# EU $CO_2$ Standards: Electric is a must!

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*There has been growing pressure globally to reduce harmful exhaust emissions with the introduction of emission standards. The recent implementation of $CO_2$ and fuel consumption standards for heavy duty vehicles (HDV) aims to reduce GHG and improve energy security. Regulatory standards have been proposed and implemented by the main economies of the world. However, to meet such stringent standards the uptake of $CO_2$ reducing technologies needs to be significant from current low market penetration. The $CO_2$ consumption benefit, cost, payback period and segment suitability are discussed in this briefing.*

## EU $CO_2$ Legislation

Following Japan, China, U.S., Canada and now India, which have all now implemented fuel consumption regulation, the European Commission (EC) has proposed its legislation with monitoring of $CO_2$ standards of all heavy-duty manufactures of trucks starting in 2019. These reported $CO_2$ standards from manufacturers will have to be reduced by 15% from the period 2025-2029 and from 2030 onwards an aspirational target of 30% has been set, to be reviewed in 2022.

The EC's impact assessment (IA) stated a possible fuel consumption reduction of 15-20% can be achieved by 2025 when comparing 2019's level if:

1) Market penetration of readily available technologies are implemented to the whole fleet such as:
    - Improved lubricants
    - Improved SCR and optimised SCR heating methods
    - Aerodynamic mud flaps
    - Tyre pressure monitoring systems
    - Closable front grille
    - Cooling fan
    - Friction reduction + improved water and oil pumps
    - Air compressor
    - Reduced losses
    - Predictive cruise control
    - Downspeeding
    - Improved turbocharging and EGR
    - Side and underbody panels at truck chassis
    - Low rolling resistance tyres on truck/trailer
2) Legal restrictions lifted to allow technologies to be implemented such as:
    - elongated cabins
    - rear-view cameras instead of mirrors

A 15% reduction in $CO_2$ is feasible but the time frame in which OEMs will have to equip heavy-duty trucks with technologies in order to meet $CO_2$ targets is very challenging. Currently, fuel consumption is reduced roughly 1% a year, over the six-year period to 2025, OEMS will have to significantly improve this to 2.7% fuel consumption reduction per annum which will then rise to 3.8% from the period 2026-2030.

VECTO will monitor OEMs $CO_2$ standards in 2019 with these values being published in 2020. The increase in transparency will benefit customers and the truck market, however, VECTO does not include all possible technologies that will benefit $CO_2$. Some effective fuel consumption reducing technologies, such as advanced drives assistance systems (ADAS) and trailer aerodynamics, are currently unable to be simulated using VECTO. This will discourage OEMS to equip European trucks with such technologies that would benefit the environment and focus only on the technologies that will help them meet the EC's emission target.

Another area of concern for OEMs is the penalty associated with exceed the emission target. On a tonne to km fuel consumption basis, HDV are far more efficient than light vehicles. However, the penalty of being 1% over the target means HDV OEM will be charged 30 times more than a passenger car manufacturer.

KGP expects some OEMs struggle to provide the short-term investment needed to implement technologies. KGP also expects mergers and acquisitions and joint ventures to intensify, for example VW's joint venture with Hino and the possibility of the former acquiring Navistar.

The IA sets out the fuel savings in monetary terms, technology costs and pay back periods for the technologies listed under bullet point 1. However, the IA only specifies these values for one vehicle group: 4x2 Tractor with GWV greater than 16 tonnes. Following this, KGP has assessed public domain information and summarised the findings in the next section.

## $CO_2$ Reducing Technologies

In order for all regions to meet regulatory targets, vehicles will have to be equipped with various $CO_2$ reducing technologies. Various technologies are already commercially available and have been for many years, however, market uptake of such technologies remain very low according to the IA. Stringent standards will force uptake of such technologies and drive development of new advanced technologies. The uptakes of these technologies will differ regionally and by vehicle class.

Regional differences such as vehicle design, i.e. U.S. has a larger nosed[1] front compared to European trucks, and speed limits, i.e. U.S. speed limits are on average higher than European roads, will cause market penetration of technologies to vary, especially for aerodynamics.

[1] European maximum length of a truck included the cab where U.S only measure the trailer length.

Technology uptake will be difficult for developed economies in North America and Europe but will be more so for developing economies such as China and India. China currently adopts few advanced technologies due to the low-cost nature of the trucking industry. To enable to meet these fuel economy and $CO_2$ standards the industry will have to dramatically change, shifting from a once low-cost overloaded truck to a highly advanced premium truck.

Long haul trucks are the most attractive segment for investment in $CO_2$ reducing technologies due to the high annual mileage covered and the respective high fuel costs as a % of total operating costs (TOC). In addition to this, they are also the highest polluting commercial vehicles contributing to roughly 37.1%[2] of heavy-duty vehicle $CO_2$ emissions in the EU. Due to the more transient cycle, lower annual mileage and lower speed of the urban, regional vocational trucks the payback period for fuel saving technologies is much higher in some cases.

