Confederazione Generale Italiana dei Trasporti e della Logistica

Intelligence Briefing

TCO and CO_2 in Italy: alternative and diesel trucks in 2025

Contents

Introduction

The road freight sector is widely recognised for its operational efficiency, offering fast, reliable and cost-effective solutions to its customers, including shippers and freight forwarders. In today's evolving economic and regulatory landscape, there are both opportunities and challenges in managing and optimising these costs. While inflation continues to exert pressure on margins, environmental policies are steering the sector towards net-zero emissions. Achieving sustainable operations that are also financially viable requires a careful strategic balance. Total cost of ownership (TCO) serves as a valuable tool in this context. It offers a holistic view of the financial performance of road freight operations. However, to align with environmental goals and benefit from regulatory developments, it is equally important to integrate CO_2 emissions into strategic planning.

Alternative powertrains are gaining traction across the EU, offering fleet operators a growing array of options to reduce their carbon emissions. While diesel remains the predominant fuel powering the EU's heavy-duty fleet, alternative solutions – such as compressed natural gas (CNG) and liquefied natural gas (LNG), hydrotreated vegetable oil (HVO), battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs) – present promising opportunities to reduce carbon emissions. These technologies can significantly reduce CO_2 emissions. However, adoption varies depending on the enabling conditions, usage and cost.

This Intelligence Briefing's TCO–CO_2 analysis uncovers key economic insights related to the financial viability of different vehicle technologies within the evolving EU regulatory framework over the next six years. Drawing on its industry expertise, IRU has developed and validated its assumptions in close collaboration with its members. This analysis incorporates future-oriented parameters, including the upcoming Emissions Trading System 2 (ETS2), to provide a representative view of the next six years.

This is the second edition of the IRU Intelligence Briefing comparing the TCO and carbon emissions of diesel and alternative powertrains across Europe. It is divided into seven country-specific briefings – France, Germany, Hungary, Italy, Poland, Spain and the UK – and one comparative Intelligence Briefing analysing the results across all seven countries.

Figure 3. Italian freight volumes reached 153 billion tkm in 2024, a 30% increase over the past decade

Italian versus EU average road freight volumes over time

Source: Eurostat (road_go_ta_tott) extracted on 2025-11-03

For a more detailed breakdown of EU road freight volumes and future trends, consult the Intelligence Briefing titled Breakdown of the latest road freight volumes, which also provides a forecast to 2030.

In Italy, the uptake of alternative fuel trucks reached around 700 units in 2024, representing approximately 3% of all new truck registrations. This growth was driven primarily by natural gas powertrains (CNG and LNG), which accounted for about 70% of these registrations. BEV adoption has also accelerated rapidly, rising from just 17 units in 2022 to more than 200 in 2024, a more than tenfold increase. This expansion is likely supported by national purchase incentives, which can reduce acquisition costs by up to EUR 24,000 for BEV, CNG and LNG trucks above 7 tonnes.[3]

For a more detailed information on incentives, please visit the **IRU Intelligence Monitoring on Zero-emission vehicle incentives – worldwide**.

Figure 11. In 2024, natural gas powertrains accounted for around 70% of alternative fuel vehicle registrations

Evolution of alternative fuel truck registrations in Italy

Source: EAFO extracted on 2025-11-03

3 https://www.confetra.com/wp-content/uploads/circ221-2025.pdf

2.3 How trucks are used during their first life

IRU's TCO methodology (see Appendix A) is based on how vehicles are used during their first life. As a general approach, it is considered that:

- Articulated T2S3 vehicles conduct long-haul operations
- Rigid R2 trucks conduct regional operations

For this analysis, both are considered to conduct national transport only (i.e. Italian trucks working in Italy). The following two sections define their first-life characteristics and usages, for both regional and long-haul operations, which are essential assumptions for the TCO analysis.

