Submission No 7

ELECTRIC BUSES IN REGIONAL AND METROPOLITAN PUBLIC TRANSPORT NETWORKS IN NSW

Organisation: Transport for NSW

Date Received: 18 December 2019

Transport for NSW submission

Legislative Assembly Committee on Transport and Infrastructure

Inquiry into electric buses in regional and metropolitan public transport networks in NSW

November 2019

Contents

Introduction

Transport for NSW's role is to lead and coordinate the development of a safe, efficient, integrated transport system that keeps people and goods moving, connects communities and shapes the future of our cities, centres and regions.

Terms of Reference

This submission will address all items in the below terms of reference.

1. Benefits of electric buses and factors that limit their wider uptake.
2. Minimum energy and infrastructure requirements to power electric bus fleets.
3. Other renewable, emissions neutral energy sources.
4. Ways to support manufacture and assembly of electric buses in NSW.
5. Experience with introducing electric bus fleets in other jurisdictions.
6. Opportunities and challenges of transitioning the entire metropolitan bus fleet to electric.
7. Any other related matters.

Definition of electric bus

In the context of this submission, an electric bus refers to a bus where an electric motor provides all or part of the vehicle's propulsion. There are three main types of electric buses:

1. **Battery electric buses** have an electric motor and a large battery that recharges by plug connection to external power.
2. **Hybrid buses** combine a conventional internal combustion engine propulsion system with an electric propulsion system.
3. **Hydrogen fuel cell buses** convert compressed hydrogen into electricity to power an electric motor.

For the purpose of this submission, references to electric buses refer to battery electric buses unless otherwise stated. Where there is a reference to zero emissions buses, these could include electric buses powered by a hydrogen fuel cell.

The NSW Electric and Hybrid Vehicle Plan

The NSW Government is committed to providing communities with accessible and safe transport choices that shape a competitive, clean and prosperous future for NSW. NSW is undertaking actions to take full advantage of new technology that improves outcomes for transport customers, communities and industry and in turn our environment and economy.

On 21 January 2019, the NSW Government released the *NSW Electric and Hybrid Vehicle Plan* (The Plan). The Plan provides a framework of policies and actions designed to help NSW prepare for and support the transition to efficient, low emission, quiet and clean electric and hybrid vehicles. The Plan was developed with input from NSW Government agencies and a wide range of industry partners. The Plan had a number of actions to encourage the uptake of electric vehicles, including:

- providing $3 million in seed funding to partner with industry and local councils to deliver fast charging in regional NSW
- providing $2 million in seed funding for chargers in commuter carparks in the Greater Sydney Metropolitan Area
- integrating NSW's first fully electric bus trial as part of the public transport network
- setting a 10 per cent target for all new government fleet passenger vehicles to be hybrid or electric by 2020-21.

Electric buses

The NSW Government is committed to taking advantage of new technology to reduce the impact that buses have on air quality and the associated health impacts. Electric buses also offer significant cost savings, a better ride experience for customers, and improved local amenity including zero emissions. NSW has already begun rolling out electric buses into the NSW bus fleet.

Customers in Sydney's Inner West have been able to experience the cleaner and quieter electric buses with TfNSW commencing a two-year trial to integrate four fully electric buses in a regular bus route service in Sydney's bus region 6. The trial, commenced in July 2019 and is being undertaken by the operator Transit Systems. It trials four battery electric buses, manufactured by BYD.

NSW is in the process of securing a further 10 electric buses for Randwick. In March 2019, the NSW Government committed $10 million to trial these electric buses and associated infrastructure upgrades at Randwick bus depot. These buses will be procured and delivered through the bus contract tender process.

Building on these trials, the NSW Government announced that it will transition all 8,000 of Sydney's buses to zero emission buses to take advantage of their significant environmental, health and operational cost benefits.

To begin the wider transition to electric buses, TfNSW will undertake a Request for Expressions of Interest (RFEOI) process in late 2019 to develop trials of zero emission buses in the Sydney and Outer Sydney Metropolitan areas by existing bus operators holding a Sydney or Outer Sydney Metropolitan Bus Service Contract. The RFEOI will seek to develop trials of zero emission technology buses developed by the market which can allow the cost-effective trial of these emerging technologies, potentially including electric buses powered by hydrogen fuel cells. The RFEOI is expected to be released in early 2020.

