

# London Buses Emissions Reduction

Santiago  
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Transport for London



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# Agenda

- The London bus network and its environmental impact
- Environmental Challenges
- Understanding the Impact
- Hybrid and 'Zero Tailpipe Emission' buses



Buses operate 24 hours per day, 7 days a week

Network contracted by TfL from Private Operators

## The London Bus Network



6.5 million journeys per week day

19,500 bus stops

700 routes

8,500 buses

# The London bus system: organisation



MAYOR OF LONDON

**The Mayor**  
Strategy  
Chair of TfL Board  
Fares

## Transport for London

Service planning & contracting.  
Monitoring of output and quality.  
Consultation & engagement.  
Vehicle Specifications.  
Stops, stands, stations.  
Information.  
Research & advice.



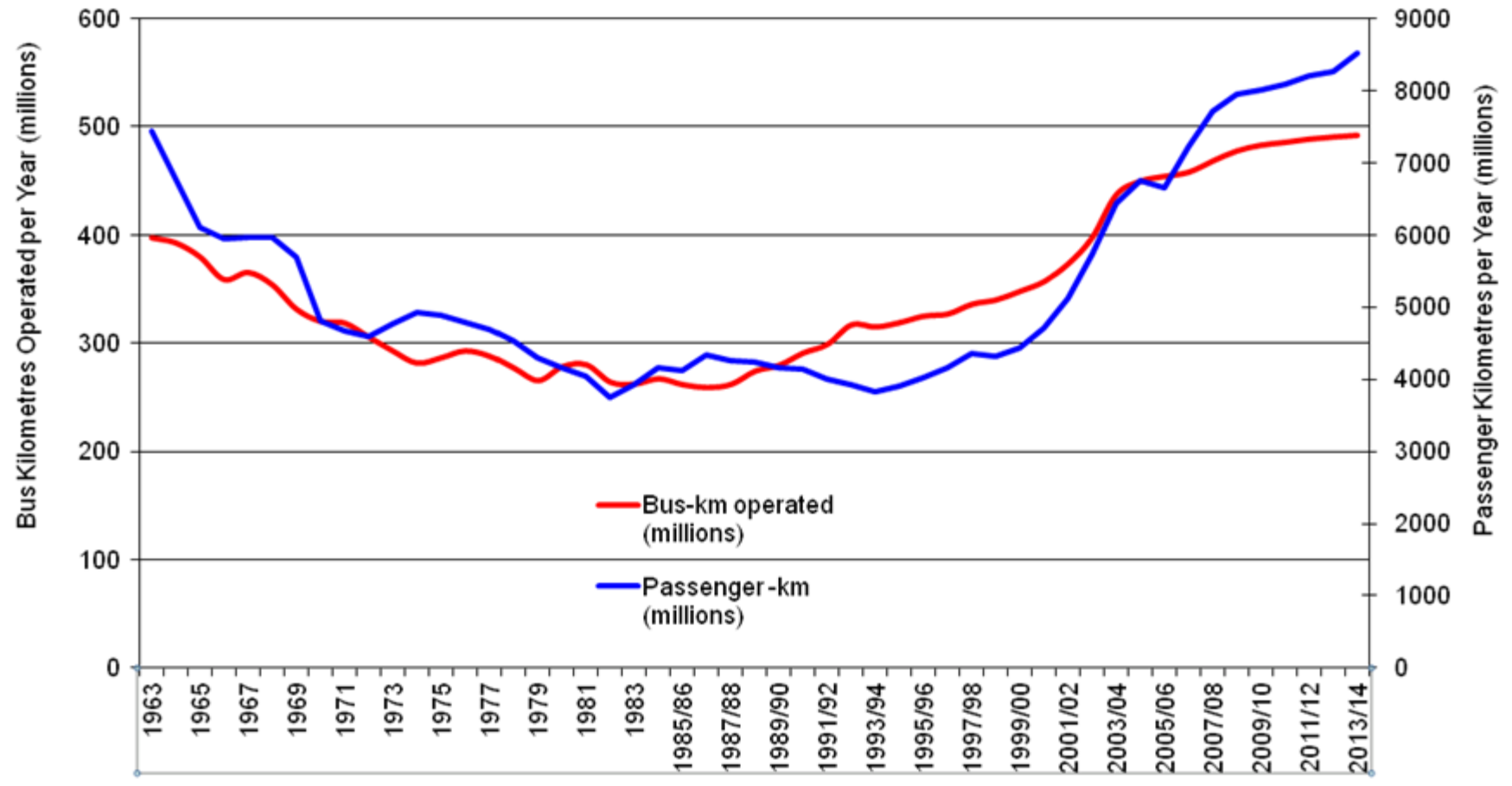
## Private sector contractors

Tender for services.  
Run services to TfL standards.  
Employ drivers, controllers, engineers and other operating staff.  
Own assets, including buses and garages.

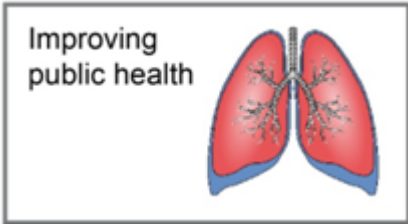


# Bus usage in London 1963-2014

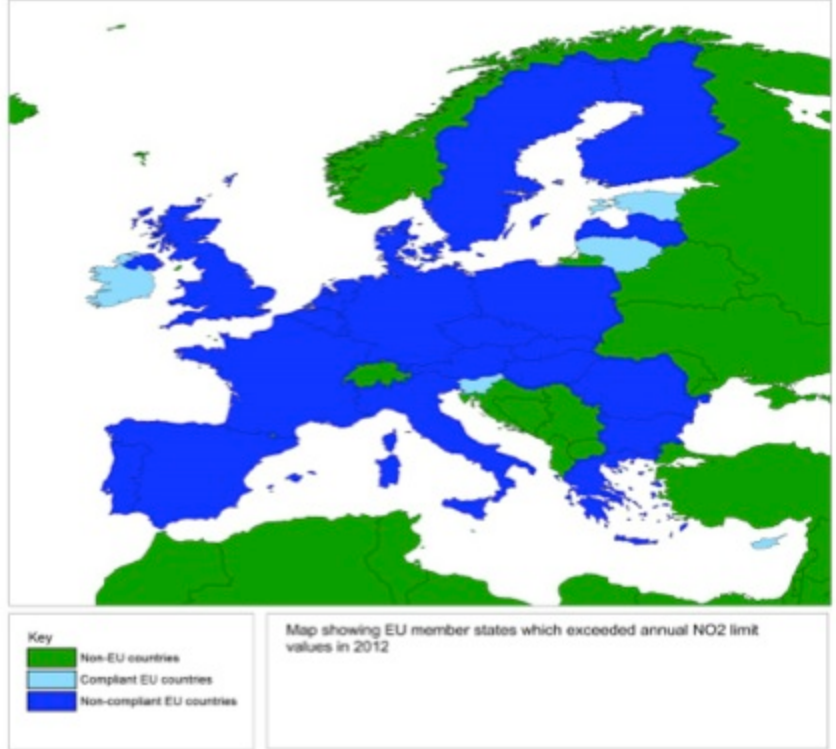
London bus network: service volume and usage  
1963-2014



