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Gas Well-to-Motion

Matthew Joss

ETI10 TEN YEARS OF INNOVATION 2007 — 2017

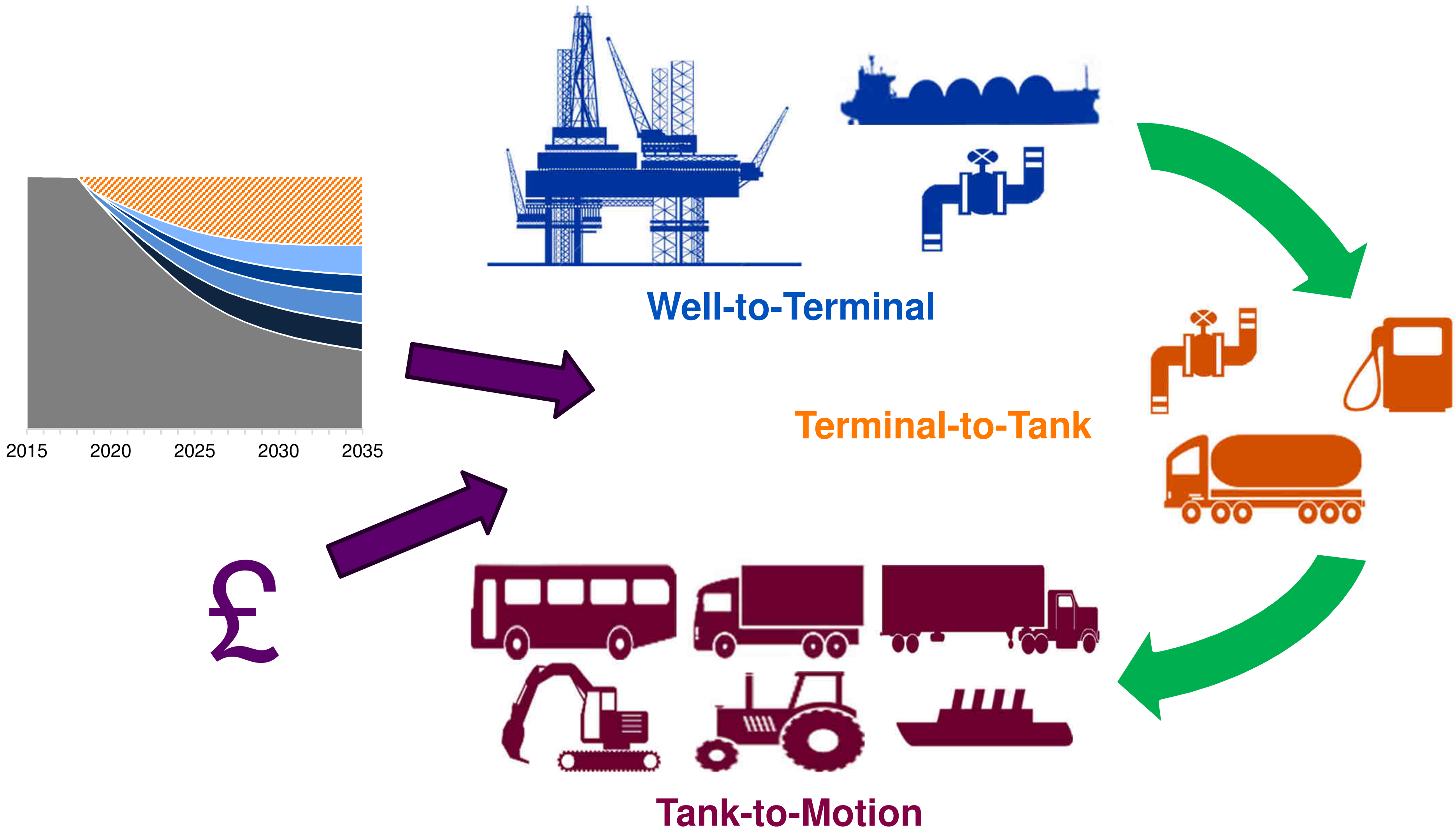

Air Quality


Waitrose
£ £ £

The Project

- Asses is Gas is the right fuel, what is the potential, what are the problems and are there any ‘glaring’ areas for further technology projects. Primarily knowledge building project.

