NRMA 100 YEARS AND ONWARDS

EVs: Accelerating Adoption in Australia

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Introduction

Electric vehicles (EVs) are in the final stages of transitioning to become a competitive rival to the mature and more established internal combustion engine (ICE) vehicle.

Within the next decade, the cost and infrastructure obstacles which have kept EVs exclusive and beyond the reach of mainstream consumers are likely to disappear.

The moment has arrived for Australia to decide what role it wants to play as a manufacturer, researcher, supplier and consumer.

This report discusses the EV industry, outlines the benefits of transitioning, and presents the barriers and challenges that need to be overcome.

It proposes 10 recommendations to help accelerate the competitiveness and expansion of the domestic EV market.

Recommendations are grouped under the categories of private fleets, government procurement, purchasing incentives, public charging, electricity demand, research & development, regulations, and community information.

EVs covered in this report include passenger cars, commercial vehicles (utility vans and trucks) and buses, which fall into the categories of Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric Vehicles (PHEVs) and Hybrid Electric Vehicles (HEVs).

Low-speed electric vehicles (LSEVs), hydrogen fuel cell electric vehicles (FCEVs), vehicles propelled by alternative fuels (E.g. biofuels), rail based electric land vehicles (e.g. trains and trams), electric bikes, motorcycles and quadricycles are not considered.

Recommendations

Private fleets

Encouraging and supporting private fleets to transition to EVs will act as a demand signal to industry. Electric fleet vehicles will also underpin the establishment of a second-hand EV market in Australia.

Governments are in a position to supercharge private fleet purchases by offering subsidies for bulk domestic orders and associated infrastructure.

Recommendation 1: That Australian governments provide EV purchasing incentives to the business sector to encourage EV fleet purchases.

Government procurement

Government procurement could play an increasingly important role supporting the development of the EV industry. Procurement policies will stimulate demand, build industry experience and widen community exposure.

At present, only around half of Australia's governments have EV procurement policies in place.

Recommendation 2: That EV procurement policies, including fleet targets for Battery Electric Vehicles (BEVs), be adopted by all Australian governments.

The purchase of EVs to expand the size of the public service fleet should be complemented by the provision of charging infrastructure in government buildings and car parks.

The installation of chargers throughout government assets will naturally stimulate demand for charging infrastructure.

Recommendation 3: That government car parks and buildings be equipped with EV charging infrastructure to facilitate the management of fleets.

Purchasing incentives

Government subsidies for EV purchases have worked in many jurisdictions by stimulating demand.

The effectiveness of a subsidy is often greater when combined with important preconditions such as investment in charging infrastructure, reduced reliance on fossil fuels for electricity generation, long running community information campaigns, and monitoring of pricing changes at dealerships.

There are elements of the Australian tax system that act to harm the growth of the EV industry. Key areas which should be reformed include:

- Altering Fringe Benefits Tax (FBT) to focus on emissions rather than price.
- Extending FBT exemptions to include novated leases.
- Exempting Battery Electric Vehicles (BEVs) from the Luxury Car Tax.

Recommendation 4: That the Commonwealth review current taxation arrangements for EVs.

Public charging

There is a strong and positive correlation between the availability of charging infrastructure and the uptake of EVs.[1] Under a moderate uptake scenario, it is estimated Australia will need 28,370 public fast chargers (DC) by 2040.[2]

A national charging infrastructure plan and clearer rules covering installation, ownership, standards and maintenance is required.

The following should be considered to support safety, consistency and efficiency:

- Targeted installation and network upgrade program to reflect existing and future demand, broader considerations of network density, as well as localised market realities such as residential buildings without off street parking (a priority roadmap outlining the infrastructure upgrades required).
- Signposting and publicly available information on charging stations.
- Comprehensive and regularly audited charger maintenance regime with key performance targets.
- Publicly owned or funded charging stations be non-proprietary.
- Standardised charging plugs be supported by regulation.
- Revised planning laws to accommodate charging stations on kerbsides, near residential buildings lacking off street parking, and in multi-unit carparks and basements (revisions to the National Construction Code).
- Strategic planning blueprints to accommodate niche land reservation for charging stations.
- Traffic laws to accommodate kerbside charging.
- Regulated charger usage rules.

Recommendation 5: That the Transport and Infrastructure Council develop a regulatory framework and national plan for rolling out public charging infrastructure.

