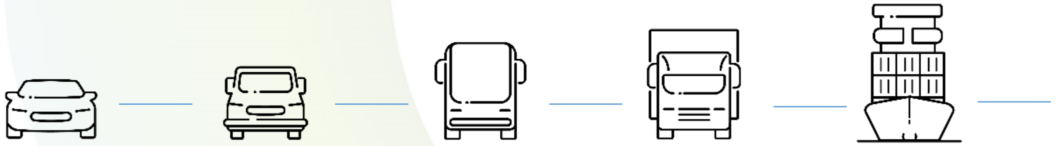
NGVA Europe
for sustainable mobility

Natural gas as transport fuel: which methane emissions ?

A. GERINI
March 2018

NGVA GHG Intensity study

NGVA Europe, thanks to a partnership of 28 industry organisations, commissioned to *thinkstep* an **industry-wide analysis of the supply and use of natural gas in Europe.**

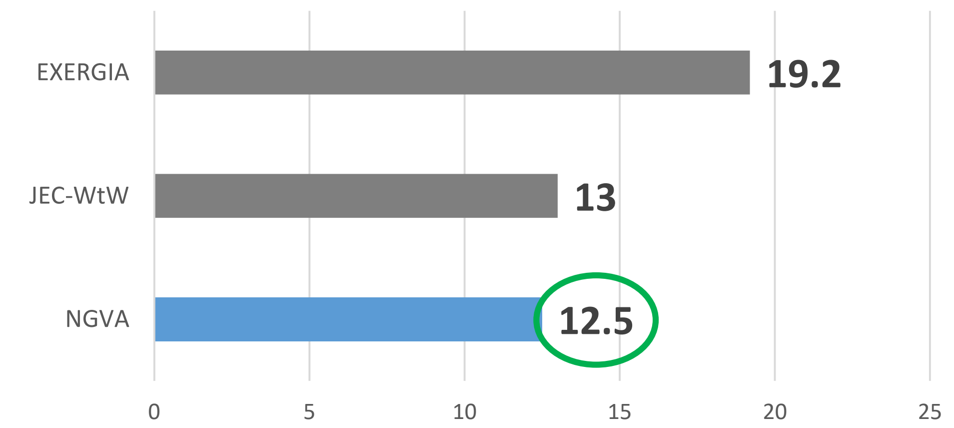