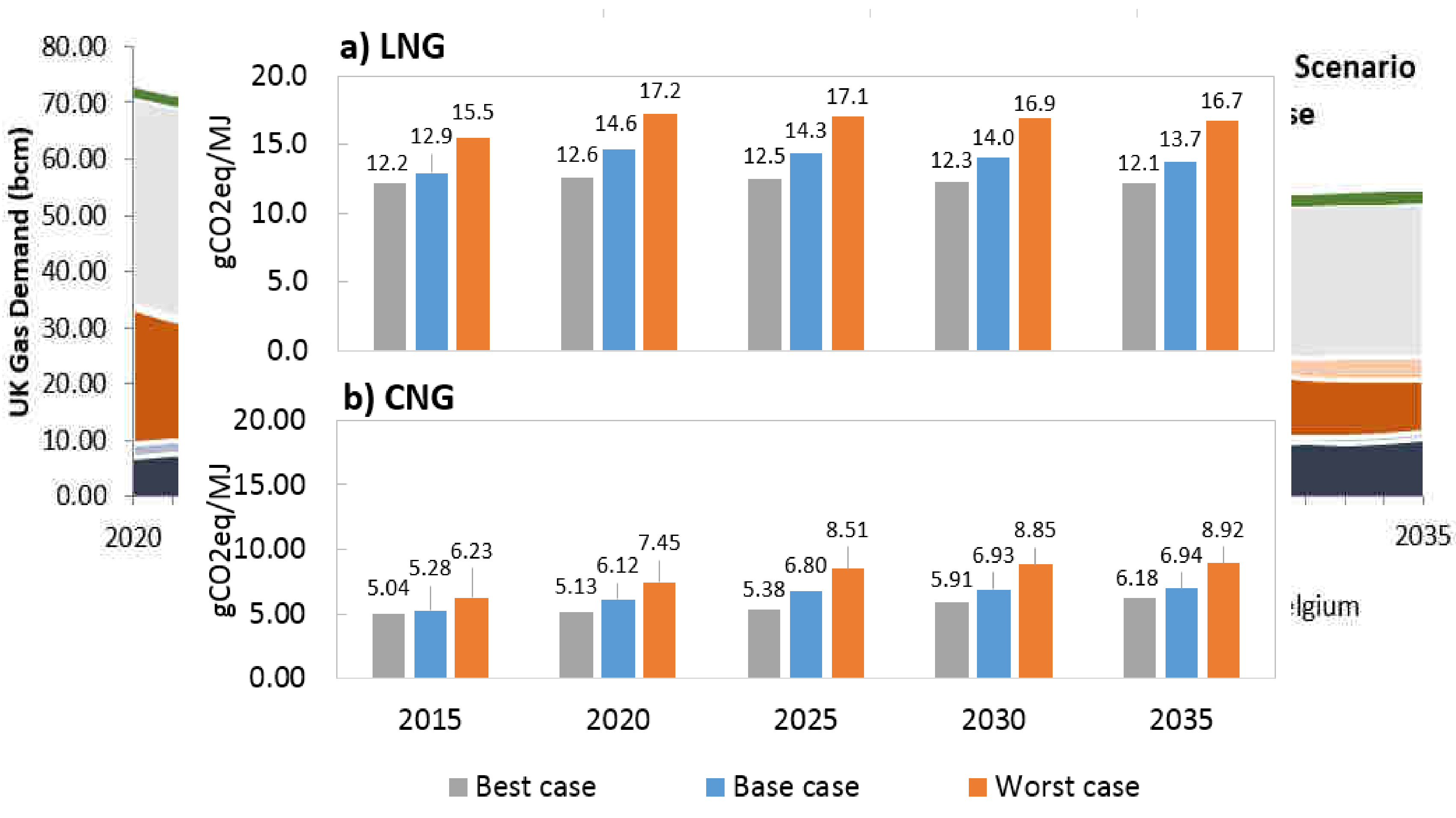
- Project Team
  - Element Energy
  - CNG Services
  - Strateco
  - UCL


