Better Fuel for Cleaner Air

RAC Response to the Department of Environment and Energy's Draft Regulation Impact Statement

January 2018

For the better

Fuel Quality Standards

RAC represents over one million Western Australians, and is the leading advocate on mobility issues and challenges facing our state. A key role for RAC is to act as a voice for our members and as a strong public advocate on mobility issues. RAC works collaboratively with all levels of Government to ensure Western Australians can move around safely, easily, and in a more sustainable way.

Better fuel quality in Australia is an important RAC advocacy priority and we welcome the opportunity to provide a submission to the Department of Environment and Energy's *Better fuel for cleaner air—draft regulation impact statement* (Draft RIS).

Background

The Draft RIS follows the earlier release of the *Better fuel for cleaner air–discussion paper* released by the Department of Environment in December 2016 (Discussion Paper); the Discussion Paper provides five options ranging from option A – business as usual (no change), with increasingly strict options down to option E – harmonisation with world standards – the strictest fuel quality standards discussed in the Paper, phased in from 2020.

The 2017 Draft RIS provides a more in-depth analysis of two of the five initial policy options (options B and C) as well as one additional option proposed by Australia's refining industry (Option F). At a high level and discussed in further detail in the following:

- **Option B** assesses and provides for stricter fuel quality standards including a reduction of sulfur to 10 parts per million (PPM), reductions in other elements including aromatics, and phasing out of 91 RON unleaded petrol from 2022, 2025 or 2027;
- **Option C** provides for the same tightening of fuel standards as option B, while still retaining 91 RON, along the same timelines; and
- The newly introduced **option F** provides for only reducing sulfur and phased in by 2027, with no other fuel quality measures introduced.
- The Draft RIS also considers fuels that are supplied in Australia but not currently regulated by the *Fuel Quality Standards Act 2000* (Cth).

Vehicles emit oxides of nitrogen (NOx), hydrocarbon emissions (including methane, benzene, toluene, xylene, and benzo[a] pyrene), carbon dioxide (CO_2), carbon monoxide (CO), oxides of sulfur (SOx), particulate matter (PM) and ozone (O_3) which collectively impact negatively on human health and the environment.

NOx affects the respiratory system, and can form smog and acid rain. Hydrocarbons include known carcinogens and hydrocarbons such as methane have 20 times the global warming impact of the same amount of CO_2. CO deprives the blood of oxygen and contributes to greenhouse gases. SOx impacts on the respiratory system and creates sulfuric acid in the atmosphere creating acid rain. When PM is inhaled, the small particles can cause serious health problems.

On the other hand, O_3 can be both good and bad for human health. Naturally occurring O_3 occurs in the upper atmosphere and absorbs some ultraviolet radiation, while tropospheric or ground level O_3 is caused by chemical reactions from pollutants and is toxic to human health. O_3 can impact negatively on the respiratory system and is one of the main contributors to smog.

In 2011, approximately 2,549 Australians fatalities were attributed to air pollution exposure, more than twice the 2017 national road toll;[1] with an estimated cost of as much as $11 billion.[2] The OECD confirms that while deaths from air pollution across Europe declined, Australian deaths rose over the same period.[3] Overall, approximately 1.3 per cent of all Australian deaths and a further 0.6 per cent of all disease and injury, can be attributed to air pollution.[4]

Australia lags well behind other nations in fuel quality rankings coming in at 70th in the world and the lowest of all OECD countries.[5] Further, the transport sector is responsible for 18 per cent of total greenhouse gas emissions, increasing to 20 per cent by 2030 and over 23 per cent of total CO_2 emissions.[6] On a per capita basis, Australia's CO_2 emissions are 50 per cent above the OECD average.[7]

