# DARREN NEWMAN
# VOLVO TRUCKS UK

LNG Account Manager

# GAS POWERED

# VOLVO FM - VOLVO FH


# Volvo Electric Vehicles


1 LNG
Product Overview
2 LNG
Environmental Case
3 LNG
Business Case
4 Electric
Product Overview
5 Electric
Environmental Case
6 Future Fuels

# Volvo core values:


Safety - Zero accidents in a Volvo Truck

Quality - Zero unplanned stops

Environment - Zero emissions

# 1 - PRODUCT OVERVIEW

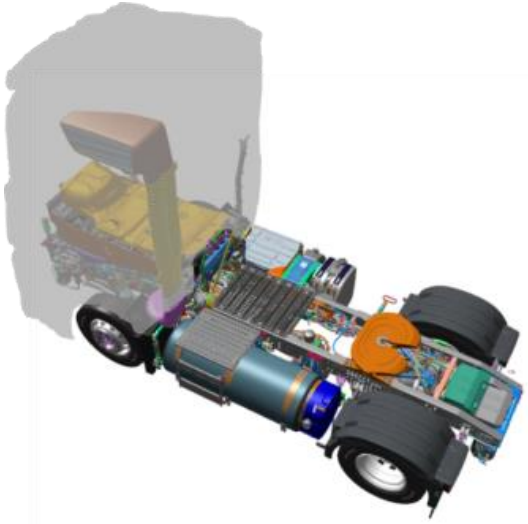
## Volvo FM


**Tractors**

**Rigids**

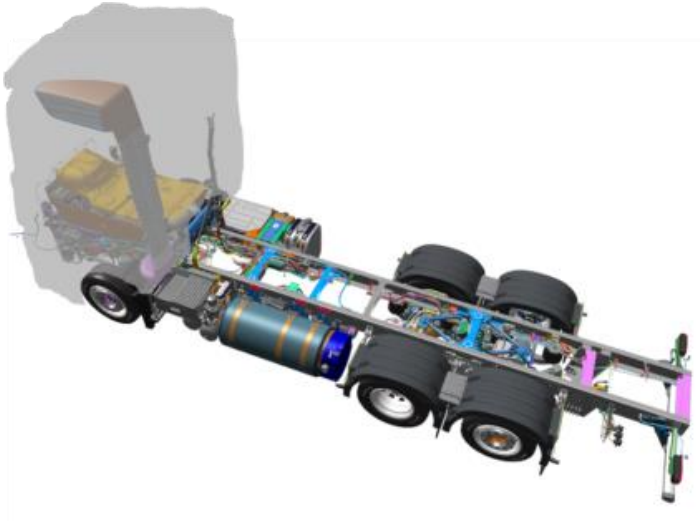
## Volvo FH

# Configurations



**4x2**
**Artic**

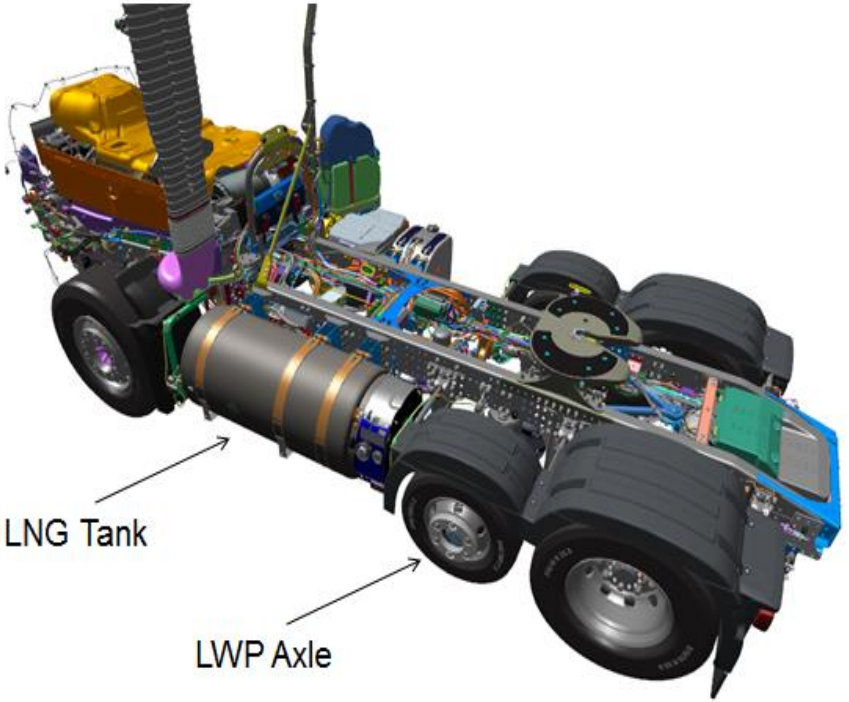
**6x2 midlift**
**Artic**



**4x2 & 6x2**
**Rigid**

# For the UK Market

## 6x2 Artic
## Lightweight Pusher

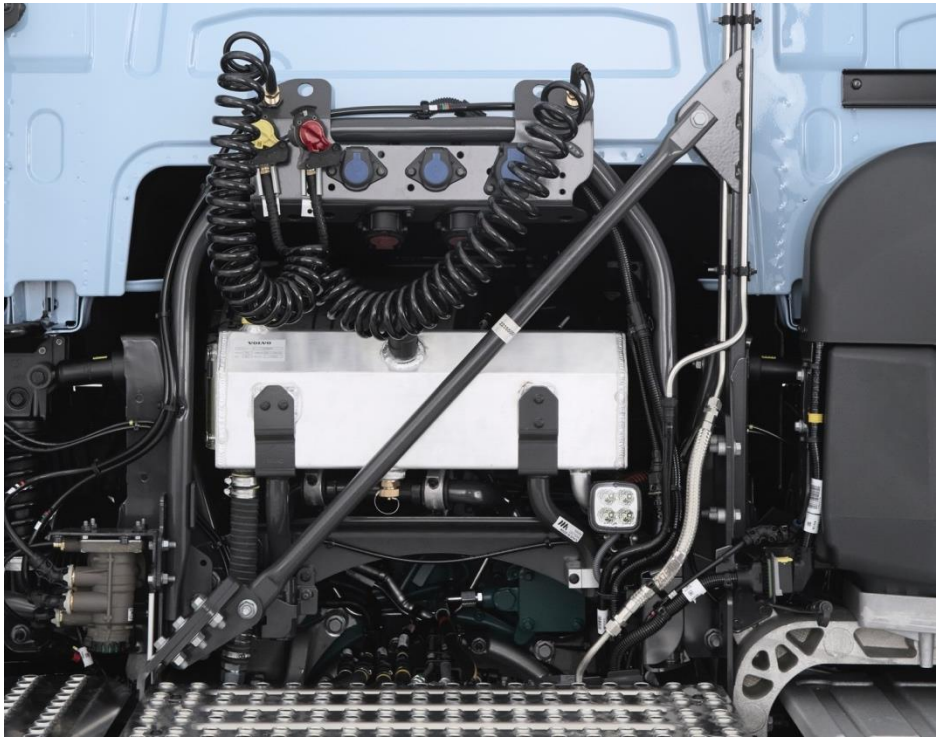


# The LNG Tank


- Integral hydraulic pump
  - Submerged in liquefied gas
  - Unique technology extends range by utilising “cold” LNG
- Insulation gap
  - Equivalent to 9m loft insulation

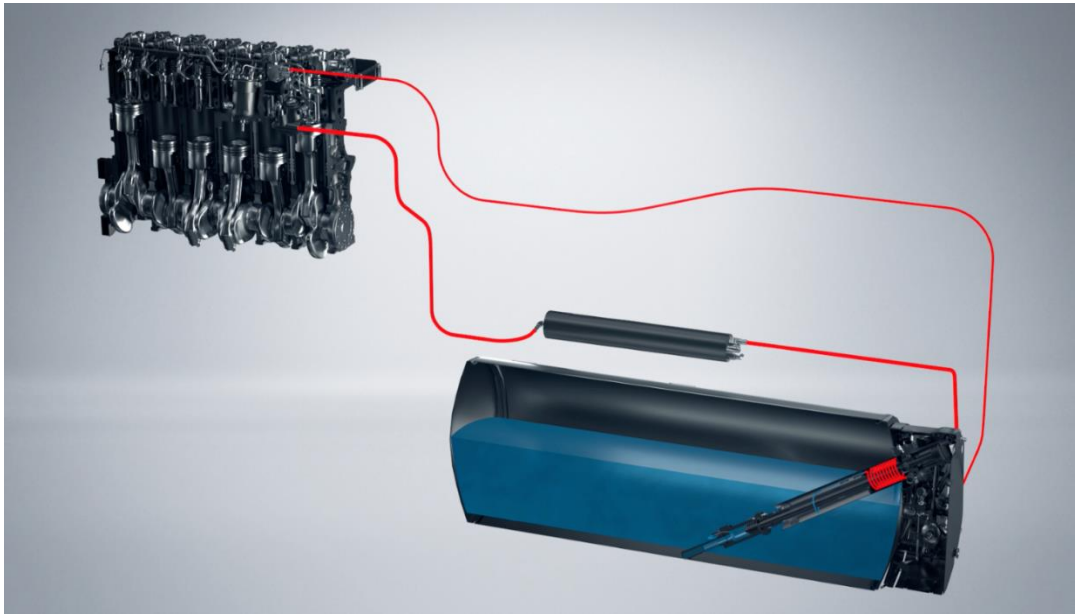
# The Hydraulic Tank

- Mounted behind cab
  - Utilises engine PTO
  - Takes up approximately 50 mm
- Attachment for vent stack