Electricity demand

Careful management of electricity networks and markets must accompany investment in EVs.

Thoroughly understanding generation capability, demand management and storage alongside EV projections will help to ensure grid resilience and consumer confidence.

Recommendation 6: That the Commonwealth undertake a comprehensive infrastructure audit of Australia's electricity grids and plan for future network investment to support the transition to EVs.

[1] International Council on Clean Transportation (2017), op. sit.
[2] Energeia, Australian Electric Vehicle Market Study, 2018.

Research & development

Grants for research, development and product innovation currently exist and should continue to encourage private sector and scientific investment in the EV industry and its related fields.

Expanding government funding for research and innovation prizes should also be considered for motivating lines of research, particularly into batteries and peripheral issues.

Proposed battery-related research streams include:

- Cost per kWh.
- Capacity.
- Charging speed.
- Heat reduction.
- Inductive charging.
- Residual life maximization.
- Material recycling.
- Disposal and end-of-life management.
- Environmentally friendly manufacturing.

Recommendation 7: That Australian governments expand their EV research and develop a wide-ranging research and innovation prize program.

The transition to a vehicle marketplace where EVs provide a substantial share will have a disruptive effect on the ICE industry and its component suppliers.

Existing suppliers should be encouraged to investigate where their existing operations can be modified to meet new demands.

Upgrade and modernisation grants should be expanded to help facilitate viable transition programs. Equally, the workforces situated in traditional ICE supply industries should be encouraged to retrain if related employment opportunities emerge.

Recommendation 8: That the Commonwealth provide modernisation grants and employee retraining assistance grants to assist ICE part manufacturers and workers transition to new roles.

Regulations

Battery-related issues such as resale, reuse, recycling, home conversion and disposal will become increasingly important.

Consumer protection rules and regulations for emerging innovations such as induction pad charging, automated parking and battery swapping will require a ‘fit-for-purpose’ review.

Recommendation 9: That Australian governments undertake a ‘fit-for-purpose’ review of their EV battery regulations.

Community information

City level awareness about the features and strengths of EVs and supporting infrastructure is a critical requirement for alleviating community concerns and boosting social acceptance.

A range of options exist to address and boost EV awareness and knowledge levels, including:

- Information campaigns designed to dispel myths about EVs.
- Advertising campaigns about the number and location of charging stations.
- EV field days encouraging test drives and Q&As.
- Assigning education institutions to conduct consumer research for accelerating the transition.
- Promoting best practices for smart charging to ease pressure on the electrical grid and reduce consumer costs.

Recommendation 10: That Australian governments develop and rollout targeted information campaigns to boost community knowledge about EVs.

Background

EVs first appeared in Europe in the 1830s and entered mass production in the latter half of the century due to advances in battery capability. EV usage peaked at the turn of that century with approximately 30,000 vehicles in global production.[3] Within a decade of this peak, ICE vehicles displaced EVs as they proved to be a more user-friendly transport option.[4]

Around 100 years on, technological advancements and shifting community attitudes have allowed EVs to re-emerge as serious competitors to ICE vehicles.[5]

The designs, features and performance characteristics of EVs today vary significantly and are based on manufacturing technology, values and functionality objectives (e.g. battery lifespan, required range, regenerative braking and plug-in capacity).

The most common EVs are Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric Vehicles (PHEVs) and Hybrid Electric Vehicles (HEVs):

- BEVs are exclusively electric and do not possess an ICE; they have large batteries.
- PHEVs possess an electric motor and also an ICE, and can be plugged in to recharge; they have smaller batteries than BEVs.
- HEVs also possess an electric motor and an ICE, however they cannot be plugged in to recharge; HEVs generally have the smallest batteries (which are recharged by the ICE).

2.26 million plug-in EVs were sold globally in 2019, an increase of nine per cent from the previous year. This equates to around 2.5 per cent of all new vehicles sold globally. The most dominant market for EVs was Norway, where 56 per cent of new sales were EVs.[6]

Sales trends over the past decade point to a consumer preference for BEVs over PHEVs, shifting from a ratio of 56/44 to 66/34 between 2012 and 2017.[7] Prior to the emergence of the COVID-19 pandemic, it was estimated that global EV market sales would reach 21 million by 2030.[8]

There are 28 EV models for sale in Australia.[9] Sales of BEVs and PHEVs in 2019 reached 2,925, up 54 per cent. Sales of HEVs during the same period were 30,641, up 53 per cent[10] – these figures do not include Tesla vehicle sales as figures are not publicly disclosed.

