



BOSCH

Response from Robert Bosch (Australia) Pty Ltd

Vehicle Emissions Working Group
The Department of Infrastructure and Regional Development
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08 April 2016

Re: Vehicle Emissions Discussion Paper, February 2016

To whom it may concern,

Robert Bosch (Australia) Pty Ltd (BOSCH) supports the reduction of emissions and improvement in efficiency of motor vehicles for improved environmental, health and energy outcomes and welcomes the opportunity to provide input to the Australian Government Ministerial Forum.

As a major supplier to automotive vehicle manufacturers worldwide, Bosch has experience and knowledge regarding systems for control of combustion in engines, treatment of exhaust gas pollutants, gasoline, diesel and alternative fuels, electric drives and intelligent vehicle systems.

Key messages

- Adoption of Euro 6 emissions standard supported
- Adoption of fuel efficiency (CO₂) standards supported
- Low sulphur gasoline recommended
- De-carbonisation of transport fuels recommended
- National Policy Framework for Intelligent Transport Systems supported

Implementation of Euro 6 noxious emissions standards

Bosch supports the adoption of Euro 6 emissions for light duty road vehicles in Australia.

Legislation of limits for noxious exhaust gases from road vehicles has proven to be a successful strategy for countless markets world-wide in improving air quality, particularly within urban air sheds. Periodic review and tightening of limits has driven continuous evolution and innovation of technologies to reduce the noxious gases fundamentally produced by the combustion



process and to then further reduce them via on-board treatment systems such as catalysts and regenerating filter traps in the exhaust.

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Despite recent and continuing strong investment in research and development of hybrid and electric drive systems and battery technology, we forecast combustion engines will remain the dominant powertrain technology in the new vehicle market for the foreseeable future, due mainly to their cost competitiveness. Dominance of combustion engine powertrains¹ coupled with forecast continued growth in market share of gasoline direct injection (GDI) engines² and an ongoing significant market share of diesel fuelled vehicles in Australia with their inherent particulate emissions, provides in our opinion a compelling motivation for adoption of the most up-to-date emissions standards.

The Euro 6 emissions standard introduces elements that extend beyond the particle mass (PM) limits of Euro 5 to specifically target ultra-fine particulates by way of its particle number (PN) limits, as well as elements to generally force improvements in real world system performance such as the real driving emissions test (RDE) and the world-wide harmonized light duty test cycle (WLTC) for passenger car and light duty vehicles.

The WLTC drive cycle for vehicle type approval will alleviate some of the currently perceived mismatch between 'real world' emissions and fuel economy of a vehicle in service and its type approval 'on-cycle' result from the test laboratory.

The RDE will force adoption of emissions and fuel economy control measures that are broader ranging, providing more consistent performance beyond the boundaries of the 'on-cycle' test conditions, as well as enabling easier in-service conformance auditing of vehicles.

Systems and components to achieve conformance to Euro 6 requirements are either already in high volume series production since 2014 when they were introduced with Euro 6 stage 1 in Europe, or in series development for implementation with Euro 6 stage 2 planned for 2017.

Fuel Quality Standards

Bosch confirms the assertions made in the discussion paper that sulphur in gasoline and diesel can directly affect the noxious and CO₂ emissions from combustion engine vehicles. State-of-the-art technologies for low emissions and fuel consumption require low sulphur fuels. Australia's sulphur content limit of 10 parts per million (ppm) for diesel is world benchmark standard as defined by the European Automotive Manufacturers Association (ACEA) Worldwide Fuels Charter (WFC) and is fully compatible with latest combustion engine emissions and fuel economy technologies.

¹ Source: VFACTS National Report December 2015. Bosch, March 2016

² Bosch prognosis 2016.

**Bosch does not see any technical reason why Australia could not adopt Euro 6 for diesel fuelled cars and light trucks.**

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Australia's sulphur content limit of 150 ppm for 'regular' gasoline is well behind world benchmark standard and is not compatible with state-of-the-art engine emissions controls technology.

