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Fragmented EU Car Labels: How To Achieve Consumer-Friendly Standardization and Transparency?

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Abstract

This study examines the EU car labelling regime for CO₂ emissions and fuel efficiency under Directive 1999/94/EC (Car Label Directive) from a legal and empirical perspective. The legal comparison of national car labels shows strongly diverging labelling methodologies across the EU: Coloured versus basic labels, relative versus absolute approaches, different units and thresholds, as well as emphasis on CO₂ emissions versus fuel economy. The very same car will have different ratings in different EU countries. This creates market frictions, undermines the EU's effort to decarbonise the car sector, and has the potential of misleading consumers. Our empirical analysis of new vehicle registrations from the European Environment Agency offers insights into the fuel efficiency and CO₂ emissions of cars in the EU as well as national label distributions. All fuel types have ranges of diverging fuel efficiency and (all but electric vehicles) direct tailpipe CO₂ emissions, which argues in favour of introducing fuel-type dependent car labels for both elements. We further find two opposing trends: On the one hand, consumers opt for more fuel-efficient car models among available options. On the other hand, fuel consumption and CO₂ emissions slightly increased for fossil-fuel-powered cars in recent years. This finding suggests that consumers care about fuel efficiency, and perhaps reducing CO₂ emissions, while manufacturers seem less committed to offering more efficient models. We also document heterogeneous national purchasing behaviour as car label distributions in 2024 diverge if the national labelling methodologies were applied to the cars registered in the individual countries and in the entire EU. To solve these discrepancies, we assess options for standardizing car labels at the EU level. A car label review could be inspired by the EU energy efficiency labelling regime for electric appliances under Regulation (EU) 2017/1369 as a labelling role model. We conclude that the future car label would preferably include two distinct coloured scales with absolute labelling thresholds for both CO₂ emissions and fuel efficiency.

Keywords Car labels · CO₂ emissions · Energy efficiency · Fuel economy · Directive 1999/94/EC · Sustainable transport

JEL Classification R4 · K300 · K320 · L920 · L980 · Q480 · Q580

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Highlights

- Car labels for CO₂ emissions and fuel economy diverge significantly across EU Member States regarding their methodology, relative versus absolute approaches, and thresholds.
- European vehicle registration data show two opposing trends: While manufacturers offer on average fossil fuel-powered cars with decreasing fuel economy and increasing CO₂ emissions, consumers opt for more fuel-efficient and less CO₂ emitting cars.
- A single EU car label could alleviate existing market inefficiencies and improve the comparability of vehicles with different fuel types.

Introduction

When consumers buy a car, their choice is determined by many factors, including the price and personal preferences regarding specific brands, models, and engine types. The CO₂ emissions and fuel economy of different cars may or may not be decisive for the individual consumer's decision. Yet, passenger cars' CO₂ emissions and fuel consumption have a negative climate impact, which poses a substantial challenge and an existential threat to humanity.

In response to climate change, the European Union (EU) has enacted a suite of policies designed to mitigate environmental impacts and propel the economy towards climate neutrality by 2050 (European Climate Law).¹ A critical focus of these initiatives is the transport sector, which accounts for nearly one-quarter of Europe's greenhouse gas (GHG) emissions (European Commission, 2021). The EU builds its decarbonisation strategy for passenger vehicles on three main pillars. First, it mandates car manufacturers to lower the CO₂ emissions of the cars they sell in the EU. In particular, the manufacturers must gradually reduce their cars' fleet-wide CO₂ emissions to reach 0 gCO₂/km from 2035 onwards.² Second, the EU has legislated a CO₂ emissions trading system to cover transport from 2027 onwards.³ This will result in additional CO₂ prices for fossil fuels and raise the financial advantages of CO₂-neutral vehicles for consumers. Third, the EU seeks to nudge consumer behaviour into purchasing vehicles with lower CO₂ emissions by using car labels as informational tools, which are the main focus of this paper.

Car labels are mandated under Directive 1999/94/EC (Car Label Directive), which stipulates that the labels must at least display information regarding a car's combined CO₂ emissions and fuel economy (*basic label*).⁴ However, some Member States went beyond these requirements in their national implementations. They have introduced a colour-coded scale on the labels, which compares a vehicle's CO₂ emissions or fuel economy across different market segments (*coloured label*). This evolution occurred through a gradual, country-specific process involving various implementation and revision stages. For example, Germany introduced the basic label on 28 May 2004 under the "Pkw-Energieverbrauchskennzeichnungsverordnung".⁵ On 22 August 2011, a coloured label with

¹ Regulation (EU) 2021/1119.

² Annex II Part A Commission Implementing Decision (EU) 2023/1623 and Article 1 (5a)(a) Regulation (EU) 2019/631.

³ Directive 2003/87/EC as amended by Directive (EU) 2023/959 and Regulation (EU) 2024/795.

⁴ Throughout this study, we refer to fuel economy or efficiency by subsuming both fossil fuel and electricity consumption of vehicles.

⁵ BGBl. 2004 I Nr. 26, 1037-1044.

letter grading was added, using a relative rating approach for CO₂ emissions.⁶ On 22 February 2024, further revisions were adopted: Cost information was added to the label, the number of grades was reduced to seven (A to G), and the relative rating was replaced by an absolute CO₂ emissions scale.⁷ While the EU has been discussing reforms to the Car Label Directive over the past two decades,⁸ the European Commission is now again assessing a revision. By law, the European Commission had to evaluate the options for introducing a fuel economy and CO₂ emissions label for new light commercial vehicles until 31 December 2024 and, where appropriate, put forward a legislative reform proposal, according to Article 15(6) Regulation (EU) 2019/631. While this has not yet happened, the European Commission is planning to review the Car Label Directive in 2026.⁹

In this study, we analyse the current car labelling regime in the EU, and especially its legal and empirical fragmentations, against the backdrop of economic and behavioural research findings. In a detailed legal comparison of national implementations of the Car Label Directive (Section “[Regulatory Fragmentation of European Car Labels](#)”), we show that the national labels vary substantially across countries in their methodologies, units, colour coding, rating scales, as well as information presented to consumers. While some scholars have covered parts of the legal comparison (Haq and Weiss, 2016), this is, to our knowledge, the first study to examine the implementation differences in such comprehensive detail. A further novel contribution of this paper is our empirical analysis of new passenger vehicle registrations in the EU. We find that consumers tend to purchase more fuel-efficient models than the average model available on the market. In contrast, the offering side follows an opposing trend as the fuel efficiency and CO₂ emissions of the offered fossil-fuel-powered models on average deteriorate over the past years. This suggests that manufacturers do not ultimately prioritise offering increasingly efficient models over time, placing the burden on consumers to identify low-consumption—and therefore less emitting—vehicles. We also analyse the car label distributions among the registered cars per country and—hypothetically—the cars registered in the entire EU (Section “[Empirical Fragmentation of European Car Labels](#)”). Our findings suggest that national labels tend to treat their national fleets more favourably than the EU’s as a whole. We investigate the effects of label fragmentation on consumers and the EU’s single market (Section “[Negative Effects of Fragmented Car Labels](#)”) and explore the options for standardizing car labels across the EU by discussing potential designs of a new car labelling framework (Section “[Options for a Single EU Car Label](#)”).

Our work contributes to the broader literature on the importance and optimal design of product labels, such as eco- and energy efficiency labels for household appliances and other products, as a policy instrument. Labels can complement or substitute traditional regulatory instruments like minimum quality standards or taxes to influence consumer behaviour and market dynamics (Golan et al., 2001). Research suggests that European consumers do pay attention to energy labels and eco-labels when making product choices (European Commission, 2023; Thøgersen, 2000). This attention seems to impact prices and translate into higher sales figures for better-performing products. Consumers were found to have a high willingness to pay for organic conversion-grade food in five EU countries (Tranter et al., 2009), for non-food agricultural products (Michaud et al., 2013), organic cotton in sportswear (Casadesus-Masanell et al., 2009), energy-efficient dishwashers (Galarraga et al., 2011), and A- and B-labelled vehicles in Spain (Galarraga et al., 2014). Moreover, labels that disclose

⁶ BGBl. 2011 I Nr. 46, 1756-1767.

⁷ BGBl. 2024 I Nr. 50 vom 22.02.2024.

⁸ See European Parliament et al. (2010); European Commission et al. (2016, 2021).

⁹ European Commission (2025), p. 11.

CO₂ emissions have been shown to enhance consumer welfare by enabling more informed choices (Caputo et al., 2013). In terms of sales volumes, Stadelmann and Schubert (2018) found that using EU energy labels increased online sales of energy-efficient appliances. Similarly, eco-labels have been shown to positively affect both the sales and market share of high-efficiency appliances. In Denmark, the greater transparency through EU energy labels increased the sales of high-efficiency cold appliances, such as freezers and refrigerators (Bjerregaard and Møller, 2019). At the EU level, Schleich et al. (2021) document that the combination of minimum energy performance standards and energy labels has increased the market share of cold appliances with A+ or better labels. Furthermore, energy efficiency labels were shown to stimulate competition among manufacturers, pushing them to innovate and produce higher-rated products (Mahlia, 2004). Despite their benefits, energy and eco-labels are not without limitations. Depending on the design, labels can have distortionary effects. Complex designs and lack of transparency can generate consumer confusion and unintended incentives for product manufacturers. Boermans et al. (2024) observe some scepticism toward eco-labels, since consumers lack understanding and therefore demand more standardization and improved transparency. Heuristic decision-making further complicates consumer choices. There is evidence that labels that signal the carbon intensity of a product can dilute the effectiveness of other environmental labels (Onozaka & McFadden, 2011). To overcome this bias, Andor et al. (2020) suggest to add operating cost information to energy labels. In addition, firms producing lower environmental quality products can gain a competitive edge by offering a lower price than the most eco-friendly options (Brécard, 2014). Eventually, the complexity and proliferation of eco-labels may reduce their efficiency by overwhelming consumers rather than guiding them (Yokessa & Murette, 2019).¹⁰ Given that a label acts as a substitute for more detailed information, consumers may misperceive the information signal stemming from it (Gonzalez-Torres et al., 2023; Houde, 2018). On the supply side, firms use voluntary environmental certification to extract consumer surplus (Houde, 2022), while sales agents selectively discuss energy efficiency only with customers they perceive as already interested, leaving the disinterested majority uninformed (Allcott & Sweeney, 2017). Therefore, while product labels influence consumer preferences and choices, their effectiveness depends on design and clear communication to consumers, which we discuss in this study in the context of car labels.

Our findings complement studies focusing on the tangible impacts of car labels on the market, thereby highlighting the various frictions that are slowing down the pace of the transition toward climate neutrality. In the Netherlands, van der Vooren et al. (2013) show that the introduction of the Car Label Directive led manufacturers to shift their portfolios toward greener models. Notably, those who improved vehicle propulsion efficiency experienced relatively higher sales. However, rising consumer demand for more energy-efficient or low-emission vehicles can also drive up prices. Alberini et al. (2016) document a 6–11% price jump in Switzerland for cars that qualify for an A rating. Even though this is a considerable cost for consumers, car labels detailing CO₂ emissions and energy consumption can support more informed purchases of low-emission vehicles, potentially contributing to cleaner air in urban areas in the long run. One challenge, however, is the growing discrepancy between CO₂ emissions measured under standardized conditions—used as input for car labels—and actual emissions under real-world driving conditions (Haq and Weiss, 2016; AIRUSE, 2016). The adoption of more stringent testing protocols, such as the Worldwide Harmonised Light Vehicles Test Procedure (WLTP), can narrow this gap. From a broader perspective, regulatory

¹⁰ For in-depth discussions on this topic, see Russo et al. (2018), and the comprehensive literature reviews by Gonzalez-Torres et al. (2023) and Solà et al. (2020).

divergence remains a major obstacle to decarbonising the automotive sector. In fact, global variation in legislation ranks as the tenth most critical barrier to greening the industry (Schögggl et al., 2024). Although this study centres on understanding the fragmentation of car labelling regimes within the EU and identifying pathways towards harmonisation, its findings may also serve as a valuable reference for policymakers in other jurisdictions.

Regulatory Fragmentation of European Car Labels

Methodologies for Car Labelling

The Car Label Directive leaves ample room for defining car labels at the national level. The methodologies employed in national car labelling standards can be differentiated according to three categories: (a) the application of colour coding versus plain numerical values, (b) the use of absolute versus relative values, and (c) reporting of fuel consumption versus CO₂ emissions. Table 1 provides an overview of the definitions used for the car label in all EU Member States.

