
# E-Fuels for Cars: An Ineffective Decarbonization Pathway

Standpoint by Future Cleantech Architects

June 2026

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## Executive Summary

In March 2023, the European Union (EU) set into law 2035 as the year in which all new passenger cars and vans will have to produce zero tailpipe greenhouse gas emissions. In practice this means that as of this date, no new internal combustion engine vehicles (ICEVs) can be registered in the EU - only battery electric vehicles (BEVs). However, following intense political pressure, the European Commission in December 2025 published a proposal[1] to amend this legislation and prolong the lifetime of ICEVs beyond 2035.[2] This regulation was already amended in early 2025 to introduce additional flexibility for manufacturers when it comes to meeting $CO_2$ emission reduction targets. The latest proposal, if approved, would not put in place a date for an end to the sale of ICEVs in the EU and instead of the 100% $CO_2$ reduction target for manufacturers from 2035 onwards, there would be a 90% reduction target. If a sufficient quantity of alternative fuels such as e-fuels are supplied to the EU market, manufacturers will be permitted to continue producing ICEVs within certain limits.

This FCA Standpoint assesses the feasibility of e-fuels for road transport by comparing them to conventional vehicles and BEVs when used in cars. A holistic look at e-fuels for road transport reveals that this decarbonization pathway is less efficient, more expensive, and provides lower emissions savings compared to electric vehicles. While e-fuels have the strong appeal of leveraging existing technology and infrastructure for road transport, they come with a significant energy penalty for the EU, as well as concerns over the deployment of subsidies or taxpayers' money to make them economically competitive. This brief will also assess the impact of incentivizing the supply of scarce energy resources such as e-fuels and biofuels to road transport, instead of prioritizing them in hard-to-abate sectors such as aviation and shipping. Finally, while the proposed changes are seemingly intended to improve the competitiveness of the EU's automotive industry, a shift away from full electrification may in fact undermine EU competitiveness in the BEV market.

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[1] https://ec.europa.eu/commission/presscorner/detail/en/ip_25_3051

[2] 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

## Key Takeaways

- **From an efficiency perspective, producing e-fuels for cars proves to be the least efficient conversion pathway** at ~16% efficiency when compared to conventional fuels at 27% efficiency, and BEVs at 73% efficiency.
- **From a total cost of ownership (TCO) perspective, an e-fueled car proves to be the most expensive option** with a lifetime cost that is ~91% more expensive than a conventional ICEV, and ~112% more expensive than a BEV.
- From **a lifecycle GHG emissions perspective**, **a BEV running solely on renewable energy offers the best emissions savings**. It is closely followed by BEV operating on grid electricity. While a car running purely on e-fuels can theoretically offer similar emissions savings to that of a BEV running on grid electricity, **high costs, scarce availability, and competition from other sectors for e-fuels make such a scenario unlikely**, and therefore the blending of e-fuels with conventional fuel will increase lifecycle emissions of such vehicles. Furthermore, this does not account for induced emissions that can result from the inefficient uses of hydrogen when renewable energy is in short supply, which could further increase emissions of an ICEV running on e-fuels. **Unsurprisingly, an ICEV running on petrol, even when blended with biofuels, offers by far the worst emissions performance of the powertrains compared.**
- Due to cost, efficiency, and lifecycle GHG emissions concerns, **e-fuels and biofuels for road transport should not be incentivized through policy mechanisms** since this would lead to an ineffective allocation of public funds and energy resources, and risk increased emissions, when compared to BEVs.
- The regulatory uncertainty promoted by frequent changes to the regulation are undermining investment, competitiveness, and affordability in the BEV market. **Diverting e-fuels or biofuels towards road transport would hamper the EU's capacity to meet decarbonization targets in hard-to-abate sectors such as aviation and shipping.** Investments in these sectors are necessary in the short term if the decarbonization targets are to be met, and the long-term availability of supply will be further thrown in doubt if these sectors must compete with road transport for scarce fuels.

- **The EU must re-commit to full electrification in road transport** to promote the competitiveness of its automotive industry, meet its climate objectives and ensure coherence and application of the energy efficiency principle in its energy policy framework.

## What Are E-Fuels?

There is a plethora of terms employed to refer to a category of fuels that often overlap when it comes to technical specifications and legal definitions under EU law. These include e-fuels, electrofuels, synthetic fuels, power-to-liquid fuels, and renewable fuels of non-biological origin (RFBNOs). E-fuels or power-to-liquid fuels are a subset of synthetic fuels that are produced by combining hydrogen ($H_2$) produced via electrolysis and carbon dioxide ($CO_2$) (the building blocks of hydrocarbon fuels) to form more complex fuels that can replace fossil fuels. These synthetic fuels are characterized by their energy-intensive production pathways. Under EU law they are known as RFNBOs when: the hydrogen is produced through electrolysis using additional renewable electricity; the $CO_2$ comes from an eligible sustainable source; and total lifecycle emissions are at least 70% lower than the fossil fuel comparator.[3] This standpoint will focus on e-fuels which are frequently touted as a decarbonization solution for hard-to-abate sectors, such as aviation and shipping, with the EU having set targets for their use in the transport sector. In this brief, FCA will use the terms e-fuels and RFNBOs interchangeably.

For these fuels to be carbon neutral, i.e. for them to release the same amount of $CO_2$ when they are burned as was added during their production, the $CO_2$ must be captured from a carbon source, such as from the air via direct air capture (DAC) or biogenic carbon from biomass processing, which similarly absorbs $CO_2$ from the air. $CO_2$ sourced from fossil-based industries such as cement plants or steel mills that will continue to emit carbon in the mid-term can be used for their production until 2040[4]. As the emissions during combustion of the e-fuels are compensated by the removal of $CO_2$ from the atmosphere (either by DAC, compliant point source or by biogenic sources), net emissions are determined by the carbon intensity of the electricity used to produce the $H_2$ and $CO_2$, and the

[3] There are other ways to produce synthetic fuels that are recognized under EU law, such as low-carbon fuels, with differing production pathways and for which there are typically no targets or multipliers under EU law. For more information please see FCA's analysis of the EU's methodology for assessing greenhouse gas emissions savings from low-carbon fuels: https://fcarchitects.org/wp-content/uploads/2025/09/Methodology-for-assessing-greenhouse-gas-emissions-savings-low-carbon-fuels.pdf

[4] https://www.efuel-alliance.eu/fileadmin/Downloads/20250902_Frontier_eFuel_Alliance_eNG_coalition_-_CO2_point_sources.pdf ; https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2023.157.01.0020.01.ENG&toc=OJ%3AL%3A2023%3A157%3ATOC

emissions produced during transportation of the fuel. For this reason, the Commission has set additionality, and temporal and geographic correlation requirements for the electricity used in the production of these fuels that aim to ensure the use of new or excess renewable electricity, instead of existing fossil fuel-based grid electricity or instead of incentivizing new fossil fuel-based electricity generation.[5] Even under optimistic scenarios for the realization of the EU's targets on renewable energy for 2030 however, inefficient uses of hydrogen (such as for the production of e-fuels for road transport) can induce fossil electricity generation and therefore net $CO_2$ emissions.[6] This underlines the importance of not only prioritizing the decarbonization of the grid, but also of choosing carefully when and for what purposes renewable electricity is used.

