**Australian Government**

**Department of Infrastructure, Transport, Regional Development, Communications and the Arts**

**March 2023**

Director – Internal Comms and Creative Services
Communication Branch
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# Executive Summary

## On average, over 160 pedestrians die on Australian roads every year. Thousands more are injured.

The impact of pedestrian road crashes is significant, costing the Australian community over $1.2 billion each year. For those involved in these crashes and their families, there is an immeasurable personal cost.

This consultation Impact Analysis focuses on a specific pedestrian safety problem relating to electric vehicles[1]. Because electric vehicle engines are typically very quiet, at low speeds, when tyre and wind noise is negligible, it can be difficult for pedestrians to hear these vehicles, increasing the risk of a collision.

This is a particular issue for the blind and low vision community, given their reliance on sound to negotiate the road network independently. A survey by the Monash University Accident Research Centre (MUARC) found that people in this community had an increased feeling of vulnerability on roads due to electric vehicles, with 35 per cent of those who participated in the survey reporting that they had experienced either a collision or near-collision with an electric vehicle.

To mitigate this risk, most major vehicle markets, including the European Union, United Kingdom, Japan, Korea, China and the United States, have mandated the fitment of Acoustic Vehicle Alerting Systems (AVAS) to their electric vehicles. These systems are designed to emit a sound external to the vehicle that must be able to be detected by pedestrians.

The United Nations (UN) World Forum for the Harmonization of Vehicle Regulations (WP.29) has established an international vehicle regulation for AVAS, known as UN Regulation 138/01 – Uniform Provisions Concerning the Approval of Quiet Road Transport Vehicles with Regard to their Reduced Audibility (UN R138/01).

The Australian Government has a strong history of taking action to improve road safety. One of its key actions is setting mandatory national vehicle standards, known as the Australian Design Rules (ADRs), under the *Road Vehicle Standards Act 2018* (RVSA). Where possible, the ADRs are harmonised with international vehicle regulations, as developed through the UN.

This consultation Impact Analysis therefore examines whether there is a case for the Australian Government to adopt UN R138/01 as a new ADR. The ADR would guarantee that new electric vehicles supplied to the Australian market are fitted with AVAS and that these systems meet the same performance standards. This is unlikely to be achieved through market forces alone. It would ensure Australians have full access to the benefits of a safety technology that has already been widely adopted overseas.

While UN R138/01 applies to all light and heavy vehicles with an electric powertrain, this consultation Impact Analysis proposes that a new ADR would apply only to light vehicles at this stage. This is due to insufficient data available at this time to determine the likely benefits and costs of mandating AVAS for heavy electric vehicles in Australia.

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[1] In this Impact Analysis, the term ‘electric vehicle’ means vehicles able to operate for any period time without an internal combustion engine, including fully electric vehicles (powered by an electric motor only), hybrid electric vehicles (powered by both an electric motor and an internal combustion engine) and hydrogen fuel cell vehicles (which generate electricity to power the vehicle through a chemical reaction of hydrogen and oxygen).

A benefit-cost analysis was undertaken for mandating a new ADR for AVAS for light vehicles, informed by independent analysis by MUARC and advice provided by light vehicle manufacturers. The proposed applicability dates used for this analysis were:

- 1 January 2025 for newly approved vehicle models.
- 1 January 2026 for all new vehicles.

Note that, if an ADR is adopted, final implementation dates would be determined following consultation with industry.

Results indicate that, over a 35-year analysis period, the ADR could save 65 lives and avoid more than 5,000 injuries. The total benefits ($321.5 million) would outweigh the total costs ($184.1 million), leaving a $137.4 million net benefit. This demonstrates a strong reason for the Australian Government to intervene in the market and introduce a new ADR.

Note that these estimated benefits are limited to pedestrian trauma only, and are therefore conservative. The fitment of AVAS would also reduce the risk of crashes involving other vulnerable road users. A study in the US found that electric vehicles present a similar level of risk to cyclists as they do to pedestrians (NHTSA 2017).

The Department of Infrastructure, Transport, Regional Development, Communications and the Arts is now seeking your views on this consultation Impact Analysis. Specifically, we would like feedback on:

- Support for the proposed introduction of AVAS for new light electric vehicles.
- The benefit-cost analysis, including the assumptions on effectiveness of the technology, the costs, and the assumed benefits.
- The suitability of UN Regulation 138/01 for adoption, including any concerns on functional and/or performance requirements, test requirements, or implementation.
- Applicable vehicle categories, implementation timeframes, alternative standards.
- The feasibility of mandating AVAS for heavy vehicles in the future.
- Any other relevant views or information, which could assist decision-making.

Feedback is requested by Friday, 26 May 2023. Submissions can be uploaded via the department's website at https://www.infrastructure.gov.au/have-your-say.

Alternatively, you can email your submission to Sustainable.Transport@infrastructure.gov.au, or send it to:

Director, Land Transport Emissions and Environment
Department of Infrastructure, Transport, Regional Development, Communications and the Arts
GPO Box 594, CANBERRA ACT 2601

Please note, alternative text has been embedded within all graphs and tables in this document.

# 1. What is the Problem?

This consultation Impact Analysis focuses on pedestrian road trauma in Australia. Specifically, it seeks to address the increased risk that electric vehicles[2] have for pedestrian safety, related to the difficulty pedestrians have in detecting these quiet vehicles at low speeds.

## 1.1 Road Crashes in Australia

The impact of road crashes on society is significant, costing the Australian community over $29 billion per year in healthcare, lost productivity, and property expenses. This translates to an average cost of over $1,100 levied upon every person in Australia. For those individuals and families involved in these crashes, there is an immeasurable personal cost.

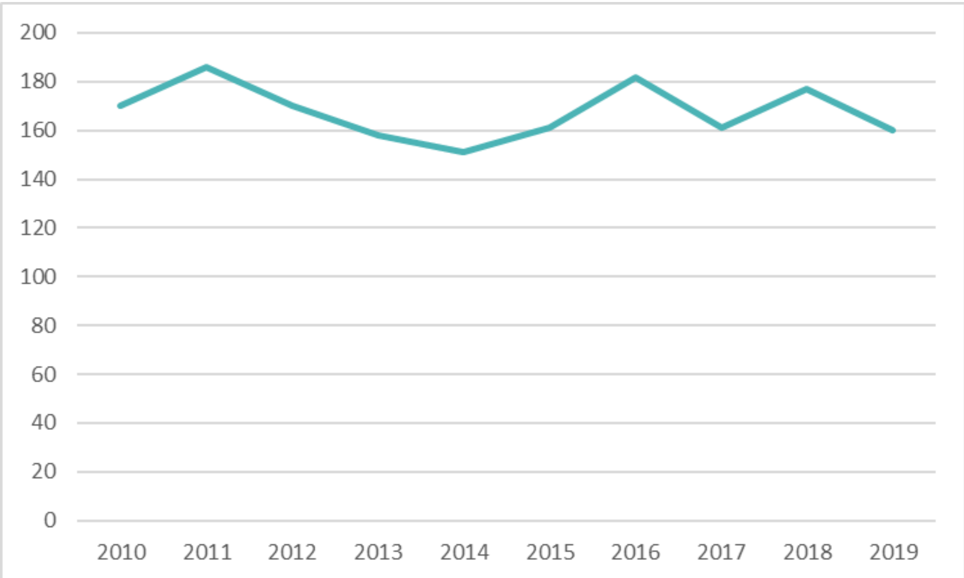
### 1.1.1 Pedestrian Trauma Rates in Australia

Pedestrians comprise the largest single road user group, as almost everyone is a pedestrian at some point of their travel journey. Most Australians regularly walk for leisure, to go to work, school or local shops and to access other modes of transport. Pedestrians are considered particularly vulnerable because they have little or no protection if struck by a road vehicle.

Pedestrians travel low kilometres relative to other road user groups, yet comprise 13 per cent of all road fatalities in Australia, amounting to over 160 deaths annually (BITRE, 2020). Thousands more are injured. Pedestrian crashes alone cost the Australian community over $1.2 billion each year.

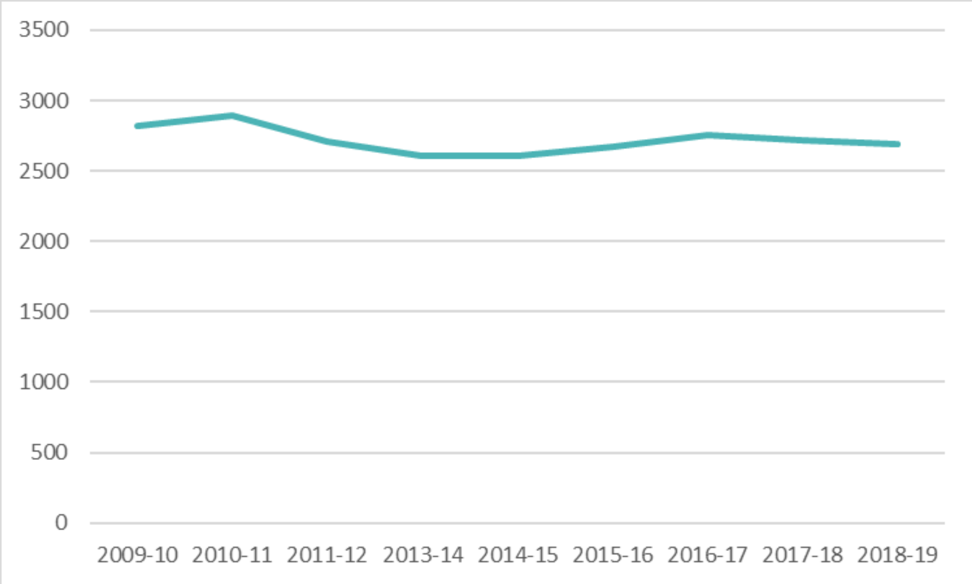
While crash outcomes for light vehicle occupants improved in the 10 years to 2019, similar improvements did not occur for pedestrians. Figure 1 shows the number of fatal pedestrian crashes in Australia from 2010 to 2019, and Figure 2 shows the number of pedestrians hospitalised with injuries. While not a perfect measure, hospital admission provides the best available indication of serious injury crashes in Australia. The majority of these incidents involved a light vehicle striking a pedestrian.

**Figure 1: Fatal pedestrian crashes in Australia, 2010 to 2019 (BITRE, 2020)**




[2] In this Impact Analysis, the term 'electric vehicle' means vehicles able to operate for any period time without an internal combustion engine, including fully electric vehicles (powered by an electric motor only), hybrid electric vehicles (powered by both an electric motor and an internal combustion engine) and hydrogen fuel cell vehicles (which generate electricity to power the vehicle through a chemical reaction of hydrogen and oxygen).

**Figure 2: Pedestrians injured in traffic accidents, 2009–10 to 2018–19 (BITRE 2021)**




## 1.2 Electric Vehicles an Emerging Risk

Electric vehicles produce significantly less noise than internal combustion engine vehicles. At low speeds, when tyre and wind noise is negligible, these vehicles can be difficult for pedestrians to detect, and there is therefore an increased risk of collisions. Furthermore, even though these collisions happen at low speeds, they can still cause serious injury and death due to the vulnerability of the pedestrians.

A 2017 study by the United States National Highway Traffic Safety Administration (NHTSA) found that, compared with an internal combustion vehicle, an electric vehicle was around 20 per cent more likely to be involved in a pedestrian crash.

