Lorry CO_2 – why Europe needs standards

July 2015

A briefing by TRANSPORT & ENVIRONMENT

Summary

In October 2014, EU heads of state committed to reduce emissions in the non-ETS sectors by 30% in 2030, compared with 2005 levels. A legal proposal for the so-called 'effort sharing decision' (ESD) will be issued in mid-2016 allocating responsibility between countries.

Transport is the biggest sector in the ESD with a share of 34%, and heavy-duty vehicles are responsible for around a quarter of transport emissions. Between 1990 and 2010 lorry CO_2 emissions rose 36% and this increase is projected to continue. The International Transport Forum, an OECD think tank, estimates the increase of road freight emissions means freight emissions will overtake passenger transport emissions as the largest source of emissions.[1]

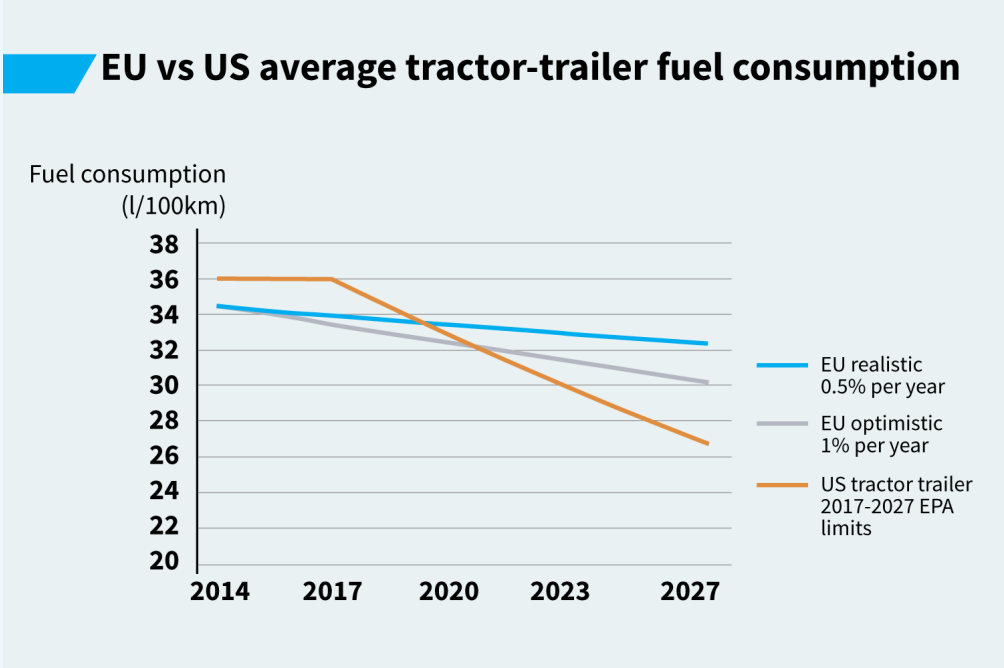
In its May 2014 communication[2] the European Commission acknowledges there is a problem – rising CO_2 emissions and stagnant lorry fuel efficiency – and proposes to introduce a 'monitoring, reporting and verification' (MRV) scheme for lorries. Similarly, the 2015 Energy Union communication[3] talks about 'measures' to improve lorry fuel efficiency but only commits to introducing an MRV in 2016. This is a welcome first step but will not deliver the required change and must be supported by CO_2/fuel efficiency standards, as has happened for cars and vans. There are five reasons for this:

1) Member states need EU help to reduce CO_2 emissions from trucks and meet the 2030 ESD targets. Lorry emissions have been on the rise for decades and while more goods are transported by road, lorry fuel economy has been stagnant since the mid-1990s (see graph p7).[4] The resulting increase in truck emissions is negating the progress made by cars and vans. Member states have limited ability to reduce lorry emissions. Standards are a proven tool to overcome market barriers and improve fuel efficiency in a cost-effective manner.

2) More fuel-efficient lorries are good for business, the economy and energy security. Diesel represents up to a third of the lorry operating costs and diesel imports for road freight cost the EU €60 billion a year. According to studies for the Commission, lorries could be at least 35% more fuel-efficient using existing technology without increasing operating costs for hauliers. CO_2 standards would ensure fuel-saving technologies are fitted as standard rather than as expensive options. The increased up-front cost would be quickly recovered through lower fuel bills and free up some €18 billion for new investments which would benefit the EU economy and create over 30,000 new jobs in the lorry manufacturing industry.

3) Europe must act to fend of America's challenge to its truck supremacy. 20 years of stagnating fuel efficiency and the introduction of fuel economy standards in other truck-producing regions like Japan (2005), the US (2011) and China (2015) have eroded Europe's leadership on truck fuel efficiency. The US has just announced a new truck fuel efficiency standards that will improve new truck fuel efficiency from around 36l/100km in 2014 to below 27l/100km in 2027. As shown in the graph below, this will make US trucks the most technologically advanced and fuel efficient in the world. At the same time it will give the US

the world's most advanced and comprehensive regulatory framework which will undermine the EU's regulatory leadership.



