

Heavy-duty vehicle fuel efficiency technology in the EU

This supplement provides more detailed information on the CO₂ emissions and market penetration of fuel efficiency technology for key segments in the European truck market. All data presented are extracted from the publicly available data reported and monitored under the scope of regulation (EU) 2018/956, for the first reporting period, July 2019–June 2020, and were obtained from the European Environment Agency’s website.¹ The figures below show the distribution and average value in each vehicle segment for several key indicators of performance, including CO₂ emissions, combustion engine efficiency and road load.

Market segmentation

The segmentation used here is based on that used in the certification regulation, (EU) 2017/2400,² which defines vehicle groups from 1 to 17 based on technical characteristics. The monitored data is only available for vehicle groups 1, 2, 3, 4, 5, 9, 10, 11, 12, and 16. The groups currently covered by the CO₂ standards, 4, 5, 9 and 10, are further differentiated according to the vehicle subgroups defined in (EU) 2019/1242.³

CO₂ emissions

CO₂ emissions are presented here for each segment in grams per kilometer (g/km), although the metric of the CO₂ standards is grams per tonne-kilometer (g/t-km), factoring in the segment’s average payload. The main findings from the 2019–2020 reporting period are the following:

- » Within each segment, there was a large spread in CO₂ emissions across truck makes and models, showing uneven rates of technology adoption across the industry.
- » Within the groups targeted by the standards, a number of models emitted significantly higher than the average emissions in their subgroups, up to a factor of 2,

1 European Environment Agency. 2021. “Monitoring of CO₂ Emissions from Heavy-Duty Vehicles - Regulation (EU) 2018/956.” June 1, 2021. <https://www.eea.europa.eu/data-and-maps/data/co2-emission-hdv>.

2 European Commission. 2017. “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 349/1. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32017R2400>.

3 European Commission. 2019. “Regulation (EU) 2019/1242 of the European Parliament and of the Council of 20 June 2019 Setting CO₂ Emission Performance Standards for New Heavy-Duty Vehicles and Amending Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC.” Official Journal of the European Union L 198 (July). <https://eur-lex.europa.eu/eli/reg/2019/1242/oj#d1e1921-202-1>.

mainly in subgroups 4-RD and 9-RD. However, these vehicles were also excluded from the metric of the CO₂ standards, as they were declared as “vocational vehicles.”