Due to availability of data, this consultation Impact Analysis focuses specifically on pedestrians. However, it is worth noting that NHTSA found cyclists in the US faced a similar risk from electric vehicles as pedestrians.

### 1.2.2 Risk Greater for the Blind and Low Vision Community

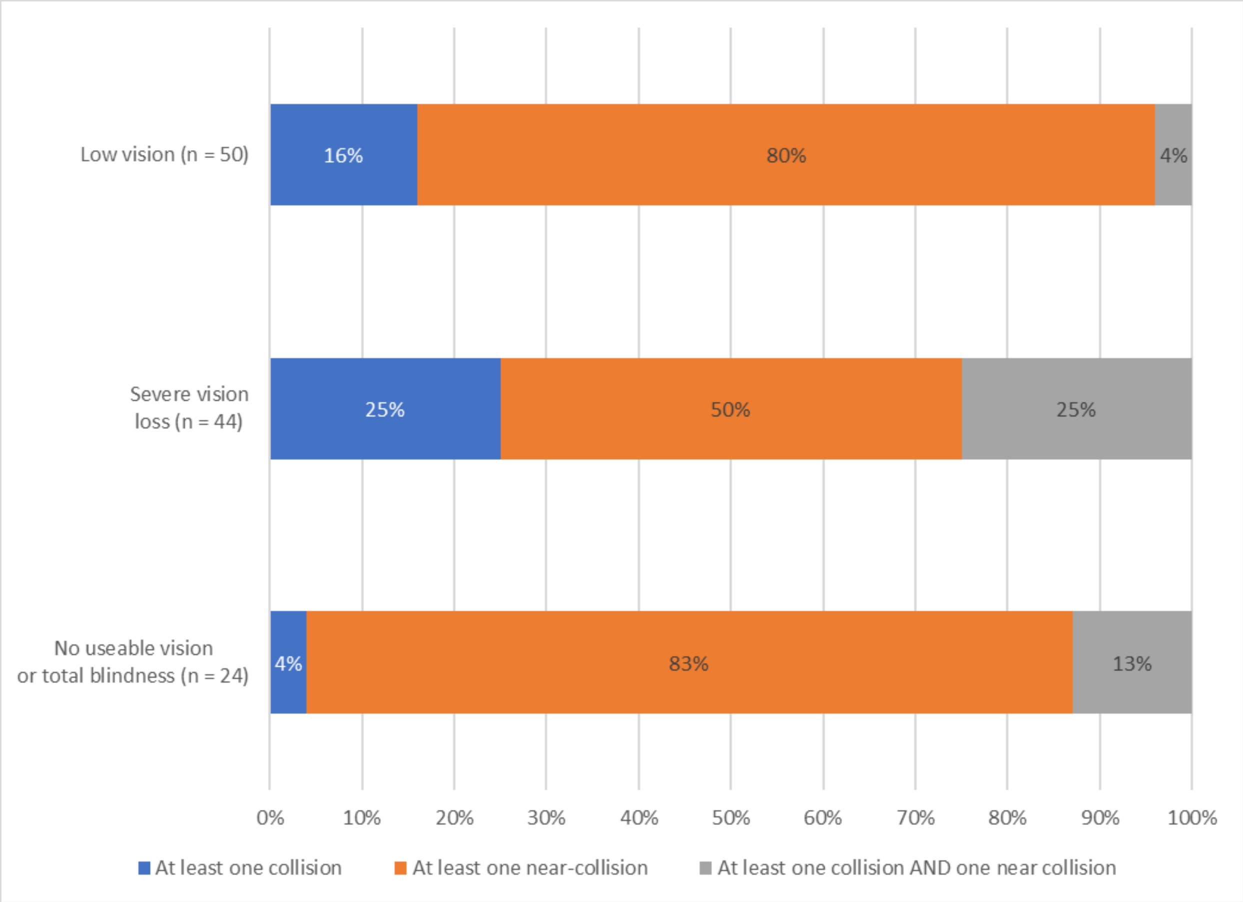
While electric vehicles present a risk for all pedestrians, there is a particular concern for blind and low vision pedestrians, given their reliance on sound to negotiate the road network independently.

In 2018, the Monash University Accident Research Centre (MUARC) conducted a study on the road safety impacts of electric vehicles on these pedestrians. The study was commissioned by Vision Australia, which provides blindness and low vision services nationally.

As part of this study, MUARC conducted a survey of 246 people who all had a degree of vision loss that cannot be corrected. When asked about collisions or near-collisions with electric vehicles (excluding bicycles), 35 per cent (86) of participants indicated they had been involved in either a collision, near-collision or both, and some more than once. The majority of these events occurred while crossing a road (58 per cent). (Liu et al, 2018)

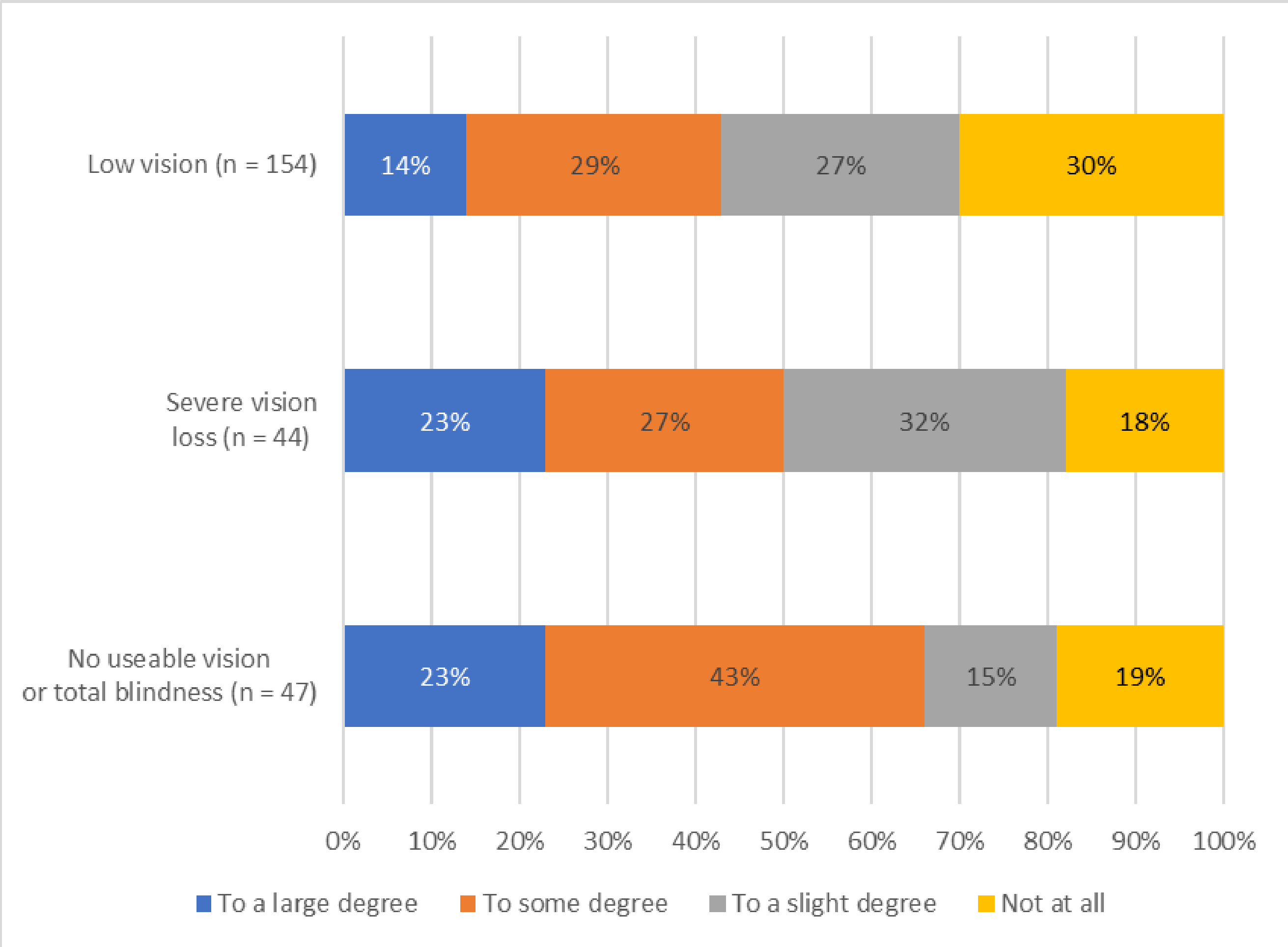
Figure 3 below shows the breakdown of these collision and near-collision events relative to vision loss.

**Figure 3 Collisions and near collisions with electric vehicles relative to vision loss (Liu et al, 2018)**




These events were found to have significant consequences for the mental health of those involved, particularly through increased anxiety and depression. Participants in the study were asked to reflect on whether the introduction of electric vehicles in Australia had reduced their confidence to walk near and cross roads. Sixteen per cent indicate that it had affected their confidence to a large degree, 31 per cent to some degree, and 26 per cent to a slight degree. Figure 4 below breaks down these figures further relative to vision loss. (Liu et al, 2018)

**Figure 4 Degree of reduced confidence as a pedestrian from the introduction of electric vehicles, relative to vision loss (Liu et al, 2018)**




### 1.2.3 Distracted Pedestrians also Emerging as a Concern

In 2020, MUARC undertook research to determine the impact of smartphone-related distractions on pedestrian safety. The research included a literature review, observational studies of pedestrian smartphone use, interviews and focus groups.

In general, the literature review found smartphone use to have a negative impact on pedestrian safety. Smartphone-using pedestrians walk slower and more unevenly, and pay less attention to their surrounding environment. (Osbourne, R. et al, 2020)

In its observational study, MUARC found that around 20 per cent of pedestrians used a smartphone when crossing a road. These pedestrians had a significantly higher proportion of critical safety events, such as near misses, compared with those not using a smartphone. The interviews and focus groups showed increasing community awareness of the safety risks associated with smartphone use on and near roads. (Osbourne, R. et al, 2020)

While MUARC did not specifically consider electric vehicles in the context of distracted pedestrians, it is logical to conclude there would be a further increased risk of collision.

## 1.3 Acoustic Vehicle Alerting Systems (AVAS)

Recognising the risk that quiet vehicles have for pedestrian safety, the United Nations (UN) World Forum for the Harmonization of Vehicle Regulations (known as WP.29) has established UN Regulation 138/01 – Uniform Provisions Concerning the Approval of Quiet Road Transport Vehicles with Regard to their Reduced Audibility. This regulation, UN R138/01, sets out requirements for AVAS for electric vehicles.

AVAS are sets of components installed in electric vehicles for the purpose of emitting a sound external to the vehicles. The sound emitted must be able to be detected by pedestrians at low speeds, particularly at speeds where the contribution of tyre and wind noise is minimal (Lawrence et al, 2020).

Most major vehicle markets, including the EU, UK, Japan, Korea, China and the US have mandated UN R138/01, or equivalent standards. This consultation Impact Analysis examines whether there is a case for the Australian Government to similarly mandate the fitment of AVAS for new electric vehicles in Australia. Reasons why this Government intervention may be required are outlined next.