Study published on May 31st 2017 and available at

www.ngvemissionsstudy.eu

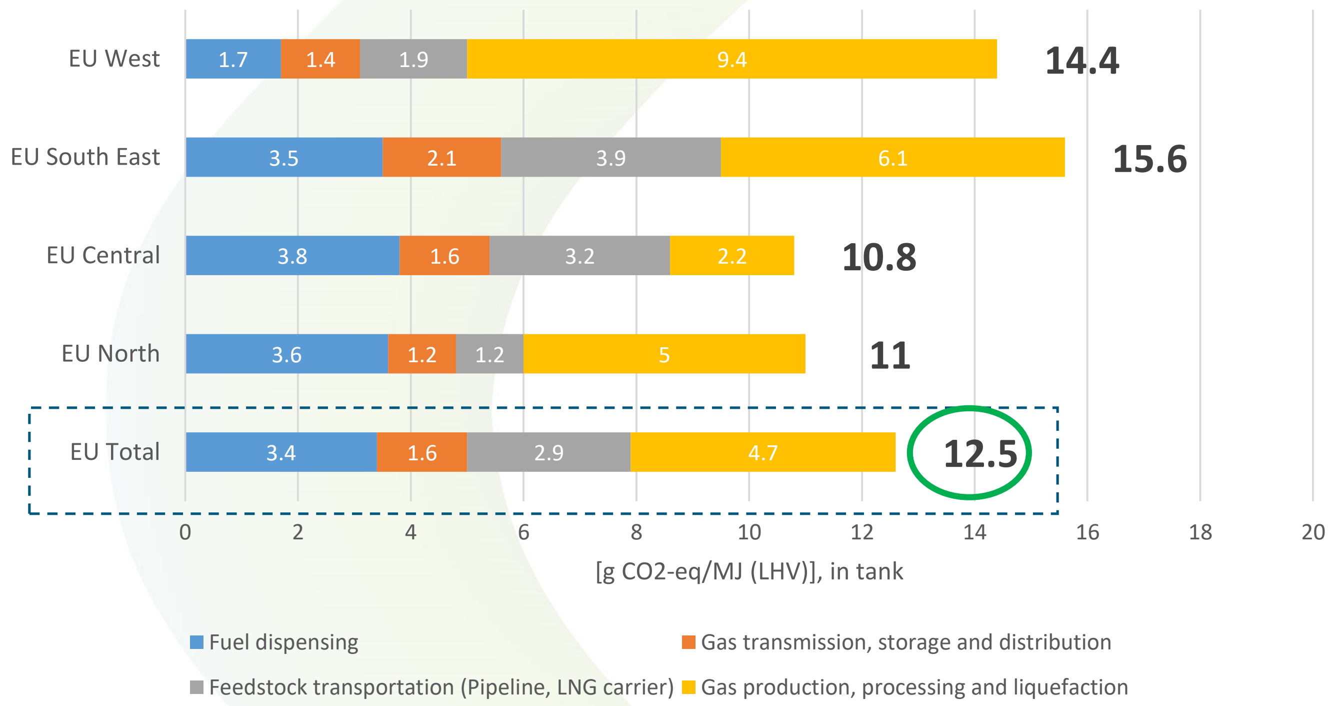
Well-to-Tank (GHG) emissions - CNG

Well-to-Tank - CNG, in tank - GHG (EU Total) [g CO2-eq/MJ]



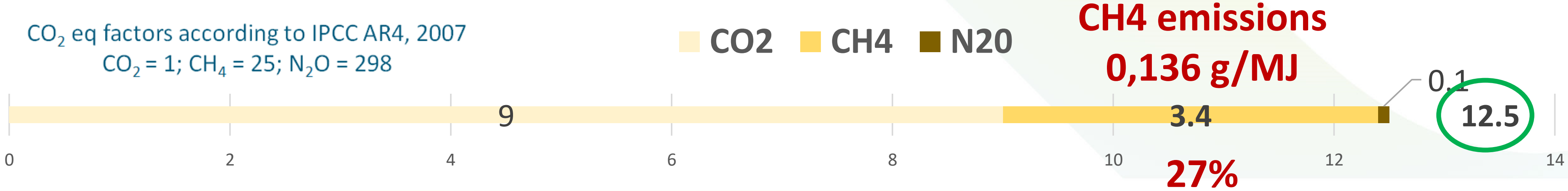
Exergia (2015)
JEC (2014)

Well-to-Tank – GHG Emissions: CNG supply
Breakdown by main individual emissions per region

