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THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

EUROPEAN HEAVY DUTY VEHICLES EFFICIENCY TECHNOLOGY POTENTIAL AND COST

The ICCT commissioned Ricardo Energy and Environment to conduct an analysis of technologies that could reduce fuel consumption and greenhouse gas emission of HDVs in the European market, in the 2020–2030 timeframe. This fact sheet summarizes that analysis. See below for full publication details.

BACKGROUND AND OBJECTIVE

Trucks, buses and coaches produce about a quarter of all carbon dioxide (CO_2) emissions from road transport in the European Union (EU), and some 5% of the EU's total greenhouse gas (GHG) emissions. And their share is growing, as emissions from cars and vans decline in response to increasingly stringent CO_2 standards for those vehicles.

Although the EU has set emissions targets for new passenger cars and vans, there are no comparable binding targets for HDVs. But the EU is pursuing a strategy to curb CO_2 emissions from HDVs over the coming years, by introducing a CO_2 emissions certification methodology, by developing a regulatory proposal for a monitoring, reporting and verification (MRV) scheme, and by carrying out the groundwork necessary to concurrently introduce CO_2 emission standards for HDVs. The commitment to speed up the analytical work required to support a rapid introduction of HDV CO_2 emission standards was reconfirmed with the European Strategy for low-emission mobility, released on 20 July 2016.

The study by Ricardo Energy and Environment analyzed a wealth of information regarding heavy-duty technology potential and cost available from the United States Phase 2 HDV GHG regulation, promulgated in 2016, and translated the findings to the EU market in terms of feasibility, effectiveness, and cost.

STUDY METHODOLOGY

The project involved literature review and consultation with experts to gather data on 2015 baseline heavy-duty vehicles and fuel consumption reduction technologies. Technology potential and costs were detailed for three vehicle segments, which account for nearly two-thirds of HDV energy consumption:

» **Rigid panel vans** between 3.5 and 7.5 tonnes gross vehicle weight (GVW), such as are used for urban deliveries or service activities. This segment was evaluated over the Urban Delivery cycle of the European truck CO_2 certification model (VECTO).

» **Rigid box-trucks** around 12 tonnes GVW, typically used for regional deliveries. This segment was evaluated over the Regional Delivery cycle of the European truck CO_2 certification model (VECTO).

» **Tractor-trailer combinations** typically of 40 tonnes GVW, used for carrying freight over long distances. For this segment, which consumes the largest fraction of all fuel used by HDVs, in addition to an "average" baseline vehicle the study defined "economy" (worse performance than the average) and "premium" (best-in-class) baselines. This segment was evaluated over the Long-Haul cycle of the European truck CO_2 certification model (VECTO).

In translating the improvement potential reported in the EPA Phase 2 studies from US to European markets, two key influences were considered:

a. Differences between the baseline vehicles (e.g., some technologies such as automated manual transmissions (AMT) have already been widely adopted in Europe)

b. Differences in usage patterns/driving characteristics for the two geographic areas (e.g., for tractor-trailer combinations undertaking long-haul journeys the allowed maximum speeds are higher for US than for EU, where HDVs are limited to 90 km/h)

Potential fuel consumption reductions were estimated for technologies separately and in combination to factor in overall engine, transmission and vehicle technology improvements. Two categories of technologies were evaluated: (1) those that are commercially available today but have very small uptake (not enough to be considered part of baseline vehicle); (2) those that the study authors expect to be available commercially by 2030 at the latest.

Lastly, the incremental costs of individual technologies were assessed. The result was the development of incremental cost/fuel consumption reduction curves and payback periods for each vehicle segment under various assumptions, including fuel price, discount rate, vehicle lifetime, vehicle miles traveled, and others.

