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Institute for Transport Studies

FACULTY OF ENVIRONMENT



UNIVERSITY OF LEEDS

Investigation of Air Pollution Standing Conference
Tuesday 1st December, Birmingham

Environmental Impact of Taxis

Is there a Business Case for Hybrids?

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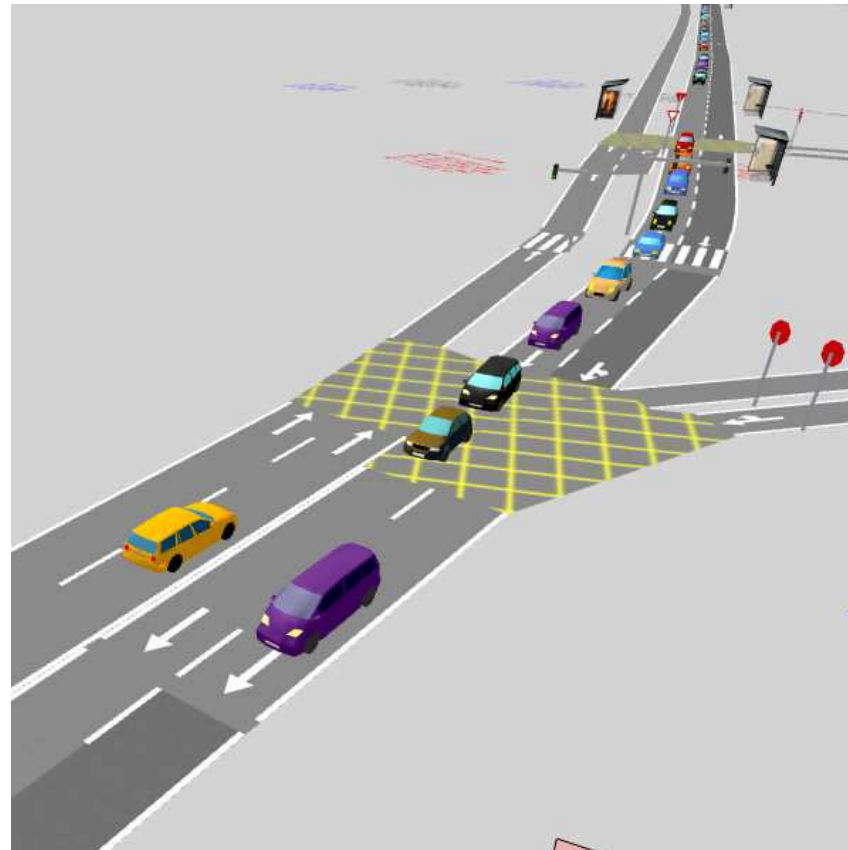
ITS

CONTENTS

TAXI operations



NETWORK impacts



Background

THE LEEDS TAXI FLEET (Feb 2015)

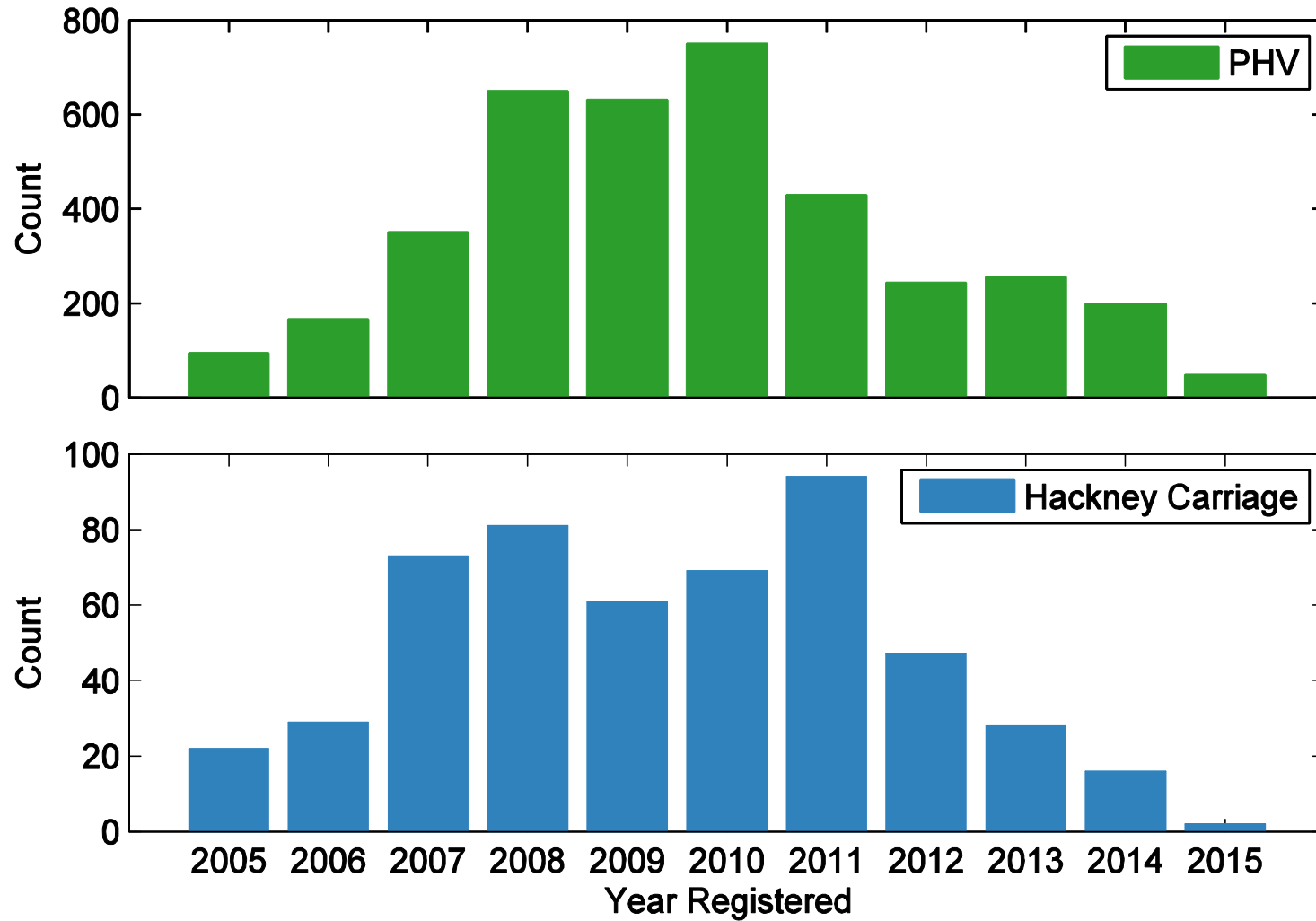
Vehicles registered in Leeds 337,779

UK passenger car average
mileage ~ 8,000 miles p.a.

- ▶ Hackney carriages 536
 - ▶ Average mileage ~ 30,000 miles p.a.
- ▶ Private Hire Vehicles (PHV) 3851
 - ▶ Average mileage ~ 60,000 miles p.a.
- ▶ License Restrictions
 - ▶ Proportion of Hackney carriage licenses wheel chair accessible
 - ▶ Vehicles up to five years old can be first registered as a taxi
 - ▶ Maximum age of a taxi 10 years
 - ▶ Mostly bought second-hand (lower purchase cost)

Background

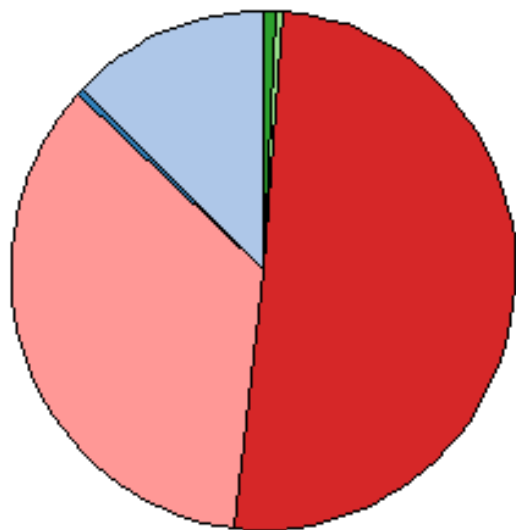
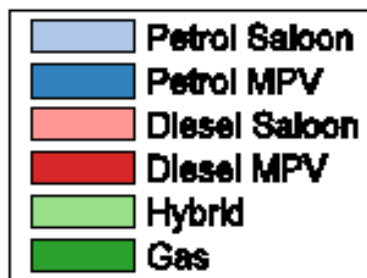
AGE OF THE LEEDS TAXI FLEET (Feb 2015)