4) The technology to make trucks more efficient is there. Studies for the Commission estimate that fuel savings would come from better aerodynamics, tires as well as incremental powertrain improvements and the stepwise introduction of advanced technologies such as waste heat recovery and hybridisation could make trucks 35% more efficient without increasing the costs of ownership for hauliers. A 2015 study by the International Council on Clean Transportation found that for US trucks fuel savings of up to 54% would pay back within 2.5 years. Also in the US Daimler just presented a truck concept that achieves below 20l/100km fuel consumption – a 115% improvement compared to a 2009 model.[5]

5) The market alone cannot deliver the required emission cuts. While fuel is an important cost for hauliers, it is far from their only consideration when buying a new truck. One reason for this is that the differences between brands are very small and that (alleged)[6] cartel practices by truckmakers undermine effective competition. Another reason is that the haulage market is dominated by small hauliers (85% of the market) that often see investments in fuel saving technologies as cumbersome, and risky, partly because of tight margins but also because of difficult access to finance.

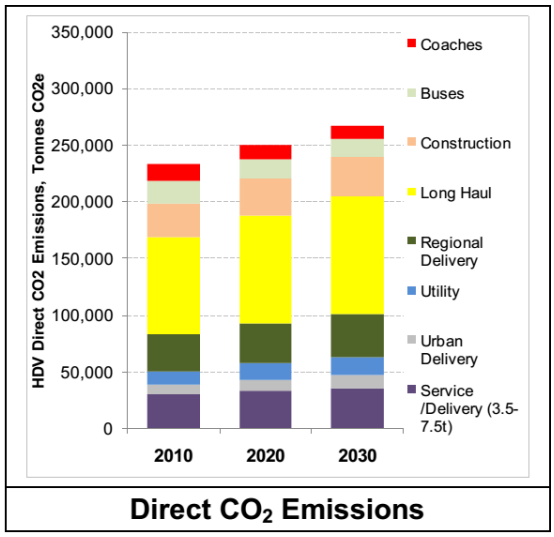
What the EU should do:

In 2016 the Commission will issue the 2030 'effort sharing decision package' and propose a 'Monitoring Reporting and Verification mechanism' for trucks. The Commission also intends to issue a decarbonisation of transport communication. **These proposals should be accompanied by a credible post-2020 strategy for trucks and followed by a legislative proposal to set mandatory limits on average CO_2 emissions from newly registered trucks.**

The post-2020 trucks strategy should provide a clear timeline for the standards proposal, an indication of likely target years as well as the required improvements by 2025-2030. With this communication and the subsequent proposal the Commission would provide investment certainty to truckmakers and automotive suppliers but also help member states plan policies to achieve the 2030 climate goals.

1. CO2 emissions from lorries are growing rapidly

With just 3% of vehicles, lorries are responsible for 25% of road transport emissions and ca. 6% of total EU emissions. That share is increasing; between 1990 and 2010 lorry emissions rose by 36%[7] and without action they could increase by another 22% by 2030.[8] According to a 2015 report by the International Transport Forum, an OECD think tank, surface freight emissions in Europe are set to increase by 28-55% by 2050. The long-haul and regional delivery segments represent 60% of total trucking emissions.[9]



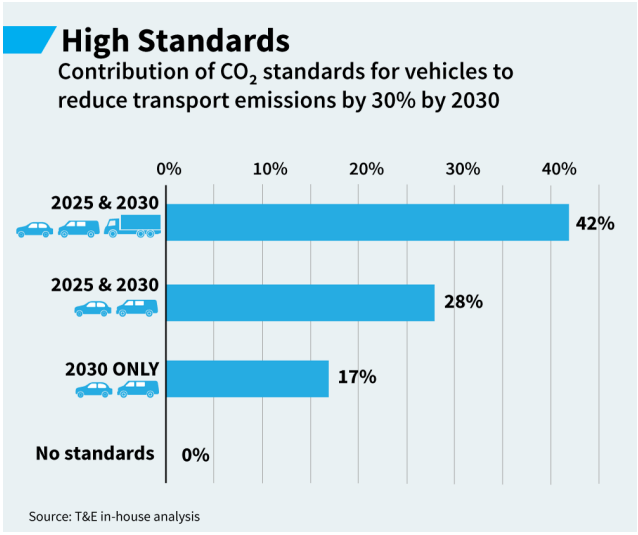
AEA-Ricardo, study for the EC 2011

The combination of growing demand for freight transport and stagnating fuel economy since the mid-1990s[10] are the key drivers of lorry CO2 growth. To offset future growth, significant improvements to vehicle fuel economy are needed. Given lorrymakers' poor past performance it is very unlikely the market will deliver this without regulatory encouragement.

2. Member states need EU help to reduce lorry emissions

In October 2014 the EU heads of state agreed that sectors outside the ETS, covered by the so-called 'Effort Sharing Decision' (ESD), which currently constitute 55% of total EU emissions, need to reduce CO_2 by 30% from 2005 levels. The ESD target must be achieved 'domestically', ie. without external offsets, and will require substantial progress to be made in transport (34%), housing (27%), and agriculture (18%) in particular, as they are the biggest contributors to the ESD.

In principle, member states are responsible for meeting the non-ETS targets with national measures but for transport and for trucks in particular, EU measures are indispensable. There are roughly two key instruments to reduce road freight emissions. The first is fuel taxation. This is a national competence but member states are limited in their ability to increase diesel taxes by the existence of fuel tax havens (e.g. Luxemburg). Minimum fuel tax rates are agreed at EU level and require unanimity. Another option is to introduce road charges but national schemes have to comply with EU legislation on road charging. It is, for example, currently not yet possible to differentiate charges based on the fuel efficiency of trucks although Germany has announced it wants to start doing this.