MAIN FINDINGS

- Nearly all the technologies included in the US regulatory impact analysis could be applied to European baseline trucks, and their fuel-consumption reduction potential is substantial. There were marked differences in reduction potential, principally arising from differences in technology baselines and vehicle usage patterns.
- The maximum cost-effective technical reduction potential was estimated for the three vehicle segments (see Figure 1),
  - Panel van maximum technical reduction potential was estimated at 43.6%. Hybrid powertrain (28%), engine improvements (8.5%), and automated manual transmission (7%) were identified as the technologies with largest potential savings. Note that some of these are exclusive: e.g., one can either replace a manual transmission with an AMT or a hybrid powertrain, but not both.
  - Rigid box truck maximum technical reduction potential was estimated at 31.5%. The largest fuel savings are observed for aerodynamics (6.3%), engine improvements (7.4%), AMT (5%), and low rolling resistance tires (4.7%).
  - Tractor-trailer maximum technical reduction potential was estimated at 33.0%. Tractor and trailer aerodynamics (10.6%), tractor and trailer low rolling resistance tires (5.1%), and waste heat recovery (4.5%) were identified as the technologies with largest potential savings
- Cost-effectiveness results for tractor-trailer technologies are summarized in Figure 2. This is plotted with the most cost-effective technology

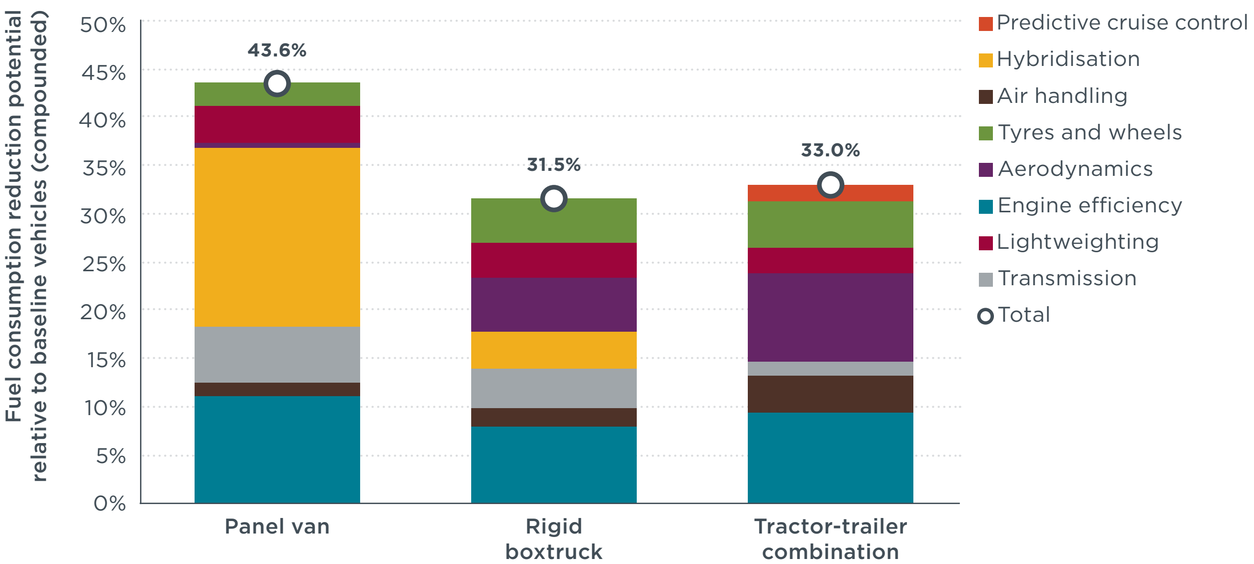

Figure 1: Potential 2030 EU vehicle fuel consumption reductions relative to 2015 baseline vehicles