Colour-Coding Versus Plain Numerical Value

The first striking observation in Table 1 is that there is a high heterogeneity across countries regarding how the CO₂ emissions and the fuel consumption information of passenger cars are presented to the consumer. While all countries require the manufacturer to inform consumers about the vehicle's actual fuel economy and CO₂ emissions (i.e., basic label), only ten countries also require a coloured label that typically has seven categories, going from A to G. Yet the number of categories is not harmonised and ranges from seven (majority of countries) to ten categories (Denmark: A+++ to G), with Austria being an outlier using a continuous scale. Studies have documented the benefits of including a letter-graded ranking into labels, but their effectiveness can drop if the scale is too granular. Labels with a letter ranking allow consumers to compare products by providing a coarse summary of more detailed and accurate information. This so-called comparative label facilitates product differentiation and guides consumers towards higher-ranked products (d'Adda et al., 2022; Newell and Siikamäki, 2014; Sammer & Wüstenhagen, 2006). The length of the scale plays a crucial role since shorter scales enhance consumers' perceptions of the different label categories and, therefore, positively affect their choices. This was demonstrated in an experimental study by Waechter et al. (2016). However, adding new classes (A+++ , A++ , etc.) to the A-G rating scale can undermine the effectiveness and could contribute to market failure, as was shown for EU energy labels (Faure et al., 2021; Heinzle & Wüstenhagen, 2012). A further layer of heterogeneity stems from the differentiation between fuel types. For instance, in Denmark, the labelling thresholds differ for petrol and diesel vehicles, while Spain employs different calculation methodologies for the two fuel types. For ease of comparison, Table 1 only reports the thresholds for petrol-powered vehicles.

Also, the colours are not aligned across the countries. Colour-coded labels convey factual information in a consumer-friendly and salient manner, with green and red serving as positive and warning signals, respectively (Brazil & Caulfield, 2017; Hille et al., 2018). Most jurisdictions rely on the green-yellow-red colour coding to signal the vehicle's "greenness" regarding emissions or fuel consumption. In addition to these, Belgium employs the colour

Table 1 National car labels

MS	Value	Unit	Coloured car label classification						
			A	B	C	D	E	F	G
AT [†]	Abs.	gCO ₂ /km	0-20	21-40	41-65	66-120	121-160	161-220	> 220
BE	Abs.	gCO ₂ /km	1-74	75-99	100-124	125-149	150-174	175-199	≥ 200
BG	Rel.	gCO ₂ /km	< -25%	-15 -	-5 -	-5% -	+5 -	+15 -	≥ +25%
		in %	< -25%	-25%	-15%	+5%	+15%	+25%	
		153*	< 115	115-130	130-146	146-161	161-177	177-192	≥ 192
CY			Basic label						
CZ			Basic label						
DE	Abs.	gCO ₂ /km	0	1-95	96-115	116-135	136-155	156-175	≥ 176
DK [‡]	Abs.	km/l	> 18.1	15.4-18.1	14.3-15.3	12.5-14.2	11.8-12.4	10.5-11.7	< 10.5
EE	Abs.	gCO ₂ /km	≤ 100	101-120	121-135	136-150	151-170	171-200	≥ 201
ES	Rel.	l/100km	< -25%	-15 -	-5 -	mean	+5 -	+15% -	> +25%
		in %	< -25%	-25%	-15%	+15%	+25%	+25%	
FI			Basic label						
FR	Abs.	gCO ₂ /km	0-100	101-120	121-140	141-160	161-200	201-250	> 250
GR			Basic label						
HR			Basic label						
HU			Basic label						
IE			Basic label						
IT			Basic label						
LT			Basic label						
LU			Basic label						
LV			Basic label						
MT			Basic label						
NL	Rel.	l/100 km in %	< -15%	-15 -	-5 -	+5 -	+15%	+25%	≥ +35%
				-5%	+5%	+15%	+25%	+35%	
PL			Basic label						
PT	Rel.	l/100km or km/l in %	Colour-coded, but no thresholds provided						
RO			Basic label						
SE			Basic label						
SI			Basic label						
SK			Basic label						

Column 1, "MS," presents the two-letter ISO country code for each EU Member State. Column 2, "Value," indicates whether the label is based on absolute (Abs.) or relative (Rel.) values, and column 3, "Units," reports the units that the classification is based on. Column 4, "Coloured car label classification," reports the thresholds used to colour code the car labels from best (class A, green) to worst (class G, red). [†] Austria has implemented a continuous label ranging from 0 (dark green) to >220 (dark red) without a letter grading: The dashed vertical lines indicate the approximate thresholds corresponding to the continuous colour scale. [‡] Denmark has a ten-step scale ranging from A+++ to G, with a shifted colour scale (A++: dark green, A: yellow, B: light orange, C: dark orange, D to G: red). For simplicity purposes, the table does not display the scales A+++, A++, A+. *The asterisk indicates the reference value of the CO₂ emissions (g/km) used for calculating the percentage of the relative car label. Source: National legislations (Appendix Table 5)

blue for zero-emissions vehicles. In Denmark, the colour scale is shifted, with A+++ being dark green, B being light orange, and the categories D to G being assigned the colour red.

Although a basic label informs prospective buyers about the absolute vehicle's emissions and fuel efficiency values, it does not put these values into context and makes a comparison for consumers more cumbersome. A coloured label provides a comparative scale and denotes the vehicle's position on it. This proves more informative than the basic label, but it also risks focusing the consumer's attention only to the coloured scale, while neglecting the non-coloured elements.

Absolute Versus Relative Values

Among the ten countries with coloured labels, Table 1 indicates a strong division regarding the values used for determining the car label categories. Six countries have chosen to use absolute values, while four countries have adopted relative values for their classifications. Among the countries using absolute values, the majority links the label to average emissions of CO₂ in grams per km (Austria, Belgium, Germany, Estonia, France). Denmark uses fuel consumption in km/litre, a unit that may confuse consumers. The choice of units for measuring fuel consumption seems to affect consumer behaviour. In the US, consumers are confused by the miles per gallon measure because they wrongly think that fuel costs scale linearly (Allcott, 2013; Larrick & Soll, 2008). The same cognitive bias applies to the km per litre measure of fuel economy (Tanaka et al., 2021).

The absolute values are part of the vehicle's technical specifications, making them straightforward to obtain and compare across different vehicles. In contrast, relative values rely on country-specific methodologies that differ considerably, particularly on the input variables they use. For example, Spain calculates a reference value for average fuel consumption based on the vehicle's length and width, along with two estimated parameters. A vehicle's label is assigned based on how it compares to this reference value for vehicles with the same surface area. Bulgaria employs a simpler method and relates the car's CO₂ emissions to the average CO₂ emissions of new passenger cars registered in the EU the previous year, with the current reference value set at 153 gCO₂/km. Generally, the process for determining relative labels lacks transparency in many countries using this approach. In Spain, the decree provides no explanation of the estimation procedure of the two input parameters. Similarly, the Dutch decree does not specify any methodology but instead refers to the Ministry of Infrastructure and the Environment for further details. In Portugal, the methodology for defining the lowest and highest fuel-consuming vehicles is unclear, and it does not establish clear thresholds for the car classification.¹¹ These transparency issues and cross-country differences are further complemented by research showing that relative rating schemes risk confusing consumers. Experiments found that switching from absolute to relative ratings leads consumers to perceive vehicles with high CO₂ emissions as more environmentally friendly than vehicles with low emissions levels due to various effects, such as colour priming and increased salience (Hille et al., 2018). When a colour code and a relative rating are combined, consumer perception regarding a car's overall environmental performance can be misled. This was one of the major criticisms of the former German car label that used a relative approach relating a car's emissions to its weight, thereby giving preferential treatment to heavier cars (Bund für Umwelt und Naturschutz Deutschland, 2018; Bundesrat Drucksache 657/23, 2023). These findings suggest that absolute rating schemes provide clearer, more direct information about

¹¹ A detailed overview of all national legal norms that implement the Car Label Directive is provided in the Appendix, Table 5.

a vehicle's environmental performance and are less prone to misinterpretation. Nonetheless, Galarraga et al. (2020) argue that both relative and absolute labelling schemes can be useful, depending on the consumers' decision-making process. In conclusion, using absolute values in coloured labels seems to offer greater transparency and reduces the risk of consumer confusion regarding the criteria used for the classification.

Fuel Consumption Versus CO₂ Emissions

Six out of ten Member States adopting a coloured label prefer to inform consumers about the vehicle's tailpipe CO₂ emissions. This approach places electric vehicles (EVs) in the highest label class as they do not directly produce CO₂ emissions. The national labels disregard the CO₂ emissions that can occur while generating electricity, e.g., in coal or gas power plants. Conversely, the four jurisdictions that have adopted fuel consumption as a reference value provide car labels solely for petrol and diesel vehicles. In these countries, electric, gas, and hydrogen vehicles do not receive a coloured label, which may indicate a regulatory bias against these types of vehicles.

One Vehicle, Many Labels

Across the EU, different car labels are assigned to the same vehicle. According to Table 1, the thresholds for the colour-coded categories and their bin width vary considerably across countries. For instance, category A is reserved only for vehicles emitting 0 gCO₂/km in Germany, while in France, vehicles eligible for the same category are allowed to emit up to 100 gCO₂/km. In contrast, a car emitting 100 gCO₂/km would receive a two-notches lower category C label in Germany and Belgium. In Austria, it would receive a yellow-coloured label, typically associated with the category D label in countries that apply letter grading. At the lower end, a car with 176 gCO₂/km would receive G in Germany, F in Belgium and Estonia, and E in Bulgaria and France. Notably, under the relative rating approach, the average vehicle has a D rating in Bulgaria and Estonia, while the Netherlands reveal an upward bias by placing it in category C. Conversely, assuming that the average vehicle registered in the EU emits 153 gCO₂/km (reference value for the Bulgarian relative rating), Belgium, Germany and Estonia would place it in category E, while France would assign it to category D. These divergences across countries might be partially attributed to a change in methodology for measuring the fuel consumption and CO₂ emissions that occurred in 2017 when the EU replaced the old New European Driving Cycle (NEDC) lab test by the stricter Worldwide Harmonised Light Vehicle Test Procedure (WLTP) for the type approval of cars (JRC, 2017).¹² However, this cannot be the sole explanation since this change should not affect the relative rating approach. Also, the existing absolute standards cannot be grouped into two consistent (NEDC- and WLTP-based) categories but instead follow six divergent approaches.

Figure 1 illustrates the dispersion of the labels for one of the most popular sports utility vehicles (SUV) sold in the EU, a Volkswagen T-Roc.¹³ We can observe that the SUV's label is assigned category B in Denmark (fifth out of ten categories, orange colour), C in France, Spain, Bulgaria, and the Netherlands, D in Belgium and Estonia, E in Germany, and no letter

¹² Commission Regulation (EU) 2017/1151.

¹³ In 2022, Volkswagen's T-Roc was the third best-selling car in Europe according to Statista (<https://www.statista.com/statistics/1127929/best-selling-car-models-in-europe-by-units-sold>). We could not use the first and second best-selling cars because their types and equipments varied across countries.

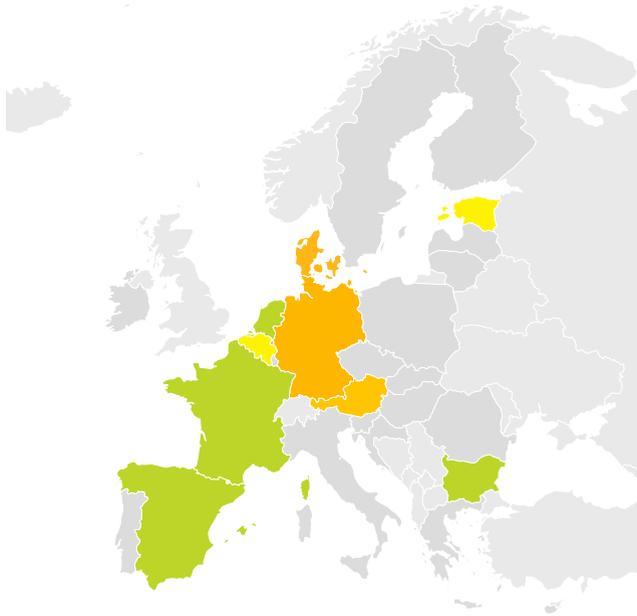


Fig. 1 EU-wide car labels of a small SUV.

