

Do gas trucks reduce emissions?

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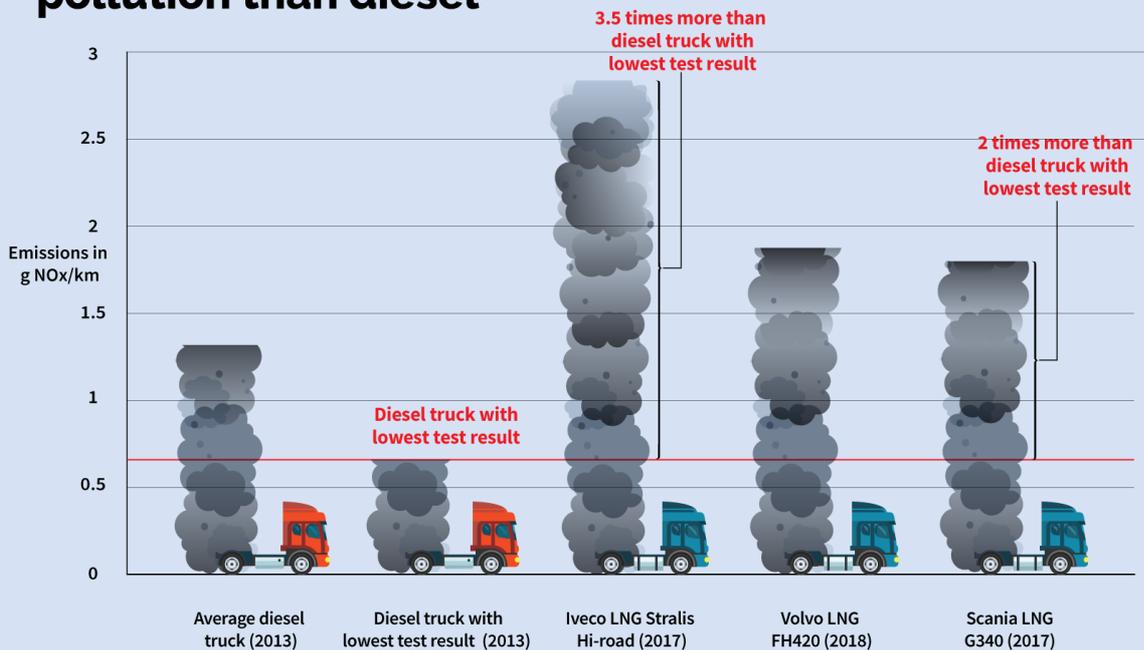
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Summary

A number of truck manufacturers claim that trucks running on gas deliver strong air quality and greenhouse gas benefits compared to diesel. On-road tests commissioned by the Dutch government were performed by TNO, an independent research organisation, to compare emissions from diesel and liquefied natural gas (LNG) trucks. The on-road data shows that many of the truckmakers' claims are false.

NOx: Six EURO VI diesel trucks produced in 2013 were tested and compared with three EURO VI LNG trucks produced in 2017/8. In urban driving the LNG trucks emit 2 to 3.5 times more NOx compared to the diesel truck with the lowest test result.

