



Legislative Assembly of New South Wales

Committee on Transport and Infrastructure

Report 1/57 – September 2020

Electric buses in regional and metropolitan public transport networks in NSW



New South Wales Parliamentary Library cataloguing-in-publication data:

New South Wales. Parliament. Legislative Assembly. Committee on Transport and Infrastructure.

Electric buses in regional and metropolitan public transport networks in New South Wales / Legislative Assembly, Committee on Transport and Infrastructure [Sydney, N.S.W.] : the Committee, 2020. 1 online resource ([67] pages) (Report no. 1/57 Committee on Transport and Infrastructure)

“September 2020”.

Chair: Ms Robyn Preston MP.

ISBN 9781921012976

1. Buses, Electric—New South Wales—Planning.
2. Buses, Electric—Environmental aspects—New South Wales.
3. Transportation and state—New South Wales.
4. Rural transportation—New South Wales.
5. Local transit—New South Wales
- I. Preston, Robyn.
- II. Title.
- III. Series: New South Wales. Parliament. Legislative Assembly. Committee on Transport and Infrastructure. Report ; no. 1/57

(388.4132209944 DDC22)

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Membership

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Chair's foreword

Cities around the world are moving their public transport bus fleets to electric. The shift to electric vehicles has many potential benefits, including better air quality, a reduction in emissions and lower noise pollution.

Our inquiry looked at the benefits of electric buses and the opportunities and challenges of transitioning public transport bus fleets in New South Wales to electric. Thirty-six submissions were received with the Committee hearing that widespread adoption of electric buses can help reduce air pollution, which is a significant public health issue around the world. There is the potential for substantial health benefits and lower health costs if we move from diesel to electric vehicles.

As well as lower tailpipe emissions, electric buses create less environmental noise. Their silent operation, means a reduction in traffic noise and improved public amenity in areas with a heavy bus presence.

Inquiry stakeholders told us that electric buses cost less to maintain and operate than diesel buses. Whilst electric buses are more expensive to buy than diesel buses, long-term savings in relation to parts, fuel and maintenance mean they are cheaper over their lifetime.

Given these benefits, we were pleased to hear that Transport for NSW has begun planning for the move to electric buses. In our view, a comprehensive transition plan is key to the successful adoption of this new infrastructure. Effective planning will also help to overcome some of the challenges with introducing electric buses.

During the inquiry we heard that planning for the shift to electric buses should consider what charging infrastructure will be used to power electric buses, including upgrades needed and how they will be funded. This would provide certainty for bus operators and give clarity on arrangements for depot upgrades.

Procurement and contractual arrangements with bus operators will also need to be included in the planning process. This will mean that bus operators can work with manufacturers to manage the supply of electric buses and gradually replace internal combustion engine buses over time.

Our inquiry found that a gradual phase in of electric buses is the right approach. A stepped process will help with planning and ensure the right type of electric bus and charging infrastructure is chosen for each bus region. As part of this approach, Transport for NSW plans to trial electric buses in a number of metropolitan bus regions. Two trials have already been held at Nowra and Sydney's Leichhardt depot, providing useful data on the performance and capacity of electric buses.

The Leichhardt trial has shown that on route charging infrastructure may not be needed for bus routes in Sydney. Recharging through braking while in service, means that buses can operate all day and be plugged in to fully recharge, when they return to the depot. We heard that some regional services will require different infrastructure due to the long distances involved in journeys between towns. Introducing electric buses in regional areas will require longer-term planning and consideration of what infrastructure is needed in each regional area.

Although acknowledging that the quiet operation of electric buses is one of their benefits, it also poses a risk to pedestrians and road users. The Committee was concerned to hear that passengers and pedestrians with a disability are especially vulnerable to injury if they can't hear an approaching bus. To address this issue, we concluded that electric buses should be fitted with automatic noise emitters. These alert systems are required in many countries that have introduced electric buses.

We also found that a safety campaign should be run to raise awareness about electric buses and alert pedestrians and road users to their presence on our public transport network.

We heard that driving an electric bus is different to driving a diesel bus and requires new skills to maximise recharging while driving. This means that drivers will need training on how to drive the buses safely and effectively. Driver training should also include the needs of passengers with a disability to improve their access to electric buses.

We were excited to hear about the many potential benefits of electric buses and we believe that with careful planning and a stepped approach, our transition to electric buses can be smoothly implemented.

Robyn Preston MP
Chair

Findings and recommendations

Finding 1	1
Electric buses reduce air and noise pollution.	
Finding 2	5
Electric buses are cheaper to maintain and operate.	
Recommendation 1	6
That Transport for NSW develops a transition plan with clear objectives and timeframes to transition the public transport bus fleet to electric.	
Recommendation 2	9
That Transport for NSW includes the length of contracts, funding of infrastructure upgrades and bus procurement in the transition plan.	
Recommendation 3	12
That training for bus drivers includes how to efficiently operate electric buses for safety and to fully realise the potential benefits of electric buses.	
Recommendation 4	15
That Transport for NSW audits its bus depots to identify local grid capacity and suitability to support the conversion to electric.	
Recommendation 5	16
That Transport for NSW considers what charging option is suitable for each bus depot and local routes.	
Recommendation 6	18
That Transport for NSW considers requiring universal chargers for flexible, standard charging across the state.	
Finding 1	19
A mix of hybrid and battery electric buses may be most suitable for Sydney's bus network.	
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That Transport for NSW identifies opportunities for renewable energy sources to power the electric bus fleet.	
Finding 4	25
Hydrogen is an option to power long distance heavy vehicles.	
Recommendation 8	27
That as part of the transition plan, Transport for NSW considers what charging infrastructure would be suitable for travel between regional areas and within regional centres.	

Recommendation 9	29
That Transport for NSW requires an automated alert or noise emitter to be installed on electric buses.	
Recommendation 10	31
That Transport for NSW runs a safety and awareness campaign for pedestrians and road users about electric buses.	
Recommendation 11	32
That Transport for NSW consults groups that represent people with disability on the accessibility of electric buses.	
Recommendation 12	34
That training be provided for bus drivers on the needs of passengers with disability.	
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Chapter One – Transitioning to an electric bus fleet

Benefits of electric buses

Summary

Electric buses significantly lower emissions, provided they are powered by renewable energy. They also improve air quality and create much less noise pollution than internal combustion engine buses. This has health benefits and reduces health costs associated with air pollution.

Finding 1

Electric buses reduce air and noise pollution.

Better air quality and lower emissions

- 1.1 Inquiry participants told us about the benefits of transitioning to electric buses. We heard that electric buses improve air quality as they have no tailpipe emissions. This reduces nitrous oxides and diesel particulate matter, which improves air quality.¹
- 1.2 Electric buses are more fuel efficient than internal combustion engine buses. This eliminates or reduces emissions, if the buses are powered by renewable electricity.²
- 1.3 Volvo told us that its diesel hybrid buses can lower nitrogen oxides and particulate emissions by up to 50 per cent and fuel and carbon dioxide emissions by up to 40 per cent. Its fully electric bus is 100 per cent emission free.³
- 1.4 Several inquiry participants noted that the transport sector produces around 20 per cent of the state's annual greenhouse gas emissions. Transport for NSW (TfNSW) told us that the transport sector is a significant emitter and has a role in the Government's goal of net zero carbon emissions by 2050.⁴

¹ Submission 22, Siemens Ltd, p2; Submission 10; Beyond Zero Emissions, p1; Submission 17, Electric Vehicle Council, pp1-2; Submission 12, Scania Australia Pty Ltd, p4; Submission 4, Volvo Buses, p9; Submission 5, ARCC Pty Ltd, pp2-3; Submission 7, Transport for NSW, p6; Submission 23, Gemilang Australia Pty Ltd, pp2, 5; Submission 25, Toshiba International Corporation Pty Ltd, p2; Submission 27, Electromotiv, p2; Submission 32, Ms Anna Nadolny, p2; Professor Guy Marks, Principal Investigator and Lead, Centre for Air pollution, energy and health Research, Transcript of evidence, 20 March 2020, p16

² Submission 22, Siemens Ltd, p2; Submission 10; Beyond Zero Emissions, p1; Submission 5, ARCC Pty Ltd, p3; Submission 13, Centre for Air pollution, energy and health Research, pp1-2, 3; Submission 24, Dr Jake Whitehead, p11; Submission 31, Dr Pedro Orbaiz and Professor Michael Brear, p2; Submission 35, Australian Bus Corporation, p2

³ Submission 4, Volvo Buses, pp8-9, 11

⁴ Submission 18, Local Government NSW, p3; Submission 17, Electric Vehicle Council, pp1-2; Submission 7, Transport for NSW, pp5-6; Submission 9, ClimateWorks Australia, pp1-2; Submission 30, Centre for Energy and Environmental Markets, University of NSW, p2

- 1.5 We heard that renewable electricity is key to meeting the goal of zero emissions and realising the full benefits of the transition to electric buses. ClimateWorks Australia told us that 'states can drive a rapid transition to reduce emissions by electrifying bus fleets and powering vehicles with 100 per cent renewable energy.'⁵ Using renewable energy to power electric buses is discussed in more detail in chapter two.
- 1.6 Ausgrid observed that electric buses could improve the liveability of metropolitan and regional areas through air quality improvements. They noted that this will become more important as NSW's population is forecast to grow to 9.9 million people in 2036.⁶
- 1.7 The Centre for Air pollution energy and health Research noted that the benefits of reducing greenhouse gases and improving air quality would be partly offset if electricity used to charge the buses was produced from fossil fuels, which contribute significantly to air pollution.⁷

Case study 1: What is an electric bus?⁸

An electric bus is a bus that is powered by electricity. There are three main types of electric bus:

- battery electric vehicles powered by electricity stored in a battery pack.
- hybrid vehicles with an internal combustion engine and an electric motor and large rechargeable battery.
- hydrogen fuel cell vehicles that convert gas or liquid hydrogen into electricity to run an electric motor.