The learnings from these trials will help inform a strategic framework for the broader roll out of electric buses that will consider the electrification of the vehicle, the energy system network and the charging system.

Benefits of electric buses and factors that limit their wider uptake

The electrification of the global bus fleet is already well underway, with over 400,000 electric buses on the road globally.[1] Cities around the world are introducing electric buses to improve air quality, reduce carbon emissions, lower operating costs, as well as take advantage of their cleaner and quieter operation. The majority of these buses are battery electric. However, hydrogen fuel cell electric buses are also being used in smaller numbers.

Cost savings

Electric buses have a lower operating cost compared to their diesel counterpart on a total cost of ownership basis.

Initial indications are that fuel costs are considerably cheaper for electric buses. Current diesel and gas buses cost around $64 per day to fuel. There is some evidence that the cost to fully charge an electric bus operating in Sydney would be $30 per day or less.

Electric buses have simpler drive trains and lower energy costs, making them cheaper to operate, particularly when operating over a large number of kilometres a day. Their electric motors do not require oil changes, they do not have a gearbox and they have less wear on brakes due to using the motor to slow the bus and regenerate the batteries. This would be offset by the need to replace batteries during the life of the bus.

The possibility of fuel and maintenance cost savings across the scale of NSW bus operations will need to be analysed further by TfNSW, and compared to whole of life operating costs.

Better customer experience

All types of electric buses deliver a cleaner, quieter service that improves amenity for passengers, neighbouring residents and businesses. Because electric buses are quieter and cleaner, they also contribute to more liveable urban centres and places that are pleasant to work and live in.

Environmental benefits

Electric buses offer significant environmental benefits. Battery electric buses have zero tailpipe emissions and therefore can reduce greenhouse gas (GHG) emissions. Hydrogen fuel cell buses emit water, so also reduce GHG emissions. Emissions from electric buses will fall further as more renewable power that is planned, approved or in construction comes online in the National Energy Market.[2] The overall emissions related to hydrogen generation is still being explored. However, green hydrogen produced from renewables would also reduce overall emissions.

The transport sector is the second largest and fastest growing source of GHG emissions.[3] The road sector is the largest transport emissions source, and the operation of this sector is almost

[1] https://about.bnef.com/electric-vehicle-outlook/
[2] Ken Baldwin et al (2018), "At its current rate, Australia is on track for 50% renewable electricity in 2025"
[3] Department of Environment and Energy (2017), Quarterly Update of Australia's National Greenhouse Gas Inventory: March 2017, p. 39

entirely dependent on imported petroleum-based fuels.[4] Without intervention, emissions from transport will continue to rise as the NSW population and economy grow, and the sector will continue to be at risk from any disruptions to the supply of imported petroleum-based fuels.

As a significant emitter of GHGs, transport has a role in operating in a more sustainable way to limit environmental impacts and to contribute to the NSW Government's aspirational goal of net zero carbon emissions by 2050.[5]

As both electric and hydrogen fuel cell buses have zero tailpipe emissions, they can operate in tunnels or underground or in enclosed interchanges or bus depots, while reducing nitrous oxides and fine particulates.

A detailed review of the environmental benefits on a whole of life cycle basis, not just the tailpipe emissions, is required. This will require an assessment of elements such as power generation emissions, transmission, substations, replacement batteries, materials and disposal. In the case of hydrogen, the method of hydrogen generation will impact on the overall environmental benefits.

NSW's Road Noise Policy found that traffic noise is the most prevalent source of noise in NSW and any reduction will have benefits for community amenity and health. The report identified that some of the most significant gains to reduce noise impacts include uptake of electric vehicles with their quieter electric motors.[6]

Health benefits

As NSW continues to grow, the NSW Government is committed to maintaining high air quality standards. Average vehicle emissions have fallen significantly since 2003, as newer, cleaner models replace older vehicles. The transition to an electric fleet, including electric buses with their zero tailpipe emissions, can help further improve air quality.