# Methane Slip Prevention - Return to tank

- Returns non-combusted methane to the tank
- Direct injection controls the amount of gas being injected
- A valve system prevents leakage of unburnt methane into the exhaust
- Vaporized LNG cools down until it is liquefied



# Fuel Capacity


| Artics | Wheelbase (m) | Tank size (kg) |
|---|---|---|
| 4x2 | 3.7 / 3.8 | 205 |
| 6x2 Pusher | 4.1 | 115 |
| 6x2 Pusher Lite | 3.8 / 4.1 | 115 / 155 |

| Rigids | Wheelbase (m) | Tank size (kg) |
|---|---|---|
| 4x2 | 5.2 | 205 |
| 6x2 Tag | 4.3 – 5.2 | 155 – 205 |
| 6x4 | 4.3 / 4.6 | 155 |
| 6x4 | 4.9 / 5.2 | 205 |

# Vehicle Range

115kg – circa 300 miles

155kg – circa 400 miles

205kg – circa 500 miles

Calculated at 8.5mpg diesel equivalent


DEVELOPED TOWARDS
-145 °C
3 BAR
If you fuel at 10 bar and -125°C, you get approximately - 10% of LNG in the tank


16 BAR
SAFETY VALVE
We don’t want venting – to avoid it, it is important to understand the tank holding times.

Volvo G13

13 litre

6 cylinder in-line

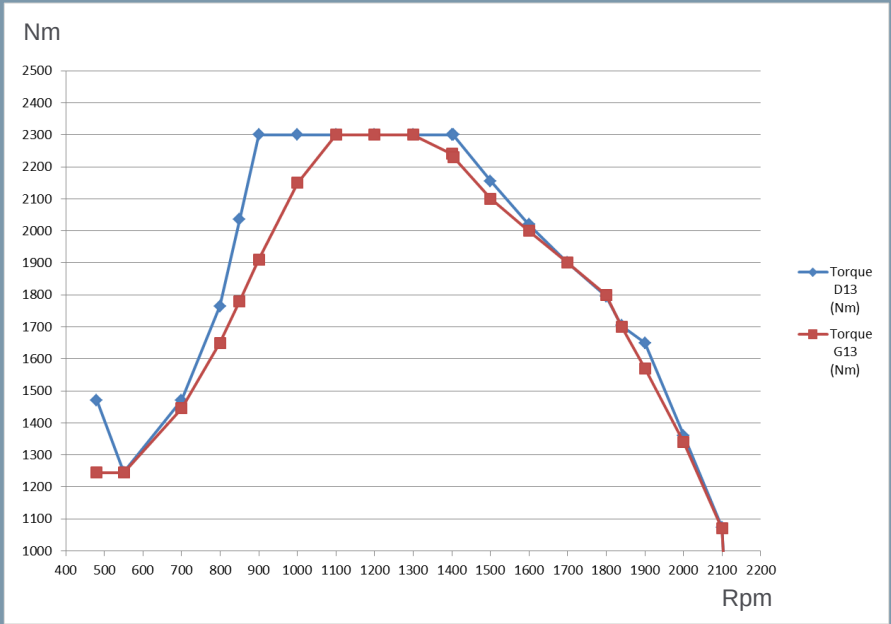
| | |
|---|---|
| **420 hp** | **2100 Nm** |
| **460 hp** | **2300 Nm** |

