Australian Automobile Association

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AAA SUBMISSION: FUEL EFFICIENCY STANDARDS FOR LIGHT VEHICLES

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MEMBER OF

Mr Tristan Kathage
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31 May 2023

Dear Mr Kathage,

Please find attached a submission from the Australian Automobile Association (AAA) in response to the Consultation Paper: *The Fuel Efficiency Standard – Cleaner, Cheaper to Run Cars for Australia.*

The AAA thanks the Department of Infrastructure, Transport, Regional Development, Communications and the Arts for the opportunity to provide a submission. The AAA would welcome the opportunity to be involved in future consultations and be kept informed of progress.

Should you wish to further discuss this matter, my office can be contacted on 02 6247 7311. [redacted]

Yours sincerely [redacted]

Michael Bradley [redacted]
Managing Director [redacted]

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Australian Automobile Association

AAA Submission on Fuel Efficiency Standards for Light Vehicles

Introduction

The Australian Automobile Association (AAA) is pleased to provide a submission to the consultation on Fuel Efficiency Standards for light vehicles. The AAA is the peak organisation for Australia's motoring clubs and their 8.9 million members. Its constituent clubs are the NRMA, RACV, RACQ, RAA, RAC, RACT and the AANT. The AAA regularly commissions research and develops in-depth analysis of issues affecting transport systems, including affordability, road safety and vehicle emissions.

The AAA thanks the Department of Infrastructure, Transport, Regional Development, Communications and the Arts for the opportunity to provide a submission. The *National Electric Vehicle Strategy* included a commitment to developing Australia's first Fuel Efficiency Standard for new light vehicles. The *National Electric Vehicle Strategy* noted that the Government will consult with stakeholders to design a Fuel Efficiency Standard for passenger and light commercial vehicles that are broadly consistent with standards in place in major advanced markets (Commonwealth of Australia 2023, p. 21).

The AAA believes strongly that Australians should have access to the best safe new car technology available, and that this should be as affordable as possible for all Australians. A such, the AAA supports the introduction of fuel efficiency standards. The AAA sees a fuel efficiency standard as a technology-agnostic means of improving the supply of latest technology vehicles to the Australian market. New vehicle models with improved fuel consumption, lower tailpipe emissions, and those utilising alternative energy sources are not currently being prioritised for the Australian market.

The design of a fuel efficiency standard should be carefully considered to ensure its suitability and applicability to the Australian new vehicle market, noting that it is not possible to suggest a target for the standard until the design elements of the standard, as outlined in the Consultation Paper, have been determined.

Australia's alignment with any international emissions standard must take into consideration the Australian vehicle fleet and how and why it differs from those found in other markets. The AAA does not support adopting a specific target that has been set in another jurisdiction as a starting point in Australia as those targets are based on that jurisdiction's fleet characteristics and the design and structure of its fuel efficiency standard. Until the design and structure of an Australian fuel efficiency standard are determined, it is not possible to comment on the feasibility or suitability of a particular target. Hence, the AAA does not propose a target at this time, but expects to support one in the future following due consideration.

Overview of Fuel Efficiency Standards

Fuel efficiency standards seek to target the direction of vehicle purchase patterns (or technical change in vehicles), to achieve lower emissions intensity (or greater fuel economy) than would otherwise be the case without standards (CIE 2023, p. 13)[1]. Having a fuel efficiency standard for new light vehicles will result in Australians having access to a greater range of Electric Vehicles (EVs). These new vehicles will eventually move into the second-hand car market. This is crucial, as about 70 per cent of Australia's annual car sales are in the second-hand car market. More than 85 per cent of all vehicles sold across the world are covered by some form of fuel efficiency standard, including those sold in the European Union, the US, China, Japan, Brazil, India, Canada, South Korea, and Mexico (Commonwealth of Australia 2023a, p. 7).

The average emissions per kilometre of new vehicles have been falling with an overall reduction of 28 per cent between 2002 and 2018 (NTC 2022, p. 12). Historically the reduction in average emissions across new car sales has been driven by improved efficiency of internal combustion engine (ICE) vehicles, while more recently and into the future this is expected to be driven by the adoption of low and zero emission vehicles (Battery Electric Vehicles (BEVs) and hybrid electric vehicles (HEVs) including plug in hybrid electric vehicles (PHEVs)) (CIE 2023, p. 5). Average emissions are expected to continue to fall steadily (CIE 2023, p. 5).

Emission standards only target vehicle efficiency of new vehicles, which are a small share of vehicles in the fleet (at least in the short term) (CIE 2023, p. 24). In any year, new vehicles make up around 5 per cent of the vehicles on the road, therefore, emission reductions achieved by emission standards are relatively modest (though they grow over time) (CIE 2023, p. 24). Any emission standard will bring forward lower emissions, as opposed to setting emissions on an entirely different trajectory (CIE 2023, p. 5).

Fuel efficiency standards are only one component of vehicles emissions. Vehicle emissions are a function of:

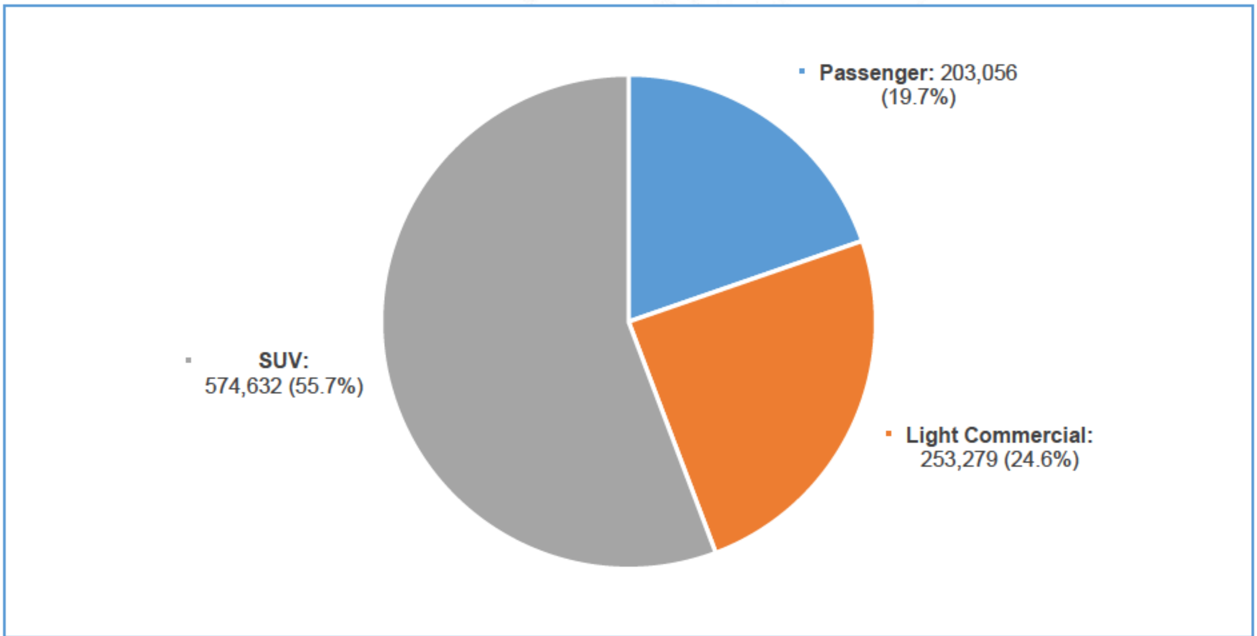
- fuel efficiency - energy density of fuel per unit of emissions
- vehicle efficiency - the characteristics of the vehicle which affect fuel consumption. This includes the powertrain (i.e. ICE, BEV, HEV), fuel type, technology, vehicle weight, vehicle aerodynamics and tyres. These aspects of vehicle efficiency are affected by technical choices in design and construction which are shaped by consumer preferences.
- driving efficiency - the impact of driving habits, knowledge of good driving techniques, driving speed and style (including accelerating and braking), tyre pressure, vehicle loading. This is also affected by congestion, the design of road networks and road surface materials.
- distance travelled - the impact of trip making decisions including, whether to undertake a trip, route choice and mode choice. This will be affected by design of road network and availability of public transport (CIE 2023, p. 15).

[1] The AAA commissioned The Centre for International Economics to prepare a report on the impact of a fuel efficiency standard on consumers, vehicle markets, emissions and fuel excise.

Australia's Vehicle Fleet Composition

Australia's vehicle fleet composition reflects our geography, lifestyle, and road safety profile, as well as tax treatment on certain vehicles. Australians like driving larger light vehicles – the Toyota Hilux was Australia's most popular-selling new vehicle in 2022. As stated in the Consultation Paper, Australia is highly dependent on the type of cars, including utes and 4-wheel drives that are driven in day-to-day lives, and, in many cases used to earn a living (Commonwealth of Australia 2023a, p. 7). SUVs make up 56 per cent of Australia's new light vehicles sales and light commercials make up 25 per cent (Figure 1). To maximise vehicle choice, the Government must consider the composition of Australia's fleet when designing a fuel efficiency standard.

Figure 1 - Australia's New Light Vehicles Sales (2022)



Source: AAA's EV Index, based on VFACTS data.

The notion that Australia must 'catch up' or match the targets in European or US fuel efficiency standards is problematic. Average levels of carbon dioxide emitted from Europe's fleet are different to Australia's for several reasons other than Australia not having a specified target. Europe has several measures that have reduced carbon dioxide emissions from motor vehicles, including:

- Low diesel taxes compared to petrol taxes (encourages consumers to purchase diesel vehicles to reduce running costs)
- Vehicle excise duties (encourages consumers to purchase low carbon dioxide-emitting vehicles)
- Consumer information on vehicles (provides information to consumers about relative carbon dioxide efficiency and the annual running costs of new vehicles)

- Consumer information in printed advertisements (provides information to consumers about relative carbon dioxide efficiency and the annual running costs of new vehicles) (NTC 2022, p. 38).

In addition, the European market is dominated by smaller cars, higher fuel prices and wider availability of public transport.

As stated in the Consultation Paper, immediately adopting an annual emissions ceiling from another market would likely disrupt the Australian vehicle market by not providing sufficient time for suppliers to establish a pipeline to Australia of vehicles fitted with more efficient ICE technologies and Low and Zero Emission Vehicles (LZEVs) (Commonwealth of Australia 2023a, p. 15). Furthermore, it is premature to consider the target for a fuel efficiency standard until the design elements of the standard, as outlined in the Consultation Paper, have been settled. Overseas experience can offer valuable lessons about designing fuel efficiency standards, as well as useful features than Australia can copy or adapt. However, an Australian CO_2 target must be designed for the Australian light vehicle fleet to encourage uptake of low CO_2 emitting cars whilst maintaining affordability and vehicle choice.

The AAA supports introducing a fuel efficiency standard for light vehicles and has consistently called on the Australian Government to introduce a standard to increase the supply of new technology and cleaner vehicles and to reduce Australia's carbon footprint. As stated earlier, over 85 per cent of the global car market already has vehicle fuel efficiency standards in place. The AAA welcomes the consultation and looks forward to participating in bilateral and roundtable discussions. The AAA notes that the Department will be undertaking detailed analysis on the potential outcomes of a fuel efficiency standard and believes this should be made publicly available at the earliest opportunity.

The AAA is strongly committed to ensuring that any regulatory measure is properly considered and introduced in a way that minimises cost to motorists and maintains choice. The speed of the transition to lower vehicle emissions must consider the total costs for consumers including changes to operating costs, maintenance costs and safety impacts including the rate of vehicle turnover and average age of fleet. The AAA accepts that the intervention of a standard in the market will increase costs and these need to be balanced against anticipated benefits. Care also needs to be taken to avoid perverse outcomes, such as an increase in cost of new vehicles that deters consumer purchase, resulting in them keeping their existing vehicles longer, resulting in worse environmental and road safety outcomes. The standard's impacts on different socio-economic groups should be assessed to ensure that the costs of the policy are not disproportionally borne by disadvantaged groups. The AAA is committed to working with Government to ensure new legislation and regulations are implemented on an appropriate timeline and do not unduly increase transport costs.

Australia is a technology-taker for new vehicle technology and the introduction of a mandatory fuel efficiency standard is expected to increase the supply of new technology vehicles to the Australian market. Australia is approximately one per cent of the global vehicle market and an Australian fuel efficiency standard cannot be expected to have any significant impact on the development of global new vehicle technology. Whilst the Australian market is a larger proportion of the right hand drive market than the global market, the introduction of an Australian fuel efficiency standard is not expected to influence vehicle technology development. Technology suppliers are not developing technology only for the right hand drive market and will be leveraging technology development regardless of left or right hand drive, driven by the larger global markets.

The AAA is a technology-agnostic advocate committed to ensuring Australia's light vehicle fleet meaningfully contributes to Australia's decarbonisation. The AAA and its members want Australians in the best possible position to adopt these new technologies and choose the transport technology options that best suit their lifestyle, household budget, and commuting needs. Owning and operating a car in Australia with its unique driving conditions should also remain affordable.

AAA Transport Affordability Index

The AAA wishes to minimise the impact of a fuel efficiency standard on the cost and affordability of transport. The AAA Transport Affordability Index (the Index) tracks the cost of transport and the impact on household budgets. Since 2016 the Index has been updated quarterly to show how transport costs change over time relative to incomes. The Index continues to show that transport costs are placing a significant strain on household budgets across both regional and metropolitan Australia. Since the March quarter of 2016, typical weekly transport costs for metropolitan households have increased by nearly $90 from $327.58 to $417.39 (in the December quarter of 2022), representing a 27 per cent increase. Similarly, since the June quarter of 2017 typical weekly transport costs for regional households have increased by nearly $80 from $266.59 to $347.68 (in the December quarter of 2022), representing a 30 per cent increase.

The December 2022 quarter findings show the typical household now spends 15.1 per cent of its income on transport costs – 15.6 per cent in the capital cities and 14.4 per cent in regional centres. Hobart (17.7%), followed by Brisbane (17.3%) and Melbourne (16.7%) had the highest transport costs as a proportion of household income in capital cities. Launceston (18.1%) had the highest cost of transport as a percentage of income in regional centres, followed by Alice Springs (16.5%) and Mount Gambier (14.7%).

Compared with the September 2022 quarter, in the December 2022 quarter, the typical Australian city household's average annualised cost of transport increased by $200 to $21,704. The average annual cost of transport for the typical regional household increased by $195 to $18,080. Of this, transport taxes cost regional families $2,796 – an increase of $632 overall due to the reintroduction of the full fuel excise rate from 29 September 2022.

AAA Real-World Testing Program

The AAA wishes to ensure that vehicle technologies for improved fuel efficiency deliver benefits to consumers. The Australian Government has provided the AAA $14 million over four years to test and report the real-world emissions and fuel consumption for select new vehicles in Australia. The Real-World Testing Program will dramatically improve consumer information provided to Australian motorists and subsequently help reduce vehicle running costs and vehicle emissions.

The AAA's Real-World Testing Program will:

- enable consumers to make more informed purchasing decisions
- make choosing a more fuel-efficient car easier
- drive down consumers' costs
- help deliver environmental benefits
- ensure emissions regulations are having a 'real-world' impact.

Motorists motivated by reduced fuel consumption and fuel costs will be able to get better information than that currently provided by mandatory laboratory testing. This will enable motorists to have more accurate information on how much the vehicle will cost to run in real-world conditions, which could save some drivers hundreds of dollars every year.

Many Australian households are paying hundreds of dollars a year more for fuel than advertised. This is because laboratory testing for fuel use and vehicle emissions doesn't reflect the actual results of driving on Australian roads. Often the cost differences are substantial. A pilot test of 30 vehicles commissioned by the AAA in 2017 found the vehicles tested in the real world used on average 23 per cent more fuel than indicated by their laboratory tests. The vehicle that produced the worst result was 59 per cent above the laboratory test findings. Only three of the 30 vehicles tested used the same amount of fuel on the road as they did in the laboratory.

The Real-World Testing Program will assess about 60 new vehicle models available in Australia each year, initially targeting models and variants in the most popular vehicle segments to maximise the program's coverage of new vehicle sales. Testing will commence from July 2023 and results will be available in late 2023. Buying and running a car is a major expense, and motorists are entitled to expect reliable information. The Real-World Testing Program will help drive fuel savings and improved environmental performance through informed consumer choice.

AAA Electric Vehicle Index

The AAA launched its EV Index in March 2023. This online dashboard brings together seven different data sets describing the technology transition of Australia's vehicle fleet. The AAA has designed the EV Index as a tool to provide unbiased, credible and up-to-date data on EV options and patterns of take-up.

The EV Index shows:

- how many EVs are being sold
- which brands and types of vehicles are being purchased
- geographic distribution of EV registrations
- vehicle specifications
- international list prices of 26 representative EV models.

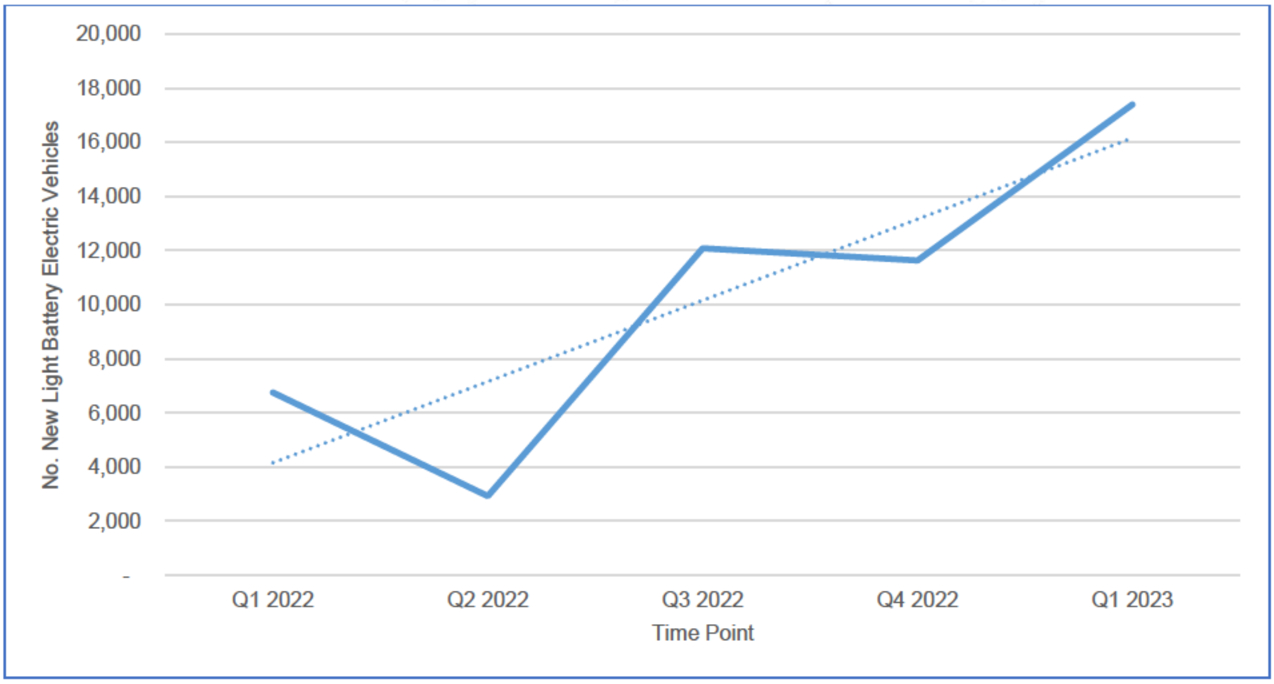
The EV Index is designed to be a resource for businesses, policymakers, motoring enthusiasts and anyone wanting more information about the transition of Australia's vehicle fleet.

Sales of Electric Vehicles

Despite Australia not having a fuel efficiency standard, BEVs accounted for 6.77 per cent of new light vehicle sales in the first quarter of 2023 (AAA 2023). This is an increase on the 4.54 per cent of new light vehicle sales that were BEVs in the fourth quarter of 2022 (AAA 2023). BEV sales in the first quarter of 2023 overtook those of ICE cars in the medium-sized car category for the first time on record.

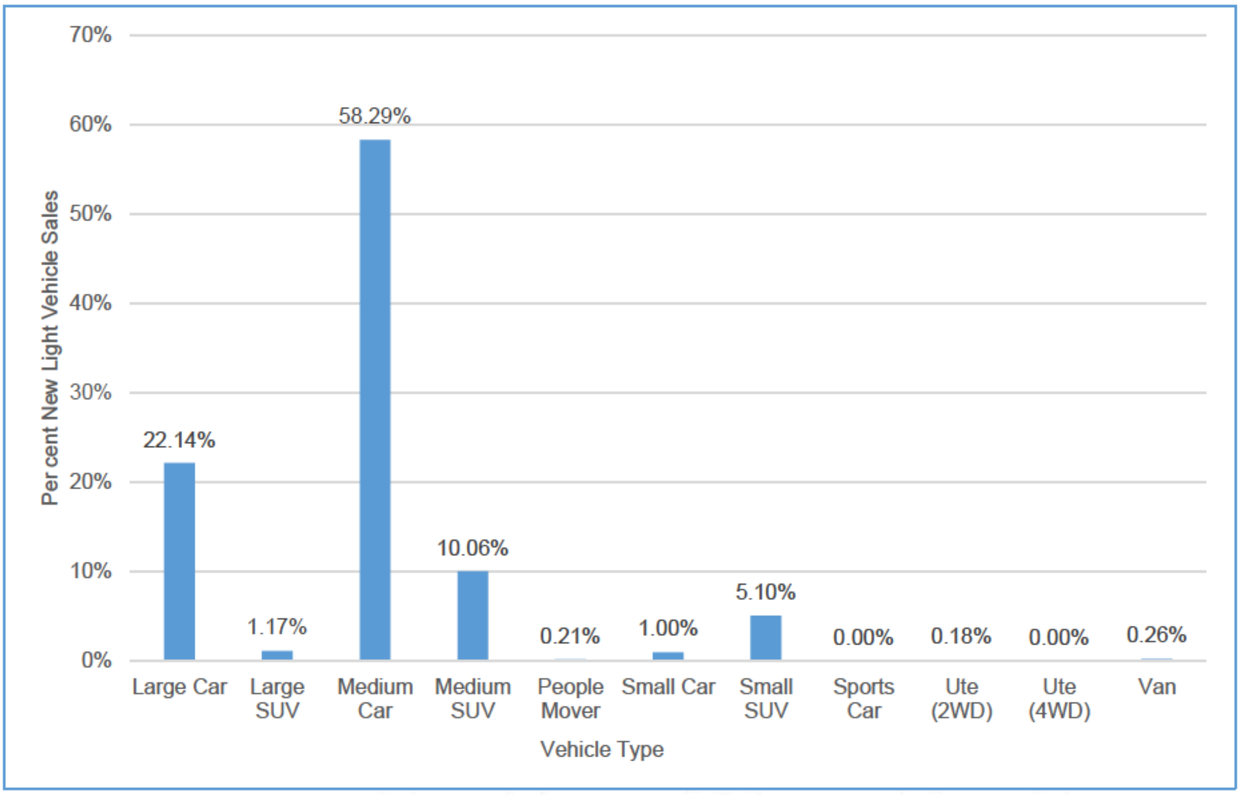
Figure 2 shows the quarterly sales of BEVs since the first quarter of 2022. Figure 3 shows Australia's sales of new light BEVs by vehicle type as a percentage of new light vehicle sales for the first quarter of 2023.

Figure 2 - Australia's Quarterly Sales of New Light Battery Electric Vehicles (Q1 2022 – Q1 2023)



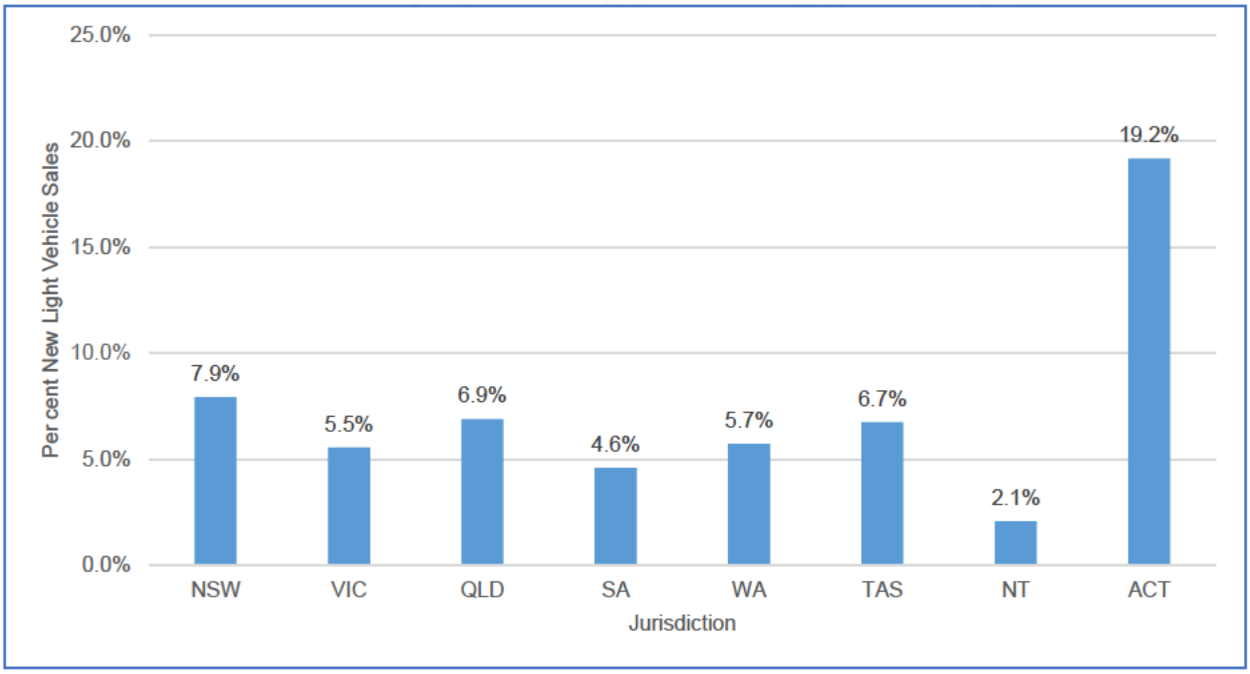
Source: AAA's EV Index, based on VFACTS data.

Figure 3 - Australia's Sales of New Light Battery Electric Vehicles by Vehicle Type (Q1 2023)



Source: AAA's EV Index, based on VFACTS data.

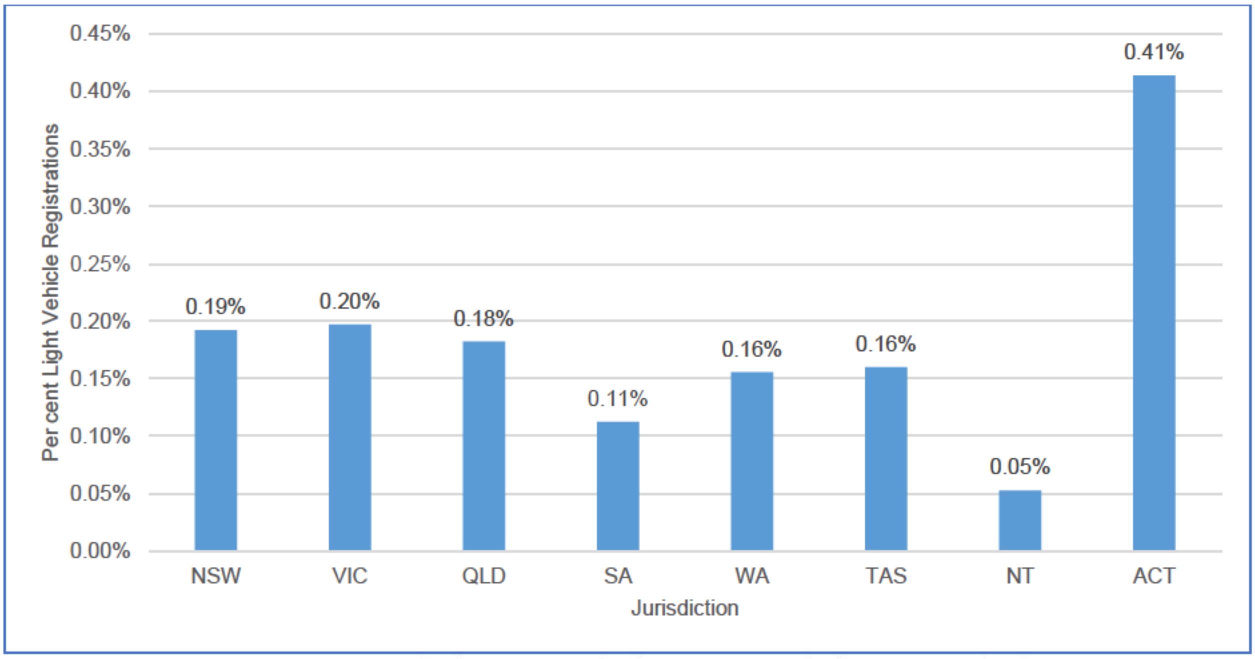
Figure 4 – Australia's New Light Battery Electric Vehicle Sales by Jurisdiction (Q1 2023)



Source: AAA's EV Index, based on VFACTS data.

Figure 4 shows for the first three months of 2023 the ACT had the highest proportion of new light BEV sales at 19.2 per cent of all new light vehicle sales. A similar pattern can be seen in Figure 5 showing new light BEV sales since inception until the end of January 2022. As at 31 January 2022, there were 34,536 registered light BEVs across Australia – or about 0.18 per cent of light vehicle registrations (BITRE 2022). The highest penetration of BEV registration is in the ACT at 0.41 per cent and the lowest is the NT at 0.05 per cent (BITRE 2022) (Figure 5).

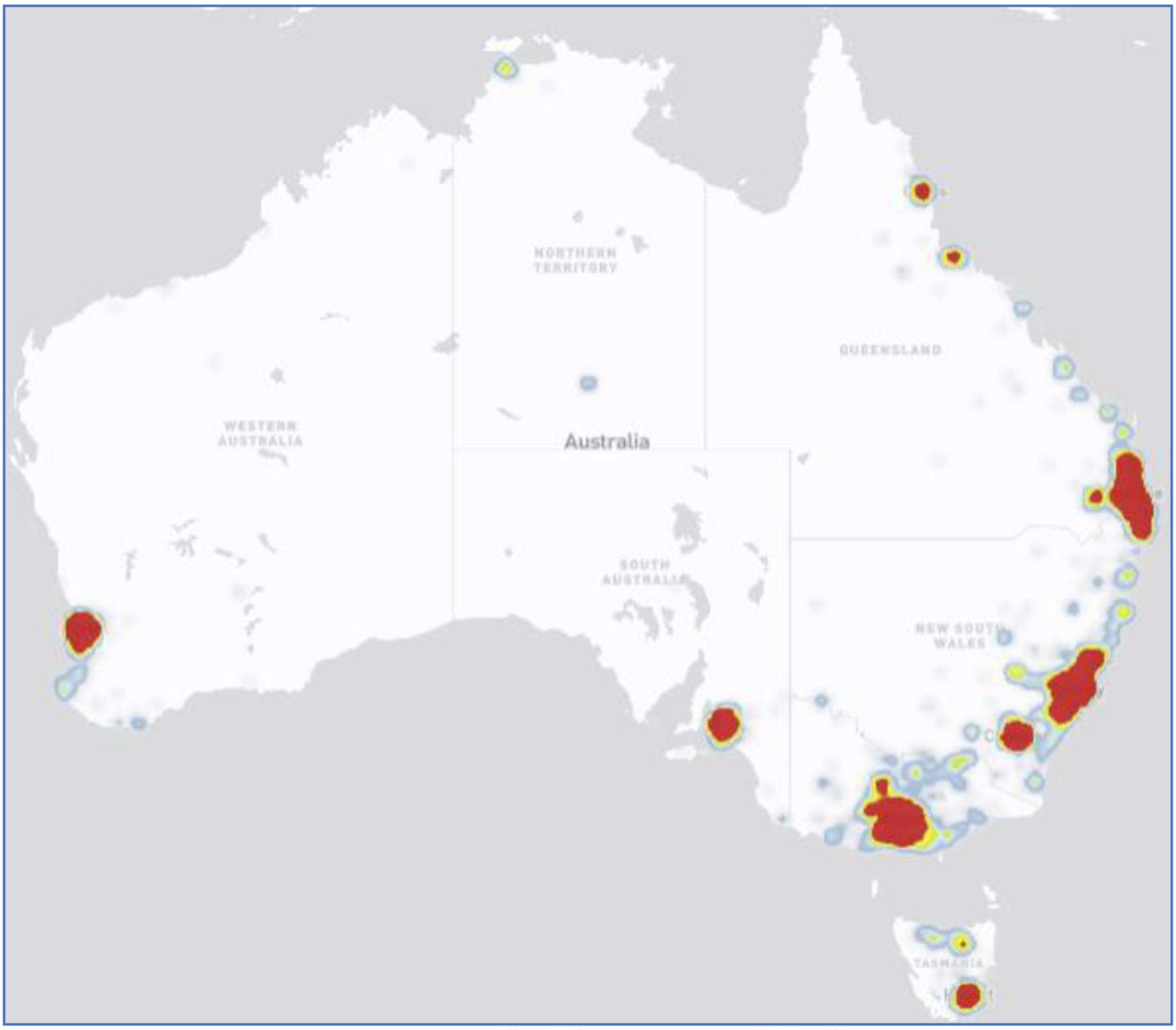
Figure 5 – Australian Light Battery Electric Vehicle Registrations by Jurisdiction (31 January 2022)



Source: AAA's EV Index, based on BITRE (2022) *Motor Vehicles, Australia, January 2022, Customised Data Extract.*

As stated in the *National Electric Vehicle Strategy*, regional areas face unique barriers to EV uptake due to large distances and limited access to necessary infrastructure (Commonwealth of Australia 2023, p. 33). BEVs represent 0.23 per cent of light vehicle registrations in Australia's major cities, but only 0.1 per cent of light vehicle registrations in Inner Regional Australia (BITRE 2022). In Outer Regional, Remote and Very Remote Australia, BEVs represented less than 0.06 per cent of light vehicle registrations (BITRE 2022). The heatmap below (Figure 6) illustrates the concentration of BEVs in urban areas as at January 2022.

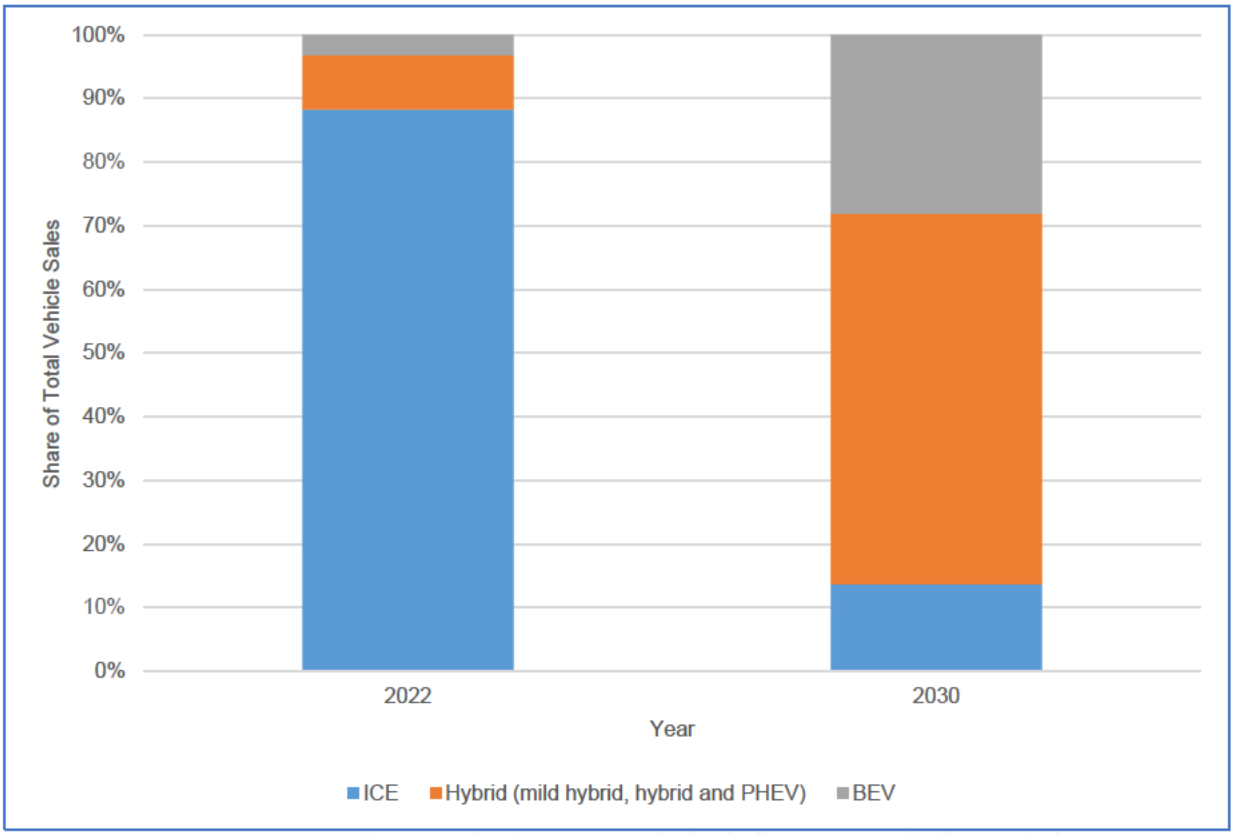
Figure 6 - Postcode Heatmap of Light Battery Electric Vehicle Registrations (31 January 2022)



Source: AAA's EV Index, based on BITRE (2022) *Motor Vehicles, Australia, January 2022, Customised Data Extract.*

Many Australian and global projections anticipate a rapid increase in EV sales. In the absence of a fuel efficiency standard, the share of BEVs is expected to increase from 3 per cent of new vehicle sales in 2022 to around 28 per cent in 2030, while hybrids are expected to account for almost 60 per cent of new vehicle sales in 2030 (CIE 2023, p. 42) as illustrated in Figure 7 below. The transition away from ICE vehicles to HEVs and BEVs is expected to be replicated across vehicle types, albeit to varying degrees. By 2030, in the absence of a fuel efficiency standard, passenger vehicles are expected to have the highest share of BEVs, accounting for around 40 per cent of sales against 54 per cent for hybrid and 6 per cent for ICE vehicles (CIE 2023, p. 42).

Figure 7 - New Car Sales by Powertrain



Source: CIE (2023) *Vehicle emission standards: Impacts on consumers, vehicle markets, emissions and fuel excise*, report prepared for the Australian Automobile Association, p. 43.

For BEVs, the purchase price premium is the key determinant of incremental ownership costs. BEVs are expected to result in a fuel cost saving of around $11 000, $15 000 and $22 500 for passenger, SUVs and LCVs respectively over a 20 year time period (CIE 2023, p. 60). When price premiums are greater than these savings, owning a BEV would be a net cost for households (CIE 2023, p. 60). The break-even threshold is higher for LCVs and SUVs due to the higher fuel consumption of these ICE vehicles (CIE 2023, p. 60).

Fuel cost savings are often cited as a rationale for implementing an emission standard, which assumes at least some households do not factor these costs into decision making (CIE 2023, p. 16). When consumers purchase a vehicle, they are purchasing a bundle of characteristics for a given price, including range, acceleration, towing capacity and running costs (CIE 2023, p. 18). As vehicle attributes improve, the amount consumers are willing to pay for vehicles increases. Consumers will purchase an EV rather than their preferred conventional fuel vehicle once the vehicle attributes are good enough and/or once the price is low enough (CIE 2023, p. 19). Choosing a vehicle with poor fuel efficiency can be efficient when:

- Consumers are aware of the difference in operating costs, and
- The value of a vehicle's other characteristics to consumers exceeds the additional fuel cost of operating the vehicle (CIE 2023, p. 17).

At 13 April 2023, 37 light BEV models were available in Australia. The AAA EV Index includes the following list of BEVs available (Table 1).