# Environmental Challenges

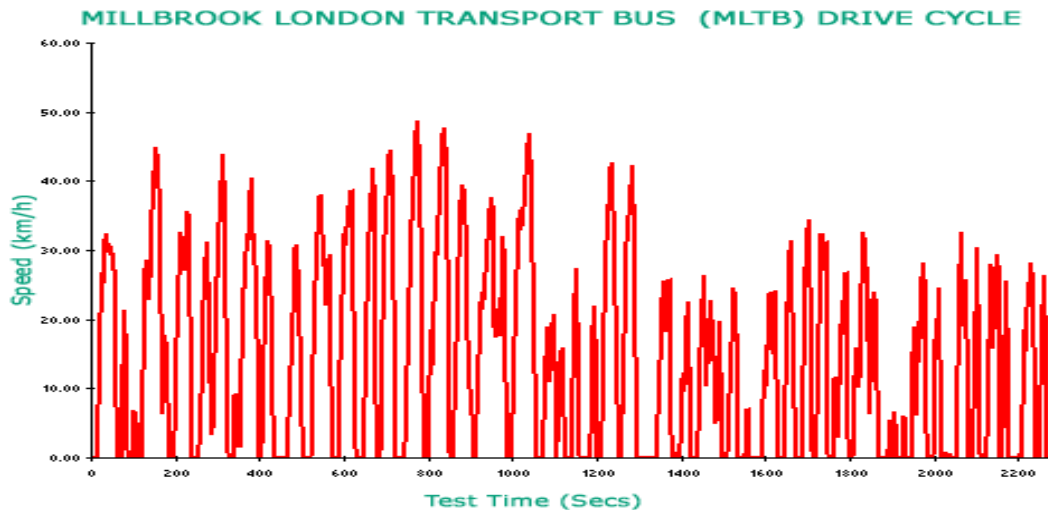


- EU Limit Values of 40 µg/m<sup>3</sup> for NO<sub>2</sub> and PM
- PM just below limit (though no safe level)
- NO<sub>2</sub> is 3 times higher than limit value in some areas
- Mayor has targeted 60% reduction in CO<sub>2</sub> by 2025 from 1990 levels



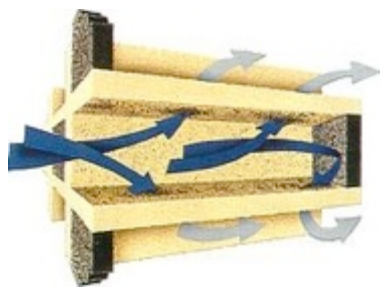
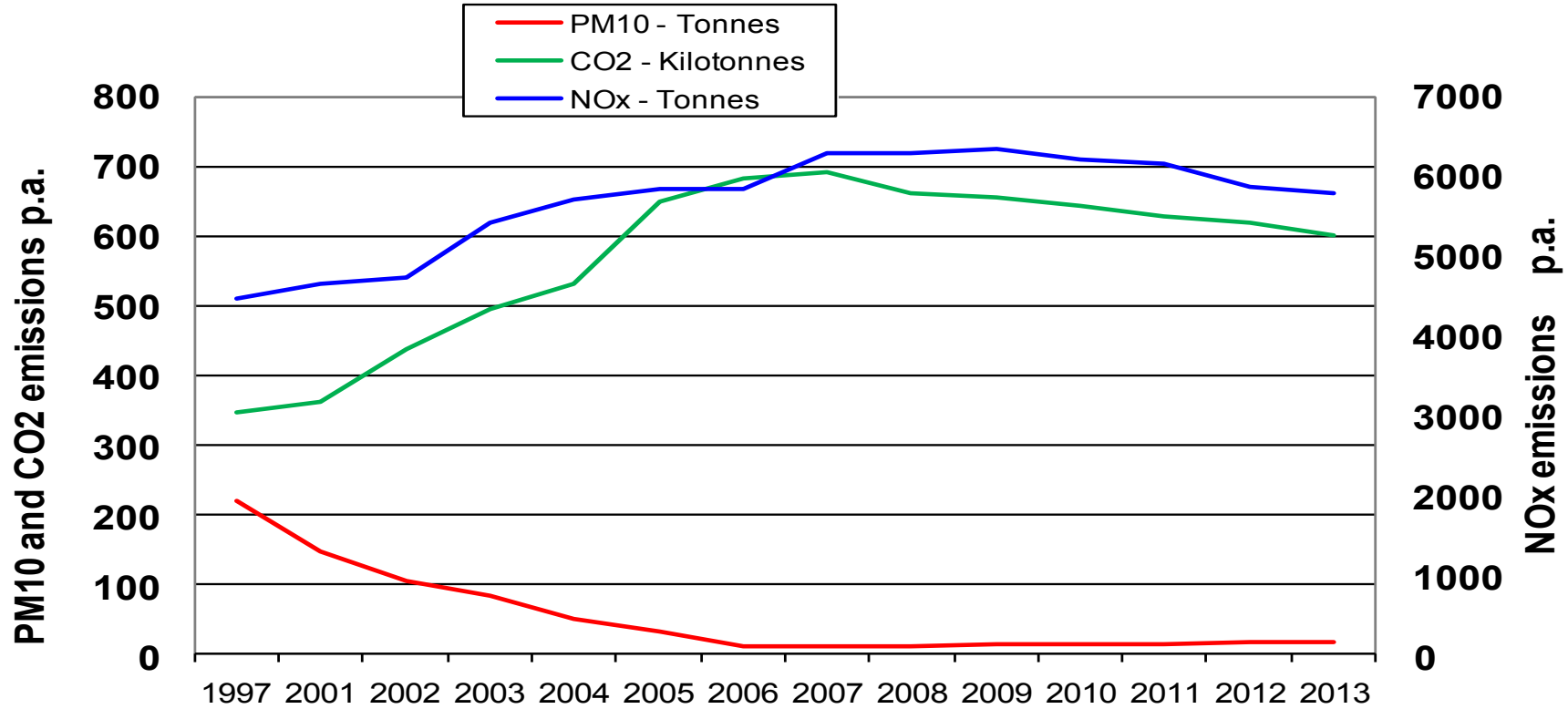
# Calculating the Environmental Impact of the Bus Fleet