A wide range of e-fuels can be synthetized, from e-methanol to e-diesel and e-kerosene. These fuels are considered drop-in fuels that can be immediately combined with conventional fuels currently in use without the need to modify engines, storage facilities, and infrastructure. The fact that e-fuels can act as a direct replacement for fossil fuels and that existing infrastructure and engines can be leveraged, seem to make them an appealing choice for the decarbonization of transport. However, given the energy-intensive production process, strong competition for scarce resources between industries, and the availability of more effective alternatives, the use of e-fuels in road transport completely undermines the energy efficiency first principle and represents an expensive, inefficient and more polluting pathway when compared to direct electrification. While full electrification remains the long-term decarbonization pathway for cars and vans under EU law, this now looks likely to be amended under proposals published by the European Commission in December 2025. The next sections will look at the BEV market in Europe, before comparing cars running on e-fuels, conventional fuels and electricity when it comes to efficiency, cost and emissions. The final section will assess the impact of the latest Commission proposal.

## The Battery-Electric Vehicle Market in Europe

The EU's regulation 2019/631 on $CO_2$ emission performance standards for new passenger cars and for new light commercial vehicles was revised in 2023 to mandate 2035 as the date for a de facto end to sale of new ICEVs through the introduction of a 100% $CO_2$ reduction target for automotive

[5] https://energy.ec.europa.eu/topics/eus-energy-system/hydrogen/renewable-hydrogen_en
[6] https://sandbag.be/wp-content/uploads/Getting-Electrification-Right.pdf

manufacturers. The objective of this revision was to accelerate decarbonization in the road transport sector through direct electrification, which as will be explained below, offers superior performance on all fronts when compared to ICEVs. Before diving into the comparative assessment of ICEVs and BEVs however, it is worth considering the outlook for BEVs in Europe, which has been shaped by this legislation.

If we look at new passenger car registrations, BEVs represented around 20% of all new registrations in January 2026 (compared to 17% in January 2025) and double their share in 2023, which is the year the rules mandating the 2035 ICEV phase-out came into force.[7] 2025 saw decreases for ICEV registrations in the EU with petrol capturing a 26.6% share of new registrations (down from 33.3% a year earlier), and diesel 8.9% of new registrations (down from 11.9% the previous year).[8] As for recharging infrastructure, up to March 2026 there were 1,125,939 recharging points in the EU, a growth of 78% on 2023.[9] Figures 1 and 2 demonstrate growth since 2016 at EU level, and the share of BEV registrations in Europe. Of course, these figures do not show the whole picture, and there is wide variation within the EU. For example, in Denmark between January and March 2026 around 74% of new registrations were BEVs, compared to only 3.5% in Croatia.[10] And while these figures are for new registrations, there is a long way to go before BEVs will represent significant shares in the total fleet in each member state. At the end of 2025, BEVs made up around 11% of the total fleet of cars and vans in Denmark, but less than 1% in Bulgaria, Croatia, Cyprus, Czechia, Estonia, Greece, Italy, Lithuania, Poland, Romania, Slovakia and Spain. Having said that, the growth rates for BEVs in new registrations are encouraging, and the crucial underpinning to continued growth is the regulatory signal provided by the EU through the regulation on $CO_2$ standards for cars. The International Energy Agency has already warned that the recent flexibility in meeting the $CO_2$ standards granted to automotive manufacturers in 2025, coupled with the weakening of subsidies may be negatively impacting both the growth of the BEV market and the availability of more affordable models.[11] The most recent proposal to further weaken the legislation risks further weakening these growth rates. An analysis of the proposal's impact assessment (IA) by the European Parliamentary Research Service highlights 'considerable weaknesses', pointing to an overreliance on stakeholder perceptions' as well as limited and partly qualitative input when it comes to justifying the proposed changes. Indeed, the Commission's final proposal deviates from the findings of the IA in several aspects, including as regards the fuel credit system, without

[7] https://alternative-fuels-observatory.ec.europa.eu/general-information/news/european-ev-market-starts-2026-20-bev-share
[8] https://www.acea.auto/pc-registrations/new-car-registrations-1-8-in-2025-battery-electric-17-4-market-share/
[9] https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27
[10] https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27/country-comparison
[11] https://www.iea.org/reports/global-ev-outlook-2025/trends-in-electric-car-markets-2

explaining the reasons or expected impacts of these discrepancies[12]. This is a worrying sign, given that the Commission argues competitiveness and flexibility are the main drivers behind these changes, even though the full impact of these changes has not been fully assessed. The next sections will demonstrate how electrification remains the best option for EU under several indicators.

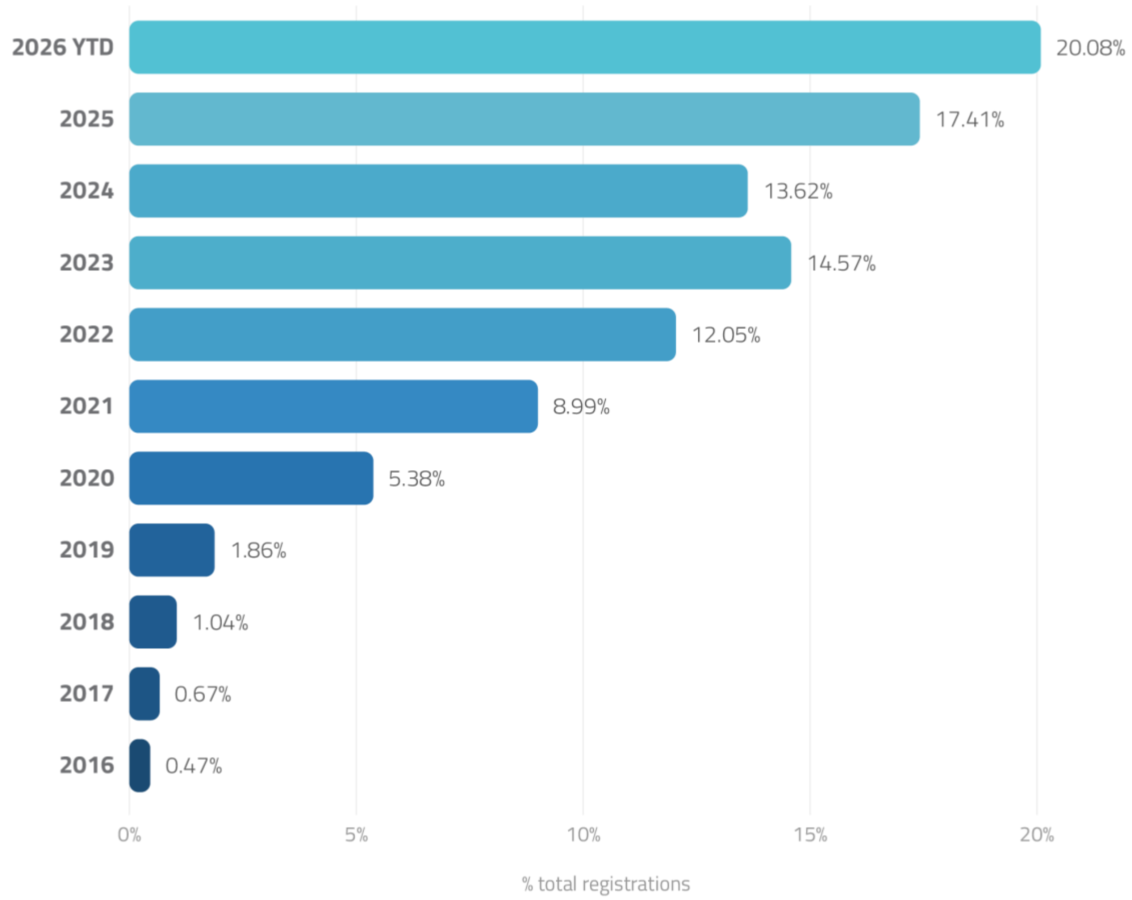


Figure 1: Percentage of BEVs registered in the EU as a share of total registrations up to February or March 2026. Source: Alternative Fuels Observatory[13]

