCFA, ACEA, INOVEV.

In other terms, the EU regulatory framework favored the sales of the heaviest and most polluting cars manufactured by the premium brands to the detriment of the lightest and less polluting cars manufactured by the generalist brands.

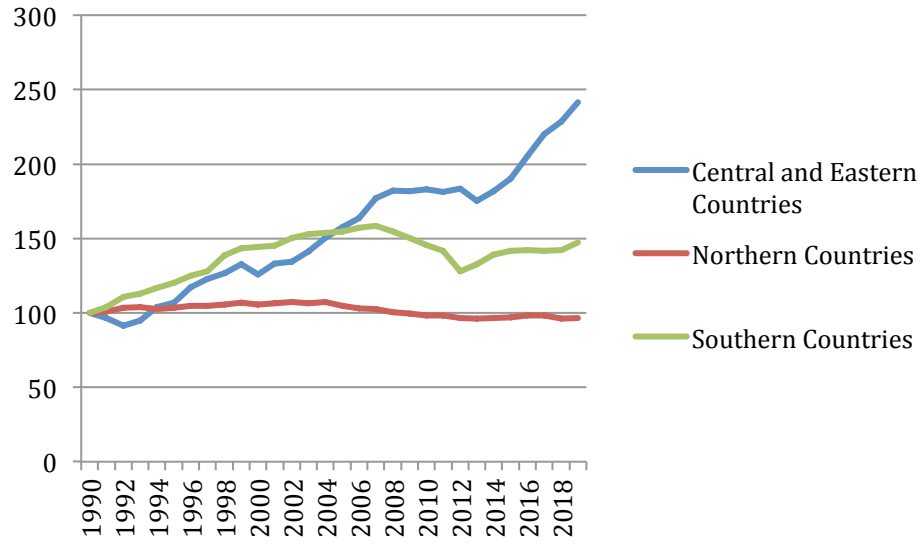
Also, by making cars more expensive (the average price of new cars grew in Europe by 66% between 2001 and 2021 against a general inflation rate in the euro zone of 38%) the upmarket drift made new cars in general a much less effective solution for decarbonizing the car fleet.

Between 2000 and 2021 the European car fleet grew by 36% (from 186 to 253 million vehicles) while new car sales declined by 23% (from 13 to 10 million). As a result, the annual rate of fleet renewal (the ratio of new car sales on total car fleet) fell from 6,9% to 3,8%. The lower the annual fleet renewal rate, the longer it takes to replace the existing car fleet with new, less polluting cars: 15 years in 2000, 26 years in 2021. Furthermore, behind this European average there is a growing divide between Northern, Southern and Central and Eastern European countries.

In Northern European countries, where the purchasing power of consumers is higher – even if the wage growth rate is lower than the automotive inflation rate, due to wage moderation macroeconomic policies favoring leasing strategies (Kaczmarczyk 2021), the number of years required to renew the whole car fleet grew "only" from 13 to 20; in Southern Europe, with lower purchasing power, it grew from 13 to 29; and in Central and Eastern European countries, it grew from 31 to 48 years. From these divergent dynamics results an increasing polarized access to recent cars: 67% of the car fleet of less than 2 years, and 65% of the car fleet of less than 10 years are located in Northern European countries; by contrast 74% of the car fleet of more than 20 years is located in Southern and Eastern European countries (in the latter cars older than 30 years can represent up to 30% of the car fleet (Pardi 2018))[10].

Now, it is precisely in those countries that have the least access to recent cars, that CO_2 emissions from cars have increased the most during the last thirty years: +241% in Central and Eastern European countries and +47% in Southern European Countries, compared with -4% in Northern European countries (figure 5).

Figure 5. Greenhouse gases from fuel combustion (cars) EU27



[10] Source: Greenhouse gas emissions by source sector (EEA).

Source: Eurostat.

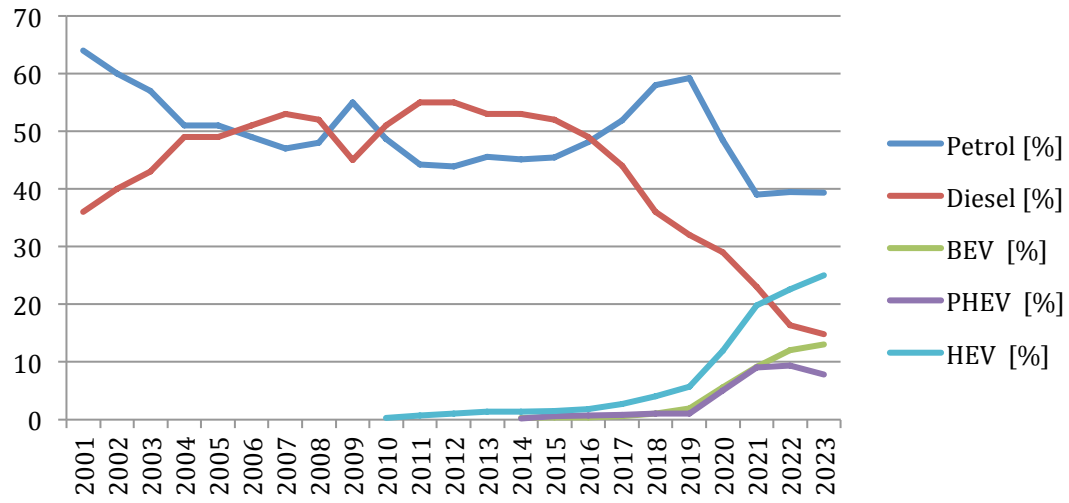
Since the upmarket drift is increasing with electrification this means that the access to new cars becomes even more difficult for these countries, leaving them without viable solutions to decarbonize their car fleets and meet the “fit for 55” targets.

3.1. When electrification meets the upmarket drift

The “fit for 55” update of the CO_2 regulation has raised the ambition by lifting the reduction target for 2030 from 37,5% to 55% (on 2021 emissions), and banned all ICEV (including HEV and PHEV) new car sales in the EU from 2035 onward. It will result in a drastic acceleration of the electrification in the coming years.

Between 2019 and 2021 the shares of EVs in new car sales have already increased rapidly – from 2% to 9% for BEVs and from 1 to 9% for PHEVs – in order to meet the 2021 CO_2 target of 95 gr (NEDC) in a context of collapsing diesels’ sales (figure 3). Yet, most of the consequences of the “fit for 55” update will be felt between 2025, when the European automotive industry will have to meet an intermediate CO_2 target of 93,6 gr (WLTP, previously 77gr NEDC), and 2030, with the last target of 49,5 gr (WLTP, previously 43gr NEDC) before the phasing out of ICEVs in 2035.

Figure 6. Shares of EU sales of new cars by type of powertrains (2001-2023)



Source: ACEA.

Electrification has been caught in the regulatory upmarket drift and now contributes in making the average new car sold in Europe even heavier and pricier and at a much faster pace than what we have witnessed during the dieselization period. We have to mention that the post-covid inflation was also due to the chip production shortage that disrupted production lines in 2020-2022, but structurally, electrification is now contributing the most to the long-term price growth.

Between 2010 and 2023 the average BEV sold in Europe gained 810 kg becoming in the process the most expensive worldwide: 66,864 € (JATO 2024).

By comparison the average BEV sold in China in 2023 was 700 kg lighter and 36,000 € cheaper than the average European one (JATO 2024). Such a comparison is useful because it shows that BEVs can be already lighter and cheaper than ICEVs with regulation that push towards the most energy efficient vehicles

(Connelly 2024; Bibra et al. 2022; JATO 2024; Alochet 2023). In Europe the weight-based standards incentivize the sales of the heaviest EVs. For instance, the 136 kg gained by the average “premium” vehicle (+8%) sold between 2019 and 2021 (1815 kg), due to the increasing sales of PHEVs (2025 kg, 23% of total sales) and BEVs (2163 kg, 7% of total sales), softened the CO_2 target of the premium group by 17 gr on average, which represented almost one third of the total CO_2 reduction achieved by the premium group since 2019 to meet the 2021 CO_2 target (T&E 2021, 40). By contrast, the generalist group added “only” 40 kg (+3%, 1355 kg) during this period and was therefore penalized with a hardening of its CO_2 target of 2 gr.

Because the upmarket drift was embedded in the EU regulatory framework till the end of 2024, the faster electrification pushed so far by the “fit for 55” update of the CO_2 regulation accelerates the upmarket drift and amplifies its negative outcomes in terms of affordability and renewal rate of the car fleet.

However, as we have already highlighted above, the change in the slope for weight based targets from positive (lower CO2 target for brands with heavier vehicles than the average) to negative (lower CO2 targets for brands with lighter vehicles than the average) that will intervene from 2025 onward, represents a 180° turn in terms of incentives, finally pushing the whole European automotive industry to go down-market towards lighter and more affordable cars.

In the next chapter, we will analyze two case studies (the Kei cars in Japan and the electric mini-vehicles in China) where these lighter and more affordable cars already exist, and we will see what can we learn from these countries that can help Europe in moving towards ASEVs.

Conclusion

An examination of the regulatory and political conditions in which the European automotive industry operates has helped us understanding why the small, affordable vehicle segment was on the verge of extinction.. The dynamic in question is structurally associated with a division of regulatory labor in the EU that organizes silos managed by different DGs and officials who have little reason to talk to each other. This logic is explained by the specificity and technicality of the issues that each has to deal with, which makes this specialization legitimate and necessary. It is also, and above all, explained by the relative fragility of the European edifice, which needs deep discussions and difficult compromises to make new policies and regulations. Each DG that then benefits from this delegation of competences has a vocation to limit itself to its own dossier and to avoid worrying about interactions with other important dimensions.

Indeed, integrating the interactions between, for example, passive safety and emissions issues means realizing that there are trade-offs to be made, which is only possible by - even implicitly - prioritizing the objectives. Since such prioritization is, by definition, outside the remit of the European bodies, it takes place ‘elsewhere’: the ‘holistic’ moments when the various relevant dimensions are considered together take place outside the European bodies. National political arenas have the legitimacy to reason in these terms, but they have relinquished some of their powers. Obviously, in order to offer compliant products without allowing prices to drift too far, manufacturers must also make trade-offs between objectives that politicians have been unable or unwilling to prioritize.

These issues, which concern both the construction of Europe and the ‘European governance of the automotive industry’, have been identified for many years (Jullien, Pardi, and Ramirez 2014; Klebaner 2020).The fact that weight and price served as an adjustment variable in a game structured by these silos had also already been established (Jullien, Lung, and Midler 2012). Recent work on the very problematic beginnings of the BEV in Europe (Pardi 2024; Galgóczi et al. 2023; Pardi 2022), as well as Luca De Meo’s

reflections in its Letter to Europe (2024) and our survey of those responsible for these issues at Renault or elsewhere, confirm these results, which the case of the Clio exemplifies perfectly.

Since it is necessary to do without the comfort of allowing mass and prices to drift in order to be able to offer light, inexpensive vehicles once again, we have to make trade-offs. Electrification, as it has been organized since 2020, had to do this within the faulty structure described above. Since the result is a political, economic and social impasse that calls for a strong political response, electrification must, for the European automotive industry as in many other areas, be an opportunity to think differently in Europe: the imperative need to break down silos and structure a body capable of leading a holistic approach must be stressed. This is a kind of precondition for the solutions for developing an affordable BEV offer in Europe that are going to be examined and proposed to emerge.

In 2024, the growth in BEV market share has been halted, while manufacturers will shortly be required to post CAFE figures 15% lower than in 2021. Beyond that, the capping of BEV sales casts doubt on the relevance of the course set for 2023 and clearly strengthens the electro-sceptic camp, which is calling for the ban to be abandoned, for intermediate deadlines to be called into question, for a return to 'technological neutrality'[11] and for the right to subsidize the purchase of combustion vehicles. In this context, there is a strong risk that the main demand for a reduction in the price and weight of electric vehicles will be forgotten. This is all the more the case given that the grooves and bureaucracies that support them are solid and that recognition of the need to break them has not yet been unanimously acknowledged. An examination of the non-European cases where these more frugal vehicles have found a place will provide a clearer and inspiring picture to avoid such a scenario.

[11] We refer here to the current use of the term in the post-European elections context where behind the return to "technology neutrality" there is the risk of jeopardizing the achievement of the 2035 target by diverting funding to less mature technologies and delaying the deployment of electric ZEVs at a time when a rapid transition to decarbonized mobility is paramount. We do however propose later in the report (chapter 4, section 2) to reform the current CO_2 regulation by introducing LCA based criteria in order to make sure that the European strategy towards electrification is one that promotes the most efficient path towards the decarbonization of road transport and not just electrification per se.

Chapter 3.
What can we learn from countries where AS(E)V exist?

In Japan small cars of less than 1000 kg – the Kei cars – represent today almost 40% of both new car sales and of car fleet. In China, the A segment made of mini-vehicles and city cars between 600 and 1200 kg has seen the fastest growth of New Energy Vehicles with production volumes increasing from 200,000 in 2019 to over a million in 2022, nearly 20% of NEV sales this year.

We have selected these two case studies to understand how different countries with advanced automotive industries have preserved and/or developed their A segment vehicles.

The first purpose of this chapter is to highlight the benefits associated with a large share of A segment in new car sales and car fleet from different perspectives: as strategic technologies to decarbonise/electrify new cars sales and road transport; as social instruments to promote affordable energy efficient/decarbonised mobility; as economic instruments to preserve/develop domestic automotive industries. In this respect, we will also evaluate the environmental, industrial and social performances of these countries by comparison with Europe, with a particular focus on the different weight and role of small cars.

The second purpose is to identify the main policies, regulations and political conditions that have enabled these different trends, and how we can learn from them to promote in Europe an ASEV.

We will focus our attention, first, on the Japanese Kei Cars that resembled a lot to the European small cars of the 1980s and early 1990s, but have followed a very different development path in the 2000s and 2010s, and second, on Chinese electric mini-vehicles that embody in many ways the ASEVs that we do not have in Europe, yet.

1. Kei Cars in Japan or what could have happened to Europe if it had kept its small cars

Contrary to Europe, which has seen the mini-car A segment vanishing since the 1990s, Japan has been successful in promoting the sales of mini cars whose market share has grown from 5% in 1985 to 39% in 2014 (36% in 2022).

The purpose of this study is double:

- First, to understand how Japan has managed to achieve this spectacular growth in mini cars' sales, and how much important has been for this development the existence of a separated category for such vehicles – the Kei car, for keijidōsha or light vehicle;
- Second, to quantify the benefits and/or drawbacks of such an important and increasing penetration of mini cars in the Japanese car fleet for decarbonising road transport, providing affordable green mobility, improving road safety and preserving domestic car production and employment.

1.1 Historical conditions for diffusion

1.1.1 From early diffusion to almost disappearance: Kei cars in the 1960s and 1970s

In 1949 Japan introduced specific category for very small lightweight vehicles called Kei-cars.

Table 4. Main regulatory changes in the definition of Kei cars

Date	Max. length	Max. width	Max. height	Max. displacement		Max. power ('gentleman's agreement between Japan's car- and lawmakers')
				four-stroke	two-stroke	
8 July 1949	2.8 m (110 in)	1.0 m (39.4 in)	2.0 m (78.7 in)	150 cc (9.2 cu in)	100 cc (6.1 cu in)	—
26 July 1950	3.0 m (118 in)	1.3 m (51.2 in)		300 cc (18.3 cu in)	200 cc (12.2 cu in)	
16 August 1951				360 cc (22.0 cu in)	240 cc (14.6 cu in)	
1 April 1955				360 cc (22.0 cu in)		
1 January 1976	3.2 m (126 in)	1.4 m (55.1 in)		550 cc (33.6 cu in)		
1 January 1990	3.3 m (130 in)			660 cc (40.3 cu in)		64 PS (47 kW; 63 hp)
1 October 1998	3.4 m (134 in)	1.48 m (58.3 in)				

In the 1950s, the Kei-cars regulation was amended several times to increase the maximum length and width, and to allow bigger engines (see table 1). The purpose of the regulation was to promote affordable small cars to replace three wheelers and provide a wider access to individual auto-mobility.