The figure illustrates the divergence in car labels across EU countries. The labels refer to Volkswagen T-Roc 1.5 TSI (2022–2024), with a fuel consumption of 6.1 l/100km and CO₂ emissions of 138 g/km. The SUV's label varies from B (Denmark) to E (Germany). Source: Own calculations based on Table 1, coches.idae.es (Spain), www.anwb.nl (Netherlands)

in Austria (light orange colour, equivalent to E). In addition, in most countries (indicated in dark grey), consumers only have access to information about the vehicle's actual fuel consumption and the CO₂ emissions without a clear, immediate indicator of the vehicle's overall environmental impact.

In countries that have adopted a coloured label, this information is provided at the vehicle's physical point of sale. National regulations typically do not account for prospective buyers often gathering information about vehicles via a pre-purchase online search. When the Car Label Directive was introduced, internet penetration was only at about 14% of the population in the European Union, which is possibly the reason why it did not prescribe car labels in online advertisements.¹⁴ Therefore, customers find car labels for new cars in online marketplaces only in some countries, notably Spain. New vehicles in other EU countries can but do not have to be accompanied by a car label in such online offers.¹⁵ As a result, the online use of car labels is fragmented both across and within EU borders. Currently, European consumers face inconsistent car labels across borders and are exposed to insufficient label transparency in online vehicle marketplaces within the individual countries.

¹⁴ According to International Telecommunication Union (ITU) World Telecommunication/ICT Indicators on "Individuals using the Internet (% of population)" (World Bank Code: IT.NET.USER.ZS) for the year 1999.

¹⁵ Based on search for the SUV's car label on the following online marketplaces: autoscout24.at, gocar.be, mobile.de, bilbasen.dk, lacentrale.fr, autoscout24.nl, auto.ria.com.

Empirical Fragmentation of European Car Labels

EU car labels diverge not only legally, but also empirically. Vehicle registration data show significant differences of label distributions and purchasing behaviour across EU countries, but also different evolutions of fuel efficiency and CO₂ emissions for different fuel types over time.

Data and Methodology

We base our analyses on data from the European Environment Agency (EEA), which maintains a repository of all new passenger car registrations in the EU and collects information such as fuel type, weight, CO₂ emissions, and fuel efficiency (EEA, 2024). We restrict the sample to the registration years 2018 to 2024, as the WLTP was gradually introduced in September 2017 for new vehicle types and became mandatory for all new vehicle registrations in September 2018. We further exclude vehicles with exotic fuel types, focusing on petrol, diesel, LPG, plug-in hybrid, and electric vehicles. Outliers in CO₂ emissions are removed at the 99th percentile, while fuel consumption is winsorized at the 1st and the 99th percentiles within each fuel category. Missing observations on CO₂ and fuel consumption are populated using the median value of the same vehicle model. A vehicle model is defined as a unique combination of the vehicle's "type," "variant," "version," and "type approval number" (see Hackmann et al., 2024). This approach allows for a granular distinction between vehicle models, with the average standard deviation of emissions within the vehicle model being only 0.9 gCO₂/km. Observations are excluded from the sample if any of the four identifiers are missing, labelled as "n.a.," or deviate substantially in string length from typical values. To avoid including erroneous models likely resulting from typos or reporting inconsistencies, we drop models with fewer than five registrations across the sample period. In instances where the same vehicle model appears with multiple fuel types, we retain the model if at least 80% of its registrations are associated with a single fuel type and exclude it otherwise. The final sample comprises 65.93 million new passenger car registrations, covering 215,395 distinct vehicle models offered across the EU. The largest shares of registrations come from Germany (27.0%), followed by France (18.0%), and Italy (14.4%).

Table 2 Descriptive statistics

Variable	Mean	SD	p1	p50	p99	Obs
CO ₂	123.91	51.84	0.00	132.00	236.00	65,854,414
Petrol	0.60	0.49	0.00	1.00	1.00	65,930,306
Diesel	0.24	0.43	0.00	0.00	1.00	65,930,306
Electric	0.09	0.28	0.00	0.00	1.00	65,930,306
Hybrid	0.04	0.21	0.00	0.00	1.00	65,930,306
LPG	0.02	0.15	0.00	0.00	1.00	65,930,306
Fuel consumption	5.30	1.57	0.80	5.40	9.00	33,245,370
Electric energy consumption	17.22	3.12	12.90	16.60	28.70	8,589,358

The table presents summary statistics of EU-wide new vehicle registrations. CO₂ reports the emissions in g/km, measured according to the WLTP testing procedure. *Petrol* (*Diesel*, *Electric*, *Hybrid*, *LPG*) is an indicator that equals one if the vehicle is petrol-powered (diesel-powered, ...), and zero otherwise. *Fuel consumption* (*Electric energy consumption*) is reported in liters per 100 km (kWh/100 km). The sample period covers 2018 to 2024. The data come from the EEA (2025b)

Table 2 presents descriptive statistics. The majority of vehicles in the sample are petrol-powered (60%), followed by diesel (24%), electric (9%), hybrid (4%), and LPG (2%) vehicles. The WLTP-based CO₂ emissions range from 0 g/km to 236 g/km, with an average of 124 g/km. The mean fuel consumption is 5.3 liters per 100 km, with hybrid vehicles being located on the left tail of the distribution.

CO₂ Emissions and Fuel Efficiency of New Cars Offered and Sold in the EU

We begin by examining the distribution of vehicles by fuel efficiency and CO₂ emissions, focusing on EU-wide registrations in the year 2024. Figure 2 differentiates between unique vehicle models available on the market (left-hand panels) and vehicle registrations (right-hand panels). By using unique vehicle models, we aim to capture the full range of vehicles available to consumers, while the total number of registrations captures the actual consumer choices given the available options. Panels A to D present the fuel economy for internal combustion engine vehicles (ICEVs) and plug-in hybrid electric vehicles (PHEVs). Panels E and F depict the distribution of electric energy consumption of PHEVs and EVs. Panels G and H show the CO₂ emissions of ICEVs and PHEVs; EVs are excluded from this panel as they do not produce direct CO₂ emissions.

A first striking observation is that nearly all distributions depicted in the left-hand panels of Figure 2 are right-skewed, indicating that each fuel type is associated with a long tail of less fuel-efficient or high-emitting vehicle models. Notably, EVs, which are always rated A in countries with CO₂-based car labels, vary considerably regarding electric energy consumption (Panel E). This highlights the need for distinguishing between high and low-energy-consuming EVs. Additionally, Panel G shows that it is primarily EVs and PHEVs that achieve or are below the EU's emissions target of 115.1 gCO₂/km for 2020–2024, while most ICEVs miss this target. The distributions on the right-hand side of Figure 2 reflect actual consumer choices and indicate that, on average, consumers purchase vehicles that consume less fuel and emit less CO₂ than the average model available in the market. In Table 3, we formally test for differences in means between the distributions of unique vehicle models and total registrations. The results indicate that, with the exception for electric energy consumption of diesel/electric hybrid vehicles, consumers tend to purchase more fuel-efficient—and therefore less CO₂ emitting—vehicles than the average offered. We interpret this finding as indicative evidence that consumers inform themselves about the fuel economy of their prospective vehicles. Therefore, car labels can serve as an important tool in enabling informed consumer decisions.

Next, we conduct a year-by-year analysis of the unique vehicle model distributions to better understand the market trends in the range of vehicle choices offered to consumers. Figures 3 and 4 report the annual distributions of fuel efficiency and CO₂ emissions, respectively, disaggregated by fuel type. Figure 3 reveals a gradual rightward shift in fuel consumption for petrol-, diesel-, and LPG-powered vehicles between 2021 and 2024, showing a gradual decline in fuel efficiency and consequent deterioration of CO₂ emissions. This indicates that manufacturers do not ultimately prioritise to offer more fuel-efficient vehicles and contrasts the previous findings where we show that consumers on average purchase more efficient models than those available on the market. As a result, consumers must expend

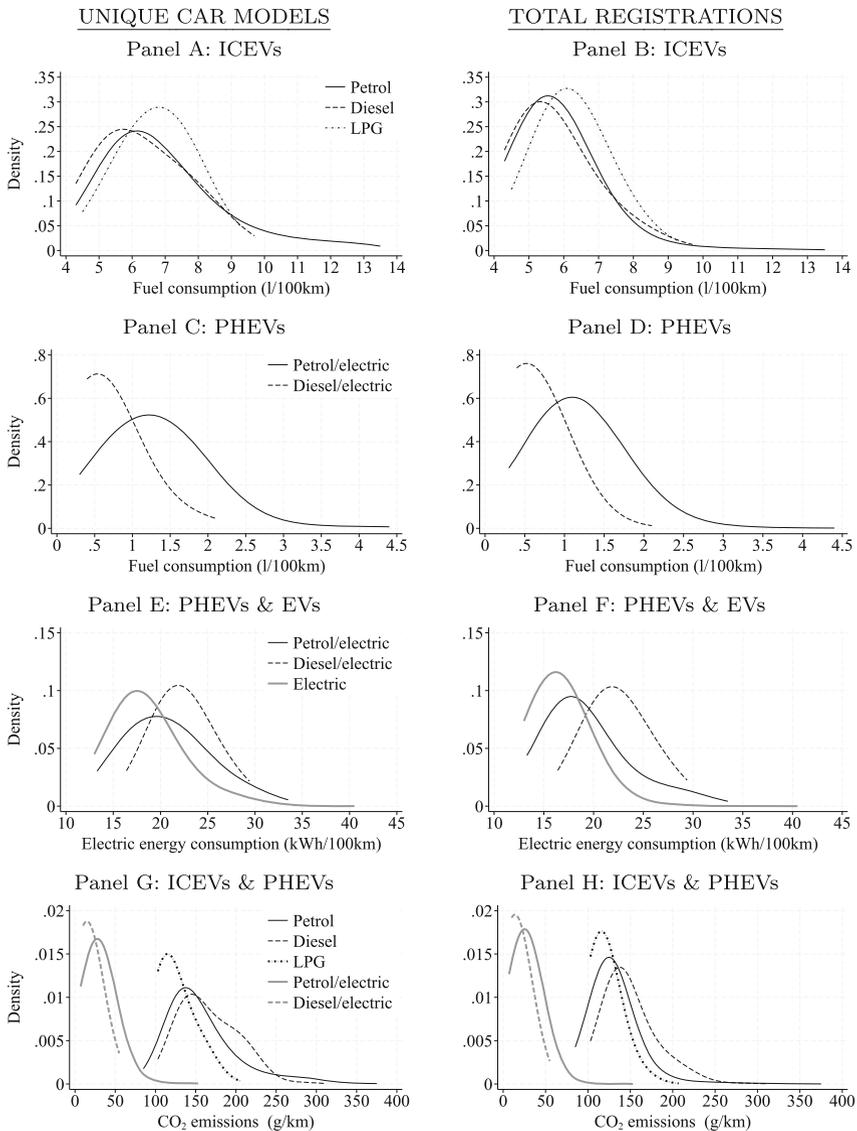


Fig. 2 Fuel efficiency and CO₂ emissions of passenger vehicles in the EU in 2024.

