THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

BRIEFING

MAY 2018

CO_2 emissions and fuel consumption standards for heavy-duty vehicles in the European Union

Heavy-duty vehicles in the European Union so far have not been subject to carbon dioxide emissions or fuel-consumption standards, making Europe the largest market without mandatory limits for such vehicles. However, the European Commission is preparing a regulatory proposal that would set mandatory CO_2 limits for the heavy-duty vehicle (HDV) categories with the highest share of emissions. This paper summarizes key findings and policy recommendations from recent ICCT research related to HDV CO_2 standards in the European Union, including technology baseline and cost-effective CO_2 reduction potential for long-haul tractor-trailers, the highest-emitting vehicle category.

BACKGROUND

The European Union has set ambitious CO_2 emissions-reduction targets for the next three decades. Relative to 1990 levels,[1] the region aims by 2050 to reduce greenhouse gas emissions (GHG) from all sources by 80-95%. Figure 1 shows GHG emissions by sector. Despite mandatory CO_2 targets for new light-duty vehicles (LDVs), transportation is the only sector that has not reduced CO_2 emissions in recent years. This upward trend is mainly a consequence of the increase in passenger and freight transportation demand, which manifests itself in a growing vehicle fleet and an increasing number of kilometers traveled by those vehicles.

1 European Commission. (2011). *A roadmap for moving to a competitive low carbon economy in 2050*. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0112

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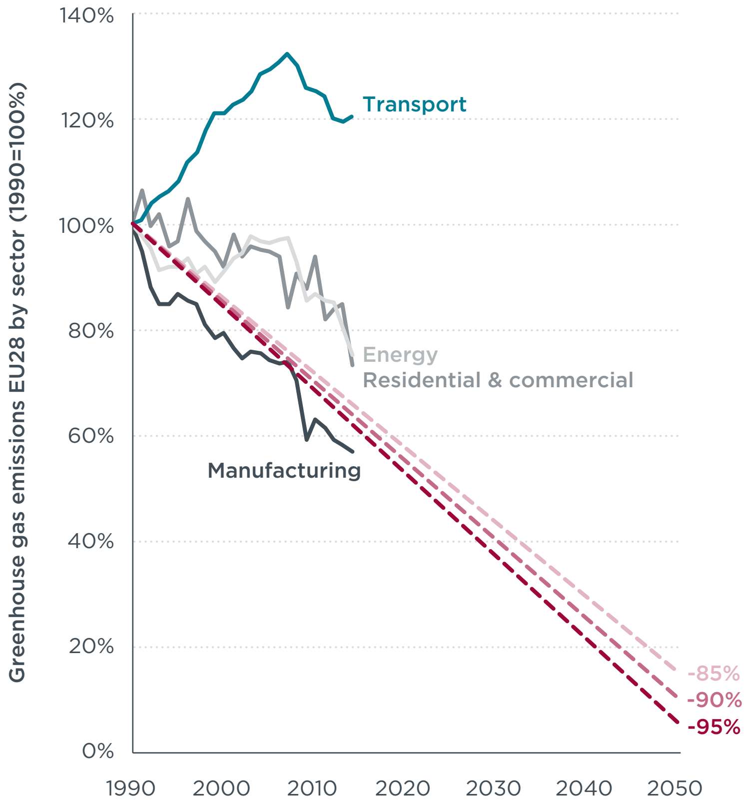

Figure 1. Greenhouse gas emissions in the European Union by sector, including linear emissions reduction trajectories (dotted lines) through 2050.[2]

The European Union also established a shorter-term binding target for reducing GHG emissions: 40% below 1990 levels by 2030.[3] To achieve this goal, the sectors covered by the EU Emissions Trading System (ETS)[4] must deliver a reduction of 43% in GHG by 2030, and the non-ETS sectors a reduction of 30%, both compared with 2005.[5] In the longer term, a reduction of at least 60% of GHGs by 2050 with respect to 1990 is required from the transport sector.[6]

Figure 2 shows the distribution of total CO_2 emissions (ETS and non-ETS) in 2015. Transport is one of the largest contributors, accounting for 32% of total emissions. HDVs are responsible for approximately 25% of the CO_2 emissions from road transportation, and due to growing freight demand and stagnating HDV fuel efficiency, are set to increase by as much as 10% by 2030.[7]

2 Mock, P. (2017). *2020-2030 CO_2 standards for new cars and light-commercial vehicles in the European Union.* Washington, DC: The International Council for Clean Transportation. Retrieved from https://www.theicct.org/publications/2020-2030-co2-standards-eu-cars-lcvs-20171026

3 European Commission. (2014). *A policy framework for climate and energy in the period from 2020 to 2030.* Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014DC0015

4 The EU Emissions Trading System covers power and heat generation, energy-intensive industry, and domestic commercial aviation. Non-ETS sectors include transport, residential, small businesses, and agriculture.

5 European Commission, 2014.

6 European Commission. (2011). White paper: Roadmap to a single European transport area—towards a competitive and resource efficient transport system. Retrieved from http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52011DC0144.

7 European Commission. (2016). *A European strategy for low-emission mobility.* Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Retrieved from http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52016DC0501

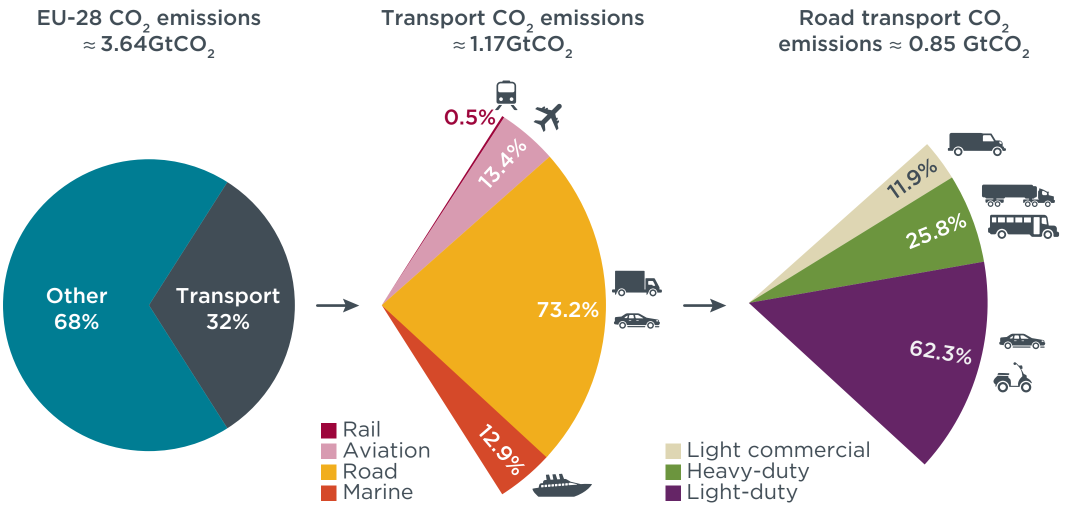

Figure 2. Distribution of total ETS and non-ETS direct CO_2 emissions in the European Union in 2015.[8] GtCO_2: gigatonnes of carbon dioxide

Average EU tractor-trailer fuel efficiency has remained flat for more than a decade. Figure 3 shows historical fuel consumption data of tractor-trailers with engines in the 300 to 400 kW power range, as measured by the technical magazine Lastauto Omnibus[9] over the past 14 years. Pollutant emission regulations and the associated introduction of pollution control technologies have a direct impact on the fuel consumption of HDV engines and seem to have offset any engine or vehicle efficiency improvements. As a result, the fuel consumption of HDVs has remained stagnant for years.