# 2. Why is Government Action Required?

## 2.1 Government Measures to Improve Road Safety

There is strong commitment from all levels of governments to improve road safety in Australia, in line with community expectations. There are a range of regulatory and non-regulatory measures already in place, including mandatory national vehicle standards, the National Road Safety Strategy and Action Plan, consumer information programs like ANCAP, and dedicated funding for road safety initiatives and infrastructure upgrades. Appendix A—Government ActionsAppendix A—Government Actions to Address Road Trauma provides further details.

## 2.2 Pedestrian Safety not Improving, and an Emerging Risk from Electric Vehicles

Despite these measures, as outlined in Section 1, we are not seeing significant improvements in outcomes for pedestrians. Further, electric vehicles are presenting a new risk for pedestrian safety, relating to the difficulty pedestrians have in detecting these quiet vehicles at low speeds. The risk of collision is exacerbated for the blind and low vision community particularly, as well as for the increasing number of pedestrians distracted by their smartphones and other digital devices.

This problem will only increase as electric vehicles become more common on Australian roads. While electric vehicles currently account for less than one per cent of passenger vehicles on the road, sales are expected to increase substantially as electric vehicles become more competitive with internal combustion engine vehicles. In 2019, it was estimated that by 2050, nearly 70 per cent of passenger vehicles on the road will be electric (BITRE, 2019). With the Australian Government recently committing to accelerating the uptake of electric vehicles in Australia, this number may end up being much higher.

## 2.3 Acoustic Vehicle Alerting Systems (AVAS) Mandated Overseas

Many governments overseas have taken action to mitigate the pedestrian safety risk from electric vehicles by mandating the fitment of Acoustic Vehicle Alerting Systems (AVAS). AVAS are designed to emit a sound from an electric vehicle to alert pedestrians to the presence of the vehicle.

It is important to note that mandating a technology overseas does not guarantee that vehicles imported into Australia from these countries will be fitted with the technology. Vehicles in different markets, that otherwise appear identical to the consumer, may be tailored by the manufacturer to the requirements of each market.

It is estimated that around 20 per cent of electric vehicles supplied to the Australian market are already fitted with AVAS, and this percentage is expected to increase over the years. However, some manufacturers, particularly those supplying higher volume models in price sensitive segments, may find it more cost effective to continue supplying vehicles to the Australian market without AVAS fitted, if it is not demanded by regulation or consumers.

There is unlikely to be a strong consumer demand for the technology, as consumers are generally more likely to focus on technologies that benefit them directly, rather than benefit other road users.

## 2.4 Australian Government Action Required to Ensure AVAS Available in Australia

Australian Government action is often needed where the market fails to find the most efficient and effective solution to a problem. The Australian Government has a strong history of intervening to improve road safety, particularly through setting mandatory national vehicle standards, known as the Australian Design Rules (ADRs), under the *Road Vehicle Standards Act 2018* (RVSA).

ADRs have played a significant role in reducing road deaths and injuries over a number of years, above and beyond what would have been achieved through market forces alone. ADRs covering vehicle structures and restraint systems have improved crash performance significantly. Passive safety features such as airbags, seat belts, collapsible steering columns, head restraints and padded surfaces help prevent or manage the forces of impact in crashes. More recent ADRs for technologies that assist in mitigating crashes, such as advanced braking systems, electronic stability control, and advanced emergency braking, are delivering further reductions in road trauma.

Where possible, the ADRs are harmonised with international vehicle regulations, as developed through the UN. Harmonising with international regulations provides consumers with access to vehicles meeting the latest levels of safety and innovation at the lowest possible cost. The Australian Government, through the Department of Infrastructure, Transport, Regional Development, Communications and the Arts (the department), has actively participated in the development of the UN regulations for a number of years.

It follows that this consultation Impact Analysis examines whether the most viable solution to the pedestrian safety problem outlined above is for the Australian Government to adopt the UN regulation for AVAS – UN R138/01 – as a new ADR. The ADR would guarantee that all new electric vehicles supplied to the Australian market are fitted with AVAS and that these systems meet the same performance standards. This is unlikely to be achieved through market forces alone. It would ensure Australians have full access to the benefits of a safety technology that has already been widely adopted overseas. The costs and benefits of mandating a new ADR for AVAS are examined in the following sections.

# 3. What Policy Options Have Been Considered?

This consultation Impact Analysis considers two policy options for reducing the risk of collisions between electric vehicles and pedestrians by increasing the fitment of AVAS.

**Option 1** is to maintain the status quo, allowing market forces to find a solution to the problem (business as usual). This is the benchmark policy option.

**Option 2** is to mandate, through a new ADR, the fitment of AVAS to all new electric vehicles entering the Australian market. The ADR would adopt UN regulation 138/01.

The exclusion of alternative non-regulatory options in Impact Analyses considering the introduction of new international vehicle standards was agreed with by the Office of Impact Analysis (then the Office of Best Practice Regulation) in late 2019. This concession was made in order to streamline the process for adopting international vehicle standards, where evidence for doing so demonstrates a net benefit to the Australian community.

## 3.1 Option 1: Business as Usual

This option relies on the market finding a solution to the problem, the community accepting the problem, or some combination of the two.

Broadly, governments will continue their efforts to reduce road trauma in Australia. Regarding the availability of AVAS on electric vehicles in Australia, it is expected that voluntary uptake will increase gradually over time. The department estimates that approximately 20 per cent of new electric vehicles supplied to the Australian market are fitted with an AVAS. This is based on consultation with vehicle manufacturers as well as desktop analysis of electric vehicle models and sales volumes.

The department further estimates that in 2025, almost 30 per cent of new electric vehicle will be fitted with AVAS. However, as outlined in Section 2, without mandating the technology, Australia is unlikely to reach 100 per cent fitment. As such, under the status quo option, we risk foregoing the full safety benefits of the technology, and risk falling behind other countries who have already mandated it.

This option was analysed in detail in order to establish a benchmark for comparison with Option 2.

## 3.2 Option 2: Mandatory Standards

Under this option, the Australian Government would mandate the fitment of AVAS to new electric vehicles supplied to the market through a new ADR under the RVSA. The new ADR would align with the technical requirements of UN R138/01 (or the equivalent US Federal Motor Vehicle Safety Standard 141). As the Government does not have jurisdiction to set requirements for vehicles currently in service, this option would not require AVAS to be retrofitted to existing vehicles already on the road.

### 3.2.1 Background

Australia mandates approximately 60 active ADRs under the RVSA. Vehicles are approved on a model (or vehicle type) basis known as type approval, whereby the Australian Government approves a vehicle type based on test and other information supplied by the manufacturer. Compliance of vehicles built under that approval is ensured by regular audits of the manufacturer’s production, design and test facilities.

The ADRs apply equally to new imported vehicles and new vehicles manufactured in Australia. No distinction is made on the basis of country of origin/manufacture under the RVSA.

A program of harmonising ADRs with international vehicle standards developed through the UN, began in the mid-1980s and has recently been accelerated. As Australia accounts for only around one per cent of global vehicle sales, harmonised Australian requirements minimise system development costs and provide manufacturers with the flexibility to incorporate or adapt systems that have already been developed and tested for markets with similar requirements. It also enables manufacturers to leverage testing and certification frameworks adopted in other markets.

### 3.2.2 Proposed Scope

The internationally agreed standard for AVAS is UN R138/01. The regulation sets requirements for minimum sound pressure level, frequency and octave levels in low speed conditions. Its scope covers all passenger (M category) and commercial (N category vehicles) with a hybrid, electric, or hydrogen fuel cell powertrain.

UN R138/01 requires electric vehicles to be fitted with AVAS producing:

- a minimum overall sound pressure level of 50 dB(A) at 10 km/h, and 56 dB(A) at 20 km/h.
- at least two one-third octaves, with at least one below or within a 1,600 Hz one-third octave band, with each band meeting minimum sound pressure levels. This minimises the risk of the sound being masked in different conditions.
- a frequency shift in at least one tone in the frequency range, where the shift is proportional to the speed within each individual gear ratio (an average of at least 0.8 per cent per 1 km/h). This helps to indicate whether the vehicle is accelerating or decelerating.

When reversing at low speeds (tested at 6km/h), UN R138/01 requires a vehicle to emit a sound with an overall sound pressure level of 47 dB(A). (United Nations, 2017).

See Appendix B—UN Regulation 138/01 Requirements for further details.

While UN R138/01 applies to all M (passenger) and N (goods carrying) vehicles with an electric powertrain, insufficient data was available to determine the likely costs and benefits of mandating AVAS for heavy electric vehicles in Australia (ADR categories MD, ME, NB and NC). It is therefore proposed that at this stage the ADR only mandate the fitment of AVAS to light electric vehicles (ADR categories MA, MB, MC and NA). Further information and consultation with heavy vehicle manufacturers would be needed before the Government can consider the costs and benefits of mandating AVAS for heavy electric vehicles. Note that the scope of the US standard is also limited to light vehicles.

### 3.2.3 Implementation Timing

The ADRs only apply to new vehicles and typically adopt a phase-in period to give established models time to update their design. The implementation lead time of an ADR is generally no less than 18 months for models that are new to the market (new model vehicles) and 24 months for models already established in the market (all new vehicles). This lead time varies depending on the complexity of the changes required to comply with the ADR.

The proposed applicability dates modelled for this option are:

- newly approved vehicle models manufactured from 1 January 2025; and
- all new vehicles manufactured from 1 January 2026.

If this option is adopted, final implementation dates will be determined following consultation with industry.

# 4. What are the Likely Net Benefits of Each Option?

In this section, the benefits and costs of mandating a new ADR for AVAS for light vehicles in Australia (Option 2) are analysed. The results are compared with what would happen if there was no intervention (Option 1). Further details are available at Appendix C—Benefit Cost Analysis.

## 4.1 Benefits

The benefits for Option 2 were calculated based on the expected level of fitment of AVAS to new electric vehicles compared with Option 1, and the effectiveness of the technology in avoiding pedestrian crashes.