Figure 7. Sales of new passenger cars in Japan by vehicle category (Mini = Kei Cars) - 1970-2022

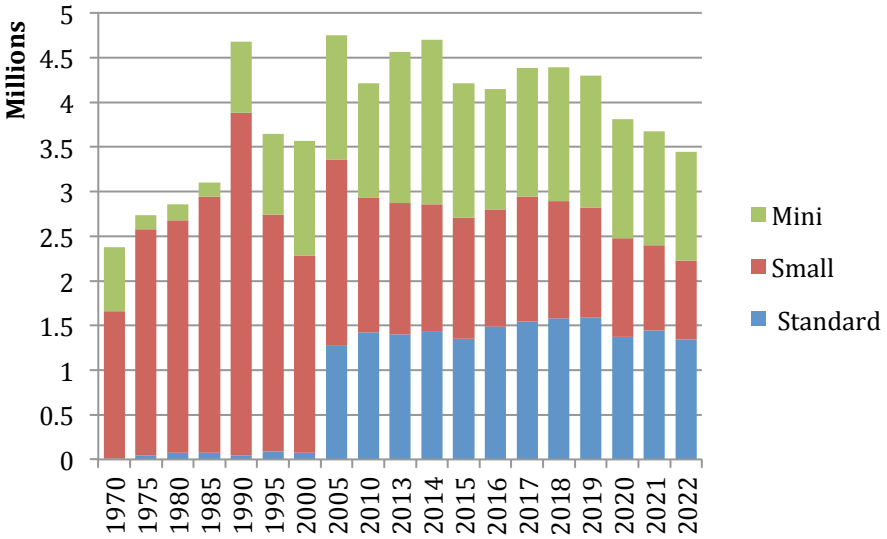
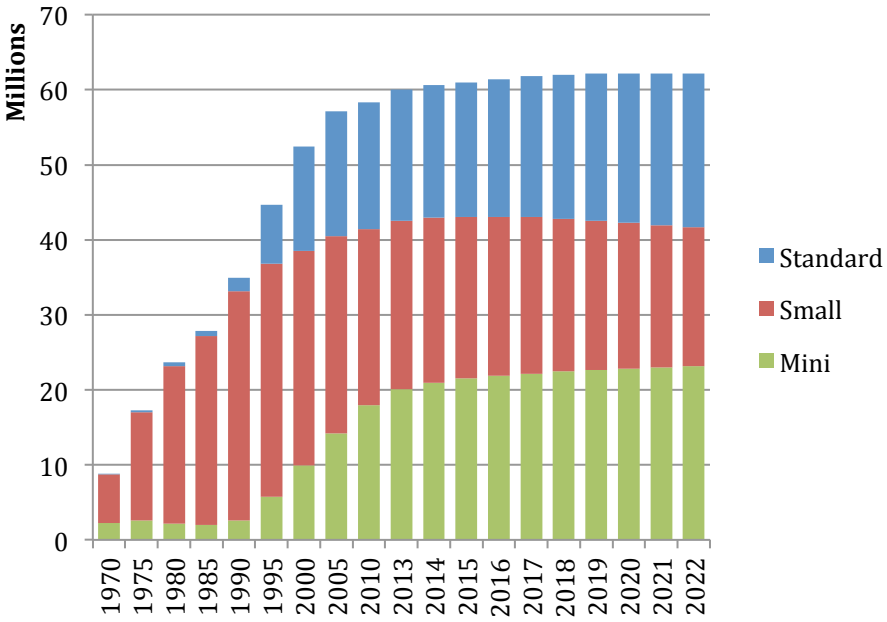


Figure 8. Passenger car fleet in Japan by vehicle categories (1970-2022)



Source: JAMA 2022

At the end of the 1960s the Kei cars (mini) segment represented 30% of the sales of new cars, and 24% of the total domestic production of cars. In the 1970s however, both the sales and production of Kei cars collapsed and fell, respectively, to 6% of total sales and 4% of total production in 1975.

There were two main reasons for this sudden drop.

The first one was the implementation of environmental regulations to reduce air pollution from cars in 1972 to both tackle local air pollution and to follow the tight US limitations. The cost of developing and equipping cars with the catalytic converters' technology required to meet US standards were extremely high (Pardi 2022; Klebaner and Ramírez Pérez 2019) and there was a clear advantage in sharing these costs

on the largest possible amount of cars produced for both export and domestic markets. By contrast, Kei cars were only produced for the domestic market, and the relative cost of equipping them with catalyst converters were prohibitive, amounting to almost 30% of their relative price (Toyoda 1987, 146).

In Japan, the specialist manufacturers of Kei cars Daihatsu, Suzuki, Mitsubishi and Subaru could only obtain from the government an amendment to the regulation to increase the size of the Kei car to 3,2m of length and 1,4m of width and its engine displacement to 550 cc in order to make "mini" cars more appealing to consumers and relatively easier to depollute.

The second reason was that the production of "small" compact cars such as the Toyota Corolla, the Honda Civic and the Nissan Sunny, fuelled by fast increasing exports, tripled between 1970 and 1980, providing the economies of scale to finally make Japanese compact cars' prices competitive with Western models (Cusumano 1985). This happened at the same time when production volume of Kei cars plummeted, making more difficult to produced them with profit. Also, the demand for compact cars was so important that some carmakers, Honda and Mazda for instance, stopped producing Kei cars to concentrate their capacity exclusively on the production of compact cars.

Similarly, to what happened in Europe to the A segment during the last twenty years, the declining sales of Kei cars during this period in Japan were not due to less demand for such cars, but to less supply. Kei cars remained popular because they were adapted to narrow roads, easy to drive and had good fuel economy. It simply became too difficult to make them profitably and affordably.

1.1.2. The return of Kei cars from the 1990s

In 1990, the share of Kei cars in the car fleet fell to its lowest level at 7% (from 26% in 1970) but then, almost unexpectedly, sales started to increase again. The market share of Kei cars jumped to 16% in 1990 (from 5% in 1985) and kept growing through the decade to reach 30% in 2000.

Several factors account for the regain in popularity of Kei-cars in the 1990s.

First, the Kei-cars regulation was amended in 1990 to increase their minimal length and the engine displacement. The new regulation spurred the interest of carmakers in launching new Kei cars models, taking also advantage of turbocharged powertrains that increased performances, reduced the cost of depollution and made these models more polyvalent and adapted to longer distance travels. For instance, some very popular "kei-sports" models were first introduced in the market at this time.

Second, the 1980s economic bubble brought the domestic market to record high sales shifting the demand from first equipment to replacement with growing multiple cars ownership. Kei cars could be now bought as the second car of the household.

Third, during the 1980s compact cars (which represented 90% of the market) went strongly upmarket to satisfy the "premium" demand of the bubble economy's years. By contrast, Kei-cars could not follow the same upmarket path because they were constrained by the regulation. The price difference between the two categories of vehicles increased significantly. After the bubble economy burst in 1991, Kei-cars became much more attractive to consumers than compact cars precisely because they were so much cheaper to buy and use. We observe during the 90s many consumers replacing their normal cars by Kei cars, while European consumers couldn't avoid the upmarket drift.

Fourth, Kei-cars did not only become much cheaper to acquire relative to small cars but they also benefited from a variety of fiscal and non-fiscal policies that further reduced their ownership costs such as reduced acquisition and use related taxes including insurance taxes, discounts on rural highways tolls, lower

inspection fees and exemptions from parking space requirements in rural areas. For example, JAMA has calculated that a standard car (2000 cc) used for 13 years in Japan would cost about 6,360 € in taxes in 2022, while a Kei car would cost about 2,268 € in taxes. These financial incentives have therefore played a role in the success of Kei cars which was at least equal to that of limiting dimensions and speed.

The purpose of these generous policies towards Kei cars was not only to promote more energy efficient cars, but also to provide affordable cars in particular for low-income households and small companies in rural areas where access to public transport was limited. Indeed, an important counterpart to the historical high taxation of cars in Japan was the development of dense, efficient and affordable public transport. Subsidised Kei cars represented a political solution to the problem of low densely populated areas, where the deployment of public transport was less efficient and the need for individual mobility more important. Moreover, Kei Cars became particularly important for women, who represented in low dense areas more than 70% of the owners; but also for elderly people, in particular with low revenues per household, with the over 60s representing in rural areas more than 40% of the total owners. The aging rural population represented a key constituency for the Liberal Democratic Party and subsidised Kei cars were part of the political compromise that kept the LDP in power since 1955 (Lipscy 2012).

Moreover, a third important buyer/user group of Kei cars was also young people in their 20s and 30s, which represented about one third of the Kei cars' owners in the 1990s and was also characterised by relative low revenues.

As a result of these comprehensive fiscal and road policies, by the early 2000s, every household living in low densely populated areas would own at least one Kei car, with often two cars per household, while in dense urban areas such Tokyo only four households on ten would own a car, and only one would own a Kei car.

The large increasing number of Kei Cars in the Japanese vehicle fleet (see figure 8 above) shows that Kei cars not only substituted for compact cars as a more rational purchase choice after the burst of the bubble economy, but also contributed to enlarge the access to cars in low densely populated areas and amongst lower revenues social groups, more particularly for women and their access to work, but also for elderly and young people.

In a way, Kei cars offer a credible alternative of affordable new cars to the aging used cars that we are familiar with in Europe.

In the 2000s-2010s the market share of Kei cars kept growing. This period saw the introduction of super-tall cubic-like models that became rapidly the best sold Kei-cars in the market, especially as family cars. More generally, when questioned about the reasons for buying a Kei car, consumers increasingly highlighted their ease to use, interior roominess, appealing styles, colours and shapes as the main reason (from 25% to 51% between the 2020 and the 2023 surveys on Kei Cars use) with affordability remaining significant (from 75% to 49%) but declining, confirming that many consumers increasingly preferred Kei-cars over compact cars and did not only buy them out of necessity.

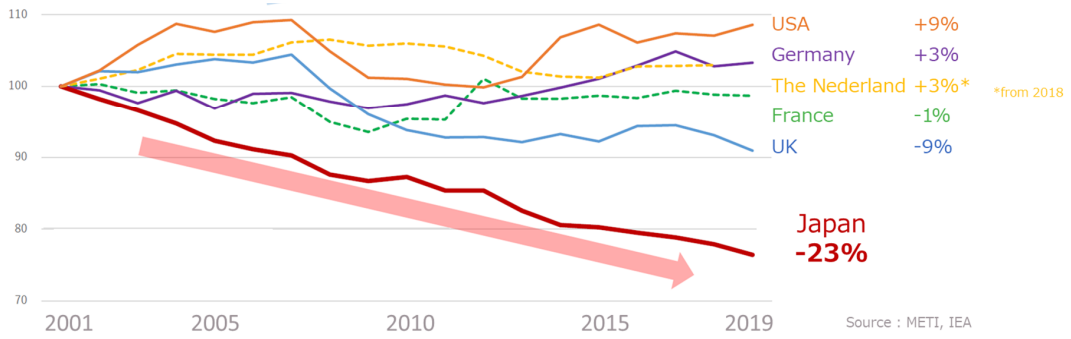
Kei cars also became during this period a strategic technological solution promoted by carmakers and the government to achieve the ambitious decarbonisation targets of new car sales and road transport first introduced in 1999 with the Top Runner program.

1.2 Cumulative advantages of Kei cars

1.2.1 The most efficient way to decarbonise transport and reduce air pollution is to shift towards lighter cars

The success of Kei-cars has been a key contributor to the decarbonisation of road transport in Japan in the last twenty years. Between 2000 and 2019 CO2 emissions from road transport declined by 23% in Japan – by far a much better result than in Europe.

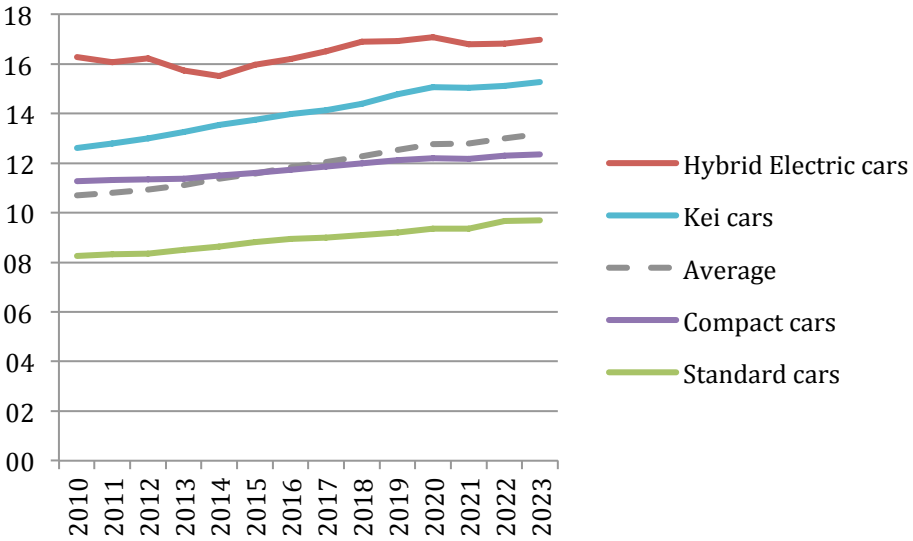
Figure 9. CO2 emissions from road transport (international comparison - 2001-2019 - base 100 in 2001



Source: JAMA.

During this period Kei-cars penetration in the car fleet almost doubled from 19% to 36% while the contribution of low-emissions "nextgen vehicles" (mostly hybrid electric vehicles) only started to be felt in the latter part of the 2010s (from 2% of the car fleet in 2010 to 19% in 2019). Kei-cars have a much better "real drive" (RD) fuel economy (km/l) than compact cars (+24% in 2023) and standard cars (+56% in 2023). Also, their RD fuel economy has improved much more than for compact and standard cars (see Figure 10 below).

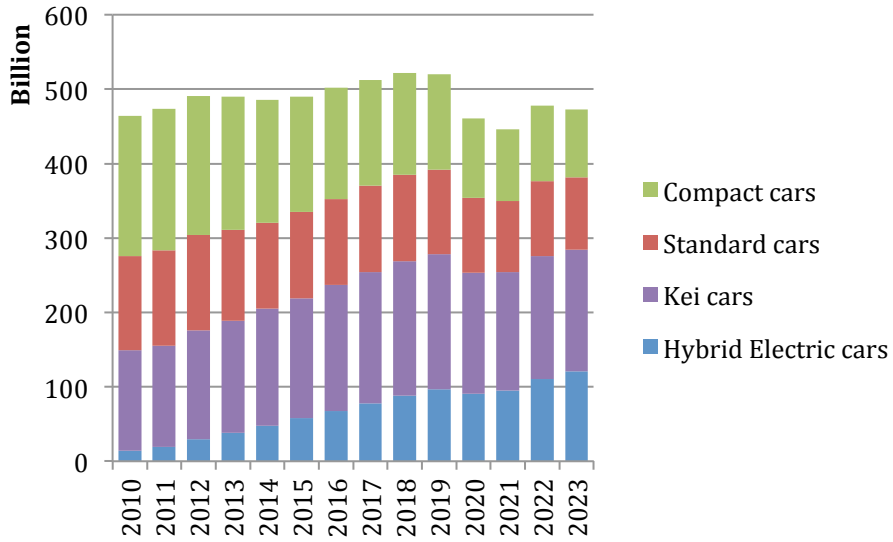
Figure 10. Average real fuel economy (km/l) by type of vehicles in Japan (2010-2023)



Source: Enquiry on fuel consumption of vehicles: https://www.e-stat.go.jp/stat-search/database?page=1&toukei=00600370&tstat=000001051698.

The real fuel economy is calculated as the ratio between the total amount of km travelled annually by each type of vehicle yearly, and the amount of gasoline used.

Figure 11. Total annual km travelled by type of vehicles in Japan (2010-2023)

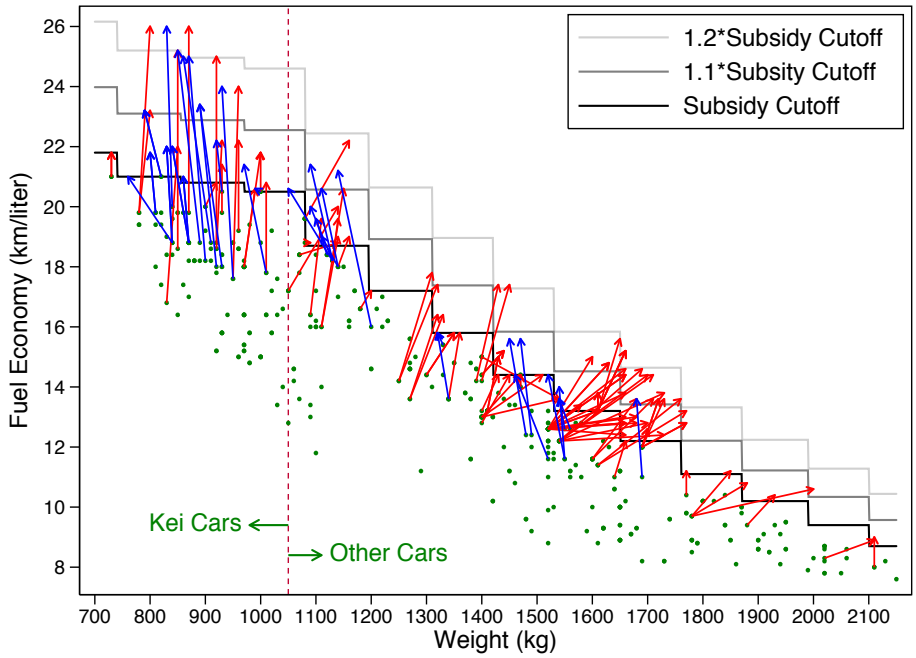


Source: Survey on fuel consumption of vehicles.

1.2.2. How Kei cars contribute more than standard cars to CO2 reduction

The main reason of this much better environmental performance of Kei cars relative to all other types of vehicles was directly tied to its smaller mass and its caped dimensions.

Figure 12. Evolution of fuel economy and weight of 106 Japanese models of cars between 2008 and 2012



Source: reproduced from (Ito and Sallee 2018).

The figure 12 shows how the fuel economy (km/l) and weight (kg) of 106 different models sold in Japan evolved between 2008 and 2012. The red/blue arrows describe this evolution for each of the 106 models. Red arrows stand for models whose weight increased and blues arrows for models whose weight decreased. The black line (subsidy cut-off) corresponds to the 2012 fuel economy target beyond which a model in each weight category (the "steps") was awarded a direct subsidy of 1000 € for "other cars" and of 700 € for "Kei cars". The dark and light grey lines correspond to, respectively, 10% and 20% better performances than the target, which awarded more subsidies via lower registration taxes.

The data shows that "Kei cars" behaved very differently from the "other cars" in meeting the 2012 fuel economy standards.

On average Kei cars reduced their mass (-5% against +6% for other cars) to achieve the targets in their initial weight categories (93% of the models), and a significant number of models (27%) achieved a 20% higher fuel economy than the subsidy target (against 7% of other cars).