[12] For example, while the IA finds that maintaining a 100% $CO_2$ reduction target for 2035 is the preferred policy choice, in the proposal the Commission opts for a 90% reduction. Similarly, the IA concludes that the preferred policy option for manufacturers would be to classify vehicles running exclusively on alternative fuels as zero-emission, but the proposal opts for a fuel credit system instead, which will provide incentives for the use of e-fuels and biofuels in road transport.
https://www.europarl.europa.eu/RegData/etudes/BRIE/2026/774751/EPRS_BRI(2026)774751_EN.pdf
[13] https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27/vehicles-and-fleet

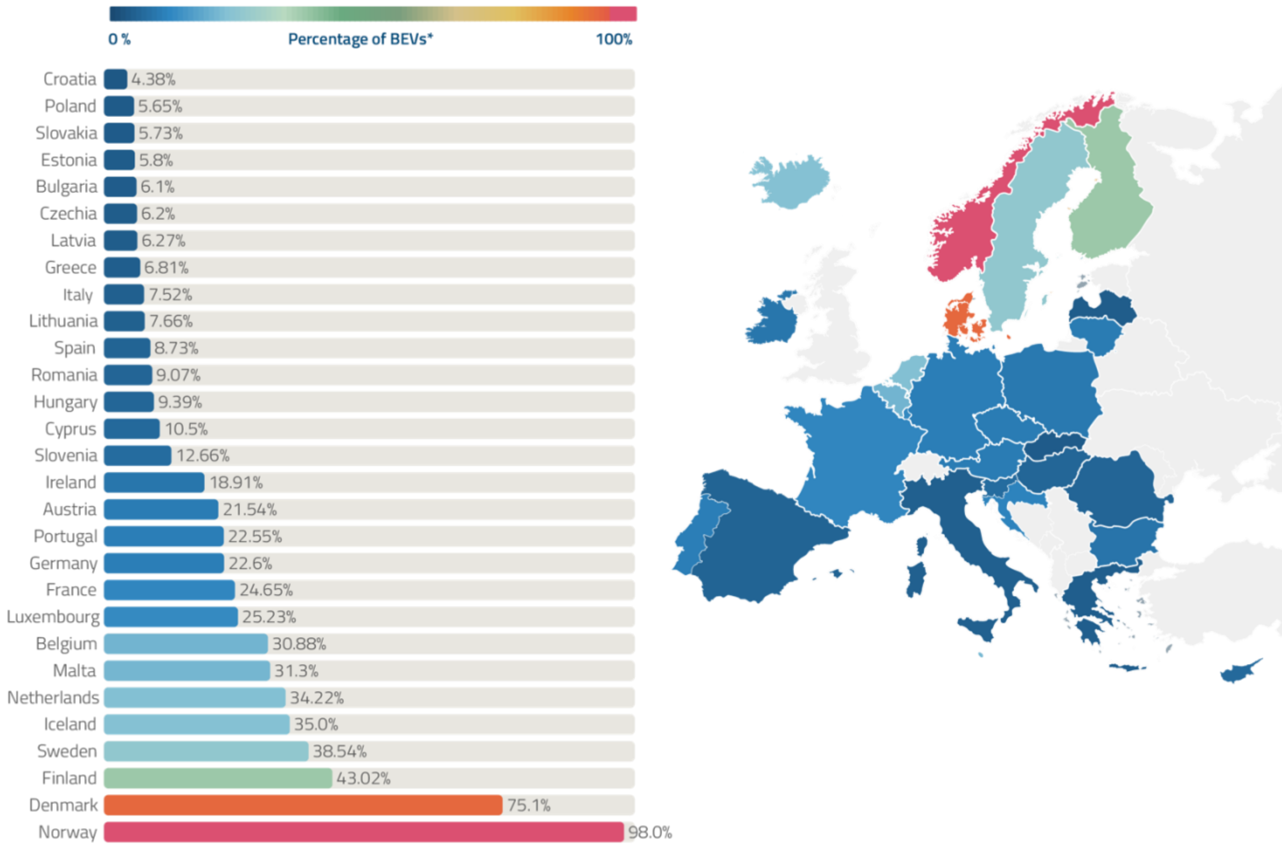


Figure 2: Percentage of BEVs registered in EU, Norway and Iceland as a share of total registrations between January and February or March 2026. Source: Alternative Fuels Observatory; International Council on Clean Transportation[14]

## E-Fuel-Powered Cars Are Less Efficient Than Battery-Electric Vehicles

The first aspect to consider as regards performance is efficiency and as shown in Fig. 1. BEVs are three times more efficient when compared to conventional ICEVs. Conventional diesel fuel

[14] The data for Belgium, Czechia, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and Sweden is up until March 2026, while for the rest only until February 2026. Source: https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27/country-comparison Figures for Norway and Iceland from European Car Market Monitor: March 2026 - International Council on Clean Transportation

production pathways are highly efficient and the majority of the losses stem from when the fuel is used in the car due to the efficiency of the engine itself, which stands at 30%, with most of the fuel's energy lost as heat. Since e-fuels are drop-in fuels that will be used in the exact same engine, the losses are the same as those for conventional fuels. Additional losses stem from the lower efficiency of the production pathway itself, which has an overall efficiency of 44 – 52%. This is due to the losses in $H_2$ production via electrolysis, $CO_2$ capture, and $H_2$ and $CO_2$ conversion to e-fuel. The additional upstream losses in the production of e-fuels make them approximately half as efficient as fossil fuels and make BEVs four to five times more efficient by comparison. Thus, **when renewable electricity is used to power BEVs, most of the electricity goes into running the vehicle itself, whereas with e-fuels most of the renewable electricity is lost in the production process.**