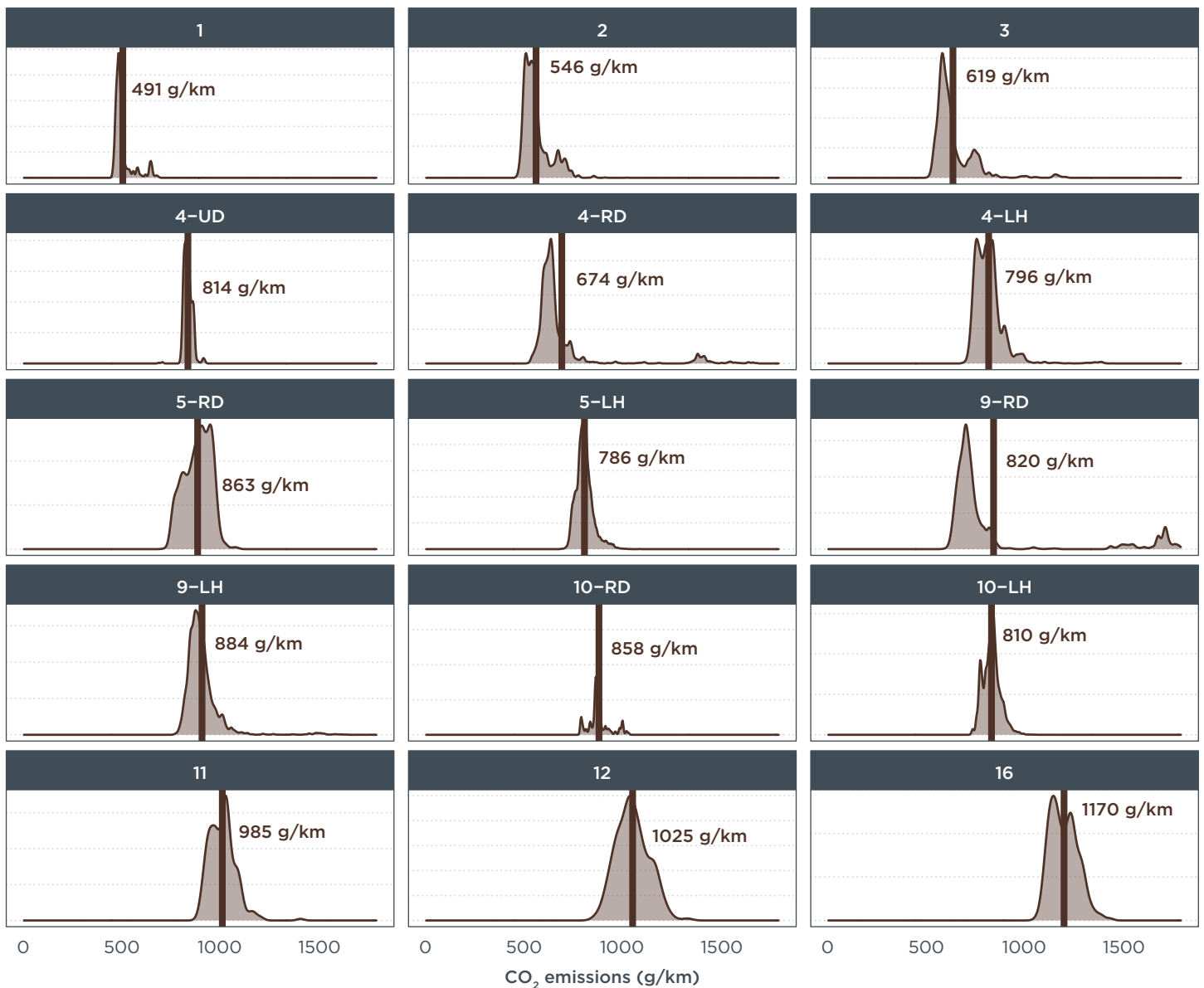


Figure 1. Density plot of the CO₂ emissions by truck segment during the first reporting period. The brown vertical line and label represent the average of all trucks in the segment. Groups 1 to 3 show data for the RDR cycle only. Group 12 shows data for the LHR cycle only. Groups 11 and 16 show data for the COR cycle only. All other groups show aggregated emissions across all applicable mission profiles (CO₂).

Internal combustion engine efficiency

The average internal combustion engine (ICE) efficiency over the World Harmonized Transient Cycle (WHTC) was calculated from the reported CO₂ emissions, in grams per kilowatt-hour (g/kWh), using the reference fuel properties from regulation (EU) 2017/2400.⁴ The main findings from the 2019–2020 reporting period are the following:

- » The maximum average efficiency was 44.5%, achieved by an MAN D38 15.3-liter diesel engine.

⁴ Lower heating values of 42.7 MJ/kg and 45.1 MJ/kg for diesel and natural gas, respectively, and carbon contents of 3.13 kgCO₂/kgFuel and 2.77 kgCO₂/kgFuel, respectively.

- » In general, higher efficiencies were achieved by larger engines used in the heavier truck segments.
- » The average efficiency of diesel engines was consistently higher than that of natural gas engines in all segments. The efficiency gap ranged from 7.5% (group 4-RD) to 17.8% (group 3).
- » There was a large spread in engine efficiency across models within each segment, showing disparities in the rate of engine technology adoption.