The second key instrument, fuel efficiency legislation, is an exclusive EU competence. A recent T&E report[11] has shown that new vehicle efficiency standards are indispensable in meeting the 2030 climate goals. Additional car and van standards could deliver 73-megaton savings. Truck standards would add another 37 megatons – one third of what vehicle standards can contribute to meeting the 2030 goals. Without truck CO_2 standards, meeting the 2030 climate goals would be challenging and bigger efforts would need to come from passenger cars or other sectors of the economy like agriculture and industry.

3. Reducing lorry CO_2 is good for business, security and the economy

Fuel represents up to a third of haulier operating costs. The increase in oil prices since the early 2000s has increased haulier awareness of this and an increasing number of hauliers train drivers and monitor their fleet's performance. But while operational efficiency improvements are a clear win-win, hauliers will remain very dependent on the vehicles on offer if they want to achieve more substantial cuts. Truck fuel economy has remained stagnant since the mid-1990s.

There is, however, significant potential to improve truck fuel efficiency. Achieving at least the 35% improvement the EU Commission considers cost-effective would help the EU economy in multiple ways and would:

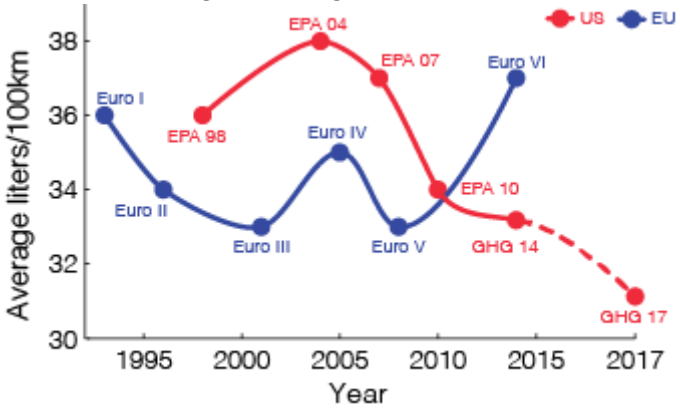
1. **Save hauliers money.** The average hauliers spends around €40,000[12] on fuel every year. 35% better fuel economy would save hauliers over €10.000 per year, per truck. Over the lifetime of a lorry fuel bills could be cut by up to €100,000.[13] In the US the EPA estimates its new 2027 standards will save American transport businesses €150 billion over the lifetime of the standard.[14]
2. **Boost automotive innovation and employment.** The increased demand for fuel efficiency technologies would benefit automotive suppliers. This would boost innovation and increase the need for high-quality engineering as well as production jobs. The 2014 commission impact assessment estimates standards would create 33,000 additional jobs in the truck manufacturing industry.[15]
3. **Provide a boost for the overall economy.** The investments required to pay for the more fuel-efficient vehicles would pay back after a break-even period of up to three years. After this, the increased fuel efficiency would save business money and enable them to reinvest it in the economy. A 2015 study by Cambridge Econometrics estimates more efficiency would free up €18,5 billion per year in avoided fuel costs by 2030.[16] Cambridge Econometrics has shown this shift in spending from imported oil to homegrown technology and consumption grows the economy and creates new jobs.[17]
4. **Improve energy security**. Europe currently imports around €300 billion worth of oil per year and 20% of it is used to fuel Europe's trucking fleet. [18] Most of the oil comes from regions like Russia and the Middle East. More efficient trucks could reduce the oil bill by €18.5 billion per year by 2030.[19] Reducing the transfer of wealth accompanying it would have geopolitical benefits.

However, delivering these goods will require overcoming a number of market barriers.

4. Global competition – Europe is losing out

While European policymakers were – very slowly – developing a test procedure to measure truck CO_2 emissions, other automotive regions have acted decisively. Japan was the first truck-producing region to introduce fuel efficiency standards in 2005. The US (2011) and China (2015) followed soon after.[20]

The US phase I standard was introduced in 2011 to end decade-long truck stagnation of fuel efficiency as well as to overcome market barriers. [21] It regulates both the engine efficiency and the whole vehicle's performance. The first phase runs until 2017 and requires improvements of nine to 23%. [22] The regulatory framework underpinning phase 1 is relatively basic. For example, the whole vehicle emissions are simulated through the GEM model which uses a lot of default factors.[23] When the EU started developing VECTO one ambition was to create a more representative, advanced simulation tool.

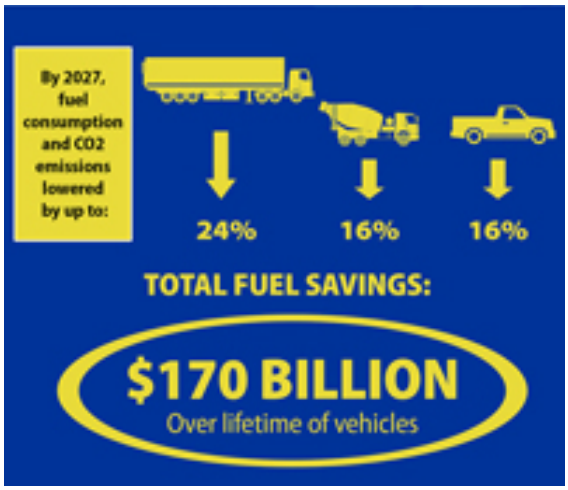


It is hard to compare global truck fuel economy but it is increasingly clear that the difference between Europe and other advanced markets is smaller than previously thought. A recent analysis by the ICCT[24] suggests that US trucks have actually overtaken European trucks when it comes to fuel economy.

