Technical Paper

TP01: Trends in Motor Vehicles and their Emissions

Advisory Committee on Tunnel Air Quality

Author: NSW Environment Protection Authority

November 2018

Key Points

- Australian new vehicle emission standards are set out in the Australian Design Rules (ADRs) and have been progressively and significantly improved over the last 40 years.
- The National Fuel Quality Standards have progressively required cleaner fuels to complement the ADRs and enable use of improved emission control technology. Proposed reforms to the Standards are underway, focusing on petrol, because Australia's petrol is not as high quality as petrol in other Organisation for Economic Cooperation and Development (OECD) countries.
- Emissions from the in-service vehicle fleet (i.e. the vehicles driven in NSW) have significantly reduced as a consequence of the more stringent emission standards and cleaner fuel.
- Vehicle kilometres travelled (VKT) are increasing steadily, with passenger vehicle VKT increasing in line with population growth at around one per cent annually, while freight vehicle VKT is growing in line with economic growth at two to three per cent annually.
- In spite of the increase in VKT, the strong reduction in vehicle emission rates has resulted in significant reductions in total fleet emissions, and these reductions are projected to continue over the next 10–20 years.
- Heavy duty diesel vehicles and in particular rigid trucks, are disproportionately high contributors to exhaust particulate matter emissions.
- As the newer vehicles in the fleet have significantly reduced emissions due to the tighter ADRs, the older vehicles in the fleet built to less stringent standards make a significant and disproportionately high contribution to the total fleet emissions.
- Fleet composition in terms of both vehicle type and age classes are important factors determining the level of emissions from any specific road corridor.

Contents

1. National Vehicle Emission Standards

New on-road motor vehicle emission standards are set by the Australian Government via the ADRs. The first ADR governing vehicle emissions was set in 1972 with ADR26, which set a limit for the exhaust concentration of carbon monoxide (CO) at idle. This was followed by ADR27 in 1974 which introduced standards based on mass of emissions per kilometre (g/km) measured under a transient drive cycle designed to represent urban driving conditions. The first emission standard for diesel vehicles was set in 1976 under ADR30/00 with the adoption of United Nations Economic Commission for Europe Regulation 24/00 which set limits for exhaust opacity (smoke) under steady state loaded conditions.

The emission standards for light and heavy duty vehicles have been progressively tightened over time based variously on United States (US) and European Union (EU) standards. The current Australian light duty vehicle emission standards are approximately 20–30 times lower than the original drive cycle-based standards in force in 1976, while current heavy duty diesel standards are four times lower for NO_x and more than 10 times lower for PM than those first introduced in 1995. In addition to the reduction in emission limits, the required durability of emission controls has been significantly extended.

The history of Australian standards for petrol passenger cars, diesel passenger cars and heavy duty diesel engines is summarised in Table 1, Table 2 and Table 3. Charts displaying the ADRs are included in Appendix A.[1] Current emission standards in Australia are Euro 5 standards for new passenger cars and Euro V for new heavy duty vehicles.

The Australian Government's Ministerial Forum on Vehicle Emissions is currently considering adoption of the Euro 6 standards for light vehicles and Euro VI standards for heavy vehicles in 2020, lagging Europe by 5–7 years. Euro 6 standards extend the limit on particle number introduced for light duty diesel vehicles with Euro 5 to include those vehicles fitted with petrol direct injection engines. This is expected to require new petrol direct injection vehicles to be fitted with an exhaust particle filter. Euro VI limits for heavy diesel vehicles are expected to result in very large reductions in emissions of NO_x, and Euro VI introduces a particle number limit which will drive particle emissions lower.

Beginning in 2017, the EU's emissions type-approval procedure for light vehicles includes a new real-driving emissions (RDE) test conducted using on-board portable emissions measurement systems (PEMS), to ensure vehicles conform to the required standards under normal on-road driving conditions. The RDE requirements will be fully implemented by January 2021 and will ensure the benefits of reduced NO_x limits are not lost through test defeat devices.

Europe has not formally proposed stricter future standards. The US has recently brought in Tier 3 standards for light duty vehicles which by 2025 will be around 80 per cent more stringent for NO_x and non-methane hydrocarbons (NMHC) than Euro 6, while possibly less stringent for PM.

Table 1: Petrol passenger car emission standards (g/km)

ADR	Standard	Date(1)	CO	HC/ NMHC(2)	HC+NO_x	NO_x	Particulate Mass	PN(3)	Test cycle
ADR27A(4)		July 1976	24.2	2.1/–	–	1.90	–	–	US FTP 72
ADR37/00	US'75	Feb 1986	9.3	0.93/–	–	1.93	–	–	US FTP 75
ADR37/01	US'90	Jan 1999	2.1	0.26/–	–	0.63	–	–	US FTP 75
ADR79/00	Euro 2	Jan 2004	2.2	–/–	0.50	–	–	–	ECE + EUDC
ADR79/01	Euro 3	Jan 2006	2.3	0.20/–	–	0.15	–	–	NEDC
ADR79/02	Euro 4	July 2010	1.0	0.10/–	–	0.08	–	–	NEDC
ADR79/03	Euro 5	Nov 2013(5)	1.0	0.10/0.068	–	0.06	0.0045(6)	–	NEDC
ADR79/04	Euro 5	Nov 2016	1.0	0.10/0.068	–	0.06	0.0045(6)	–	NEDC
ADR79/05	Euro 6	Proposed 2020	1.0	0.10/0.068	–	0.06	0.0045(6)	$6x10^{11}$(6)	WLTP

1. Standard applies to all vehicles built after this date, generally applies to new models one year earlier
2. Non-methane hydrocarbons
3. PN (particle number) per km
4. ADR27A was the first introduction of g/km limits for CO, hydrocarbons (HC) and NO_x
5. Applies to new models only
6. PM and PN standards apply to petrol direct injection engines only.

1 More detailed information on the ADRs may be found at http://www.infrastructure.gov.au/roads/environment/index.aspx

Table 2: Diesel passenger car emission standards (g/km)

ADR	Standard	Date[1]	CO	HC/ NMHC[2]	HC+NO_x	NO_x	Particulate Mass	PN[3]	Test cycle
ADR70/00	Euro 1	Jan 1996	2.72	–	0.97	–	0.14	–	ECE + EUDC
ADR79/00	Euro 2	Jan 2003	1.0	–	0.70/0.90[4]	–	0.08/0.10[4]	–	ECE + EUDC
ADR79/01	Euro 4	Jan 2007	0.50	–	0.30	0.25	0.025	–	NEDC
ADR79/02	Euro 4	Jan 2010[5]	0.50	–	0.30	0.25	0.025	–	NEDC
ADR79/03	Euro 5	Nov 2013[6]	0.50	–	0.23	0.18	0.0045	–	NEDC
ADR79/04	Euro 5	Nov 2016	0.50	–	0.23	0.18	0.0045	$6x10^{11}$	NEDC
ADR79/05	Euro 6	Proposed 2020	0.50	–	0.17	0.08	0.0045	$6x10^{11}$	WLTP

1. Standard applies to all vehicles built after this date, generally applies to new models one year earlier
2. Non-methane hydrocarbons
3. PN (particle number) per km
4. First limit applies to indirect injection engines, second applies to direct injection engines
5. Same standard as ADR79/01 (Euro 4) but extends to more vehicle classes
6. Applies to new models only, applies to all vehicles from ADR79/04.