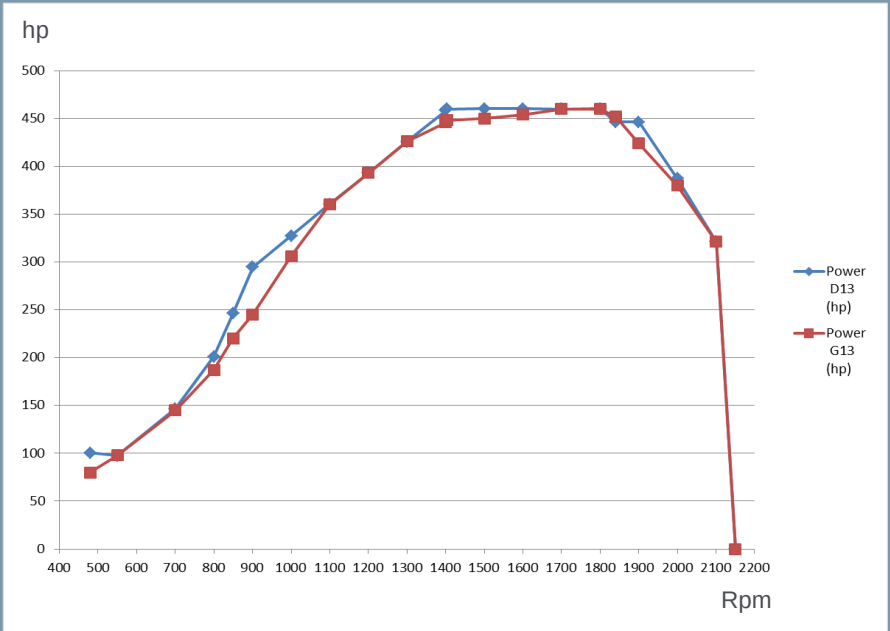
High torque achieved by using conventional diesel cycle timing and injection system without spark plugs

# Euro VI - HPDI Technology

- A small amount of diesel is injected on the compression stroke
  - It is compressed which creates heat and it ignites
- Natural gas is then injected at high pressure
  - It is ignited by the ignited diesel
- Minimal diesel usage
  - Over 90% gas in all conditions
- Engine performance is
  - Similar power and torque to a diesel engine
  - Similar fuel efficiency to a diesel engine
  - Full engine braking performance across rpm range
- Tolerant to a wide range of fuel methane composition

# Comparison G13-D13 460 hp E6




i-Shift software adapted to the torque curve

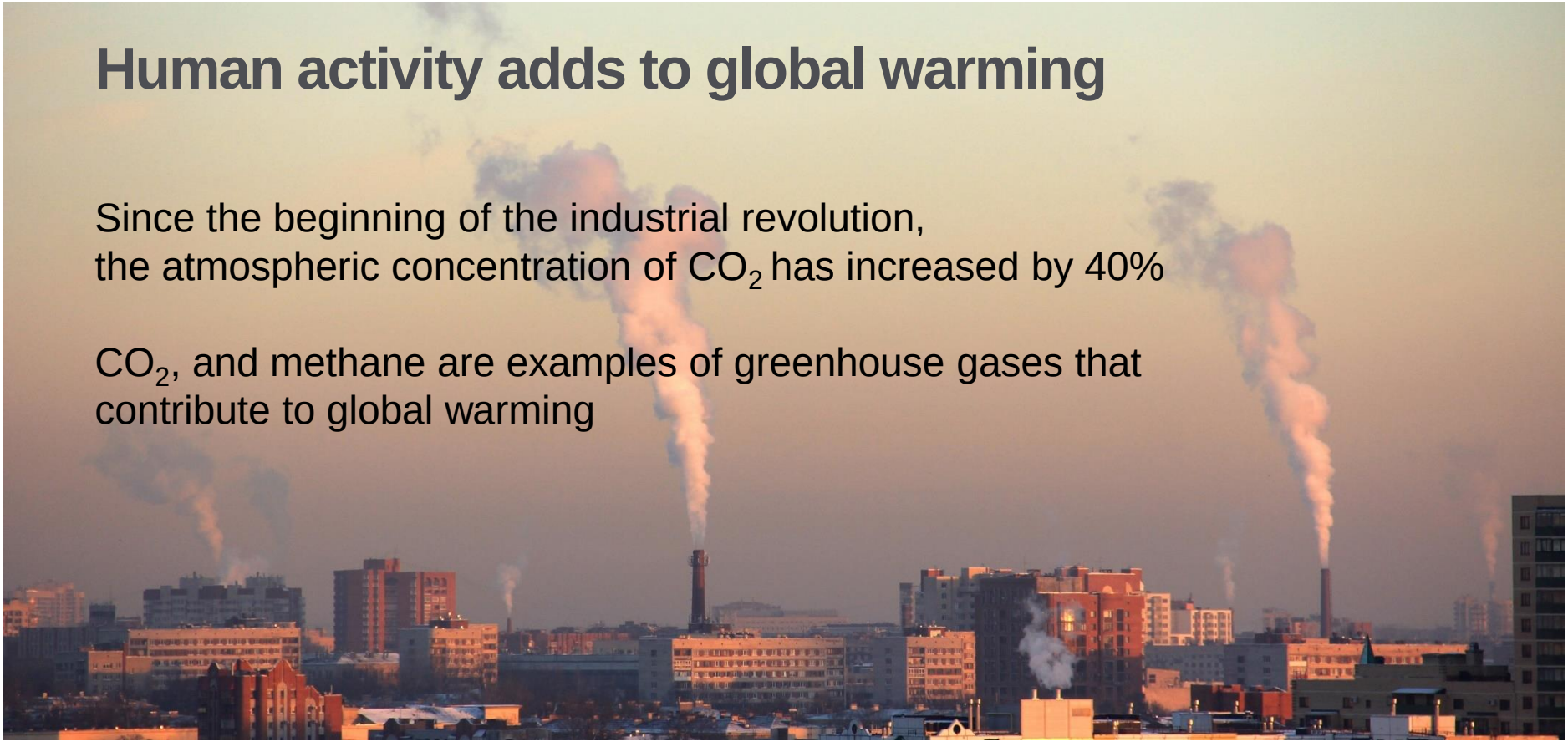
# ENVIRONMENTAL CASE

# Climate change is real

Scientist forecast the global average temperature will rise 5-6°C by 2100

Global warming is caused by the greenhouse effect, which is directly relevant to Volvo Trucks