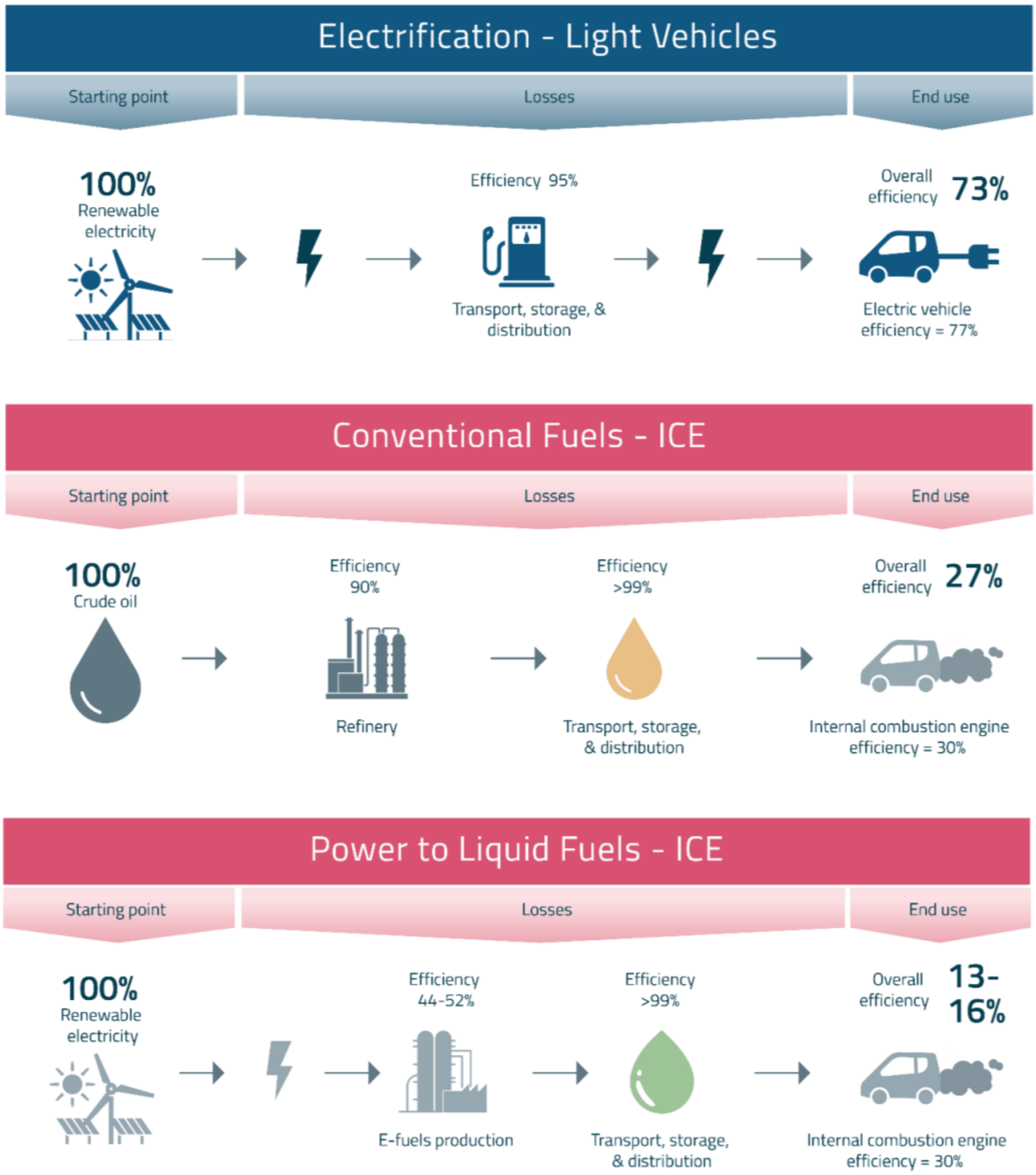


Figure 3: A comparative assessment of conversion efficiencies for BEVs and ICEVs running on conventional fuel and e-fuels.[15]

[15] Data regarding efficiencies were retrieved from the Hydrogen science coalition. Data on the efficiency of e-fuel production was also retrieved from the International Council on Clean Transportation (ICCT).

## E-Fuel Powered Cars Are More Expensive Than Battery-Electric Vehicles

When evaluating the merits of a particular technology, it is important to consider the costs of owning a vehicle, particularly the total cost of ownership (TCO), i.e. the costs associated with the purchase of the vehicle over its lifetime. By far, the two largest contributors to TCO are upfront costs associated with purchasing the vehicle, and the fuel costs throughout the vehicle's lifetime. Additional costs incurred include maintenance, financing, and insurance, which can add up to between 15% and 25% of the TCO of the vehicle.[16] Maintenance costs tend to be lower for BEVs compared to ICEVs, while insurance costs tend to be higher for BEVs compared to ICEVs, although particularly as regards insurance costs, these can vary significantly between member states.[17]

Two popular vehicle models in the EU were selected to best illustrate the cost differential between owning a BEV, a conventional ICEV, and an e-fuel ICEV over their lifetime. The VW Golf is an ICEV that can be operated using either conventional fuel or e-fuel, and the VW ID.3 Neo is a BEV[18]. The TCO of these three vehicles over a 10-year period is shown in Figure 4.[19]

[16] https://www.transportenvironment.org/topics/cars/efuels

[17] For maintenance and insurance costs we have used the Transport & Environment figures which estimate that the price of insurance, maintenance and the cost of a private charger would amount to 0.075 €/km for a BEV, and 0.074 €/km for an e-fuel ICEV. Maintenance and insurance costs have also been found to be much lower for a BEV than for an ICEV.

[18] FCA has used the prices shown on the Volkswagen Germany website for both models.

[19] We have decided to exclude depreciation as a cost component in our analysis for a couple of reasons. Firstly, residual values of BEVs vary significantly between countries and models, and are influenced heavily by the stage of market development, with a lot of uncertainty surrounding future trends. Furthermore, e-fuels are not expected to be available at commercial scale for a number of years at which point the BEV market is widely expected to have expanded significantly in many parts of the EU with wider uptake of more affordable BEVs, improvements in battery technology and the rollout of charging infrastructure expected to close the gap between BEVs and ICEVs.