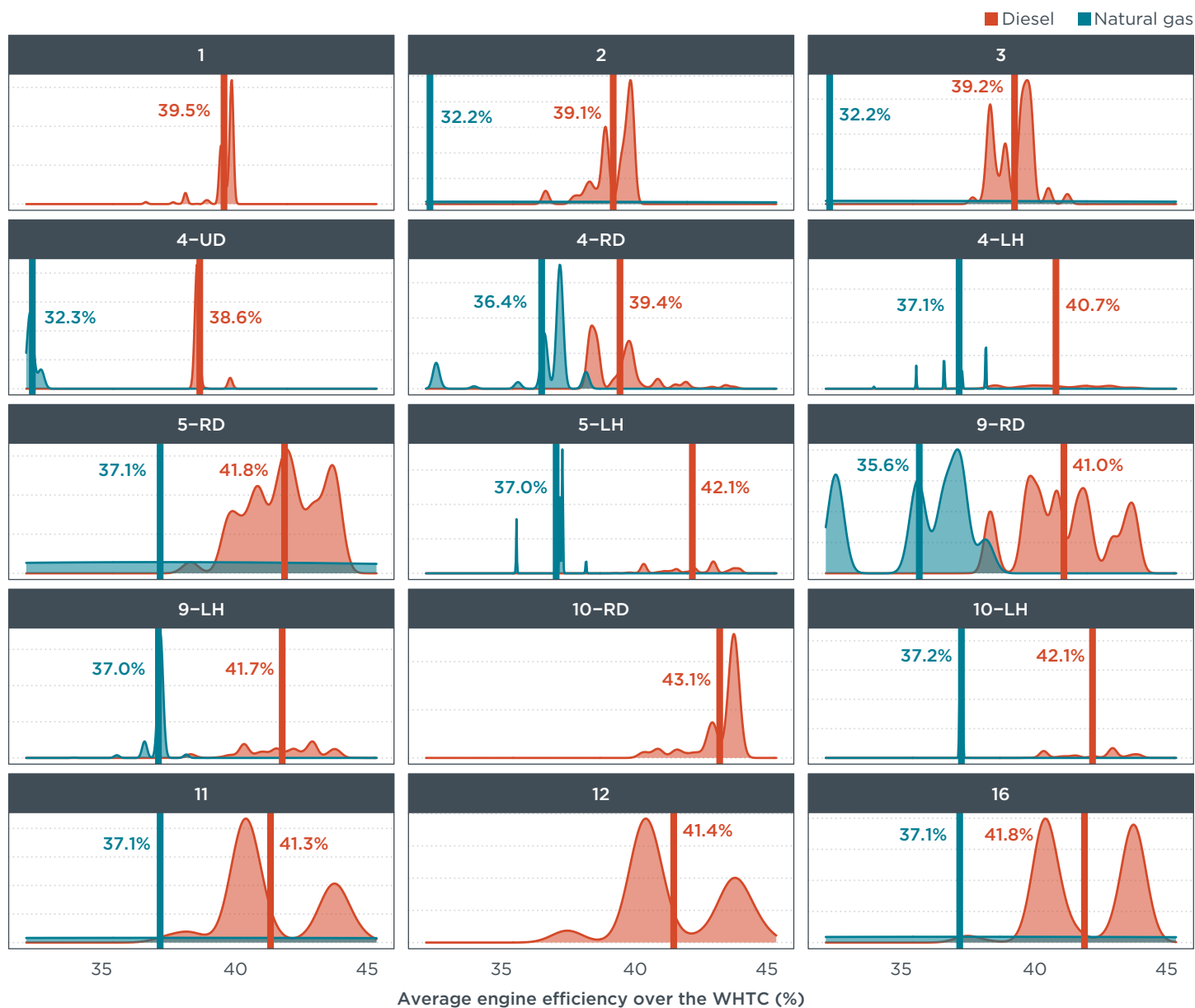


Figure 2. Density plot of average engine efficiency over the WHTC by segment and fuel type.

Road load

To reduce CO₂ emissions, truck makers can reduce the energy consumption of their vehicles by reducing the road load. The three main components of road load aerodynamic drag, tire rolling resistance, and vehicle curb mass.

Aerodynamic drag

Improving a truck's aerodynamic drag performance is key to reducing its CO₂ emissions—for trucks in particular, air drag contributes to about 40% of the usable mechanical energy produced by the engine.⁵ Data for the aerodynamic drag performance were only reported for the regulated truck segments. Although manufacturers have the option to use standard air drag values, we present data for the measured air drag values only. The main findings for the 2019–2020 reporting period are the following:

- » Within each group, LH subgroups have much lower air drag area ($C_d \times A$) values, as manufacturers can achieve higher fuel savings from lowering the air drag in these subgroups.
- » There was a large spread in the air drag area values with each subgroup, showing once again the heterogenous technology adoption rate across the industry.

