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Natural Gas Pathway Analysis for Heavy Duty Vehicles

Matthew Joss

ETI 10 TEN YEARS OF INNOVATION 2007 — 2017

energy technologies institute

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- We are a £400m industry and government funded research institute into low carbon energy system planning and technology development to address UK energy and climate change targets

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Energy Vectors for HDV

Hybridisation, lightweight structures, improved aerodynamics and powertrain efficiency could deliver significant reductions in fuel consumption. Costs are a barrier to more aggressive measures.

Small foothold in the HDV market and compliment existing vehicle architectures and efficiency developments.

Considering both plug-in hybrids (PHEVs) and pure battery electric vehicles (BEVs).

Barriers are high, but could be more suitable for certain sectors.

Compliment Pass Car.

Continued innovation could enable hydrogen fuelled vehicles to be successful.

Barriers are high.

The Project

- Asses the potential of natural gas as a future HDV fuel
- Build a knowledge base
- Assess fugitive emissions through the pathway (CO_2 and CH_4)
- Create a techno economic and emission analysis model to assess future potential of Natural Gas

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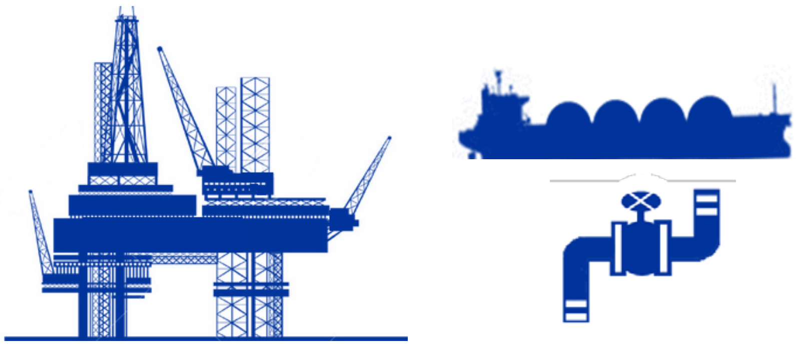
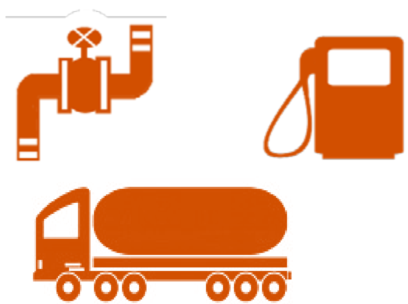
Structure