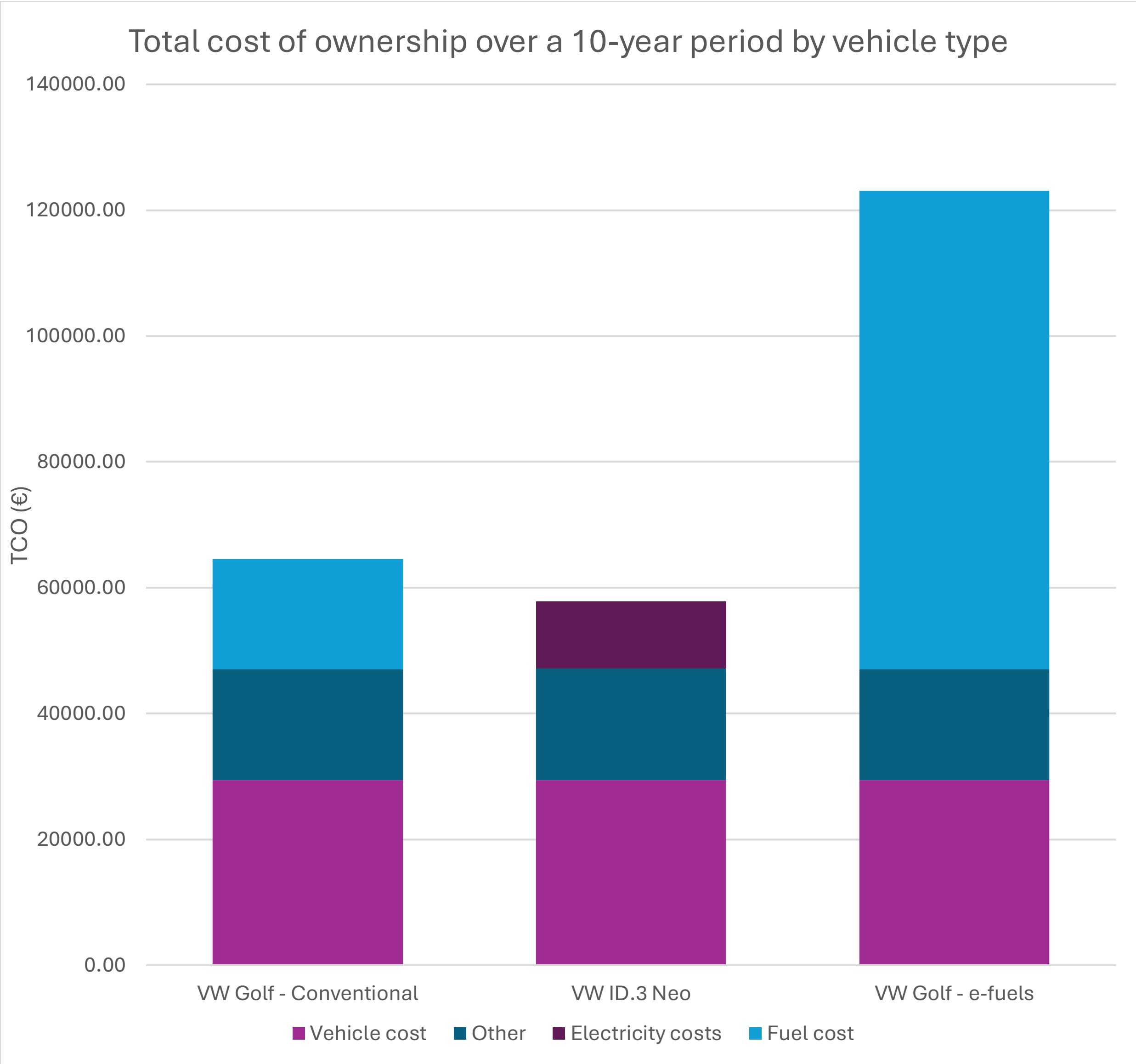


Figure 4: Total cost of ownership of the VW Golf using conventional fuel, the VW ID.3 Pure (BEV), and the VW Golf using e-fuel over a ten-year period. The category other includes maintenance, insurance and the cost of a private charger. Source: https://www.transportenvironment.org/topics/cars/efuels

As displayed in Fig. 4[20], lower annual electricity costs for charging based on the average price of electricity in the EU lead to an overall lower TCO for the BEV compared to both a conventional and

[20] The vehicle costs were retrieved from the Volkswagen website for the different models. Fuel costs were based on the average price for diesel and petrol per liter in the EU, obtained from the European Commission. Electricity costs were based on the EU average per

an e-fuel-powered ICEV. The price of a VW ID.3 Neo includes a discount under a scheme offered by Volkswagen to incentivize the sale of BEVs (although it excludes any national incentive schemes that may be available[21]). The average price of BEVs is typically higher than that of ICEVs[22], although the price of BEVs is expected to become increasingly competitive vis-à-vis ICEVs, and in China it has already happened for the SUV segment[23]. While the availability of affordable models remains a barrier to BEV uptake, the higher costs of running an ICEV over its lifetime (particularly if running on e-fuels), favorable subsidy schemes, and a growing second-hand BEV market in the EU (potentially up to 18.3 million used BEVs on the market by 2035[24]), BEVs for lower-income households are becoming more accessible than ever. The new legislative proposal on clean corporate vehicles will hopefully further increase the availability of affordable BEVs.

Turning to the TCO for ICEVs running on fossil fuels, it must be noted that the above figures are for a VW Golf running on diesel, which in the first half of 2025 cost just under 6% less than the EU average cost for petrol in the same period. However, given very similar vehicle, maintenance, and insurance costs, the results for petrol ICEV would be of the same order of magnitude. Furthermore, the figures do not capture the spike in fuel prices that has occurred as a result of the US and Israeli attack on Iran, the effects of which may be to accelerate BEV sales given how significant price rises have been.[25]

As for a VW Golf operated with e-fuels, the largest variable cost is the cost of the fuel itself which makes it the most expensive option of all considered. Current estimates for e-fuel prices vary because of different underlying assumptions regarding production pathways, input prices, capital expenditure and operating costs given that commercial e-fuel production for the road and air transport sectors in Europe today is non-existent. To estimate the fuel cost therefore, we have used figures from a Transport & Environment study that considered costs under two scenarios: e-petrol produced in a dedicated e-petrol facility, and e-petrol produced as a co-product at an e-

kWh from Eurostat. The cost of e-fuels was calculated on the basis of figures prepared by Transport & Environment. The costs covered under other, including insurance and maintenance, were retrieved from Transport & Environment. All calculations for TCO were then made based on an estimate of the average distance travelled in the EU by car annually, over a 10-year period.

[21] As an example, Germany recently introduced an incentive scheme for low and middle-income households that would offer further discounts on the purchase of a BEV https://alternative-fuels-observatory.ec.europa.eu/general-information/news/germanys-2026-ev-incentive-programme-supporting-socially-targeted-ev

[22] https://www.iea.org/reports/global-ev-outlook-2025/trends-in-electric-car-affordability

[23] https://www.iea.org/reports/global-ev-outlook-2025/trends-in-electric-car-affordability

[24] https://uploads.transportenvironment.org/production/files/How-leasing-companies-can-become-a-key-driver-of-affordable-electric-cars-in-the-EU-1.pdf?dm=1714405510

[25] https://www.theguardian.com/environment/2026/apr/12/interest-evs-surge-europe-fuel-prices-iran-war

kerosene facility. Taking the average of the two gives an estimated final cost for a consumer of €7.26/liter.[26]

This makes the e-fuel car ~91% more expensive than a conventional ICEV and ~112% more expensive than a BEV over its lifetime. These differences are substantial and show that despite the benefit of being drop-in fuels that can be used in existing ICEVs, e-fuels for road transport, due to their energy-intensive production process that relies on scarce inputs from renewable electricity and green hydrogen to sources of $CO_2$, are unlikely to be cost-competitive with fossil fuels or electricity without significant financial subsidies.

As of writing, around 40 e-fuel planned production sites for the aviation and maritime sectors have yet to achieve a final investment decision, and this is despite the legally binding targets for e-kerosene that are in place under ReFuelEU which will come into force in 2030.[27] The reasons for this are varied, including enduring uncertainties around pricing, revenues, contracts, and the viability of the existing targets. As these are sectors where electrification cannot be widely deployed (dissimilarly to road transport) e-fuels have been prioritized as a key technology in the decarbonization pathways for both sectors by the EU. E-kerosene is currently forecasted to cost up to twelve times more than conventional fossil jet fuel, depending on the production pathway[28]. In recognition of this, under the emissions trading system airlines can receive allowances to cover part or all of the price differential between fossil kerosene and alternatives such as e-fuels.[29] This measure is intended to incentivize the uptake of these fuels in a hard-to-abate sector, and it further strengthens the argument that the uptake of e-fuels in road transport is unlikely to be realized without significant financial incentives. In response to the lack of final investment decisions for e-fuel production, the Commission published the Sustainable Transport Investment Plan in late 2025 but time is running out for facilities to come online in time for meeting the 2030 targets.

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[26] E-fuels are expected to be reserved largely for the aviation or shipping sectors, which may make the co-product pricing scenario more likely to be realized than the dedicated e-petrol facility scenario. Given no production is currently taking place, the figures we have used are based on an assumption that both plants will begin production in 2030. The production cost for e-petrol produced at Fischer-Tropsch pathway plant in Norway would be €4.36/liter, or €7.65/liter with distribution, profit margins and taxes added on. The production cost for e-petrol produced at a Methanol-to-Gasoline plant in Norway is estimated at €3.87/liter, or €6.87 with distribution, profit margins and taxes added on. https://www.transportenvironment.org/articles/e-fuels-in-cars-unaffordable-for-drivers

[27] https://www.iata.org/en/iata-repository/publications/economic-reports/are-e-saf-projects-emerging-in-cost-competitive-locations/

[28] The European Aviation Safety Agency publishes reference prices for different types of aviation fuel and estimates the production cost per ton of e-fuels for aviation at 7520 €/ton which is almost 12 times the cost of conventional jet fuel at 640 €/ton. The range for e-fuels produced with industrial CO2 is €6,710 – €8,420 per ton. This figure does not include downstream costs such as distribution and profits. https://www.easa.europa.eu/en/document-library/general-publications/2025-aviation-fuels-reference-prices-refueleu-aviation