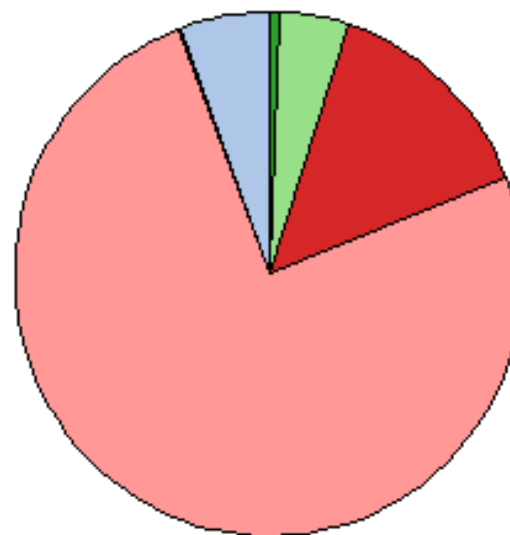
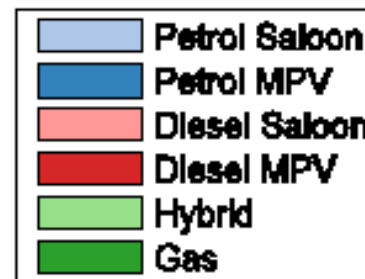
Background

THE LEEDS TAXI FLEET (Feb 2015)

HACKNEY CARRIAGE



PHV



TAXI operations

AN INSTRUMENTED TOYOTA PRIUS



CAR

- ▶ Toyota Prius 1.8 VVT-IT
- ▶ Petrol 1798 cc
- ▶ Kerb weight 1370 kg
- ▶ CO₂ emission rating 92 g/km

Portable Activity Monitoring Systems (PAMS)

- ▶ GPS (Vbox Lite II)
 - ▶ Road gradient from Digital Surface Model
- ▶ IMU (X, Y, Z acceleration etc)
- ▶ OBD logger (HEM mini logger)
 - ▶ Vehicle operation
 - ▶ ICE, Electric Motor, Battery (SOC)

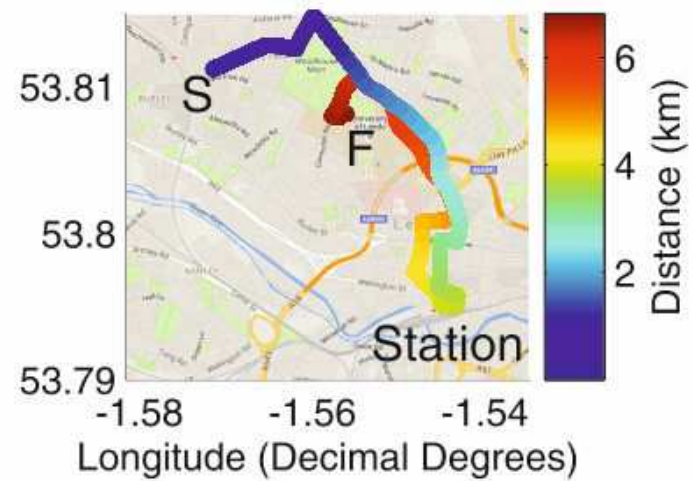
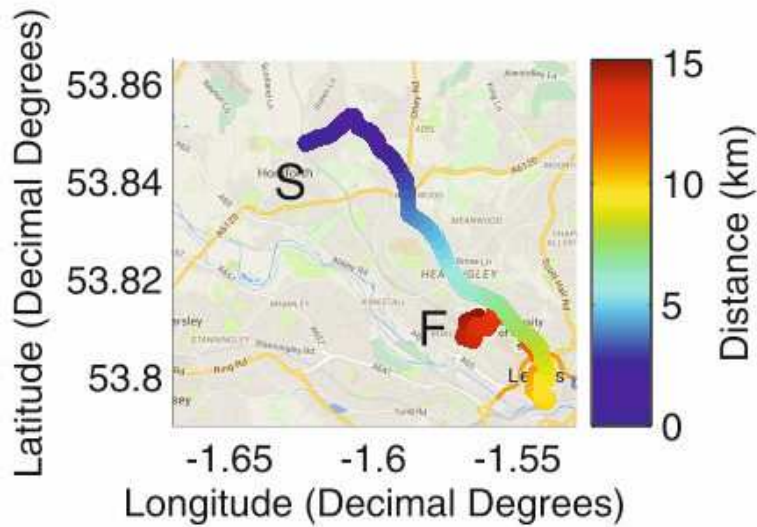
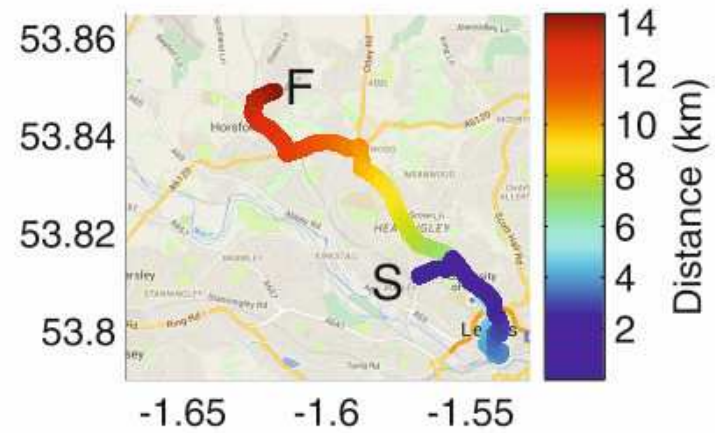
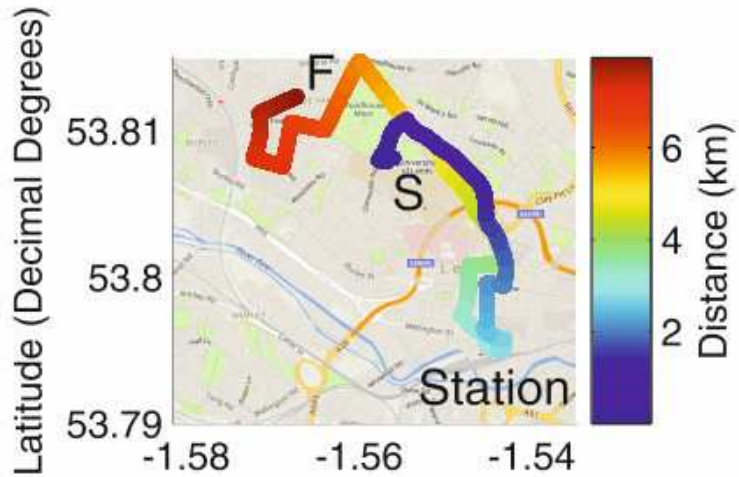
TAXI operations

SURVEYS

- ▶ Routes selected after interviewing taxi drivers
 - ▶ Trip distance frequencies
- ▶ Start or End point railway station
- ▶ Mix of Peak and Off-peak periods (28th April & 21st May 2015)
- ▶ Different Driving styles