LNG trucks in cities emit over 2 times more NOx pollution than diesel

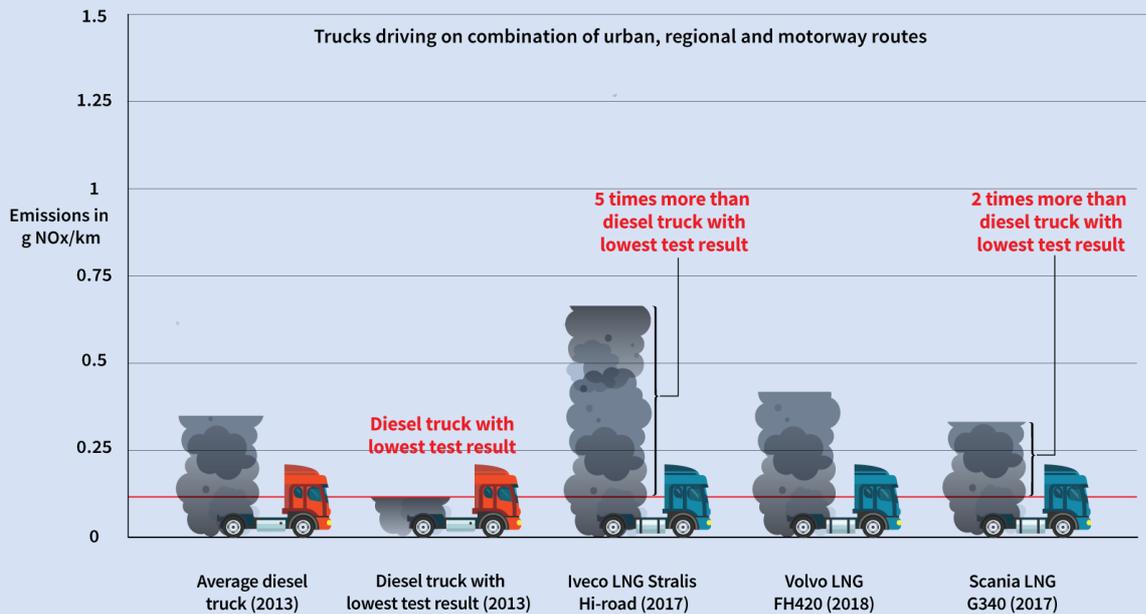


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Source: T&E based on TNO report, Emissions testing of a Euro VI LNG-diesel dual fuel truck in the Netherlands (2019)

In combined driving (urban, regional and highway) the LNG trucks emit 2 to 5 times more NOx than the diesel truck with the lowest result. If biomethane is used (instead of fossil gas), it does not reduce NOx emissions because the fuel characteristics of biomethane and fossil gas are approximately the same.ⁱ

Clean gas? LNG trucks emit up to 5 times more NOx pollution than diesel



Particles: Truckmakers claim that by using LNG, “particle emissions are almost completely eliminated” - or reduced by 95% compared to diesel.^{ii iii iv} The TNO reports show that these claims are not true and gas trucks still produce significant numbers of particles.

Greenhouse gas emissions: Tested LNG trucks with spark ignition engines record tailpipe emissions 3 to 5% lower than the diesel truck with lowest test result. Volvo’s LNG truck with High Pressure Direct Injection (HPDI) records tank-to-wheel emissions 14% less compared to the tested diesel vehicle that had the lowest GHG emissions. However, well-to-tank emissions from the production and transport of gas are on average 26% higher in the EU than fossil diesel.^v T&E analysis shows that when considering the full emissions cycle, spark ignition LNG trucks are worse for the climate than the diesel truck that showed the lowest values in the test, while HPDI gas trucks hardly deliver any benefit.

Research & tax policies: Significantly more EU research money has been spent on gas trucks (up to €17m) compared to truck electrification/batteries and hydrogen (up to 12m).

Italy gives a 99.5% tax cut to gas compared to diesel, with €675m lost in tax revenue each year. Tax cuts are not as severe in other Member States but annual revenue losses are still €143m in Spain, €62m in Germany, and €50m in France.

Europe needs to use the revision of the Alternative Fuels Infrastructure Directive, the reform of the Energy Tax Directive, and its new research programme, Horizon Europe, to help decarbonise trucking. In particular, investment needs to support technologies with zero tailpipe emissions such as battery electric, catenary and hydrogen. Tax levels on gas used in transport will need to be raised. Overall, the evidence that gas in transport does not warrant further public spending or support is clear, requiring an important shift in policy-making.

1. EU countries and truckmakers pushing the LNG market

Some truckmakers see gas trucks as the way forward to make trucking more sustainable. Iveco claims that LNG powered vehicles emit 10% less CO₂, 95% less particles and 35% less NO_x compared to Euro VI diesel trucks.^{vi vii}

According to Scania, LNG trucks would cut CO₂ emissions up to 20% compared to diesel, NO_x emissions are reduced by at least one third while particle emissions would almost be eliminated i.e. 95% lower.^{viiiix} The Natural & bio Gas Vehicle Association (NGVA Europe) states that NO_x emissions of trucks running on natural gas are between 30 and 60% lower than diesel.^x

Iveco announces diesel-free stand at IAA 2018



Volvo recently launched a new LNG model (Volvo FH LNG) with high pressure direct injection (HPDI) technology which, according to Volvo, strongly improves the engine efficiency of LNG trucks. Based on tank-to-wheel emissions (TTW), Volvo claims a CO₂ reduction of 20% compared to a regular diesel Volvo truck.^{xi}



