

Safety, Accessibility and Sustainability Panel



Date: 7 July 2015

Item: Emissions from the TfL Bus Fleet

This paper will be considered in public

1 Summary

- 1.1 The accompanying presentation provides an overview of:
- (a) current environmental impact & environmental challenges
 - (b) Business Plan commitments
 - (c) Retro-fit programme
 - (d) Fleet renewal
 - (e) Future technology trials

2 Recommendation

- 2.1 The Panel is asked to note this presentation.

List of appendices to this report:

Appendix 1: Emissions from the TfL Bus Fleet

List of Background Papers:

None

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Emissions from the TfL Bus Fleet



Safety, Accessibility and Sustainability Panel
7 July 2015

Mike Weston
Director of Buses



Content

- **Overview of current environmental impact & Environmental Challenges**
- **Business Plan commitments**
- **Retro-fit programme**
- **Fleet Renewal**
- **Future Technology trials**



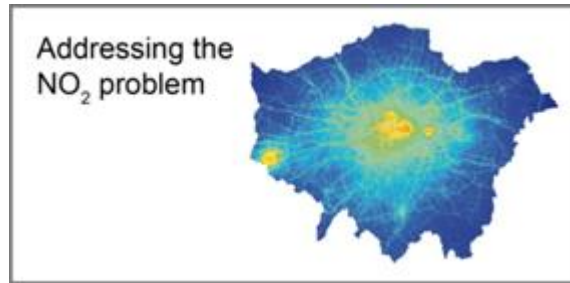
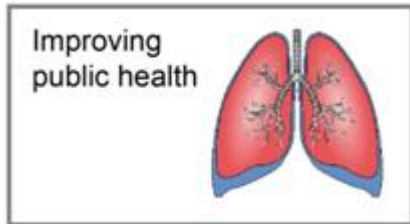
Air Quality in London



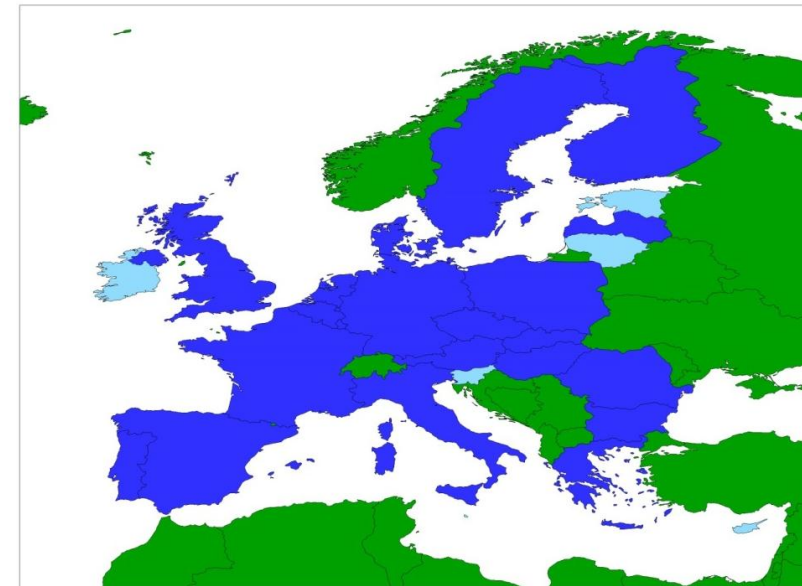
- A House of Commons Environmental Audit Committee said that particle pollution has claimed the lives of over 4,300 people a year in London and has an annual cost of around £2bn.
- Affects most vulnerable parts of society
- The Mayor of London is legally obliged to work towards the UK Government's air quality objectives, who in turn are committed to meeting limit values set out in European Union legislation.
- Air quality in London currently exceeds EU limit values Nitrogen Dioxide (NO₂)



Environmental Challenges



- EU Limit Values of 40 µg/m³ for NO₂ and PM
- PM just below limit (though no safe level)
- NO₂ is 3 times higher than limit value in some areas
- Mayor has targeted 60% reduction in CO₂ by 2025 from 1990 levels