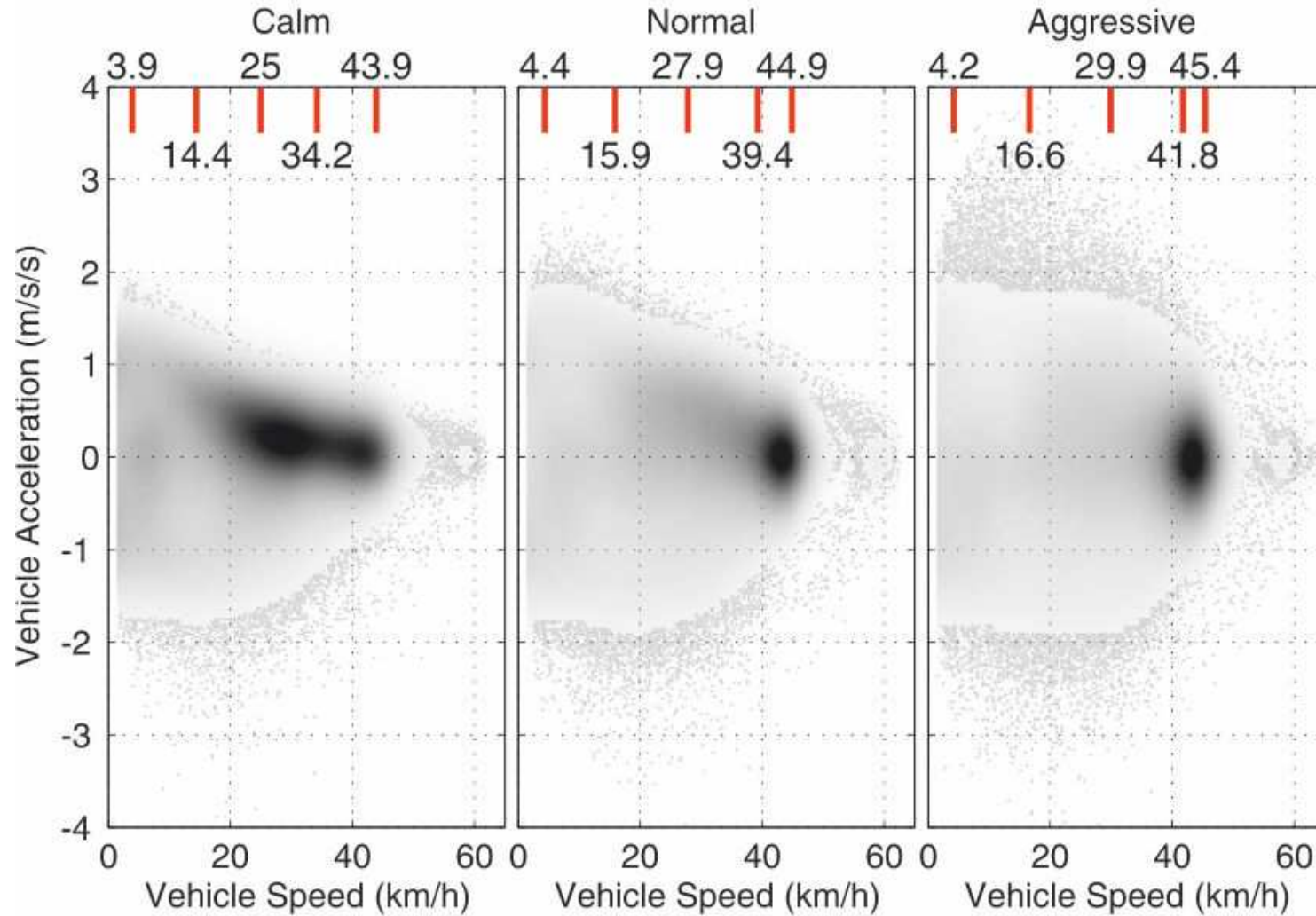
| Parameter | Calm | Normal | Aggressive |
|---------------------|------|--------|------------|
| Number of Runs | 24 | 24 | 24 |
| Total Time (hours) | 17.3 | 16.3 | 15.9 |
| Total Distance (km) | 260 | 260 | 260 |

TAXI operations SURVEYS



TAXI operations

DRIVING STYLE



TAXI operations

DIESEL COMPARISON

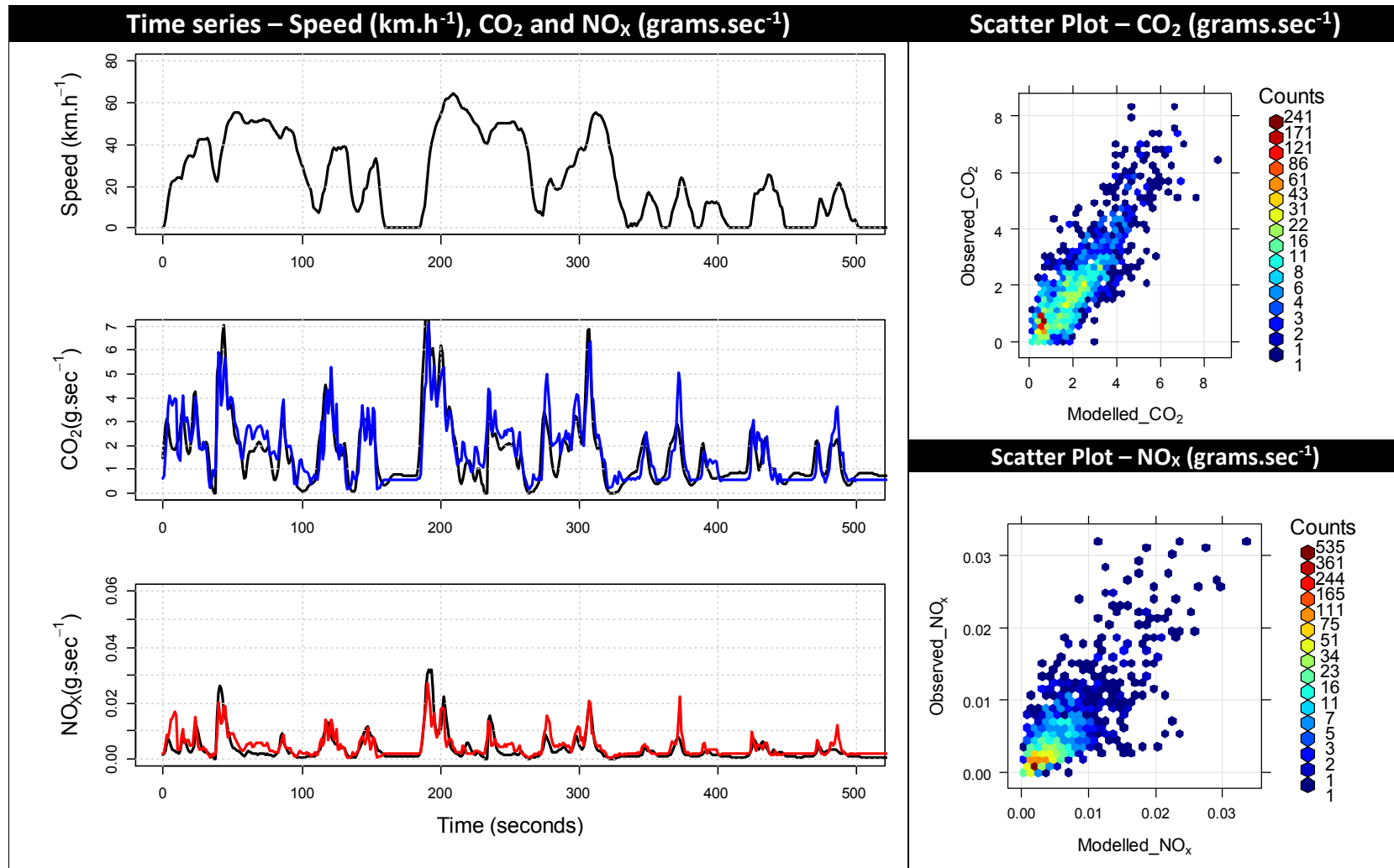
- ▶ Simulated using Instantaneous Emission Model (IEM) PHEM*

INPUT

- ▶ Observed (hybrid-petrol) speed profile
- ▶ Road gradient from GPS + Digital Surface Model (cleaned)
- ▶ Comparator vehicle:
 - ▶ Toyota Avensis saloon 2.0D-4D