Many Member States as well as truckmakers are promoting gas trucks. In almost all Member States the tax rate for fossil gas in transport is much lower than for diesel. Italy, Europe's largest fossil gas consumer in transport, has one of the lowest tax rates for fossil gas - only 0.09€/GJ compared to 17.22 €/GJ for diesel - which amounts to a 99.5% tax cut for gas.^{xii} Germany on the other hand recently decided to exempt LNG trucks from the truck toll scheme which will strongly reduce the operating costs of gas trucks.^{xiii}

In short, policy makers are creating a regulatory framework that makes LNG trucks much more attractive by substantially lowering their operating costs. At the same time we see several truckmakers heavily investing in LNG trucks. As a result, truck operators are buying more and more gas powered vehicles. In 2016, the sales of gas-powered trucks in Europe increased by 15%.^{xiv}

2. TNO putting different LNG and diesel trucks to the test

Commissioned by the Dutch Ministry of Infrastructure and Water Management, the Dutch Organisation for Applied Scientific Research TNO, an independent research organisation, set up different on-road emissions testing programmes, measuring pollutants (such as NO_x and particles) and TTW greenhouse gas emissions (GHGs) of LNG and diesel trucks.

TNO tested three LNG vehicles:

- A 2018 **Volvo Euro VI step C long-haul LNG truck** with a dual fuel engine running on LNG as the primary fuel and diesel as the secondary fuel injected to ignite the LNG - the so-called High Pressure Direct Injection, or HPDI. This new Volvo model can be considered as state of the art LNG truck technology.^{xv}



- Two 2017 LNG Euro VI models (**Iveco Stralis Hi-road Euro VI 400hp and Scania G340 Euro VI 340hp**) with spark-ignition engines were tested.^{xvi}



These three LNG trucks were compared with earlier on-road TNO test results of **diesel trucks with first generation Euro VI Step A engines produced in 2013.**^{xvii}

All the trucks were tested in comparable conditions, driven on the same route (involving urban, rural and motorway travel) with two different payloads. The tailpipe emissions were measured using a PEMS, Portable Emissions Measurement System.

2.1 Trucks running on gas not delivering air pollutant benefits

2.1.1 Why should we care?

Policy makers at all levels are trying to reduce the harmful impact of transport on air quality and human health. One of the big challenges is to reduce NO_x emissions coming from transport. Recent research for example shows that the unlawful NO_x emissions from diesel cars due to dieselgate has led to approximately 5,000 additional premature deaths annually in Europe.^{xviii}

Three in every four Europeans live in urban areas and this is only set to increase.^{xix xx} It is therefore vital that NO_x emissions of vehicles are reduced, especially in urban travel. In cities such as London, Paris and Copenhagen trucks already account for more than 20% of NO_x emissions coming from transport.^{xxi xxii xxiii}

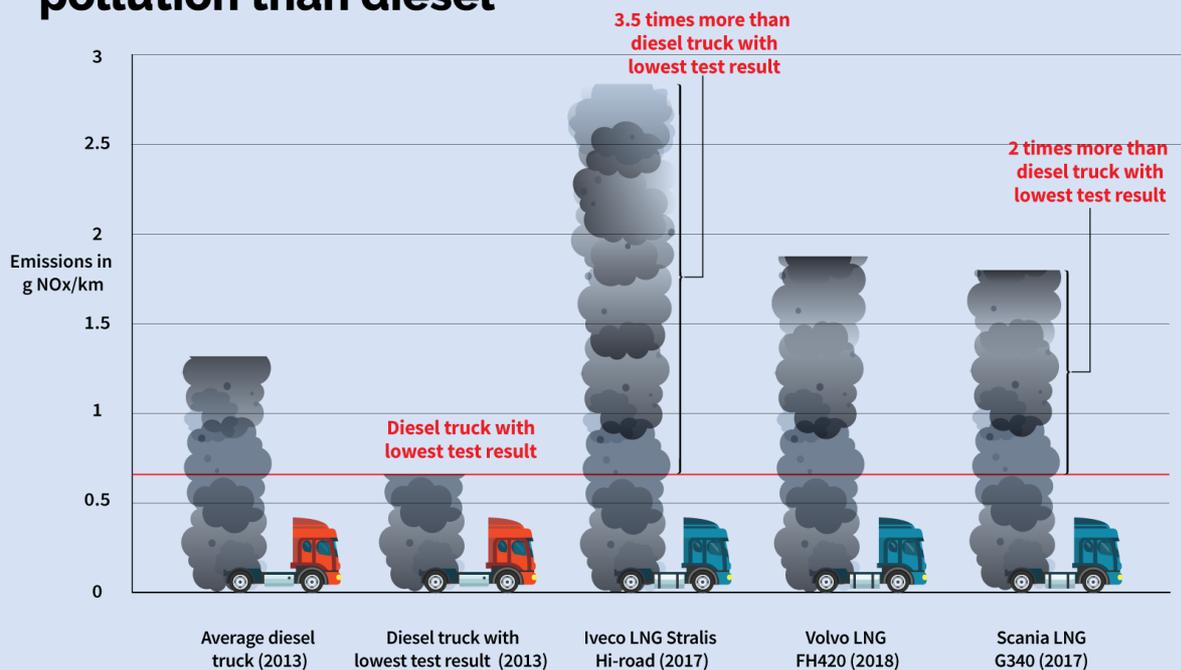
Trucks running on LNG regularly operate in cities. Supermarkets in the Netherlands, France and Spain use LNG vehicles for city delivery.^{xxiv xxv xxvi} City bans such as the one announced in Paris would also encourage hauliers to switch to gas-powered trucks - as gas trucks would still have access under the proposal for Paris.^{xxvii} NO_x emissions from trucks are also typically much higher in urban conditions compared to rural and motorway driving.