This figure depicts the Gaussian kernel density estimates of fuel efficiency and CO₂ emissions for unique vehicle models (left-hand panels) and total new vehicle registrations in 2024 (right-hand panels). A vehicle model is defined as a unique combination of the vehicles' (i) type approval number, (ii) type, (iii) variant, and (iv) version. The density estimates were smoothed by applying bandwidths 1 (Panels **A**, **B**), 0.5 (Panels **C**, **D**), 3 (Panels **E**, **F**), and 20 (Panels **G**, **H**). Panels **A** and **B** report the petrol consumption in l/100km for ICEVs, shown as a solid line; diesel consumption, depicted with a dashed line; and liquefied petroleum gas consumption, represented by a dot-dashed line. Panels **C** and **D** mirror Panels **A** and **B** but focus on PHEVs and battery use. Panels **E** and **F** report the energy consumption in kWh per 100 km for petrol- and diesel-powered PHEVs (solid and dashed lines) and pure electric vehicles (thick solid grey line). Panels **G** and **H** report the CO₂ emissions for all the above engine types, except for EVs, as they have direct tailpipe emissions of 0 gCO₂/km. The data come from EEA (2025a)

Table 3 Test for differences in distributions

	UNIQUE CAR MODELS			TOTAL REGISTRATIONS			T-stat	P-value
	Mean	SD	Obs	Mean	SD	Obs		
Panel A: Fuel consumption (l/100 km)								
Petrol	6.89	1.77	23,900	5.79	1.10	6,134,096	95.9	0.00
Diesel	6.28	1.22	17,669	5.69	1.02	1,546,022	64.1	0.00
LPG	6.74	0.90	293	6.24	0.72	318,633	9.5	0.00
Petrol/electric	1.30	0.62	3,492	1.15	0.47	696,540	13.6	0.00
Diesel/electric	0.62	0.33	482	0.54	0.18	44,121	5.4	0.00
Panel B: Electric energy consumption (kWh/100 km)								
Petrol/electric	20.69	4.17	3,410	19.23	3.93	677,908	20.4	0.00
Diesel/electric	22.43	2.48	482	22.44	2.48	44,121	-0.1	0.89
Electric	18.46	3.24	4,426	16.42	1.96	1,432,208	41.8	0.00
Panel C: CO ₂ emissions (g/km)								
Petrol	157.04	44.00	24,443	130.45	27.22	6,309,285	94.4	0.00
Diesel	165.32	34.00	18,037	148.96	28.52	1,585,406	64.4	0.00
LPG	123.56	19.86	304	118.64	12.75	319,675	4.3	0.00
Petrol/electric	29.59	15.38	3,492	26.09	10.74	696,540	13.4	0.00
Diesel/electric	16.10	8.34	482	14.13	4.41	44,121	5.2	0.00

The table presents the t-test results on the equality of means of unpaired data (unique vehicle models vs. total vehicle registrations) with unequal variances. The tests are conducted for fuel consumption (Panel A), electric energy consumption (Panel B), and CO₂ emissions (Panel C). The sample covers the year 2024. The data come from the EEA (2025a)

more effort in identifying fuel-efficient models. For petrol/electric vehicles, reductions in fossil fuel consumption appear to be offset by higher electric energy use (Panels D and F). In contrast, diesel/electric shows improvements in both fuel and electric energy consumption (Panels E and G). Also, the distribution mass for electric vehicles has shifted further to the left (Panel H), suggesting increased efficiency among newer EV models. Figure 4 focuses on CO₂ emissions over a longer period, from 2018 to 2024. The longer-term trend is positive, with the average CO₂ emissions being generally lower for newer vehicles. However, for the more recent years, we observe signs of stagnation or even slight reversal, confirming the findings in Figure 3, Panels A to C. In conclusion, we find substantial room for improvement in both future fuel and energy efficiency, as well as CO₂ emissions, across the whole EU car fleet.

Car Label Distributions for EU and National Car Fleets

We now turn to national car label distributions. Using the absolute CO₂ emission thresholds presented in Table 1, we assign each vehicle registered between 2021 and 2024 a national car label based on its emissions.¹⁶

¹⁶ Car labels that are based on fuel economy rely predominantly on relative thresholds, which are based on non-transparent and complex rating methodologies. We therefore abstain from running the same analysis for those labels.

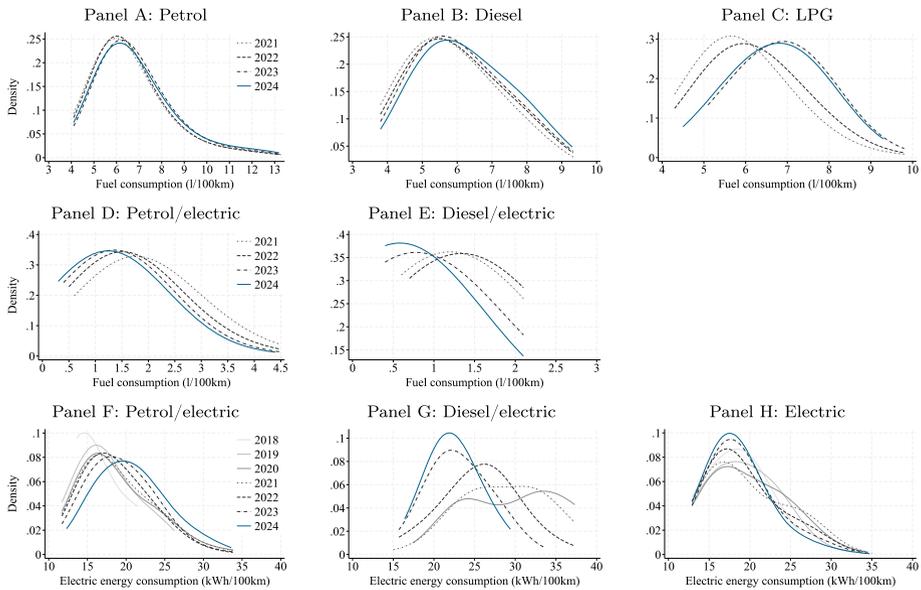


Fig. 3 Fuel efficiency over time.

This figure depicts the Gaussian kernel density estimates of unique vehicle models’ fuel efficiency. A vehicle model is defined as a unique combination of the vehicles’ (i) type approval number, (ii) type, (iii) variant, and (iv) version. The density estimates were smoothed by applying bandwidths 1 (Panels A to E) and 3 (Panels F to H). Panels A to E (F to H) report the fossil fuel (electric energy) consumption for the years 2021 to 2024 (2018 to 2024). The plots are based on new vehicle registrations in the EU. The data come from EEA (2025b)

Figure 5 presents the car label distributions of the national (dashed line) and the EU-wide car fleet (solid line) under the rating methodologies of the six countries with CO₂-based ratings. We observe that if the Austrian (Panel A) or German (Panel F) labelling methodology were applied across the EU, the majority of vehicles would be assigned a D rating or worse. The Belgian methodology (Panel B) seems to be more balanced, while the Bulgarian (Panel C), Estonian (Panel D), and the French (Panel E) labels are less penalising, with the majority of vehicles having a C-rating or better. The old German labelling methodology was similarly lenient (Panel F, long-dashed grey line), before it switched from a relative to an absolute rating approach in 2024.¹⁷ The French methodology seems to favour in particular its national car fleet, as indicated by the larger share of A- to C-rated vehicles compared to the European average. The higher proportion of F- and G-rated vehicles in the national fleets of Austria, Bulgaria, Estonia, and Germany suggests that consumers in these countries are more inclined to purchase vehicles with higher CO₂ emissions compared to the European average. These discrepancies highlight the need for a standardized European car labelling approach.

Negative Effects of Fragmented Car Labels

The legal and empirical fragmentation of car labels across the EU has negative impacts. A lack of harmonisation at the EU level leaves national legislators ample discretion for promoting

¹⁷ Pkw-EnVKV 2024.

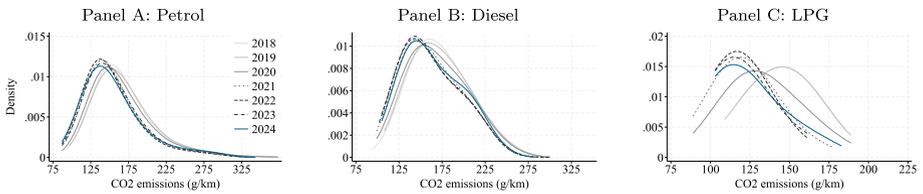


Fig. 4 CO₂ emissions over time.

This figure depicts the Gaussian kernel density estimates of unique vehicle models’ CO₂ emissions. The density estimates were smoothed by applying a bandwidth of 20. Panels A to C report the emissions of petrol-, diesel-, and LPG-powered vehicles for 2018 to 2024. The plots are based on new vehicle registrations in the EU. The data come from EEA (2025b)

the interests of their national car manufacturers, which runs the risk of resulting in regulatory capture at the national level. More generally, it creates market frictions for the EU’s single car market, which hampers both trade and financing.

Regulatory Capture at the National Level

Leaving the modalities and methodologies of car labelling to national legislators runs the risk of fostering regulatory capture. Regulatory capture describes the phenomenon of “subversion of regulatory agencies by the firms they regulate” (Posner, 2013). It results in regulators promoting the interests of industries instead of taming them (e.g., the car industry dominating the process that is supposed to regulate it). On some occasions, Member States have been found to create rules that deliberately privilege their national industries against foreign competitors. Such behaviour erects trade barriers threatening the EU’s single market and hampers fair competition between car manufacturers from different EU countries. The former German car label of 2011 provides an illustrious example (Pkw-EnVKV 2011). In addition to the absolute emission values of gCO₂/km and fuel consumption in l/100km, it contained a coloured label on “CO₂ efficiency” with eight scales from A+ to G. It adopted a relative labelling approach relating the CO₂ emissions to the car’s weight and treated heavier cars

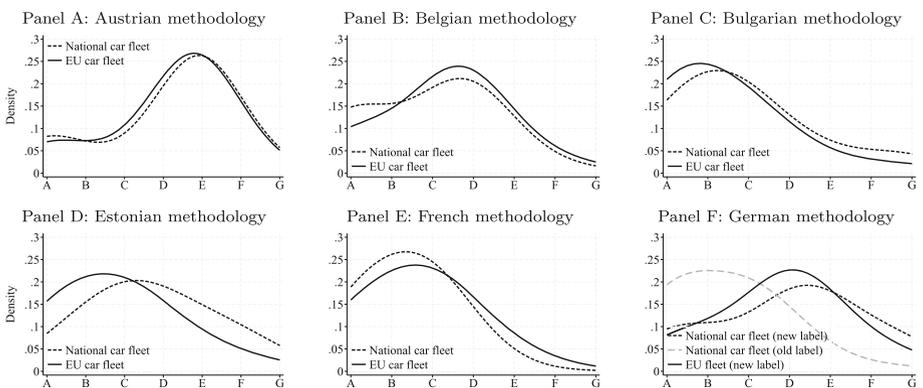


Fig. 5 CO₂ car label distributions using national labelling methodologies.

The figure depicts the Gaussian kernel density estimates of car labels, defined using the national CO₂ labelling methodologies (see Table 1). The labels are applied to passenger vehicles registered in the respective country (dashed line) and across the whole EU (solid line) between 2021 and 2024 (38.86 million vehicles in total). The data come from the EEA (2025b) database

preferentially. Given that German car manufacturers produce, on average, heavier cars with a particular focus on SUVs (Keil & Steinberger, 2024), this regime treated them preferentially against EU competitors. The preferential treatment for heavier cars in the EU's largest economy was introduced due to hefty lobbying by the German car industry, and the thresholds were intentionally chosen to include large parts of the German car manufacturers' fleets in the green categories as opposed to EU competitors. The German environmental NGO (Deutsche Umwelthilfe, 2013) brought this to light after seeking an information injunction that also involved the European Court of Justice (C-515/11). This former German regime is an early example of institutional greenwashing. While it was abolished and replaced by a solid and strict labelling regime based on absolute and comparatively strict thresholds that shows no longer signs of regulatory capture (Table 1 and Section "Disclosure of CO₂ Emissions and Consumption of Energy Source (basic label)"), it remains a remarkable example of the risk of regulatory capture at the national level (Meckling & Nahm, 2018). Given that regulatory capture can also arise at the EU level, the EU co-legislators would have to take into account this risk in the process of harmonising the car labels.

Market Frictions

Diverging national car labelling schemes create market frictions that raise entry costs, impact the functioning of the internal market, and complicate access to financial markets. Manufacturers seeking to enter the EU automobile market have to navigate a patchwork of national labelling rules, each with its own compliance mechanisms and documentation requirements. This regulatory heterogeneity increases compliance risks, which may materialise as penalties or delays in product introductions, and results in higher administrative burdens for both new entrants and incumbent players. Furthermore, the lack of harmonised information across Member States leads to suboptimal vehicle choices by consumers and sends mixed signals to manufacturers regarding the production of cleaner vehicles (European Commission et al., 2021). The complexity and lack of coordination also create opportunities for non-compliance. For instance, Scopa et al. (2016) find that over 50% of car advertisements studied fail to link fuel consumption and CO₂ emission data with specific car models and thus do not fully comply with the Car Label Directive.

Fragmented labelling also undermines the usefulness of car labels in the European financial market. The European auto asset-backed securities (auto ABS) industry is legally required to disclose environmental performance information on vehicles (i.e., car labels) financed by loans or leases.¹⁸ Despite this requirement, there does not yet exist an agreed-upon definition of a "green" auto ABS that takes into account the greenness of the underlying collateral. Therefore, investors, such as mutual funds, who have to report sustainability risks in compliance with the Sustainable Finance Disclosure Regulation,¹⁹ face the challenge of identifying and using sustainability-related metrics for their auto ABS investments. A straightforward solution would be using the car labels from the loan-level data. However, due to their inconsistencies across countries, car labels are currently being disregarded for credit or climate risk analyses.²⁰ A single meaningful standard for European car labels would provide an important element for creating a standardized European green auto ABS. Next to

¹⁸ Regulation (EU) No. 2017/2402 and the loan-level data template Annex 5, data field AUTL57, "Energy Performance Certificate Value" of the European Securities and Markets Authority.