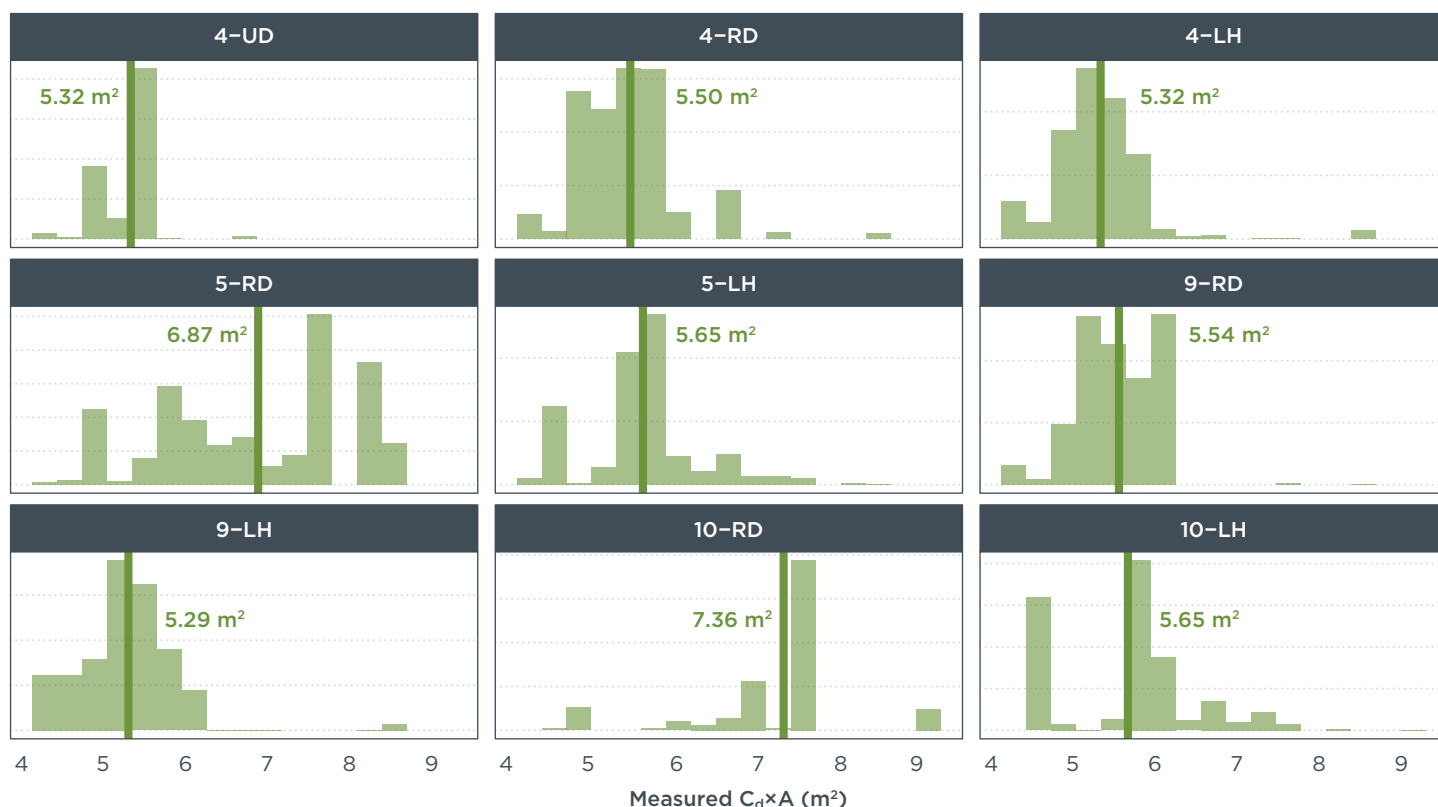


Figure 3. Histogram of the measured values of air drag area by segment. For each regulated truck, the air drag area ($C_d \times A$, in m^2), defined as the product of the drag coefficient (C_d) and the cross-sectional area of the truck (A), is reported as a $0.15 m^2$ range, in bins A1 to A24. Each bin from the histogram corresponds to a regulatory air drag area bin (A8 through A24). To compute the average, we assume the air drag area of each truck to be at the median value of its bin.

Tire rolling resistance

Tire rolling resistance data were reported for all segments. During the 2019–2020 reporting period, there was a large spread in the values within each segment. However, there was a greater uniformity across segments compared to other technology areas.