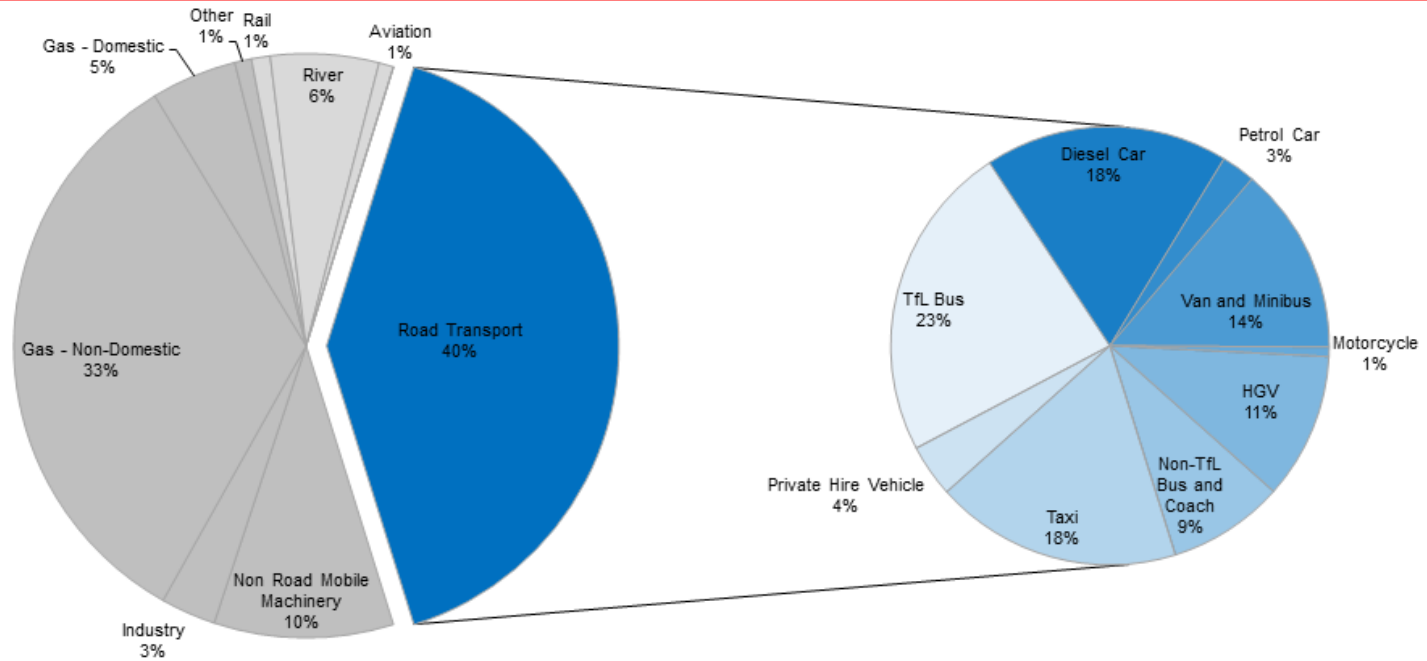


Key

Green	Non-EU countries
Light Blue	Compliant EU countries
Dark Blue	Non-compliant EU countries