Although urban air quality in NSW is good by international standards, air pollution continues to have a significant impact on human health and the economy of NSW. Each year air pollution leads to:

- 520 premature deaths and 6,300 cumulative years of life lost in Sydney [7]
- 1,180 hospital admissions in Sydney;[8] and
- an estimated $6.4 billion (2015 AUD) in health costs in the NSW Greater Metropolitan Region. [9]

---

[4] Department of Environment and Energy (2019), Liquid Fuel Security Review Interim Report, p15
[5] Climate Change Policy Framework (2016) https://www.environment.nsw.gov.au/topics/climate-change/policy-framework
[6] https://www.epa.nsw.gov.au/publications/noise/2011236-nsw-road-noise-policy
[7] Morgan, G, Broome, R and Jalaludin, B (2013), "Summary for policy makers of the health risk assessment on air pollution in Australia." Prepared for the National Environment Protection Council. Canberra, ACT. www.environment.gov.au/system/files/pages/dfe7ed5d-1eaf-4ff2-bfe7-dbb7ebaf21a9/files/summary-policy-makers-hra-air-pollution-australia.pdf
[8] Broome, RA; Fann, N, Navin Cristina, TJ; Fulcher, C; Duc and Morgan, G., (2015), "The health benefits of reducing air pollution in Sydney, Australia." http://dx.doi.org/10.1016/j.envres.2015.09.007
[9] DEC (2005) "Air pollution economics - health costs of air pollution in the Greater Sydney Metropolitan Region." Department of Environment and Conservation. Sydney, NSW. www.environment.nsw.gov.au/resources/air/airpollution05623.pdf

The World Health Organisation considers air pollution to be the single largest environmental danger to public health globally, estimating that around 7 million people die globally every year from exposure to fine particles in polluted air.[10]

Exposure to air pollutants can result in a wide range of serious cardiovascular health effects including asthma, heart disease, stroke, lung cancer, and chronic obstructive pulmonary disease.[11]

Poor air pollution disproportionately affects the most vulnerable members of society including unborn babies, children, the elderly, and those with pre-existing health conditions.[12]

In the United Kingdom, a child experiencing an asthma attack is admitted to hospital every 20 minutes as a result of poor air quality.[13]

Poor air quality is linked with an increase of miscarriages and premature births.[14] Evidence also indicates that inhalation of air pollution by pregnant women affects the development of the foetus. [15]

Transitioning our bus fleet to electric will help reduce air pollution and the health impacts poor air quality have on our communities.

Improved electricity grid utilisation

Australia has one of the largest uptakes of rooftop solar in the world, and is also a global leader in the uptake of stationary battery storage.[16]

The increasing uptake of distributed energy resources such as solar and wind is leading toward a decline in the reliance on the electricity grid.[17]

There is a limit to the amount of distributed energy resources that electricity networks can manage while maintaining network stability. Electric buses can offer an important market for off-peak electricity that can help balance the energy network demand. Electric buses charged outside of peak demand can help to improve utilisation of the current electricity grid, if charging is done when demand is low, such as in the middle of the day or overnight.

---

[10]World Health Organisation Regional Office for Europe (2017); https://www.ccacoalition.org/en/news/world-health-organization-releases-new-global-air-pollution-data

[11] The Electric Vehicle Council (2019) Cleaner and Safer Roads for NSW, https://electricvehiclecouncil.com.au/wp-content/uploads/2019/06/EVC-Cleaner-and-Safer-Roads-for-NSW_V3-Single.pdf

[12] NSW Health (2013), Who is affected by air pollution?. Retrieved from https://www.health.nsw.gov.au/environment/air/Pages/ who-is-affected.aspx.

[13] https://www.theguardian.com/environment/2019/feb/05/uk-parents-worryingly-unaware-of-damage-air-pollution-is-doing-children

[14] Malley, Kuylenstierna, Vallack, Henze, Blencowe, Ashmore (2017), Preterm birth associated with maternal fine particulate matter exposure: A global, regional and national assessment. Retrieved from https://www.ncbi.nlm.nih.gov/ pubmed/28196630

[15] Korten, I., Ramsey, K., and Latzin, P. (2017). 'Air pollution during pregnancy and lung development in the child', Paediatric Respiratory Reviews, 21: 38-46, doi: 10.1016/j.prrv.2016.08.008; Fleischer, N.L., Merialdi, M., van Donkelaar, A., Vadillo-Ortega, F., Martin, R.V., Betran, A.P., Souza, J.P., and O'Neill, M.S. (2014). 'Outdoor air pollution, preterm birth, and low birth weight: analysis of the World Health Organization Global Survey on Maternal and Perinatal Health', Environmental Health Perspectives 122: 425-430, doi: 10.1289/ehp.1306837.