2.3.1 First-life characteristics

A vehicle's first life is the period between its purchase and resale by the first owner. Its characteristics are its duration, annual mileage, and the number of operational days per year.

Table 1. Life duration and operational days during the first year by vehicle type in Italy

	First-life duration	Operational days first year
T2S3	6 years	235 days
R2	6 years	222 days

Source: IRU estimates

It is assumed that the first owner operates the vehicle the most during its first year, with annual mileage gradually decreasing thereafter. A constant yearly mileage may be a reasonable proxy for vehicle usage, but it does not account for inflation and other cost increases, nor for the operational range of an electric vehicle, which will depend less on public charging over time.

The IRU Green Compact has created a mileage projection line for trucks based on first life duration, nationality, and the number of operational days. The values below are then used as assumptions for IRU's TCO calculations.

Table 2. Yearly mileage by vehicle type for general cargo in Italy (in km)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
T2S3	141,000	139,000	137,000	136,000	134,000	132,000
R2	89,000	89,000	86,000	85,000	84,000	83,000

Source: IRU estimates

2.3.2 Usage definitions

The IRU Alternative Fuels and Efficiency Model (AFEM) calculates energy consumption based on vehicle parameters and usage (see Appendix B). Usage is based on speed and altitude profiles, describing regional and long-haul operational patterns. It also considers the share of empty trips.

IRU's Alternative Fuels and Efficiency Model (AFEM)

To help transport operators explore decarbonisation solutions, IRU has developed AFEM, a vehicle dynamics model that considers vehicle speed and altitude changes to assess energy consumption, the TCO and carbon emissions. The tool simulates virtual vehicles, where changing powertrains and other technical parts can be explored to develop a tailor-made decarbonisation strategy. AFEM has been validated against industry gold standards.

You can learn more by contacting us at **information@iru.org**.