Map showing EU member states which exceeded annual NO₂ limit values in 2012

Environmental impact of bus fleet –NO_x*

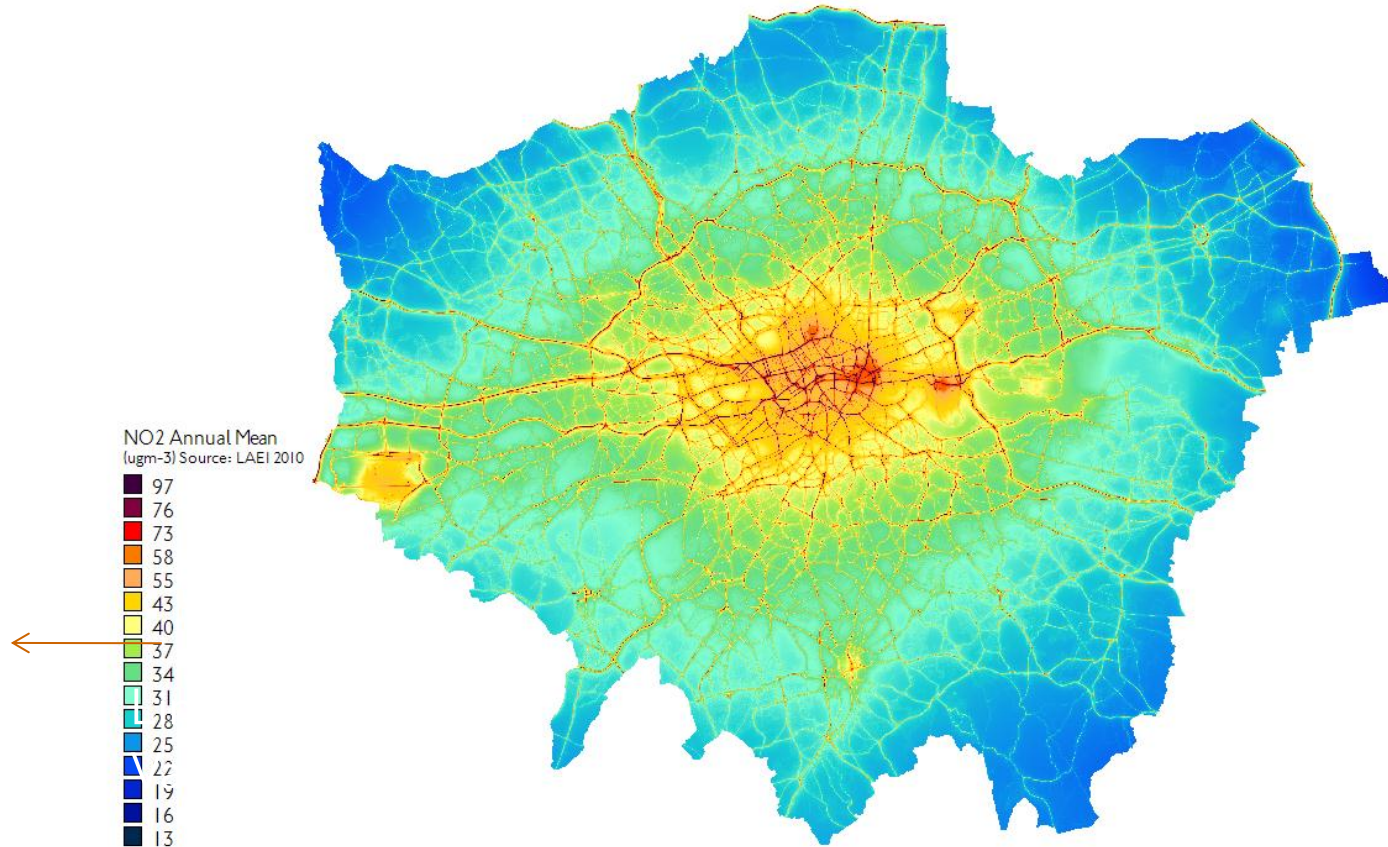


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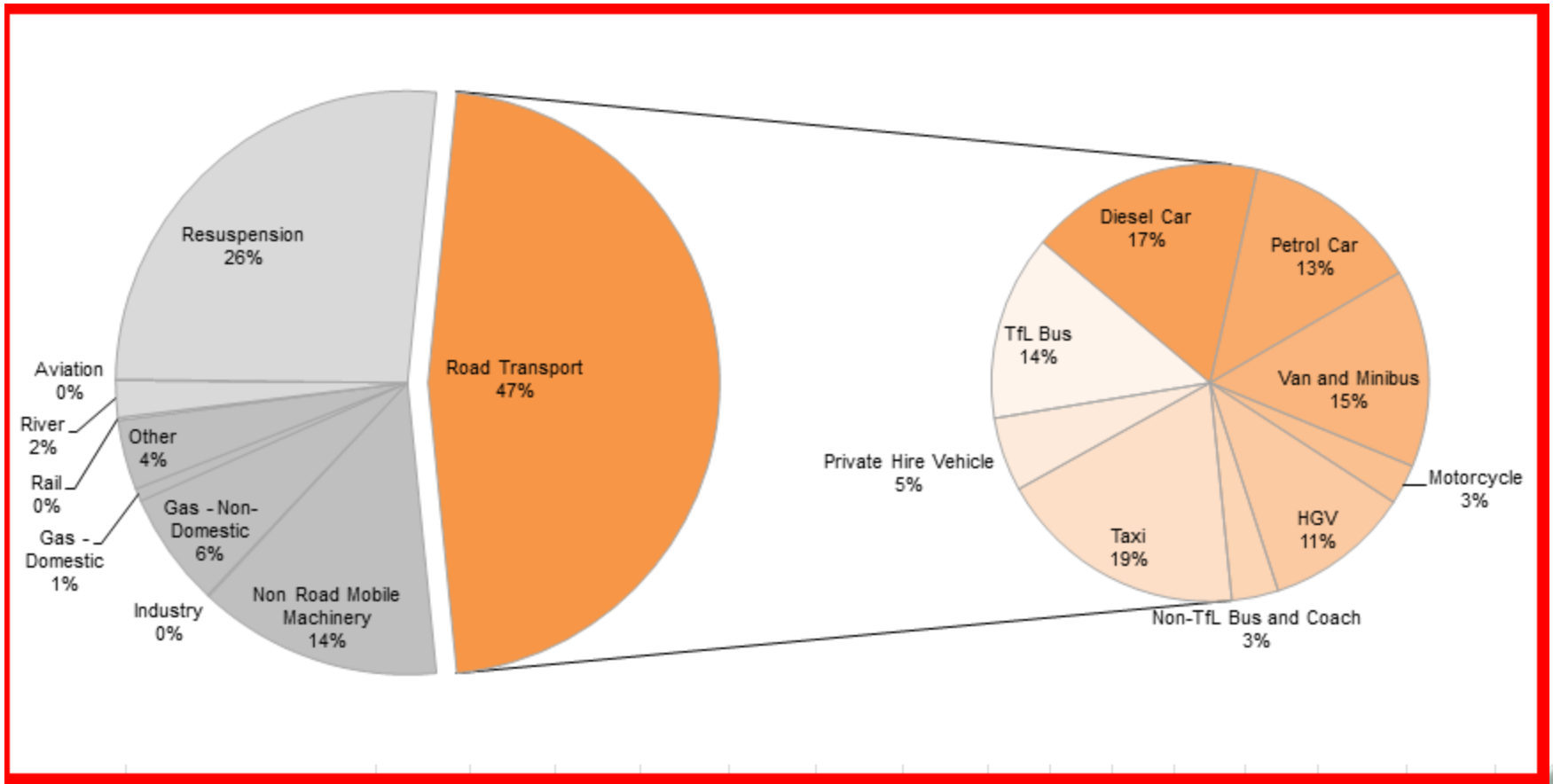