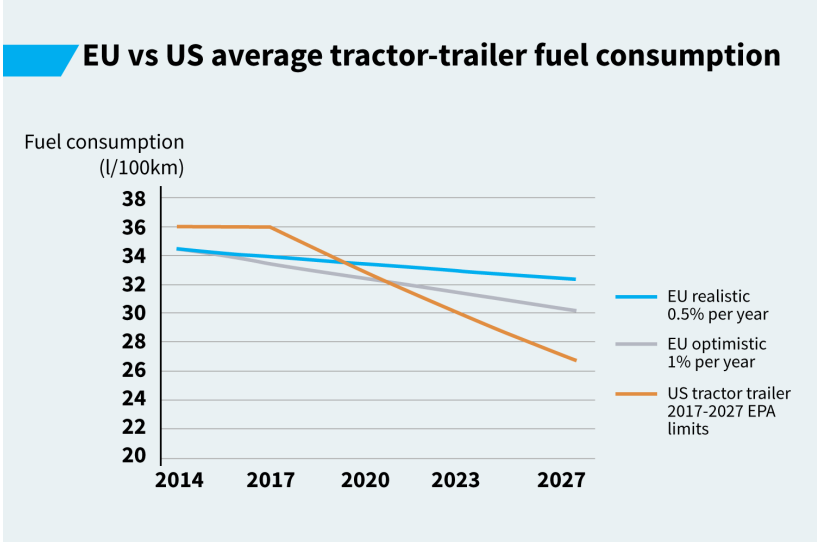
5. Changing the game – the US post-2020 truck fuel economy standard

In 2014 the Obama administration announced that it would set new heavy truck fuel economy standards to force the adoption of new fuel-efficient technologies on trucks and semi-trailers.

The phase 2 rule was announced on 19 June 2015[25] and requires 12-24% improvement in fuel efficiency by 2027.[26] Taken together, Phase 1 and the proposed Phase 2 amount to a 21% to 42% (lower range for vocational and higher range for long haul trucks) reduction in fuel use and carbon emissions from a model year 2010 baseline.[27] The yearly improvement required for new US trucks would range between around 1,25% to 2.5%. For comparison, European new tractor trailers[28] are expected to improve at a rate of 0.5-1% and this assumes that EU truckmakers will – without regulatory intervention - put an end to 20 years of stagnating fuel efficiency.[29]



In the US tractor trailers now average around between 33-36l/100km today. The proposed new standard is going to bring that down to below 27l/100km by 2027. Truck fuel economy in the US will improve more than twice as fast as in the EU in the next decade. This means US trucks will overtake European lorries as the most efficient in the world, from the early 2020s as shown below and explained in this note.[30]



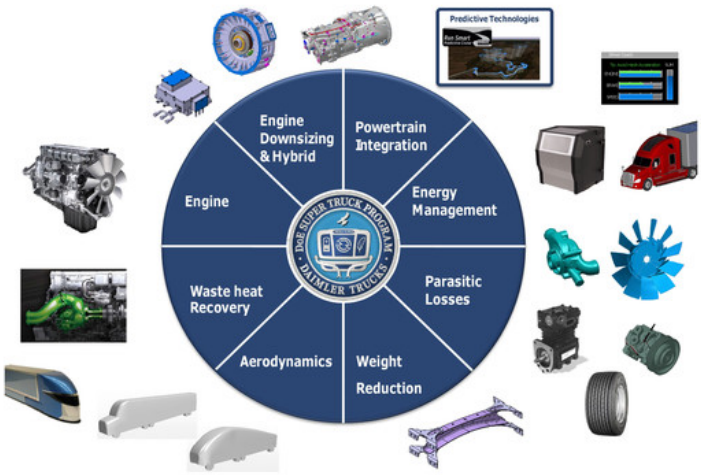
The US authorities expect the new standard will force U.S. truck and engine makers to deploy advanced powertrain technologies such as waste heat recovery or hybridisation. This is also why the regulatory framework was updated to encompass trailers, waste heat recovery, hybrid engines and alternative powertrains such as CNG/LNG. The GEM simulation tool – similar to the EU's VECTO tool – that estimates whole-vehicle fuel efficiency and CO_2 emissions was given a thorough update too.

The EU should be worried about this. EU truckmakers currently have a dominant position in the global truck manufacturing market but they are being overtaken as technology leaders. The US's advanced

regulatory framework also means other countries – for example, India[31] – will look to the US example when regulating truck emissions. Both trends will undermine Europe's competitiveness.