[1] BITRE (2017) Road deaths Australia, December 2017. Accessed on 16 February 2018, https://bitre.gov.au/publications/ongoing/rda/files/RDA_Dec_2017.pdf
[2] Department of Environment and Energy, citing Marsden Jacob Associates Pty Ltd (2017). Analysis of AIHW burden of disease data, in Revised fuel quality standards: economic analysis, report prepared for the Department of the Environment and Energy. Accessed on 8 February 2018.
[3] OECD (2014), The Cost of Air pollution: Health Impacts of road Transport, OECD Publishing. http://www.keepeek.com/Digital-Asset-Management/oecd/environment/the-cost-of-air-pollution_9789264210448-en#page54
[4] AIHW (2016). Australian burden of disease study: impact and causes of illness and death in Australia 2011, AIHW, Canberra. https://www.aihw.gov.au/getmedia/d4df9251-c4b6-452f-a877-8370b6124219/19663.pdf.aspx?inline=true
[5] Stratas Advisors (2017). Fuel quality standards in Australia. Accessed on 5 February 2018, https://apfiforum.com/wp-content/uploads/2016/03/STRATAS-You-Wei-Aw-publish.pdf
[6] Department of Climate Change, (2017), National Greenhouse Gas Inventory 2015. Available online at: http://ageis.climatechange.gov.au/NGGI.aspx#
[7] Climate Council (2016). What's the deal with transport emissions? Accessed on 16 February 2018 https://www.climatecouncil.org.au/transport-emissions-and-climate-solutions

Fuel compounds

Fuel quality in Western Australia

During the process of this review RAC commissioned independent sampling and testing of fuel from randomly selected locations across the Perth metropolitan area, using the international standard for fuel testing to determine the quality specific to WA. This standard is determined by ASTM, an international organization that develops and publishes technical standards. The preliminary results of the sample testing show variability across each of the fuels, and in particular sulfur content in unleaded fuels. The sample selection covered all areas of Perth and included all brands of fuel retailers and all fuel types.

A fuel's ability to resist detonation while being compressed is measured by its Research Octane Number (RON), commonly referred to as its octane rating. A further measure, Motor Octane Number (MON) is the resistance to detonation occurring under higher heat and load conditions. The MON value for a given petrol type is approximately 10 points lower than its RON value.

One hypothesised outcome of the testing was that fuel quality across Perth would produce almost uniform results, reflective of WA's reliance on a single local refinery. This doesn't appear to be the case. While all fuel sampling results were within fuel quality standard parameters, there did appear to be a lack of uniformity across retailer brands and locations. Samples from the same fuel retailers at different locations didn't appear to have any like results, nor samples taken from sites within close proximity to each other.

The key petrol variations are as follows:

- For ULP 91, the RON numbers ranged from 91.1 to 91.9, with MON ranging from 82.2 up to 83.4; sulfur ranging from as high as 80ppm to as low of 44ppm.
- For PULP 95, the RON numbers ranged from 95 up to 95.9, with MON ranging from 85.2 up to 86; sulfur levels were as high as 30ppm and as low as 10ppm.
- For PULP 98 the RON numbers ranged from 98.1 up to 98.5, with MON ranging from 86.5 up to 87.2 (a higher Sensitivity number than the other types of petrol); levels of sulfur weren't as low as expected and with a high level of fluctuation, from as high as 45ppm (higher than the PULP 95 samples) and as low as 10ppm.

Olefins, saturates and aromatics also produced variable results. For ULP 91 aromatic content fluctuated significantly, from a minimum of 31.09 up to 37.3.

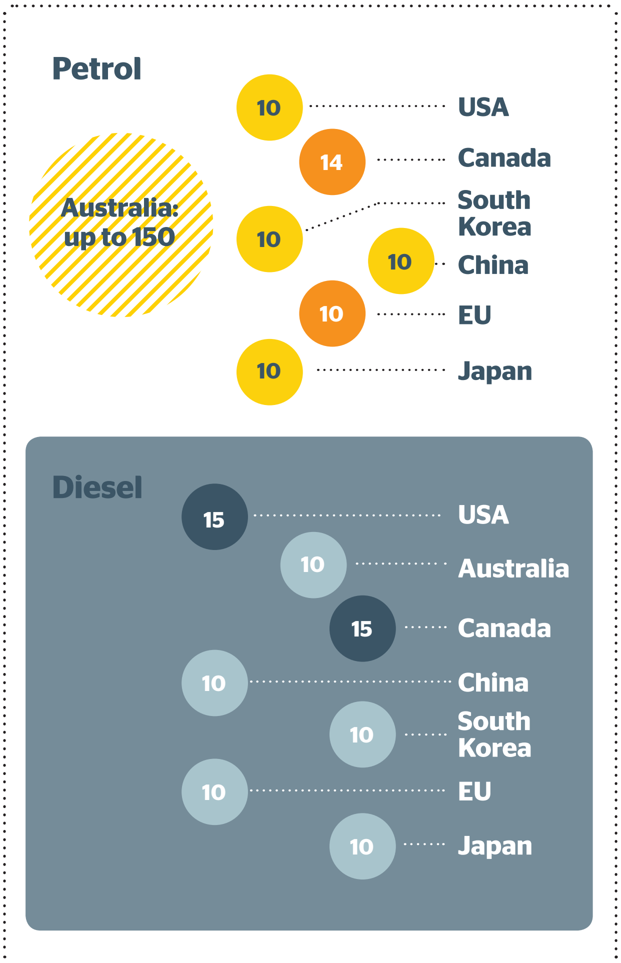
Aromatic and sulfur content fluctuations were quite small for PULP 95, fluctuating between 39.37 per cent and 40.96 per cent. While 80 per cent of the PULP 98 sampled had individual aromatics above the 42 per cent pool average standard, this was still less than the 45 per cent cap.