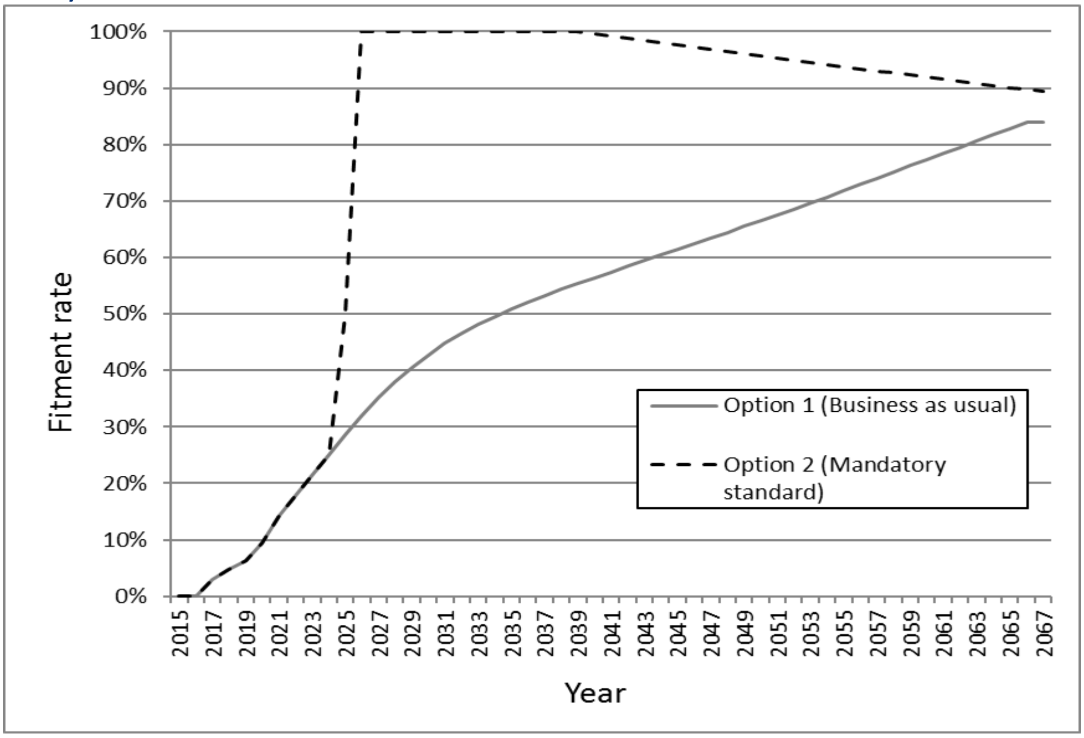
### 4.1.1 Fitment Rate

For Option 1, the business as usual fitment rate was based on information supplied by manufacturers or from automotive website Redbook on which models are currently fitted with an AVAS, or are likely to be fitted with an AVAS in the future. It is anticipated that while fitment will increase gradually over time, without regulation it will not reach 100 per cent – peaking at around 84 per cent of new vehicles sold.

For Option 2, it is expected that the ADR will be in place for 15 years, during which time the fitment rate will be 100 per cent. Although it is expected that the ADR would sustain high fitment rates well into the future, it is not guaranteed. For example, through disruptive change in the vehicle industry, the technology may not be as relevant for future vehicles. After the 15 years, the fitment is therefore modelled to return gradually to business as usual rates.

Figure 5 shows the expected fitment rate of AVAS under Options 1 and 2.

**Figure 5: Expected fitment rate under Option 2 (mandatory standards) relative to Option 1 (business as usual)**



### 4.1.2 Effectiveness

To support the benefit-cost analysis for this consultation Impact Analysis, the department engaged MUARC to report on the crash reduction benefits of introducing AVAS for electric vehicles in Australia. For its analysis, MUARC primarily used police-reported light vehicle crash data in Victoria from 2014 to 2018, which it extrapolated for Australia. The department can provide a copy of this report on request.

The department used a number of key outcomes of this report to estimate the overall effectiveness of AVAS in avoiding pedestrian crashes in Australia.

Firstly, MUARC identified the crashes that would be applicable to AVAS. Broadly, these are pedestrian crashes in low speed conditions (up to 20 km/h as set out in UN R138/01). As the available crash data did not include the speed of the vehicle at impact, MUARC identified relevant crash types based on speed zone and vehicle movement. Specifically, MUARC focused on speed zones up to 70 km/h, where the vehicle movement or driver intention was:

- turning left or right,
- leaving a driveway,
- undertaking a U-turn,
- reversing,
- parking, or
- slowing down or stopping.

Applying these criteria to the available crash data, MUARC estimated that 36.8 per cent of all light vehicle crashes involving pedestrians occurred in conditions applicable to AVAS. Of these, 1.2 per cent were fatal, 46.9 per cent resulted in serious injury, and 51.9 per cent resulted in minor injury (a ratio of 1:39:43).

Secondly, MUARC estimated around 17.7 per cent of pedestrian crashes involving an electric vehicle in low speed conditions could be avoided if all electric vehicles in Australia were fitted with an AVAS. MUARC notes that this value takes into account the expected crash reduction benefits associated with the introduction of Autonomous Emergency Braking Systems (AEBS), which will be mandatory in new light vehicles in Australia, phased in from 2023 to 2026.[3]

To estimate the overall effectiveness of AVAS against all light vehicle crashes, the department multiplied the proportion of light vehicle crashes that are applicable to AVAS by the effectiveness of AVAS in avoiding these crashes: 36.8 per cent x 18 per cent = 6.5 per cent overall effectiveness.

### 4.1.3 Reduction in Trauma

The department then used this effectiveness value along with the expected fitment rate to determine the overall reduction in road trauma that would be achieved under Option 2.

The department calculated that this option would avoid 65 deaths, 2,569 serious injuries, and 2,845 minor injuries over the 35-year analysis period. This would amount to over $321 million in avoided road trauma costs.

These estimated benefits are limited to pedestrian trauma avoided. However, the fitment of AVAS would also reduce the risk of crashes involving other vulnerable road users, such as cyclists. If the incidence of cyclist crashes in Australia was similar to that experienced in the United States (NHTSA 2017), the safety benefits of AVAS for cyclists could be of a similar magnitude to that estimated for pedestrians.

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[3] AEBS are designed to reduce the likelihood of a crash by warning the driver and then automatically braking to reduce impact speed when a collision is imminent.

## 4.2 Costs

The costs for Option 2 include system development and fitment costs (for manufacturers), and ADR administration costs (for the Government). The department estimated these costs based on research, discussions with manufacturers, and previous experience with ADR development.

### 4.2.1 System Development Costs

The cost to fully develop an AVAS for a new vehicle model was estimated at around $50,000 to $100,000. This cost covers system design, logistics, production line floor area allocation, and other overheads.

However, given that all light vehicles in Australia are imported, and that most come from markets that have already mandated UNR138/01 (or equivalent standards), the system development cost for mandating AVAS in Australia would likely be substantially reduced. Manufacturers will largely be able to adapt the AVAS that they already fit to similar models sold in other markets. For this analysis, the department used 10 per cent of the full system development cost.

An additional $10,000 per model was added to cover validation and testing, and a further $10,000 per model for certification and regulatory expenses to obtain a type approval for the Australian market.

### 4.2.2 Fitment Costs

In 2016, NHTSA estimated the incremental cost of fitting an AVAS would be approximately US$55 (A$77) for vehicles where an AVAS has already been developed for it and US$130 (A$182) for vehicles without an AVAS developed. Consultations with vehicle manufacturers suggest the changes required for individual models could range from minor software updates to the addition of a speaker system, with associated wiring and harnesses.

Again, given that all light vehicles in Australia are imported, and that most come from markets that have already mandated UN R138/01 (or equivalent standards), the department assumed, for the main analysis, that fitment costs to meet a new ADR would be at the lower end of this scale (i.e. A$77).

Sensitivity tests were conducted using the average cost US$93 (A$130) and highest cost US$130 (A$182) estimates.

### 4.2.3 Government Costs

There would be an estimated annual cost of $50,000 for the department to create, implement and maintain a new ADR. This includes costs to draft the ADR and provide ongoing maintenance and interpretation advice.

## 4.3 Benefit-Cost Analysis Results

Table 1 details the results for the benefit-cost analysis. A 7 per cent discount rate was used for the options.

**Table 1: Summary of benefits, costs, lives saved and injuries avoided for Option 1 and Option 2 (Likely Case)**

| Case | Gross benefits ($m) | Net benefits ($m) | Cost to business ($m) | Cost to Govern-ment ($m) | Benefit-cost ratio | Number of lives saved | Serious injuries avoided | Minor injuries avoided |
|---|---|---|---|---|---|---|---|---|
| **Option 1** | - | - | - | - | - | - | - | - |
| **Option 2** | 321.5 | 137.4 | 183.6 | 0.5 | 1.75 | 65 | 2,569 | 2,845 |

### 4.3.1 Sensitivity Analysis

A sensitivity analysis was carried out to determine the effects of key variables on the outcome of the benefit-cost analysis.

Firstly, while a 7 per cent real discount rate was used, the benefit cost analysis was also tested with rates of 3 per cent and 10 per cent. Table 2 shows that the benefit-cost ratio remained positive in both the low and high discount rate scenarios.

**Table 2: Sensitivity analysis – changes to the real discount rate**

| Case | Benefit-cost ratio | Net benefits ($m) |
|---|---|---|
| **Low discount rate (3 per cent)** | 2.75 | 454.1 |
| **Base case discount rate (7 per cent)** | 1.75 | 137.4 |
| **High discount rate (10 per cent)** | 1.31 | 45.4 |

Next, the business as usual fitment rate was subjected to a sensitivity analysis, including both a high and a low fitment rate scenario (business as usual fitment curves adjusted +/- 10 per cent), to account for variations in the market uptake of light vehicle AVAS. As shown in Table 3, the net benefits remained positive in both the high and the low fitment rate scenarios.

**Table 3: Sensitivity analysis - changes to business as usual fitment rate**

| Case | Benefit-cost ratio | Net benefits ($m) |
|---|---|---|
| **Low fitment rate (-10 per cent)** | 1.80 | 160.4 |
| **Base case fitment rate** | 1.75 | 137.4 |
| **High fitment rate (+10 per cent)** | 1.68 | 114.5 |

Finally, the fitment cost range was varied, based on the average and highest cost estimates by NHTSA. As shown in Table 4, the net benefits using the average cost estimate remained positive. However, if all vehicles experienced the maximum cost increase estimated by NHTSA, there would be a net cost.

**Table 4: Sensitivity analysis - changes to fitment costs**

| Case | Benefit-cost ratio | Net benefits ($m) |
|---|---|---|
| **Base case fitment cost ($77)** | 1.75 | 137.4 |
| **Average fitment cost ($130)** | 1.04 | 12.4 |
| **High fitment cost ($182)** | 0.74 | -112.8 |

## 4.4 Analysis of impacts

This section considers how the benefits and costs of Option 2 may be distributed among affected parties.

### 4.4.1 Business

#### Benefits

There would be few direct benefits for businesses as a result of a new ADR for AVAS. Component suppliers (mostly international) would benefit directly in terms of increased revenue from supplying additional equipment to manufacturers.

There would be an indirect benefit to businesses as a result of the reduction in the number of work days lost due to employees being injured in collisions with electric vehicles. There would also be a minor reduction in recruitment, training and development costs associated with the replacement of employees killed or permanently incapacitated by collisions.

There would be negative impacts to businesses in the event that an electric vehicle not fitted with an AVAS is involved in a pedestrian collision. This may include financial losses as a result of reputational damage for vehicle manufacturers in addition to affecting the ability of business owners to conduct their trade as the involved vehicle within the corporate fleet can be impounded / destroyed.

Other benefits to business include the creation of a level playing field for all vehicle manufacturers as AVAS requirements are standardised across the new vehicle fleet.

#### Costs

There would be a direct cost to light vehicle manufacturers as a result of design, development, fitment and testing costs for the additional vehicles fitted with AVAS. Manufacturers may then pass this increase in costs on at the point of sale to light vehicle owners. However, the extent to which this may happen is influenced by a highly competitive vehicle market in Australia. The department notes the adoption of previous ADRs does not appear to have led to a direct impact on vehicle retail prices.

### 4.4.2 Consumers

#### Benefits

There would be a direct benefit for vehicle owners from fewer pedestrian crashes. Owners would save on costs like vehicle repair and replacement, compensation, and legal costs, as well as avoid the significant mental trauma involved with these crashes.

There would also be a direct benefit for the wider Australian community. Fewer individuals, and their families and friends, would have to deal with the physical and mental trauma, medical costs and lost income of being involved in a crash.