[29] https://climate.ec.europa.eu/document/download/9a82627a-8a5c-4419-93de-e5ed2d6248eb_en?filename=policy_ets_allowances_for_saf_en.pdf

If and when these sites begin producing e-fuels for the aviation and maritime sectors, the quantities of e-petrol that could be produced as a co-product at these facilities would be very small when compared to the overall fuel needs of the road transport sector.[30] The naphtha by-product does not necessarily need to be converted into e-petrol however, and can in fact be further processed into e-kerosene or e-plastics.[31] As for dedicated e-petrol facilities, these could in theory lower the price of the fuel for road transport slightly, and costs more generally may be expected to fall as overall production increases, but such facilities would compete with the scarce and expensive inputs needed to produce e-kerosene or e-fuels for the maritime sector, and therefore risk undermining the EU's decarbonization targets in both. For this reason, and the very high costs associated with the use of e-fuels in road transport, it is clear that financial incentives would be much better directed towards electrification where BEVs also offer better efficiency and value for money by comparison.

## E-Fuel Powered Cars Are More Polluting Than Battery-Electric Vehicles

Having compared efficiency and cost, the lifecycle GHG emissions of a conventional ICEV, an e-fuel ICEV, and a BEV should also be compared. Figures for a comparative lifecycle assessment of GHG emissions of medium-sized ICEVs and BEVs obtained from the International Council on Clean Transportation (ICCT) can be seen in Fig. 4.[32]

[30] https://uploads.transportenvironment.org/production/files/202604_BRIEFING_epetrol_price_PUBLISHED.pdf?dm=1777451539

[31] https://uploads.transportenvironment.org/production/files/202604_REPORT_epetrol_price_PUBLISHED.pdf?dm=1777294354

[32] The study compared the 100-year global warming potential of the life-cycle GHG emissions of passenger cars with different powertrain and fuel types, considering, among other things: emissions from the production, maintenance, and recycling of vehicles; raw material extraction and processing; component production and assembly; recycling and disposal; emissions from the fuel cycle, including fuel and electricity production and consumption; for biofuels, the indirect land use change emissions resulting from the conversion of land for cultivation; upstream and direct emissions from electricity generation, factoring in infrastructure construction, operations, and decommissioning requirements for energy power plants and the energy losses during transmission and distribution across the electrical grid. https://theicct.org/publication/electric-cars-life-cycle-analysis-emissions-europe-jul25/

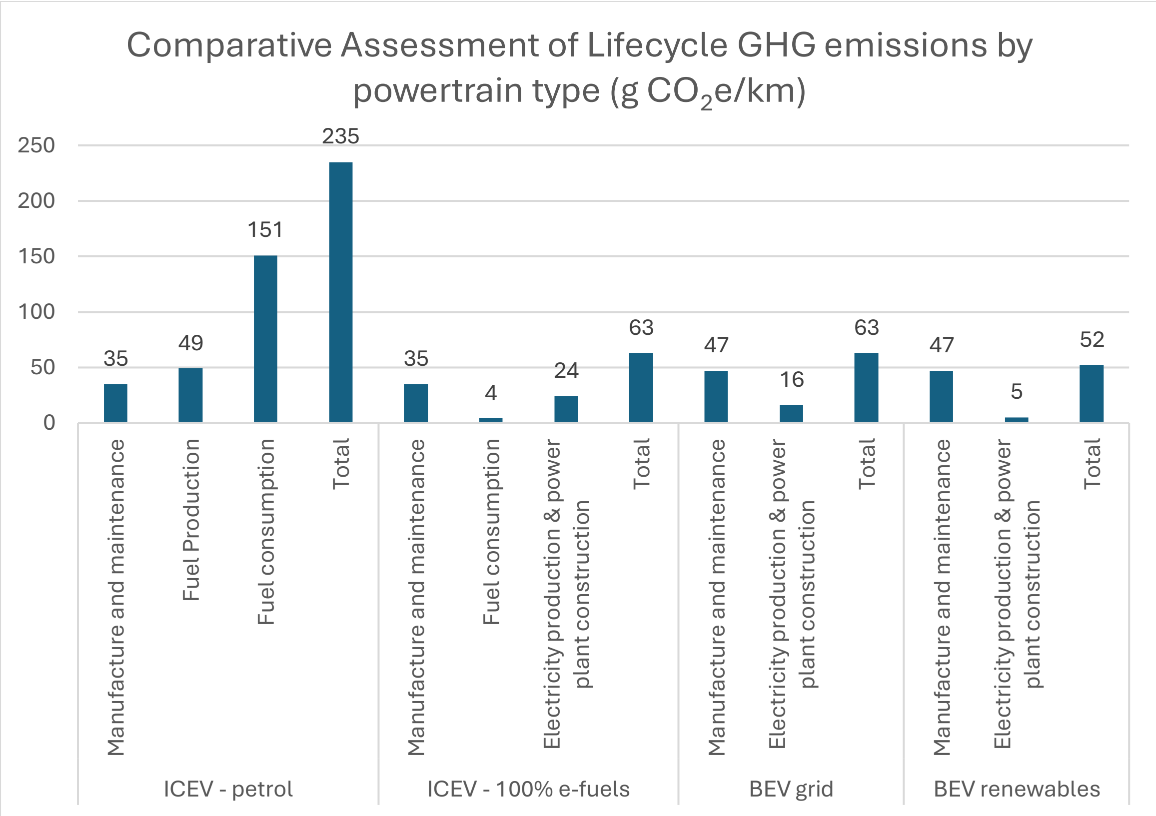


Figure 5: Comparative Assessment of Lifecycle GHG emissions by powertrain type (g $CO_2$e/km). Source: International Council on Clean Transportation

The study by ICCT shows that a petrol ICEV has the highest lifecycle emissions of any powertrain type at around 235 g $CO_2$e/km.[33] The majority of the emissions are the result of fossil fuel consumption and it is worth bearing in mind that ICCT have assumed an average biofuel share of 7% in the blend for the lifetime of the vehicle, while acknowledging that the rules around the blending of biofuels could change in future. As will be addressed later on, FCA recommends that in tandem with the electrification of road transport, existing biofuel production should be redirected away from road transport and towards the aviation and maritime sectors where they would offer better GHG savings.

The study also considers the emissions of an ICEV running solely on e-fuels, an option that would provide roughly the same GHG savings as a BEV running on electricity from the grid when factoring in the expected evolution of the electricity mix of the grid in Europe over the lifetime of the vehicle[34].

[33] As petrol and diesel ICEVs had almost the exact same GHG emissions, we have included only petrol in figure 3.

[34] https://theicct.org/publication/electric-cars-life-cycle-analysis-emissions-europe-jul25/

However, ICCT point out that high costs, limited availability, multipliers for their use in the aviation and maritime sectors, and a lack of incentives would make it unlikely that such fuels will be used in road transport. Since the publication of this study however, the European Commission has indeed outlined an incentive scheme for their use in road transport under the proposed revision of the $CO_2$ standards regulation, which, as we will address later in the report, could be further expanded during inter-institutional negotiations. At member state level meanwhile, Germany has approved a law mandating 10% usage of e-fuels in cars by 2040.[35]

At this stage it is difficult to predict whether these developments could result in the future in cars running entirely on e-fuels or using conventional fuel with e-fuels blended in, as is currently done with biofuels.[36] Given the aforementioned reasons, FCA believes it is unlikely that cars would run purely on e-fuels, at least in a widespread fashion, and therefore in a scenario in which they are blended with fossil fuels, the lifecycle emissions of such cars would increase. This would mean that an e-fueled ICEV no longer competes with a BEV running on grid electricity when it comes to lifecycle GHG emissions. Furthermore, the Commission acknowledges in its own Impact Assessment that $CO_2$ emissions and energy demand will increase in a scenario where a fuel credit system is introduced, while energy demand also increases if ICEVs running purely on e-fuels are permitted[37].

