BRIEFING

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Commercial fleet renewal programs as a response to the COVID-19 crisis in the European Union

Author: Felipe Rodríguez

The COVID-19 crisis has had a large impact on the supply and demand of new heavy-duty vehicles in Europe. Registrations of new trucks and buses above 3.5 tonnes were down 37% in the first five months of 2020, compared to the same period in 2019. Although the recovery measures for the automotive industry have mostly focused on the passenger car sector, proposals for stimulating the heavy-duty vehicle sector have emerged in recent weeks.

This briefing provides recommendations to maximize the effectiveness and environmental benefits of potential truck fleet renewal programs adopted at the national or European level. It does not attempt to evaluate the effectiveness of truck fleet renewal programs in relation to other recovery measures.

Fleet renewal programs that incentivize the purchase of new Euro VI trucks without consideration for the environmental impact of the vehicles they replace will fail to advance the environmental agenda of the European Union. The economic, climate, and air quality benefits of fleet renewal programs can be optimized by tailoring the incentives to the vehicle segment.

Experience from the 2008 global financial crisis suggests that the tractor-trailer segment could recover the fastest from the current economic downturn. Although tractor-trailers have the highest market penetration of Euro VI vehicles, they have seen little improvement in fuel efficiency. In addition, they have a limited impact on urban air quality, as they are used for long distance transport. Therefore, fleet renewal incentives aimed at tractor-trailers warrant a CO_2 component. Such a measure would also aid truck makers in meeting the upcoming CO_2 standards for heavy commercial vehicles.

In contrast, construction and urban delivery vehicles (under 16 tonnes), which were affected the most by the last global economic crisis, have the lowest market penetration of Euro VI vehicles and impact urban air quality more directly. Although Euro VI trucks have a much better pollutant emissions performance than older technologies, they still exhibit poor performance during urban operation. Therefore, fleet renewal programs targeting urban trucks should only incentivize the latest implementation of the Euro VI standard, step E, and should include additional incentives for zero-emission technologies.

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COMMERCIAL VEHICLE MARKET BEHAVIOR DURING THE 2008 GLOBAL FINANCIAL CRISIS

The global financial crisis of 2008, and the economic recession that followed, had a significant impact on the commercial vehicle market. The recovery measures at the time focused on reactivating the passenger car industry and excluded stimuli for the commercial vehicle market. Figure 1 shows the impact of the 2008 global financial crisis on the new registrations of trucks and buses over 3.5 tonnes in the EU.

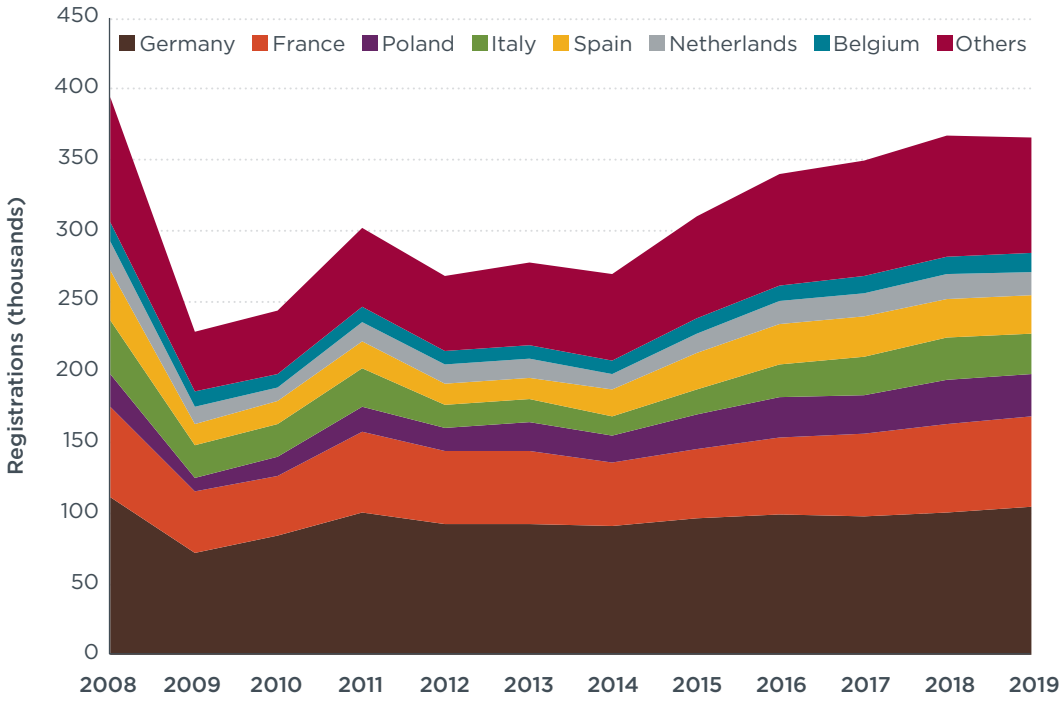

Figure 1. New vehicle registrations of trucks and buses over 3.5 tonnes in the EU. Data for the United Kingdom is not included.

Registrations of new commercial vehicles in 2009 dropped by 42% compared to the previous year and exhibited little growth in 2010. In 2011, the market bounced back and totaled a cumulative growth of 32% compared to 2009. In the years that followed, in the midst of the Eurozone crisis, the number of new registrations fluctuated sharply, averaging a growth of around 0.7% per year from 2012 to 2015. In the years after and up to the COVID-19 crisis, the market consistently expanded, with most of the growth taking place in 2015 and 2016.