*Figure 1 Summary of Technologies $CO_2$ Benefit, Manufacturing Cost and Payback Period*

| | Technology | $CO_2$ Benefit (%) | | | Cost (€) | | | Payback Period (years) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Urban Truck & Bus | Regional Coach & Truck | Long Haul Truck | Urban Truck & Bus | Regional Coach & Truck | Long Haul Truck | Urban Truck & Bus | Regional Coach & Truck | Long Haul Truck |
| Powertrain | Engine Friction Reduction | - | 2.0-7.0 | 1.5-5.0 | - | 310 | 310 | 0-1 | 0-1 | 0-1 |
| | Advanced Turbocharging | - | 2.0-5.0 | 2.5-5.0 | - | 1050 | 1050 | - | 0-1 | 0-1 |
| | Turbocompounding | 1.0 | 2.5 | 3 | 7000 | 7000 | 7000 | >10 | >10 | 5-6 |
| | Waste Heat Recovery | 1.0-1.5 | 2.0-2.5 | 2.5-5.0 | 5000-11600 | 5000-11600 | 5000-11600 | >10 | >10 | 0-6 |
| | AMT | 5.0 | 1.5-3.0 | 1.5-3.5 | 3500 | 2600-3500 | 3400-4700 | 4-8 | 5-10 | 5-10 |
| | Transmission Friction Reduction | 0.5-1.0 | 1.0-2.0 | 1.0-2.5 | 190 | 190-250 | 190-250 | 0-1 | 0-1 | 0-1 |
| Tyres | Low Rolling Resistance | 1.0-2.0 | 3.0-8.0 | 5.0-8.5 | - | 140-350 | 350-420 | - | 0-1 | 0-1 |
| | Single Wide | 4.0 | 1.0-6.0 | 2.0-5.0 | 825 | 825 | 1300 | 1-3 | 0-1 | 0-1 |
| | Pressure Monitoring Systems | - | 0.5-1.5 | 0.5-2.0 | - | 140-250 | 350-475 | - | 0-2 | 0-2 |
| | Automatic Pressure Adjustment | - | 0.5-1.5 | 0.5-2.0 | - | 1080-3460 | 1080-3460 | - | >10 | >10 |
| Other | Stop Start | 4.0-6.0 | 1.0-3.0 | 0.0-1.0 | 640 | 640 | 940 | 0-2 | 1-2 | 2-3 |
| | Lightweighting | 2.0-6.0 | 1.0-4.5 | 2.0-5.0 | Varies | Varies | Varies | Varies | Varies | Varies |
| | Predictive Cruise Control | - | 1.0-5.0 | 1.0-5.0 | - | 80-1400 | 80-1400 | - | 0-2 | 0-1 |
| | Aerodynamic Improvements | 0.5-3.0 | 3-6 | 4-11 | 200-500 | 400-3500 | 2000-3500 | 0-5 | 0-2 | 0-1 |
| | Auxilliaries | 0.0-1.5 | 0.0-1.5 | 0.0-2.5 | 50-1000 | 50-1000 | 50-1000 | 0-2 | 0-2 | 0-1 |

*Source: KGP analysis and Public Domain Information[3]*

One of the most cost effective available technologies for improving fuel consumption is a switch from manual (MT) to automated manual transmissions[4] (AMT) which is of particular benefit for transient drive cycles, hence urban and regional trucks. A switch to AMT also provides a secondary benefit of reducing diver fatigue, improving safety and reducing wear and tear damage. An increase in transmission gears will also benefit fuel consumption across all segments.

[2] Hill et al., (2011) Reduction and Testing of Greenhouse Gas (GHG) Emissions from Heavy Duty Vehicles – Lot 1: Strategy
[3] TIAX, (2011) European Union Green House Gas Reduction Protentional for Heavy-Duty Vehicles.
Ricardo, (2017) Heavy Duty Vehicles Technology Potential Cost and Study.
SWRI (2015) Commercial Medium-and Heavy—Duty Truck Fuel Efficiency Technology Study.
Tetra Tech (2015) Commercial Medium- and Heavy-Duty Truck fuel Efficiency Technology Cost Study.
TNO (2018) Assessments with Respect to the EU HDV $CO_2$ Legislation.
Hill et al., (2011) Reduction and Testing of Greenhouse Gas (GHG) Emissions from Heavy Duty Vehicles – Lot 1: Strategy.
[4] U.S. long haul trips have mainly MT whereas the majority of European long haul trucks are already equipped with AMT.

Unfortunately for European long-haul trucks the majority are already equipped with AMT so have already benefited from the $CO_2$ benefit, unlike in the U.S. where most trucks still have MT.

Aerodynamic and low rolling resistance improvements are a focus for long haul trucks which a significant benefit of fuel consumption can be achieved. Improvements in fuel consumption are limited for vehicles which stop start regularly.

Advanced technologies are currently being researched and developed. A key technology for long haul trucks is turbocompounding and waste heat recovery systems. Albeit costly, they have a significant fuel consumption benefit for engines which run at high loads on a steady state drive cycle.