The fuel economy achieved by Kei cars between 2008 and 2012 (-26%) was much higher than that achieved by "other cars" (-15%). As stressed by Ito and Salle (2018), the almost flat weight-based targets of Kei cars certainly contributed to this performance, providing less room for weight adjustment as a compliance strategy. Yet, and more generally, the constraints placed by the Kei cars category on carmakers protected them from the upmarket drift.

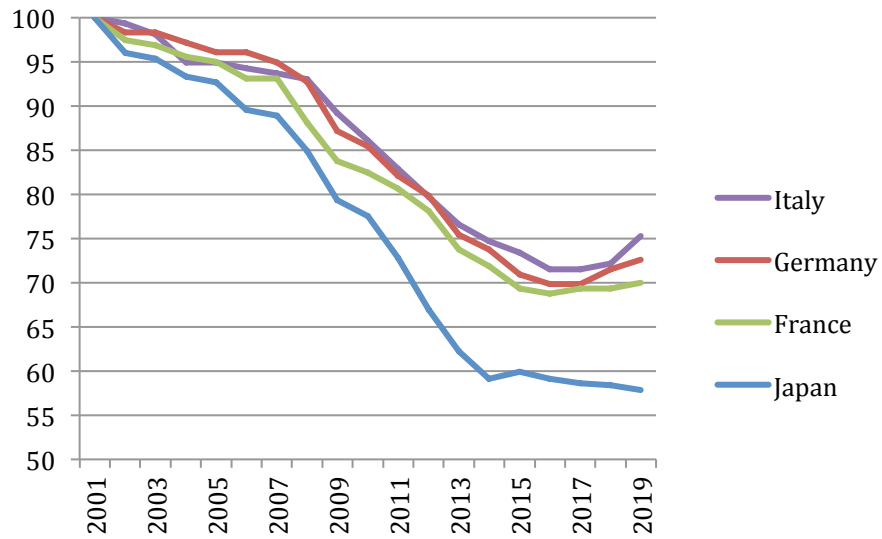
1.2.3. The distinctive role of Kei cars in Japan's record decarbonisation track

If we zoom out from this specific period and we consider how Kei cars evolved by comparison with compact and standard cars between 2000 and 2022 we find that, first, their average mass increased by only 4%, by comparison with a 12% increase for "other cars"; and second, we estimate that their average price increased by 17% by comparison with 42% for compact cars and 58% for standard cars further contributing to the increasing diffusion of Kei cars during this period (see figure 15 below).

It is clear that Japanese carmakers achieved a much faster and much more important reduction of CO2 gr/km in new car sales than their main European competitors.

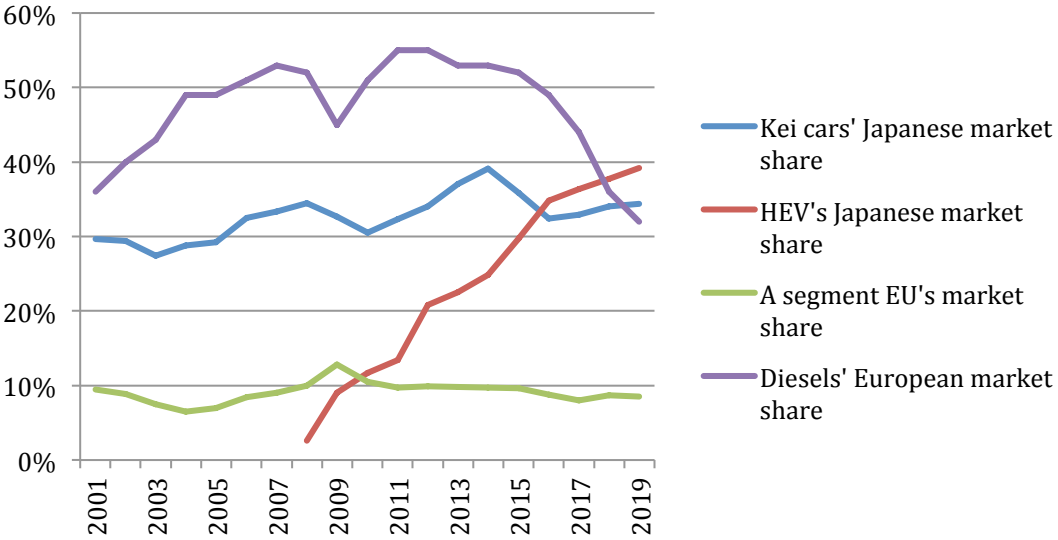
Up to 2008, this faster and more effective decarbonisation was almost exclusively driven by Kei cars' increasing fuel economy and market share. Starting from 2009, it was reinforced by the increasing market share of HEVs. That Kei cars remained central in the reduction of CO2 even after 2009, it is not only confirmed by our previous analysis of how Japanese carmakers met the new fuel economy standards of 2012, but also by the fact that after 2014 and the drop of Kei cars' market share due to the realignment of their acquisition taxes with compact and standard cars, the reduction of CO2 emissions of new car sales almost stop in Japan, and this happened despite fast increasing market share of HEVs.

Figure 13. Comparison of average CO2 gr/km emissions of new car sales in Japan, Germany, France and Italy (2001-2019)



Source JAMA; ICCT.

Figure 14. Comparison of the relative market shares of Kei cars and HEVs in Japan, and of A segment cars and diesels in Europe (EU27) (2001-2019)



Source: JAMA, ICCT.

In Europe, the contribution of the A segment to the decarbonisation of new car sales has been almost non-existent. Not only because its market share stagnated and then declined for most of the period; but also because the A segment followed the general upmarket drift as its mass increased by 12% (+105 kg) between 2001 and 2019 (ICCT 2023). The main driver of decarbonisation in Europe was dieselisation, but it came at the price of heavier and more expensive cars (Pardi 2022) and of much worse air pollution by comparison with gasoline powertrains. Starting from 2020, with diesel sales collapsing following the Dieselgate scandal, European carmakers were forced to shift towards BEVs and PHEVs.

1.2.4. Electrification of Kei cars

Besides HEVs, Japan has not promoted until very recently electric vehicles. Yet, since 2022 a subsidy of about 3,500 € - 5,000 € is given to buyers of BEVs. In 2023 the BEV market has grown to 2,2% of the total market and two electric Kei cars accounted for 50% of these sales: the Nissan Sakura and the Mitsubishi eK-X (Connelly 2024, 47).

Electrifying Kei cars, rather than compact or standard cars, presents some key advantages.

First, Kei cars are used mostly everyday but for short distance, cumulating on average less than 600 km per month. They are therefore adapted to electrification even with relative small batteries and little autonomy. For instance, Kei cars owners declared on average that 170 km of autonomy would be enough for commuting and daily use; and that 250 km would provide enough autonomy for leisure and holidays (JAMA 2023).

Second, the extra cost of an electric Kei car relative to an ICE version is small in absolute term – between 2500 and 4000 € – and is currently completely covered by the government bonus. Considering the willingness of Kei cars' buyers to pay on average 1200 € more for an electric version (JAMA 2023), the market for electrified BEVs is very promising and is expected to take off from 2025 onward when vehicles achieving 80% of Japan's energy-saving target will receive a 50% further tax reduction on the top of the current bonus.

1.2.5. Air pollution

According to JAMA (Zenkei Jikyo 2024), a Kei Car generates seven times less road and tires abrasion than an average standard car because it is much lighter than other cars. Since with modern powertrains mechanical abrasion has become the most important sources of NOx emissions the advantage of a lighter car fleet for reducing air pollution has become increasingly more important for ICEVs, but also for BEVs (OECD 2020).

1.2.6. Road safety impact

Kei-cars must meet the same regulatory standards as compact and large cars, but these standards do not always apply in the same way and temporary exemptions have been given to Kei-cars due to their specific features (smaller footprint and vehicle surface, caped speed and engine power) and use contexts (for instance average lower speed in case of accidents).

The table 5 below details the evolution of vehicle type approval regulations for Kei cars, in particular for passive and active road safety between 1994 and 2013 based on TRL 2014:

« The history of the Kei car is interesting in that safety requirements for it were introduced in a gradual manner to align with M1 requirements currently. The authors believe that this is a good example of standards being set at a technically feasible level taking into account the characteristics of the vehicle and its operating environment. » (Edwards et al. 2014, 17)

Overall, the increasing penetration of Kei-cars in the car fleet has not been detrimental to road safety. Between 2012 and 2022 - road fatalities have decreased in Japan by 40% and are currently at 0,4 per 10,000 registered vehicles, one of the lowest ratios amongst IRTAD countries – ahead of Germany (0,5) and France (0,7).

Table 5. Kei Cars progression in safety requirements

Year	Length x width (Max height = 2m)	Engine displacement	Engine power	Safety requirements and reasons for changes
1949	2.8m x 1m	4 stroke ≤ **150 cm2** 32 stroke ≤ **100 cm2**	Approx. 1.2 kW	
1950	2.8m x **1.3m**	4 stroke ≤ **300 cm2** 2 stroke ≤ **200 cm2**		Manufactures input on feasibility
1951	**3m** x 1.3m	4 stroke ≤ **360 cm2** 2 stroke ≤ **240 cm2**		
1954	3m x 1.3m	**All ≤ 360 cm2**	Approx. 27 kW 36 hp) [Subaru 360)	
1976	**3.2m** x **1.4m**	All ≤ **550 cm2**	Approx. 40 kW (55 PS, 54 hp) [Subaru Rex VX]	Needed to meet emission legislation
1990	**3.3m** x 1.4m	All ≤ **660 cm2**	47 kW (64 PS; 63 hp)	Power for air conditioning
1994				**Full-width frontal impact 40 km/h**
1998	**3.4m x 1.48m**	All ≤ 660 cm2		**Full-width frontal impact 50 km** Space for crumple zones **Side impact Mobile Deformable Barrier (MDB) 50 km/h**
2005				**Pedestrian (Head)**
2007				**Offset frontal impact (56 km/h)**
2013				**Pedestrian (leg)**

Source: (Edwards et al. 2014).

Furthermore, there are clear advantages in having lighter car fleets.

First, heavier vehicles have higher accident rates than lighter ones. Evans (1984) notably found that 2 ton vehicles have accident rates that are 39% higher than 1 ton vehicles and White (White 2004) and Anderson

(2008) found that US light trucks are 13% to 45% more likely to have multivehicle accidents than passenger cars.

Second, when heavier vehicles have accidents, they are more likely to cause fatalities and severe injuries. Anderson and Auffhammer (2014) found, based on US data, that a reduction of 100 kg of the average mass of the car fleet would reduce the risk of fatalities due to car accidents by 10,5%. They estimate, as a counterfactual, that if the US consumers had bought only Kei cars between 1989 and 2005, this would result in 26,034 less annual fatalities on the road (2014: 26). Ommeren et al. (2013) arrived at similar conclusions using Dutch data and estimated at 14% the increasing risk of fatalities due to 100 kg increase in average vehicle mass. The Economist has more recently confirmed these results by carrying an extensive research on 7.5 million car crashes in 14 American states between 2013 and 2023. The study found that for every 10,000 accidents, the heaviest vehicles kill 37 people, by comparison with 5,7 for median weight vehicles and 2,6 for the lightest vehicles. The study also found that because of the constant increase of weight in the average US car fleet the number of pedestrian killed by cars has almost doubled since 2010 (Economist 2024).

1.2.7. The evolving social role of Kei cars as affordable and practical cars: diffusion and market

Kei-cars play an important social role, providing affordable access to personal mobility in rural regions and small-medium cities, where public transport is less available, in particular to women with children, elderly and young people.

Table 6. Number of Vehicles and Mini-Vehicles (Kei Cars) per 100 households, by different prefectures (2022)

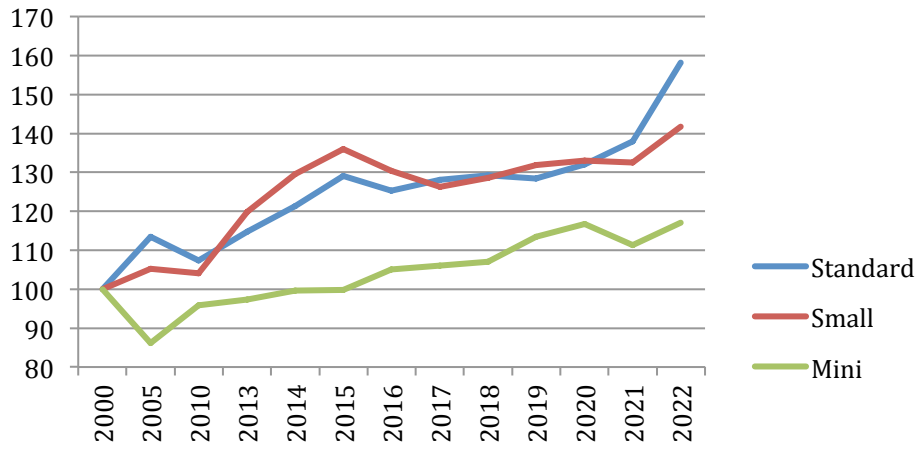
	Veh	Mini-Veh.	**Mini-Veh %**	People per square km	Average income (mill. Yen)
1. Fukui	170,8	94,9	**56%**	192	27,2
3. Yamagata	164,2	96,9	**59%**	125	23,3
6. Nagano	155,8	96,9	**62%**	159	27,2
12. Saga	149,9	98,7	**66%**	125	24,6
14. Tottori	144,3	99	**69%**	168	23
16. Shimane	138,7	97,3	**70%**	107	22,4
41. Chiba	94,9	37,9	**40%**	1260	29,8
42. Saitama	94,1	36,6	**39%**	1840	29,5
45. Kanagawa	68,4	20,5	**30%**	3748	32
46. Osaka	62,7	26,2	**42%**	4670	30
47. Tokyo	42,1	11	**26%**	6017	41,6
National Average	103,72	51	**49%**	343	29,2

Source: (JAMA 2023), authors treatment.

In table 6 above we can see that Kei cars represent on average 49% of the cars own by households, but that this percentage increases in low densely populated areas that also have lower average income levels,

where Kei cars can represent up to 70% of the car fleet owns by households. As expected, households in Tokyo own much less cars (42,1 per 100 households) and “only” 26% of them are Kei cars.

Figure 15. Unit value of automobile production (OEMs) in Japan by vehicle categories of passenger cars (2000-2022)



Source: JAMA.

The figure 15 shows the evolution of the average production value[12] of Mini (Kei cars), small (compact) and standard cars manufactured in Japan. It confirms that Kei cars have less increased in value during the last twenty years than the other cars, remaining and becoming increasingly more affordable than alternative vehicles.

1.3. Economic and employment impact

Japan is the second main exporter of passenger cars behind China. Since Kei cars are only produced for the domestic market their share in total production has remained relatively small.

It has nevertheless doubled since the 1990s from an average of 10% to an average of 20% in the 2020s, a volume of about 1,5-2 million vehicles that represents on average about 35% of the cars manufactured for the domestic market. In terms of value of production, Kei cars represent 9% of the total value produced in 2022, from 4% in 1990.

Kei cars production is concentrated in relative few groups – Daihatsu, Suzuki, Mitsubishi, Honda – that manufacture also for other groups (and notably for Toyota and Nissan). In terms of brands, the market leader is Daihatsu (565 930, 32% market share), followed by Suzuki (531 707), Honda (318 563) and Nissan (189 627).

The main advantages of Kei cars production are:

- Not reliant on exports and therefore less vulnerable to economic risks and currency fluctuations;
- Not exposed to foreign competition;
- Relative stable production volumes due to consistent demand and policy support.

[12] This is the ratio between the total value of production by type of vehicles provided by the Ministry of Economy, Trade and Industry (National accounts) and the number of vehicles produced each year.

1.4. Conclusions: from Kei cars to EU ASEV

Since the 1990s, Kei cars have played an increasing central role in decarbonising new car sales and road transport in Japan, and in providing affordable personal mobility to lower revenue population. Kei cars represent more than half of the car fleet in rural areas, and around one third in dense urban areas.

They embody a strong historical political compromise between citizens, carmakers and governments where a comprehensive package of evolving fiscal and non-fiscal measures has supported the affordability and convenience of acquiring and using Kei cars relative to other cars for the populations who are the most dependant on cars for their mobility. The institutionalisation of this compromise relied on stable policies that have proved resilient to shifts in political power.

While Kei cars appear to be particularly well suited for Japanese road and urban configurations characterised by relative narrow roads, small parking places and low speed limits, we suggest below some takeaways from their deployment that may contribute to the success of ASEVs in Europe:

1. The success of Kei cars is the result of an agreement between legislators with a clear political vision, carmakers with a strategic interest in developing these vehicles, and customers who benefit from an affordable offer adapted to their needs, which, incidentally, have expanded considerably compared to the original intention of a car designed mainly for urban use. As a result, mass, size, and performance constraints are seen as valuable assets, not insurmountable obstacles;
2. The ASEV proposal must have the same objectives and be sufficiently open to allow all shareholders to participate, as they will understand how it will help them;
3. Kei cars are a remarkable alternative to used cars as we know them in Europe, i.e., offering affordable mobility to people with limited mobility (e.g., in rural areas) and/or low income. As one of the key challenges of the European transition to decarbonization is to achieve a mass market of new cars (and not prolongation of used cars), ASEV with the same performance and values as Kei cars, adapted of course to the characteristics of the European market, is a very relevant proposal.

2. An affordable and sustainable Electric Vehicle, what do we learn from the Chinese NEV case?

In less than 20 years, starting from scratch, and despite very disappointing results until 2013 (fewer than 60,000 NEVs sold since sales began in 2006), the NEV (New Energy Vehicle) industry has established itself as a leader by 2021, with more than 50% of global Electric Rechargeable Vehicle sales made in China.