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

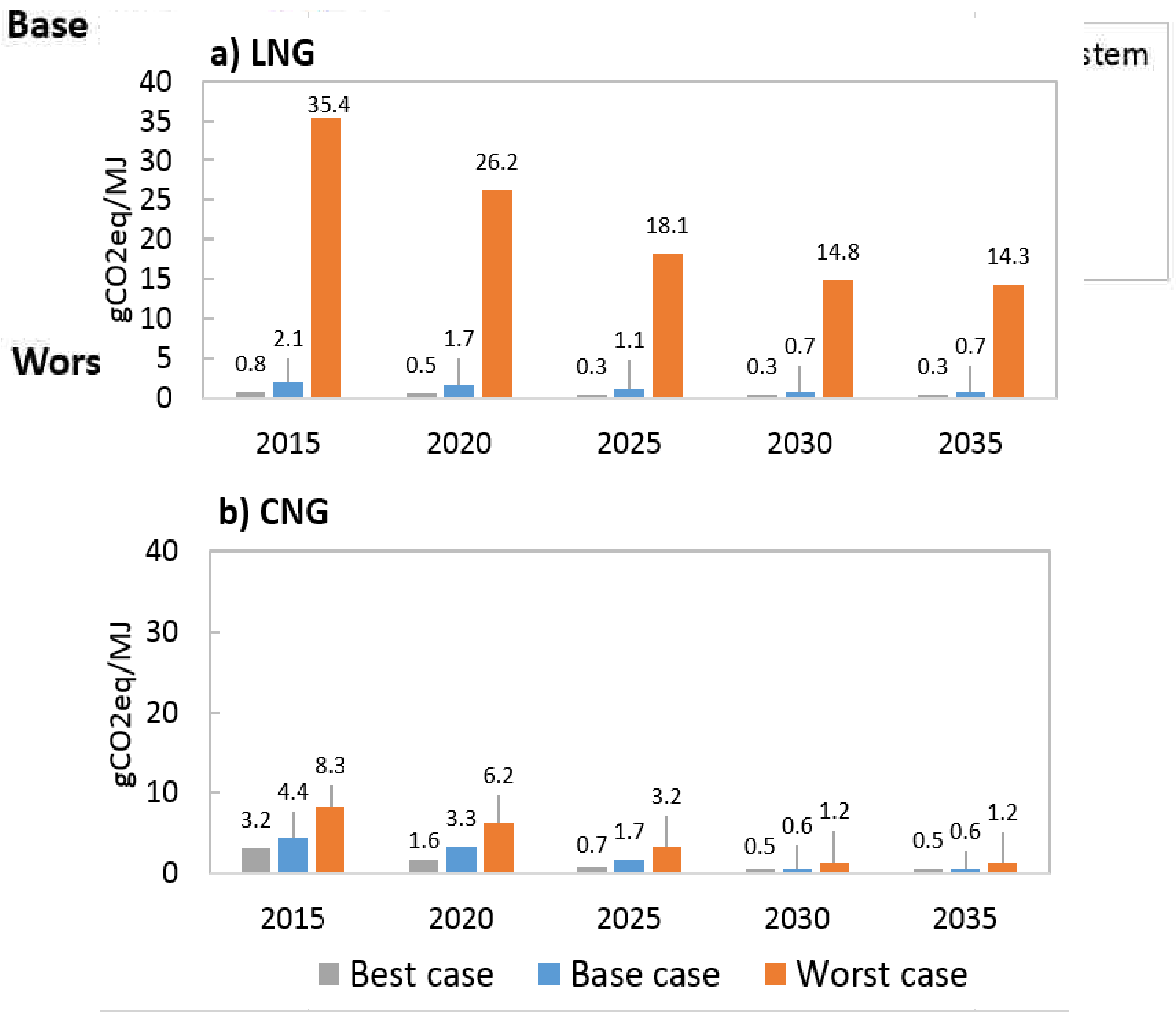
Scenario's

- Best Case
- Base Case
- Worst Case

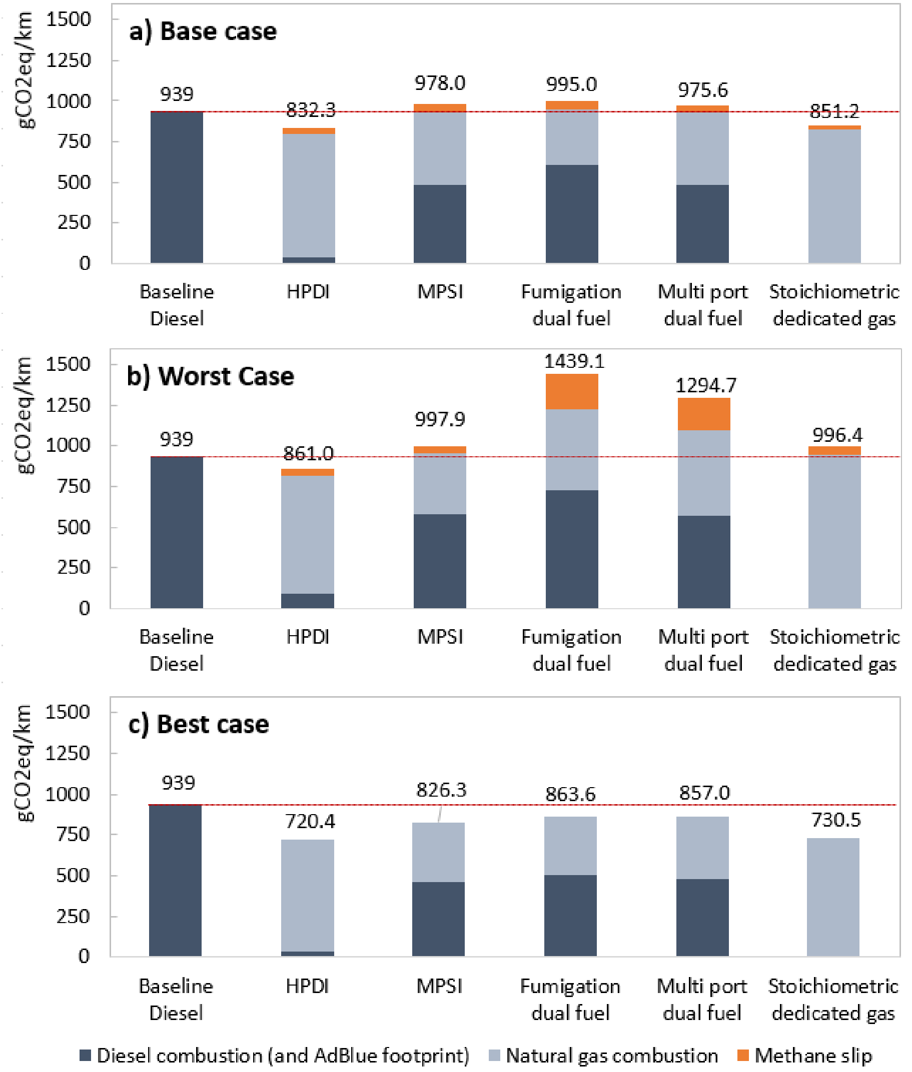
Well to Terminal



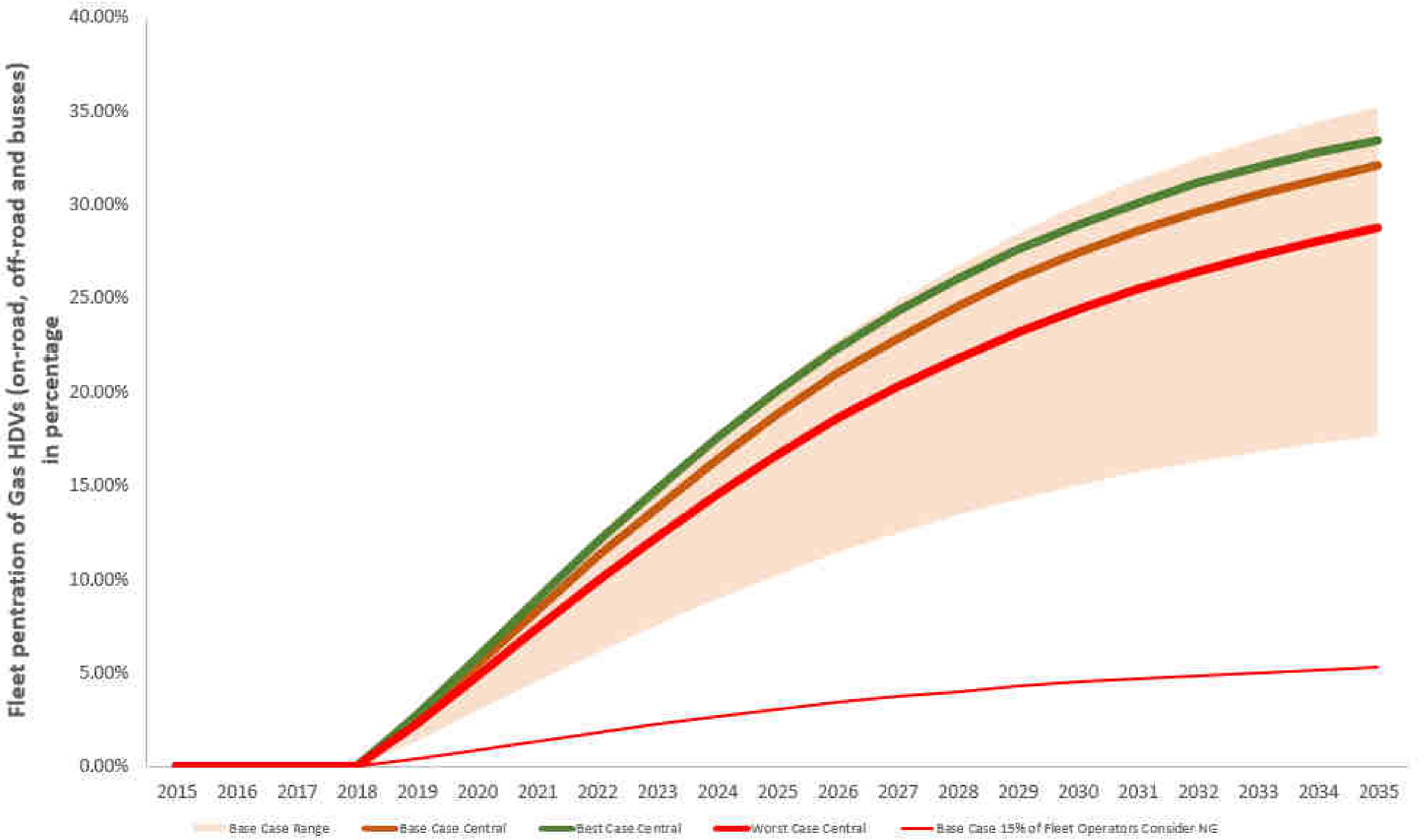
Tank to Terminal



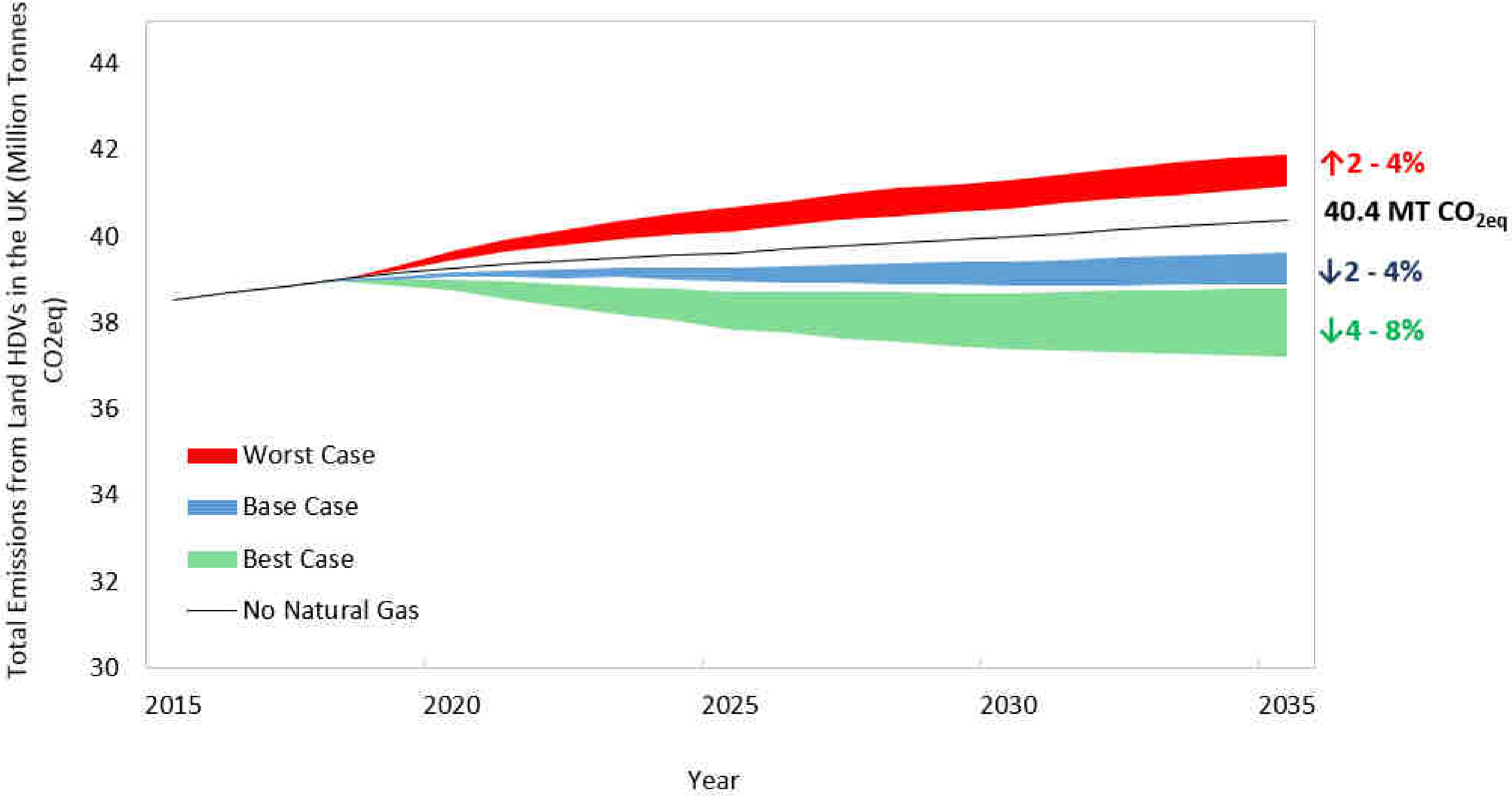
Tank to Motion