Table 1 - Available Electric Vehicles by Model, ANCAP Rating, Listed Price and Range (13 April 2023)

Model	Variant	ANCAP Rating	Listed Price - $AUD (Redbook)	Range - km (Green Vehicle Guide)
Audi e-tron	2022 Audi e-tron 55 quattro	5 star, 2019	NA	459
Audi e-tron GT	2023 Audi e-tron GT Auto quattro MY23	Unrated	$180,200	540
BMW i4	2023 BMW i4 eDrive40 M Sport G26 Auto	4 star, 2022	$99,900	520
BMW i7	2023 BMW i7 xDrive60 M Sport G70 Auto AWD	Unrated	$306,900	625
BMW iX	2023 BMW iX xDrive40 I20 Auto AWD	5 star, 2021	$135,900	420
BMW iX3	2023 BMW iX3 G08 Auto	5 star, 2017	$104,900	440
BYD Atto 3 (Standard)	2023 BYD ATTO 3 Standard Auto	5 star, 2022	$48,011	345
Genesis G80 BEV	2022 Genesis G80 Auto AWD MY22	Unrated	$145,000	520
Genesis GV60	2022 Genesis GV60 AWD Auto AWD MY22	5 star, 2022	$103,700	470
Genesis GV70 BEV	2023 Genesis GV70 Performance Auto AWD MY23	Unrated	$127,800	445
Hyundai Ioniq 5 (MY23)	2023 Hyundai IONIQ 5 DYNAMIQ Auto 2WD MY23	5 star, 2021	$72,000	451
Hyundai Ioniq 6	2023 Hyundai IONIQ 6 DYNAMIQ Auto 2WD MY23	5 star, 2022	$74,000	614
Hyundai Kona BEV	2023 Hyundai Kona Electric Elite Auto	5 star, 2017	$54,500	305
Jaguar I-Pace	2023 Jaguar I-PACE EV400 SE Auto AWD MY23	5 star, 2018	$146,857	446
Kia EV6	2023 Kia EV6 Air Auto MY23	5 star, 2022	$72,590	528
Kia Niro BEV (Plus EV S)	2023 Kia Niro Plus EV S Auto MY23	5 star, 2022	$64,450	427
LDV eT60	2023 LDV eT60 Auto Dual Cab	Unrated	$92,990	NA
LDV Mifa9	2023 LDV MIFA 9 Mode Auto	5 star, 2022	$106,000	NA
Lexus UX BEV	2022 Lexus UX 300e Hatch Auto	5 star, 2019	NA	360
Mazda MX-30 BEV	2022 Maxda MX-30 E35 Astina DR Series Auto	5 star, 2020	$65,490	224
Mercedes-Benz EQA	2023 Mercedes-Benz EQA EQA250 Auto	5 star, 2019	$81,700	524
Mercedes-Benz EQB	2023 Mercedes-Benz EQB EQB250 Auto	5 star, 2019	$87,800	507
Mercedes-Benz EQC	2023 Mercedes-Benz EQC EQC400 Auto 4MATIC	5 star, 2019	$128,000	430
Mercedes-Benz EQE	2023 Mercedes-Benz EQE EQE300 Auto	5 star, 2022*	$134,900	626
Mercedes-Benz EQS	2023 Mercedes-Benz EQS EQS53 AMG Auto 4MATIC+	Unrated	$328,400	587

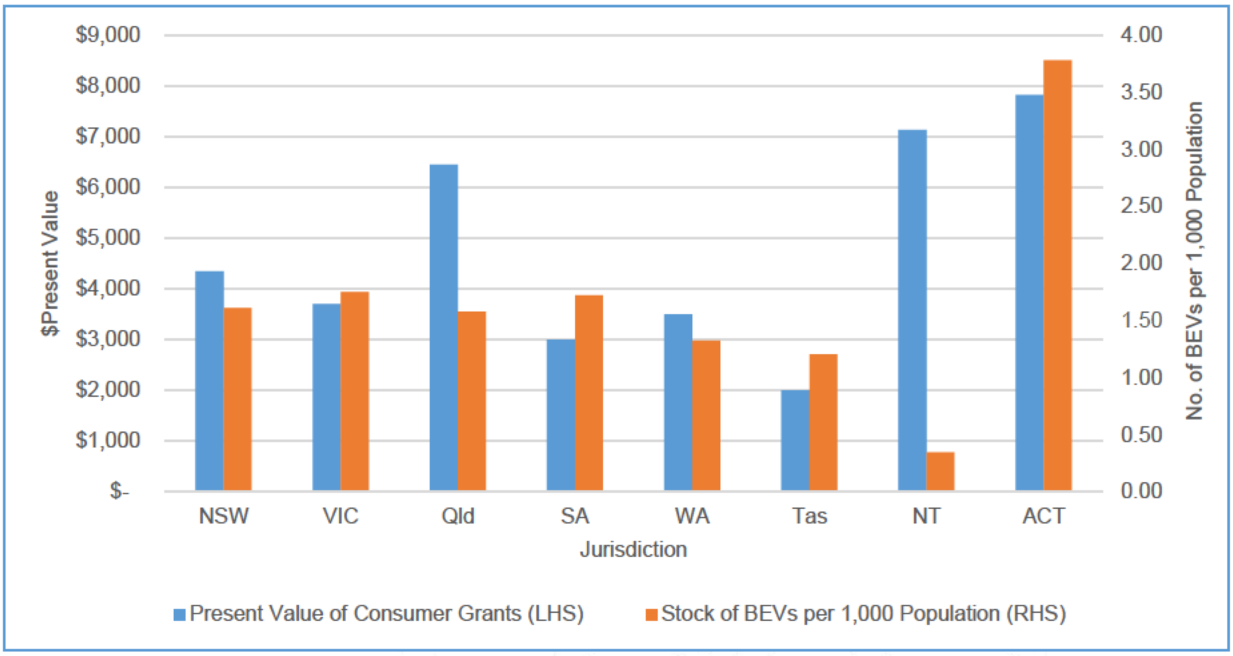
Model	Variant	ANCAP Rating	Listed Price - $AUD (Redbook)	Range - km (Green Vehicle Guide)
Mercedes-Benz eVito Tourer	2023 Mercedes-Benz eVito Tourer 129 Medium Wheelbase Auto	Unrated	$116,115	421
Mercedes-Benz eVito Van	2023 Mercedes-Benz eVito 112 Medium Wheelbase Auto	Unrated	$89,353	NA
MG ZS BEV	2023 MG ZS EV Excite Auto MY22	Unrated	$43,990	360
MINI Hatch BEV	2023 MINI Hatch Cooper SE Classic Auto	Unrated	$55,650	222
Nissan Leaf	2023 Nissan LEAF ZE1 Auto MY23	5 star, 2018	$50,990	311
Polestar 2 (MY23)	2023 Polestar 2 Standard range Single motor Auto MY23	5 star, 2021	$63,900	625
Porsche Taycan	2023 Porsche Taycan Y1A Auto RWD MY23	Unrated	$158,100	405
Renault Kangoo BEV	2022 Renault Kangoo ZE Van	Unrated	NA	264
Tesla Model 3	2023 Tesla Model 3 Rear-Wheel Drive Auto	5 star, 2019	$60,900	559
Tesla Model Y (Standard)	2023 Tesla Model Y Rear-Wheel Drive Auto	5 star, 2022	$68,900	510
Volvo C40	2023 Volvo C40 Recharge Auto MY23	5 star, 2022	$75,990	540
Volvo XC40 BEV	2022 Volvo XC40 Recharge Pure Electric Auto MY23	5 star, 2018	$73,990	510

*Mercedes-Benz EQE received a 5 star, 2022 rating in May 2023, prior to this date it was unrated.

Source: AAA's EV Index, based on data from Redbook, the Green Vehicle Guide and ANCAP.

EV prices are expected to decrease over time, which will make them more affordable for more Australians. According to FCAI analysis of 2021 sales, the listed price of approximately 51 per cent of new light vehicle purchases from January to September 2021 was less than $40,000. As set out in the *National Electric Vehicle Strategy*, there are several Australian Government initiatives to increase the supply and demand for EVs. In addition, States and Territories also have initiatives and incentives to encourage more Australians to purchase EVs. The AAA EV Index includes an up-to-date list of the incentives in place for each jurisdiction. Figure 8 below shows the range of financial incentives available to consumers. These appear to have had some impact on uptake as jurisdictions with larger incentives tend to have higher EV uptake (CIE 2023).

Figure 8 - Current Value of Consumer Financial Incentives for Battery Electric Vehicles and Uptake by Jurisdiction



Note: The stock of electric vehicles is based on reporting by NTC for 2021. Ongoing incentives, such as reduced or waived vehicle registration and interest free loans are measured over 10 years and converted to present value terms using a discount rate of 7 per cent. Queensland doubled its Queensland Zero Emission Vehicle Rebate Scheme from $3 000 to $6 000 in April 2023 – the impact of which is not reflected in the stock of electric vehicles which is based on 2021.

Source: CIE (2023) based on NTC and https://www.mynrma.com.au/cars-and-driving/electric-vehicles/buying/ev-incentives

As stated in the *National Electric Vehicle Strategy*, making EVs more affordable and reducing their running costs is crucial to increasing demand for these vehicles (Commonwealth of Australia 2023, p. 30). The *National Electric Vehicle Strategy* notes several factors tempering demand for EVs – including cost, perceived limited travelling distance of EVs, lack of charging infrastructure, and lengthy charging time (Commonwealth of Australia 2023, p. 30). The AAA welcomed the announcement of a national mapping tool to support optimal investment in and deployment of EV charging infrastructure in the *National Electric Vehicle Strategy*. This is expected to facilitate efficient and effective roll-out of public chargers, which should help build consumer confidence and alleviate many drivers' concerns about infrastructure availability, driving ranges and viable route options.

Australian Vehicle Fleet

The average age of a passenger vehicle in Australia is 10.8 years (BITRE 2022, p.10). The average age of passenger vehicles varies across Australia – the average age of passenger vehicles in the ACT is 9.8 years and in Tasmania is 12.4 years (Table 2).

Table 2 - Average Age of Passenger Vehicles in Years (2022)

Jurisdiction	Average age
ACT	9.8
NSW	10.0
NT	10.1
VIC	10.6
QLD	11.0
WA	11.4
SA	12.4
TAS	12.4
National Average	***10.8***

Source: BITRE (2022) *Motor Vehicles, Australia, January 2022 (First Issue),* p. 10.

The AAA notes that the *National Road Safety Strategy 2021-30* sets an expectation that the average age of the light vehicle fleet will be under 9 years by 2030 (Commonwealth of Australia 2021). In addition, the *National Road Safety Action Plan 2023–25* includes an action to investigate opportunities to reduce the average fleet age in regional communities (Commonwealth of Australia 2023b).

Light vehicles have a lifetime of 15 to 20 years, so fleet turnover can take decades to achieve. If a fuel efficiency standard increases the cost of new vehicles this will not only affect the affordability of new cars, but this could also result in consumers keeping older, less fuel-efficient, and less-safe cars for longer.

Australia's light vehicle fleet has about 15.1 million passenger vehicles and 3.8 million light commercial vehicles (BITRE 2022). New light vehicles account for about 1.1 million sales each year and about 600,000 vehicles are retired from the fleet (CIE 2023, p. 76), meaning roughly six per cent of the light vehicle fleet turns over each year. Under a fuel efficiency standard for new light vehicles, it would take around a decade for more than half of the fleet to be covered by a standard after its implementation.

Feedback on General Questions

Are these the right guiding principles? Are there other principles that you think we should keep in mind?

The AAA agrees with the guiding principles. The principles are the right ones from an environmental perspective. An additional principle should be affordability. Although the purpose of a fuel efficiency standard is to reduce the average amount of CO_2 emitted, the impact on consumers must also be acknowledged. The AAA accepts that the intervention of a standard in the market will increase costs and these need to be balanced against anticipated benefits. Care also needs to be taken to avoid perverse outcomes, such as an increase in cost of new vehicles that deters consumer purchase, or incentivises the purchase of a less fuel efficient vehicle resulting in worse environmental and/or road safety outcomes.

Are there any design assumptions that you think will put at risk the implementation of a good FES for Australia?

The AAA believes that the design principles outlined in the *Consultation Paper* are unlikely to put the implementation of a fuel efficiency standard at risk. The AAA recommends two additional design assumptions to ensure successful implementation of a fuel efficiency standard:

- regular reviews to ensure the fuel efficiency standard is working and there are no unintended consequences or barriers for consumers.
- consider the development and evolution of new technologies when designing the standard and when conducting regular reviews. For example, alternative fuels (including biofuels and biofuels range extenders) and synthetic fuels (also known as e-fuels) that can use green electricity, hydrogen from water and CO_2 from the atmosphere to produce fuels for ICE vehicles that are net-zero CO_2 emissions. The AAA notes that the EU approved legislation in March 2023 ending sales of new ICE vehicles by 2035 except for those that run exclusively on e-fuels. The use of e-fuels also offers the opportunity to reduce emissions from the existing ICE light vehicle fleet.

Are the exclusions for military, law enforcement, emergency services, agricultural equipment and motorcycles the right ones?

The envisaged fuel efficiency standard is for light vehicles and imposes an obligation on light vehicle suppliers to ensure that new vehicles entering the market meet the standard. Agricultural equipment and motorcycles would therefore not be subject to a fuel efficiency standard. The AAA considers that any new light vehicles first registered for road use should be subject to the standard, including those for military, law enforcement and emergency services. The AAA notes that the New Zealand Clean Car Standard excludes vehicles such as motorsport vehicles, scratch-built vehicles and special interest vehicles (Waka Kotahi NZ Transport Agency 2023). The AAA suggests the government considers ways to facilitate other technology such as advanced biofuel/electric options to decarbonise specialist and hard-to-electrify applications.

Are there any particular FES features that you think we need to take particular care with?

There are many features that need to be taken into consideration when determining a fuel efficiency standard for Australia. These features need to be fully explored, considered and settled before a target can be determined or its impact assessed. As noted in Minister King and Minister Bowen's foreword to the *Consultation Paper*: *"There is considerable complexity to designing a fuel efficiency standard and we are committed to getting it right"* (Commonwealth of Australia 2023a, p. 3).

What principles should we consider when setting the targets?

The design elements of the fuel efficiency standard, as outlined in the *Consultation Paper* must be determined before considering the target. The principles for setting a fuel efficiency standard outlined in the *Consultation Paper* (Commonwealth of Australia 2023a, p. 12) should be considered when setting the targets, but affordability should also be included as a principle. The standard's impacts on different socio-economic groups should be assessed to ensure that the costs of the policy are not disproportionally borne by disadvantaged groups, including low-income households as well as regional and remote motorists.

The AAA understands that the release of the fuel efficiency standard, expected at the end of 2023, will be subject to a Policy Impact Analysis (previously known as a Regulation Impact Statement). The Policy Impact Analysis should ensure that the standard's impacts are fully explored and evaluated. The AAA recommends, as a minimum, the benefits and costs outlined in Table 3 below are included in the Policy Impact Analysis.

Table 3 - Benefits and Costs for Inclusion in a Policy Impact Analysis of Emission Standards

Factor	Description - Benefit/Cost
Private value of fuel savings	The treatment of these benefits in the cost benefit analysis underlying the Policy Impact Analysis depends crucially on the understanding of the original rationale for the standard. In the absence of clearly identified fuel efficiency market failures, it is not appropriate to include private benefits. In the presence of market failures, at least some of the private benefits should be included.
Value of emissions reduction	This needs to be understood in the wider context of emissions policy and includes both CO_2 and other emissions. Emissions reductions should be valued at the economy wide cost of emissions reductions, accounting for the fact that there may be other low cost abatement options available.
Technology cost or cost of fleet mix change	There is a wide range of technology cost estimates available. The analysis should allow for sensitivity around estimates. As Australia is a technology-taker (technological options are likely to be driven by other markets), the standard may also involve costs (from the Australian import perspective) in terms of upgrading the efficiency of the fleet, compared with what would otherwise have been the case.
Opportunity cost	This factor is often excluded from explicit consideration. However, focus on fuel efficiency characteristics of vehicles must involve some opportunity cost in terms of other characteristics that consumers value.
Rebound effect	It is widely understood that energy efficiency measures involve a 'rebound effect'. In the case of a vehicle efficiency standard, this is an increase in kilometres travelled due to the effective reduction in the cost of vehicle travel brought about by increased fuel efficiency.
Other implications of the rebound effect	Increased kilometres travelled will have other implications, including increased congestion and other environmental impacts.
Indirect implications for fuel prices	Fuel efficiency from standards may require improvements in fuel quality. This will have indirect implications for fuel prices that need to be included in the analysis. Note that changes in fuel prices will affect all vehicles, not just new vehicles.
Compliance costs	Complying with the standard will involve compliance costs for vehicle brands.
Administrative costs	Administering the standard will involve government administration costs
Cost of taxation (to cover administration costs)	Administration costs will involve the use of tax revenue, which has an opportunity cost.

Source: CIE (2023) *Vehicle emission standards: Impacts on consumers, vehicle markets, emissions and fuel excise*, report prepared for the Australian Automobile Association, pp. 30-31.

How many years ahead should the Government set emissions targets, and with what review mechanism to set limits for the following period?

The AAA supports emission targets being set with the earliest timing capable of providing enough time for a considered rather than rushed transition. This will provide certainty for industry as well as consumers. Targets should be set for a decade ahead to provide direction for industry.

As stated in the *Consultation Paper*, setting emissions targets in the future requires a trade-off between certainty and flexibility. It is worth noting that in both the US and the EU, car manufacturers were given sufficient time to comply with their respective targets. In the case of the US, regulation for the 2025 target passed into formal regulation in 2012, giving manufacturers 14 years notice to reduce emissions by an estimated 43 per cent (Environmental Protection Agency 2012). In the EU, 2021 targets were foreshadowed in 2009 legislation, giving manufacturers 12 years notice to reduce emissions by an estimated 35 per cent (European Parliament and of the Council 2009). In both instances, an existing fuel efficiency standard was operating.

The AAA recommends that the Australian fuel efficiency standard also includes a mechanism to enable adjustments. The AAA recommends undertaking reviews every three to five years to enable any necessary adjustments to the standard.

Given the uncertainty of setting targets far into the future, the AAA considers it may be appropriate to set a 10-year target to indicate broad direction and that may be subject to revision as a result of progress reviews, and targets with a 5-year time horizon may be able to be set with a greater degree of confidence.

How should the Government address the risks of the standard being found to be too weak or too strong while it is operating?

The regulator of the fuel efficiency standard should be required to report annually on the standard's operation and effectiveness. As stated earlier, the legislation for the fuel efficiency standard must establish a mechanism to enable the Government to review and adjust the standard subject to consultation. This would provide an avenue to address the standard being too weak or too strong and would also enable adaptive responses to technological advances. The AAA recommends that the Australian fuel efficiency standard also includes a mechanism to enable adjustments.

Feedback on Technical questions

What should Australia's CO_2 FES targets be?

The design elements of the fuel efficiency standard, as outlined in the *Consultation Paper* must be determined before considering the target. Rather than contemplating a particular target, it may be more appropriate to align the trajectory of Australia's rate of reduction of new vehicle emissions with that of standards in the US or Europe. This recognises that Australia is starting from a different position at a different point in time with a different new vehicle fleet, and the trajectory of the rates of reduction reflect the rate of penetration of new technology vehicles into the fleet.

The AAA agrees that *"failure to set globally competitive FES emission ceilings risks providing insufficient incentive to global vehicle manufacturers to supply in-demand LZEVs to Australia"* (Commonwealth of Australia 2023, p. 15). However, as the *Consultation Paper* notes, *"immediately adopting an annual emissions ceiling from another market would likely disrupt the Australian vehicle market by not providing sufficient time for suppliers to establish a pipeline to Australia of vehicles fitted with more efficient ICE technologies and LZEVs"* (Commonwealth of Australia 2023, p. 15).

The AAA favours adopting an achievable CO_2 target that rewards vehicle manufacturers that surpass the set targets, as opposed to setting a stringent target that imposes penalties on manufacturers that fail to comply. The fuel efficiency standard for new light vehicles must deliver the maximum environmental benefits while ensuring Australians can purchase vehicles that suit their needs and are affordable and safe.

How quickly should emissions reduce over what timeframe?

The AAA believes that until the design features and the associated issues of the fuel efficiency standard are fully explored, considered, and settled, the target and timeframe for emissions reductions cannot be properly assessed. The AAA recommends aligning Australia's rate of reduction of new vehicle emissions with that of standards in the US or Europe. This recognises that Australia is starting from a different position at a different point in time with a different new vehicle fleet, and rates of reduction reflect the rate of penetration of new technology vehicles into the fleet.

Should the Australian FES start slow with a strong finish, start strong, or be a straight line or take a different approach?

The AAA supports the cautious start – finish strong option and the straight line option, noting that the straight line option may be overly simplistic and may become non-linear if reviews adjust the target.

As stated in the *Consultation Paper*, the cautious start – finish strong option would give suppliers more time to adapt to the system, while achieving more modest emission reductions early. While access to EVs might not increase initially, it would provide some time for suppliers to adapt the technology they import to Australia and would allow more time for Australians to adapt to technologies normally supplied to advanced markets with fuel efficiency standards. This option will also provide time to ensure consumers are fully informed and aware of the impacts of a fuel efficiency standard. A review process would allow any necessary adjustment to the standard.

Should an Australian FES adopt a mass-based or footprint-based limit curve?

The AAA recommends a mass-based limit curve. Vehicle mass (the attribute used in the EU, UK and New Zealand), rather than vehicle footprint (the attribute used in the US), has been previously found to have a much stronger correlation with CO_2 emissions for vehicles sold in Australia (ABMARC 2016). As stated in the *Consultation Paper*, a mass-based limit curve most closely reflects vehicle markets similar to Australia and the industry voluntary fuel efficiency standard, providing a framework for compliance that is familiar to suppliers (Commonwealth of Australia 2023a, p. 19). Furthermore, a mass-based attribute caters for the addition of new safety features and other vehicle technologies that add weight to vehicles and therefore increase the energy consumption and emissions of vehicles. When using a footprint-based standard, for a given footprint, the energy consumption and emissions is restricted by the limit value curve, regardless of mass.

If Australia adopts a mass-based limit curve, should it be based on mass in running order, kerb mass, or another measure?

The AAA recommends that if Australia adopts a mass-based limit curve it should be based on mass in running order which is used in the EU.

Should Australia consider a variant of the New Zealand approach to address incentives for very light and very heavy vehicles? If so, noting that new vehicles that weigh under 1,200 kg are rare, where should the weight thresholds be set?

The AAA has no objection to consideration of this approach but does not have specific threshold values to suggest at this time.

Should an Australian FES adopt two emissions targets for different classes of vehicles?

The AAA recommends applying different limit value curves to MA (passenger cars) and NA+MC (four-wheel drive and light commercials) categories as defined under the Australian Design Rules.

Placing passenger cars and four-wheel drive/light commercials in separate categories provides flexibility to introduce different rates of CO_2 reductions for each group in the future. Passenger cars are markedly different to four-wheel drive and light commercial vehicles; their use is different and importantly, their ability to adopt technologies capable of reducing CO_2 emissions, is currently very different. In addition, in other markets different targets have been set for passenger and light commercial vehicles, which recognises that LZEV technology is currently more widely available in passenger vehicles (Commonwealth of Australia 2023a, p. 21). The AAA notes that the US and the EU have separate targets for passenger cars and light commercials, or light trucks in the case of the US. This adds flexibility for car makers, allowing them to sell a wider range of vehicles to ensure more consumer choice.

Is there a way to manage the risk that adopting two targets erodes the effectiveness of an Australian FES by creating an incentive to shift vehicle sales to the higher emission LCV category

The AAA considers that, if designed properly, the targets for each category will reflect their respective rates of technology adoption, and therefore in real terms, their effective stringency will be equal. Hence, if the targets properly reflect each segments' capacity to adopt/deploy technology, there should be no incentive to "shift" vehicle sales.

Is there anything else we should bear in mind as we consider this design feature?

The AAA does not have a view on this question.

Are there other policy interventions that might encourage more efficient vehicle choices?

The AAA believes the introduction of a market-based, technology agnostic regulatory mechanism, such as a fuel efficiency standard, will deliver least cost abatement across Australia's fleet and best serve consumers.

The AAA notes that other jurisdictions have introduced high taxes, restrictions, and penalties on ICE vehicles and their fuels to incentivise the adoption of more efficient vehicles and the AAA does not support such an approach in Australia due to the associated impact on transport affordability.

The AAA recommends that consideration be given to an information campaign aimed at educating drivers on how to reduce fuel consumption through their driving style (ecodriving, e.g. racq.com/ecodrive). Improved information to drivers across the full fleet about driving behaviour and the financial savings that can be achieved would help meet the government's emission reduction targets.

Consumers must also be made aware of the benefits and costs of fuel efficiency. The AAA recommends a communications campaign to ensure consumers are fully informed. The AAA's constituent clubs NRMA, RACV, RACQ, RAA, RAC, RACT and the AANT have 8.9 million members. These clubs continue to support improved information to consumers by providing information supporting EV charging infrastructure, engaging directly with consumers at dedicated EV drive days, and providing ongoing and detailed advice via multiple communication channels. The AAA's member clubs are well-placed to engage consumers and deliver information.

As outlined earlier in the submission, the Australian Government provided the AAA $14 million over four years to test and report the real-world emissions and fuel consumption for selected new vehicles in Australia. The Real-World Testing Program will dramatically improve consumer information provided to Australian motorists and subsequently help reduce vehicle running costs and vehicle emissions. The Real-World Test Program will assess about 60 new vehicle models available in Australia each year and will initially target models and variants in the most popular vehicle segments to maximise the proportion of new vehicle sales covered by the program. Testing will commence from July 2023 and results will be available in late 2023. Buying and running a car is a major expense, and motorists are entitled to expect reliable information. The Real-World Testing

Program will help drive fuel savings and improved environmental performance through informed consumer choice.

The AAA also recommends that all governments ensure the transport system is as efficient as possible. The efficiency of our transport system has a significant effect on the emissions of the transport sector. Allowing growing congestion in our cities would erode gains made in vehicle efficiency. The AAA continues to call on the Government to ensure adequate funding is invested in land transport infrastructure, and to pursue initiatives that ensure our current transport system achieves maximum efficiency.

The AAA also recommends removing the luxury car tax to encourage more efficient vehicle choices. This is an inefficient tax that targets vehicles that are often the leaders in providing safety and environmental benefits. Removing the luxury car tax would contribute to downward pressure on new vehicle prices and allow more high-technology vehicles to enter the Australian vehicle fleet. This would contribute to the Government's road safety, air quality and greenhouse objectives.

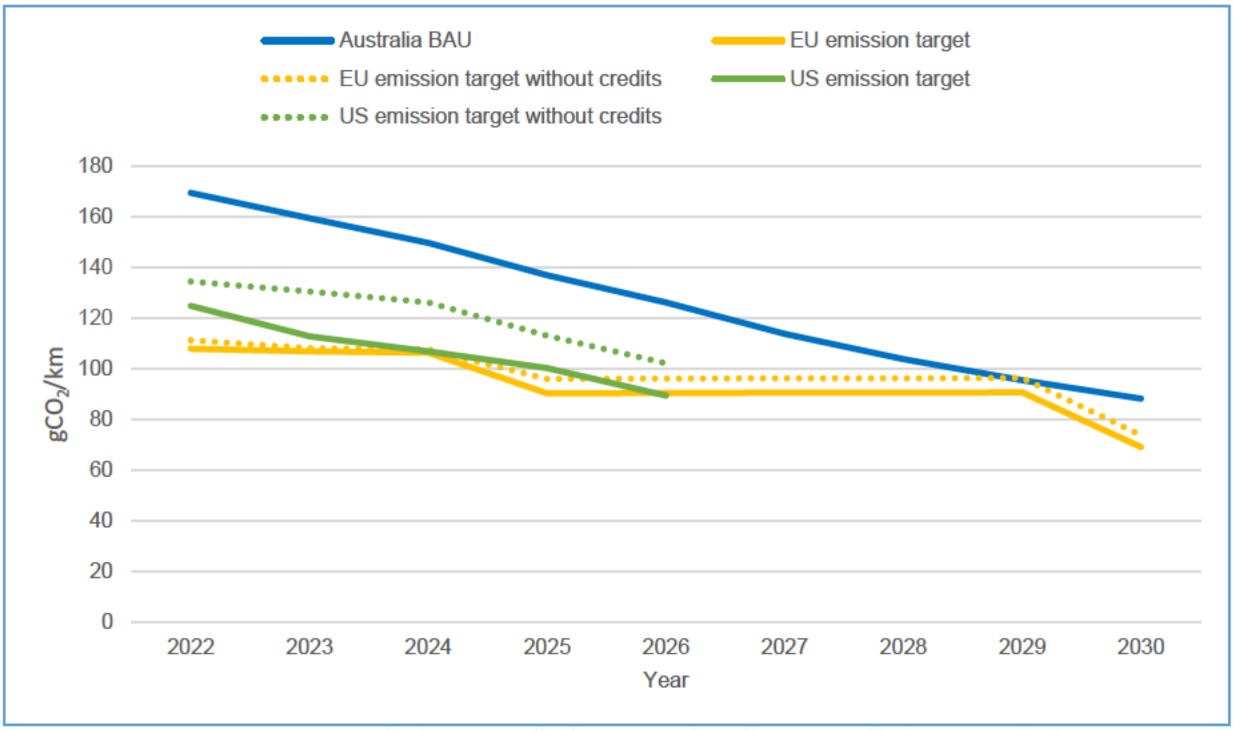
Developing technologies such as e-fuels (synthetic fuels produced using zero emission electricity) should be monitored for commercial viability and cost effectiveness as these have the potential to provide existing and future ICE vehicles with the possibility to operate with net zero emissions.

To what extent should the Australian FES allow credit banking, transferring and/or pooling?

The AAA supports credit and debit banking, transferring and/or pooling as these provide individual vehicle brands with flexible options to meet emissions targets over time, providing a least-cost mechanism for achieving the overall objective of the entire new vehicle fleet meeting the target. The flexible options minimise financial penalties on individual vehicle brands, which would be expected to be passed on to consumers.

Key features of emission standards established and implemented in numerous countries include systems of credits or super credits. These credits can generally be traded between brands, so that brands who do not reach their target through vehicle sales, may fulfil their obligations by purchasing credits from other brands. (CIE 2023, p. 32). It is worth noting that targets set by jurisdictions do not reflect tailpipe emission reductions as the schemes allow a range of credits and adjustments (CIE 2023). Figure 9 below illustrates an estimate of targets for the US and EU removing these credits.

Figure 9 - Emissions Targets Adjusting for the Impacts of Credits



Source: CIE (2023) *Vehicle emission standards: Impacts on consumers, vehicle markets, emissions and fuel excise*, report in preparation for the Australian Automobile Association, p. 33.

Given that credits are key features in other jurisdictions, an Australian fuel efficiency standard should allow credit banking, transferring and pooling. This will also meet the government's objective of designing a fuel efficiency standard that is broadly consistent with standards in place in major advanced markets (Commonwealth of Australia 2023, p. 21).

Investment in accredited carbon offsets such as Australian Carbon Credit Units (ACCUs) to address greenhouse gas emissions that cannot be abated is strongly supported by the AAA.

Should credits expire? In what timeframe?

The AAA recommends that vehicle manufacturers should be permitted to use credits between the two limit value curves as well as bank, transfer and/or pool credits. Vehicle manufacturers should be permitted to carry forward credits and debits for up to three years.

Should an Australian FES include multiplier credits for LZEVs?

Super credits (also known as multiplier incentives) apply a multiplier to the sales volume for vehicles meeting particular criteria (usually low and zero emissions vehicles) and hence reduce the calculated average emissions across sales. The AAA notes that the reduced average emissions calculated in this manner are not real emissions abatement. However, super credits can be used as a policy tool to further incentivise the supply of particular types of vehicles into the market and these incentives can be phased down and/or out over time.

There may be a case to consider super credits for particular classes or types of vehicle, for example zero emissions utility vehicles or zero emissions passenger vehicles with a purchase price of less than $30,000. This would provide suppliers with an additional incentive to deliver these specific vehicle types to Australia. The AAA notes that reductions in purchase price for vehicles should not come at the expense of safety.

If so, what level should the multipliers be, should they apply equally to both classes of vehicle (if adopted) and for how long should they apply?

The AAA does not have a view on this question.

Should the total benefit available from these credits be capped?

The AAA does not have a view on this question.

If not, should the Government consider another approach to incentivising the supply and uptake of LZEVs?

The AAA does not have a view on this question.

Should an Australian FES include off-cycle credits for specified technologies?

Credits for emissions reduction technologies that are not assessed in the laboratory test ("off cycle" technologies) are an included element of fuel efficiency standards in other jurisdictions. As stated in the *Consultation Paper*, the purpose of these measures is to encourage the development and supply of new and innovative technologies to reduce CO_2 emissions from vehicles or to acknowledge CO_2 benefits not recognised by the standardised laboratory emissions test (Commonwealth of Australia 2023a, p. 22).

The AAA supports the use of off-cycle credits (eco-innovations) for ICE vehicles, consistent with those issued in the EU (e.g. LED headlamps, photovoltaic sunroofs, high efficiency alternators) up to a maximum of 7g CO_2/km per manufacturer per year.

If so, should the per-vehicle benefit be capped and how should an Australian FES ensure that off-cycle credits deliver real emissions reduction?

The AAA supports the use of credits for off-cycle credits (eco-innovations) for ICE vehicles, consistent with those issued in the EU (e.g. LED headlamps, photovoltaic sunroofs, high efficiency alternators) up to a maximum of 7g CO_2/km per manufacturer per year.

Should the Government consider any other form of off-cycle credits for an Australian FES?

The AAA does not have a view on this question.

Should an Australian FES include credits for using low global warming potential air conditioning refrigerants, and if so, for how long should this credit be available?

The AAA does not have a view on this question.

Could the issue of high global warming potential refrigerants be better dealt with by another policy or legislative framework?

The AAA does not have a view on this question.

If such a credit is permitted, should the emissions target be lowered to ensure consumers realise the fuel cost savings and EV availability benefits of a FES?

The AAA does not have a view on this question.

When do you think a FES should start?

The need for a fuel efficiency standard must be balanced with the required transition times for industry and consumers. Industry will be best placed to advise what is a feasible and achievable period. An understanding of vehicle manufacturers' Australian market plans is essential to inform implementation timeframes, ambition levels, compliance and enforcement. This would minimise regulatory costs, which are ultimately passed on to consumers. As stated in the *Consultation Paper*, government best practice requires a period of time for business to implement new policies and for government to undertake any targeted education on how to comply with new legislation (Commonwealth of Australia 2023a, p. 25). A compliance system needs to be in place, along with a way of effectively regulating a new fuel efficiency standard (Commonwealth of Australia 2023a, p. 25).

Consumers must also be made aware of the benefits and costs of a fuel efficiency standard. The AAA recommends a communications campaign to ensure consumers are fully informed. The AAA's constituent clubs NRMA, RACV, RACQ, RAA, RAC, RACT and the AANT have 8.9 million members. These clubs continue to support improved information to consumers by providing information supporting EV charging infrastructure, engaging directly with consumers at dedicated EV drive days, and providing ongoing and detailed advice via multiple communication channels. The AAA's member clubs are well-placed to engage consumers and deliver information.

The AAA is committed to reducing the environmental impact of transport and supports a standard designed specifically for the Australian light vehicle fleet, introduced over a reasonable timeframe, that does not unduly restrict vehicle choice or increase costs to the consumer. There must be reasonable lead times and compliance periods to avoid adverse impacts and unintended consequences on consumers' vehicle choice and costs.

All other things equal, a more rapid transition may imply a more limited set of vehicle options (at a higher price) than may occur under a slower transition (CIE 2023, p. 10). This will also have implications for new and used car markets, as consumers faced by high prices may choose to:

- purchase a new car regardless of higher prices
- retain their existing vehicle for longer, or
- purchase a used car (CIE 2023, p. 10).

How should the start date interact with the average annual emissions ceiling?

The AAA does not have a view on this question.

Should the Government provide incentives for the supply of EVs ahead of a FES commencing? If so, how?

The AAA notes that many state and Commonwealth incentives already exist, and that they primarily boost demand for LZEVs, without making Australia a more attractive market for OEMs to supply.

The AAA is concerned that there are a range of barriers to increased supply of LZEVs to the Australian market. As stated in the *Consultation Paper*, Australia represents only one per cent of the global car market and is already in the minority right-hand drive market, which can affect supply for vehicles with limited global reach (Commonwealth of Australia 2023a, p. 10). In the absence of a fuel efficiency standard, this means Australia is a relatively low-priority market for vehicle suppliers when introducing new technologies they could otherwise sell into other markets with fuel efficiency standards.

Therefore, the AAA believes a fuel efficiency standard is the most effective (and cost-effective) way of incentivising supply of LZEVs.

What should the penalties per gram be? Would penalties of A$100 per gram provide a good balance between objectives? What is the case for higher penalties?

The AAA believes that penalties must be aligned with those in fuel efficiency standards in other markets. Penalties that are too low will not incentivise suppliers to provide Australia with the most fuel-efficient and safe vehicles. Penalties too high may mean suppliers avoid providing vehicles to Australia because they prefer to focus on larger markets elsewhere with lower penalties.

The design of a penalty system must be well-balanced to provide sufficient incentives to suppliers to comply. The AAA supports penalties in the order of $100 per gram of CO_2. In addition, the government should disclose whether revenue from penalties will be hypothecated to be reinvested in initiatives to help reduce light vehicle emissions or returned to consolidated revenue. The AAA has consistently called on the Australian Government to prioritise public transport and active transport infrastructure in its future funding programs to improve both metropolitan and regional services.

What if any concessional arrangements should be offered to low volume manufacturers and why? If so, how should a low volume manufacturer be defined?

The administrative efficiency of such an exclusion needs to be balanced with its potential socio-economic impact. The AAA supports efforts to reduce administrative burden and align with other markets' regulatory models. However, the AAA would be concerned if equity issues arose from exclusions of high-emission, low-volume brands.

Of the 52 manufacturers reporting sales data to VFACTs, 17 sold less than 1,000 light vehicles in 2022, accounting for only 3,500 light vehicle sales in total. While the EU standard provides an exemption for manufacturers responsible for less than 1,000 vehicles a year, the US EPA provides concessional arrangements for small volume manufacturers producing less than 5,000 vehicles per year and has proposed to require compliance with the primary standard by 2032.

The Government is keen to ensure any regulatory administrative costs are kept to a minimum while ensuring that outcomes are robust. What should the department keep in mind in designing the system for suppliers to provide information and in relation to record keeping obligations?

The AAA does not have a view on this question.

What should the reporting obligations be? What information should be published and how regularly?

The regulator of the fuel efficiency standard should be required to report annually on the standard's operation and effectiveness.

How long should suppliers keep required information?

The AAA does not have a view on this question.

Is a penalty of 60 penalty units appropriate for this purpose?

The AAA notes that the penalty for vehicle suppliers failing to keep appropriate records under the fuel efficiency standard will need to be sufficient to deter suppliers from weighing up the cost of penalties for record keeping with those for non-compliance with the limit value curve.

Should the regulator be the department? What other options are there?

The AAA supports the Department being the regulator. As stated in the *Consultation Paper*, the Department already has a range of regulatory functions across the transport sector, covering land transport, aviation and maritime.

How should the regulated entity be defined in an Australian FES?

The AAA does not have a view on this question.

What reasons are there to depart from the standard regulatory tool kit for an Australian FES?

The AAA does not have a view on this question.

Should an Australian FES use WLTP test results in anticipation of the adoption of Euro 6 and if so, what conversion should be applied to existing NEDC test results, or how might such a factor be determined?

The AAA believes that an Australian fuel efficiency standard should use the Worldwide Harmonised Light Vehicle Test Procedure (WLTP) test results in anticipation of the adoption of Euro 6. The AAA has long advocated for the introduction of a fuel efficiency standard designed for the Australian market alongside the introduction of improved fuel quality and noxious emissions standards (Euro 6). This would provide an incentive for vehicle manufacturers to offer models with the latest engine technologies that consume less fuel and produce lower tailpipe emissions.

Conclusion

A well-designed fuel efficiency standard will increase the supply of new technology vehicles, including EVs, to Australia. This will provide consumers with greater choice of latest technology vehicles and improve road safety. The AAA is committed to reducing the environmental impact of transport and supports a fuel efficiency standard designed specifically for the Australian light vehicle fleet, introduced over a reasonable timeframe without unduly restricting choice or increasing costs to consumers.

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Australian Automobile Association

Attachment:

Vehicle emission standards

Impacts on consumers, vehicle markets, emissions and fuel excise

Prepared

8 August 2023

Prepared by

The CIE

Prepared for

Australian Automobile Association

COMMERCIAL IN CONFIDENCE

REPORT

Vehicle emission standards

Impacts on consumers, vehicle markets, emissions and fuel excise

Prepared for
Australian Automobile Association

8 August 2023

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BOXES, CHARTS AND TABLES

Glossary

AAA	Australian Automobile Association
ABS	Australian Bureau of Statistics
BAU	Business as usual
BEV	Battery electric vehicle
BITRE	Bureau of Infrastructure and Transport Research Economics
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DWL	Dead weight loss
FCAI	Federal Chamber of Automotive Industries
HEV	Hybrid electric vehicle
ICE	Internal combustion engine
LCV	Light commercial vehicle
LEV	Low emission vehicle
MHEV	Mild hybrid electric vehicle (vehicle that cannot run solely on battery)
NTC	National Transport Commission
Powertrain	Source of energy for the vehicle
PHEV	Plug in hybrid electric vehicle
SUV	Sport utility vehicle
WTP	Willingness to pay
ZEV	Zero emission vehicle
FBT	Fringe benefits tax
HDV	Heavy duty vehicle
GHG	Greenhouse gas
EPA	(US) Environmental Protection Agency
GJ	Gigajoules
kL	Kilolitres
CH_4	Methane (greenhouse gas)
N_2O	Nitrous oxide (greenhouse gas)
WLTP	Worldwide Harmonised Light Vehicle Test Procedure

Summary

The Commonwealth Government has announced its intention to introduce a fuel efficiency standard. This is intended to improve the supply and variety of battery electric vehicles (BEVs) coming into the Australian market, to help reduce vehicle emissions and fuel costs for Australian Motorists.[1]

This report seeks to identify and quantify the different impacts of an emission standard, with a focus on the impact on consumers, emissions, fuel consumption and fuel excise (referred to as the 'analysis' in this report).

What are emission standards?

Emission standards are a policy instrument that target greenhouse gas emission and fuel consumption for new vehicles. They are normally expressed as an average target (across the fleet of new vehicles) in terms of gCO_2/km. The ultimate objective of emission standards is to reduce emissions from the light vehicle fleet by addressing market failures, which include:

- carbon externality: failure to account for the full cost of carbon emissions
- myopia: not accounting for long term efficiency benefits (lower fuel costs) of fuel efficient vehicles
- failures in availability of efficient options in particular markets (through the choices of vehicle brands, for example).

There are various options to implement emission standards. The most common approach is to envisage a target for overall emissions intensity that is allowed to vary by vehicle type or size but that achieves a particular target average emissions intensity.

In principle emission standards seek to create an implicit price incentive in favour of lower emissions vehicles.[2] It is by changing prices that purchasing behaviour can be changed relative to business as usual (BAU).

For a vehicle brand to achieve some average emissions intensity (lower than BAU) they:

- must move purchases away from the current BAU pattern
- need to offer a series of discounts or premiums in order to shift consumer purchases. This will look like an implicit:

1 Department of Climate Change, Energy, the Environment and Water 2023, *The National Electric Vehicle Strategy*.

2 The precise mechanism by which an emission standard achieves its objective depends on the regulatory specifics of the standard.