A final point to consider on e-fuels is the risk of induced emissions that can result from the production of e-fuels in certain countries where the energy could otherwise be used to decarbonize the grid or be used in sectors such as aviation and shipping where direct electrification cannot be widely deployed. A study by Sandbag illustrates how there is a risk of a net increase in $CO_2$ emissions resulting from the production of hydrogen during periods where there is limited renewable energy supply.[38] The resulting emissions under different scenarios can vary significantly within a range of 5-30 $tCO_2$ per ton of hydrogen produced on average across member states.[39] For these reasons, they recommend extreme caution on the timing of electricity use, with the incentivization of RFNBOs in areas such as road transport risking creating a vicious cycle of

[35] Bill Passed: Germany Requires Cars to Use 10% e-Fuels by 2040 :: Both2nia

[36] In its Impact Assessment, the Commission modelled a scenario in which the regulation were amended to permit the use of cars running entirely on e-fuels from 2035 (i.e. without the proposed fuel credit system), but that high fuel costs, and the availability of cheaper alternatives would translate into only 1% of new cars being be an ICEV.

[37] https://eur-lex.europa.eu/resource.html?uri=cellar:a9bf8353-db5c-11f0-8da2-01aa75ed71a1.0001.02/DOC_1&format=PDF

[38] ''The climate impact of electricity use is very sensitive to the emission intensity of marginal power production at the time of production. Any extra electricity demand load at times of fossil marginal generation creates a net increase in CO2 emissions unless the overall energy conversion rate from fossil fuel to power to end use is higher than 100%'' Source: https://sandbag.be/wp-content/uploads/Getting-Electrification-Right.pdf

[39] https://sandbag.be/wp-content/uploads/Getting-Electrification-Right.pdf

inefficiency that pushes energy demand higher and higher.[40] This risk may therefore mean the emissions of ICEVs running on e-fuels are underestimated by the ICCT study.

It is a BEV operating solely on renewable energy that delivers the highest GHG emission savings with only 52 g $CO_2$e/km over the course of the vehicle's lifetime, 78% lower than an ICEV running on petrol, and around 17% lower than an ICEV running only on e-fuels. Factoring in the risk of induced emissions resulting from producing e-fuels for road transport, both types of BEVs would yield the best GHG emissions-savings, thereby strengthening the case for direct electrification in road transport. Accelerated decarbonization of the electricity grid through the deployment of clean energies could further improve the lifecycle emissions of BEVs running on grid electricity.

With BEVs performing better than e-fueled power cars in terms of efficiency, TCO, and lifecycle GHG emissions, the next section will assess the impact of the latest proposals from the European Commission on the decarbonization pathway for cars and vans.

## Implications of the Automotive Package

On 16 December 2025, the European Commission published a proposal to revise the regulation on $CO_2$ emission standards for cars and vans as part of the so-called Automotive Package, the third revision to the law in 3 years. It has proposed a weakening of the $CO_2$ emission-reduction targets vehicle manufacturers must meet between now and 2035. The most notable proposed change is that instead of a 100% $CO_2$ reduction target for new cars and vans registered in the EU that is due to come into force in 2035, the target would be reduced to 90%, and no new date is set for reducing emissions by 100%. Under the proposal, the remaining 10% of emissions that would still be permitted from 2035 would be offset by two credit systems: up to 7% for the use of low-carbon steel by manufacturers, and up to 3% for the supply of alternative fuels. While manufacturers would have to utilize low-carbon steel to produce cars in order to receive the former offset credits, they would not have to make any effort to receive fuel credits, as these would be provided to manufacturers on the basis of the share of alternative fuels that is supplied to road transport in the EU.[41] The fuels that would count towards the fuel credit system under the proposal are e-fuels, and

[40] https://sandbag.be/wp-content/uploads/Getting-Electrification-Right.pdf

[41] The excess CO2 emissions that would result from the relaxation of the targets would translate into 3.3g CO2 per km for cars and 5.4g CO2 per km for vans, contingent on the supply of eligible alternative fuels to the market. Manufacturers could therefore continue to produce ICEV cars and vans that bring their average emissions up to these limits. Fuel credits can only represent a maximum of 3% of a

biofuels and biogas produced from feedstocks listed in Annex IX of the renewable energy directive, although feedstocks produced from Part B of this annex (such as used cooking oil and animal fats) are capped at 1%. As pointed out by ICCT, **the fuel credit system would effectively introduce double counting of alternative fuels under both the $CO_2$ standards regulation and the renewable energy directive without creating any incentive for manufacturers to lower their emissions**.[42] Importantly, despite the inferior performance compared to BEVs when it comes to TCO, efficiency and lifecycle emissions, the proposed changes would provide incentives for the use of e-fuels in road transport.

As regards the list of eligible fuels under the fuel credit system, with the exception of biofuels and biogas produced from feedstocks under Part B of Annex IX, none are currently available at commercial scale (although this is expected to change as we approach 2035 when the credit system would enter into force, if the Commission's proposal were approved as is). However, the Commission's proposal will now be amended by the co-legislators. The European Parliament's rapporteur has already proposed to weaken these provisions through a number of changes to the Commission's text, including: bringing the fuel credit system into operation once the regulation comes into force instead of 2035; expanding the list of eligible fuels under the fuel credit system; and increasing the cap on Part B biofuels.[43] While this is only an initial proposal which will be subject to negotiations with other political groups and then the Council, it is indicative of the potential for the $CO_2$ targets to be further weakened during inter-institutional negotiations, and for further incentivization of the use of e-fuels and biofuels in road transport.

Until the proposed revision of the regulation on $CO_2$ standards for cars and vans in December, full electrification of the car and van segments was enshrined in EU law. This would have opened up the possibility of shifting liquid biofuel production to biojet fuel to help achieve other transport decarbonization targets such as those under ReFuelEU Aviation. Shifting 35% of today's biodiesel production alone could help achieve the 2030 target while converting 100% of today's EU liquid biofuel production to biojet fuels could help achieve 45% and 30% of the 2040 and 2050 non-RFNBO SAF targets, respectively.[44] Indeed, FCA analysis has found that beyond 2030, there is a high likelihood that demand for biojet fuel will have to be covered by diverting current liquid biofuel production to biojet fuel, installing additional capacity, and imports, with a heavier reliance on

manufacturers' 2021 reference emissions, while credits from biofuels and biogas produced from feedstocks in Part B of Annex IX are capped at 1% of 2021 reference emissions. https://theicct.org/wp-content/uploads/2025/12/ID-537-%E2%80%93-EU-CO2-proposal_policy-brief_final.pdf

[42] https://theicct.org/eu-renewable-fuels-in-the-car-co2-standards-dec25/

[43] https://www.europarl.europa.eu/doceo/document/ENVI-PR-787667_EN.pdf

[44] This refers only to production for fuels made from feedstocks covered under annex IX of the renewable energy directive 2018/2001, which are those also those eligible for meeting the targets under ReFuelEU regulation 2023/2405.

imports in the longer term. These supply challenges will arise from the strengthened feedstock restrictions of the revised renewable energy directive (RED III), due to the limited supply of eligible feedstocks such as forest residue, municipal solid waste (MSW), and waste oil.