Hybrid and electric technology is of high importance with product launches intensifying over the last year. Over the next ten years, KGP expects micro hybrids to reach a near 100% market penetration due to the simplistic nature in comparison to other hybrids, micro hybrids offer stop/start technology and regenerative braking to improve fuel consumption but unlike the mild hybrid an electric motor is not used. Although fully integrated hybrids and electric vehicles are suitable for urban and regional applications and allow for 20-100% reductions in $CO_2$ emissions, the current technology is not yet feasible for long haul trucks.

*Figure 2 $CO_2$ Reducing Technologies' Market Penetration and Segment Suitability*

| | Technology | Current Market Penetration | | | Current Suitability | | | Medium-Long Term Suitability | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Urban Truck & Bus | Regional Coach & Truck | Long Haul Truck | Urban Truck & Bus | Regional Coach & Truck | Long Haul Truck | Urban Truck & Bus | Regional Coach & Truck | Long Haul Truck |
| Powertrain | Engine Friction Reduction | ↘ | ↘ | ↘ | ↑ | ↗ | → | ↑ | ↗ | ↗ |
| | Advanced Turbocharging | ↘ | ↘ | ↘ | ↗ | ↗ | ↗ | ↑ | ↑ | ↑ |
| | Turbocompounding | ↓ | ↓ | ↓ | ↓ | ↓ | ↗ | ↓ | ↓ | ↑ |
| | Waste Heat Recovery | ↓ | ↓ | ↓ | ↓ | ↓ | ↗ | ↓ | ↓ | ↑ |
| | AMT | ↘ | ↘ | ↗ | ↑ | ↗ | ↗ | ↑ | ↑ | ↑ |
| | Transmission Friction Reduction | ↘ | ↘ | ↘ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ |
| Tyres | Low Rolling Resistance | → | → | → | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ |
| | Single Wide | ↗ | ↗ | ↗ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ |
| | Pressure Monitor Systems | ↘ | ↘ | ↘ | ↗ | ↗ | ↗ | ↑ | ↑ | ↑ |
| | Automatic Pressure Adjustment | ↓ | ↓ | ↓ | ↗ | ↗ | ↗ | ↑ | ↑ | ↑ |
| Other | Lightweighting | ↘ | ↘ | ↘ | ↗ | → | ↘ | ↑ | ↗ | → |
| | Predictive Cruise Control | ↘ | ↘ | ↘ | ↓ | ↑ | ↑ | ↓ | ↑ | ↑ |
| | Aerodynamic Improvements | ↘ | ↘ | ↘ | → | ↗ | ↑ | ↗ | ↗ | ↑ |
| | Auxilliaries | ↘ | ↘ | ↘ | ↑ | ↑ | ↗ | ↑ | ↑ | ↑ |
| Hybridisation | Micro Hybrid | ↘ | ↓ | ↓ | ↑ | ↗ | ↗ | ↑ | ↑ | ↑ |
| | Mild Hybrid | ↘ | ↓ | ↓ | ↑ | ↗ | ↗ | ↑ | ↑ | ↑ |
| | Sereis Hybrid | ↘ | ↓ | ↓ | ↗ | ↘ | ↘ | ↑ | → | ↘ |
| | Parallel Hybrid | ↘ | ↓ | ↓ | ↗ | ↘ | ↓ | ↑ | → | ↘ |
| | Full Electric | ↘ | ↓ | ↓ | ↗ | ↘ | ↓ | ↑ | → | ↓ |

*Source: KGP analysis*

| ↓ | ↘ | → | ↗ | ↑ |
|---|---|---|---|---|
| Low | | Medium | | High |

## Real World Impact

KGP believes the real-world fuel consumption reductions from technologies will be lower than the values reported in many of the IAs and believe OEMs will struggle to meet stringent $CO_2$ standards, hence the market penetration of alternative fuels needs to significantly increase.

This was evident at Integer, with many OEMs stating that reducing $CO_2$ emissions of conventional vehicles will not be enough to meet the stringent target of 15%, hence, a push towards electrification is needed. Although electrification is not feasible in the long-haul segment, a shift to electric in regional delivery trucks will be sped up over the next couple of years due to EC's regulation. The market has already seen many electric product launches, with many more to come.

This leads on to the infrastructure problem – chicken or the egg? In order to sell electric trucks charging infrastructure needs to be significantly improved but for this to happen there needs to be significant sales in electric vehicles. Other issues arise around this subject such as infrastructure cost, capability of the grid, battery technology performance and cost, fuel tax revenues replaced with electric vehicle tax?

Another issue with the current regulations around the world is the focus on tank to wheel standards, simply ignoring the real issue of wheel to wheel $CO_2$ emissions. There is a lot of hype around hybrid and electric vehicles but the electricity being generated to power these vehicles needs to be renewable in order for world GHG emissions to fall adequately. An area which isn't as talked about but could be very cost-effective in improving GHG emissions in the short term is biofuels along with more focus towards natural gas.

***If you would like to find out more detail about $CO_2$ reducing technologies and alternative fuels, please contact KGP regarding our new database and study on Hybrid and Electric Commercial Vehicles. The study builds on our CV and NRMM global engine forecasts to assess alternative fuel penetration by vehicle segment for each of the global markets, as well as the cost impact, $CO_2$ impact, technology adoption and battery demand for each of three scenarios.***

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