5 Delgado, Oscar, Felipe Rodríguez, and Rachel Muncrief. 2017. "Fuel Efficiency Technology in European Heavy-Duty Vehicles: Baseline and Potential for the 2020–2030 Timeframe." Washington, D.C.: International Council on Clean Transportation. <https://theicct.org/publications/fuel-efficiency-technology-european-heavy-duty-vehicles-baseline-and-potential-2020>.

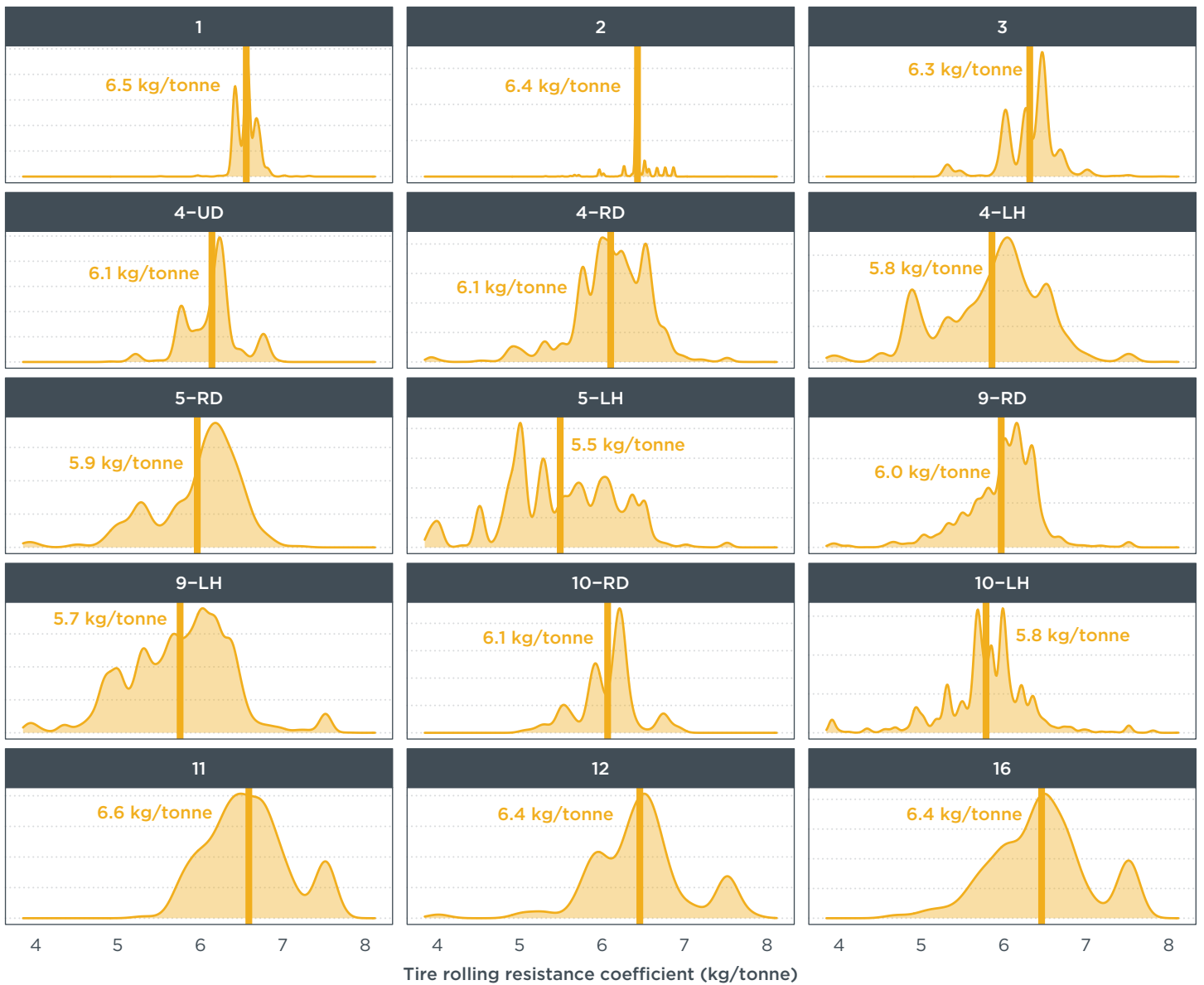


Figure 4. Density plot of rolling resistance coefficient, by segment.