Between 2011 and 2018, Australian businesses were the largest purchasers of EVs, being responsible for 63 per cent of total stock sold.[11] However, private purchases accounted for 51 per cent of Australian EV sales in 2019 compared to 37 per cent in 2018, while fleet sales made up the rest.[12] This indicates increased interest among private motorists to embrace the EV revolution.

[3] Gerdes, J. (2012). 'The Global Electric Vehicle Movement: Best Practices From 16 Cities' *Forbes* 11 May 2012.
[4] Features like the electric starter motor, the muffler, cheaper petroleum and improvements in the road network.
[5] Advancements in batteries, semiconductors, power convertors and microprocessors, and air quality and energy generation concerns.
[6] Electric Vehicle Council, The State of Electric Vehicles in Australia, August 2020.
[7] Hertzke, Muller, Schenk & Wu (2018). 'The global electric-vehicle market is amped up and on the rise', May 2018.
[8] Deloitte LLP, New market. New Entrants. New Challenges. Battery Electric Vehicles. 2019. UK. Figure 2.
[9] Electric Vehicle Council, The State of Electric Vehicles in Australia, August 2020.
[10] Costello, M (2020). 'VFACTS: 2019 new car sales results', CarAdvice, 6 January 2020.
[11] Electric Vehicle Council, The State of Electric Vehicles in Australia, Second Report: Driving Momentum in Electric Mobility, June 2018.
[12] Electric Vehicle Council, The State of Electric Vehicles in Australia, August 2020.

Overseas markets and trends

In 2019, nearly half (47 per cent) of the world's EV fleet was in China. Europe, with 1.7 million EVs accounted for 25 per cent, and 1.5 million units in the United States represented 20 per cent of global stock. Norway was the global leader at 13 per cent of total stock in 2019.[13] Not surprisingly, EV uptake is strongest in jurisdictions that have put in place a wide variety of policy settings which encourage EV adoption, research, development and production.

Outlined below is a summary of the primary objectives of global EV policies:

- Technological advancement and IP ownership.
- Employment creation.
- Industrial development.
- Energy security.
- Climate change response.
- Improving air quality.

The objectives of each jurisdiction vary, as does the effectiveness of their policies. Outlined below is a summary of the major policy measures and their effectiveness.

Exemptions, credits, rebates and bonuses for EV purchases

A summary of purchasing incentives provided by key nations is provided.

Table 1: EV Purchase Incentive Table*[14]

Nation	New Cars	New Vans & Trucks	Notes
China	$11,566		Incentivise EVs with a range over 150km.
USA	$4,073 - $12,221		Credit is limited to a set number of vehicles produced by qualifying manufacturers. Several states also offer additional EV purchasing assistance.
Canada	$2,600 - $5,200		List of regularly updated eligible vehicles (BEVs and PHEVs) manufactured by Audi, BMW, Chevrolet, Chrysler, Ford, Honda, Hyundai, Kia, Mini, Mitsubishi, Nissan, Smart, Tesla, Subaru, Volkswagen and Toyota.

[13] IEA Global EV outlook 2020.
[14] ACEA, European Automobile Manufacturers Association, Electric Vehicles: Tax Benefits & Incentives in the EU, May 2019.

Germany	$5,318 - $7,091		BEVs and PHEVs.
Spain	$9,950	$10,636 - $26,590	Cars, vans, medium vehicles and heavy vehicles.
Romania	$7,977 - $17,726		BEVs and HEVs. BEV buyers also eligible for €1,500 for scrapping vehicles older than eight years.
Norway	Exempt from purchase taxes since 1991. Exempt from 25 per cent sales tax since 2001.		Being phased out.
UK	$7,024	$16,054	
EU			15 states in the European Union offer incentives for EV purchases, consisting of tax exemptions and reductions, with bonus payments for BEVs and PHEVs.

** Converted to AUD$*

It is important to note that the magnitude of a purchasing incentive is not the only factor encouraging EV buyers. Norway offered the highest financial benefit and was the most successful market. However, in 2015, other countries (including China, France and the US) offered similar or higher financial incentives per vehicle than the second most successful country, The Netherlands, and failed to generate similar interest in uptake. Inadequate and negative experiences with charging infrastructure and a lack of consumer information hampered the uptake of EVs in these countries.[15]

Entitlements for EV users

Some countries offer unique entitlements to EV users to encourage ICE users to make the switch. In this space, Norway has been an international pioneer with its entitlements, including free battery recharging, waiving parking fees, exemptions from road and ferry tolls and free access to bus lanes.