This is the result of four main factors, the first of which is the Chinese government's strong, long-standing strategic determination to build a world-leading automotive industry. This has been driven by a series of strategic plans, such as the five-year plans starting with the 8th (1990-1995), the "Made in China 2025" plan (2015), and successive strategic plans dedicated to the automotive industry.

The second factor is the continuous involvement of provincial and even municipal authorities through successive national demonstration programs. The "Ten Cities with a Thousand Vehicles" program (2009-2012) was the first large-scale program focused on the holistic deployment of the electric mobility system. It was followed by several programs that focused on the central and eastern regions of China, all of which required the development of the battery and NEV industries in parallel with the deployment of vehicles and the charging network. They have thus supported the "scaling up" of the electric mobility industrial system and facilitated the acceptance of NEVs by end users. Local authorities have developed their own strategies to meet the requirements of national deployment and to develop their local industry.

The third factor is the overwhelming dominance of the battery value chain, from mining to processing and manufacturing of cells and packs, which has benefited from all the lessons learned from the takeover of the rare earths value chain since the 1960s.

The fourth factor is a regulatory and financial framework that supports the deployment of an industrial system for the entire lifecycle of an electric vehicle, from materials extraction to recycling. To achieve this, two complementary strategies have been deployed simultaneously: the creation of the NEV industry and the continuous improvement of the performance of all vehicles, traditional energy vehicles (TEVs) and NEVs.

Building on a detailed description of the mechanisms underlying these four factors provided in a report published in 2023 (Alochet 2023), we focus on what China's regulatory and financial frameworks, at both the national and local levels, can teach us about how to achieve an affordable and sustainable EV.

2.1. Why are Chinese NEVS affordable?

While China has low labor and energy costs compared to the other leading automotive regions, this is not enough to explain the significant price gap in favor of Chinese NEVs which also have a better performance/cost ratio than European cars.

Indeed, the Chinese NEVs sold in Europe have been homologated according to the European type approval regulations, offer rather better range, charging and speed performance than European EVs – all else equal – and of the 23 vehicles rated by EuroNCAP since 2019, 21 have achieved 5*, 1 has achieved 4* in 2021 and 1 has achieved 3 * in 2019[13].

[13] Source: EuroNcap rating for electric vehicles between 2018 and 2024.

This indicates that the explanation is structural and follows the creation of the NEV industry, almost from scratch, under the impulsion of the Chinese government.

The large and simultaneous investments (at least €110-160 billion for the visible tip of the iceberg by 2022) in all industries involved in the NEV lifecycle, from raw material mining to battery recycling, have borne fruit because they have contributed to build a strong manufacturing hub through converging strategies:

1. The main regulatory texts issued by NDRC and MIIT[14] from 2007 to the early 2020s all set high requirements for companies wishing to enter the industry in terms of appropriate production capacity (real car manufacturers, not just final assemblers), design, production quality and conformity, maintenance and after-sales service. For example, in 2012, the MIIT made it mandatory for companies supplying batteries or electric motors to obtain ISO9001 and ISO/TS 16949 certification;
2. Between 2016 and 2019, the NDRC and regional authorities (DRC) have issued at least 34 approvals for an additional production capacity of 4,560,000 vehicles and a total investment of around 20 billion euros;
3. Protectionist measures between 2015 and 2018, combined with a high level of funding from national and local public authorities, have led to the launch and commissioning of the Chinese battery industry significant new production capacity to overcome both Japanese and Korean capacity;
4. Strong financial support to both offer and demand sides with purchase subsidies and tax credit amounting to €15.5 billion in 2023 alone.

In addition, we mention some other design and supply chain factors that contribute to the affordability of NEVs:

1. New battery design: for example, BYD has introduced LFP blade array technology which has almost the same gravimetric energy density as NMC technology at a lower cost of about 15%;
2. Simplification of vehicle design: for example, the charging station takes care of stabilizing the current and voltage, simplifying the design of the on-board charger and reducing the overall cost;
3. Most of the key components related to electrification, such as on-board charger, inverter, and even BMS, are already commodities proposed by many suppliers, which also contributes to cost reduction[15];
4. Development of battery swap (strongly promoted by the Chinese government): NIO already offers Battery as a Service and CATL has launched its modular battery swap solution (EVOGO). Both solutions (will) contribute to reducing the TCO of the vehicle.

Of course, sooner or later, there will be problems of huge sunk costs (due to the disappearance of the weakest competitors) and overcapacity along the entire value chain, but so far, the manufacturing system is at scale and delivering affordable vehicles.

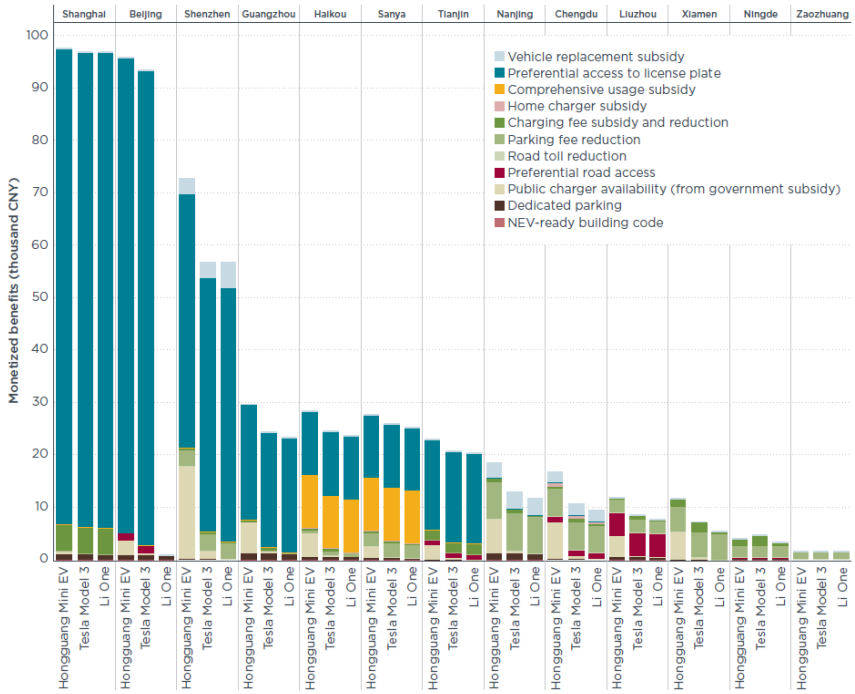
While these dispositions apply to all types of cars, we have no evidence that national regulatory and financial frameworks have in any way favored small cars over other segments. Therefore, how do we explain that the small cars market in China is experiencing significant growth and development in recent years?

[14] The NDRC (National Development Reform Commission) and MIIT (Ministry of Industry and Information Technology) have played a dominant role in the development of the NEV industry.

[15] Interview with an engineering manager of a European OEM based in China.

First, under pressure from the central government, local authorities have developed financial and non-financial incentives to successfully increase the sales of NEVs. In a study published by ICCT in 2023[16], the authors compare the financial and non-financial incentives developed by 13 cities (including 3 cities that were not selected in a national demonstration program) to promote the uptake of NEVs. To evaluate the benefits that different city policies bring to an individual NEV buyer, they have monetized all incentives for three car models: the 120 km electric range Wuling Hongguang Mini BEV, the 445 km electric range Tesla Model 3 BEV and the 148 km electric range Li One PHEV (see figure below).

Figure 16 : Comparison of monetized private consumer benefits from city incentives for the three selected models in 2020



Source: (Lingzhi, Yidan, and Xiyuan 2023).

Without going into the details of the different strategies used by these cities, we observe that the Wuling Hongguang Mini BEV provides slightly higher benefits to users than the other two models. While the preferential access to the license plate has a greater impact than all other types of incentives in the cities where it is applied, the authors point out the positive effect of the availability of the charging network and the existence of incentives favoring its use. In fact, for the Wuling Hongguang Mini BEV, which has a very low battery capacity, easy and inexpensive access to a charging network is a real advantage, enabling its use in cities.

The second main reason for the increase in small car sales is the government's efforts to stimulate domestic consumption and economic growth in general, while the third reason is specific to the automotive demand side, as summarized below:

1. Small cars are very efficient and cheap to use in the sprawling, congested urban areas where a large proportion of the population resides in the eastern and central regions targeted as priority areas for NEV development;

[16] https://theicct.org/publication/pv-chinese-cities-nev-policies-feb23/

2. These priority areas have growing middle-class populations looking for affordable and convenient transportation options, and the many small BEVs proposed by many OEMs meet their expectations;
3. Another trend in the market is the increasing customization options for small cars and OEMs, putting a lot of marketing effort into selling these vehicles, are offering a wide range of customization options, allowing customers to choose from various colors, trims, and accessories. This trend not only enhances customer satisfaction but also drives sales by appealing to a broader range of consumers[17].

In summary, a strong industry producing at scale and a high demand for affordable small cars suitable for use in congested cities explain why there is a high level of sales of low-cost, low-range NEVs (some of which do not even qualify for purchase subsidies, but are so low priced that they easily find customers), the use of which is facilitated by the existence of a dense charging network.

2.2. Are Chinese NEVs sustainable?

The regulations governing the creation of the NEV industry and defining the eligibility criteria for purchase subsidies and NEV credits[18] are both highly consistent with each other and strongly push (with different metrics) for vehicle performance improvement defined by criteria: range, battery gravimetric energy density and vehicle energy consumption. Among these criteria, two may have a significant contribution to sustainability:

1. The increase in the gravimetric energy density of the battery drives the optimization of the chemical composition of the electrodes/electrolyte at the cell level, while it drives architectural innovation (cell to pack, cell to chassis) at the pack level, conducive to a mass reduction for the same energy capacity.
2. Reducing the energy consumption of a vehicle means reducing the mass of the vehicle, optimizing its aerodynamics, minimizing the total electrical consumption, increasing energy recovery, etc. In other words, all of these design actions (should) contribute to more sustainable vehicles.

In fact, the average energy consumption of BEVs of 12.5 kWh/100 km in 2025, as set out in the New Energy Automobile Industry Development Plan (2021-2035), was supposedly achieved in 2022 coming from 15.7 kWh/100 km in 2016 [19].

However, we point out some loopholes in the current regulatory framework that don't really encourage the production of sustainable vehicles:

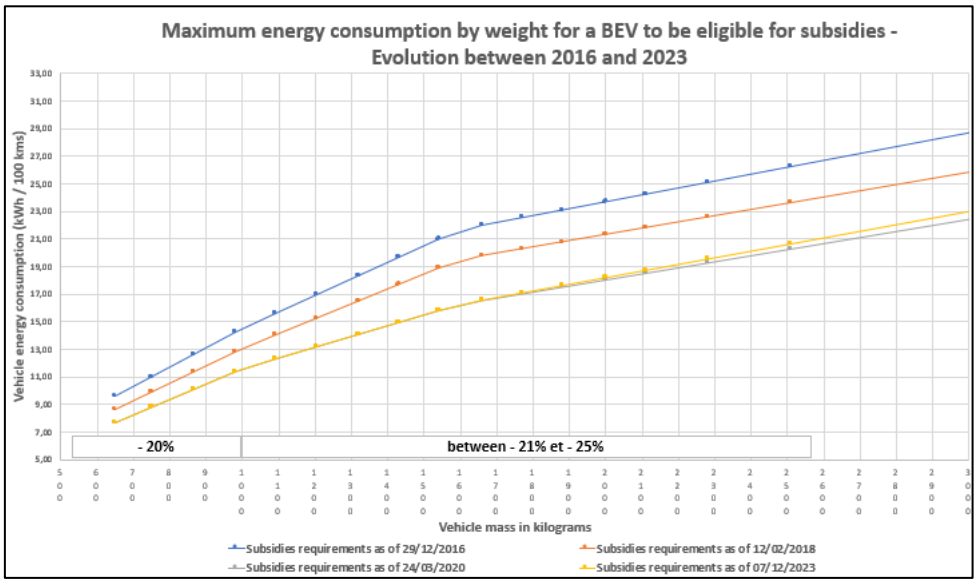
1. Although the thresholds have been lowered quite significantly between 2016 and 2023 (see figure below), vehicle energy consumption is calculated on the basis of vehicle mass, which is similar to the European CAFE calculation method, which has not favored light vehicles in the recent past.

[17] https://fr.statista.com/outlook/mmo/passenger-cars/small-cars/china#analyst-opinion

[18] In short, any automaker - Chinese or otherwise - that produces or imports more than 2,000 NEVs per year must meet a NEV credit target. Each automaker's score is the sum of all NEV credits earned by all vehicles divided by the number of vehicles sold.

[19] Since we do not have details on the distribution of energy consumption for all vehicles sold, this figure should be interpreted with caution even though it appears to be a favorable trend. Source: https://www.chinaev100.com/news/detail/1255

Figure 17 : Maximum BEV energy consumption to be eligible for subsidies as a function of the mass of the vehicle



Source: synthesis of regulations addressing the amount of subsidies

2. There is no indicator (and no target) related to the total CO2 footprint of BEV manufacturing that doesn't encourage CO2 footprint reduction and the decarbonization of the energy used along the entire value chain.
3. To achieve battery pack architectural innovations (cell to pack and cell to chassis), battery cells are glued together, which, at least in absence of information about detailed design and processes, raises questions about the repairability and recyclability of batteries.

On the other hand, we now know that the Chinese electric mobility ecosystem can move quickly once the State Council decides to make a strategic move. While, for a long time, China has been working on a project of LCA applied to the automotive industry, the points below show that they have started to move:

1. China is now part of the UN groups related to the electric vehicle and is very attentive to the directions proposed at the EU level;
2. In the Development Plan for the New Energy Automobile Industry (2021-2035)[20], it is stated "…Improve the parallel management of enterprise average fuel consumption and new energy vehicle credits, effectively undertake fiscal subsidy policies, and study the establishment of a linkage mechanism with the carbon trading market …";
3. The Chinese government is strongly promoting the implementation of a circular economy for the automotive industry with the introduction of extended producer responsibility and the launch of a large-scale demonstration program for battery and vehicle recycling.

From this brief summary, we conclude that the following orientations could be useful to implement the conditions for the production of sustainable electric vehicles:

1. Vehicle performance criteria as far as they are not directly related to vehicle mass;
2. Battery innovation to increase the gravimetric density and reduce cost while offering impeccable reparability and recyclability;

[20] Chapter VIII safeguard measures Section I

3. The national regulatory framework has been critical in getting the new NEV industry off the ground, while supply and demand support at the national and local level has ensured rapid market uptake, including for small cars;
4. Use of financial/non-financial incentives, such as free use of the charging network, preferential access to roads and parking spaces, etc., at the city level to encourage the use of ASEVs;
5. Rapid deployment of a dense charging network enabling the reduction of vehicle battery capacity.

Conclusion

What is particularly interesting in comparing the case of Kei cars in Japan and of electric mini-vehicles in China, is that they are very different. In Japan the creation of a dedicated category for a small, sustainable and affordable vehicle has played a decisive role in preserving and promoting this type of vehicle via a comprehensive package of specific policies. By contrast, in China electric mini-vehicles have been successful so far without any dedicated categories and/or specific policies, even though they have benefited from the generalised regulatory, fiscal and non-fiscal support for NEVs.

One of the reasons of this main difference is the role of second-hand cars in the two markets. In China, the market of second-hand cars is still small relative to the growing demand for cars. It is also regulated in such a way that second hand vehicles cannot be traded between different regional markets (Deng 2020), limiting their availability to consumers. Given the restrictions placed by cities on the access to car ownership, the possibility of overstepping many of these restrictions when buying a NEVs, and the very low prices of electric mini-vehicles relative to standard cars, there was no need of promoting their specific production and sale. In many ways, the success of electric mini-vehicles in China during the last couple of years reminded the success of the illegal low-speed vehicles of the 2000s (Chen 2018; Chen and Midler 2016) in the sense that they were both driven by the consumers' demand and the limited availability of affordable standard cars (either new or second hand).

The sharp decline in the sales of electric mini-vehicles in China in 2023 suggests however that in the absence of protective policies towards small vehicles demand can quickly swings upmarket when the availability of increasingly affordable compact/standard cars (notably the Wuling Bingo and the BYD Seagull) increases. This was precisely what happened in Japan in the 1980s.

What saved and later developed Kei cars in Japan was the establishment of a political compromise on Kei cars as a differentiated and subsidised category of vehicles. Fiscal policies played a crucial role in making the acquisition and use of new/recent Kei cars more affordable relative to other vehicles, including second hand cars, due also to the high cost of technical inspection that in Japan becomes compulsory every year for cars older than 10 years.

In Europe aging second hand cars have taken the role that Kei cars fulfil in Japan: providing an affordable mobility solution to low revenues populations highly dependent on cars in peri-urban and rural areas; but also, to a certain degree, the role of electric mini-vehicles in China by providing (via imports from Western countries) cheap access to car mobility in Central and Eastern European countries where first equipment demand was particularly strong during the last twenty years.

For obvious reasons this European approach is now increasingly problematic:

- first, because the accelerated upmarket drift of electrified vehicles is reducing the supply of new cars, which, in turn, will reduce the supply of second-hand cars and increase their relative cost for these populations leading either to acquisition problems or increasing aged car fleets;
- second, because such a process also reduces the overall efficiency of the electrification strategy by slowing down the renewal rate of the car fleet leaving ICEVs longer on the road;
- third, because, under these circumstances it is going to be increasingly difficult to electrify new car sales without closing down factories and drastically reducing the employment in the automotive sector due to low production volumes;
- and finally, because CO2 targets for new car sales are part of a wider set of European policies with binding decarbonisation targets for EU member states that, associated with the introduction of a carbon market for road transport from 2027 onward (Pardi 2024)[21], will make the use of ICE second hand cars increasingly costly (higher gasoline price, higher taxes) and awkward (reduced access to cities).