However NO_x is not the only pollutant of concern for air quality as also small particles (particulate matter) emitted from vehicle exhausts have been linked to cardiorespiratory and central nervous system adverse health effects.^{xxviii} Particulate air quality limits (PM₁₀ and PM_{2.5}) continue to be exceeded across Europe^{xxix} and while trucks make up only 5% of the vehicles on EU roads they emit 13% of PM_{2.5} in London and 20% of PM₁₀ in Berlin of total urban air pollution.^{xxx} As such it is therefore important that particulate emissions from trucks are monitored and reduced in order to improve air quality in Europe.

2.1.2 NO_x emissions: LNG trucks are worse than the diesel truck with the lowest test result during city operations and overall

The TNO test results show that in **urban driving conditions**, NO_x emissions from all three tested LNG trucks are substantially higher (an increase of 39-117% depending on the LNG model) than the average diesel vehicle tested earlier. Compared to the lowest diesel value measured the NO_x emissions are 2 to 3.5 times more.^{xxxi} According to TNO, the higher emissions from the Volvo LNG truck are mainly emitted just after the cold start of the engine.^{xxxii}

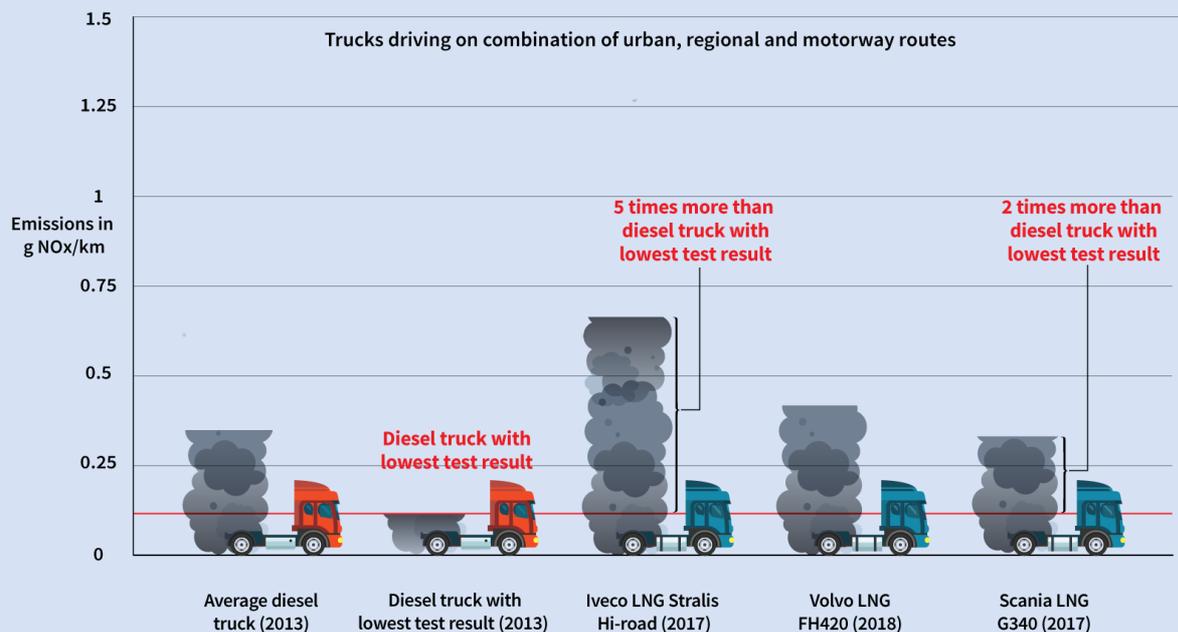
LNG trucks in cities emit over 2 times more NOx pollution than diesel