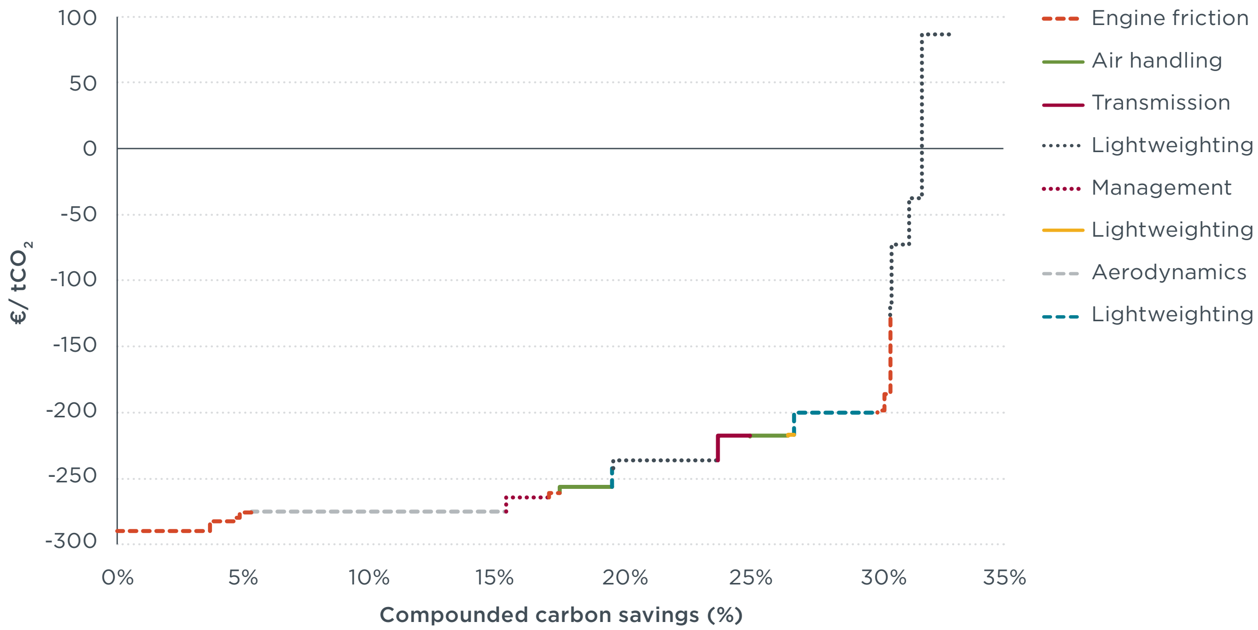

Figure 2: Incremental cost-fuel consumption reduction potential curve for long-haul tractor-trailer (relative to average European 2015 truck)

category on the left, and the least cost-effective on the right. The compounded effect of all the cost-effective measures is calculated to be a fuel-consumption reduction potential of 33.0%, relative to the baseline vehicle. In terms of cost-effectiveness the figure shows that all options generate a net benefit over the ten-year lifetime of the vehicle except for light-weighting options costing more than €5 per kilogram of weight saved.

» If for the tractor-trailer analysis above the maximum acceptable payback period were set at 5 years, then the compounded fuel consumption reduction potential would be slightly lower, 30.52%, with some additional light-weighting options deemed cost-ineffective. For a payback period of 2 years, the compounded fuel consumption reduction potential would be 23.70% because some technologies, most notably turbocompounding and waste heat recovery, would not be deemed cost-effective. The cost-effectiveness potential under various payback period assumptions is summarized in Figure 3 for the three vehicle categories, showing the extent to which the