Well-to-Terminal

Base Case



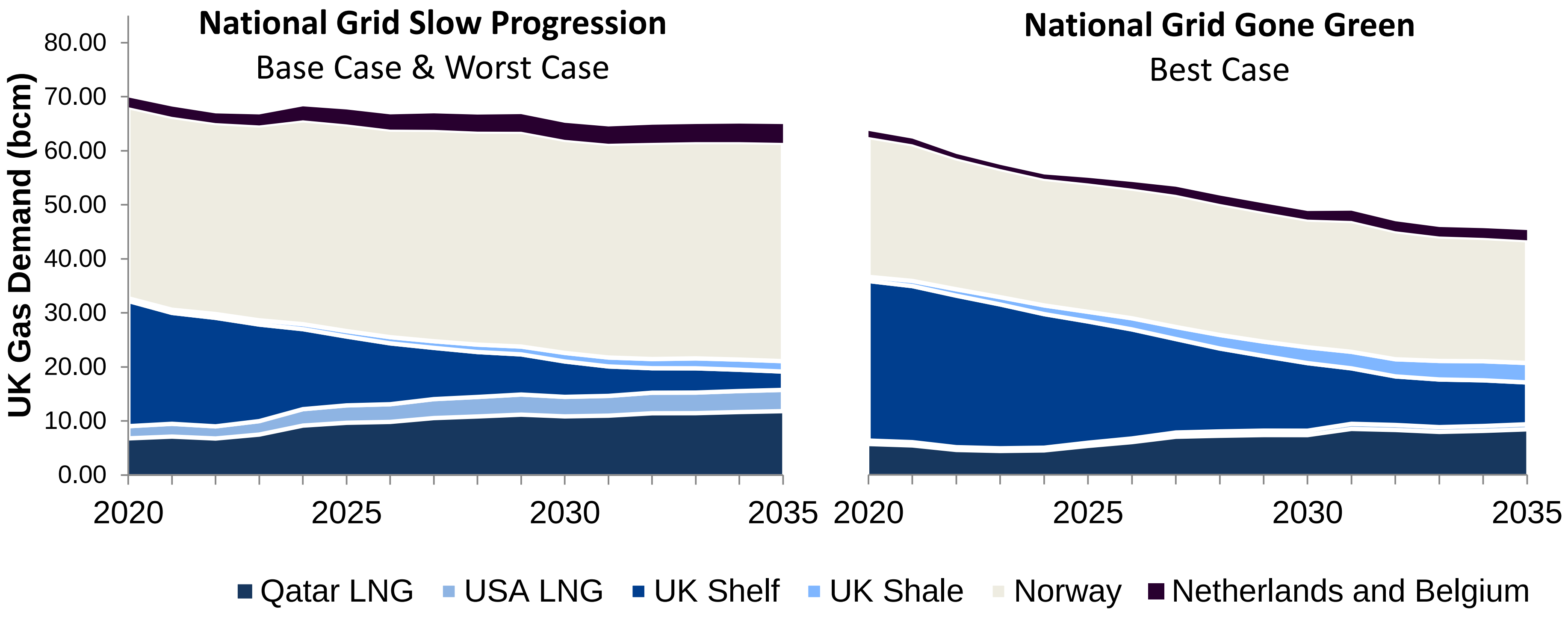
Terminal-to-Tank

Best Case

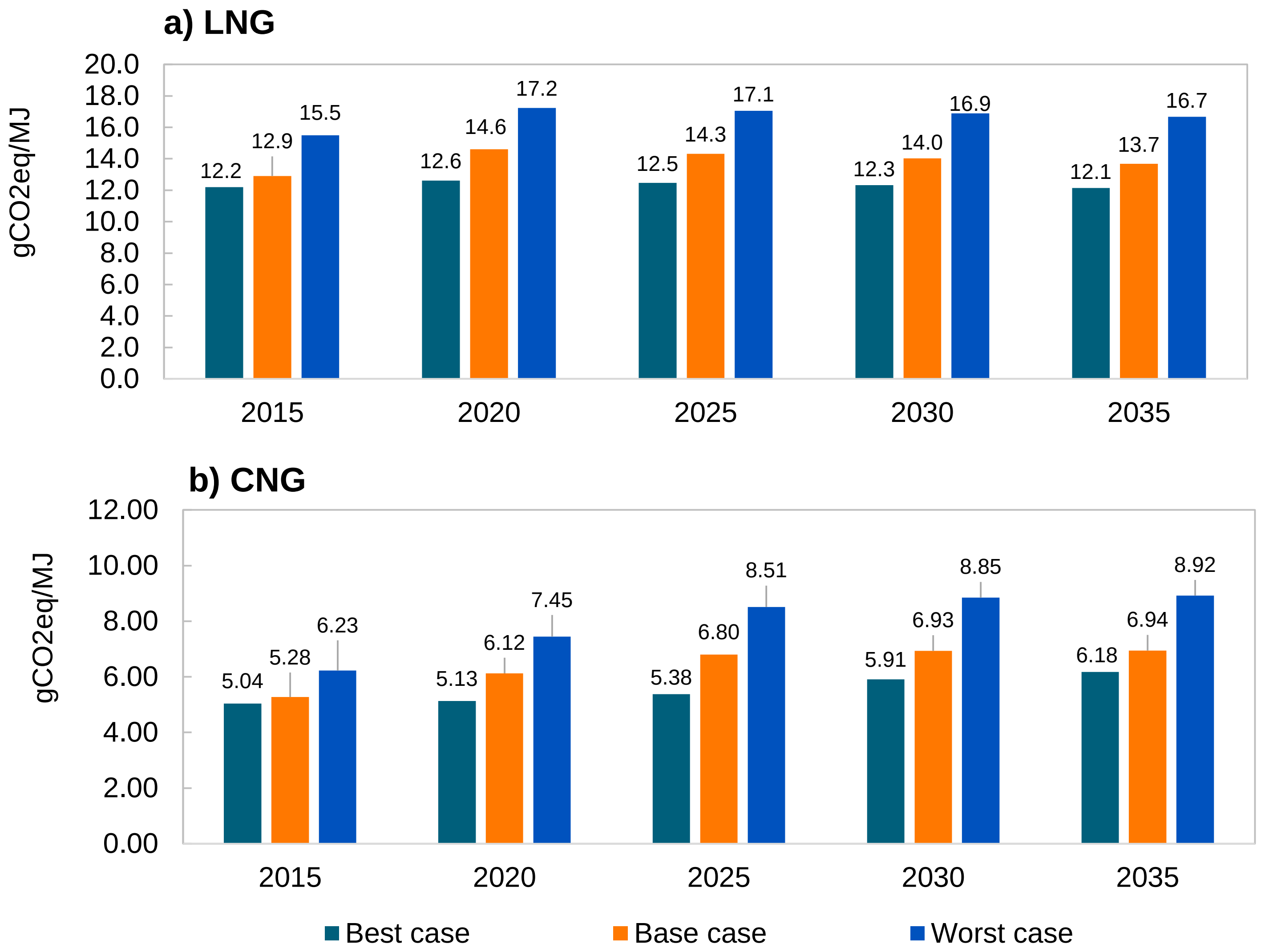
Worst Case

Tank-to-Motion

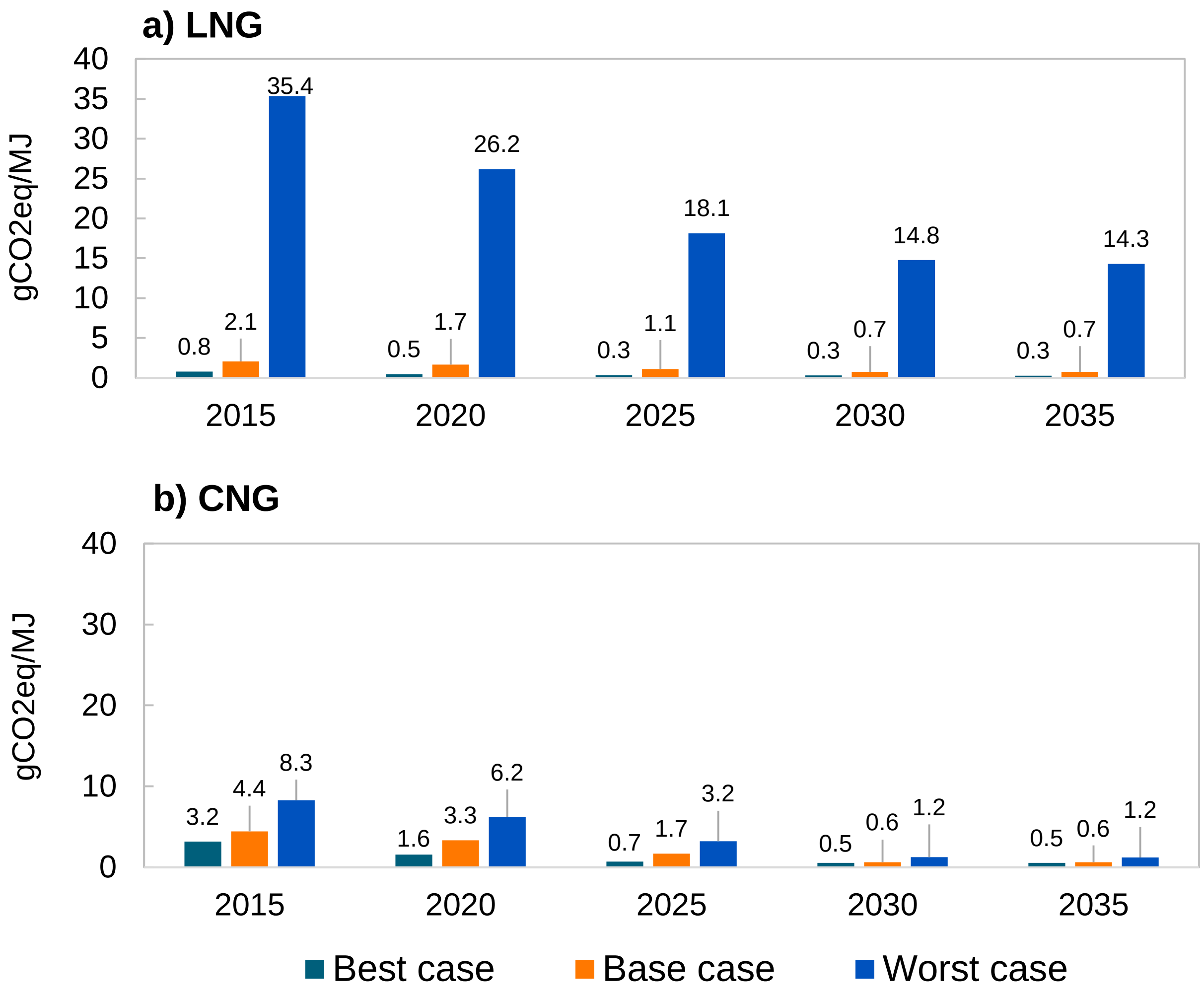