Figure 17. Speed profile of regional delivery vehicles
VECTO tool

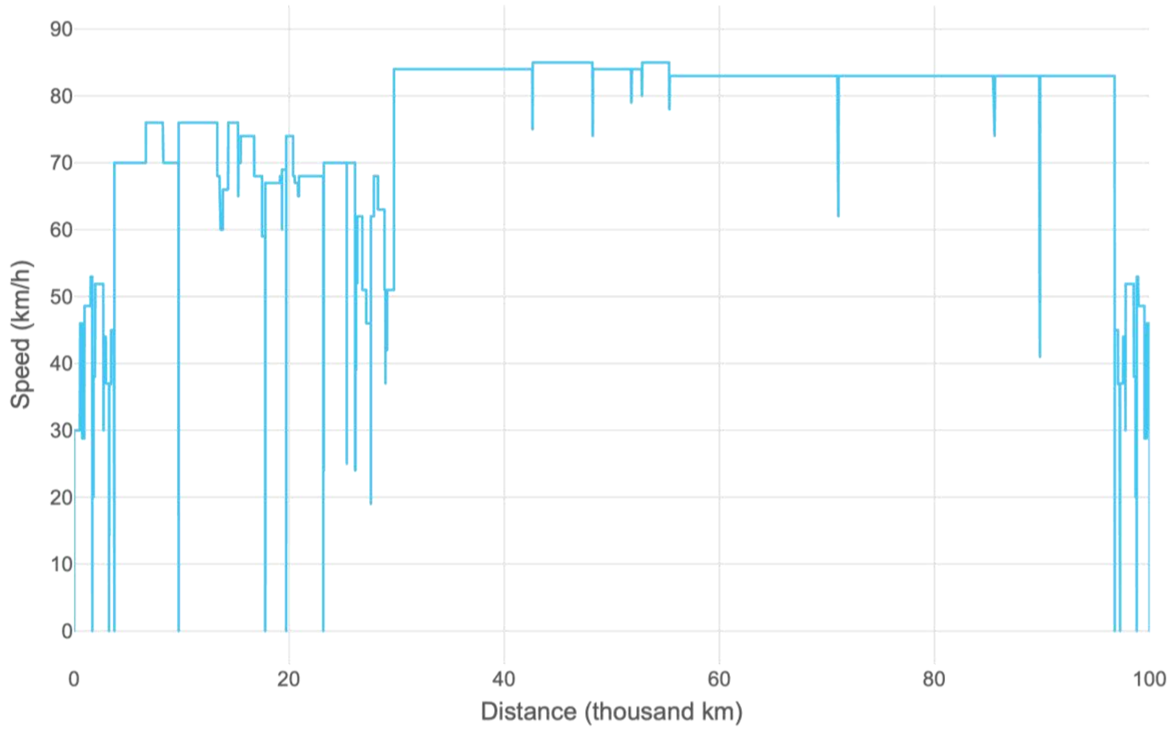
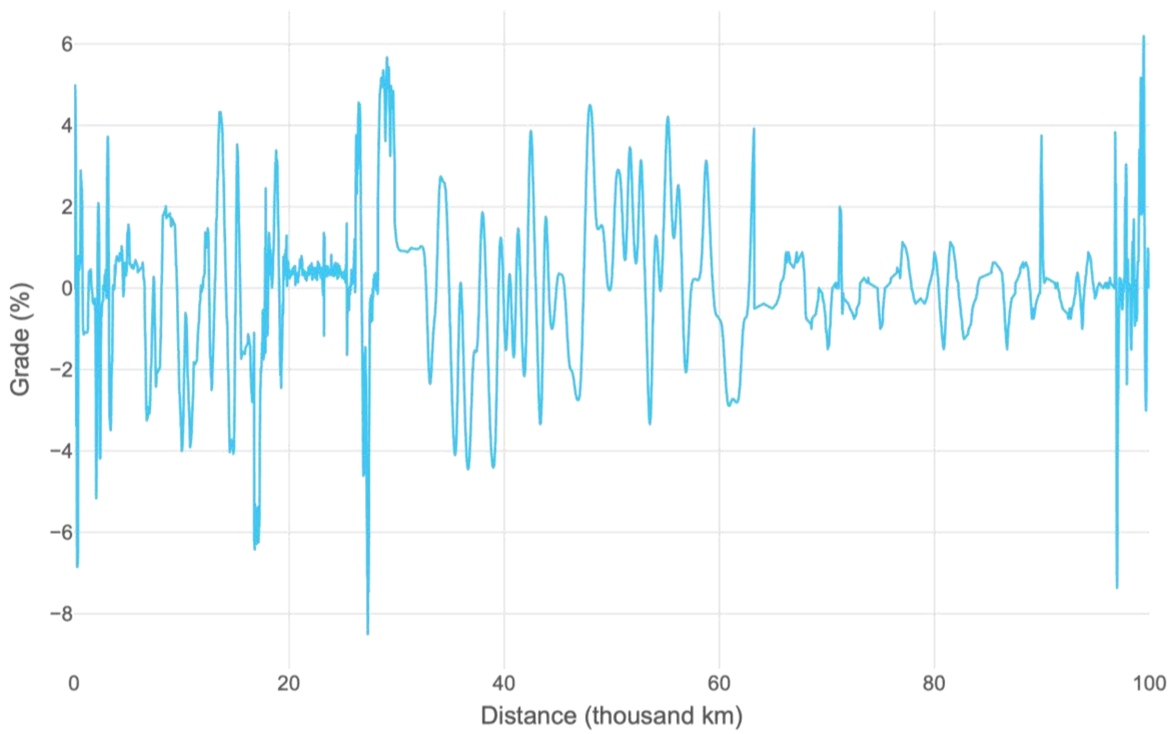