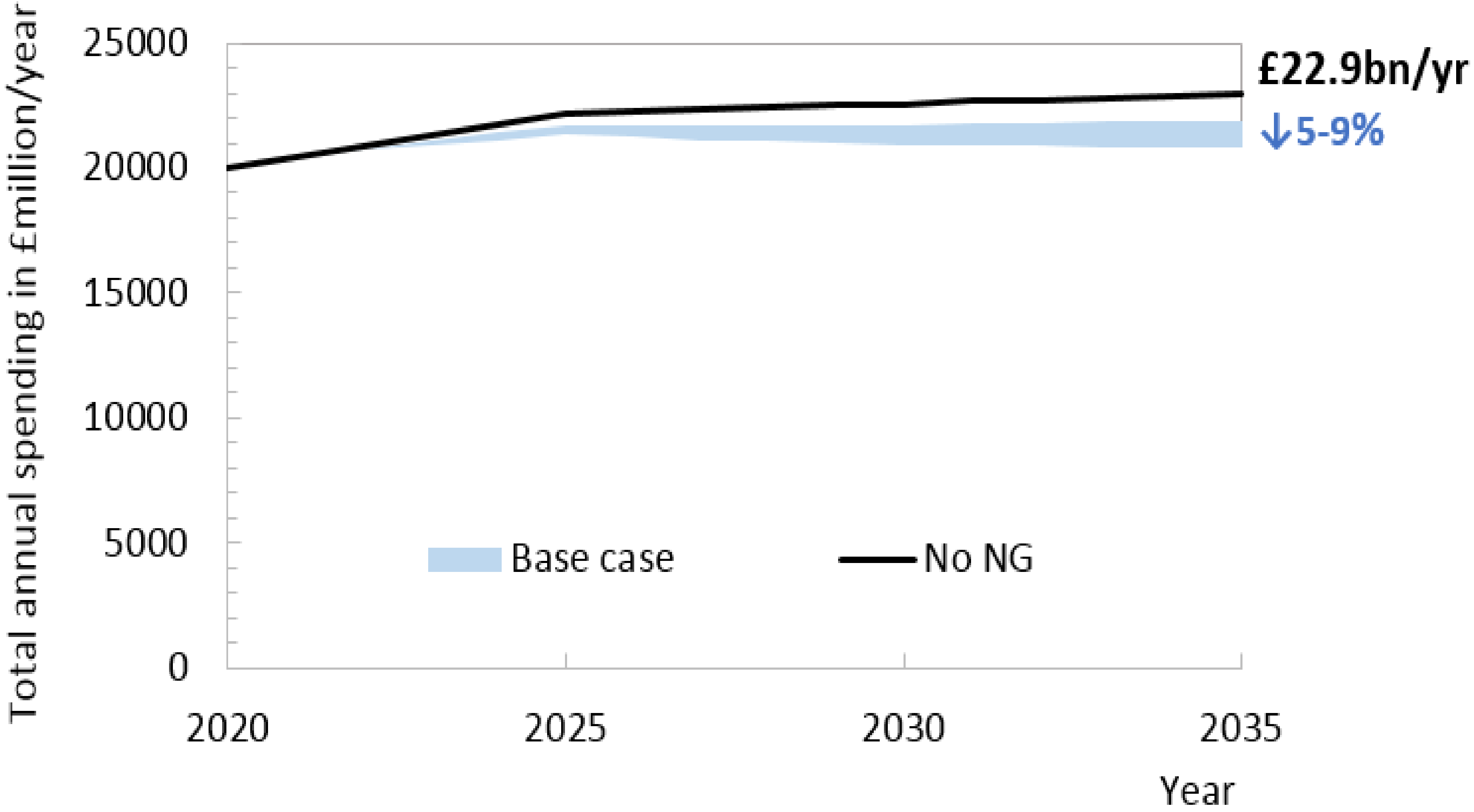
Fleet Uptake



Fleet Emissions



HMRC Fuel Duty



Summary

- Natural Gas can deliver a benefit in a long haul HGV sector that is difficult to decarbonise at low cost.
- At the vehicle level, natural gas in LNG and CNG form has the potential to reduce CO_2eq emissions over the well-to-motion pathway by 17% (LNG) - 23%(CNG).