The European commercial vehicle market is highly heterogeneous, ranging from 3.5 tonne delivery vans to 40 tonne long-haul tractor-trailers. Therefore, the impact of the global financial crisis of 2008 was not felt evenly across all vehicle segments. Figure 2 shows the evolution of sales in key commercial vehicle segments.

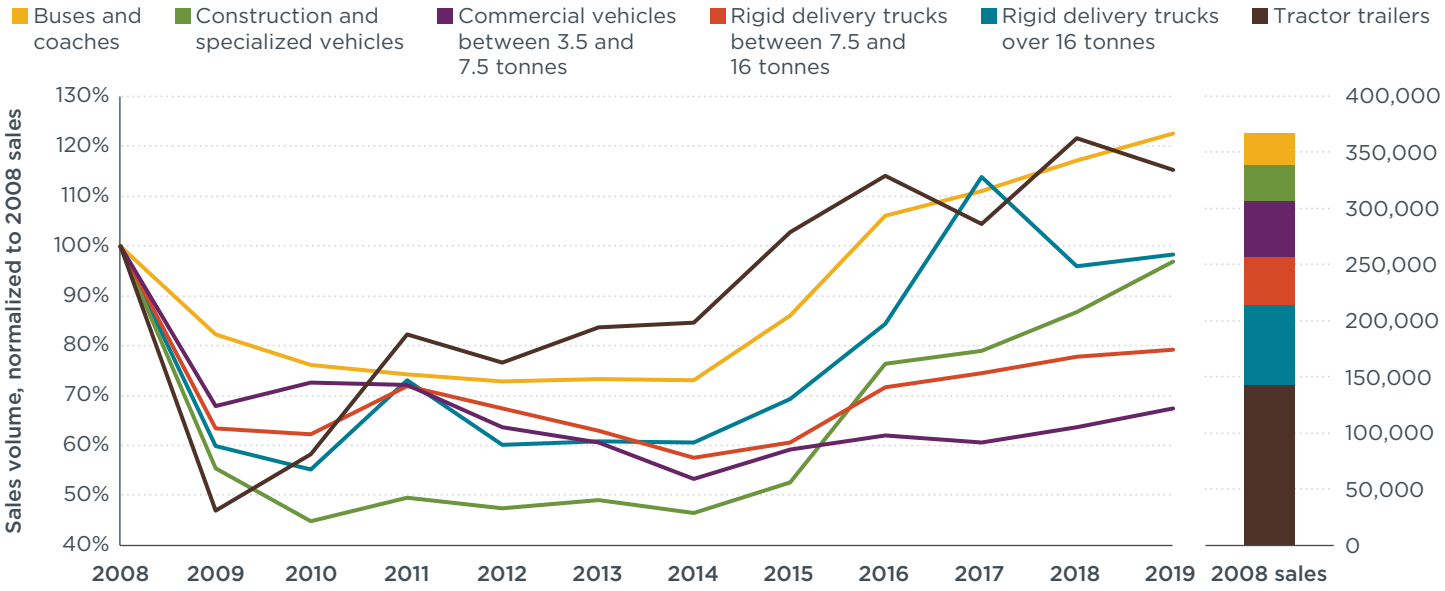

Figure 2. EU-27 sales in the different vehicle segments normalized to 2008. Data for the United Kingdom is not included.

The tractor-trailer segment felt the shock of the global financial crisis more markedly, but was also the segment that recovered the fastest. In 2009, the sales of tractor-trailers dropped by more than 50% compared to 2008, but rapidly bounced back the following two years with an average growth rate of 32% per year. The tractor-trailer segment rebounded to pre-crisis sales volumes in 2015. The market for rigid delivery trucks over 16 tonnes showed a similar behavior as tractor-trailers. In 2009, the sales of heavy rigid trucks dropped 40%, bouncing back in the two years after with an average growth rate of 10% per year. That growth rate, however, was not sustained, and the segment did not reach pre-crisis volumes until 2017.

The commercial vehicle segments covering gross vehicle weights between 3.5 tonnes and 16 tonnes saw a reduction of approximately 35% in 2009 compared to the previous year, and stabilized to around 60 thousand units for most of the subsequent decade. The market for vocational vehicles, such as construction and garbage collection trucks, contracted by more than 50% in 2009 and settled at those lower volumes, around 15 thousand units, until 2014. From 2014 onwards, the vocational vehicle market reactivated, growing at an average rate of 16% per year to almost pre-crisis sales volumes in 2019.

The bus-and-coach segment was the least affected by the global financial crisis. It registered a 25% contraction in 2009 compared to the previous year, had a sustained growth of 11% per year since 2014, and achieved pre-crisis sales volumes in 2016.

Summary

The over-16-tonne truck segments represent close to 60% of the sales volume of commercial vehicles. These segments, in particular tractor-trailers, experienced the fastest recovery after global financial crisis of 2008. The market for trucks under 16 tonnes contracted less sharply than other vehicles segments, but did not bounce back as rapidly, stabilizing at lower sales volumes for most of the subsequent decade.

COMMERCIAL FLEET RENEWAL PROGRAMS IN RESPONSE TO THE 2020 COVID-19 CRISIS

The COVID-19 crisis ended the seven-year growth streak of EU's commercial vehicle market. While new vehicle registrations had shown signs of slowing down in the first two months of 2020, down 9% compared to January/February of 2019, the containment measures had significant impact on new vehicle registrations. In the first five months of 2020, the market for new commercial vehicles in the EU contracted by over 35%, compared to the same timeframe in 2019.[1] This contraction in new vehicle registrations cannot be solely attributed to shrinking demand for commercial vehicles; reduced production volumes also stemmed from manufacturing plant closures, supply chain challenges, and stay-at-home orders. While market analysts forecast a rebound in the EU commercial vehicle market in the second half of 2020,[2] the market effects of the COVID-19 crisis remain difficult to know with certainty.