From this perspective it is possible to understand the current absence of an ASEV in Europe as the result of a fundamental flow in the European strategy of decarbonisation of road transport: its exclusive focus on the electrification of new cars sales. What is needed is a European strategy to support the decarbonisation of the car fleet, and we believe than an ASEV could be a central piece of such a strategy by providing an affordable alternative to very old/aging second hand ICE cars.

To move forward in this direction, we can retain from the analysis developed in this chapter on Kei cars and NEV mini-vehicles the following key points:

- From the Kei cars case study:
    - the central role of a dedicated caped vehicle category to prevent the upmarket drift and to attract a comprehensive set of complementary policies that will subsidise the acquisition and use of such a vehicle by comparison with other new or second-hand ICE vehicles;
    - the promotion of ASEVs as a strategic technological solution to decarbonising faster and more efficiently the car fleet and the road transport;
    - the importance of developing ASEVs as a mass market where all OEMs and brands can contribute with different products and technological solutions;
- From the NEV mini-vehicles study:
    - The strategic role of cities in the promotion of NEVs (including small cars) as part of a more general reconfiguration of urban mobility;
    - The necessity of a comprehensive industrial policy to create the conditions for bringing down the overall technological and manufacturing costs of BEVs and of ASEVs.

The next chapter will focus on how to translate these insights into a concrete proposal for the promotion of a European ASEV.

[21] The Emissions Trading System 2 for CO2 emissions from fuel combustion in buildings and road transport will be fully operational in 2027 : https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/ets2-buildings-road-transport-and-additional-sectors_en

Chapter 4.

How can we promote a European made ASEV?

In this chapter, we would like to present our proposal, which consists of 5 complementary measures:

1. Creation of a specific category for ASEV;
2. Adaptation of the CO2 regulation to promote ASEV in the very short term and to open up opportunities for more efficient and systemic decarbonization in the medium term;
3. Introduction of a financial framework to support the takeoff of ASEVs production;
4. Introduction of a European Eco score for cars;
5. Promotion of a European ASEV toolkit for Member States, regions and cities.

1. Creation of a specific category for Affordable Sustainable Electric Vehicle

The most efficient way to achieve an Affordable Sustainable Electric Vehicle (ASEV) is to reduce the mass, because the higher the mass, the higher the carbon emissions in the production phase and the higher the cost of the vehicle. In addition, reducing the size of the vehicle promotes mass reduction and helps to reduce the use of all materials used in the production of the vehicle and its components, thereby contributing to the sustainability and affordability of the vehicle.

Being affordable and sustainable is not enough to pave the way for an ASEV's success. It must offer features that can convince OEMs and policymakers to support its introduction in the regulatory framework and in the market:

1. A vehicle defined by supranational regulations that provide a common framework binding on all member states;
2. A vehicle that, thanks to its use in urban, peri-urban (see SUMP requirements[22]) and semi-rural conditions, creates a competitive and sustainable space where there can be a volume effect, one of the key conditions of affordability;
3. A vehicle that contributes to CAFE and helps manufacturers meet their targets in the next decade;
4. A vehicle that offers impeccable safety for both the occupants and other road users.

Specifically, we make two proposals to address these needs:

1. M0 ASEV, a vehicle limited in mass, dimensions and use that requires the creation of a new category of type approval;
2. M1 ASEV, a vehicle limited in mass and dimensions that requires the modification of the existing M1 type-approval category to create an ad-hoc sub-category.

The table 1 below summarizes the key features of the two proposals compared to the existing vehicle categories (L6e, L7e and M1) while table 2 shows how the definition of an M0 ASEV contributes to reducing the impact of current regulations without compromising the safety of occupants and other road users[23]. Finally, we compare (using a SWOT approach) the two proposals (Table 3) and indicate the minimum regulatory impact[24] of each proposal (Table 4).

[22] Sustainable urban mobility plans (SUMPs) are the cornerstone of European urban mobility policy - https://transport.ec.europa.eu/transport-themes/urban-transport/sustainable-urban-mobility-planning-and-monitoring_en

[23] In accordance with the requirements listed and grouped by category in Annex II of (EU) 2019/2144, as last amended on 30/07/2023

[24] Especially for M0 ASEV, which basically requires modification of "type approval" and "GSR2" regulations, and where many options in the definition of the vehicle can be discussed, it is rather difficult to propose an extensive list of regulations to be modified.

Table 7. Overall comparison of L6e, L7e, M1, M0 ASEV and M1 ASEV categories

Items	L6e	L7e	M1 car	M0 ASEV	M1 ASEV
	BSR	B or B1	B	B	B
	<= 2	<= 4	<=9	4	4
	< 425 w/o battery	< 450 w/o battery	<= 3500 including battery	<= 1000 including battery	<= 1000 including battery
	<= 6 KW	<= 15 KW	No limit	<= 40 KW (peak)	<= 50 KW (peak) (Motorway)
	L 3,7 X W 1,5 X H 2,5	L 3,7 X W 1,5 X H 2,5	L 12 x W 2,5 x H 4	L 3,8 x W 1,7 x H 2 wheelbase < 2,2	L 3,8 x W 1,7 x H 2 wheelbase < 2,2
	NO	NO	YES	Partial, see table below	YES
ADAS/GSR2	NO	NO	YES	Partial, see table below	YES
	Only authorized roads	Only authorized roads	No limit	No Motorway	No limit

Notes:

1. The current Dacia Spring model sold in France is very close to the definition of a M1 ASEV with a mass of 951 kilograms (MVODM), dimensions L 3,7 x W 1,58 x H 1,49, wheelbase = 2,42 and an e-motor with a maximum power of 48KW[25]. In addition, this vehicle is fully compliant to all current regulations.
2. In view of the rapid technological innovation in batteries, there are no proposals regarding the battery capacity and the vehicle energy efficiency, leaving plenty of room for solutions resulting from future innovations, as long as they respect the mass, size and e-motor power limits.

Table 8. Proposed definition of a M0 ASEV versus the main requirements listed and grouped by category in Annex II of (EU) 2019/2144 as last amended on 30/07/2023

[25]https://www.dacia.fr/gamme-electrique-et-hybride/spring-citadine/configurateur/recapitulatif.html?conf=https%3A%2F%2Ffr.co.rplug.renault.com%2Fc%2FBAISw%2FA7rEg

Requirements sorted by category	M0 ASEV (Compliant to M1 requirements with the exceptions noted below)
A Restraint system, Crash testing, Fuel system integrity and high voltage electric safety	Frontal impact: Shock with barrier and intermediate severity between UN regulations n° 95 and n°135 requirements Side impact: Euro-NCAP quadricycle standard Rear impact: Proposal of a new shock procedure adapted to this type of vehicle (derived from an OEM actual practices) Requirements related to fuels (A14 – A18) are out of scope
B Vulnerable Road Users, Vision and Visibility	No implementation of “Pedestrian leg and head protection” and “Enlarged head impact zone” Improve detection of vulnerable road users by optimizing technical solutions using cameras only, i.e., without radar / lidar for ADAS
C Vehicle chassis, Braking, Tires and Steering	Technical solution optimization with the use of camera only, i.e., without radar / lidar for ADAS
D On-board Instruments, Electrical System, Vehicle Lightning and Protection against unauthorized use including cyberattacks	No intelligent speed assistance No gear shift indicator as they are not necessary for the proposed use of the vehicle
E Driver and System Behavior	No automated driving version No driver drowsiness and (advanced) attention warning features as they are not necessary for the proposed use of the vehicle
F General Vehicle Construction and Features	Suppression of the towing devices (restriction in use)
G Environmental performance and emissions	Only recycling requirements as other requirements are related to ICEVs
H Access to vehicle information and software update	Access to vehicle repair and maintenance information is mandatory Access to vehicle OBD information for EVs is under study[26] (feature not unique to M0 ASEV) Software update requirements to be compliant with UN Regulation 156

Note: the suppression of towing devices and of automated driving features could also be applied to M1 ASEV creating a more favorable framework for affordability.

[26] European Parliament notice to members related to Petition No 0215/2023 by G. S. (German) on the development of a standard On-board diagnostics (OBD) interface for all vehicles on November 11, 2023.

Table 9. SWOT comparison of M0 ASEV and M1 ASEV proposals

<table>
<tr><th></th><th>M0 ASEV</th><th>M1 ASEV</th></tr>
<tr><td rowspan="2">Strengths</td><td colspan="2">Contributions of limitations in mass, size and e-motor power to affordability and sustainability
Limitation of power required at charging station</td></tr>
<tr><td>An additional gain in mass and cost due to the adaptation of the safety requirements to the use of the vehicle</td><td>No limitation in use
CAFE eligible
“Limited” regulatory effort to transform the proposal in law</td></tr>
<tr><td>Weaknesses</td><td>Restriction in use
The political effort to get this proposal accepted (CAFE eligibility and specific safety solutions) will be long and complex (UN regulations should be created / modified)</td><td>The proposal is (too) close to (some) existing vehicles and may not have the expected disruptive effect</td></tr>
<tr><td rowspan="2">Opportunities</td><td colspan="2">Due to the inversion of the slope of the emissions curve with respect to mass, all OEMs will have to reduce the mass of their vehicles from 2025 onwards
Linking the ASEV concept with CAFE bonus, Eco-score bonus (other type of bonus) at European level and financial/non-financial incentives at national/local level gives traction to the proposal
Additional contribution of optimized solutions for safety
Possible re localization of production in Europe</td></tr>
<tr><td></td><td>The concept could be extended to other vehicle segments with an appropriate definition of the mass, size and peak power of the electric motor</td></tr>
<tr><td rowspan="2">Threats</td><td colspan="2">Insufficient financial/non-financial incentives to ensure segment success</td></tr>
<tr><td>This proposal may not be suitable for use in low-income European regions where a car is the only mobility proposal and there is a low density of the charging network
Risk of increasing regulatory pressures with the massive diffusion of this new category of vehicle</td><td>Density of the charging network not adapted to type of housing and usage</td></tr>
</table>

Table 10. Summary of the minimum regulatory impact of each proposal

		Regulations to be amended / created (a minima)
M0 ASEV	Creation of a new category M0 ASEV	Regulation (EU) 2018/858 lastly amended as of 28/05/2024
	Modification of safety requirements	Regulation (EU) 2019/2144 lastly amended as of 30/07/2023
	Shock	New UN regulations for frontal and rear impacts and probably others depending on the final definition of a M0 ASEV
M1 ASEV	Introduction of M1 ASEV sub-category in M1 category	Regulation (EU) 2018/858 lastly amended as of 28/05/2024
Both M0 and M1 ASEV	Attribution of bonuses	See relevant sections of the C02 and Eco-Score policy proposals

2. A new CO2 regulation to promote both ASEV and open avenues for more efficient decarbonization

2.1. A multiplier for ASEV

The interest in considering ASEV as part of the M1 category is that it will contribute to the CO2 targets. Since by 2025 the correlation between the weight of the vehicles and the specific targets of the car manufacturers will become negative, there are clear incentives for the car manufacturers to produce small EVs.

However, to make them affordable and accelerate their adoption, we suggest creating a multiplier for ASEVs, as was done for EVs in the 2010s. The rationale behind a temporary multiplier is to encourage automakers to produce and sell ASEVs in large quantities to achieve the economies of scale of a mass market. We recommend a degressive multiplier from 2x in the first year of implementation of ASEVs to 1.5x 4 years later and then to 1 starting 5 years later. We strongly suggest that the first year of implementation is 2026 to secure both 2030 and 2035 targets.

If, given the current stagnation of BEV sales and the inherent difficulties of European OEMs in meeting the 2025 target, a multiplier for EVs in general should be re-introduced before 2026 (as recently demanded by some OEMs), then our proposal would consist in having a higher and longer lasting multiplier for ASEVs by comparison with other EVs.

2.2. Opening up new avenues to accelerate the downsizing

This multiplier proposal will primarily support the deployment of ASEVs in the short term. However, most BEVs are too expensive for customers and too heavy to be truly sustainable

in production and we believe that all carmakers, in continuation of the momentum associated with the creation of ASEVs, must follow the path of downsizing.

In addition to the original intent of this report, we suggest here some ways in which CO2 regulation can help improve affordability and sustainability for other vehicle segments. It would also avoid a situation where an automaker that is too close to the CAFE target, thanks to its light vehicles, could weaken its CO2 reduction efforts. These proposals are intended for medium-term use. They will also contribute to improve safety and reduce risks of fatalities in car accidents by further reducing the average mass of the car fleet.

This could be done by applying one or a combination of some of the measures suggested below:

1. Granting an additional CO2 bonus to car manufacturers that have reduced the average measured mass of new vehicles sold, excluding ASEVs, by a certain percentage.
2. Another solution, in the longer term, could be to extend the ASEV concept to other vehicle segments, also defined by size, dimensions and peak electric motor power, and give them super bonuses.
3. Finally, EVs emit CO2 during production and charging. Because it would be unfair to penalize automakers that sell EVs in high carbon energy countries (and they will need to do so to meet the 100% ZEV target in 2035) or that have customers who frequently visit these high carbon energy countries, we propose to modify the CAFE methodology to include the total carbon footprint in production only in the target calculations. It is another way to emphasize the effort of decarbonization by considering a parameter in the hands of the automakers. Since it would be a significant and rather pointless effort for ICEVs not to be ZEVs, we propose to have a phase-in starting in 2031 focusing only on ZEVs with 20% of ZEVs, 40% of ZEVs in 2032, 60% of ZEVs in 2033, 80% of ZEVs in 2034.

3. A financial framework to support the takeoff of ASEV production

Currently the production of BEVs in Europe is not profitable. According to the recent European Union enquiry on the economic situation of the European automotive industry (carried out in the context of the investigation on Chinese illegal state aid (European Union 2024, 174)), BEV sales made by European OEMs generated on average a negative profit rate of -10,8% between the 30th of September 2022 and the 1st of October 2023.

The production of ASEV requires the development of new technologies and products to achieve the expected significant mass reduction, e.g., lighter body, trim parts, glasses, seats, etc. The IPCEI framework, which has proven its effectiveness in supporting the development of a European battery cell industry, could be used to accelerate the establishment of the European value chain needed to produce ASEVs.

In addition, Europe could draw inspiration from the provisions implemented in the US IRA, which make it possible to provide massive and rapid incentives for production (production

tax credit), where European funding for the production of green technologies is notoriously inadequate, and for the purchase of vehicles (purchase tax credit).

4. Eco score calculation

The aim of this section is first of all to summarize the current state of play of eco-labelling in Europe. We will successively review the relevant European regulations – noting that most of them are still in preparation and that there is no regulation dedicated to this subject, the existing proposals for an Eco score and the only regulation in force so far, the French Eco bonus. We then discuss important methodological issues related to the implementation of the eco-score. Finally, we propose to create an eco-score that can transversally measure the environmental footprint of cars. While the first step is to use the eco-score in European legislation as a label for consumers (modification of Car labelling - Directive 1999/94/EC), we also identify future steps to develop its influence on the uptake of ASEVs.

4.1. Relevant European regulations

In fact, there is no regulation that directly addresses the question of what an eco-score is for an electric vehicle, and the regulations that come closer to the concept actually deal with materials recycling and reuse as well as carbon footprint and carbon leakage, the latter being defined as follows:

- *"'carbon footprint' means the sum of greenhouse gas emissions and greenhouse gas removals in a product system, expressed as carbon dioxide equivalents and based on a Product Environmental Footprint (PEF) study using the single impact category of climate change"* [27],
- *"Carbon leakage occurs if, for reasons of costs related to climate policies, businesses in certain industry sectors or subsectors transfer production to other countries or imports from those countries replace equivalent products that are less intensive in terms of greenhouse gas emissions"*[28].

The table below summarizes the key regulations to consider and their main provisions that could contribute to the definition of an Eco score. Our analysis of these regulations leads us to the following key takeaways:

1. While the methodology for the calculation of the carbon footprint of vehicles will be proposed by the end of 2025 for a voluntary declaration starting in 2026, regulations on battery carbon footprints are far from being applied (compared to what is already applied in the US through the IRA vehicle tax credit), as many delegated acts need to be adopted to define calculation and verification methods, applicable thresholds, etc. In addition, the first delegated act in preparation addressing the methodology for the calculation of the environmental footprint of batteries proposes an indicator in kg CO2e/kWh over the whole

[27] Regulation (EU) 2023/1542, Article 3, item (21)
[28] Regulation (EU) 2023/956, Introduction, item (9)

life cycle, which is not conducive to the assessment of the overall carbon footprint of the battery and consequently of the vehicle.

2. In the CBAM as defined, the annex defining the products subject to the obligation of declaration integrates the main materials (ferrous, aluminum and alloys, …) and some assembly components (rivets, bolts, screws, etc.) used in the production of a vehicle.

