Australian Government
Department of Industry, Science, Energy and Resources

Future Fuels Strategy:

Discussion Paper

Powering choice.

February 2021

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Contents

Purpose

This Future Fuels Strategy: Discussion Paper sets out the Australian Government's direction and practical actions that will enable the private sector to commercially deploy low emissions road transport technologies at scale.

The Government is seeking feedback on this paper, which will help to:

- shape the final Future Fuels Strategy
- influence the design and rollout of the Government's investment programs, including the Future Fuels Fund and the Freight Energy Productivity Program; and
- inform the priorities for the Commonwealth's work with state and territory energy ministers, where coordination is needed to best integrate electric vehicles into the electricity grid.

Progress on the delivery of the Strategy's priority initiatives will also inform annual Low Emissions Technology Statements and other potential future Government investment.

The Government aims to create an environment that enables consumer choice, stimulates industry development and reduces emissions in the road transport sector. The Strategy will be underpinned by Government investments through the Australian Renewable Energy Agency (ARENA), the Clean Energy Finance Corporation (CEFC), along with the recently announced $74.5 million Future Fuels Package and $24.5 million Freight Energy Productivity Program that forms part of the King Review Technology Co-Investment Fund. These programs and agencies will be central to the Strategy going forward.

Managing the increased uptake of new road transport technologies involves all levels of government, the community and industry. Australian Government funding will leverage private sector and state government funding for projects that reduce barriers to the uptake of new vehicle technologies.

Introduction

The future of road transport in Australia will consist of a mix of vehicle technologies and fuels. Increased availability of new vehicle technologies and refuelling infrastructure will give consumers more choice, and provide additional productivity, emissions reduction, fuel security and air quality benefits.

In the short to medium term, conventional vehicles that use petrol and diesel will continue to be the most popular and widely available vehicles in Australia (BITRE 2019a). Conventional engine technology is evolving, as is the potential for greater use of biofuels. New technology provides an opportunity to reduce emissions and gain productivity benefits across Australia's vehicle fleet.

The world's largest vehicle manufacturers are driving the development of new vehicle technologies, including plug-in hybrid, battery and hydrogen fuel cell electric vehicles. These new technology vehicles are currently more expensive to produce. However, the Government is optimistic that this gap will steadily reduce over time to sell at similar prices or match conventional petrol and diesel vehicles through technological and production process improvements. This pace will also depend on vehicle type and driving behaviour (for example: commercial fleet use compared to private use) (McKinsey 2019; BNEF 2020).

Currently, closing the total cost of ownership gap with battery electric vehicle subsidies would not represent value-for-money. Analysis shows that this would be expected to cost the taxpayer $195-747 per tonne of carbon dioxide equivalent, depending on the vehicle type and usage. This is high when compared to the Emissions Reduction Fund price of $16 per tonne of carbon emitted. This translates to around $4,500 to $8,000 over the life of the vehicle, or around 10-40 cents per kilometre over a 10 year vehicle life (see Attachment A).

The Government's first focus to support future fuels will be on the areas where current trends in consumer choice can be supported and on sectors that can derive the most benefit from adopting new technologies first. This will be done through the Strategy's five priority initiatives (see Figure 1).

Australians are already making the choice to switch to new technologies such as hybrids where the total cost of ownership cost gap is small for private ownership and has closed for fleet use. Hybrid sales almost doubled in the last year, increasing from 31,191 vehicles in 2019 to 60,417 vehicles in 2020 (FCAI 2021). In some cases consumers are showing a preference for hybrids over the petrol equivalent. For example, Toyota has reported that hybrids made up around 70% of Camry and Rav4 sales, and around half of all Corolla sales in 2020 (Toyota 2021). Hybrids are a natural choice as consumers are able to incrementally adjust to the change from a traditional internal combustion engine vehicle to a new technology.

Hybrids also have immediate emissions reduction benefits, even over battery electric vehicles, across parts of Australia. Currently, driving a hybrid in many Australian states has a lower emissions intensity profile than driving a battery electric vehicle (see Attachment A). In New South Wales, Victoria, Queensland and the Australian Capital Territory, consumers will have a lower emissions impact driving a hybrid over a battery electric vehicle. Only in South Australia and Tasmania does driving a battery electric vehicle have a significantly lower emissions impact than a hybrid.

A 'fleets first' approach is an effective pathway for early adoption, with businesses accounting for around 40% of new light vehicle sales in 2020 (FCAI 2021). This large proportion of sales will allow more Australians to be familiar with new technologies, increasing acceptance and uptake more widely. Bulk fleet purchasing could also drive vehicle makers to provide a wider range and more affordable new vehicle technology models to Australia.

If this 40% proportion were applied to hybrid sales, over 24,000 new hybrids were added to business fleets in the last year. In practice, it is likely that fleet buyers contribute a higher proportion of hybrid sales due to their cost advantages over longer distances. For the Government fleet, hybrid vehicles now make up 28% of the COMCAR fleet after the addition of 45 hybrid Toyota Camrys in 2020.

Battery electric vehicles are also likely to become cost competitive for fleets before other sectors in coming years because of reduced fuelling and maintenance costs compared to conventional vehicles (McKinsey 2019; BNEF 2020) (see Attachment A for examples). Total cost of ownership is the primary consideration for fleet managers and, with upfront costs forecast to fall further over the coming years, this creates an opportunity for uptake in high use fleet applications. This will have not only savings benefits for businesses, but will have a bigger impact on emissions reduction in the transport sector.

As new plug-in hybrid and battery electric vehicle models come to market, sales are increasing (BNEF 2020; FCAI 2020; IEA 2020). In December 2020, Australians have access to 50 different battery electric, plug in hybrid and hybrid vehicle models, not including the multiple options of each vehicle that are often available. Twenty eight of these vehicles have a starting price under $65,000 (see Attachment B for further details). The range of new vehicle technology options in the Australian market is expected to continue to increase each year. By 2030, the Department of Industry, Science, Energy and Resources' Emissions Projections 2020 report forecasts battery electric vehicle sales to reach 26% of annual new vehicle sales in Australia (Commonwealth of Australia 2020a).

Enabling this uptake creates a need for new infrastructure, planning and regulatory considerations. Ensuring consumer choice and confidence in buying new vehicle technologies and accelerating improvement in enabling technology and infrastructure are priorities for the Government. The Government's five priority initiatives (see Figure 1) will encourage uptake while safeguarding consumer choice.

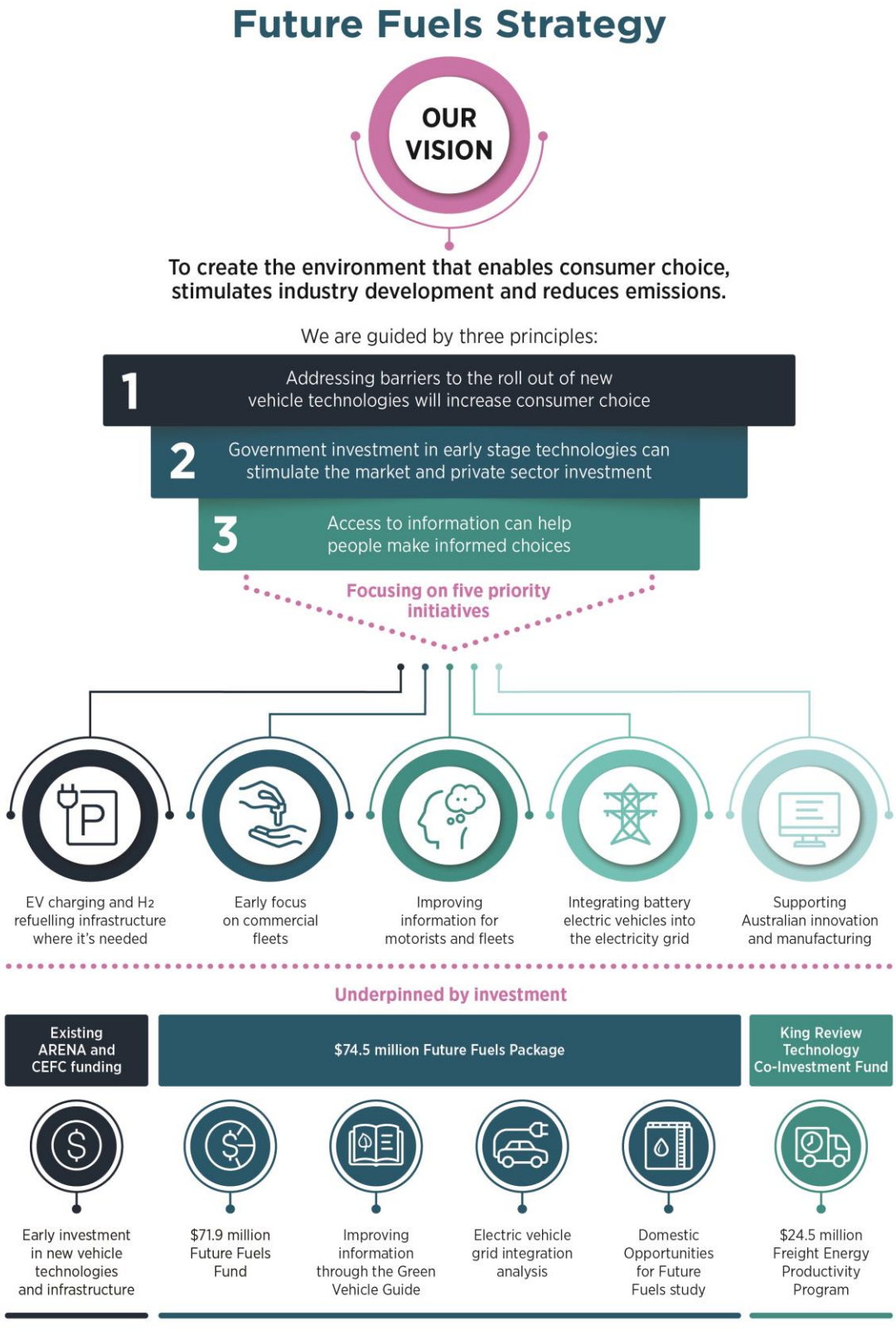


Figure 1: Future Fuels Strategy - Overview

The Strategy

Principles

The Australian Government's Strategy will be guided by three principles:

1. *Addressing barriers to the roll out of new vehicle technologies will increase consumer choice.*
2. *Government investment in early stage technologies can stimulate the market and private sector investment.*
3. *Access to information can help people make informed choices.*

Priority areas

The Government has identified five priority initiatives:

1. *Electric vehicle charging and hydrogen refuelling infrastructure where it is needed*

Motorists expect convenient access to refuelling facilities for their vehicles. Coordinating private and public investment will enable the efficient rollout of charging and refuelling infrastructure. This will give consumers more confidence to buy battery and hydrogen fuel cell electric vehicles.

2. *Early focus on commercial fleets*

In 2020, 40% of light vehicles in Australia were sold to businesses (FCAI 2021). Business vehicles generally travel greater distances than private vehicles. Fuel and maintenance savings from new technologies can help to offset the price premium of buying the new technology. Supporting commercial fleet investment in new vehicle technologies will also drive uptake from private users, as fleet vehicles are generally replaced more regularly than private vehicles. This benefits the second hand market and provides private consumers with second hand vehicles at lower prices.

3. *Improving information for motorists and fleets*

New vehicle technologies offer benefits for motorists, but information barriers inhibit consumer confidence. Historically, incremental developments in vehicle technology have occurred at a pace motorists could easily understand. However, battery and hydrogen fuel cell electric vehicles represent step changes in technology use and the way vehicles are fuelled. Access to reliable, easy-to-understand information is needed to help consumers make informed choices.