Table 3: Heavy duty vehicle diesel emission standards (g/kWh)

ADR	Standard	Date[1]	CO	HC/ NMHC[2]	NO_x	Particulate Mass	PN[3]	Test cycle
ADR70/00	Euro I	Jan 1996	4.5	1.1/–	8.0	0.36	–	ECE-R49
ADR80/00	Euro III	Jan 2003	2.1/5.45[4]	0.66/0.78	5.0/5.0	0.10/0.16	–	ESC/ETC
ADR80/02	Euro IV	Jan 2008	1.5/4.0	0.46/0.55	3.5/3.5	0.02/0.03	–	ESC/ETC
ADR80/03	Euro V	Jan 2011	1.5/4.0	0.46/0.55	2.0/2.0	0.02/0.03	–	ESC/ETC
ADR80/04	Euro VI	Proposed 2020	1.5/4.0	0.13/0.16	0.4/0.46	0.01/0.01	$8x10^{11}$/ $6x10^{11}$	WHSC/ WHTC

1. Standard applies to all vehicles built after this date, generally applies to new models one year earlier.
2. Non-methane hydrocarbons
3. PN (particle number) per kWh
4. First limit applies to ESC test cycle, second to the ETC cycle.

2. National Fuel Standards

Complementing the progressive tightening of the vehicle emission standards, the national fuel standards have also been revised to reduce vehicle emissions in several ways:

- Specifications which support the implementation of new emission control technology (e.g. elimination of lead in petrol and reductions of sulfur levels in fuel to enable the use of exhaust catalysts)
- Specifications to directly reduce engine-out (i.e. before exhaust catalyst) emissions (e.g. reductions in benzene concentrations in petrol)
- Reduction of petrol volatility to reduce evaporative fuel emissions.

Generally, Australian fuel specifications have been aligned to European fuel standards. This has been applied to match the requirements of vehicle technology designed to the EU emission standards that Australia has adopted. Key fuel specifications are detailed in Table 4 for petrol and Table 5 for diesel.[2]

Table 4: Key petrol fuel standard specifications

Property	Standard	Fuel Grade	Implementaion Date
Sulfur	≤500 ppm	Unleaded petrol	1 Jan 2002
	≤150 ppm	Premium unleaded petrol	1 Jan 2002
	≤150 ppm	All	1 Jan 2005
	≤50 ppm	Premium unleaded petrol	1 Jan 2008
Benzene	≤1% by vol.	All	1 Jan 2006
Lead	≤0.005 g/L	All	1 Jan 2002
Olefins(1)	18% pool av. over 6 months; 20% cap	All	1 Jan 2004
	≤18% by vol.	All	1 Jan 2005
Aromatics(1)	45% pool av over 6 months; 48% cap	All	1 Jan 2002
	42% pool av over 6 months; 45% cap	All	1 Jan 2005
Reid Vapour Pressure(2)	62 kPa from Nov to March	All	1 Nov 2004(3)

1. Pool average over all batches in any six month period, cap applies to any single batch
2. Vapour pressure limit is NSW regulation
3. Low volatility fuel was introduced by a memorandum of understanding in 1998 but was not regulated in NSW until 2004.

Table 5: Key diesel fuel specifications

Property	Standard	Implementaion Date
Sulfur	≤500 ppm	31 Dec 2002
	≤50 ppm	1 Jan 2006
	≤10 ppm	1 Jan 2009
Cetane Index	≥46	1 Jan 2002
Density	820-860 kg/m^3	1 Jan 2002
	820-850 kg/m^3	1 Jan 2006
Distillation T95	370°C	1 Jan 2002
	360°C	1 Jan 2006
Polyaromatic Hydrocarbons	11% by mass	1 Jan 2006

In December 2016, the Ministerial Forum on Vehicle Emissions released a discussion paper on improving fuel quality standards and invited public comment until March 2017. The discussion paper highlighted two fuel parameters of particular concern: sulfur and octane in petrol. Sulfur reduces the efficiency of vehicle catalytic converters, so reduced petrol sulfur levels will significantly reduce emissions. Higher octane fuels can be used in high compression petrol engines which are more fuel efficient and produce less greenhouse gas emissions.

A draft regulation impact statement proposing improvements to fuel standards under the *Fuel Quality Standards Act 2000 was* released in January 2018. These changes are designed to bring key properties of Australia's fuel quality into line with international standards.

2 More detailed information may be found at http://www.environment.gov.au/topics/environment-protection/fuel-quality/standards.

3. In-service Fleet Performance

The effectiveness of the tighter emission standards on the in-service petrol passenger vehicle fleet is demonstrated with data from the Commonwealth's Second National In-Service Emission Study (NISE2) (DEWHA, 2009).

The average hydrocarbon (HC) emissions for the four ADR classes tested in the NISE2 project are shown in Figure 1. The data shown is for the 20 km Australian Combined Urban Emission Drive Cycle[3] (CUEDC) for both a start from cold and a start with a fully hot engine. The emission rates are seen to have decreased by an order of magnitude from the ADR37/00 cars of the 1990s to the latest vehicles tested in this project, 2006–07 ADR79/01 (Euro 3) vehicles.

The corresponding NO_x emissions are shown in Figure 2 and are also seen to have decreased by an order of magnitude from ADR 37/00 to ADR79/01.

The Sydney Particle Characterisation Study showed that $PM_{2.5}$ emissions from vehicles have fallen by around 40 per cent over the last 15 years, despite increases in vehicle use (ANSTO, 2016).

European real world in-service test data on Euro 5 and 6 petrol vehicles has demonstrated that these standards have been effective in driving significant emission reductions.

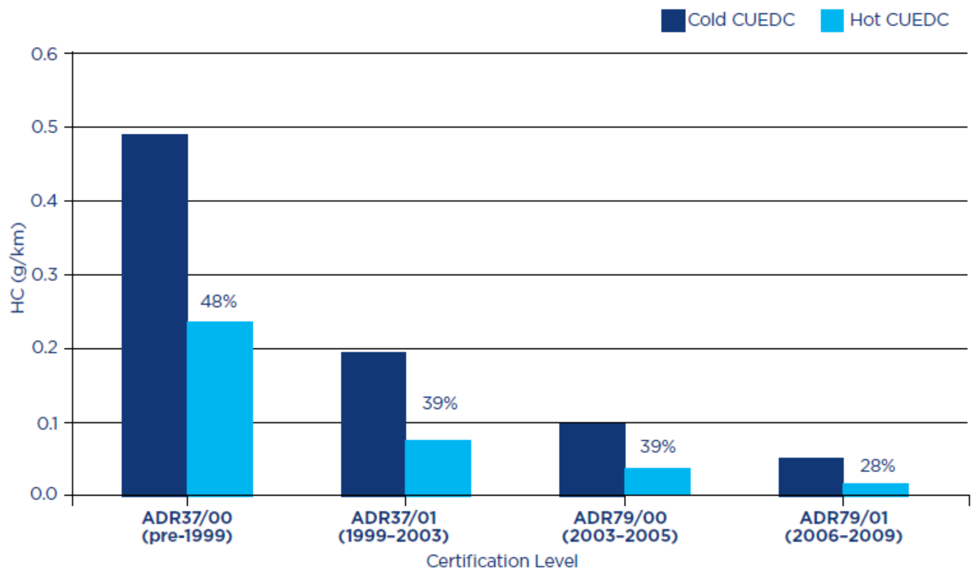

Figure 1: HC emissions for petrol passenger vehicles from NISE2 project (DEWHA, 2009) (numbers are a percentage of hot emissions compared to cold emissions)