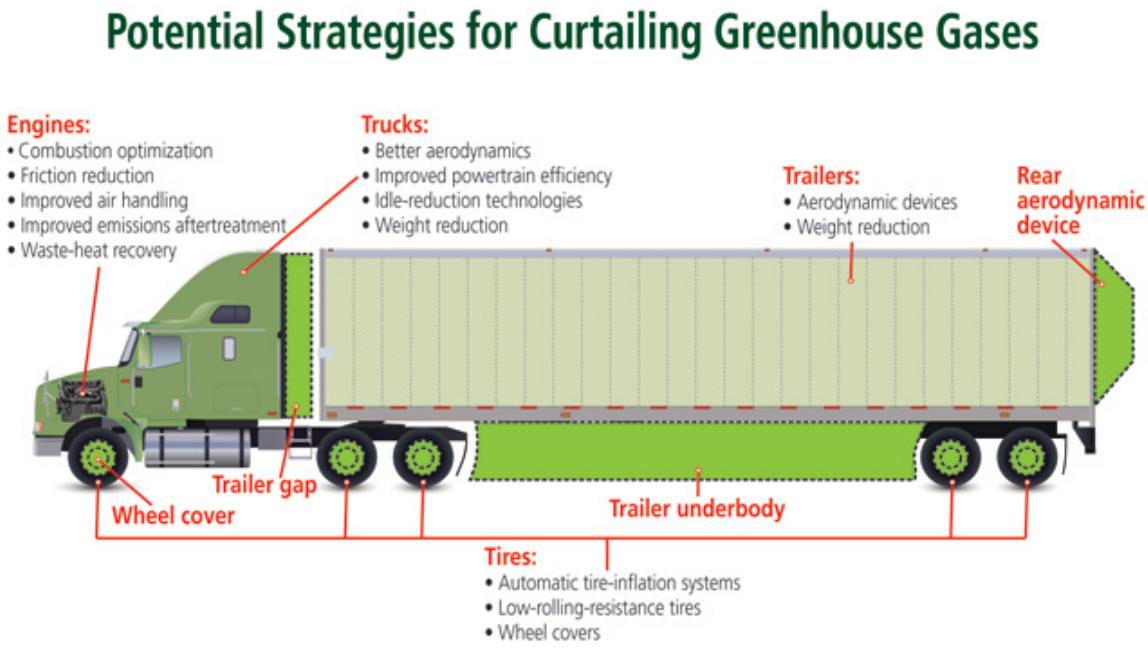
6. The technology to make trucks more efficient is there

Several studies have shown there is significant potential to improve lorry fuel economy. Quick wins include improvements to tractor and trailer aerodynamics or low resistance tires. But the engine and transmission can also be made more fuel efficient, partly through incremental improvements and engine downsizing but also by deploying more advanced solutions like waste heat recovery, start-stop or hybridisation. [32]



Fuel saving strategies according to Daimler (2013)[33]

In 2014-2015, the US government ran the supertruck programme which set American truckmakers, including EU truckmakers Daimler and Volvo, a goal of improving truck efficiency by 50% while also achieving thermal engine efficiency of 50%.[34] All truck and engine makers achieved the goals and Daimler (Freightliner in the US) even produced a vehicle that consumes less than 20l/100km – a 115% improvement compared to 2009.[35]



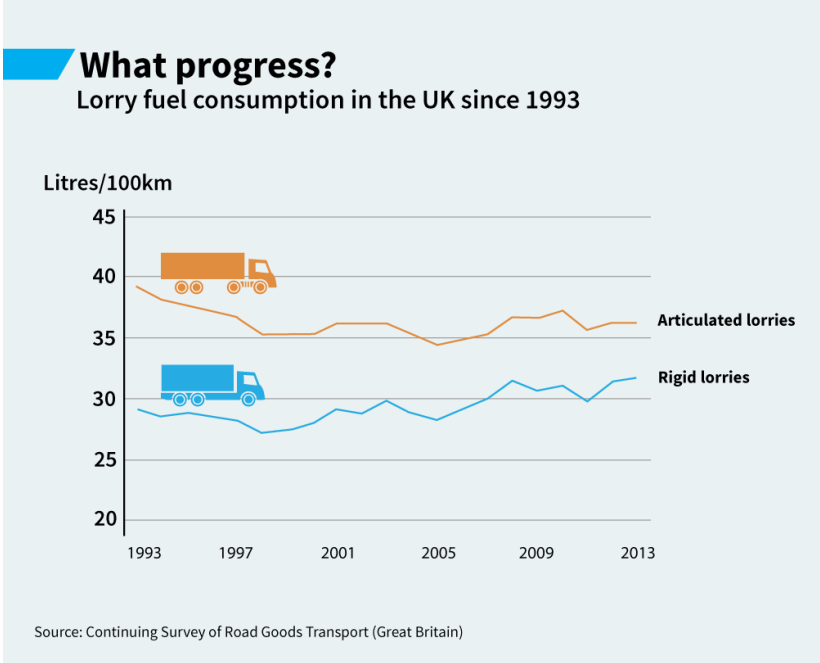
Strategies to comply with the new truck fuel efficiency standard (Transport topics infograph[36])

A 2013 study for the European Commission – based on 2011 technology assumptions – found that trucks could be 35% more fuel efficient while still saving money for hauliers. [37] The study did not take account of new technological developments or the opportunities provided by the new tractor dimension rules that would enable more aerodynamic tractor and trailers while providing extra space and weight for fuel-saving technologies such as waste heat recovery so the potential is likely to be greater.

In the context of the preparations for the US post-2020 standards, the International Council on Clean Transportation did a comprehensive review of different technologies and costs in the 2020-2030 framework. The study concludes that fuel efficiency improvements of up to 54% would pay back in less than 2.5 years.[38] While these US results cannot be translated directly into EU saving potentials it is clear that truck technology in the US and Europe is very similar. Daimler (Freightliner) and Volvo, the EU's biggest truckmakers, also have a strong presence in the US.