[16] Clean Energy Regulator, 2018, 'Australian install two million solar PV systems'

[17] https://energy.nsw.gov.au/renewables/renewable-generation/renewable-energy-nsw

As technology improves in the future, electric buses have the potential to act as mobile batteries, feeding energy back in to businesses or the electricity grid, and in both the metropolitan and regional context can help use the increasing amount of renewable energy entering the grid.

Factors that limit wider uptake of electric buses

Upfront cost

Electric buses have a higher upfront purchase price. They are around $240,000 more expensive than an equivalent diesel bus. However, these electric buses are already cost competitive with diesel buses in total operating costs, with the price offset by operational savings generated over their service lifetime.

Forecasts predict that electric buses will reach unsubsidised upfront cost parity with diesel buses by around 2030.[18] Increasing demand for electric buses could also bring their purchase price down, with forecasts predicting higher demand electric buses could reach cost parity with diesel buses by the mid-2020s.[19]

In the meantime, new business models such as battery leasing may need to be explored to overcome the higher upfront purchase price.

With hydrogen fuel cell electric buses, the technology is still being developed and costs are not as well established as for electric buses. Indicatively, hydrogen fuel cell buses cost around $2 million. This price reflects both the high cost of the fuel cell and associated components, but also the lack of economies of scale in production.

Vehicle standards

While there are many electric buses, and to a smaller degree hydrogen fuel cell buses, now operating around the world, only a small number of manufacturers have been identified with Australian Design Rule (ADR) compliant buses – BYD, Yutong, Bus and Coach International (BCI) and Precision. Both BYD and Yutong are Chinese manufacturers who have developed the electric bus in China.

European manufacturers are now starting to develop electric buses. European manufacturers remain focused on hybrid technology as a way of introducing zero emission technology in conjunction with existing diesel technology. However, trials of hybrid buses and feedback from industry through a TfNSW market sounding process indicated that the added complexity of having both electric and diesel technology increases maintenance costs, while fuel savings are marginal. Maintaining diesel technology gives these European manufacturers continued scope or opportunity to maintain their competitive advantage around diesel technology for as long as possible.

As part of a wider uptake of electric buses, TfNSW will undertake a design review and testing and acceptance process for the buses, and for the charging systems used.

[18] BNEF, Electric buses in Cities, March 2019, p1
[19] BNEF, Electric buses in Cities, March 2019, p1

Charging

A limiting factor in the wider uptake of electric buses is their reliance on charging infrastructure. The transition to electric buses will require infrastructure upgrades to bus depots and other strategic locations to incorporate electric charging units.

The operation of electric buses can be less flexible than diesel buses, due to their battery range and reliance on charging. This creates a challenge when incorporating them into bus routes that run over long periods of time. As more electric buses are rolled out, this can be mitigated.

Lack of charging infrastructure is a barrier to the wider uptake of electric vehicles in Australia. As of July 2019, the total number of electric vehicle charging stations (AC and DC) in Australia is 1,930.[20] TfNSW is investing $3 million in seed funding to partner with industry and local councils to install fast chargers in regional NSW and a further $2 million to provide chargers in commuter carparks in the Greater Sydney Metropolitan area.

The regional charging program will target key regional routes and destinations where charging points are less likely to be provided on a fully commercial basis. This will help regional residents and businesses to share in the cost savings and other benefits of EVs, improve access to regional NSW by EV owners, reinforces the regional tourism economy and support local investment in regional centres. The metropolitan charging program will focus on providing public chargers to people who do not have access to home charging.

The Australian Renewable Energy Agency (ARENA) is investing $21 million to support the roll out of ultra-rapid electric vehicle charging to enable all electric vehicle drivers to confidently drive between Australia's major cities.[21]

[20] The Electric Vehicle Council (2019), The State of Electric Vehicles in Australia, https://electricvehiclecouncil.com.au/wp-content/uploads/2019/09/State-of-EVs-in-Australia-2019.pdf

21 https://arena.gov.au/projects/chargefox-electric-vehicle-charging-network-project/; https://arena.gov.au/projects/national-ultrafast-ev-charging-infrastructure-network/

Minimum energy and infrastructure requirements to power electric bus fleets

Minimum energy requirements

TfNSW will need to work with the energy sector to ensure there is enough electricity to support the charging of electric buses. Locations of depots with charging infrastructure will need to be carefully considered to ensure there are substations nearby to deliver the required amount of power. Timing of charging during the day will also be a key consideration for both price of electricity and impact on the electricity grid.