On June 3rd 2020, the German government agreed to a €130 billion COVID-19 economic recovery package,[3] including about €8 billion to support the automotive industry and accelerate the transition to electric mobility, mostly in the light-duty sector. To revive the commercial vehicle sector, the German government intends to put forward a temporary EU-wide fleet renewal program in the 2020-2021 timeframe, financed through EU funds. Under the German proposal, the replacement of a Euro V truck with a new vehicle compliant with the latest Euro VI emission standards would be subsidized by €15,000. In the case of Euro III or Euro IV trucks, the replacement subsidy would amount to €10,000.

The follow analysis provides fact-based recommendations to maximize the effectiveness and environmental benefits of a EU fleet renewal program, along the lines of the German proposal.

FLEET COMPOSITION BY EURO EMISSION STANDARDS

While Euro VI emission standards were fully phased-in in 2014, Euro VI vehicles only represent about a quarter of the in-use commercial vehicle fleet in the EU (see Figure 3).

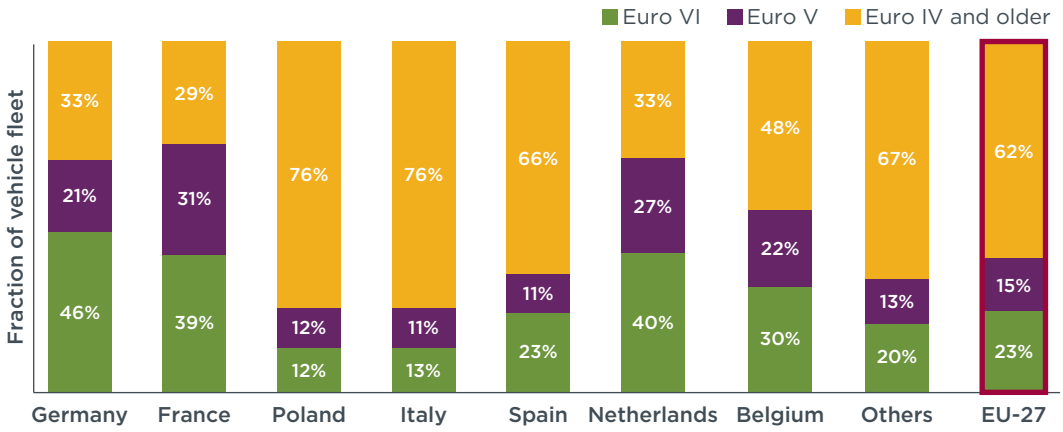

Figure 3. Estimated fleet composition of heavy-duty trucks per Euro emission standards in EU and selected EU member states in 2018. The fleet composition by Euro standard is estimated from the fleet age distribution. Data source: ACEA, "Report: Vehicles in Use – Europe 2019."

1 ACEA - European Automobile Manufacturers' Association, "Commercial Vehicle Registrations: -36.7% Five Months into 2020; -44.4% in May | ACEA - European Automobile Manufacturers' Association," June 24, 2020, https://www.acea.be/press-releases/article/commercial-vehicle-registrations-36.7-five-months-into-2020-44.4-in-may.

2 Power Systems Research, "PSR Truck Production Index," July 22, 2020, https://www.powersys.com/resources/truck-production-index-tpi/.

3 Federal Ministry of Finance, "Eckpunkte Des Konjunkturpakets: Corona-Folgen Bekämpfen, Wohlstand Sichern, Zukunftsfähigkeit Stärken," June 3, 2020, https://www.bundesfinanzministerium.de/Content/DE/Standardartikel/Themen/Schlaglichter/Konjunkturpaket/2020-06-03-eckpunktepapier.pdf?__blob=publicationFile&v=10.

Euro V trucks, brought into the market in 2009, account for 15% of the fleet. Euro IV trucks and older account for approximately 60% of the fleet. This large volume of pre-Euro V trucks is a consequence of the long useful lives of heavy-duty vehicles and the associated slow fleet turn-over rate. In Europe, trucks are, on average, 12.4 years old.[4]

The distribution of vehicles across the different Euro emission standards varies greatly across the different EU member states. As shown in Figure 3, Germany has seen the fastest adoption of Euro VI trucks, accounting for 46% of the fleet, while other important truck markets like Poland, have seen a lower adoption of Euro VI trucks.

Given the diversity of applications among commercial vehicles, there is also a strong differentiation in the share of Euro VI trucks across weight classes. Figure 4 shows the fleet composition of the different truck segments by Euro standard for Germany.[5] The tractor-trailer segment—typically used for long-haul applications—shows high adoption rates of Euro VI vehicles, totaling 71% of fleet. On the other hand, smaller Euro VI trucks with gross vehicle weight below 12 tonnes—typically used for urban delivery—only account for around a quarter of the segment's fleet.