Battery electric buses differ from internal combustion engine and hybrid buses, as they can be directly charged using electricity, and operate only on electricity. Electricity to charge and fuel electric buses comes from power grids, which rely on a range of sources from fossil fuels to clean renewable energy.

Improved community health

- 1.8 We heard that transitioning to electric buses could have significant health benefits and reduce health costs. TfNSW stated that 'transitioning our bus fleet to electric will help reduce air pollution and the health impacts poor air quality have on our communities.'⁹
- 1.9 Inquiry participants referred to the World Health Organisation's findings that poor air quality is the world's number one cause of death, with seven million people dying each year globally from exposure to fine particles in polluted air.¹⁰

⁵ Submission 9, ClimateWorks Australia, pp1-2, 6

⁶ Submission 21, Ausgrid, p3

⁷ Submission 13, Centre for Air pollution, energy and health Research, p1

⁸ Submission 24, Dr Jake Whitehead, p5; Submission 7, Transport for NSW, p3

⁹ Submission 7, Transport for NSW, pp6-7

¹⁰ Submission 12, Scania Australia Pty Ltd, p11; Submission 7; Transport for NSW, p7

- 1.10 Air pollutants can cause asthma, heart disease, stroke, lung cancer, and chronic obstructive pulmonary disease. Air pollution disproportionately affects vulnerable people, such as unborn babies, children, the elderly, and those with pre-existing health conditions.¹¹
- 1.11 TfNSW noted that each year air pollution leads to 520 premature deaths in Sydney. In terms of the yearly impact on the health system, it leads to 1,180 hospital admissions in Sydney, and around \$6.4 billion (2015) in health costs in the Greater Metropolitan Region.¹²
- 1.12 The Electric Vehicle Council's Cleaner and Safer Roads for NSW report outlined the health and safety benefits of transitioning to electric vehicles. The report noted research that for each electric vehicle replacing an internal combustion engine vehicle in the Sydney-Newcastle-Wollongong region, NSW would save at least \$2,400 in health costs.¹³
- 1.13 Inquiry participants highlighted estimated health savings in countries that have adopted electric buses. New York City's transition of 5,700 buses from diesel to electric is predicted to save \$150,000 per bus each year in health care costs. The Electric Vehicle Council noted that Chicago's Transit Authority had calculated health savings from adopting electric buses. It found that the drop in harmful emissions lowers incidents of illnesses and respiratory diseases, which is valued at US\$55,000 annually per bus, or US\$660,000 over the expected 12-year bus lifespan.¹⁴
- 1.14 Volvo told us that some cities are now evaluating the wider contribution of electric buses. This includes assessing 'financial benefits of reducing noise, emissions and health impacts and placing an economic value on each element'. This approach is different to traditional methods of costing contracts as it also considers the value of societal impacts.¹⁵
- 1.15 We heard that it's important to consider the original energy source when calculating the health benefits of electric buses. The Centre for Air pollution, energy and health Research stressed that any health benefits 'may be negated by community exposure to air pollutants associated with the burning of ... fossil fuels and increases in greenhouse gas emissions'.¹⁶

Reduced noise pollution

- 1.16 Another benefit of transitioning to electric buses is a drop in noise pollution. We heard that electric buses are much quieter than diesel buses as they produce less

¹¹ Submission 7, Transport for NSW, pp6-7; Submission 13, Centre for Air pollution, energy and health Research, p2; Submission 24, Dr Jake Whitehead, p10

¹² Submission 7, Transport for NSW, p6

¹³ Submission 17, Electric Vehicle Council, p3; Ms Larissa Cassidy, Manager of Policy Electric Vehicle Council, Transcript of evidence, 20 March 2020, p3

¹⁴ Submission 9, ClimateWorks Australia, pp3-4; Mr Michael Li, Senior Project Manager (Cities and Policy), ClimateWorks Australia, Transcript of evidence, 20 March 2020, p13; Submission 17, Electric Vehicle Council, p4

¹⁵ Submission 4, Volvo Buses, p4

¹⁶ Submission 13, Centre for Air pollution, energy and health Research, p2; Professor Marks, Transcript of evidence, 20 March 2020, p16

noise when operating and are totally silent when stationary. This means that passengers have a quieter journey and there is less environmental noise pollution.¹⁷

- 1.17 TfNSW told us that the NSW Road Noise Policy found traffic noise to be the most prevalent source of noise in the state, and that any reduction would benefit community amenity and health. The policy noted that electric vehicles' quieter electric motor would offer significant gains in lowering noise impacts.¹⁸
- 1.18 We heard that buses can have a major impact on noise levels in residential areas, and the introduction of electric buses is likely to have a positive impact on the liveability of residential areas near busy bus routes.¹⁹ According to Local Government NSW (LGNSW), communities report significantly improved amenity due to reduced noise. This is especially the case for people living close to bus stops whose sleep is disturbed by internal combustion engine bus noise.²⁰
- 1.19 Beyond Zero Emissions observed that reducing bus noise would increase urban amenity and make our streets more pedestrian and cyclist friendly. It could also allow an increase in transport services around busy transport corridors.²¹
- 1.20 The Electric Vehicle Council highlighted the health and social costs of noise from road transport. Conventional buses and trucks often reach 80 decibels – 100 times louder than a typical residential street. The World Health Organisation has ranked noise as the second environmental threat to public health, after air pollution. The social costs of vehicle noise in NSW are estimated at \$1.4 billion annually.²²
- 1.21 Less noise and vibrations also make for a more pleasant and comfortable journey for passengers. According to ARCC, lower noise and fumes mean that electric bus transport is 'an overall more enjoyable public transport experience' for drivers and passengers.²³

Lower cost over lifetime

Summary

Electric buses are cheaper than diesel buses over their lifetime. While the vehicles cost more than diesel buses and require charging infrastructure, they cost less to run and maintain.

¹⁷ Submission 12, Scania Australia Pty Ltd, p4; Submission 22, Siemens Ltd, p2; Submission 17, Electric Vehicle Council, p4; Submission 25, Toshiba International Corporation Pty Ltd, p3; Submission 26, Nexport Pty Ltd, p3; Submission 35, Australian Bus Corporation, p1

¹⁸ Submission 7, Transport for NSW, p6

¹⁹ Submission 21, Ausgrid, p4

²⁰ Submission 18, Local Government NSW, p5

²¹ Submission 10, Beyond Zero Emissions, p1

²² Submission 17, Electric Vehicle Council, p4

²³ Submission 5, ARCC Pty Ltd, p2; Submission 18, Local Government NSW, p5; Submission 12, Scania Australia Pty Ltd, p4; Submission 35, Australian Bus Corporation, pp1-2

Finding 2

Electric buses are cheaper to maintain and operate.

- 1.22 Electric buses cost less to operate over their lifetime. While they have higher upfront costs, lower operating and maintenance costs make them cheaper than diesel or hybrid buses.²⁴
- 1.23 We heard that although upfront costs are currently higher than diesel buses, they are predicted to drop. The Electric Vehicle Council noted that high initial costs are largely due to the cost of batteries, which is expected to fall. Inquiry participants noted forecasts that electric buses will cost the same, or be cheaper, than diesel buses by 2030.²⁵
- 1.24 We also heard that growing demand for electric buses could reduce their purchase price, and that higher demand electric buses may reach cost parity with diesel buses by the mid-2020s.²⁶
- 1.25 In spite of current higher purchase costs, electric buses are competitive with diesel buses because of lower operating costs. ClimateWorks Australia cited results from the trial of an electric bus at the Nowra depot, showing that the bus has reduced daily running costs by 72 per cent compared to diesel buses.²⁷
- 1.26 Beyond Zero Emissions noted that electric buses are around \$240,000 more expensive than diesel buses, but this is offset by lower maintenance and fuel costs over the bus's lifetime. ARCC estimated that with savings due to reduced service and fuel costs the payback period for a new bus would be around three years.²⁸
- 1.27 We heard that electric motors don't require oils or filters, gearboxes, or fuel tanks. They have a smaller air compressor and a smaller heat exchanger, or none at all. There is less wear on brakes as the motor is used to slow the bus and regenerate the batteries. This would be offset by the need to replace batteries during the bus's life.²⁹
- 1.28 The Australian Bus Corporation told us that 'decreased maintenance downtime will partially offset the additional fuelling/charging time required by an electric fleet.'³⁰
- 1.29 TfNSW noted evidence that the cost to fully charge an electric bus operating in Sydney would be \$30 a day or less, while diesel and gas buses cost around \$64 a

²⁴ Submission 10, Beyond Zero Emissions, p1; Submission 32, Ms Anna Nadolny, p2; Submission 36, Inverted Power Pty Ltd, p1; Mr John King, President, BusNSW, Transcript of evidence, 20 March 2020, p27