Charging infrastructure

Electric bus fleets will require new charging infrastructure, either in the depot or en route. Electric buses require electric vehicle charging units to recharge the battery. There are three different types of charging infrastructure:

1. **Plug in systems:** traditional plug in charging stations are currently the cheapest and most common option for charging in depots. Charging normally occurs overnight or during a daytime layover.
2. **Pantograph:** overhead charging uses roof mounted equipment to make an electric connection between an overhead power supply and the bus. The pantograph can either be installed on the roof of the bus or an overhead mast. Charging occurs when the bus arrives at the charging point and the pantograph is extended to make contact with the charger. These are usually located at bus stops or bus terminals. The charger is usually between 150kW and 300kW, allowing for a fast top-up of the battery.
3. **Inductive charging:** this uses coils installed under the road surface that can transfer energy to matching coils fitted underneath the bus. There are two types of inductive charging: stationary and dynamic. With stationary charging, the bus must be positioned over the coils to begin charging. Stationary inductive charging is usually located at terminals or selected bus stops to allow the battery to be topped-up while passengers are boarding. In dynamic wireless charging, the buses are charged while in motion. This is a new technology that is currently being tested.

The four electric buses that are part of the trial in bus region 6 operate predominantly on routes 431, 433, 447 and 470. These routes were chosen due to their close proximity to Leichhardt Depot so that the operator can closely monitor the buses and their performance in Sydney's operating conditions. The total battery capacity of these vehicles is 328kW, which usually takes five to eight hours to charge. The vehicle uses around 80kW per hour. However, the vehicle also regenerates approximately 30-40 per cent of its battery capacity through braking, depending on traffic conditions.

Before the wider roll-out of electric buses, the impacts of the charge rate (the time to charge the battery) on both the charging infrastructure and the vehicle battery life needs to be understood. The effects of fast charging on the battery and whether this affects the battery life may determine the charging infrastructure requirements.

Innovation will be needed with the charging infrastructure chosen to maximise the limited space in depots.

Other renewable, emissions neutral energy sources

Hydrogen fuel cell buses

Hydrogen fuel cell (HFC) buses convert compressed hydrogen into electricity to power an electric motor. Like battery electric buses, they have zero tailpipe emissions.[22] Hydrogen also has the advantage of being abundant in nature, and can be produced by many different methods, including renewable sources.

HFC buses have higher upfront costs compared to battery electric buses.[23] However, they have the advantage of relatively short refuelling times, longer ranges and lighter weights, compared to battery electric buses.[24]

As HFC buses emit no carbon and only produce water vapour as a by-product, they present a potentially attractive option for cities, such as Sydney, that are experiencing high pollution from transport. The draft National Hydrogen Strategy identifies the opportunity of making hydrogen in Australia. Using locally made hydrogen for fuel could help reduce Australia's current dependence on importing liquid fuels. This could improve fuel security as hydrogen fuel prices are likely to be more stable compared with fluctuations in oil and petrol prices which are driven by the finite nature of fossil fuel reserves.[25]

Transport for London currently has eight HFC buses in operation and has ordered a further 20 HFC double-decker buses, which are due to be in operation in 2020.[26]

Limitations of hydrogen fuel cell buses

HFC vehicles and buses are not generally available to the Australian market.

The absence of refuelling infrastructure is a key barrier in rolling out HFC buses on a wider scale. Currently, there is very little refuelling infrastructure in Australia, and the roll-out of stations has been inhibited by the high cost (in excess of $1 million per unit).[27]

Although the likely retail price for Australian hydrogen fuel is unknown, we can safely assume it will be expensive to cover the high costs of production. In the United Kingdom, the current price is £10-15 pound per kg (AU$19-28)[28] and in California the current price is US$14-16 (AU$20-23).[29] A kilogram of hydrogen is enough to take a light vehicle 100km.