- Careful, cycle specific powertrain technology selection is key to providing benefits over a given usage cycles.
- Upstream Pathways:
  - Benefits in the CNG pathway rely on electricity grid emission reductions.
  - LNG pathway emissions occurring outside of the UK contribute a significant amount to the pathway emissions.
  - CNG pressure tiers
  - LNG station practices

£

- The economic proposition for natural gas in the HGV space in particular hinges upon the fuel duty differential.

Questions

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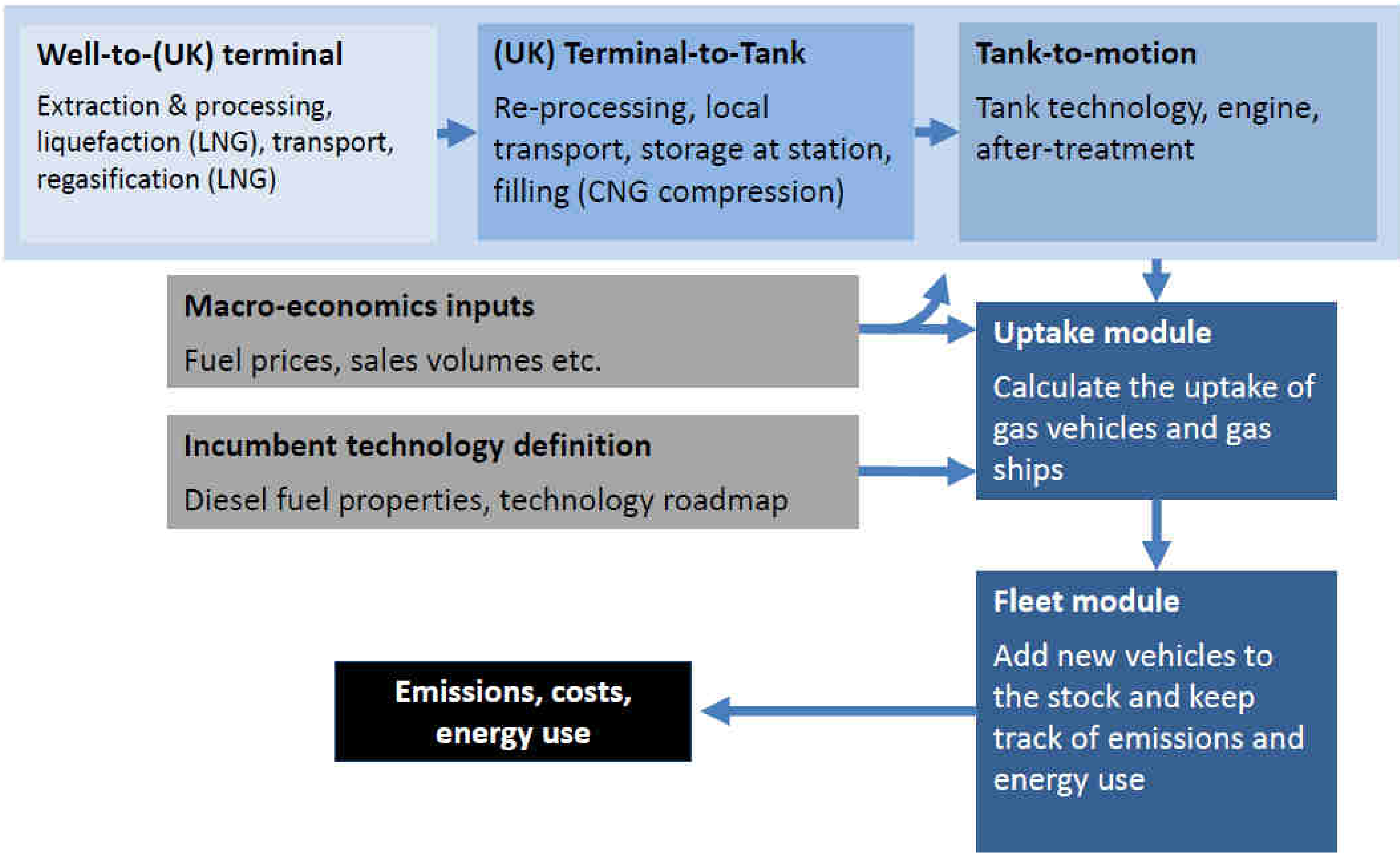
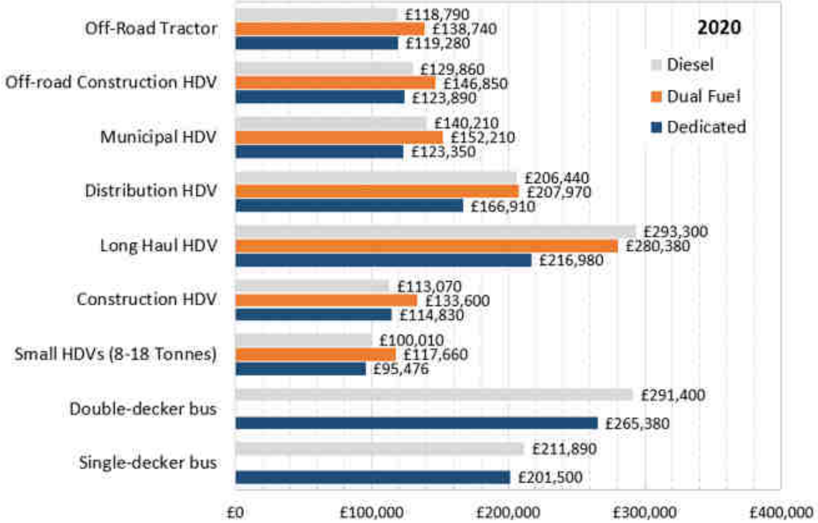
Overview of Model Structure