Well-to-Terminal



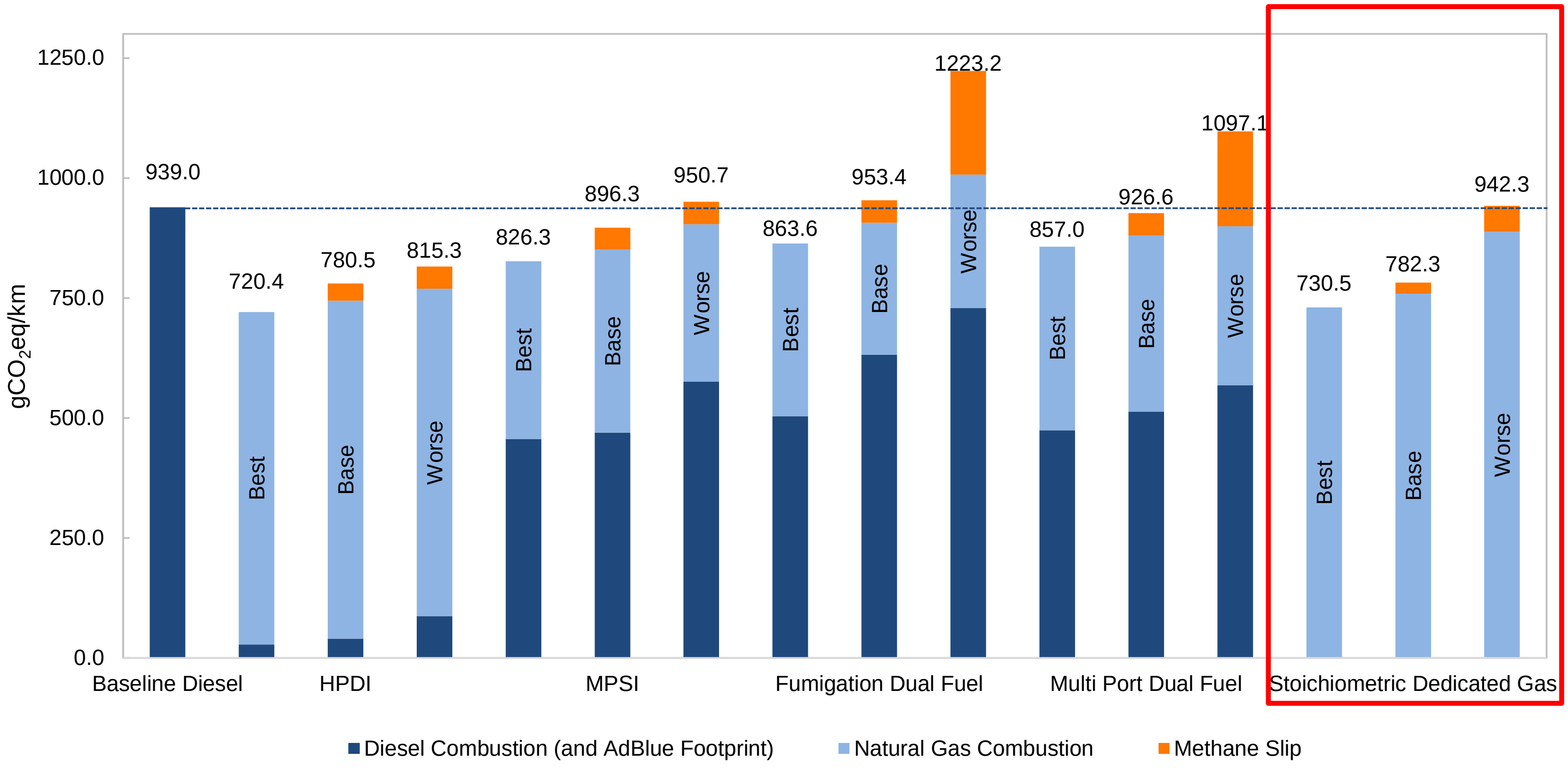
Well-to-Terminal



Terminal-to-Tank



Tank-to-Motion



Tank-to-Motion

HPDI – Substitution rates of 90-95%, direct cylinder injection of the gas