4. *Integrating battery electric vehicles into the electricity grid*

Unmanaged battery electric vehicle charging, especially during peak demand periods, could contribute to electricity network congestion where battery electric vehicles are concentrated. In contrast, well managed charging could provide valuable grid support while unlocking benefits for consumers. Action is needed to influence vehicle charging to reduce network congestion risks, and help manage electricity demand to benefit the grid.

5. *Supporting Australian innovation and manufacturing*

Australia has a comparative advantage in high value niche vehicle technology and manufacturing markets. Enabling opportunities is important to maximise a high-value export industry.

The priority initiatives and objectives are outlined in Figure 2 (over page).

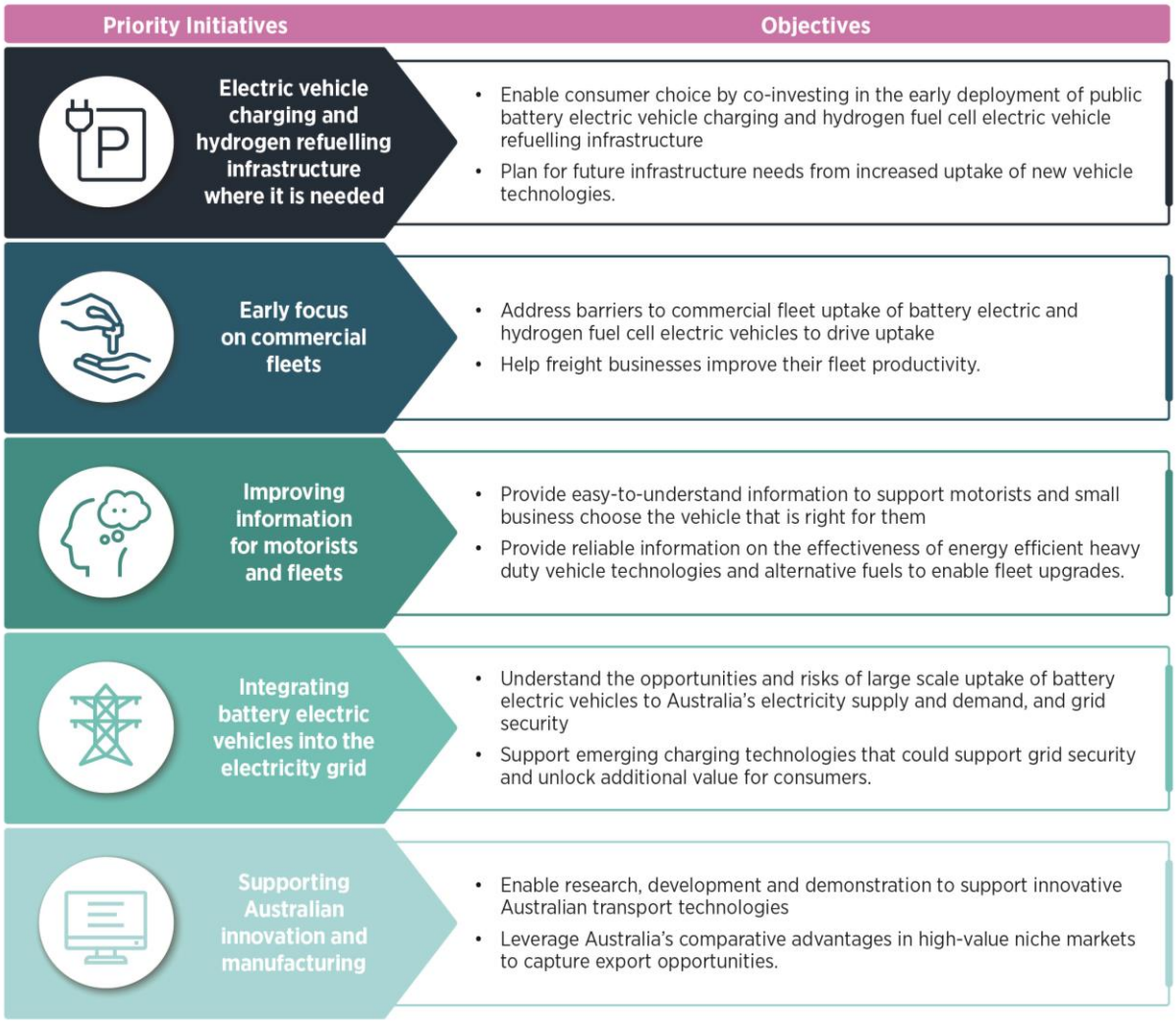


Figure 2: Future Fuels Strategy - priority initiatives and objectives

Alignment with the Government's action on low emissions transport technologies

The Strategy will:

- support the direction of Australia's Technology Investment Roadmap's First Low Emissions Technology Statement
- integrate the transport-related outcomes of the National Hydrogen Strategy and Bioenergy Roadmap
- build on the ongoing investment in new fuels, vehicles and infrastructure provided by ARENA and the CEFC
- build on the work of the Transport and Infrastructure Ministers Meeting, and
- become an important element of the Government's technology-based Long-term Emissions Reduction Strategy.

Further detail on the Government's actions on transport technology is provided at Attachment C.

Have your say

The Government invites feedback on the priorities and actions in this paper that are designed to create an environment that enables consumer choice, stimulates industry development and reduces emissions in the road transport sector.

The feedback will inform the final Strategy, the rollout of the Future Fuels Package and Freight Productivity Program, and work by the Commonwealth with states and territories energy ministers on nationally relevant issues such as integration of electric vehicles into the electricity grid.

Consultation on the Future Fuels Strategy: Discussion Paper closes on Friday 2 April 2021.

The consultation questions are listed at the end of each priority initiative section. You can submit responses to some or all of the questions in our consultation hub online survey. You can also upload a written submission.

Visit our consultation hub to submit your response: https://consult.industry.gov.au/climate-change/future-fuels-strategy

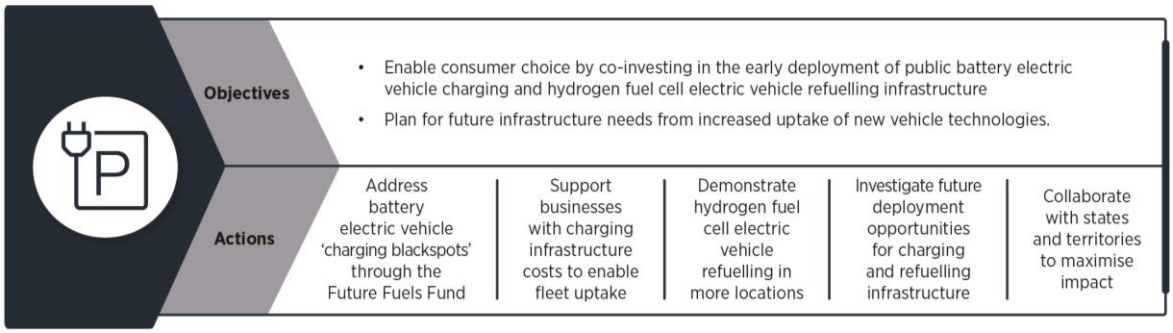
For further information, please email futurefuels@industry.gov.au

Next steps

Figure 3: Future Fuels Strategy - Timeline

Priority initiatives

1. Electric vehicle charging and hydrogen refuelling infrastructure where it is needed



Issues and opportunities

All motorists expect convenient access to refuelling facilities for their vehicles.

Lack of access to publicly available chargers is a barrier to consumer and business confidence in buying battery electric vehicles. Plug-in hybrid and battery electric passenger vehicles can charge wherever electricity supply is available. While a large proportion of charging will happen at homes and businesses, this will not be an option where off street parking is not available (Commonwealth of Australia 2019a; IEA 2020). Motorists also need to know they can travel longer distances and have easy access to a public charger.

To support uptake, there is a need for more public chargers across metropolitan, regional and rural Australia to fill 'charging blackspots'. For rural and regional areas, the market is likely to supply fewer chargers because lower population density means a slower increase in demand, reducing the return on investment. In the absence of commercial providers, state and local governments are considering installing public charging infrastructure. However, complexities in planning, grid connection and installation costs are barriers to the roll out of more chargers.

Commercial vehicles, including trucks and buses, will have varying infrastructure needs depending on the technology adopted. As new models enter the Australian market, light commercial vehicles such as vans and utilities could use passenger electric vehicle charging infrastructure. However drivers may be concerned about certainty of access. Buses, rigid trucks and long haul trucks will need dedicated public charging infrastructure, due to their larger batteries. Charging stations will need to set up along major transport routes and regional centres to leverage existing network capacity and support greater range.

Commercial fleets will also need 'back to base' private charging infrastructure. In this case, commercial buildings and fleet vehicle parking facilities will likely require electrical upgrades. This acts as an additional barrier for businesses to start incorporating battery electric vehicles into their fleet, on top of the change in fleet management practices. This cost could be significant if a business has a large fleet, or uses larger commercial vehicles such as trucks, and needs substantial electrical upgrades (ChargeTogether Fleets 2020).

For hydrogen refuelling, infrastructure is not available in the same way as conventional liquid refuelling or battery electric vehicle charging. Hydrogen refuelling infrastructure will need to develop in step with industry and hydrogen fuel cell electric vehicle deployment to ensure scale up is commercially viable (Commonwealth of Australia 2019b; BITRE 2019b). In the National Hydrogen Strategy, Australian governments have agreed to encourage consortium models to coordinate supply and demand, and reduce project risk. Early opportunities for hydrogen fuel cell electric vehicles include site specific industrial uses, such as at ports, or remote industrial sites; 'back to

base' transport applications, such as fleet vehicles and metropolitan public transport; and regional freight transport.

Sustainable biofuels can be used in conventional vehicles with little or no modification, and offer a low-carbon alternative for commercial fleets. Biofuels are generally compatible with existing fuel storage and distribution infrastructure, although may not be suitable in all cases (CEFC and ARENA 2019). The Bioenergy Roadmap will assess biofuel opportunities and challenges in more detail.

Actions

The Government will co-invest in the rollout of charging and refuelling infrastructure through the $71.9 million Future Fuels Fund. The Future Fuels Fund supports the Government's First Low Emissions Technology Statement that identifies electric vehicle charging and hydrogen refuelling infrastructure as 'emerging' technologies.

The Future Fuels Fund will co-invest with the private sector to address public 'charging blackspots' (see 1.1) and demonstrate hydrogen refuelling infrastructure (see 1.3). Due to its compatibility with existing refuelling infrastructure, biofuel related projects are explored in priority 2.

The Future Fuels Fund will also support commercial fleet projects that undertake electrical upgrades and charging installation (see 1.2). The fund recipients will share knowledge gained in the trials and publish 'investment grade' information to inform others who are considering integrating battery electric vehicles into their fleets (see 1.4 and 1.5). ARENA will seek input to the Fund program guidelines and feedback on this paper will also help inform the rollout of the Fund.

1.1 Address battery electric vehicle 'charging blackspots' through the Future Fuels Fund

The Government, through ARENA, has already committed $21 million to two major projects to install battery electric vehicle charging stations powered by renewable energy along Australia's national highways.

The Government will continue to co-invest in building Australia's public charging network. ARENA expects applications for the initial round of the Future Fuels Fund to open in February 2021. Funding will be focused on making the greatest impact for motorists and it will address 'charging blackspots' where private sector investment is not yet commercially viable.