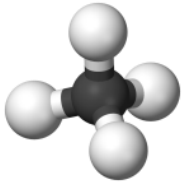
# Human activity adds to global warming



Since the beginning of the industrial revolution,
the atmospheric concentration of $CO_2$ has increased by 40%

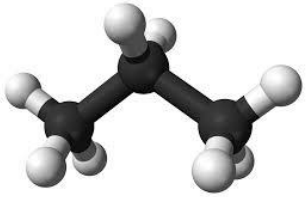
$CO_2$, and methane are examples of greenhouse gases that contribute to global warming


Usage of fossil fuels adds to global warming
• Oil
• Coal
• Natural gas
Oil, coal and natural gas are all fossil fuels. Natural gas is the least harmful



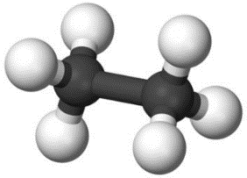
Methane $CH_4$

25% carbon



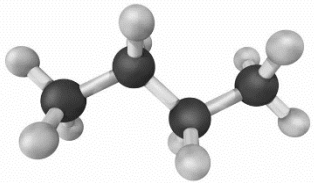
Propane $C_3H_8$

38% carbon



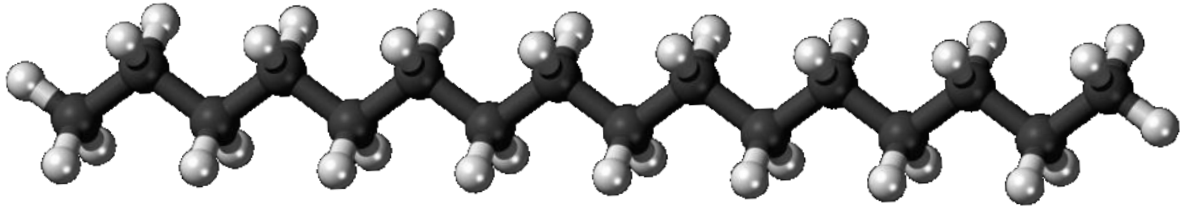
Ethane $C_2H_6$

33% carbon



Butane $C_4H_{10}$

40% carbon



Diesel $C_{14}H_{30}$

47% carbon

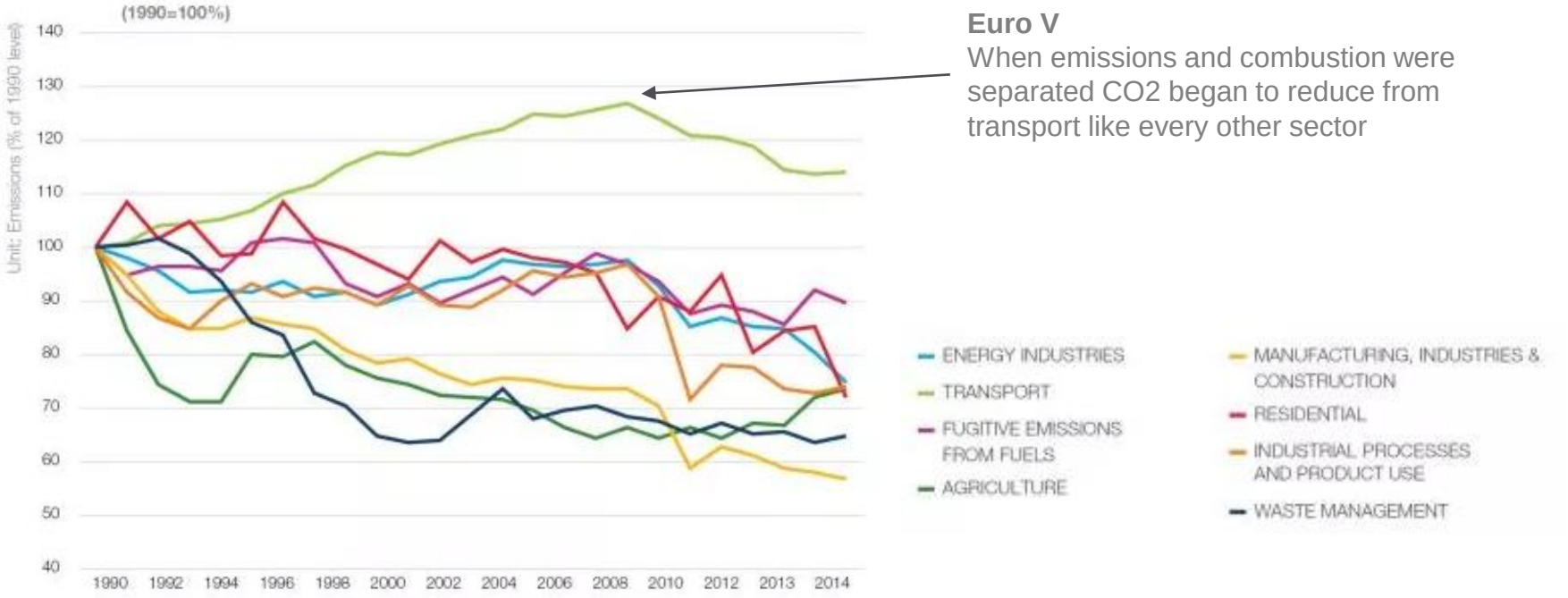

Analysts predict oil and coal usage will flatten out in the next decades
Natural gas is expected to increase
Source: IEA WEO2016


# 20% lower $CO_2$ emissions

100% lower $CO_2$ when use of liquefied bio-LNG and Synthetic Diesel (HVO) – tank-to-wheel

# CO2 Emission Trends by Sector

(European Environment Agency 2015)




**Euro V**

When emissions and combustion were separated CO2 began to reduce from transport like every other sector