¹⁹ Articles 6, 8, and 9 of Regulation (EU) 2019/2088.

²⁰ In their replies to ESMA's public consultation on changes to the securitisation disclosure templates (ESMA12-2121844265-3053) associations representing the banking, securitisation, and insurance industry

mutual funds, further users of vehicle-related sustainability information are banks, insurance companies, rating agencies, the Eurosystem, and scholars (e.g., André et al., 2022; Panizza et al., 2022). They all depend on a standardized definition of the European car label to calculate sustainability metrics, perform credit and climate risk analyses, or evaluate the effectiveness of these labels across the EU.

Options for a Single EU Car Label

Although there are limits to labelling methods and “in some circumstances the most environmentally sustainable option is no purchase at all” (Horne, 2009, p. 181), our findings argue in favour of a standardized car label that uniformly applies in all EU Member States. Similarly, a large proportion of stakeholders supported the harmonisation of the car label in the consultation conducted by European Commission et al. (2021). To reform the car labelling regime, a new regime needs proper legal ramifications, i.e., an appropriate legal basis, a legal act that fits the purpose, and is suitable for monitoring and supervision. In the Appendix, Table 8, we outline different legal options for introducing a new car label. We suggest to follow the example of EU energy-efficiency labels and delegate the power to adopt the specific thresholds and requirements of the EU-wide label to the European Commission (EC) by means of a delegated regulation.

Lessons from EU Energy-Efficiency Labels for Household Appliances

Consumers face similar decisions when purchasing a car or major household appliances (e.g., fridges). Although cars are more expensive than most household appliances, they both need a lot of energy and impact the energy/fuel bill of households, which is why they have been subject to comparison in marketing and energy research (e.g., Newman and Staelin, 1972; Ramakrishnan et al., 2020). Hence, car labels could be inspired by the EU energy-efficiency labelling regime for household appliances that offer consumers direct insight into the energy efficiency and consumption of specific products. These labels have proven successful at informing consumers and steering their choices towards more energy-efficient products (Section “[Introduction](#)”).

Effectiveness of Energy-Efficiency Labels Under Regulation (EU) 2017/1369

Regulation (EU) 2017/1369 lays down the current framework for labelling energy-related products according to their energy efficiency, energy consumption, and use of other resources to allow consumers to choose more efficient products in order to reduce their energy consumption. This labelling regime only applies to new (not second-hand) products and does not apply to means of transport for persons or goods.²¹ Manufacturers and importers (suppliers) must ensure that each product placed on the market is accompanied by accurate printed labels and product information sheets free of charge.²² Dealers have to display the label provided by

(10 in total) ask for a removal of the car label since it “can be misleading and unhelpful” (reply of Joint Associations, p. 15).

²¹ Article 1(2) Regulation (EU) 2017/1369.

²² Articles 3(1), 2(14) Regulation (EU) 2017/1369.

the supplier in a visible manner, including for online distance selling, and make the product information sheet available to customers.²³

The energy labels under Regulation (EU) 2017/1369 are graphic diagrams with a closed scale using letters A to G, each letter representing a class and each class corresponding to energy savings, in seven different colours from dark green to red, in order to inform customers about energy efficiency and energy consumption.²⁴ The EC determines the specificities of each label and the product to which it applies in delegated acts.²⁵ The current energy labelling regime covers the household appliances listed in the Appendix Table 6. Some of the labels have replaced and rescaled previous labels under Directive 2010/30/EU, while other labels continue to exist under the previous regime of Directive 2010/30/EU and have not yet been modified or updated under the new regime (see Appendix Table 7)

Label Review and Rescaling in Light of Technological Progress

The energy-efficiency labels' information value over time depends on technological progress, and hence needs to be updated regularly. Directive 2010/30/EU mandated the EC to review the classification based on evidence that its information value becomes obsolete because a significant proportion of the respective products is categorised in the two highest energy efficiency classes.²⁶ Some delegated regulations require the EC to review the technological progress at the latest after five years.²⁷ Some labels have been gradually tightened and first rescaled to a scale ranging from A+ to F, then to a scale ranging from A++ to E, and then to a scale ranging from A+++ to D. This applies to air conditioners whose label was rescaled every two years between 2013 and 2019.²⁸ Other products, including space heaters that use boilers, cogeneration, or heat pumps, as well as low-temperature heat pumps, initially adopted a nine-ladder scale ranging from A++ to G. This scale was later condensed to range from A+++ to D.²⁹

The new regime under Regulation (EU) 2017/1369 established a product database held by the EC to conduct market surveillance on evolving energy efficiency data (Berwald et al., 2019).³⁰ Regarding periodic review and rescaling, it seeks a standardized approach to existing and new labels. Labels that continue under the previous regime are meant to be harmonised consistently with the new ones on a scale from A to G.³¹ Technological progress is supposed to lead to rescaling once the EC estimates that either 30% of the respective products fall in the top category A or 50% of the products fall into the top two categories A and B.³² This development aligns with research indicating that shorter scales are more effective in influencing consumer product choices (Waechter et al., 2016).

²³ Article 5(1) Regulation (EU) 2017/1369.

²⁴ Article 2(14) Regulation (EU) 2017/1369.

²⁵ Article 16(1) Regulation (EU) 2017/1369.

²⁶ Article 10(4) para. 4 Directive 2010/30/EU.

²⁷ Article 7 Commission Delegated Regulation (EU) No 626/2011.

²⁸ Article 3(4) and Annex III Commission Delegated Regulation (EU) No 626/2011.

²⁹ Article 3 and Annex III Commission Delegated Regulation (EU) No 811/2013.

³⁰ Article 12 Regulation (EU) 2017/1369.

³¹ Article 11(5) Regulation (EU) 2017/1369.

³² Article 11(6) Regulation (EU) 2017/1369.

Lessons for Car Labels

The EU energy efficiency labels exemplify a successful energy-related consumer information tool and can serve as a role model for unified EU car labels. Cars are, in fact, an outlier compared to household appliances. While energy labels are unified across Europe and offer the exact same information to all EU consumers, car labels diverge starkly between Member States (Section “[Regulatory Fragmentation of European Car Labels](#)”). An energy label is a well-known feature that informs various consumer purchase decisions across the EU. In addition, their regulatory governance provides a solid framework that could inspire EU car labels. The delegation of rule-making power to the EC via delegated acts could prove equally effective in the context of car labels (Table 8). Similarly, a periodic label review and rescaling process would make sure that the label does not stagnate against an evolving market and steers towards the more ambitious products.

Scope of Application: New and Second-Hand Cars and Vans

Broad coverage across all Member States would increase the effectiveness of the car label. It could also cover newly registered vans, albeit with different thresholds in light of their fleet-wide CO₂ emission targets. The label would further gain relevance if the scope was extended to second-hand cars.³³ As the average CO₂ emissions from new passenger cars in the EU have declined over the past two decades (EEA, 2024), second-hand cars emit, on average, more CO₂ than new cars. However, this is only the average, and comparing individual new and second-hand cars can produce different results. Fuel efficiency shows slightly different results. While the average fuel consumption of cars in the EU declined steadily between 1990 and 2012, it rose again from 2013 onwards (EEA, 2019). Our analysis of vehicles registered in 2021 to 2024 supports this finding: There is a rightward shift of the fuel consumption distributions for both petrol and diesel cars over the years 2021 to 2024 (Fig. 3, Panels A and B). Hence, even on average, second-hand cars are not necessarily less fuel-efficient than new ones. This argues in favour of applying the same scales to new and used cars and introducing two mandatory colour-coded scales for CO₂ emissions and fuel/energy efficiency to enhance comparability (Section “[Two Coloured Scales \(A to G\) for CO₂ Emissions and Fuel Efficiency \(coloured label\)](#)”). Another important element is the type of setting in which the car label must be used in terms of use modalities. The label’s effectiveness would be increased if the label were displayed in all offline and online settings where cars or vans can be purchased, leased, or rented. In addition, it could be included in the product descriptions on the manufacturers’ websites. These measures would secure the interested buyers’ exposure to the label.

Disclosure of CO₂ Emissions and Consumption of Energy Source (basic label)

Similar to the current regime, the label could be based on absolute measures for the vehicle’s combined CO₂ emissions in g/km and the combined consumption of the respective energy source in l/100 km (for petrol, diesel and LPG vehicles), kg/100 km (for gas and hydrogen-

³³ According to European Commission et al. (2016), car labels cover used vehicles in Finland and the UK.

powered vehicles), or kWh/100 km (for EVs). In the case of PHEVs, the label could list the consumption rates in both modalities. This would add information for EVs and PHEVs compared to the current regime. In addition to the overall combined fuel consumption, the label could state the vehicle's consumption in four different modalities of use, i.e., within cities, on city outskirts, country roads, and highways, which follow the four WLTP test phases "low," "medium," "high," and "extra high" under Regulation (EU) 2017/1151. This would give consumers a better understanding of the vehicle's specific fuel consumption, depending on their prevalent vehicle use. The label could further state the average range in EVs' all-electric modality and the equivalent all-electric range for PHEVs. The latest German car label, effective since May 2024, and the Canadian EnerGuide label give valuable examples for including such comprehensive information.³⁴ In addition, labels could be equipped with Quick Response (QR) codes that link to interactive tools, enabling consumers to calculate fuel costs and emissions based on their individual driving patterns (ANEC and BEUC, 2014). These tools could help raise awareness about a vehicle's real-world emissions and air pollution. Cleaner air brings substantial societal benefits, including improved public health, increased workforce productivity, and reduced healthcare costs (WHO, 2013). While causal evidence on the air quality effects of car label policies is still lacking, the broader environmental benefits of low-emission vehicles are well documented. Empirical studies show that increased adoption of such vehicles has contributed to measurable improvements in air quality in countries like China (Liang et al., 2019), Italy (Ferrero et al., 2016), Spain (Soret et al., 2014), and the United States (Filigrana et al., 2022; Tessum et al., 2014).

Two Coloured Scales (A to G) for CO₂ Emissions and Fuel Efficiency (coloured label)

The range of different vehicle models on European roads varies considerably in terms of fuel and electricity consumption and CO₂ emissions, with some models being significantly more efficient or less emitting than others (Fig. 2). As Figure 2 shows heterogeneous distributions of fuel efficiency within all fuel types and heterogeneous distributions of CO₂ emissions within all fuel types except for purely electric vehicles, there should be a dedicated label of fuel efficiency and CO₂ emissions per fuel type. To make both transparent to consumers, we propose a coloured label with two colour-coded scales linked to empirical data and regulatory requirements, one for fuel efficiency and one for CO₂ emissions to compare different vehicles more easily. This could build on existing energy-efficiency labels (Section "Lessons from EU Energy-Efficiency Labels for Household Appliances") and have a seven-scale letter grading and follow an absolute instead of a relative approach because it is less likely to confuse consumers (Section "Absolute Versus Relative Values"). Although a price premium was documented only for A-rated vehicles (Alberini et al., 2016), which suggests that consumers might be unable to process the entire A to G rating scale in a graded manner, car labels influence consumer choices towards eco-friendlier cars. In the Appendix, we discuss options for both scales in depth.