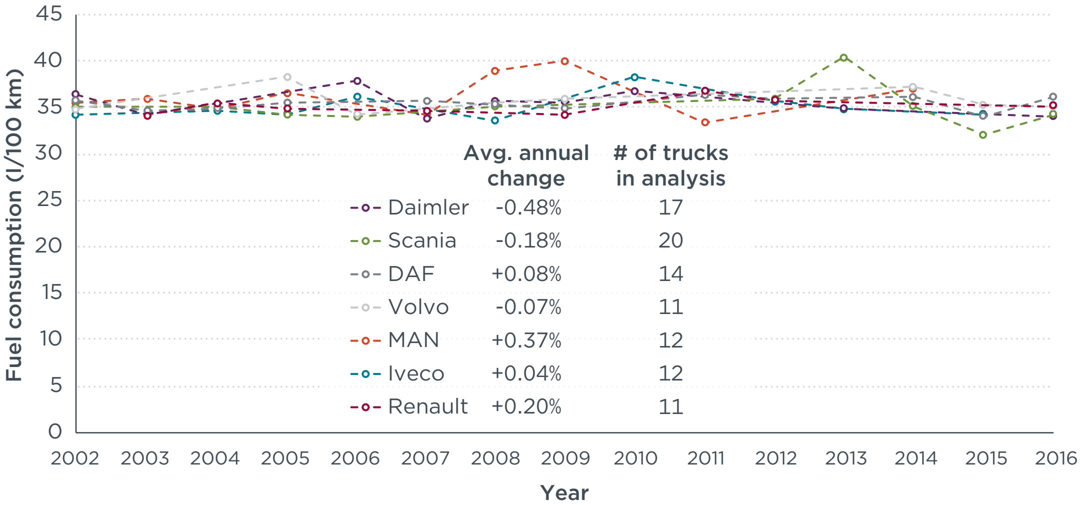

Figure 3. Fuel consumption of tractor-trailers with engine power between 300 and 400 kW.[10]

There are prevailing market barriers that prevent and delay technology uptake. Fuel cost represents about a quarter of operating cost for commercial trucking fleets, and there is a strong incentive to use fuel as efficiently as possible. Despite the flat fuel

8 European Environment Agency. (2017). *National emissions reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism.* Directorate-General for Environment, United Nations Framework Convention on Climate Change. https://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-13

9 Lastauto Omnibus is a German trucking magazine. The magazine performs extensive real-world fuel-consumption testing on a select number of HDVs each year. The testing route used by Lastauto Omnibus changed in the year 2010. However, the ICCT has not been able to estimate the impact of the new testing route on fuel consumption due to a lack of information on the speed and elevation profiles of each testing route.

10 Muncrief, R. (2017). Shell game? Debating real-world fuel consumption trends for heavy-duty vehicles in Europe [Staff Blog, The ICCT]. Retrieved from http://www.theicct.org/blogs/staff/debating-EU-HDV-real-world-fuel-consumption-trends

consumption trend observed in recent years, there is a set of available efficiency technologies with attractive payback periods that have not reached significant levels of market uptake (see Figure 6). This indicates that there are some prevailing market barriers, and market forces alone are not enough to guarantee technology adoption. Based on a review of the literature,[11] these barriers to technology adoption generally fall into four categories (see Figure 4):

1. **Uncertain return on investment.** A lack of credible information on the real-world performance of new technologies can lead to uncertainties about effectiveness, payback time, driver acceptance, reliability, and maintenance requirements.
2. **Capital cost constraints.** Upfront capital cost of a technology becomes a barrier when a trucking fleet is not able to secure initial capital to purchase the technology, despite attractive payback periods. Lower total cost of ownership is usually not a variable considered by lending institutions.
3. **Split incentives.** This market barrier occurs when the entity buying the technology is not the same entity that accrues the fuel-cost savings. For example, fleets can have provisions in their contracts under which fuel costs can be passed directly to the shippers, so there is no incentive for carriers to invest in fuel-consumption reduction technologies. Another example is when trailers towed by heavy-duty tractors are not owned by the trucking fleet. In that case there is an inadequate pass-through of price signals from trailer users to their buyers, which may result in low adoption of fuel saving technologies.
4. **Lack of technology availability.** Fleets can face barriers to acquiring certain technologies because of limitations placed by providers that either don't make a technology available in certain markets or offer it only as part of a wider package. In some cases, a technology might be available in the market but not from the fleet's preferred supplier.

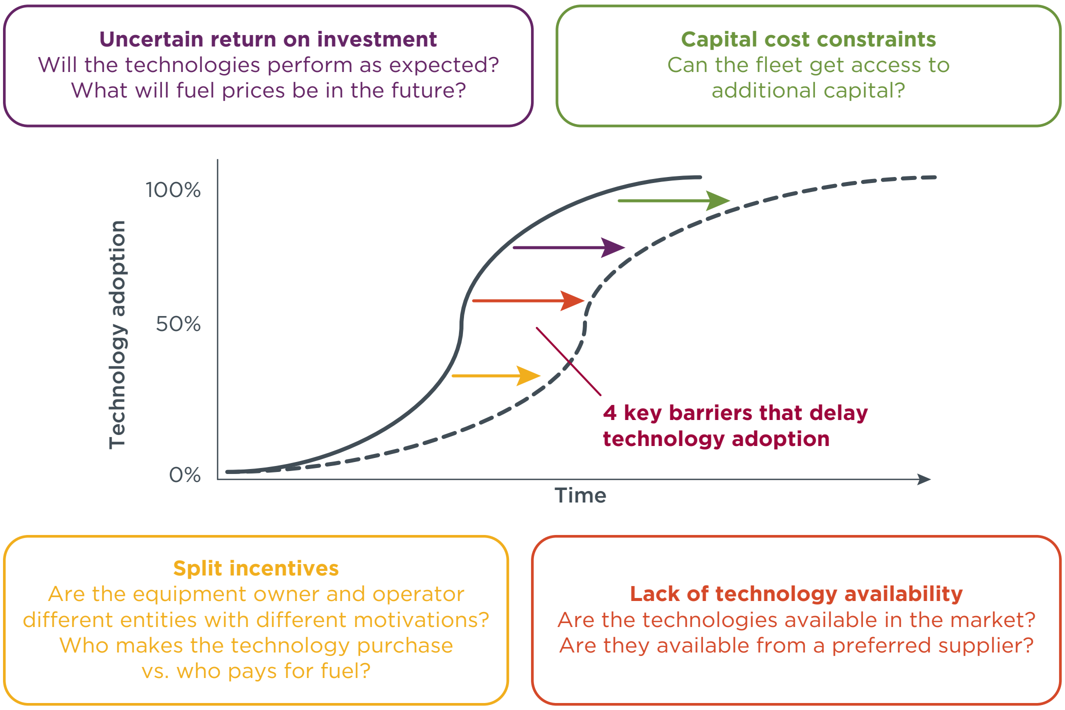

Figure 4. Four barriers that delay the uptake of fuel-saving technologies.[12]

11 Sharpe, B. (2017). *Barriers to the adoption of fuel-saving technologies in the trucking sector.* Washington, DC: The ICCT. Retrieved from http://theicct.org/barriers-to-fuel-saving-technologies-trucking-sector

12 Sharpe, 2017.

Given the increasing relevance of HDVs in the transport sector's CO_2 emissions, these market barriers justify strong regulatory measures that promote fuel-efficiency improvements and contribute toward meeting the European Union's CO_2 mitigation targets. In the light of these market inefficiencies, several countries around the world have already introduced CO_2 standards for HDVs.

The EU will be the last major HDV market to introduce fuel-efficiency standards. Japan established the first mandatory fuel-efficiency standards for HDVs in 2006, following a "top-runner" approach in which the standards are set based on the performance of the best vehicles in the market in the baseline year. Improvements were limited to engine modifications and resulted in modest emissions reductions of 1.2% per year. A second stage, proposed in 2017, incorporates additional technologies such as aerodynamics and tires. It targets 13-14% reductions on average for trucks and buses but only 3.7% for tractors.