Australia's national highway charging network

The Australian Government has committed $15 million in ARENA funding towards a $50.2 million Evie Networks ultra-fast charging network, comprising 42 charging sites powered by renewable energy. This complements the $6 million ARENA committed in 2018 to a $15 million Chargefox project to build an ultra-fast network of 21 sites from Adelaide to Brisbane, around Perth and in Tasmania. With these ARENA-funded networks in place, it will be possible for the average plug-in hybrid and battery electric vehicle on the market today to travel from Brisbane to Adelaide.

In addition, Tesla, the Queensland Government, the NRMA and the Royal Automobile Club of Western Australia have also contributed to Australia's charging network.

1.2 Support businesses with charging infrastructure costs to enable fleet uptake

Through the Future Fuels Fund, the Government will support businesses with commercial fleets to undertake charging installation projects, including electrical upgrades, such as for three-phase power. For example, the Future Fuels Fund could help businesses make electrical upgrades and

install battery chargers at a depot for battery electric delivery trucks, where installation costs might be a barrier to battery electric vehicle uptake. Consultation with industry on this component of the Future Fuels Fund will take place in early 2021.

1.3 Demonstrate hydrogen fuel cell electric vehicle refuelling in more locations

Through the Future Fuels Fund, the Australian Government will work with industry and state governments to co-invest in demonstration hydrogen refuelling stations. This is consistent with the approach for hydrogen in transport agreed to in the National Hydrogen Strategy. Supporting the demonstration of refuelling infrastructure will lower the risk for private investors seeking to invest in hydrogen fuel cell electric vehicles as they become more widely available. Consultation on this component of the Future Fuels Fund will take place from the second half of 2021.

To enable hydrogen in transport to reach scale, the National Hydrogen Strategy will initially focus on transport tasks that do not require an extensive network of refuelling stations. Through the National Hydrogen Strategy, Australian governments have also agreed to support refuelling stations on major freight and passenger road corridors to support greater range for hydrogen fuel cell electric vehicles.

Additionally, the Government has announced $70.2 million to support the development of the first Australian regional hydrogen export hub and supply chain development. The hub will bring hydrogen users and exporters together in one place, matching demand with supply. This hub model will help reduce risks and costs for industry, and accelerate the use of hydrogen in the transport sector.

Hydrogen fleet and refuelling demonstration trials

There are several commercial hydrogen fleet and refuelling trials planned and underway. These include hydrogen fuel cell electric: forklifts, cars, shuttle and regional buses, and trucks for mining and refineries. These vehicles are supported by demonstration refuelling facilities located across Australia.

The Australian Government, through ARENA, has already invested over $4 million for hydrogen transport-related demonstration projects, including with Toyota Australia and BOC Limited.

1.4 Investigate future deployment opportunities for charging and refuelling infrastructure

The Bureau of Infrastructure and Transport Research Economics (BITRE) is investigating when and where battery electric vehicle fleet market penetration is most likely to develop. This can assist infrastructure providers assess the commercial viability of future charging locations.

ARENA is commissioning a complementary study to better understand key charging ‘blackspot locations’ for the Future Fuels Fund. Due to be delivered in early 2021, the outputs of the study will help inform the priority routes for initial funding rounds.

Through the National Hydrogen Strategy, preliminary work is underway to map and prioritise hydrogen refuelling infrastructure needs, gaps and opportunities. This work is being undertaken as part of the National Hydrogen Infrastructure Assessment, which will help guide government and private sector investment in hydrogen infrastructure, including refuelling. An assessment every 5 years will help track infrastructure and hydrogen fuel cell electric vehicle deployment and highlight priorities for future infrastructure investments. ARENA will consider the findings of the National Hydrogen Infrastructure Assessment in future rounds of the Future Fuels Fund.

1.5 Collaborate with states and territories to maximise impact

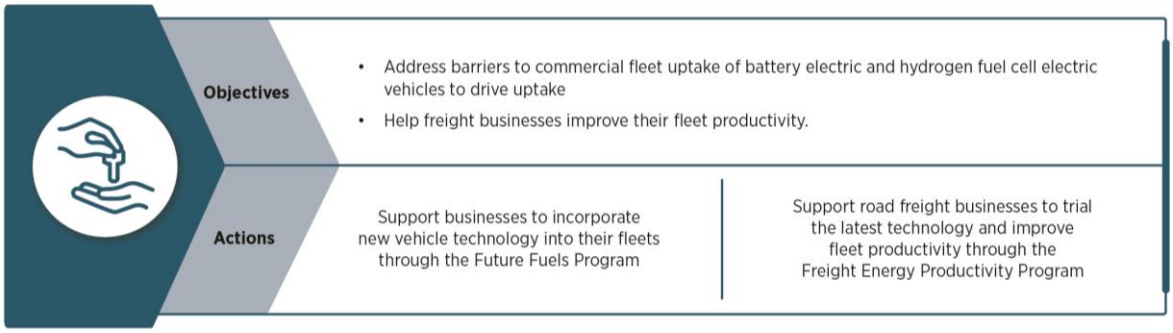
The Government is working with states and territories on bilateral agreements to leverage government infrastructure investment in fleet projects for battery and hydrogen electric vehicles in Australia, such as Commonwealth and NSW Bilateral Energy and Emissions Reduction Memorandum of Understanding.

Australian governments are also working to reduce market barriers to uptake. At the Infrastructure and Transport Ministers Meeting on 5 June 2020, ministers agreed to a work program to address some of these barriers. The work program includes developing national road signage standards, providing charging infrastructure installation guidance for road operators, and progressing interoperable data and payments standards.

Charging and refuelling infrastructure - Questions

1. What are the highest priority charging and refuelling blackspots that should be considered under the ARENA administered Future Fuels Fund?
2. What technical issues remain for rolling out recharging and refuelling in both metropolitan and regional blackspots?
3. What are the biggest commercial barriers to installing new charging or refuelling infrastructure?
4. What barriers are there to co-locating charging with existing infrastructure (for example carparks or service stations) compared to standalone charging stations?
5. What information do businesses need to ensure an integrated charging network can be delivered across Australia?

2. Early focus on commercial fleets



Issues and opportunities

Fleets are an effective pathway for early adoption of new vehicle technologies. In 2020, 40% of light vehicles in Australia were sold to businesses (FCAI 2021). Developments in this significant segment could greatly impact the market and vehicle trends more broadly.

Fleet vehicles typically travel further than privately owned vehicles, this results in higher fuel costs and more frequent servicing. For this reason, the total cost of ownership, not just the initial purchase price, is a key consideration for fleet managers. Hybrid vehicles are well suited to fleet use as the marginally higher upfront purchase prices can be fully offset by fuel savings within the vehicle's lifetime. This benefit is due to the fuel efficiency advantages of hybrid drivetrains, and increases with distance travelled.

New vehicle technologies such as battery electric vehicles are expected to have lower fuelling or private charging costs compared to conventional internal combustion engine vehicles.[1] They also have significantly lower expected maintenance costs due to their simpler design. For example, a pre-paid service plan for a Hyundai Kona electric vehicle costs about 40% less than for a Kona with a conventional engine (Hyundai 2020). These reduced costs can help offset the current price premium for new vehicle technology.

Uptake in fleet vehicles can help all Australians become more familiar with new technologies. For instance, many Australians' first experience with a hybrid vehicle was in a taxi or company vehicle, and they are now becoming increasingly popular with private purchasers. Fleet purchasing could also stimulate the second hand market for new vehicle technologies. Businesses generally replace vehicles on a more regular basis than private buyers, which in turn provides a supply of vehicles to the second hand market at lower prices.

Barriers still remain for fleets to take up new vehicle technologies:

- The expected fuel cost savings from a small battery electric vehicle are currently insufficient to overcome the higher upfront purchase prices compared with conventional vehicles.
- Lease costs are generally higher under standard finance models, as the purchase price for battery and hydrogen fuel cell electric vehicles is higher than comparative internal combustion engine models.
- There is a perception that battery electric vehicles available today depreciate faster than internal combustion engine vehicles due to rapid technological development, the small number of these vehicles available in the market, and uncertainty about the longevity of lithium-ion

1 In 2019, electricity was $0.30/kWh AEMC (2019) and a litre of petrol was $1.43 BITRE (2019). This equates to ~$3.50/100km for an electric vehicle compared to between $8 and $12/100km for a small to large ICE vehicle.

batteries (Gotsis 2018). Consultation with industry suggests this is becoming less of an issue, particularly as manufacturers are providing extended warranties on batteries.
- Concerns about the cost and practicality of installing electric charging infrastructure, especially in leased or heritage buildings.
- Small businesses are often unable to absorb large upfront capital costs and may see lack of charging infrastructure as a barrier.
- Concerns about the availability and safety of hydrogen refuelling infrastructure.
- Concerns about the cost, availability and quality of biofuel blends when used in conventional vehicles.

COMCAR Electric Vehicle Fleet Trial

Within the Australian Government Department of Finance, COMCAR will undertake a 2 year trial to consider the viability of implementing battery electric vehicles in its future vehicle fleet. The focus of the trial is to investigate and undertake a detailed assessment of charging infrastructure requirements, costs and implications for COMCAR operations nationally.

It is anticipated that findings from the trial will also provide valuable insights on how to integrate battery electric vehicles into other Government fleets. This will also progress the Government's understanding of available charging infrastructure and technologies. COMCAR will share its findings with the Department of Industry, Science, Energy and Resources, and the Australian Government Fleet, to help inform future decisions on battery electric vehicle use.

In 2019, there were 37,960 trucks and vans, and 1,445 buses sold in Australia (Trucksales 2020; Australasian Bus and Coach 2020). Medium and heavy commercial vehicle fleets have different operating requirements, and as a result, they have different expected trajectories for technology uptake. Buying trucks and buses is primarily driven by the total cost of ownership, with some customisation for larger trucks, buses and coaches.

Australia relies heavily on road freight to move food and essential items across the country. The expert panel examining additional sources of low cost abatement (the King Review) identified transport as one of the sectors with untapped potential for reducing emissions. The review noted that to date, the Emissions Reduction Fund has had limited success in incentivising emissions reductions in the sector. The reasons for this include: the complexity of abatement activities and lack of simple, accessible information; split incentives (such as freight clients paying fuel costs); and difficulties demonstrating that abatement is additional (beyond business as usual). The Government is working to increase participation in the Emissions Reduction Fund by speeding up the development of methods and reducing the costs of participation.

Previous road freight programs and studies have identified several challenges to improving energy efficiency in the sector. This includes limited reliable information on the impacts of energy productivity measures. Many small-medium road freight operators often lack the time and resources to build sufficient knowledge and experience on energy efficiency improvements to confidently make informed decisions.

Liquid fuels are projected to remain the most commonly used fuels in the heavy freight industry, due to their high energy-density and convenience to store and handle (CEFC and ARENA 2019; McKinsey 2018). Diesel is the primary liquid fuel used, with Australian diesel sales increasing by 38% between 2010-11 and 2019-20 (Commonwealth of Australia 2020b; Commonwealth of Australia 2019c).

Sustainable biofuels also could offer a low carbon alternative to liquid fuels that avoids the additional purchase depreciation and insurance costs of new vehicle technologies (CEFC and ARENA 2019). While greater use of sustainable biofuels can be a 'drop in' fuel for emissions reduction, the price premium over conventional fuels can be a barrier (Commonwealth of Australia 2019c). In the medium to longer term, hydrogen fuel cell electric vehicles could be used for long-distance freight due to advantages in range, weight and refuelling times compared to battery electric vehicles. As such they could complement battery electric vehicle use in larger, heavier vehicle applications and in longer-distance operations (BITRE 2019b).