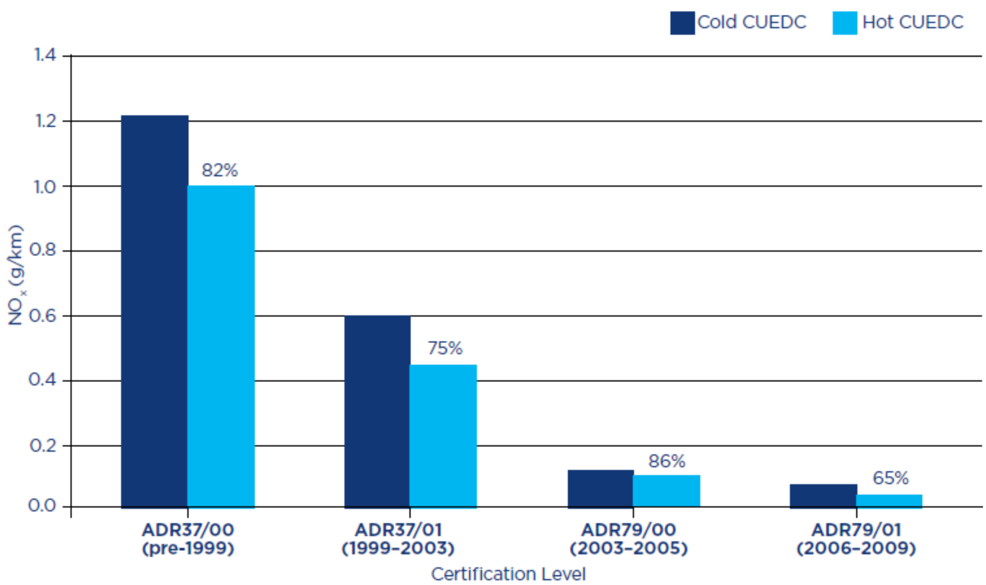

Figure 2: NO_x emissions for petrol passenger vehicles from NISE2 project (DEWHA, 2009) (numbers are a percentage of hot emissions compared to cold emissions)

3 The Combined Urban Emissions Drive Cycle is a 'real-world' vehicle test cycle developed from monitoring of thousands of kilometres of actual vehicle operation across Australian capital cities.

4. Vehicle Kilometres Travelled

VKT are estimated by Transport for NSW's Transport Performance and Analytics (TPA). The TPA estimates VKT using sophisticated strategic transport models calibrated with pooled data from the annual NSW Household Travel Survey (HTS) for passenger transport and commercial transport surveys for freight transport (BTS, 2011, TDC, 2010). TPA estimates are generally in agreement with other VKT sources such as the Australian Bureau of Statistics Survey of Motor Vehicle Use (SMVU).

The TPA modelled growth in VKT for passenger vehicles and freight vehicles for the NSW greater metropolitan region (GMR) are shown in Figure 3. The vehicle classes represented by the dashed lines refer to the right hand axis. The total fleet annual VKT growth rate is around one per cent per year. Passenger vehicles dominate the VKT and grow at population growth of also around one per cent per year, while VKT growth rates for both rigid and articulated trucks are in line with economic growth at around two to three per cent per year.

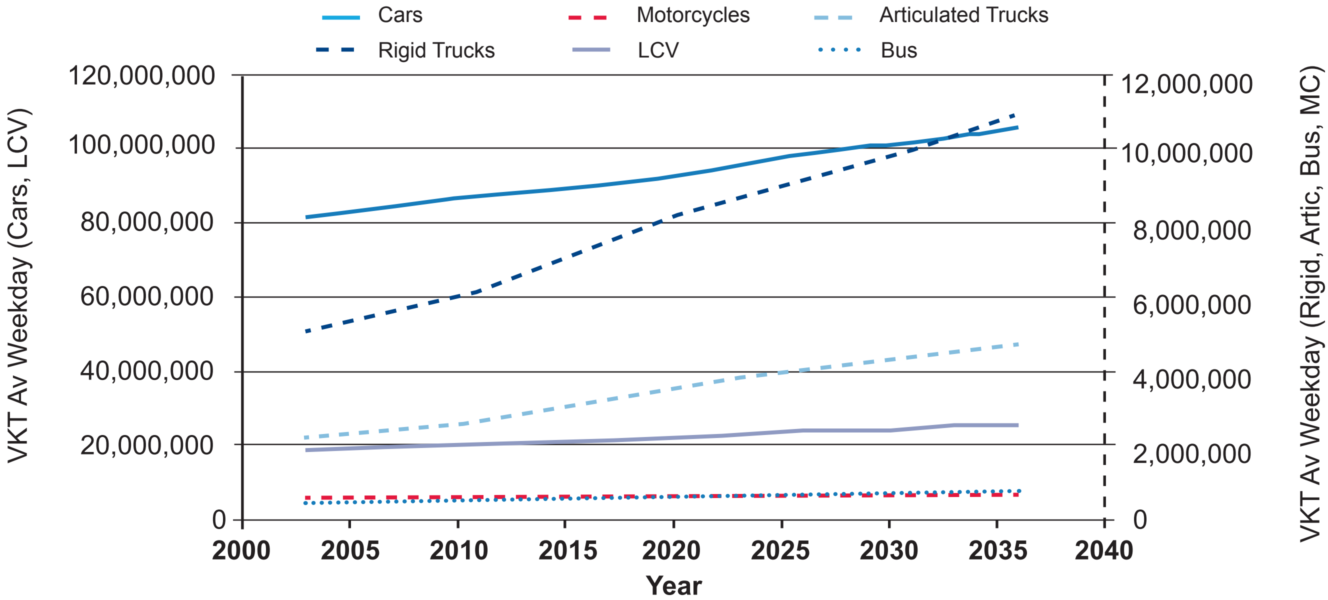

Figure 3: Average weekday VKT growth 2003–2036

5. Motor Vehicle NSW GMR Emission Inventory Projections

The NSW Environment Protection Authority (EPA) motor vehicle emission inventory model is used to project the entire fleet emissions for the NSW GMR to future years as shown in Figure 4 (EPA, 2012). VKT growth and congestion are estimated from the TPA data above, and the model includes fleet turnover and the resultant adoption of new technology.[4]

The projections depicted with the solid lines in Figures 4 and 5 exclude proposed adoption of Euro 6/VI for light/ heavy vehicles. The dashed lines demonstrate the impact of adoption of Euro6/VI and a 10 ppm sulfur limit for petrol.