A new ADR for AVAS would particularly benefit the blind and low vision community, by giving them greater confidence to walk on and near roads, allowing them to participate more in social and economic activities. This would have flow-on mental health benefits, particularly with respect to reduced anxiety and depression. (Liu et al 2018)

#### Costs

There would be an indirect cost for consumers buying new vehicles, due to manufacturers passing on the costs of meeting the new ADR. However, as noted above, the extent to which this may happen is influenced by a highly competitive vehicle market in Australia.

### 4.4.3 Governments

#### Benefits

There would be an indirect benefit to governments from fewer pedestrian crashes, for example through reduced burden on public health systems.

There would be an indirect benefit to the Australian Government by supporting its commitments under the *UN Convention on the Rights of Persons with Disabilities* (UN CRPD). In 2008, Australia ratified the UN CRPD, which establishes normative standards and principles for the treatment of people with disability under international human rights law.

In line with Australia's commitments under the UN CRPD, the national disability policy framework - Australia's Disability Strategy 2021–2031 – plays an important role in protecting, promoting and realising the human rights of people with disability.

The strategy identifies accessibility of transport systems as a policy priority area, necessary to ensure people with disability have economic security and enabling them to plan for the future and exercise choice and control over their lives. A new ADR for AVAS would support this priority area, by giving the blind and low vision community greater confidence to walk on and near roads.

### Costs

The Australian Government would incur administrative costs to develop, implement and maintain the new ADR.

# 5. Regulatory Burden and Cost Offsets

The Australian Government Guide to Regulatory Impact Analysis (2020) requires that all new regulatory options are costed using the Regulatory Burden Measurement (RBM) Framework. Under the RBM Framework, the regulatory burden is the cost of a proposal to business and the community (not including the cost to government). It is calculated in a prescribed manner that usually results in it being different to the overall costs of a proposal in the benefit-cost analysis.

In line with the RBM Framework, the average annual regulatory costs were calculated for this proposal by totalling the undiscounted (nominal) cost (including development and fitment cost) over the 10-year period 2025–2034 inclusive, and then dividing this total by 10.

The average annual regulatory costs for Option 2 are estimated to be $17.8 million. There are no costs associated with Option 1 as it is the status quo case.

The Australian Government Guide to Regulatory Impact Analysis further states that where a proposal leads to higher regulatory compliance burdens, departments need to investigate options to offset these burdens. It is anticipated that regulatory savings from further alignment of the ADRs with international standards will offset the additional RBM costs of this measure.

**Table 5: Average annual regulatory costs for Option 2**

| Sector | Change in costs ($m) |
|---|---|
| **Business** | 17.8 |
| **Community organisations** | - |
| **Individuals** | - |
| **Total change in costs** | **17.8** |

# 6. Consultation

## 6.1 Previous Consultation

The department has prepared this consultation Impact Analysis considering:

- Advice from vehicle manufacturers in Australia on the current and expected fitment rates of AVAS.
- Independent analysis by MUARC of the crash reduction benefits of the fitment of AVAS in Australia.
- Consultation with Vision Australia, and research commissioned by them on the impact of electric vehicles on blind or low vision pedestrians.

The proposal to mandate AVAS for new vehicles in Australia has been discussed a number of times at meetings of the peak vehicle standards consultative forum, the Strategic Vehicle Safety and Environment Group (SVSEG). SVSEG consists of senior representatives of government (Australian and state/territory), the manufacturing and operational arms of the industry (including organisations such as the Federal Chamber of Automotive Industries, Truck Industry Council and the Australian Trucking Association), and consumer and road user organisations (including the Australian Automobile Association).

The proposal has also been raised within the Infrastructure and Transport Ministers' Meetings (ITMM). The ITMM bring together Commonwealth, state, territory and New Zealand ministers with responsibility for transport and infrastructure, as well as the Australian Local Government Association. It is supported by the Infrastructure and Transport Senior Officials' Committee (ITSOC).

## 6.2 Consultation Plan

The department has published this Impact Analysis for full public consultation to elicit views from all interested parties on its proposal. The department is specifically seeking feedback on:

- Support for the proposed introduction of AVAS for new light electric vehicles in Australia.
- The benefit-cost analysis, including the assumptions on effectiveness of the technology, the costs, and the benefits.
- The suitability of UN Regulation 138/01 for adoption under the ADRs, including any concerns on functional and/or performance requirements and test requirements.
- Applicable vehicle categories, implementation timeframes, alternative standards.
- Costs, benefits, and feasibility of mandating AVAS for heavy electric vehicles in Australia in the future.
- Any other relevant views or information, which could assist decision-making.

Feedback is requested by Friday, 26 May 2023. Submissions can be uploaded via the department's website at https://www.infrastructure.gov.au/have-your-say.

Alternatively, you can email your submission to Sustainable.Transport@infrastructure.gov.au, or send it to:

Director, Land Transport Emissions and Environment
Department of Infrastructure, Transport, Regional Development, Communications and the Arts
GPO Box 594
CANBERRA ACT 2601

A summary of public comment and departmental responses will be included in the final Impact Analysis that is used for decision making by the responsible minister.

# References

Australasian New Car Assessment Program (ANCAP) (2022), *ANCAP Safety Ratings Explained, retrieved from* https://www.ancap.com.au/safety-ratings-explained.

Australian Bureau of Statistics (2020), *Motor Vehicle Census, Australia, 31 Jan 2020*. Report No. 9309.0, retrieved from https://www.abs.gov.au/statistics/industry/tourism-and-transport/motor-vehicle-census-australia/31-jan-2020.

Australian Government (2020), *Australian Government Guide to Regulatory Impact Analysis*, retrieved from https://www.pmc.gov.au/resource-centre/regulation/australian-government-guide-regulatory-impact-analysis.

Bureau of Infrastructure, Transport and Regional Economics (BITRE) (2019), *Electric Vehicle Uptake: Modelling a Global Phenomenon*, retrieved from https://www.bitre.gov.au/publications/2019/bitre-report-151.

Bureau of Infrastructure and Transport Research Economics (BITRE) (2020), *Road Trauma Australia – 2019 Statistical Summary*, retrieved from https://www.bitre.gov.au/sites/default/files/documents/road_trauma_australia_2019_statistical_summary.pdf.

Bureau of Infrastructure and Transport Research Economics (BITRE) (2021), *Road Safety Statistics – Hospitalised Injuries*, retrieved from https://www.bitre.gov.au/statistics/safety.

Federal Chamber of Automotive Industries (FCAI) (2020). *New Vehicle Sales – Monthly Reports.* VFACTS National Reports.

Lawrence, B., Fitzharris, M., Liu, S., and Newstead, S. (2020), *Enhancing the Safety of Quiet Road Transport Vehicles (QRTV) – Crash Reduction Benefits of the Fitment of Acoustic Vehicle Alerting Systems in Australia*, Clayton: Monash University Accident Research Centre.

Liu, S., Fitzharris, M., Oxley, J., and Edwards, C. (2018). *The impact of electric/hybrid vehicles and bicycles on pedestrians who are blind or have low vision*. Clayton: Monash University Accident Research Centre.

National Highway Traffic Safety Administration (NHTSA) (2016), *49 CFR Parts 571 and 585 - Federal Motor Vehicle Safety Standards - Minimum Sound Requirements for Hybrid and Electric Vehicles*, Federal Register / Vol. 81, No. 240 / Wednesday, December 14, 2016 / Rules and Regulations [Docket No. NHTSA–2016–0125].

National Highway Traffic Safety Administration (NHTSA) (2017), *Updated analysis of pedestrian and pedal cyclist crashes with hybrid vehicles*, NHTSA Traffic Safety Facts, Research note, DOT HS 812 371.

Osbourne, R., Horberry, T., Young, K. (2020). *Pedestrian distraction from smartphones,* Clayton: Monash University Accident Research Centre.

United Nations (2017), *Uniform provisions concerning the approval of Quiet Road Transport Vehicles with regard to their reduced audibility*, UN Regulation No. 138 Revision 1, 01 series of amendments– Date of entry into force: 10 October 2017, retrieved from https://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2017/R138r1e.pdf.

Victorian Government – Department of Transport (2020), *Victorian Road Safety Strategy 2021–2030*, retrieved from https://www.tac.vic.gov.au/road-safety/victorian-road-safety-strategy/victorian-road-safety-strategy-2021–2030.

Vision Australia (2018). Media release: *Electric and hybrid cars putting pedestrians at risk*, retrieved from https://www.visionaustralia.org/news/2019-08-23/electric-and-hybrid-cars-putting-pedestrians-risk.

# Appendix A—Government Actions to Address Road Trauma

All levels of government are currently working to reduce road trauma in Australia. Key initiatives are outlined below, with a focus on initiatives that are helping to improve vulnerable road user safety.

## National Vehicle Standards

The Australian Government administers the *Road Vehicle Standards Act 2018* which requires that all new road vehicles comply with national vehicle standards, known as the Australian Design Rules, before they can be offered to the market for use in transport in Australia. The ADRs set minimum national standards for vehicle safety, emissions and anti-theft performance.

Recent ADRs for technologies that assist in mitigating crashes, such as advanced braking systems, electronic stability control, and advanced emergency braking, will deliver reductions in road trauma, including for trauma involving vulnerable road users.

## National Road Safety Strategy

In May 2021, infrastructure and transport ministers approved the National Road Safety Strategy (NRSS) 2021–30. The NRSS represents the commitment of all levels of government to deliver significant reductions in road trauma over the next decade and progress towards ‘Vision Zero’, or zero deaths and serious injuries on our roads by 2050. The NRSS includes trauma reduction targets for the decade to 2030 of at least 50 per cent reduction in actual annual deaths to fewer than 571 and at least a 30 per cent reduction in actual annual serious injuries to fewer than 29,000. The NRSS identifies nine priority areas for reducing harm on our roads, including improving vehicle safety and prioritising vulnerable road users.

National road safety action plans provide a detailed roadmap for governments to implement the NRSS. In December 2022, infrastructure and transport ministers agreed to the National Road Safety Action Plan 2023–2025. It sets out the key actions all governments will undertake to 2025, in pursuit of the agreed priorities identified in the NRSS. Under the vehicle safety priority, the Australian Government has committed to legislating AVAS for electric vehicles, subject to the outcomes of this Impact Analysis process.

## State and Territory Government Action

State and territory governments target identified vehicle safety concerns through investment in research projects, education campaigns and strategic partnerships. Most jurisdictions have committed to Vision Zero through their road safety strategies. Vulnerable road user safety features prominently within the strategies. For example, the Victorian Road Safety Strategy 2021–2030 has overarching goals to ‘improve outcomes for vulnerable and unprotected road users who are involved in a crash’ and ‘ensure unprotected and vulnerable road users are supported by the road system, not impacted by it’. (Victorian Government, 2020)

## Australasian New Car Assessment Program

The Australasian New Car Assessment Program (ANCAP) is an independent vehicle safety authority, that works in partnership with 23 member organisations, including governments.

ANCAP publishes safety ratings for a range of new passenger, sports utility and light commercial vehicles entering the Australian and New Zealand markets, using a rating system of 0 to 5 stars. These ratings are continually reviewed to keep pace with technology developments and to ensure that star ratings reward the most effective technologies.