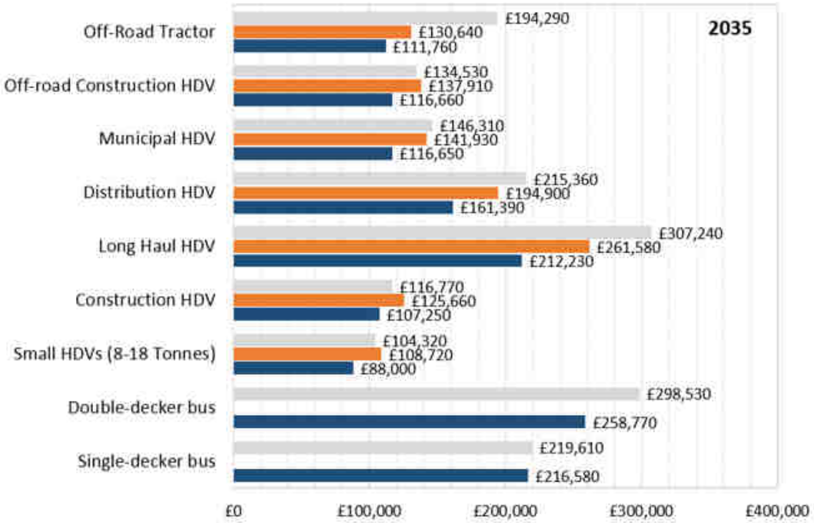


Tank-to-Motion Numbers

Engine	Methane slip(gCH_4/kWh)	Efficiency loss (%)	Diesel substitution rate (%)
	Base case		
Baseline Diesel	0	N/A	N/A
HPDI	0.4	3%	96%
MPSI	0.5	4%	45%
Fumigation dual fuel	0.5	7%	33%
Multi-port dual fuel	0.5	7%	44%
Stoichiometric dedicated gas	0.25	6%	100%
	Worst case		
Baseline Diesel	0.0	N/A	N/A
HPDI	0.5	5%	90%
MPSI	0.5	8%	40%
Fumigation dual fuel	2.1	18%	30%
Multi-port dual fuel	2.1	8%	30%
Stoichiometric dedicated gas	0.5	24%	100%
	Best case		
Baseline Diesel	0	N/A	N/A
HPDI	0	0%	97%
MPSI	0	1%	50%
Fumigation dual fuel	0	5%	45%
Multi-port dual fuel	0	5%	45%
Stoichiometric dedicated gas	0	2%	100%