Crucial Cost Information for Consumers: Expected Lifetime Cost

Vehicle ownership is one of the largest recurring expenses for most households (Gössling et al., 2022; Liu & Kontou, 2022). Consequently, consumers should care about the lifetime cost when purchasing a car and would likely benefit from the inclusion of such costs in the

³⁴ See Annex I Pkw-EnVKV 2024 (German label), [vehicles.nrcan.gc.ca](https://www.vehicles.nrcan.gc.ca) (Canadian label).

car label. Studies on the effect of providing lifetime energy cost information for households appliances are mixed. On the one hand, monetary information on energy consumption can facilitate consumer understanding of the technical data reported (de Ayala & Solà, 2022). In particular, presenting lifetime cost information has been shown to increase consumer demand for energy-efficient appliances (Andor et al., 2019), and there are proposals to using a “10-year energy cost” label as an effective approach to increase energy-efficient choices (Hardisty et al., 2020). On the other hand, Kallbekken et al. (2013) find that provision of lifetime energy cost information is only effective under certain conditions, notably when energy costs are high and the information is being presented to customers by trained sales staff. Also, Carroll et al. (2016) do not find a statistically significant sales effect of providing pure consumption cost information. Evidence on the positive effect of cost information is clearer for goods with high energy costs, such as buildings. Carroll et al. (2024) find that when prospective buyers are shown explicit monetary estimates of energy costs, demand shifts markedly toward more energy-efficient buildings. Similarly, vehicle labels that present fuel costs or future fuel-saving information—rather than fuel consumption—tend to increase consumers’ willingness to pay for higher fuel efficiency (Brazil et al., 2019; Camilleri & Larrick, 2014; Codagnone et al., 2016). The reason being that consumers are often poorly informed about and inattentive to fuel economy (Allcott & Knittel, 2019; Turrentine & Kurani, 2007). Also, information on tax savings and annual costs seems to positively impact consumers’ vehicle choices according to surveys with participants from Germany, Ireland, Italy, the Netherlands, Spain, the UK, the Czech Republic, and Lithuania (Folkvord et al., 2020).

However, consumers face difficulties determining vehicle-related costs, as many are hidden. There are different approaches to comparing the vehicles’ estimated lifetime costs (Furch et al., 2022). One of the main cost components is the cost of the energy used to propel the vehicle. The standardized label could potentially include information on the average cost of fuel/energy for an average annual mileage (e.g., 10,000 km) in the past year. In addition, it could state the applicable national vehicle tax. Both elements differ across countries, so the EU regime could require Member States to monitor and disclose such cost information. Additional information could be the expected CO₂ price for the future. While the current EU emissions trading system (ETS1) applies to the CO₂ emissions of electricity generation and some other energy-intensive industry sectors,³⁵ the new emissions trading system (ETS2) will cover road transport and fuel from 2027 onwards.³⁶ Thus, future CO₂ prices will strongly affect petrol and diesel prices over a vehicle’s lifetime.

In some EU countries, the coloured car labels inform consumers about the cost of the propellant for a specific mileage. In Estonia, the label has to state the fuel costs for 10,000 km.³⁷ In Germany, the labelling regime mandates five energy-specific labels for (i) petrol-, diesel- and LPG-fuelled, (ii) gas-powered, (iii) electric, (iv) plug-in hybrid, and (v) fuel cell cars that include two cost elements. First, labels have to state the average cost of the respective energy used to propel the car for 15,000 km in the preceding year as monitored by the Federal Ministry for Economic Affairs and Climate Action. Second, these energy-specific car labels also give estimates about the future cost of CO₂ emissions under three scenarios (low,

³⁵ Directive 2003/87/EC.

³⁶ Directive 2003/87/EC as amended by Directive (EU) 2023/959 and Regulation (EU) 2024/795.

³⁷ Section 6(4) no. 6 Uue mootorsõiduki kasutajale antavate andmete loetelu ja kasutaja teavitamise kord, Vastu võetud 18.11.2016 nr 53.

medium, high) to make consumers aware of the expected extra costs of fossil fuels in the future.³⁸ Both the Estonian and the German labels have to be updated on a yearly basis.³⁹ A standardized EU car label could follow these national examples and create cost-related transparency at the EU level, with a single database for all cost information that could be administered by the EEA.

Conclusion

This study shows that consumers in different EU countries see very different car labels when purchasing a new car. Our research identifies a substantial fragmentation of (coloured) car labels within the EU, stemming from divergent national implementations of the Car Label Directive. These differences include a varying focus on either CO₂ emissions or fuel economy, application of relative or absolute rating methodologies, and use of different thresholds among countries applying the same methodology.

Our empirical analysis of new passenger vehicle registrations across the EU reveals that consumers typically opt for more fuel-efficient models among available options. This finding implies that consumers dedicate time and effort to examining technical vehicle specifications, a process that could be facilitated with a well-designed, standardized EU-wide car label. In contrast, we find a slightly decreasing average fuel efficiency of fossil-fuel-powered vehicles over the past years. This suggests that vehicle manufacturers do not ultimately prioritise offering increasingly fuel-efficient models over time, so consumers may have to expend more effort to identify efficient models.

We propose to reform the current car labelling framework by drawing insights from the adoption of energy efficiency labels for electric household appliances. Our recommendation includes the introduction of a standardized, EU-wide label featuring two coloured rating scales based on absolute values for CO₂ emissions and fuel efficiency. We also discuss potential supplementary features for the label, such as information on the national vehicle taxes, the previous years' average national price of relevant energy sources (fuel or electricity), and expected future CO₂ prices.

³⁸ Annex I Pkw-EnVKV 2024.

³⁹ Section 11(2) Pkw-EnVKV 2024; Section 6(5) Uue mootorsõiduki kasutajale antavate andmete loetelu ja kasutaja teavitamise kord, Vastu võetud 18.11.2016 nr 53.

Appendix for “Reforming EU Car Labels: How To Achieve Consumer-Friendly Transparency?”

This appendix contains supplementary materials for the article titled “Reforming EU Car Labels: How To Achieve Consumer-Friendly Transparency?”

Proposal for Two Coloured Scales for CO₂ Emissions and Fuel Efficiency

Reasons for Two Scales

Given that CO₂ emissions and fuel economy are two pieces of information that matter to consumers, we suggest to visualise both elements in their own scale. While CO₂ emissions and fuel economy matter equally under the Car Label Directive, a single colour code focuses consumer attention only on one of the two elements. Six out of ten EU countries with coloured labels focus on CO₂ emissions, and four on fuel consumption (Section “[Fuel Consumption Versus CO₂ Emissions](#)”). The display of one colour code for CO₂ emissions and another for fuel/energy efficiency would help consumers disentangle the two elements and make an informed decision based on both. The colour code for energy efficiency is also important to better compare EVs and PHEVs. While EVs can be graded A regarding direct CO₂ emissions, their energy efficiency varies considerably across car models. To help consumers compare the energy efficiency of electric vehicles and the fuel efficiency of petrol and diesel cars, the label should include a specific colour-coded scale for energy/fuel efficiency based on absolute values. The ranking could be based either on a comparison within the vehicle group based on engine type (i.e., EVs with EVs)⁴⁰ or between vehicle groups (i.e., EVs with ICEVs). A comparison between vehicle groups could strengthen consumers’ awareness of a vehicle’s overall energy efficiency, where EVs currently seem to outperform ICEVs (IEA, 2024, p. 149). However, comparing different engine types regarding energy efficiency risks creating confusion among consumers about the point of comparison. Hence, regarding fuel efficiency, we propose a comparative ranking within vehicle groups based on empirical data from the EEA on the fuel efficiency of different engine types.

Thresholds of Colour-Coded Scale For Fuel Economy

As there is no mandatory fuel economy target in the EU, the colour-coded scale for fuel economy could be aligned with the latest empirical evidence from newly registered cars in the EU. Figure 6 illustrates this. The fuel economy label has different units depending on the vehicle’s fuel type. The reference point for the D rating is the median fuel consumption of unique vehicle models registered in the EU in 2024 (Fig. 2 Panels A, C, and E). The choice of the median value of the fuel efficiency distribution incentivises manufacturers to improve future car models’ fuel/energy efficiency. Starting from D, the absolute thresholds for the remaining six rating categories could be based either on pre-defined bin widths for each rating class or on percentiles of the empirical distributions.⁴¹ For the remainder of this study,

⁴⁰ Weiss et al. (2024) propose various options for categorising EVs according to their energy efficiency in a car label (A to G).

⁴¹ For instance, a bin width of 1l/100km would imply the following rating thresholds for petrol-fueled vehicles: A = [0–3.9); B = [3.9–4.9); C = [4.9–5.9); D = [5.9–6.9); E = [6.9–7.9); F = [7.9–8.9); G = [8.9 and above). If equidistant percentiles (with a distance of 1/7) were applied the density in Figure 2 Panel A, the thresholds for petrol-fueled vehicles would be the following: A = [0–4.3); B = [4.3–5.5); C = [5.5–5.8); D = [5.8–6.4); E = [6.4–7.1); F = [7.1–8.3); G = [8.3 and above).

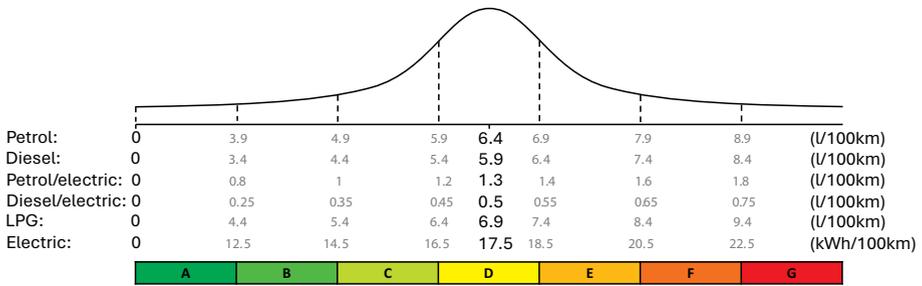


Fig. 6 Fuel and electricity economy.

This figure reports the median value of fuel and electricity efficiency for all vehicle models registered in the EU in 2023, suggested to fall under rating D. The authors’ proposed rating thresholds are presented in italicized grey font. Source: Own calculations, EEA (2025b)

we propose a predefined fixed bin width for each fuel type. The resulting rating thresholds are indicated in italics in Figure 6. To account for the general technological progress and, therefore, increases in efficiency, the thresholds could be updated regularly based on empirical data. This could be done using the EEA data for vehicles registered in the previous year. The process could follow the model of energy efficiency labels for household appliances (Section “Label Review and Rescaling in Light of Technological Progress”) by mandating a rescaling once 30% of cars fall into category A or 50% fall into categories A and B.

Thresholds of Colour-coded scale for CO₂ Emissions to Follow EU’s Decarbonisation Targets

Like the fuel economy label, the CO₂ emissions label should be time-varying. However, instead of using historical values, we suggest aligning the label’s thresholds with the EU’s average CO₂ goals for newly registered vehicles in the EU. These targets are 93.6 gCO₂/km for cars and 153.9 gCO₂/km for vans in 2025–2029, 49.5 gCO₂/km for cars and 90.6 gCO₂/km for vans in 2030–2034.⁴² From 2035 onwards, only cars and vans emitting 0 gCO₂/km will be registered.⁴³ Figure 7 illustrates the coloured labelling scale for cars. The mandatory average of CO₂ emissions should constitute the midpoint of category D in the relevant time period. At the same time, the thresholds for the rating classes could be based on a combination of pre-defined bin widths and additional requirements, such as A being assigned exclusively to zero-emission vehicles.⁴⁴ For illustration purposes, we propose a bin width of 20 gCO₂/km, which lies in the range of bin widths used by the Member States in Table 1. The resulting rating thresholds for the period 2025–2029 are indicated in italics in Figure 7. It is advisable to apply this label to second-hand vehicles to raise prospective buyers’ awareness of the extent to which the vehicle is aligned with the EU’s emissions targets.

⁴² Annex II Part A and B Commission Implementing Decision (EU) 2023/1623.

⁴³ Article 1 (5a)(a) Regulation (EU) 2019/631 as introduced by Article 1(1)(b) Regulation (EU) 2023/851.

⁴⁴ For instance, the CO₂ thresholds for cars in the period 2025–2029 could be based on bin width of 10 gCO₂/km for category D and lower, with A being reserved for zero-emission vehicles, and the remaining CO₂ range being distributed equally between B and C. This procedure would yield the following CO₂ thresholds: A = [0]; B = (0–44.3]; C = (44.3–88.6]; D = (88.6–98.6]; E = (98.6–108.6]; F = (108.6–118.6]; G = (118.6 and above].

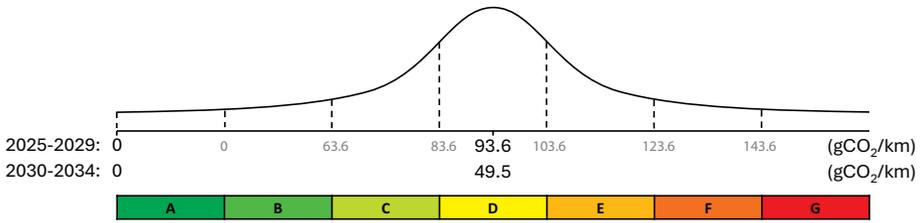


Fig. 7 CO₂ emissions according to decarbonisation targets.