Curb mass

Chassis curb mass data were also reported for all segments. The curb mass values for the 2019–2020 reporting period were more concentrated around the mean in each segment than for other technology areas. In addition, within each regulated group, the trucks in the long-haul subgroups were heavier.

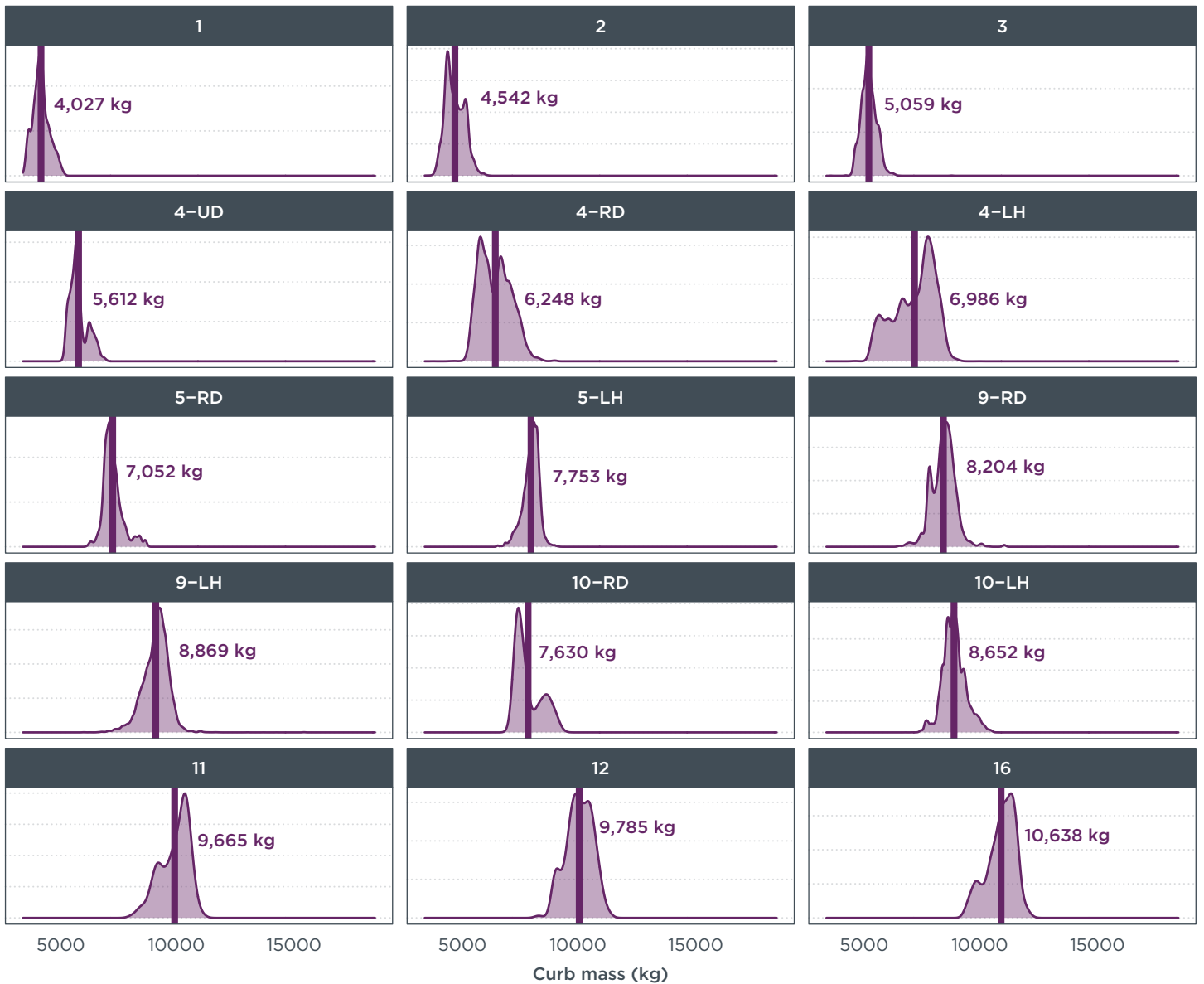


Figure 5. Density plot of chassis curb mass, by segment.

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