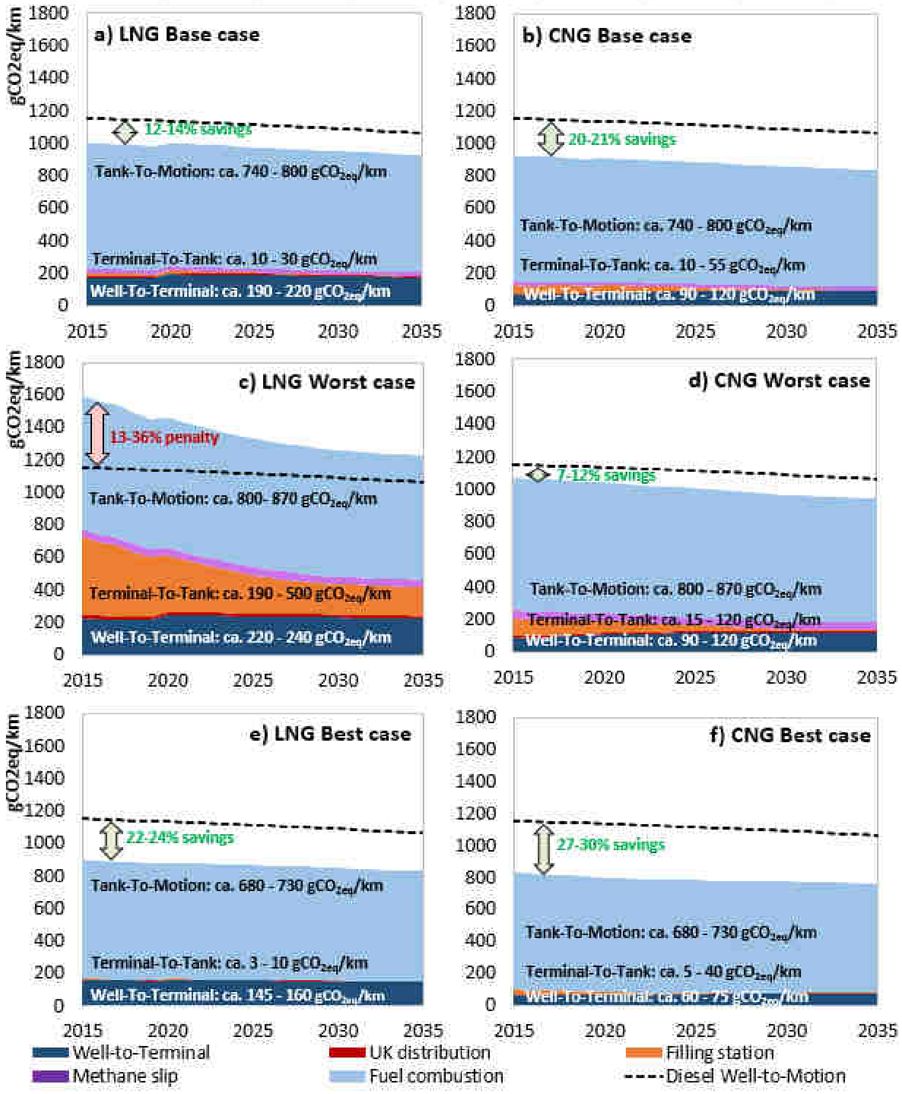
Tank-to-Motion Numbers





Tank-to-Motion Numbers

Natural gas vehicle cost premiums:	2020	2035
HPDI (LNG)	£28,500	£22,000
MPSI (LNG)	£33,000	£27,000
MPSI (CNG)	£31,800	£25,400
Fumigation (LNG)	£32,000	£27,000
Fumigation (CNG)	£30,000	£25,400
Multi-Port (LNG)	£32,000	£27,000
Multi-Port (CNG)	£30,000	£25,400
Stoichiometric Gas (LNG)	£27,000	£18,200
Stoichiometric Gas (CNG)	£25,500	£16,700



a) LNG Base case
12-14% savings
Tank-To-Motion: ca. 740 - 800 gCO2eq/km
Terminal-To-Tank: ca. 10 - 30 gCO2eq/km
Well-To-Terminal: ca. 190 - 220 gCO2eq/km
b) CNG Base case
20-21% savings
Tank-To-Motion: ca. 740 - 800 gCO2eq/km
Terminal-To-Tank: ca. 10 - 55 gCO2eq/km
Well-To-Terminal: ca. 90 - 120 gCO2eq/km
c) LNG Worst case
13-36% penalty
Tank-To-Motion: ca. 800- 870 gCO2eq/km
Terminal-To-Tank: ca. 190 - 500 gCO2eq/km
Well-To-Terminal: ca. 220 - 240 gCO2eq/km
d) CNG Worst case
7-12% savings
Tank-To-Motion: ca. 800 - 870 gCO2eq/km
Terminal-To-Tank: ca. 15 - 120 gCO2eq/km
Well-To-Terminal: ca. 90 - 120 gCO2eq/km
e) LNG Best case
22-24% savings
Tank-To-Motion: ca. 680 - 730 gCO2eq/km
Terminal-To-Tank: ca. 3 - 10 gCO2eq/km
Well-To-Terminal: ca. 145 - 160 gCO2eq/km
f) CNG Best case
27-30% savings
Tank-To-Motion: ca. 680 - 730 gCO2eq/km
Terminal-To-Tank: ca. 5 - 40 gCO2eq/km
Well-To-Terminal: ca. 60 - 75 gCO2eq/km
gCO2eq/km
0 200 400 600 800 1000 1200 1400 1600 1800
2015 2020 2025 2030 2035
Well-to-Terminal
UK distribution
Filling station
Methane slip
Fuel combustion
Diesel Well-to-Motion

Key Insights

- Natural Gas has the potential to reduce GHG emissions by up to 10% on-highway, in a sector that's very difficult to decarbonise.
- To do this, best practice throughout the pathways should be followed otherwise Natural Gas could be worse on a GHG basis than the incumbent fuel.
- Careful consideration should be taken as to the source of Natural Gas and the associated extraction practices and 'mix's'.
- L-CNG stations offer the best refuelling options in all scenarios.
- Practices such a employing vapour recovery systems to prevent gas venting during refuelling, which are low cost systems, are 'no brainer' solutions that should be followed at LNG and L-CNG stations.
- If Natural Gas is to be extracted from the grid, efforts should be made to extract this from the high pressure local transmission system.
- Methane Slip at the vehicle outweighs emissions elsewhere in the pathway.
- Dedicated Gas and High Pressure Dual Fuel engines offer the best options for vehicle propulsion.