In the short to medium term, conventional vehicles will continue to be the most popular and widely available vehicles in Australia. To support Australia's long-term fuel supplies, the Government has developed a comprehensive fuel security package. The Government's long-term fuel security goal is to enhance fuel security by increasing our domestic stockholdings and support a sovereign refining capability that meets our needs during an emergency, and into the future. This will secure our local industry's capabilities, while keeping fuel prices in Australia among the lowest in the OECD (Commonwealth of Australia 2019d).

Broad uptake of electric vehicles in fleets will bring emission reduction benefits. The Australian Government considers these emissions reduction benefits relative to their cost on an economy-wide basis. For example, the Emissions Reduction Fund was designed to reduce emissions at least cost and has a price of $16 per tonne. By comparison, bridging the total cost of ownership gap over the 10 year lifespan of a battery electric vehicle purchased today would be high and cost around $195-747 per tonne depending on vehicle type and usage (see Attachment A). This high cost of abatement will decline as the upfront price of battery electric vehicles reduces, but will likely remain a small factor in the cost of ownership. Consumers and fleet managers will choose these vehicles based on fuel cost savings and other benefits as the up-front price declines, rather than based on emissions.

Actions

The Strategy takes a 'fleets first' approach to help fast track battery electric and hydrogen fuel cell electric vehicles on the road more broadly.

The Future Fuels Fund will help businesses overcome barriers to incorporating new vehicle technology into their fleets (see 2.1). The $24.5 million Freight Energy Productivity Program will focus on increasing the energy productivity of heavy road freight businesses using existing liquid fuels and future fuels (see 2.2). Feedback on this paper will inform the rollout of the Fund and the Program.

2.1 Support businesses to incorporate new vehicle technology into their fleets through the Future Fuels Fund

The Future Fuels Fund will expand on the CEFC co-finance programs that targeted the needs of commercial fleet managers and private buyers to encourage low emissions vehicle purchases. The co-finance programs helped deploy more than 1,100 plug-in hybrid and battery electric vehicles (CEFC 2020).

The Future Fuels Fund will support businesses to trial new vehicle technologies and fuel options across the spectrum of fleet vehicles used in Australia, and help with infrastructure needs. The 'investment grade' information and lessons from these trials will be shared so other businesses can use it to inform their own investment decisions. Consultation on the commercial fleet component of the Future Fuels Fund will take place in early 2021.

CEFC's electric vehicle drive days

The CEFC has hosted electric vehicle drive days to showcase the ever-growing range of commercially available electric and hybrid vehicle models. Giving fleet managers and organisations a firsthand experience to test drive and learn more about plug-in hybrid and battery electric vehicles helps them make more informed decisions when investing in their future fleets.

2.2 Support road freight businesses to trial the latest technology and improve fleet productivity through the Freight Energy Productivity Program

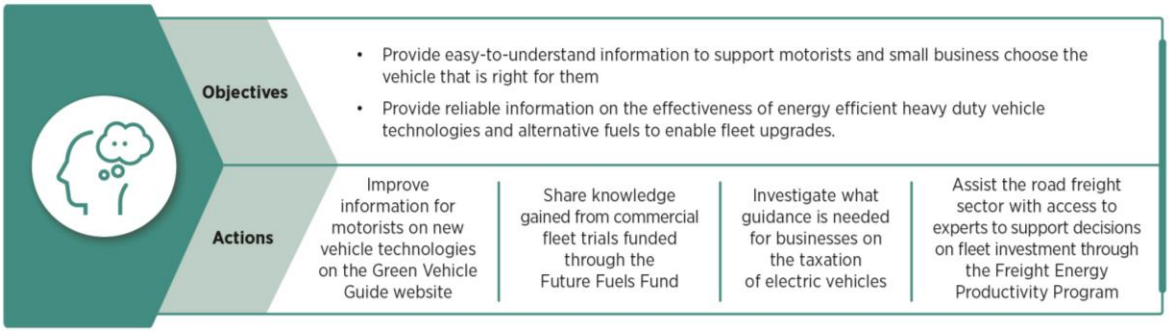
Road freight sector businesses will be supported through the Freight Energy Productivity Program. This program will help heavy road freight businesses assess and evaluate the benefits of new technologies. For example, these may include aerodynamic aids for trucks, new engine technologies (such as hybrid or electric drivetrains), alternative fuels, and telematics systems that aid more efficient driving and reduce fuel consumption. The competitive grants program can support efficiency improvements for diesel vehicle fleets as well as vehicle modifications or new vehicle technologies.

The Freight Energy Productivity Program will also trial more efficient heavy duty vehicle technologies and publicise the results. This will give businesses the evidence-base they need to justify investing in more energy efficient heavy-duty vehicle fleet technologies and vehicles. Testing could also verify the efficiency, performance and emissions impacts of biodiesel blends in conventional or hybrid trucks and evaluate maintenance concerns. Consultation on the Freight Energy Productivity Program will commence in 2021, with the first trial grants expected to start in the second half of 2021 through ARENA.

Early focus on commercial fleets – Questions

1. What are the main barriers to adding new vehicle technology into light and heavy duty vehicle fleets?
2. How could the Future Fuels Fund help address these barriers?
3. In what ways (other than direct funding) could the Government assist businesses to increase uptake of new vehicle technologies in their fleets?
4. What specific cost effective vehicle technologies should be trialled under the Freight Energy Productivity Program?

3. Improving information for motorists and fleets



Issues and opportunities

Historically, incremental developments in vehicle technology occurred at a pace motorists could easily understand, such as the introduction of seat belts or the phase-out of leaded petrol. However, battery and hydrogen fuel cell electric vehicles represent a step change in technology use and the way vehicles are fuelled. Technological advancements benefit motorists, but information barriers inhibit confidence and uptake.

Providing public information to support informed decision-making is a key priority for Australian governments (Transport and Infrastructure Council 2019). To support motorists and small businesses to choose the vehicles that are right for them, there is a need for trusted, factual information and data. Providing access to such information can improve motorists' confidence and reduce the risk of overinvesting in public charging and refuelling infrastructure (Evenergi 2019).

There is also a need for clear guidance on how new vehicle technologies are treated from a taxation perspective for those that use their vehicles for business purposes. For example, those considering purchasing an electric vehicle may not understand the tax treatment of electric vehicles as a business expense. This could be a barrier to electric vehicle uptake for potential buyers.

Actions

The Australian Government will ensure there is access to reliable, easy-to-understand information to help consumers make informed choices (see 3.1 and 3.3). Commercial fleet trials undertaken through the Future Fuels Fund will share 'investment grade' information for other businesses to use (see 3.2). The Freight Energy Productivity Program will connect heavy freight businesses with experts and share the energy efficient technology trial results (see 3.4).

3.1 Improve information for motorists on new vehicle technologies on the Green Vehicle Guide website

The Green Vehicle Guide website will be redeveloped and expanded to include information about new light vehicle technology available to buy in Australia. This will include information on the technology available, such as vehicle types, battery sizes, range, charging times, case studies, Australia's charging network, and on using biofuels. The Green Vehicle Guide will also include information on hydrogen fuel cell electric vehicles when they become available for private purchase.

Access to objective information to compare vehicle technologies will allow consumers, small-to-medium businesses and industry stakeholders to make informed choices. Market research will underpin the upgrade of the Green Vehicle Guide to ensure it provides the information people need.

3.2 Share knowledge gained from commercial fleet trials funded through the Future Fuels Fund

Fleet trials can establish credible real-world information on performance and costs. Through the Future Fuels Fund, the Government, trial participants and vehicle suppliers will work together to mitigate risks by publishing data and communicating results to help other businesses and motorists.

The Charge Together Fleet initiative

The Government, through ARENA, announced $460,000 of funding towards a $1.05 million Charge Together Fleet initiative. The project aims to help fleet managers build a business case for switching to battery electric vehicles. Developed by Evenergi in partnership with the Electric Vehicle Council, the initiative uses an online platform to educate businesses on charging their vehicles with renewable energy and petrol vehicle comparisons.

3.3 Investigate what guidance is needed for businesses on the taxation of electric vehicles

The Australian Taxation Office (ATO) provides advice on taxation to businesses and individuals. The Government, through the ATO, will investigate and issue updated guidance on the tax treatment of electric vehicles where appropriate. In particular, it will:

- monitor developments in the electric vehicle market and taxpayer requests
- assess where further public advice and guidance could be provided
- where possible, look to normalise electric vehicle expenses to internal combustion vehicle expenses in public advice.

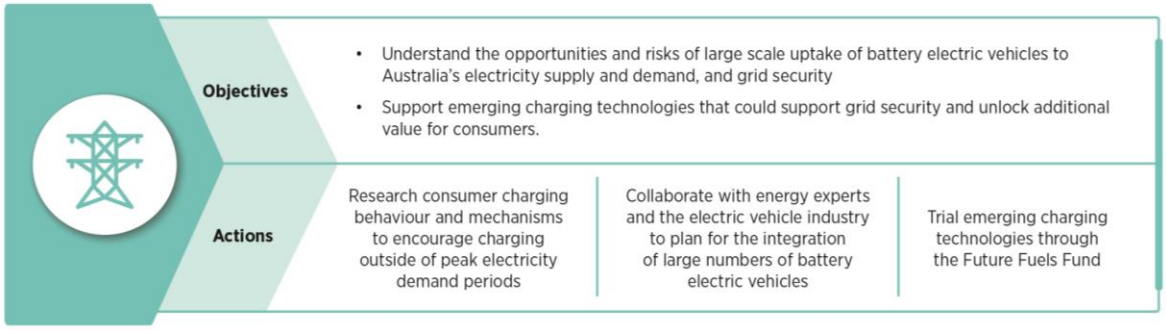
3.4 Assist the road freight sector with access to experts to support decisions on fleet investment through the Freight Energy Productivity Program

The Freight Energy Productivity Program will provide grant funding to develop 'investment grade' information for heavy freight businesses. The program will support road freight businesses to access experts with the skills and knowledge to test, assess and evaluate the benefits of new technologies. Outcomes of the trials will be published so the wider industry can accurately assess the benefits of new technologies.

Improving information for motorists and fleets - Questions

1. What is the most important information to provide to motorists and fleets about new vehicle technologies and future fuels?
2. What are the highest priority knowledge sharing areas to be targeted in future fleet trials?
3. What additional guidance do businesses need on technical or taxation matters in relation to new vehicle purchases?

4. Integrating battery electric vehicles into the electricity grid



Issues and opportunities

Battery electric vehicle charging offers a new form of flexible demand to support the electricity grid, if well-managed. However, without appropriate planning for large scale uptake, battery electric vehicles could add to 'network congestion' in peak periods and increase costs for consumers.

The overall supply and demand balance across the National Electricity Market (NEM) is not expected to be materially impacted from an increased uptake of battery electric vehicles in the coming decade. Figure 4 shows the estimated electricity demand on the NEM from battery electric vehicles at different rates of fleet penetration. The graph shows that even if 50% of the light vehicle fleet was battery electric, this would add around 9% to annual demand to the National Energy Market and the Western Australian Wholesale Energy Market (Commonwealth of Australia 2021; ABS 2020).