China has issued three stages of progressively more stringent standards. The first stage, the "Industry Standard," was implemented in 2012 and covers three segments—tractors, straight trucks, and coach buses. The second stage, the "National Standard," went into effect in 2014. It incorporated city buses and dump trucks and tightened the limits by an average of 10.5-14.5%, depending on vehicle category. The proposal for Stage 3 would tighten fuel-consumption limits by an additional 12.5-15.9% and is scheduled to take effect in 2019.

The U.S. Phase 1 and Phase 2 GHG standards for HDVs are arguably the most comprehensive standards yet as they incorporate a larger set of technologies, including separate standards for engines and trailers. The highest fuel-consuming segment, tractor-trailers, will see reductions of about 50% in 2027.

In 2017, India finalized its first fuel-efficiency standards for commercial HDVs. Phase 1 goes into effect in 2018, and Phase 2, in 2021. The target reductions are about 11% on average. Figure 5 shows the relative stringency of the different tractor-truck efficiency standards with respect to the baseline defined when the standards were introduced.

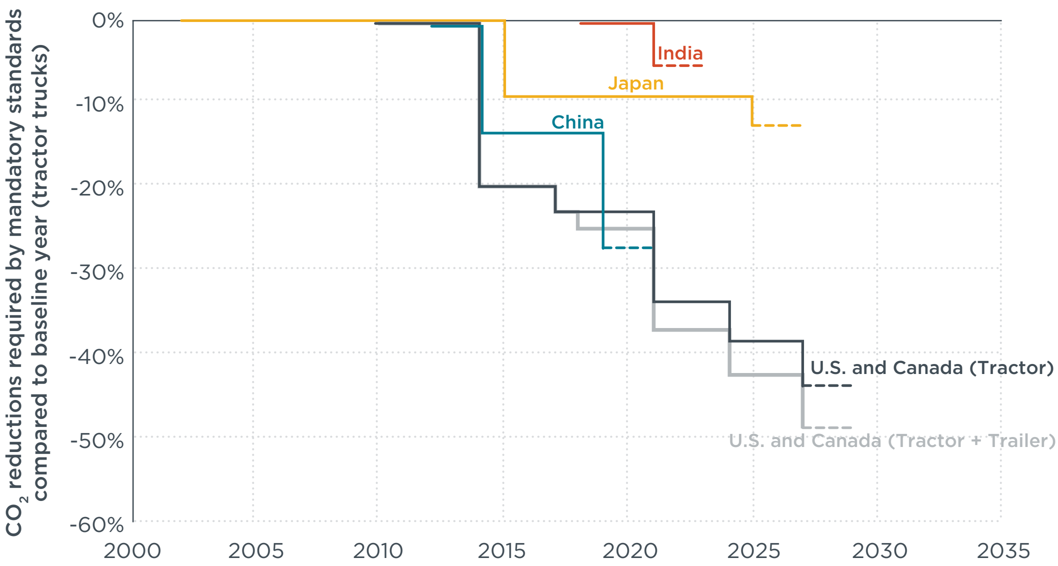

Figure 5. Tractor-truck standards around the world. The EU will be the last major economy to introduce HDV efficiency standards.[13]

13 A direct comparison of stringency among the standards is not possible with the information provided in the figure. The figure attempts to show the efficiency targets around the world in a single diagram by relating the reduction requirements to a fixed baseline. Note, however, that the technology baselines, testing methodologies, test cycles, allowed payloads, and evaluated metrics are country-specific. The figure is presented for illustrative purposes and does not capture all the underlying details that are common or different across regions.

The European Union will be the next region to propose mandatory CO_2 limits for HDVs. The proposed stringency and timing of the future standards had not been announced at the time of publication of this briefing paper. The policy pathway that the EU has followed for curbing CO_2 emissions of HDVs rests on three pillars:

1. A regulation for the declaration of the CO_2 emissions and fuel consumption of HDVs (using a tool known as VECTO).[14]
2. A monitoring and reporting scheme for HDV CO_2 emissions and fuel consumption.[15]
3. Mandatory CO_2 standards for new HDVs, to be announced in the first half of 2018.[16]

European vehicle manufacturers and suppliers have usually been at the forefront of technology developments but now are facing increasing global competition.[17] The standard-driven improvements in other markets can negatively affect the European companies' competitiveness in those regions as local manufacturers advance their research and development capabilities and improve their products. The coming proposal represents an opportunity to ensure that Europe's truck manufacturing industry remains competitive, that the pace of innovation and technology uptake is accelerated, and that those advances translate into lower operational costs for transport operators and more efficient and lower-cost freight delivery. The following sections seek to inform the stringency and timing of the expected proposal for HDV CO_2 standards.

CURRENT STATUS OF TRACTOR-TRAILER TECHNOLOGY

Market penetration of efficiency technologies is low. Available technologies that have the potential to reduce HDV fuel consumption have not reached significant levels of uptake because of market inefficiencies. Figure 6 shows technologies applicable to tractor-trailers, divided into four quadrants according to 2015 market penetration and potential for fuel-consumption reduction. Most of the technologies applicable to EU tractor-trailers are in the upper left quadrant, which contains the technologies that have less than 50% adoption in new vehicles and that provide more than 1% fuel economy improvements. This is the quadrant most relevant for future efficiency improvements.

14 European Commission. (2017, December 29). Regulation (EU) 2017/2400 of 12 December 2017 implementing regulation (EC) No 595/2009 of the European Parliament and of the Council as regards the determination of the CO2 emissions and fuel consumption of heavy-duty vehicles and amending directive 2007/46/EC of the European Parliament and of the Council and Commission Regulation (EU) No 582/2011. *Official Journal of the European Union L 349.* Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L:2017:349:TOC

15 European Commission. (2017, May 31). *Proposal for a Regulation of the European Parliament and of the Council on the Monitoring and Reporting of CO2 Emissions from and Fuel Consumption of New Heavy-Duty Vehicles.* Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52017PC0279

16 European Commission. (2017, May 31). *Europe on the move: An agenda for a socially fair transition towards clean, competitive and connected mobility for all.* Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52017DC0283

17 European Commission, 2017, May 31. *Europe on the move: An agenda for a socially fair transition towards clean, competitive and connected mobility for all.*