Vehicles are evaluated against four key areas, one of these being vulnerable road user protection. This area assesses the design of the front of a vehicle, based on how well it minimises injury risk to a struck pedestrian. It also assesses a vehicle's ability to actively avoid or mitigate impacts with pedestrians or cyclists. (ANCAP, 2022). Note that AVAS has not yet been adopted within the ANCAP rating system.

## National Funding for Road Safety Initiatives

The Australian Government allocates dedicated funding for a number of non-infrastructure road safety programs. For example, the Road Safety Awareness and Enablers Fund provides $4 million over four years from 2019–20 for grants to fund road safety awareness, education and collaboration initiatives.

The Road Safety Innovation Fund provides $12 million over four years from 2019–20 to support road safety research and the development of new road safety technologies. A number of successful projects focus on vulnerable road users, including a University of Sydney project reducing pedestrian crashes through better intersection design by establishing an Australian evidence base for the relationship between intersection design, delay and safety outcomes. Another project focuses on research, development and testing of a system to detect mobility-impaired pedestrians on and in the vicinity of the roadway to increase their safety and promote inclusivity.

# Appendix B—UN Regulation 138/01 Requirements

UN Regulation 138/01 applies to electrified M (passenger) and N (goods carrying) category vehicles which can be propelled in the normal mode, in reverse or at least one forward drive gear, without an internal combustion engine operating in respect to their audibility.

For the purposes of this regulation, electrified vehicles are defined “a vehicle with a powertrain containing at least one electric motor or electric motor-generator.” These include:

- Pure Electric Vehicles (PEV) – vehicles with an electric motor as its sole mean of propulsion,
- Hybrid Electric Vehicles (HEV) – vehicles with a powertrain containing at least one electric motor or electric motor generator and at least one internal combustion engine as propulsion energy converters, and
- Fuel Cell Vehicles (FCV) - vehicles with a fuel cell and an electric machine as propulsion energy converters.

UN Regulation 138/01 requires vehicles to comply with minimum sound requirements in:

- a constant speed test performed at 10 km/h,
- a constant speed test performed at 20 km/h, and
- a reversing test performed at 6 km/h.

Tests may be performed indoors or outdoors, in motion or with the vehicle speed simulated by an external signal to the AVAS with the vehicle in standstill condition. Vehicles may emit a sound when stationary, but are not permitted to have a ‘pause’ function.

Table 6 outlines the minimum sound level requirements for each of these tests.

**Table 6: Minimum sound level requirements for AVAS in db(A)**

| Frequency in Hz | Constant Speed Test (10 km/h) | Constant Speed Test (20 km/h) | Reversing Test |
|---|---|---|---|
| **160** | 45 | 50 | - |
| **200** | 44 | 49 | - |
| **250** | 43 | 48 | - |
| **315** | 44 | 49 | - |
| **400** | 45 | 50 | - |
| **500** | 45 | 50 | - |
| **630** | 46 | 51 | - |
| **800** | 46 | 51 | - |
| **1,000** | 46 | 51 | - |
| **1,250** | 46 | 51 | - |
| **1,600** | 44 | 49 | - |
| **2,000** | 42 | 47 | - |
| **2,500** | 39 | 44 | - |
| **3,150** | 36 | 41 | - |
| **4,000** | 34 | 39 | - |
| **5,000** | 31 | 36 | - |
| **Overall** | **50** | **56** | **47** |

A separate test performed at speeds varying from 5 km/h to 20 km/h is also performed to measure frequency shifts to signify acceleration and deceleration. The following methods may be used for this test:

- Test of the complete vehicle in motion on an outdoor test track.
- Test of the complete vehicle in standstill condition on an outdoor test track with simulation of the vehicle movement to the AVAS by an external signal generator.
- Test of the complete vehicle in motion in an indoor facility on a chassis dynamometer.
- Test of the complete vehicle in standstill condition in an indoor facility with simulation of the vehicle movement to the AVAS by an external signal generator.
- Test of the AVAS without a vehicle in an indoor facility with simulation of the vehicle movement to the AVAS by an external signal generator

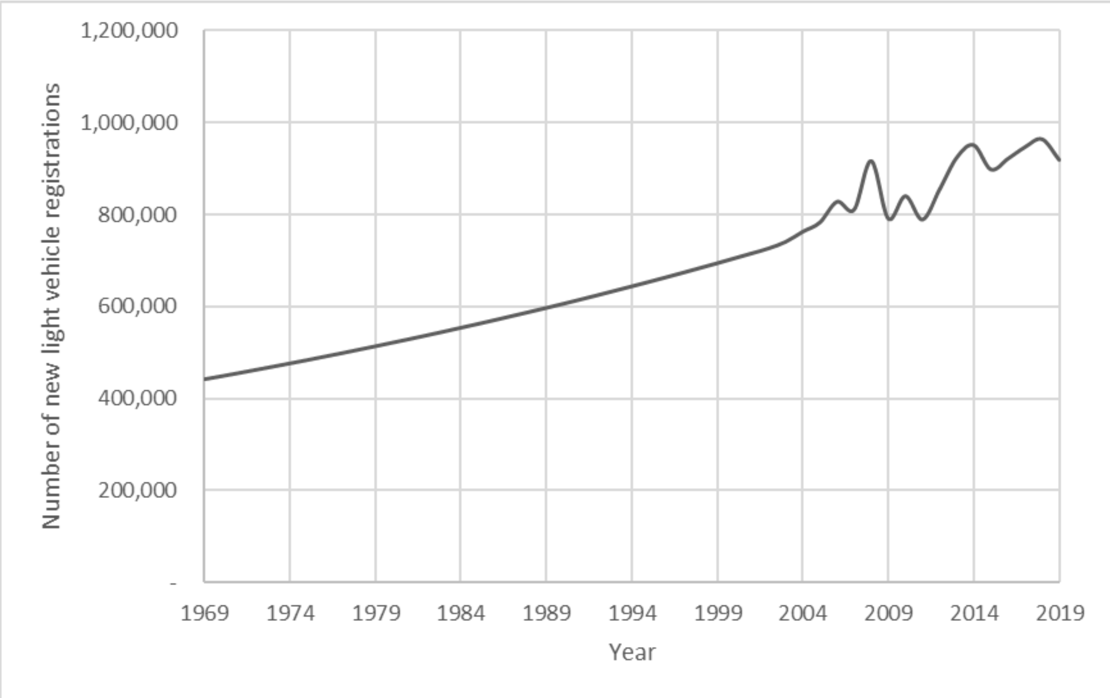
# Appendix C—Benefit Cost Analysis

The model used in this analysis was the Net Present Value (NPV) model. The estimated benefits and costs for Option 2 (mandatory standards) were summed over time. The further the cost or benefit occurred from the nominal starting date, the more they were discounted. This allowed all costs and benefits to be compared equally, no matter when they occurred.

The analysis was broken up into the steps outlined below.

1. The number of new light vehicles registrations was established for each year between 1969 and 2020 inclusive, utilising available Australian Bureau of Statistics Motor Vehicle Census (report series 9309.0) data (Australian Bureau of Statistics, 2020), and registrations per capita for years prior to availability of census data (Figure 6):

**Figure 6: New light vehicle registrations in Australia, 1969 to 2019**



2. Data from MUARC (2020) was used to determine the typical pedestrian crash frequency by age for light vehicles (Figure 7).

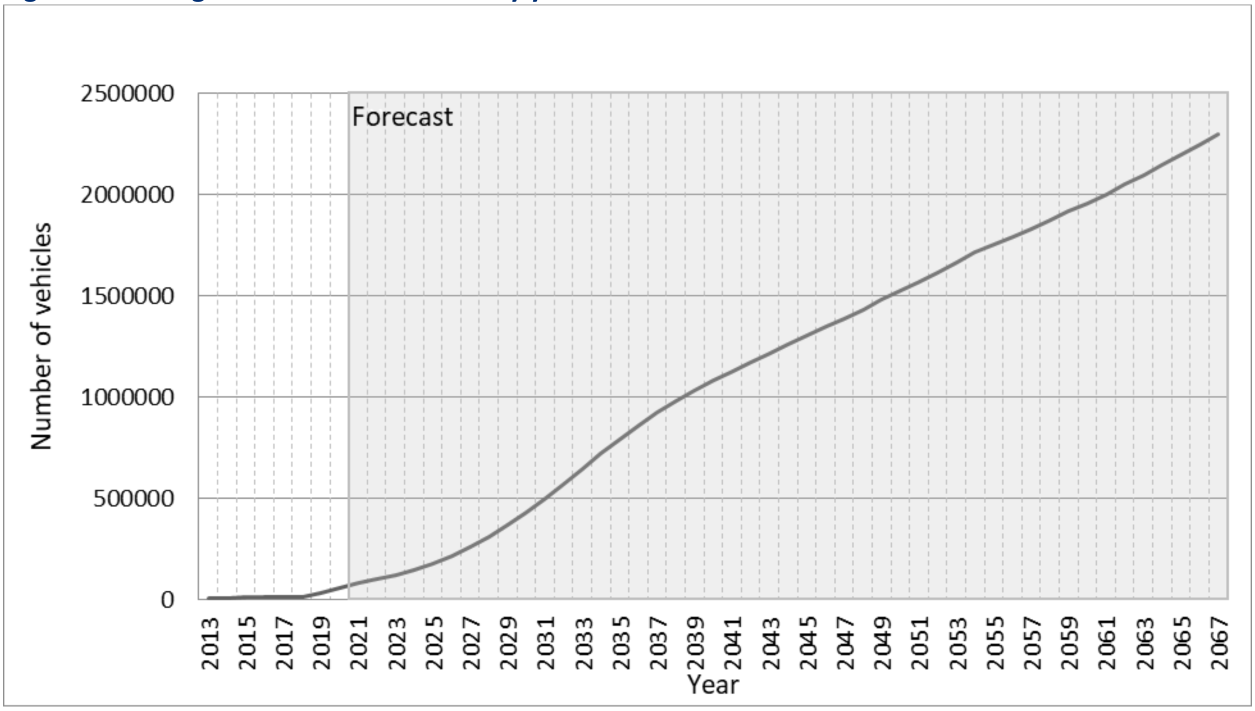
**Figure 7: Pedestrian crash frequency by age of vehicle**


3. The data from steps 1 and 2 were used to determine the likelihood of a vehicle of a given age being involved in a casualty crash over the course of one year as a function of number of registered vehicles of a given age (Figure 8).