Table 11. Summary of European regulations that somehow deal with potential eco-score items

BEV / PHEV value chain stage	Regulation		Main dispositions that could contribute to the definition of an Eco score
	Name or Objective	Identification / Status / DG in charge	
Extraction of raw materials and refining	Critical Raw Material act (CRMA)	Regulation (EU) 2024/1252 In force since May 23, 2024 DG Internal Market	Article 31 (Environmental Footprint Declaration), §2: "The Commission shall by 24 November 2026 submit a report to the European Parliament and to the Council setting out which critical raw materials are to be prioritized for assessing whether the obligation to declare the environmental footprint of a critical raw material is necessary and proportionate"
Battery production	Battery Directive	Regulation (EU) 2023/1542 In force since August 17, 2023 DG ENV	Article 7 (Carbon footprint of electric vehicle batteries, rechargeable industrial batteries and LMT batteries): a) The carbon footprint declaration shall apply from 18 February 2025 or 12 months after the date of entry into force either of the delegated act or of the implementing act defining the carbon footprint calculation methodology (see point b) below), whichever is the latest; b) The Commission shall adopt, by 18 February 2024 adopt a delegated act to supplement this Regulation by establishing the methodology for the calculation and verification of the carbon footprint; c) The carbon footprint performance class requirements in the first subparagraph shall apply from 18 August 2026 or 18 months after the date of entry into force either of the delegated defined in d); d) The Commission shall adopt, by 18 February 2025, a delegated act in accordance with Article 89 to supplement this Regulation by establishing the carbon footprint performance; e) The requirement for a maximum life cycle carbon footprint threshold shall apply as of 18 February 2028 or 18 months after the date of entry into force of the delegated act referred in f); f) The Commission shall, by 18 August 2026, adopt a delegated act in accordance with Article 89 to supplement this Regulation by determining the maximum life cycle carbon footprint threshold.
Production of vehicle	Strengthening the CO2 emission performance standards	Regulation (EU) 2023/851 In force since May 9, 2023 DG CLIMA	Article 7a, (Life-cycle CO2 emissions): a) The Commission shall by 31 December 2025 publish a report setting out a methodology for the assessment and the consistent data reporting of the full life-cycle CO2 emissions of passenger cars and light commercial vehicles that are placed on the Union market. b) By 31 December 2025, the Commission shall adopt delegated acts in order to supplement this Regulation by laying down a common Union methodology for the assessment and the consistent data reporting of the full life-cycle CO2 emissions of passenger cars and light commercial vehicles. c) From 1 June 2026, manufacturers may, on a voluntary basis, submit to the Commission the life-cycle CO2 emissions

			data for new passenger cars and new light commercial vehicles using the methodology referred to in b) above
	CBAM (Carbon Border Adjustment Mechanism)	Regulation (UE) 2023/956 In force since May 17, 2023 DG Taxation and Customs	A CBAM declaration is mandatory by 31 May of each year (article 6), starting in 2027, for the year 2026, and must contain: a) The total quantity of each type of goods imported during the preceding calendar year, expressed in megawatt-hours for electricity and in tons for other goods. b) The total embedded emissions in the goods referred to in point (a) of this paragraph, expressed in tons of CO2e emissions per megawatt-hour of electricity or, for other goods, in ton of CO2e emissions per ton of each type of goods, calculated and verified in accordance with Articles 7, 8.
Battery recycling	Battery Directive	Regulation (EU) 2023/1542 In force since August 17, 2023 DG ENV	Article 8 (Recycled content in industrial batteries, electric vehicle batteries, LMT batteries and SLI batteries) a) By 18 August 2026, the Commission shall adopt a delegated act to supplement this Regulation by establishing, for the batteries referred to in the first and second subparagraphs, the methodology for the calculation and verification of the percentage share of cobalt, lithium or nickel that is present in active materials and that has been recovered from battery manufacturing waste or post-consumer waste, and the percentage share of lead that is present in the battery and that has been recovered from waste, and the format for the documentation. b) From 18 August 2031, the following minimum percentage share of, respectively, cobalt, lithium or nickel that has been recovered from battery manufacturing waste or post-consumer waste, and the minimum percentage share of lead that is present in the battery and that has been recovered from waste, for each battery model per year and per manufacturing plant: (a) 16 % cobalt; (b) 85 % lead; (c) 6 % lithium; (d) 6 % nickel. c) From 18 August 2036, the following minimum percentage share of, respectively, cobalt, lithium or nickel that has been recovered from battery manufacturing waste or post-consumer waste, and the minimum percentage share of lead that is present in the battery and that has been recovered from waste, for each battery model per year and per manufacturing plant: (a) 26 % cobalt; (b) 85 % lead; (c) 12 % lithium; (d) 15 % nickel.

Sources: Articles quoted from the relevant regulations.

However, vehicles' parts, sub-assemblies or systems (such as batteries, e-motors) are not listed in this annex. Consequently, the CBAM provide only limited information for the calculation of an Eco score.

3. There is no project of regulation addressing the application of an Eco score over the whole life cycle of a vehicle either via the introduction of a brand-new regulation or by taking advantage of the construction / modification of an existing regulation close to this subject.

4.2. On-going proposals for an Eco score[29]

The review of a European Citizens' Initiative[30] for the creation of a European Eco-Score, which aims to provide transparent information on the environmental impact of products manufactured or sold on the European Union market, provides valuable insights into what an Eco-Score is expected to be from a citizen's perspective. We point out three main takeaways which could be of interest for our study:

1. An EU-wide eco-score, not private or national proposals with little legitimacy across Europe;
2. A system of bonus/malus points could be added to the calculation method to favor certain desirable characteristics;
3. The importance of a calculation method based on scientific evidence such as life cycle assessment (LCA method) but to be developed and simplified to be applied to a large scale of products (and deep and complex value chains – comment from the authors).

For the automobile industry, we analyzed two formal proposals from Tesla[31] and T&E[32], as well as the guidelines proposed in the recent FNH / IMT report[33] on the relevance and capacity to produce A/B segment BEVs in France.

For each of these proposals, we summarize the intent and content of the eco-score, as well as the proposed regulatory framework on which the eco-score would be based, which is of the utmost importance in assessing the complexity of the legislative work to be undertaken.

[29] To be complete on this topic, we mention the Belgian ecoscore website (https://ecoscore.be/calculations/new?locale=en), which proposes a calculation of a vehicle's eco-score based on information provided on the vehicle's certificate of conformity about CO2 and pollutant emissions for an ICEV and about energy consumption for an EV. The calculation does not take into account production and recycling, and the calculation methodology is not fully explained.

[30] ECI(2021)000005 - This initiative was closed in February 2023 https://citizens-initiative.europa.eu/initiatives/details/2021/000005_en

[31] Deep dive: Towards a new EU-wide vehicle eco-score, March 13th, 2024

[32] https://www.transportenvironment.org/articles/a-streamlined-ev-eco-score-would-encourage-green-made-in-europe-electric-cars

[33] Produire les citadines électriques en France, pourquoi est-ce pertinent et possible ? Rapport Fondation pour la Nature et l'Homme et Institut des Mobilités en Transition, Mai 2024

4.2.1. Tesla proposal

Tesla's proposal takes stock of a complete set of regulations that now cover the scope of decarbonizing road mobility, but also of their complexity, their incompleteness (many pending delegated acts), as well as the mushrooming of fail/pass requirements.

It is then argued that an EU-wide eco-score should overcome all these drawbacks and aim to provide clear information to customers, give states a common basis for defining their incentive policies, let automakers define the best solutions to achieve a high score, and modulate the Extended Producer Responsibility fees (the lower the eco-score, the higher the fees). Consequently, Tesla proposes that the Eco-score:

1. Should be based ONLY on existing EU legally binding requirements (to avoid the development of national eco-score).
2. Should be only supported by static data (no in use data to inform about range, energy consumption, etc.)
3. Should take an equal contribution of each criterion in the final addition.

The ultimate objective is to replace the existing pass/fail requirements (such as those for recycling, CO2 footprint, etc.) with the new EU-wide eco-score.

According to this definition, the proposed eco-score includes five criteria, all based on existing EU regulations and each contributing 20% to the final score:

1. Energy efficiency of the vehicle, as measured under Worldwide harmonized Light-duty vehicles Test Procedure (WLTP) under Regulation (EU) 2017/1151;
2. Electric range of the vehicle, as measured under Worldwide harmonized Light-duty vehicles Test Procedure (WLTP) under Regulation (EU) 2017/1151;
3. The carbon footprint of the battery and its associated performance class, as required by article 7 of Regulation (EU) 2023/1542 (EU Batteries Regulation);
4. The embedded carbon emissions of steel and aluminum used in the vehicle, calculated in accordance with the CBAM regulation (Regulation (UE) 2023/956);
5. The levels of recycled content present in vehicles, as required by Article 10 of ELVR, OR the levels of recycled content in the battery, as required by Article 8 of Regulation (EU) 2023/1542 (EU Batteries Regulation).

Regarding the regulatory framework, it is proposed to take advantage of the ongoing decision process of the “Circular Vehicles Regulation” [34] to introduce the eco-score as a circularity requirement (adding an article in Chapter II) and to include the eco-score as a component of the proposed "Circularity Vehicle Passport" (Article 13, Chapter III) and as a basis for modulating the Extended Producer Responsibility fees for vehicles (Article 21, Chapter IV).

In addition, other regulations must be amended to:

[34] Proposal for a Regulation of the European Parliament and the Council on circularity requirements for vehicle design and on management of end-of-life vehicles, amending Regulations (EU) 2018/858 and 2019/1020 and repealing Directives 2000/53/EC and 2005/64/EC - https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52023PC0451

1. Suppress fail / pass requirements ((EU) 2023/1542 for the battery requirements and possibly (EU) 2023/851 depending on the definition of the upcoming vehicle Life-cycle CO2 emissions requirements);
2. Regulation (EU) 2018/858 to add the eco-score as new criteria for inclusion in vehicle certificate of conformity and EU Car Labelling Directive (1999/94/EC) to add eco-score as new criteria in vehicle label.

The possibility of modulating EPR fees, integrating the eco-score into the vehicle's Certificate of Conformity, and overcoming existing pass/fail requirements shows that Tesla intends for the eco-score to go much further than simply informing consumers by influencing OEM strategies.

On the other hand, Tesla's proposal involves many DGs (DG ENV, DG CLIMA, and DG Internal Market) in both creating a new regulation and revising existing regulations, and may result in a rather lengthy and complex process to achieve the eco-score.

4.2.2. T&E proposal

T&E fully supports the Commission's decision in favor of zero-emission vehicles by 2035, but considers that the existing regulatory framework has crippling shortcomings:

1. Since ZEVs completely eliminate tailpipe emissions, it is assumed that they should all have the same impact on decarbonizing mobility. T&E states that this is not true because 50% and 60% of the lifecycle emissions of electric vehicles are related to vehicle production which is directly related to vehicle size, weight and battery capacity.
2. Energy consumption (measured in kWh/100 km on the WLTP cycle) thresholds alone aren’t enough as a good energy efficiency can be achieved by smart design of heavy and large cars with a large capacity battery.
3. Life-cycle emissions methodology is not the right approach because it is too complex and almost impractical for both automakers to collect the necessary data and for regulators to evaluate and compare individual vehicle models.
4. The absence of clear rules and standards for evaluating the overall environmental performance of EVs.

Therefore, T&E proposes an EU-wide eco-score that combines both the energy efficiency (in kWh/ 100 km) and the carbon footprint of the battery, steel and aluminum (in kgCO2e) at the production stage of the vehicle, given that batteries, steel and aluminum together account for 70-75% of the embedded carbon footprint of electric cars. In addition, this eco-score gives a clear advantage to BEVs produced in Europe, which should perform much better than those produced in China thanks to a more decarbonized value chain and the suppression of transportation-related emissions.

This proposed eco-score takes advantage of the existing calculation rules already defined in the CBAM for imported materials from outside Europe (and public data on the carbon footprint intensity of value chains for European production) as well as the forthcoming calculation rules to be defined by the Batteries Directive. It is suggested that this could be a

new criterion in car labeling and proposed to be addressed through the expected revision of the relevant Directive 1999/94/EC (DG CLIMA).

4.2.3. FNH/IMT guidelines

The report "*Produire les citadines électriques en France, pourquoi est-ce pertinent et possible ?* » is very close to our topic as it analyzes the capacity to produce affordable A/B segment BEVs in France. This report focuses mainly on the definition of an efficient industrial policy to achieve a significant re localization of production in France. However, some of the proposals are interesting guidelines for our study on eco-score. We mainly note the following proposals made in the report:

1. Introduction of a Europe-wide eco-score that takes into account the cost of carbon in conjunction with the definition of progress trajectories and assessment levers that are stable over time (through labeling, differentiated taxation or regulation).
2. The proposal to ban the export of active materials from recycled batteries or manufacturing waste from Gigafactories could be part of the above proposal as it promotes the development of a circular economy.
3. Consolidate the demand for electric vehicles in segments A and B on the French market:
    a. Apply the weight penalty to electric vehicles and define a gradual reduction path, whereas today it applies only to internal combustion vehicles;
    b. Lower the weight criterion for calculating the number of vehicles eligible for the environmental bonus to 1,800 kilograms in order to stop subsidizing models that consume too much energy. The current weight criterion of 2.4 tons is not very restrictive;
    c. Introduce a progressive eco-score by supporting cars in the A and B segments produced in France and Europe (including a weight criterion), thus strengthening the link between the score and the amount granted.

This report doesn't explicitly identify the regulatory framework on which the eco-score would be based.

4.2.4. A in-force regulation, the French eco bonus[35]

The intention of the French eco-bonus is to support the decarbonization of the road transport sector, which accounts for 31% of national emissions in 2021 – 50% of which come from passenger cars – in order to reach the target of 66% electrification of passenger cars by 2030.

The ecological bonus is a purchase subsidy that favors new vehicles with a low carbon footprint. This aid is conditional on a number of criteria, including the vehicle's ecological score and the applicant's tax income.

[35] Based on https://www.economie.gouv.fr/particuliers/bonus-ecologique# https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000048167407 and the DGE conference (J.Nguyen / A.Zola) "The French Electric Vehicle and Battery Strategy" at the 2024 GERPISA Colloquium

The ecological bonus applies to new (passenger) cars meeting all the following conditions:

1. Be a new passenger car in category M1 registered for the first time in France in a definitive series;
2. Not be sold by the purchaser or leaseholder within a year of its first registration, or before it has covered at least 6,000 kilometers;
3. Run exclusively on electricity, hydrogen or a combination of the two;
4. The acquisition cost of the car must be less than 47,000 euros (including tax), including the cost of acquiring or leasing the battery, where applicable;
5. Have a mass of less than 2.4 tons;
6. Achieve an environmental score higher than the minimum required.

The environmental score is currently calculated using car footprint data provided by the OEM and public data on the carbon footprint intensity of value chains. In the future, it is expected to be combined with some circular economy indicators yet to be defined.

It uses a simplified LCA approach, based only on CO2 emissions (expressed in kg-eq CO2) of:

1. The production of ferrous materials used in the production of the vehicle except the battery;
2. The production of aluminum (including alloys) material used in the production of the vehicle except the battery;
3. The production of all other material (i.e., non-ferrous and non-aluminum) used in the production of the vehicle except the battery;
4. The production of the battery;
5. The assembly of the vehicle except the battery;
6. The transportation of the vehicle from the assembly plant to the distribution point in France.

The environmental score calculation process is supported by the ADEME platform, and automakers that haven't achieved a high score can fill in a claim and demonstrate that they actually achieve better results than those obtained through the calculation process ("Derogatory Mechanism").

The conditions for the granting of the environmental bonus are defined in the " Article D251-1 - Code de l'énergie " and the calculation mechanism is defined in an ad hoc delegated act published in the JORF n° 0234 dated 08/10/2023.

4.3. What could be an eco-score in favor of ASEV?

4.3.1. Discussions and propositions

Not surprisingly, the proposals and the only effective regulation we analyzed, the French eco-bonus, do not have the same intent and content, as summarized in the table below:

1. Tesla proposal is clearly aimed at favoring their vehicles as it considers some performance characteristics where they are better than their competitors (energy efficiency and range). The other components, namely battery carbon footprint, CO2 emissions and reuse of materials, are imposed by EU regulations. On top of

everything else, Tesla intention is to suppress all the fail / pass requirements and replace them by this eco-score. Tesla suggests an interesting use of the eco-score to modulate Extended Producer Responsibility fees which could be supportive of an ASEV.

2. T&E proposal clearly aims at reducing EVs carbon footprint of materials used for the production of the vehicle and production of the battery but doesn't explicitly call for smaller and lighter vehicles (there is no criterion to favor these characteristics). In addition, this eco-score gives a clear advantage to BEVs produced in Europe, which should perform much better than those produced in China.
3. The FNH / IMT proposal is rather close to our intention, as it aims to relocate the production of A/B segment BEVs in France (in Europe more widely in our study). Even if it doesn't give very precise indications on what an eco-score could be, the report states the need to reduce the maximum weight of EVs and to integrate progressive measures to favor the production of A/B segments BEVs in France (in Europe).
4. The French eco-bonus addresses one of the issues we want to address with an eco-score based on the (almost) total carbon footprint of the production of BEV and battery as well as a fairly simple method to assess it. This eco-score also gives a clear advantage to BEVs (and batteries) produced in Europe which perform much better than those produced in China. However, we note that the price and weight thresholds are too high to truly benefit our defined ASEVs.

Besides these differences, we do see some commonalities among them:

1. An EU-wide eco-score based on existing legally binding EU requirements with strong legitimacy across Europe (during the Gerpisa Colloquium, the DGE representatives supported the principle of an EU-wide eco-score);
2. The importance of a scientifically based calculation method, such as the Life Cycle Assessment (LCA) method[36], and, at the same time, the need to simplify such methods, as it could be too complicated to collect data and calculate the eco-score, especially in the case of complex and deep value chains, such as the automotive industry.
3. Of the two proposals dealing with the issue of the legal framework on which the eco-label could be based, the modification of the vehicle labeling directive is the basic choice to ensure a correct communication toward customers.

Before making some suggestions for the content and use of an eco-score, we must emphasize that the issue of calculating eco-scores illustrates both the need and the difficulty of overcoming two difficulties: breaking out of silos and quickly agreeing on a common basis that can be expanded in future steps.