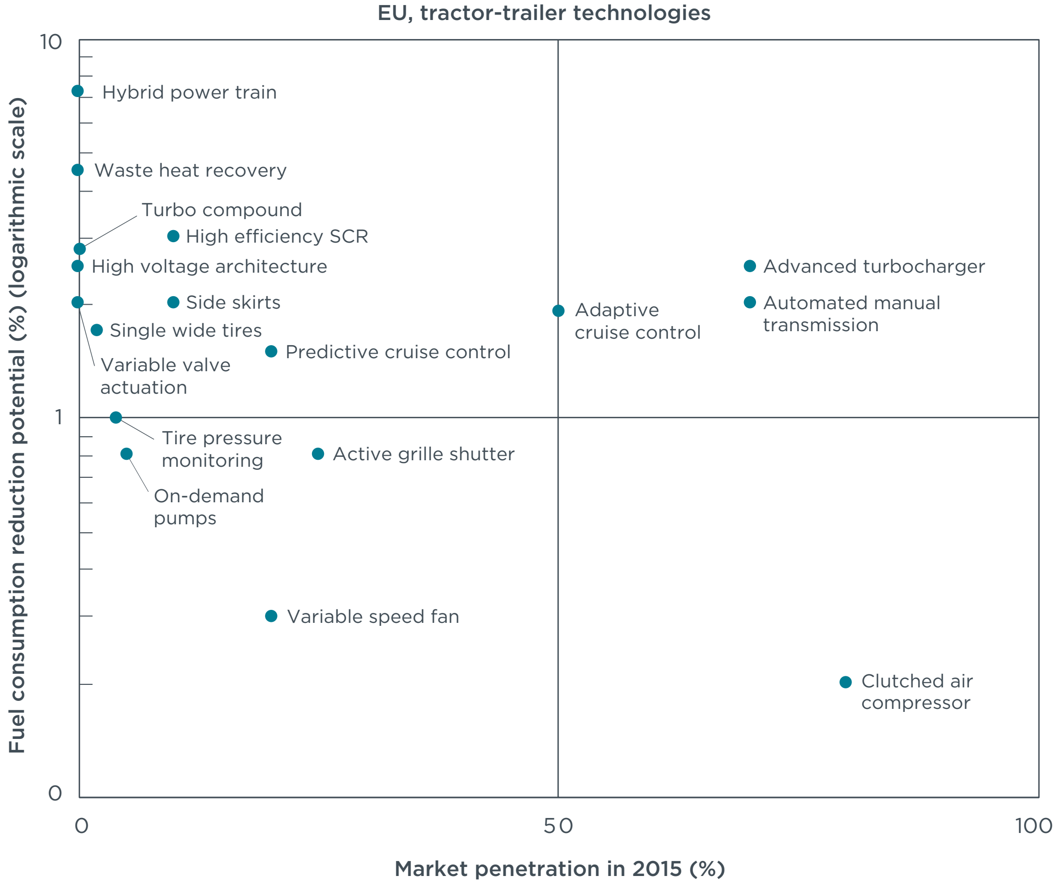

Figure 6. Market penetration and potential for fuel-consumption reduction of tractor-trailer technologies.[18]

2015 baseline tractor-trailer. A tractor-trailer baseline was developed using the technology penetration data in addition to registrations and sales data, findings from a literature review, consultation with experts, and purchase of component data from engineering service providers. The resulting technical specifications for the 2015 baseline tractor-trailer are shown in Figure 7. Using vehicle simulation,[19] the fuel consumption of the baseline tractor-trailer was estimated to be 33.1 L/100 km over the EU regulatory VECTO Long Haul cycle, with a regulatory payload of 19.3 tonnes. A comparison of the 2015 baseline tractor-trailer for the European Union with its 2015 counterpart in the United States shows slightly lower energy consumption by the EU vehicle. However, our modeling indicates that U.S. tractor-trailers in 2027 will be approximately 17% more efficient than the 2015 EU baseline.[20]

18 Rodríguez, F., Muncrief, R., Delgado, O., & Baldino, C. (2017). *Market penetration of fuel efficiency technologies for heavy-duty vehicles in the EU, the U.S. and China.* Washington DC: The ICCT. Retrieved from http://www.theicct.org/market-penetration-HDV-fuel-efficiency-technologies

19 Autonomie was the vehicle simulation modeling software tool used in this study.

20 Delgado, O., Rodríguez, F., & Muncrief, R. (2017). *Fuel efficiency technology in European heavy-duty vehicles: Baseline and potential for the 2020–2030 time frame.* Washington DC: The ICCT. Retrieved from http://www.theicct.org/EU-HDV-uel-efficiency-tech-2020-2030

Baseline specifications	Tractor-trailer
Gross vehicle weight (t)	40
Vehicle curb weight (t)	14.4
Axle configuration	4×2
Aerodynamic drag area (m²)	6.0
Tire rolling resistance (N/kN)	5.5
Engine emissions	Euro VI
Engine displacement (L)	12.8
Engine power (kW)	350
Engine peak efficiency (%)	44.8
Transmission type	AMT
Transmission gear number	12
Transmission gear ratios	14.93–1.0
Rear axle ratio	2.64
Accessory power (kW)	5.6

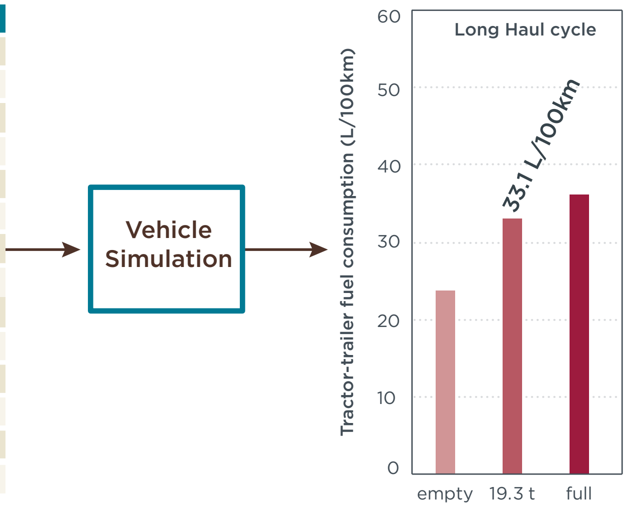

Figure 7. 2015 baseline tractor-trailer for the EU as identified by the ICCT's analysis.[21]

COST-EFFECTIVENESS OF TRACTOR-TRAILER TECHNOLOGIES

Substantial reductions in fuel consumption are feasible in the 2020-2030 time frame. With the aid of vehicle simulation modeling software, the ICCT estimated the baseline tractor-trailer's potential for reducing CO_2 emissions between 2020 and 2030. The analysis of technology potential[22] was performed as a stepwise addition of increasingly advanced technology packages, representing a possible pathway for exploiting the full technology potential for diesel-powered tractor-trailers.

Figure 8 shows how fuel consumption could feasibly be reduced with the introduction of different technology packages over time. The analysis is based on the EU Long Haul cycle at 19.3 tonnes of payload. Packages that offer reductions of as much as 27% could be implemented in the 2020-2025 time frame, as they largely consist of technologies that are already commercially available. The most efficient technology packages offer reductions of as much as 43%. They include technologies that are not yet commercialized but are either close to it, or have been demonstrated as a prototype, or have a proven pathway to development. These technologies could be phased in during the 2025-2030 time frame.