PHEM validation

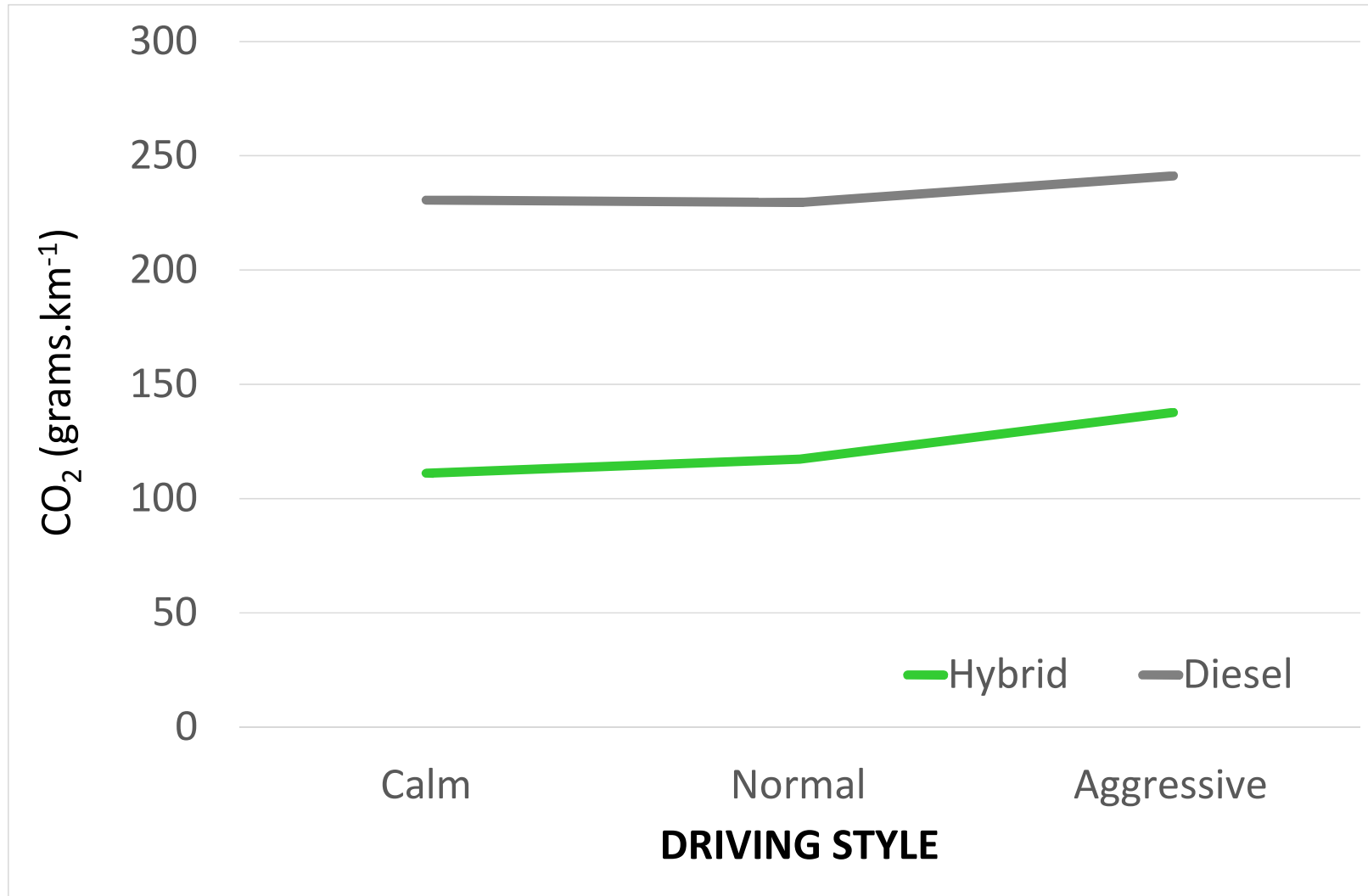
e.g. MPV EU5 diesel – TfL* London Drive Cycle



* Transport for London. 2015. In-service emissions performance of Euro 6/VI vehicles. <https://www.london.gov.uk/sites/default/files/In-service%20emissions%20performance%20of%20Euro%206VI%20vehicles%20WEBSITE%20COPY.pdf>

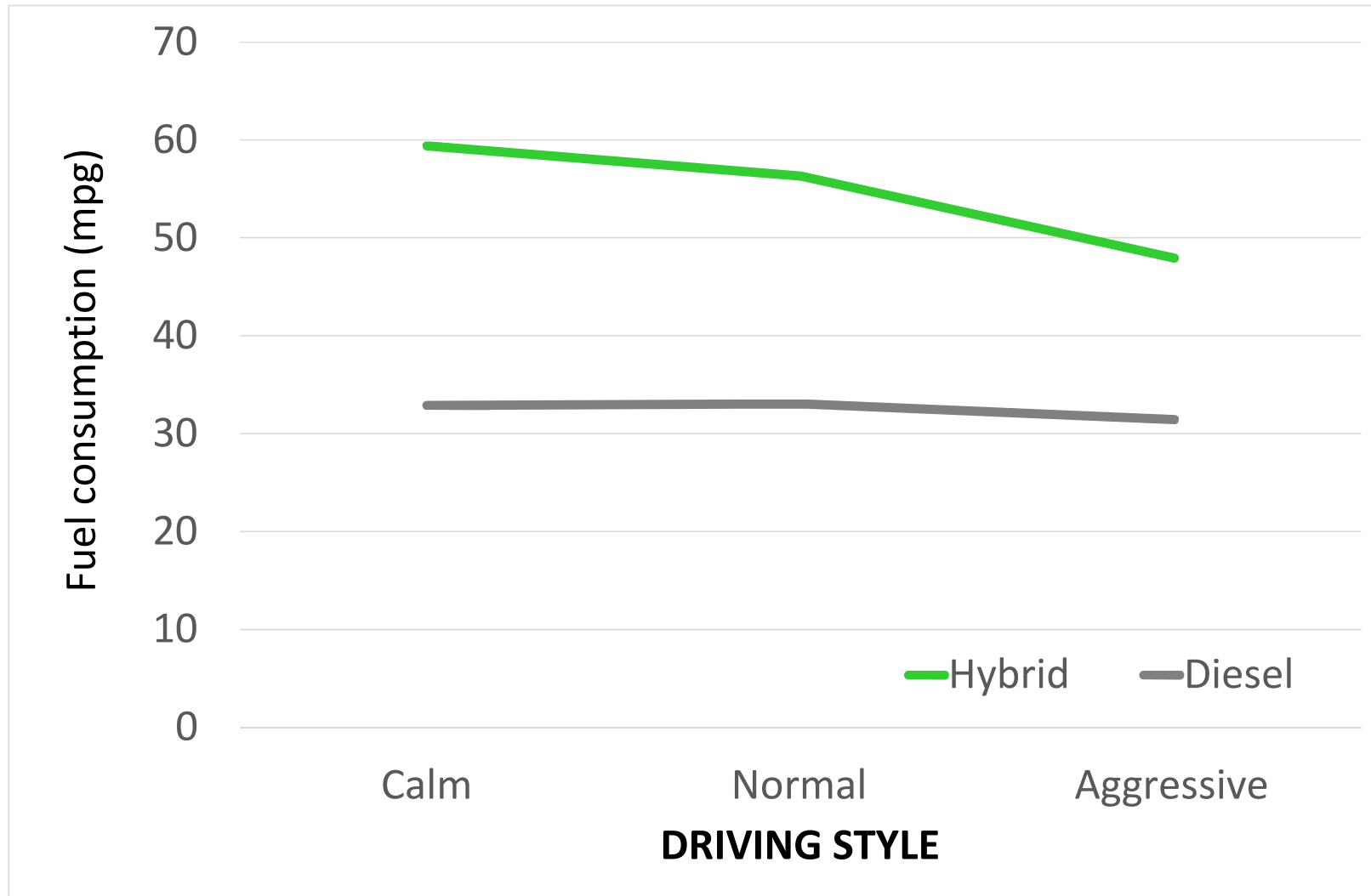
TAXI operations

CO₂



TAXI operations

FUEL CONSUMPTION



TAXI operations

BUSINESS CASE

PURCHASE COST

- ▶ Conventional passenger car £5,000 (5 years old Diesel car)
- ▶ Toyota Prius £10,700 (5 years old)

INSURANCE ▶ No difference

MAINTENANCE ▶ No difference?