# The European market is dominated by long- and regional haul

Volvo LNG trucks are perfectly suited for both long- and regional-haul

# BUSINESS CASE


**D**iesel
**S**ubstitution
**F**actor

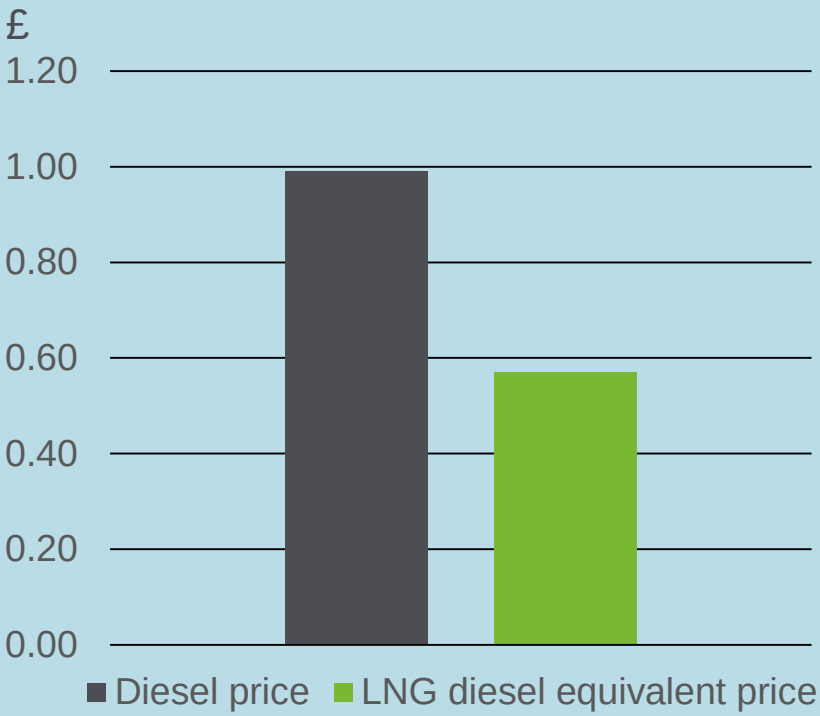
# 90–95% LNG

Each injection contains a fuel mixture of approximately 90%–95% LNG and 5%–10% diesel.


# Up to 30% lower operating costs

Based on typical diesel and LNG price differential and increased maintenance cost.

# Fuel cost savings




40p per litre less fuel duty

| | |
|---|---|
| Diesel price: | 1.05 £/l |
| LNG price: | 0.80 £/kg |
| LNG price eq. | 0.58 £/l |

# ROI Summary

- Typical ROI is between 2.5 and 3 years dependant on operation
- The higher the mileage the shorter the payback
- The worse the current fuel consumption the shorter the payback
- The higher the delta between diesel and LNG cost the shorter the payback
- For low mileage (120,000 km pa) and low fuel consumption (11 mpg) ROI could be up to 4.5 to 5 years
- For high mileage (200,000+ km pa) and high fuel consumption (8 mpg) ROI could be as low as 2 years

# JOHN COMER
# VOLVO TRUCKS UK

Head of Product Management

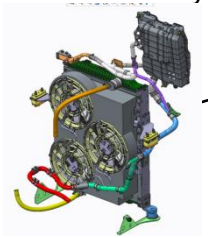
# Volvo Electric Vehicles
# Product Overview

# Well proven solutions

- Experience from hybrid trucks and buses
- 400 electric busses in operation
- Strong retail network and good relations to cities and authorities
- Teamed up with Europe´s leading body builder

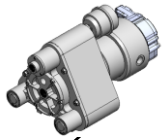
# P4283 – SCOPE ILLUSTRATION: BEV Truck Chassis

New Cooling & Coolant syst.



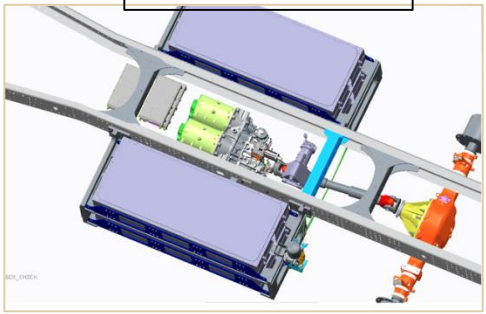
EHPS

eCompressor



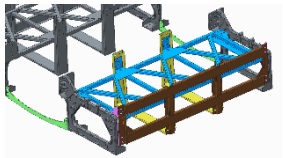
Electric Motor150KW & 2 speed Gearbox

2 EMs variant



Power Modular Box

Battery Packs installation



Chassis Structure adaptation

APM & Air tanks instal.



Electric Motor Drive & other EE comp. inst.

# CCS - Combined Charging System

AC-charging
22-50 kW
(pending On-Board Charger)

DC-charging
50 – 150 kW

2025 400? kW

# Volvo Electric Environmental Case

# Low Emission Zones

- Urbanisation is a global trend - more and more of the population are living in large cities
- This is driving cities to further scrutinise air quality
- Responsibility for air quality is being transferred from central to local authority control
- Irresponsible behaviour has contributed to the declining reputation of diesel
- Electric vehicles can displace emissions from vehicles to power generation plants away from people in cities


# The Vision for Air Quality in London

## LEZ Low Emission Zone and ULEZ Ultralow Emission Zone

CLEANERAIR FOR LONDON

### Past

**Particulates Matter**
**Control of PM**

**2008** - Euro 3
PM levels

**2012** - Euro 4/5
PM levels

24hours a day.
Every day including weekends, public and bank holidays.