21 Delgado et al., 2017.
22 Delgado et al., 2017.

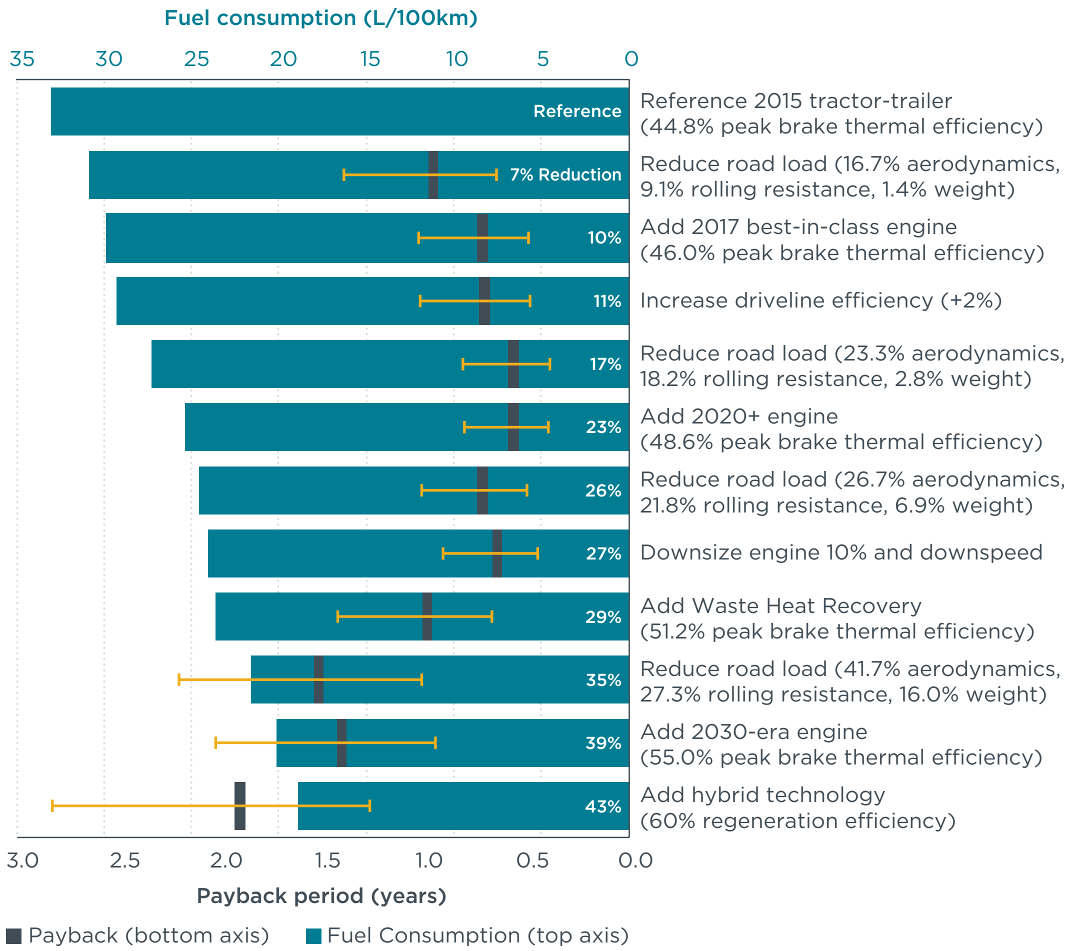

Figure 8. Cumulative fuel-consumption benefits and payback periods for tractor-trailer efficiency technologies in 2030 (EU Long Haul cycle at 19.3 tonnes of payload). The "whiskers" show payback period range under varying economic assumptions, including technology cost, fuel price, and discount rate.[23]

Figure 9 illustrates the potential 2030 reduction in fuel consumption from the baseline tractor-trailer through the application of a range of technologies. These include an engine with waste heat recovery and 55% peak efficiency, a hybrid powertrain, and advanced aerodynamics that require the redesign of the tractor front and an integrated aerodynamic tractor-trailer design. The use of such a technology package over the regulatory EU Long Haul cycle results in a 43% reduction of CO_2 emissions by 2030 compared with the 2015 baseline. The package offers even greater reductions over the Regional Delivery cycle. Increasing the thermal efficiency of the engine alone results in a reduction of 18% in fuel consumption.

The sole use of advanced trailer technologies allows for a 28% reduction in the air drag of the tractor-trailer, as well as a 14% reduction of in the rolling resistance and a 1,400 kg reduction in the combined vehicle mass. The application of these trailer-only improvements to the baseline tractor-truck translates in a 12% lower fuel consumption.[24]

23 Meszler, D., Delgado, O., Rodriguez, F., & Muncrief, R. (2018). *European heavy-duty vehicles—Cost-effectiveness of fuel-efficiency technologies for long-haul tractor-trailers in the 2025-2030 time frame* (Washington, DC: The ICCT). Retrieved from http://theicct.org/publications/cost-effectiveness-of-fuel-efficiency-tech-tractor-trailers

24 Rodriguez, F., Muncrief, R. & Delgado, O. (2018). *Comments regarding the cost-effective technology potential of tractor-trailers in the EU, in the context of the upcoming HDV CO2 standards.* Public comment. (Washington, DC: The ICCT). Retrieved from https://www.theicct.org/news/comments-ec-hdv-co2-stds-20180119

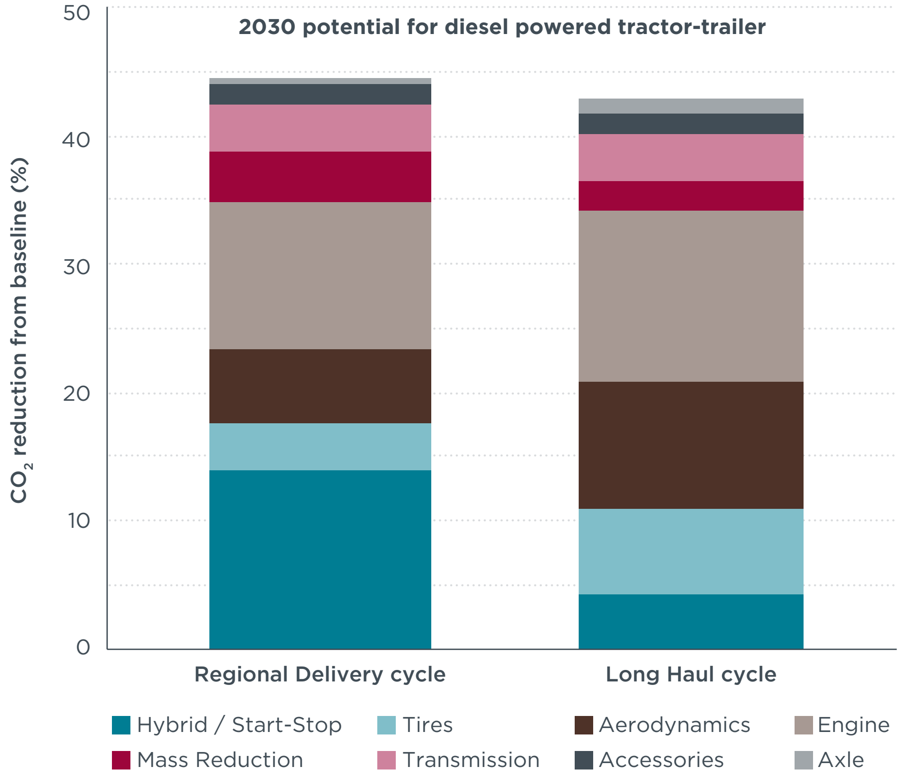

Figure 9. Potential 2030 fuel-consumption reduction of diesel-powered EU tractor-trailers over the regulatory VECTO Regional Delivery and Long Haul cycles, using the regulatory payloads mandated for CO_2 certification. The color bands provide an indication of the relative contribution of different technology categories and do not represent the absolute fuel-consumption reduction potential of improvements in specific subsystems.

Technology improvements are not only feasible but also cost-effective. To assess the cost-effectiveness of technology packages, the ICCT conducted a thorough economic analysis.[25] The fundamental approach involved deriving HDV technology costs from the best available data for assessing the cost-effectiveness of increasingly advanced technology packages. The key economic outputs were technology cost curves, payback periods, and net user economic benefits. To capture a range of possible economic scenarios, the study used three discount rates: 4%, 7%, and 10%; three diesel fuel prices per liter: €0.70, €1.10, and €1.40; and two evaluation years: 2025 and 2030. The economic assessment is based on 2016 euros, excluding value-added tax.

In Figure 8, the brown bars show the payback periods associated with technology packages under average economic assumptions. The “whiskers” of each payback band reflect the range of payback periods across worst- and best-case economic assumptions. The findings indicate that the payback periods for the technologies required to achieve a cumulative 27% reduction in fuel consumption are generally less than one year. This technological level can be achieved by 2025.

The most advanced technology package, with a potential fuel-consumption reduction of 43%, is estimated to cost €30,900 in 2030, increasing the price of the baseline tractor-trailer by approximately 20%. The contribution of the different technology areas to the overall cost increase is detailed in Figure 10.