For the Iveco and Scania trucks, only a small share of the higher NOx emissions of LNG trucks is due to the cold start of the engine. Therefore, also during appropriate operating temperatures and acceleration (which happens a lot during stop and go in cities), TNO measured higher NOx emissions for both trucks tested.^{xxxiii}

With **combined (urban, rural and motorway) driving** the TNO tests show that the NOx emissions of the tested LNG trucks are on par, or there is an increase up to 89% depending on the LNG model, compared to the NOx emissions of the average diesel truck tested. Compared to the diesel truck that showed lowest NOx emissions, the gas powered trucks emit 2 to 5 times more NOx.^{xxxiv}

Clean gas? LNG trucks emit up to 5 times more NOx pollution than diesel

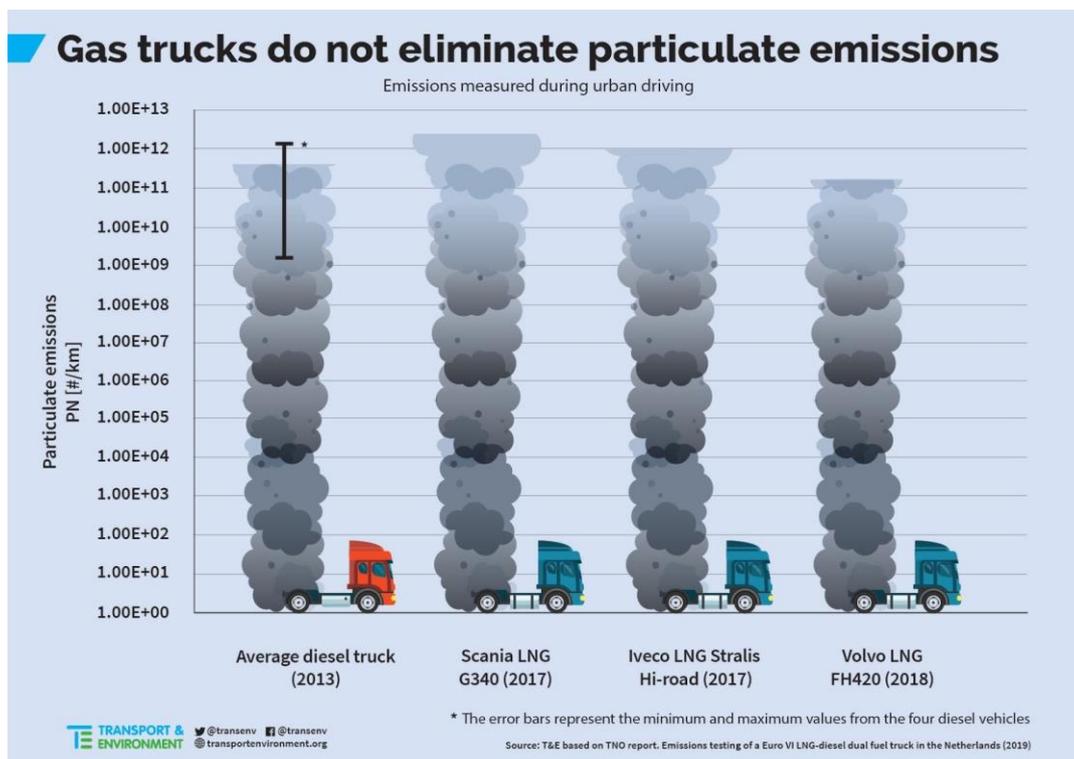


These findings are in strong contrast with the claims made by gas truckmakers (30-35 % less NOx).^{xxxv xxxvi} One also needs to take into account that in this testing programme, the latest LNG trucks were compared with older diesel trucks with first generation Euro VI Step A engines from 2013.^{xxxvii}

It is also important to underline that one of the three truckmakers discussed here confirmed in writing that “biomethane will not make any difference when it comes to NOx emissions from the engine”. The actual fuel characteristics of bio-LNG and fossil LNG are practically the same, and thus so are the tailpipe emissions.^{xxxviii} Put simply, trucks using biomethane have approximately the same NOx emissions as fossil gas.