A recent study for the German Environment Agency[39] quotes far smaller cost-effective reduction potentials – 12% for long-haul trucks. However, the study is based on technologies *currently* on sale, vehicle manufacturer inputs and it is based on current *prices* – so not costs[40]. It was thus designed to estimate what is immediately achievable at current prices rather than as an assessment of the 2020-2030 potential and costs. In fact, a 2014 study for ACEA estimates that by 2020 truck-trailer combinations could be 15-17% more efficient compared to 2014.[41]

7. Six reasons why the market won't deliver without regulation



Virtually all of the fuel efficiency improvements in trucks happened more than 20 years ago. Since then fuel efficiency has stagnated.[42] EU policymakers have focused on identifying market failures that could explain the lack of progress since the 1990s.[43] One of the oft-quoted problems is that there is no official, certified way to assess and compare the fuel economy performance of different lorries. To address this 'lack of information' the Commission started developing a test procedure for lorries in 2010-2011. The Commission is currently finalising the VECTO simulation tool and is expected to launch a proposal by mid-2016 to monitor, report and verify CO_2 emission from the most important truck categories. In its first phase, VECTO will only provide CO_2 and fuel consumption information for tractors, but not for trailers. The introduction of VECTO could have a number of positive benefits (described in detail here[44]) but there is a limit to the savings the trucking market can realistically achieve without regulatory intervention.

Better information would be useful but it will not overcome key market barriers. This is a strong argument against the proposals of vehicle manufacturers to first introduce monitoring, reporting and verification and then wait a number of years to assess whether fuel economy progress picks up, before considering regulation. Key market barriers include:

1. **The difference in fuel economy between comparable lorries is small**
   Tests by magazines show the difference between comparable models is less than 5%[4546] While this is not insignificant for a high mileage (>100,000km/year) vehicle[47], it is unlikely to be the single decisive factor when buying a lorry, especially since tests only provide a representative or average value which could play out very differently on the haulier's specific duty cycle. This will not change with a certified fuel economy test procedure.

	DAF XF460 Super Space Cab	MAN TGX 18.480 XXL	Mercedes Actros 1845 LS Gigaspace	Scania R450 LA Topline	Volvo FH 460 Globetrotter XL
Fuel used /100km	36.76l /100km	37.03l /100km	35.39l /100km	36.05l /100km	37.15l /100km
Price	€103,000	€105,000	€110,000	€108,000	€108,000

Lastauto Omnibus, Euro-6-Zugmaschinen im Vergleich, 15/01/2014[48]

2. **Fuel economy is not the decisive factor when buying a truck.** A recent market survey, executed by French consultancy GIPA[49], found that of the French and German hauliers interviewed, only 3% had ever changed brands because of differences in fuel economy. In Poland this was 13%, 20% in the UK and 22% in Spain. This finding appears to contradict earlier studies, e.g. CE Delft found fuel efficiency is the number one buying criterion. But this is actually not illogical. Hauliers care about fuel economy but the market reality seems to be that when they compare new vehicles, they usually have very similar fuel economy so other factors become more important. In reality, reliability, price, brand and dealer loyalty as well as service conditions play a very important role.[50]
3. **Hauliers are risk-averse and have limited capacity to invest.** 85% of haulage companies are small companies with one to 10 trucks.[51] These SMEs have difficult access to finance and generally have less capacity to monitor, compare and improve fuel efficiency than bigger companies. The road freight sector also has very small margins.[52] This is likely to discourage additional, 'unnecessary' or 'risky' investments, especially over longer periods. So while the first period of ownership for a truck is around five years, the payback periods for fuel-saving investments are much shorter. All of this helps explain why hauliers focus on "low risk, high yield" improvements such as driver training and monitoring.
4. **Hauliers are dependent on (expensive) options.** Many fuel-saving technologies, such as cab spoilers, are not standard on new lorries and have to be purchased at a (high) price[53] that is only partly attributable to additional manufacturing costs.[54] For example, a roof spoiler costs around €1,500 as an option.[55] Economy or eco-packs on offer often cost in excess of €10,000. This suggests margins on fuel-efficiency technologies are often very high which makes them prohibitively expensive and unattractive. For small hauliers that make up 85% of the sector,[56] these high(er) upfront costs are a serious barrier. More transparency would make it clearer which options are worthwhile but would not necessarily fundamentally alter what's on offer, how the options are priced and packaged, or hauliers' capacity to buy them. Standards, however, would force truckmakers to offer many of these expensive options as part of the standard offer, at reduced prices.
5. **Cartel behaviour by OEMs undermines effective competition.** The European truck manufacturing market is dominated by three big players – Daimler, Volvo-Renault and Scania-MAN (Volkswagen) – and two smaller ones – DAF and IVECO. There is virtually no American or Asian competition. The European Commission has accused all European truckmakers of being engaged in price fixing and a cartel between 1997 and 2011.[57] The same uncompetitive behaviour was apparent when lorrymakers successfully lobbied for a ban on voluntary (!) changes to new tractor cabs until 2022.[58] In fact, lorrymakers argued that for reasons of 'competitive neutrality' they could not accept that one lorrymaker would be allowed to innovate before the others were ready.
6. **The lack of information is exaggerated.** A recent CE Delft study found that most fleet managers – i.e. of bigger haulage fleet – are relatively well aware of different solutions to reduce fuel consumption.[59] For tractors, good information can be found in professional magazines that

undertake testing and some of the bigger companies perform their own testing. An EU type approval value for fuel consumption is unlikely to fundamentally alter their purchasing behaviour.