The projections do not account for any uptake of hybrid or electric vehicles. In 2016, new registrations of electric and hybrid vehicles comprised 0.1 per cent and 1.2 per cent respectively of new light vehicles. As new petrol and diesel vehicles have very low emissions, and the contribution of older vehicles dominates fleet emissions, a large uptake of electric vehicles would be required to have significant impact on the fleet emissions.

Figure 4 shows two lines for $PM_{2.5}$. The light blue line shows exhaust emissions of $PM_{2.5}$ and shows strong decreases with the penetration of new technology into the fleet as a direct response to the large reductions in emissions limits in the ADRs. Exhaust PM is mostly less than 1.0 μm in diameter) (PM_1), and represents more than 99 per cent of the number of PM_1 particles emitted and more than 85–90 per cent of the mass of PM_1 particles emitted. Adoption of Euro 6 standards for light vehicles and Euro VI for heavy vehicles would significantly reduce the projected $PM_{2.5}$ exhaust emissions.

The dark blue line is the total $PM_{2.5}$ which includes non-exhaust sources of tyre, brake and road wear added to the exhaust emissions. Non-exhaust particles comprise larger size fractions than exhaust PM, with only 34 per cent of total PM as $PM_{2.5}$, of which seven per cent is PM_1.

As there is no current abatement technology or legislated standards for the non-exhaust sources of PM, emissions from this source grow as a direct function of VKT. Hence the total $PM_{2.5}$ reaches a minimum around 2026 and then starts to grow.

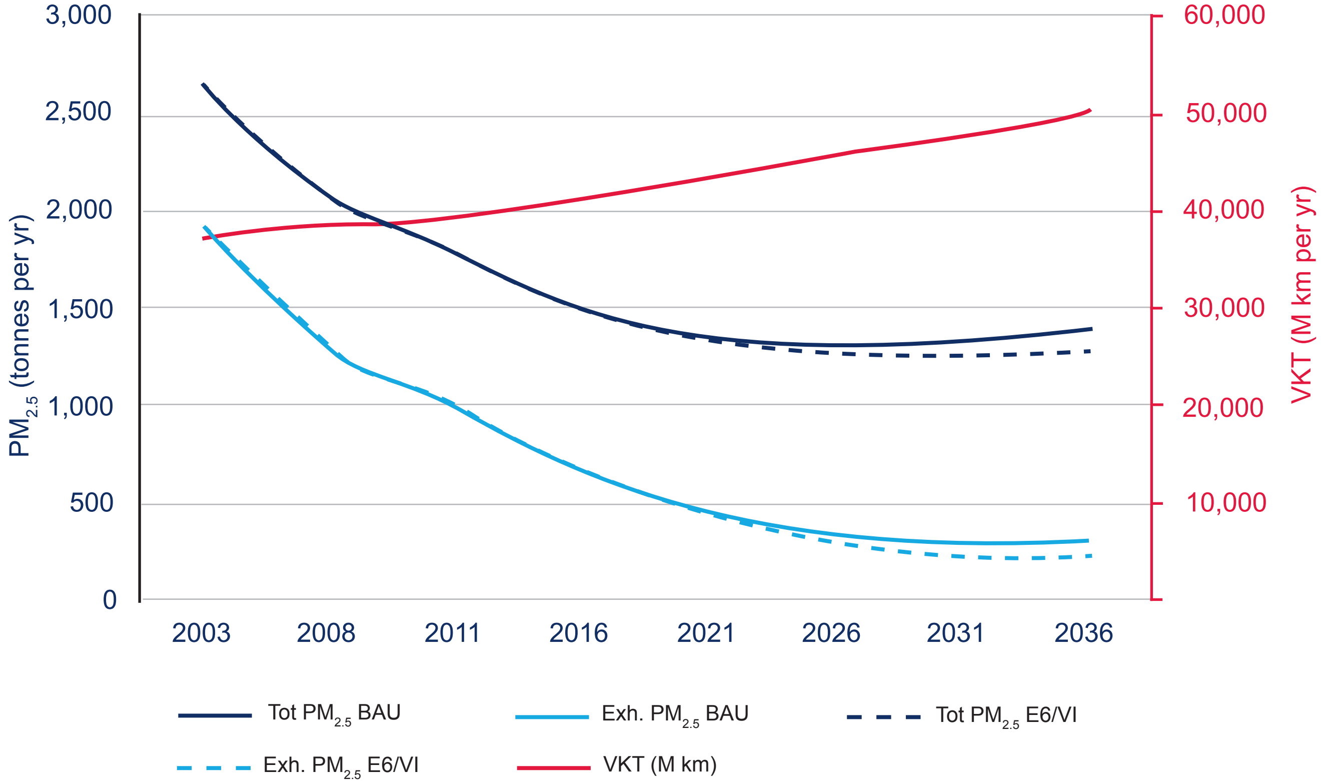

Figure 4: Projected NSW GMR PM2.5 motor vehicle emissions (EPA, 2017)

The $PM_{2.5}$ data on the blue lines is plotted against the left hand axis. VKT data represented by the red line is plotted against the right hand axis. Note: VKT is in millions of kilometres per year (million km/year).

4 Full details of the motor vehicle inventory model are given in the report at http://www.epa.nsw.gov.au/air/airinventory2008.htm with projection assumptions given in Appendix B.

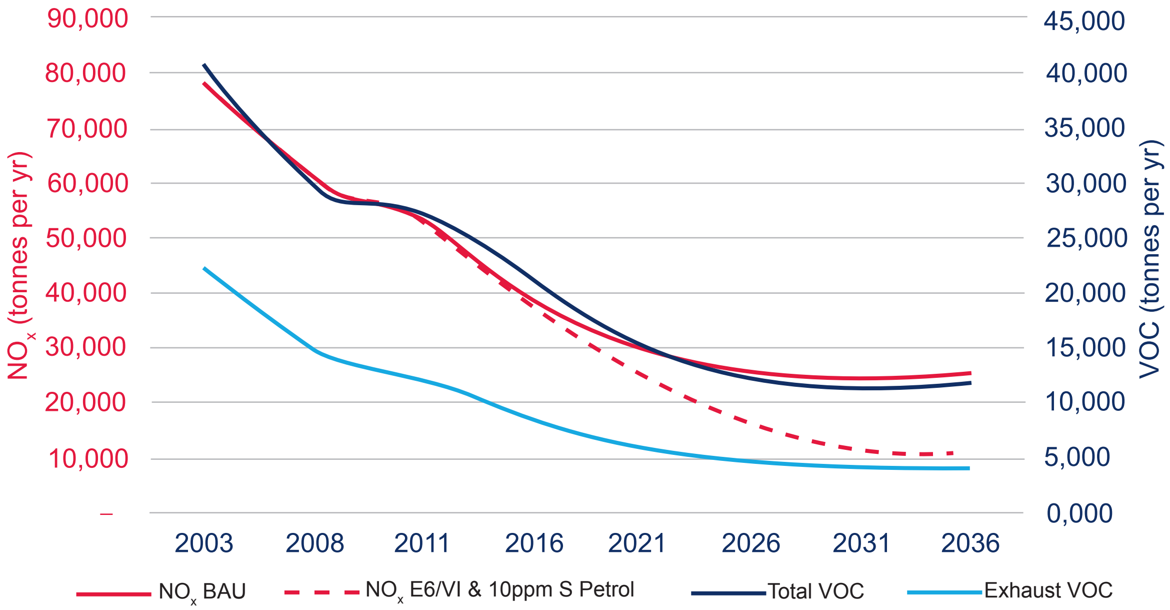

Figure 5: Projected NSW GMR NO_x and VOC motor vehicle emissions (EPA, 2017)

Note: The NO_x data is represented by the red lines and are plotted against the right hand axis. VOC data are represented by the blue line and are plotted against the left hand axis.