Business development, research and product support

Almost every nation analysed provides business development and research support to expand their domestic EV industries.

Grants, incentives, tax credits and subsidies are available for plant construction, component development, primary research, testing, training, and battery production, enhancement and recycling.

Several nations also provide small funding assistance to consumers purchasing EV-related products such as plug-in conversion kits, home-based charging stations and business charging stations.

[15] Broadbent GH, Drozdzewski D, Metternicht G. Electric vehicle adoption: An analysis of best practice and pitfalls for policy making from experiences of Europe and the US. Geography Compass. 2017.

Financial support for Electric Vehicle Service Equipment (EVSE)

According to the International Clean Council on Transportation, the availability of a widespread charging network has a positive correlation with EV uptake.[16] By the end of 2019, there were 7.3 million EV chargers installed worldwide, of which 6.5 million chargers were private light-duty vehicle (LDV) slow or normal chargers.[17]

Differing business strategies, environment policy, government interventions (regulations and incentives) and planning reforms have led to very different ownership outcomes of public charging stations. In Europe, 79 per cent of public charging infrastructure is operated by utilities and oil companies; in the United States, 62 per cent is managed by EV pure-play operators (those who solely focus on EV charging); and in China, the market is dominated by equipment manufacturers.[18] Increasingly, utilities and oil and gas companies are investing larger stakes in the EVSE industry, led by Europe and North America.

The degree of direct public intervention in the EVSE market also varies across jurisdictions. The Norwegians are directly investing in their EVSE transition through a range of methods, including the installation of wireless, induction-based charging stations for their privately owned taxi fleet.[19] In contrast, Australia has only begun to offer financial incentives for charging station development.

Penalties and deadlines

Some nations have opted to penalise and ban ICE vehicles for poor fuel efficiency and environmental outcomes. These penalties have an important effect on undermining their competitiveness and favoring the uptake of environmentally friendly EV alternatives.

A summary of ICE vehicle sale phase out years is provided.

Table 2: ICE Vehicle Sales Phase Out Timetable (government commitments)

Phase Out Year	Jurisdictions
2025	Norway, Austria
2030	United Kingdom (exc. HEVs), Germany, India, Ireland, Iceland, Israel, Netherlands, Slovenia, Denmark, Sweden
2035	California
2040	Spain, France, Singapore, Sri Lanka, Taiwan, Canada, New York City

The US has no federal policies on this matter. However, several states are moving independently on bans under the leadership of California, including Colorado, Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, Vermont and Washington.[20]

Globally, a number of cities are moving toward ICE access restrictions within their municipal boundaries, including Amsterdam, Brussels, Bristol and Hong Kong.[21]

It should be noted that much of the legislative action taken to end ICE sales is currently non-binding.[22]

[16] International Council on Clean Transportation, Emerging best practices for electric vehicle charging infrastructure, Washington, 2017.
[17] IEA Global EV outlook 2020.
[18] Coren, M (2019). 'Oil companies and utilities are buying up all the electric car charging startups'.
[19] Statt, N (2019). 'Norway will install the world's first wireless electric car charging stations for Oslo taxis'.
[20] https://dec.vermont.gov/air-quality/mobile-sources/zev.
[21] https://www.coltura.org/world-gasoline-phaseouts.
[22] Burch, I. & Gilchrist, J (2018), Survey of Global Activity to Phase Out ICEs, Center for Climate Protection.

Public and private benefits

Direct emissions

ICE vehicles emit a diverse range of particulates, contaminants and gases as a result of the combustion process. Carbon dioxide, carbon monoxide, sulfur dioxide, and nitrogen dioxide are all generated internally and emitted through ICE tailpipe emissions.

Conversely, BEVs do not emit gases, particulates or contaminants at a vehicle level. PHEVs and HEVs only generate modest emissions compared to ICE vehicles. This is due to their overall fuel efficiency and performance.

Overall, EVs offer a low-cost solution to improving air quality, reducing greenhouse gas emissions and reducing future outlays on managing climate change.

Indirect emissions

It is important to note that the production and charging of EVs is not emissions free. Emissions are produced during the vehicle and battery manufacturing process.