8. Europe has a problem – truck fuel efficiency standards are the solution

CO_2 or fuel efficiency standards are a highly effective and proven instrument to kick start fuel efficiency. The EU's has already introduced standards for cars and vans and in its 2014 impact assessment accompanying its truck CO_2 strategy it concluded that standards would deliver the highest CO_2 cuts while "*support[ing] innovation improving HDV performance, employment, competitiveness and growth, and (…) reduc[ing] energy dependency*".[60] The 2014 truck CO_2 strategy concluded standards are "*the most apparent option*" to tackle road freight CO_2. As a regulatory instrument standards have three key benefits:

1. **Standards ensure a level-playing field between manufacturers** and ensure genuine competitive neutrality on the basis of performance. All lorry makers would have to meet a target of comparable stringency and have to focus their research and development on achieving these targets in a given period. That avoids the problem of some lorry makers fearing a first mover *dis*advantage.
2. **Standards create investment certainty for suppliers** (engine makers, component manufacturers) that have the certainty that their fuel-efficient development investments will pay off in the future. According to a leading industry expert, the EU CO_2 standards cars have stimulated the largest innovation wave since the World War II.[61]
3. **Standards enable hauliers to buy more fuel-efficient vehicles at lower cost.** Regulation would force lorry makers to include fuel-saving technologies as standard, rather than as expensive options. Experience shows this is usually done at lower than projected cost. Standards would ensure hauliers buy the improved products and see that their development investments pay off.

9. Conclusion – what Europe should do

In 2016 the Commission will propose the implementing legislation for the 2030 climate and energy framework. It should accompany the effort-sharing proposal with a package of EU measures to help member states achieve their climate goals. For cars and vans, the EU has planned post-2020 standards but for trucks the EU still lacks a credible plan. The European Commission test procedure for lorries, VECTO, is now ready for use and promises high levels of accuracy.[62] It will be introduced in 2016 as part of an MRV, and the first data will likely be available in 2018. The MRV proposal should be accompanied by a post-2020 strategy for trucks and followed by a legislative proposal to set mandatory limits on average CO_2 emissions from newly registered trucks.

Meanwhile, the Commission should continue developing the VECTO tool to include trailers, all remaining vehicle categories as well as advanced technologies such as hybrids. The Commission should not succumb to industry delaying tactics and claims that the new test procedures need to be tested for several years before they can be used. Similarly, it is very unlikely that introducing a truck CO2 test procedure will revolutionise the freight market and kick start fuel economy progress. Standards were set in the US and Japan without years of monitoring. Europe has already lost enough time, now it's time to act.

Further information

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Endnotes

[1] International Transport Forum, Transport Outlook, 2015
[2] European Commission, *Strategy for reducing heavy-duty vehicles' fuel consumption and CO_2 emissions*, 2014. http://ec.europa.eu/clima/policies/transport/vehicles/heavy/docs/com_285_2014_en.pdf
[3] European Commission, *Energy Union Communication*, 2015, p13. http://ec.europa.eu/priorities/energy-union/docs/energyunion_en.pdf
[4] UK Department for Transport data series
[5] http://www.freightlinersupertruck.com/
[6] http://europa.eu/rapid/press-release_IP-14-2002_en.htm
[7] See EC strategy p3. Unfortunately, there are no final data on truck CO_2 emissions after 2010 available yet. Overall transport emissions are somewhat lower in 2012 than in 2010.
[8] The strategy's assumption that lorry fuel economy will improve by 1% p/a and that this could offset emissions growth deviates from the assumptions in the studies that underpin it, notably AEA-Ricardo LOT 1 (2011) http://ec.europa.eu/clima/policies/transport/vehicles/docs/ec_hdv_ghg_strategy_en.pdf.
T&E prefer the more conservative assumptions (0.3% improvement p/a).
[9] Lorries are responsible for 85% of emissions from Heavy Duty Vehicles. Long haul and regional distribution represent 51% of HDV emissions. This means long haul and regional emit ca. 60% of lorry CO2. AEA-Ricardo, LOT 1, p164.
[10] Department for Transport Statistics, Fuel consumption by HGV vehicle type in Great Britain, 1993-2010.
[11] http://www.transportenvironment.org/sites/te/files/2015%2006%20esd%20briefing_FINAL_June.pdf
[12] 100,000km p/a, 33l/100km, €1.2/l
[13] Reduction of 28-36% for truck that drives 100,000km at 33l/100km, €1.2l/l excl VAT = €11,000-€13,000
[14] http://www.epa.gov/oms/climate/documents/420f15900.pdf
[15] Commission Impact Assessment 2014, p40.
[16] Cambridge Econometrics, The Impact of Improved Vehicle Efficiency on Energy Dependency in Europe, 2015, p9. http://www.camecon.com/Libraries/Downloadable_Files/The_Effects_of_Vehicle_Fuel_Efficiency_Improvements_on_Energy_Dependency_-_Final_Report.sflb.ashx
[17] ECF, Fueling Europe's future – how auto innovation leads to EU jobs, 2013.
[18] http://www.transportenvironment.org/sites/te/files/media/4846_defreportEdB.pdf
[19] Ibidem 21.
[20] http://transportpolicy.net/index.php?title=Global_Comparison:_Heavy-duty_Fuel_Economy_and_GHG
[21] http://www.theicct.org/sites/default/files/publications/ICCT-NACFE-CSS_Barriers_Report_Final_20130722.pdf
[22] http://www.epa.gov/oms/climate/documents/420f11031.pdf
[23] http://www.c2es.org/federal/executive/vehicle-standards#hdv_2014_to_2018
[24] http://www.theicct.org/blogs/staff/europes-global-leadership-vehicle-emission-standards-at-risk-truck-sector
[25] http://www.epa.gov/oms/climate/regs-heavy-duty.htm
[26] For a comprehensive update on the new standard see: http://www.theicct.org/sites/default/files/publications/ICCT-update_US-HDV-Ph2-NPRM_jun2015_v2.pdf
[27] http://www.theicct.org/blogs/staff/5-numbers-you-need-know-about-proposed-us-truck-efficiency-rule
[28] T&E assume the fuel efficiency of an average 40t tractor trailer combination is 34,5l/100km, i.e. in the middle of the 33-36l/100km range established by the ICCT (see note 46) and exactly at the level estimated by the German Umweltbundesamt in its 2015 cost and technology assessment (see note 17) http://www.theicct.org/sites/default/files/publications/ICCT_HDV_FC_lit-review_20150209.pdf
[29] The Commission impact assessment (p13) assumes 1% p/a but the LOT1 study (see p190) that underpin the assessment assume a 0.5% annual improvement up to 2030.
[30] http://www.transportenvironment.org/publications/explanatory-note-comparing-us-and-eu-truck-fuel-economy
[31] http://www.theicct.org/sites/default/files/publications/ICCT_HDV-test-procedures_India_20150420.pdf
[32] http://www.theicct.org/sites/default/files/publications/ICCT_ATTEST_20150420.pdf
[33] From ICCT super truck assessment, p16
http://www.theicct.org/sites/default/files/publications/ICCT_SuperTruck-program_20140610.pdf
[34] http://www.theicct.org/us-supertruck-program-expediting-development-advanced-hdv-efficiency-technologies
[35] Ibidem 4.
[36] http://www.ttnews.com/
[37] http://www.finanzen.net/mediacenter/unsortiert/autobauer_und_co2.pdf
http://ec.europa.eu/clima/policies/transport/vehicles/heavy/docs/hdv_2012_co2_abatement_cost_curves_en.pdf
[38] http://www.theicct.org/sites/default/files/publications/ICCT_tractor-trailer_tech-cost-effect_20150420.pdf
[39]
http://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_32_2015_summary_future_measures_for_fuel_savings.pdf
[40] This is an important distinction. Prices are set on the basis of commercial considerations and are not a sound basis for regulatory cost assessments. Therefore, regulations are generally based on cost analysis.
[41] "By 2020, new vehicles and trailers are expected to be 15-17% more fuel efficient than they are in