- 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 CO<sub>2</sub>, PM and NOx emissions meet TfL's requirements
- Enables TfL to model the impact of the Bus Fleet on London emissions and predict the impact of interventions such as hybrid buses





# Fleet Emission Trends 1997-2013



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



# Hybrid trial and evaluation



- Hybrids chosen as they offered the most cost effective means of CO2 reduction
- The hybrid programme has spurred bus manufacturers to develop hybrid buses
- Trials consisted of 56 buses across 8 major operators
- £5.4 m London Government Climate Change fund for the additional on-cost of the vehicles and 5 year warranty
- Monitoring and evaluation period 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



# Hybrid whole life cost – issues that affect contract price

- Capital cost of vehicles
- Life of batteries and replacement cost
- Drive motor and other hybrid component life costs
- Maintenance costs
- Finance leasing and residual values
- Fuel costs



# Hybrid Buses - Deployment

All operators bid with prices for 'diesel' or 'hybrid' buses

A competitive price for hybrid buses will have more change of winning the tender – hybrid buses will then be specified in the contract

800 hybrid buses now in service

1700 to be in service by 2016

£23m UK Government Green Bus fund part funded the on-cost of 334 Hybrid buses

GBF1 – 80% funding

GBF2 – 70% funding

GBF3 – 60% funding

GBF4 – 50% funding





## New Routemaster

New Routemaster with second generation hybrid technology demonstrates even more significant benefits

47% reduction in CO2

78% reduction in NOx

## Flywheel Technology

The Williams hybrid system utilises a high speed flywheel that stores energy (from braking for example) and releases the energy to aid vehicle propulsion

- significantly lower cost
- 20-30% CO2 reduction
- 25 single deck buses going into service this year with more planned
- No zero emission capability



# Electric, Plug-in Hybrid Bus & Induction Charging Trial

- 2 Pure Electric Buses from BYD in service on route 507 and 521
- 6 more electric buses from Optare going into service this year
- 4 Inductively charged hybrid buses going into service in 2015