### ULEZ and extension of LEZ for trucks

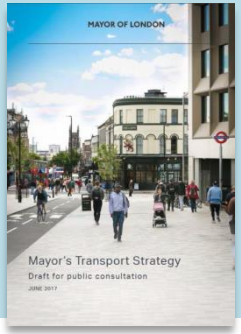
- Focus on NOx
- Euro VI minimum standard for trucks

### Phased approach to ULEZ

- April 2019 Congestion Charge Zone for all modes of transport
- October 2020 ULEZ moves to today's LEZ area – for trucks and coaches the M25 and is described now as an extension of LEZ
- October 2021 wider central zone for cars, vans and motorbikes

### Future

- The Mayor's Transport Strategy
- Central London and town centre zero emission zones from 2025
- **Zero emission transport by 2050**

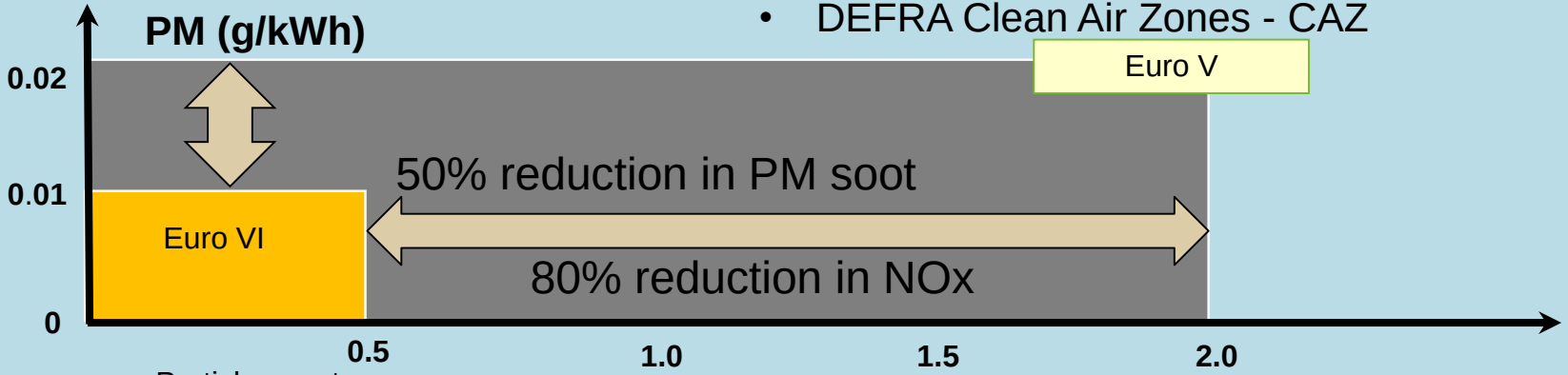


# Clean air and ultra low emission zones

## How does EuroV to Euro VI measure up?

Euro VI The entry level for

- London Ultra Low Emission Zone - ULEZ
- DEFRA Clean Air Zones - CAZ




- Particle count
- Ammonia Slip Catalyst
- Closed crankcase ventilation
- Seven years - in service compliance

# 2020 – New expansion for trucks out to current LEZ

## Implementation date 26th October 2020

**2020 Proposal**

Euro VI standard applies London-wide for heavy vehicles

| Vehicle class* | Min emission standard** | or | Daily Charge |
|---|---|---|---|
| | Euro 3 | | £12.50 |
| | Euro 4 petrol or Euro 6 diesel | | £12.50 |
| | Euro VI<br>Euro IV PM | | £100<br>£300 |
| | Euro 3 PM | | £100 |

- 2020: to tighten LEZ standards to a Euro VI requirement for heavy vehicles
- Expected to reduce NOx emissions by 19 per cent London-wide

**Euro VI standard applies London-wide for heavy vehicles**

- LEZ is now Euro VI minimum for trucks

# London Ultra Low Emission Zone In Force

Implementation date 8th April 2019

**2019** - Confirmed

ULEZ replaces T-Charge. Introduction of Euro 6/VI diesel standard and change in charge and hours

| Vehicle class* | Min emission standard** | or Daily Charge |
|---|---|---|
| | Euro 3 | £12.50 |
| | Euro 4 petrol or Euro 6 diesel | £12.50 |
| | Euro VI | £100 |
| | Euro IV PM | £200 |
| | Euro 3 PM | £100 |

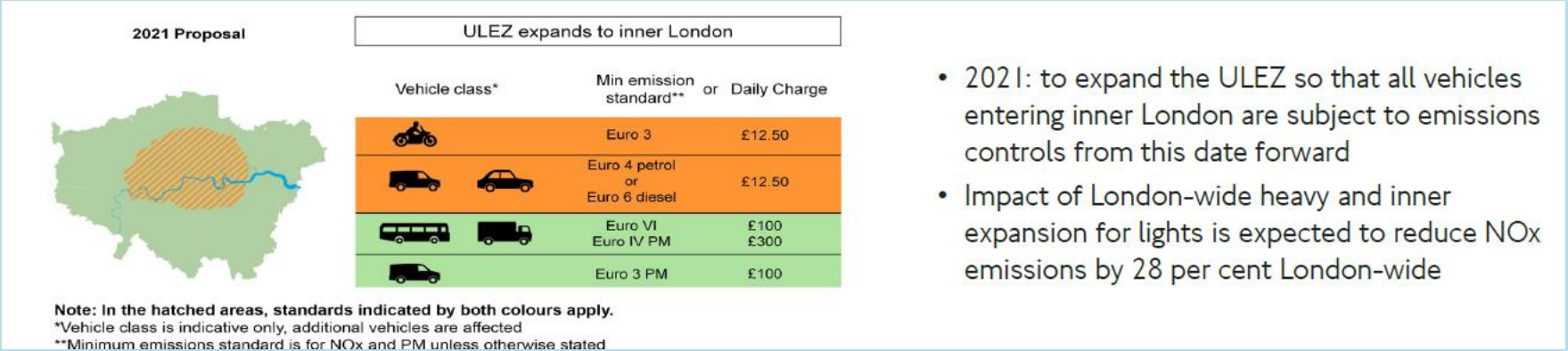
- In 2019 the Ultra Low Emission Zone (ULEZ) will replace the T-Charge in central London and operate 24/7
- Expected to save 20 percent of road transport NOx in 2019 in central London

- On 8 April, the London ULEZ came into force, covering the same area as the Congestion Charge Zone - operating 24 hours a day, seven days a week.
- Cars, vans and minibuses that do NOT meet Euro 4 petrol or Euro 6 diesel standards will be charged £12.50.
- Trucks, buses or coaches that do not meet Euro VI will be charged £100 a day or older trucks that do not meet Euro IV £200