---

[22] Department of Transport (UK) 2018 The Road to Zero: Next steps towards cleaner road transport and delivering our Industrial Strategy, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf p44

[23] COAG, 2019 National Hydrogen Strategy Transport Issue Paper, https://consult.industry.gov.au/national-hydrogen-strategy-taskforce/national-hydrogen-strategy-issues-papers/supporting_documents/NationalHydrogenStrategyIssue8HydrogenforTransport.pdf p5

[24] The Road to Zero: Next steps towards cleaner road transport and delivering our Industrial Strategy, p44

[25] COAG, 2019 National Hydrogen Strategy Transport Issue Paper, https://consult.industry.gov.au/national-hydrogen-strategy-taskforce/national-hydrogen-strategy-issues-papers/supporting_documents/NationalHydrogenStrategyIssue8HydrogenforTransport.pdf p3

[26] https://www.theguardian.com/uk-news/2019/may/10/london-to-have-world-first-hydrogen-powered-doubledecker-buses

[27] CSIRO, 2018 National Hydrogen Roadmap https://www.csiro.au/en/Do-business/Futures/Reports/Hydrogen-Roadmap p39

[28] https://insideevs.com/news/333970/honda-pays-10-kg-nearly-13-for-claritys-hydrogen-supplies-in-uk/

[29] https://cafcp.org/content/cost-refill

Hydrogen fuel presents a number of safety challenges associated with its flammability, storage at very high pressures, and containment challenges. Technologies such as ventilated workshops and specially designed tools are already commercially available and able to manage these risks. Perceived safety risks with HFC vehicles, particularly related to accidents and collisions, such as leaks, ruptures, fires and explosions, are related to low levels of public awareness and will have to be addressed through public information campaigns.

Hydrogen refuelling

HFC buses have different fuelling needs. While they could be operated in a similar way to diesel buses, the hydrogen generation, supply and refuelling industry in Australia is still being developed with only a number of pilot operations in existence nationally.[30]

The draft National Hydrogen Strategy sets out the longer term strategy for hydrogen in Australia and also identifies that transport, in particular buses and heavy freight vehicles, would be early use cases that could be trialled as the industry establishes.

Renewable energy

The energy sector is currently undergoing a major transformation, with the share of renewable energy in the electricity mix growing. Renewable energy is now the cheapest form of power generation in Australia.[31]

There is the opportunity to offset operational emissions on projects. Sydney Metro is offsetting 100 per cent of its operational emissions from electricity used on Sydney Metro North West. The offset was realised through a Green Products Purchase Agreement to procure Beryl solar farm, a large scale solar farm in regional NSW.[32]

Pairing electric buses with renewable energy would provide zero emission buses.

Advancements in battery technology

Currently electric buses and vehicles are powered by lithium-ion batteries. However, lithium-ion batteries have limitations including their weight and degradation with age. Work is happening globally to advance battery technology.

One example of developments in battery technology is graphene batteries. Graphene batteries have the potential to be the most superior available in the market. A Spanish company, Graphenano has introduced a graphene polymer battery that could allow electric vehicles to have a maximum range of 800 kilometres. The battery can also be charged in just a few minutes.[33] Currently, there are no electric vehicles powered by graphene batteries.

---

[30] COAG, 2019 National Hydrogen Strategy Transport Issue Paper, https://consult.industry.gov.au/national-hydrogen-strategy-taskforce/national-hydrogen-strategy-issues-papers/supporting_documents/NationalHydrogenStrategyIssue8HydrogenforTransport.pdf p6

[31] https://energy.nsw.gov.au/renewables/renewable-generation/renewable-energy-nsw

[32] https://www.sydneymetro.info/article/beryl-gets-go-ahead-help-power-sydney-metro-northwest

[33] https://futurism.com/scientists-develop-better-battery-thanks-graphene; https://sciencetrends.com/will-graphene-battery-power-tomorrows-tesla-car/

Ways to support manufacture and assembly of electric buses in NSW

The transition to electric buses and their associated industries offers new opportunities for growing local businesses and employment. A shift to electric buses has the potential to create a range of new employment opportunities. This will require investment in new skills and training, as well as the creation of new service industries.

These opportunities are not only in manufacturing and assembling of electric buses and their components, but also in supplying and installing the charging units.

The chassis of region 6 electric buses are designed and built in China by BYD. The body of the bus is designed and provided by Gemilang Australia, with construction taking place in the manufacturer's Malaysian bus body facility. Gemilang Australia is planning to build future electric buses in Australia.