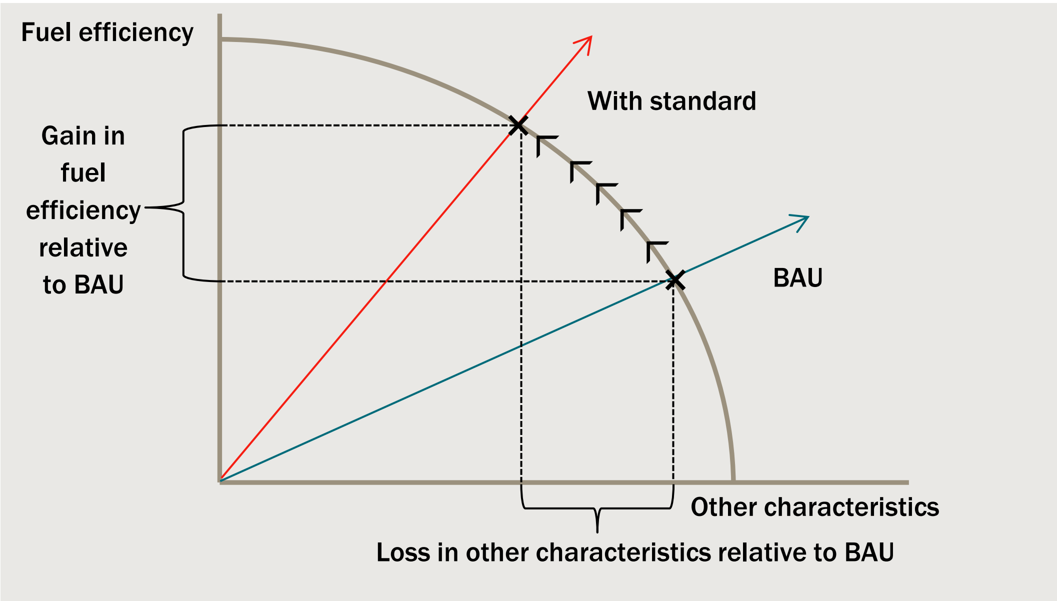
– tax on relatively high emissions vehicles (above the emissions target)
– subsidy to relatively low emissions vehicles (below the emissions target).

This cross subsidy may create a dead weight loss (DWL) or loss of economic efficiency. This DWL is a cost to society associated with an inefficient allocation of resources. For emission standards this relates to shifting households to purchase low emission vehicles (and their associated characteristics) when in the absence of an emission standard they would prefer to purchase higher emission vehicles (and their associated characteristics).

This is shown conceptually in Chart 1. Under BAU vehicle characteristics will evolve with some combination of fuel efficiency and other characteristics that are available for a given vehicle type. The potential vehicle characteristic combinations are improving over time, but there is a trade-off between emission intensity (fuel efficiency) and other vehicle characteristics (a towing capacity, acceleration, price and operating costs etc.).

An emission standard seeks to force consumers to trade off other vehicle characteristics for improved fuel efficiency. It is this deviation from BAU, where consumers would have purchased a particular vehicle in the absence of an emission standard, which results in the DWL.

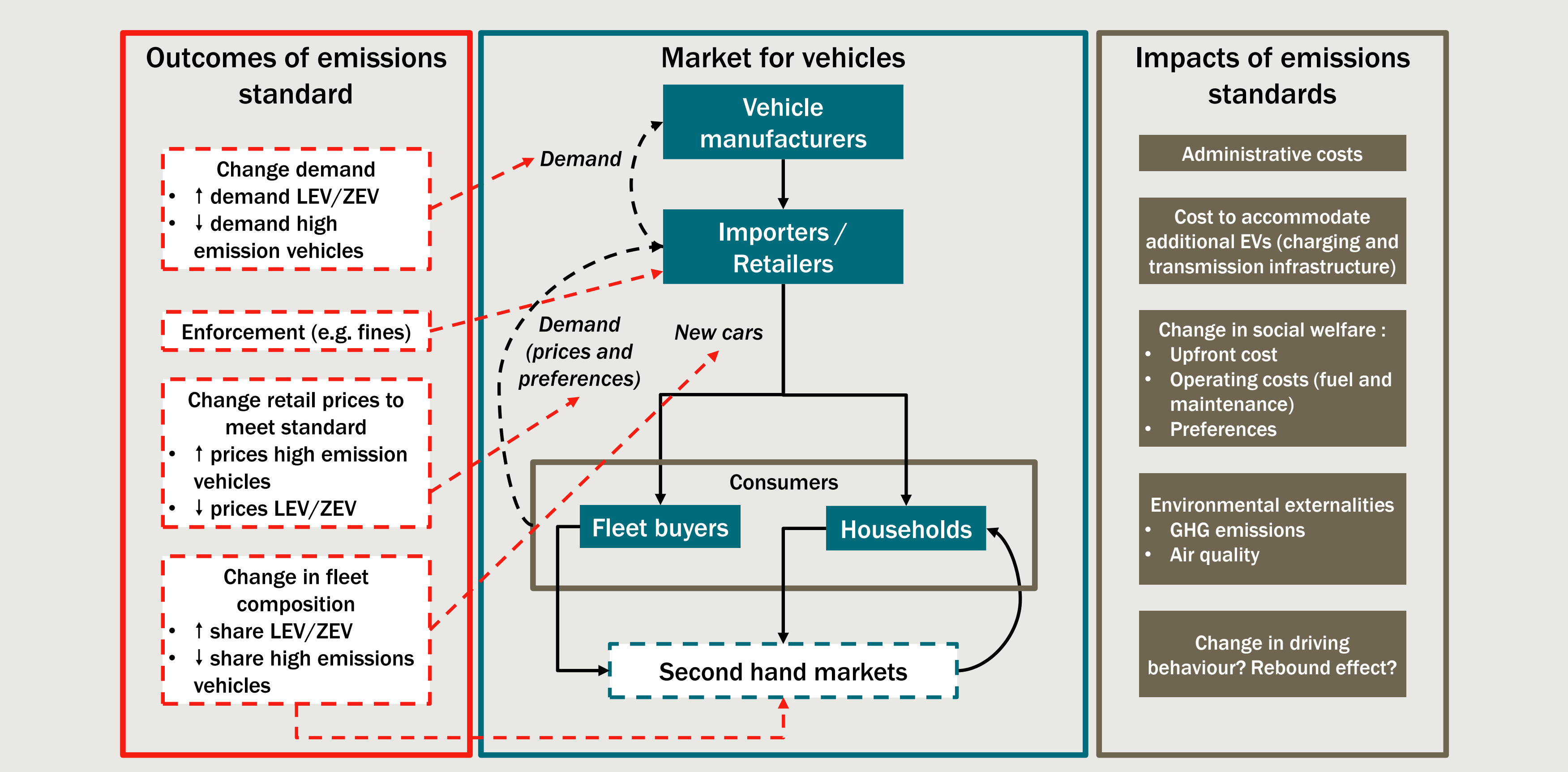
1 Gains and losses relative to BAU



Data source: CIE.

The outcomes and impacts of an emission standard are summarised in Chart 2.

2 Expected outcomes and impacts of emission standards



Note: LEV = low emission vehicles, ZEV = zero emission vehicle, GHG = greenhouse gas.

Source: CIE.

Existing emission standards

Emission standards have been widely adopted internationally, while the Federal Chamber of Automotive Industries (FCAI) developed a voluntary industry-led emission standard for Australia in 2020.

Key features of these schemes include:

- Setting emission targets for individual vehicle brands which would achieve some level of emission across the entire fleet of new vehicles.
  - Targets for vehicle brands are adjusted for vehicle size – often measured using vehicle mass or footprint. This allows vehicle brands selling larger or heavier vehicles to get a higher CO_2 target than those of lighter vehicles, reflecting the relationship between vehicle size and fuel consumption.
- Credits are earned if a vehicle brand exceed their annual emission target (i.e. have average CO_2 emissions below their target). These credits can generally be traded between vehicle brands, such that brands who do not reach their target through vehicle sales, may fulfil their obligations by purchasing credits from other brands.
- Penalties for manufacturers or brands who do not meet targets, either through sales or purchasing credits.

Targets reported for these schemes do not generally reflect tailpipe emission reductions (based on emissions testing), as the schemes allow a range of adjustments and credits. These include:

- super credits for low and zero emission vehicles. These credits place a greater weight on each of the low and zero emission vehicles sold in calculating the average emission across sales
- innovation credits for vehicle features which reduce non-tailpipe emissions or have an additional impact on tailpipe emissions which are not captured by emission testing.

These credits effectively loosen emission standards and reduce transparency around the tailpipe reductions which are being achieved by a given scheme.

Scenarios modelled

For this analysis a range of emission standards have been developed based on information provided by FCAI.

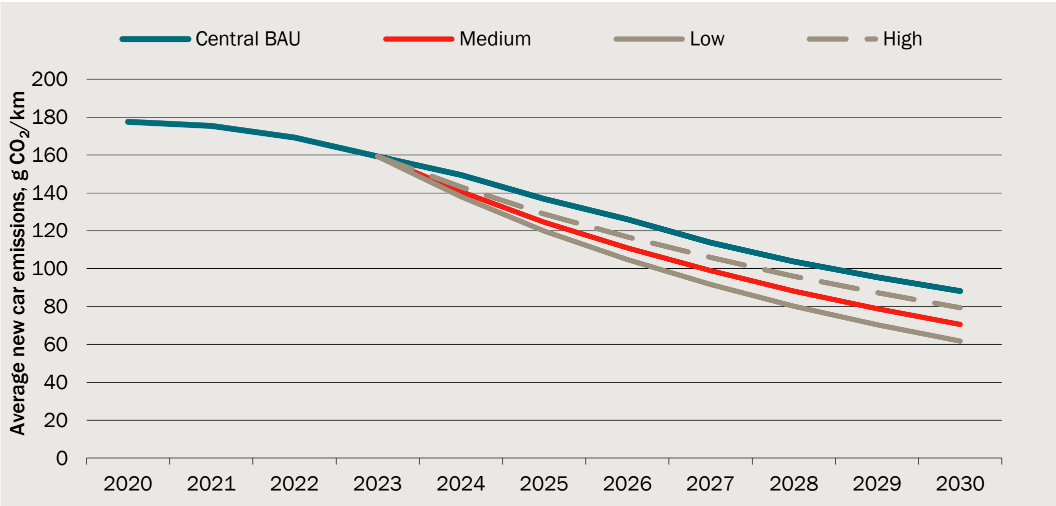
Under BAU, (without an emission standard), average emissions are expected to continue to fall steadily (Chart 3). Historically the reduction in average emissions across new car sales has been driven by improved efficiency of internal combustion engine (ICE) vehicles, while more recently and into the future this is expected to be driven by the adoption of low and zero emission vehicles (Battery Electric Vehicles (BEVs) and hybrid electric vehicles (HEVs) including plug in hybrid electric vehicles (PHEVs), Charts 4 and 5). Any emission standard will bring forward lower emissions, as opposed to setting emissions on an entirely different trajectory.

Three emission standard scenarios were developed to examine the impacts of a potential emission standard, assuming the standard comes into force in 2024. They were constructed as deviations from the central BAU in 2030 and include:

- low (most strict): 30 per cent reduction in emissions in 2030 compared to BAU
- medium: 20 per cent reduction in emissions in 2030 compared to BAU
- high (least strict): 10 per cent reduction in emissions in 2030 compared to BAU.

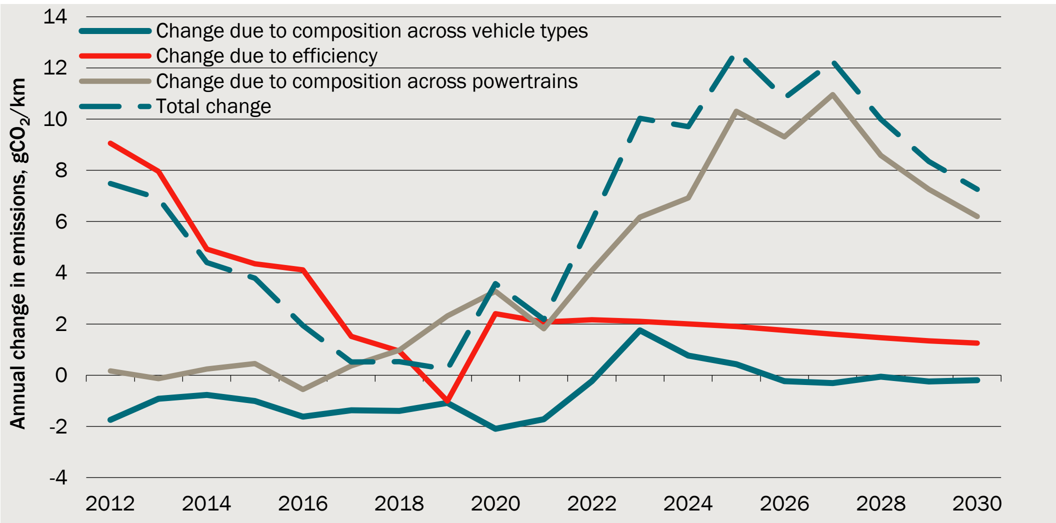
In addition to the three scenarios, an alternative low EV uptake BAU was developed, which was used in sensitivity testing of results.

3 Emission standard scenario for new light vehicles, by year



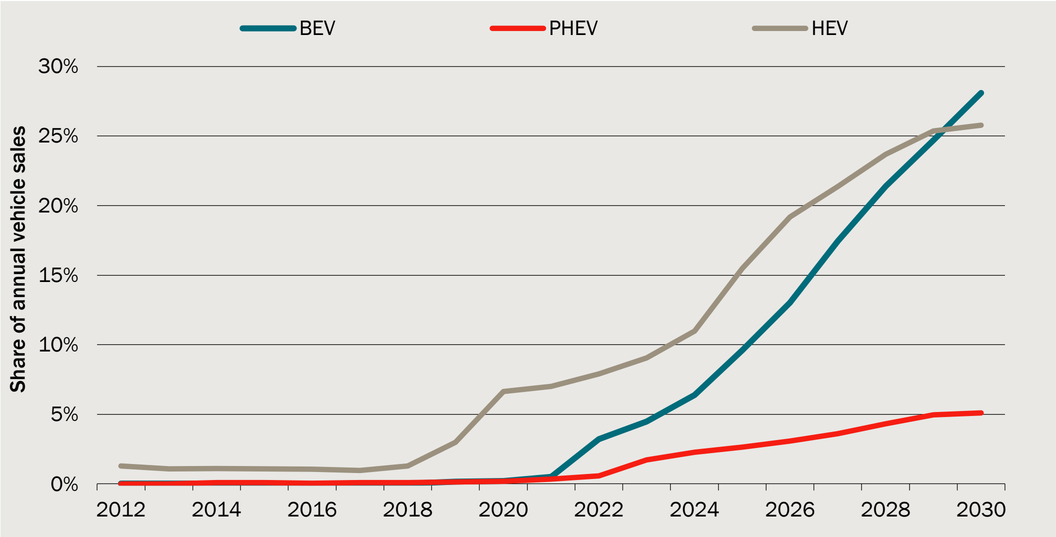
Data source: CIE based on FCAI and S&P Global Mobility data.

4 Decomposed change in new vehicle annual average emissions, by year



Data source: CIE based on FCAI and S&P Global Mobility data.

5 Share of new vehicle sales by powertrain by year



Data source: CIE based on FCAI and S&P Global Mobility data.

Impacts of emission standards

Households

Emission standards impact households by influencing their new car choice. This results in the following impacts for households:

- social welfare impacts (i.e. DWL) associated with the subsidy and implicit tax inbuilt into the scheme. This was estimated using consumer preferences previously estimated by the CIE for the AAA.[3] These describe the willingness to pay for different attributes across powertrains for different vehicle types. We use this to estimate by how much prices would need to change to induce consumers to switch to lower emission vehicles. We use this change in prices to estimate the potential DWL or social welfare cost:
  - the medium emission standard scenarios would result in a $760 million welfare loss in 2025 and $1.6 billion welfare loss in 2030. This compares with a fuel cost saving of around $300 million in 2025 and $1.3 billion in 2030 for the medium emission standard scenario
  - the social welfare cost is larger for:
    - stricter (low emission standard)
    - SUVs compared to passenger vehicles
    - LCVs compared to SUVs
    - in 2030 compared to 2025
  - these results indicate that an emission standard in an undistorted market would result in significant DWL or social welfare costs. However, these costs may be

3 CIE 2019, Demand for electric vehicles: A discrete choice survey, prepared for Australian Automobile Association.

offset to some extent where the policy corrects other distortions in the market. The actual social welfare cost may be lower where an emission standard moves the market closer to the social optimum (undoing BAU market distortions):

  - in the absence of detailed analysis of existing interventions, such as Fringe Benefit Tax (FBT) exemptions for LCVs and some SUVs and for low emissions vehicles, and state subsidies and grants for BEVs, it is difficult to definitively conclude whether an emission standard will move the market towards or away from the social optimum
  - given this uncertainty, a higher emission standard (i.e. less strict) is less likely to result in a DWL, given there are a range of existing policies which seek to lower emissions (e.g. a low or extremely strict emission standard may overcorrect for the market distortion). In addition, there is some uncertainty as to size of the distortion of the FBT exemption for LCVs and some SUVs given the recent FBT exemption for zero and low emission vehicles.

- a cross subsidy paid by households who purchase new ICE vehicles to households who purchase BEVs and other low emission vehicles, which is estimated to around $2.4 billion in 2025. The costs for ICE consumers are substantial which demonstrates the importance of assessing the distributional impacts of emission standards
- change in out-of-pocket costs for households purchasing a car noting the change in ownership costs is uncertain. However, overtime low emission vehicles are expected to deliver cost savings compared to ICE vehicles as price premiums for vehicles fall.

Bringing together the possible range of social welfare costs and the change in in the cost of ownership, we can estimate the total marginal cost of emissions abatement. This represents the total cost to society of using an emission standard to reduce emissions. From this we can conclude:

- there is likely to be some cost of emission standards, although this is difficult to precisely estimate
- emission standards are likely to become less costly forms of abatement as BEV price premiums compared to ICE vehicles fall
- the marginal costs of abatement are likely largest for LCVs, then SUVs and passenger vehicles. This reflects the higher DWL required to induce LCV consumers to switch from ICE vehicles to BEVs
- the range of marginal cost of abatement include some particularly high values, which are greater than recommended costs of carbon (the NSW Government recommends a cost of carbon of $123 per tonne CO_2 in 2023, in their economic appraisals). This implies that an emission standard may currently be a relatively expensive form of abatement.

Emissions, fuel consumption and excise

A key outcome of emission standards is to reduce vehicle emissions, and fuel consumption. As emission standards only affect new vehicles, the impact on total emissions and fuel consumption is initially modest. However, as vehicles have relatively long asset lives the benefits of lower emission are persistent.

Higher fuel efficiency will result in lower fuel excise revenue compared to BAU. Lower excise revenue will need to be accompanied by:

- spending reductions by government, resulting in lower investment in land transport infrastructure or reduced spending elsewhere
- increasing other taxes, e.g., the lost fuel excise under the medium emission standard could be recovered with:
  - a road user charge of $0.001 per km travelled levied on all vehicles
  - a road user charge of $0.018 per 100 km travelled levied on BEVs only.

Next steps for emission standards

The analysis findings have a number of implications for policy design, understanding the impact of the chosen standard and planning for fuel tax revenue declines.

The achievement of Australia's 2030 and 2050 emissions reduction targets does not require that all emissions sources be reduced simultaneously. Maximising the effectiveness and efficiency of Australian climate policy will require ordering the pursuit of abatement options in line with Australia's marginal cost of abatement curve — starting with low (or even negative) cost abatement options before pursuing higher cost options in later years. Leaving higher cost abatement options to the latter years of Australia's decarbonisation journey will give time for technological developments to lower the long end of the emissions abatement cost curve, reducing the cost of currently high-cost abatement options before they need to be pursued. One of the advantages of this approach is that governments can maximise the amount of abatement achieved for any given budgetary outlay.[4]

Implications for policy design

The implications for policy design of an emission standard include:

- Flexibility:
  - It is important that any scheme is technology agnostics and focuses on genuine emissions reductions.
  - Given uncertainties around overseas polices, supply chains and consumer preferences, policies should be adaptable to unexpected outcomes.
- Transparency:

4 Productivity Commission 2023, Updated Submission to National Electric Vehicle Strategy Consultation. Available here: https://www.pc.gov.au/research/supporting/electric-vehicle-strategy-submission/electric-vehicle-strategy-submission.pdf

  - Emission standard schemes should be transparent so there is a clear understanding of the expected emission reductions it will deliver. The rationale for adjustments in an emission standard, namely super credits for low and zero emission vehicles, is not clear.
  - Emission standards should take care when seeking to move adoption a long way from BAU as this is likely to result in high marginal abatement costs.
- Policy diversity:
  - Emission standards only affect emissions for new vehicles. Other policies are needed to support emission reductions from the stock of vehicle fleet.[5]
  - Emission targets need to be supported by complementary investment to make low emission vehicles as attractive as possible (e.g. charging infrastructure).

Understanding impacts on a variety of road users/population groups

There are impacts on road users, including:

- An emission standard should be subject to a Policy Impact Analysis (previously a Regulation Impact Statement), including a full cost benefit analysis. This should include a detailed consideration of the distributional impacts of any emission standards.
- Analysis of an emission standard should consider the impact of existing passenger vehicle market policies, namely FBT exemptions for LCVs and some SUVs and for low emissions vehicles, and state subsidies and grants for BEVs. To provide a comprehensive assessment of an emission standard would require modelling all these distortions.
- The impacts of different groups of society should be an important consideration to ensure that the costs of the policy are not disproportionally borne by any one group in society:
  - The cost of low emission technology means that vehicles are often offered at the more expensive end of the car market. An emission standard may disproportionally disadvantage lower income households who even with subsidies are unable to afford a new BEV (through higher prices in used car markets and higher prices for affordable ICE vehicles).
  - Distances and availability of charging infrastructure may hinder BEV uptake for regional communities. Again, there is a risk that an emission standard disproportionately disadvantages regional communities.

Planning for fuel tax revenue declines

Fuel excise revenue (and implicitly, the funding of road infrastructure) and emissions targets are a joint issue and should be considered together.

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5 For example, the need for broader reform to reduce transport emissions is discussed in: Cheung, H., Bradshaw, S., Rayner J. and Arndt D. 2023, Shifting Gear: The path to cleaner transport, Climate Council. Available here: https://www.climatecouncil.org.au/resources/shifting-gear-the-path-to-cleaner-transport/

1 Background

This report

This report provides a detailed analysis of the potential impacts of vehicle emission standards on light vehicle users, in particular the sort of motorist represented by Australia's automotive clubs.

The analysis presented here has been developed across stages. Using both public and some privately provided data from a very wide range of sources, our analysis has also involved consultation with various stakeholders in the automotive sector. We are grateful to participants in conversations with:

- each of the individual club members of the AAA
- Australasian Fleet Management Association
- Electric Vehicle Council.

We are particularly grateful to the FCAI for a number of consultations that provided a detailed examination of the supply side of low emission vehicle availability. The FCAI have also been of great assistance in providing some underlying data that we developed into the business as usual (BAU) 'reference case' of low emission vehicle uptake in the absence of a vehicle emission standard. Key data underlying the BAU reference case has been taken from S&P Global Mobility *Sales Based Powertrain Forecast*, March 2023.

Transport and emissions targets

The Commonwealth Government has adopted greenhouse emissions targets of 43 per cent reduction in emissions (relative to 2005) by 2030, and then net zero emissions by 2050.

What this means for the transport sector, and specifically the light motor vehicle segment is still subject to uncertainty as specific policies continue to be developed and implemented. Already, however, differences are emerging as to how rapid the transition to zero and low emissions vehicles (including BEVs and various forms of hybrids) should be, with some arguing for full uptake of zero emissions vehicles (for new sale) by 2030, and others arguing for a more gradual transition to 2050. Different pathways will have different implications for consumers and the wider economy.

Different vehicle emission targets imply a different implied speed for low emissions vehicle uptake, which — depending on the international supply situation — will determine the characteristics and price of the vehicles available in Australia. All other things equal, a more rapid transition may imply a more limited set of vehicle options (at a higher price) than may occur under a slower transition. This will also have implications for new and used car markets, as consumers faced by high prices may choose to:

- purchase a new car regardless of higher prices
- retain their existing vehicle for longer, or
- purchase a used car.

The speed of the transition to lower vehicle emissions may also affect a range of costs of benefits. On the benefits side, increased uptake of low emission vehicles will speed up the rate of emission reductions (compared with what would otherwise have been the case). There will also be the financial impacts for government arising due to changes in fuel excise revenue from improved fuel efficiency and for motorists due to the change in ownership costs of a switch to zero/low emission vehicles. There may also be some safety impacts for motorists insofar as the policy may affect rate of vehicle turnover and average age of the fleet.

In the remainder of this chapter, we describe emission standards in greater detail, the problems they are seeking to address, how they work and their likely impacts. This chapter builds on previous analysis undertaken by the CIE for the AAA, examining policy options to reduce greenhouse emission for light vehicles.[6]

What are emission standards?

Emission standards are a policy instrument that target greenhouse gas emissions and fuel consumption for new vehicles. They are normally expressed as an average target (across the fleet of new vehicles) in terms of gCO_2/km.

There are several options to implement an emission standard. The most common approach is to envisage a target for overall emissions intensity that is allowed to vary by vehicle type or size but that achieves a particular target average emissions intensity. Brands are then required to achieve this average across the vehicles they sell within a particular time frame.

Key features of an emission standard typically include:

- Allowing brands exceeding their targets to generate credits which can be sold to other car brands to meet their obligations. This provides a financial mechanism to reward manufacturers exceeding emission targets and penalises those who do not meet the target based on the emissions of their own sales.
- Penalties are imposed on those not meeting targets, either by directly meeting emission targets or purchasing credits.

Emission standards seek to target the direction of vehicle purchase patterns (or technical change in vehicle types bought by consumers e.g. BEVs), to achieve lower emissions intensity (or greater fuel economy) that would otherwise be the case without standards.

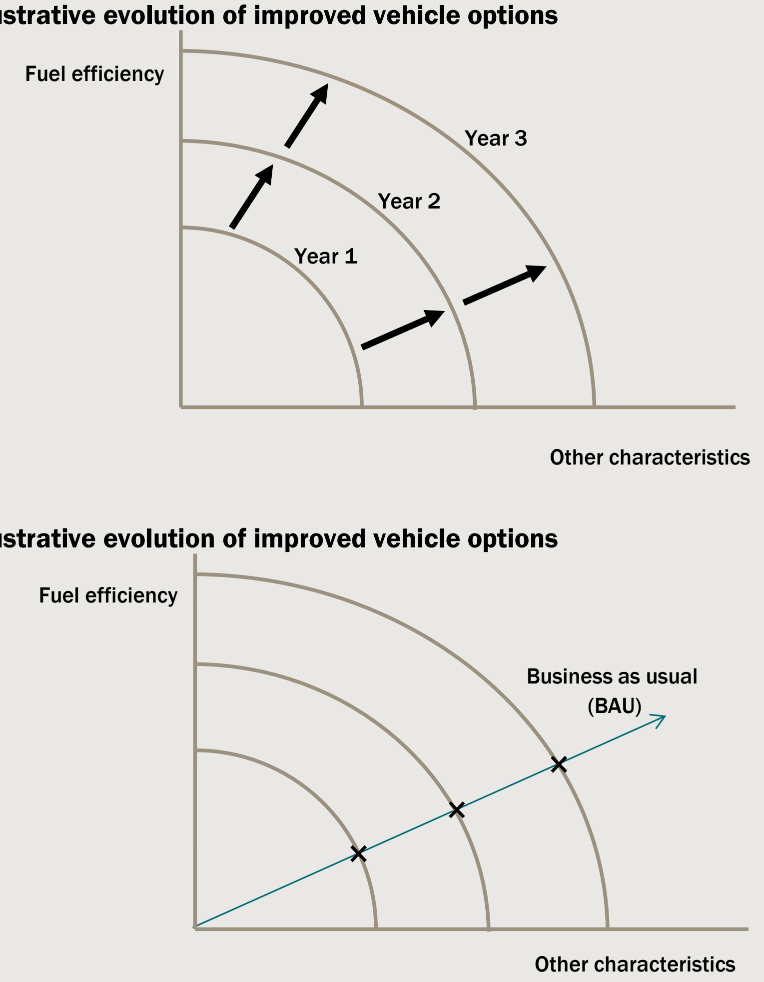
6 CIE 2016, Reducing greenhouse emissions from light vehicles: Compulsory standards and other policy options, prepared for the Australian Automobile Association.

Panel 1 of Chart 1.1 shows the potential combinations of fuel efficiency and other characteristics that are available for a given vehicle type. The potential combinations are improving over time, but there is a trade-off between emissions intensity (fuel efficiency) and other vehicle characteristics (a towing capacity, acceleration, price and operating costs etc.).

Panel 2 of Chart 1.1 shows the evolution of fuel efficiency and other characteristics over time under BAU; that is, in the absence of standards. In this example, both fuel efficiency and other characteristics are improving. The BAU line is determined by a variety of factors including consumer preferences, technical constraints and other market outcomes.

1.1 BAU evolution of vehicle characteristics

Panel 1: Illustrative evolution of improved vehicle options



Panel 2: Illustrative evolution of improved vehicle options

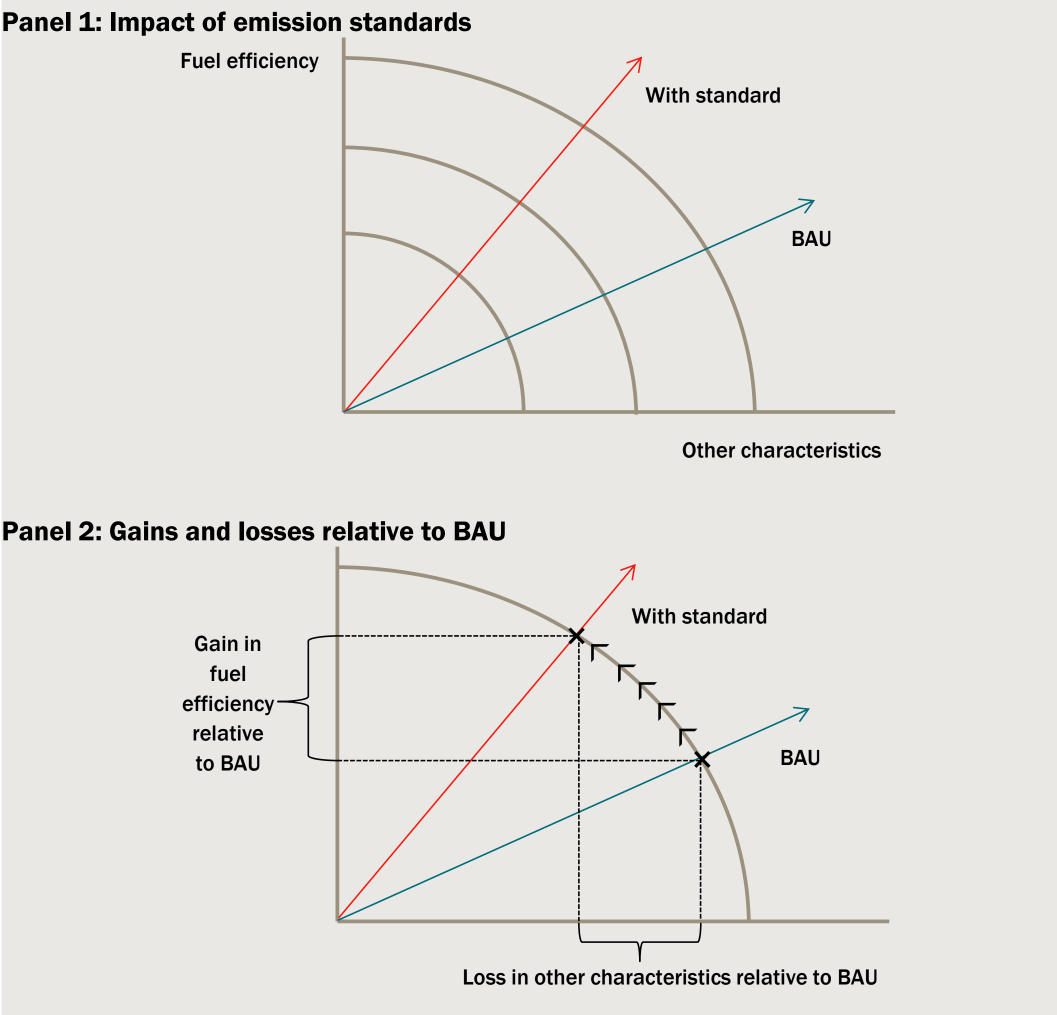
Note: Adapted from CIE 2016, Reducing greenhouse emissions from light vehicles: Compulsory standards and other policy options, prepared for the Australian Automobile Association.

Source: CIE.

Chart 1.2 illustrates the implications of imposing an emission standard. An emission standard results in a faster improvement in emissions intensity or fuel efficiency than under BAU. As a trade-off, this results in a decline in the rate of improvement in other characteristics, including vehicle costs (Panel 1). Overtime, these characteristics may continue to improve, but at a slower rate than under BAU.

Panel 2 of Chart 1.2 shows the gains and losses; an increase in fuel efficiency relative to BAU, and a decline in other characteristics relative to BAU.

1.2 Standards target changes in favour of emission intensity (fuel efficiency)



Note: Adapted from CIE 2016, Reducing greenhouse emissions from light vehicles: Compulsory standards and other policy options, prepared for the Australian Automobile Association.

Source: CIE.

In assessing the value of an emission standard, we consider the relative size of the:

- gain in fuel efficiency relative to BAU – this and the associated externalities are the benefits of a fuel efficiency standard
- loss in other characteristics relative to BAU – this is the cost to consumers of the fuel efficiency standard and the corresponding move away from consumer preferences.

What problems are emission standards seeking to address?

Vehicle emissions are a function of:

- fuel efficiency – energy density of fuel per unit of emissions
- vehicle efficiency – the characteristics of the vehicle which affect fuel consumption. This includes the powertrain (i.e. ICE, BEV, HEV), fuel type, technology, vehicle weight, vehicle aerodynamics and tyres. These aspects of vehicle efficiency are affected by technical choices in design and construction which are shaped by consumer preferences
- driving efficiency – the impact of driving habits, knowledge of good driving techniques, driving speed and style (including accelerating and braking), tyre pressure and vehicle loading. This is also affected by congestion, the design of road networks and road surface materials
- distance travelled – the impact of trip making decisions including, whether to undertake a trip, route choice and mode choice. This will be affected by design of road network and availability of public transport.

Each of these dimensions which determine emissions may be associated with a range of 'market failures' and 'externalities' that mean consumers do not necessarily account for the full costs (or benefits) of their decisions.

In establishing an emission standard, we primarily seek to address market failure associated with not accounting for the collective, and cumulative, effect of individual emissions on the global climate. This is the failure to account for the wider cost of greenhouse gas emissions in individual decision making (what car to purchase and how to use it).

There are however a range of other market failures which feature in discussions of climate and related polices. These include:

- the general notion of an 'efficiency gap' — the fact that individuals do not necessarily adopt the most energy efficient technologies and behaviours, even when it appears that it would be in their own interest to do so
- policy failures that create perverse incentives or incentives that move against the overall objective of lowering emissions. This includes, for example, some tax policies as well as planning, road policies and so on.

Driving itself is also associated with a range of 'externalities', the two most significant being congestion and traffic crashes.

Table 1.3 summarises potential market failures by emission drivers.

1.3 Market failures associated with drivers of vehicle emissions

Emission drivers	Potential market failures
Fuel efficiency	Carbon externality: failure to account for the full cost of carbon emissions
Vehicle efficiency	Carbon externality: failure to account for the full cost of carbon emissions Ignorance about the energy and emissions efficiency of different vehicles and vehicle types Myopia: not accounting for long term efficiency benefits (lower fuel costs) of fuel efficient vehicles Failures in availability of efficient options in particular markets (through the choices of vehicle brands, for example) Policies which discourage purchase of particular new vehicles (e.g. tariffs, car taxes)
Driving efficiency	Carbon externality: failure to account for the full cost of carbon emissions Ignorance of good driving techniques. Poor driving habits Congestion externalities: effect on drivers of congestion in urban areas leading to less efficiency
Distance travelled	Carbon externality: failure to account for the full cost of carbon emissions Factors indirectly encouraging vehicle travel including absence of alternative transport options

Note: Adapted from CIE 2016, Reducing greenhouse emissions from light vehicles: Compulsory standards and other policy options, prepared for the Australian Automobile Association.

Source: CIE.

New vehicle emission standards only affect one of the drivers of emissions: vehicle efficiency. Further this only affects the future path of vehicle efficiency and does not affect efficiency of the stock of vehicles.

In the following section we discuss myopia and failures in availability of lower emission vehicles as well as discuss other reasons which may be determining the rate of BEV uptake.

Consumers failing to internalise the value of fuel savings

Myopia, or consumers not accounting for long term efficiency benefits (lower fuel costs) of fuel-efficient vehicles, would result in households foregoing potential fuel savings. Fuel cost savings are often cited as a rationale for implementing an emission standard, which assumes at least some households do not factor these costs into decision making.[7]

Fuel savings for drivers are typically private benefits. Given these are important costs for running a vehicle, it seems likely that consumers would consider at least some of these cost savings from low emission vehicles in their purchase decisions. Choosing a vehicle with poor fuel efficiency can be efficient when:

7 Terrill, M., Burfurd, I. and Fox, L. 2021, The Grattan car plan: Practical policies for cleaner transport and better cities, The Grattan Institute. Available here: https://grattan.edu.au/wp-content/uploads/2021/10/Grattan-Car-Plan.pdf

Quicke, A. 2022 Fuelling efficiency, The Australia Institute. Available here: https://australiainstitute.org.au/wp-content/uploads/2022/08/P1269-Fuel-Efficiency-Standards-WEB.pdf

- consumers are aware of the difference in operating costs
- the value of a vehicle's other characteristics to consumers exceeds the additional fuel cost of operating the vehicle.

Previous estimates of consumer willingness to pay for light vehicles show that consumers have a positive average willingness to pay for lower vehicle operating costs (Table 1.4, which implies a marginal williness to pay of $1,792 per operating cost saving per 100 km travelled). This estimate suggests that consumers are likely to internalise all operating costs into their decision making.[8] If in practice some consumers do not consider the entire fuel cost saving in their decision making, educating these customers of the savings would be a very effective way to increase demand (and for BEV and low emission vehicle brands to increase sales).

Lack of supply of low emissions vehicles

The lack of supply of low emission vehicles, in particular BEVs, is often cited as a justification for an emission standard. The argument follows that brands prioritise markets with emission standards with low emission vehicles which results in a supply shortage, which constrains uptake of low emission vehicles. The implication being incentives are required to make Australia an attractive destination for low emission vehicles.

This argument is plausible given:

- the penalties associated with not meeting standards in overseas markets (see Chapter 2 for a summary of the EU and US schemes)
- other subsidies and incentives available for BEVs and low emission vehicles in overseas markets (which increase demand and prices at which vehicles can be sold).

These penalties and other incentives mean there may be greater value in diverting a low emission vehicle from Australia to those other markets where supply is constrained. Several industry stakeholders have noted that manufacturers prioritise overseas markets which constrain supply to Australia.[9]

The influence that an absence of an emission standard may have on supply into the future is somewhat uncertain as production of low emission vehicles increases overtime. As the global supply of electric vehicles increases, and constraints associated with COVID-19 dissipate, the supply constraint for the Australian market may become less severe. This is already reflected to some extent by the rapid increase in BEV sales in

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8 Assuming a 20-year asset life for new cars and travelling 13,000km per year, a $1 operating cost saving is equivalent of $130 per year. Using a discount rate of 7 per cent gives a present value saving of $1,474. Based on this discount rate implies that consumers may overweight operating cost savings in their decision making.

9 For example see: https://www.smh.com.au/politics/federal/car-industry-begs-morrison-government-to-adopt-sector-specific-emissions-target-20210324-p57dof.html, https://www.abc.net.au/news/2021-05-30/nissan-says-australia-missing-out-electric-vehicle-market/100173124 and https://www.aaa.asn.au/newsroom/electric-vehicle-strategy-will-boost-take-up/

Australia (for example BEV sales increased by 19.5 per cent from March 2022 to March 2023), as well as longer term projections which expect strong growth in BEV market share (see Chapter 3 for further information on BAU scenarios).

Despite increasing supply, challenges to reach higher levels EV uptake are likely to remain due to:

- some new electric vehicles not being brought to Australia due to the structure of supply chains and costs of developing cars for a right-hand drive market
- the characteristics of Australia's transport network and consumers preferences potentially not matching the types of BEVs which are imported to Australia
- overseas countries continuing to ratchet up their emission standards and EV uptake policies. Although supply of low emission vehicles is increasing, incentives to allocate vehicles to different markets continue to evolve.

Other explanations of lower BEV uptake than overseas

In addition to the supply constraints for electric vehicles, a key determinant of the number of sales is demand for electric vehicles. This relates to how much consumers are willing to pay for electric vehicles, given their characteristics, compared to ICE and hybrid substitutes.

Demand and supply are related to one another; all else equal, higher demand allows brands to charge higher prices and generate higher profits. This makes a market more attractive as there is possibility to extract higher profits.

A lack of demand in Australia, under BAU, could also explain or at least have contributed to Australia's comparatively slow EV adoption.

When consumers purchase a vehicle, they are purchasing a bundle of characteristics for a given price. These include range, acceleration, towing capacity and running costs. As attributes improve, the amount consumers are willing to pay for vehicles increases and so too will demand.

Table 1.4 shows average consumer willingness to pay (WTP) for a BEV across various changes in vehicle and charging attributes across all vehicle types (i.e. the reduction in purchase price that would have the same impact on demand as the specified improvement in the vehicle/charging).

1.4 Average willingness to pay for a marginal change in vehicle/charging attributes

Attribute	Unit	Marginal WTP ($ in purchase price)
Fuel range (PHEV only)	per 50 km	1,548
Acceleration	per second (decrease)	388
Towing capacity	per 250 kg	1,244
Carbon emissions	per 50 g/km (decrease)	244
Destination charging time	Change from 120 to 60 minutes	686
Destination charging time	Change from 60 to 15 minutes	25
Highway charging time	Change from 60 to 30 minutes	1,350
Highway charging time	Change from 30 to 15 minutes	1,137
Highway charging time	Change from 15 to 5 minutes	1,120
Running cost	per $/100 km (decrease)	1,792

All vehicle types n=3,021, reweighted to account for oversampling of persons with university degrees.

Source: CIE 2019, Demand for electric vehicles: A discrete choice survey, prepared for Australian Automobile Association.