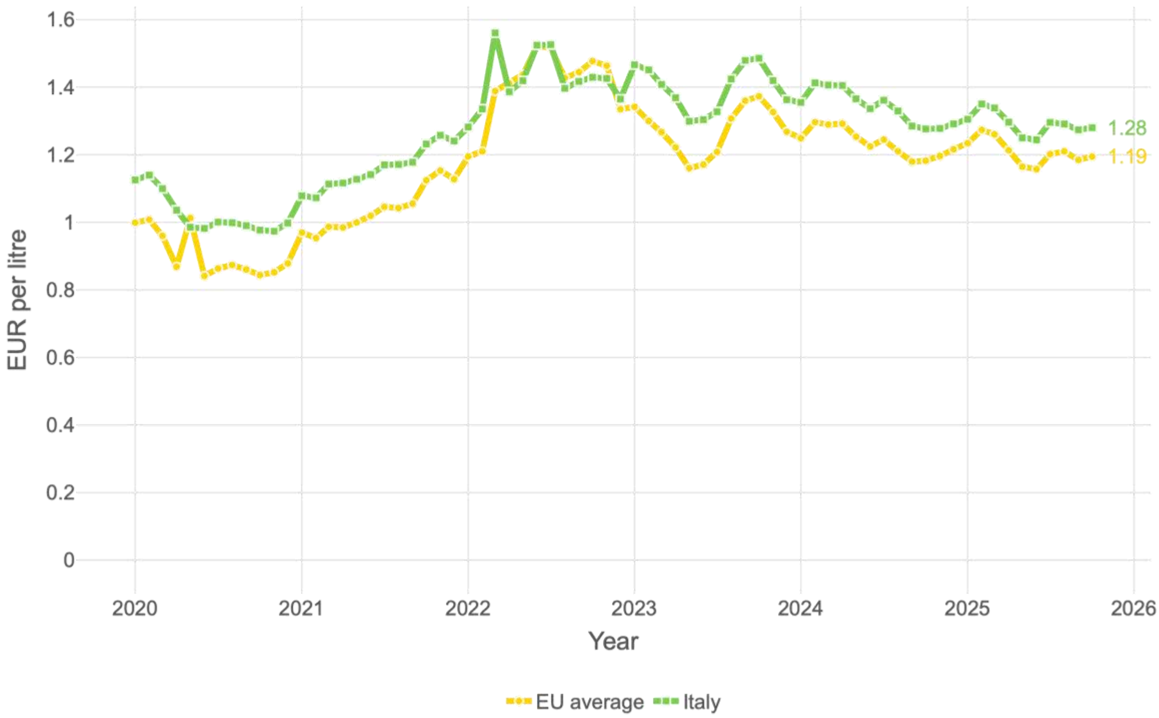
Figure 18. Altitude profile of regional delivery vehicles
VECTO tool



Source: VECTO

Until 2021, diesel prices remained under EUR 1.40 per litre (without VAT), before surging to a historic peak of nearly EUR 1.56 per litre due to the war in Ukraine and the post-Covid-19 economic rebound. Since then, prices have gradually declined, with some volatility, stabilising close to EUR 1.28 per litre, still above the pre-2022 historical value, and above the average EU price (7.6% higher). These recent stable results may potentially lead to a more predictable freight market.

Figure 24. In 2026, the price of diesel in Italy has stabilised at EUR 1.28 per litre, above the EU average (7.6% higher)
Price of diesel in Italy (without VAT)



Source: xavvy

AdBlue is an additive required to make diesel engines compliant with pollutant emission requirements. AdBlue use typically corresponds to about 7% of overall diesel or HVO consumption. Across the EU, AdBlue cost was less than EUR 1 per litre until early 2022, before peaking in mid-2022, which was followed by a gradual decline and stabilisation in 2024. Italian AdBlue prices followed a similar trend. Nonetheless, they are far more volatile and are above the EU average (24.7% higher), fluctuating at around EUR 1.01 per litre by the end of 2025.