- ▶ Prius acknowledged as being more reliable (less down time)
- ▶ Less brake-wear

FUEL

- ▶ Assumed mileage 48,280 km p.a.
- ▶ Fuel price (AA, May 2015) 109.0 p/L petrol | 110.6 p/L diesel

TAXI operations

BUSINESS CASE ► SWITCH HYBRID

| Driving style | Annual Fuel Saving (£) | Payback Time (Years, Months) |
|----------------------|-------------------------------|-------------------------------------|
| Calm | 2,086 | 2, 9 |
| Normal | 1,926 | 2, 11 |
| Aggressive | 1,698 | 3, 4 |

ASSUMPTIONS:

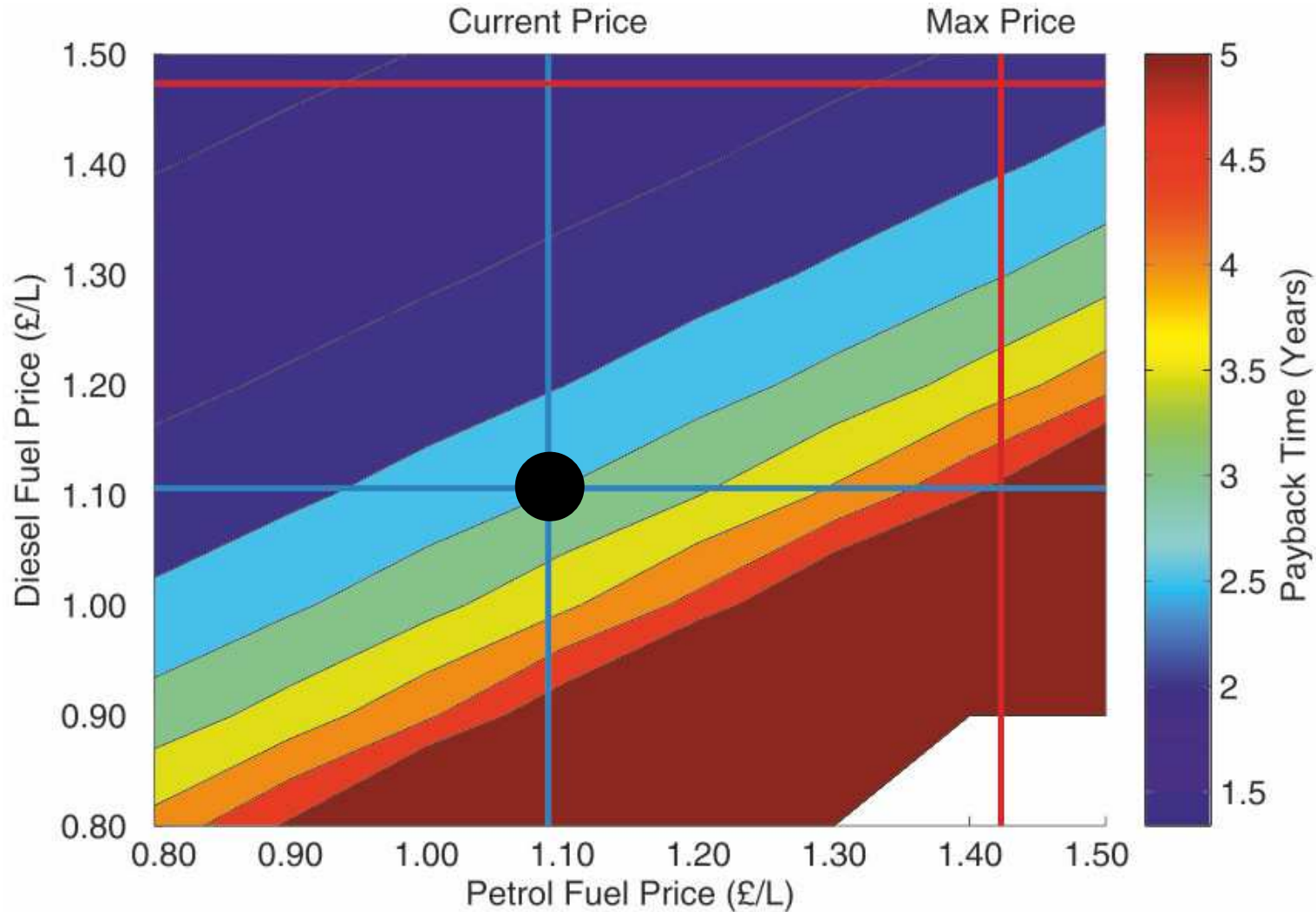
Diesel (ICE) saloon car

Annual mileage 48,280 km p.a.