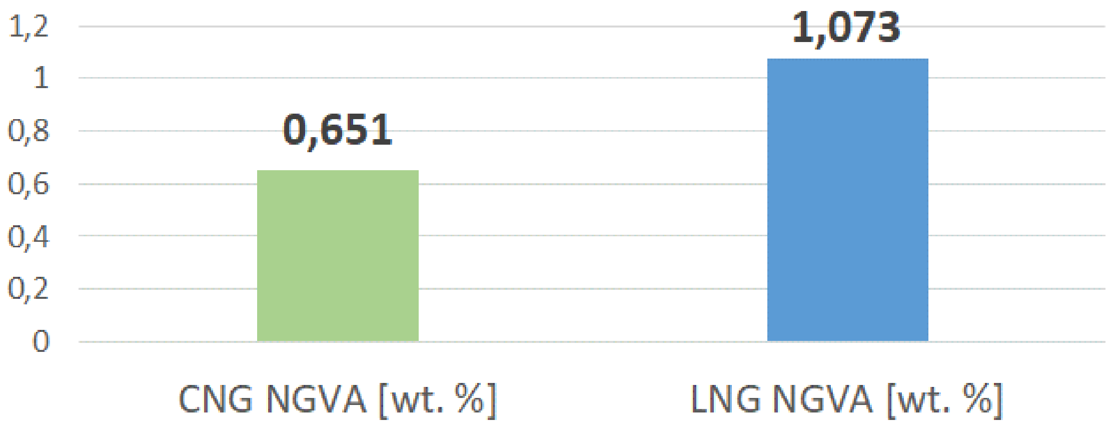


Well-to-Tank – GHG Emissions: CNG supply breakdown by main individual emissions

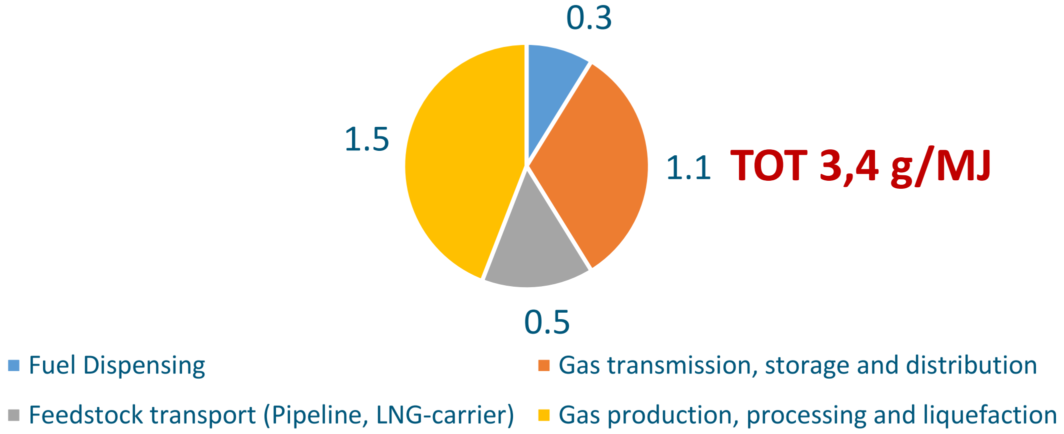
CO_2 eq factors according to IPCC AR4, 2007
CO_2 = 1; CH_4 = 25; N_2O = 298



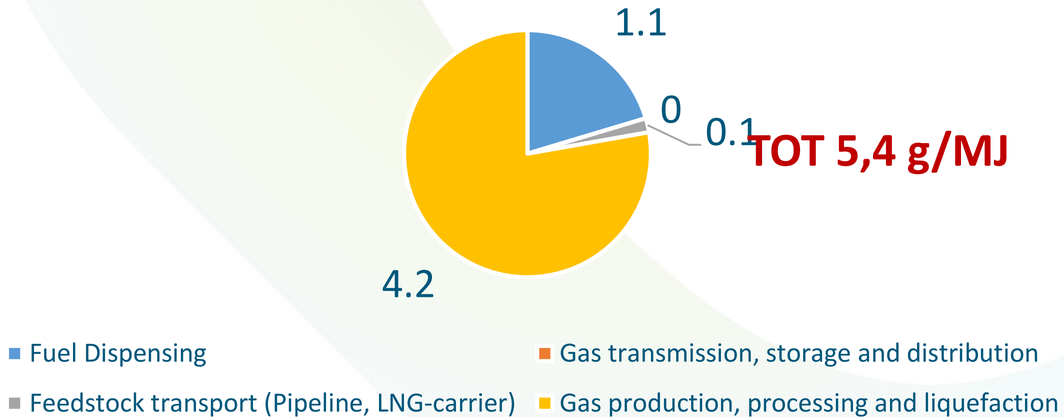
Well to Tank methane emissions



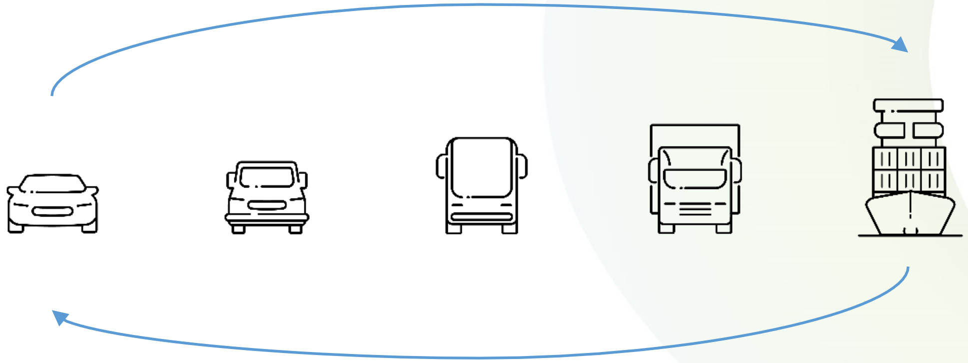
WtT - EU Total - **CNG**, in tank - Methane Emissions [g CO2-eq/MJ (LHV)]