²⁵ Submission 17, Electric Vehicle Council, p7; Submission 7, Transport for NSW, p8; Submission 24, Dr Jake Whitehead, p41; Submission 31, Centre for Energy and Environmental Markets, UNSW, p3; Mr Li, Transcript of evidence, 20 March 2020, p13

²⁶ Submission 7, Transport for NSW, p8; Submission 9, ClimateWorks Australia, p3

²⁷ Submission 9, ClimateWorks Australia, p2, 3

²⁸ Submission 10, Beyond Zero Emissions, p2; Submission 5, ARCC Pty Ltd, p2

²⁹ Submission 7, Transport for NSW, p5; Submission 5, ARCC Pty Ltd, p2; Submission 24, Dr Jake Whitehead, p10; Submission 27, Electromotiv, p3

³⁰ Submission 35, Australian Bus Corporation, p2

day to fuel.³¹ The Electric Vehicle Council cited estimates by the Chicago Transit Authority of annual net savings in fuel costs for each electric bus of US\$25,000, or \$300,000 over the expected 12-year lifespan of each bus.³²

- 1.30 We heard that the cost of electric buses also includes infrastructure to power the fleet. The Electric Vehicle Council observed that initial purchases include an investment in infrastructure, which can then be used by later generations of buses.³³
- 1.31 LGNSW commented on the need to factor in the cost of setting up a complex and expensive system to support the fleet, in addition to the purchase cost of buses. LGNSW echoed the point that overall lifetime costs make electric buses competitive with diesel buses: 'once the initial set up costs have been factored in, as well as the overall extended lifespan of electric buses and the ongoing cost reductions in battery prices, electric buses are cost competitive with diesel fleets when total cost of ownership is calculated.'³⁴

Transition plan

Summary

A plan with clear timeframes and goals is needed to transition the public transport bus fleet to electric. A gradual rollout would allow enough time to develop a comprehensive plan for the transition.

Recommendation 1

That Transport for NSW develops a transition plan with clear objectives and timeframes to transition the public transport bus fleet to electric.

Developing a plan to roll out electric buses

- 1.32 We consider that a transition plan is needed to move the public transport bus fleet to electric. Transport for NSW should develop a plan with clear objectives and timeframes to ensure the transition is managed effectively. We discuss elements of the plan in more detail below.
- 1.33 Inquiry participants encouraged the government to develop a long-term plan to transition the entire bus fleet.³⁵ They told us that policy direction and certainty can help address barriers to the uptake of electric vehicles.³⁶
- 1.34 We note that the Government has stated that it will transition all 8000 buses in Sydney to zero emission buses. A two year trial of four fully electric buses began in July 2019 in Sydney's inner west. There will also be a further trial of 10 electric

³¹ Submission 7, Transport for NSW, p5

³² Submission 17, Electric Vehicle Council, p4

³³ Submission 17, Electric Vehicle Council, p4

³⁴ Submission 18, Local Government NSW, pp5-6

³⁵ Mr Behyad Jafari, CEO, Electric Vehicle Council, Transcript of evidence, 20 March 2020, p1; Submission 26, Nexport Pty Ltd, p9

³⁶ Submission 20, BusNSW, pp2-3

buses at the Randwick depot, to be procured through a bus contract tender process. Infrastructure upgrades will be part of the trial.³⁷

- 1.35 In May 2020 bus operators with existing contracts were asked to submit expressions of interest to trial zero emission buses, including battery electric and hydrogen fuel cell, in the Sydney and outer metropolitan areas. TfNSW told us that the 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.'³⁸
- 1.36 These trials are part of the *NSW Electric and Hybrid Vehicle Plan*. A further step in the plan is assessing the feasibility of transitioning one or more bus depots to partial or full electric operations. This would involve considering power supply and charging infrastructure requirements and other operational factors.³⁹
- 1.37 TfNSW told us that trials have shown that the strategic framework should cover:
- environmental benefits – power generation emissions, transmission, substations, replacement batteries, materials and disposal
 - electricity supply – local limits in depots and opportunity charge locations, investments needed to develop infrastructure for a growing fleet
 - cost of electricity – amount used and time of use in a contract agreement with the energy supplier
 - impacts of time to charge on charging infrastructure and battery life, or the generation of hydrogen, and refuelling and bus operations
 - relative maintenance costs and the life of parts of an electric fleet, charging system costs and scalability
 - design review and testing, and acceptance process for vehicle and charging system
 - phased plan for more trials, evaluation of trials and expansion, with parallel program of infrastructure development
 - risk assessments of vehicle safety in operations and charging
 - capital and operating costs.⁴⁰

Adopting electric buses gradually

- 1.38 Inquiry participants supported a staged, gradual rollout of electric buses.⁴¹ AGL Energy suggested a road-mapping model with pilots and trials to reduce infrastructure costs. Trials would allow testing and learning before a wider rollout and procurement process. They could focus on different charging options, orchestration, vehicle selection, and infrastructure. AGL told us that the roadmap

³⁷ Submission 7, Transport for NSW, p4

³⁸ Submission 7, Transport for NSW, p4 and Transport for NSW, [Expressions of interest sought for Zero Emission Bus Trials](#), media release, 4 May 2020, viewed 21 July 2020

³⁹ NSW Government, [NSW Electric and Hybrid Vehicle Plan](#), January 2019, viewed 21 July 2020

⁴⁰ Submission 7, Transport for NSW, p17

⁴¹ Submission 4, Volvo Buses, p7; Submission 26, Nexport Pty Ltd, p9

should set goals, milestones, gaps and barriers, actions, priorities, and timelines.⁴²

- 1.39 The Electric Vehicle Council said that a staged rollout of electric buses would allow planning and early work to be done, to 'ensure a smoother and speedier electrification process.' The Council noted that engaging now with energy suppliers would allow them to plan for bus electrification. This could speed up grid connection, which can be time consuming.⁴³
- 1.40 BusNSW suggested electric buses be introduced gradually given the scale of change needed, and continual changes in electric vehicle technology and energy generation. The shift should involve short, medium and long-term strategies, which consider different operating conditions and needs in NSW.⁴⁴
- 1.41 We consider that trials of electric buses show that a gradual phase in with trials of electric buses will help to plan the transition. Through the trials TfNSW has gathered data on bus performance, and gained insight on grid capacity and upgrades needed to power electric buses.
- 1.42 Transit Systems, the operator of the inner west trial, said that real-time data has been captured from the BYD-Gemilang vehicles. This allows staff to monitor carbon dioxide and nitrogen oxide savings, and the range and overall performance of each bus. Information on depot grid capacity has also been obtained.⁴⁵
- 1.43 TfNSW plans to use knowledge gained from Sydney electric bus trials before rolling out in regional areas. Inquiry participants supported this approach. BusNSW said that the transition to electric buses should initially be limited to urban operations, as they 'provide the necessary scale to benefit from a whole of lifecycle perspective whilst providing higher environmental and social outcomes than that in regional areas'.⁴⁶ We discuss introducing electric buses in regional areas in more detail in chapter 2. The case study below outlines the adoption of electric buses around the world.

Case study 2: Adoption of electric buses around the world⁴⁷

Electric bus adoption in public transport fleets is growing around the world. Over 34 cities have pledged to buy only zero emission buses from 2025. Below are examples of the introduction of electric buses in different countries:

- China has more than 420 000 electric buses and is forecast to have 600 000 by 2025. Around 98% of electric buses were deployed in Chinese cities at

⁴² Submission 19, AGL Energy Ltd, p3

⁴³ Submission 17, Electric Vehicle Council, pp8, 11

⁴⁴ Submission 20, BusNSW, pp2-3

⁴⁵ Submission 11, Transit Systems Pty Ltd, p9; Mr Greg Balkin, General Manager, New Technology and Innovation, Transit Systems Pty Ltd, Transcript of evidence, 18 March 2020, p11

⁴⁶ Ms Elizabeth Mildwater, Deputy Secretary, Greater Sydney, Transport for NSW, Transcript of evidence, 20 March 2020, p30; Submission 20, BusNSW, p3

⁴⁷ Submission 4, Volvo Buses, p11; Submission 17, Electric Vehicle Council, p10; Submission 21, Ausgrid, pp5-6; Submission 24, Dr Jake Whitehead, pp6, 30-31, 34-35; Submission 27, Electromotiv, pp 6; Submission 29, Transdev

the end of 2018. Shenzhen was the first city in the world to fully electrify its buses in 2017.

- Chile recently added 200 new electric buses to its fleet, with an expected 500 more to follow next year, as it aims for a fully electric fleet by 2040.
- California has a target to move to a 100% zero emission bus fleet by 2040. The California Resources Board has set a rule that 25% of all new buses purchased must be electric by 2023, rising to 50% by 2026, and all new buses by 2029.
- North Los Angeles's Antelope Valley Transit Authority set a goal to be the first US public transport operator to fully electrify its fleet. By December 2019, 49 of the AVTA's 88 buses were zero emission buses manufactured in the Antelope Valley.
- In February 2017 NZ Bus began a trial of electric buses, first in Auckland and then in Wellington, as part of a strategy to transition to electric-powered public transport in New Zealand.
- In Europe there are over 4000 electric buses running. The United Kingdom, the Netherlands, France and Poland are major European markets for electric buses. London has Europe's largest fleet with more than 200 electric buses.