The diesel results showed less contrast:

- Cetane across the diesel samples varied by four points, from 53 up to 57, above the minimum cetane level of 46. The proprietary or brand-name diesels also fell within these observations.
- Due to the stricter sulfur regulations imposed on diesel, the sulfur content varied from 6ppm up to 9ppm, under the required maximum of 10ppm.

As expected, all of the samples showed compliance with the Fuel Standards.

Figure 1 » Sulfur content in fuel - parts per million



Sulfur content

Human activity has been the cause of 99 per cent of sulfur in the air. The main sources are emissions from coal fired power plants and vehicle engine exhausts, plus wood and tree burning, petroleum refining and metal processing. On its own, sulfur is a colourless gas and has a sharp, choking smell. Sulfur can bind with other compounds in the atmosphere to form small toxic particles and clusters that create visible smog, and easily dissolves in water. When large amounts of sulfur mix with water in the atmosphere, it contributes to acid rain.[8]

Sulfur dioxide impacts humans when inhaled. Sulfur is an irritant to the airways, including the nose and throat, and can cause coughing, wheezing, shortness of breath and tightness in the chest. People with respiratory conditions are most at risk of developing issues when inhaling sulfur. Sulfur can also cause burning to the eyes and skin. Particles can be inhaled deep into the lungs causing further serious health problems.[9]

With up to 150ppm allowable sulfur content in Australian unleaded petrol, Australian fuel standards permit up to 15 times the 'international standard', much to the detriment of Australian health, environment and vehicle operability.[10]

Across Europe, China, Russia, the US and Canada the sulfur limit is 10ppm. South Korea and Singapore, where over 80 per cent of Australia's imported refined fuel is imported from[11] also have minimum fuel specifications for sulfur of 10ppm.[12]

By 2020, India, New Zealand and several Middle Eastern countries will also require 10ppm sulfur maximum fuel. In fact, New Zealand will overtake Australia from July this year with the New Zealand Government announcing new fuel specifications in December 2016, with formal confirmation taking place in October 2017 and a start date of July 2018. The New Zealand refining industry raised no objections to meeting higher fuel standards within such a timeframe.[13]

In terms of reducing sulfur emissions from vehicles, the introduction of ultra-low sulfur fuels will have an immediate and extensive impact on the worst emitters – being older vehicles – which were manufactured under much less stringent emissions standards. Through lowering sulfur content, reductions occur from across the entire vehicle fleet.[14]

Aromatics (BTEX)

Aromatic content (aromatics) were introduced to fuel to improve octane following the removal of lead. Although benzene is a key component of aromatics, aromatics also comprise toluene, ethyl-benzene and xylene (BTEX). Benzene is also formed through combustion of aromatics, as well as being an initial component.

Australian limits for total aromatic content are the equal-highest of OECD countries along with New Zealand at 45 per cent. With South Korea prescribing the lowest allowable limits of aromatics of 22 per cent.

Combustion engine vehicle emissions is the largest source of benzene, which is an aromatic volatile organic compound (VOC), accounting for approximately 70 per cent of all benzene emissions in Europe with an additional 10 per cent attributed to refining and distribution.[15] The highest benzene exposure occurs at petrol filling stations, with much higher levels found inside vehicles than in residential air.[16] Benzene in fuel is currently limited to one per cent (rounded to); however this is proposed to be clarified (reduced) to 1.00 per cent.