Figure 5 shows the projected emissions of NO_x and VOC emissions with new vehicle standards. NO_x emissions can be seen to strongly decline into the future as a result of the new low emission vehicles entering the fleet. The dashed red line shows that the adoption of Euro 6/VI standards for light/heavy diesel vehicles and adoption of 10 ppm sulfur petrol would significantly reduce NO_x emissions.

Although motor vehicle emissions are projected to decline, health evidence indicates that particulate matter is a non-threshold pollutant and O_3 (formed from hydrocarbons and oxides of nitrogen) is also likely to be a non-threshold air pollutant. Hence, ongoing emission reductions will continue to deliver positive public health benefits (WHO 2013, Bell & Dominici 2008).

The data trends shown in Figures 4 and 5 as an aggregation across the GMR may not reflect changes in any one location or road corridor which may have significantly different VKT growth rates and traffic mixes. For instance, rigid trucks tend to be replaced at a much slower rate than articulated trucks. The emission contribution by vehicle type is presented in the next section.

5.1 Emission contribution by vehicle type

The NSW EPA motor vehicle emissions inventory estimates the contribution by vehicle type to the total 2008 NSW GMR motor vehicle emissions. This is shown in Figure 6, Figure 7 and Figure 8 for PM_{10}, VOC and NO_x respectively. The vehicle type abbreviations used are given in Table 6.

Table 6: Vehicle type abbreviations

Abbreviation	Vehicle Type
ART	Articulated trucks and heavy truck-trailer combinations
BUS	Heavy diesel public transport buses
DLCV	Diesel light commercial vehicles (utes and vans)
DPV	Diesel passenger vehicles (cars and SUV/4WD)
HDD	Heavy-duty diesels (rigid trucks, articulated trucks, heavy buses)
HDCP	Heavy-duty commercial petrol (>3,500 kg)
LDD	Light-duty diesels <3,500 kg (light commercial vehicles and cars and SUV/4WD)
MC	Motor cycles
MC+HDCP	Motor cycles and heavy-duty commercial petrol
PLCV	Petrol light commercial vehicles (utes and vans)

Abbreviation	Vehicle Type
PPV	Petrol passenger vehicles (cars and SUV/4WD)
RIG	Rigid trucks (>3.5t to ~25t)

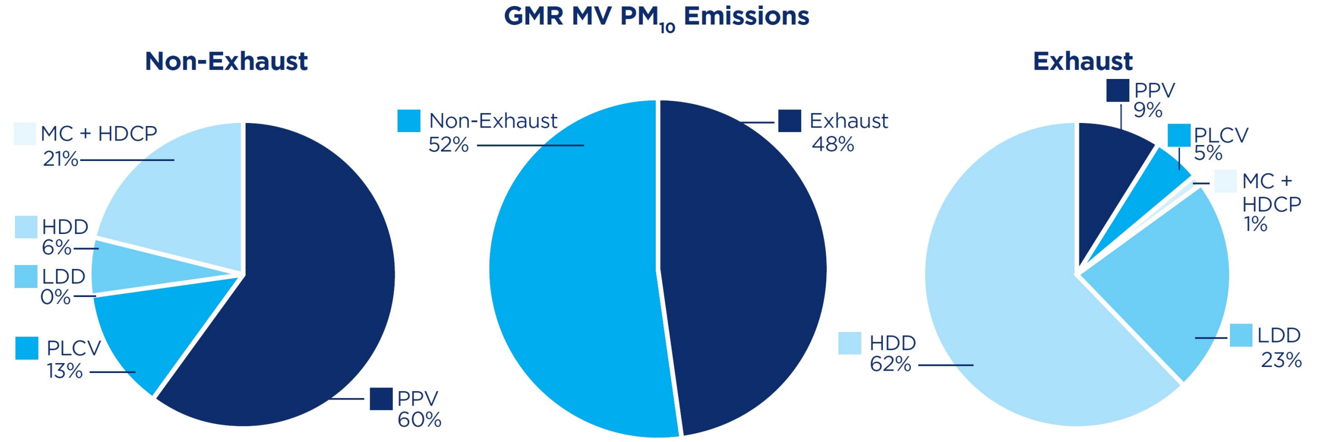

Figure 6: Contribution by vehicle type to 2008 NSW GMR PM_{10} emissions

Non-exhaust sources of PM_{10} account for more than half of the total motor vehicle PM_{10}, of which most (60 per cent) is generated by petrol passenger vehicles due to their dominance in VKT.

Heavy duty diesel vehicles are disproportionately high contributors to PM_{10} exhaust emissions at more than 60 per cent, while accounting for only six per cent of VKT. Light duty diesel vehicles are also significant contributors at 23 per cent while accounting for five per cent of VKT.

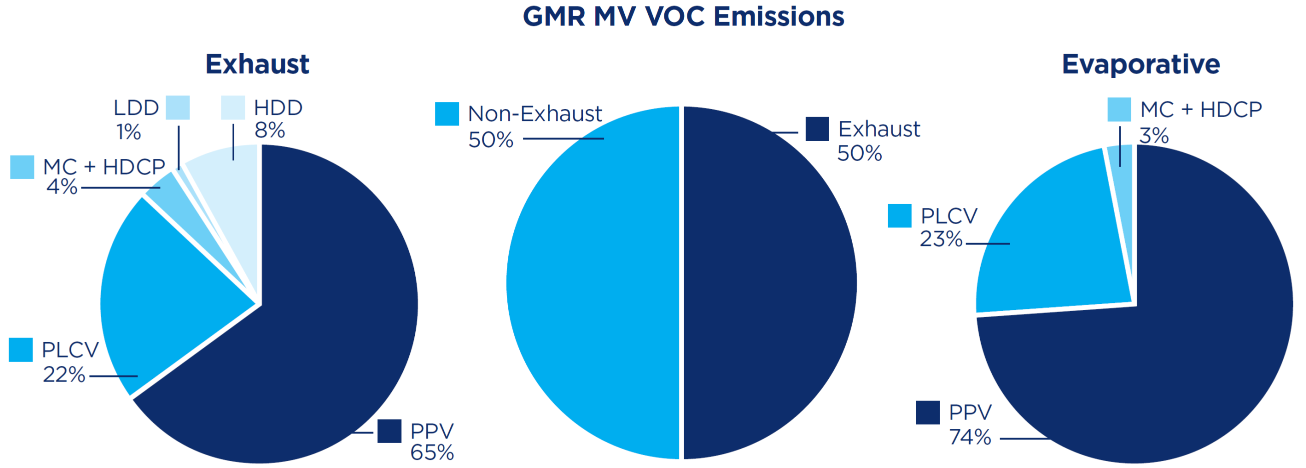

Figure 7: Contribution by vehicle type to 2008 NSW GMR VOC emissions

Evaporative fuel emissions and exhaust emissions are estimated to contribute equally to total motor vehicle VOC emissions. Of the 50 per cent emitted by exhaust, petrol vehicles dominate. Evaporative emissions are only emitted by petrol vehicles and increase when the weather is hotter. Vehicles standards now require some control on vehicle evaporative emissions. NSW limits petrol volatility in summer to manage the increase in evaporative emissions during warmer months.