Fuel price 109.0 p/L petrol | 110.6 p/L diesel

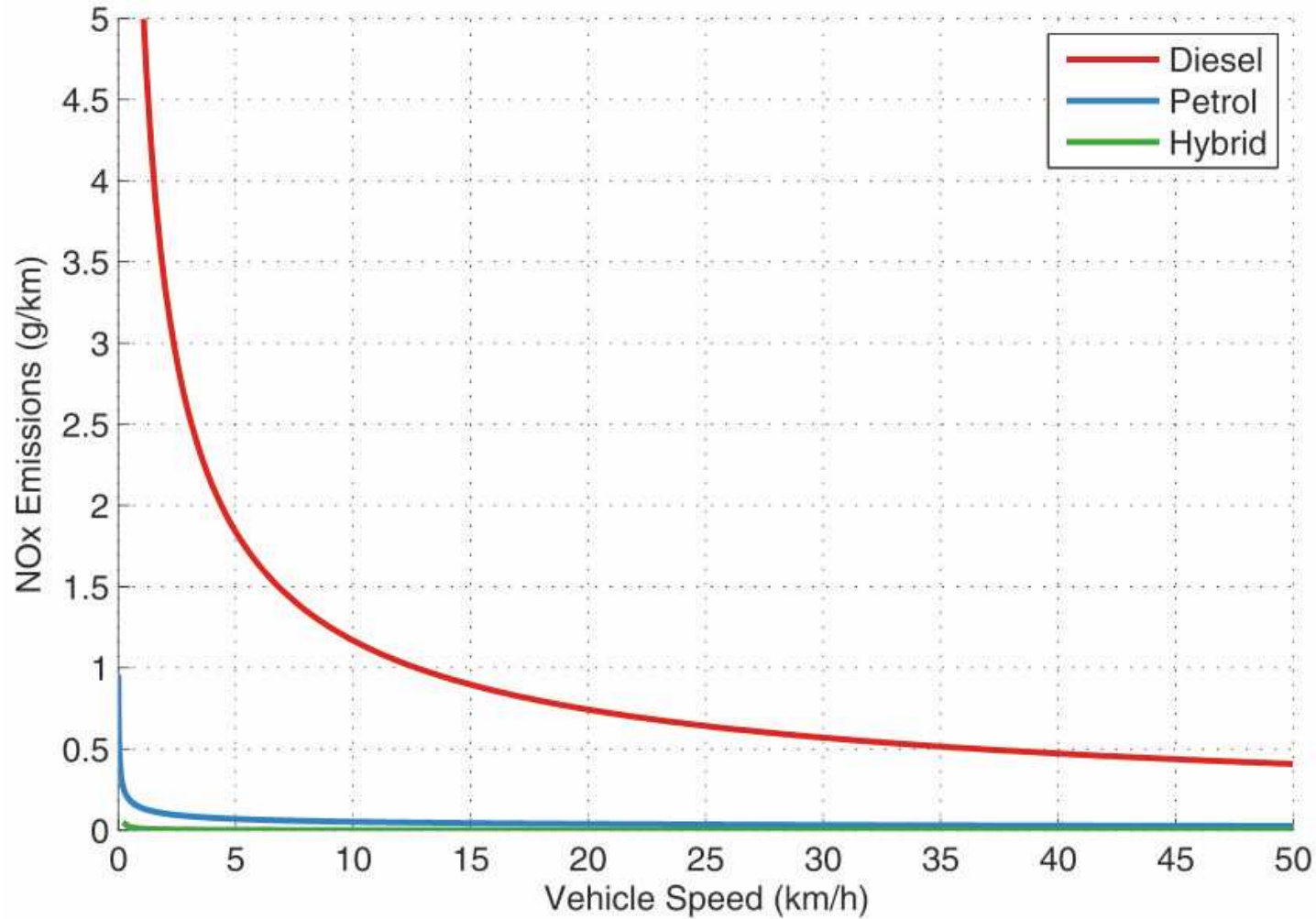
TAXI operations

PAYBACK TIME ► Investing in a Hybrid



TAXI operations

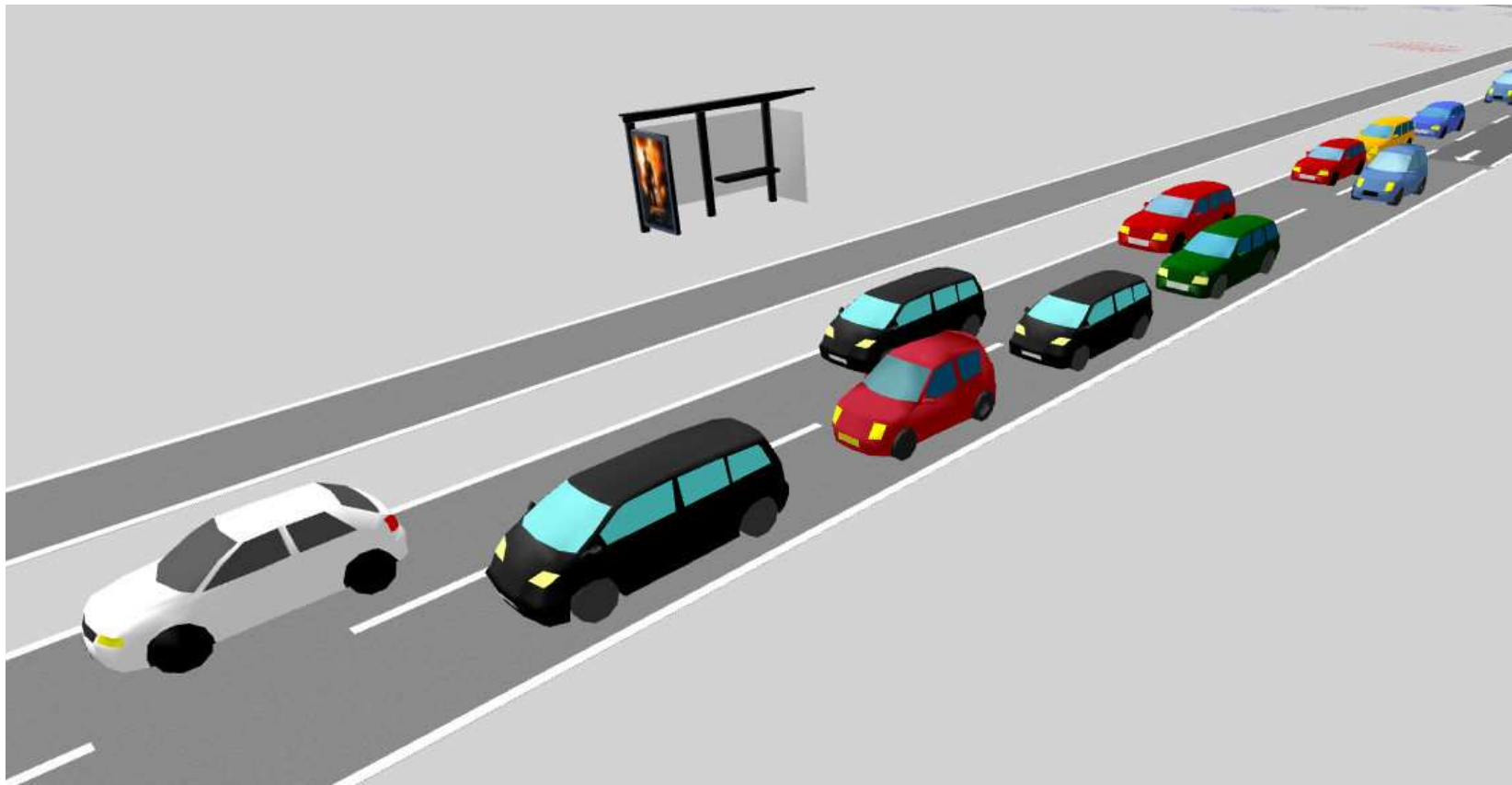
NO_x emissions ▶ Euro 5 passenger cars



Network Impacts

METHOD

- ▶ **Traffic Simulation** (www.aimsun.com)
- ▶ **Vehicle emission simulation** (**PHEM**)