4.
IRU carbon emission factor assumptions

A carbon emission factor (CEF) is used to derive the total amount of CO_2 emitted based on energy consumption. In this report, CEF values are based on a well-to-wheel approach, meaning they include the production stage, incorporating the CO_2 emitted during the production of the fuel or energy. Each fuel or energy has a CEF which may vary depending on its source, production and distribution process.

Table 11 summarises the CEF of electricity, hydrogen, diesel, HVO, CNG, LNG, and AdBlue. CEF values are reported in different units to reflect the specific energy sources.

Table 11. CEF for Italy in 2026

Energy or fuel	2026
Electricity	259 gCO_2/kWh
H2	11.4 $kgCO_2/kg$
Diesel	3.35 $kgCO_2/L$
HVO[1]	0.36 $kgCO_2/L$
CNG	3.33 $kgCO_2/kg$
LNG	3.58 $kgCO_2/kg$
AdBlue	0.3 $kgCO_2/L$

[1]CEF values exclude HVO sourced from Indirect land use change (ILUC)

4.1 Electricity

In 2024, nearly half of Italian electricity was generated from non-renewable, high-carbon-emission sources, primarily natural gas (44.4%) and oil (3.1%).[7] The other half comes from renewable energy sources such as hydropower (19.8%), solar PV (13.2%) and wind (8.2%). There is a rather strong reliance on non-renewable fossil fuels, placing Italy among the EU countries with high carbon-emitting electricity. In 2024, the CEF of electricity was estimated at 288 gCO_2 per kWh in Italy.[8]

The introduction of cleaner energy sources, such as renewables or nuclear, have lowered Italy's electricity CEF. To anticipate future emission reductions, a linear extrapolation of the reduction

7 https://www.iea.org/countries/italy/electricity
8 https://ourworldindata.org/grapher/carbon-intensity-electricity

Figure 38. FCEVs incur higher costs per tonne-kilometre, regardless of the payload
TCO by powertrain in Italy (long-haul)