Does my vehicle comply? Click Here

# 2021 – New ULEZ zone for cars, bikes and vans

Implementation date 25th October 2021



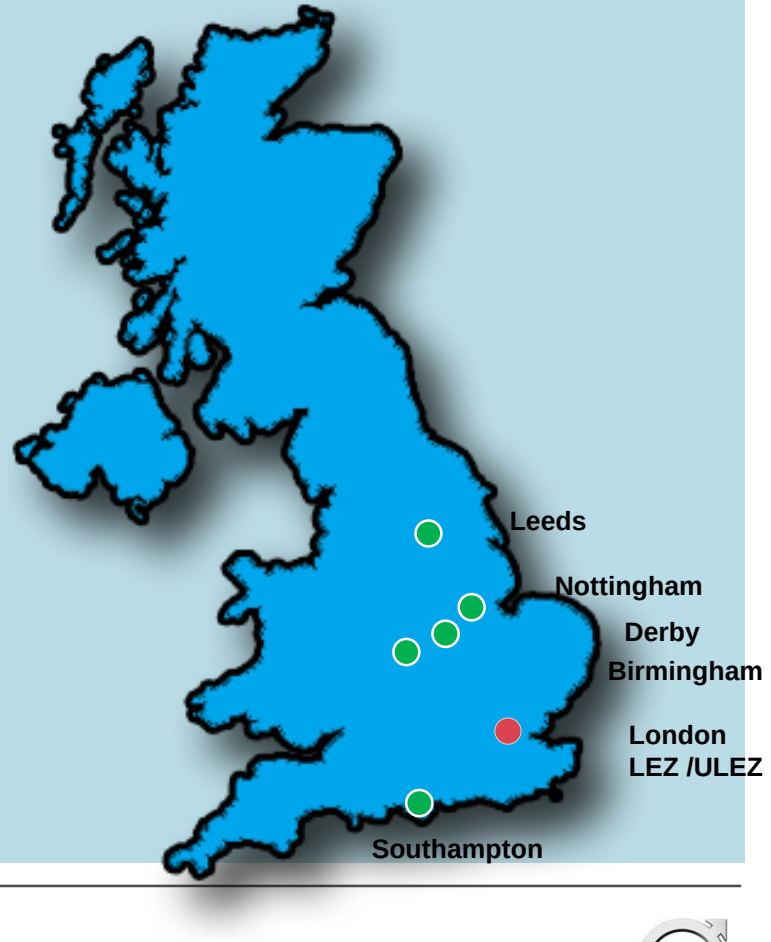

- 2021: to expand the ULEZ so that all vehicles entering inner London are subject to emissions controls from this date forward
- Impact of London-wide heavy and inner expansion for lights is expected to reduce NOx emissions by 28 per cent London-wide

- New boundary of North and South Circular for motorbikes, cars and vans with the relative minimum emission level shown in the table.
- No changes in boundaries or minimum emission levels for trucks.

# Clean air zones Phase 1

## Euro VI for trucks minimum demand

| Local Authority | 2017 NO2 concentration | Action Planned | Date | Current Plan | Status | Vehicles affected |
|---|---|---|---|---|---|---|
| Greater London Authority | 97 | ULEZ | 2019 | ULEZ | Central Zone ULEZ from 8 April 2019. expansion to North South Circular 25 October 2021 | All |
| Southamption City Council | 58 | CAZ | 2019 | CAZ B | Consultation ongoing for whole city CAZ | Buses, Coaches, HGVs, Taxi, PHV |
| Leeds City Council | 58 | CAZ | 2019 | CAZ B | 1st Stage consultation | Buses, Coaches, HGVs, Taxi, PHV |
| Birmingham City Council | 58 | CAZ | 2019 | CAZ D | Consultation closed. Proposal for CAZ D within A540 Middleway ring road. | All |
| Nottingham City Council | 57 | Air quality management plan | 2019 | Air quality management plan | Consultation air quality strategy ongoing. Includes measure to encourage fleet renewal. No CAZ | N/A |
| Derby City Council | 57 | Air quality management plan | 2019 | Air quality management plan | Consultation air quality strategy ongoing. Includes measure to encourage fleet renewal. No CAZ | N/A |



# Clean air zones Phase 2


- Bolton Metropolitan Borough
- Bristol
- Bury
- Coventry
- Fareham
- Gateshead
- Guildford
- Manchester
- Middlesbrough
- New Forest
- Newcastle
- North Tyneside
- Rochford
- Rotherham
- Rushmoor
- Salford
- Sheffield
- Stockport
- Surrey Heath
- Tameside
- Trafford

# Clean air zones Phase 3

- Ashfield
- Basingstoke and Deane
- Blaby
- Bolsover
- Bournemouth
- City of Bradford
- Broxbourne
- Burnley
- Calderdale
- Cheltenham
- Dudley
- Kirklees
- Leicester
- Liverpool
- Newcastle-under-Lyme
- Oldham
- Oxford
- Peterborough
- Plymouth
- Poole
- Portsmouth
- Reading
- Sandwell
- Sefton
- Solihull
- South Gloucestershire
- South Tyneside
- Southend-on-Sea
- Stoke-on-Trent
- Sunderland
- Wakefield
- Walsall
- City of Wolverhampton

# National Air Quality Demands

## February 2019 new Levy rates

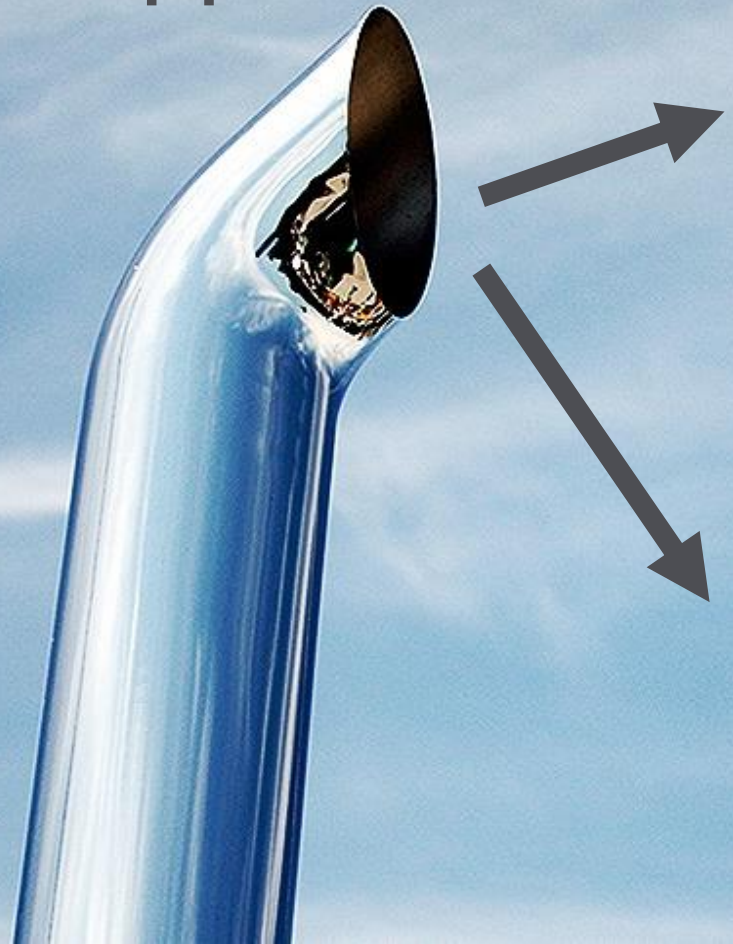
This measure changes the HGV levy which is currently up to £10 a day or £1,000 a year, depending on the vehicle's size and weight. In future the levy will also depend on vehicle emissions. The newest lorries generate 80% less nitrogen oxide (NOx) emissions than older ones, so from 1 February next year, lorries meeting the latest Euro VI emissions standards will be eligible for a 10% reduction in the cost of the HGV levy.