2.1.3 LNG trucks do not emit less particles

Truckmakers claim that by using LNG, “particle emissions are almost completely eliminated” - or reduced by 95% compared to diesel.^{xxxix xl} The TNO reports show that these claims are not true. In fact, the Scania and Iveco trucks tested emitted quite large numbers of particles per kilometer during urban driving conditions. These emissions during urban driving are particularly worrying as they can have a significant impact on air quality in towns and cities.



Unlike diesel trucks, LNG trucks are not required to meet emission limits on the number of particles until 2023 - which could be the reason the Scania and Iveco trucks tested showed high PN in urban driving. Most LNG trucks are not fitted with particulate filters, as is the case for the Scania and Iveco trucks used in the TNO study. The Volvo LNG truck was fitted with a DPF filter: however, during the whole test (combined driving cycle), the Volvo truck did not show a significant improvement compared to LNG trucks without filters.^{xli}

The above-mentioned tests did not examine particles smaller than 23nm in diameter, which are currently not regulated but are of significant concern for health. Evidence to date from the EU's Joint Research Centre (JRC) shows that sub 23nm particles could be a bigger concern for gas than diesel vehicles.^{xlii}

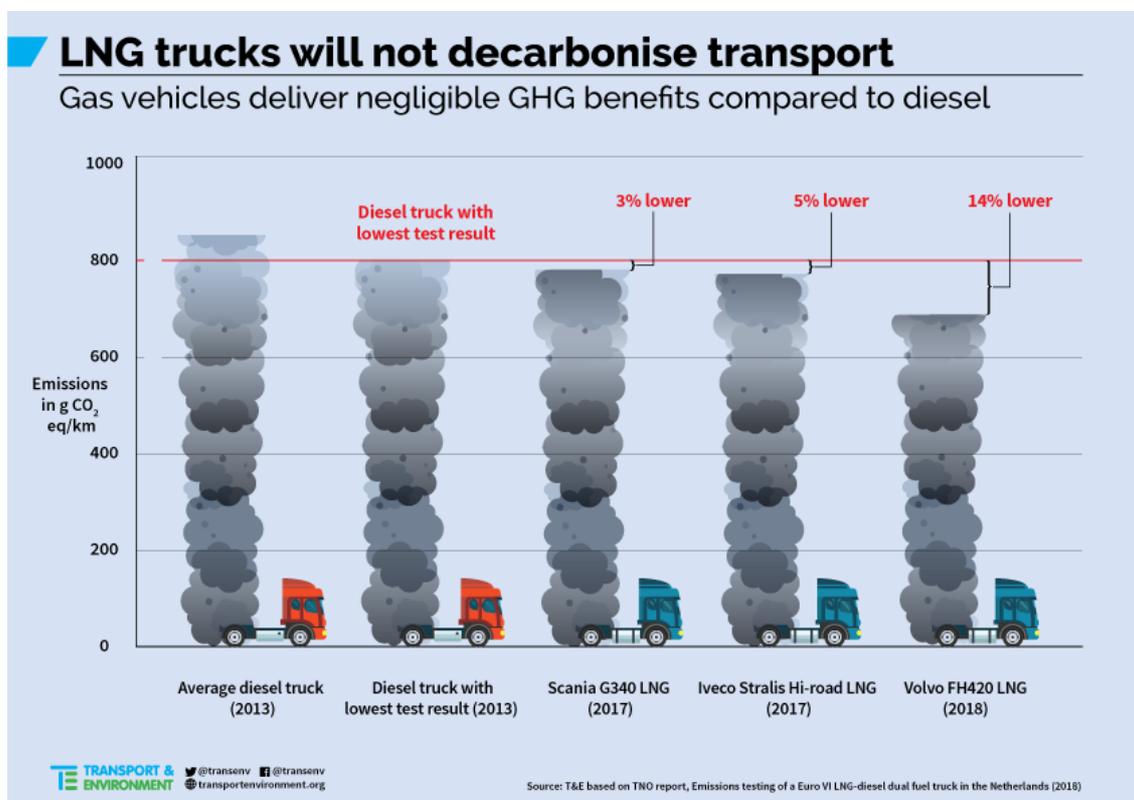
3. LNG trucks and greenhouse gas emissions