London's NO₂ concentrations

NO₂ Annual Mean - 2010



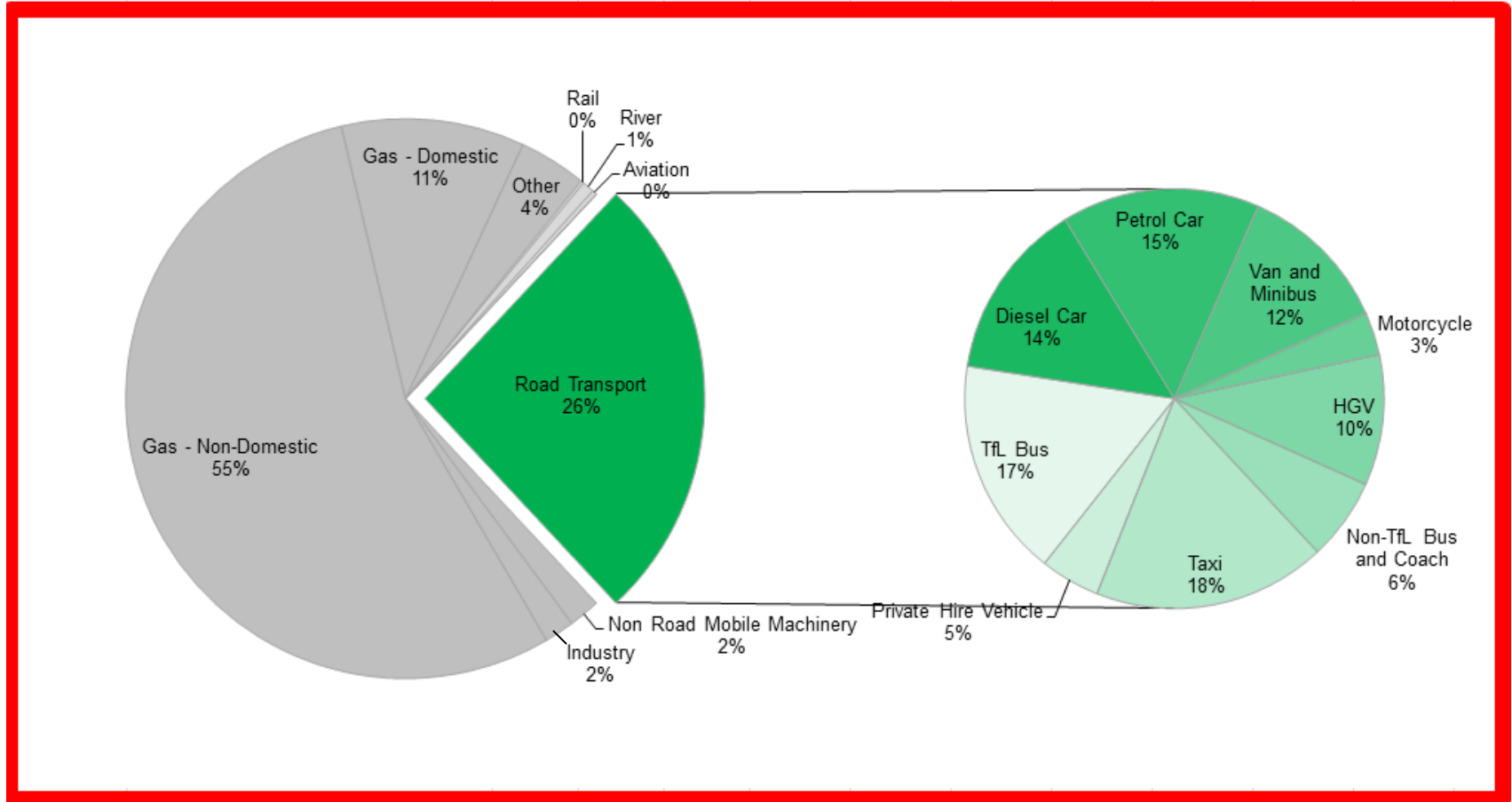
Environmental impact of bus fleet –PM*



*rounded



Environmental impact of bus fleet – CO₂*



*rounded

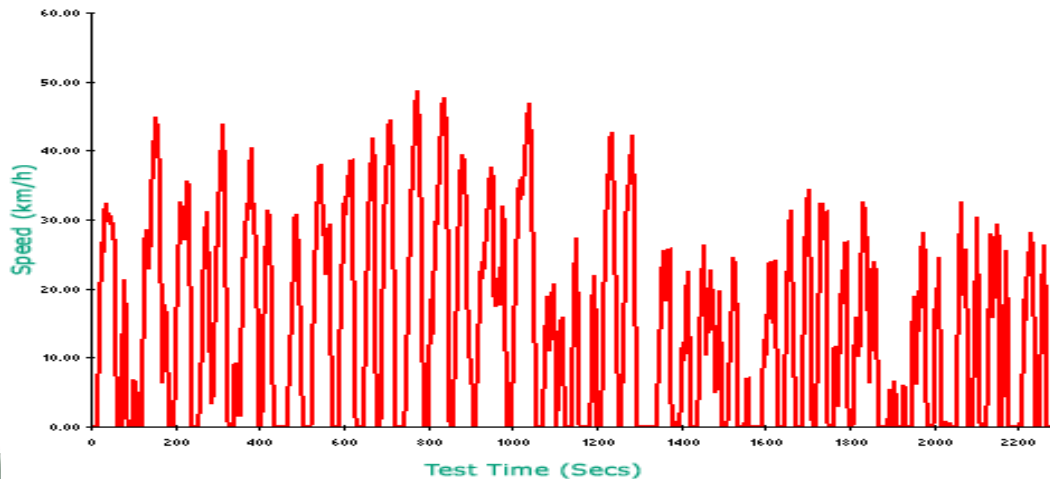


Calculating the Environmental Impact of the Bus Fleet

- TfL developed with Millbrook a 'real world' drive cycle based on Route 159 from Brixton to Oxford Street
- Every new type of bus is tested to ensure CO₂, PM and NO_x emissions meet TfL's requirements
- Enables TfL to model the impact of the Bus Fleet on London emissions and predict the impact of interventions