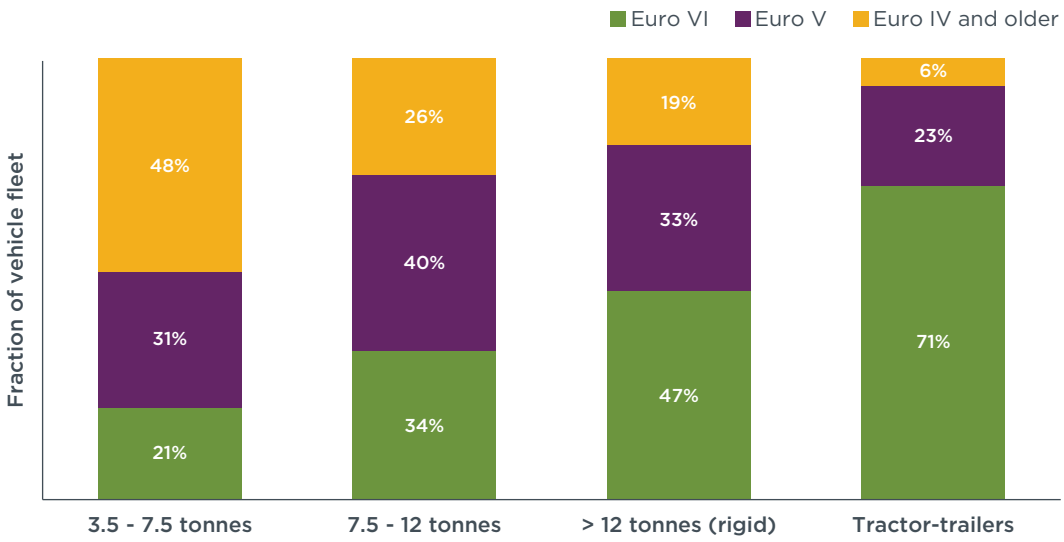

Figure 4. Truck fleet composition according to the Euro emission standards across the different vehicle segments in Germany in 2018. Data source: KBA, "Fahrzeugzulassungen (FZ), Bestand an Kraftfahrzeugen nach Umwelt-Merkmalen, 01. Januar 2019 (FZ 13)."

The environmental impact of the on-road fleet is linked to its Euro-standard composition and, more importantly, to the distance traveled by those vehicles. As vehicles age, their typical usage rates decline sharply year after year. For example, the average tractor-trailer is typically driven around 130,000 kilometers in its first year of use, but only half of that once it reaches 10 years of age.[6] Figure 5 shows the Euro-standard distribution of kilometers traveled by German trucks on toll roads in January 2019.[7] Compared to the fleet composition by Euro standard (see Figure 4), the distribution of kilometers traveled by Euro standard a noticeable shift to Euro VI vehicles.

4 ACEA, "Report: Vehicles in Use - Europe 2019," 2019, https://www.acea.be/uploads/publications/ACEA_Report_Vehicles_in_use-Europe_2019.pdf.

5 Kraftfahrt-Bundesamt (KBA), "Fahrzeugzulassungen (FZ), Bestand an Kraftfahrzeugen nach Umwelt-Merkmalen, 01. Januar 2019 (FZ 13)" (German Federal Motor Transport Authority, June 2019), https://www.kba.de/DE/Statistik/Fahrzeuge/Bestand/Umwelt/umwelt_node.html.

6 European Commission, "TRACCS Database," 2014, https://www.eea.europa.eu/data-and-maps/data/external/traccs.

7 Bundesamt für Güterverkehr (BAG), "Monatliche Mautstatistik Für Januar 2019" (German Federal Agency for Freight Transport, May 17, 2019), https://www.bag.bund.de/SharedDocs/Downloads/DE/Statistik/Lkw-Maut/19_Monatstab_01.html?nn=13100.

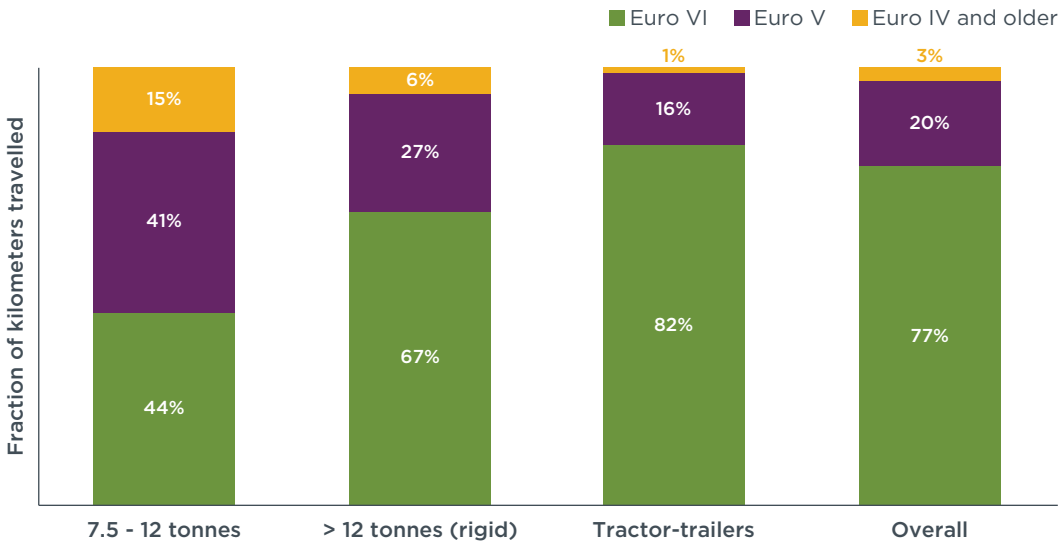

Figure 5. Distribution kilometers traveled by German trucks on German toll roads by Euro emission standards across different vehicle segments in January 2019. Data source: BAG, "Monatliche Mautstatistik Für Januar 2019."