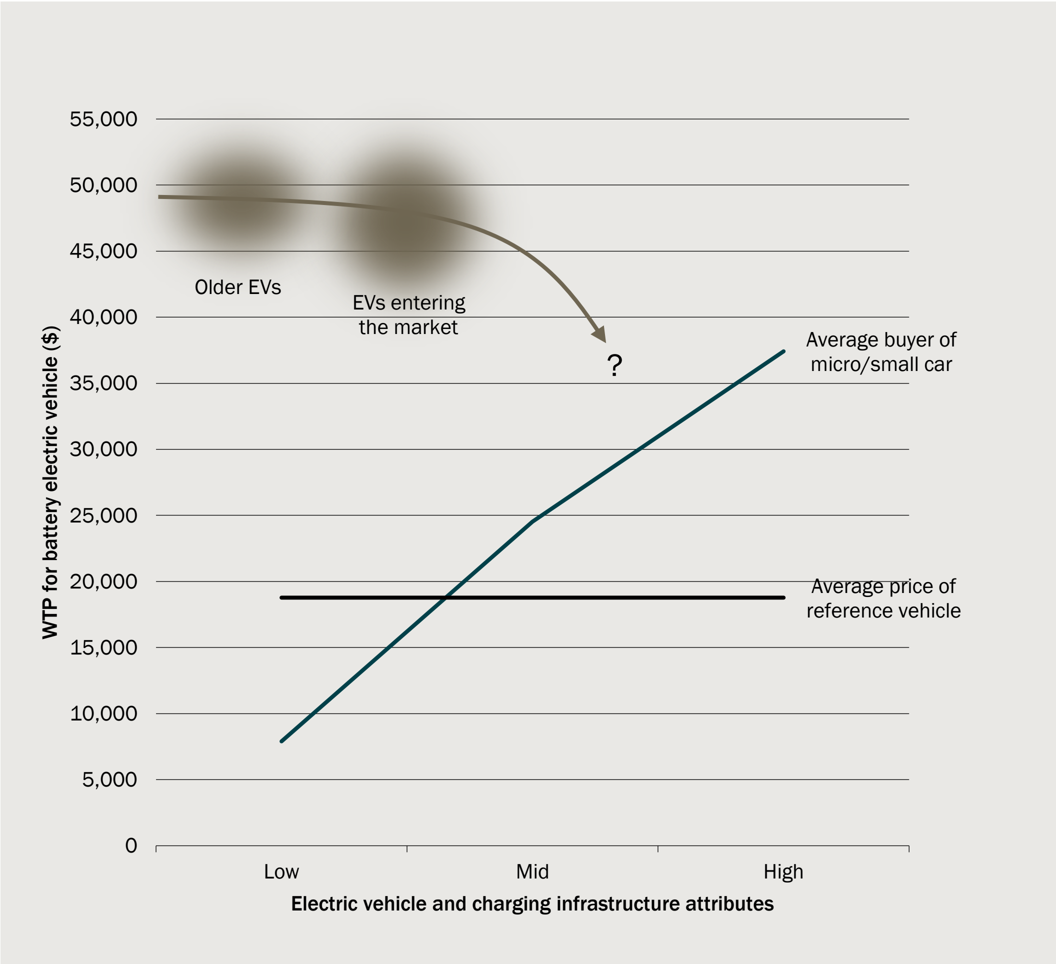
Previous work has found that consumers will purchase a BEV rather than their preferred conventional fuel vehicle once the vehicle attributes are good enough and/or once the price is low enough.[10]

It is currently difficult to purchase a BEV in Australia in the vehicle classes with highest demand – namely LCVs. This is expected to change in the coming years, with new models advertised to be entering the Australian consumer market.[11] As the price and characteristics of BEVs get closer to WTP, uptake will continue to increase (Chart 1.5).

10 CIE 2019, Demand for electric vehicles: A discrete choice survey, prepared for Australian Automobile Association.

11 This is reflected in the BAU low emission vehicle uptake outlined in Chapter 3.

1.5 Willingness to pay for EVs compared to existing vehicles



Note: Older EVs are based on the 2012 Nissan Leaf (~$47,000) and the 2012 Mitsubishi MiEV (~$48,800), while BEVs entering the market are based on the 2018 Nissan Leaf (~$50,000), Hyundai Ioniq (~$43,000) and Renault Zoe (~$51,000).

Data source: CIE 2019, Demand for electric vehicles: A discrete choice survey, prepared for Australian Automobile Association.

Emission standards are one way to bridge the gap between willingness to pay and the costs of electric vehicles, by providing an implicit subsidy for low emission vehicles and an implicit tax on higher emission vehicles (reducing the relative price difference).

A range of demand side policies, both in Australia and overseas, have been implemented to support BEV uptake. Demand side policies seek to increase the WTP for consumers for electric vehicles. These include:[12]

- financial incentives to consumers, including purchase subsidies and vehicles' registration and tax rebates:
  - as uptake of electric vehicles has increased and their price parity with ICE vehicles become similar, some markets have begun winding back incentives.[13] For example,

12 https://www.iea.org/reports/global-ev-outlook-2021/policies-to-promote-electric-vehicle-deployment

13 https://www.iea.org/reports/global-ev-outlook-2023/policy-developments

the UK has phased out their plug-in car grant, which was a direct subsidy for consumers, as fully electric vehicles account for 1 in 6 new cars sold in the UK[14]

- across Australian jurisdictions there are a range of financial incentives available to consumers (Chart 1.6). These appear to have had some impact on uptake as jurisdictions with larger incentive(s) tend to have higher electric vehicle uptake, except for Queensland where incentives recently increased and the Northern Territory.[15]

- government investment in charging infrastructure and subsidies for the installation of private chargers
- local and regional governments restricting road access in specific locations to low or zero emissions vehicles or, where road pricing is implemented, lower road user charges being applied to low emissions vehicles
- banning the sale of ICE vehicles after some date
- government procurement policies, such as targeting some share of low emission vehicles in the government fleet:

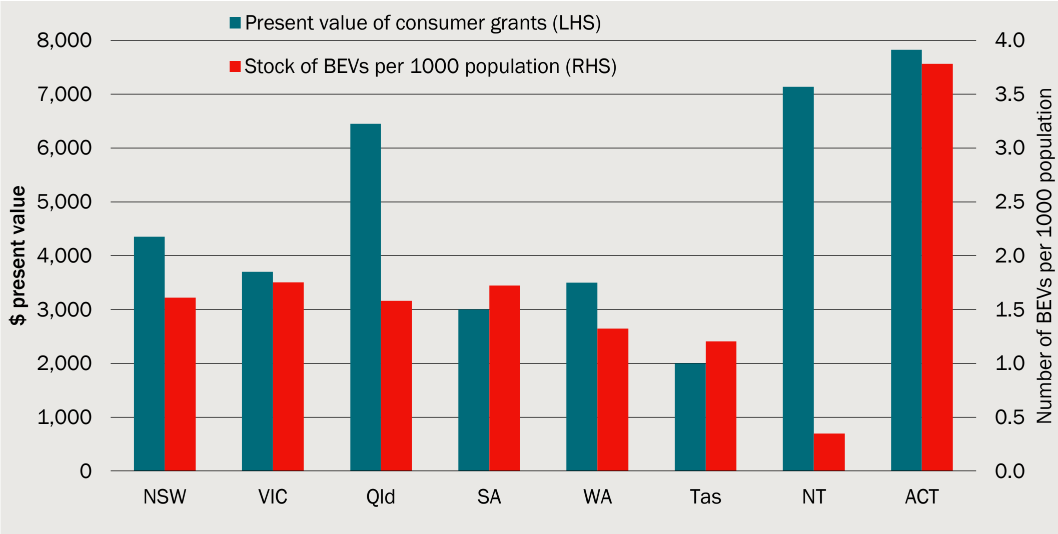
as a part of the Net Zero Government Initiative, the Australian Government has committed to ensuring Commonwealth fleet new passenger vehicle purchases and leases are 75 per cent low emission vehicles by 2025.[16] The Government has also joined the international Zero-Emission Government Fleet Declaration which marks Australia's aspirations to procure 100 per cent zero-emissions vehicle classes (light, medium and heavy-duty) for the Government fleet by 2035. Similar commitments to target electric vehicle uptake in government fleets have been made by state and territory governments.

14 https://www.gov.uk/government/news/plug-in-grant-for-cars-to-end-as-focus-moves-to-improving-electric-vehicle-charging

15 Queensland doubled their Queensland Zero Emission Vehicle Rebate Scheme from $3,000 to $6,000 in April 2023 – the impact of which are not reflected in the stock of electric vehicles which is based on 2021.

16 Department of Climate Change, Energy, the Environment and Water 2023, National Electric Vehicle Strategy: Increasing the uptake of EVs to reduce our emissions and improve the wellbeing of Australians, p. 22.

1.6 Current consumer financial incentives for electric vehicles and uptake



Note: The stock of electric vehicles is based on reporting by NTC for 2021. Ongoing incentives, such as reduced or waived vehicle registration and interest free loans are measured over 10 years and converted to present value terms using a discount rate of 7 per cent. Queensland doubled its Queensland Zero Emission Vehicle Rebate Scheme from $3,000 to $6,000 in April 2023 – the impact of which is not reflected in the stock of electric vehicles which is based on 2021.

Data source: CIE based on NTC and https://www.mynrma.com.au/cars-and-driving/electric-vehicles/buying/ev-incentives.

How do standards achieve their objective?

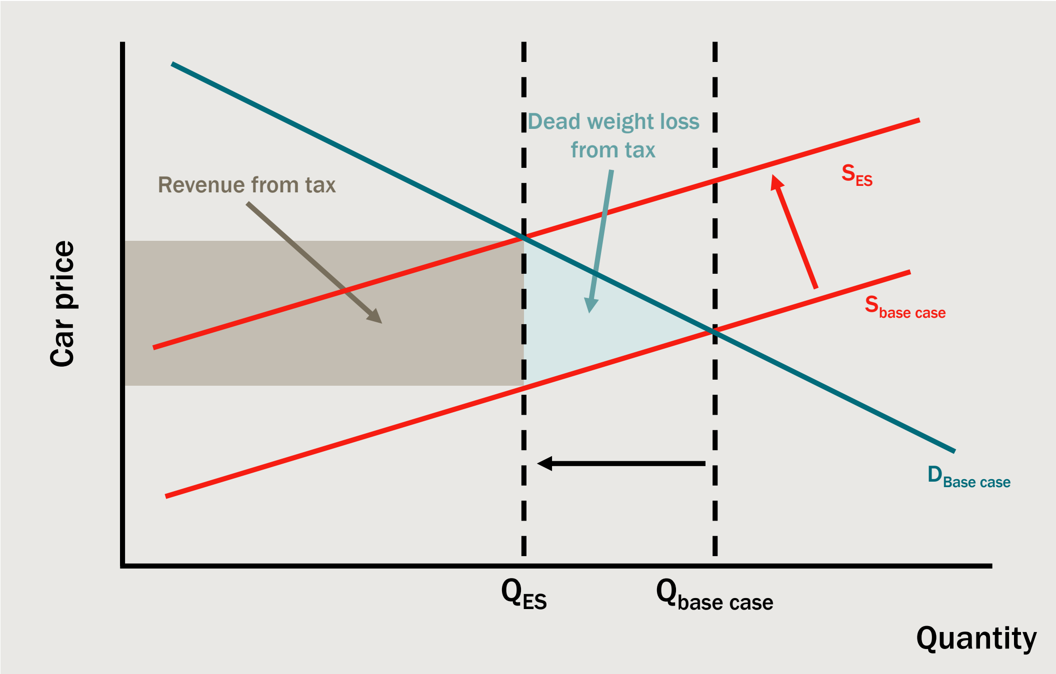
In principle, emission standards seek to create an implicit price incentive in favour of lower emissions vehicles.[17] It is by changing prices that consumer purchasing behaviour can be changed relative to what they would have been under BAU. For example, for a vehicle brand to achieve the required average emissions intensity they must move purchases away from the current pattern or BAU (if an emission standard does not change this there would be no need for a standard) by offering a series of discounts and premiums in order to shift consumer purchases by cross subsidising low emission vehicles.

In effect, this will be:

- **an implicit tax** on relatively high emissions vehicles (above the emissions target). This will be equivalent to an upward shift in the supply curve for higher emission vehicles (Chart 1.7). This results in a DWL, or loss of economic efficiency, which describes the loss in social welfare
- **an implicit subsidy** to relatively low emissions vehicles (below the emissions target). This will be equivalent to a downward shift in the supply curve for low emission vehicles (Chart 1.8). This subsidy benefits buyers of low emission vehicles, however results in a DWL associated with the subsidy paid to change consumer choices.

17 The precise mechanism by which an emission standard achieves its objective depends on the specifics of the regulatory arrangements.

1.7 Impacts on higher emission vehicles

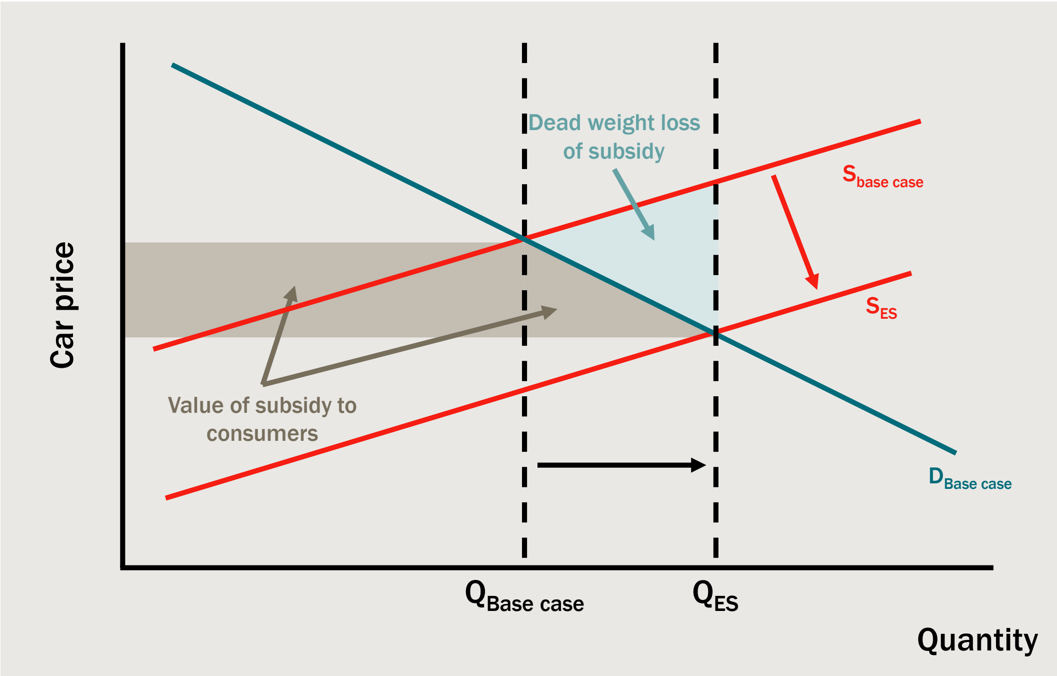


Note: $S_{base\ case}$ is the original supply curve in the absence of the emissions standard. S_{ES} is the supply curve in the presence of the emissions standard. $Q_{base\ case}$ is the original quantity of sales, and Q_{ES} is the quantity in the presence of the emissions standard.

Data source: CIE.

The DWLs represented in Charts 1.7 and 1.8 represent the social welfare cost of moving off the "BAU" curve to the "with standard" curve illustrated in Chart 1.2. This is the cost of shifting consumer purchases to place a greater weight on fuel efficiency than the other vehicle characteristics consumers consider in decision making. These DWLs will be largely invisible within the market as they are incorporated into prices overtime.

1.8 Impacts on low emission vehicles



Note: $S_{base\ case}$ is the original supply curve in the absence of the emissions standard. S_{ES} is the supply curve in the presence of the emissions standard. $Q_{base\ case}$ is the original quantity of sales, and Q_{ES} is the quantity in the presence of the emissions standard.

Data source: CIE.

Emission standards do not impact all margins of adjustment

Emission standards are a narrowly focused policy that target only one margin for adjustment – new vehicle efficiency. Table 1.9 summarises how five broad policy alternatives affect emission drivers, which include vehicle efficiency, driving efficiency and distance travelled.

Emission standards only target vehicle efficiency of new vehicles, which are a small share of vehicles in the fleet (at least in the short term). In any year, new vehicles make up around 5 per cent of the vehicles on the road. Therefore emission reductions achieved by emission standards are relatively modest (though they grow over time). These benefits may also be unwound, if emission standards were to result in an increase in distance travelled by new vehicles.

1.9 Effects of various policies: do they create incentives to reduce emissions from relevant factors?

Effect of policy on:	Carbon price	New vehicle emission standard	Tariffs and taxes	Eco-driving training	Infrastructure
Does the policy reduce emissions from the following drivers?					
Vehicle efficiency: new vehicles	Yes	**Yes**	Yes	No	No
Vehicle efficiency: existing vehicles	No	**No**	No	No	No
Driving efficiency: new vehicles	Yes	**No**	No	Yes	Yes
Driving efficiency: existing vehicles	Yes	**No**	No	Yes	Yes
Distance travelled: new vehicles	Yes	**No, possible rebound effect**	No, possible rebound effect	No, possible rebound effect	Yes
Distance travelled: existing vehicles	Yes	**No**	No	No	Yes
Does the policy have potential to lower driving related externalities?					
New vehicles	Yes	**No, may increase with rebound effect**	No, may increase with rebound effect	No, may increase with rebound effect	Yes - congestion
Existing vehicles	Yes	**No**	No	No, may increase with rebound effect	Yes - congestion

Source: CIE 2016, Reducing greenhouse emissions from light vehicles: Compulsory standards and other policy options, prepared for the Australian Automobile Association.

Outcomes and impacts of emission standards

The key outcomes and impacts of emission standards are outlined in Chart 2.

As noted in previous sections emission standards change the market share of high and low emission vehicles, decreasing the price of low emission vehicles compared to high emissions vehicles.

The outcomes of an emission standard include:

- a cross subsidy for low emission vehicles paid for by households who purchase higher emissions vehicles:
  - the subsidy is not likely to be explicit, but to incorporated into prices
  - some consumers will be winners from this policy, namely lower emission new car consumers, including those who switch their car choice because of the subsidy and those who would have purchased a low emission vehicle under BAU
  - while others will be losers, namely higher emission new car consumers who pay the subsidy
  - overall prices are expected to increase because of the policy

- increased demand for low emission vehicles and decreased demand for high emission vehicles:
  - this is the ultimate objective of the policy
  - this increase in demand, is expected to result in additional low emission vehicles being imported to Australia. This may come from additional production capacity or could result in vehicles being delivered to Australia from overseas markets (if global supply is constrained)
- change in fleet composition, with the share of low emission vehicles increasing and share of high emission vehicles decreasing:
  - as new cars in any year account for around 5 per cent of the total vehicle fleet, and cars have an average asset life of around 20 years, change in the composition of the vehicle stock from an emission standard (or any other change in consumer purchasing behaviour) is gradual.

These changes may then have secondary outcomes for new and used car markets:

- increased demand in low emission vehicles may result in a supply response from producers to produce more low emission vehicles. Any supply response is likely to relatively modest as Australia does not have its own vehicle manufacturing industry and accounts for a very small share of global new car demand (around 1 per cent of global demand)[18]
- because of increased prices, there is likely to be a reduction in demand for new cars. This will likely result in an increase in the average fleet age and may result in higher prices in the used car market as:

  consumers may extend the life of their cars (defer purchasing a new car) due to higher prices. This may reduce supply of vehicles to the used car market, increasing average age of the vehicle fleet; this may slow diffusion of new safety technology into the vehicle fleet
  - consumers may switch to the used car market if the cost of new high emission cars increases.

An emission standard is expected to have the following impacts:

- reduced emissions and fuel consumption from passenger vehicles. Note these benefits will initially be small and increase overtime from car fleet turnover. Also note that:
  - reduced fuel consumption will also negatively affect fuel excise revenue
  - if the supply of low emission vehicles is constrained globally, this policy may have limited immediate impact on global emissions. Although emissions in Australia may be lower, they could be offset by higher emissions overseas (Chart 1.10). Note this impact is likely to be limited overtime, as global supply responds to higher demand
- across the new car market there is likely to be a net cost, or loss of efficiency, due to changing consumption patterns compared to the BAU. This is because an emission

18 Australians purchase around 1 million new passenger cars each year against global production of around 80 million cars per year. Available here: https://www.acea.auto/figure/world-motor-vehicle-production/

standard forces consumers to place a greater weight on fuel efficiency compared to other vehicle characteristics (such as size, acceleration, towing capacity, safety features and prices) in their purchasing decision. Moving consumption away from consumer preferences has a cost which can be measured as the DWL associated with:

  – charging a price premium for high emission vehicles which is equivalent to charging a tax (Chart 1.7)
  – paying a subsidy for low emission vehicles (Chart 1.8).

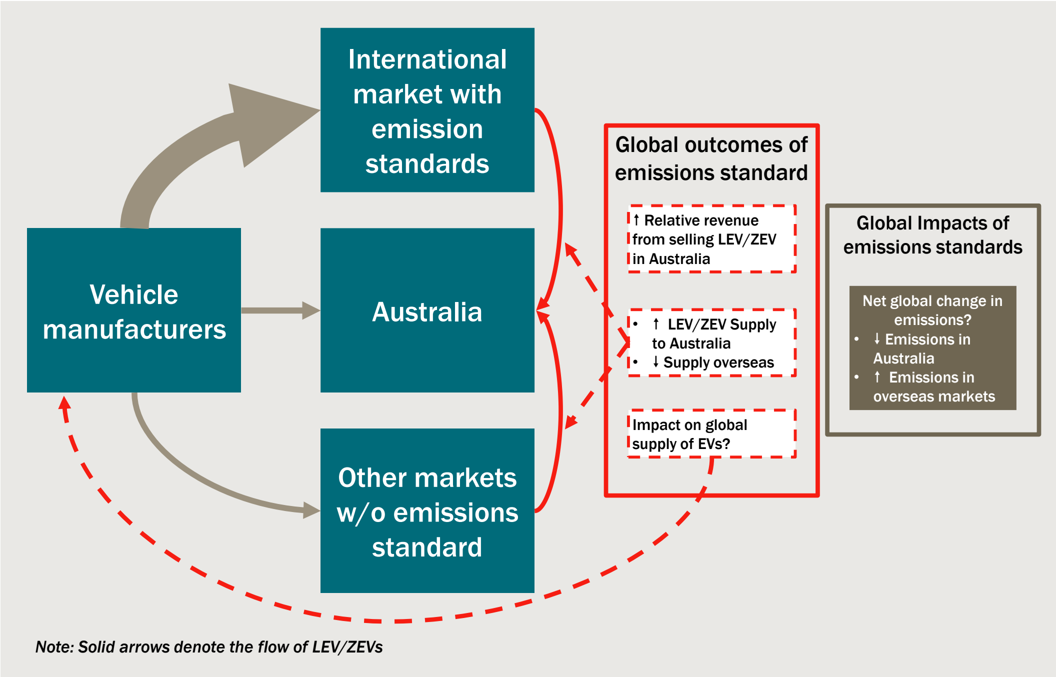
  The ultimate impact on social welfare is uncertain as the emission standard may correct other distortions in the market (i.e., it may move the market closer to the social optimum)

- consumers are not likely to uniformly impacted by the policy, as there are likely to be winners and losers. Those who are less price elastic (i.e. do not respond to changes in prices) are likely to bear the greatest cost of emission standards. This includes consumers who have very specific vehicle requirements such as towing, size or range
- change in vehicle ownership costs. Note that these costs may be internalised into decision making to some extent, insofar as people purchasing high emission vehicles do so, accepting higher operating or ownership costs as a trade-off of other vehicle characteristics. This will primarily include fuel costs and maintenance
- There may be an increase in vehicle kilometres travelled (VKT). If individuals buy more fuel-efficient cars, they will use less fuel for their standard travel tasks. The fuel savings could be banked. However, it is also possible that drivers could respond by increasing their driving (this is called the 'rebound' effect in the literature). Rebound effects are a very common finding in the analysis of fuel efficiency policies, and there is a large body of literature looking at their importance and magnitude. These include recent studies undertaken by the UK Energy Research Centre[19] and the International Transport Forum[20]. An increase in VKT could result in higher emissions, but would primarily result in additional externalities associated with road congestion, environmental impacts and safety due to increased travel
- increasing the age of the vehicle fleet may result in increased vehicle kilometres being travelled by older vehicles which are generally less safe than newer vehicles, increasing crash risk for the vehicle fleet on Australian roads.

19 UK ERC 2007 The Rebound Effect UK Energy Research Centre, October. Available here: http://www.ukerc.ac.uk/asset/3B43125E-EEBD-4AB3-B06EA914C30F7B3E/

20 See van Dender K, and Crist P 2011 *What does improved fuel economy cost consumers and what does it cost taxpayers? Some illustrations*. International Transport Forum, Discussion Paper 2011 16.

1.10 Impact on international flow of LEV and ZEV



Note: LEV = low emission vehicles, ZEV = zero emission vehicle.

Data source: CIE.

Emission standards and private benefits

The extent to which emission standards create private versus public benefits depends on whether they are solving a problem in the market for new vehicles. Emission standards generate public benefits by reducing CO_2 emissions. This is independent of whether emission standards are solving a specific problem in the market for new vehicles (such as consumer myopia or manufacturers failing to import low emission vehicles). Emission standards may also result in private benefits from fuel savings for drivers. These savings exist, in an economic sense, if emission standards *allow* drivers to access these fuel savings by solving a problem (such as manufacturers withholding better technology from the market or consumer myopia). If drivers access fuel savings, then emission standards create this benefit for drivers with (probably) very little or no opportunity cost.

However, if emission standards *impose* fuel savings on drivers – that is, the standards force drivers to purchase efficient vehicles they would not otherwise buy – then we cannot simply assume the standards create straight (net) private benefits. While the standards create fuel savings, they also impose opportunity costs on drivers, such as a loss of utility, by forcing them to switch to vehicles with characteristics that are not necessarily preferred.

Potential opportunity costs imposed on drivers by emission standards

If drivers can access the vehicle they prefer, in the Australian market (where cars are imported and Australian policy and consumer preferences may have limited impacts on research and development [R&D]), the opportunity costs can be imposed on drivers by brands changing the composition of sales.[21] That is, brands could increase the price of larger, less fuel-efficient vehicles and decrease the price of smaller, more fuel-efficient vehicles to prompt drivers to switch towards the latter. This would impose opportunity costs on drivers, as those who desire or need larger, less fuel-efficient vehicles (such as tradies, large families, people living in remote and regional areas etc.) would be forced to pay more for these vehicles. The 'opportunity cost' is the benefits they lose from not being able to spend this extra money on their other wants.

How to treat the fuel savings and opportunity costs created by standards

If emission standards solve the problem that prevents drivers from purchasing preferred, lower emitting vehicles, then the opportunity costs created by standards are likely to be very low or zero. The standards allow drivers to *access* the fuel savings created by the more fuel-efficient vehicles, which are supplied because of the standard and which are preferred. These fuel savings that standards allow access to can be treated as a straight (net) benefit, which is added to the public benefit of emissions reduction.

However, if emission standards are not solving a problem and are simply *imposing* fuel savings on drivers by forcing them to switch to vehicles that would otherwise not be preferred, then the standards create fuel savings and impose opportunity costs on drivers. In this case the opportunity cost must be at least as big as the fuel savings otherwise consumers would choose low emission vehicles under BAU, and an emission standard would not be binding. In this case we would only count the public benefit of an emissions reduction.

Our experience tells us the answer probably lies somewhere in the middle. Standards will allow some drivers to access fuel savings (by resolving issues around myopia and brands not bringing some low emission vehicles to market) but will impose opportunity costs on others. This means, for evaluating emission standards we would count:

- only part (between 0 and 100 per cent) of the fuel savings created by the standard. This would be considered a private benefit, depending on the share of drivers who would not be able to access their preferred vehicle if the emission standards did not exist
- 100 per cent of the public benefit: the emissions reduction generated by the standard.

21 Another way manufacturers may meet an efficiency standard would be by increasing their R&D expenditure on fuel economy improving technologies and would likely pay for this extra R&D by *decreasing* R&D expenditure on other technologies or changing other features of a vehicle (for example, safety technologies, communication technologies, etc.). If drivers value the benefits that are created by R&D on these other technologies (that is, extra safety, better communications, etc.), then reducing this R&D expenditure will impose an opportunity cost on consumers, as they will miss out on these other advances. The loss of these benefits was illustrated in Chart 1.2. As Australia accounts for a relatively small share of global vehicle markets, domestic policies may have little impact on R&D budgets given many manufacturers will already have changed R&D in response to overseas emission standards.

What are the benefits and costs of emission standards?

Any future emission standard for Australia should be subject to a thorough Policy Impact Analysis (previously a Regulation Impact Statement). This should evaluate the impacts discussed above in detail and should also compare emission standards to alternative policies.

Table 1.11 sets out the key cost and benefit factors that need to be considered.

1.11 Benefits and costs to include in a Policy Impact Analysis of emission standards

Factor	Description
Benefit/cost	
Private value of fuel savings	The treatment of these benefits in the cost benefit analysis underlying the Policy Impact Analysis depends crucially on the understanding of the original rationale for the standard. In the absence of clearly identified fuel efficiency market failures, it is not appropriate to include private benefits. In the presence of market failures, at least some of the private benefits should be included
Value of emissions reduction	This needs to be understood in the wider context of emissions policy and includes both CO_2 and other emissions. Emissions reductions should be valued at the economy wide cost of emissions reductions, accounting for the fact that there may be other low-cost abatement options available
Technology cost or cost of fleet mix change	There are a wide range of technology cost estimates available. The analysis should allow for sensitivity around estimates. As Australia is a technology-taker (technological options are likely to be driven by other markets), the standard may also involve costs (from the Australian import perspective) in terms of upgrading the efficiency of the fleet, compared with what would otherwise have been the case
Opportunity cost	This factor is often excluded from explicit consideration. However, focus on fuel efficiency characteristics of vehicles must involve some opportunity cost in terms of other characteristics that consumers value
Rebound effect	It is widely understood that energy efficiency measures involve a 'rebound effect'. In the case of a vehicle efficiency standard, this an increase in kilometres travelled due to the effective reduction in the cost of vehicle travel brought about by increased fuel efficiency
Other implications of the rebound effect	Increased kilometres travelled will have other implications, including increased congestion and other environmental impacts
Indirect implications for fuel prices	Fuel efficiency from a standard may require improvements in fuel quality. This will have indirect implications for fuel prices that need to be included in the analysis. Note that changes in fuel prices will affect all vehicles, not just new vehicles
Compliance costs	Complying with the standard will involve compliance costs for vehicle brands
Administrative costs	Administering the standard will involve government administration costs
Cost of taxation (to cover administration costs)	Administration costs will involve the use of tax revenue, which has an opportunity cost

Source: CIE.

2 Existing emission standards

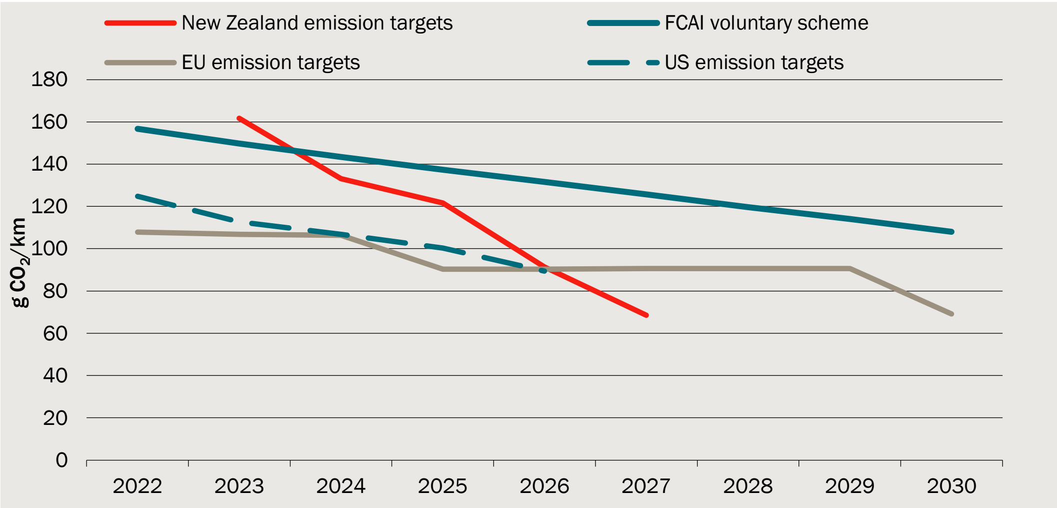
Emission standards have been widely adopted internationally. In the EU, US and NZ, emission standards play a significant role in encouraging uptake of zero- and low-emission vehicles. In the absence of a government mandated emission standard the FCAI developed a voluntary industry-led emission standard for Australia in 2020.

Key features of vehicle emission standards include:

- Setting emission targets for individual vehicle brands which would achieve some level of emissions across the entire fleet of new vehicles. Targets for brands are adjusted for vehicle size – often measured using vehicle mass or footprint. This allows brands selling larger or heavier vehicles to get a higher CO_2 target than those of lighter vehicles, reflecting the relationship between vehicle size and fuel consumption.
- Credits are earned if vehicle brands achieve an annual emission target. These credits can generally be traded between brands, so that brands who do not reach their target through vehicle sales, may fulfil their obligations by purchasing credits from other brands.
- Penalties for brands who do not meet targets, either through lower sales or the purchase of credits.

Emission targets for these schemes are shown in Chart 2.1.

2.1 Existing emissions targets by year



Note: These targets include adjustments for vehicle size, super credits and out of cycle credits, and will not be equal to the sales weighted average emissions.

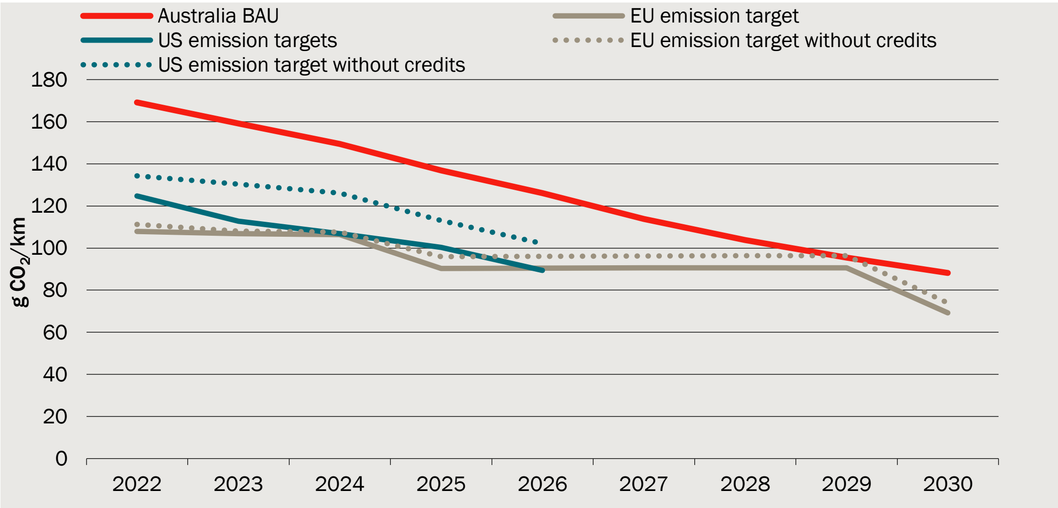
Data source: CIE compilation based on New Zealand Transport Agency, *Clean Car Standard CO_2 value*; Federal Chamber of Automotive Industries (FCAI), 'Australia's automotive industry delivers on emission reduction targets', in *FCAI Media Releases*; United States Environmental Protection Agency (EPA), *Final Rule to Revise Existing National GHG Emissions Standards for Passenger Cars and Light Trucks Through Model Year 2026*; and European Commission, *CO_2 emission performance standards for cars and vans.*

These targets, however, do not purely reflect tailpipe emission reductions (based on emission test cycles), as the schemes allow a range of credits and adjustments. These include:

- Super credits for low-and zero-emission vehicles. These place a greater weight on each low and zero emission vehicle sold in calculating average emissions across sales. Table 2.3 summarises the multipliers introduced in the super credit system to weight vehicle sales in calculating fleet average emissions under the scheme.
- Innovation credits for vehicle features which reduce non-tailpipe emissions or have an additional impact on tailpipe emissions which are not captured by emission testing:
  - examples include active aerodynamic improvements, engine idle start-stop and reducing leakage of hydrofluorocarbon refrigerants from air-conditioning or using air conditioning gases with lower global warming potential
  - Table 2.4 summarises credits awarded to approved emission-reducing technologies. Some of these technologies are considered "off-cycle" technologies whose benefits are not captured in standard testing cycles.

In Chart 2.2, we show our estimate of emission targets for the US and the EU removing these credits. Further information on these credits and their impact on reaching emission targets is provided in Appendix A.

2.2 Emissions targets adjusting for the impact of credits by year



Data source: CIE

2.3 Summary of multipliers in super credits for light duty vehicles

	Multiplier
EU super credits for vehicles emitting <50 gCO_2/km	
2020	2.0
2021	1.67
2022	1.33
2023-24	1.0
2025+	1% uplift of emission target for additional 1% to defined share of zero- and low-emission vehicles, with a cap at 5%
US Environmental Protection Agency (EPA) super credits by powertrain	
Battery electric vehicles and fuel cell vehicles	
2022	1.0
2023-24	1.5
2025+	1.0
Plug-in hybrid electric vehicles	
2022	1.0
2023-24	1.3
2025+	1.0
Flexible fuel vehicles	
2022	2.0
2023+	1.0
Australia FCAI by emission	
Emission=0	3.0
0<Emission ≤ 1/3 reference emission [a]	2.0
1/3 reference emission < emission ≤ 2/3 reference emission	1.5
2/3 reference emission < emission ≤ reference emission	1.0

[a] At a given vehicle mass, there is a reference emission based on the mass-based emission curve defined each year.

Note: 1.0 means no multiplier.

Source: CIE compilation based on Table 5.2 in United States Environmental Protection Agency (EPA), *The 2022 EPA Automotive Trends Report - Greenhouse gas emissions, fuel economy and technology since 1975*; European Commission, *CO_2 emission performance standards for cars and vans*; and Figure 6.1 in Federal Chamber of Automotive Industries (FCAI), *CO_2 Standard: Rules for Calculating Brand Targets and Assessing Brand Compliance*.

2.4 Summary of credits awarded to emission-reducing technologies

	Credit
	gCO_2/km
EU “off-cycle” credits [a]	
2021-23	≤7per year per manufacturer
US EPA	
Air conditioning credits	
for reducing refrigerant emissions	Calculated
for reducing fuel combustion	≤3.1 for passenger cars ≤4.5 for light trucks
Off -cycle credits	
Passenger vehicles	0.2-2.0
Light truck	0.3-2.7
Australia FCAI	
Air conditioning credits	Calculated
Off -cycle credits	
Passenger vehicles	0.2-2.0
Light truck	0.3-2.7

[a] EU provides multipliers to grams of CO_2 saved per km arising from the technologies. The CO_2 saved per km are multiplied by 1.9, 1.7 and 1.5 in the year 2021, 2022 and 2023 respectively.

Note: Australia FCAI off-cycle credits are in line with US EPA off-cycle credits. Each approached technology on the menu corresponds to definitive credits.

Source: CIE compilation based on U Tietge, P Mock & J Dornoff, *Overview and evaluation of eco-innovations in European passenger car CO_2 standards* 2018; United States Environmental Protection Agency (EPA), *The 2022 EPA Automotive Trends Report - Greenhouse gas emissions, fuel economy and technology since 1975*, 2022; and Tables 5.1 to 5.2 in Federal Chamber of Automotive Industries (FCAI), *CO_2 Standard: Rules for Calculating Brand Targets and Assessing Brand Compliance*, 2020.

EU emission standard

The EU has fleetwide CO_2 emission targets to and continuing from 2030:[22]

- 95 g CO_2/km for new passenger cars and 147 g CO_2/km for new light commercial vehicles (LCV) from 2020 to 2024
- 80.8 g CO_2/km for new passenger cars and 125.0 g CO_2/km for new LCV from 2025
- 59.4 g CO_2/km for new passenger cars and 101.4 g CO_2/km for new LCV from 2030.

The standard provides a mass based average target for each vehicle type at the manufacturer level. These targets are used to administer financial incentives and penalties. This is determined each year based on the EU fleet-wide targets and average mass in running order.[23]

22 European Commission, CO_2 emission performance standards for cars and vans. Available here: https://climate.ec.europa.eu/eu-action/transport-emissions/road-transport-reducing-co2-emissions-vehicles/co2-emission-performance-standards-cars-and-vans_en#target-levels

23 This is the vehicle unladen mass plus fuel, liquids, standard equipment and the driver.

If a manufacturer fails to meet its emissions target each year, the manufacturer has to pay an excess emission premium of €95 per g CO_2/km for each of its vehicles newly registered in that year.[24]

The EU has separate regulations for heavy duty vehicles, as per light vehicles.[25]

Implementation of emission standards

Key implementation elements are summarised in Table 2.5

2.5 Implementation elements of EU CO_2 emission regulation of new vehicles

Type of vehicles	Flexibility	Credits	Penalties	Exemptions
Passenger cars and light commercial vehicles (LCV)	Pooling - manufacturers can group together and act jointly to meet their emission targets	▪ Super credits for zero- and low-emission vehicles ▪ Credits for eco-innovations	An excess emission premium of €95 per g CO_2/km above target is applied to a manufacturer's fleet if it exceeds specific emission target per year	Small-volume and niche manufacturers can apply for a relaxation of emission targets
Heavy duty vehicle (HDV)	▪ Banking and borrowing of CO_2 credits ▪ Manufacturers can balance emissions between different groupings within their portfolio, even from non-regulated vehicle categories	▪ Super credits for zero- and low-emission vehicles	The penalties of €4,250 per g CO2/tonne-km in 2025 and €6,800 per g CO2/tonne-km in 2030 will be applied	Vocational vehicles such as garbage trucks and construction vehicles are exempted due to their limited potential for cost effective CO_2 reduction

Source: European Commission, *CO_2 emission performance standards for cars and vans*; European Commission, *Reducing CO_2 emissions from heavy duty vehicles.*

Super credits

Super credits are awarded for new passenger vehicles and HDV which satisfy a low emission threshold to encourage sale of zero- and low-emission vehicles. They are awarded in the form of a multiplier to the sales number of zero- and low-emission passenger vehicles emitting less than 50 g CO_2/km. This means they are counted more than actual sales to meet the fleet target for a manufacturer by offsetting emissions from the sale of high emitting conventional vehicles. The multiplier was set at 2.0 in 2020, declining to 1.67 in 2021 and 1.33 in 2022, and will phase out in 2023. The difference between fleet emissions with and without super credits was capped at 7.5 g CO_2/km

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24 If a manufacturer exceeds their target by 1 g CO_2/km and they sell 100,000 vehicles, the fine would be €9.5 million, which is around A$15 million.