WtT - EU Total - **LNG**, in tank - Methane Emissions [g CO2-eq/MJ (LHV)]



Emissions due to fuel usage in transport



Tailpipe TTW emissions : CNG passenger car example

EURO 6 limit - THC	100 mg/km
EURO 6 limit - NMHC	68 mg/km
Representative SoA C-segm vehicle	
CO2 emissions	105,0 g/km
CH4 emissions	0,042 g/km
N2O emissions	0,0015 g/km
Fuel consumption	39 g/km
Energy consumption	1,85 MJ/km
CO2 equivalent	106,5 g/km

Impact of tailpipe unburned CH_4 emissions as CO_2 equivalent emissions = 1,0%

CH_4 emissions 0,107% w/w (emitted / burnt)

CH_4 emissions 0,022 g/MJ

Technologies make difference

OEM CNG DEDICATED 44t TRUCK				
	CO2	CH4	CO2 eq	IMPACT CH4
	g/km	g/km	g/km	%
URBAN DELIVERY	1212	0,09	1214	0,2%
REGIONAL DELIVERY	1048	0,06	1050	0,1%
LONG HAUL	1000	0,24	1006	0,6%

DUAL FUEL RETROFIT 44t TRUCK					
	CO2	CH4	CO2 eq	IMPACT CH4	SUBSTITUTION RATE
	g/km	g/km	g/km	%	CNG / TOTAL (energy base)
URBAN DELIVERY	1548	9,36	1782	15,1%	29%
REGIONAL DELIVERY	1168	17,52	1606	37,5%	40%
LONG HAUL	774	13,41	1109	43,3%	47%


Department for Transport

LowCVP Low Carbon Vehicle Partnership | Connect Collaborate Influence

Emissions Testing of Gas-Powered Commercial Vehicles

The results of tests to measure the greenhouse gas and air pollutant emission performance of various gas-powered HGVs, on behalf of Department for Transport.