Summary

Euro VI trucks account for only one quarter of the on-road commercial vehicle fleet in the EU. However, the fleet composition by Euro standard varies widely across member states. In Germany, Euro VI trucks still account for less than half of the fleet. However, the adoption rate of Euro VI vehicles in the tractor-trailer segment, responsible for most of the tonne-kilometers travel, is over 70%. Overall, more than three-quarters of the vehicle kilometers traveled is done by Euro VI vehicles. Euro IV and Euro V trucks drive shorter distances, indicating that their use is more focused on urban operation.

CO_2 EMISSIONS OF EURO VI VEHICLES VS. OLDER TECHNOLOGIES

The certification of CO_2 emissions of trucks is a recent addition to the type-approval requirements for heavy-duty vehicles. The CO_2 certification methodology was implemented in 2019, covering most of the vehicles in the over-16-tonnes segment. Therefore, there is no official data source to quantify the CO_2 performance of Euro VI trucks compared to older technologies.

In the absence of official, fleet-wide CO_2 performance values, other publicly available, yet limited, data sources are useful. Lastauto Omnibus, a German trucking magazine,[8] performs extensive real-world fuel consumption testing on a limited number of trucks over a fixed route and payload each year. Figure 6 shows the fuel consumption trends for long-haul tractor-trailers as measured by Lastauto Omnibus since 2002.

8 Lastauto Omnibus, "Fuel Consumption Data from Lastauto Omnibus Tests," *ETM Verlag*, n.d., www.lastauto-omnibus.de.

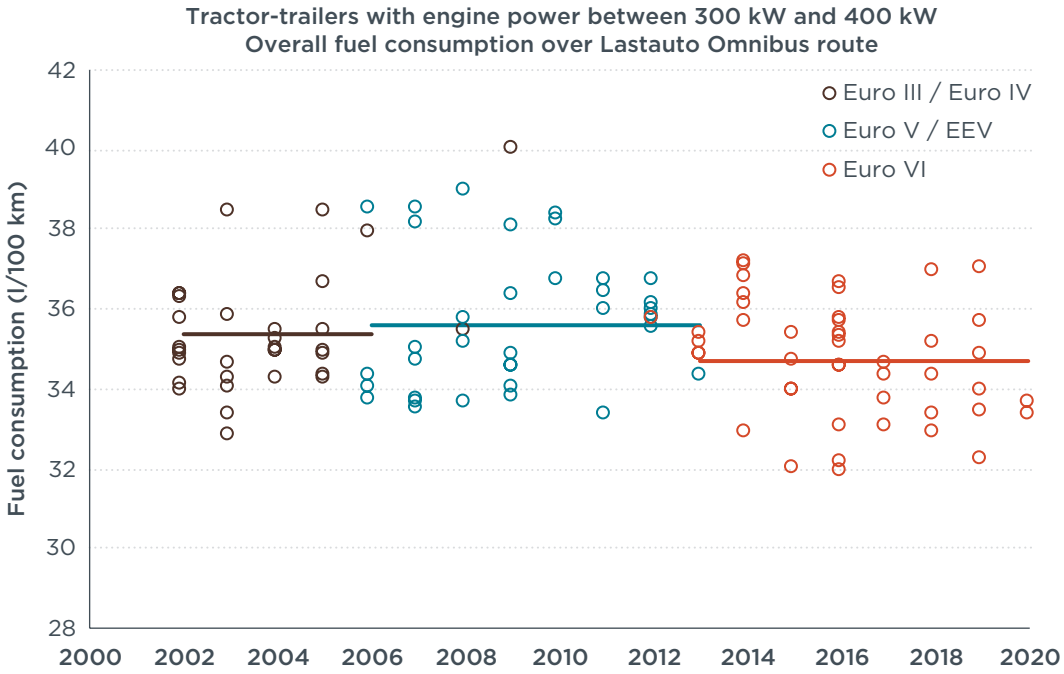

Figure 6. Fuel consumption of tractor-trailers with engines in the 300 to 400 kW power range, as measured by Lastauto Omnibus. Solid lines are average fuel consumption of trucks certified to the different Euro standards.

The long-term fuel consumption trends for heavy commercial vehicles in Europe indicate that the real-world fuel consumption of commercial fleets, and consequently their CO_2 emission performance, has been relatively stagnant over time. Reductions in pollutant emissions driven by the Euro VI standard were not accompanied by significant improvements in fuel consumption or reductions in CO_2 emissions. The available data, which is not necessarily representative of the fleet, suggests a fuel consumption improvement of Euro VI tractor-trailers of approximately 3%, or 1 liter of diesel every 100 km.

The adopted CO_2 standards for heavy-duty vehicles[9] aim to drive technologies onto the market that would curb the stagnant fuel consumption trend downwards. The adopted targets will reduce the certified CO_2 emissions from the highest emitting HDV segments by 15% in 2025 and by 30% in 2030, both relative to a baseline determined from 2019 and 2020 data.

While no official data is yet available to gauge what the baseline CO_2 level will be, the European Automobile Manufacturers' Association (ACEA) provides some insight. According to ACEA's data,[10] the certified average fuel consumption of Euro VI long-haul tractor-trailers registered in the second half of 2019 is approximately 30 l/100 km.[11] As shown in Figure 7, approximately 10% of long-haul trucks have a fuel consumption at least 7% better than the average, and 10% have fuel consumption at least 5% worse than the average.