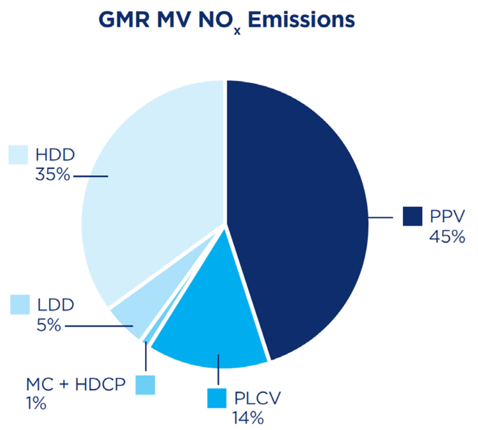

Figure 8: Contribution by vehicle type to 2008 NSW GMR NO_x emissions

Heavy duty diesels contribute a disproportionately high 35 per cent of NO_x emissions, while accounting for only six per cent of the entire fleet's VKT. Petrol passenger vehicles and petrol light commercial vehicles contribute the majority of the remainder.

The significantly different rates of emissions per vehicle type indicate that the composition of the vehicle fleet on any particular road corridor will be an important factor in the level of emissions in that corridor.

5.2 Emission contribution by age

The contribution to the total daily emissions by age class (ADR compliance) and vehicle type are shown in Figure 9 and Figure 10 for exhaust $PM_{2.5}$ and NO_x respectively for the 2008 calendar year. The stacked bars show the emissions by age class with the oldest vehicles at the bottom and the newest at the top. The per cent figures shown are the total contribution of all ages of each vehicle type to total fleet emissions.

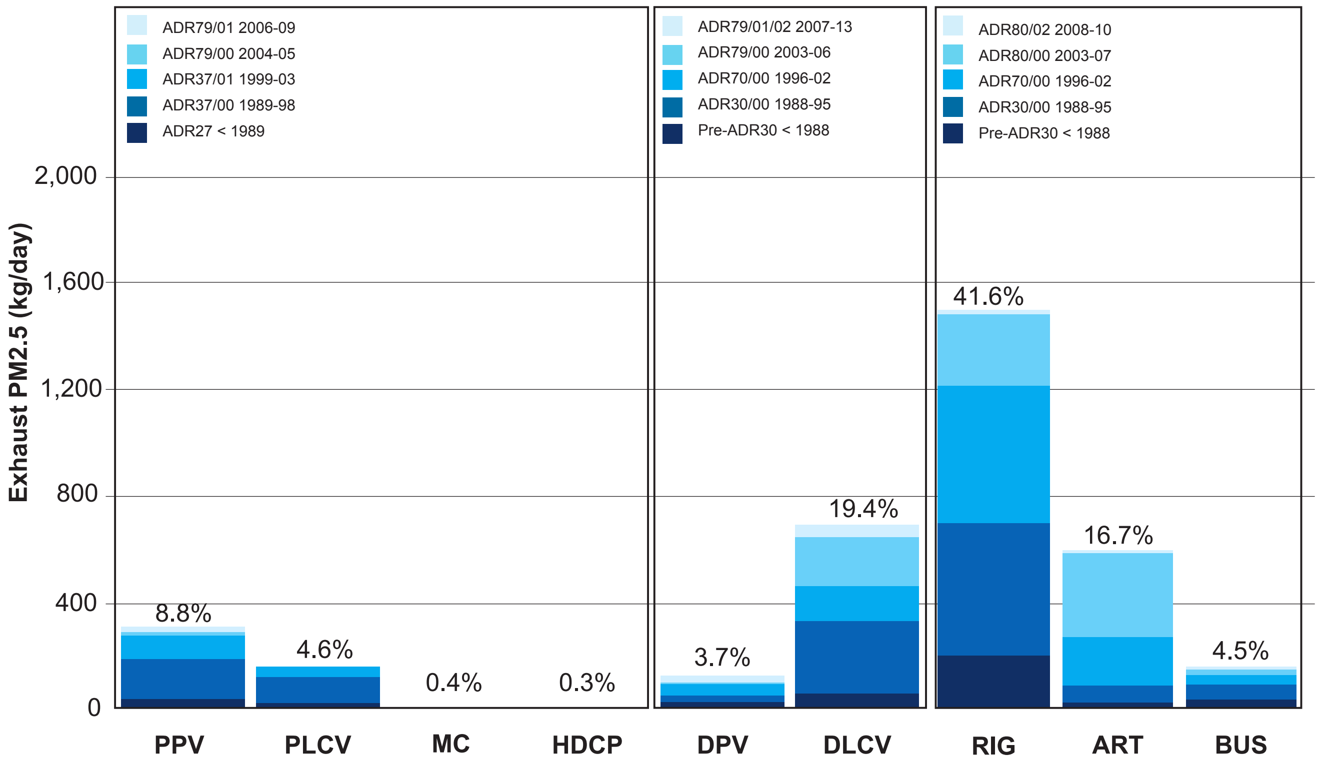

Figure 9: $PM_{2.5}$ emission contribution by age class by vehicle type (2008)

As shown in the previous section, exhaust PM is dominated by heavy duty diesels (RIG, ART, BUS) with a significant contribution from diesel light commercial vehicles (DLCV). For the two largest contributors, DLCV and rigid trucks, together comprising over 60 per cent of total exhaust emissions, around 50 per cent of the emissions are produced by vehicles older than 1996 (ADR70/00 and older certification). These pre-1996 vehicles account for only 15 per cent and 18 per cent of the respective vehicle class VKT, and are thus significantly disproportionate contributors to emissions at around three times the fleet average emission rate (per kilometre).

For articulated trucks, the pre-1996 vehicles contribute 17 per cent of the $PM_{2.5}$ emissions and account for nine per cent of the VKT, and hence are emitting at around twice the fleet average rate.