Elements of the transition plan

Summary

The transition plan for the rollout of electric buses should cover the funding of charging infrastructure, bus procurement and contracts with bus operators.

Recommendation 2

That Transport for NSW includes the length of contracts, funding of infrastructure upgrades and bus procurement in the transition plan.

- 1.44 We recommend that Transport for NSW's transition plan covers the length of contracts with bus operators, funding of infrastructure upgrades and procurement of buses. We heard that these are key elements of a plan for the transition to electric buses.

Charging infrastructure and energy supply

- 1.45 The need for planning and coordination to overcome challenges with charging infrastructure was raised by several inquiry participants. We heard that planning is needed to provide certainty about who is responsible for funding, building and operating charging infrastructure. ClimateWorks Australia said that a coordinated transition would help to address charging infrastructure gaps across the state.⁴⁸

Australasia Pty Ltd, p2; Antelope Valley Transit Authority, [About our fleet](#), viewed 28 August 2020; Elektrek, [Electric buses surging in Latin America, Chile adding to fleet as it aims for all-electric by 2040](#), 24 May 2019, viewed 28 August 2020; Zero Emission Urban Bus System, [ZeEUS eBus Report #2 An updated overview of electric buses in Europe](#), viewed 31 August 2020

⁴⁸ Submission 9, ClimateWorks Australia, p5

- 1.46 AGL Energy told us that electrification of the fleet will require energy supply, charging strategies and infrastructure, and vehicle choice to be considered jointly. Electricity demand will increase, and locally generated green energy supply will be needed. In addition, charging infrastructure will have to be installed and integrated into the electricity network. AGL suggested an integrated, system-wide approach to find the right charging solution for the network.⁴⁹
- 1.47 Volvo told us that detailed planning and preparation is critical to implement electric buses. They explained that commissioning and building infrastructure can take more than 12 months, depending on the grid, power availability and coordination with planning authorities and councils.⁵⁰
- 1.48 Gemilang Australia raised the question of who would fund charging infrastructure and depot upgrades, commenting that 'mass uptake of electric buses will be difficult without supplemented funding or a new way of funding buses – such as leases or purchase agreements.'⁵¹
- 1.49 Dr Jake Whitehead suggested the Government provide clear guidelines and application pathways, so that requests to install charging infrastructure can be handled in a consistent and timely way. He noted the Government may need to consider financial support for grid upgrades.⁵²
- 1.50 Transit Systems echoed this view, stating that the cost of upgrades would be prohibitive for most bus operators.⁵³ Nexport estimated that on site depot upgrades involving a new substation can cost between \$200,000 and \$700,000. This would allow 50 to 200 buses to be charged.⁵⁴
- 1.51 TfNSW acknowledged that charging infrastructure can limit the wider uptake of electric buses. They told us that bus depots and other locations will need infrastructure for electric charging units.⁵⁵ While infrastructure upgrades to government-owned depots will be funded by the government, the model for funding upgrades to privately operated depots is unclear. We heard that this issue will be examined as part of the current expression of interest process and through the renewal of 14 contracts for bus regions in Sydney.⁵⁶

Bus procurement and contracts

- 1.52 Bus operators in NSW buy buses under contract through a TfNSW procurement panel, which negotiates the cost of available buses. Procurement strategies can include open tenders, direct negotiations with operators and industry-based negotiations. BusNSW told us that each type of procurement needs mechanisms

⁴⁹ Submission 19, AGL Energy Ltd, p2

⁵⁰ Submission 4, Volvo Buses, pp14-15

⁵¹ Submission 23, Gemilang Australia Pty Ltd, p6

⁵² Submission 24, Dr Jake Whitehead, pp12-13

⁵³ Submission 11, Transit Systems Pty Ltd, p3

⁵⁴ Submission 26, Nexport Pty Ltd, p6

⁵⁵ Submission 7, Transport for NSW, pp8-9

⁵⁶ Ms Mildwater, Transcript of evidence, 20 March 2020, p37

that allocate risk in a fair way, reflecting the 'uncertainty around operating a fleet that has a growing proportion of electric buses during the contract term'.⁵⁷

- 1.53 We heard that careful tendering and procurement processes are important for a successful transition to electric buses. Dr Pedro Orbaiz and Professor Michael Brear stated that 'tenders must define the minimum required vehicle performance under local conditions and also establish vehicle baselines for the evaluation of warranties'.⁵⁸
- 1.54 Volvo suggested that procurement should allow enough time for routes to be assessed and accurate, detailed project plans to be provided. This would also allow operators to work with local manufacturers to ensure locally built bus bodies that meet the TfNSW panel's specifications.⁵⁹ BusNSW highlighted the importance of long-term supply of chassis and body parts, to be sourced by operators when bus models are no longer available.⁶⁰
- 1.55 AGL Energy observed that the charging strategy has to be considered when choosing vehicles, as battery capacity will affect the cost of vehicle procurement. Large batteries allow for longer periods without charging, but will cost more.⁶¹
- 1.56 Inquiry participants supported a gradual shift to procure electric buses. Diesel buses operate for 18 to 25 years. We heard that the fleet currently has an average age of 11 years; 18.5 per cent of buses in the Sydney metropolitan region are less than five years old.⁶²
- 1.57 Scania told us that if 650 buses were replaced with electric buses each year, it would take 25 years to replace the whole fleet. They suggested a gradual start, with older buses being replaced with electric rather than diesel buses. The pace of change could increase as local bus bodybuilders and infrastructure suppliers develop the skills and capacity to meet demand for electric buses.⁶³
- 1.58 We heard that upfront capital costs of electric buses should be considered in contract arrangements with operators.⁶⁴ The Electric Vehicle Council told us that different capital and operating costs of electric buses – higher upfront costs and lower maintenance costs – should be considered during the procurement process. Infrastructure requirements and external benefits such as public health savings should also be factored in to accurately measure the costs and benefits of buses.⁶⁵
- 1.59 Transit Systems argued that the term of contracts with operators has to be looked at 'to give more certainty over longer periods so these investments can be

⁵⁷ Submission 20, BusNSW, p9; Mr Balkin, Transcript of evidence, 18 March 2020, p11, p15

⁵⁸ Submission 31, Dr Pedro Orbaiz and Professor Michael Brear, p4

⁵⁹ Submission 4, Volvo Buses, pp14-15

⁶⁰ Submission 20, BusNSW, pp2-3

⁶¹ Submission 19, AGL Energy Ltd, p2

⁶² Answers to questions on notice, 20 March 2020, Transport for NSW, p2; Mr Steve Issa, Acting Executive Director, Services, Greater Sydney, Transport for NSW, Transcript of evidence, 20 March 2020, p35

⁶³ Submission 12, Scania Australia Pty Ltd, pp14, 20

⁶⁴ Submission 12, Scania Australia Pty Ltd, p20

⁶⁵ Submission 17, Electric Vehicle Council, p7

material over the period of time.' Interline Bus Services indicated that a contract of around seven years may be suitable to set up a depot and install infrastructure to operate electric buses.⁶⁶

- 1.60 We heard that electric buses are heavier than diesel buses due to the weight of batteries. As buses must comply with national gross mass limits, electric buses have a lower carrying capacity and fit fewer passengers than diesel buses.⁶⁷
- 1.61 Some inquiry participants suggested a waiver process or a national review of mass limits to support the adoption of electric buses and give industry time to address the issue. However, TfNSW noted that vehicle design is changing to accommodate the weight of batteries and ensure they meet design and weight requirements.⁶⁸

Staff training

Summary

Driver training on electric buses should cover efficient and safe operation of the vehicles, so that their benefits can be fully realised. Maintenance staff will also require training to service the vehicles.

Recommendation 3

That training for bus drivers includes how to efficiently operate electric buses for safety and to fully realise the potential benefits of electric buses.

Training drivers to drive electric buses effectively

- 1.62 Driving electric buses is different to diesel buses and requires specialised training. We recommend that drivers be trained on efficient operation of electric buses, so that the benefits of electric buses are fully realised.
- 1.63 Inquiry participants told us that electric buses operate in a different way and require different driving techniques. Electric vehicles can accelerate far more quickly than internal combustion engine vehicles. When they brake, the motor can act as a generator, producing electricity to charge the battery.⁶⁹
- 1.64 We heard that driving a diesel bus involves a different approach that doesn't require awareness of how the vehicle is being powered. To drive an electric vehicle drivers have to take their foot off the pedal more and be aware of regeneration. Diesel buses require more side to side movement between brake and accelerator pedals, while electric buses involve more acceleration and less braking: 'the best way to drive an electric vehicle is to utilise the accelerator and

⁶⁶ Mr Balkin, Transcript of evidence, 18 March 2020, pp11, p15; Mr Joe Oliveri, Director, Operations and Maintenance Manager, Interline Bus Services, Transcript of evidence, 18 March 2020, pp14-15

⁶⁷ Mr Balkin, Transcript of evidence, 18 March 2020, p11; Submission 23, Gemilang Australia Pty Ltd, p3; Submission 17, Electric Vehicle Council, p5

⁶⁸ Submission 17, Electric Vehicle Council, p5; Submission 20, BusNSW, pp7-8; Mr Issa, Transcript of evidence, 20 March 2020, p33