9 Parliament and Council of the European Union, "Regulation (EU) 2019/1242 of the European Parliament and of the Council of 20 June 2019 Setting CO_2 Emission Performance Standards for New Heavy-Duty Vehicles and Amending Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC," *Official Journal of the European Union* L 198 (June 20, 2019), http://data.europa.eu/eli/reg/2019/1242/oj.

10 ACEA, "CO_2 Emissions from Heavy-duty Vehicles – Preliminary CO2 Baseline (Q3-Q4 2019)" (European Automobile Manufacturers Association, March 2020), https://www.acea.be/publications/article/paper-co2-emissions-from-heavyduty-vehicles-preliminary-co2-baseline.

11 Note that the certified fuel consumption cannot be directly compared with the Lastauto Omnibus data due to differences in payload and driving cycle.

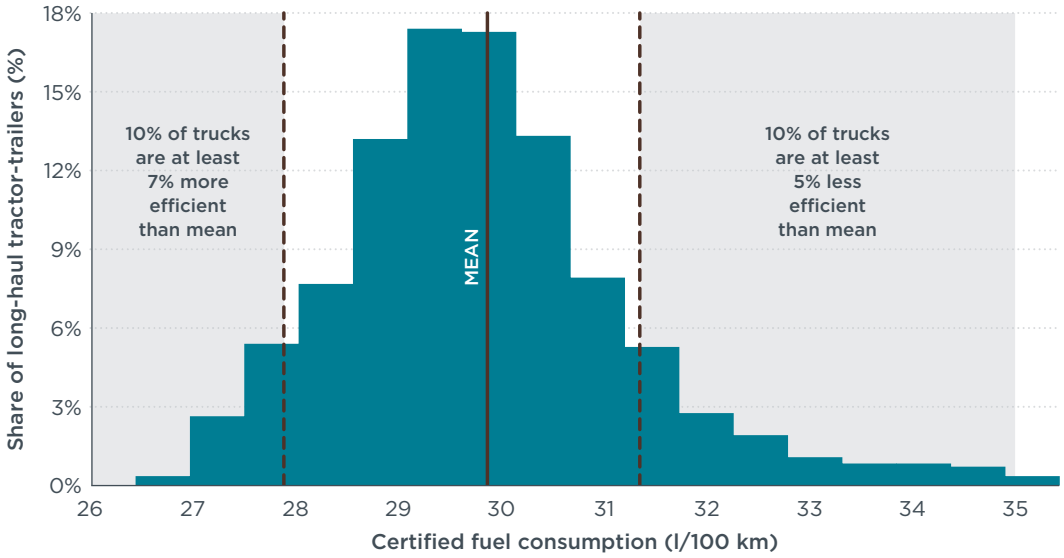

Figure 7. Distribution of the certified fuel consumption of Euro VI long-haul tractor-trailers registered in the second half of 2019. Data source: ACEA, "CO2 Emissions from Heavy-duty Vehicles – Preliminary CO2 Baseline (Q3-Q4 2019)."

Summary

There is no official data source that will allow a comparison of the fuel consumption of Euro VI vehicles with older technologies. Still, best available data indicates that the average fuel efficiency of Euro VI trucks has not significantly improved compared to previous emission standards. Nevertheless, the large range in the fuel consumption of Euro VI vehicles indicates that more fuel-efficient vehicles are available in the market in large volumes.

AIR POLLUTANT EMISSIONS

Over the past two decades, a series of increasingly stringent Euro standards for heavy-duty vehicles have been adopted. However, due to the large gap between certified and real-world emissions, heavy-duty vehicles continue to be a major source of NO_x emissions in the EU, accounting for around 40% of road transport.[12] The emission limits for key pollutants, as well as the implementation dates, are shown in Table 1.

Table 1. Euro emission standards for diesel heavy-duty vehicles over the transient test

	Implementation date (new types)	NO_x (g/kWh)	PM (mg/kWh)	PN (#/kWh)
Euro III	October 2000	5.0	160	-
Euro IV	October 2005	3.5	30	-
Euro V	October 2008	2.0	30	-
EEV	Voluntary until 2013	2.0	20	-
Euro VI	January 2013	0.46	10	6.0×10^{11}

While the emission limits set by the standards have been gradually tightened, the real emission performance of vehicles has not improved as expected. Heavy-duty vehicles built and certified to Euro IV and V emissions standards frequently do not

12 European Commission, "IMPACT ASSESSMENT. Accompanying the Document Proposal for a Regulation of the European Parliament and of the Council Setting CO_2 Emission Performance Standards for New Heavy Duty Vehicles" (Brussels, May 17, 2018), http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2018:185:FIN.

achieve considerable nitrogen oxide (NO_x) emissions improvements.[13] In addition, it was expected that the stricter particular matter (PM) emission standards of Euro IV and Euro V standards, compared to Euro III, would force the introduction of diesel particulate filters (DPF). However, by tuning their engines for high levels of NO_x and low soot formation, manufacturers were able to comply with the Euro IV and V emission standards without the use of filters. As a result, although the total mass of particulates decreased, Euro VI and V standards did not reduce emissions of the smallest and most dangerous particles.

The adoption of Euro VI, which went into effect in the EU starting with new vehicle types in 2013 and became mandatory for all new vehicles in 2014, not only tightened the NO_x certification level but also made significant changes to the certification test protocol. Compared to Euro V, Euro VI standards introduced new transient and stationary test cycles, a particle number (PN) emission limit, and added new on-road testing requirements for type-approval and in-service conformity. The introduction of the on-road test demanded more robust engine and aftertreatment calibrations, resulting in substantial improvements the in-use NO_x emissions performance of Euro VI trucks. Correspondingly, the new PN limit effectively forced the widespread adoption of DPFs. Figure 8 shows estimates for the real-world emission of Euro IV, V, and VI trucks.