25 C Serra, 2020 Heavy-duty vehicles CO2 emissions: EU policy context, Directorate-General for Climate Action - European Commission, 28 October 2020, p.9. Available here: https://joint-research-centre.ec.europa.eu/system/files/2020-10/dg_clima_ze-hdv-jrc-webinar-2810020_public.pdf

between 2020 and 2022. Benchmark-based super crediting will replace the current system in 2025. The new system will award a manufacturer a 1 per cent uplift of its emission target if its fleet exceeds the defined share of zero- and low-emission vehicles in the new fleet by 1 per cent, until the maximum award of 5 per cent is reached. A similar super credit structure is applied to heavy vehicles.

Banking and borrowing of super credits from one year to the next are allowed for HDV manufacturers to reduce compliance costs during long development cycles in the HDV industry.[26] This not available for light vehicles.

Credits for eco-innovations

Manufacturers can receive a maximum of 7 g CO_2/km of credits for the adoption of innovative technologies whose benefits are not captured by the test cycle used to measure tailpipe emissions (Worldwide Harmonised Light Vehicle Test Procedure (WLTP)). As part of the regulations there is a list of approved eco-innovations, which include LED lights, motor generators, smart diesel fuel heater and alternators.[27]

US EPA national greenhouse gas emission standards

The US Environmental Protection Agency (EPA) established the first nationwide greenhouse gas (GHG) emission standard in 2010. The current targets, as part of the Safer Affordable Fuel Efficient (SAFE) Vehicles Rule, run from 2021 to 2026. The emission standard requires a projected vehicle industry-wide emission target of 161 g CO_2/mile in 2026 (Table 2.6).

In each model year, each manufacturer has its own standards for passenger car and light truck categories, based on sales-weight footprint-based CO_2 standard curves of vehicles produced in the year. This differs from the EU standard which is based on vehicle mass. The curves are continually flattened from 2022, implying more stringent standards from 2023 and beyond. The footprint-based standard curves, along with fleet mix projections, underlie the industry-wide fleet average targets shown in the Table 2.6.

26 G Erbach, *CO2 emission standards for heavy-duty vehicles*, EPRS | European Parliamentary Research Service, August 2019. Available here: https://www.europarl.europa.eu/RegData/etudes/BRIE/2018/628268/EPRS_BRI(2018)628268_EN.pdf

27 European Commission 2022, List of eco-innovations approved under WLTP. Available here: https://circabc.europa.eu/ui/group/4cf23472-88e0-4a52-9dfb-544e8c4c7631/library/3531be64-acd5-4817-8dff-1cd5ea361d99/details

2.6 EPA fleet-wide CO_2 emission target projection 2023-2026

Year	New passenger cars	New light trucks	Combined
	g/mile	g/mile	g/mile
2022 (the SAFE rule)	181	261	224
2023	166	234	202
2024	158	222	192
2025	149	207	179
2026	132	187	161

Source: Table 1, United States Environmental Protection Agency, *Final Rule to Revise Existing National GHG Emissions Standards for Passenger Cars and Light Trucks Through Model Year 2026*, 2021.

Implementation of EPA emission standard

As part of the US EPA greenhouse gas (GHG) emission program, the EPA develops a set of compliance flexibilities in forms of performance credits and adjustments for methane (CH_4) and nitrous oxide (N_2O) emissions to determine annual emission performance to be compared against the emission standard for each manufacturer. For each manufacturer, program credits are generated if the emission performance is below the standard (i.e. exceeds the target) or deficits are generated if the emission performance is above the standard. These credits are measured in megagrams of CO_2, converted from the CO_2 emission rate (grams of CO_2 per mile).

A manufacturer's total credit balance - in terms of total mass of CO_2 emissions - shows credits or deficits accrued in previous model years, credits earned in early adoption scheme, credit expirations, credit forfeitures and credit trades. They altogether determine a positive or negative credit balance in the current year and thus the final compliance status of each manufacturer. Manufacturers who maintain a positive or zero credit balance are considered in compliance with the program. Manufacturers who close any model year with a deficit have up to three years to offset that deficit to avoid non-compliance and any penalty.[28]

How is EPA GHG standard different from other standards?

The EPA GHG standard is not the only suc standard in the US. The National Highway Traffic Safety Administration (NHTSA) established the corporate average fuel economy (CAFE) standard in 1975. The CAFE standard regulates the sales-weighted average fuel economy in miles per gallon (mpg) of the vehicles in a manufacturer's fleet (Table 2.7).

NHTSA's CAFE standard does not interfere with manufacturer's ability to comply with the EPA GHG emission standard as both organisations coordinate standards.

28 United States Environmental Protection Agency 2022, The 2022 EPA Automotive Trends Report - Greenhouse gas emissions, fuel economy and technology since 1975, December 2022, p. 78.

Manufacturers are able to produce a fleet of vehicles which achieves compliance with both standards at once.[29]

2.7 NHTSA's CAFE CO_2 emission standard

Year	New passenger cars	New light trucks	Combined
	mpg	mpg	mpg
2022 (SAFE rule)	44.9	32.1	37.9
2023 (SAFE rule)	45.6	32.6	38.5
2024	49.2	35.1	40.6
2025	53.4	38.2	44.2
2026	59.4	42.4	49.1

Source: CIE compilation based on Table II-15 to Table II - 17, United States Environmental Protection Agency, *The Safer Affordable Fuel Efficient (SAFE) Vehicles Final Rule for Model Years 2021-2026*, 2020; and Table II-4 and Table II-5, National Highway Traffic Safety Administration (NHTSA), *Corporate Average Fuel Economy Standards for Model Years 2024–2026 Passenger Cars and Light Trucks*, 2022.

In addition to the CAFE standard, California implemented its own light duty vehicle GHG emission standard. The California Air Resources Board (CARB) issued the Low-Emission Vehicle (LEV) III Regulation which sets up emission standards for GHG and key pollutants for new light duty vehicles sold within California. This standard projects GHG emission targets from 2017 to 2025 (Table 2.8). The state's standards are at least as protective as the federal standards.[30] Other states can either follow California's emission standards or the EPA emission standards.[31]

2.8 Projected targets of California's LEV III GHG CO_2 emission standard

Year	New passenger cars	New light trucks	Total
	g/mile	g/mile	g/mile
2017	214	291	240
2018	203	281	231
2019	192	271	223
2020	183	265	213
2021	174	244	198
2022	164	233	189
2023	157	221	180
2024	151	210	171
2025	145	201	164

Source: CIE compilation based on Figure 2, California Air Resources Board (CARB), *Advanced Clean Cars Summary*; TransportPolicy.net, 'California: Light-duty: GHG', 2023.

29 United States Environmental Protection Agency 2021, *Final Rule to Revise Existing National GHG Emissions Standards for Passenger Cars and Light Trucks Through Model Year 2026*, 15 December 2021, p. 24.

30 California Air Resources Board 2022, California & the waiver: The facts.

31 L Cattaneo 2022, EPA's Revived Clean Cars Waiver for California, in *Harvard Law School Environmental and Energy Law Program*, April 2022.

EPA compliance flexibility options

EPA implements a range of flexibility options, recognising the lead time for manufacturers in transition to more stringent emission standards.

These consist of:

- Performance credits for alternative fuel vehicles, which are like the super credits under the EU emission standard. They are defined as multipliers to the production number of eligible vehicle (Table 2.9).
- Performance credits for improved air conditioning systems:
  - credits of reducing leakage of hydrofluorocarbon refrigerants, calculated as refrigerant emissions in terms of grams CO_2 per year based on production number, performance, technology, fitting, seals and hoses of the air condition system
  - credits of reducing combustion of fuel to provide mechanical power to the air conditioning systems, referred to as a menu of approved technologies and associated credit values in terms of g CO_2/mile, with a cap at 5.0 and 7.2 g CO_2/mile for passenger cars and light trucks in 2017 and beyond
- Performance credits for off-cycle technologies that reduce emissions but are not captured on EPA's regulatory test cycles. These may be based on:
  - a menu of approved technologies and associated credit values in terms of g CO_2/mile, with a cap at 10 g CO_2/mile in 2022 and 15 g CO_2/mile in 2023 and beyond and 7.2 g CO_2/mile for passenger cars and light trucks in 2017 and beyond, or
  - additional laboratory testing to determine credits.

2.9 Multipliers to the alternative fuel vehicles

Year	Electric vehicles and fuel cell vehicles	Plug-in hybrid electric vehicles	Dedicated and flexible fuel vehicles
2017	2.0	1.6	1.6
2018	2.0	1.6	1.6
2019	2.0	1.6	1.6
2020	1.75	1.45	1.45
2021	1.5	1.3	1.3
2022	1.0	1.0	2.0
2023	1.5	1.3	1.0
2024	1.5	1.3	1.0
2025 or later	1.0	1.0	1.0

Note: 1.0 means no multiplier.

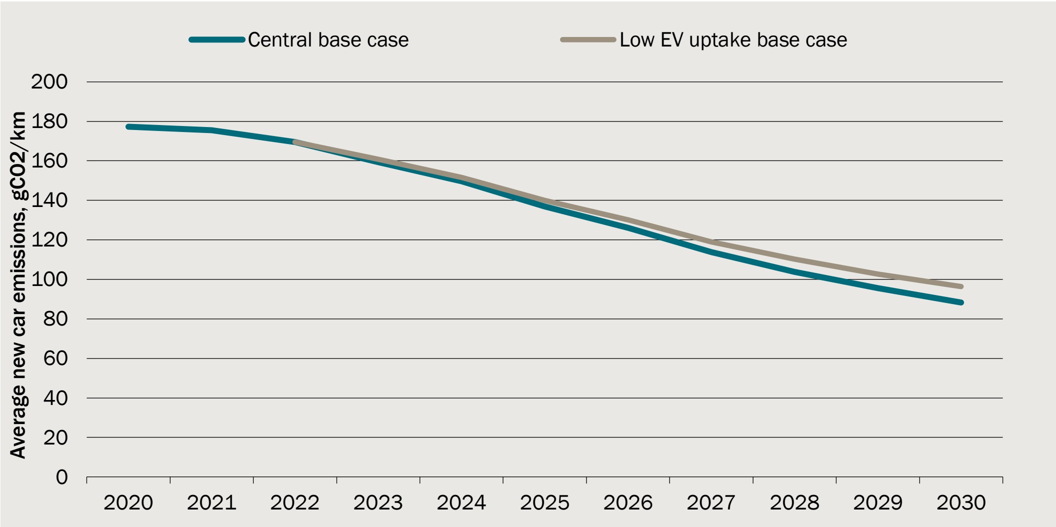
Source: Table 5.2, United States Environmental Protection Agency (EPA), *The 2022 EPA Automotive Trends Report - Greenhouse gas emissions, fuel economy and technology since 1975*, December 2022.

3 Emission scenarios modelled

Emissions scenarios have been developed to model the impacts of emission standards in Australia. These scenarios are defined by the average emissions for new passenger cars, SUVs and LVCs each year to 2030. The scenarios consist of:

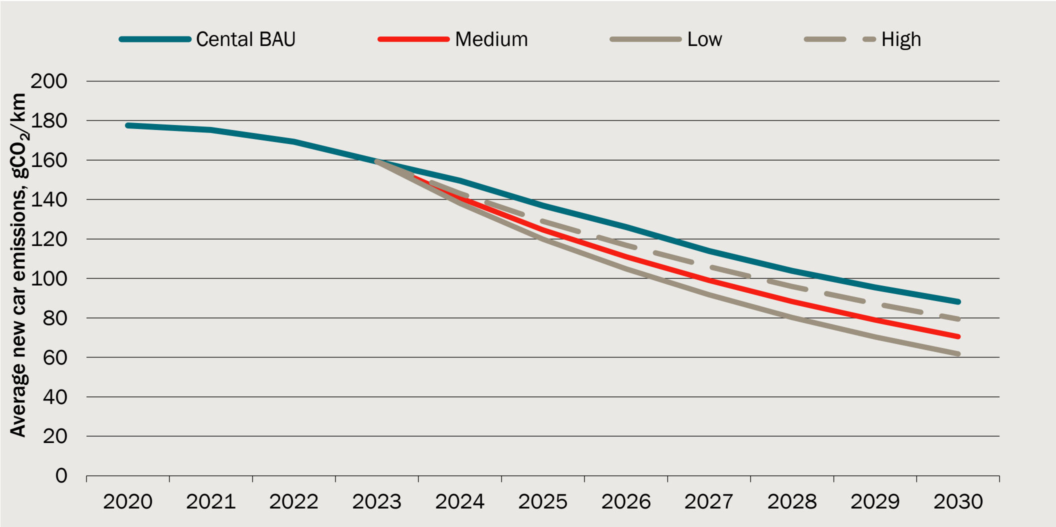
- Two BAU scenarios (without emission standards) reflecting the uncertainty under the base case (Chart 3.1):
  a) a central scenario which is based on a bottoms-up analysis of vehicle availability
  b) an alternative scenario where specifically BEV uptake is slower than envisioned by the central scenario
- Three with emission standard scenarios to measure the costs of different emission standard targets, assuming the standard comes into force in 2024 (Chart 3.2):
  a) low (most strict): 30 per cent reduction in emissions by 2030 compared to BAU
  b) medium: 20 per cent reduction in emissions by 2030 compared to BAU
  c) high (least strict): 10 per cent reduction in emissions by 2030 compared to BAU.

3.1 BAU scenarios by year



Data source: CIE based on FCAI and S&P Global Mobility data.

3.2 Emission standard scenarios for new light vehicles by year



Data source: CIE based on FCAI and S&P Global Mobility data.

Further information on the scenarios is provided in the following sections.

Business as usual

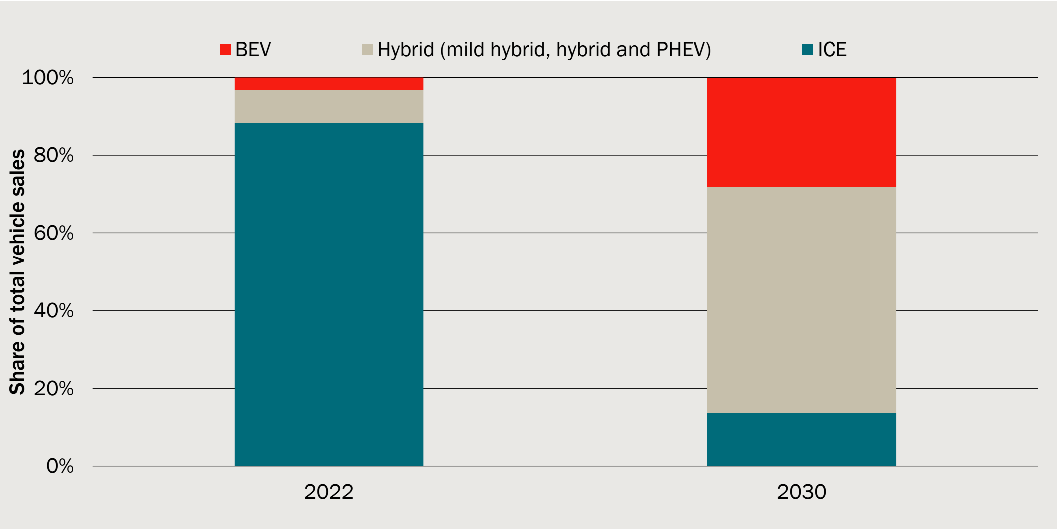
The key drivers of the BAU scenarios are:

- new car sale projections disaggregated by vehicle type (passenger car, SUV and LCV) powertrain and fuel type
- average emissions for new vehicles.

New car sale projections were provided by FCAI and provide a current view on projected future vehicle sales. This provides a bottoms-up estimate of expected future vehicle sales. To 2030, these projections expect a considerable move away from ICE vehicles towards hybrids and BEVs. The share of BEVs is expected to increase from 3 per cent of new vehicle sales in 2022 to around 28 per cent in 2030, while hybrids are expected to account for almost 60 per cent of new vehicle sales in 2030 (Chart 3.3).

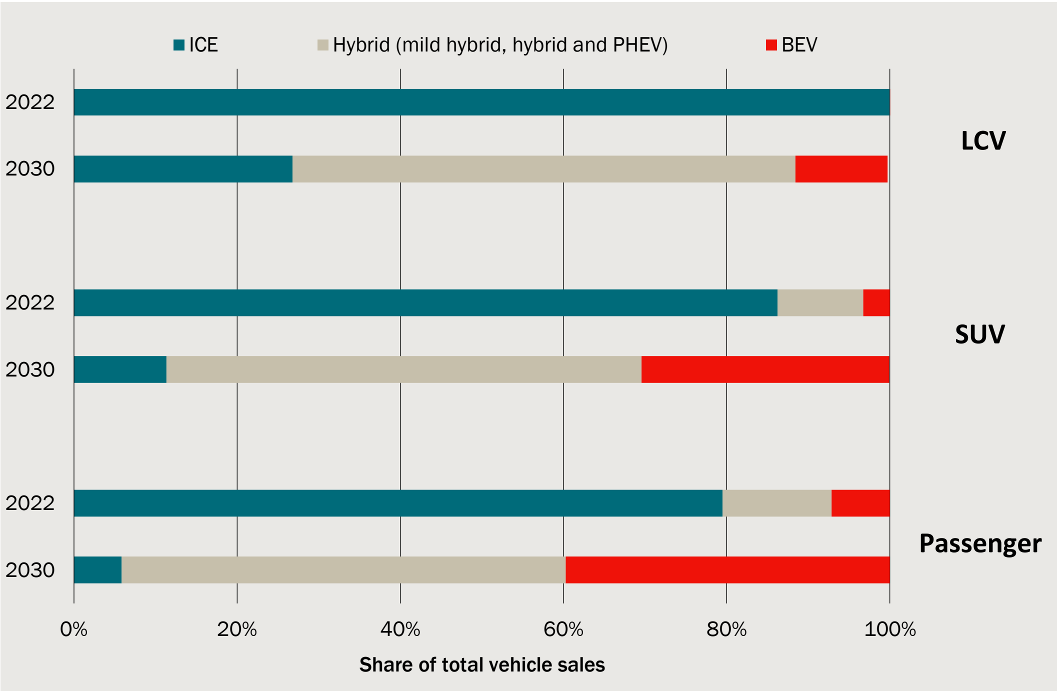
The transition away from ICE vehicles to HEVs and BEVs is expected to be replicated across vehicle types, albeit to varying degrees (Chart 3.4). By 2030 passenger vehicles are expected to have the highest share of BEVs, accounting for around 40 per cent of sales against 54 per cent for hybrid and 6 per cent for ICE vehicles. SUVs and LCVs are expected to have lower BEV shares in 2030, compared to passenger vehicles, but are coming off a low base.

3.3 New car sales by powertrain, 2022 and 2030



Data source: CIE based on FCAI and S&P Global Mobility data.

3.4 New car sales by powertrain and vehicle type



Data source: CIE based on FCAI and S&P Global Mobility data.

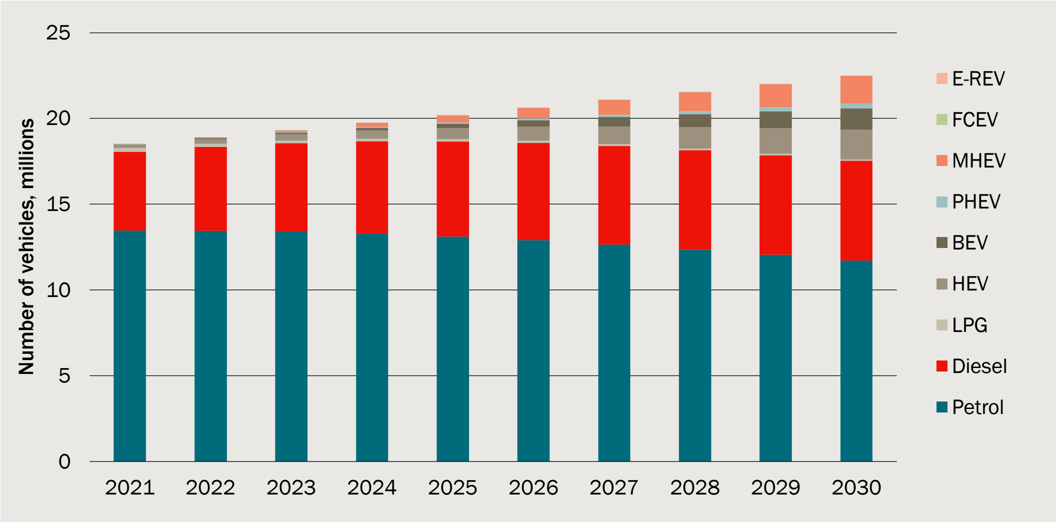
Projected vehicle sales are mapped to emissions by applying average emissions by vehicle type to these estimates. Historical emission by powertrain and vehicle type are taken from the National Transport Commission (NTC) light vehicle emissions intensity reporting. Further information on the emissions estimates is provide in Appendix B.

The composition of the stock under the base case changes slowly overtime (Chart 3.5). We assume that the vehicles being replaced today reflect the composition of vehicle sales

20 year ago (to reflect an average asset life of 20 years), while the size of the fleet continues to grow in line with population growth. This implies that the share of:

- ICE vehicles (including petrol, diesel and LPG) fall from 97 per cent of the fleet in 2023 to 78 per cent of the fleet in 2023
- BEV increases from around 0.5 per cent in 2023 to 6 per cent in 2030
- Hybrids (HEV and PHEV) increase from around 2 per cent in 2023 to around 9 per cent in 2030.

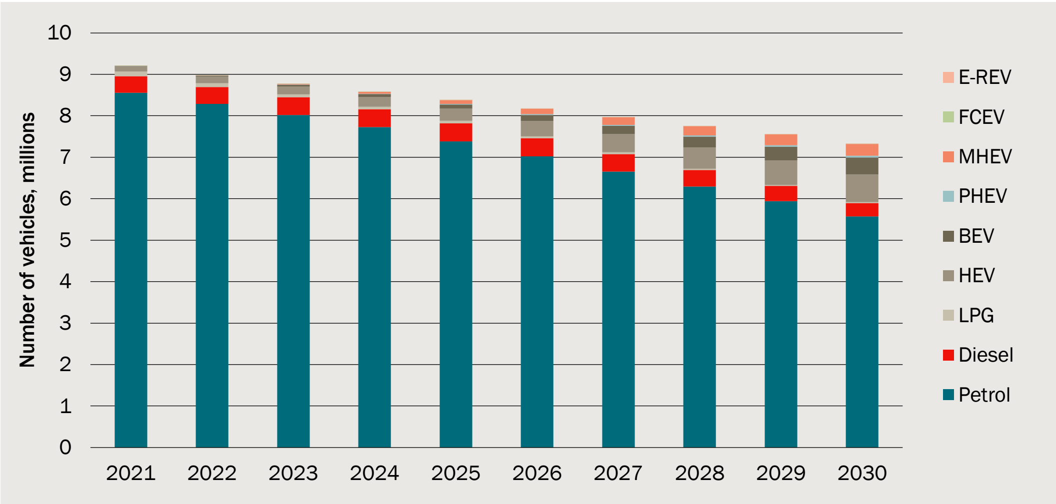
3.5 Stock of vehicles – passenger, SUV and LCV by year



Data source: CIE based on FCAI, S&P Global Mobility and ABS data.

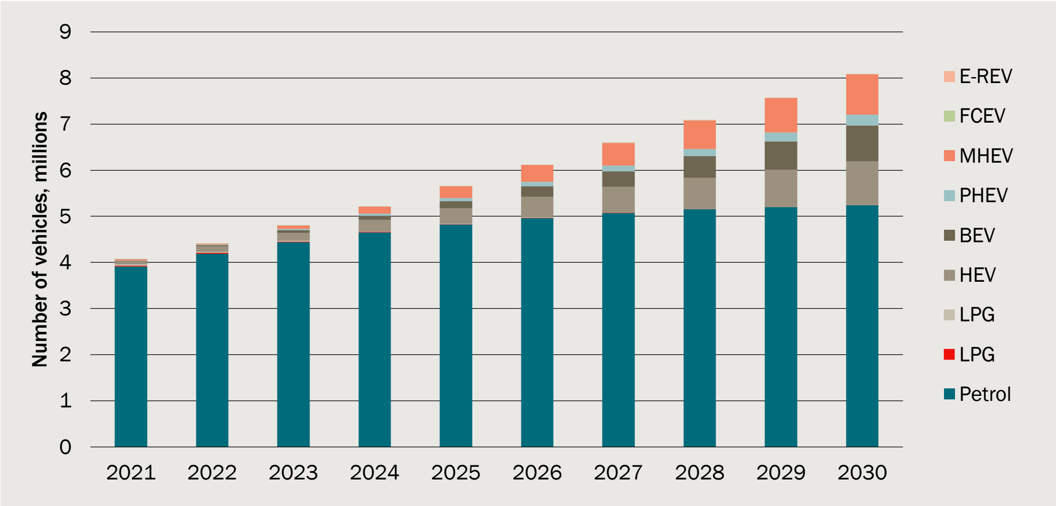
The change in the composition of the stock of vehicles is shown for passenger, SUV and LCV in Charts 3.6, 3.7 and 3.8 respectively.

3.6 Stock of vehicles – passenger by year



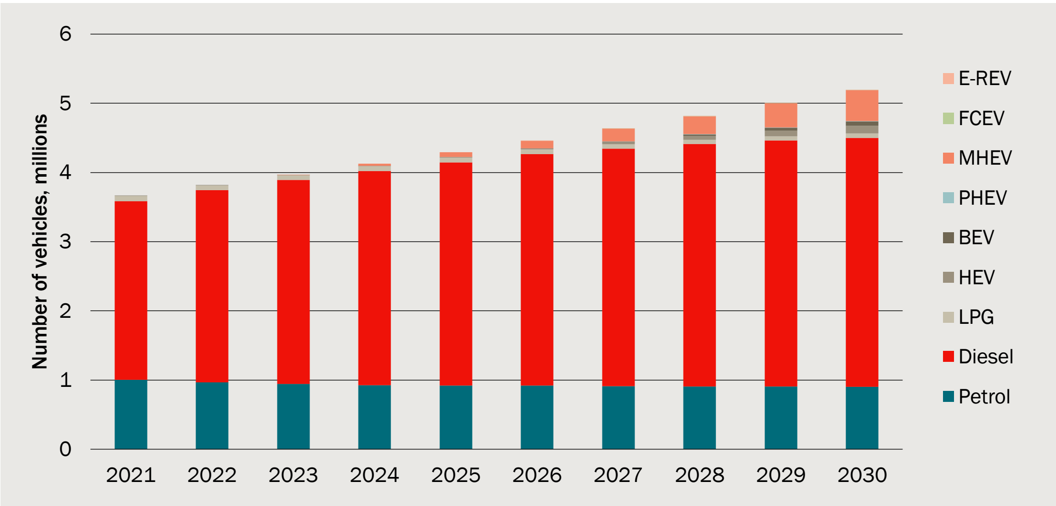
Data source: CIE based on FCAI, S&P Global Mobility and ABS data.

3.7 Stock of vehicles –SUV by year



Data source: CIE based on FCAI, S&P Global Mobility and ABS data.

3.8 Stock of vehicles – LCV by year



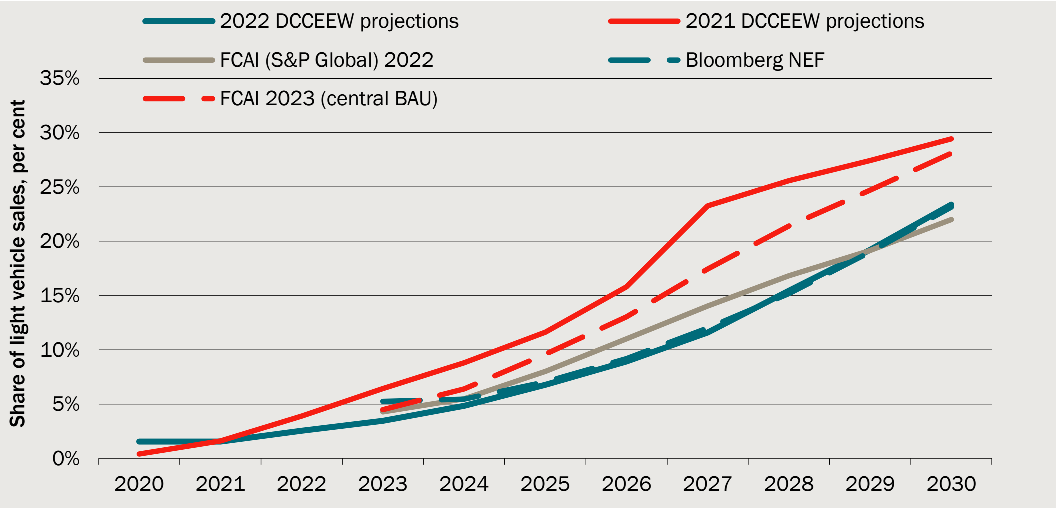
Data source: CIE based on FCAI, S&P Global Mobility and ABS data.

Comparison with other BAU projections

We compared the BAU provided by FCAI and S&P Global Mobility with other publicly available projections. Across a range of projections, reported by the Department of Climate Change, Energy and Environment and Water (DCCEEW), there is little difference in the rate of uptake of BEVs across projections (Chart 3.9).[32] The most pessimistic projection indicates BEVs will account for around 22 per cent of new light vehicle sales in 2030, compared to 29 per cent for the most optimistic scenario. The projections used for this report (shown in Chart 3.9 as FCAI 2023 (central BAU)), are towards the upper end of the projected uptake.

32 Department of Climate Change, Energy and Environment and Water 2023, Australia’s emissions projections 2022, p, 40-41.

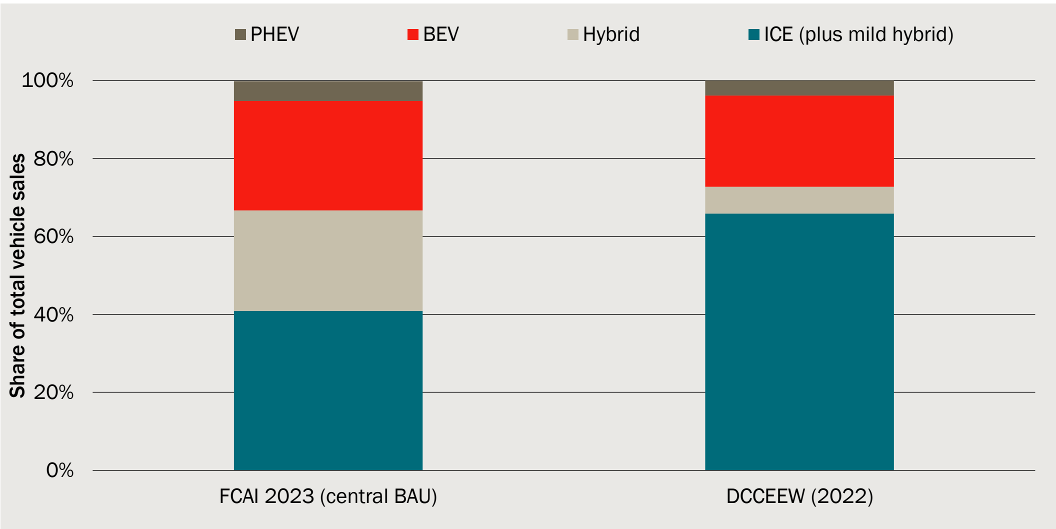
3.9 Projected share of BEVs in light vehicle sales by year



Data source: CIE, FCAI, S&P Global Mobility and Department of Climate Change, Energy and Environment and Water 2023, Australia's emissions projections 2022, p, 41.

Although projections are similar for BEV uptake between the BAU used in this analysis and the DCCEEW 2022 projection, there are larger differences for other powertrains. The central BAU used in this analysis assumes that hybrid vehicles will account for around 26 per cent of new car sales in 2030 compared to only 7 per cent under the DCCEEW 2022 projections (Chart 3.10). The DCCEEW projections assume that the lower market share of hybrids will be replaced by ICE and mild hybrid vehicles.

3.10 Projected new car sales by powertrain



Data source: CIE, FCAI, S&P Global Mobility and Department of Climate Change, Energy and Environment and Water 2023, Australia's emissions projections 2022, p, 40.

Assuming the same distribution of sales across vehicle types as the BAU (i.e. the split between passenger, SUVs and LCVs), vehicle emissions of new cars sold in 2030 would be around 22 per cent higher under the DCCEEW 2022 projections compared to the BAU used in this report. The implications of this are twofold:

1. the choice of BAU is likely to affect the emission standard – a more optimistic BAU may result in a lower (stricter) emission target, compared to a more pessimistic target. In this case, using the DCCEEW 2022 scenario to establish the baseline for a standard could result in a higher emission standard being set
2. given a particular target, lower BAU emissions will reduce the costs of achieving the emission target. That is, the cost of achieving an emission standard would be greater if the DCCEEW 2022 projections were to eventuate, as opposed to the BAU scenario used in this study.

Low EV uptake BAU

In addition to this central BAU scenario, we undertook sensitivity testing using an alternative "low EV uptake scenario". While the projections above report the most likely BAU, there is considerable uncertainty around the composition of future car sales. Holding Australia's policies constant, the key risks to these forecasts are:

- changing international policies. Increased subsidies or more restrictive emissions regulations in a few large markets (such the US proposed update to the emission standards) may result in resources being diverted. In the short run, this could compromise the ability to meet the projected BAU BEV market shares
- changing technology, namely technological breakthroughs which may accelerate the reduction in price and increase the features of BEVs. This may result in low emissions vehicle uptake exceeding projections.

For this analysis we focused on the scenario where uptake is lower than expected. As part of sensitivity testing, we estimated the impacts of the emission standards where BEV uptake is 20 per cent lower than the central BAU, with those vehicles instead being ICE vehicles. This scenario sees BEVs accounting for around 22 per cent of car sales in 2030 (similar to the low range of other projections), compared to 28 per cent in central BAU. This has a relatively modest impact on the stock of vehicles:

- ICE vehicles share of the stock in 2030 increases to 79 per cent from 78 per cent under the central BAU scenario in 2030
- BEV falls to 5 per cent from increases in ICE vehicles from 78 per cent to 79 per cent under the central BAU scenario in 2030
- Hybrids (HEV and PHEV) and other powertrain types are unaffected.

Scenarios

Emissions scenarios have been developed which are based on improvements from BAU emissions outcomes in 2030. We assume three scenarios relative to BAU (T able 3.11):

1. 10 per cent reduction in emission in 2030 ("high" emission standard scenario)
2. 20 per cent reduction in emissions in 2030 ("medium" emission standard scenario)
3. 30 per cent reduction in emission in 2030 ("low" emission standard scenario).

3.11 Annual new car sale average CO_2 emissions

Scenario	Passenger cars	SUV	LCV	Total new car sales
	g CO_2/km	g CO_2/km	g CO_2/km	g CO_2/km
Central BAU	60	72	158	88
Low EV uptake BAU	71	80	162	96
High emission target	54	64	142	79
Medium emission target	48	57	126	71
Low emission target	42	50	110	62

Source: CIE based on NTC and FCAI and S&P Global Mobility data.

Taking the emissions for these scenarios, we back solve for the powertrain and fuel shares that would be required to reach the emission standard, holding constant the breakdown of new vehicles by type and the emission by vehicle type by powertrain and fuel. We assume that reductions in emissions under the hypothetical emission standards modelled are achieved by:

- increasing the market share of BEV, PHEV and HEVs:
  - we assume that the PHEV and HEV market shares increase proportionally with BEVs, such that in the scenario the ratio between BEVs, PHEVs and HEVs is the same under BAU
- decreasing the market share of petrol, diesel and mild hybrid vehicles – that is any increases in BEVs, PHEVs and HEVs are offset by fewer ICE or mild hybrid vehicles.[33] This assumes the same number of vehicles are sold with or without the emission standard.
- we then iteratively increase BEV market share until we meet the emission target.

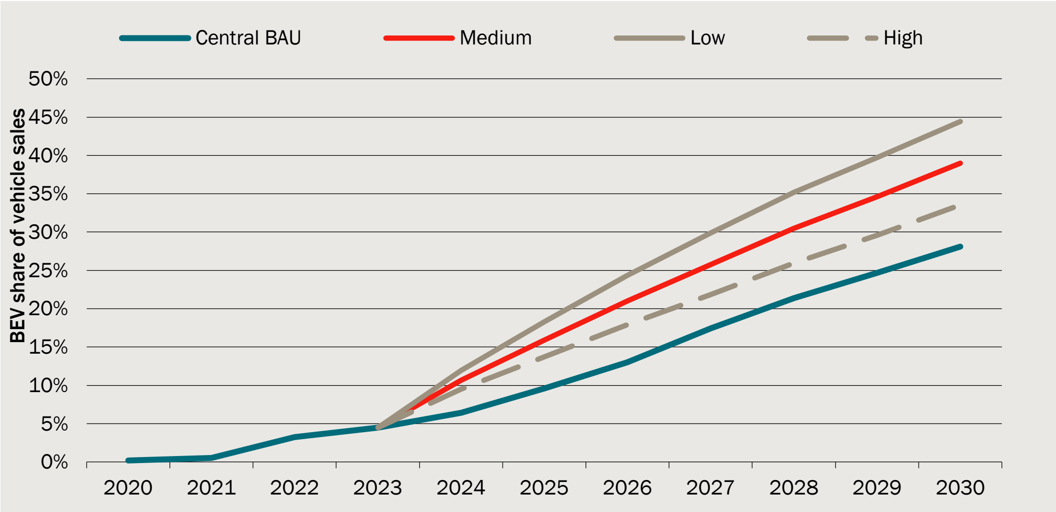
This is only one way to meet emission standards, alternative approaches include:

- increasing PHEVs and HEVs relative to BEVs market shares
- changing the within vehicle type mix of vehicles, which could result in lower ICE emissions (for example, if customers substituted from larger to smaller ICE SUVs)
- changing the mix of new vehicle types (we assumed that consumers do not substitute between vehicle types).

The implied BEV share of sales for these different emission standards are shown in Chart 3.12.

33 We assume that mild-hybrid emissions are 15 per cent lower than petrol ICE vehicles.

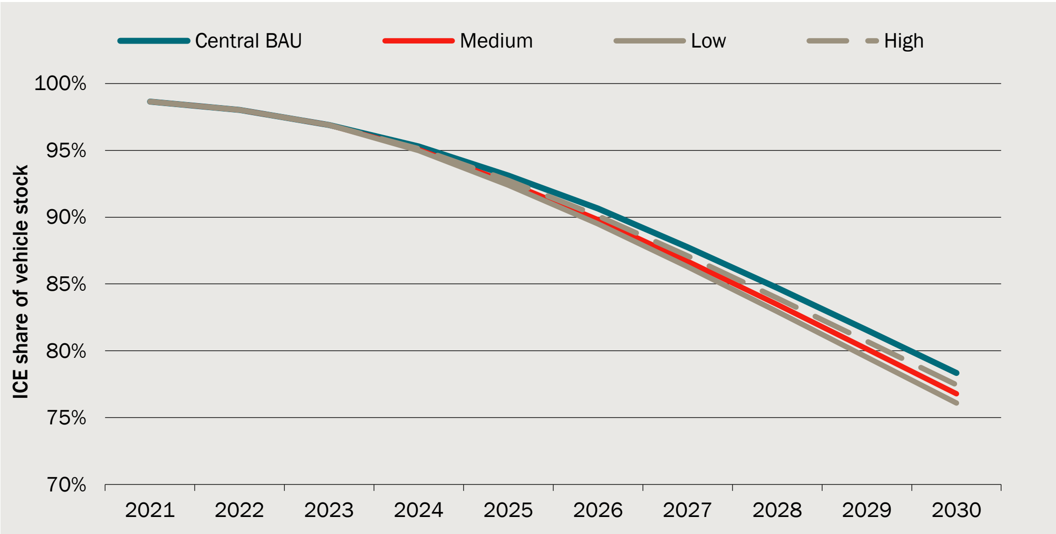
3.12 BEV market share under emission scenarios by year



Data source: CIE based on FCAI, S&P Global Mobility and NTC data.

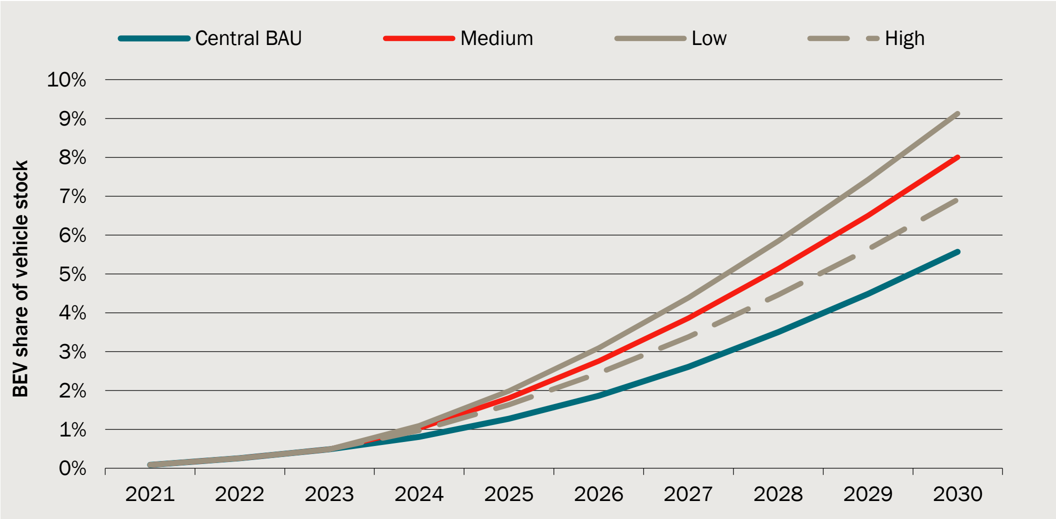
Across the scenarios there is little difference in the composition of the total vehicle fleet, reflecting the relatively long asset lives of vehicles (Charts 3.13 and 3.14). Across the scenarios there is at most around a 3 per cent difference in the share of ICE or BEV vehicles compared to BAU in 2030 (Table 3.15).