25 Meszler et al., 2018.

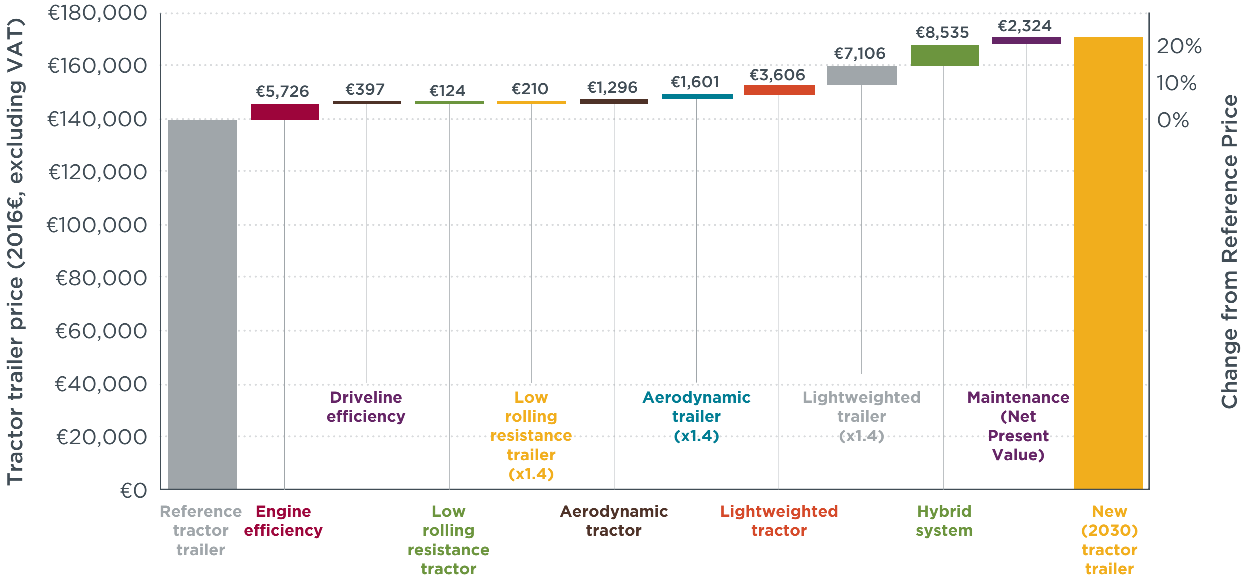

Figure 10. Tractor-trailer cost increase for the most advanced efficiency technology package in 2030.[26]

While upfront technology costs can be significant, the economic return and short payback times more than justify an investment in efficiency technologies. The most advanced package has a payback period of 1.7 years under average economic assumptions of €1.1/liter of diesel and a 7% discount rate. The attractive payback periods of tractor-trailer efficiency technologies persist even under the most unfavorable economic conditions analyzed—higher technology costs, low fuel prices, and high discount rates. In the worst-case scenario—€0.7/liter of diesel and 10% discount rate—the most advanced technology package would have a payback period of 2.7 years in the year 2030.

Beyond the payback period, HDV efficiency technologies provide significant economic benefits by reducing the operating costs related to fuel. For first owners who typically keep a vehicle five years, available efficiency technologies offering a 43% reduction in fuel consumption for new 2030 tractor-trailers would result in €73,000 in fuel savings, or 2.5 times the initial capital investment, under average economic assumptions. Under the best-case scenario of €1.4/liter for diesel and a 4% discount rate, fuel savings would be as much as €98,000, or 3.3 times the initial capital investment. Over the complete vehicle lifetime, the same set of technologies would result in fuel savings of approximately €115,000 per tractor-trailer under average economic assumptions and as much as €167,000 in the best-case scenario.

BEYOND CONVENTIONAL DIESEL-POWERED TRACTOR-TRAILERS

Emerging zero-emissions technologies might prove essential to fully decarbonize the transport sector. The diesel technologies discussed so far are attractive for achieving CO_2 reductions in the 2020-2030 time frame, but they can do so by only about 40-45%. These technologies might prove limited in the post-2030 period, when much deeper emission cuts will be necessary to meet ambitious environmental goals. An ICCT study[27] assessed total cost of ownership for conventional diesel-powered and zero-emissions

26 Meszler et al., 2018.

27 Moultak, M., Lutsey, N., & Hall, D. (2017). *Transitioning to zero-emission heavy-duty freight vehicles.* Washington DC: The ICCT. Retrieved from https://www.theicct.org/publications/transitioning-zero-emission-heavy-duty-freight-vehicles

vehicles. Figure 11 illustrates the findings for the European Union. In the 2030 time frame, excluding infrastructure costs, overhead catenary electric heavy-duty vehicles would have a total cost of ownership of approximately 26% less than that of diesel vehicles. Hydrogen fuel-cell vehicles are estimated to have a 22% lower total cost of ownership than diesel vehicles. These technologies offer lifecycle CO_2 emissions reductions of 85% for catenary electric and 72% for hydrogen fuel cell as compared with a 2015 conventional diesel baseline (see Figure 12).

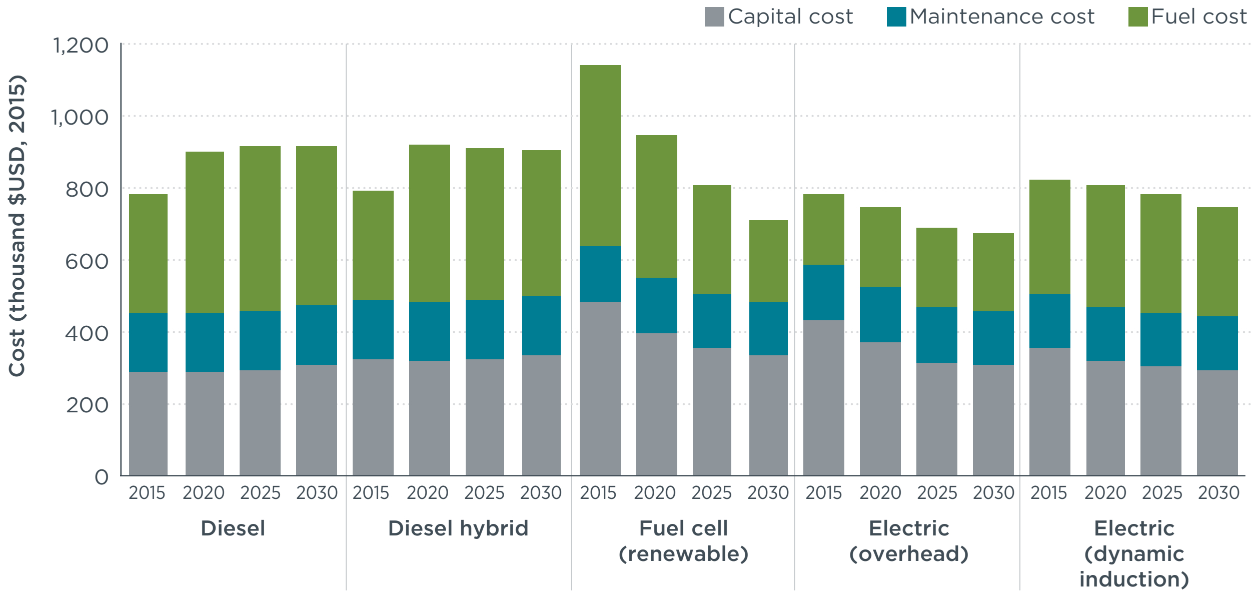

Figure 11. Cost of ownership in Europe for long-haul heavy-duty truck technologies for a vehicle purchased in 2015–2030 broken down by capital cost, maintenance cost, and fuel cost.[28]