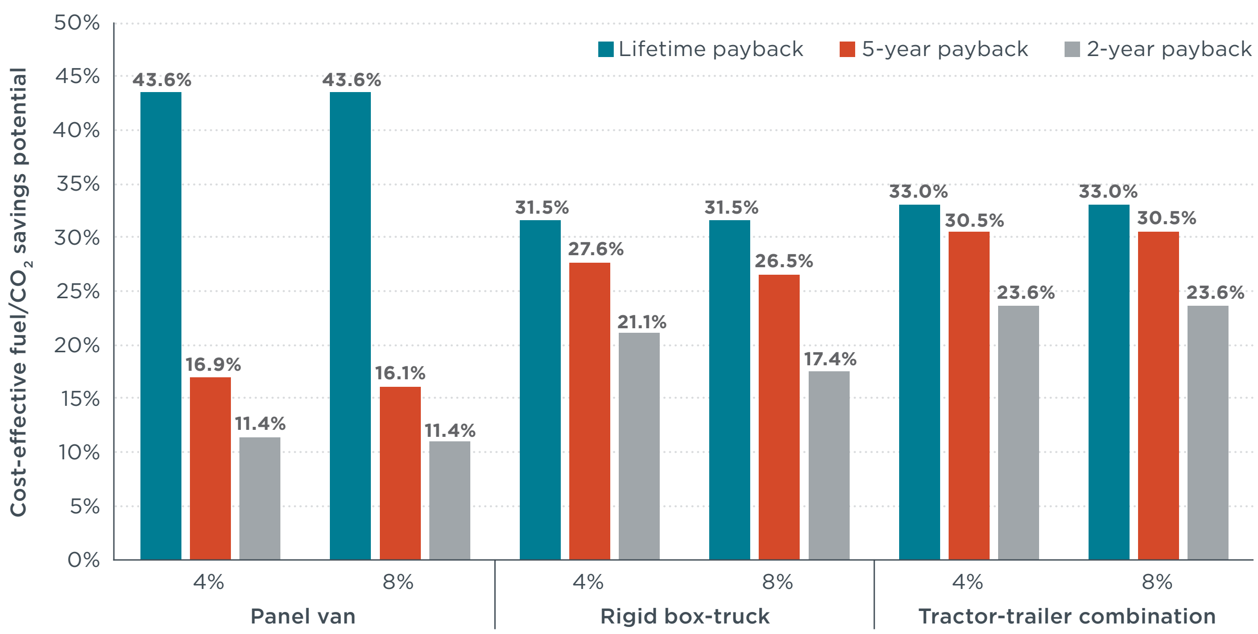

Figure 3: Summary of the 2030 cost-effectiveness potential under various payback period assumptions for different technologies for the three vehicle segments

payback calculations are sensitive to the financial assumptions made in the analysis. One aspect where the payback period changes from within to beyond the expected life of the vehicle is for full hybridization of the panel van. If the discount rate is increased from 4% (for the social perspective) to 8% (the typical rate for private/end-user investments), then a full hybrid system would not generate a payback within 12 years.

POLICY IMPLICATIONS

- The EU can substantially reduce CO_2 emissions from heavy-duty vehicles, and most of the technologies investigated by the US during the Phase 2 rulemaking are also applicable to EU trucks. The findings of this study could inform policymakers' deliberations in the ongoing development of standards, particularly regarding stringency, cost, and timing of the regulation.
- The VECTO methodology does not currently incorporate all technologies that were considered in this study. For example, trailer aerodynamics have significant reduction potential, but the current version of VECTO does not account for improvements made to the trailer because the trailer defined in the VECTO methodology is a "standard" default trailer only. Another example is the fuel consumption reduction that comes from hybrid powertrains that was considered in the study. The current VECTO tool is not designed to account for this category of technological improvement. Ultimately, the technology accounting methodology will need to align with the technology packages that are selected to inform any regulatory stringency.

FURTHER READING

- Market penetration of fuel efficiency technologies for heavy-duty vehicles in the European Union, the United States, and China. http://www.theicct.org/market-penetration-HDV-fuel-efficiency-technologies
- **Overview** of the heavy-duty vehicle market and CO_2 emissions in the European Union. http://www.theicct.org/overview-heavy-duty-vehicle-market-and-co2-emissions-european-union
- Advanced tractor-trailer efficiency technology potential in the 2020-2030 timeframe. http://www.theicct.org/us-tractor-trailer-efficiency-technology
- Cost effectiveness of advanced efficiency technologies for long-haul tractor-trailers in the 2020-2030 timeframe. http://www.theicct.org/us-tractor-trailer-tech-cost-effectiveness

FURTHER INFORMATION

Title: *Heavy duty vehicles technology potential and cost study*

Authors: Ricardo Energy & Environment

Download: http://theicct.org/HDV-technology-potential-and-cost-study

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