BEVs and PHEVs also indirectly produce emissions based on the electricity they use to recharge their batteries.

Australia's National Energy Market (NEM) services NSW, the ACT, Queensland, Victoria, South Australia and Tasmania. Approximately 77 per cent of the electricity generated for the NEM is sourced from coal or gas power stations.[23] As a result, EVs charging via this market will be indirectly producing a range of emissions, including sulfur dioxide and oxides of nitrogen. However, as the energy mix transitions to more renewables, indirect emissions will progressively decline.

An analysis across all states and territories in Australia shows that an average EV charged from the grid in 2016 emitted less than an average ICE vehicle in all states, except Victoria, where it was slightly higher.[24]

Table 3: 2016 Australian CO2-e Grid Intensity[25]

State	NSW / ACT	NT	QLD	SA	TAS	VIC	WA	AUS
Grid Intensity CO2-e / kWh	830	640	790	490	140	1,080	700	920

[23] Australian Energy Market Operator, The National Energy Market Fact Sheet 2018.
[24] Electric Vehicle Council (2018), op. sit.
[25] V-Facts (2017) and Department of Energy and Environment (2017).

Energy security

Except for Australia's LPG vehicle fleet, the vast majority of ICE vehicles consume petrol and diesel fuels which are majority foreign sourced. This means a key element of our economy is vulnerable to price and supply shocks in the global oil market.

All forms of EVs reduce our demand and reliance upon foreign oil as they replace the energy source with domestically produced alternatives, including renewables.

EVs also can return power to the grid to buffer local power supplies. If managed carefully, EVs can draw power from the grid during off-peak and return it during peak hours.

Motoring costs

EVs are widely regarded to have lower motoring costs than ICE vehicles.

EVs have fewer components and are simpler in design, and they require less maintenance over their operating life. According to the Australian Energy Market Operator, customers will spend $380 per annum on EV maintenance costs compared to $750 per annum for ICE vehicles.[26] This provides a valuable benefit for the EV user, but could impact traditional services for ICE motorists (e.g. motor mechanics).

The cost of recharging a vehicle's battery is 3 cents per km [27] compared to 10 cents per km for fuel.[28] This cost can be further reduced if charged from domestic solar.

[26] Annual maintenance costs, AEMO Insights, Section A.3.5.
[27] This is assuming no discounts applied to the retail electric city price for consumers.
[28] Based on the latest fuel efficiency of new ICE vehicles/BEVs currently available on the market.

Barriers to entry

Cost

Cost barriers for EVs fall into two categories: purchase price and total cost of ownership.

Purchase price relates to the price a consumer will pay when buying a vehicle from a dealership.[29] EVs cost more than ICE vehicles due to their high production costs and the inability of manufacturers to offset the price through production volumes or economies of scale.

The biggest contributor to the cost is an EV's battery which, according to McKinsey, can be between 35 to 45 per cent of the cost.[30] Batteries are a critical component of EVs as they determine the vehicle's range, recharging capabilities and life cycle.

Additionally, EV batteries lose efficiency. A 2019 study conducted by Electric Autonomy estimated that on average, batteries lost 2.3 per cent of charging capacity per year of driving. Globally, most EV battery warranties cover capacity loss of the battery for up to 70 per cent. Currently in Australia, most manufacturers offer warranties of up to eight years or 160,000 km.[31]

Lithium-ion batteries are the mainstay of EV fleets and are expensive and complex to produce. While the cost of lithium-ion batteries has decreased from US$1,183/kWh in 2010 to US$156/kWh in 2019,[32] experts remain divided on whether they will follow the same deflationary path of other consumer products. Moreover, supply chains for essential raw materials remain volatile. However, given recent price falls, some analysts such at BloombergNEF estimate the price of an average battery pack to be around US$100/kWh by 2024 and US$60/kWh by 2030.[33]

It is widely accepted that EVs can achieve purchase price parity with ICE vehicles once battery prices fall to US$100/kWh.

Competitive strength – oil price and asset depreciation

Competitive strength is another area where EVs are vulnerable.

EVs are widely acknowledged to be competitive in terms of operating costs – especially in regard to fuel efficiency. However, this cost advantage erodes as the price of oil drops.