The South Australian Government has awarded Precision Buses a $2 million grant to build two electric and two low-emission diesel buses.[34]

In 2018, the Victorian Government announced a deal to bring electric vehicle manufacturing to Victoria by providing funding to Australian company SEA Electric. SEA Electric will set up a manufacturing plant in the region and is expected to create hundreds of new job opportunities.[35]

[34] https://www.businessinsider.com.au/south-australia-just-built-the-nations-first-electric-bus-2017-6
[35] https://www.abc.net.au/news/2018-10-30/electric-cars-set-to-bring-500-jobs-to-latrobe-valley/10448344

Experience with introducing electric bus fleets in other jurisdictions

Australia

ACT

In 2017, the ACT Government trialled two electric buses and one hybrid bus running on diesel over a two-year period. The buses serviced a number of routes throughout Canberra. Following the trial, the ACT launched the Climate Change Strategy 2019-25. The Plan outlines the Government's actions to develop and implement a roadmap for transitioning Transport Canberra buses to zero emissions by 2040.[36]

South Australia

The South Australian Government is trialling two electric buses in Adelaide. In 2019, the South Australian Government awarded Scania Australia the contract to supply approximately 340 buses for a potential 10-year term for the Metropolitan Adelaide Bus Network. The contract includes a demonstration hybrid bus to be provided by 2020, with the first full evaluation hybrid to be delivered in 2021.[37]

Victoria

As a result of a recent hybrid bus trial, which concluded that hybrid buses use 30 per cent less fuel than a standard bus, the Victorian Government has committed to procuring 50 hybrid buses to be delivered by 2022.[38]

International

China

China is the largest producer of electric buses and has a total of 412,000 electric buses on its roads.

Domestic demand for electric buses in China is driven by national targets, supportive subsidies to manufacturers, and municipal air quality targets.[39]

Shenzhen in China became the first major city in the world to switch its entire bus fleet to electric.

London

The city of London aims to convert its entire fleet of 4,000 buses to electric by 2020. London currently has more than 200 electric buses, making it Europe's largest electric bus fleet. In September, Transport for London awarded contracts to operators for a further 78 electric double-decker buses. [40]

---

[36] https://www.environment.act.gov.au/__data/assets/pdf_file/0003/1414641/ACT-Climate-Change-Strategy-2019-2025.pdf
[37] https://premier.sa.gov.au/news/new-contract-to-build-buses-will-deliver-public-transport-boost
[38] https://www.premier.vic.gov.au/hybrid-technology-for-50-new-metropolitan-buses/
[39] BNEF, Electric buses in Cities, March 2019 page 4
[40] https://www.london.gov.uk/press-releases/mayoral/london-has-europes-largest-electric-bus-fleet

Opportunities and challenges of transitioning the entire metropolitan bus fleet to electric

Opportunities

Sydney has the largest bus fleet in Australia with over 8,000 buses providing 332 million passenger journeys annually.[41] In 2016/17, State Transit alone operated over 2,100 buses and consumed over 42 million litres of diesel and 23 million cubic metres of compressed natural gas fuel, with total fuel costs of more than $51 million.[42]

Energy benefits

Electric buses offer a market for off-peak electricity that can help balance energy network demand. Power operators have significant spare supply capacity outside of peak periods. Electric buses can use this spare capacity, thereby minimising pressure on the grid.

As the technology evolves, there is the potential for electric bus batteries to become part of a distributed electricity storage network that can feed power generated by wind and solar back into the grid.

Fuel security

The wider transition to electric buses also increases NSW's fuel security by reducing the state's reliance on imported liquid fuels and vulnerability to fuel price variations and potential supply disruptions.[43] About 90 per cent of Australia's liquid fuel is imported from overseas, and NSW is reliant on overseas or interstate oil refining capacity.[44]

It is estimated that 500 barrels of diesel are displaced each day for every 1,000 electric buses on the road.[45]

Battery repurposing opportunities

Battery repurposing and recycling are emerging industries that will benefit from electric vehicle growth. After electric vehicle batteries no longer meet performance standards, which generally includes maintaining around 80 per cent capacity, they can be repurposed as stationary storage.[46]

Challenges

Transitioning to an electric bus fleet will require upgrades to bus depots and electrical sub-stations.

---

[41] https://www.transport.nsw.gov.au/news-and-events/reports-and-publications/transport-for-nsw-annual-reports
[42] https://www.transport.nsw.gov.au/news-and-events/reports-and-publications/state-transit-authority-20162017-annual-report
[43] Malcolm Sutton (2016), "Defence White Paper 2016: Dependency on fuel imports 'a risk' amid South China Sea tensions"
[44] https://www.bloomberg.com/news/articles/2019-05-15/in-shift-to-electric-bus-it-s-china-ahead-of-u-s-421-000-to-3
[45] https://www.bloomberg.com/news/articles/2019-05-15/in-shift-to-electric-bus-it-s-china-ahead-of-u-s-421-000-to-300
[46] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/second-life-ev-batteries-the-newest-value-pool-in-energy-storage

Charging without impacting services

Route selection would likely impact on the amount of distance each vehicle travels, the diesel consumption of the bus that is being replaced, and the amount of charging infrastructure required.