Apart from air pollutants, TNO also measured and compared the greenhouse gas emissions (GHG) from diesel and LNG vehicles. In their assessment TNO measured tank-to-wheel (or direct) vehicle emissions, mainly focusing on CO₂ emissions and methane emissions from the truck. Both greenhouse gasses have a major impact on climate change, with fossil methane having a global warming potential 30 times higher than CO₂ for a time horizon of 100 years.^{xliii}

Volvo states that the new LNG model delivers a 20% CO₂ benefit on a tank-to-wheel basis.^{xliv} According to the TNO tests, the Volvo LNG truck with HPDI technology emits 19% less CO₂ equivalent emissions compared to the average diesel for the combined route (urban, rural and motorway driving); this includes tailpipe methane which is approximately 2% of the CO₂ equivalent emissions. Compared to the diesel truck with the lowest test result, the difference is 14%.^{xlv}



For the **Scania and Iveco models**, the tailpipe CO₂ equivalent emissions (including tailpipe methane which is approximately 0.3% of the CO₂ equivalent emissions) for the combined route are 9 - 10% lower compared to the average of the diesels tested. Compared to the lowest value of the diesel trucks tested, emissions are only 3 - 5% lower.^{xlvi} The savings that Scania and Iveco claim in their advertisements (10 to 20%) don't exist in reality.^{xlvii xlviii}



There are also other important factors that put these GHG results into perspective:

- **Diesel trucks used for comparison:** All the tested LNG trucks are compared with diesel trucks with first generation Euro VI Step A engines of the manufacturing year 2013 which gives the gas-powered trucks a bigger advantage.
- **Well-to-wheel GHG emissions:** We also need to be aware that the average EU greenhouse gas emissions from fossil gas on a well-to-tank (WTT) basis are 26% higher per MJ than fossil diesel.^{xlix} This is due to energy consumption and methane emissions when extracting and transporting the fossil gas. According to Volvo, adding upstream GHG emissions increases the WTW emissions by 9 percentage points.^l As noted above, TNO found the HPDI truck to have 14% lower TTW emissions compared to the diesel truck with the lowest test result. Factoring in WTT emissions lowers this reduction and means overall GHG emissions from HPDI gas trucks are little better than the lowest diesel GHG values measured.^{li}

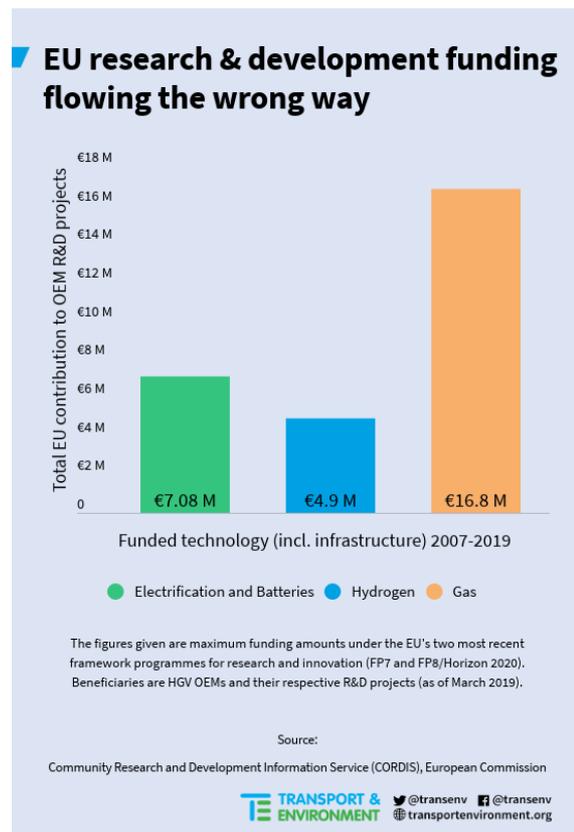
In practice, therefore, when the full emissions cycle is considered, spark ignition gas trucks are worse for climate than diesel truck with the lowest test result, while a high pressure direct injection (HPDI) gas truck only delivers a small benefit.^{lii}

4. EU research money subsidising fossil fuels

The TNO evidence shows that for all tested LNG trucks, the NOx emissions are higher compared to the diesel trucks with the lowest values measured (in all driving conditions). With regard to GHG emissions, LNG trucks with spark ignition technology are delivering hardly any benefits on a tank-to-wheel basis. Gas-powered trucks with HPDI technology may offer more but are not a long-term solution to decarbonise the trucking sector especially when also taking into account well-to-wheel emissions.