36 We mention here the existence of an LCA methodology proposed by the French PFA to assess the carbon footprint of vehicles and batteries over their entire life cycle, which complies with the ISO 14 040 and ISO 14 044 standards and paves the way for the application of future European methodologies (Analyse de cycle de vie appliquée à un véhicule ou un équipement automobile – préconisations méthodologiques – April 2022). Available at https://pfa-auto.fr/recherche-et-developpement/.

The summary table we have provided shows that different DGs, i.e., Clima, Env, Internal Market Taxation and Customs could be involved in defining a possible European eco-score. While there is a common aim to produce an LCA-based indicator addressing the vehicle and the battery, eventually complemented by other indicators, the competences and objectives of each DG are different, making challenging a quick adoption of such a synthetic indicator. In addition, the fact that the delegated acts have yet to be defined according to non-coordinated timetables makes the roadmaps that automotive companies have to define very difficult to write. For this reason, it is necessary to define a European eco-score, starting from a common basis and able to evolve according to rules whose forms and timetables for precision have already been announced.

Table 12. Comparison of the main characteristics of proposals / in force regulation addressing an eco-score

<table>
<tr><th>Proposal / Regulation</th><th>Vehicle weight</th><th>Vehicle dimensions</th><th>Vehicle cost</th><th>Energy efficiency</th><th>CO2 footprint</th><th>Reuse of recycled materials</th><th>Regulatory framework to be created / modified (DG in charge)</th></tr>
<tr><td rowspan="2">Tesla</td><td rowspan="2">None</td><td rowspan="2">None</td><td rowspan="2">None</td><td colspan="3">Calculation as defined by relevant EU regulations</td><td rowspan="2">“Circular Vehicles Regulation” (DG ENV)
Regulation (EU) 2018/858 (DG internal market)
Car Labelling Directive 1999/94/EC (DG CLIMA)
CBAM (EU) 2023/956 (DG Taxation and Customs)
Suppress all fail / pass requirements
Regulation (EU) 2023/1542 (DG ENV)
Regulation (EU) 2023/851 (DG CLIMA)</td></tr>
<tr><td>20%
+ 20% on range</td><td>20% CBAM
20% Battery</td><td>20%
Vehicle or Battery</td></tr>
<tr><td>T&E</td><td colspan="3">No proposition of explicit criteria</td><td>As defined by EU regulation</td><td>CBAM for materials and battery carbon footprint (on-going definition process)</td><td>None</td><td>Car Labeling Directive 1999/94/EC (DG CLIMA)</td></tr>
<tr><td>FNH / IMT</td><td>Weight Malus for EVs
Reduce the weight limit for French Eco Bonus (1800 kgs)</td><td colspan="2">Progressivity of eco score to favor A/B segments EVs produced in France</td><td>None</td><td>Cost of Carbon</td><td>None</td><td>No indication</td></tr>
<tr><td>French Eco Bonus</td><td>Weight limit (2400 kgs)</td><td>None</td><td><= 47,000€ including VAT</td><td>None</td><td>Simplified LCA (in kg-eq CO2) method
Materials used for the construction of the vehicle
Production of the vehicle and the battery
Vehicle transportation</td><td>Circularity requirements to be defined later</td><td>French regulations which have been created / modified
Conditions for granting the environmental bonus:
Article D251-1 - Code de l'énergie
Calculation mechanism in an ad hoc delegated act published: JORF n° 0234 dated 08/10/2023.</td></tr>
</table>

It will nevertheless be difficult, because it will involve breaking down silos: when the requirements of the four DGs involved have to be combined, trade-offs have to be made, and the issues raised are as much about industrial policy as they are about environmental policy or the Single Market.
Nevertheless, formally, the method successfully adopted by French officials is based on three principles and could inspire the one to adopt to build the EU proposal:

1. The issue of the eco-score and that of its use by policy makers are separate;
2. The eco-score is defined in a way that can evolve and vary depending on how it is used;
3. Future steps are announced, e.g., future circularity requirements for the French Eco bonus.

The French eco-score is emblematic because it is designed to reassure consumers that only environmentally virtuous BEVs will be awarded a bonus. It also has the advantage of blocking the way for imports of Chinese vehicles exclusively on environmental grounds, and it could, ultimately, allowing for discriminating between vehicles whose batteries come from European Giga-factories with a higher CO2 footprint than the one located in France.

Typically, the issue raised here can be presented in a technical way by emphasizing that we need measurement tools that are consistent with what is already being done, for example, to administer the carbon tax at the borders (CBAM). The truth is that differentiating the carbon content of components between EU countries is objectively possible and relevant, but that going down this road is technically very difficult.

The government departments (DGEC, ADEME, DGE) in charge of the eco-bonus dossier were quite clever in this respect, as they only half-opened this Pandora's box, considering that they would not make any difference for batteries and aluminum in general. Since the aim was to define a regime applicable from 2024, and since neither model allocations nor battery sourcing had time to be reviewed by that date, it was necessary to "carve out an imperfect slope" that would facilitate the assessment of European assembly and sourcing. This means that the carbon footprint measurement is not fully satisfactory in principle, but sufficient to achieve the 2024 implementation of the eco-bonus in a relevant way.

The eco-score as defined in France could eventually, without any radical changes, incorporate the differentiation between European countries, or add the reparability of vehicles or batteries to its list of criteria. The important thing is that, even if we leave these very relevant questions unanswered, it has been possible to quickly come up with a proposal for such an eco-score. It could have been nothing more than consumer information, but in this case, it is a key tool in car tax policy, as it plays a role in the decision to buy EVs by distributing the €4,000 bonus or not (other conditions related to vehicle registration and tax income of the recipient are also taken into account, as explained above).

It would be quite possible - and we all want it - to have a European eco-label, which would allow manufacturers to make their forecasts and seek the best possible label in full

knowledge of the facts. This would not prevent each country from making specific use of it in terms of taxation or regulation. In the same way that low emission zones exist everywhere, but may or may not lead to restrictive measures depending on the wishes of local authorities and/or the prevalence of air quality problems, it is perfectly possible to develop a common metric and then - since this is the division of powers defined by the European treaties - leave taxation or road allocation rules to vary locally.

If we retain our analysis of the French eco-score and the conditions under which it emerged, we highlight the fact that it can (or must) be defined:

1. By reserving the right to develop it to specify requirements that we do not have the technical and/or political means to define immediately;
2. Without presuming its use in national and/or regional public policy.

From this point of view, the agreement on the definition of the eco-score can be fairly broad, even if it is fairly exhaustive and demanding, since it is not binding: you may or may not base your policy on it. Defining a hierarchy of the environmental virtues of vehicles accepted in the 27 Member States and then allowing collective preferences to be settled locally is probably the best way of achieving this.

Finally, we can draw some recommendations to define the content of a future eco score starting from a common basis with numerous possible evolutions. For the initial common basis, we define our proposal as follows:

1. The eco-score must combine an indicator related to the total CO2 footprint of the battery and an indicator related to the total CO2 footprint of the vehicle (except the battery) in order to clearly distinguish ASEV from other cars on the market;
2. The methodology for the CO2 footprint of the vehicle must be based on the forthcoming proposal (by the end of 2025 - Regulation (EU) 2023/851, Article 7) and the total CO2 footprint of the battery is calculated as the proposed indicator (Draft delegated act CFB methodology – Ares (2024)3131389) multiplied by the capacity of the battery in kWh;
3. Any regulation dealing with carbon footprints must stipulate that the actors in the value chain are responsible for collecting the primary data needed to contribute to the LCA calculation;
4. The forthcoming delegated acts on recycling and reuse of materials seem to be sufficient to bring about significant improvements in terms of results in this area. Therefore, we don't see any interest in including some specific criteria related to this issue in the eco-score, as this would make it more complex and less easy to understand;
5. One unique regulation to be modified to define the content of the eco-score and communicate to customers in an appropriate manner, namely the Car Labeling - Directive 1999/94/EC (DG CLIMA).

We thus make three proposals to extend the scope and the impact of the eco score and introduce the national fiscal use of an Eco score.

We propose the following extensions of the EU eco score, which can of course be supplemented by others:

1. Reparability, especially of batteries , where some new designs glue cells together, is a regulatory blind spot while being of the utmost importance for both sustainability and total cost ownership, a key issue for affordability[37]. It would therefore make sense to include an item related to reparability in the eco-score, but some preparatory work with experts is needed to determine appropriate metrics and calculation methodology.
2. The use of *bonus* / *malus* to associated to the eco score to favor an affordable and sustainable EV in terms of (i) CAFE and (ii) EPR fees, etc. would increase the impact of the eco-score on OEMs design and manufacturing strategies (not only informing consumers but shaping OEMs strategies) and offer other means to reach the objective.

Lastly, the table below summarizes the regulations which need to be amended to (i) define the Eco score and (ii) to efficiently use it to support ASEV deployment with a role that contributes to shaping the design and production strategies of OEMs.

Table 13. Proposed regulations to extend the scope and use of an Eco Score

Intention	Appropriate regulation(s)
Battery reparability	Battery Directive - Regulation (EU) 2023/1542 (DG ENV)
Eco Score to define CO2 bonus for ASEV vehicles	CAFE - Regulation (EU) 2023/851 (DG CLIMA)
Eco Score to modulate EPR fees for ASEV vehicles	Articles 20, 21 Proposal for a Regulation of the European Parliament and the Council on circularity requirements for vehicle design and on management of end-of-life vehicles, amending Regulations (EU) 2018/858 and 2019/1020 and repealing Directives 2000/53/EC and 2005/64/EC (DG ENV)

4.3.2. Around the Eco-score, we need new fiscal policies

The Treaties do not give the EU powers in fiscal matters and the fiscal use of an eco-score must be treated at the national level. The disjunction between a common metric and its differentiated uses is basically in line with the experience of the construction of the 'single market' for cars: (i) agreement was reached on the rules for type-approval of vehicles and for measuring consumption and emissions (NEDC then WLTP) and (ii) Member States and/or local authorities were left to use this common framework as they saw it appropriate to support their objectives.

[37] The cost of changing a complete battery in after sale would be about 10,000€ for a small car and probably more than 20,000€ for a large car / SUV. Assumption from the authors.

This has resulted in European markets that have differed significantly from country to another one in terms of sales of diesel cars and/or product mix. Nations thus express differentiated 'collective preferences', particularly through their respective tax systems.

In terms of emissions, the question of transition is about fundamentally changing what matters: from vehicle direct emissions on the road to emissions in the production of vehicles and the energy they consume while being driven. What WLTP measurements provide as a basis for expressing collective preferences in terms of road mobility must now be replaced by an LCA-type indicator, first to coexist with WLTP to set or modulate CAFE requirements, and then to allow BEVs to be differentiated from each other.

In terms of fiscal policy, fuel taxation is currently the main tool for steering markets and making the automotive industry pay the amounts deemed necessary to cover externalities. For ICEs, large vehicles that consume and emit more were taxed more heavily, and there was less need for an ownership tax to regulate contributions to covering externalities and structuring incentives.

Beyond the question of bonuses and penalties, all the evidence suggests that the taxation of electric vehicles will have to be based largely on purchase taxes (such as the vehicle registration certificate) or ownership taxes (such as the motorway tax sticker or annual VAT), backed up by measures relating to the characteristics of the vehicles whose production and purchase we wish to encourage[38].

For electric vehicles, tax systems will need to evolve, and the most logical approach would be to differentiate contributions according to LCA, with eco-scores of course being the benchmark.

It is highly unlikely, and probably not necessary, that they can be harmonized. For manufacturers and public policy designers, it is therefore essential that the bases for defining these differentiated taxes are common: the standardized eco-score will have this role by using fiscal and non-fiscal incentives.

In most national configurations, part of the car taxation system is already managed at the local and/or metropolitan authority level, which is logical because a large part of the externalities associated with cars occur and are managed locally. In some cases, these are car policies that seek to facilitate the use of cars at a reasonable cost (as in the case of Kei cars in rural areas of Japan). In other cases, the policies seek to discourage car use by promoting alternative modes. Between these two orientations, local authorities need to break out of this dichotomy by not treating all types of mobility and / or vehicles in the same way.

[38] A tax on the electricity used to charge the vehicle is also one of the hypotheses mentioned. https://www.tresor.economie.gouv.fr/Articles/2023/12/04/rapport-intermediaire-les-enjeux-economiques-de-la-transition-vers-la-neutralite-carbone

In order to differentiate the treatment of vehicles according to whether they consume more or less space or electricity, the eco-score is a simple tool that local authorities (whether urban or rural) would benefit from including in their toolkits. They could start by using it to structure their tax systems. They could also use it to support their very important policies on road use (traffic, parking, urban tolls, access rights to city centers, etc.) or their policies on public procurement and/or support for car mobility through social leasing. In this sense, local authorities could, as they do with public transport operators, forge partnerships with car manufacturers and/or distributors to build high-quality, low-carbon car services around the eco-score. The next section on promoting an ASEV toolkit will make some concrete suggestions on how to do this.

5. Promotion of a European ASEV toolkit for Member States, regions and cities

The work on decarbonization carried out by governmental (SGPE, 2024) and non-governmental (T&E, 2024) organizations systematically emphasizes the essential nature of decarbonizing vehicle fleets and, at the same time, stresses the need to combine it with other policies on sobriety and the development of new modes of mobility.

When it comes to promoting the development of electric mobility, the issue of vehicle affordability and sustainability raised in this rapport is only one aspect of the problem. Users must be convinced to use BEVs, and public authorities must be convinced that BEVs can solve more than emissions problems. This means that ASEVs also depend on their ability to convince public authorities that they are part of the solution to mobility problems to find their market.

As a result, manufacturers, collectively and individually, must have two interrelated marketing strategies for these vehicles: one that seeks to attract buyers and one that seeks to attract states, regions, and municipalities to become prescribers. We argue here that, in this second perspective, ASEVs would fit perfectly into the toolbox of those in charge of public policies, both to ensure the promotion of electric mobility and to contribute to the various aspects of the decarbonization of mobility.

At the national level, there are several solutions from existing programs for BEVs in general that can be easily adapted to ASEVs [39], so we focus here on local mobility.

The issue of local mobility is at the heart of a “contradiction” between public authorities, who want to encourage high passenger flows at peak times while controlling investment and operating costs and returning urban space to residents – i.e., reducing car use as much as possible –, and users, who see the car as the safest, most flexible and cheapest means of transport available to them.

While in densely populated urban centers the existence of numerous mobility alternatives to the car can enable local authorities to achieve their objectives, this is not the case in smaller urban centers where there are not enough mobility alternatives, nor in the peri-urban or semi-rural areas that users have to pass through on a daily basis, regardless of the size of the urban center in question.

In other words, the car is no longer necessarily the absolute enemy, but must be seen as part of the solution if it can be shared and used intelligently as a form of public transportation. For example, it can be used as a tool to get people to and from transportation hubs that take them to and from city centers or workplaces. Any car can contribute to a more efficient mobility system (e.g., in the case of carpooling), but the result will be even more profitable for society if it doesn't take up too much space and has limited

[39] Such as advantageous taxation and scrapping schemes connected with Eco score, public procurement, social leasing…

emissions of pollutants in use as well as minimal CO2 emissions in its production and use: this is exactly why ASEVs could make a significant contribution to solving local mobility problems.

In 2013, the European Commission introduced the concept of Sustainable Urban Mobility Planning (SUMP), which was well received by cities and municipalities across Europe. This provided the basis for sharing experiences and learning from best practices, by supporting the creation and updating of hundreds of urban mobility plans.
The original concept was updated in 2023, taking into account new EU strategies and policy priorities, while maintaining the original philosophy. In March 2023, the Commission adopted a Recommendation calling on each Member State to establish a national program with a dedicated office to support cities in sustainable urban mobility planning. National SUMP support programs should include guidance material, training programs and capacity building, and provide technical expertise and financial support to cities.
The proposal also includes the introduction of performance indicators for these SUMPs. They are called UMI for Urban Mobility Indicators and relate to the 7 main categories of final objectives of SUMPs, namely (i) reduction of injuries and fatalities; (ii) modal split; (iii) noise; (iv) air pollution; (v) congestion; (vi) greenhouse gas emissions; and (vii) access to mobility services.
While the objectives and areas covered by SUMPs are those of large cities, the Commission is careful to specify that "*a SUMP should cover the entire functional urban area (a city and its commuting zone), taking into account real traffic flows*". A SUMP should foresee cooperation and synergies between all levels of government, local, regional, national and across different policy areas. It should be prepared in partnership with local residents and stakeholders. It ensures a variety of sustainable transport options for the safe, healthy and fluid passage of people and goods, with all due consideration for fellow residents and the urban environment.

Due to their characteristics, namely lower mass and dimensions compared to other vehicles as well as the electric traction system, the use of ASEVs in urban, peri-urban and semi-rural areas contributes directly to the reduction of injuries and fatalities, noise, air pollution and greenhouse gas emissions during operation. In combination with other approaches that go beyond their specific contribution, ASEVs can efficiently contribute to the implementation of modal split, congestion reduction and access to mobility services, which are probably the points where the mobility system in general is stuck in contradictions due to the lack of affordable and sustainable vehicles.

Before making some proposals to support the use of ASEVs, we point out that incentives for EVs need to be carefully balanced to ensure an optimum use of all vehicles (including remaining non-ZEVs) and to ensure the efficiency of public transport. The example of the policies applied in Oslo at the beginning of the 2010s have favored an amazing increase in sales of BEVs but have also produced many severe adverse effects (Aasness and Odeck 2015) as summarized below:

1. The exemption from tolls has reduced the capacity of creating / maintaining road infrastructure;

2. The exemption of parking fees has led to economic losses and made society lose sight of the fact that a parking lot is a public space with costs that must be regulated according to its use, regardless of the type of vehicle occupying it;
3. The free use of transit lanes has reduced the efficiency of public transport, leading to increased congestion during peak hours and additional travel costs for public transport users.