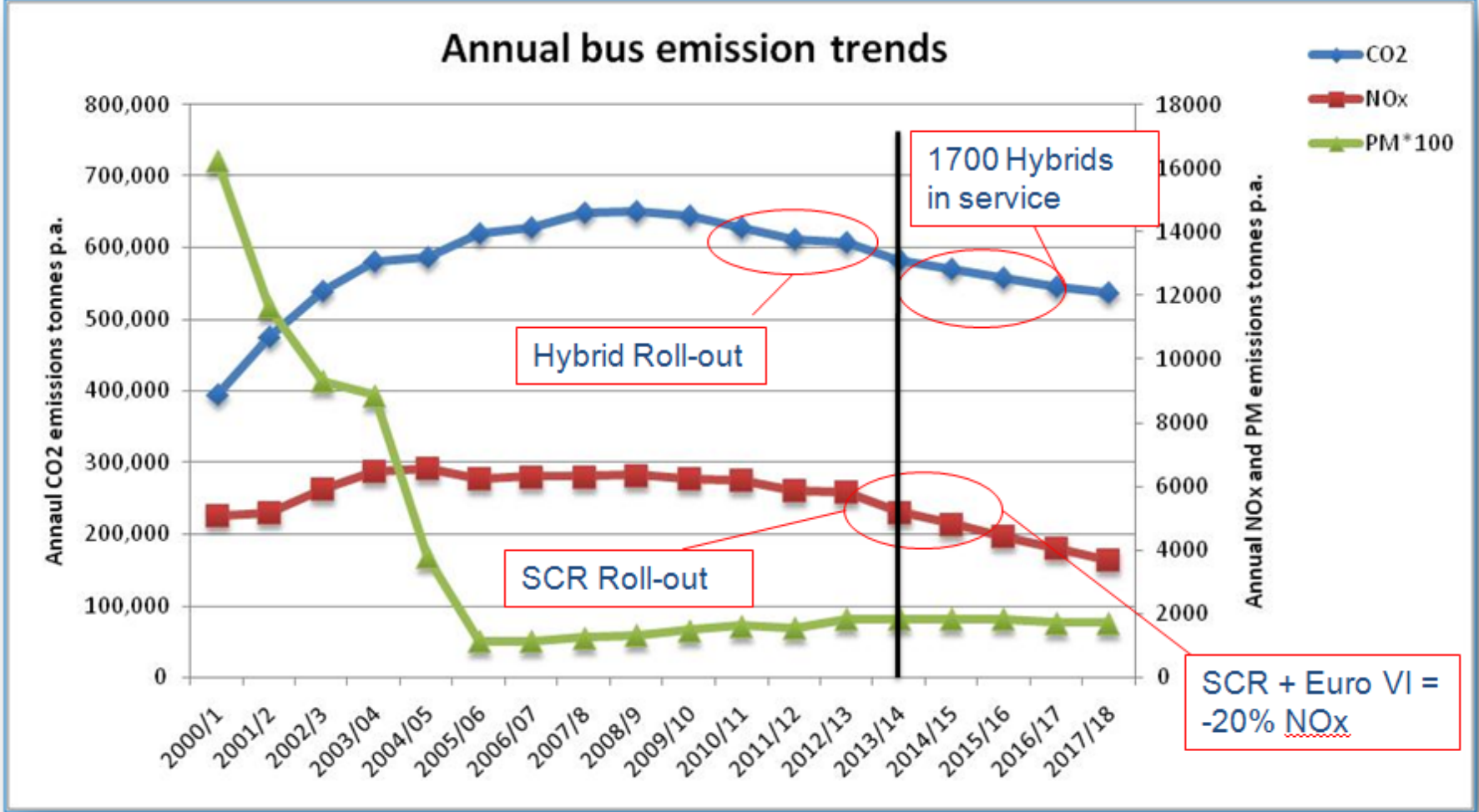


# Hydrogen Fuel Cell Buses

- Zero 'tailpipe' emission buses
- A fleet of 8 hydrogen buses are 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



# Emissions Projections





# Environmental Targets

1700 hybrid buses by 2016

All buses to meet Euro IV standard for PM and NOx by 2015 to be met by retrofit of SCR and accelerating the uptake of Euro VI

Ultra Low Emission Zone proposed for central London by 2020

All double deck buses operating in central London to be hybrid by 2020

All single deck to be 'zero tailpipe emission' (electric or hydrogen) by 2020



# Summary and recommendations

- Hybrids biggest contributor to CO2 reduction with increasing emphasis on further electrification
- Electric and hydrogen buses offer potential to move to zero emissions policy in future
- Essential to set a CO2 reduction target for hybrids – e.g 30% less CO2 over a real world drive cycle
- Many of the hybrid drive-lines, control and battery management systems in use and proven in London could be integrated into buses used in Chile



**Questions?**