The World Health Organisation (WHO) advises *'Benzene is carcinogenic to humans, and no safe level of exposure can be recommended'*.[17] Benzene is (and has been) classified as a Group 1 carcinogen for over 30 years – the highest carcinogen classification.[18] A reduction in aromatics is aimed at reducing the negative health outcomes of exposure and would enable compliance with Euro 6 and equivalent international standards in vehicles. In the majority of the current light vehicle fleet, running lower aromatic content fuels would be expected to reduce the risk of combustion chamber and injector deposits and reduce particulate emissions.[19]

Polycyclic Aromatic Hydrocarbons

Diesel emissions contain polycyclic aromatic hydrocarbons (PAHs). There are over 500 detectable PAHs and related compounds, most notably napthalene and benzo(a)pyrene. PAHs are identified as mutagenic, carcinogenic and teratogenic – meaning they can bind to DNA and RNA, causing cell damage and mutation. PAHs are carcinogenic and toxic to fetuses, causing adverse birth outcomes.[20]

[8] Agency for Toxic substances and disease registry (US), (1998) Public health statement sulfur dioxide. Available online: https://www.atsdr.cdc.gov/ToxProfiles/tp116-c1-b.pdf
[9] Department of the Environment and Heritage, (2005) Sulfur dioxide (SO2) Air quality fact sheet. Available online: http://www.environment.gov.au/protection/publications/factsheet-sulfur-dioxide-so2
[10] ICCT, (2014) China V gasoline and fuel quality standards, January 2014. Available online: http://theicct.org/sites/default/files/publications/ICCTupdate_ChinaVfuelquality_jan2014.pdf
[11] Department of Environment and Energy (2017), Australian Petroleum Statistics, December 2017. Accessed on 16 February 2018 https://www.energy.gov.au/publications/australian-petroleum-statistics-2017
[12] S&P Global Platts (2018), Methodology and specifications guide Asia Pacific and Middle East refined oil products, January 2018. Accessed online on 16 February 2018 https://www.platts.com/IM.Platts.Content/MethodologyReferences/MethodologySpecs/Asia-refined-oil-products-methodology.pdf
[13] S&P Global Platts (2017), New Zealand rolls out new gasoline specs Oct 2, sulfur to drop to 10 ppm July 2018, October 2017. Accessed online on 16 February 2018 https://www.platts.com/latest-news/oil/singapore/new-zealand-rolls-out-new-gasoline-specs-oct-27876392
[14] Fiebig et al. (2014) Particulate emissions from diesel engines: correlation between engine technology and emissions. Journal of Occupational Medicine and Toxicology 2014 9:6. Accessed online https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3973853/pdf/1745-6673-9-6.pdf
[15] Bassett, W.H. (1999). Clay's Handbook of Environmental Health, Eighteenth edition. Pg. 731. Accessed on 19 February 2018 https://books.google.com.au/books?id=ck2qO5Gyj40C&printsec=frontcover#v=onepage&q&f=false
[16] World Health Organisation, (2010) Preventing disease through healthy environments. Accessed on 19 February 2018 http://www.who.int/ipcs/features/benzene.pdf
[17] Ibid.
[18] Ibid.
[19] Department of Environment and Energy (2018), Better fuel for cleaner air: draft regulation impact statement, citing, ABMARC (2017). Technical advice on fuel parameters and specifications, August, report prepared for the
[20] European Commission, Scientific Committee on Food (2002). Polycyclic Aromatic Hydrocarbons – Occurrence in foods, dietary exposure and health effect, 4 December 2002. Accessed on 20 February 2018 https://ec.europa.eu/food/sites/food/files/safety/docs/sci-com_scf_out154_en.pdf

The main sources of PAH emissions are wood-burning home heating and motor vehicle emissions. In the air, PAHs are often absorbed into PM and therefore easily inhaled deep into the lungs;[21] PAHs are most easily absorbed by lipids (fats) so are quickly absorbed once inside the human body.[22]

The level of allowable PAHs in diesel directly impacts on the noxious emissions levels that are produced while driving and can also impact on the engine operability.