3.13 ICE share of the vehicle stock by year



Data source: CIE based on FCAI, S&P Global Mobility and NTC data.

3.14 BEV share of the vehicle stock by year



Data source: CIE based on FCAI, S&P Global Mobility and NTC data.

3.15 Difference in composition of vehicle fleet between scenarios (2030)

	Per centage point difference from central BAU	Difference in number of vehicles
Share ICE		
Low	-2.7%	-613 786
Medium	-1.9%	-426 488
High	-1.1%	-248 318
Share BEV		
Low	3.2%	716 886
Medium	2.2%	488 326
High	1.2%	269 023

Source: CIE based on FCAI, S&P Global Mobility and NTC data.

4 *Impacts of emission standards*

In this chapter we present our 'analysis' results estimating the impact of emission standards on:

- households
- emissions
- fuel consumption and excise
- car markets.

At the end of this chapter we also undertake a sensitivity analysis to consider the impact of key uncertainties on the conclusions of the analysis that aims to identify and quantify the different impacts of an emission standard, with a focus on the impact on consumers, emissions, fuel consumption and fuel excise.

Households

Emission standards impact households by influencing their new car choice, encouraging adoption of low emission vehicles. This results in two main impacts for households:

4. social welfare impacts associated with the subsidy and implicit tax inbuilt into the emission standard:
   - this is measured by the DWL of these market interventions. DWL is a cost to society associated with an inefficient allocation of resources. For emission standards this relates to shifting households to purchase low emission vehicles (and their associated characteristics) when in the absence of an emission standard they would prefer to purchase higher emission vehicles (and their associated characteristics)
   - note this efficiency cost does not include other externalities, such as the greenhouse gas externality associated with vehicle choices, which is discussed separately in the emissions section of this chapter
5. changes in out-of-pocket costs for households purchasing a car, which include:
   - upfront costs of purchasing a new vehicle
   - maintenance and operating costs, including fuel costs.

The two impacts are related to one another. Out of pocket costs directly affect the welfare of households – paying more for a BEV with similar specifications to an ICE vehicle leaves households less money available to spend on other goods and services. These costs are also considered by households when choosing which car to purchase. For example, previous analysis has found that consumers are willing to pay less for vehicles as operating costs increase.[34]

If consumers appropriately perceive and incorporate differences in costs across low and high emission vehicles, then the change in out-of-pocket costs will be fully internalised into decision making. In this case, the social welfare impacts are the only relevant considerations for decision makers, as the change in out-of-pocket costs are fully incorporated into measures of social welfare. Where consumers only consider part of these cost differences, both DWL and change in costs for consumers will reflect the impact on households.

Social welfare impacts of emission standards

Social welfare impacts are measured in two parts, the impact of:

1. higher prices on the purchase of new high emission vehicles (which has the same impact as a tax)
2. the subsidy on the purchase of new low emission vehicles.

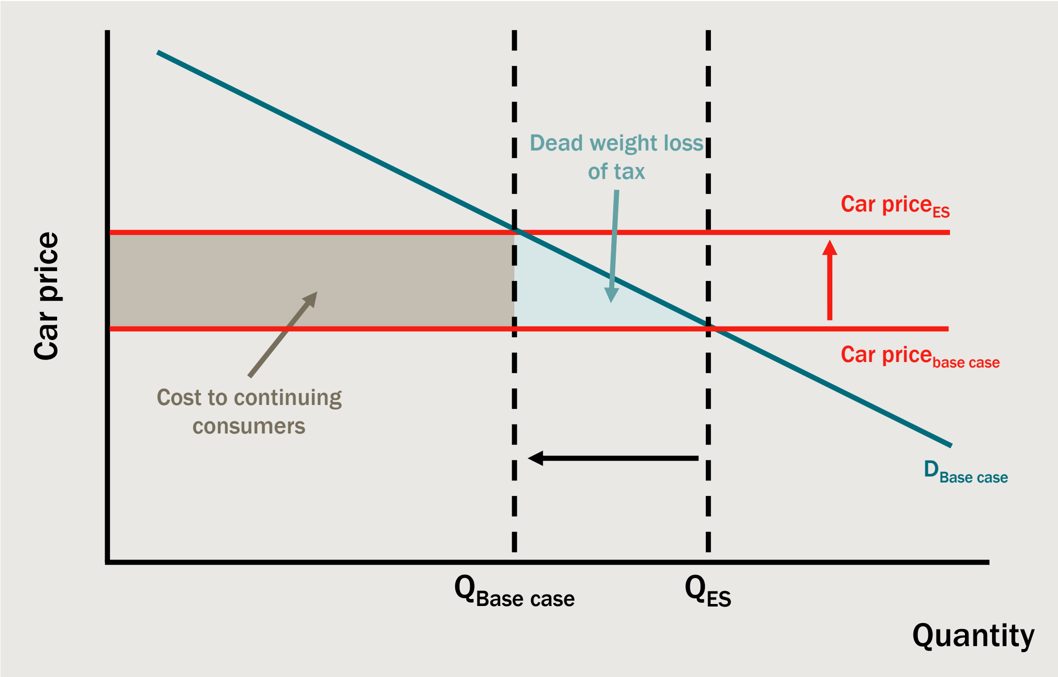
This is estimated using consumer preferences previously estimated by the CIE for the AAA.[35] These describe the WTP for different attributes across vehicle type powertrains. We use this to estimate by how much prices would need to change to induce consumers to switch to lower emission vehicles, which allows us to the estimate the change in price (Charts 4.1 and 4.2). We can then estimate the DWL by:

- using the change in vehicle sales by type and powertrain from the scenarios (Chapter 3):
  - we aggregated PHEV and BEV together in the estimate, which is consistent with the assumption that BEV and PHEV market shares remain in proportion across the emission standard scenarios
  - we used this to estimate the difference between ICE and BEV prices required to achieve the emission standard for a given scenario. Then we determined by how much ICE prices needed to rise, and BEV prices needed to fall, assuming the difference in prices is fixed and revenue from the tax is large enough to offset the cost of the subsidy
- assuming that the supply curve is infinitely elastic. We made this simplifying assumption as it is unclear how responsive supply is to prices. In doing so we assumed that all the benefits and costs of the subsidy and the tax are incurred by consumers (in practice it is likely these are shared with vehicle brands). This is a conservative assumption as the size of the subsidy or tax would need be larger if supply were upward sloping.

34 CIE 2019, Demand for electric vehicles: A discrete choice survey, prepared for Australian Automobile Association.

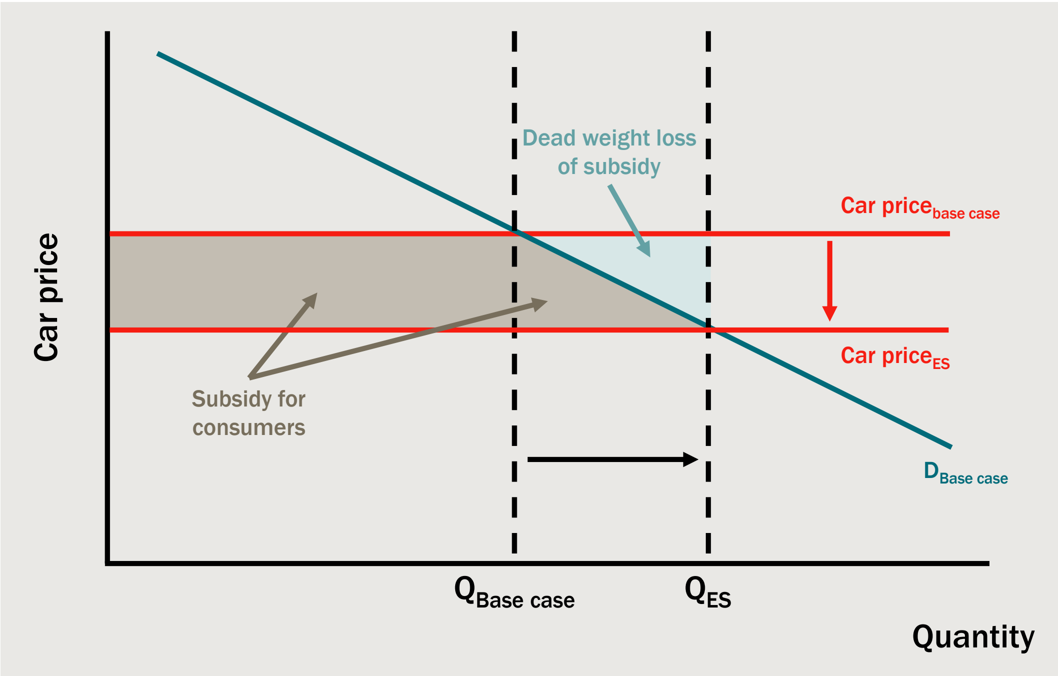
35 CIE 2019, Demand for electric vehicles: A discrete choice survey, prepared for Australian Automobile Association.

4.1 Impacts of emissions standards on higher emission vehicles



Data source: CIE.

4.2 Impacts of emissions standards on low emission vehicles



Data source: CIE.

The market for new cars in the BAU is distorted by a range of policies, including:

- state subsidies and grants to BEVs

- Fringe Benefit Tax for some eligible vehicles (including LCVs and some SUVs)[36]
- Fringe Benefit Tax for zero and low emission vehicles[37]
- the external impact of vehicles (this includes the congestion, environment and greenhouse gases) may not be reflected in the purchase price of a vehicle.

This means that a tax or a subsidy may improve economic efficiency by moving the market equilibrium closer to the socially optimal outcome.[38]

Results

Table 4.3 reports the price difference between BEV and ICE vehicles which is required to achieve the BEV uptake for each scenario. Under the BAU, we assumed there is $25,700 difference in the price between BEV and ICE vehicles. To achieve higher levels of BEV uptake than the BAU scenario, requires this price difference to be smaller.

All else equal a stricter emission standard (i.e. the low scenario in Table 4.3) requires a smaller difference between ICE and BEV prices.

The price difference required is smaller for:

- SUVs compared to passenger cars
- LCV compared to SUVs
- in 2030 compared to 2025 (Table 4.4, note the negatives in the table imply that BEV prices need to be lower than ICE prices). This reflects the assumption that by 2030 the difference between BEV and ICE vehicle prices under BAU will be half as large as in 2025 due to technological improvement. Abstracting from this assumption the difference in prices needs to be smaller as it seeks to achieve higher levels of BEV penetration, which is further away from BAU in 2030 compared to 2025.

The above assumptions reflect consumer preferences. Consumers purchasing SUVs and LCVs may place a greater value on range and towing performance or are purchased by households in regional and remote areas where there may be limited charging infrastructure. This means they need to be compensated by a smaller price difference with BEVs for them to move away from ICE vehicles.

36 https://www.ato.gov.au/Business/Fringe-benefits-tax/Types-of-fringe-benefits/fbt-on-cars,-other-vehicles,-parking-and-tolls/exempt-use-of-eligible-vehicles/

37 https://www.ato.gov.au/Business/Fringe-benefits-tax/Types-of-fringe-benefits/fbt-on-cars,-other-vehicles,-parking-and-tolls/electric-cars-exemption/

38 Note a more effective approach to reach the socially optimal outcome could be to remove existing distortions from the market.

4.3 Required difference in price to meet emission standard scenario market shares – BEV and ICE 2025

Vehicle type	Passenger	SUV	LCV
Emission standard scenario	$ '000	$ '000	$ '000
BAU	25.7	25.7	43.5
Medium	16.4	9.7	10.3
High	19.2	15.1	19.9
Low	13.6	4.1	0.6
1 percentage point increase in BEV share	24.2	23.1	39.3

Source: CIE.

4.4 Required difference in price to meet emission standard scenario market shares – BEV and ICE 2030

Vehicle type	Passenger	SUV	LCV
Emission standard scenario	$ '000	$ '000	$ '000
BAU	12.9	12.9	21.8
Medium	4.2	-7.0	-23.6
High	8.3	2.4	-2.2
Low	0.1	-16.0	-44.0
1 percentage point increase in BEV share	11.9	10.9	18.5

Source: CIE.

Tables 4.5 and 4.6 show the prices for ICE and BEV vehicles under the emission scenarios which are required to:

- meet the required difference in prices in Table 4.3
- ensure that enough additional revenue is collected from high emission vehicles to offset the implicit subsidy paid to the purchase of high emission vehicles.

This change in prices results in an increase in overall prices of vehicles sold. In some cases, the implicit subsidy and tax results in higher prices for both BEV and ICE vehicles, although the difference between the two is smaller. Although we assumed that the total number of vehicles sold is constant across scenarios, in practice higher prices would be expected to result in fewer new car sales. This could result in an increase in the average age of the vehicle fleet as owners keep their existing cars longer (see section on impacts on car markets later in this chapter for further discussion).

4.5 Prices under different emission standard scenarios – 2025

		BAU	Medium	High	Low	1 percentage point increase in BEV share
		$ '000	$ '000	$ '000	$ '000	$ '000
Passenger	ICE	33.7	36.3	35.4	37.5	34.0
	BEV	59.4	52.8	54.6	51.2	58.2
SUV	ICE	46.9	51.0	49.3	53.2	47.4
	BEV	72.7	60.7	64.4	57.3	70.5
LCV	ICE	50.2	54.0	52.2	56.6	50.4
	BEV	93.8	64.4	72.1	57.2	89.7

Source: CIE.

4.6 Prices under different emission standard scenarios – 2030

		BAU	Medium	High	Low	1 percentage point increase in BEV share
		$ '000	$ '000	$ '000	$ '000	$ '000
Passenger	ICE	33.7	46.7	43.0	50.7	40.4
	BEV	46.5	50.8	51.4	50.8	52.3
SUV	ICE	46.9	65.6	58.6	73.6	53.4
	BEV	59.8	58.6	60.9	57.6	64.2
LCV	ICE	50.2	71.9	60.7	86.6	53.8
	BEV	72.0	48.3	58.5	42.6	72.3

Source: CIE.

From the price change we calculated the DWL of the subsidy and implicit tax (Table 4.7). The results suggest that the medium emission standard would result in a $760 million welfare loss in 2025 and $1.6 billion welfare loss in 2030. This compares with a fuel cost saving of around $300 million in 2025 and $1.3 billion in 2030 for the medium emission standard scenario. As noted previously there is considerable uncertainty around this estimate as:

- a subsidy and tax could be efficient where it moves the market equilibrium closer to the socially optimal outcome
- assumptions around how supply responds to changes in prices is conservative.

4.7 Total dead weight loss for emission standard scenarios – 2025 and 2030

		Medium	High	Low	1 percentage point increase in BEV share
2025		$ million	$ million	$ million	$ million
Passenger	ICE	22	9	44	0.4
	BEV	55	26	93	1.5
SUV	ICE	85	31	180	1.4
	BEV	244	106	442	6.1
LCV	ICE	40	14	92	0.1
	BEV	314	158	526	4.4
Total 2025		**760**	**345**	**1 378**	**14.0**
2030		$ million	$ million	$ million	$ million
Passenger	ICE	126	46	248	7
	BEV	42	23	62	6
SUV	ICE	583	182	1,250	17
	BEV	38	18	101	12
LCV	ICE	388	94	977	4
	BEV	424	121	789	0
Total 2030		**1,602**	**484**	**3,428**	**45**

Source: CIE.

DWL loss per customer switching from an ICE to a BEV is shown in Table 4.8. The largest welfare cost is associated with changing LCV purchasing behaviour, with a cost of around $16,600 per customer switching from ICE to BEV in the medium emission standard scenario. The costs for passenger vehicles is the comparatively small gap in vehicle capabilities. Customer requirements mean that changes in BEV uptake can be achieved with smaller changes in prices and therefore less social welfare costs.

4.8 Dead weight loss per vehicle switching for emission standard scenarios – 2025

Emission standard scenario		Medium	High	Low	1 percentage point increase in BEV share
Vehicle type		$ per switching customer	$ per switching customer	$ per switching customer	$ per switching customer
Passenger	ICE	1,367	870	1,954	197
	BEV	3,345	2,433	4,142	644
	Total	**4,712**	**3,303**	**6,096**	**841**
SUV	ICE	2,070	1,216	3,135	251
	BEV	5,968	4,110	7,681	1,089
	Total	**8,038**	**5,326**	**10,816**	**1,340**
LCV	ICE	1,892	977	3,189	53
	BEV	14,705	10,854	18,294	2,043
	Total	**16,597**	**11,830**	**21,482**	**2,095**

Source: CIE.

Does an emission standard move the market equilibrium closer to a socially optimum?

These results indicate that an emission standard in an undistorted market would result in significant social welfare costs. However, these costs may be offset to some extent where the policy corrects other distortions in the market. To provide a comprehensive assessment would require modelling all these distortions; however, in the absence of detailed analysis we can make the following observations:

- State subsidies and grants to BEVs are likely to correct for the unpriced GHG externality to some extent. Where this externality is accounted for here, an emission standard would further distort the market resulting in a social welfare loss.
- FBT for zero and low emission vehicles[39] is likely to correct for the unpriced GHG externality to some extent. Where this externality is accounted for here, an emission standard would further distort the market resulting in a social welfare loss.
- FBT for some eligible vehicles[40] (including LCVs and some SUVs), may result in the over consumption of these types of vehicles. An emission standard may unwind this distortion by increasing the price of these larger vehicles which typically have higher emissions.

While the evidence is mixed a key conclusion we can take from this is that a higher emission standard is less likely to result in a DWL, given there are a range of existing policies which seek to lower emissions (such that a low or extremely strict emission standard would overcorrect for the market distortion) and there is some uncertainty as to size of the distortion of the FBT exemption for LCVs and some SUVs given the recent FBT exemption for zero and low emission vehicles.

Cost of the gross subsidy to ICE vehicle consumers

An emission standard involves higher prices for ICE vehicles (i.e. higher emission vehicles) being used to subsidise the purchase of lower emission vehicles. This results in a transfer from ICE purchasers, which is determined by the modelled price change from the BAU to achieve the same emission standard.

This transfer, which is a cost for ICE consumers and a benefit for LEV consumers, is shown in Table 4.9 for the medium emission standard in 2025. The costs for ICE consumers are substantial and demonstrates the importance of assessing the distributional impacts of emission standards.

39 https://www.ato.gov.au/Business/Fringe-benefits-tax/Types-of-fringe-benefits/fbt-on-cars,-other-vehicles,-parking-and-tolls/electric-cars-exemption/

40 https://www.ato.gov.au/Business/Fringe-benefits-tax/Types-of-fringe-benefits/fbt-on-cars,-other-vehicles,-parking-and-tolls/exempt-use-of-eligible-vehicles/

4.9 Transfer from ICE vehicle consumers to LEV consumers – medium emission standard 2025

	Total transfer	Transfer per ICE vehicle
Vehicle type	$ million	$
Passenger vehicle	328	2,734
SUV	1,414	4,140
LCV	721	3,785
Total	**2,463**	

Source: CIE.

Change in costs of ownership

The financial cost of owning a vehicle consist of:

- upfront costs (i.e. the purchase price)
- operating costs, including fuel, maintenance and insurance and registration, which recur each year over the life of the car.

By comparing these costs across different powertrains, we can measure the potential financial impact of changing new car choices on households. This change in financial costs in turn can be used to measure the marginal abatement cost to a household seeking to reduce their own emissions. To compare costs of car ownership, in particular the upfront purchase prices, across powertrains we need to compare like with like. This is difficult because of:

- differences in vehicle characteristics between ICE and BEV vehicles and brands – even where different vehicles have similar specifications, there may be differences which are not immediately observable or quantifiable (such as brand value, which would need to be estimated) that affect the value placed on different vehicles
- strategic pricing by car brands – where brands offer similar vehicles with different powertrains (i.e. the same model is offered with both an ICE and BEV, or different models which target the same market segment), they may strategically set prices to avoid their BEV products competing with their own ICE products and cannibalising their ICE sales. This may overstate the actual difference in prices of comparable vehicles, in particular when comparing ICE prices to BEVs from electric only brands
- limited availability of BEV vehicles in some market segments:
  - in some cases, there may not be a comparator within the single vehicle category which does not allow a meaningful comparison
  - limited availability will limit competition and may result in inflated prices. In this case, it is not possible to assume thar price equivalency will be replicated across market segments
  - in some segments, BEVs may already be at or close to price parity with HEV and ICE vehicles
- differences in costs depending on manufacturing approaches – purpose built BEV vehicles are likely to have lower price premiums compared to BEVs which are based

on an ICE vehicle platform, as accommodating an electric drive train in a chassis design for an ICE vehicle may increase manufacturing costs

- price premiums are likely to change overtime, such that premiums based on current (2023) retail prices will overstate future price premiums which overtime will fall due to:
  – increased competition with more BEVs brands and models entering the market
  – reduced manufacturing costs from technological improvements and economies of scale. To account for this uncertainty, we estimated the cost of ownership across a continuum of price premiums. Incremental ownership costs, compared to ICE vehicles, are estimated over the life of the vehicle asset (assumed to be 20 years), with future costs discounted and expressed in present value terms based on an annual discount rate of seven per cent.[41]

Charts 4.10, 4.11 and 4.12 show the incremental ownership costs compared to ICE vehicles for BEVs, PHEVs and HEVs respectively. Along the y-axis, positive values imply higher ownership costs compared to ICE vehicles. Note these are financial costs and do not take into account the transfers (i.e. the cross subsidies) associated with an emission standard, nor the social welfare costs associated with these transfers.

For BEVs, the price premium is the key determinant of incremental ownership costs. BEVs are expected to result in a fuel cost saving of around $11,000, $15,000 and $22,500 for passenger, SUVs and LCVs respectively – larger cost savings reflect higher fuel consumption by ICE vehicles of that type. In addition to fuel cost savings, there are modest maintenance savings and negligible difference in insurance costs, while we assume all other costs (registration and tyres, etc.) are the same. When price premiums are greater than these savings, owning a BEV would be a net cost for households. The break-even threshold is higher for LCVs and SUVs due to the higher fuel consumption of these ICE vehicles.

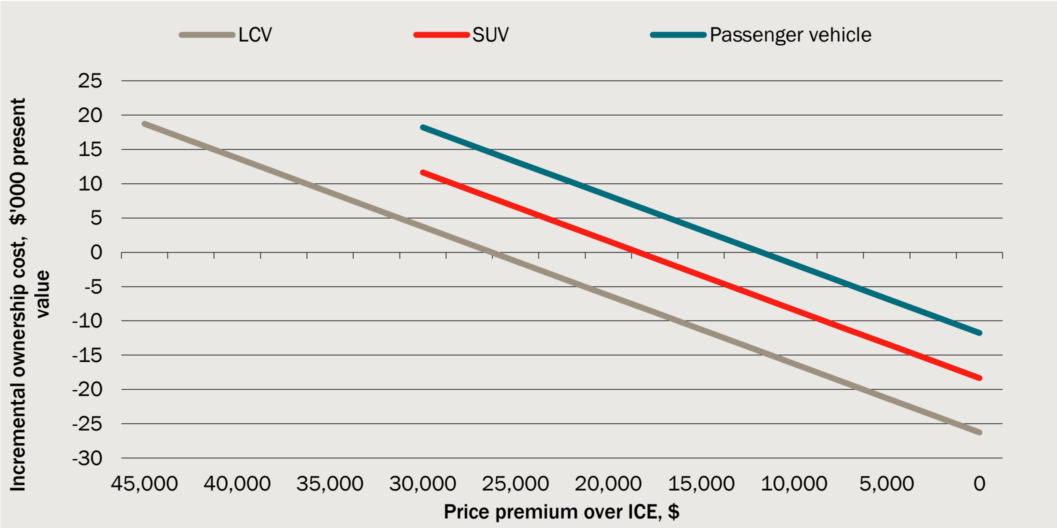
Based on the observed price premiums for BEVs, assuming a premium of around $25,0000 for passenger and SUVs and around $43,000 for LCVs (Table B.6), purchasing a BEV would result in higher costs to consumers. In present value terms over 20 years compared to an ICE vehicle, BEVs would cost:

- $14,000 more for passenger cars
- $9,600 more for SUVs
- $19,500 more for LCVs.

Note, as discussed above, using observed market prices for comparable vehicles on which these price premium estimates are based is likely to overstate the cost of purchasing a BEV. The actual price premium in the market is likely to be smaller and these results should be considered an upper bound estimate. Overtime as prices for BEVs approach those of ICE vehicles, BEV uptake will increase. This is likely to be one of the main drivers of BEV uptake in the central BAU projection scenario.

41 The data underlying these results are shown in Tables B.10, B.11 and B.12, in Appendix B.

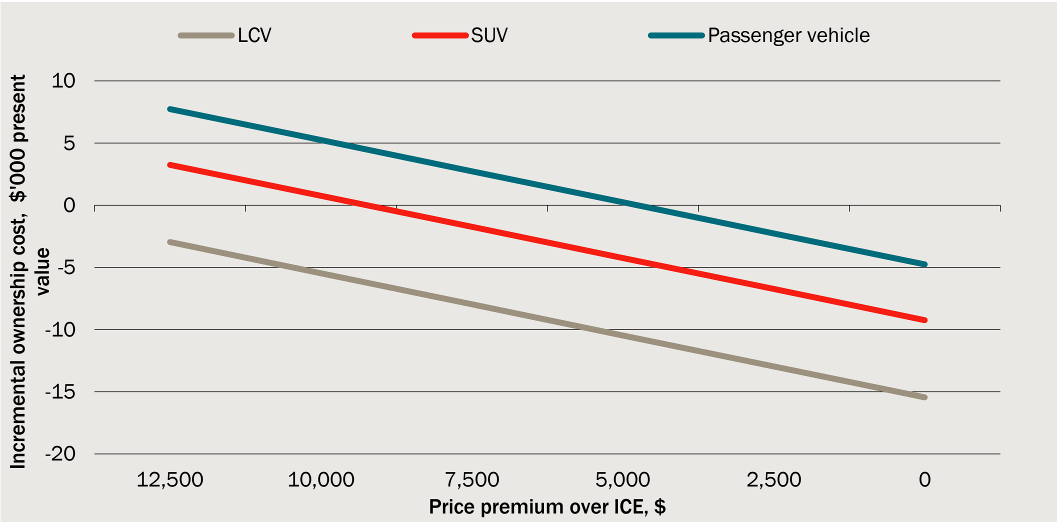
4.10 Incremental present value ownership costs – BEVs



Note: Ownership costs are incremental to the ownership costs of ICE vehicles.

Data source: CIE.

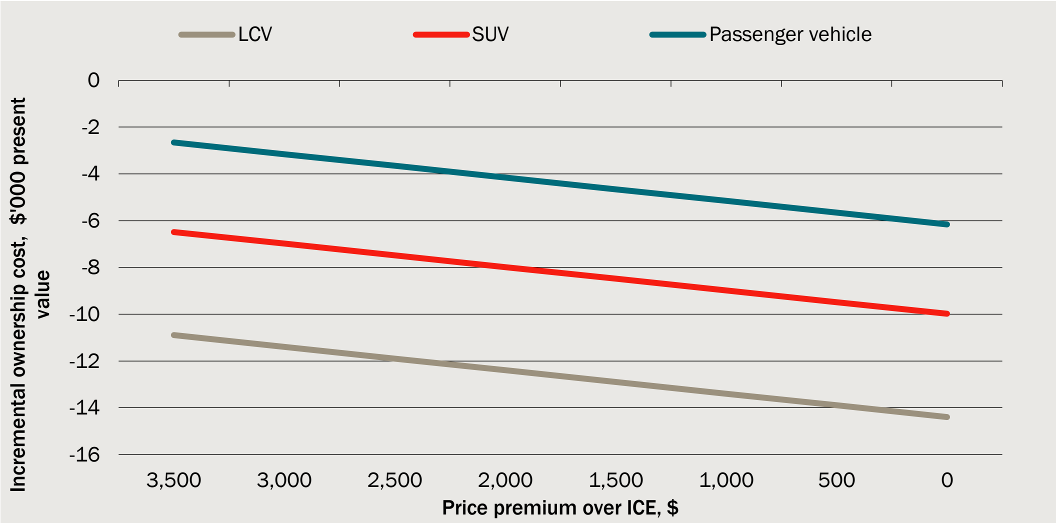
4.11 Incremental present value ownership costs – PHEVs



Note: Ownership costs are incremental to the ownership costs of ICE vehicles.

Data source: CIE.

4.12 Incremental present value ownership costs – HEVs



Note: Ownership costs are incremental to the ownership costs of ICE vehicles.

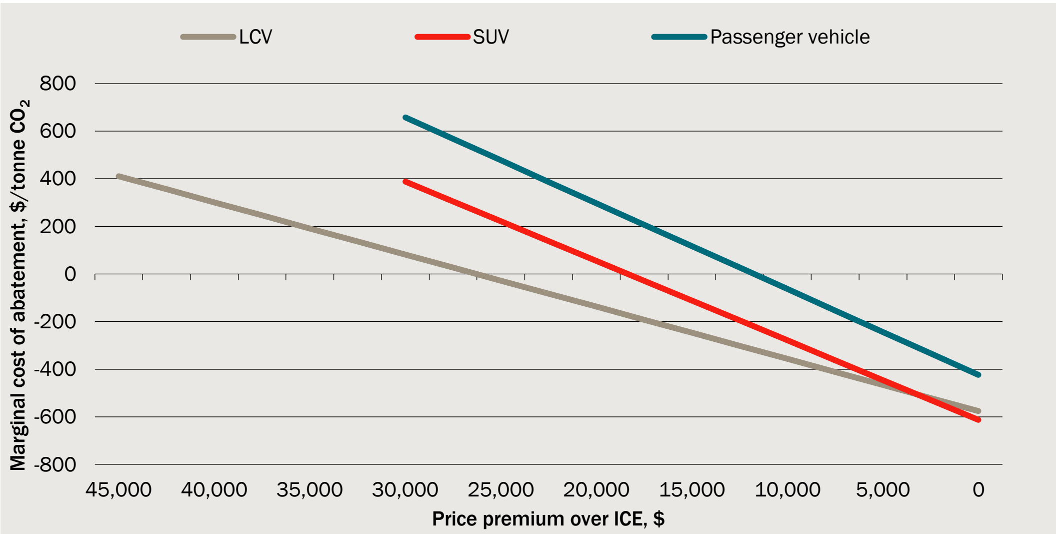
Data source: CIE.

The breakeven point for PHEVs is lower, reflecting the smaller fuel cost savings, which means for them to be cost neutral, prices need to be closer to those of ICE vehicles.

In contrast, HEVs have lower ownership costs than ICE vehicles due to the small price premium (around $3,500 based on current retail prices (Table B.6)) compared to the value of the fuel saving. This is likely to be one of the reasons why historically HEV uptake has been stronger than BEVs.

Using these cost differences and information on emissions we calculated the marginal financial abatement cost for a household seeking to manage their own CO_2 emissions. This is the cost of reducing one unit of emissions, which in this case is one tonne of CO_2 (Chart 4.13).

4.13 Marginal financial abatement costs – BEVs



Data source: CIE.

For passenger and SUV BEVs, at a price premium based on similar vehicle models (Table B.6), we found a marginal abatement cost of around $500 and $250 per tonne CO_2. For LCVs this is around $400 per tonne CO_2 (based on a BEV price premium of around $43,000). This is higher than the cost of carbon used by NSW Government economic assessments[42], and implies that currently there may be lower cost approaches to reduce emissions.

To have a marginal cost of abatement equal to the NSW Government cost of carbon ($123 per tonne CO_2 in 2023) would require BEV ownership costs (equivalent of upfront costs) to be:

- $10,500 lower for passenger vehicles
- $6,000 lower for SUVs
- $16,400 lower for LCVs.

For context, the present cost value of carbon from an ICE vehicle sold in 2023 is around $4,500 for passenger vehicles, $4,800 for SUVs and $9,700 for LCVs over 20 years (also based on projected distance travelled by each vehicle type).[43] However as noted before, this is likely to be an upper bound estimate. Some BEVs currently have smaller price premiums compared to ICE vehicles, and these price premiums are expected to continue to fall.

Marginal cost of abatement

Bringing together the possible range of social welfare costs and the change in the cost of ownership of BEVs, we can estimate the total marginal cost of abatement. This represents the total cost to society of using an emission standard (in this case we present the medium emission standard) to reduce emissions. Given uncertainties in measures of the cost of abatement we present results as a range. This reflects uncertainties around the extent to which:

- vehicle operating costs and potential cost savings from choosing a BEV over an ICE vehicle are internalised in decision making:
  - where cost savings are fully internalised in decision making, there is no cost saving from shifting a car purchase from an ICE vehicle to a BEV. In this case the marginal cost of abatement would not include the change in ownership costs from switching from an ICE vehicle to a BEV
- an emission standard is correcting existing distortions in the market for new cars:
  - if an emission standard moves the market equilibrium close to the socially optimum point, the DWL of an emission standard would be smaller than the estimate presented in this study.

42 NSW Treasury 2023, Technical note to NSW Government Guide to Cost-Benefit Analysis TPG23-08 Carbon value in cost-benefit analysis.

43 This corresponds to a cost of around $0.28 per litre of petrol.

Results are shown for passenger, SUV and LCV in Charts 4.14, 4.15 and 4.16 respectively. At high BEV price premiums over ICE vehicles, the range of the potential marginal cost abatement is very large:

- the upper bound reflects financial costs not being internalised in decision making and the full DWL
- the lower bound reflects financial costs being fully internalised in decision making, and there being no DWL.

Around the point where ownership costs are equal for BEVs and ICE vehicles, the range of the potential marginal costs of abatement narrows, as at this point only the DWL loss is relevant:

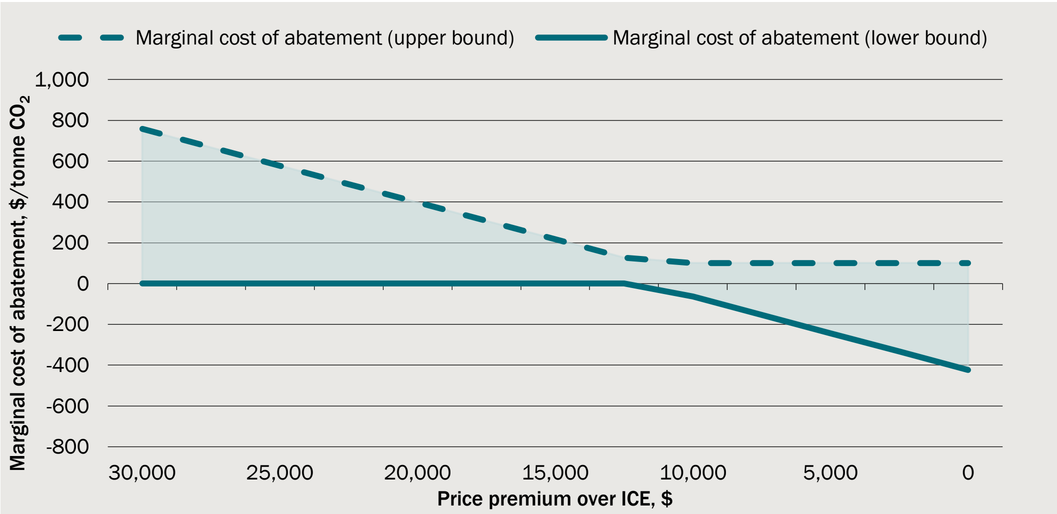
- the upper bound reflects the full DWL
- the lower bound reflects there being no DWL.

At lower BEV price premiums, the range of the potential marginal costs of abatement widens:

- the lower bound reflects financial costs not being internalised in decision making and there being no DWL
- the upper bound reflects financial costs being fully internalised in decision making and the full DWL.

It is unlikely that the marginal cost of abatement would be at either extreme; in practice we would expect it to be somewhere in the middle.

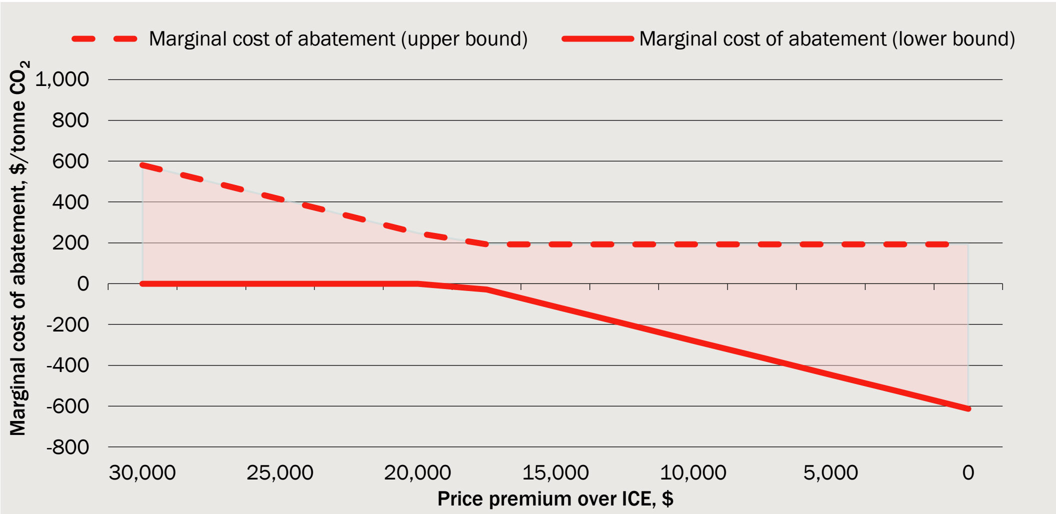
4.14 Marginal cost of abatement to society– passenger vehicle BEVs, present value



Note: The upper bound is based on the medium emission standard scenario.

Data source: CIE.

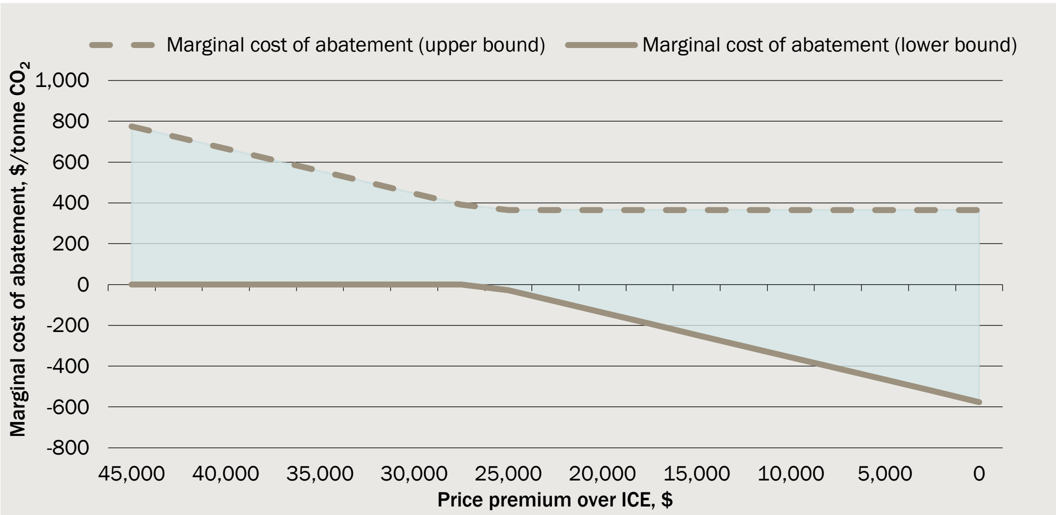
4.15 Marginal cost of abatement to society – SUV BEVs, present value



Note: The upper bound is based on the medium emission standard scenario.

Data source: CIE.

4.16 Marginal cost of abatement to society – LCV BEVs, present value



`*Note:* The upper bound is based on the medium emission standard scenario.

Data source: CIE.

The key implications of the results in these charts are:

- emission standards are likely to become less costly forms of abatement as BEV price premiums fall
- the marginal costs of abatement are likely largest for LCVs, then SUVs and then passenger vehicles. This reflects the higher DWL required to induce LCV consumers to switch from ICE vehicles to BEVs
- the range of the marginal cost of abatement includes some particularly high values, which are greater than recommended costs of carbon (the NSW Government recommends a cost of carbon of $123 per tonne CO_2 in 2023, in their economic appraisals). This implies that an emission standard may currently be a relatively expensive form of abatement:

– Note this is broadly consistent with findings from the Productivity Commission that finds high marginal costs of abatement for existing demand side polices.[44] For example:
  ⋯ marginal cost of abatement for the FBT exemption for EVs between $987 and $20,084 per tonne CO_2
  ⋯ marginal cost of abatement for the NSW $3,000 BEV subsidy and stamp duty exemption between $271 and $4,914 per tonne CO_2.

Emissions

A key outcome of emission standards is to reduce vehicle emissions, which in turn reduces fuel consumption. Vehicle emissions depend on:

- fuel efficiency – which is assumed to remain constant
- vehicle efficiency – which is directly impacted by the emission standard
- driving efficiency – which is assumed to remain constant. This can be interpreted as to why real-world emissions may differ from new vehicle emissions based on controlled tests
- distance travelled – which is assumed to remain constant.

Using data for fuel efficiency, driving efficiency and distance travelled we estimated how tailpipe emissions are expected to change under different emission standard scenarios. In addition to tailpipe emissions, we also estimated emissions from electric generation related to BEVs and PHEVs. Note emission standards are based on controlled test cycles. These test cycles may not reflect actual driving behaviour which determines actual emissions outcomes. In contrast, emission results here are based on emissions reflecting actual driving behaviour. We accounted for this difference by adjusting emission data based on test cycles for real-world emissions:

- emissions based on test cycles in taken from NTC light vehicle emissions reporting
- actual emissions are based on DCCEEW [45] analysis to estimate real-world emissions.

This data, and associated adjustment is outlined in Box 4.17. Information on other key assumptions is provided in Appendix B.