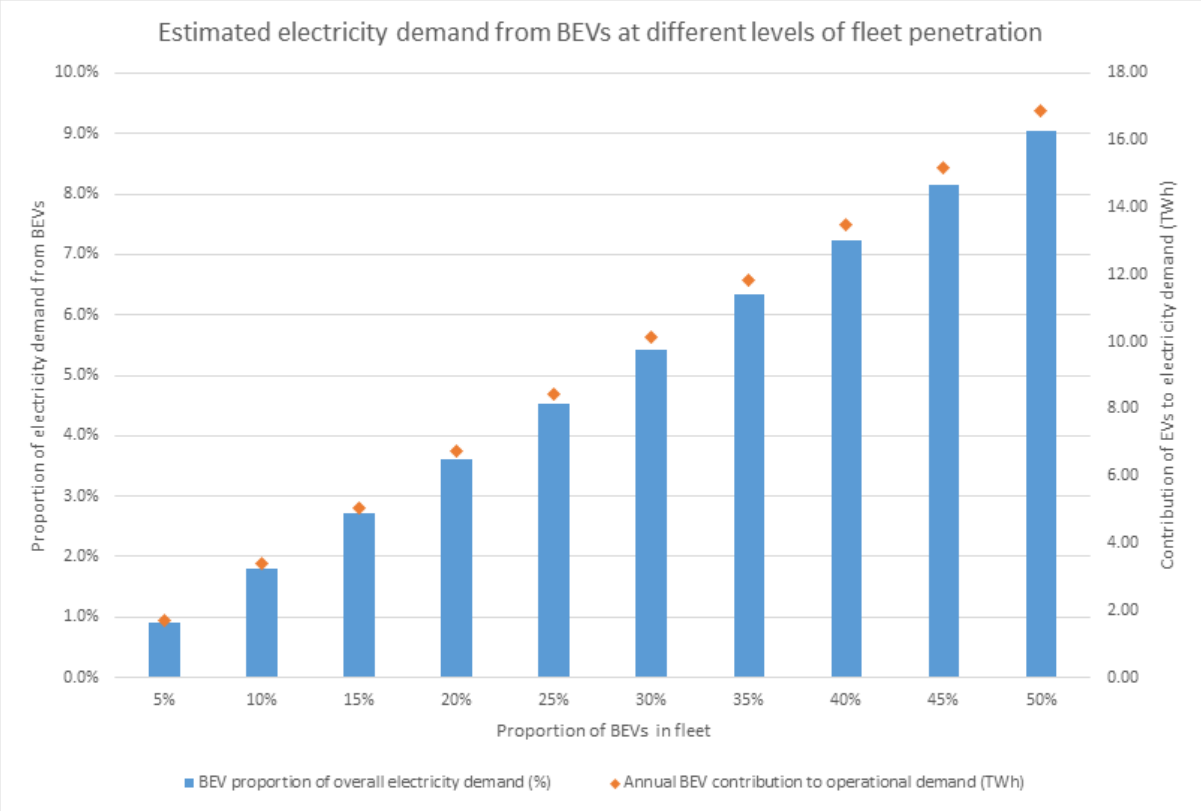


Figure 4: The impact of battery electric vehicle charging on annual electricity demand

However, an increased uptake of battery electric vehicles presents new challenges for grid managers. This is because a large amount of battery electric vehicles charging at the same time

could lead to 'network congestion' within the low voltage distribution network.[2] If charging behaviour increases demand in the daily peak periods between 5 pm and 8 pm, increased network investment may be required.

Battery electric vehicles are also mobile, which makes it harder to predict when, where and for how long they will charge on the network. Grid managers will need new data tools to better forecast battery electric vehicle charging. Internationally harmonised standards for electric vehicle chargers could also play a role, to ensure charging technology allows consumers to charge at optimum times for the grid.

Managed well, an increased uptake of battery electric vehicles could provide valuable grid support while unlocking benefits for consumers. This could be achieved by influencing charging behaviour (where, when and for how long) away from daily peak periods and towards lower demand periods. Shifting charging demand to low or minimum demand periods could help reduce or delay costly generation and network investments, benefitting all energy users by lowering wholesale energy prices.

Bidirectional charging technology, including vehicle-to-grid applications, could share excess electricity with the grid when it is needed. Battery electric vehicles have a large capacity that will rarely be completely required, as they typically spend about 95% of their lifetime parked (IEA 2019). This makes these vehicles an attractive option to charge during low demand, and discharge during times of peak demand to the home or the electricity grid. Bidirectional charging is at an early stage of technological development and further research is needed to understand implications for grid integration.

These solutions could be supported by work underway to incentivise grid support. The Australian Government, with state and territory governments, tasked the Energy Security Board to develop a design for a two-sided electricity market that could enable distributed energy resources, including battery electric vehicles, to contribute to system security and reliability, while improving market efficiency. A two-sided market would better value and reward the services provided by consumers, including load, generation and system services such as frequency control. This could provide significant benefits to energy users, traders, and the energy market and distribution network operators.

Another factor to consider is the need for public battery electric vehicles to charge quickly. Ultra-fast 350 kW (kilowatt) public chargers have unique impacts on distribution networks. These chargers can create high demand for short periods of time, but outside of these periods do not significantly draw on the network. The network tariff costs charged to companies who install ultra-fast chargers can affect commercial rates of return for charging operators while charger use is low. Stakeholders have differing views on the degree to which network tariff arrangements are cost-reflective and appropriate.

Actions

The Australian Government is committed to a coordinated approach to integrating battery electric vehicles with the grid. Through the Strategy, the Australian Government will take early action (see 4.1) to ensure battery electric vehicle uptake benefits the electricity grid and does not impose costs on other motorists or electricity consumers. To support this, the Government will collaborate with energy market experts and the electric vehicle industry to plan for large numbers of battery electric

2 The part of the network that typically delivers electricity to end consumers, operated at 240 V in Australia.

vehicles (see 4.2) and trial emerging charging technologies (see 4.3). Feedback on this paper, and recommendations from actions 4.1 and 4.2, will inform the Commonwealth's approach and discussions with state and territory energy ministers in 2021 to address issues on the integration of battery electric vehicles into the grid.

4.1 Research consumer charging behaviour and mechanisms to encourage charging outside of peak electricity demand periods

As part of the Future Fuels Package, the Government will undertake a study to better understand likely consumer behaviour. This will include mechanisms to encourage motorists to charge at periods of low demand to keep electricity prices low. Work on this study will occur throughout 2021.

JET Charge making battery electric vehicle charging smarter, cheaper and more user friendly

The CEFC is supporting JET Charge to develop smart charging technology and hardware, through a $3.5 million equity investment. JET Charge will reduce the cost of smart and connected charging stations and make them more user friendly. The proprietary technology will ensure battery electric vehicle charging occurs when the electricity grid can best support it and has the potential to match charging to times when renewable power generation is high.

4.2 Collaborate with energy experts and the electric vehicle industry to plan for the integration of large numbers of battery electric vehicles

The Government is working collaboratively to consider the large scale charging demand of battery electric vehicles in the electricity grid. ARENA, AEMO and the Electric Vehicle Council are leading the Distributed Energy Integration Program's (DEIP) Electric Vehicle Grid Integration Working Group. This group brings together key representatives from electricity peak bodies, energy market authorities, the vehicle industry, and consumer associations. The Government, through the Department of Industry, Science, Energy and Resources and ARENA, is a founding member.

The DEIP Electric Vehicle Working Group will see the industry working together on issues related to the integration of battery electric vehicles with electricity grids. In 2020, the Working Group led work to improve data availability, investigate grid integration standards for battery electric vehicles, and explore new tariff designs that encourage efficient network usage.

4.3 Trial emerging charging technologies through the Future Fuels Fund

The Government is supporting emerging charging technology trials through ARENA. Bidirectional charging, including vehicle-to-grid and vehicle-to-home applications, offer the potential for battery electric vehicles to serve as distributed energy storage. Lessons learned from these trials will help to reduce the commercial, technological and behavioural barriers to large scale uptake.

Through the Future Fuels Fund, ARENA will continue to co-invest in projects that help demonstrate emerging charging technologies that support the grid and provide benefits for consumers. Consultation on this component of the Future Fuels Fund will take place in 2021.

World-leading vehicle-to-grid and smart charging trials

The Government, through ARENA, is supporting several world-leading vehicle-to-grid and smart charging trials, including:

- $2.4 million in funding to ActewAGL for the Realising Electric Vehicle-to-Grid Services project to demonstrate vehicle-to-grid services in Australia. The project will deploy 51 Nissan LEAF battery electric vehicles to provide ancillary services to the National Electricity Market.
- $838,000 in funding to Origin Energy to trial electric vehicle smart charging across the National Electricity Market. The $2.9 million trial will evaluate the benefits of and barriers to controlled smart charging, to encourage future participation in charge management programs.
- $2.9 million in funding to the AGL Electric Vehicle Orchestration Trial. The trial will orchestrate the charging of 300 vehicles across Queensland, New South Wales, Victoria and South Australia to show the benefits battery electric vehicles can bring to the grid.

Integrating battery electric vehicles into the grid - Questions

1. What are the highest priority issues to consider when integrating large numbers of battery electric vehicles into the electricity grid?
2. What further action is needed to ensure consumers and the electricity grid can benefit from bidirectional charging technology?
3. What are the opportunities for tariff innovation or reform to support the rollout of public charging infrastructure?
4. How could motorists be incentivised to charge their battery electric vehicles outside periods of high electricity demand to help keep prices low?

5. Supporting Australian innovation and manufacturing

Issues and opportunities

Australian vehicle technology and manufacturing companies are focusing on niche markets where Australia can leverage its comparative advantages to drive growth. Enabling opportunities across the Australian automotive industry value chain to maximise a high-value export industry is important. The Australian industry has a skilled workforce in automotive design and system integration, mining of critical minerals, and component manufacturing. Australian vehicle component manufacturers are already exploiting opportunities with their recognised expertise across vehicle components, batteries, fast charging systems, battery cooling technologies, lightweight vehicle body components and high performance materials such as carbon fibre. Australian industry also has capabilities in heavy truck and bus and manufacture and assembly, including trailers and components.

Through Australia's established research institutions including the Cooperative Research Centres (CRC) Program, support is being provided to the Australian electric vehicle value chain. The Future Battery Industries CRC and Innovative Manufacturing CRC are delivering technology outputs being commercialised by industry.

Australian made

There are a broad spectrum of electric vehicle technology and manufacturing companies in Australia with growth potential in future fuel technologies. For example:

Tritium: a designer and manufacturer of direct current (DC) fast charging infrastructure, is exhibiting global leadership in their field, gaining significant market share in Australia, New Zealand, Norway, the United States of America and the United Kingdom. Their Brisbane headquarters now employs almost 200 staff to meet their growing demand, with a diverse range of skills spanning high tech engineering, automotive processes and manufacturing.

Nissan Casting Australia: in Dandenong, Victoria, Nissan Casting Australia has positioned itself as the 'mother plant for electric vehicle parts' globally within the Renault-Nissan-Mitsubishi Alliance. It has been at the forefront of the manufacturing transition from internal combustion to electric vehicle powertrain manufacturing.

Australian Clean Energy Electric Vehicle (ACE-EV) Group: the Australian Government is supporting domestic battery electric vehicle manufacturing through a $5 million grant to ACE-EV Group for an advanced manufacturing facility and vehicle-to-grid trial.

Actions

5.1 Support next generation technologies through ARENA

The Strategy will support the Technology Investment Roadmap to accelerate the development of low emissions technologies. The Australian Government will continue to provide ARENA funding for projects to drive research, development and innovation. This includes investments in novel sustainable biofuel feedstock plants and hydrogen based fuels to demonstrate their commercial potential.

5.2 Support Australian manufacturing and innovation through the Modern Manufacturing Strategy

In the 2020-21 Budget, the Government announced a $1.5 billion Modern Manufacturing Strategy. The Modern Manufacturing Strategy is part of the Government's JobMaker plan and will help Australian manufacturers build scale, competitiveness and resilience by focusing on six national manufacturing priorities. This includes sectors where there may be opportunities to support future transport-related opportunities, such as resources technology and critical minerals processing, recycling and clean energy, and defence.