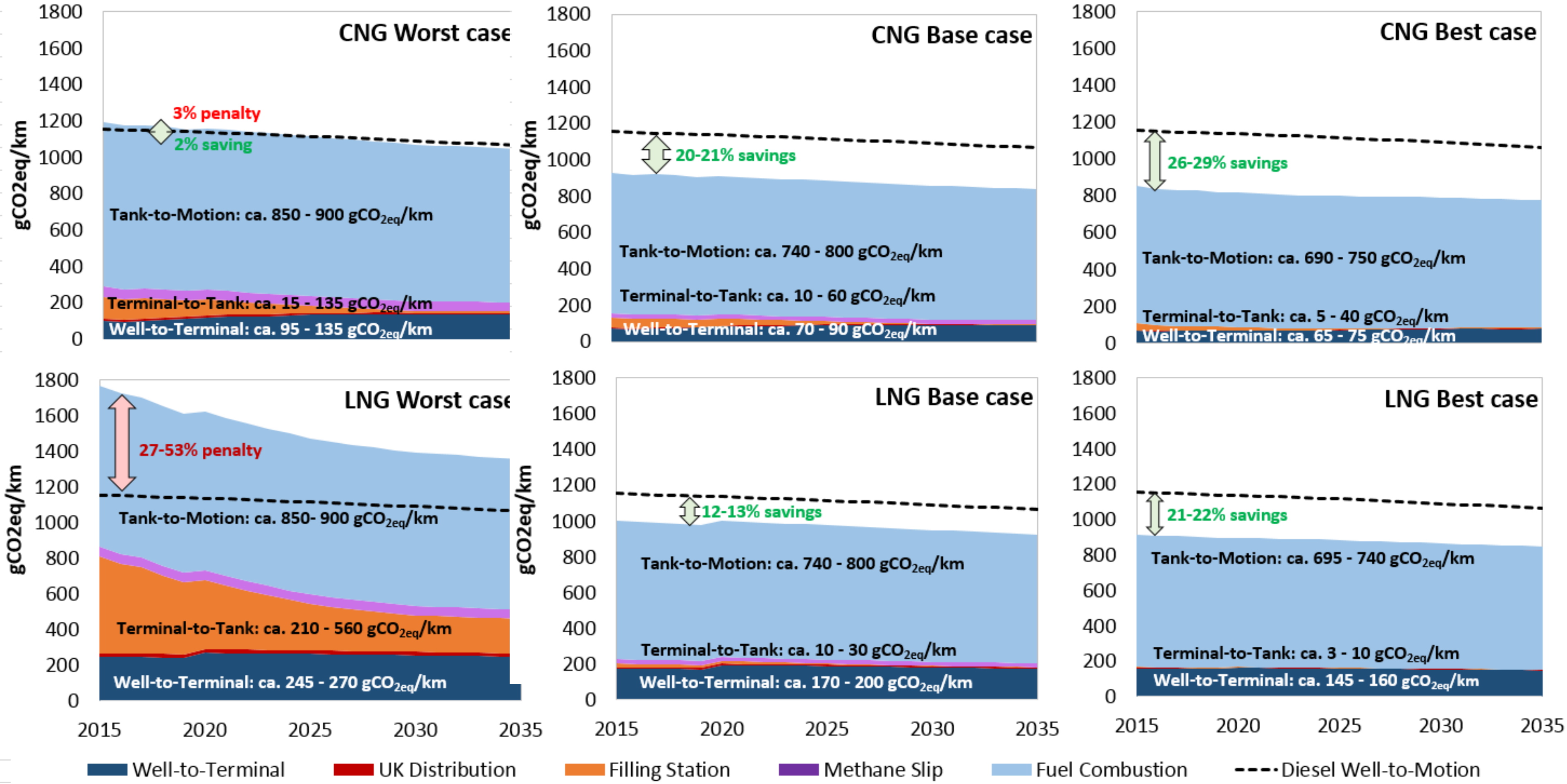
MPSI – Substitution rates of 50-80%, multiple gas injectors located near inlet valves per valve to allow precise timing of injection.

