

A life-cycle comparison of the greenhouse gas emissions from combustion, electric, and hydrogen trucks and buses in Europe

Transport is the biggest emitter of greenhouse gas emissions (GHG) in Europe, contributing almost 30% to the total. Buses and trucks are responsible for approximately a quarter of these GHG emissions. Today, Europe's trucks and buses rely almost completely on internal combustion diesel powertrains. To become a carbon-neutral continent by 2050, as stated in the European Climate Law, alternative technology and fuel options need to dramatically lower these emissions. The European Commission is planning to review the currently adopted CO₂ reduction targets to accelerate the transition in the sector.

There is potential to reduce GHG emissions in this sector through different powertrain options (electric batteries, fuel cell batteries, and combustion engines), and different fuel or energy choices (hydrogen, biofuels, natural gas). The climate impacts of these technologies and fuels vary over the lifetime of the vehicle model. From extracting and processing raw materials to operation and maintenance, some powertrain options are more energy intensive to build than their counterparts, while some fuel sources can produce higher emissions during their production or use.

A new ICCT study uses a life-cycle assessment to analyze these options in order to allow policymakers and manufacturing companies to compare which powertrain and fuel options provide the largest GHG emissions reductions. This analysis evaluates the lifetime emissions of different powertrains on a fully harmonized basis, comparing both the emissions attributable to fuel production and consumption as well as the emissions attributable to the vehicle's manufacturing. It investigates the current best-in-class diesel models against their natural gas, battery electric, and hydrogen fuel cell electric alternatives in the European market. The key results are highlighted below.

KEY FINDINGS

- » **Battery electric trucks and buses outperform their diesel, hydrogen, and natural gas counterparts in reducing GHG emissions over their lifetime.** 2021 vehicle models produce at least **63% lower** lifetime emissions compared to diesel. This reduction is already possible using today's EU electrical grid, which is not 100% renewable. The high energy efficiency of the electric powertrains shrinks their carbon footprint, making them a cleaner option even if the source of electricity is

not fully clean. As the grid continues to decarbonize, the emissions of these battery-electric vehicles will continue to fall—projections show up to a 92% reduction of emissions when 100% renewable electricity is used.

- » **Fuel cell battery trucks and buses run on hydrogen produced from fossil fuels reduce GHG emissions by 15 to 33% compared to their diesel counterparts in a lifecycle analysis.** The emissions reduction depends heavily on the source of hydrogen. With hydrogen solely produced with renewable electricity, **emissions fall by up to 89**. In contrast to battery electric trucks and buses, the emissions of hydrogen trucks and buses are not drastically reduced when using a non-renewable energy source—in this case, fossil hydrogen.

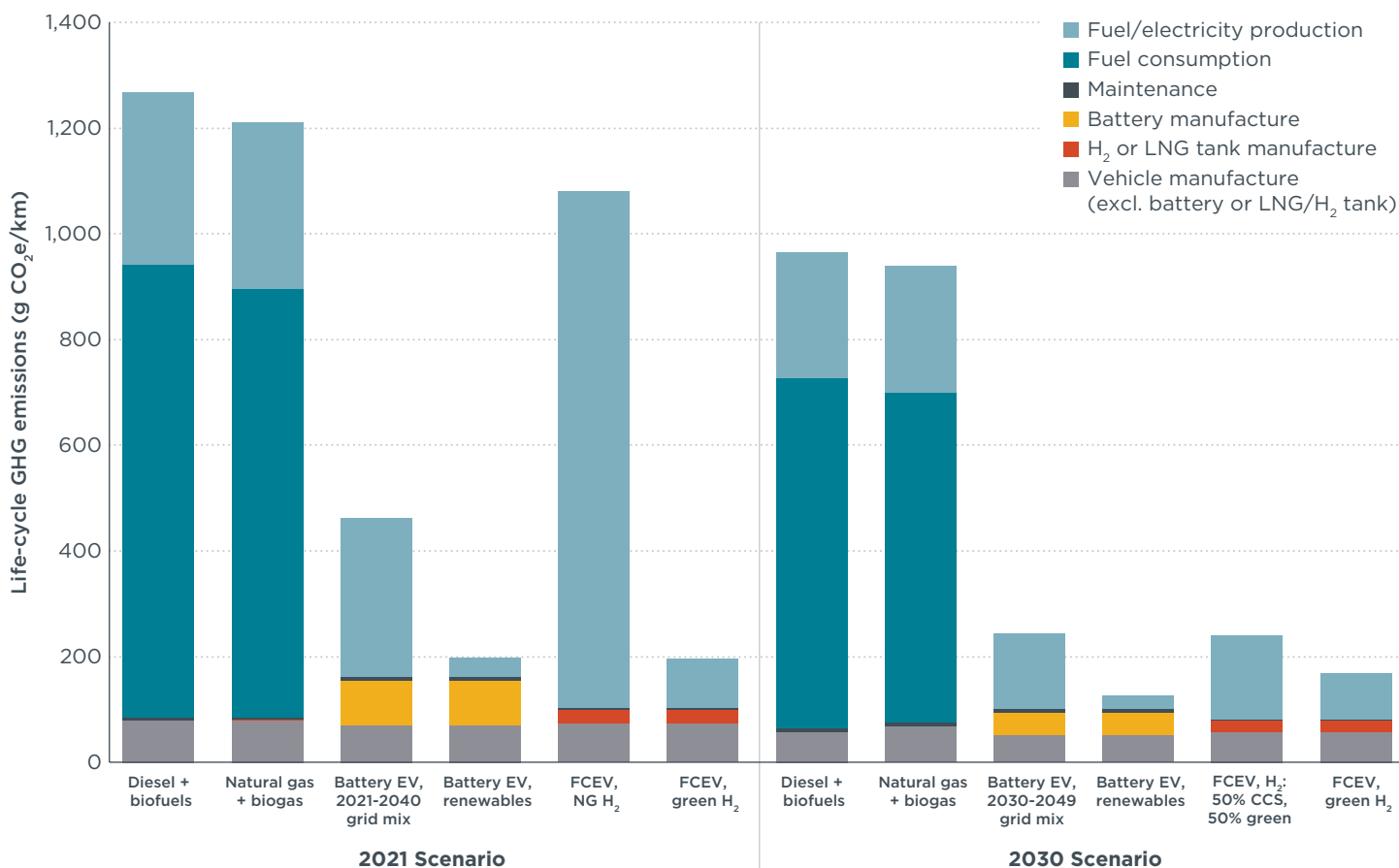


Figure 1. Life-cycle GHG emissions for 40-tonne tractor trailer in 2021 and 2030 scenarios

- » **Natural gas trucks and buses provide marginal GHG reductions, at best, compared to diesel.** For the 2021 scenario, we find that natural gas trucks and buses may reduce emissions from 4% to 18% compared to their diesel counterparts. The contribution of methane, a potent GHG which can leak from vehicle and throughout the production and supply of the natural gas, is a significant driver of this powertrain’s emissions. However, the benefits from natural gas vehicles disappear when using a near-term global warming potential for methane, which results in them having a 0% to 21% greater lifetime climate impact than diesel vehicles.
- » **The biggest portion of lifecycle GHG emissions produced by trucks and buses over their lifetime corresponds to the use (or fuel consumption) phase, not to the vehicle manufacturing.** For diesel and natural gas trucks, the consumed fuel accounts for over 90% of their lifetime emissions. Thus, the higher vehicle and battery production emissions of battery electric trucks are offset by their high efficiency and low lifetime fuel cycle emissions.

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