In light of this warning about BEV incentive policies that may not be beneficial to the overall mobility system, we recommend a more systemic and holistic approach to promoting the use of ASEVs, such as the following examples (which are not exhaustive of all possibilities):

1. In urban areas, free parking is only available in spaces reserved for charging stations. More broadly, modulate parking fees according to usage needs, not just the fuel of the vehicle: have high fees (reduced for ASEVS versus non-ASEVS) when the need for space turnover is high, and lower or even zero fees when the need for turnover is low;
2. In peri-urban or semi-rural areas, free parking fees for all vehicles in carpooling areas and low parking fees for ASEVs in parking lots near transport hubs;
3. Access to fast transit lane freely opened to ASEVs and non-ASEVs vehicles in (effective) situation of carpooling and to public transport vehicles;
4. For rural or peri-urban areas where car use remains the best solution, ASEVs could quickly replace the use of old cars for low-income households if their purchase (and that of the charging station) is supported by public funds, following the example of Japanese rural provinces that subsidize Kei cars;
5. Combine these policies with intelligent energy policies that facilitate, for example, controlled recharging, which is the most compatible with the production of decarbonized electricity and the problems of intermittency that it can pose;
6. Promote the use of ASEVs as the sole or main household vehicle by working with public transport providers or ASEV rental companies to develop practical intermodal solutions for families;
7. …

To be complete, we mention that in France, a law adopted in 2019 (known as 'Loi d'Orientation des Mobilités') considered that mobility policy concerned all territories, regardless of their density, while centralized mobility governance (known as 'Autorités Organisatrices des Transports' or AOTs) existed only for large cities. Today, all territories are covered by such an authority (known as 'Autorité Organisatrice des Mobilités' or AOMs), which plays the role of SUMP manager.

The existence of AOMs makes it possible to better identify local mobility needs at the private, public and business levels and to fine-tune ad hoc solutions adapted to the topographical, social and economic characteristics of each territory.

Conclusion

At the heart of our proposals, ASEV must convince users to buy it, automakers to produce it profitably, and policymakers that it solves much more than emissions problems, which is expressed in 5 main features summarized below:

1. An accessible vehicle that offers impeccable performance for use in urban, peri-urban and semi-rural conditions;
2. A vehicle defined by supranational regulations that provide a common framework binding on all member states;
3. A vehicle that creates a competitive and sustainable space where there can be a volume effect, one of the key conditions for affordability;
4. A vehicle that contributes to CAFE and helps manufacturers meet their targets in the next decade;
5. A vehicle promoted by local authorities because it contributes to the improvement of their mobility system.

Our proposal of ASEV is carried out by two emblematic types of vehicles:

1. An ASEV M0, limited in mass, dimensions and peak power of the electric motor and in use (speed limited to 110 km/h), which offers impeccable safety conditions, but whose limited use and the complexity and duration of the regulatory framework required for its adoption may hinder both its implementation and widespread use;
2. An ASEV M1, limited in mass, dimensions and peak power of the electric motor, not limited in use, requiring rather limited modifications of the existing regulatory framework but whose (almost) full compliance with the M1 requirements may not bring as many cost and affordability breakthroughs as M0 ASEV.

In addition, both offer an excellent opportunity for all automakers to reduce the mass of their vehicles from 2025, and both could be jeopardized by insufficient financial/non-financial incentives at the national and local levels to ensure the segment's success.

We propose to link the ASEV concept with CAFE bonus, a dedicated financial framework for production take-off, Eco-score bonus at European level and financial/non-financial incentives at national/local level to give more traction to the proposal.

The basic proposal for CAFE bonus is inspired to what has already done previously for EVs, i.e., a multiplier for ASEVs. The rationale behind a temporary multiplier is to encourage automakers to produce and sell ASEVs in large quantities to achieve the economies of scale of a mass market. We recommend a degressive multiplier from 2x in the first year of implementation of ASEVs to 1.5x 4 years later and then to 1 starting 5 years later. We strongly suggest that the first year of implementation is 2026 to secure both 2030 and 2035 targets.

Although not central to this report, we believe that affordability and sustainability need to be improved for all BEVs. Therefore, we have proposed some additional measures to be implemented in the medium term to extend the concepts of ASEVs to other vehicle segments.

At present, there are no European regulations that directly address the definition and application of an eco-score. While the existing proposals and the only regulation in force (in France) may bring some interesting contributions to the definition of its content, we have built an original proposal to be applied in successive steps. For step1, we propose the following framework:

1. The eco-score must combine an indicator related to the total CO2 footprint of the battery[40] and an indicator related to the total CO2 footprint of the vehicle calculated according to the EU regulations under construction;
2. One unique regulation to be modified to define the content of the eco-score and communicate to customers in an appropriate manner, namely the Car Labelling - Directive 1999/94/EC (DG CLIMA);
3. Based on this definition, Member States can already apply a set of financial/non-financial incentives, mainly based on ASEV ownership taxes in a first approach, while local authorities can also apply their set of incentives, fine-tuned to local characteristics, to favour the uptake of ASEVs.

For the next steps, we mainly suggest to give the eco score a higher weight in the definition of carmakers' strategies by influencing their design choices through additional CAFE bonus or modulation of some fees, e.g., fees for extended producer responsibility.

Finally, we are convinced that ASEVs are a very good tool for local authorities to improve their mobility system, as they can efficiently contribute to achieving significant performance according to the Urban Mobility Indicators associated to SUMPs. Due to their characteristics, namely lower mass and dimensions compared to other vehicles, as well as the electric traction system, the use of ASEVs in urban, peri-urban and semi-rural areas contributes directly to the reduction of injuries and fatalities, noise, air pollution and greenhouse gas emissions during operation. In combination with other approaches that go beyond their specific contribution, ASEVs can efficiently contribute to the implementation of modal split, congestion reduction and access to mobility services, which are probably the points where the mobility system in general is stuck in contradictions and the lack of affordable and sustainable vehicles.
Taking into account the lessons learned from the deployment of EVs in Norway at the beginning of the last decade, we suggest that ASEVs incentives must be embodied in a holistic and systemic definition of a mobility system to ensure an excellent complementarity between all its components, be it ASEVs and non-ASEVs, public transport or scooters, bikes, etc.
ASEVs - like Kei Cars - do not need to be defined as urban vehicles: they are affordable small vehicles with very low environmental impact, small footprint and low electricity consumption. In themselves, they offer enough benefits to be bought (or leased) by customers, profitably produced at scale by automakers, and efficiently promoted by local authorities to significantly improve their mobility system.

[40] For the battery, we need the total carbon footprint calculated by multiplying the proposed indicator (Draft delegated act CFB methodology – Ares (2024)3131389) by the capacity of the battery in KWH.

Chapter 5.
What would be the impact of ASEV on decarbonisation, just transition and European industry competitiveness?

ACEA's latest report on the European car fleet indicates that there are 250 million vehicles in circulation in the 27 Member States, and that the annual growth in this fleet has been around 1.3% in recent years. If we think in terms of renewal rate (annual registrations / cars on roads), the fact that registrations have fallen from 15.6 million in 2018 to 12.8 million in 2023 has decreased this rate from 6.5% to 5%. This means that, if we were to make this level of registrations the new 'normal level', the renewal of the European car fleet, which used to take 15 to 16 years, would now take more than 20 years (and up to 45 years in central and eastern European countries), and the decarbonization desired for 2050 would be increasingly unlikely. This also implies that the 'overcapacities' that were so much debated in the 2010s would now be evident, and that the restructuring and downsizing at assembly sites and throughout the value chain would be extremely wide-ranging, as is already being observed in Europe in the last couple of years. These arguments added to the difficulties met to pursue the growth of EV market shares converge to underline the urgent need for a reorientation of policies not only to be able to maintain the ban of ICE vehicles in 2035 but also to help the European auto industry to cope with the transition and meet the intermediate deadlines of 2025 and 2030.

It is therefore clear that from an industrial, social and environmental point of view the situation observed at present is highly problematic and should not be allowed to persist. It is from this perspective that the creation of a significant and sustainable market for ASEVs is studied in this work. The reasons why we do not have in Europe such a market, the Japanese and Chinese counter-examples and the examination of various ways of rectifying this shortcoming converge to consider the creation of a large, sustainable market for ASEVs as the most convincing practical solution in 2024 to these problems.

5.1. Policy implementation of ASEV

The timeline of our proposal is detailed in the table 14 below.

We assume that the ASEV regulation will be adopted in 2025, and will enter in force in 2026. The parallel modification of the CO2 regulation (CAFE) with the introduction of a multiplier for ASEVs from 2026 (x2) until 2029 (x1,25) will incite all OEMs to launch models in this new category.

The adoption of the European Eco-Score in 2026 will provide clear information to the consumers on the contribution of ASEVs to the decarbonisation of transport and automotive

production. The Eco-Score will also become available as a tool for fiscal policies supporting the diffusion of ASEVs at national level.

The publication of the M1 ASEV policy toolkit in 2026 will detail how the Eco-Score can/should be used by EU governments to promote the diffusion of ASEVs. The creation of a dedicated label “Cities and/or Territories for ASEV” will further contribute to the diffusion of ASEVs via their integration in the EU Sustainable Urban Mobility Planning at each area level.

To maximise the decarbonisation impact of ASEVs we expect a reconfiguration of fiscal policies promoting BEVs from 2026/2027 onward with a strong focus on conversion bonuses and social leasing to incite the owners of the most aged and polluting part of the European car fleet to scrap their old ICE and acquire/lease an ASEV.

By this time ASEVs will be supported by fiscal and non-fiscal measures to reduce their acquisition and use costs relative to other vehicles, to promote their use in cities (free parking, preferential lanes, etc.), to integrate their acquisition/leasing in simplified multimodal mobility services for city access and long-distance travel. These policies would be therefore designed with the aim of both developing electromobility and limiting cars number and use.

We also expect that the creation of the ASEV category as well as the introduction of the European Eco-Score will modify the general European regulatory framework for new cars, and for ASEVs in particular, from the current siloed maximalist and techno-solutionist approach to a more holistic one where environmental sustainability and social affordability will work as transversal criteria adopted by all the DGs involved to manage trade-offs between its different dimensions.

The implementation of all these measures will rely on a strong European political compromise over the ASEV proposal, as well as different but complementary national compromises adapting the ASEV proposal to different national, regional and city/area context. These compromises will be based:

- on a clear determination to limit the reduction in production and headcount associated with electrification, by linking the electrification objective with a target for volumes and/or the rate of fleet renewal; the maintain of a rate of fleet renewal above 5% could become a target for the EU, which could then be broken down into 27 national targets depending on current car fleet renewal rates;
- on the strong contribution of ASEVs to the achievement of the “fit for 55” CO2 targets for new car sales of 2030 and 2035 (for OEMs and automotive suppliers);
- on the appeal of ASEVs as an affordable, sustainable, safe, new and innovative mobility solution in particular for those populations that own and drive the oldest and most polluting cars in Europe and are currently excluded from the access to BEVs;
- on the appeal of ASEVs for the EU, EU member states, regions and cities, but also for environmental NGOs, as a strategic technology to decarbonise road transport faster and more efficiently and to rethink urban/peri-urban/rural mobility in a way that is both more ecologically and politically sustainable (greener and more affordable).

5.2. A desirable future with ASEV

Based on these assumptions, we expect that at least 3 million ASEVs will be sold in 2028. We expect that at least half of these sales will be supported by scrapping schemes promoting a faster renewal of the car fleet that will grow from the current 5% to 6-6,5%. ASEVs will represent from 2028 onward 18% of the total sales of new cars, whose total volume will grow from the current 13 (2023) to 16 million cars, restoring the total European automobile production to pre-Covid levels, preventing the loss of thousands of jobs in the automotive production.

We believe that such a volume of production will provide a welcome stimulus to the currently difficult structuring of a complete European battery value chain, but also to the reactivation of core competences of automotive suppliers in lightening and optimise parts/components for small vehicles, that will be both key in driving down the cost of manufacturing ASEVs. This would enrich the European automotive innovation system by diversifying it. This broadening of its range of skills would maximise its capacity to adapt and its ability to remain a key player in the global automotive game.

More specifically, ASEVs will also reactivate and further develop the existing capabilities of the European automotive eco-system in making affordable small cars, contributing to preserve and develop its overall competitiveness, not only in the premium segment, but also in the volume segment where otherwise Chinese imports and Chinese European based production could capture significant market share. While the compensation currently proposed by the EU to offset the various types of aids received by Chinese vehicle importers could be a satisfactory temporary solution, it does not resolve the entire competition problem. The assembly plants set up by Chinese manufacturers in Europe as a result of this policy will concentrate on accessible vehicles, and it is therefore the development of such products designed and manufactured in Europe by European manufacturers that is urgently needed. By creating such a vehicle category to stimulate and securitise car manufacturers product policies considering this segment as a crucial one, EU would give to its pro-EVs orientations a real chance to survive these attacks.

We estimate that under such conditions, our proposal could contribute to reduce CO2 emissions from the car fleet of 24% (71 million tons CO2) in 2035 and of 38% (40 million tons CO2) in 2050 by comparison with a scenario without ASEVs that is currently incompatible with the achievement of carbon neutrality in 2050 (see box below for the methodology). We think in particular that ASEV will represent the main technological solution to decarbonise faster the most aged car fleets in Southern and Central and Eastern Europe.

5.3. A new European coalition for ASEVs

While we are fully aware of the challenges that our proposal raises in terms of policy-making, we believe that it could gather a wide support from all the main stake-holders in the automotive sector and in all EU member states.

First, starting from 2025 onward all European OEMs will have to move towards lighter cars in order to comply with the CO2 regulation given the shift from a positive to a negative slope for weight-based standards. ASEVs should therefore appeal to all OEMs and ACEA as their representative body. Furthermore, ASEVs will not compete directly with the current supply of BEVs, precisely because the current supply does not cater for the demand for such

vehicles. ASEVs are meant to compete against aged second-hand cars which is why they will contribute to boost sales and production.

We therefore expect that also European automotive suppliers will benefit from ASEVs and should support our proposal via their representative European body, the CLEPA. European and national automotive trade unions should also support the proposal, all the more as it is already coherent with several of their own proposals for smaller and more affordable electric cars (Fondation Nicolas Hulot and CFDT 2021; CGT Renault 2023). In the same manner, we expect the European Committee of Regions and in particular the CoR's Automotive Regions Alliance to see the benefits of producing ASEVs, in particular in regions where volume of production is now particularly threatened.

Because our proposal is meant to reduce significantly acquisition and use cost of cars for millions of European consumers while helping them to board the train of electrification, we also expect the BEUC to see how proposal in favorable terms.

We also think that our proposal could speak to the EU governments that are currently concerned by the respective capacity of their own countries and automotive industries to board the train of electrification while preserving employment and ensuring good job quality.

Environmental NGOs, which have become key players in Europe, should also logically support such proposals. They have already spoken out in favor of smaller, lighter and more ecologically virtuous vehicles. They should be seduced by a “fleet policy” that would, for example, set renewal targets, possibly accompanied with targets for fleet growth (or stagnation or decline).

Finally, and more generally, the ASEV proposal will give a welcome stimulus and a clearer direction to different strands of the European Union Green Deal policies – such as the Net Zero Industrial Act, the Batteries Regulation, the CBAM, the Vehicle Type Approval Regulation, the CO2 regulation, the Just Transition framework and fund, the ETS 2 carbon market, etc. – making easier for the European Commission to articulate them as a coherent industrial policy.

Conclusion

What is at stake in our proposal is the idea that electrification should be an opportunity for a New Deal around the car and its place as an industry and as a mobility tool in European societies. In a way, Joe Biden's IRA dealt with electrification and the hostility it aroused in a very political way, by linking the return to the Paris Agreements to a policy of massive subsidies and very firm protection against Chinese imports and installations. As the year 2024 shows, the EU can no longer simply set very ambitious electrification targets and then leave the industry to deal with the consequences. If, as seems to be the case, there is no question of turning back the clock, then we need to get back on track and seek compromises that will make this transition ecologically, socially and industrially credible. In the same way that ASEVs would be a major component of local mobility policies, the policy and financial framework designed to create this category and give it the importance it deserves could in the coming months symbolise this reorientation.

Table 14. Timeline of ASEV proposal implementation

Year	2024	2025	2026	2027	2028	2029	2030		2031	2032	2033	2034	2035	
Technical regulations	Regulation proposal: introduction of the ad-hoc category M1 ASEV	Regulation adoption	Entry in force of M1 ASEV	No new technical requirement for ASEV			Full adoption of pre-2030 technical regulations for ASEV	Adoption of ART package for M1 non-ASEV					Full adoption of pre-2035 technical regulations for ASEV	Adoption of ART package for M1 non-ASEV
			First Automotive Round Table (ART)	Adoption of ART1 package					Second ART	Adoption of ART2 package				
CAFE		Modification of CAFE regulation to introduce ASEV and multiplier for ASEV	Multiplier x2	. x1.75	. x1.5	x1.25	No multiplier						End of non-ZEV	Adoption of new metrics (LCA)
Eco-score	Debate on Eco-score	Draft proposal on Eco-Score	Adoption of Eco-Score	Entry in force of Eco-score			Progressive withdrawal of lowest eco-score vehicles + progressive tightening of eco-score regarding the climate damaging							
National and local Policy package			Publication of the M1 ASEV policy Toolkit	Fiscal policies based on the Eco-score / Social leasing and conversion bonus tied to ASEV category										
			Label "Cities for ASEV"											

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