⁶⁹ Submission 5, ARCC Pty Ltd, p3; Submission 17, Electric Vehicle Council, p5

the regeneration that kicks in when you take your foot off the pedal'.⁷⁰

- 1.65 BusNSW told us that the driver's skill can have a substantial effect on an electric bus's performance. Well trained drivers have a better understanding of regeneration techniques. They drive up hills at a lower speed than with a diesel bus, and know that regeneration will occur when they drive downhill. During trials, the most competent drivers returned with 38 per cent battery charge, while the least competent had a 27 per cent charge.⁷¹
- 1.66 Electric buses are quieter and don't vibrate as much as internal combustion vehicles. We heard that drivers enjoy the smoother ride and using the pedals less in comparison to diesel buses. BusNSW noted that the silent nature of the buses means a 'positive experience for the commuter and the worker'.⁷²
- 1.67 Nexport surveyed its drivers and found that 'staff who were driving and operating the buses ... just felt generally more at ease at the end of their shift—less stressful.' Many drivers who had driven electric buses were reluctant to go back to driving diesel buses, as they found the buses more comfortable overall.⁷³
- 1.68 However some inquiry participants told us that the lack of noise when driving an electric bus can be unsettling. Drivers can be unaware of what the bus is doing due to the lack of engine noise, and be surprised by how quickly it starts. The Transport Workers Union said that 'if you are not paying attention, that vehicle is moving before your brain has actually switched onto the fact that it is moving.' They noted that some older drivers don't feel comfortable driving the buses.⁷⁴
- 1.69 BusNSW told us that experienced diesel bus drivers need around four to six hours of theoretical and practical driver training on the basics of electric buses and their performance. The TWU stressed the need for inexperienced drivers to receive adequate and detailed training to operate the buses' safely.⁷⁵
- 1.70 Drivers also need to be trained on processes to complete before an electric bus leaves the depot and at the end of a shift, and on how to charge the vehicles. We heard that operating a diesel bus involves a 10-minute start and finish process, while electric buses require 30 minutes at the start and end of a driver's shift. Drivers must unplug and secure the charger before they get on the bus, and the process for starting an electric bus is different to a diesel bus.⁷⁶

Training maintenance staff to service electric buses

- 1.71 Inquiry participants also noted that maintenance staff will require training to service electric vehicles. We heard that the franchise model for Sydney bus contracts will mean that several bus operators manage the training of drivers and

⁷⁰ Mr King, Transcript of evidence, 20 March 2020, p24; Mr Luke Todd, Managing Director, Nexport Pty Ltd, Transcript of evidence, 20 March 2020, p7

⁷¹ Mr King, Transcript of evidence, 20 March 2020, p24

⁷² Mr King, Transcript of evidence, 20 March 2020, p27

⁷³ Mr Todd, Transcript of evidence, 20 March 2020, p7

⁷⁴ Mr Alan Smith, Member, Transport Workers' Union, Transcript of evidence, 18 March 2020, p16

⁷⁵ Mr King, Transcript of evidence, 20 March 2020, p24; Mr Smith, Transcript of evidence, 18 March 2020, pp16-17

⁷⁶ Mr King, Transcript of evidence, 20 March 2020, p24

maintenance staff on electric buses. During the transition period there will be a need for maintenance staff who can service internal combustion engine, hybrid and battery electric vehicles.⁷⁷

- 1.72 Staff with a different skill set will be needed to service electric bus batteries and roof components. We were told that workshops will need space to maintain buses, including for working at heights equipment, and staff will need training in high voltage safety and an understanding of how the buses are powered.⁷⁸
- 1.73 BusNSW observed that developing a workforce with the skills to service electric vehicles is a challenge. Training qualifications and pathways for mechanics and workshop staff on safe handling of high voltage systems will have to be developed. Wider training on business practices and work health and safety will also be needed, particularly for bus drivers and operational staff.⁷⁹
- 1.74 TfNSW told us that training packages on new buses are developed and supplied by bus operators in partnership with suppliers. A specific package was developed for both regions that have run trials of electric buses. TfNSW noted that NSW bus operators have to complete the Bus Operator Accreditation Scheme – a safety management and training program for operators seeking to run services with vehicles that seat more than 12 passengers.⁸⁰

⁷⁷ Submission 22, Siemens Ltd, p12; Submission 17, Electric Vehicle Council, p6

⁷⁸ Submission 4, Volvo Buses, p6; Submission 23, Gemilang Australia Pty Ltd, pp5-6; Mr King, Transcript of evidence, 20 March 2020, p28

⁷⁹ Submission 20, BusNSW, pp6-7

⁸⁰ Mr Issa, Transcript of evidence, 20 March 2020, p34

Chapter Two – Meeting the fleet's energy needs

Charging infrastructure

Summary

Transport for NSW should audit its depots to determine the capacity of the local grid to power electric buses.

Recommendation 4

That Transport for NSW audits its bus depots to identify local grid capacity and suitability to support the conversion to electric.

Auditing bus depots

- 2.1 An audit of Transport for NSW bus depots will help to identify the ability of each depot to house a fleet of electric buses. We heard that TfNSW is unsure if all its depots can be adapted for electric buses. A depot audit will help identify gaps in their capability, especially the availability of a sufficient supply of energy. We were told that energy supply is the main consideration when adapting depots to electric.⁸¹
- 2.2 Ausgrid highlighted the benefits of an audit, which they suggested could also assess potential sites for charging facilities. We heard an audit could also help identify the type of electric bus most suited for each depot and the routes operating from the depot. The best charging infrastructure to use at each site and how it should be powered can also be considered.⁸²
- 2.3 AGL Energy highlighted the need for cooperation between energy and transport operators. Working with energy providers as part of the audit process can help ensure a successful transition to electric buses for all stakeholders.⁸³
- 2.4 The electricity grid is not a uniform structure across the state. AGL Energy told us that the grid's capacity varies. In some areas this can impact the ability to meet increased energy demands of electric buses. The geographical distribution of the bus network across the state also needs to be considered. There may be depots where options to connect to the grid are limited.⁸⁴
- 2.5 Another issue to consider when adapting depots to electric is the need for space

⁸¹ Mr Mead, Transcript of evidence, 18 March 2020, p2; Ms Mildwater, Mr Issa, Transcript of evidence, 20 March 2020, p38

⁸² Ms Elizabeth Molyneux, General Manager, Energy Market Regulation, AGL Energy Ltd, Transcript of evidence, 18 March 2020, pp37-38

⁸³ Submission 7, Transport for NSW, p10; Submission 21, Ausgrid, p8; Ms Ms Molyneux, Transcript of evidence, 18 March 2020, p37

⁸⁴ Submission 19, AGL Energy Ltd, p2; Ms Molyneux, Transcript of evidence, 18 March 2020, p37

to safely install chargers, and house cabling. It may be necessary to install other electrical equipment such as a distribution transformer or a substation to ensure a depot has enough energy supply to charge its fleet.⁸⁵

- 2.6 These network constraints were also raised by Ausgrid. They noted that if bus charging infrastructure is in an area where there are already other large commercial energy loads, like a data centre, there could be network capacity issues.⁸⁶

Choosing charging infrastructure

Summary

Transport for NSW should consider what charging infrastructure is best suited to each bus depot, based on local operational requirements.

Recommendation 5

That Transport for NSW considers what charging option is suitable for each bus depot and local routes.

- 2.7 We heard the main charging infrastructure options are depot based charging and en route or opportunity charging. For depot charging, buses are connected to a charger while parked at the depot overnight or during day time layovers. En route or opportunity charging involves installing fast chargers along routes that buses connect to for shorter periods.
- 2.8 Depot charging is regularly used in cities and is cheaper in terms of capital costs. It can allow flexibility through cheaper, off-peak charging. En route charging gives more operational flexibility as buses don't need to return to the depot as often. Smaller batteries are used, which can mean greater passenger capacity as a smaller battery pack weighs less.
- 2.9 Another charging option is inductive charging. This system uses coils placed under the road surface to transfer energy to matching coils attached underneath the bus. This technology is new and still being tested.⁸⁷
- 2.10 Depending on the charging option, capital costs for the transition to electric buses can be reduced. Upgrading electricity grid connections to meet the extra energy demand can be expensive. Installing renewable energy generation like solar panel arrays at depots, possibly combined with batteries for onsite energy storage could be a better option, depending on the depot. However, some upgrades can be cheaper, such as upgrading a depot's local power connection to increase capacity. This is in contrast to a more expensive upgrade that requires

⁸⁵ Submission 26, Nexport Pty Ltd, p5; Submission 29, Transdev Australasia Pty Ltd, p10