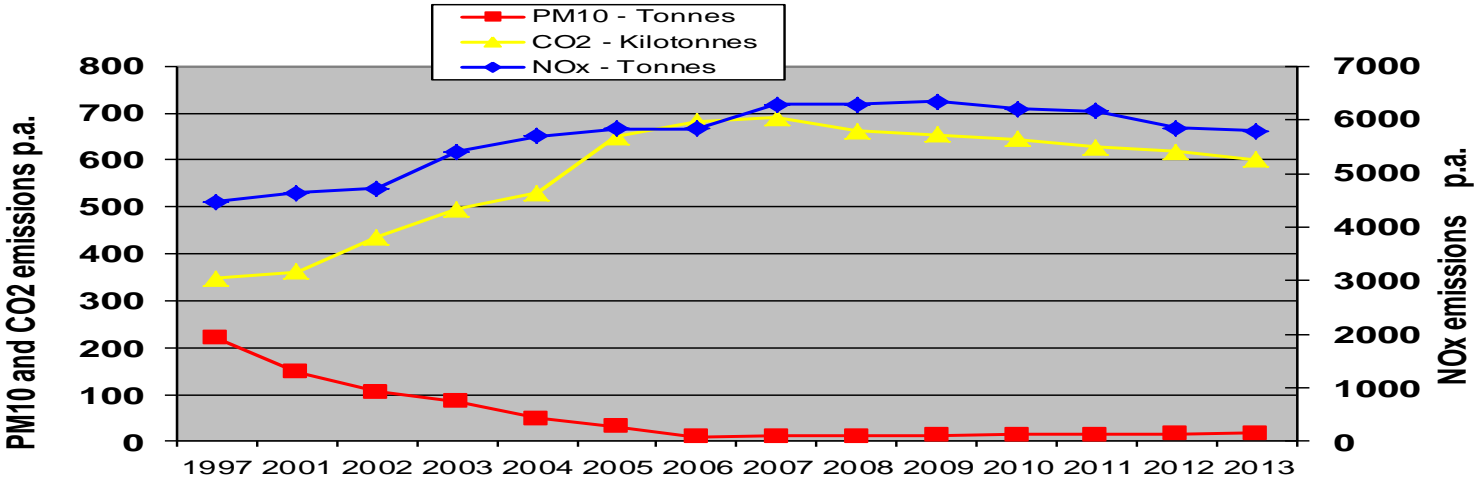
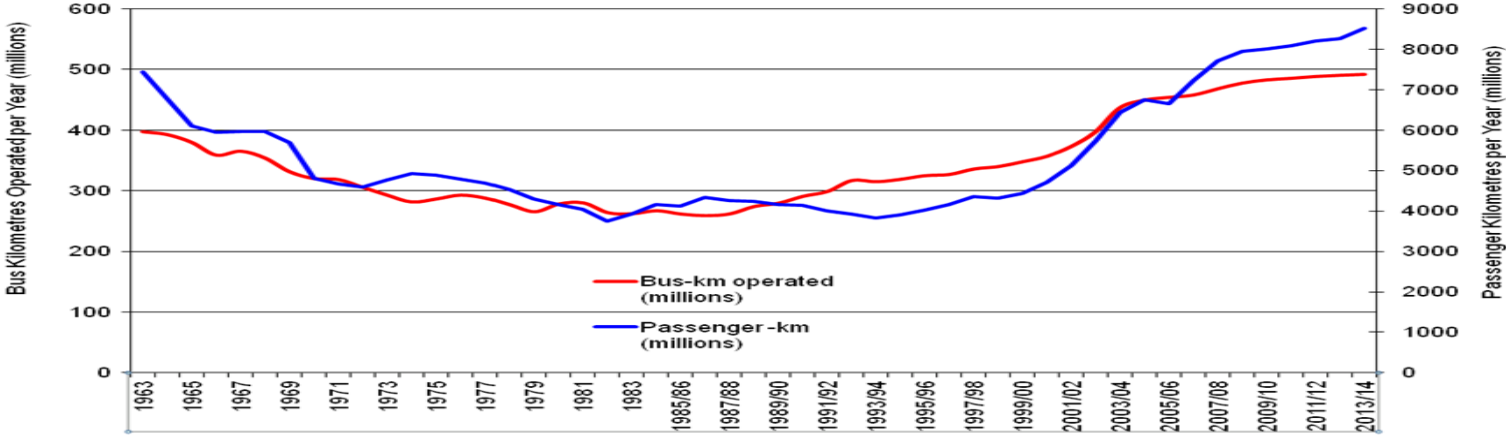