**Figure 8: Casualty crash likelihood with vehicle age**

4. Recent electric vehicle sales data for the relevant vehicle categories were established (Figure 9):

**Figure 9: New light electric vehicle sales by year**

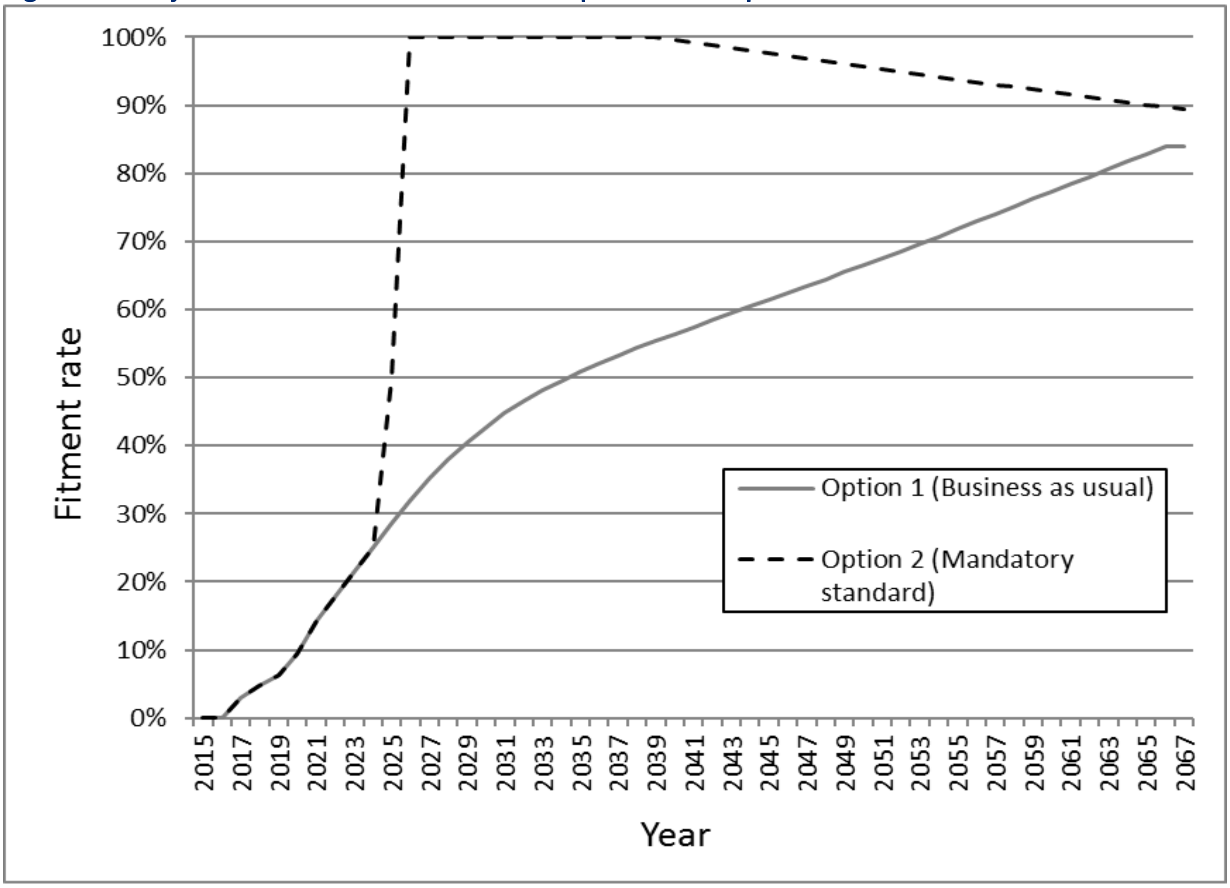



Short to medium term forecast sales were derived from industry data of past sales (VFACTS), growth factors approximated using data from the Australian Bureau of Statistics. Electric vehicle uptake was estimated in accordance with BITRE (2019).

To estimate hybrid vehicle sales, all new vehicle sales from 2054 were assumed to be electric vehicles (consistent with Lawrence et al 2020). Hybrid vehicle sales were assumed to increase gradually from current levels to a level where hybrids account for all non-plug-in electric vehicle sales from 2054.

5. The projected increased fitment rate for electric vehicles at sale under Option 2 was established (Figure 10).

**Figure 10: Projected AVAS fitment rate under Option 1 and Option 2**




6. From sales data (step 4) and fitment data (step 5), the fitment increase under Option 2 was determined (Table 7).

**Table 7: Increase in fitment of AVAS due to Option 2**

| Year | Fitment increase |
|---|---|
| 2025 | 38,162 |
| 2026 | 146,531 |
| 2027 | 168,447 |
| 2028 | 192,887 |
| 2029 | 219,710 |
| 2030 | 248,226 |
| 2031 | 278,544 |
| 2032 | 307,751 |
| 2033 | 336,736 |
| 2034 | 364,976 |
| 2035 | 390,566 |
| 2036 | 413,372 |

| Year | Fitment increase |
|---|---|
| 2037 | 432,918 |
| 2038 | 449,394 |
| 2039 | 461,745 |
| 2040 | 467,579 |
| 2041 | 471,417 |
| 2042 | 473,566 |
| 2043 | 474,269 |
| 2044 | 473,643 |
| 2045 | 471,763 |
| 2046 | 468,745 |
| 2047 | 464,560 |
| 2048 | 459,236 |
| 2049 | 452,788 |
| 2050 | 445,161 |
| 2051 | 436,351 |
| 2052 | 426,341 |
| 2053 | 415,155 |
| 2054 | 402,751 |
| 2055 | 385,588 |
| 2056 | 367,544 |
| 2057 | 348,595 |
| 2058 | 328,707 |
| 2059 | 307,842 |

7. From the fitment increase data in step 6, the likely additional fitment costs over the intervention policy period (15 years) were established (Table 8).

**Table 8: Additional fitment cost for Option 2**

| Year | Additional fitment costs ($) |
|---|---|
| 2025 | 2,938,448 |
| 2026 | 11,282,923 |
| 2027 | 12,970,408 |
| 2028 | 14,852,290 |
| 2029 | 16,917,699 |
| 2030 | 19,113,392 |

| Year | Additional fitment costs ($) |
|---|---|
| 2031 | 21,447,856 |
| 2032 | 23,696,807 |
| 2033 | 25,928,696 |
| 2034 | 28,103,179 |
| 2035 | 30,073,618 |
| 2036 | 31,829,619 |
| 2037 | 33,334,714 |
| 2038 | 34,603,306 |
| 2039 | 35,554,342 |

8. From the first year of intervention (2025), the number of crashes affected by the increased fitment was determined for each year over a 35-year period (Table 9). The 35-year analysis period covers the 15-year intervention period, followed by 20 years for the life of the vehicle. The crashes affected each year are the product of the likelihood of crash at the vehicle's age (from step 3) and the increased fitment of AVAS at sale (from step 5), summed as they infiltrate the fleet over time.

**Table 9: Expected reduction in casualty crashes under Option 2**

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | Crashes avoided |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 7 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 7 |
| **2** | 20 | 28 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 48 |
| **3** | 21 | 75 | 32 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 129 |
| **4** | 21 | 81 | 86 | 37 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 225 |
| **5** | 21 | 80 | 93 | 99 | 42 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 336 |
| **6** | 22 | 81 | 92 | 107 | 113 | 48 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 463 |
| **7** | 20 | 84 | 93 | 106 | 121 | 127 | 54 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 606 |
| **8** | 19 | 77 | 97 | 107 | 120 | 137 | 143 | 59 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 759 |
| **9** | 21 | 72 | 88 | 111 | 122 | 136 | 154 | 158 | 65 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 927 |
| **10** | 20 | 81 | 82 | 101 | 127 | 138 | 153 | 170 | 173 | 70 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 1,114 |
| **11** | 19 | 78 | 93 | 94 | 115 | 143 | 154 | 169 | 186 | 187 | 75 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 1,314 |
| **12** | 17 | 72 | 90 | 106 | 107 | 130 | 161 | 171 | 185 | 202 | 201 | 79 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 1,519 |
| **13** | 17 | 64 | 82 | 103 | 121 | 121 | 146 | 177 | 187 | 200 | 216 | 212 | 83 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 1,729 |
| **14** | 14 | 65 | 73 | 94 | 117 | 136 | 136 | 162 | 194 | 202 | 214 | 228 | 222 | 86 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 1,945 |
| **15** | 14 | 52 | 75 | 84 | 107 | 133 | 153 | 150 | 177 | 210 | 216 | 227 | 239 | 231 | 89 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 2,157 |
| **16** | 14 | 53 | 60 | 86 | 95 | 121 | 149 | 169 | 164 | 192 | 225 | 229 | 237 | 248 | 237 | 90 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 2,370 |
| **17** | 13 | 53 | 61 | 69 | 98 | 108 | 136 | 164 | 185 | 178 | 205 | 238 | 240 | 246 | 255 | 240 | 91 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 2,581 |
| **18** | 10 | 49 | 61 | 70 | 78 | 111 | 121 | 150 | 180 | 201 | 191 | 217 | 250 | 249 | 253 | 258 | 242 | 91 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 2,782 |
| **19** | 8 | 39 | 56 | 70 | 80 | 89 | 124 | 134 | 165 | 195 | 215 | 202 | 227 | 259 | 256 | 256 | 261 | 243 | 91 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 2,968 |
| **20** | 6 | 30 | 45 | 64 | 80 | 90 | 99 | 137 | 146 | 178 | 209 | 227 | 211 | 236 | 266 | 259 | 258 | 262 | 243 | 91 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 3,140 |
| **21** | 6 | 24 | 35 | 51 | 73 | 90 | 101 | 110 | 150 | 158 | 191 | 221 | 238 | 219 | 242 | 270 | 261 | 259 | 262 | 243 | 91 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 3,297 |
| **22** | 5 | 23 | 28 | 40 | 58 | 83 | 101 | 112 | 120 | 163 | 169 | 202 | 231 | 247 | 225 | 245 | 272 | 262 | 260 | 262 | 242 | 90 | X | X | X | X | X | X | X | X | X | X | X | X | X | 3,441 |
| **23** | 3 | 17 | 26 | 32 | 46 | 66 | 93 | 112 | 123 | 130 | 174 | 179 | 212 | 240 | 254 | 228 | 247 | 273 | 263 | 260 | 261 | 241 | 89 | X | X | X | X | X | X | X | X | X | X | X | X | 3,568 |
| **24** | 3 | 13 | 20 | 30 | 36 | 52 | 74 | 102 | 122 | 133 | 139 | 184 | 188 | 220 | 247 | 257 | 230 | 249 | 273 | 262 | 259 | 259 | 239 | 88 | X | X | X | X | X | X | X | X | X | X | X | 3,679 |
| **25** | 3 | 12 | 15 | 23 | 34 | 41 | 58 | 82 | 112 | 133 | 142 | 147 | 193 | 195 | 226 | 250 | 259 | 231 | 249 | 273 | 261 | 257 | 257 | 236 | 87 | X | X | X | X | X | X | X | X | X | X | 3,775 |
| **26** | 2 | 10 | 13 | 17 | 26 | 39 | 46 | 64 | 89 | 122 | 142 | 150 | 154 | 200 | 200 | 228 | 252 | 260 | 231 | 249 | 272 | 260 | 255 | 254 | 232 | 86 | X | X | X | X | X | X | X | X | X | 3,854 |
| **27** | 1 | 8 | 11 | 15 | 20 | 30 | 44 | 50 | 70 | 97 | 130 | 150 | 158 | 160 | 206 | 203 | 230 | 253 | 261 | 231 | 248 | 270 | 257 | 252 | 250 | 229 | 84 | X | X | X | X | X | X | X | X | 3,917 |
| **28** | 1 | 4 | 9 | 13 | 17 | 22 | 33 | 48 | 55 | 76 | 104 | 138 | 157 | 164 | 165 | 208 | 205 | 231 | 253 | 260 | 230 | 246 | 268 | 254 | 248 | 246 | 224 | 82 | X | X | X | X | X | X | X | 3,962 |
| **29** | 1 | 3 | 4 | 10 | 14 | 20 | 25 | 37 | 53 | 60 | 81 | 110 | 144 | 163 | 168 | 167 | 210 | 205 | 232 | 253 | 259 | 229 | 244 | 265 | 251 | 244 | 241 | 219 | 80 | X | X | X | X | X | X | 3,991 |
| **30** | 1 | 3 | 4 | 5 | 11 | 16 | 22 | 28 | 40 | 57 | 64 | 86 | 115 | 150 | 168 | 170 | 168 | 211 | 206 | 231 | 252 | 258 | 227 | 241 | 261 | 247 | 239 | 236 | 213 | 77 | X | X | X | X | X | 4,006 |
| **31** | 0 | 2 | 4 | 4 | 6 | 13 | 18 | 24 | 30 | 43 | 61 | 68 | 90 | 119 | 154 | 170 | 172 | 169 | 211 | 206 | 231 | 250 | 255 | 224 | 238 | 257 | 242 | 234 | 229 | 207 | 74 | X | X | X | X | 4,005 |
| **32** | 0 | 1 | 3 | 4 | 5 | 6 | 15 | 20 | 27 | 33 | 47 | 65 | 71 | 94 | 122 | 156 | 171 | 172 | 169 | 211 | 205 | 229 | 248 | 253 | 221 | 234 | 252 | 236 | 227 | 223 | 198 | 71 | X | X | X | 3,987 |
| **33** | 0 | 0 | 2 | 3 | 5 | 5 | 7 | 16 | 22 | 29 | 35 | 49 | 68 | 74 | 96 | 124 | 157 | 172 | 173 | 169 | 210 | 203 | 227 | 245 | 249 | 217 | 229 | 246 | 230 | 221 | 213 | 189 | 67 | X | X | 3,952 |
| **34** | 0 | 0 | 0 | 2 | 4 | 5 | 6 | 8 | 18 | 24 | 31 | 37 | 52 | 70 | 76 | 97 | 125 | 158 | 172 | 172 | 168 | 209 | 202 | 224 | 242 | 245 | 213 | 224 | 239 | 223 | 211 | 203 | 179 | 63 | X | 3,902 |
| **35** | 0 | 0 | 0 | 0 | 2 | 4 | 6 | 6 | 9 | 19 | 26 | 33 | 39 | 54 | 72 | 77 | 98 | 126 | 158 | 172 | 172 | 167 | 207 | 199 | 221 | 238 | 240 | 208 | 218 | 232 | 214 | 201 | 193 | 169 | 59 | 3,838 |