2014." TML, *GHG reduction measures for the road freight transport sector,* 2014, p3.
[42] See Acea, *Commercial vehicles and CO2*, 2010, p8 and UK Department for Transport data series, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/404918/rfs0141.xls
[43] In particular CE Delft 2012 and AEA-Ricardo 2012
[44] T&E memorandum on VECTO, T&E presentation to VECTO editing board http://www.transportenvironment.org/publications/discussing-vecto-test-measure-co2-emissions-trucks-and-buses
[45] According to the experienced truck testing magazine Lastauto Omnibus: http://www.eurotransport.de/test/1000-punkte-test-euro-6-zugmaschinen-im-vergleich-6529107.html
[46] Difference between best and worst lorry in this test ca. 1l/100km http://www.verkehrsrundschau.de/erster-vergleich-von-euro-6-lkw-1287692.html or 1.5l/100km. http://www.eurotransport.de/test/1/9/6/9/0/1/6/Daten_und_Messwerte_im_Vergleich_.pdf
[47] With €1,2 diesel price cost difference per year €2100 between best and worst
[48] http://www.eurotransport.de/test/1000-punkte-test-euro-6-zugmaschinen-im-vergleich-6529107.html
[49] GIPA, Market survey on fleet managers'purchase behavior, 2015. (to be published)
[50] Ricardo-AEA, Opportunities to overcome the barriers to uptake of low emission technologies for each commercial vehicle duty cycle, 2012 p7.
[51] AEA-Ricardo, *Reduction and Testing of Greenhouse Gas (GHG) Emissions from Heavy Duty Vehicles – Lot 1*: report, pIV.
[52] https://www.pwc.co.uk/transport-logistics/assets/lr14-report-web-060514.pdf
[53] http://www.theicct.org/market-barriers-increased-efficiency-european-road-freight-sector
[54] TNO 2012, *support for revision of REG 443/2009*, from p9
[55] Verkehrsrundschau, VOLVO FM 450 test, 2014. http://www.verkehrsrundschau.de/sixcms/media.php/4395/VR_2014_51_48_53_VR-014-4645-y_Volvo.pdf
[56] LOT 1, AEA-Ricardo 2011
[57] http://www.ft.com/intl/cms/s/0/da53eb98-8073-11e4-872b-00144feabdc0.html
[58] http://www.endseurope.com/35761/council-may-favour-weaker-lorry-dimensions-law?r
[59] CE Delft, *Market barriers to increased efficiency in the European on-road freight sector*, 2012, p47.
[60] Commission impact assessment accompanying its May 2014 strategy
[61] http://www.finanzen.net/mediacenter/unsortiert/autobauer_und_co2.pdf
[62] http://ec.europa.eu/clima/policies/transport/vehicles/heavy/docs/hdv_co2_certification_en.pdf