Fumigation Dual Fuel – 30-60% diesel substitution, single point injection system, gas mixes with the air prior to entering the combustion chamber

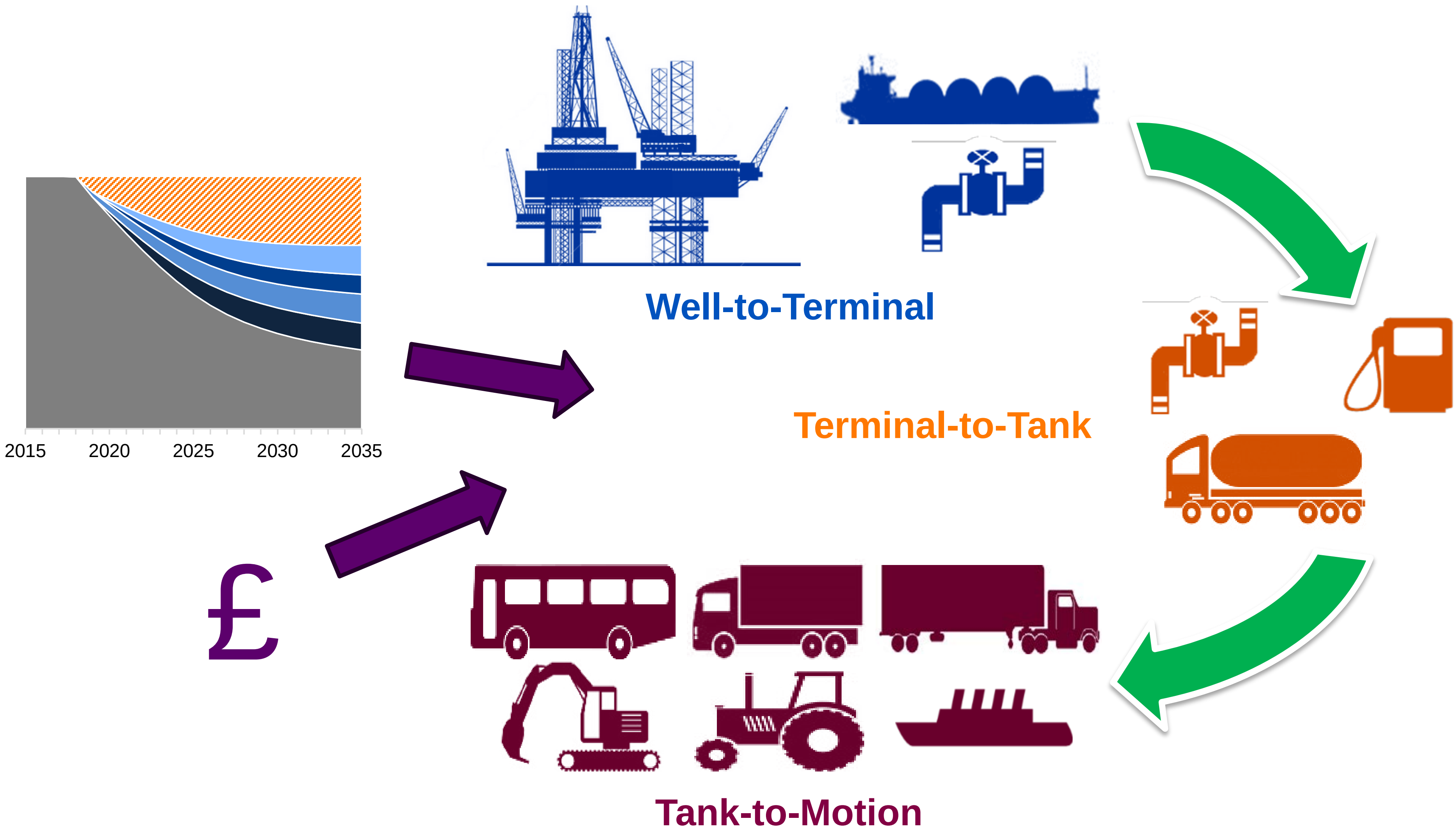
Multi Port Dual Fuel – 30-60% diesel substitution, multiple injectors but multiple ports per injector