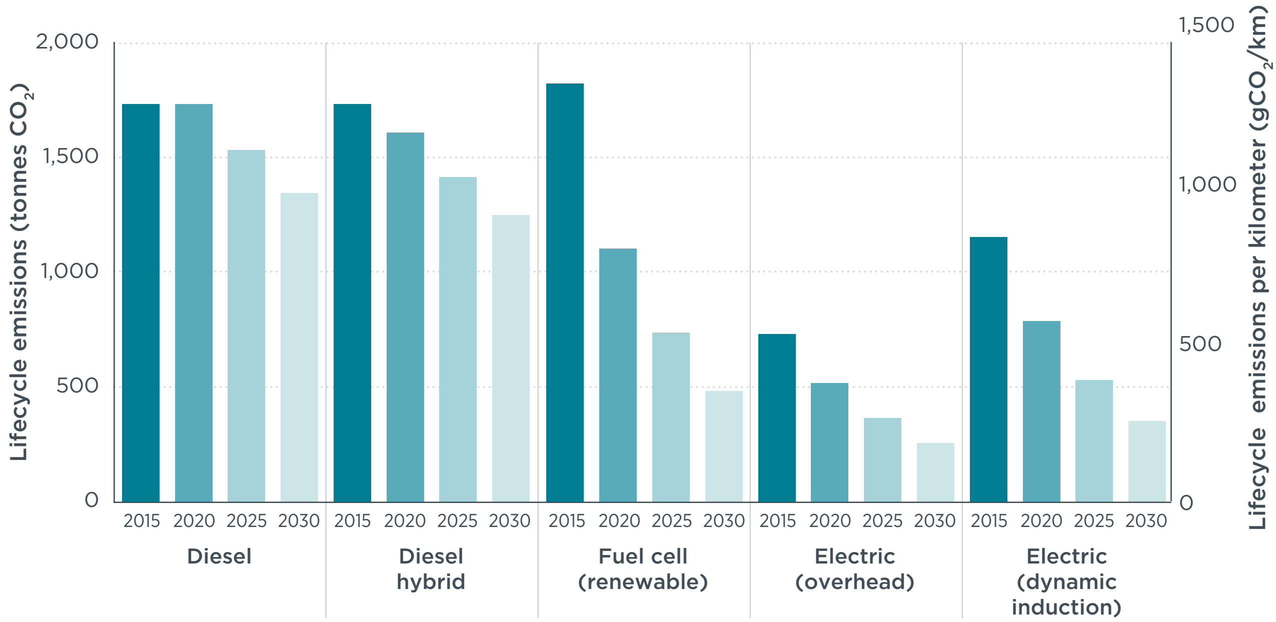

Figure 12. Long-haul tractor-trailer lifecycle CO_2 emissions over vehicle lifetime (left axis) and per kilometer (right axis) by vehicle technology type.[29]

Adoption of these technologies, however, must overcome formidable barriers and will require sustained and extensive infrastructure investments by government and industry. The required infrastructure is particularly important for long-haul heavy-duty tractors, as

28 Moultak et al., 2017.
29 Moultak et al., 2017.

these trucks cover large distances and would need extensive infrastructure for charging, such as overhead catenaries or fast chargers, or for hydrogen refueling. Once completed, the infrastructure would enable high utilization, which would allow for overall system costs to be spread over many heavy-duty vehicles over time.

POLICY OPTIONS

Stringent long-term standards will ensure technology development and deployment. The attractive and robust payback periods of efficiency technologies and their associated net economic benefits indicate that there are prevailing market barriers to technology introduction, warranting the introduction of stringent, technology-forcing efficiency standards. HDV efficiency standards are the single largest regulatory lever that policy makers can adopt to mitigate CO_2 emissions from the on-road freight sector. The EU has set reduction targets for non-ETS emissions of 30%[30] in the 2005-2030 period and for transport of 60%[31] in the 1990-2050 period. To achieve these goals, it is advisable to develop and introduce stringent, long-term standards that provide the lead time required for deployment of new technologies while also guaranteeing significant CO_2 reductions.

Separate engine and trailer standards would guarantee emission reductions in key areas. About one-third of the projected fuel-efficiency gains shown in Figure 9 come from engine improvements. In contrast with some vehicle-level technologies, engine improvements translate to CO_2 benefits across a wide range of vehicle duty cycles and payloads and remain with a vehicle for its full lifetime. A separate engine standard in conjunction with a full-vehicle standard will send the required regulatory signal to help ensure long-term investment in engine efficiency technology R&D. This will help maintain the European Union’s international leadership on HD engine regulations and could be used to cover vehicle segments that are not included in the first roll-out of the CO_2 standard, ensuring that some reductions are achieved in all segments. Development of a separate HD engine CO_2 standard could be accomplished in the European Union using the existing EU engine type-approval data combined with the approach followed for the U.S. Phase 2 regulation, as described in a study by the ICCT.[32]

Because of the significant impact of trailers in the road load forces of long-haul tractor-trailers, it is desirable to include them in the regulatory measures targeting efficiency improvements in HDVs. Trailer efficiency standards would incentivize the development and deployment of trailer road-load reduction technologies—aerodynamics, low rolling-resistance tires, and light-weighting—that would account for fuel-consumption reductions of as much as 12% in 2030.

CO_2 REDUCTION SCENARIOS

2030 Scenarios. Figure 13 shows the projected impacts of adopted, proposed, and potential CO_2 standards for LDVs and HDVs on direct CO_2 emissions from the EU vehicle fleet to 2030. The estimates of direct CO_2 emissions from cars, vans, trucks, and buses in the European Union are projected using the ICCT’s global transportation roadmap

30 European Commission, 2014.

31 European Commission, 2011.

32 Muncrief, R., & Rodriguez, F. (2017). *A roadmap for heavy-duty engine CO2 standards within the European Union framework.* Washington, DC: The ICCT. Retrieved from https://www.theicct.org/publications/roadmap-heavy-duty-engine-co2-standards-within-european-union-framework

model.[33] Under the adopted 2020/2021 standards for cars and vans, LDV emissions are projected to be 20% below 2005 levels by 2030. The recent proposal for 2025 and 2030 CO_2 targets for cars and vans are projected to result in 29% lower CO_2 emissions by 2030, compared with 2005 levels.[34] Since the European Commission's proposal for LDVs does not exhaust the cost-effective potential for reducing CO_2 from cars and vans, Figure 13 includes an additional LDV scenario, corresponding to a 70% reduction in LDV fuel consumption from 2021-2030.

By contrast, truck and bus emissions are projected to grow in the absence of mandatory CO_2 targets. The ICCT Roadmap Model was used to estimate the impact of a CO_2 standard for HDVs with a moderate ambition, corresponding to CO_2 reductions of 20% for rigid trucks and 27% for tractor-trailers by 2030.[35] The moderate CO_2 standard could reduce HDV fleet emissions by approximately 9% below 2005 levels. More-stringent HDV standards relying on the entire potential of cost-effective technology, equivalent to a 32% fuel-consumption reduction for rigid trucks[36] and 43% for tractor-trailers,[37] could lower HDV fleet emissions by about 18% compared with 2005 levels.