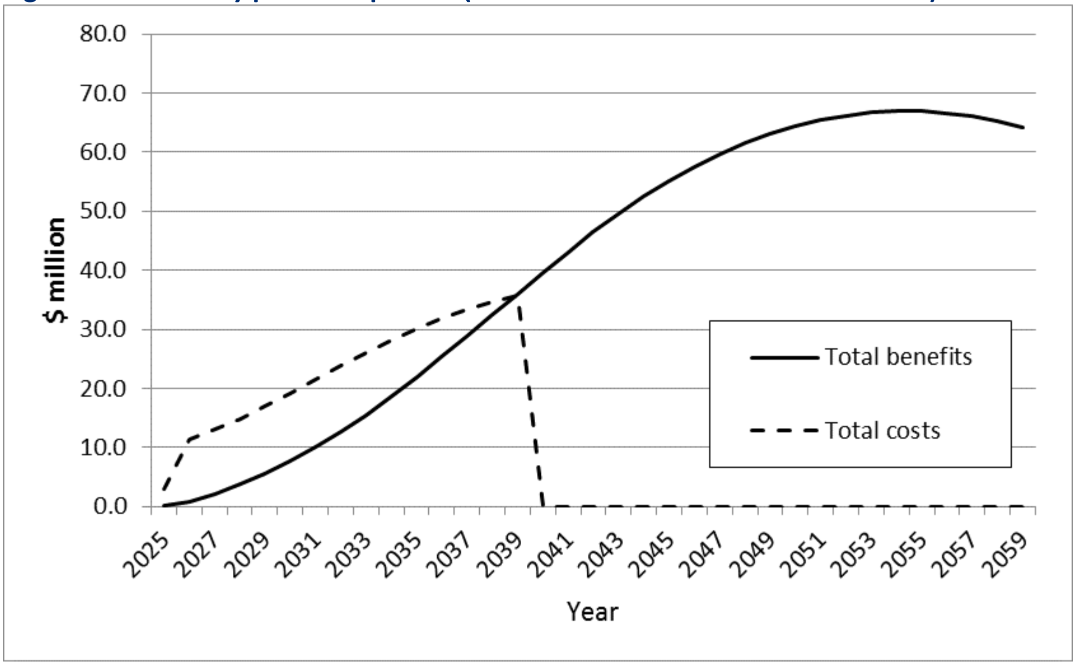
9. From the number of crashes affected determined in step 8, the trauma alleviated by year was determined as the product of effectiveness for each trauma type and the technology impact (Table 10).

**Table 10: Expected reduction in fatal and serious and minor injury crashes under Option 2**

| Year | Fatal crashes avoided | Serious injury crashes avoided | Minor injury crashes avoided |
|---|---|---|---|
| **2025** | 0.01 | 0.22 | 0.25 |
| **2026** | 0.04 | 1.46 | 1.61 |
| **2027** | 0.10 | 3.92 | 4.34 |
| **2028** | 0.17 | 6.87 | 7.61 |
| **2029** | 0.26 | 10.24 | 11.33 |
| **2030** | 0.36 | 14.10 | 15.61 |
| **2031** | 0.47 | 18.47 | 20.45 |
| **2032** | 0.58 | 23.14 | 25.63 |
| **2033** | 0.71 | 28.24 | 31.27 |
| **2034** | 0.86 | 33.97 | 37.61 |
| **2035** | 1.01 | 40.04 | 44.34 |
| **2036** | 1.17 | 46.30 | 51.27 |
| **2037** | 1.33 | 52.72 | 58.37 |
| **2038** | 1.50 | 59.29 | 65.65 |
| **2039** | 1.66 | 65.75 | 72.80 |
| **2040** | 1.82 | 72.26 | 80.01 |
| **2041** | 1.99 | 78.67 | 87.10 |
| **2042** | 2.14 | 84.79 | 93.89 |
| **2043** | 2.28 | 90.48 | 100.19 |
| **2044** | 2.42 | 95.70 | 105.97 |
| **2045** | 2.54 | 100.49 | 111.27 |
| **2046** | 2.65 | 104.88 | 116.13 |
| **2047** | 2.74 | 108.77 | 120.43 |
| **2048** | 2.83 | 112.15 | 124.18 |
| **2049** | 2.90 | 115.06 | 127.40 |
| **2050** | 2.96 | 117.48 | 130.08 |
| **2051** | 3.01 | 119.39 | 132.20 |
| **2052** | 3.05 | 120.76 | 133.71 |
| **2053** | 3.07 | 121.67 | 134.72 |
| **2054** | 3.08 | 122.12 | 135.22 |
| **2055** | 3.08 | 122.08 | 135.18 |
| **2056** | 3.07 | 121.53 | 134.56 |
| **2057** | 3.04 | 120.46 | 133.38 |
| **2058** | 3.00 | 118.94 | 131.70 |
| **2059** | 2.95 | 116.98 | 129.53 |
| **Total** | **65** | **2,569** | **2,845** |

10. The cost savings due to loss of life avoided were estimated using the statistical value of a life recommended by Office of Impact Analysis ($4.9 million) and the totals established in step 9. The typical cost of a serious and minor injury was established using methods outlined in BITRE Report 102. Figure 11 shows the total undiscounted benefits and costs for Option 2.

**Figure 11: Summary plot for Option 2 (total undiscounted benefits and costs)**




11. Finally, Table 11 below summarises the figures from the above analysis.

**Table 11: Summary of benefit-cost analysis for Option 2 relative to Option 1**

| Option 2 | Net benefits ($m) | Cost to business ($m) | Cost to Government ($m) | Benefit-cost ratio | Lives saved | Serious injuries avoided | Minor injuries avoided |
|---|---|---|---|---|---|---|---|
| Best | 137.5 | 183.6 | 0.5 | 1.75 | 65 | 2,569 | 2,845 |
| Likely | 137.4 | 183.6 | 0.5 | 1.75 | 65 | 2,569 | 2,845 |
| Worst | -112.8 | 433.8 | 0.5 | 0.74 | 65 | 2,569 | 2,845 |

# Appendix D—Acronyms and Abbreviations

| | |
|---|---|
| AEB/AEBS | Autonomous (Advanced) Emergency Braking (System) |
| ADR | Australian Design Rule |
| AVAS | Acoustic Vehicle Alerting System |
| BITRE | Bureau of Infrastructure, Transport and Regional Economics |
| dB(A) | A-weighted sound pressure level |
| EU | European Union |
| FMVSS | Federal Motor Vehicle Safety Standard |
| FCV | Fuel Cell Vehicle |
| GVM | Gross Vehicle Mass |
| HEV | Hybrid Electric Vehicle |
| ICEV | Internal Combustion Engine Vehicle |
| ITSOC | Infrastructure and Transport Senior Officials' Committee |
| MUARC | Monash University Accident Research Centre |
| NHTSA | National Highway Traffic Safety Administration |
| NRSS | National Road Safety Strategy |
| PEV | Pure Electric Vehicle |
| RBM | Regulatory Burden Measurement |
| RVSA | Road Vehicle Standards Act 2018 |
| SVSEG | Strategic Vehicle Safety and Environment Group |
| UN | United Nations |
| UN CRPD | United Nations Convention on the Rights of Persons with Disabilities |
| US | United States |
| WP.29 | United Nations World Forum for the Harmonization of Vehicle Regulations |

# Appendix E—Glossary of Terms

Benefit-Cost Ratio: The ratio of expected total (gross) benefits to expected total costs (in terms of their present monetary value) for a change of policy relative to business as usual

Bus (or Omnibus): A passenger vehicle having more than nine seating positions, including that of the driver

Certification: Assessment of compliance to the requirements of a regulation/standard. Can relate to parts, sub-assemblies, or a whole vehicle

Crash: Any apparently unpremeditated event reported to police, or other relevant authority, and resulting in death, injury or property damage attributable to the movement of a road vehicle on a public road

Discount Rate: A rate of interest used to translate costs which will be incurred and benefits which will be received across future years into present day values

Fatal Crash: A crash for which there is at least one death

Gross Vehicle Mass: The maximum laden mass of a motor vehicle as specified by the manufacturer.

Hospitalised Injury: A person admitted to hospital from a crash occurring in traffic. Traffic excludes off-road and unknown location

Light Vehicle: For the purposes of this Impact Analysis, a passenger vehicle with nine seats or less or goods carrying vehicle with a gross vehicle mass up to 3.5 tonnes

Heavy Vehicle: For the purposes of this Impact Analysis, a passenger vehicle with more than nine seats or goods carrying vehicle with a gross vehicle mass over 3.5 tonnes

Net Benefit: The sum of expected benefits (in monetary terms), less expected costs associated with a change of policy relative to business as usual

Net Present Value (NPV): The difference between the present economic value (determined using an appropriate discount rate) of all expected benefits and costs over time due to a change of policy relative to business as usual.

Road Crash Fatality: A person who dies within 30 days of a crash as a result of injuries received in that crash

Type Approval: Written approval of an authority/body that a vehicle type (i.e., model design) satisfies a specific technical requirement