As of October 2020, the price of oil (Asian crude) has fallen 36.9 per cent over the past 12 months (due to a range of factors including the COVID-19 pandemic and oil price competition between nation-state suppliers). Until oil prices return closer to trend, EVs will be at a disadvantage.

EVs also suffer a competitive weakness on their speed of depreciation. EVs have a sharper depreciation rate than ICE vehicles, undermining their value to business balance sheets. This is likely a short term issue largely driven by the pace at which battery technology is developing.

[29] Broadbent GH, Drozdzewski D, Metternicht G. Electric vehicle adoption: An analysis of best practice and pitfalls for policy making from experiences of Europe and the US. Geography Compass, 2017.
[30] Wilmot, S. (2019), The big obstacle on the road to electric vehicles, WSJ.
[31] www.caradvice.com.au/859099/electric-car-battery-warranty.
[32] www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/as-battery-costs-plummet-lithium-ion-innovation-hits-limits-experts-say-58613238.
[33] https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices.

Regulations and taxes

Regulation and tax arrangements for the operation of Australia's land-based vehicles have largely been designed for ICE vehicles, with limited regard for the challenges facing EVs and the technology underpinning them.

Some regulations are blind to the advantages of EVs such as lower noise pollution, whereas others make it harder to extract the raw materials necessary for EV manufacturing, resupply, recycling and repair.

Some examples include:

- Environmental Effects Statements and Regulatory Impact Statements which don't value EV 'whole-of-life' benefits when assessing manufacturing plants and approvals.
- Building regulations which obstruct the installation of charging units in car parking spaces in existing buildings and other planned zones.
- Profit caps for energy suppliers which undermine energy infrastructure investment.
- Lack of harmonisation on charging standards.
- Prohibition of kerbside charger installation.
- Luxury Car Tax and Fringe Benefits Tax arrangements.
- CBD parking levies on CBD charging sites.

Each of these regulations and taxes present a degree of cost or frustration to operators in the emerging EV industry.

Infrastructure – recharging stations and energy grid modernisation

While EVs will use the existing road network in a near identical fashion to ICE vehicles, there are several related infrastructure shortfalls which are limiting EV expansion. These shortfalls can be listed under two categories: recharging stations and energy grid modernisation.

Recharging stations – network size, maintenance, speed and operability

Network size

Charging stations are an essential component of the EV operational network. There are now over 350 fast and ultra-fast charging stations (50kW and over) at over 150 locations across Australia. There are also almost 2,000 standard charging stations (less than 50kW) at over 1,200 locations. This represents an increase of more than 40 per cent in the last 12 months.[34] However, more charging stations are needed to make EVs more appealing to consumers.

[34] EVC, State of Electric Vehicles, August 2020.

Australia's underdeveloped charging network presents a significant obstacle for wide scale EV adoption.

Firstly, fewer charging options potentially forces users to alter their traditional travel routes; secondly, range limitations of some EVs restricts travel freedom and adds risk to long distance travel.

Both these obstacles have been repeatedly cited as key reasons for motorists deciding against an EV purchase.

Maintenance

Reliability of charging stations is also an area which requires improvement. Ongoing maintenance will be critical to maintaining and building community confidence in the industry. A particularly disastrous period in the UK (2015) saw '40 per cent of London's public chargers out of service at any one time, and nationally about 23 per cent of chargers unable to be used.' [35]

Careful planning and system design must be undertaken to avoid a similar service delivery failure.

Speed

The time allocated to recharging an EV is another consumer frustration. While recharging times vary and are improving overall, they still do not compare with the speed and ease of the ICE experience.

The advent of fast chargers has accelerated the recharging speeds of compatible batteries. While the adoption of fast chargers is expanding across the globe, not all charging stations can host the technology.

Faster chargers typically require a level of electrical infrastructure which is not common in residential buildings. Moreover, not all public access charging stations have suitable connections. This can lead to one of two things: the inability to install fast chargers or grid instability because the local infrastructure wasn't designed to cope. Both will need to be resolved to assist with EV expansion.

Operability

Operability is a critical component for the EV industry's success, and Australia is still working through its associated challenges. Regarding the chargers in the EV marketplace, three factors matter:

- Power output range.
- Socket/connector.
- Protocol for communications between the vehicle and charger.

Success in this space will be achieved by ensuring the local variances are as few as possible so that the domestic charging network can service the widest range of vehicles.

[35] Sharman, A. (2015), 'Power struggle stalls London's EVs', Financial Times.