Despite these findings we see that the amount of EU research money flowing into projects for gas-powered trucks is disproportionately higher when compared with research for zero emission alternatives.

Our own analysis shows that over the last 13 years, under the EU research Framework Programme Horizon 2020 and FP 7, European truckmakers received up to €17 million funding for research on gas powertrains. This is in strong contrast with the money allocated to truck electrification/batteries and hydrogen projects (up to €12m).^{liii}



5. National tax breaks for gas

This on-road evidence is in line with earlier independent analysis showing that also for cars, vans, trucks and buses, gas-powered vehicles offer no real benefit over diesel.^{liv} However, EU Member States are strongly undertaxing natural gas used in transport. While slightly differentiated taxation for diesel and CNG/LNG could be justified (e.g. based on different carbon or energy content), there is no conceivable justification for the current tax rates for fossil gas.^{lv} By removing this tax break for fossil gas in transport and putting it on par with diesel, they could generate additional revenue as outlined in the table below.

Tax breaks for fossil gas in road transport

Member State	Diesel excise duty rate €/GJ (nat currency)	Fossil gas excise duty rate €/GJ (nat currency)	Tax revenues at gas rate (in € million)	Potential tax revenue if diesel rate is applied to gas (in € million)
 France	16.56	1.53	5.13	55.50
 Germany	13.12	3.86	25.69	87.28
 Italy	17.22	0.09	3.55	678.47
 Spain	10.57	1.15	17.45	160.41
 United Kingdom	18.14 (GBP 16.16)	6.37 (GBP 5.67)	data not available	
 Poland	9.57 (PLN 40.96)	4.53 (PLN 19.38)*	2.35 (PLN 10.04)	4.96 (PLN 21.21)

Sources: CE Delft (2017), European Commission Excise Duty Tables (2019), Eurostat (2019)

Notes: Excise duty rates and exchange rates are as of January 2019

Revenues are based on 2017 final gas consumption in road transport (excl. VAT)

*Gas excise duty rate for Poland is for LNG (CNG rate is lower)

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The tax levels for gas vehicles should be increased and more support should go to true zero emission alternatives such as charging infrastructure for battery electric trucks, grid modernisation, and zero emission buying subsidies for transport companies, as well as infrastructure for catenary vehicles.

6. EU policy measures

LNG is still seen by the EU policymakers as a way to make transport cleaner. The main goal of the Alternative Fuels Infrastructure Directive (AFID) is to support roll-out of infrastructure for alternative fuels to improve the EU's energy security but also to reduce the environmental impact of transport.^{lvii} The current AFID considers LNG as the main alternative fuel for heavy duty vehicles and the legislation sets requirements on gas refueling infrastructure.

This new evidence shows that further promoting infrastructure for LNG contradicts with the key goal of the Directive. By the end of 2020 the European Commission will review and amend if appropriate the AFI Directive. In this review, and in line with the evidence, LNG should no longer be counted as an alternative fuel for trucks. Instead the Directive should promote infrastructure that enables trucking with zero tailpipe emissions. This means ultra-fast charging infrastructure for battery electric trucks in urban areas. For long-haul trucking, the Directive should set clear goals for ultra-fast charging and/or infrastructure for catenary trucks and possibly hydrogen.

Regarding research funding, there was a clear bias towards gas in the most recent round of EU research projects. This needs to change in the EU's next research programme, Horizon Europe, with much stronger allocations to zero emissions solutions in particular. Because gas has no long-term decarbonisation contribution, it only makes sense to fund research for technologies that are in line with the long-term objectives of the European Commission which is net-zero emissions by 2050.^{lviii}

On taxation, the EU's Energy Tax Directive governs minimum tax levels on transport fuel and is set to be reviewed in 2020/1. Reform is badly needed, in particular the alignment of minimum tax levels of fuels such as LNG and diesel based on carbon content.

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