Australia's limit of 50 ppm for 'premium' gasoline approaches WFC Category 3 which at 30 ppm is deemed suitable for Euro 4 vehicles. For compatibility with current state-of-the-art engine and vehicle emissions controls technologies such as those required to meet US and California LEV II and III, and Europe's Euro 5 and 6, WFC recommends Category 4 and 5 fuels which have sulphur limits of 10 ppm. The low sulphur limits enable sophisticated technologies for treatment of oxides of nitrogen (NOx) and PM in the exhaust gas and ensure long term durability of three-way catalysts, a core component of both port fuel injection (PFI) and GDI systems.

Whether or not the actual levels of sulphur in gasoline available in Australia and whether or not 50 ppm sulphur for 'premium' gasoline is sufficiently low to ensure long term durability and performance of even the current Euro 5 compliant vehicles in service, remains to be seen.

Bosch recommends limiting sulphur in gasoline in Australia to 10 ppm and adoption of Euro 6 emissions limits for gasoline fuelled vehicles.Implementation of Fuel Efficiency standards for light vehicles**Bosch agrees with the approach of legislating mandatory fuel efficiency / CO₂ emissions limits for light vehicles.**

In the worldwide markets where they have been applied for some time already, legislated mandatory CO₂ limits have provided planning security for companies and a framework conducive to development and market placement of new and innovative technologies; for combustion engines, exhaust treatment systems and vehicle weight reduction but also extending to alternative low and zero carbon fuels, hybrid and electric drives, battery energy storage and others.

Even though we believe in a future of vehicle electrification and are heavily investing in R&D towards that end, the technical and commercial challenges and uncertainties associated with fully electric vehicles mean that, in our opinion, their market entry will continue to be evolutionary rather than revolutionary.

Further cost effective evolution of combustion engines

Fully electric vehicles, energised with grid electricity from 'green' generation sources while undoubtedly a stand-out technical solution for CO₂ reduction,



are still some years away from being commercially competitive with current alternatives. For the immediate future, continued evolution of combustion engine technologies can deliver more cost effective CO₂ reduction and therefore be more likely to achieve mass market adoption and desired environmental outcomes, in our opinion.

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Costs of CO₂ reduction technologies

As a supplier to vehicle manufacturers of engine and emissions control systems we are not in a position to comment regarding their strategies around how much, if any, of the cost of such technology is passed on to end customers. We have observed however that for fuel saving technologies such as variable valve actuation, exhaust gas recirculation systems, turbo-charging, advanced fuel injection systems and others, in most cases the cost is of a level that can be recovered via fuel savings within what most manufacturers consider an acceptable period of initial ownership. Furthermore, we have observed worldwide that real prices of new vehicles have increased at rates disproportionately low when compared to the technology, performance and feature content added to the vehicles. Manufacturers have demonstrated an ability to significantly increase content and value in vehicles with only minimal price increase.

Further complementary emission reduction measures

The exploration by Government of opportunities for CO₂ abatement beyond that of exhaust tailpipe emission limits for new vehicles, is an approach strongly supported by Bosch. New cars sales account for circa 1.1 million vehicles p.a., or 6% of Australia's 18 million total vehicle parc³, so we believe solutions that can apply to both new cars and existing in-service vehicles should be part of any future CO₂ strategy.

Bosch supports de-carbonisation of combustion fuels

Combustion engines were present in approximately 99.5% of all new passenger car and light duty vehicles sold worldwide in 2015, a market share that will fall only slightly to 98% by 2020⁴. Clearly, in addition to improving the fuel efficiency of combustion engines, any strategy for reducing CO₂ emissions from vehicles in the foreseeable future would benefit also from reducing the carbon content of the fuels consumed. Furthermore, low carbon and carbon-neutral fuels can also be used with some of the existing in-service fleet, delivering broader effective national emissions reductions.

Many state-of-the-art gasoline and diesel engine components are already compatible with fuels such as LPG, CNG, ethanol blends and bio-diesel.

³ Source: VFACTS National Report December 2015. Australian Bureau of Statistics Motor Vehicle Census 2015.