This figure reports the EU’s mandatory car fleet CO₂ emission targets, suggested to fall under rating D. The authors’ proposed rating thresholds are presented in italicized grey font for the period 2025–2029. Source: Annex II Part A and B Commission Implementing Decision (EU) 2023/1623

Application of the Proposed Fuel and CO₂ Car Labels on the EU Car Fleet

We apply the proposed thresholds for fuel economy and CO₂ emissions, (Figs. 6 and 7) to about 28.85 million passenger vehicles registered in the EU between 2021 and 2023. The resulting rating distributions are presented in Figure 8. We observe that if the label were based on the 2025–2029 EU emissions targets, the majority of vehicles would receive a D rating or lower for CO₂ emissions. Notably, the proposed labelling scheme shifts the distribution of the car fleet similarly to the right, as under the application of the current Austrian or German methodologies (see Fig. 5, Panels A and F). In contrast, our proposed fuel economy ratings generate a right-skewed distribution, with most vehicles falling within the B to D range.

Additional analyses reveal that among the 12.3% of vehicles with an A rating for CO₂ emissions, approximately 35% are rated D or lower for fuel economy (see Table 4). This finding confirms the need to improve the transparency regarding both CO₂ emissions and fuel economy. We further analyse the rating distributions across individual countries and observe a distinct divergence between Eastern and Western Europe for the CO₂ label (see Figs. 9 and 10). In Western European countries (e.g., AT, BE, DK, FI, FR; IE, LU, MT, NL, SE), a sizeable portion of vehicles fall into the A and B rating categories. In contrast, Eastern European countries (e.g., CZ, EE, ES, HR, HU, PL, SI, SK) predominantly rely on ICEVs, which are rated between E and G. This highlights that there is a considerable potential for reducing emissions in these countries by providing consumers with information about vehicle emission levels that is easy to understand.

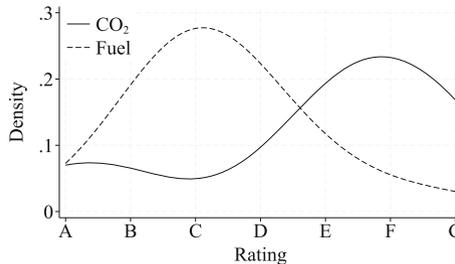


Fig. 8 EU car fleet distribution under the proposed labels.

This figure depicts the rating distributions for the EU car fleet under the two proposed labelling systems: The CO₂-based car label (represented by a solid line) and the fuel-efficiency car label (dashed line). It includes 38.86 million passenger vehicles registered in the EU between 2021 and 2024. The rating thresholds for the CO₂ emissions (2025–2029) and the fuel economy come from Figures 7 and 6, respectively. Source: Own calculations, EEA (2025b)

Table 4 Distribution of standardized car labels across the EU

		CO ₂ emissions							Total
		A	B	C	D	E	F	G	
Fuel economy	A	0.2	0.6	0.0	0.7	0.5	0.1	0.0	1.9
	B	2.5	0.6	0.0	2.6	8.5	2.1	0.2	16.4
	C	5.7	1.4	0.0	0.1	14.9	21.5	1.5	45.2
	D	3.0	1.3	0.0	0.0	0.5	6.0	10.4	21.1
	E	0.7	1.3	0.0	0.0	0.9	0.3	4.6	7.9
	F	0.3	0.6	0.0	0.0	0.0	0.0	2.2	3.1
	G	0.3	2.1	0.2	0.0	0.0	0.0	1.7	4.4
Total		12.7	7.8	0.2	3.4	25.3	30.0	20.6	100

The table reports the relative distribution of the two proposed car labels for CO₂ and fuel economy for 38.86 million new passenger vehicles registered in the EU between 2021 and 2024. The rating thresholds for the CO₂ emissions (2025–2029) and the fuel economy come from Figures 7 and 6, respectively. Source: Own calculations, EEA (2025b)

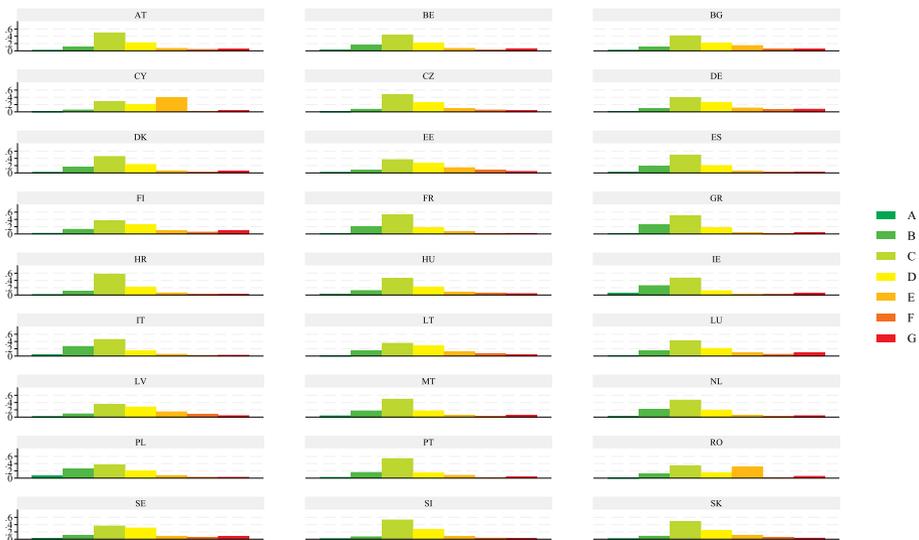


Fig. 9 Car label distribution under the proposed fuel economy label.

The figure depicts the rating distribution of the national car fleets in EU Member States under the proposed fuel economy label. The underlying vehicles represent new passenger vehicles registered between 2021 and 2024. The rating thresholds come from Figure 6. Source: Own calculations, EEA (2025b)

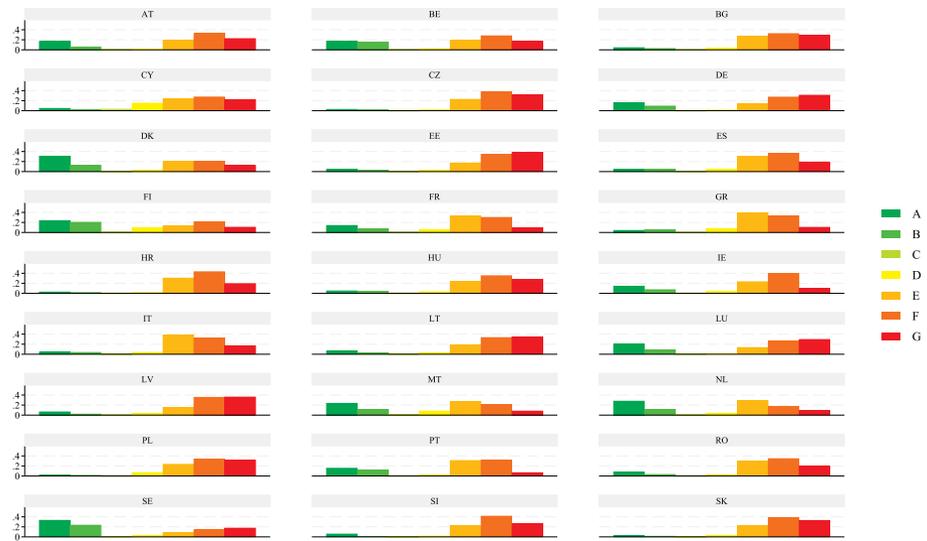


Fig. 10 Car label distribution under the proposed CO₂ label for 2025–2029. The figure depicts the rating distribution of the national car fleets in EU Member States under the proposed CO₂ label for 2025–2029. The underlying vehicles represent new passenger vehicles registered between 2021 and 2024. The rating thresholds come from Figure 7. Source: Own calculations, EEA (2025b)

Table 5 National car label legislations

Country	National regulation	Source
AT	Änderung der Personenkraftwagen-Verbraucherinformationsverordnung 2018 – Pkw-VIV 2018	Link
BE	Arrêté royal modifiant l'arrêté royal du 5 septembre 2001 concernant la disponibilité d'informations sur la consommation de carburant et les émissions de CO ₂ à l'intention des consommateurs lors de la commercialisation des voitures particulières neuves	Link
BG	Наредба за изискванията за етикетирание на нови пътнически автомобили и за предоставяне на информация относно разхода на гориво и на емисиите на въглероден диоксид	Link
CY	ΚΔΠ 622/2003, Το Περί Εμπορικών Περιγραφών (Ενεργειακός Οδηγός - Επιβατηγά Αυτοκίνητα) Διάταγμα 2003, ΕΕ Παρ.ΙΙΙ(1), Αρ. 3739, Σελ. 3643, 25/7/2003	Link
CZ	Vyhledka o náležitostech informačních štítků a plakátů s údaji o spotřebě pohonných hmot a emisích CO ₂ při prodeji nových osobních vozidel	Link
DE	Zweite Verordnung zur Änderung der Pkw-Energieverbrauchskennzeichnungsverordnung	Link
DK	BEK nr 655 af 20/06/2012 - Bekendtgørelse om energimærkning m.v. af nye person- og varebiler	Link
EE	Uue mootorsõiduki kasutajale antavate andmete loetelu ja kasutaja teavitamise kord	Link
ES	Real Decreto 837/2002, de 2 de agosto, por el que se regula la información relativa al consumo de combustible y a las emisiones de CO ₂ de los turismos nuevos que se pongan a la venta o se ofrezcan en arrendamiento financiero en territorio español	Link
FI	Valtioneuvoston asetus autojen polttoaineenkulutuksen ja hiilidioksidipäästöjen ilmoittamisesta	Link
FR	Arrêté du 10 avril 2003 relatif à l'information sur la consommation de carburant et les émissions de dioxyde de carbone des voitures particulières neuves ΚΥΑ 90364_2002 (ΦΕΚ 110_Β_31.01.2002) - Πρόγραμμα ενημέρωσης και παροχής πληροφοριών προς τους καταναλωτές σχετικά με την οικονομία καυσίμου και τις εκπομπές CO ₂ των προς εμπορία νέων επιβατηγών αυτοκινήτων	Link
GR	καυσίμου και τις εκπομπές CO ₂ των προς εμπορία νέων επιβατηγών αυτοκινήτων	Link Link
HR	Pravilnik o dostupnosti podataka potrošačima o službenoj potrošnji goriva i službenim specifičnim emisijama CO ₂ novih osobnih vozila	Link
HU	12/2002. (III. 14.) GM-KöViM-KöM együttes rendelet az új személygépkocsik üzemanyag-gazdaságosságai és szén-dioxid-kibocsátási adatainak közzétételéről	Link
IE	S.I. No. 339/2001 - European Communities (Consumer Information on Fuel Economy and Co ₂ Emissions of New Passenger Cars) Regulations, 2001	Link

Table 5 continued

Country	National regulation	Source
IT	Decreto del presidente della Repubblica 17 febbraio 2003, n. 84, in materia di Attuazione della direttiva europea in tema di dati consumi carburanti ed emissione CO2	Link
	Dėl Lietuvos Respublikos aplinkos ministro 2003 m. spalio 8 d. įsakymo Nr. 493 „Dėl Informacijos apie degalų taupymą ir išmetamųjų CO2 dujų kiekį pateikimo vartotojams parduodant naujus keleivinius automobilius tvarkos patvirtinimo“ pakeitimo	Link
LT		Link
LU	Règlement grand-ducal du 6 avril 2001 concernant la disponibilité d'informations sur la consommation de carburant et les émissions de CO2 à l'intention des consommateurs lors de la commercialisation des voitures particulières neuves	Link
	Ministru kabineta 2004. gada 20. jūlija noteikumi Nr. 608 "Noteikumi par marķējuma un reklāmas publikācijās patērētājiem sniedzamo informāciju par jaunu vieglo automobiļu degvielas patēriņu un CO2 izplūdi".	Link
LV		Link
MT	Availability of Consumer Information on Fuel Economy and Carbondioxide Emissions in respect of the Marketing of New Passenger Cars Regulations	Link
NL	Besluit etikettering energiegebruik personenauto's	Link
PL	ROZPORZĄDZENIE MINISTRA GOSPODARKI I PRACY z dnia 28 grudnia 2004 r. w sprawie produktów objętych obowiązkiem zaopatrzenia w informacje istotne z punktu widzenia ochrony środowiska	Link
PT	Decreto-Lei n.º 304/2001, de 26 de novembro	Link
RO	HOTĂRÂRE nr. 343 din 18 martie 2004 privind furnizarea informațiilor referitoare la consumul de carburant și emisiile de CO(2) ale autoturismelor noi, destinate comparatorilor la comercializare	Link
	Proposition 2023/24:55 Information om bränsleförbrukning och koldioxidutsläpp vid marknadsföring av nya personbilar	Link
SE	KOVFS 2018:3 Konsumentverkets allmänna råd om information om nya personbils bränsleförbrukning och koldioxidutsläpp	Link
SI	Uredba o informacijah o varčnosti porabe goriva, emisijah ogljikovega dioksida in emisijah onesnaževal zunanjega zraka, ki so na voljo potrošnikom o novih osebnih avtomobilih	Link
SK	Nariadenie vlády č. 384/2004 Z. z. Nariadenie vlády Slovenskej republiky o dostupnosti spotrebiteľských informácií o spotrebe paliva a o emisiách CO2 pri predaji a leasingu nových osobných automobilov	Link