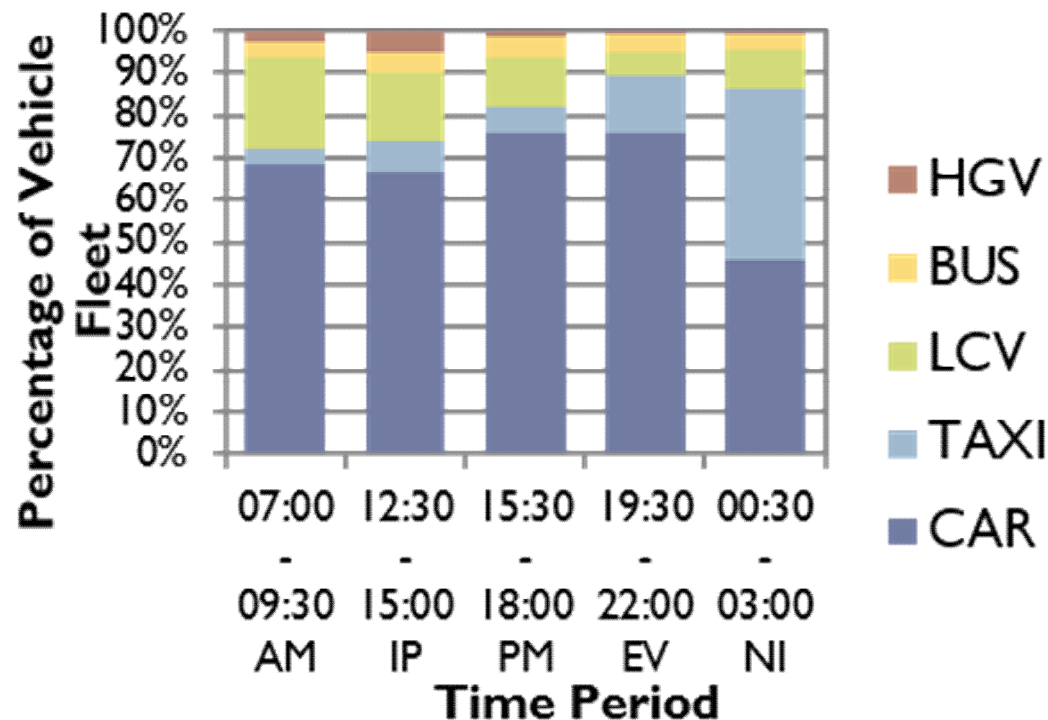


Network Impacts

METHOD

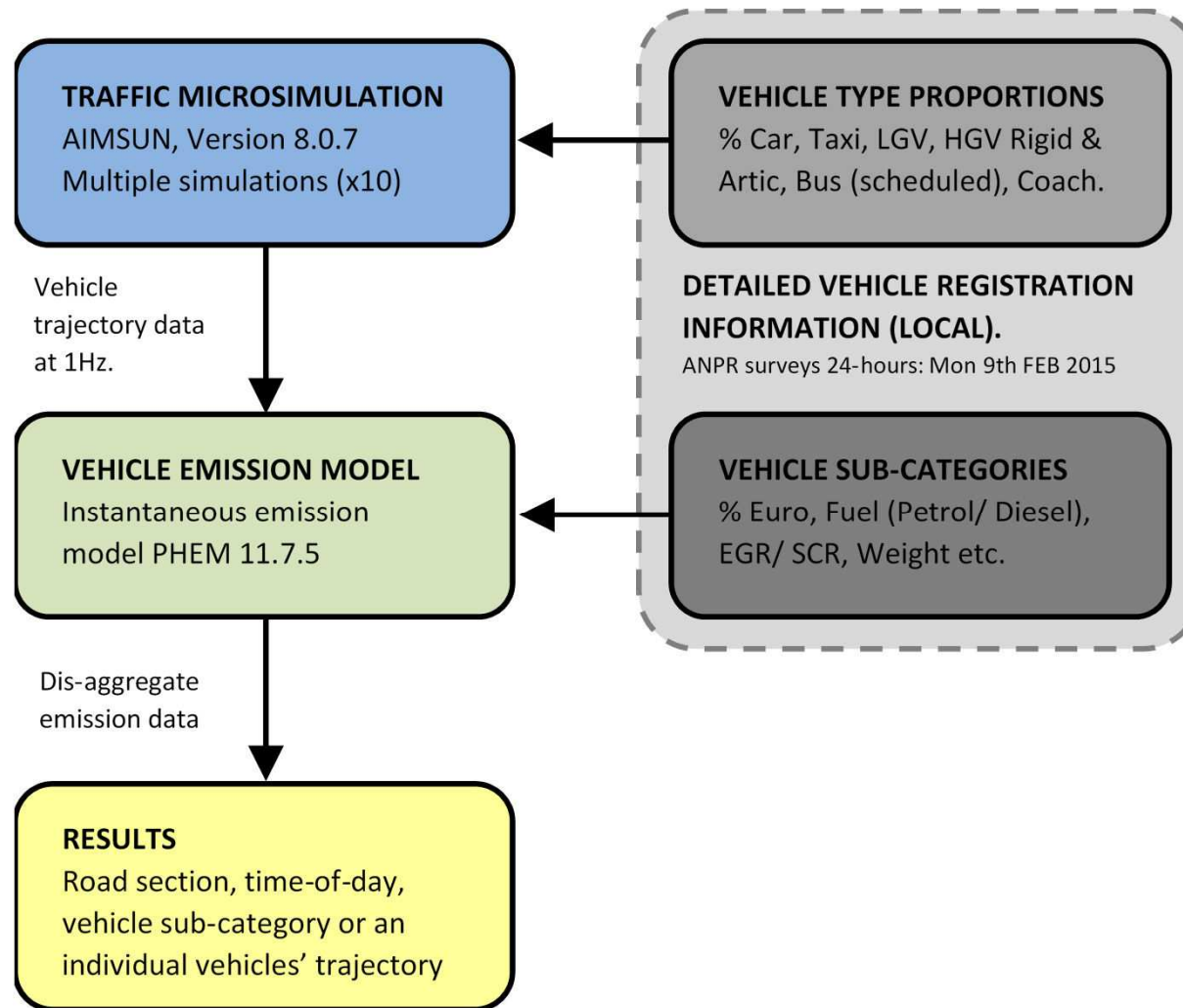
▶ Simulate the operational fleet (composition)

- ▶ 24-hour ANPR survey (9th February 2015)
- ▶ Cross reference number plates (VRMs) with UK detailed Vehicle registration database (www.carweb.co.uk)