Octane

The overall energy efficiency of an internal combustion engine has many influencing factors, including the amount the air/fuel mixture is compressed in the cylinder, the completeness of combustion process itself, the air to fuel ratio, the ignition timing and the mechanical design of the engine and its lubrication.

An engine's compression ratio is established by the vehicle manufacturer and built into the mechanical design of the engine based on around a reference fuel that the engine will use in service, so that an optimal design can be achieved.

The higher the compression ratio of an internal combustion engine, the higher its thermal efficiency, providing energy from the combustion of the fuel can be optimised. Petrol engines employ a spark to ignite the air-fuel mixture in the engine's cylinder, with the engine designed to have the fuel-air mix burn at a fixed point in the cycle. Higher engine compression ratios introduce the potential for an engine to have its thermal efficiency improved, providing the combustion of the fuel can still be controlled under these more highly compressed conditions. If the fuel's combustion can be controlled under higher compression, greater engine efficiency can be achieved. Alternatively, more power can be extracted from the same amount of fuel.

In a correctly running engine the air-fuel mixture burns very quickly in a smooth and controlled fashion. Where a fuel's octane rating is too low for an engine's compression ratio and other settings such as its ignition timing, pre-ignition can occur. Symptoms of pre-ignition include a loss of engine power and a 'knocking' or 'pinging' sound. It is caused by the air/fuel mixture detonating too early, rather than burning in a controlled fashion after being ignited by the spark plug(s). Pre-ignition can also place undue stress on engine components.

A fuel's ability to resist detonation while being compressed is measured by its RON, commonly referred to as its octane rating. In engines with relatively high compression ratios, a higher octane fuel is required to optimise efficiency and operability. The availability of higher octane fuels provides manufacturers with the opportunity to build engines with higher compression ratios, which in turn can utilise higher octane fuels to improve engine efficiency.[23]

There are several ways of measuring octane, the most common of which is RON. RON is determined using a test engine which has a variable compression ratio and is run at 600rpm. MON is a second type of octane rating which is also determined using a test engine, however this measure simulates slightly higher load and heat conditions. The MON value for a given petrol type is approximately 10 points lower than its RON value.

In 2017, Australia imported over 95 per cent of all new vehicles sold from nations which are either regulated by stricter fuel standards or that manufacture vehicles predominantly for export. From 2018, Australia will import 100 per cent of its new vehicles, 85 per cent of which will come from markets in Japan, Thailand, Europe, and South Korea.[24] Alarmingly, there is anecdotal evidence that the process of 'de-rating' occurs among a variety of imported vehicles, whereby some manufacturers

[21]US Department of Health and Human Services (1995). Toxicological profile for Polycyclic Aromatic Hydrocarbons. Accessed online 20 February 2018 https://www.atsdr.cdc.gov/toxprofiles/tp69.pdf

[22]Hussein, I. A-S & Mona S.M.M, (2015) A review on polycyclic aromatic hydrocarbons: Source, environmental impact, effect on human health and remediation. Egyptian Journal of Petroleum. Accessed on 20 February 2018 https://ac.els-cdn.com/S1110062114200237/1-s2.0-S1110062114200237-main.pdf?_tid=820c400e-15e2-11e8-8f47-00000aacb35f&acdnat=1519092502_bcbf71a47c474e6bf8a1bd6643e0d1e5

[23]Stone, R. (2012) Introduction to combustion engines, Department of Science, University of Oxford, Fourth edition. Accessed on 19 February 2018 https://books.google.com.au/books?id=afYcBQAAQBAJ&printsec=frontcover#v=onepage&q&f=false

[24]VFACTS, (2017). VFacts national report – New vehicle sales, December 2017

modify engines to enable them to run on Australia's low octane, high sulfur fuel, usually to the detriment of performance and efficiency.

Reducing engine compression ratios to accommodate Australia's low octane 91 RON fuels has resulted in the most economical of vehicle models offered in Australia being less economical than variants of the same model sold to other markets. Further, vehicles manufactured in line with the Euro 6 fuel quality standard produce more emissions when using higher sulfur fuels than those they are designed to use.[25] It stands that de-rating a fuel efficient car, such as lowering its engine's compression ratio, has the potential to increase its fuel consumption and exhaust emissions, where all other conditions are equal.