Note that those lorries that don't meet the latest emissions standards will be expected to pay 20% more, except where the levy is already set at its maximum rate allowable under European legislation.

This measure is being used to reduce the rates for Euro VI vehicles as The HGV Road User Levy Act allows for rates to be reduced (but not increased) through secondary regulations. Primary legislation is required for any raising of rates. That aspect of the changes will be done via the Finance Bill 2018.

# FUTURE FUELS

# Tailpipe Emissions

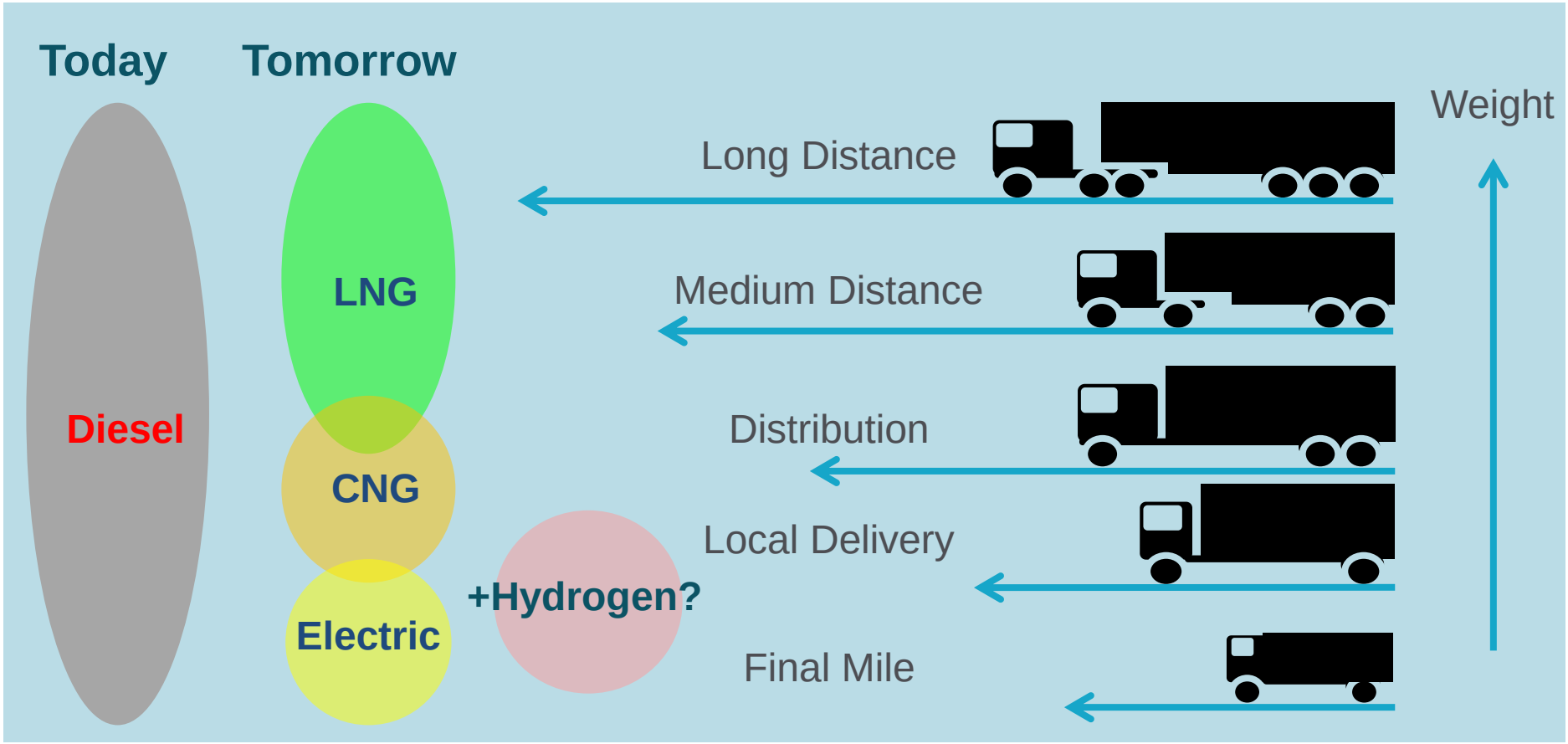


**Greenhouse Gasses:**
Contribute to Climate Change
Includes:

- CO2 – Carbon Dioxide
- Methane – LNG / CNG vehicles
- N20 – Nitrous Oxide

**Air Quality:**
Harmful to health
Includes:

- PM – Particulate Matter
- NOx – Oxides of Nitrogen
- SO2 – Sulphur Dioxide
- CO – Carbon Monoxide


Today
Tomorrow
Diesel
LNG
CNG
Electric
+Hydrogen?
Long Distance
Medium Distance
Distribution
Local Delivery
Final Mile
Weight

# Making the right choice

# Evaluation Criteria

- Climate impact
- Energy efficiency
- Land use efficiency
- Fuel potential
- Vehicle adaptation
- Fuel cost
- Fuel infrastructure

# Volvo Alternative Fuels Offer

LNG for long distance low carbon heavy transport

Electric for local distribution and clean air



# Any Questions?