Energy grid modernisation

It goes without saying that Australia's electricity network was not designed to cater for EVs.

An average EV travelling 40 kilometres per day would require approximately 7kWh of energy to recharge (around the daily equivalent of a small household).[36] Therefore, meeting future EV charging needs will require parts of Australia's energy grid to be modernised. Some complex and costly challenges include:

- Upgrading distributive transformers and utility lines to cope with increased downstream demand.
- Compensating for voltage drop due to increased current usage.
- Upgrading segments of the network to offset phase imbalance/power quality.
- Upgrading utility lines to better host charger station integration.
- Capacity upgrades to facilitate ultra-fast charging (e.g. 350kW capacity);
- Accelerated smart meter rollout.
- Changes in peak demand times.
- Increased maintenance schedules due to an increase in high usage hours.

Public opinion

Three issues dominate public apprehension about EVs – range, cost and infrastructure.

Range anxiety relates to a customer's fear about using the vehicle without planned recharging and the vehicle not having enough charge to reach its destination. This problem is being progressively overcome by improving battery capacities. The latest Tesla BEV has a range of more than 500km, however this comes at a cost – batteries which deliver extended range are expensive.

Cost relates to the purchase price of a vehicle. Almost all EVs are more expensive than their ICE equivalents, with many priced well into the luxury car range (even attracting the Luxury Car Tax). A considerable part of the cost equation relates to the battery. Meeting consumer expectations on range at the same time as meeting their affordability thresholds presents a challenge for product manufacturers.

Infrastructure relates to consumer concerns about the availability of charging stations for EV operators. Consumers are seeking charging stations at similar numbers to petrol stations, with higher expectations in areas lacking off street parking.

Concerns also exist regarding the availability of charging stations on freeways and the speed of recharging.

[36] Brazil, M. (2019), 'Australia's electricity grid can easily support EVs -if we get smart', The Conversation.

Continuation of existing ICE industry – market size and production costs

The development of an EV manufacturing base in Australia will face many of the challenges experienced by the ICE industry.

The relatively small size of the domestic vehicle market and its diversity will present a major challenge for local manufacturers seeking to achieve long term viability and economies of scale. Local production is likely to be an offshoot of existing vehicle manufacturers which have an integrated global supply chain, a local presence, adaptive domestic supply lines and a positive brand image.

This market reality will also be complicated by the fact that EVs may never appeal to all vehicle users and that almost all EV manufacturers have a stake in the existing ICE market. Existing ICE manufacturers and their local component supply chains will be focused on making sure any transition occurs with the least impact on their historic investments, existing business models and long term plans.

Potential domestic producers will also face serious challenges from production lines operating in lower wage countries. Domestic EV production may have some advantages in terms of their proximity to local consumers, access to raw materials and a continuing shift to automation and 3D printing; however, all production lines will still need to manage Australia's baseline overheads, wages and input costs. As a result, identifying our natural competitive advantages and leveraging them will be critical to any domestic industry's success and value for money in regard to taxpayer support.

Conclusion

The adoption of EVs offers an opportunity to transform mobility in Australia and reduce the cost of transportation for consumers. It will also help reduce greenhouse gas (GHG) emissions, air pollution and noise produced by ICE based vehicles at low operating speeds. However, for these benefits to materialise, supportive policies and regulations will have to be in place to provide value to customers and support efficient use of the energy grid.

The establishment and maintenance of charging networks that provide adequate coverage, government procurement programs that enhance the viability of the EV industry, and information campaigns sustained over a long period of time to educate consumers will increase uptake.

With the right support, our educational and research institutions could play an increased role in creating technology that enhances EV battery capacity and increases vehicle range. Our local manufacturing industry could become a vital part of the global EV component supply chain.

Australia leads the world in lithium production and possesses an estimated 6.3m tons of lithium reserves. Lithium refinement, battery component manufacture and recycling could create 100,000 new jobs nationally by 2025.[37]

Advancing the rate at which EVs are integrated into the transport mix in Australia by adopting the recommendations put forward in this paper will not only align us with global trends that point towards electrification, but also increase our stake in a global industry that is projected to reach $802.81 billion by 2027.[38]

[37] www.theguardian.com/australia-news/2020/sep/10/how-australias-white-gold-could-power-the-global-electric-vehicle-revolution.
[38] www.alliedmarketresearch.com/electric-vehicle-market.


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