44 Productivity Commission 2023, Updated Submission to National Electric Vehicle Strategy Consultation, Canberra.

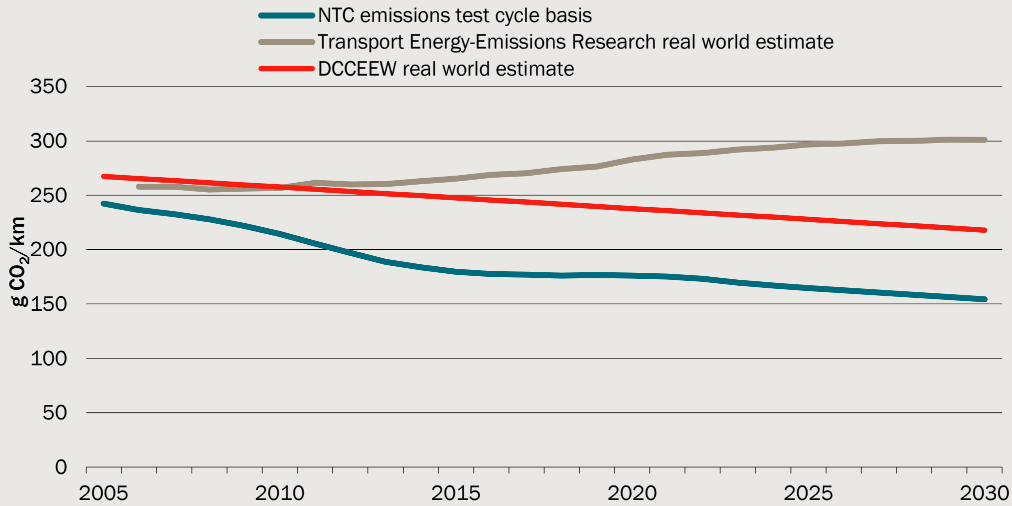
45 Department of Climate Change, Energy and Environment and Water 2023, Australia's emissions projections 2022, p, 38.

4.17 Adjusting test cycle emissions for real world conditions

NTC new vehicle emissions data is collected on a New European Driving Cycle (NEDC) test cycle basis. However, real-world emissions intensity is on average higher than test cycle intensities, but the magnitude of this difference is uncertain.

To resolve this uncertainty the DCCEEW engaged a consultant (Transport Energy-Emissions Research (TER)) to estimate historic and future emission intensities of vehicles (Chart 4.18). As this was higher than initially thought by the DCCEEW it developed their own estimates based on forecasts from TER alongside other data sources. Both TER and DCCEEW estimates are significantly higher than emissions based on test cycles.

4.18 Historical and projected CO_2 emissions intensity for new petrol passenger vehicles



Data source: CIE and Department of Climate Change, Energy and Environment and Water 2023, Australia's emissions projections 2022, p, 38.

To account for this in our analysis we scaled up NTC emission data using petrol emissions across all vehicles (passenger, SUV and LCV). We assumed that emissions for all powertrains and fuel types increase in proportion with petrol vehicles going from test cycle data to real-world outcomes.

Total emissions by scenario are shown in Table 4.19. Emissions fall with emission standard scenarios, and the reductions are larger with lower or a stricter emission standard. Note that these estimates do not include upstream emissions related to the manufacture of vehicles, which may differ between powertrains. The expected reductions are relatively modest to 2030 given the overall fleet turns over slowly (with asset lives of around 20 years). However, this also means that the benefits of a lower emission standard are persistent overtime (i.e. emission reductions compared to BAU are experienced over 20 years (Chart 4.20)).

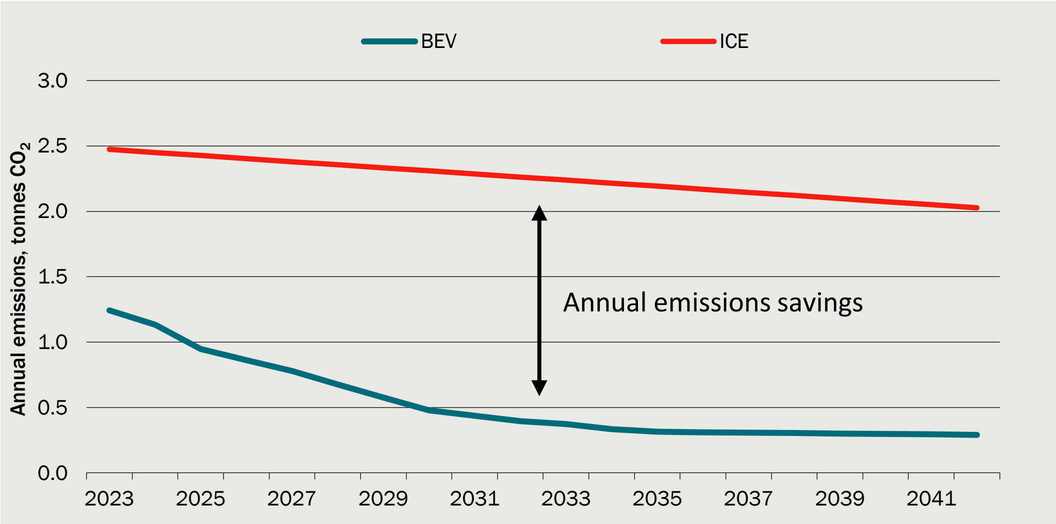
The monetary value of emissions savings is shown in Table 4.21 for the medium emission standard scenario using different estimates of the social cost of carbon (SCC). Emission savings increase overtime to between $40 million and $210 million per year in 2030, depending on the social cost of carbon used.

4.19 Total CO_2 emissions by emission standard scenario, millions of tonnes

	Source of emissions	2024	2025	2026	2027	2028	2029	2030
		MT CO_2	MT CO_2	MT CO_2	MT CO_2	MT CO_2	MT CO_2	MT CO_2
BAU	Tailpipe	69.2	69.6	69.9	70.1	70.2	70.2	70.0
	Electricity generation	0.2	0.3	0.4	0.5	0.6	0.7	0.7
	Total	69.4	69.9	70.3	70.6	70.8	70.8	70.8
Medium	Tailpipe	69.0	69.2	69.3	69.2	69.0	68.7	68.3
	Electricity generation	0.3	0.4	0.6	0.7	0.9	0.9	1.0
	Total	69.3	69.6	69.9	69.9	69.9	69.6	69.3
High	Tailpipe	69.0	69.3	69.5	69.6	69.5	69.3	69.1
	Electricity generation	0.3	0.4	0.5	0.7	0.8	0.8	0.9
	Total	69.3	69.7	70.0	70.2	70.2	70.1	69.9
Low	Tailpipe	68.9	69.1	69.0	68.8	68.5	68.1	67.5
	Electricity generation	0.3	0.5	0.7	0.8	1.0	1.1	1.1
	Total	69.2	69.5	69.7	69.7	69.5	69.1	68.6
	Difference from BAU							
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Medium	Tailpipe	0%	-1%	-1%	-1%	-2%	-2%	-2%
	Electricity generation	26%	38%	44%	42%	40%	39%	38%
	Total	0%	0%	-1%	-1%	-1%	-2%	-2%
High	Tailpipe	0%	0%	-1%	-1%	-1%	-1%	-1%
	Electricity generation	19%	26%	29%	26%	24%	22%	21%
	Total	0%	0%	0%	-1%	-1%	-1%	-1%
Low	Tailpipe	0%	-1%	-1%	-2%	-2%	-3%	-4%
	Electricity generation	33%	52%	61%	60%	58%	57%	56%
	Total	0%	-1%	-1%	-1%	-2%	-2%	-3%

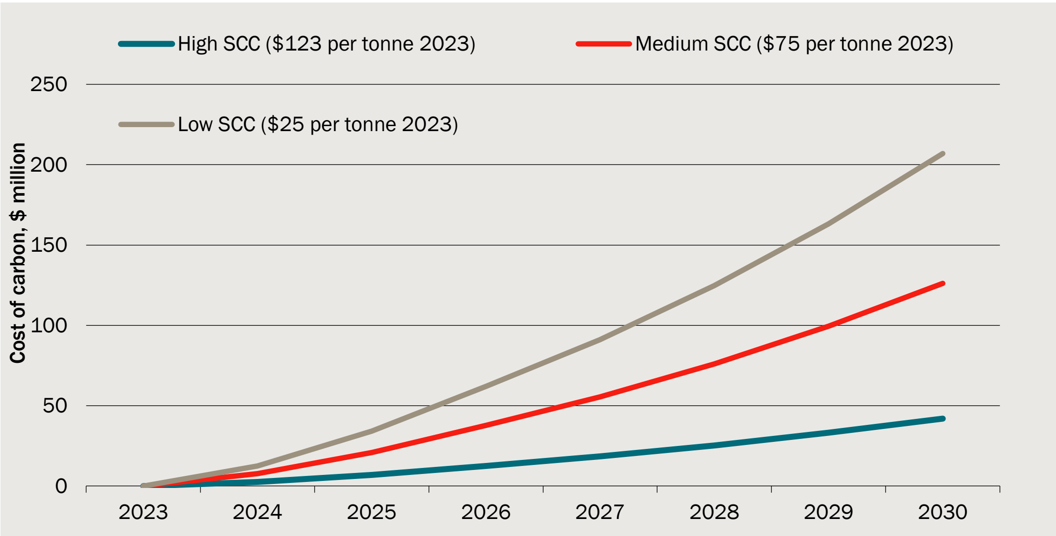
Source: CIE.

4.20 Emissions savings from BEV compared to ICE purchased in 2023 by year



Data source: CIE.

4.21 Medium scenario value of avoided CO_2 emissions (social cost of carbon values [SCC])



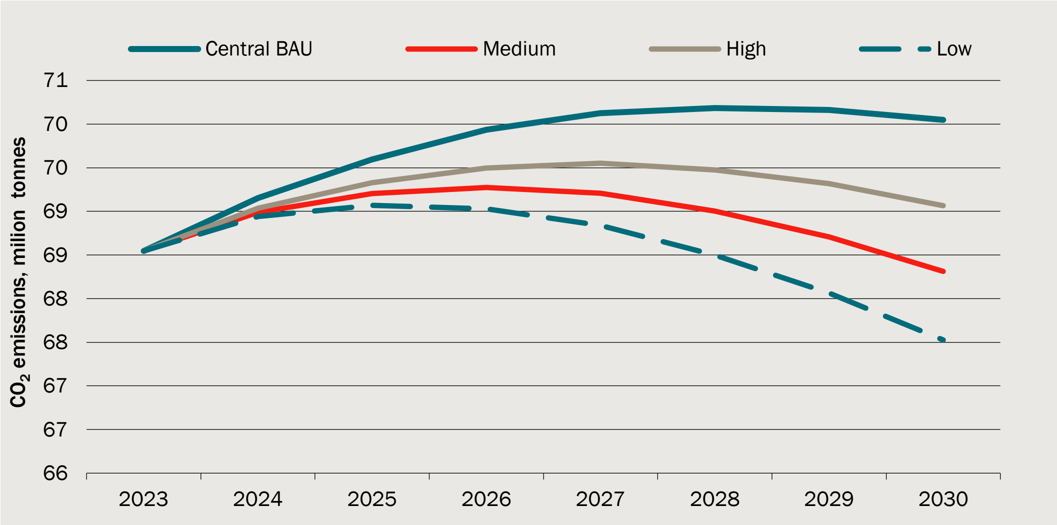
Data source: CIE.

The emissions scenarios see tailpipe emissions being substituted for electricity generation emissions (Charts 4.22 and 4.23). Electricity emissions continue to increase, in line with increased uptake of BEVs and PHEVs; however, emissions per electric vehicle are expected to fall overtime as the emissions intensity of the grid declines (Chart 4.24).[46]

46 We have used the emissions intensity of the grid to measure emissions associated with electricity used for charging vehicles. Even though some BEV owners will use electricity generated by their household solar panels and batteries, we have taken this approach as using one kWh of household solar PV energy to charge a BEV means one less kWh is available for other uses. We conservatively assume this would then be generated at the grid's average emission intensity (noting the marginal intensity would give a more accurate estimate).

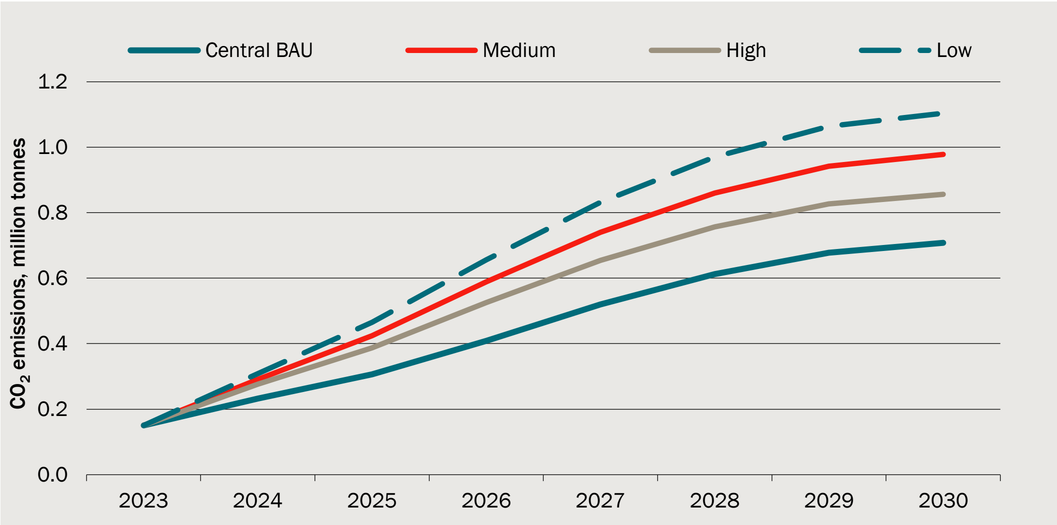
This reduction in emissions intensity of the grid will be an important driver of reductions in total emissions for BEV and PHEV compared to the other powertrains (Table 4.25).

4.22 Emissions from fuel consumption by year



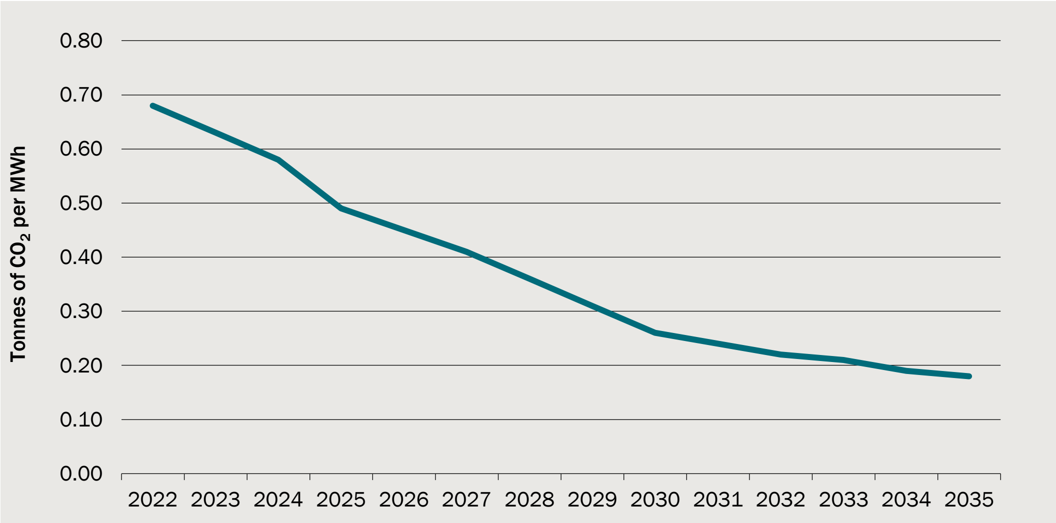
Data source: CIE.

4.23 Emissions from electricity generation due to BEV and PHEV by year



Data source: CIE.

4.24 Scope 2 emissions factors for Australia's electricity grid by year



Data source: Department of Climate Change, Energy and Environment and Water 2023, Australia's emissions projections 2022, p, 38.
Note: Scope 2 refers to indirect emissions associated with electricity use.

4.25 Emissions per g CO_2/km, including tailpipe and electricity generation – car purchased in 2023

Year	2023	2024	2025	2026	2027	2028	2029	2030
Powertrain	g CO_2/km	g CO_2/km	g CO_2/km	g CO_2/km	g CO_2/km	g CO_2/km	g CO_2/km	g CO_2/km
BEV	103	95	80	74	67	59	51	43
PHEV	140	134	122	116	110	104	97	90
Hybrid	127	128	128	127	126	126	125	124
Mild hybrid	174	175	174	174	173	172	171	170
Petrol	205	205	205	205	203	202	201	200
Diesel	262	263	263	262	260	259	258	256

Source: CIE.

Fuel consumption and fuel excise

Fuel consumption is directly linked to vehicle emissions (see Table B.5 for the relationship between emissions and fuel consumption), such that the pattern of fuel consumption is the same as emissions (Table 4.26). Like emissions, the fall in fuel consumption is relatively modest across emission standard scenarios, due to the 20-year asset life of vehicles, although the fall is persistent.

4.26 Total fuel consumption by emission standard scenario

Year	2024	2025	2026	2027	2028	2029	2030
	Mega litres	Mega litres	Mega litres	Mega litres	Mega litres	Mega litres	Mega litres
BAU	28,559	28,706	28,806	28,845	28,826	28,773	28,682
Medium	28,492	28,546	28,537	28,473	28,349	28,187	27,983
High	28,510	28,596	28,629	28,612	28,541	28,434	28,288
Low	28,471	28,490	28,438	28,323	28,145	27,926	27,665
Difference from BAU							
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Medium	-0.2%	-0.6%	-0.9%	-1.3%	-1.7%	-2.0%	-2.4%
High	-0.2%	-0.4%	-0.6%	-0.8%	-1.0%	-1.2%	-1.4%
Low	-0.3%	-0.8%	-1.3%	-1.8%	-2.4%	-2.9%	-3.5%

Source: CIE.

Although fuel consumption is expected to fall, fuel excise revenue is expected to increase, due to its indexation (Table 4.27 and Chart 4.28). Compared to BAU, an emission standard will result in lower fuel excise revenue across scenarios. By 2030, under the medium emission standard scenario, fuel excise is expected to be 2.4 per cent lower than under BAU. Lower fuel excise revenue will need to be accompanied by:

- spending reductions by government, resulting in lower investment in land transport infrastructure or reduced spending elsewhere
- increasing other taxes. For example, the lost fuel excise under the medium emission standard could be recovered with:[47]
  - a road user charge of $0.001 per km travelled levied on all vehicles
  - a road user charge of $0.018 per km travelled levied on BEVs only, noting
    - in addition to making up a funding shortfall, road user charging may also help offset the external impacts of car use, including congestion and environmental impacts.

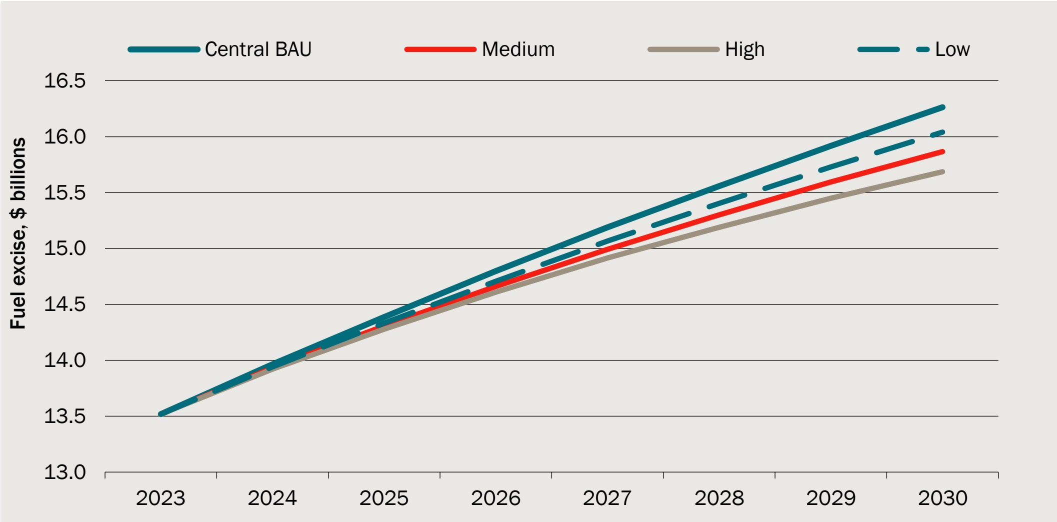
47 Note this is the road user charge to make up for lost revenue from increased uptake of low emission vehicles due to an emission standard (i.e. the deviation from BAU). It does not make up for revenue lost due to BAU low emission vehicle uptake. Making up lost revenue under BAU would require a higher road user charge.

4.27 Fuel excise revenue by scenario

Year	2024	2025	2026	2027	2028	2029	2030
	$ million	$ million	$ million	$ million	$ million	$ million	$ million
BAU	13,964	14,387	14,798	15,188	15,558	15,917	16,264
Medium	13,931	14,307	14,660	14,992	15,300	15,593	15,867
High	13,940	14,332	14,707	15,066	15,404	15,730	16,040
Low	13,921	14,279	14,609	14,913	15,190	15,449	15,687
Difference from BAU							
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Medium	-0.2%	-0.6%	-0.9%	-1.3%	-1.7%	-2.0%	-2.4%
High	-0.2%	-0.4%	-0.6%	-0.8%	-1.0%	-1.2%	-1.4%
Low	-0.3%	-0.8%	-1.3%	-1.8%	-2.4%	-2.9%	-3.5%
Annual revenue gap from BAU							
	$ million	$ million	$ million	$ million	$ million	$ million	$ million
Medium	-33	-80	-138	-196	-257	-324	-397
High	-24	-55	-91	-122	-154	-187	-224
Low	-43	-108	-189	-275	-368	-468	-577

Source: CIE.

4.28 Fuel excise revenue by scenario



Data source: CIE.

Car markets

Where prices of new vehicles increase, instead of switching from a new petrol car to a new BEVs, consumers may choose to:

- purchase the ICE car they would have purchased in the absence of an emission standard and incur the additional cost
- switch to a lower emission car

- not purchase a vehicle and retain their exiting vehicle
- purchase a used vehicle.

In this section we examine how emission standards may play out in car markets and their implications.

Impacts on new car markets

Emission standards are expected to result in higher new car prices due to (Table 4.29):

- an implicit tax on higher emission vehicles
- pushing consumers to purchase lower emission vehicles, which are more expensive than higher emission vehicles (ICE vehicles).

4.29 Weighted average vehicle prices across emission standard scenarios - 2025

Emission standard scenario	BAU	Central	High	Low	1 percent increase in BEV
	$'000	$'000	$'000	$'000	$'000
Passenger	38.8	40.6	40.0	41.3	39.0
SUV	51.3	53.1	52.4	53.9	51.5
LCV	50.9	55.2	53.8	56.6	51.3
		Per cent increase from BAU	Per cent increase from BAU	Per cent increase from BAU	Per cent increase from BAU
Passenger		4.6%	3.0%	6.4%	0.7%
SUV		3.7%	2.3%	5.2%	0.5%
LCV		8.4%	5.7%	11.4%	0.9%

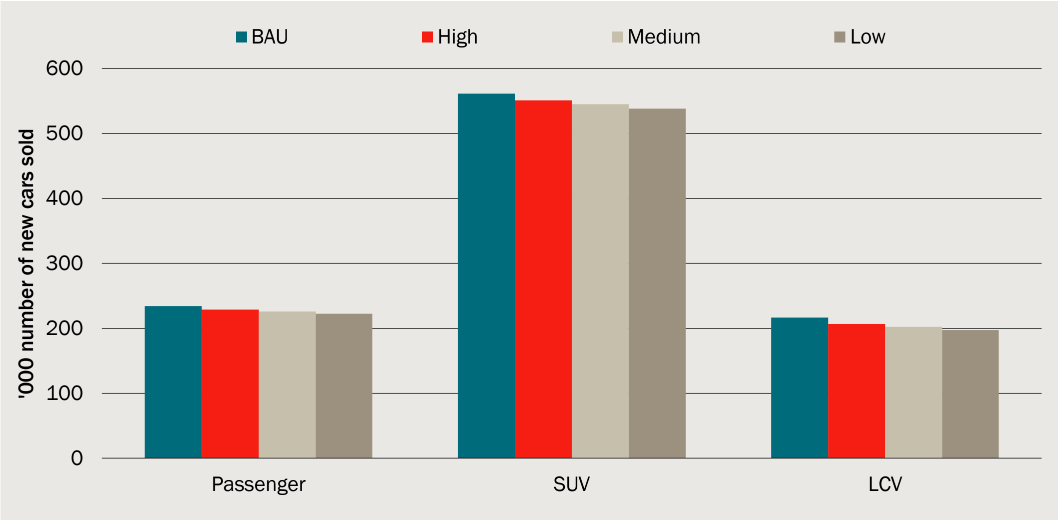
Source: CIE.

Price changes across scenarios can be used to understand the impact on new car sales. We used a price elasticity of -0.79 per cent, based on an average across a range of studies.[48] This implies that a 1 per cent increase in price results in a 0.79 per cent reduction in demand.

Vehicle sales with price impacts are shown in Charts 4.30 and 4.31. For the medium scenario, the price increases resulted in a 4, 3 and 7 per cent reduction in demand in 2025 for passenger, SUV and LCVs respectively. In 2030, demand would be 17 per cent lower for passenger vehicles, 13 per cent lower for SUVs and 15 per cent lower for LCVs. This implies that revenues would increase for car brands by around 0.8 per cent in 2025 and 8.4 per cent in 2030 for the medium emission standard scenario.

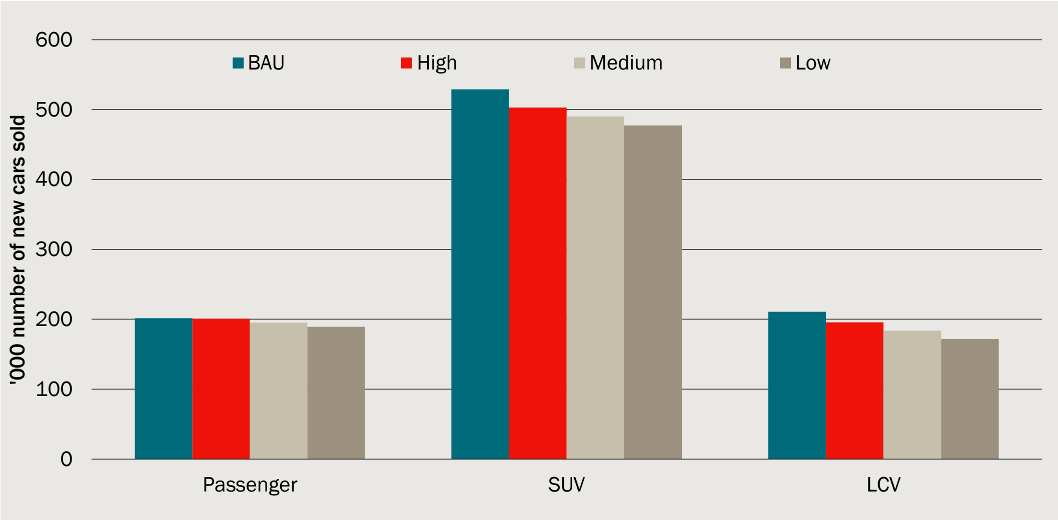
48 Jacobsen, M., R. Beach, C. Cowell, AND J. Fletcher. The Effects of New-Vehicle Price Changes on New- and Used-Vehicle Markets and Scrappage. U.S. Environmental Protection Agency, Washington, DC. Available here: https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=352754&Lab=OTAQ

4.30 2025 new car sales allowing price impacts by emission standard scenarios



Data source: CIE.

4.31 2030 new car sales allowing price impacts by emission standard scenarios

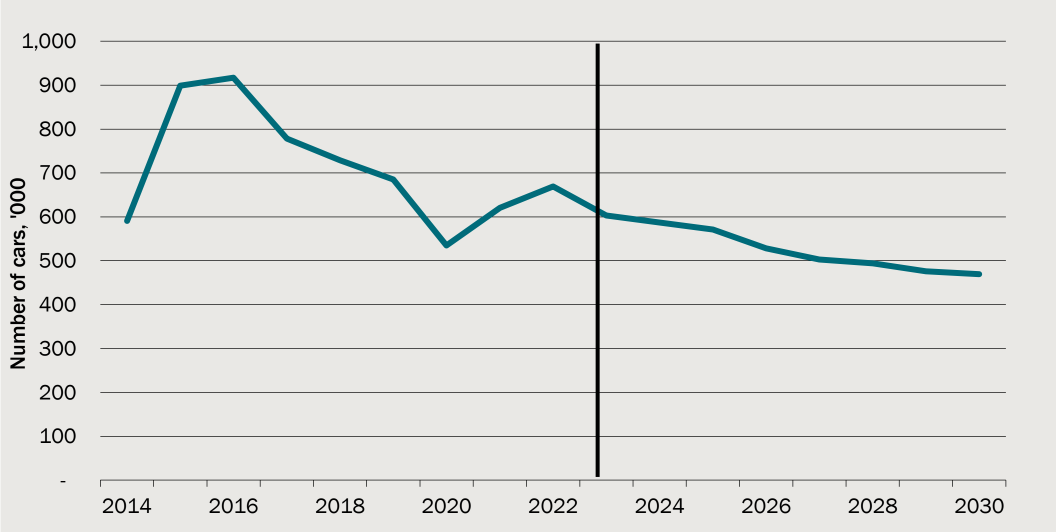


Data source: CIE.

Reduced demand for new cars is likely to result the asset lives of some vehicles being extended, increasing the average asset life of the fleet. For example:

- In 2025 we estimated that around 600,000 vehicles will be retired from the fleet (Chart 4.32), such that the medium scenario will see around 7 per cent fewer cars retired in that year (around 39,000 fewer new car sales). This will have a negligible impact on fleet age.
- In 2030 we estimate that around 470,000 vehicles will be retired from the fleet (Chart 4.32), such that the medium scenario will see around 34 per cent fewer cars retired in that year (around 162,000 fewer new car sales). Assuming a 20-year asset life, this would increase fleet age by around 0.14 years. An older fleet will generally result in higher emissions, offsetting the benefits of an emission standard by a small amount, in addition to poorer road safety outcomes.

4.32 Number of vehicles retired from fleet, BAU emission standard scenario



Note: This is calculated for year n as $sales_n - (stock_n - stock_{n-1})$.
Data source: CIE.

Flow-on impacts on fleet age and road safety

An older fleet may result in poorer road safety outcomes as older cars tend to offer less occupant protection than newer cars. As new car sales decrease, the rate at which new safety technology is adopted decreases. This means crashes may occur more frequently and potentially have more severe consequences. Conversely, bringing newer, safer vehicles into the light duty vehicle fleet, and replacing older, less safe vehicles can bring about significant road safety benefits to Australian.[49]

A one-year reduction in the average age of Australia's light vehicle fleet will bring about significant road safety and environment benefits.[50] If the average age of the fleet was reduced by one year every four years over a period of 2014 to 2034, there would be 5.4 per cent reduction in crashes. This would imply 1,377 fewer road deaths, 44,457 fewer hospitalised injuries and fewer 262,995 non-hospitalised injuries, and a corresponding savings accrued from the road trauma of A$19 billion (in 2015 dollars) for this 20-year period.

Used car markets

Used car markets are directly related to the new car market – an emission standard for new car sales in likely to impact on the used car market. Such impacts include:

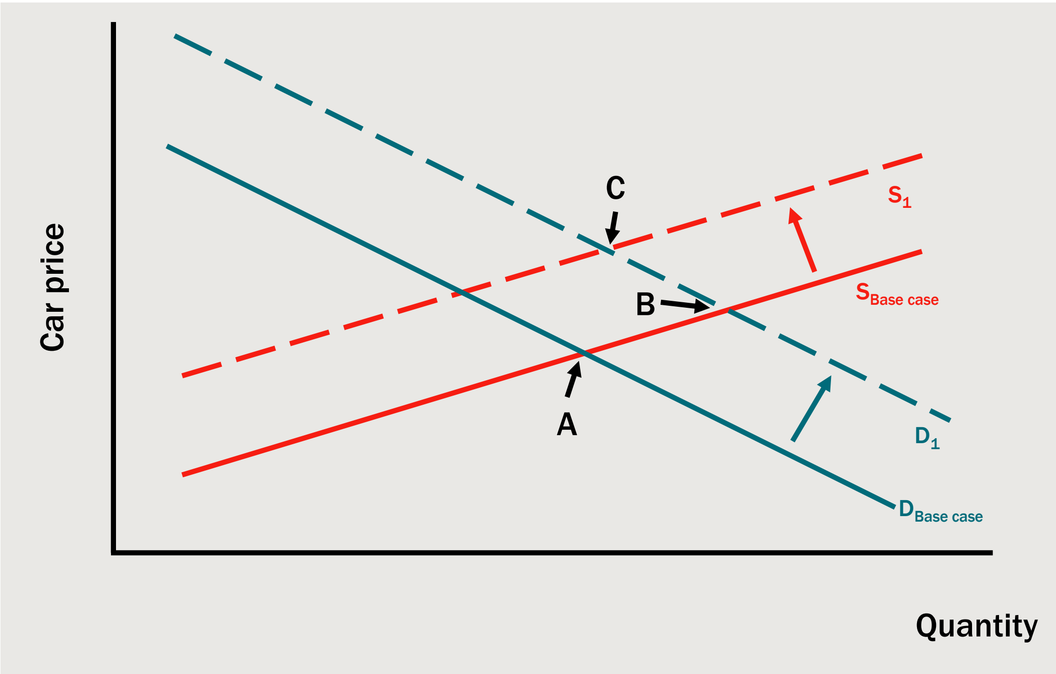
- Higher uptake of low emission vehicles is likely to overtime result in increased supply of these vehicles in used market. This will benefit consumers in used car markets by increasing vehicle choice.

49 Economic Connections, *Benefits of reducing the age of Australia's light vehicle fleet - Summary Report*, Australian Automobile Association, March 2018, p. 8.

50 Ibid. p.7.

- Prices in used car markets are likely to increase due to an emission standard. The chain of effects at market level is illustrated in a simplified supply and demand illustration for new and used cars (Chart 4.33):
  - prior to introduction of an emission standard, the used car market starts at point A
  - the increases in prices in new car markets is expected to result in an increase in demand for used cars (as consumers substitute from new to used cars), seeing demand shift to D_1 and the equilibrium move to point B
    - The amount of new- and used-car demand curves shift is determined by the elasticity of substitution between new and used cars
  - overtime another response to higher new car prices may be consumers holding onto their cars for longer, reducing supply to the used car market. This reduced turnover may result in an upward shift in the supply curve to S_1 and the market reaching a new equilibrium at point C
  - at point C, prices will be higher, with the overall impact on turnover (the number of used car sales) uncertain.

4.33 Emission standard impacts on used car markets



Note: Solid lines represent initial supply or demand. Dashed lines represent new supply or demand.
Data source: CIE.

Sensitivity testing

Alternate BAU

While the above results report impacts relative to the most likely BAU for an emission standard, there is considerable uncertainty around the composition of future car sales.

We re-estimated results using an alternative low EV uptake BAU. This scenario takes a slightly more pessimistic view of BEV uptake meaning the proposed scenarios need to have a larger impact on consumer vehicle choice.

The alternative BAU results in a larger DWL across emission scenarios (Table 4.34). This is because it requires a larger increase in BEV uptake compared to the central BAU – in 2030 BEV uptake in the low uptake BAU is around 5 percentage points lower than the central BAU.

4.34 Total dead weight loss 2025 – low EV uptake BAU by emission standard scenarios

Emission standard scenario		Medium	High	Low
Vehicle type	Powertrain	$ million	$ million	$ million
Passenger	ICE	35	17	62
	BEV	82	46	128
SUV	ICE	134	58	262
	BEV	358	182	592
LCV	ICE	44	15	98
	BEV	329	168	548
Total		**982**	**486**	**1,689**
Per cent change from central BAU				
Passenger	ICE	55%	81%	41%
	BEV	50%	76%	37%
SUV	ICE	58%	84%	45%
	BEV	46%	72%	34%
LCV	ICE	8%	9%	7%
	BEV	5%	6%	4%
Total		**29%**	**41%**	**23%**

Source: CIE.

Across other outcomes the impacts will be in the same direction. Compared to results under the central BAU, the low BEV uptake BAU will see emission scenarios:

- change consumer behaviour by more, resulting in a larger DWL
- result in a larger reduction in emissions, fuel consumption and excise
- increase new and used car prices.

Path of vehicle characteristic improvements

To estimate the welfare impacts of an emission standard in the future requires assumptions to be made around how vehicle characteristics are expected to improve. When the gap between characteristics of ICE and BEVs is smaller, particularly in relation to price, consumers will more readily switch between vehicle types, as the opportunity cost of switching is smaller.

The impact of this is difficult to measure in our model as any improvements in BEV characteristics is likely to flow through to higher uptake of low emission vehicles in the BAU.[51] Uptake of BEVs in the BAU is based on the expected path of technological development, such that moving off that path would result in an alternative BAU. However, we can make the general observations for a fixed emission standard target:

- faster technological improvement for low emission vehicles will make the target easier to reach, as the gap between BAU and the target will be smaller
- slower technological improvement for low emission vehicles will make the target more difficult to reach, as the gap between BAU and the target will be larger.

Moving consumers across vehicle categories

In the analysis we assumed that consumers do not substitute across vehicle types, but only substitute across powertrains. In practice this is unlikely to be the case. For example, a consumer may compare SUVs to LCVs when making their purchasing decision. Insofar as the emissions of those vehicles are different (and therefore attract a different subsidy or tax under an emission standard), an emission standard could influence the choice of vehicle type.

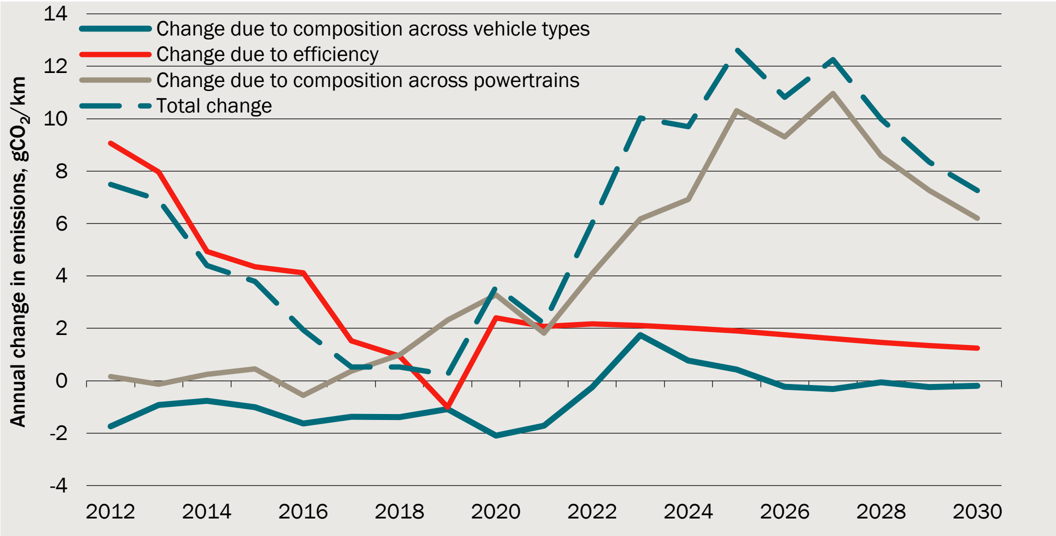
Allowing switching between vehicle categories may reduce the welfare costs of emission standards because:

- ICE vehicles across vehicle types have different emissions, with passenger vehicles lower than SUVs, and SUVs lower than LCV
- the costs of changing powertrain types (i.e. from ICE to BEV) is different across vehicle types with the social welfare costs for passenger vehicles lower than SUVs, and SUVs lower than LCV.

Historically the trend away from passenger vehicles towards SUVs and LCVs has increased emissions (Chart 4.35). Into the future this is expected have a neutral impact under BAU as market share across vehicle types is expected to stabilise (Chart 4.36).

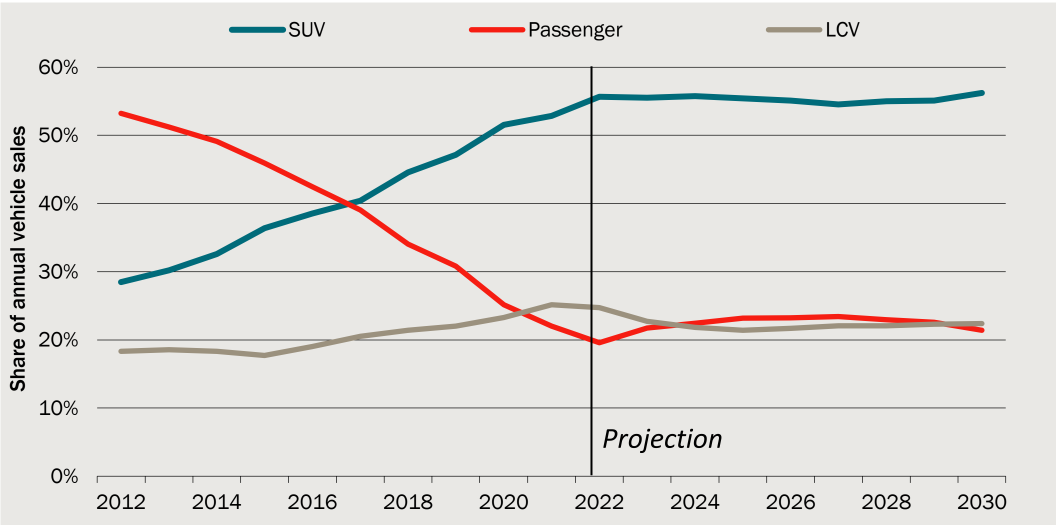
51 Abstracting from these complications, assuming price parity for BEVs by 2025 results in a 16 per cent reduction in DWL for the medium emission standard scenario. This impact is relatively modest as changes are measured relative to the BAU.

4.35 Decomposed change in new vehicle annual average emissions, historical and BAU



Data source: CIE based on NTC and FCAI data.

4.36 Share of vehicle sales by type, historical and BAU



Data source: CIE based on FCAI data.

We calculated the impact of moving new car sales from one vehicle type to another (Table 4.37, assuming BAU powertrain shares by vehicle type). A 10 percentage point reduction in LCV sales and corresponding increase in passenger sales results in a 7 and 10 per cent reduction in emissions in 2025 and 2030 respectively. This would go a long way to achieving the emission standard under the medium scenario. More importantly, this would reduce the cost of further lowering emissions, by changing powertrains, as passenger vehicles have a lower welfare cost per customer switching from an ICE vehicle to a BEV.