⁴ Source: Bosch, 2016



Components requiring further engineering would in most cases be variants of existing parts and therefore the costs associated with such engineering would generally be much lower than that of developing all new components. Use of low carbon fuels with combustion engines is therefore a cost competitive approach to CO₂ reduction.

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Bosch supports Intelligent Transport Systems

Bosch supports the exploration by Government of Intelligent Transport Systems (ITS) solutions for reduction of vehicle emissions. We believe technologies for vehicle-to-vehicle and vehicle-to-infrastructure communication have strong potential to enable solutions for reduced fuel consumption from the road transport sector by; 1) improving vehicle fuel efficiency, and 2) improving the convenience and appeal of alternatives to individual vehicle use.

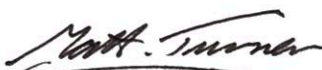
Solutions that improve traffic flow such as coordinated traffic light sequencing, dynamic lane allocations during peak periods, vehicles that can 'know' in advance of a red traffic light change or can alert the driver to alternate routes around a traffic snarl, and 'platooning' of vehicles for highway cruising are just some examples of technologies that enable vehicles to use less fuel and therefore emit less emissions for a given distance travelled.

Solutions that enable reduced vehicle use centre around provision of easy access to high quality travel related information so people can make more informed decisions about where, when and how they travel. For example, internet cloud access to systems that can identify availability of parking at an intended destination, availability of car-share and ride-share options, schedule and real-time status information for multi-modal public transport options, and many more.

In our opinion, future strategies for vehicle CO₂ abatement should include vehicle-to-vehicle and vehicle-to-infrastructure communication technologies that are standardised, robust and accessible in order to provide a foundation on which a range of innovative products and services can be developed. To this end, Bosch supports the Government's leadership in development of a new National Policy Framework for ITS in Australia.

We would be happy to support the Working Group or the Ministerial Forum with additional information should any of the above require further clarification.

Yours sincerely,


Matt Turner

Technical Specialist – Automotive Powertrain Systems





Bosch has had a presence in Australia since 1907, opening its first wholly owned subsidiary, Robert Bosch (Australia) Pty Ltd in 1954. Bosch generates revenues of more than 750 million Australian dollars per annum in Oceania, and employs over 1,400 associates. Our regional activities are operated through six wholly owned subsidiary companies and cover a diverse range of businesses including household appliances, security technology, power tools and accessories, engineering services and contract manufacturing, parts and equipment for automotive workshops and motorsport enthusiasts, franchised car servicing, equipment, services and solutions for manufacturers, drives and control technology, software innovations, hot water and heating systems, packaging technologies and service support for Bosch equipped eBikes.

The Bosch Group is a leading global supplier of technology and services. It employs roughly 375,000 associates worldwide (as of December 31, 2015). According to preliminary figures, the company generated sales of more than 70 billion euros in 2015. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Bosch Group comprises Robert Bosch GmbH and its roughly 440 subsidiaries and regional companies in some 60 countries. Including sales and service partners, Bosch's global manufacturing and sales network covers some 150 countries. The basis for the company's future growth is its innovative strength. Bosch employs 55,800 associates in research and development at roughly 115 locations across the globe. The Bosch Group's strategic objective is to deliver innovations for a connected life. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is "Invented for life."

The company was set up in Stuttgart in 1886 by Robert Bosch (1861-1942) as "Workshop for Precision Mechanics and Electrical Engineering." The special ownership structure of Robert Bosch GmbH guarantees the entrepreneurial freedom of the Bosch Group, making it possible for the company to plan over the long term and to undertake significant up-front investments in the safeguarding of its future. Ninety-two percent of the share capital of Robert Bosch GmbH is held by Robert Bosch Stiftung GmbH, a charitable foundation. The majority of voting rights are held by Robert Bosch Industrietreuhand KG, an industrial trust. The entrepreneurial ownership functions are carried out by the trust. The remaining shares are held by the Bosch family and by Robert Bosch GmbH.