As 91 RON is the dominant petrol type consumed in Australia, the majority of vehicles imported to Australia are not optimised to run on high-octane petrol (e.g. 95 RON, 98 RON). This reduces fuel efficiency (up to six per cent), could increase consumer fuel costs, and results in the release of more noxious emissions and greenhouse gases per kilometre travelled than from vehicles optimised for high-octane petrol. Vehicles that are designed to operate on high-octane petrol (e.g. 95 RON, 98 RON) can be five per cent more energy efficient, and perhaps eight per cent if turbocharged, meaning similar reductions in greenhouse and noxious emissions.[26]

Draft RIS (Department of Environment and Energy)

Cetane

The cetane of diesel fuel is used for a similar purpose as octane in unleaded petrol. However, cetane is a measure of the compression required to ignite it, and combustion speed. Though compared to octane, the cetane number itself is a lower number – between 25 and 65.

Lower cetane numbers produce higher levels of PM and unburned hydrocarbons. Higher cetane numbers also reduce fuel consumption. There is evidence that increasing the cetane number in diesel fuel by one single number can reduce PM emissions by up to eight per cent and hydrocarbon emissions by up to four per cent.

Currently the cetane minimum number for Australian fuel is 46, with a proposal under both Options B and C of increasing the cetane number by five points up to 51 minimum, harmonising Australian diesel cetane with European standards.

Where we stand

For reasons of the environment, health, vehicle performance and to better facilitate adoption of new technologies there is a need for higher quality fuel in Australia. In regards to health impacts in particular, the most serious, toxic and even deadly outcomes have been long known, having been documented in numerous studies in the 1980s, 1990s and early 2000s. Further, there are similarly devastating outcomes for the environment which need to be ameliorated. RAC's position on fuel quality in Australia is based on providing Western Australians the highest level of protection from harmful emissions, and access to clean and safe vehicle technologies.

Sulfur and aromatics

In alignment with each element of the Policy assessment criteria for the Draft RIS, RAC supports implementing Option C with an implementation date of 2022, providing for a pathway to long-term adoption of Option B, to provide the most benefit to Australians. Fuel quality standards will have an immediate and widespread impact on reducing emissions across the existing vehicle fleet, will dovetail and pave the way for the introduction of an Australian CO_2 standard for new vehicles (Figure 2). In the longer term, an eventual shift to higher octane fuels (95 and 98 RON) would enable the adoption of technological advances for both engine efficiency / fuel economy and emissions reduction, while also enabling better harmonisation of fuel regulations.

[25]FCAI, (2017). FCAI Response to Better fuel for cleaner air Discussion paper. Accessed on 8 February 2018, https://www.fcai.com.au/library/publication/fcai_response_to_better_fuel_discussion_paper.pdf

[26]Department of Environment and Energy (2018), Better fuel for cleaner air: draft regulation impact statement. Accessed on 28 February 2018 http://www.environment.gov.au/system/files/consultations/56be59ae-a8ff-4c7e-8586-6b25b975b212/files/better-fuel-cleaner-air-draft-ris.pdf