MILLBROOK LONDON TRANSPORT BUS (MLTB) DRIVE CYCLE



Fleet Emission Trends

London bus network: service volume and usage
1963-2014



TfL Retrofitted Diesel Particulate Filters (DPF) on all its Euro II and III buses by 2005



Business Plan Commitments

800 NRM buses

1,700 hybrid buses by 2016

NOx retrofit of c1,800 Euro III buses by December 2015

Early replacement of remaining Euro III buses with Euro VI by December 2015

ULEZ Commitments 2020

Use of biodiesel in the bus fleet

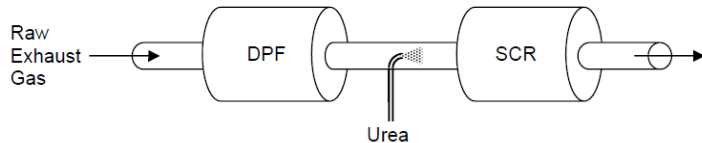
Continuation of hydrogen bus programme to 2019/20

Technology trials (including electric bus and inductive charging to 2021/22)



NO_x Abatement Retrofit

- Initially £10 million (DfT/TfL) scheme to retrofit 900 Euro III buses with selective catalytic reduction (SCR)



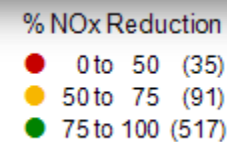
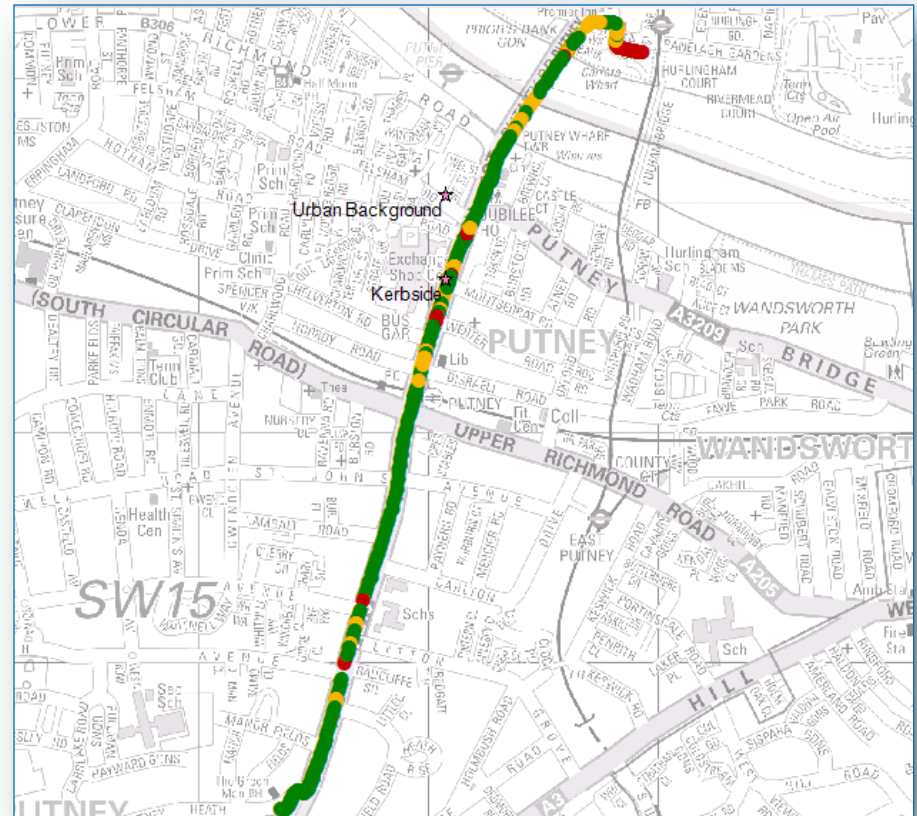
- NO_x reacts with ammonia over the catalyst and reduces it to nitrogen and water
- Technology approved for three bus types - Dennis Trident and Dart, and Volvo B7
- Technology proven on the three bus types over six months – in service performance was monitored
- Three suppliers – Eminox, HJS and Proventia have fitted systems to buses operated by seven different operators
- 1,350 Euro 3 vehicles fitted rising to 2000 by end 2015



SCR Emissions Test Results

88% NO_x Reduction achieved on both the Denis Dart and Volvo Double Deck

Test No 11762/63, 822/23/24		Baseline Test	
Date	15/11/11 & 1/12/11	NO_x	NO₂
Units:		g/km	g/km
Analysers:		Bag	FTIR
Phase 1	Outer London	10.49	0.49
Phase 2	Inner London	18.43	0.84
Combined result		12.72	0.59
Test No 11775, 11827 & 829		With NO_x Abatement Device	
Date	17/11/11 & 2/12/11	NO_x	NO₂
Units:		g/km	g/km
Analysers:		Bag	FTIR
Phase 1	Outer London	1.12	0.21
Phase 2	Inner London	2.38	0.42
Combined result		1.47	0.27
Change vs Baseline		-88.4%	-54.6%