Modern Manufacturing Initiative

A key component of the Modern Manufacturing Strategy is the $1.3 billion *Modern Manufacturing Initiative* (MMI). The MMI will co-fund large manufacturing projects that have broad benefits beyond individual businesses and support the National Manufacturing Priorities through three targeted streams:

- the *Manufacturing Collaboration Stream* will provide funding for very large projects that support business-to-business and business-to-research collaboration, to build economies of scale
- the *Manufacturing Translation Stream* will help manufacturers translate good ideas into commercial outcomes and invest in non-R&D innovation
- the *Manufacturing Integration Stream* will help manufacturers integrate into local and international supply chains and markets.

Supporting Australian innovation and manufacturing - Question

1. What are Australia's market niches in future fuels to maximise high-value domestic and export outcomes?

Other Australian Government activities underway

The Australian Government is undertaking a range of activities that complement the five priority initiatives.

Considering the revenue implications of new technology vehicles

Australian and state governments collect levies, fees and charges from all vehicles. The largest contributor to road-related revenue is the Australian Government's fuel excise. After allowing for estimated Fuel Tax Credits, the net gain to the underlying cash balance from the fuel tax system is expected to be $11.4 billion in 2020-21.

The South Australian and Victorian governments announced their intentions to introduce a road user charge for low and zero emissions vehicles as part of their respective 2020-21 Budgets.

At the November 2019 Infrastructure and Transport Ministers Meeting, ministers committed to consider the revenue implications of new technology vehicles. The Australian Government continues to work collaboratively with jurisdictions on this matter.

Consulting on improved noxious emissions standards for light and heavy vehicles

Global manufacturers are developing new vehicle and engine technologies to lower emissions. This includes turbocharged petrol engines with advanced direct injection fuelling systems, and hybrid and electrified powertrains (National Transport Commission 2020).

Australia mandates the Euro 5 and Euro V noxious emissions standards. The Department of Infrastructure, Transport, Regional Development and Communications (DITRDC) is consulting on the introduction of improved noxious emissions standards for both light and heavy duty vehicles (known as Euro 6 and Euro VI respectively).

In October 2020, DITRDC released draft Regulation Impact Statements (RISs) that evaluate whether the Government should mandate Euro 6 and Euro VI in Australia (Commonwealth of Australia 2020c). Comments on the draft RISs are requested to be provided to DITRDC by 26 February 2021.

Evaluating international standards and lessons from overseas experience of installing public charging infrastructure

Activities across Government are drawing on lessons learnt from overseas.

The Infrastructure and Transport Ministers Meeting work program is also working to:

- streamline payment options for charging battery electric vehicles
- integrate electric vehicles into registration data, and
- develop guidelines to support the installation of charging and refuelling infrastructure, and national signage standards to help identify charging and refuelling infrastructure.

DITRDC is leading work to consider whether to adopt international standards around Acoustic Vehicle Alerting Systems for hybrid, battery electric and hydrogen fuel cell electric vehicles.

Harmonising the measurement of battery electric vehicle charging

The National Measurement Institute (NMI) develops and maintains physical measurement standards to underpin the measurement of energy by battery electric vehicle charging stations. The NMI is chairing an international technical committee to develop a harmonised standard for the measurement of energy by battery electric vehicle charging stations. This work is part of an

International Organisation of Legal Metrology (OIML) project that is updating the standard for electricity meters (OIML R 46) to provide greater support for new technology. The NMI is engaging with industry and consumers to ensure the standard serves Australia's needs.

Leveraging the Bioenergy Roadmap

Biofuels offer opportunities for emissions reduction, particularly for heavy duty vehicle fleets. Biofuels contribute around 0.4% of transport fuel consumption in Australia (Commonwealth of Australia 2020d). Low oil prices, performance concerns and the low availability of biofuels have made it hard for fleet operators to take advantage of these opportunities.

The Minister for Energy and Emissions Reduction requested ARENA to develop a Bioenergy Roadmap. This Roadmap will investigate ways the bioenergy sector can stimulate regional development, enhance energy security and help Australia further reduce its emissions. Biofuel trials in vehicle fleets will be eligible for support from the Future Fuels Fund, where Government support is necessary to undertake projects that will provide information from which other businesses can learn.

Funding research to assess domestic opportunities for future transport fuels

Alternative energy sources for transport could reduce import requirements of liquid fuels, diversify fuel options and create opportunities for Australian businesses (Commonwealth of Australia 2019c).

As part of the Future Fuels Package, the Australian Government will fund research to model Australia's future transport fuel mix. This work will take place in 2021. The results will help inform Australia's long term liquid fuel security, including the delivery of the Government's fuel security package, to ensure Australians have access to fuel when they need it.

Glossary

Battery electric vehicle (BEV): An electric vehicle that exclusively uses chemical energy stored in rechargeable battery packs to power at least one electric motor with no secondary source of propulsion.

Bidirectional charging: A blanket term covering both vehicle-to-home (behind the meter), and vehicle-to-grid (V2G) (exporting electricity from a battery electric vehicle battery to the electricity grid).

Biofuels: Biofuels are a class of renewable energy derived from living materials. The most common transport biofuels are ethanol, biodiesel and renewable diesel.

Charging / recharging: The process of restoring electrical energy in a battery or a battery-operated vehicle by connecting it to a power supply.

Conventional internal combustion engine (ICE) vehicle: A conventional vehicle is a vehicle with only an internal combustion engine system.

Electric vehicle: For the purposes of the Strategy, the term 'electric vehicle' includes battery electric vehicles, plug-in hybrid electric vehicles and hydrogen fuel cell electric vehicles.

Fleet vehicle: A vehicle owned or leased by a business.

Hybrid vehicle: A hybrid vehicle combines a conventional internal combustion engine (ICE) system with a battery electric propulsion system (hybrid vehicle drivetrain). The batteries in a hybrid vehicle are recharged by its on-board engine and generator only.

Hydrogen fuel cell electric vehicle (FCEV): An electric vehicle that uses electricity from a fuel cell powered by compressed hydrogen, rather than electricity from batteries.

Green Vehicle Guide: The Australian Government's website that provides information about the environmental performance of new light vehicles sold in Australia.

Heavy duty vehicle: Vehicles with over 4.5 tonnes gross vehicle mass.

Last mile delivery: In a product's journey from warehouse shelf to customer doorstep, the "last mile" of delivery is the final step of the process.

Light vehicle: A vehicle of up to 3.5 tonnes gross vehicle mass.

Light commercial vehicle: Motor vehicles constructed to carry goods or specialised equipment that are less than or equal to 3.5 tonnes gross vehicle mass, such as utility vehicles, panel vans, cab chassis vehicles and goods vans.

Plug-in hybrid electric vehicle (PHEV): A hybrid electric vehicle whose battery can be recharged by plugging it into an external source of electric power, as well as by its on-board engine and generator.

Public charging: Electric vehicle charging at facilities that are available to the general public, as opposed to private charging facilities with limited access.

Zero emissions vehicles: Vehicles that are able to operate with zero tailpipe emissions. Lifecycle emissions depend on the emissions intensity of the electricity or fuel supplied to the vehicle.

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Attachment A: Cost walk – Total cost of ownership comparison

The Government is optimistic that the total cost of ownership (TCO) gap between battery electric vehicles and internal combustion engine vehicles will further close as costs decline, technology improves and mass production increases. This has already happened with hybrid vehicles, which has resulted in more Australians choosing this new vehicle technology. However, the pace of this cost reduction for other technologies is dependent on several factors, including reduction in the cost of new vehicle technologies and manufacturing, vehicle type (for example, battery size) and consumer driving behaviour (for example, commercial fleet use versus private use).

Table 1 shows the path for battery electric and hybrid vehicles to reach TCO parity with conventional petrol vehicles under private, fleet and commercial use scenarios. In high use cases, hybrid vehicles already have a lower cost of ownership than conventional vehicles. Fuel savings and maintenance costs of battery electric vehicles already bridge some of the gap to conventional petrol vehicles. Forecast reductions in the upfront prices in the coming years could make battery electric vehicles a rational economic choice, particularly for light vehicles in business fleets.

The following cost walk through table is for **illustrative** purposes only. The outcomes of individual examples would depend on many factors. Detail on the methodology for the table is at the end of this attachment.

Table 1: Cost walk through examples

Vehicle type and model	TCO ICE vehicle ($ per km)	TCO BEV / Hybrid ($ per km)	Additional cost for BEV / Hybrid ($ per km)	BEV / Hybrid savings ($ per km)			Remaining TCO gap for BEV / Hybrid ($ per km)	Cost to abate $ per tonne)
				Fuel savings	Maintenance savings	Carbon credit benefit		
Small private vehicle Toyota Corolla (ICE) vs Nissan Leaf (BEV)	0.655	0.988	0.332	0.035	-0.008	0.001	0.304	531
Small private vehicle Toyota Corolla (ICE) vs Toyota Corolla (Hybrid)	0.669	0.671	0.002	0.026	0.000	0.001	-0.025	3.60
Small fleet vehicle Toyota Corolla (ICE) vs Nissan Leaf (BEV)	0.329	0.451	0.122	0.035	-0.008	0.001	0.095	195
Small fleet vehicle Toyota Corolla (ICE) vs Toyota Corolla (Hybrid)	0.241	0.223	-0.018	0.026	0.000	0.001	-0.045	-29
Small light commercial vehicle Renault Kangoo (ICE) vs Renault Kangoo (BEV)	0.730	1.198	0.467	0.046	0.030	0.001	0.390	747

As shown in Table 1, some hybrid vehicles are already cost effective when used as a fleet vehicle. Because of this, the Australian taxi industry has driven uptake of hybrids to the point that taxi fleets are mostly hybrid vehicles (Drive 2020). The price premium for hybrid vehicles has declined over time, so even private vehicle purchasers are able to offset this price premium within 2 to 5 years, depending on distance travelled. Cost competitiveness has led to hybrid versions of some vehicle models growing from 6-20% of sales in 2017 to 50-70% in 2020 (Toyota 2019, Toyota 2021). Similarly, as the price of battery electric vehicles becomes more competitive, these could become the rational economic choice for private and fleet buyers.

There is a carbon credit value of 0.1 cents per kilometre shown in Table 1: Cost walk through examples that represents the value of carbon credits from substituting conventional vehicles with battery electric or hybrid vehicles, at an assumed Emissions Reduction Fund price of $16 per tonne of carbon emitted. This value is based on replacing a conventional petrol vehicle with a battery electric vehicle charged at the projected average grid emissions intensity over the next 5 years. Electricity grid emissions are projected to continue declining in the future (Commonwealth of Australia 2020a).

Table 2 shows there is still a significant cost of ownership gap over the life of an electric vehicle. Bridging the total cost of ownership gap over the 10 year lifespan of a battery electric vehicle purchased today would cost an estimated $195-747 per tonne. This translates to around $4,500 to $8,000 over the life of the vehicle (excluding hybrids), or around 10-40 cents per kilometre over a 10 year vehicle life.

For hybrids, in the fleet usage example, there is no longer a total cost of ownership gap. In comparison to an electric vehicle, the abatement cost of a small private hybrid vehicle is much smaller at $3.60 per tonne. This translates to only $30.60 over the life of the vehicle.