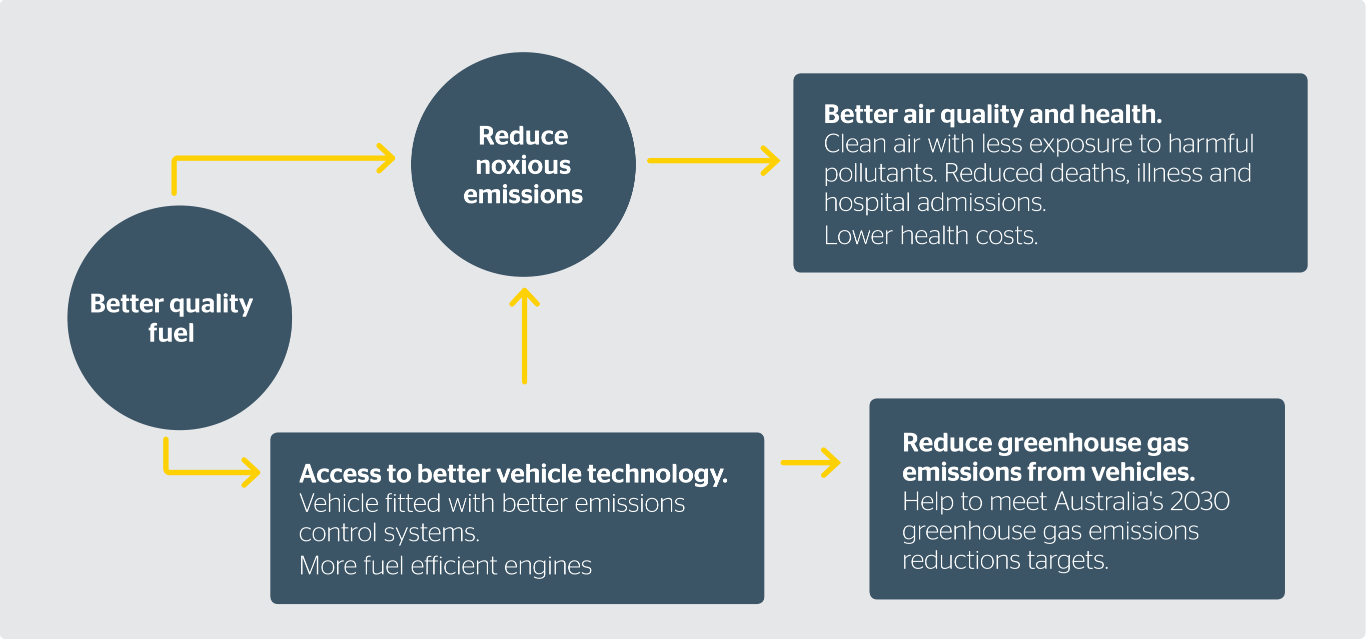


Figure 2 » Fuel quality impacts on vehicle emissions

98 RON unleaded petrol

Unlike 91 RON and 95 RON petrol, the Australian petrol standard currently does not include a minimum octane limit for 98 RON petrol. Given consumers pay a price premium for 98 RON fuels, they should also have the benefit of knowing these fuels are regulated in the same way as 91 and 95 RON fuels, especially where their vehicles specify it. As referred to in the Draft RIS, a standard for 98 RON petrol specifying the minimum RON should be considered in order to provide assurance that petrol meets the 98 RON octane limit if a fuel labelled as such is being supplied.

Fuel labelling

While changes to fuel standards are under consideration, now is an opportune time to address fuel labelling at the fuel retail outlets.

A system of uniform colour coding and clear labelling would assist consumer in identifying the differences in fuels. A uniform fuel labelling system was implemented across the European Union in 2016 (EN16942). The uniform fuel labelling system includes:

- prescribed colour scheme;
- fuel types;
- size required for labelling;
- number representing ethanol/bio-diesel content;
- specified shapes for each fuel type; and
- specified font to ensure uniformity and compliance.

In an RAC survey of 137 members who 'misfuelled' over 19 days in 2016, 56 per cent of them put petrol into diesel vehicles, seven per cent put diesel into petrol vehicles and 37 per cent unsure of how they 'misfuelled'. This represents a large number of vehicle issues that would not occur with correct fuelling.

Summary recommendations

1. **Providing better fuel quality**
   RAC supports better fuel quality available for the Australian public through implementation of the Government-proposed Option C by 2022; comprising a reduction in sulfur to 10 ppm; reduced aromatics to 35 per cent.
2. **Enhancing fuel efficiency and vehicle performance**
   RAC supports a long-term view which incorporates consensus on a pathway for Option B, whereby the more widespread use of higher octane fuels like 95 RON and 98 RON would enable further adoption of the technology available elsewhere that enhances engine efficiency, provides fuel economy and lessens emissions.
3. **Accelerating broader and complementary emissions policy**
   RAC supports better fuel quality as part of a multi-faceted approach to emissions, which includes the other pillars of the Ministerial Forum's emissions review. The package of work has numerous cross-overs and reliance on other pieces of work to be successful.

RAC has welcomed the opportunity to participate in the Australian Government's Ministerial Forum on Vehicle Emissions review of fuel quality. We trust RAC's response which is based on providing Western Australians with higher levels of protection from harmful emissions is useful in progressing fuel quality reform.

For further information please
contact advocacy@rac.com.au

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