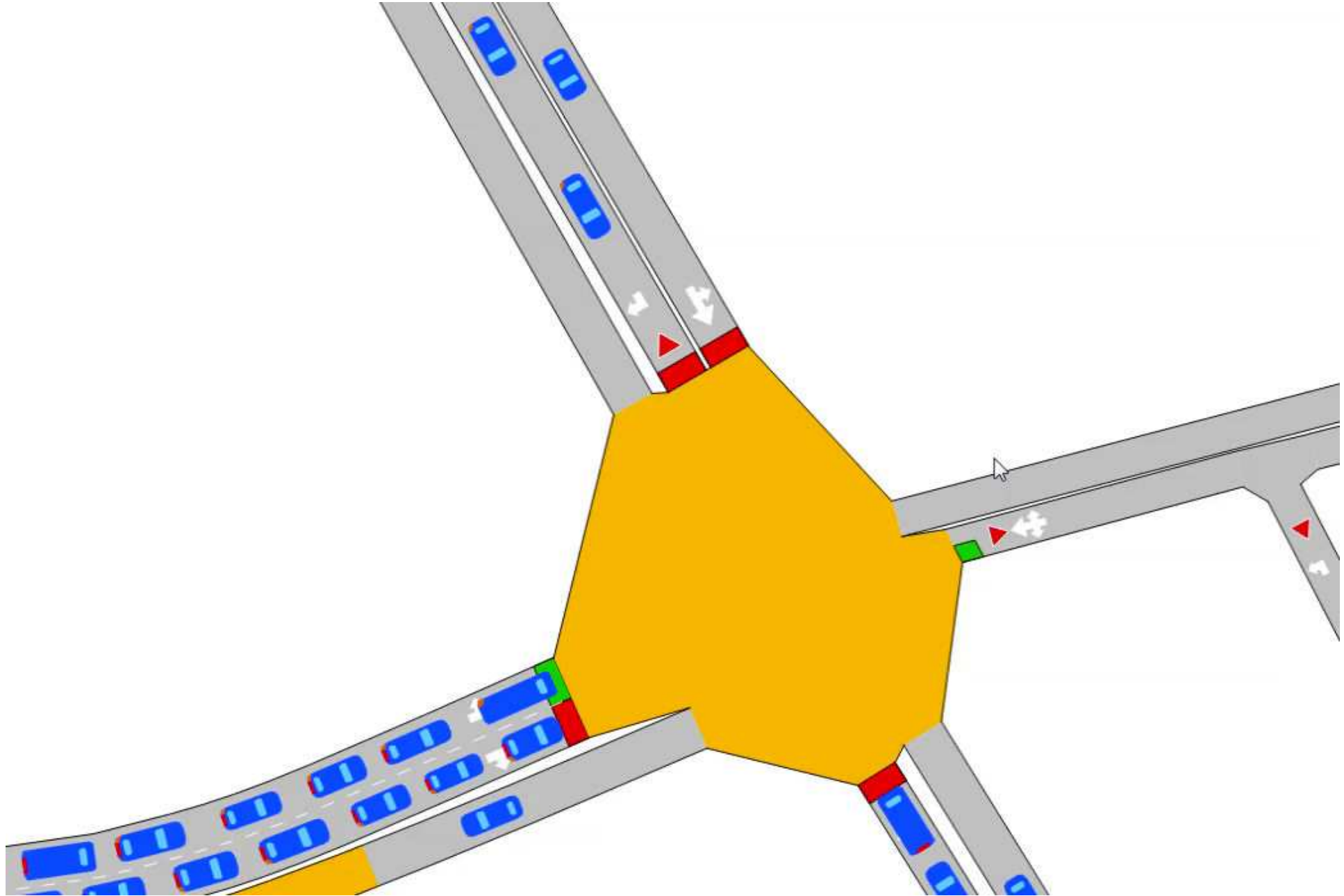


Network Impacts

MODELLING FRAMEWORK

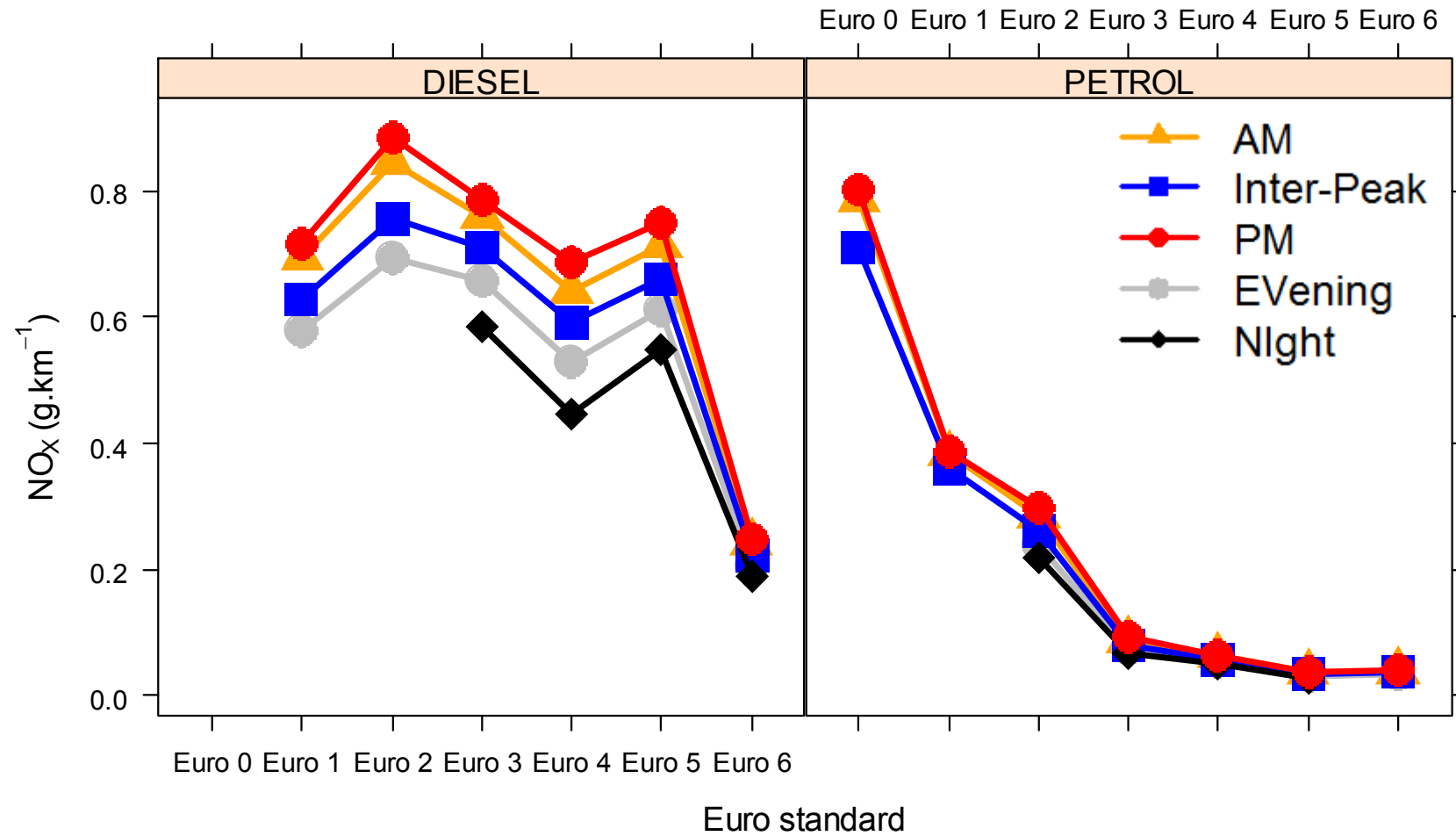


TRAFFIC MICROSIMULATION: Headingley 2015 AM Peak www.aimsun.com



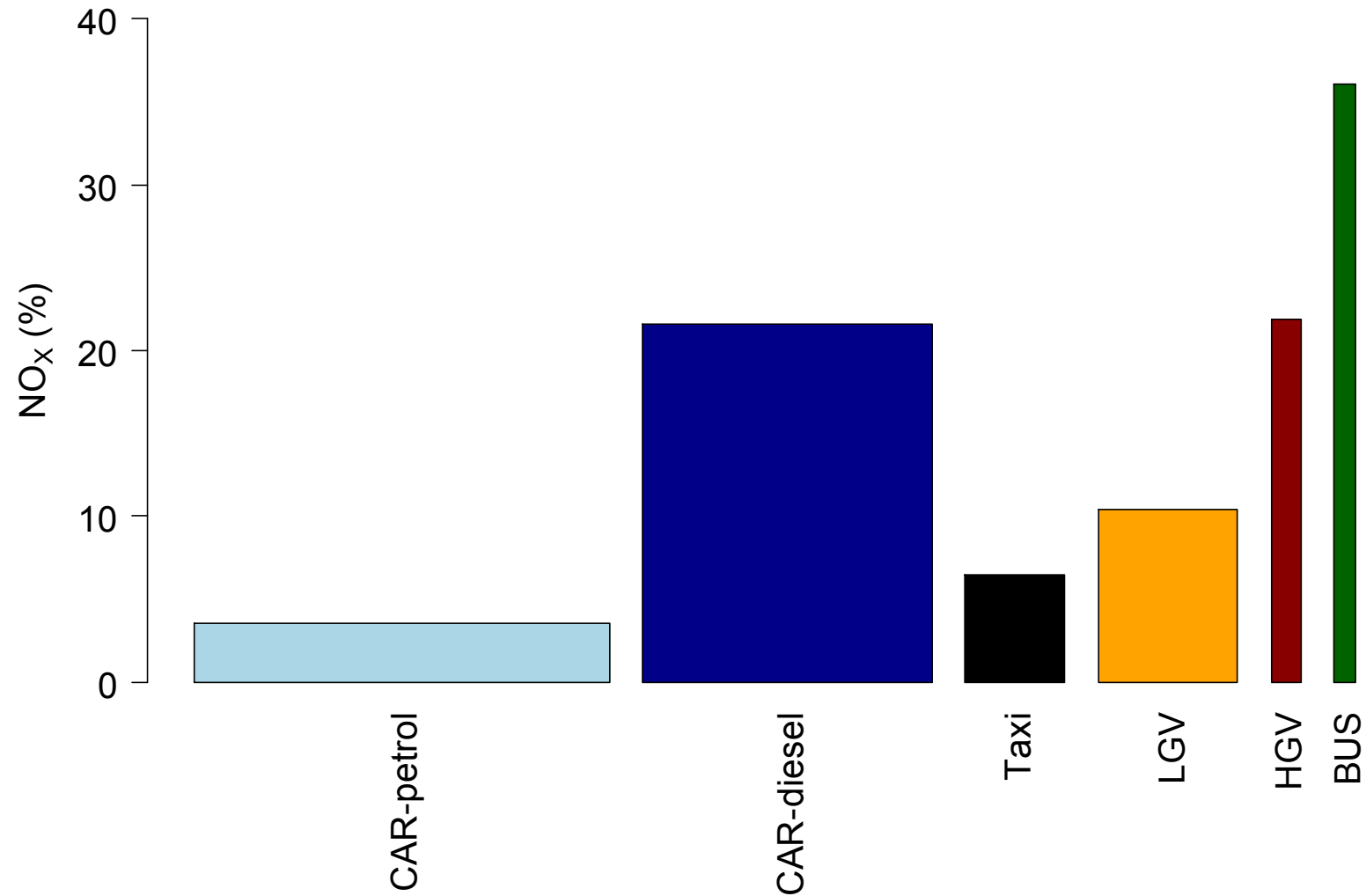
Network Impacts

MODELLED EMISSION FACTORS



Network Impacts

MODELLED EMISSION CONTRIBUTIONS (24-hours)



ENVIRONMENTAL IMPACT OF TAXIS

Summary & Conclusions

- ▶ Hybrid-PETROL technology is Low Emission (CO₂ and NO_x)
 - ▶ Mature, good value Clean Vehicle Tech (growing second-hand market)
- ▶ Hybrid-PETROL urban Taxis: A rare “win-win”
 - ▶ Greater profitability drivers/ operators
 - Communicate to the Taxi community
 - ▶ Cleaner air (↓ 7% NO_x emissions on Leeds A660 arterial)
- ▶ Incentives needed for Hybrid-PETROL (HEV) and Plugins (PHEV)
 - ▶ ULEV Taxi scheme
 - ▶ London ULEZ “Zero emission capable”
 - ▶ Declare PRIORITY Taxi ranks “Green vehicle only” by 2020? 2025?
- ▶ MPV and LGV Hybrid-PETROL vehicles needed (close to market)

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