The high cost of abatement for electric vehicles will decline as the upfront price of battery electric vehicles reduces. Providing Government subsidies for battery electric vehicles at this high cost would not represent value-for-money for taxpayers compared to the Emissions Reduction Fund price of $16 per tonne. Similarly, introducing policy to phase out or ban internal combustion engine vehicles would limit consumer choice, preventing Australians from driving the vehicles they prefer.

Table 2: Cost of carbon abatement and Total Cost of Ownership gap

Vehicle type and model		Abatement cost ($ per tonne)	Total cost of ownership gap ($)
Small private vehicle	Toyota Corolla (ICE) vs Nissan Leaf (BEV)	531	4,555
	Toyota Corolla (ICE) vs Toyota Corolla (Hybrid)	3.60	30.60
Small fleet vehicle	Toyota Corolla (ICE) vs Nissan Leaf (BEV)	195	6,264
	Toyota Corolla (ICE) vs Toyota Corolla (Hybrid)	-29	-937
Small light commercial vehicle	Renault Kangoo (ICE) vs Renault Kangoo (BEV)	747	7,980

This analysis shows why the Government is focusing on closing the gap through technological improvements and consumer choice. Measures as part of the five priority initiatives including prioritising the roll out of charging and refuelling infrastructure, taking an early focus on supporting uptake in commercial fleets and improving information for consumers will be the best way forward for all Australians.

Methodology

The total cost of ownership of vehicles is dependent on the costs of financing and operating the vehicle. Analysis of the total cost of ownership in Table 1: Cost walk through examples accounts for financing costs for the full purchase price of the vehicle over 5 years, plus allowance for depreciation of commercial vehicles. Depreciation for private vehicles is not considered in these charts. The total cost also includes fuel costs, maintenance and registration costs based on owning a vehicle in New South Wales. The analysis is based on an average annual distance of 13,700 kilometres for private vehicles, 17,100 kilometres for light commercial vehicles (ABS 2019) and an estimated 51,300 kilometres for fleet vehicles.

While vehicle models were chosen to provide equivalent specifications, costs of ownership varies with choice of models. Insurance costs have not been included in the analysis and depreciation rates are assumed to average 12.5% annually for commercial vehicles.[3] Electricity costs are assumed at $0.30/kWh, compared to $1.43/litre for petrol.[4] Financing estimates are from CANSTAR (2020).[5] Costs do not account for any bulk discounts.

For Figure 5 and Figure 6 below, the emissions of the Nissan Leaf battery electric vehicle charging in different jurisdictions and grids was calculated using emissions factors for Australia's electricity grids, averaged over the period of 2021 to 2025 (Commonwealth of Australia, 2020a).[6] Emissions for the conventional and hybrid vehicles and battery electric vehicle energy consumption (Wh/km) were sourced from the Green Vehicle Guide (Commonwealth of Australia, 2021). In Figure 6, the cost of abatement by jurisdiction and grid was calculated using the abatement cost for the Nissan Leaf battery electric vehicle compared to conventional and hybrid Toyota Corollas.

Comparison of emissions

Hybrid vehicles have immediate emissions reduction benefits across many areas of Australia, even compared to battery electric vehicles. Figure 5 shows consumers will have a lower emissions impact driving a hybrid over a battery electric vehicle in New South Wales, Victoria, Queensland and the Australian Capital Territory. Only in South Australia and Tasmania does driving a battery electric vehicle have a significantly lower emissions impact.

3 Based on the ATO's straight line method. See, for example, https://atotaxrates.info/tax-deductions/work-related-car-expenses/depreciation-of-vehicles/

4 In 2019, electricity was $0.30/kWh (AEMC 2019) and a litre of petrol was $1.43 (BITRE 2019a). This equates to ~$3.50/100 km for an electric vehicle compared to between $8 and $12/100 km for a small to large ICE vehicle.

5 Borrowing the whole vehicle price through NRMA over 5 years.

6 see table 'Indirect Scope 2 and 3 combined emissions factors, tonnes CO2-e per MWh'. The Green Vehicle Guide includes Scope 3 emissions for ICE vehicles.

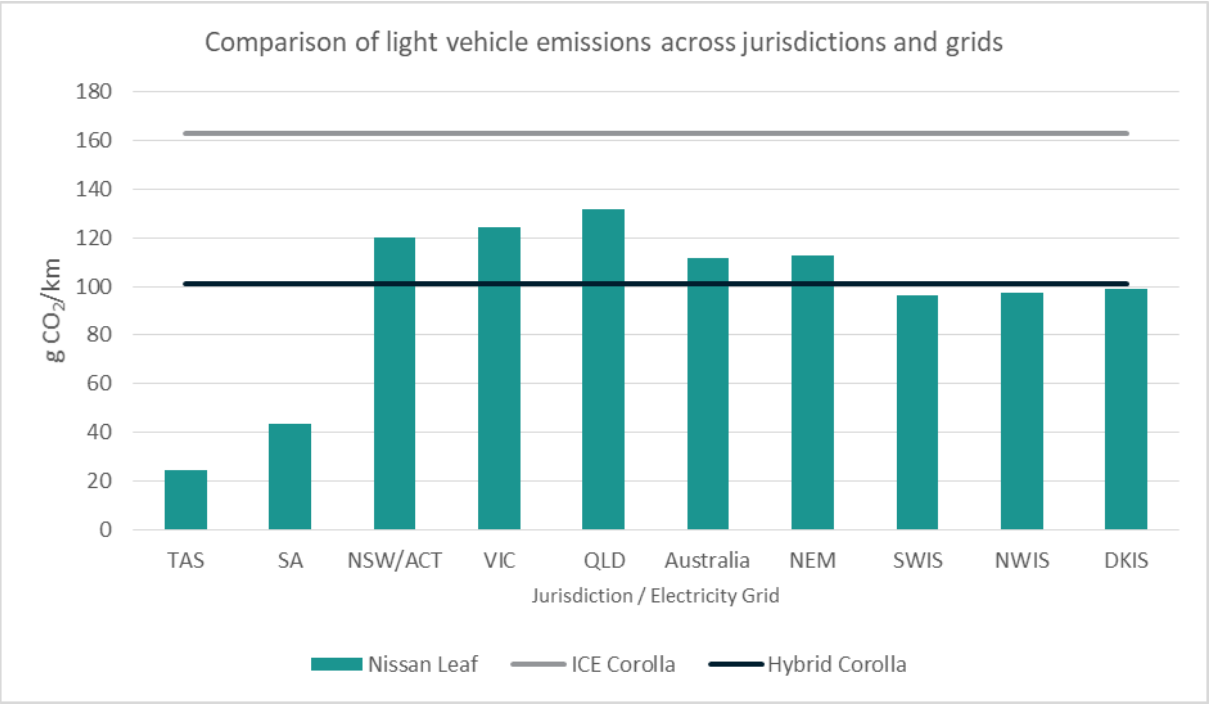
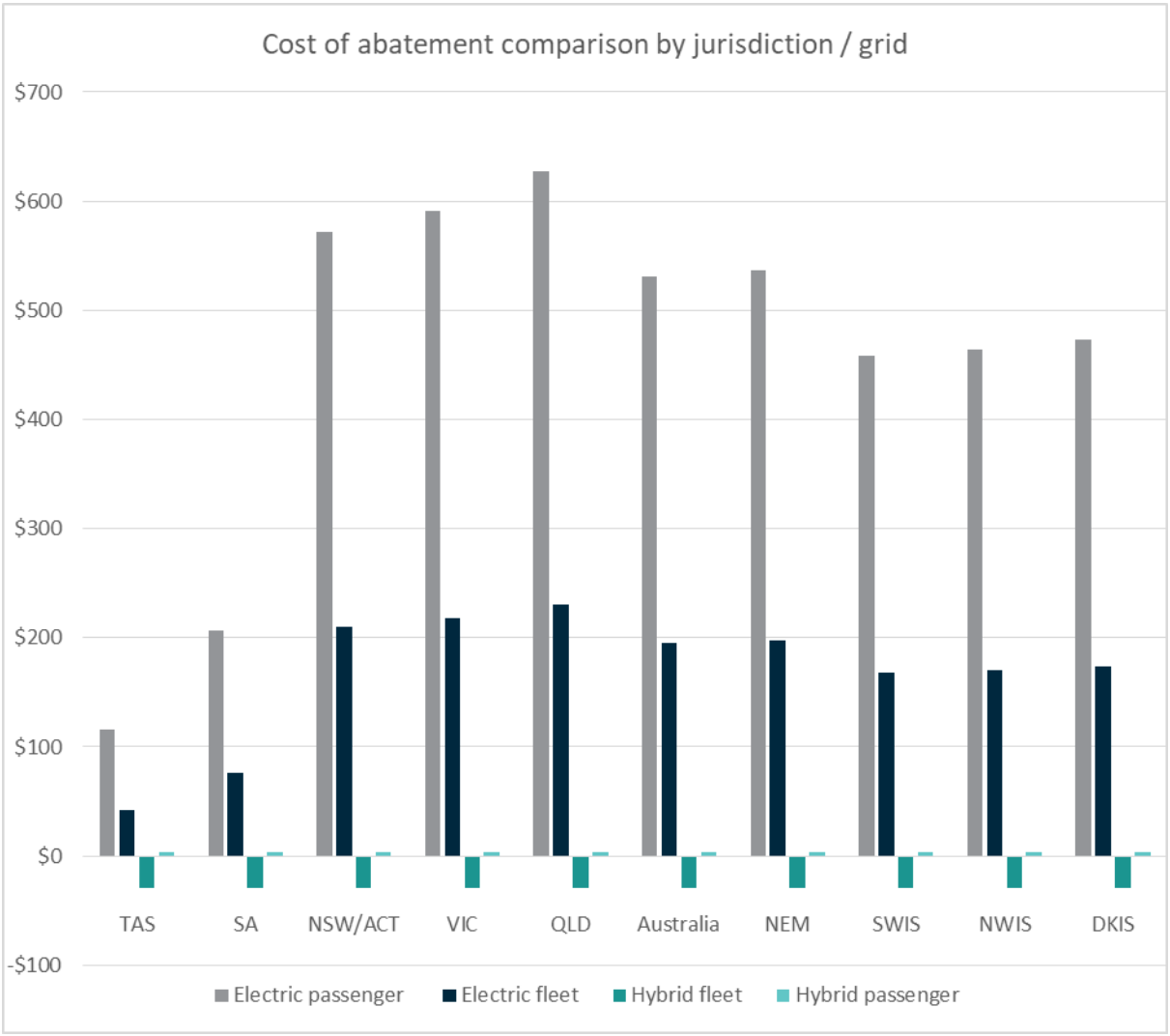


Figure 5: Comparison of light vehicle emissions across Australian jurisdictions and grids



Vehicle type	TAS	SA	NSW /ACT	VIC	QLD	Aus	NEM	SWIS	NWIS	DKIS
Electric passenger	$115.7	$207.0	$572.1	$591.6	$627.5	$531.3	$536.2	$458.0	$464.5	$472.7
Electric fleet	$42.5	$76.1	$210.3	$217.5	$230.7	$195.4	$197.2	$168.4	$170.8	$173.8
Hybrid fleet	-$29.0	-$29.0	-$29.0	-$29.0	-$29.0	-$29.0	-$29.0	-$29.0	-$29.0	-$29.0
Hybrid passenger	$3.6	$3.6	$3.6	$3.6	$3.6	$3.6	$3.6	$3.6	$3.6	$3.6

Figure 6: Cost of abatement comparison ($/tonne) by jurisdiction / grid

Attachment B: Electric vehicle models in the Australian market, December 2020

Table 3 shows Australians currently have access to 50 electric vehicle models including 21 hybrid vehicles, 16 plug-in hybrid vehicles and 13 battery electric. A number of these models also come in different battery and power specifications. Six battery electric models, 4 plug in hybrids and 18 hybrid models are available under $65,000.