Prepared by Low Carbon Vehicle Partnership

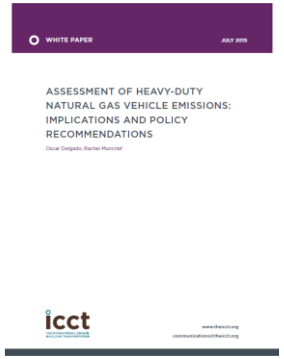
January 2017

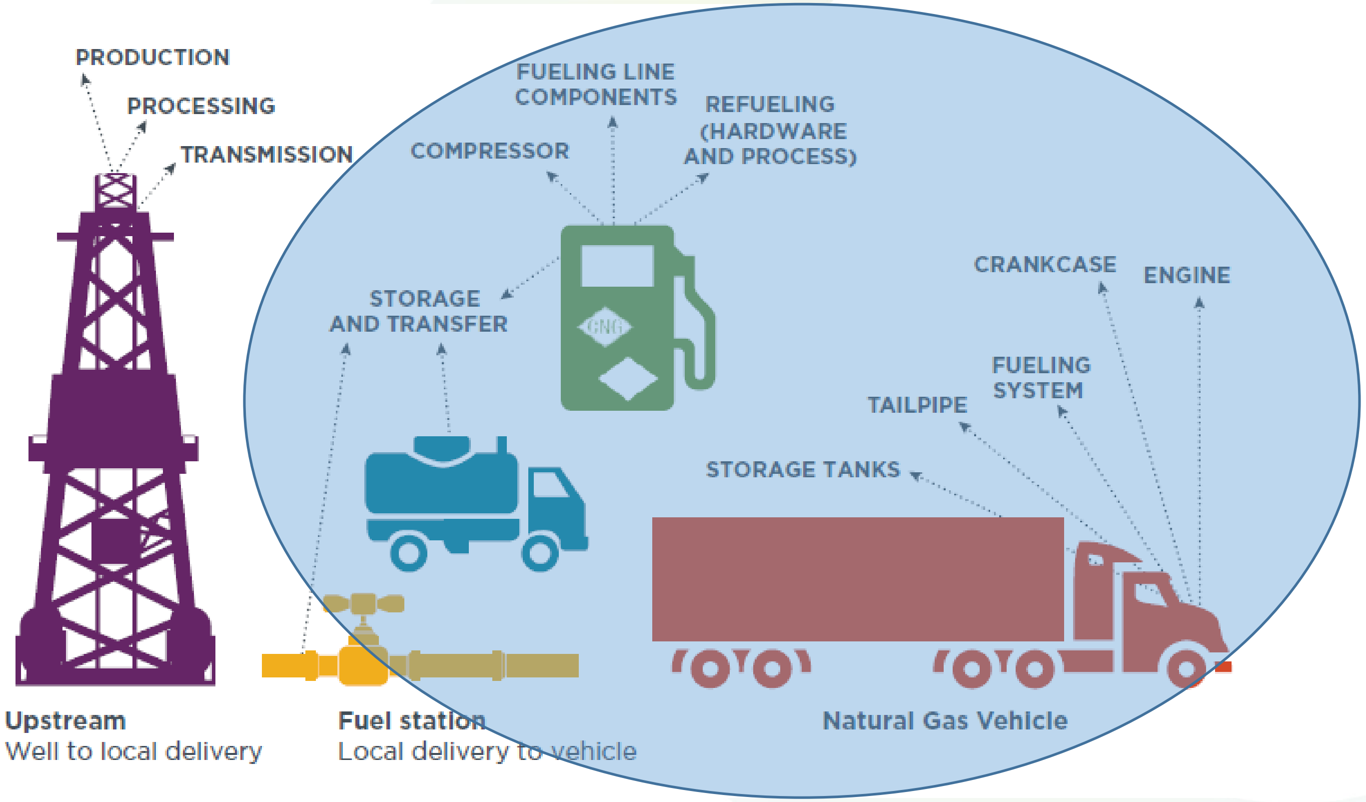
Written by: Brian Robinson CEng CEnv MIMechE, Programme Manager (Commercial Vehicles)

Reviewed by: Andy Eastlake CEng FIMechE, Managing Director

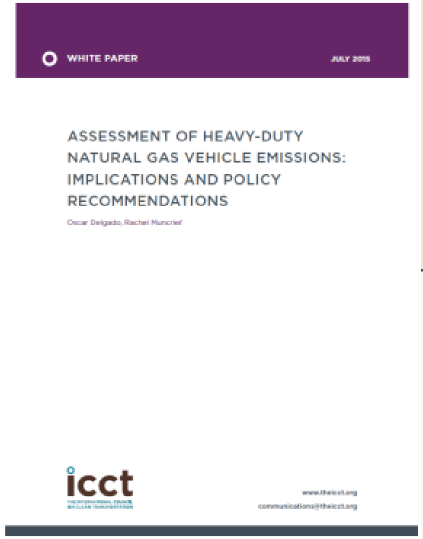
NGVA "Zero Venting Target Policy" Working Group

Scope of the group is to collect information from Members about best practices, new solutions and technologies to reduce venting operations at the gas stations and during vehicle operations. Comparison with literature data.





Data collection – venting, leakages, unburned


WHITE PAPER JULY 2015

ASSESSMENT OF HEAVY-DUTY NATURAL GAS VEHICLE EMISSIONS: IMPLICATIONS AND POLICY RECOMMENDATIONS

Oscar Delgado, Rachel Muncrief

icct

Fuel Station	Storage and Transfer	Underutilized station's LNG tank boil-off venting	0.03–0.08% of volume/day (Chen, et al., 2004)
	Compressor	Crankcase losses	0.30% from leakage and venting at the station (Burnham et al., 2014)
	Fueling Line Components	Continuous or intermittent leaks in valves, piping, and fittings	0.30% from leakage and venting at the station (Burnham et al., 2014)
	Refueling	Intentional venting of tank prior to refueling, nozzle connection/disconnection losses	0.30% from leakage and venting at the station (Burnham et al., 2014)
Vehicle	Tailpipe	Unburned methane in the exhaust	0.6–1.1%* (US EPA, 2014)
	Crankcase	Methane leaks past piston rings; open crankcase vent to the atmosphere	0.1–0.6% (Johnson and Covington, 2014)
	Storage	Vehicle's LNG tank boil-off vents	2.6% of the initial mass of liquid in the tank (Ursan, 2011)
	Fueling System	HPDI system dynamic venting	0.15% (Dunn et al., 2013)

* Certification data include tailpipe and crankcase emissions combined.