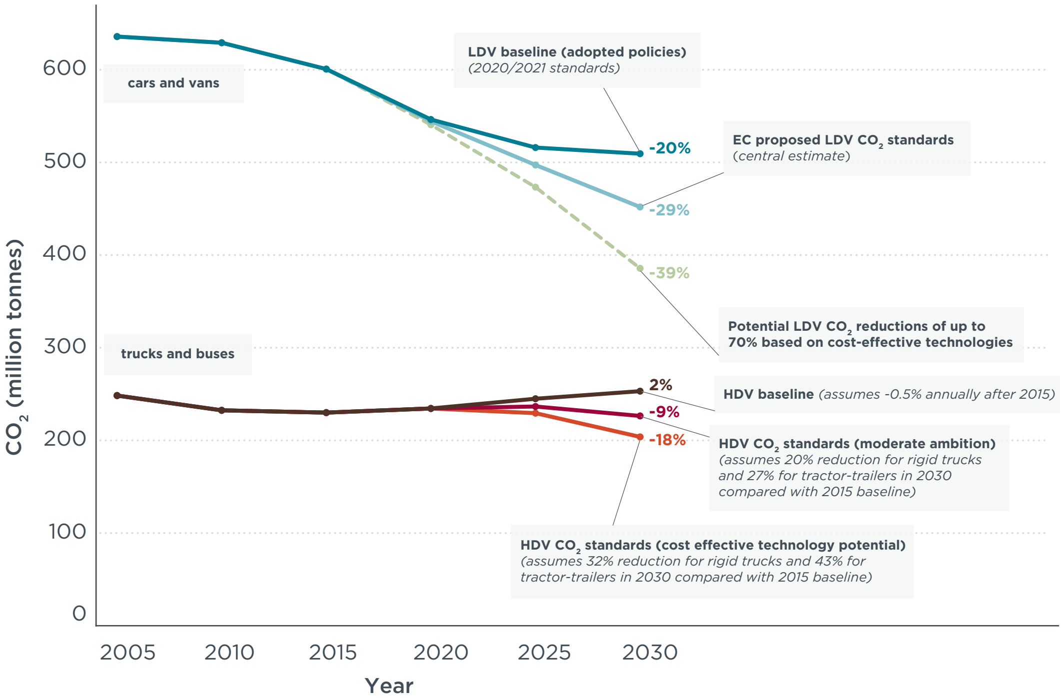

Figure 13. *Direct CO_2 emissions in the European Union from LDVs and HDVs with adopted, proposed, and potential CO_2 standards. Data labels for 2030 show the percentage change in emissions from 2005 levels. Results are estimated using the ICCT Roadmap Model.*[38]

33 The model uses historical data for freight activity (tonne-km) and vehicle registrations sourced from the International Energy Agency's Mobility Model and checked for consistency with the ICCT's European Vehicle Market Statistics Pocketbook. Future activity levels for trucks are based on projected growth rates to 2050 from the EC's "EU Reference Scenario 2016." Load factors, defined as tonnes of cargo per vehicle-km, have been calibrated to align with the European Environment Agency's data for historical CO2 emissions from road transport. Further information on the ICCT's transportation model can be found at https://www.theicct.org/transportation-roadmap

34 Dornoff, J., Miller, J., Mock, P, & Tietge, U. (2018). *The European Commission regulatory proposal for post-2020 CO2 targets for cars and vans.* Washington, DC: The ICCT. Retrieved from https://www.theicct.org/publications/ec-proposal-post-2020-co2-targets-briefing-20180109

35 Dornoff et al., 2018.

36 Norris, J., & Escher, G. (2017). *Heavy Duty Vehicles Technology Potential and Cost Study.* Harwell, Oxfordshire, U.K.: Ricardo Energy & Environment. Retrieved from https://www.theicct.org/publications/heavy-duty-vehicles-technology-potential-and-cost-study

37 Meszler et al., 2018.

38 Dornoff et al., 2018.

2050 Scenarios. Figure 14 shows the combined effects of adopted, proposed, and potential CO_2 standards on EU road transport CO_2 emissions to 2030, compared with the EU targets for the years 2030 and 2050. The benefits of more-stringent targets are more salient when put into perspective with long-term climate goals. The EC's proposed LDV standards, together with potential HDV standards with moderate ambition, would reduce fleet-wide CO_2 emissions by approximately 1.4% annually from 2020 to 2035. To meet a long-term climate target such as the 60% reduction in total transport emissions from 1990 levels targeted by the European Union,[39] fleet-wide CO_2 emissions would have to be reduced more than three times as quickly, or 5.5% a year, from 2035 to 2050. Setting more ambitious LDV and HDV CO_2 standards for 2021–2030 would increase the likelihood of meeting the long-term climate target. As depicted below, fleet-wide CO_2 emissions could be reduced by approximately 3.0% yearly from 2020 to 2035. Fleet-wide emissions would still need to fall by at least 3.9% annually from 2035 to 2050 to meet the European Union's long-term climate target. HDVs with zero-emissions technology will need to be phased in within this time frame to meet those goals. Consequently, forward-looking HDV CO_2 standards should include provisions to incentivize early development of zero-emissions technology.

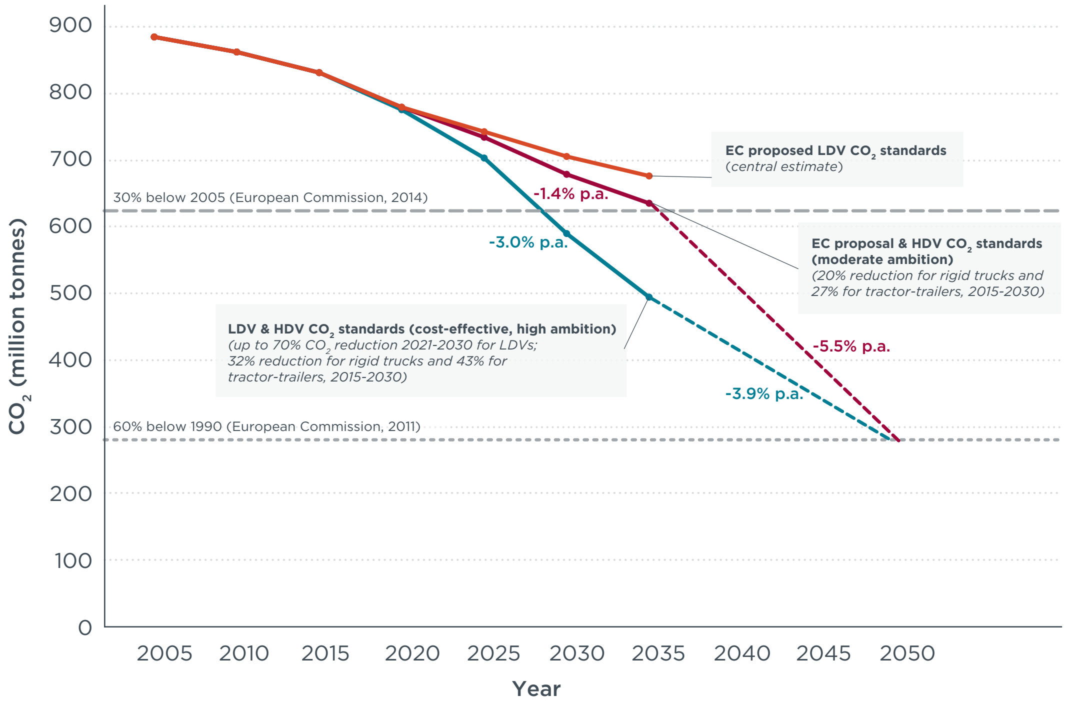

Figure 14. Direct CO_2 emissions in the European Union from road transport (excluding motorcycles) with adopted, proposed, and potential CO_2 standards against the EU CO_2 mitigation targets. Results are estimated using the ICCT Roadmap Model.[40]

CONCLUSION

A well-designed, technology-forcing standard can be beneficial for all stakeholders, ensuring CO_2 reductions while at the same time lowering the total cost of ownership for transport operators. Standards create a level playing field for manufacturers as they all are required to make investments and improve their products. This will help EU manufacturers to stay at the forefront of technology and remain competitive in international markets. The stringency of the coming HDV CO_2 standards for the European Union ideally would be set at a level in line with the EU climate goals for 2030 and include provisions to incentivize early development of zero-emissions technologies.

39 European Commission, 2011.

40 Dornoff et al., 2018.