Table 4 shows the new electric vehicles that may be available in Australia in the near future, including 2 hydrogen fuel cell vehicles, although these will not be for sale to the public.

Table 3: Hybrid and electric vehicles available in Australia, December 2020[7]

Brand	Models*	BEV/FCEV/ PHEV/ Hybrid	Size	Battery Range (km)	Price**	Comparable ICE Powered Vehicle^	Comparable ICE price
Audi	e-tron Quattro 50	BEV	SUV	336	$137,100	Audi Q7 50 TDI Quattro	$112,900
	e-tron Quattro 55	BEV	SUV	436	$169,950	Audi Q7 50 TDI Quattro	$112,900
BMW	330e	PHEV	Sedan	60	$77,257	BMW 3 Series 320i	$68,900
	i8	PHEV	Sports	55	$318,900	2020 BMW M8	$354,900
	i3	BEV	SUV	260	$70,900	BMW1 Series 118i	$51,208
MINI	Countryman	PHEV	Mini	19	$57,200	MINI Countryman	$50,662
Honda	Accord VTi-LX	Hybrid	Sedan	N/A	$50,490	Honda Accord VTi-LX	$47,990
Hyundai	Ioniq (2)	PHEV/BEV	Sedan	63-311	$42,410 – $48,970	Elantra Sport	$35,412
	Kona (2)	BEV	SUV	449	$60,140 – $64,490	Hyundai Kona Highlander	$40,200
	Ioniq Hybrid	Hybrid	Hatch	N/A	$35,140	Hyundai Kona Highlander	$40,200
Jaguar Land Rover	I PACE	BEV	SUV	470	$119,000	E-PACE	$62,730
	Range Rover	PHEV	SUV	48	$128,200 – $175,101	Range Rover Sport	$97,729 –$179,401
Lexus	CT 200h	Hybrid	Hatch	N/A	$47,575	BMW 1 Series 118i M Sport	$46,990
	ES 300h	Hybrid	Sedan	N/A	$60,488	Lexus IS 300	$60,500
	IS 300h	Hybrid	Sedan	N/A	$63,500	Lexus IS 300	$60,500
	UX 250h	Hybrid	Luxury SUV	N/A	$52,958	Lexus UX200 Luxury	$55,500
	LC 500h	Hybrid	Luxury Coupe	N/A	$190,350	Lexus LC LC500 Auto	$189,792
	LS 500h	Hybrid	Luxury Sedan	N/A	$194,388	Lexus LS 500 Sports Luxury Sedan	$194,136
	NX 300h	Hybrid	SUV	N/A	$58,200	Lexus NX 300 2WD	$55,700
	RX 450h	Hybrid	SUV	N/A	$91,090	Lexus RX450hL Luxury Auto 4x4	$93,858
Mercedes Benz	EQC	BEV	SUV	434	$137,900	Mercedes-Benz GLC-Class GLC43 AMG	$110,892
	A250e	PHEV	Hatch/ Sedan	73	$62,000 – $64,600	Mercedes A250	$50,700 – $59,700
	C300e	PHEV	Sedan	52	$82,300	Mercedes C-Class C300 Auto	$74,200
	GLC300e	PHEV	SUV	46	$83,500	Mercedes GLC300	$79,335

7 Based on 2020 models as at 17 December 2020 and represent the entry-level new vehicle price provided by manufacturers (Redbook.com.au).

Brand	Models*	BEV/FCEV/ PHEV/ Hybrid	Size	Battery Range (km)	Price**	Comparable ICE Powered Vehicle^	Comparable ICE price
	E300e	PHEV	Sedan	50	$119,600	Mercedes E- Class E300	$113,936
Mitsubishi	Outlander	PHEV	SUV	54	$47,390	Mitsubishi Outlander ES ZL	$30,490
Nissan	Leaf	BEV	Small car	270	$49,990	Toyota Corolla SX	$32,014
	Pathfinder ST	Hybrid	SUV	N/A	$62,140	Nissan Pathfinder ST	$48,840
Porsche	Cayenne E-hybrid	PHEV	Wagon	42 – 44	$136,700	Porsche Cayenne S 9YA	$156,200
	Panamera E-Hybrid	PHEV	Sedan	50 - 51	$252,400	Porsche 911 Carrera S 992	$264,600
Renault	Kangoo MAXI	BEV	Light commercial van	200	$49,990	Renault Kangoo Compact SWB	$25,990
Subaru	XV Hybrid	Hybrid	SUV	N/A	$35,580	Subaru XV2.0 AWD	$31,610
	Forester Hybrid	Hybrid	SUV	N/A	$39,990	Subaru Forester AWD 2.5i S5 Auto	$35,190
Tesla	Model S	BEV	Sedan	490 - 660	$119,990 – $189,990	Porsche Panamera 4	$219,200
	Model X	BEV	SUV	425 - 575	$138,990 – $153,990	2020 BMW X7	$133,900 - $179,900
	Model 3	BEV	Sedan	460 – 560	$66,900 – $102,469	BMW 3 Series 320i 2020 BMW M3	$65,900 $154,900
Toyota	Yaris SX Hybrid	Hybrid	Hatch	N/A	$29,020	Toyota Yaris SX	$27,020
	Corolla Hybrid	Hybrid	Hatch/ Sedan	N/A	$27,395	2020 Toyota Corolla Ascent Sport Auto	$25,395
	Camry Hybrid	Hybrid	Sedan	N/A	$31,790	Toyota Camry	$28,990
	Prius	Hybrid	Hatch	N/A	$37,890	Toyota Corolla SX Auto	$32,014
	Prius V	Hybrid	Wagon	N/A	$37,590	Toyota Corolla SX Auto	$28,795
	RAV4 Hybrid	Hybrid	SUV	N/A	$36,790	Toyota RAV4 GX	$32,290
	C-HR Koba	Hybrid	SUV	N/A	$37,665	Koba C-HR	$34,690
	Yaris Cross	Hybrid	SUV	N/A	$28,990	Toyota Yaris SX	$27,020
Volvo	XC90 T8	PHEV	Sedan	45	$114,990	Volvo XC90 T6	$96,990
	XC60 T8 Polestar	PHEV	SUV	45	$98,990	Volvo XC60 T6 R-Design	$78,990
	S60 T8	PHEV	Sedan	49	$84,990	Volvo S60 T5 R-Design	$64,990
	V60 T8	PHEV	Wagon	49	$86,990	Volvo V60 T5 Momentum	$56,990

Table 4: Hybrid and electric vehicles which may be available in Australia in the near future

Brand	Models	BEV/ FCEV/ PHEV/ Hybrid	Size	Battery Range (km)	Indicative Price[#]	Comparable ICE Vehicle^	Comparable ICE price
MINI	Mini electric	BEV	Mini	270	$54,800	Mini Countryman Classic Auto	$50,662
BMW	iX	BEV	SUV	> 600	TBC	BMW1 Series 118i M Sport	$51,208
Lexus	UX300e	BEV	SUV	400	TBC	Lexus UX200	$52,958
MG	ZS EV	BEV	SUV	262	$46,990	MG ZS Essence Auto 2WD	$29,490
Nissan	Leaf e+	BEV	Small car	384	TBC	Toyota Corolla SX Auto	$32,014
Mazda	MX-30	BEV	SUV	224	TBC	Mazda CX-30	$29,980
Porsche	Taycan	BEV	Sedan	365 – 420	$190,400 – 338,500	Porsche 911 Carrera 992	$258,200
Volvo	XC40	PHEV/BEV	SUV	46 – 400	$64,990	Volvo XC-40	$54,114
	Polestar 2	BEV	Wagon	500	$95,050	Volvo S60 T5	$64,990
Hyundai	Santa Fe Hybrid	Hybrid	SUV	N/A	TBC	Hyundai Santa Fe	$44,990
	Kona EV	BEV	SUV	484	$64,490	Hyundai Kona Highlander	$40,200
	Ioniq 5	BEV	SUV	TBC	TBC	Elantra Sport Auto	$35,412
	Nexo[***]	FCEV	SUV	666	TBC	Hyundai Tucson	$29,990
Kia	Sorento	Hybrid/ PHEV	SUV	480	TBC	Kia Sorento	$43,690
	e-Niro/e-Soul	BEV	SUV	TBC	TBC	Kia Sportage	$29,790
Tesla	Model Y	BEV	SUV	505	TBC	BMW X3 M40i	$111,900
Toyota	Kluger hybrid	Hybrid	SUV	N/A	TBC	Toyota Kluger	$51,098
	Mirai[***]	FCEV	Sedan	> 600	TBC	BMW1 Series 118i M Sport	$51,208
Volkswagen	ID.4	BEV	SUV	520	TBC	Tiguan 162TSI Highline Allspace	$53,190

[*]Some models have been combined due to the range of model configurations available. Every individual model may not appear in this list.

[**] Price information based on publicly available information based on 2020 models as at 17 December 2020. Prices were sourced from Redbook wherever available, and represent the new vehicle price provided by manufacturers.

[***] At the time of writing, this vehicle was available in limited numbers for lease to fleets but not on the general market.

^ Comparable ICE vehicle is for indicative purposes only and should not be considered as a like-for-like comparison in all instances.

[#] Prices of vehicles that may be available in the future has not been supplied by manufacturers, and is subject to change.

Attachment C: Government actions on low emissions transport technologies

The Australian Government's recent announcements

In September 2020, the Australian Government announced $1.9 billion to invest in new energy technologies. The Government dedicated nearly $100 million in transport technology measures, including a $74.5 million Future Fuels Package. Through the King Review Technology Co-investment Fund, the Government has dedicated $24.5 million to a Freight Energy Productivity Program. This funding expands on the previous funding on new fuels, vehicles and infrastructure through ARENA and the CEFC. Since 2016, ARENA has invested $44.4 million in grant funding and the CEFC has provided over $139.9 million in financing to new vehicle technology projects and studies.

The Technology Investment Roadmap's Low Emissions Technology Statements

The First Low Emissions Technology Statement identifies vehicle charging and refuelling infrastructure as an emerging technology as they are the focus of existing policies and funding support. Battery, hybrid and plug-in hybrid electric vehicles and more efficient internal combustion engine vehicles fall into the 'watching brief technologies' group. The Government will continue to monitor these technologies and ensure consumers can choose these where it makes sense for them to do so.

National Hydrogen Strategy

Through the National Hydrogen Strategy, Australian governments have articulated a shared vision of hydrogen being a clean, cost competitive fuel option for Australia. The Government recognises hydrogen as an alternative transport fuel that complements battery electric vehicles, in particular for heavy duty and long range applications.

Bioenergy Roadmap

The Government, through ARENA, is developing the Bioenergy Roadmap. The Roadmap will consider, amongst other things, the potential for biofuels to lower emissions in the industrial and transport sectors, and contribute more broadly to Australia's fuel security.

Infrastructure and Transport Minister's Meeting

The Infrastructure and Transport Ministers Meeting (previously the Transport and Infrastructure Council) plays a key role in delivering national reforms to improve the efficiency, safety and productivity of Australia's infrastructure and transport systems. The Future Fuels Strategy will build on their work program focusing on zero and low emissions vehicles.

Long Term Emissions Reduction Strategy

The Future Fuels Strategy will be an important element of the Government's technology-based Long Term Emissions Reduction Strategy, which will be released before the 2021 United Nations Climate Change Conference known as COP26.