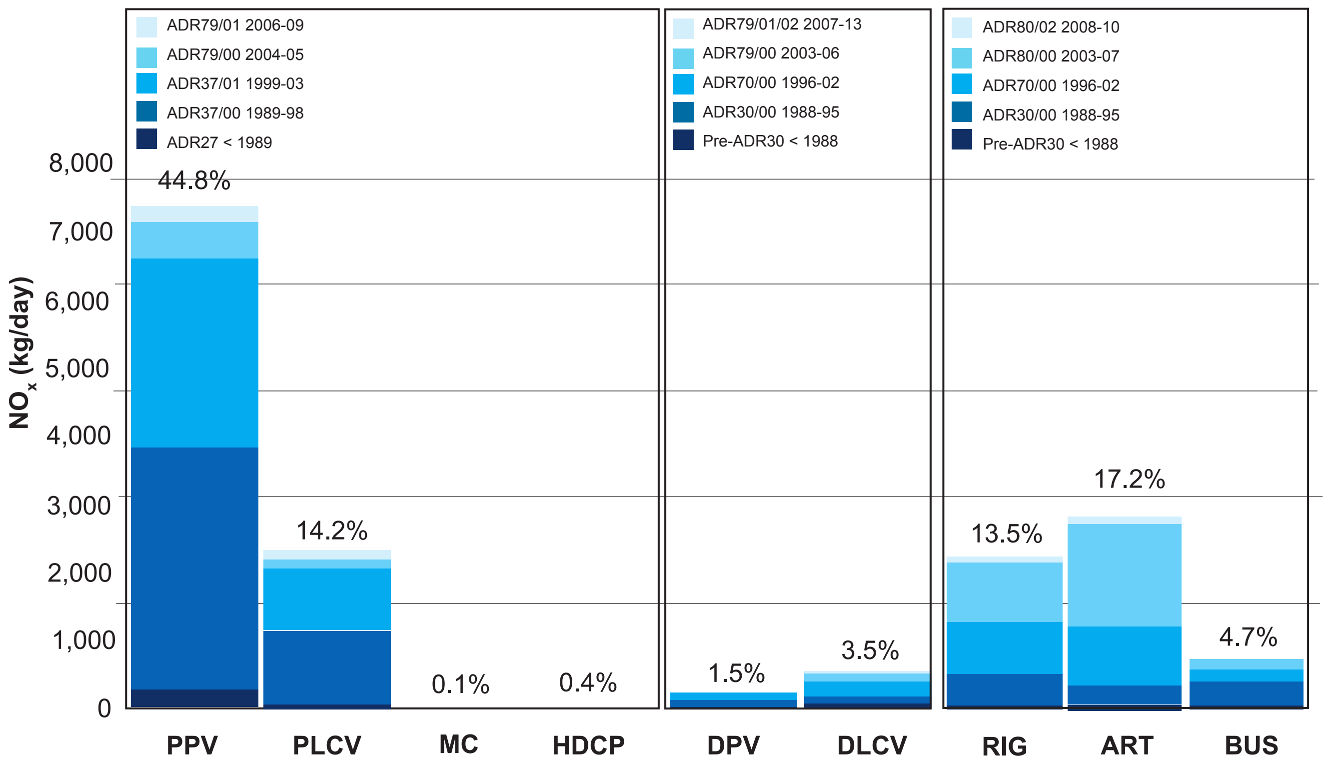

Figure 10: NO_x emission contribution by age class by vehicle type (2008)

For NO_x the dominant contributors are petrol passenger vehicles and petrol light commercial vehicles. The pre-1999 petrol vehicles (pre-ADR37/01) contribute approximately half of their respective vehicle type emissions, but only account for around 30 per cent of the VKT. The high emission rates of older vehicles in the fleet indicate that the fleet's age profile and vehicle type composition are both important factors in estimating the level of emissions from any specific road corridor.

6. References

ANSTO (2016), Sydney Particle Characterisation Study. PM2.5 Source Apportionment in the Sydney Region between 2000 and 2014.
http://www.epa.nsw.gov.au/your-environment/air/regional-air-quality/sydney-particle-characterisation-study.

Bell ML, Dominici F (2008). Effect modification by community characteristics on the short-term effects of ozone exposure and mortality in 98 US communities. American Journal of Epidemiology, 167(8):986–997.

BTS (2011), Sydney Strategic Travel Model (STM), Modelling future travel patterns, Bureau of Transport Statistics, February 2011.

DECCW (2007), Air Emissions Inventory for the Greater Metropolitan Region in NSW, Technical Report 1: Criteria Pollutant Emissions for All Sectors.
https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/air/tr1aei0712.ashx

Department of Environment and Energy (2018) Better fuel for cleaner air - Draft regulation impact statement, January 2018.

DEWHA (2009), Second National In-Service Emissions Study (NISE2), Light duty petrol vehicle emissions testing: RTA.07.2828.0309 final report, Department of the Environment, Water, Heritage and the Arts, March 2009. https://www.environment.gov.au/archive/transport/publications/nise2.html

EPA (2012), Air Emissions Inventory for the Greater Metropolitan Region in NSW, 2008 Calendar Year, Technical Report 7: On-road Mobile Emissions, EPA 2012/0256, ISBN 978-1-74293-557-7.
https://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008

EPA (2012a), Air Emissions Inventory for the Greater Metropolitan Region in NSW, 2008 Calendar Year, Technical Report 1: Consolidated Natural and Human-Made Emissions: Results, EPA 2012/0255, ISBN 978-1-74293-556-0.
https://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008

EPA (2017), Clean Air Summit Background Papers
http://www.epa.nsw.gov.au/your-environment/air/clean-air-nsw.

TDC (2010), 2008/09 Household Travel Survey; Summary Report, 2010 Release, Transport Data Centre, June 2010.

WHO (2013), Review of evidence on health aspects of air pollution – REVIHAAP project, Technical Report, World Health Organisation Regional Office for Europe, 2013.