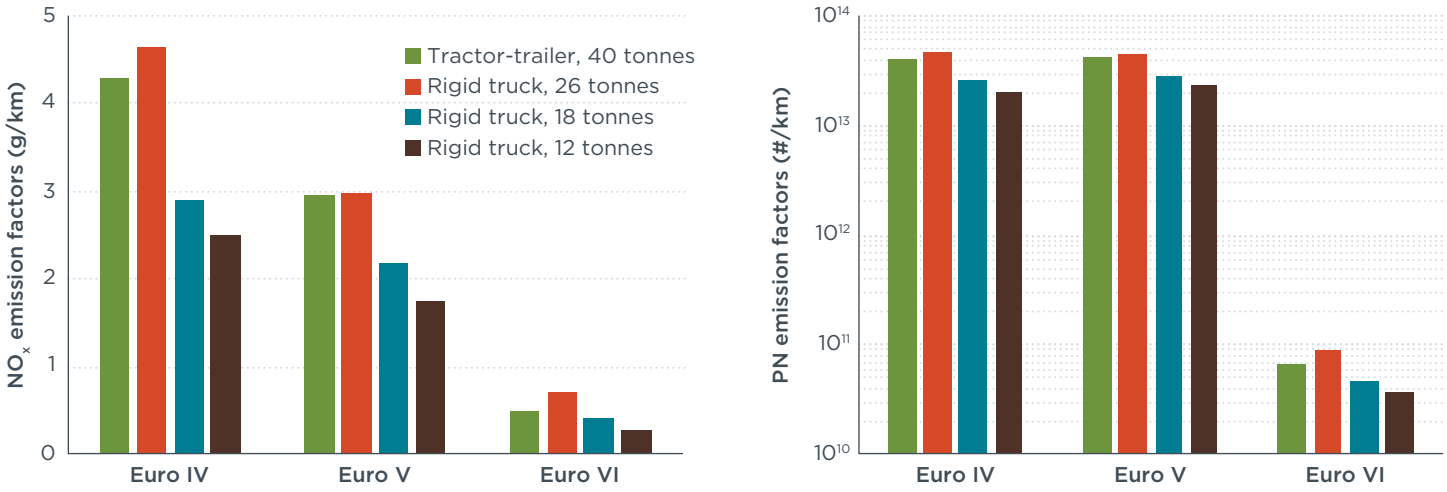

Figure 8. Emission factors by emission standards level for rigid trucks and tractor-trailers. Note that the y-axis scale in the right chart is logarithmic. Data source: HBEFA, Handbook Emission Factors for Road Transport, (version 4.1), https://hbefa.net/e/index.html.

While the overall NO_x emissions of Euro VI trucks represent a significant improvement, there are still challenges associated with urban operation that are not appropriately captured by emission factors, such as those shown in Figure 8. Low exhaust temperatures, like those found during cold-start and extended low-load operation, can significantly reduce the effectiveness of the emission control system. As a result, emission rates of Euro VI vehicles during urban driving are much higher than in other types of operation. Figure 9 shows the NO_x emission performance of 19 Euro VI trucks across three speed ranges as reported by the European Commission's

13 Rachel Muncrief, *Comparison of Real-World off-Cycle NO_x Emissions Control in Euro IV, V, and VI*, (ICCT: Washington, DC, 2015), https://www.theicct.org/publications/comparing-real-world-cycle-nox-emissions-control-euro-iv-v-and-vi.

Joint Research Centre (JRC),[14] the Association for Emissions Control by Catalyst (AECC),[15] and the ICCT.[16]