Methane emissions from boil off operations on LNG trucks

TNO innovation for life

TNO report

TNO 2017 R11336
Emissions testing of two Euro VI LNG heavy-duty vehicles in the Netherlands: tank-to-wheel emissions

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Project number 060.04301

Table 5: Overview of the estimated additional TTW GHG emissions of Euro VI diesel and LNG trucks: boil-off gas, N_2O and crank case venting in % of the tail-pipe CO_2 emissions.

Emissions in % of tailpipe CO_2	Diesel Euro VI	LNG Euro VI
Tail-pipe CO_2	770 g/km	702 g/km
BOG **[3.1.3]**		
1 BOG event/year	0%	0.4%
5 BOG events/year+1 tank blow-off/lifetime	0%	3.8% (strongly depending on usage and parking times)
Methane slip **[2.4.5]** 2 cold starts/day, 9.5 gCH_4 per cold start	0%	0.3%
Crankcase venting **[3.1.4]**	0%	0%
N_2O **[3.1.5]**	0.5-30% (few data)	0.4% (few data)

Diesel Euro VI	LNG Euro VI
755	706 best
801 (with N_2O)	755 worst

R&D actions - H2020 projects

www.hdgas.eu/project/scope/

HDGAS

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Scope

The overall objective of HDGAS is to provide breakthroughs in LNG vehicle fuel systems, natural gas and dual fuel engine technologies as well as aftertreatment systems. The developed components and technologies will be integrated into three demonstration vehicles that are representative for long haul heavy duty vehicles in the 40 ton range. The demonstration vehicles will:

- comply with the Euro VI emission regulations;
- meet at minimum 10% CO2 reduction compared to state of the art technology;
- show a range before fueling of at least 800 km on natural gas;
- be competitive in terms of performance, engine life, cost of ownership, safety and comport to 2013 best in class vehicles.

News

ATS design for natural gas based engines
December 11, 2017

Accelerated ageing testing on HDGAS dual-fuel aftertreatment hardware
December 4, 2017

SAG delivers prototype tank systems with pumps
November 23, 2017

Press Release – NGVA Europe published new study that validates natural gas as key solution for transport decarbonisation
May 31, 2017

Design of an advanced spark-ignition engine for LNG operation

www.HDGAS.eu

AVL, BorgWarner, BOSCH, DAIMLER, ECOCAT, FPT, Applus IDIADA, IVECO, MAN, Politecnico, RICARDO, SAG, TNO, TU Graz, University of Eastern Finland, Hochschule Esslingen, UNIRESEARCH, VOLVO, Virtual Vehicle, Westport

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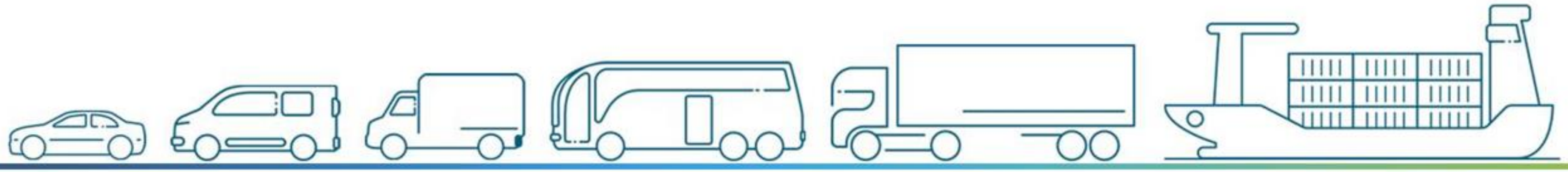

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