Appendix A: Australian ADR Emission Limits

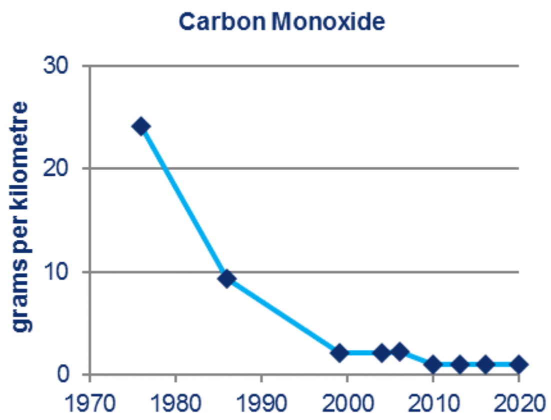

Figure A1: Petrol light duty carbon monoxide emission limits

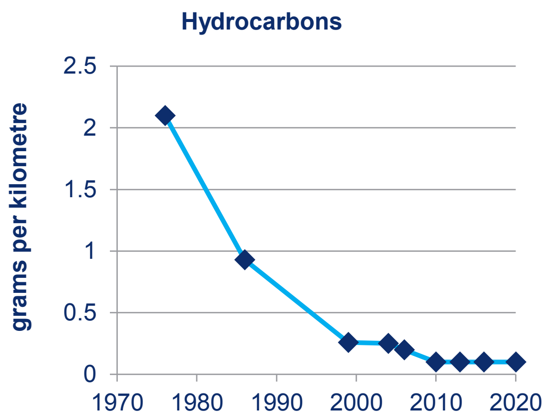

Figure A2: Petrol light duty hydrocarbon emission limits

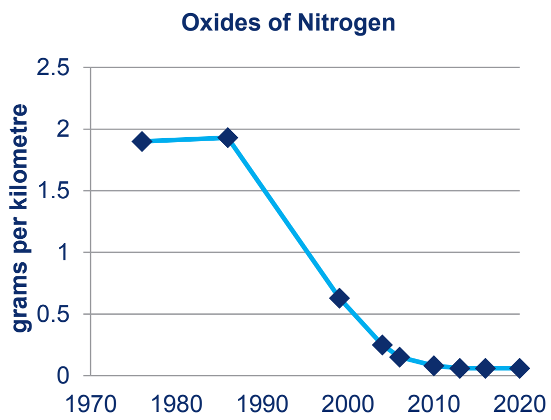

Figure A3: Petrol light duty oxides of nitrogen emission limits

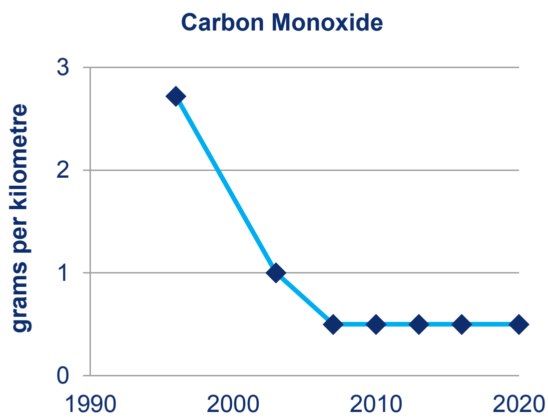

Figure A4: Diesel light duty carbon monoxide emission limits

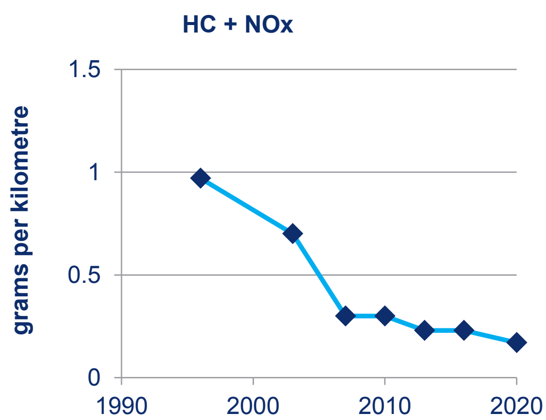

Figure A5: Diesel light duty combined hydrocarbon and oxides of nitrogen emission limits

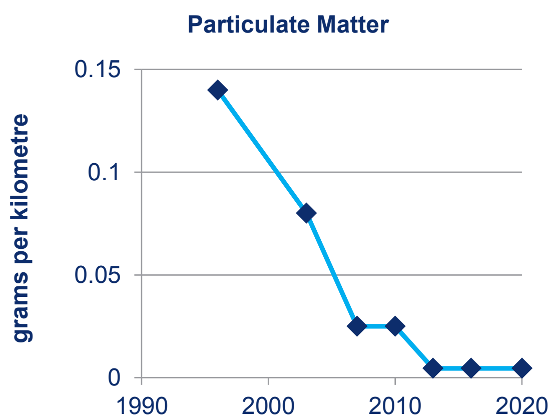

Figure A6: Diesel light duty particulate matter emission limits

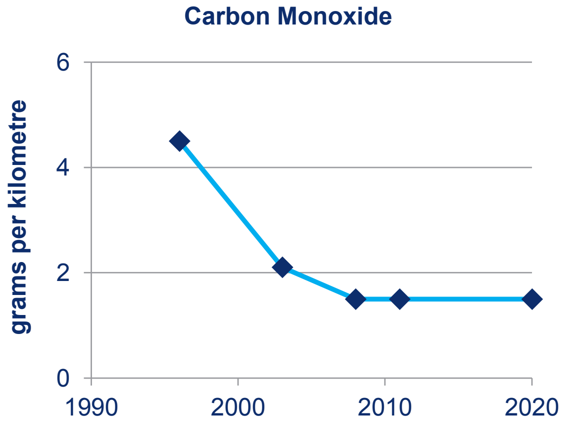

Figure A7: Diesel heavy duty carbon monoxide emission limits

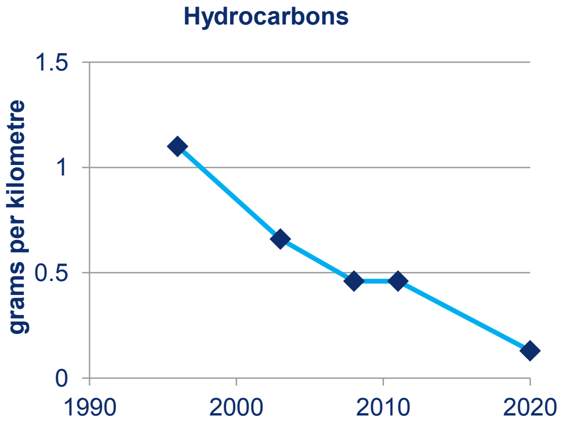

Figure A8: Diesel heavy duty hydrocarbon emission limits

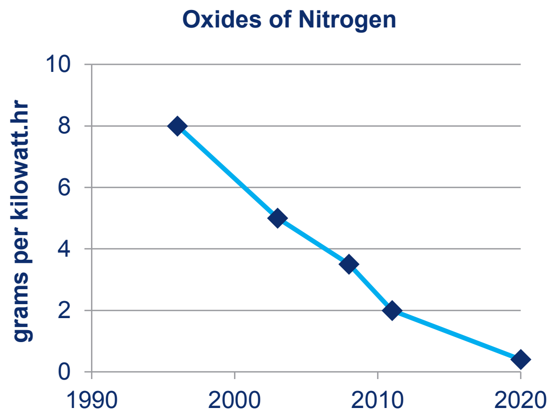

Figure A9: Diesel heavy duty oxides of nitrogen emission limits

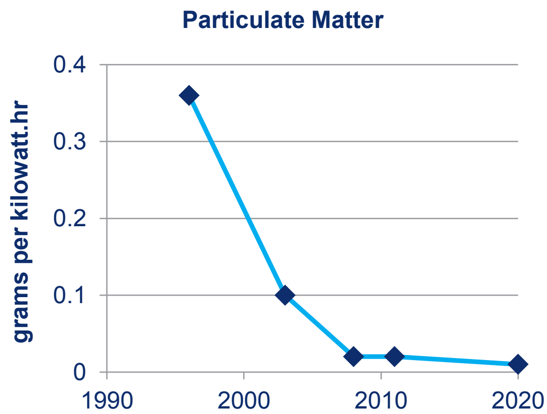

Figure A10: Diesel heavy duty particulate matter emission limits

NSW
GOVERNMENT