As for the production of e-fuels for aviation that will be required under ReFuelEU, we estimate that an additional 872 TWh[45] of renewable electricity will be needed for the production of renewable hydrogen to meet ReFuelEU Aviation's minimum 2050 synthetic jet fuel sub-target. This makes the feasibility of producing synthetic jet fuels at the required quantities in the coming decades a question of renewable electricity availability. The creation of incentives for the use of these fuels in road transport through the fuel credit system coincides with a significant ramp-up of the decarbonization targets for both aviation and shipping. Cross-sectoral competition for electricity as a feedstock to produce highly energy-intensive synthetic fuels, such as synthetic jet fuels for aviation and e-methanol and e-ammonia for shipping, will only grow as 2050 approaches. This could create further strain on supply and threaten decarbonization pathways in the different transport modes. And as we have already mentioned, co-production of e-petrol can be avoided and will in any event yield small quantities of fuel compared to the sector's overall needs.

Taken together, FCA sees there is a challenge when it comes to ensuring security of supply of alternative fuels to the transport sector. There is now a risk that further pressure is placed on the supply of these fuels through a redirection away from aviation and shipping and towards road transport. This could come about not only as a result of the fuel credit system, but the wider weakening of $CO_2$ emission reduction targets under the proposal that is expected to lower the share of BEVs over the coming years, if for example biofuels continue to be used in road transport.[46] This could therefore jeopardize the achievement of the EU's decarbonization targets across the transport and energy sectors and introduce strong incoherence in the EU policy framework given increased competition over scarce resources and a lack of prioritization of these inputs in transport and energy policy.

A final comment on the competitiveness of the EU's automotive industry, which appears to be the main motivating factor behind the proposal to revisit the ICEV phase-out.[47] The chief concern around the drive towards electrification seems to be that the rules in place are resulting in a loss of manufacturing capacity and jobs in the EU and are providing a competitive advantage to countries

[45] Equivalent to 65% of today's EU annual renewable electricity production European Electricity Review 2026 | Ember

[46] Transport & Environment indicate that around 23 million additional ICEVs are expected to be on the market by 2050 as a result of the reduction of the CO2 target from 100% to 90%; ICCT's modeling indicates that by 2030, the share of battery electric vehicles could fall by 17 percentage points, from 61 to 44% of new registrations.Sources: https://www.transportenvironment.org/uploads/files/2026-02_Car-CO2-options-briefing.pdf and https://theicct.org/publication/european-commissions-risks-and-opportunities-of-the-proposed-co2-standards-dec25/

[47] https://ec.europa.eu/commission/presscorner/detail/en/ip_25_3051

such as China. China is indeed making inroads in the EU's BEV market with one in four EVs sold in the EU in 2024 being made in China, and the average price of Chinese models significantly lower than the average price of a European BEV model.[48] However, this trend is a result of several factors including a long-standing industrial policy in the country geared towards electrification.[49] There are many policy tools at the EU's disposal to ensure the survival of its domestic BEV industry, including demand-side measures, trade defence and market distortion measures, and R&D. To weaken the $CO_2$ reduction targets for vehicle manufacturers at this juncture risks further delaying electrification by EU manufacturers, and as we have already mentioned, the full impact of these changes has not been fully assessed by the Commission in its impact assessment. The changes could therefore further entrench the competitive edge in the BEV market held by China.[50]

Despite the efforts to slow down or undo the electrification of road transport however, the market trend towards electrification is clear, with electric vehicles (both BEVs and plug-in hybrid electric vehicles) accounting for 25% of total sales globally in 2025.[51] In China, almost 55% of new vehicles are either BEVs or plug-in hybrid electric vehicles.[52] The same trend can be seen in recharging infrastructure with over 75% of all motorways in Europe having a fast-charging station every 50 km.[53] As already mentioned, the crisis in energy markets provoked by the war in Iran may further accelerate the move towards electrification in road transport. In the face of such trends, and in light of the superior performance of BEVs, European industry would do better to embrace electrification rather than delay or seek expensive, inefficient, and more polluting alternatives to fossil fuels in the form of e-fuels, a policy completely misaligned with the energy efficiency first principle underpinning EU climate policy.

[48] https://www.bruegel.org/policy-brief/smart-european-strategy-electric-vehicle-investment-china
[49] https://www.bruegel.org/policy-brief/smart-european-strategy-electric-vehicle-investment-china
[50] https://www.bruegel.org/policy-brief/smart-european-strategy-electric-vehicle-investment-china
[51] https://www.iea.org/reports/global-ev-outlook-2026/trends-in-electric-cars
[52] https://www.iea.org/reports/global-ev-outlook-2026/trends-in-electric-cars
[53] https://iea.blob.core.windows.net/assets/7ea38b60-3033-42a6-9589-71134f4229f4/GlobalEVOutlook2025.pdf

## Conclusions and Policy Recommendations

As outlined in the above sections, from an efficiency, TCO, and lifecycle GHG emissions standpoint, there is no uncertainty that electrification remains the best suited technology for decarbonizing road transport. Proposals that have been put forward to delay or limit electrification in road transport may incentivize the use of biofuels and e-fuels in road transport, despite a need for these resources in sectors with few alternatives such as aviation and shipping. If these proposals are approved in their current form, or the fuel credit system is expanded or brought into force earlier, the EU risks jeopardizing its decarbonization targets in transport and energy and undermining electrification by the European automotive industry. In light of this, FCA recommends the following to policymakers:

- **Remove the fuel credit system from the proposal on $CO_2$ standards for cars and vans.** Incentivizing the use of e-fuels and biofuels in road transport to permit manufacturers to produce more ICEVs will undermine decarbonization targets by: 1) diverting scarce energy resources from sectors that need it the most, such as aviation and shipping, potentially leading to induced emissions in the electricity grid; 2) undermining electrification in road transport with potential knock-on effects on the availability of affordable BEVs; and 3) providing no additional incentive for automotive manufacturers to reduce their emissions by permitting double counting of alternative fuels.
- **Re-commit to direct electrification for cars and vans** in the revision of the regulation on $CO_2$ standards for cars and vans by setting a target for a 100% $CO_2$ reduction by manufacturers, given the superior energy, cost, and emissions-reduction performance. Ideally, the 100% $CO_2$ reduction target for 2035 would remain in place, but a later date for such a target would still send a clear signal that electrification remains the best long-term decarbonization pathway for road transport. The successive revision of regulatory targets is negative for the investment climate, for industrial competitiveness and for compliance with climate targets.
- **Remove the flexibility introduced for manufacturers to average emissions over 3 years** from 2030-2032. This will only delay the rollout of more affordable BEVs, punish first movers, and increase GHG emissions.
- **Focus on support measures to help the EU's automotive sector and citizens in the transition to full electrification.** These include measures such as agreeing to ambitious electrification targets in the corporate fleets proposal, and proposals that can stimulate

demand for 'made-in-Europe' BEVs without compromising on affordability in the industrial accelerator act; support for social leasing schemes and other financial incentives, and increased funding for charging infrastructure under the Connecting Europe Facility; targeted market-distortion and trade-defense mechanisms to ensure a level playing field internationally; and additional funding for research and development, skills and training in the field of electrification to help protect jobs and advance developments in battery technologies.

## Acknowledgements and Further Information


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