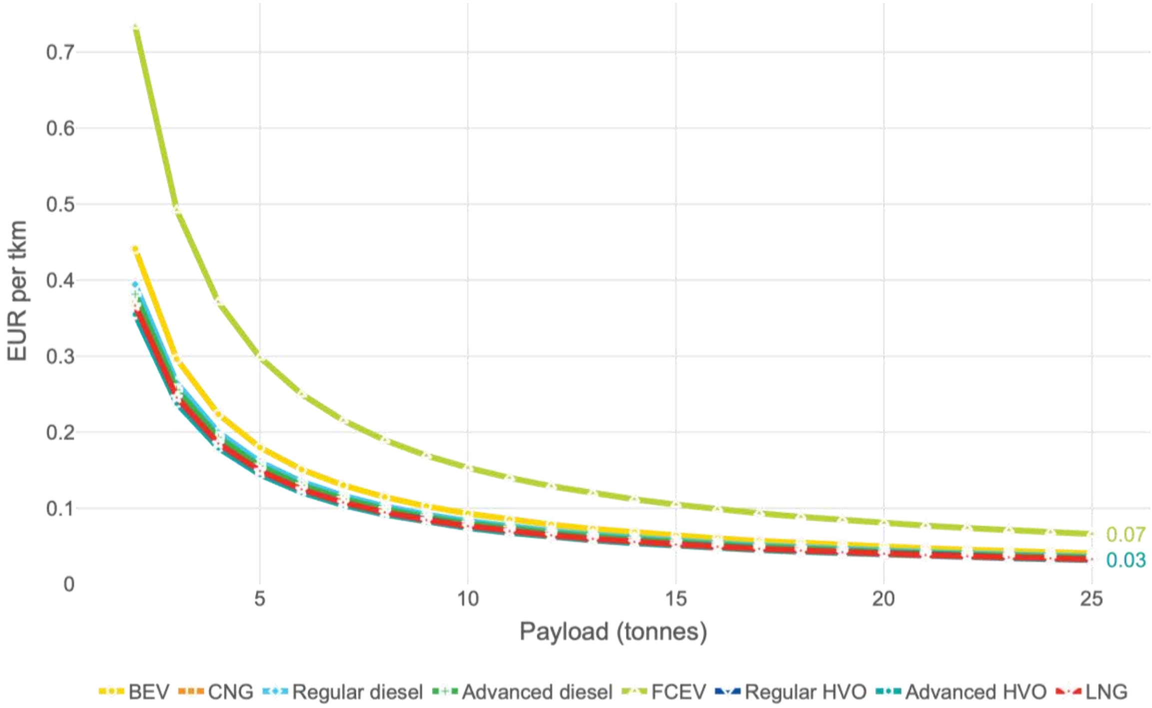
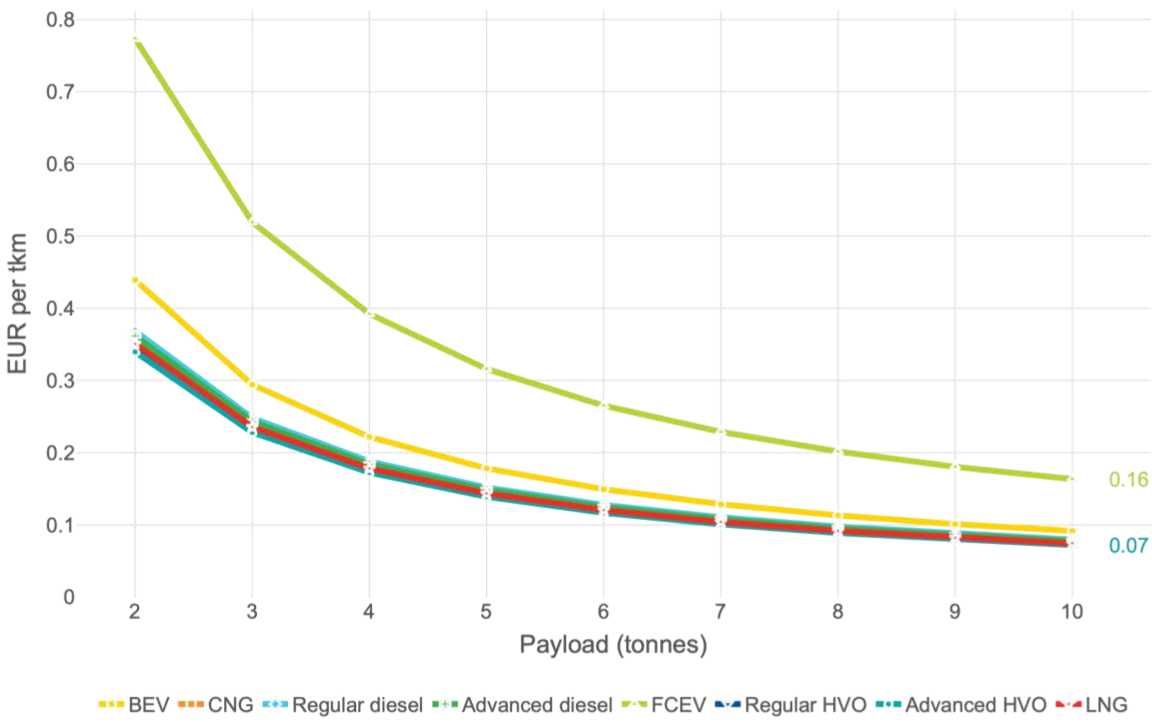


Figure 39. Like CO_2 reduction, payload optimisation also significantly lowers TCO per tonne-kilometre
TCO by powertrain in Italy (regional)



IRU

La Voie-Creuse 16, CP 44
CH-1211 Geneva 20, Switzerland
+41-22-918 27 00 (tel)
iru@iru.org

iru.org