⁸⁶ Submission 21, Ausgrid, p4

⁸⁷ See Submission 4, Volvo Buses, pp12-14; Submission 7, Transport for NSW, p10; Submission 11, Transit Systems Pty Ltd, p2; Submission 17, Electric Vehicle Council, p6; Submission 26, Nexport Pty Ltd, p5; Submission 29, Transdev Australasia Pty Ltd, pp8-10; Submission 30, Centre for Energy and Environmental Markets, UNSW, pp4-7

changes to the capacity of the electricity grid itself.⁸⁸

- 2.11 We heard that commercial scale solar panels or arrays could be installed at some depots. This could generate enough electricity to power buses and reduce the operator's energy costs and greenhouse gas emissions.⁸⁹
- 2.12 Transit Systems, who operate Sydney's Leichhardt bus depot and are trialling electric buses, spent around \$300 000 to upgrade the depot's distribution board and cabling. They told us that for solar to be a practical option, it's best to have batteries as a static energy storage system. However this is more expensive – for the Leichhardt depot it could cost at least \$1 million.⁹⁰
- 2.13 Electromotiv told us they used battery storage as part of a project to defer the need for a zone substation costing \$25 million. The batteries will mean they save \$500 000 to \$1 million a year.⁹¹
- 2.14 We heard that getting approval for depots to be upgraded or adapted to electric can be time consuming. Bus operators deal with multiple stakeholders such as energy suppliers, landholders and local councils. Interline Bus Services told us they spent a lot of time and money to set up their depot to charge two electric buses. BusNSW told us that it took 18 months for the operator of an electric bus trial on the NSW South Coast to get approval to install a power station at their depot.⁹²
- 2.15 The size of the fleet, route distances, the length of time buses will be offline are other factors to consider when choosing the right charging infrastructure. This is in addition to a depot's capacity and capability to house the infrastructure.⁹³
- 2.16 We heard that these operational requirements should determine the choice of charging option. Using a mix of charging infrastructure could give operators more flexibility and be more affordable. However, this will depend on how the buses at each depot will be used and the size of their battery. Different bus operators may have different requirements.⁹⁴
- 2.17 Smaller buses with smaller batteries for high frequency services might need fast en route charging to maintain quick turnaround timeframes. Other services may

⁸⁸ Ms Jane Butler, Manager, New Business Distributed Energy, AGL Energy Ltd, Transcript of evidence, 18 March 2020, p39; Mr Issa, Transcript of evidence, 20 March 2020, p34

⁸⁹ Submission 17, Electric Vehicle Council, p9; Submission 19, AGL Energy Ltd, p2; Submission 22, Siemens Ltd, p7; Submission 23, Gemilang Australia Pty Ltd, p3; Submission 27, Electromotiv, p4; Submission 30, Centre for Energy and Environmental Markets, UNSW, p8; Submission 32, Anna Nadolny, p4; Submission 36, InvertedPower Pty Ltd, pp3-4

⁹⁰ Submission 11, Transit Systems Pty Ltd, p3; Mr Balkin, Transcript of evidence, 18 March 2020, p12

⁹¹ Submission 27, Electromotiv, p4

⁹² Mr Oliveri, Mr Gus Defalco, Compliance, Training and Policy Manager, Interline Bus Services, Transcript of evidence, 18 March 2020, pp12, 13; Ms Cassidy, Transcript of evidence, 20 March 2020, p5; Mr King, Transcript of evidence, 20 March 2020, p27

⁹³ Submission 24, Dr Jake Whitehead, p15

⁹⁴ Mr Toby Roxburgh, Managing Director, Electromotiv, Mr Mark Edmunds, General Manager, Energy Storage and eMobility Solutions, Toshiba International Corporation Pty Ltd, Mr Damien Brown, Commercial Director, Australian Bus Corporation, Transcript of evidence, 18 March 2020, p28; Ms Molyneux, Transcript of evidence, 18 March 2020, p38

use standard size buses – similar to diesel and gas buses currently used in cities – with larger batteries that only need overnight depot charging.⁹⁵

- 2.18 TfNSW told us they recognise the need for flexibility in choosing the best charging infrastructure for each depot. TfNSW are talking with bus operators and energy providers about what charging infrastructure would be best for individual depots. This could mean solar panels rather than a grid connection or using a different type of battery. This cooperation will help to ensure a reliable, safe and secure energy supply.⁹⁶
- 2.19 The Sydney electric bus trial has shown that en route charging may not be needed. We heard there is confidence that in the Sydney metropolitan area an electric bus can complete its daily journeys on a single charge.⁹⁷ More information about the trial is provided at paragraph 2.39.
- 2.20 TfNSW also told us there are other energy supply options apart from sourcing directly from the grid. They recognise that having a diversity of power sources would allow for contingency planning if something were to happen to the grid. However, their primary concern is ensuring access to a reliable power supply.⁹⁸ The use of renewable energy sources is discussed in more detail at paragraph 2.44.

Requiring standard chargers

Summary

Universal chargers should be considered by Transport for NSW, as they can provide flexible, standardised charging.

Recommendation 6

That Transport for NSW considers requiring universal chargers for flexible, standard charging across the state.

- 2.21 To avoid bus operators having to install specific chargers for each make or model of bus they operate, consideration should be given to introducing a standardised plug for electric buses. This would avoid bus operators needing to install duplicate charging infrastructure. It would also provide flexibility by allowing buses to be moved around the state as needed, especially during emergency situations.
- 2.22 We heard that at present each electric bus manufacturer has a charger that is designed to be used on their buses. TfNSW said that as technology evolves they expect more standardisation. There are moves toward a standard or universal

⁹⁵ Submission 17, Electric Vehicle Council, p8; Mr Roxburgh, Mr Edmunds, Ms Sarah Forbes, Executive Manager, Gemilang Australia Pty Ltd, Mr Brown, Transcript of evidence, 18 March 2020, p28; Mr Jafari, Transcript of evidence, 20 March 2020, p2 Submission 17, Electric Vehicle Council, p8

⁹⁶ Submission 21, Ausgrid, p5; Ms Molyneux, Transcript of evidence, 18 March 2020, p38; Ms Mildwater, Mr Issa, Transcript of evidence, 20 March 2020, p34

⁹⁷ Mr Issa, Transcript of evidence, 20 March 2020, p34

⁹⁸ Mr Issa, Ms Mildwater, Transcript of evidence, 20 March 2020, pp34, 37

charger, especially in Europe and Asia. Multipurpose chargers that work across a number of models are also available.⁹⁹

- 2.23 TfNSW explained that as NSW is only just starting to transition to electric buses, they have not specified a requirement for a standard charger.¹⁰⁰
- 2.24 Siemens highlighted that in New Zealand bus operators have different charging plugs and have to duplicate their charging infrastructure to use both plug types.¹⁰¹ We heard that Singapore has introduced shared opportunity charging infrastructure that can be used by several bus operators. We were also told that Auckland is considering a similar idea for shared infrastructure.¹⁰²
- 2.25 We heard that when Qatar tendered for electric buses they specified that only manufacturers of high powered charging infrastructure could tender for charging infrastructure. This was so that operators had access to fast charging infrastructure that could be used with any bus they might operate in the future. This gives operators more choice, as not all manufacturers are able to provide this type of charger.¹⁰³

Performance of batteries and buses

Summary

A mix of hybrid and electric buses could give Sydney the benefits of electric buses at a lower cost.

Operating both hybrid and battery electric vehicles

Finding 1

A mix of hybrid and battery electric buses may be most suitable for Sydney's bus network.

- 2.26 An alternative to a fully electric bus is a hybrid bus. As hybrids have lower emissions and less reliance on base load power, they could be part of a mixed fleet of full electric and hybrid buses. This could give bus operators more operational flexibility, while also helping to meet environmental targets.¹⁰⁴
- 2.27 A hybrid bus has both an electric motor and an internal combustion engine powered by fossil fuel, biodiesel or another form of biofuel. The electric battery is charged by the engine. Another type is the plug-in hybrid that also has an electric motor and engine, and can be plugged in to charge.¹⁰⁵

⁹⁹ Mr Issa, Transcript of evidence, 20 March 2020, pp38, 39

¹⁰⁰ Mr Issa, Transcript of evidence, 20 March 2020, p39

¹⁰¹ Submission 22, Siemens Ltd, p11

¹⁰² Ms Olivia Laskowski, Promoter of Electric Vehicle Charging Infrastructure, Siemens Ltd, Transcript of evidence, 18 March 2020, p3

¹⁰³ Ms Laskowski, Transcript of evidence, 18 March 2020, pp2, 4

¹⁰⁴ Submission 12, Scania Australia Pty Ltd, p21; Submission 20, BusNSW, p3

¹⁰⁵ Submission 4, Volvo Buses, pp7-11; Submission 7, Transport for NSW, p3; Submission 12, Scania Australia Pty Ltd, pp3, 9-10; NSW Government: Future Transport 2056, [NSW Electric and Hybrid Vehicle Plan](#), accessed 15 July 2020

- 2.28 We heard that hybrids could be a viable alternative as they don't have the high capital costs of a fully electric bus. They can run in electric mode for long periods, and don't require investment in additional infrastructure. Route flexibility can be maintained as hybrids can operate for long periods. In addition, they can help to reduce carbon emissions. However, more research may be needed to identify if big savings in maintenance costs can be achieved with hybrid buses.¹⁰⁶
- 2.29 Carbon dioxide emissions can be reduced by up to 25 per cent as hybrids use less fuel, especially when travelling under 40 kilometres per hour. A hybrid bus needs around 365 grams per kilowatt hour of energy when using a biofuel or 700 grams using standard diesel. This compares to 790 grams per kilowatt hour of energy for an electric bus. However, we also heard about a Transport Canberra trial using electric buses and a hybrid (diesel/electric) bus, which showed electric buses performed better in energy efficiency and economic costs.¹⁰⁷
- 2.30 Volvo highlighted that Singapore has a mixed fleet, with both electric and hybrid vehicles. This gives its land transport system a level of security as services can operate if there's a problem with the electricity grid. Singapore's approach also allows time to develop the ability to support the fleet. This includes training enough technicians to service vehicles, and increasing parts and warehouse capability.¹⁰⁸