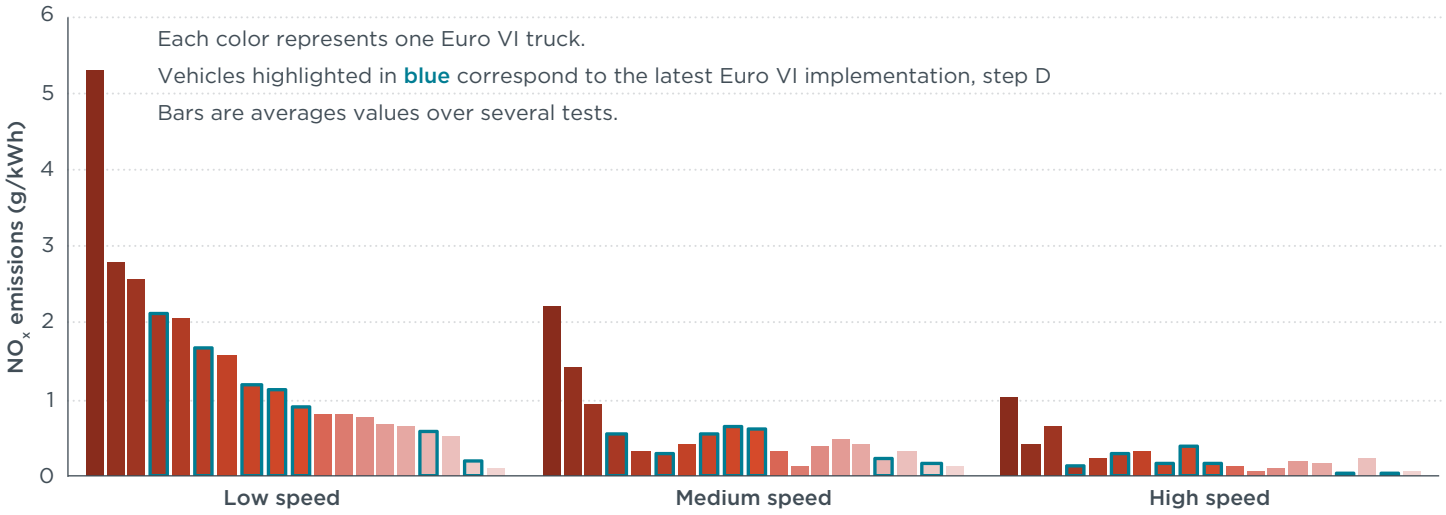

Figure 9. Real-world NO_x emissions of 19 Euro VI vehicles binned by speed ranges.

NO_x emissions during low speed driving, typical of urban operation, are on average 3 times higher than those occurring in the medium speed ranges, and approximately 6 times higher than the emission occurring in the high-speed ranges. The data also shows that there's a wide range in real-world performance of Euro VI trucks, particularly at low speed. The few Euro VI trucks included in this small data sample that were certified to the latest implementation of the standard, step D (highlighted in blue in Figure 9), do not necessarily fare better than previous Euro VI implementations (A through C). The addition of cold-start to the on-road test provisions in the next implementation step (Euro VI-E) scheduled for January 2021 is expected to address some of the issues that result in poor NO_x performance at low-speeds.

Summary

Euro VI trucks represent a substantial improvement compared to trucks certified to older Euro emission standards. Particulate emissions (PN) improved by almost three orders of magnitude. NO_x emissions in combined operation (i.e., a mix of urban, rural, and motorway) decreased by approximately 80%. Still, Euro VI trucks show poor performance in low speed driving, which is the operation that matters most for urban air quality. The next implementation of the Euro VI standard, step E, scheduled for January 2021, is expected to address some those issues.

POLICY RECOMMENDATIONS

The economic and environmental effectiveness of commercial fleet renewal programs in response to the recent COVID crisis must be carefully assessed by policy makers, particularly in comparison to other recovery measures. The recommendations below provide key elements to enhance the benefits of commercial fleet renewal programs, should that be the preferred measure.

14 Theodoros Grigoratos et al., "Real World Emissions Performance of Heavy-Duty Euro VI Diesel Vehicles," *Atmospheric Environment* 201 (March 15, 2019): 348–59, https://doi.org/10.1016/j.atmosenv.2018.12.042.

15 Association for Emissions Control, "AECC Project Results on Euro VI HDV Real-World Emissions," 2020.

16 Francisco Posada, Huzeifa Badshah, and Felipe Rodríguez, *In-Use NO_x Emissions and Compliance Evaluation for Modern Heavy-Duty Vehicles in Europe and the United States*, (ICCT: Washington, D.C, 2020), https://theicct.org/publications/inuse-nox-hdvs-us-eu.

Commercial fleet renewal programs that indiscriminately incentivize the purchase of new Euro VI heavy-duty vehicles, such as the one proposed by the German government in its economic recovery package, can be counterproductive. The commercial vehicle fleet is composed of heterogeneous segments that respond differently to economic shocks and fiscal incentives. Furthermore, the environmental impacts of the separate truck segments also differ in nature. Therefore, the economic, climate, and air quality benefits of fleet renewal programs can be improved by tailoring them to the different truck segments.

URBAN TRUCKS

At the onset of the last global economic crisis, the market for trucks under 16 tonnes, most of them being urban delivery vehicles, contracted less sharply than other vehicles segments. Yet, the impact of the crisis was longer-lived. Trucks under 16 tonnes, which represent around a quarter of the sales volume, also have the lowest market penetration of Euro VI vehicles. While Euro VI trucks have a much better pollutant emissions performance than older technologies, they still show poor performance in low-speed driving, which is the operation that matters most for urban air quality. The next implementation step of the Euro VI standards, step E, scheduled for January 2021, is expected to correct some of these issues.

A fleet renewal program targeting trucks under 16 tonnes would maximize its cost-effectiveness by only incentivizing Euro VI-E vehicles. Furthermore, given the higher market availability of zero-emission technologies in the urban truck segment, a fleet renewal incentive should include purchase premiums for zero-emission vehicles commensurate with their cost and environmental benefits.

LONG-HAUL TRUCKS

Tractor-trailers experienced the fastest recovery after global financial crisis of 2008, raising the question of whether market interventions, in the form of purchase premiums, would be a cost-effective use of limited recovery funds. Tractor-trailers, which have the highest market penetration of Euro VI vehicles, have not improved their average fuel efficiency in the past decade. Therefore, it is required to include a CO_2 component in the design of a fleet renewal program targeting long-haul trucks so that the policy intervention leads to a climate benefit. Fleet renewal premiums for long-haul trucks should be limited to trucks that emit at least 7% less CO_2 than the average. For a sustainable recovery, truck manufacturers should further be supported in bringing technologies to market that would help them meet the forthcoming CO_2 standards.

The implementation of the CO_2 certification regulation for heavy trucks in 2019 enables the introduction of CO_2 requirements into any fleet renewal program. The large spread in the fuel consumption of Euro VI vehicles indicates that there's a large number of fuel-efficient tractor-trailers on the market available for purschase to comply with a fleet renewal program that includes CO_2 requirements.