Stoichiometric Dedicated Gas – Diesel replacement spark ignited ignition

Pathway Analysis



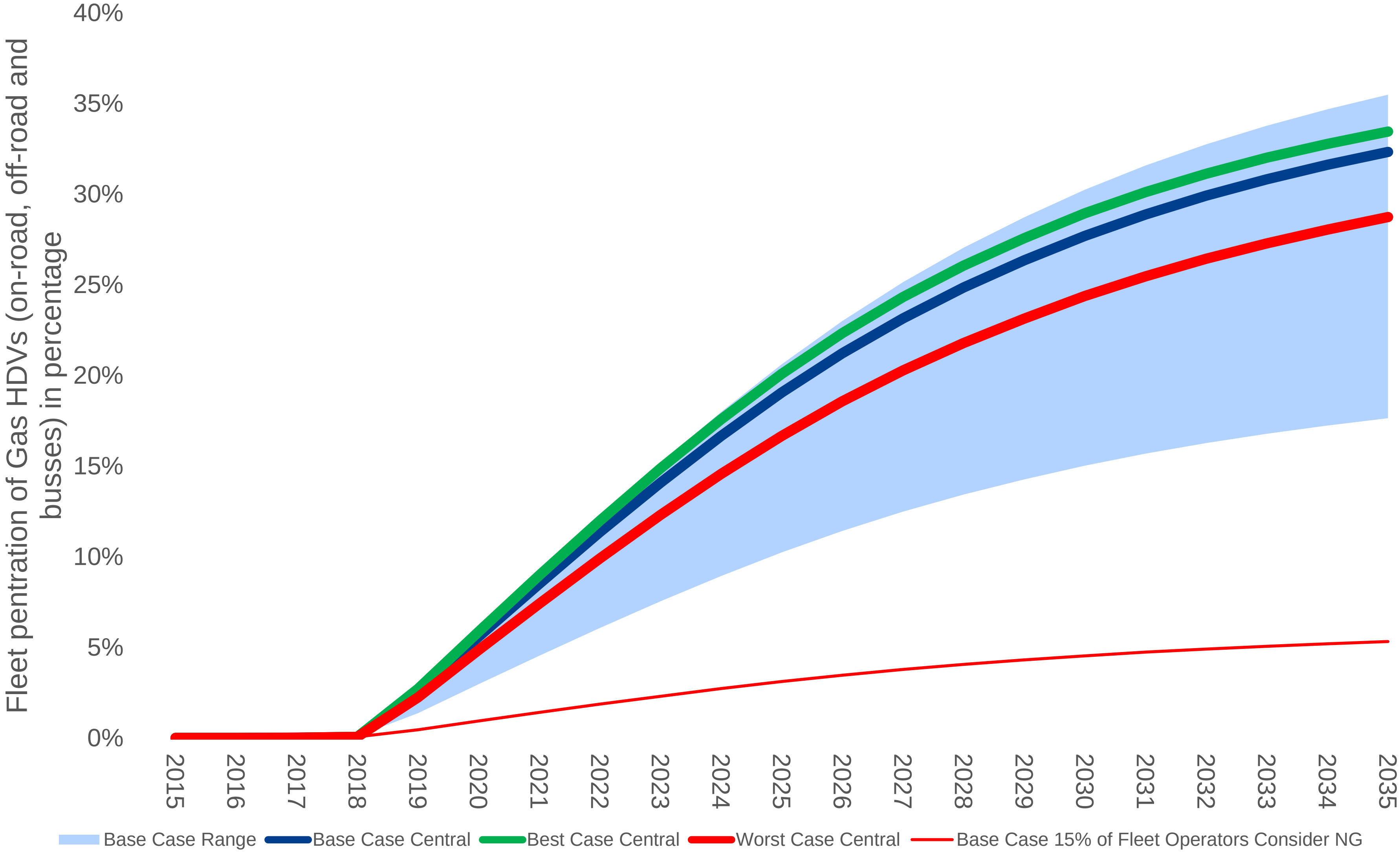
The Model


2015
2020
2025
2030
2035
£
Well-to-Terminal
Terminal-to-Tank
Tank-to-Motion

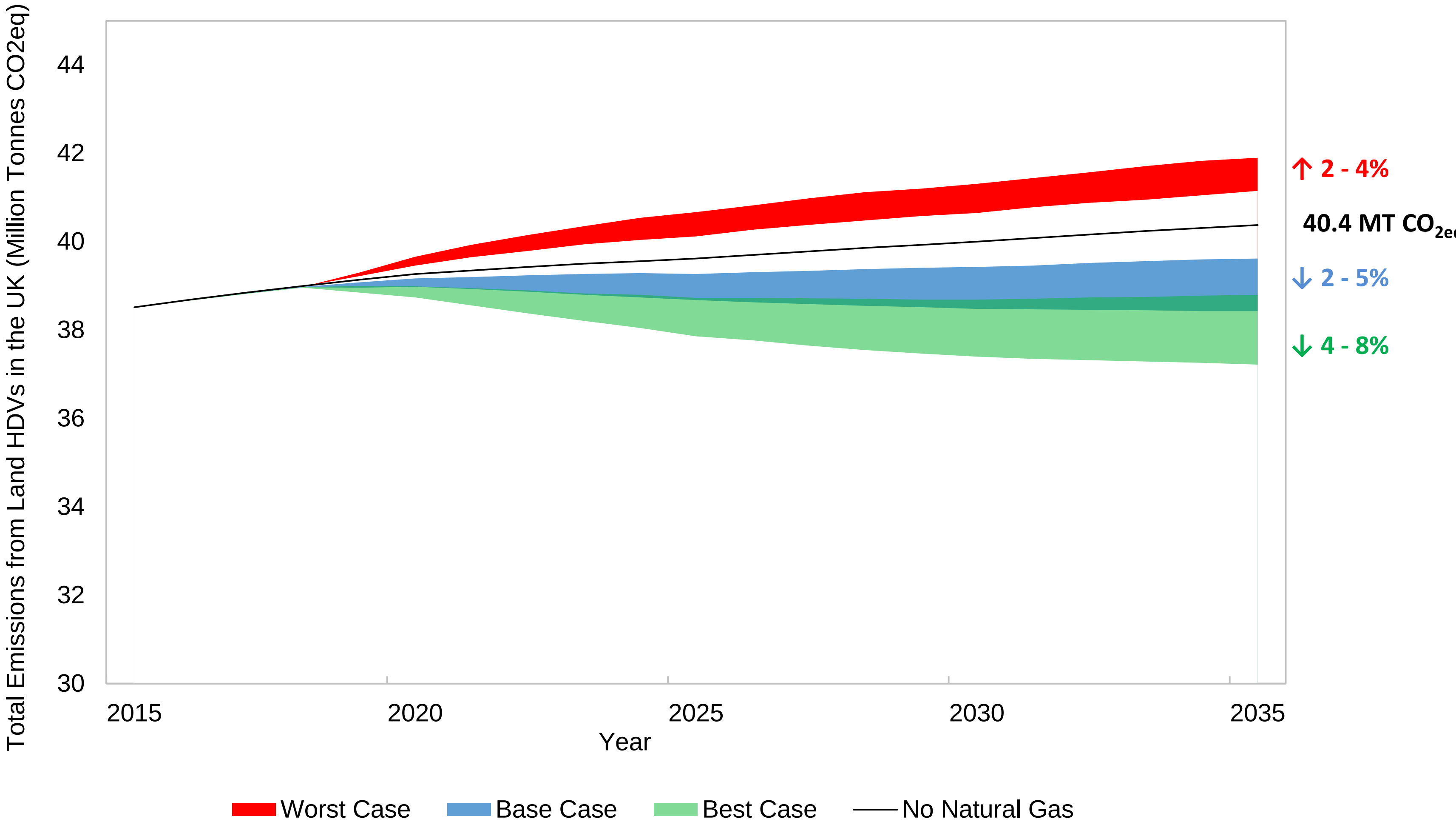
Uptake Scenario

Uptake for Case	Base Case	Best Case	Worst Case
Central Scenario	80% (100% for long haul and distribution)	80% (100% for long haul and distribution)	80% (100% for long haul and distribution)
Minimum Uptake	50%	50%	50%
Maximum Uptake	100%	100%	100%