However, it is important to note that future emission reductions in the BAU will be driven by changes in powertrains, which will be necessary to achieve more ambitious emission targets.

4.37 Impact of 10 percentage change in market share

	Change in emissions 2025	Change compared to BAU 2025	Change in emissions 2030	Change compared to BAU 2030
	g CO_2/km	Per cent	g CO_2/km	Per cent
BAU	140		96	
Passenger to SUV	141	1%	98	2%
Passenger to LCV	149	7%	107	11%
SUV to passenger	138	-1%	96	0%
SUV to LCV	148	6%	104	8%
LCV to passenger	130	-7%	87	-10%
LCV to SUV	132	-6%	86	-11%

Source: CIE.

Alternative assumptions around future trends in emissions

In the analysis we assume that emission intensity falls overtime for all vehicles with an engine due to continued efficiency improvements in ICE engines. However, this rate of progression is somewhat uncertain.

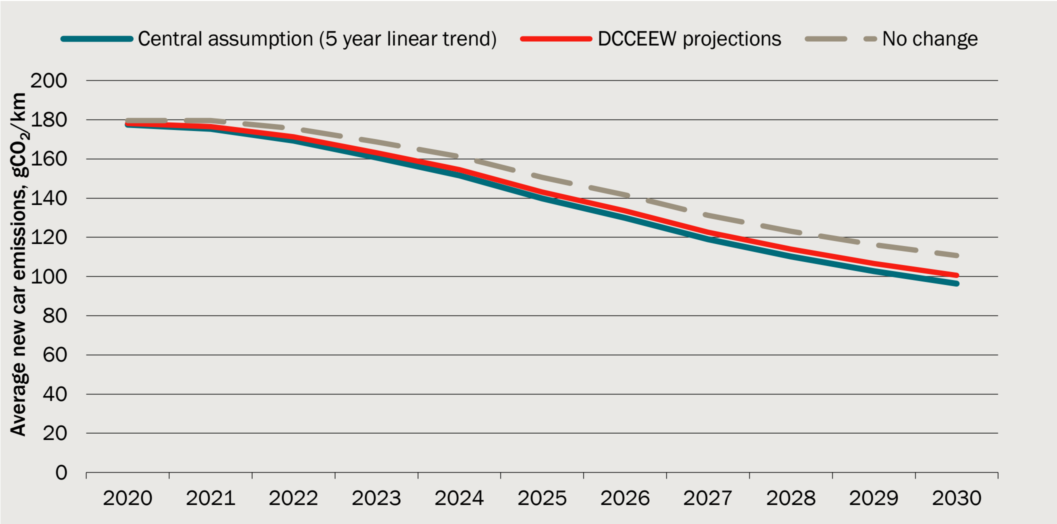
We developed three assumptions:

- five-year linear trend (2015-2019) for each vehicle type (central assumption)
- DCCEEW petrol vehicle emission projections[52]
- emissions remain constant.

BAU emissions using the three alternative assumptions is shown in Chart 4.38. There are only small differences across assumptions – between the central and no change assumption there is a 14 gCO_2/km difference in emissions with the central assumption emissions around 13 per cent lower. All assumptions are expected to follow a similar trajectory as emissions for new vehicles overtime are expected to be primarily driven by the uptake of BEVs and hybrid vehicles (Chart 4.35). The assumption around future trends in emissions will therefore have a negligible impact on the results of the analysis.

52 Department of Climate Change, Energy and Environment and Water 2022, Australia's emission projections 2022, figure 15, p. 38.

4.38 Emissions under alternative future trends in emissions



Data source: CIE.

5 Next steps for emission standards

Some general findings

Motorists will purchase low emissions vehicles (LEVs) to the extent that they balance their personal preferences with the higher capital cost of LEVs and their lower operating costs (particularly fuel costs) than ICE vehicles. A steady preference for LEVs as seen in the central BAU scenario presented here (which is in turn based on industry expectations) indicates that even without an emission standard, the purchase of new LEVs will become prominent in new vehicle purchases.

An emission standard encourages additional purchases of LEVs beyond BAU through a complex implicit system of taxes and subsidies. While imposed on vehicle brands, the costs associated with complying with an emission standard are inevitably borne, and paid for, by vehicle users. Where the emission standard seeks to shift purchase patterns well beyond BAU, the implicit costs imposed can become large, with the implication that the implicit cost of abatement under an emission standard may become very high, potentially much higher than abatement costs elsewhere in the economy.

A second important feature of emission standards is that they only operate on one margin of emissions reductions when it comes to motor vehicles: the choice of a new vehicle to purchase. Emission standards have no effect on the existing stock of vehicles which in the Australian context are often long lived. Thus, an emission standard while changing the profile of new vehicles, has a diluted effect on total vehicle emissions.

In many countries, emission standards are implemented with systems of credits or super credits which are offered to particular types of vehicles. These arrangements, while seeking to recognise that there are transitional costs of emission standards, has the effect of substantially reducing the transparency of the emission standard and its implementation. In effect, it hides away the actual emissions reduction to be achieved. Rather than using credits or super credits as a transitional measure, it would be better to appropriately calibrate the entire emission standard system to recognise this.

Implications for policy design

The general findings outlined above have several implications for the design of an emission standard scheme.

Flexibility

- Avoid picking technology winners. Any emission standard scheme design should be as technology agnostic as possible and focus on genuine emissions reductions.

- Ensure that policies are adaptable to unexpected outcomes. Emissions projections are inherently uncertain, e.g. the:
  – number of vehicle sales is not known with certainty, and may be affected by overseas policies
  – share of different vehicles (BEV versus ICE for example) may evolve in unpredictable ways.

Transparency

- Any emission standard targets should be transparent so there is a clear understanding of the expected emission reductions the targets will deliver. The rationale for adjustments in an emission standard, namely super credits for low and zero emission vehicles, is not clear.
- Emission standards should take care when seeking to move adoption a long way from BAU as this is likely to result in high marginal emission abatement costs.

Policy diversity

- Continue to develop policies to support the reduction of emissions from the stock of vehicle fleet. Emission standards only impact new vehicles and will have a limited impact on emissions from the stock of vehicles.
- Emission targets need to be supported by complementary investment to make LEVs as attractive as possible. For example, for BEVs this includes ensuring there is enough charging infrastructure to support adoption of the technology.

Understanding impacts on a variety of road users/populations

An emission standard should be subject to a Policy Impact Analysis (previously a Regulatory Impact Analysis), including a full cost benefit analysis.[53] This should include a detailed consideration of the distributional impacts of any emission standard, including:

- Analysis of an emission standard should consider the impact of existing passenger vehicle market policies, namely FBT exemptions for LCVs and some SUVs and for low emissions vehicles, and state subsidies and grants for BEVs. To provide a comprehensive assessment of an emission standard would require modelling all these distortions.
- The impacts on different groups in society should be an important consideration to ensure that the costs of the policy are not disproportionally borne by any one group in society:
  – The cost of low emission technology means that such vehicles are often offered at the more expensive end of the car market. An emission standard may disproportionally disadvantage lower income households who, even with

53 Office of Impact Analysis 2023, Australian Government Guide to Policy Impact Analysis, Department of Prime Minister and Cabinet.

subsidies, are unable to afford a new BEV (through higher prices in used car markets and higher prices for affordable ICE vehicles).

- Distances and availability of charging infrastructure may hinder BEV uptake for regional communities. Again, there is a risk that an emission standard disproportionately disadvantages regional communities.

Planning for fuel tax revenue declines

Fuel excise revenue (and implicitly, the funding of road infrastructure) and emissions targets are a joint issue.

When designing an emission standard, policy should also consider the implications of fuel tax revenue declines (both in absolute terms and relative to what would otherwise have been the case).

A Impact of credits on emission reductions

Credits are provided to manufacturers to reduce compliance costs to meet CO_2 emission standards, incentivise sales of zero- and low-emission vehicles and encourage innovations.

This means that under existing emission schemes, including the FCAI's voluntary scheme for Australia, that the sales weighted average emissions are not equal to emissions calculated under the relevant scheme. This makes comparing emission targets across schemes difficult, as schemes have different credit allowances.

In this appendix we examine how much higher emission standards would be in the absence of these credits for the EU and US emission standards.

Impact of credits on EU emissions of new passenger cars

A detailed breakdown of fleet-wide impact of credits and a phase-in provision is summarised in Table A.1. The average CO_2 actual emissions from new passenger cars in 2021 was 15 per cent lower than in 2020. Incorporating flexible compliance mechanisms, final emissions declined by additional 1.7 per cent from this actual emission.

A.1 Detailed summary of impacts of credits and a phase-in provision on CO_2 emissions

Year	Target	Actual emissions	Super credits	Eco-innovation credits	Phase-in provision	Adjusted emissions
	g CO_2/km	g CO_2/km	g CO_2/km	g CO_2/km	g CO_2/km	g CO_2/km
2013		126.7	-0.6	0.0	0.0	126.1
2014		123.4	-0.5	0.0	0.0	122.9
2015	130	119.5	-1.0	0.0	0.0	118.5
2016	130	118.1	0.0	0.0	0.0	118.1
2017	130	118.5	0.0	0.0	0.0	118.5
2018	130	120.8	0.0	0.0	0.0	120.8
2019	130	122.0	0.0	0.0	0.0	122.0
2020	95	107.5	-6.6	-0.8	-4.0	96.1
2021	119 [a]	115.0 [b]	-0.7	-1.3	0.0	113.0

[a] in 2021, the 2020 target of 95 g CO_2/km over the NEDC was converted to 119 g CO_2/km WLTP. Meanwhile, CO_2 emission performance and compliance are measured by WLTP from 2021 onwards. Super credits and eco-innovation were also translated to WLTP in 2021.

[b] 2021 WLTP emission of 115 g CO2/km is converted to NEDC emission of 92 g CO_2/km, based on the conversion of 2020 target of 95 g CO_2/km over the NEDC to 119 g CO_2/km WLTP.

Source: CIE compilation based on International Council on Clean Transportation, *CO_2 emissions from new passenger cars in Europe: Car manufacturers; performance*, 2012-2021; European Environmental Agency, *Monitoring of CO_2 emissions from passenger cars - Regulation (EU) 2019/631*, 2023.

The impact of flexible compliance mechanisms for new light trucks is not available due to a lack of publicly available data.

Impact of performance credits in US EPA greenhouse gas program

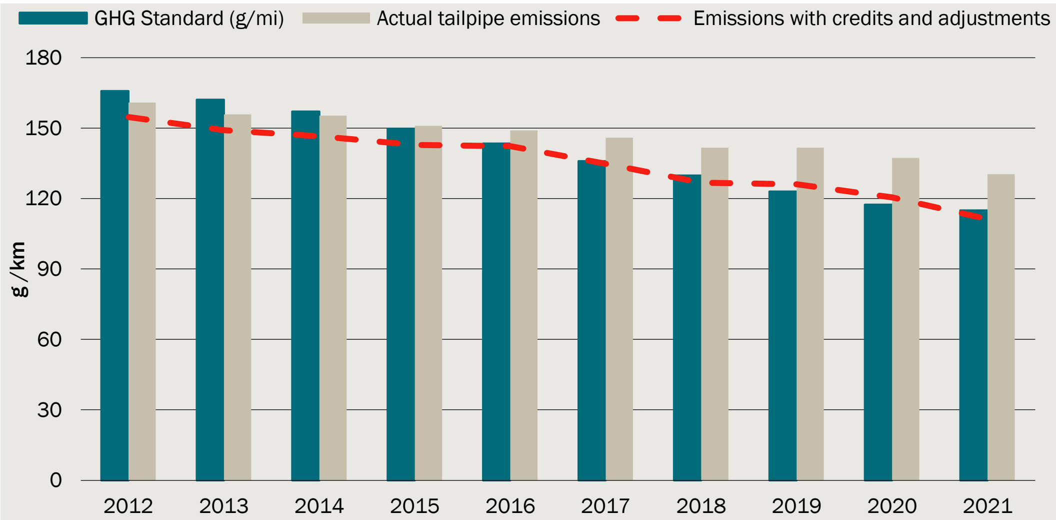
The US EPA provides optional flexibility provisions in forms of performance credits to manufacturers as part of its greenhouse gas (GHG) program. These performance credits are awarded to:

- electric vehicles, plug-in hybrid electric vehicles, fuel cell vehicles, compressed natural gas vehicles and gasoline-ethanol flexible fuel vehicles
- vehicles that deploy air conditioning (A/C) systems that reduce leakage of hydrofluorocarbon or fuel combustion for the A/C systems
- vehicles that deploy "off-cycle" technologies that are not adequately captured on the test procedures.

Additional flexibility is available in adjustments for alternative methane (CH_4) and nitrous oxide (N_2O), where manufacturers increase CO_2 emissions if they propose a less stringent CH_4 and/or N_2O standard.

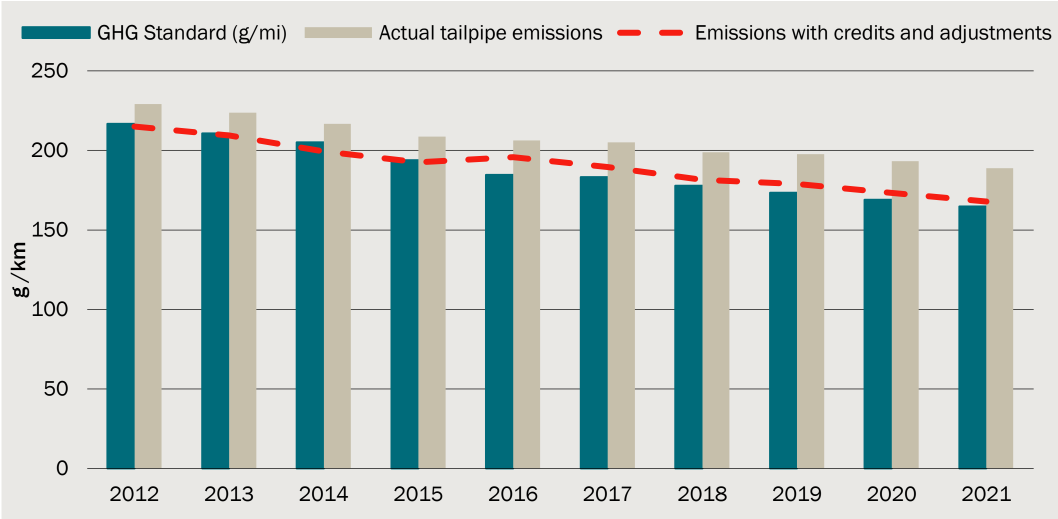
The EPA's flexibility provisions - performance credits and adjustments for CH_4 and N_2O standard - play a significant role in reducing compliance efforts to meet standards for new passenger cars and light trucks (Charts A.2 and A.3).

A.2 Impact of EPA credits and adjustments on emissions of new passenger cars



Data source: CIE compilation based on United States Environmental Protection Agency (EPA), *Database H. Compliance Data: Industry Performance by Model Year* 2023.

A.3 Impact of EPA credits and adjustments on emissions of new light trucks



Data source: CIE compilation based on United States Environmental Protection Agency (EPA), *Database H. Compliance Data: Industry Performance by Model Year* 2023.

A detailed breakdown of fleet-wide impact of EPA performance credits and adjustments is summarised in Table A.4. The average CO_2 tailpipe emission in 2021 was 5 per cent lower than 2020 for new passenger cars and 2 per cent lower for new light trucks. Including performance credits and adjustments, final emissions declined by additional 15 per cent for new passenger cars and 11 per cent for new light trucks.

A.4 Detailed summary of impact of performance credits and adjustments for new passenger vehicles and new light trucks on CO_2 levels per year

Year	Emission target	2-cycle test emission	Super credits	A/C credits	Off-cycle credits	CH4 and N2O debits	Final emission
	g CO_2/km	g CO_2/km	g CO_2/km	g CO_2/km	g CO_2/km	g CO_2/km	g CO_2/km
New passenger vehicles							
2012	166	161	2.5	3.4	0.4	-0.1	155
2013	162	156	2.5	3.9	0.4	-0.2	149
2014	157	155	2.9	4.7	1.4	-0.2	147
2015	150	151	1.9	5.0	1.4	-0.1	143
2016	144	149	0.0	5.5	1.4	-0.1	142
2017	136	146	2.7	6.3	2.2	0.0	135
2018	130	142	4.7	8.0	2.6	0.0	127
2019	123	142	3.9	9.1	2.7	0.0	126
2020	117	137	4.0	9.8	3.2	-0.1	121
2021	115	130	5.3	10.6	3.3	0.0	111
New light trucks							
2012	217	229	9.0	4.5	1.0	-0.2	215
2013	211	224	8.6	4.9	1.1	-0.2	209
2014	205	217	8.9	6.0	2.9	-0.1	199
2015	194	209	6.4	6.8	2.9	-0.1	193
2016	185	206	0.0	7.3	3.2	-0.1	196
2017	183	205	0.1	10.7	4.8	-0.1	190
2018	178	199	0.4	11.8	5.8	-0.1	181
2019	173	198	0.4	12.5	6.2	-0.1	179
2020	169	193	0.3	13.4	6.6	-0.2	173
2021	165	189	0.9	14.1	6.5	-0.3	168

Note: credits and emissions are converted to g CO_2/km from g CO_2/mile. Super credits are the sum of flexible fuel vehicle (FFV) credits and advanced technology credits.

Data source: CIE compilation based on United States Environmental Protection Agency (EPA), *Database H. Compliance Data: Industry Performance by Model Year* 2023.

B Data

Vehicle numbers

New vehicles

Data on historical and projected new vehicle sales were provided by FCAI:

- historical data is from FCAI's VFACTS database which reports vehicle sales by powertrain type
- future car sales are based on projections developed for FCAI from S&P Global. We understand that this is "bottoms up" sales forecast disaggregated by powertrain. We used projections out to 2030 for the purpose of this report.

Stock of vehicles

The historical stock of vehicles in Australia is based on:

- ABS Survey of Motor Vehicle Use – this provides data to 2020[54]
- BITRE Motor Vehicles Australia 31 January 2022.[55]

Where there are missing data over the history, we interpolate data by applying an exponential trend. The future stock of vehicles is estimated by calculating the historical number of passenger vehicles (passenger plus SUV) and LCVs per population from 2012 to 2022 (chart B.1). We then used the exponential growth trend over this period to project the number of vehicles per population into the future.

Historical population data is from ABS National, state and territory population, September 2022,[56] while we used Australian Government population projections to forecast the future stock of vehicles.[57]

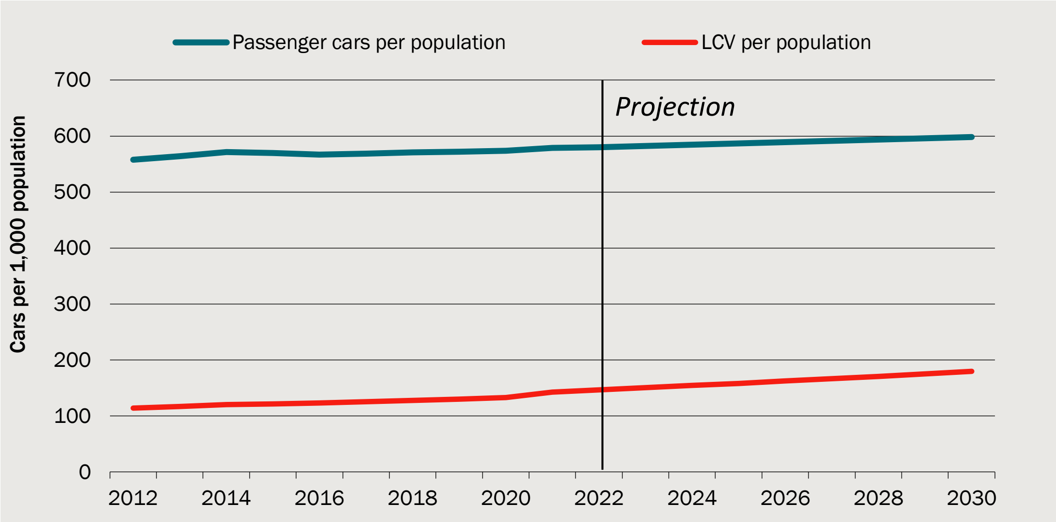
54 Available here: https://www.abs.gov.au/statistics/industry/tourism-and-transport/survey-motor-vehicle-use-australia/12-months-ended-30-june-2020

55 Available here: https://www.bitre.gov.au/publications/2022/motor-vehicles-australia-january-2022-first-issue

56 Available here: https://www.abs.gov.au/statistics/people/population/national-state-and-territory-population/sep-2022

57 Centre for Population 2022, 2022 Population Statement, The Australian Government, Canberra. Note we applied the growth rate from the population statement to the ABS historical series to avoid discontinuity between the history and the projection.

B.1 Number of passenger and light commercial vehicles per 1,000 population by year



Data source: CIE, based on ABS and BITRE data.

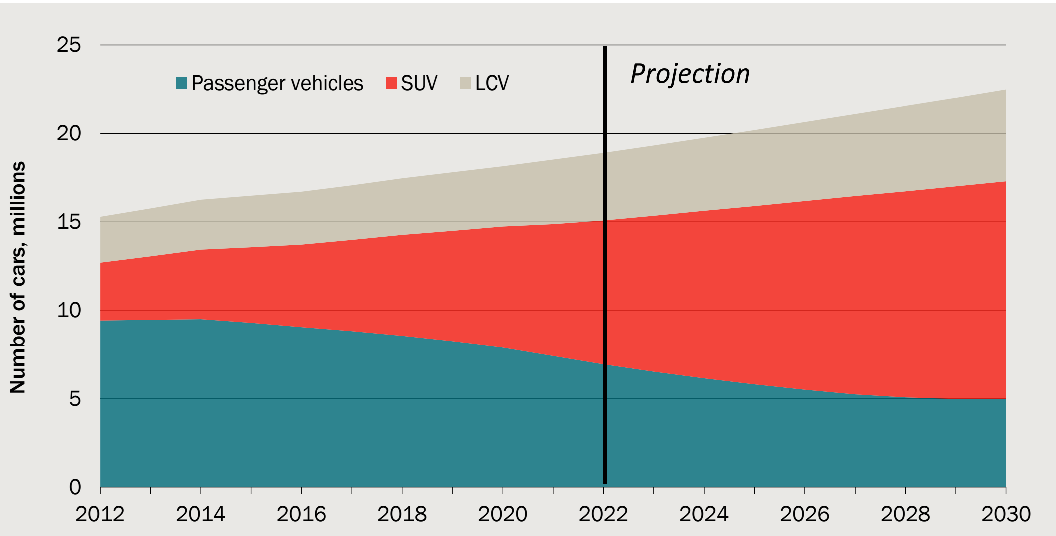
Stock of vehicle by type and powertrain

The stock of vehicles in the source data is only disaggregated into:

- passenger vehicles (passenger plus SUV)
- LCVs.

Passenger vehicles are disaggregated into passenger vehicles and SUVs using the share of sales over the past 10 years (for a given year), which is provided by FCAI (Chart B.2).

B.2 Estimated stock of vehicles by type by year



Data source: CIE based on BITRE and ABS.

We then estimated the number of vehicles by powertrain type from 2021 onwards in the following steps:

1. Data on the stock of vehicles by transition type was taken from BITRE Motor Vehicles Australia (31 January 2022):[58]
   – This disaggregates the fleet into petrol, diesel, dual fuel (i.e. petrol with LPG), HEVs (which we believe includes both HEVs, as defined in the FCAI data, and PHEVs), BEVs and other or unknown, for passenger and SUV, and LCV.
2. We applied the market shares by powertrain and fuel type for 2021 to our data series for the stock of vehicles by type in 2021.
   – For powertrain types not included in the BITRE data, we assumed that the stock was proportional to BEVs, based on the number of vehicles sold over the past 10 years (from FCAI vehicle sales data).
   – We disaggregated passenger vehicles and SUVs, in their separate components, using sales data for the past 10 years to inform relative proportions of the total.
3. The number of vehicles was projected into the future using information on the future stock of vehicles, and sales by powertrain and fuel type provided from FCAI.

Vehicle emission intensity

New vehicles

Projected vehicle sales were mapped to emissions by applying average emissions by vehicle type and powertrain. Historical emission by powertrain and vehicle types were taken from the NTC light vehicle emissions intensity reporting.

Emission by powertrain and fuel type for the different vehicle types was estimated in the following steps:

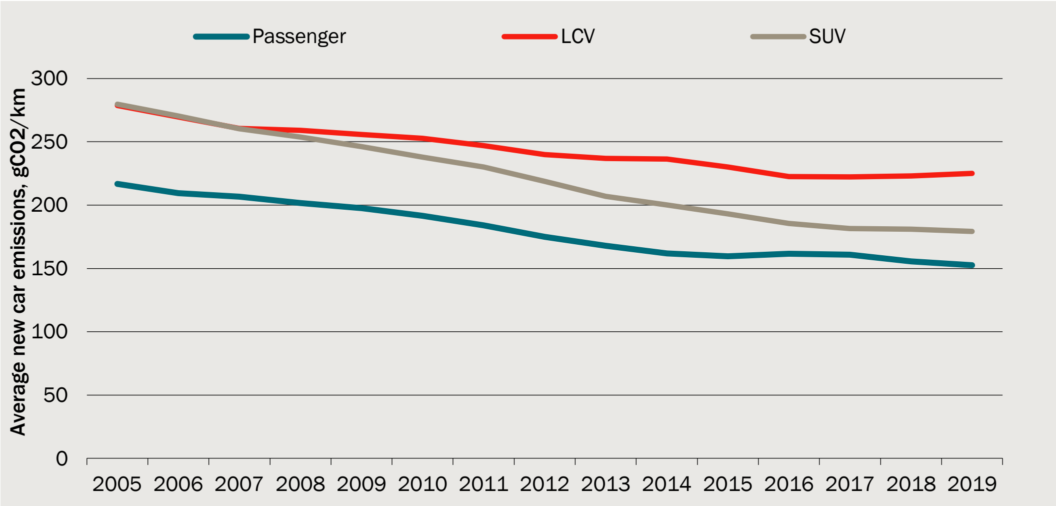
1. Collection of data on average vehicle type from NTC light emission reporting. We used data from 2005 to 2019 (Chart B.3),[59] excluding data for 2020 and 2021. For these years the FCAI included emissions credits in their calculations of emissions consistent with FCAI voluntary reporting. As a result, the data does not provide an accurate view of the actual level of emissions.
2. Information on the emissions for different powertrains and fuel types were collected from the 2021 NTC light vehicle emissions reporting. Noting the issues with this data in the previous paragraph, we did not use this level of this data, but rather we used it to determine relativity between emissions of different powertrains and fuels (i.e. between other powertrains and fuels relative to petrol, Table B.4). NTC does not provide estimates for mild hybrids, for which we assumed emissions are 15 per cent lower than petrol vehicles.

58 Available here: https://www.bitre.gov.au/publications/2022/motor-vehicles-australia-january-2022-first-issue

59 Recent reporting is available here: https://www.ntc.gov.au/light-vehicle-emissions-intensity-australia

3. We then used this emissions data along with sales projections to solve the average emissions by powertrain and fuel subject to the constraints that the total equals average emissions collected in the first step and the relativities of emission are fixed.
4. We then projected emissions into the future by applying a growth rate to future ICE emissions. This assumed that the relative emissions between powertrains and fuel types remains constant overtime.

B.3 Historic average emissions data



Data source: CIE based on NTC data.

B.4 Ratio to emission by power train and fuel type relative to petrol only by vehicle type

	Passenger vehicle and SUV	LCV
Petrol only	1.00	1.00
Diesel only	1.28	1.02
Mild hybrid	0.85	0.85
HEV	0.62	0.65
PHEV	0.28	0.30
BEV	0.00	0.00
Fuel cell (hydrogen)	0.00	0.00

Source: CIE based on NTC data.

To project emissions we tested three assumptions:

1. five-year linear trend (2015-2019) for each vehicle type (central scenario)
2. DCCEEW petrol vehicle emission projections[60]
3. emissions remain constant.

60 Department of Climate Change, Energy and Environment and Water 2022, Australia's emission projections 2022, figure 15, p. 38.

We chose to test a range of assumptions recognising the uncertainty in how technology will develop, and vehicle within category market shares may evolve (i.e. overtime the share of small SUVs may increase, which would reduce SUV average emissions).

There are several important things to note in interpreting these emission numbers:

- they are based on tailpipe emissions only and do not include emissions from electricity generation
- vehicle emissions data is reported by the NTC based on FCAI provided data. This emissions data is based on controlled test cycles (specifically the New European Driving Cycle (NEDC)). Real-world emissions will be greater than those observed during test cycles – this is accounted for in assessing the impact of emission standards on actual emissions (Box 4.17).

Stock of vehicles

Data on fuel consumption for the stock of vehicles is taken from ABS Survey of Motor Vehicle Use, Australia.[61] Where there are missing data over the history, we interpolated data by applying an exponential trend. This was mapped back to tailpipe emissions using the relationship between emissions and fuel consumption in Table B.5.

Data for passenger and SUVs is combined, which we disaggregate by assuming the difference in fuel consumption is proportional to the difference in emissions for new car sales by category.

Into the future, emissions are estimated by taking a weighted average of emissions for the stock of vehicles, and emissions of new vehicles entering the fleet.

Accounting for differences between test cycle and actual emissions

NTC new vehicle emissions data is collected on a NEDC test cycle basis. However real-world emissions intensity is on average higher than test cycle intensities, but the magnitude of this difference is uncertain. Further detail on the approach taken to correct for this is provided in Box 4.17.

Note we do not consider differences in real-world emissions for different powertrain types. In particular, the actual tailpipe emission for PHEVs may be larger than for other powertrain types – a European study found that actual tailpipe emission for PHEVs are up to 2.8 times and 5.3 time higher than emissions reported in test cycles, for private and company car vehicles respectively[62] This may result in emissions being overstated for hybrid powertrain types.

61 Available here: https://www.abs.gov.au/statistics/industry/tourism-and-transport/survey-motor-vehicle-use-australia/latest-release

62 Plötz P, Link S, Ringelschwendner H, Keller M, Moll C, Bieker G, Dornoff J, Mock P. 2022, Real-world usage of plug-in hybrid vehicles in Europe. ICCT. Available here: https://theicct.org/wp-content/uploads/2022/06/real-world-phev-use-jun22-1.pdf

Relationship between fuel consumption and emissions

The relationship between fuel consumption and tailpipe emission intensity is shown in Table B.5. This is based on DCCEEW Australian National Greenhouse Accounts Factors which assumes scope 1 emissions[63] of:

- 67.4 kg $CO_{2\text{-}e}$/GJ for gasoline, given an energy content of 34.2 GJ/kL
- 69.9 kg $CO_{2\text{-}e}$/GJ for diesel oil, given an energy content of 38.6 GJ/kL.

B.5 Fuel consumption and corresponding average emission intensity

Fuel consumption	Petrol	Diesel
L/100 km	g CO2/km	g CO2/km
0.5	12	13
1	23	27
1.5	35	40
2	46	54
2.5	58	67
3	69	81
4	92	108
5	115	135
6	138	162
7	161	189
8	184	216
9	207	243
10	231	270
11	254	297
12	277	324
13	300	351
14	323	378
15	346	405

Source: CIE based on Department of Climate Chang, Energy and Environment and Water 2023, Australian National Greenhouse Accounts Factors: 2022, p, 20.

New vehicle characteristics

Information on vehicle characteristics were used to inform household impacts. As the characteristics of low emissions vehicles improve (including prices falling) overtime consumers will increasingly adopt these vehicles, even in the absence of an emission standard. Future vehicle characteristics are highly uncertain. To estimate changes in economic welfare, we developed a set of assumptions for 2025 and 2030 – 2025 assumptions are largely informed by the current vehicle characteristics, while 2030 assumptions are based on assumed change from current vehicle characteristics.

63 Scope 1 greenhouse gas emissions are the emissions released to the atmosphere as a direct result of an activity or series of activities at a facility level.

Assumptions for passenger, SUV and LCVs are shown in Tables B.7, B.8 and B.9 respectively. The data are based on the following sources:

- Purchase price for petrol and diesel vehicles were based on a sales weighted average price for the 3 to 5 most popular vehicles in each category in the NTC light vehicle emissions reporting.[64] The price for vehicles was collected from vehicle brands' websites:
  - Purchase prices for BEVs, PHEVs and HEVs were based on the difference between these vehicles and comparable ICE vehicles sold by a given brand. Data collected from brands' websites controlled for the differing trim and specification across powertrain types (i.e. prices for ICE and BEV vehicles had similar specifications). We compared average BEV/PHEV/HEV prices respectively with ICE prices for comparable models. This only included models for which an ICE as well as BEV/PHEV/HEV is available. We then used this difference as the price premium in our analysis (Table B.6):
    - Note the price premium for LCV BEVs is calculated based on the LDV T60 MAX and eT60. PHEVs and HEVs for LCVs are based on the passenger and SUV price premiums.
  - The price premium was assumed to be 50 per cent smaller in 2030 compared to 2025.

B.6 Price premiums compared to ICE

	Passenger and SUV	LCV	Passenger and SUV	LCV
	2025 (observed 2023)	2025 (observed 2023)	2030 (assumption)	2030 (assumption)
	$	$	$	$
BEV	25,745	43,527	12,872	21,764
PHEV	11,842	11,842	5,921	5,921
HEV	3,407	3,407	1,704	1,704

Source: CIE.

- Fuel consumption and carbon emissions were based on emissions data for new vehicles (explained in the previous sections).
- Running costs included:
  - Fuel consumption and assumed fuel prices. For the analysis we used an unleaded price for $1.90 per litre and diesel price of $2.0 per litre, which we assumed remained constant in real terms overtime.
  - Electricity consumption and assumed electricity price. For the analysis we assumed an electricity price of $0.25 per kWh and consumption of:
    - 16.4 kWh/100km for BEVs and based on the averages of energy consumption calculated from RACQ Private vehicle expenses 2022.[65]

64 Recent reporting is available here: https://www.ntc.gov.au/light-vehicle-emissions-intensity-australia

65 Available here: https://www.racq.com.au/about-us/news-and-media/news/2022/12/racq-vehicle-operating-costs-2022

    - 18.0 kWh/100km for PHEVs based on a small sample of PHEV data collected from the Australian Government Green Vehicle Guide.[66]
  - Maintenance and insurance costs were based on averages calculated from RACQ Private vehicle expenses 2022.[67]
- Towing capacity, fuel range, acceleration and battery range are based assumptions developed as part of the CIE's previous work estimating the demand for electric vehicles.[68] We assumed that these characteristics are constant between 2025 and 2030.

66 Available here: https://www.greenvehicleguide.gov.au/Vehicle/QuickCompareVehicles

67 Available here: https://www.racq.com.au/about-us/news-and-media/news/2022/12/racq-vehicle-operating-costs-2022

68 CIE 2019, Demand for electric vehicles: A discrete choice survey, prepared for Australian Automobile Association.

B.7 New passenger car characteristics by year

Year	Powertrain	Fuel consumption	Running cost	Carbon emissions	Towing capacity	Fuel range	Acceleration	Battery range	Purchase price
		L/100 km	$/100 km	g CO_2/km	Kg braked	km	seconds 0-100 km/h	km	$
2025	Petrol	6.5	16.2	148	920	553	10.1	0	33,659
2025	BEV	0.0	7.5	0	307	0	11.6	300	59,404
2025	PHEV	1.8	11.8	41	920	553	11.6	75	45,501
2025	HEV	4.0	11.5	92	920	831	10.7	0	37,066
2030	Petrol	6.2	15.6	141	920	553	10.1	0	33,659
2030	BEV	0.0	7.5	0	307	0	11.6	450	46,531
2030	PHEV	1.7	11.6	40	920	553	11.6	113	39,580
2030	HEV	3.9	11.2	88	920	831	10.7	0	35,363

Source: CIE.

B.8 New SUV characteristics by year

Year	Powertrain	Fuel consumption	Running cost	Carbon emissions	Towing capacity	Fuel range	Acceleration	Battery range	Purchase price
		L/100 km	$/100 km	g CO_2/km	Kg braked	km	seconds 0-100 km/h	km	$
2025	Petrol	6.7	17.5	153	2,200	640	10.0	0	46,907
2025	BEV	0.0	7.8	0	733	0	11.5	300	72,652
2025	PHEV	1.9	12.8	43	2,200	640	11.5	75	58,749
2025	HEV	4.2	12.7	95	2,200	800	10.0	0	50,315
2030	Petrol	6.1	16.3	139	2,200	640	10.0	0	46,907
2030	BEV	0.0	7.8	0	733	0	11.5	450	59,780
2030	PHEV	1.7	12.5	39	2,200	640	11.5	113	52,828
2030	HEV	3.8	12.0	86	2,200	800	10.0	0	48,611

Source: CIE.

B.9 New LCV characteristics by year

Year	Powertrain	Fuel consumption	Running cost	Carbon emissions	Towing capacity	Fuel range	Acceleration	Battery range	Purchase price
		L/100 km	$/100 km	g CO_2/km	Kg braked	km	seconds 0-100 km/h	km	$
2025	Petrol	8.1	21.3	217	3,000	580	16.0	0	50,248
2025	BEV	0.0	8.6	0	1,000	0	18.4	300	93,775
2025	PHEV	2.8	14.9	64	3,000	580	18.4	75	62,090
2025	HEV	6.1	17.2	139	3,000	680	16.0	0	53,655
2030	Petrol	7.9	20.8	209	3,000	580	16.0	0	50,248
2030	BEV	0.0	8.6	0	1,000	0	18.4	450	72,012
2030	PHEV	2.7	14.7	62	3,000	580	18.4	113	56,169
2030	HEV	6.1	17.2	139	3,000	680	16.0	0	51,952

Source: CIE.

Ownership costs

New vehicle costs were used to estimate ownership costs over a 20-year asset life. This takes the costs detailed in the previous section, applies them to the number of kilometres travelled per year (for fuel costs) and then converts them to a present value using a 7 per cent discount rate.

Note this does not consider large and uncertain repair costs over the life of a vehicle, such as replacing a battery in a BEV or engine in an ICE vehicle. Similarly, we do not include registration costs, which in many jurisdictions in Australia is cheaper for low emissions vehicles. We excluded this from our analysis as it is not clear whether these arrangements will continue and do not reflect a difference in resource costs.

B.10 Ownership costs – passenger vehicle purchased in 2023 by powertrain

	BEV	PHEV	HEV	ICE
	$ present value	$ present value	$ present value	$ present value
Fuel	5,200	8,729	10,132	16,290
Maintenance	2,512	4,300	3,669	3,669
Insurance	19,738	21,424	19,251	19,251
Total	27,450	34,453	33,051	39,210
Difference compared to ICE	322	236	-281	

Note: Costs are discounted using a discount rate of 7 per cent.

Source: CIE based on ABS and RACQ.

B.11 Ownership costs – SUV purchased in 2023 by powertrain

	BEV	PHEV	HEV	ICE
	$ present value	$ present value	$ present value	$ present value
Fuel	5,200	10,516	12,673	22,659
Maintenance	3,009	5,150	4,394	4,394
Insurance	19,490	21,155	19,009	19,009
Total	27,700	36,821	36,077	46,062
Difference compared to ICE	-18,363	-9,241	-9,985	

Note: Costs are discounted using a discount rate of 7 per cent.

Source: CIE based on ABS and RACQ.

B.12 Ownership costs – LCV purchased in 2023 by powertrain

	BEV	PHEV	HEV	ICE
	$ present value	$ present value	$ present value	$ present value
Fuel	7,650	12,549	18,069	32,467
Maintenance	4,750	8,129	6,936	6,936
Insurance	29,602	32,130	28,871	28,871
Total	42,001	52,809	53,876	68,274
Difference compared to ICE	-26,273	-15,466	-14,399	

Note: Costs are discounted using a discount rate of 7 per cent.

Source: CIE based on ABS and RACQ.

Consumer preferences

Consumer preferences used in this study were taken from a previous study prepared for AAA.[69] Detailed estimation outputs are available in Appendix D of that report.[70]

Overseas emission standards

Information on overseas and Australian (voluntary) standards are shown in Table B.13. Note these are not adjusted for credits incorporated into regulatory standards and are not directly comparable to average tailpipe emissions weighted by sales, and do not include emissions associated with electricity generated used to power BEVs and PHEVs.

B.13 International emission standards by vehicle type

Year	New passenger cars	New LCV
	g CO_2/km	g CO_2/km
EU [a]		
2020-2024	95.0	147.0
2025-2029	80.8	125.0
2030+	59.4	101.4
US EPA standard [b]		
2022	112.5	162.2
2023	103.1	145.4
2024	98.2	137.9
2025	92.6	128.6
2026	82.0	116.2
New Zealand		

69 CIE 2019, Demand for electric vehicles: A discrete choice survey, prepared for Australian Automobile Association.

70 Available here: https://www.thecie.com.au/publications-archive/demand-for-electric-vehicles

Year	New passenger cars	New LCV
	g CO_2/km	g CO_2/km
2023	145.0	218.3
2024	133.9	201.9
2025	112.6	155.0
2026	84.5	116.3
2027	63.3	87.2
Australia's FCAI voluntary emission standard		
2030	100.0 [c]	145.0 [c]

[a] EU standards are all expressed in emission rate (g CO_2/km) over *New European Driving Cycle (NEDC)* testing procedure to be comparable with FCAI standards, despite that NEDC has been replaced by *Worldwide Harmonised Light Vehicle Test Procedure (WLTP)* from 2021 onwards.

[b] US EPA standard is converted to g CO_2/km from g CO_2/mile.

[c] Australia's FCAI standard set targets at 100 g/km and 145 g/km for MA category and MC+NA category respectively. MA category includes passenger car and light SUVs. MC+NA category includes heavy SUVs and light-duty commercial vehicles.

Source: CIE compilation based on New Zealand Transport Agency, *Clean Car Standard CO_2 value*; Federal Chamber of Automotive Industries (FCAI), 'Australia's automotive industry delivers on emission reduction targets', in *FCAI Media Releases*; United States Environmental Protection Agency (EPA), *Final Rule to Revise Existing National GHG Emissions Standards for Passenger Cars and Light Trucks Through Model Year 2026*; and European Commission, *CO_2 emission performance standards for cars and vans.*

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