Oxford St Bus NO_x Reduction

Oxford St Route	TVR	30/01/2013	30/06/2014	ULEZ 2020
6	26	E3	E3 - SCRT	E6 hybrid
7	22	E4	E6 hybrid	E6 hybrid
8	30	E3	E5 NRM	E5 NRM
10	23	E4	E5 NRM	E5 NRM
13	21	E5 Hybrid	E5 Hybrid	E6 hybrid
23	31	65% E5 Hybrid	65% E5 Hybrid	E6 hybrid
25	59	E5	E5	E6 hybrid
55	31	E3	E3 - SCRT	E6 hybrid
73	51	E5 Hybrid	E5 Hybrid	E6 hybrid
94	31	40% E3 / 60% E5 Hybrid	40% E3 SCRT / 60% E5 Hybrid	E6 hybrid
98	26	E3	E3 - SCRT	E6 hybrid
137	30	E3	E3	E6 hybrid
139	21	90% hybrid E5	90% hybrid	E6 hybrid
159	38	E3	E3 - SCRT	E6 hybrid
189	17	95 % hybrid E5	95 % hybrid	E6 hybrid
390	21	E5 NRM	E5 NRM	E5 NRM
% NOx Reduction from 2013			48	95



CO₂ Reduction – Roll-out



- Hybrids chosen as they offered the most cost effective means of CO₂ reduction
- Trials consisted of 56 buses across 8 major operators with the monitoring and evaluation period from 2006 to 2010



- Four manufacturers – ADL, Volvo, Wrights and Optare – single and double deck
- 30% CO₂ saving to be demonstrated over MLTB test cycle – Low Carbon Bus Certificate and 40% for New Routemaster

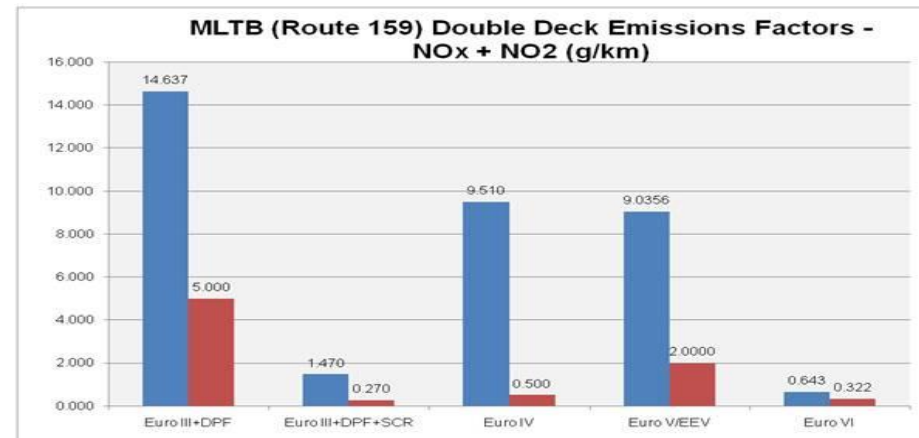
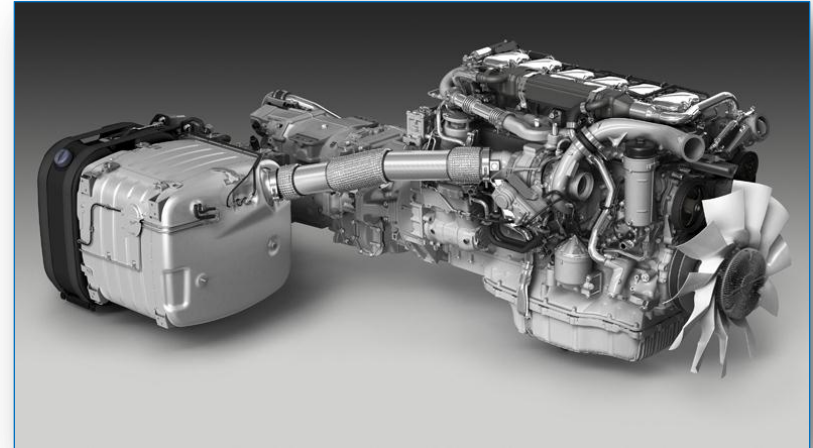


- Currently 1,280 rising to over 1,700 by 2016 and 3,300 by 2020 (ULEZ)



Euro VI Roll Out

- Euro VI engines are equipped with EGR, SCR and DPFs and new legislation sets 'real world' emission limits
- Testing by TfL on 3 bus types demonstrates NO_x emissions 95% lower than Euro V
- TfL is accelerating the roll-out of a Euro VI so that all buses meet a minimum of Euro IV standard for PM and NO_x by Dec 2015



Future Technology Trials

Electric bus trials



- Two BYD buses on route 507 from December 2013
- Four Optare Metro City's in service on route H98
- Two further Optare vehicles on the 312 and total route conversion in September 2015
- Two Irizar 12m electric buses on route 507 and 521 July 2015
- Tender issued with electric options for routes 507, 521, C10 & W5
- Pure electric double deck trial late 2015 – challenge weight & range