The table provides an overview of national legislations that have implemented the Directive 1999/94/EC

Table 6 EU energy labels under Regulation (EU) 2017/1369

Appliance	Current Delegated Act	Former Delegated Act
Electronic displays	Commission Delegated Regulation (EU) 2019/2013	Commission Delegated Regulation (EU) No 1062/2010
Household washing machines and household washer-dryers	Commission Delegated Regulation (EU) 2019/2014	Commission Delegated Regulation (EU) No 1061/2010 and Commission Directive 96/60/EC
Light sources	Commission Delegated Regulation (EU) 2019/2015	Commission Delegated Regulation (EU) No 874/2012
Refrigerating appliances	Commission Delegated Regulation (EU) 2019/2016	Commission Delegated Regulation (EU) No 1060/2010
Household dishwashers	Commission Delegated Regulation (EU) 2019/2017	Commission Delegated Regulation (EU) No 1059/2010
Refrigerating appliances with a direct sales function	Commission Delegated Regulation (EU) 2019/2018	
Household tumble dryers	Commission Delegated Regulation (EU) 2023/2534	
Smartphones and slate tablets	Commission Delegated Regulation (EU) 2023/1669	

This table lists the household appliances for which the EU has introduced energy labels via delegated acts under Regulation (EU) 2017/1369. The last column lists the former delegated acts that have been repealed

Table 7 EU energy labels under Directive 2010/30/EU

Appliance	Current Delegated Act
Air conditioners	Commission Delegated Regulation (EU) No 626/2011
Space heaters, combination heaters, packages of space heaters, temperature control and solar devices and packages of combination heaters, temperature control and solar devices	Commission Delegated Regulation (EU) No 811/2013
Water heaters, hot water storage tanks and packages of water heaters and solar devices	Commission Delegated Regulation (EU) No 812/2013
Domestic ovens and range hoods	Commission Delegated Regulation (EU) No 65/2014
Residential ventilation units	Commission Delegated Regulation (EU) No 1254/2014
Professional refrigerated storage cabinets	Commission Delegated Regulation (EU) 2015/1094
Local space heaters	Commission Delegated Regulation (EU) 2015/1186
Solid fuel boilers and packages of a solid fuel boiler, supplementary heaters, temperature controls and solar devices	Commission Delegated Regulation (EU) 2015/1187

Table 7 continued

Appliance	Current Delegated Act
Vacuum cleaners ^a	Commission Delegated Regulation (EU) No 665/2013

This table lists the household appliances for which the EU has introduced energy labels via delegated acts that continue to apply under Directive 2010/30/EU despite the new labelling regime under Regulation (EU) 2017/1369

^aThe EC adopted Commission Delegated Regulation (EU) 2015/1187 establishing an energy label for vacuum cleaners, but it was successfully challenged before European courts. The General Court first dismissed the case (Case T-544/13, *Dyson Ltd v European Commission* (ECLI:EU:T:2015:836)). The appeal before the Court of Justice was partially successful (Case C-44/16 P, *Dyson Ltd v European Commission* (ECLI:EU:C:2017:357)). After the appeal, the General Court annulled the delegated act because it calculated the vacuum cleaner’s energy performance based on an empty receptacle, a method that the General Court found neither accurate nor scientifically valid (Case T-544/13 RENV, *Dyson Ltd v European Commission* (ECLI:EU:T:2018:761) paras 62-82.)

Table 8 Legal ramifications

Choice of	Options	Reasons
Legal basis ^a	EU environmental policy competence ^b	Car labels relate to the EU’s decarbonisation goal as an environmental policy aim. Directive 1999/94/EC is based on this competence
	EU energy policy competence ^c	Informing consumers about fuel consumption relates to energy efficiency. The energy efficiency labels under Directive 2010/30/EU and Regulation (EU) 2017/1369 are based on this competence
	EU internal market competence ^d	Harmonising car labels affects the EU’s internal market for cars. Many legal acts regulating products in the EU are based on this general competence
<p>Recommendation: The EU legislators should base the new car labelling regime on both the EU environmental and energy policy competences. The European Court of Justice accepts using a dual legal basis if the legal acts affects both substance matters equally and the procedures do not substantially differ.^e A single car label aims to inform consumers about fuel consumption as an energy efficiency aspect and CO2 emissions as an environmental concern related to climate change. Both aspects are equally important and the procedures of Article 192(1) TFEU and Article 194(2) TFEU are similar</p>		
Legal act ^f	Directive ^g	A directive offers more flexibility to national legislators and is less intrusive regarding EU law subsidiarity. However, this is mirrored by the disadvantage of leaving fragmented rules across the EU single market

Table 8 continued

Choice of	Options	Reasons
	Regulation ^h	A regulation harmonises market rules more strongly and reduces trade barriers between Member States resulting from diverging legal rules. It does not require national implementation and is better placed to create a level playing field at the EU level. The disadvantage is that a regulation pursues a “one size fits all” approach and does not allow the Member States to choose the means to achieve the required result
	Directive ⁱ or regulation ^j + delegated act by the European Commission ^k	The delegation of power to the EC has the advantage of flexibility and timely reactions to market changes. The process of delegated rule-setting is much swifter than a full legislative procedure involving the European Parliament and the Council. This argues in favour of adopting a framework regulation that establishes the objectives of providing consumers with accurate, robust, and comparable information on the fuel and energy consumption and CO ₂ emissions of new passenger cars placed on the market. The energy efficiency labels for household appliances under Regulation (EU) 2017/1369 and its delegated regulations provide a useful example
	<u>Recommendation:</u> Given the current state of label fragmentation, the co-legislators should legislate the general principles of the label in a regulation and empower the EC to specify more technical details by means of delegated regulations. This would enable the EC to modify the label’s methodology, values, and adaptations to technological changes more quickly and swiftly than an ordinary legislative procedure	
Monitoring and supervision	National	The national type approval authorities could approve the data displayed on the car labels alongside the manifold technical requirements within the type approval procedure. ^l The type approval of cars under Regulation (EU) 2018/858 limits immediately health-damaging emissions such as CO, NO _x , and particulate matter and includes rules on the measurement of CO ₂ emissions of individual cars. ^m

Table 8 continued

Choice of	Options	Reasons
	Supranational	Car labels could be included in the European Environment Agency’s (EEA) database of car types and CO ₂ emissions to better monitor the achievement of vehicle-related climate targets and measure the effectiveness of these labels. ⁿ The EC could verify compliance with the label requirements alongside the compliance verification procedure it exercises regarding the type approval requirements. ^o
	Mix of national and supranational	To ensure effective supervision and create synergies with the type approval procedure, supervising the car label could be delegated to the national type approval authorities and the EC. While the national type approval authorities would approve the data displayed on the car labels, the EC could verify compliance with the label requirements. In addition, the EEA could monitor the car label data to support timely regulatory updates
<p><u>Recommendation:</u> The institutional governance of the labelling regime would benefit from a mix of supranational and national monitoring and supervision. An amendment to Regulation (EU) 2018/858 would be sufficient to implement these additional institutional competences at the national and EU levels</p>		

^a Legislating on a single EU car label requires a suitable EU competence providing for a legal basis under the principle of conferral, Article 5(2) TEU

^b Article 192(1) TFEU

^c Article 194(2) TFEU

^d Article 114(1) TFEU

^e Case C-178/03, Commission of the European Communities v European Parliament and Council of the European Union (ECLI:EU:C:2006:4) paras. 57-60

^f When legislating, the EU legislators must choose an appropriate legal instrument, Article 288 TFEU

^g Article 288(3) TFEU

^h Article 288(2) TFEU

ⁱ Article 288(3) TFEU

^j Article 288(2) TFEU

^k Article 290 TFEU

^l Article 7 Regulation (EU) 2018/858

^m Appendix 2 Point 4 Part I 2A Regulation (EU) 2018/858

ⁿ See EEA’s Datahub “Monitoring of CO₂ emissions from passenger cars Regulation (EU) 2019/631.”

^o Article 9 Regulation (EU) 2018/858

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Author Contributions Both authors wrote and reviewed the manuscript. They equally contributed to this paper with N.B. focusing on the legal and M.R. on the economic aspects. M.R. also prepared the figures, tables and graphs. The authors planned and discussed all analytical steps together and consider the resulting paper in total as joint work.

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Data Availability The empirical part relies on the European Environment Agency’s dataset on EU and national car registrations: <http://co2cars.apps.eea.europa.eu/>

Declarations

Competing Interests The authors declare no competing interests.

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Cases: European Union

Deutsche Umwelthilfe eV v Bundesrepublik Deutschland (case C-515/11) ECLI:EU:C:2013:523

Legislation

A detailed overview of all national legal norms that implement the Car Label Directive is provided in the Appendix, Table 5.

European Union

Commission Delegated Regulation (EU) No 626/2011 of 4 May 2011 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of air conditioners (2011) OJ L 178/1

- Commission Delegated Regulation (EU) No 811/2013 of 18 February 2013 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to the energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device (2013) OJ L 239/1
- Commission Implementing Decision (EU) 2023/1623 of 3 August 2023 specifying the values relating to the performance of manufacturers and pools of manufacturers of new passenger cars and new light commercial vehicles for the calendar year 2021 and the values to be used for the calculation of the specific emission targets from 2025 onwards, pursuant to Regulation (EU) 2019/631 of the European Parliament and of the Council and correcting Implementing Decision (EU) 2022/2087 (2023) OJ L 200/5
- Commission Regulation (EU) 2017/1151 of 1 June 2017 supplementing Regulation (EC) No 715/2007 of the European Parliament and of the Council on type-approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information, amending Directive 2007/46/EC of the European Parliament and of the Council, Commission Regulation (EC) No 692/2008 and Commission Regulation (EU) No 1230/2012 and repealing Commission Regulation (EC) No 692/2008 (2017) OJ L 175/1
- Directive 1999/94/EC of the European Parliament and of the Council of 13 December 1999 relating to the availability of consumer information on fuel economy and CO₂ emissions in respect of the marketing of new passenger cars (1999) OJ L 12/16
- Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (2003) OJ L 275/32
- Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products (2010) OJ L 153/1
- Directive (EU) 2023/959 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union and Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading system (2023) OJ L 130/134
- Regulation (EU) 2017/1369 of the European Parliament and of the Council of 4 July 2017 setting a framework for energy labelling and repealing Directive 2010/30/EU (2017a) OJ L 198/1
- Regulation (EU) 2017/2402 of the European Parliament and of the Council of 12 December 2017 laying down a general framework for securitisation and creating a specific framework for simple, transparent and standardised securitisation, and amending Directives 2009/65/EC, 2009/138/EC and 2011/61/EU and Regulations (EC) No 1060/2009 and (EU) No 648/2012 (2017b) OJ L 347/35
- Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO₂ emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 (2019a) OJ L 111/13
- Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector (2019b) OJ L 317/1
- Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law') (2021) OJ L 243/1
- Regulation (EU) 2024/795 of the European Parliament and of the Council of 29 February 2024 establishing the Strategic Technologies for Europe Platform (STEP), and amending Directive 2003/87/EC and Regulations (EU) 2021/1058, (EU) 2021/1056, (EU) 2021/1057, (EU) No 1303/2013, (EU) No 223/2014, (EU) 2021/1060, (EU) 2021/523, (EU) 2021/695, (EU) 2021/697 and (EU) 2021/241 (2024) OJ L 2024/795

Estonia

Uue mootorsõiduki kasutajale antavate andmete loetelu ja kasutaja teavitamise kord, Vastu võetud 18.11.2016 nr 53

Germany

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