Battery charging options

- 2.31 Choosing the right battery for the right bus route is important. Large capacity batteries can go for long periods without charging. Smaller, cheaper batteries need to be charged more often. As with charging infrastructure, depot conditions, the number of buses to be charged, and route distances are factors that influence the choice of battery.¹⁰⁹
- 2.32 As all buses in a depot are unlikely to be charged at the same time, it's important to have a charging schedule that considers the range of the bus and the time to recharge the battery. The schedule should avoid putting extra stress on the electricity grid, especially during peak morning and afternoon periods. We were told that software that combines bus operations with energy management could ensure buses are charged efficiently.¹¹⁰
- 2.33 Charging in the middle of the day or overnight – outside peak demand – means bus operators could make use of lower tariffs that encourage off peak charging. Charging at these times can improve the use and stability of the grid.¹¹¹

¹⁰⁶ Submission 7, Transport for NSW, p8; Submission 12, Scania Australia Pty Ltd, p21; Submission 20, BusNSW, p4; Submission 29, Transdev Australasia Pty Ltd, pp11, 15; Mr Mead, Transcript of evidence, 18 March 2020, p1

¹⁰⁷ Submission 12, Scania Australia Pty Ltd, p21; Submission 17, Electric Vehicle Council, p10; Submission 26, Nexport Pty Ltd, p7; Mr Mead, Transcript of evidence, 18 March 2020, p1

¹⁰⁸ Submission 4, Volvo Buses, pp9, 10; Submission 20, BusNSW, p3; Mr Mead, Transcript of evidence, 18 March 2020, p3

¹⁰⁹ Submission 19, AGL Energy Ltd, p2; Submission 24, Dr Jake Whitehead, p15

¹¹⁰ Submission 22, Siemens, p4; Submission 29, Transdev Australasia Pty Ltd, p17; Submission 30, Centre for Energy and Environmental Markets, UNSW, p1

¹¹¹ Submission 7, Transport for NSW, p7; Submission 19, AGL Energy Ltd, p2; Submission 21, Ausgrid, p10

- 2.34 Slow overnight depot charging is the cheapest option but requires a large number of chargers and depot space. Depending on the number of buses being charged, it can cause issues with the local electricity grid. It also requires operators to ensure the batteries can complete their daily schedule on a single charge.
- 2.35 The other option is en route charging where batteries are charged throughout the day. This requires infrastructure to be built along routes, which can add to costs. Smaller, cheaper batteries can be used but there is less flexibility as buses can only service routes with charging infrastructure.¹¹²
- 2.36 The topography of bus routes can be an additional drain on battery power. Routes with steep inclines mean buses use more power, although they regenerate power going downhill. Using air conditioning while the bus is in service also requires significant power. Air conditioning on electric and hybrid buses in Singapore uses up to 50 per cent of the buses energy.¹¹³
- 2.37 As battery technology and reliability improves, buses can travel greater distances on a single charge. The reliability of batteries and electric vehicles is expected to improve, with the need for less servicing. The lifespan of a battery is longer than originally expected. The useful life of battery on a bus can be up to ten years. We heard that batteries used in London's hybrid bus fleet are lasting up to nine years.¹¹⁴
- 2.38 Buses fitted with older, less efficient batteries can have them swapped out for new and better batteries. Installing new and more efficient batteries could make fast charging an option without the need to alter the depot's electricity network.¹¹⁵ The reuse and recycle of batteries is discussed in chapter four.

Performance of buses in Sydney electric bus trial

- 2.39 The trial of electric buses based at the Leichhardt bus depot, operated by Transit Systems, is very promising. We heard that the buses are performing better than expected. They are returning to the depot after being out for 12 to 16 hours with 40 to 50 per cent battery charge remaining. Part of the reason for the positive results is the stop-start power regeneration from braking. This is recharging the buses by almost 35 per cent while they travel along their route.¹¹⁶
- 2.40 Given the size of the batteries being used, they were expected to take five to eight hours to charge. As the buses can complete a full day's work on a single charge, they don't need as much time or power to recharge. We heard they can

¹¹² Submission 24, Dr Jake Whitehead, p17; Submission 30, Centre for Energy and Environmental Markets, UNSW, pp5-7; Submission 31, Dr Pedro Orbaiz and Professor Michael Brear, pp2, 3

¹¹³ Mr Evans, Mr Mead, Transcript of evidence, 18 March 2020, pp2, 3; Dr Iain MacGill, Associate Professor, Joint Director (Engineering), Centre for Energy and Environmental Markets, UNSW, Transcript of evidence, 20 March 2020, p21

¹¹⁴ Submission 26, Nexport Pty Ltd, p12; Mr Trevor O'Brien, Product Manager, Scania Australia Pty Ltd, Mr Mead, Transcript of evidence, 18 March 2020, p4; Ms Forbes, Transcript of evidence, 18 March 2020, p24; Dr MacGill, Transcript of evidence, 20 March 2020, p22

¹¹⁵ Ms Anna Nadolny, Research Officer, 100% Renewable Energy Research Group, Australian National University, Transcript of evidence, 20 March 2020, p21

¹¹⁶ Mr Balkin, Transcript of evidence, 18 March 2020, pp11-12; Mr Issa, Transcript of evidence, 20 March 2020, pp30-31, 34

be fully recharged in less than 2.5 hours. We also heard that the trial shows that overnight depot charging is a viable option for Sydney's potential fleet of electric buses. This gives flexibility when considering the need for opportunity charging. Transport for NSW said that the effects of fast charging on batteries will be studied to see how it impacts battery life.¹¹⁷

- 2.41 TfNSW said that inner west bus routes allow for the capacity and endurance of the buses to be tested. Route geography, topography and traffic congestion mean the buses are tested in various environments. They travel up to 200 kilometres a day, with capacity to travel 350 to 400 kilometres on a single charge. The buses have performed well in wet weather, and on days with very high temperatures, when demand on air-conditioning is higher.¹¹⁸
- 2.42 Transit Systems told us that advances in battery technology mean they don't see a need for en route charging. In their experience, 200 kilometres each day from a bus should be enough to cover two shifts.¹¹⁹
- 2.43 As mentioned earlier, Leichhardt depot needed work to host electric buses. This meant eight buses could be charged at one time. It was anticipated that charging more than eight buses would require a more extensive substation upgrade but Transit Systems believes that with buses performing better than expected, almost 30 buses can be charged using existing infrastructure.¹²⁰

Renewable, emissions neutral energy sources

Summary

Transport for NSW should identify ways to power the electric bus fleet with renewable, zero emission energy.

Meeting zero emissions targets

Recommendation 7

That Transport for NSW identifies opportunities for renewable energy sources to power the electric bus fleet.

- 2.44 The electricity to charge electric buses should ideally come from renewable energy sources. Using renewable energy to power the network of electric buses allows them to be a true zero emission technology. This ensures the environmental and health benefits of the buses are fully realised.¹²¹
- 2.45 Focussing on renewable energy to power a large fleet of electric buses can help NSW meet its goal of net zero carbon emissions by 2050. The transport sector is

¹¹⁷ Submission 7, Transport for NSW, p10; Submission 23, Gemilang Australia Pty Ltd, p5; Mr Issa, Transcript of evidence, 20 March 2020, p34

¹¹⁸ Mr Issa, Transcript of evidence, 20 March 2020, pp30-31, 34

¹¹⁹ Mr Balkin, Transcript of evidence, 18 March 2020, p14

¹²⁰ Mr Balkin, Transcript of evidence, 18 March 2020, p11

¹²¹ Submission 9, ClimateWorks Australia, p6; Mr O'Brien, Transcript of evidence, 18 March 2020, pp1-2; Ms Molyneux, Transcript of evidence, 18 March 2020, p37; Professor Marks, Transcript of evidence, 20 March 2020, p16

the second largest and fastest growing source of greenhouse gas emissions in the country. Within that sector, road transport is the largest source of emissions, given its dependence on petroleum based fuels. Transport makes up 21 per cent of the state's greenhouse gas emissions.¹²²

- 2.46 The NSW government's *Net Zero Plan Stage 1: 2020-2030* is part of the plan to transition to zero emissions. The government wants to cut emissions by 35 per cent by 2030 compared to 2005 levels. The plan supports initiatives targeting a range of industries and areas, including electric vehicles.¹²³
- 2.47 Introducing electric buses into the state's public transport network would support the ambition set out in the plan. In particular, we were told that it would support two of the plan's four priorities: to 'drive an uptake of proven emissions reduction technologies', and 'ensure the NSW Government leads by example'.¹²⁴
- 2.48 Greater use of renewable energy sources also improves our fuel security, with less reliance on imported fossil fuels. The transition to electric buses offers a chance to better integrate renewables into the energy system. Within the energy sector, renewable energy is the cheapest form of energy generation. We heard that the cost of new build solar powered energy is falling, and expected to fall further. This will make it competitive with new build fossil fuel generators.¹²⁵