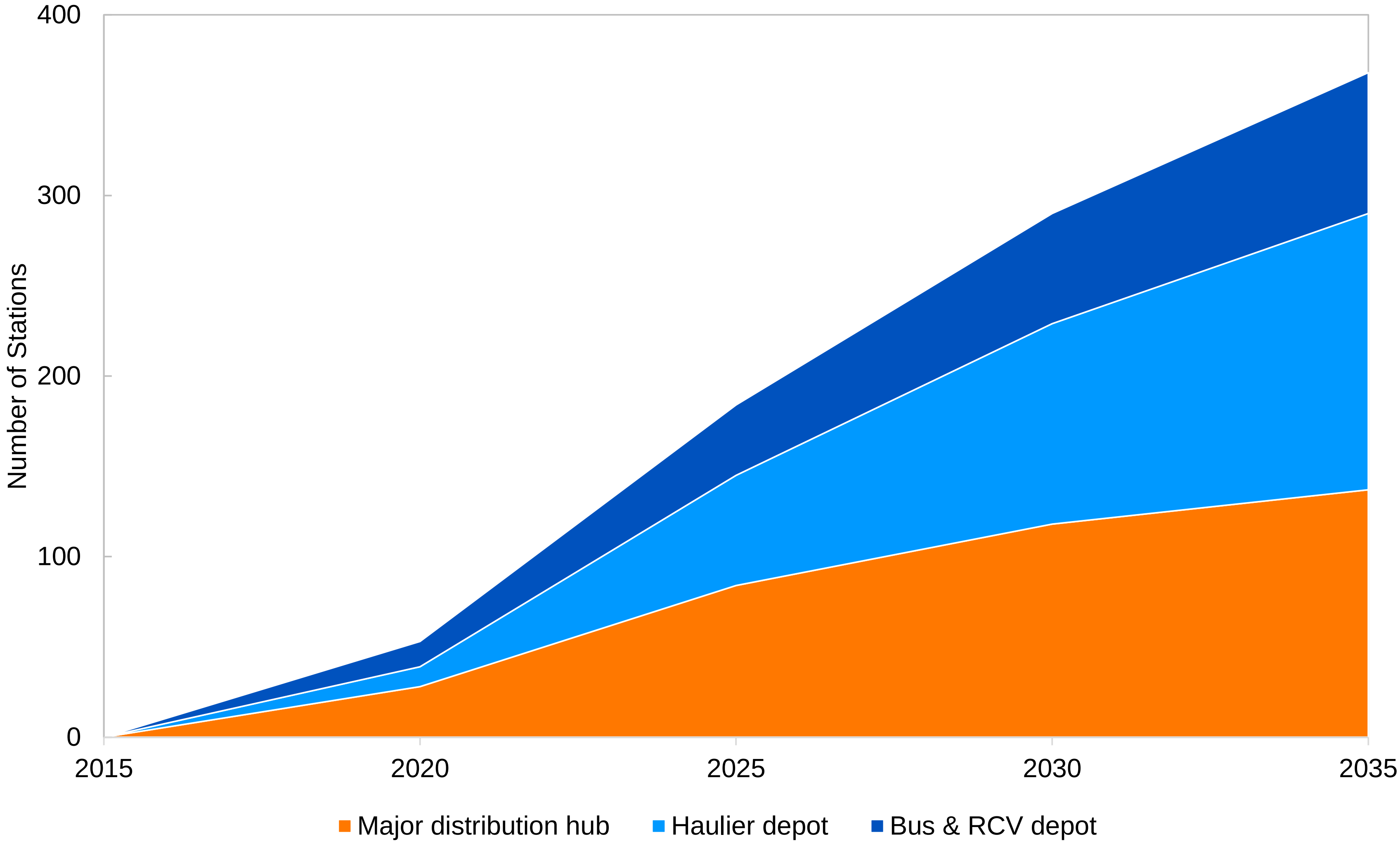
Fleet Uptake



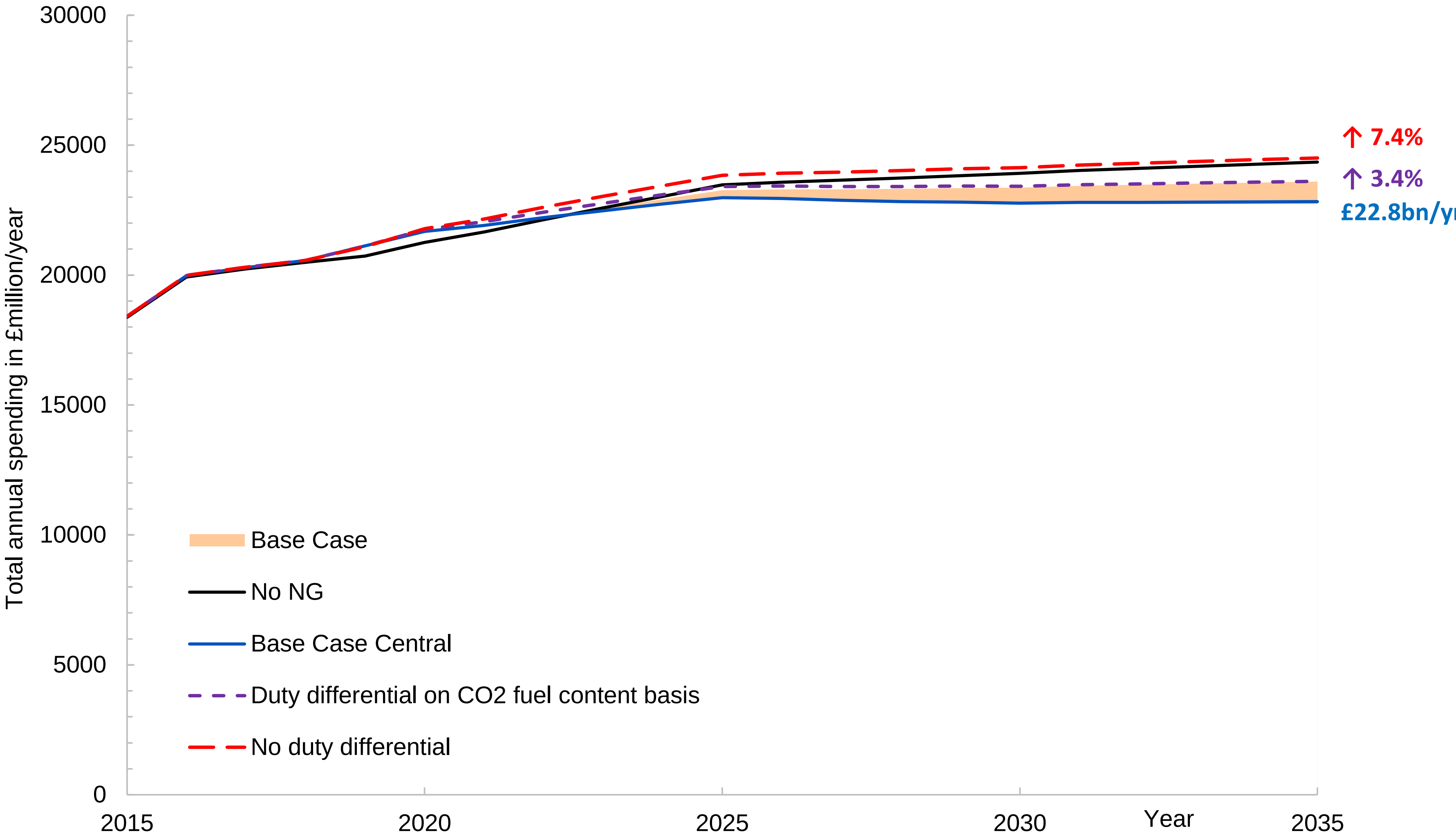
Fleet Emissions



Infrastructure



HMRC Fuel Duty – Cost to the Fleet



Overall Conclusions

- Economics for natural gas in the HGV fleet hinges upon the fuel duty differential and currently only the long haul segment is economic in the near term.

- Fuel duty tax stability is key to enable market confidence to invest in natural gas vehicles and the necessary supporting infrastructure.

- Natural Gas has the potential to reduce pathway Greenhouse Gas (GHG) emissions over the Well-to-Motion pathway by:
  - Dedicated - 13% (LNG) – 20% (CNG) per vehicle in the 2035 timeframe.
  - Dual Fuel - 16% (LNG) – 24% (CNG) per vehicle in the 2035 timeframe.

Pathway Technology Conclusions

- Cycle specific powertrain technology selection and pathway optimisation are key to providing GHG emission benefits over given usage cycles.

- Dual fuel and converted engines can have high methane emissions, often being worse than baseline diesel powertrains on a GHG emission basis.

- Providing methane catalysis at real world operating temperatures, i.e. below 350°C.

- Employing 'best practices' at LNG, CNG and L-CNG stations is a key driver to providing pathway benefits.

Energy Vectors for HDV

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Registered Office
Energy Technologies Institute
Holywell Building
Holywell Park
Loughborough
LE11 3UZ

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