TfL's wireless charging bus demonstration project

- TfL is to demonstrate “plug-in” series hybrid (or range-extended electric) buses
- Induction charging or ‘Inductive Power Transfer’ used to provide opportunity charging
- Infrastructure is to be installed in TfL bus stations at either end of route 69 at Canning town and Walthamstow
- Objective is to operate on grid electricity as much as possible (80% target); battery will provide a significant amount of the energy required
- Flexibility of hybrid power-train retained

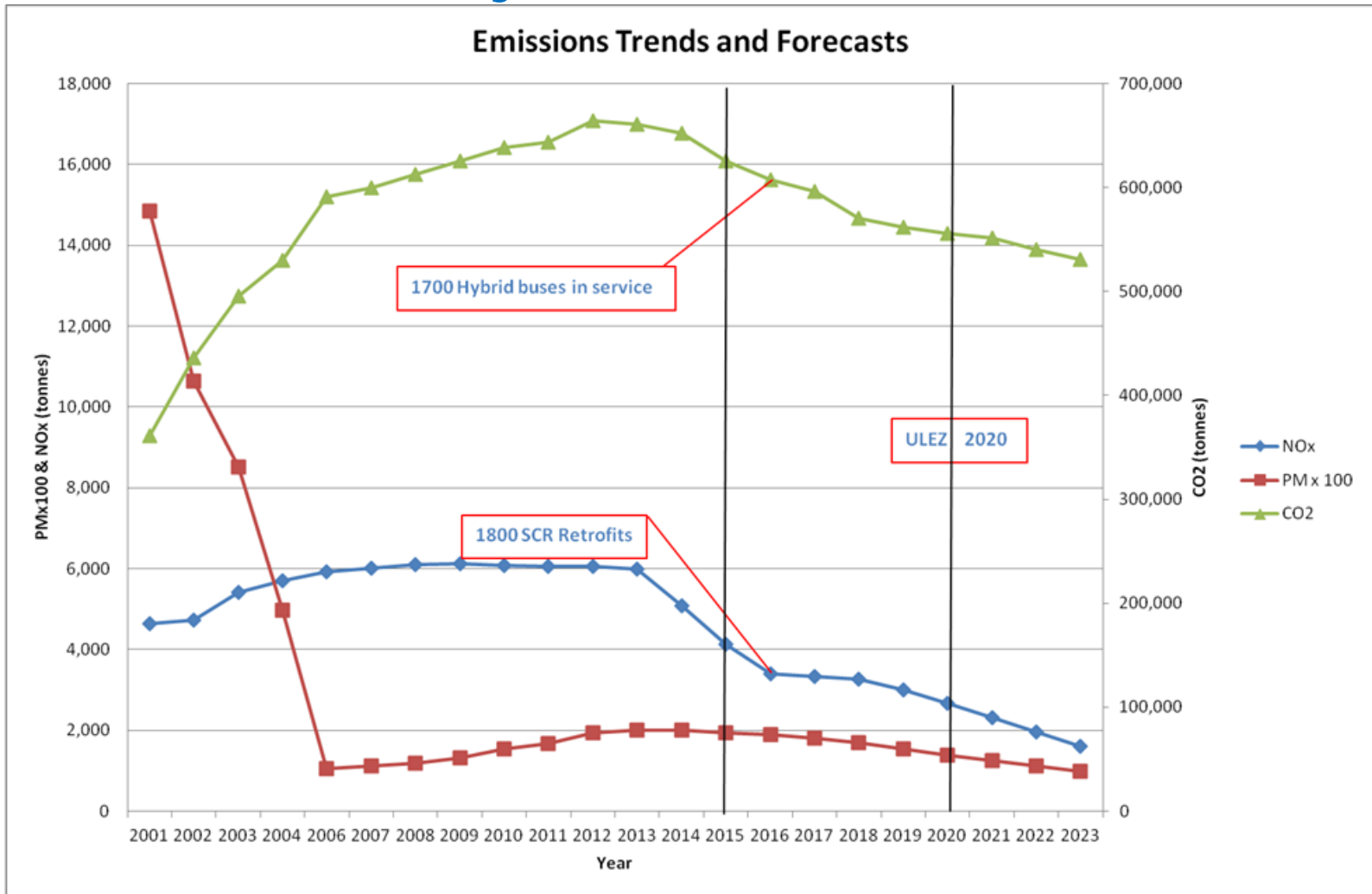


Hydrogen Fuel-Cell Vehicles

- Zero 'tailpipe' emission buses
- A fleet of eight hydrogen buses in operation
- Aim to achieve operation as close as possible to diesel buses
- New maintenance and refuelling facility constructed within a standard bus depot
- Longer-term strategy



Emission Projections



Summary and Conclusions

- **Significant emissions reduction from the bus fleet has been already been demonstrated with much more planned**
- **The retrofit of 'bespoke' exhaust aftertreatment technology to existing buses has led to substantial PM and NO_x reduction**
- **The majority of new buses now entering the fleet are hybrid so even with growth in the network, CO₂ is being reduced**
- **Electric and hydrogen buses offer potential to move to zero emissions policy in future**