Grid impacts

The impact of the wider uptake of electric buses on the NSW electricity supply network, local limitations in bus depots and other possible charge locations, and the investments needed to support the transition to an electric fleet still needs to be understood.

The current trials of electric buses are small scale, and therefore the wider uptake of electric buses will require close collaboration between TfNSW, service providers and the energy sector to ensure that the transition to electric buses causes minimal impact on the grid.

Battery life unknown

There is uncertainty around the residual value of the bus, which is largely driven by the uncertainty around the life time of the battery and end-of-life options. Electric buses have only recently been deployed and therefore the life and performance of the battery is still not yet fully known.

One possible solution to overcome this challenge is to consider the introduction of policies that regulate the end-of-life requirements for batteries that provide clear responsibilities to the different parties involved. As the market for electric buses and lithium-ion batteries matures, some of these concerns will be alleviated.[47]

Once batteries no longer have sufficient capacity to operate a bus, they still hold significant charge (usually around 80 per cent). These second hand batteries can be used to support storage and charging at bus depots.

Business model

Electric buses may require a change in the current business model from the current ownership and operation model. The number of stakeholders involved will most likely increase to include transport, environment and energy agencies, bus operators, electricity providers, charging providers and software management platforms.

Pedestrian safety

One of the primary benefits of electric buses is their quiet operation. However, at speeds less than 20km/h, they produce so little noise that they may pose a risk to vulnerable road users, especially visually impaired pedestrians.

To address this, it has been suggested that electric vehicles should generate an artificial sound when traveling at speeds of less than 20km/h.

NSW will work with the Federal Government to update the Australian Design Rules, where required, to improve the safety of vulnerable road users.

[47] BNEF, Electric buses in Cities, March 2019 page 50

Any other related matters

Transport for NSW is focussed on developing a strategic framework to inform the wider roll-out of zero emissions buses. One of the key inputs into developing this strategic framework is the conducting of trials and research that consider the electrification of buses, the bus network, the energy system network and charging systems. Transport for NSW is already conducting trials of electric buses to help inform this strategic framework and will expand these trials in the near future. The trials are already providing valuable insights and have shown that the framework should include the following:

- A detailed review of the environmental benefits on a cradle to grave basis. This total view requires an assessment of elements such as power generation emissions, transmission, substations, replacement batteries, materials and disposal.
- Reference to the NSW electricity supply network, local limitations in the home depots and opportunity charge locations, and the investments needed in the development of this infrastructure to supply a growing fleet.
- A careful assessment of the price of electricity in terms of the amount used and the time of use in any contract agreement with the energy supplier (critical in determining the amount of energy that can be drawn and the varying costs relative to that demand).
- An assessment on the impacts of charge rate (time to charge) on both the charging infrastructure and the battery life or, in the case of hydrogen, the generation of hydrogen and refuelling and bus operations.
- A comprehensive assessment of the relative maintenance costs and the life of components of a wider electric bus fleet, as well as the charging system costs and scalability.
- A design review and testing and acceptance process for the vehicle and charging system.
- A phased plan for further zero emissions bus trials, evaluation of trials and expansion, with a parallel program of infrastructure development.
- Reference to detailed risk assessments of vehicle safety in operations and charging.
- The capital and operating costs.

One of the main learnings from a recent trial of an electric Yutong E12 bus by Premier Transport in Nowra in early 2019 was that the implementation of an electric bus involves the installation of a complete system. The acquisition of the electric bus itself for the trial was the easy part. The installation of the charging station, as well as integrating charging into routes and layovers, remain the most difficult parts.

Expanding the electric bus fleet into regional NSW would require more detailed consideration, and likely a greater investment in supporting charging infrastructure. Testing would need to establish whether electric buses are compatible with features of many regional bus networks, such as unsealed roads and the potential for longer distance routes. For smaller cities and towns, investment in charging infrastructure is likely to be required, as many smaller bus operators do not have dedicated bus depots where charging infrastructure could be located.