Managing energy demand

- 2.49 As previously noted, batteries and solar panels could be used to store electricity for later use. We heard this can help reduce demand on the grid. It can also reduce the need for more expensive grid upgrades. Batteries, combined with solar, can give operators more flexibility in how and when they charge their fleet. They don't have to rely on overnight depot charging that is connected to the electricity grid. Batteries can also give energy security as they are a backup if there are problems with the grid.¹²⁶
- 2.50 Solar panels on depot roofs or uncovered parking areas could generate enough electricity to power the buses, and reduce energy costs and greenhouse gas emissions. Buses are in peak service between 7am to 10am and 3pm to 7pm. As most solar power generation happens between 10am to 3pm, depots could charge most of their fleet when there is less demand for bus services.¹²⁷ The case

¹²² Submission 7, Transport for NSW, pp5-6; Submission 9, ClimateWorks Australia, p1; Ms Molyneux, Transcript of evidence, 18 March 2020, p37; Professor Marks, Transcript of evidence, 20 March 2020, p16

¹²³ NSW Government, Department of Planning, Industry and Environment, [Net Zero Plan Stage1: 2020-2030](#), accessed 20 July 2020

¹²⁴ Submission 10, Beyond Zero Emissions, p4; Mr Li, Transcript of evidence, 20 March 2020, p11; NSW Government, Department of Planning, Industry and Environment, [Net Zero Plan Stage1: 2020-2030](#), accessed 20 July 2020

¹²⁵ Submission 7, Transport for NSW, p12; Submission 10, Beyond Zero Emissions, p4; Submission 20, BusNSW, p4; Dr MacGill, Ms Nadolny, Transcript of evidence, 20 March 2020, p15

¹²⁶ Submission 22, Siemens Ltd, p7; Submission 30, Centre for Energy and Environmental Markets, p8; Submission 36, InvertedPower Pty Ltd, p4

¹²⁷ Submission 17, Electric Vehicle Council, p9; Submission 19, AGL Energy Ltd, p2; Submission 22, Siemens Ltd, p7; Submission 23, Gemilang Australia Pty Ltd, p3; Submission 27, Electromotiv, p4; Submission 30, Centre for Energy and Environmental Markets, UNSW, pp5-6; Submission 32, Anna Nadolny, p4; Submission 36, InvertedPower Pty Ltd, pp3-4

study overleaf outlines the potential for solar and battery storage at the Ryde bus depot.

- 2.51 We heard that depots with their own solar powered energy generation could sell excess energy to the grid. This could be a source of revenue for some depots. Electric buses could also act as a 'solar sponge' helping to support the grid. With the large uptake of solar panels, more energy than needed is generated via solar during the peak hours of sunshine each day. Charging buses at this time of day could help with grid management as the buses use that excess energy. This is also typically the time of day when electricity prices are lowest.¹²⁸
- 2.52 On their own, depot installed solar panels, and battery storage, may not always be enough to meet demand. We heard that a combination of centralised and decentralised power sources could offer the best solution. Centralised energy sources are large-scale and operated by energy generators, like AGL, that connect to and supply the broader electricity grid. This can include electricity generated from renewable sources of energy. Decentralised sources, such as individual depot based solar battery systems, are installed closer to where that energy will be used.¹²⁹
- 2.53 Transport for NSW informed us that they are willing to use renewable energy sources. They recognise that a diverse range of power sources would provide more reliability. For them, access to a power supply capable of charging the necessary number of buses is key.¹³⁰
- 2.54 TfNSW also told us that there is potential to offset emissions. They highlighted that Sydney Metro offsets 100 per cent of the emissions from the electricity used to run Metro North West. Under a Green Products Purchase Agreement, the offset was achieved by procuring energy from a large scale solar farm in regional NSW.¹³¹

Case study 3: Solar power and battery storage at the Ryde bus depot¹³²

Ryde depot is one of the largest depots in Sydney with around 300 buses. It has available roof area of around 4000m². Estimates of its solar power generation potential are:

- system size of 3840kW
- solar generation of 5,196,941 kW hours per year
- solar value of \$1,818,929 (based on offsetting electricity rate of \$0.35/kWh).

The Ryde depot could have a battery system as large as 50MWh. For comparison, the Tesla Big Battery in South Australia is 129MWh.

¹²⁸ Submission 21, Ausgrid, pp10-11; Submission 30, Centre for Energy and Environmental Markets, UNSW, p8; Submission 32, Anna Nadolny, p4; Submission 35, Australian Bus Corporation, p6; Submission 36, InvertedPower Pty Ltd, p4; Ms Butler, Transcript of evidence, 18 March 2020, p39; Mr Jafari, Transcript of evidence, 20 March 2020, p2; Dr MacGill, Transcript of evidence, 20 March 2020, p18

¹²⁹ Ms Molyneux, Transcript of evidence, 18 March 2020, p38; Ms Nadolny, Transcript of evidence, 20 March 2020, p18

¹³⁰ Mr Issa, Ms Mildwater, Transcript of evidence, 20 March 2020, p37

¹³¹ Submission 7, Transport for NSW, p12

¹³² Submission 22, Siemens Ltd, p7; Submission 30, Centre for Energy and Environmental Markets, UNSW, pp8-9

Solar power creates greater energy resiliency in blackouts. Integrating solar battery storage into a bus depot has the following benefits:

- access to renewal power overnight and during low solar times
- savings through lowering peak demand for grid power
- smoothing power variations
- lower grid reinforcement infrastructure costs.

Using hydrogen for long distance heavy vehicles

Summary

Hydrogen may be a suitable, low emissions energy source for heavy vehicles travelling over long distances.

Finding 4

Hydrogen is an option to power long distance heavy vehicles.

- 2.55 Hydrogen is a renewable energy source that could be used to power heavy vehicles, like buses, trucks and ferries. As hydrogen powered vehicles have a longer range, they are likely to better meet the needs of heavy transport services that operate over distances up to 600 kilometres. Hydrogen powered vehicles can be refuelled within minutes. Additionally, the battery on a hydrogen bus is smaller so its weight doesn't impact passenger capacity.¹³³
- 2.56 We were interested to hear there could be flexibility to transition from full battery electric buses to hydrogen powered buses. As hydrogen production and fuel cell technology evolve and become more affordable, transitioning to hydrogen powered buses could be done with proper planning.¹³⁴
- 2.57 We also heard that in time, hydrogen may become the preferred energy source for transport networks. Operators of battery electric buses could reach a point where charging a large fleet may not be feasible due to a lack of energy at the depot. In such situations, economies of scale mean that operators with more than ten buses could find that hydrogen is a cheaper fuel alternative.¹³⁵
- 2.58 A hydrogen fuelled bus is an electric buses with an on board source of electricity generation to charge the battery.¹³⁶ We were interested to hear about the potential advantage of building electric buses to a modular design system. This design could help avoid fleet obsolescence and reduce investment risk as part of

¹³³ Submission 9, ClimateWorks Australia, pp5-6; Submission 11, Transit Systems Pty Ltd, p2; Submission 27, Electromotiv, p5; Submission 29, Transdev Australasia Pty Ltd, p11; Submission 31, Dr Pedro Orbaiz and Professor Michael Brear p3; Submission 35, Australian Bus Corporation, pp3-4; Ms Forbes, Transcript of evidence, 18 March 2020, p30; Mr Li, Transcript of evidence, 20 March 2020, pp11-12; Dr MacGill, Transcript of evidence, 20 March 2020, p19

¹³⁴ Mr O'Brien, Transcript of evidence, 18 March 2020, p6; Mr Roxburgh, Transcript of evidence, 18 March 2020, pp29, 30; Ms Molyneux, Transcript of evidence, 18 March 2020, p40

¹³⁵ Submission 29, Transdev Australasia Pty Ltd, pp4, 11; Mr Evans, Transcript of evidence, 18 March 2020, p3; Ms Nadolny, Transcript of evidence, 20 March 2020, p19

¹³⁶ Mr Balkin, Transcript of evidence, 18 March 2020, p14

a future transition to hydrogen fuelled buses. A modular design could allow for drivetrain and other technology upgrades to buses during their 25 year lifespan.¹³⁷

- 2.59 For hydrogen to become a viable fuel source, there needs to be a domestic market to meet demand and supply. As the domestic market increases, hydrogen is expected become more affordable.¹³⁸
- 2.60 The current lack of supply and high production costs are some of the issues limiting the adoption of hydrogen fuelled buses in Australia. We heard that the production of hydrogen is limited, with much of it produced for the export market. We also heard that it would be more efficient if hydrogen production was located closer to where it will be used. While hydrogen is a renewable energy source, it requires large amounts of energy to be produced. To ensure true zero emissions, it is best to produce it using renewable energy sources. In Europe, solar, wind and hydro are some of the energy sources used to produce hydrogen.¹³⁹
- 2.61 The cost of hydrogen fuelled buses and supporting infrastructure is high. We heard that a hydrogen bus can be up to twice price of a diesel bus that costs \$450 000 to \$500 000, although prices are expected to drop by 2030. Electric buses are expected to be cheaper than hydrogen, at around \$600 000 over the same period to 2030. We also heard there are fuel safety issues that need to addressed to ensure hydrogen is safely stored and used.¹⁴⁰
- 2.62 Australia's National Hydrogen Strategy aims to develop the country's hydrogen industry by 2030. This includes increasing the commercialisation and production of hydrogen to supply a growing domestic market, and export to international markets around the world. While hydrogen has future potential, we were told that electric bus technology is a more mature technology that can be deployed immediately.¹⁴¹

Charging options in regional areas

Summary

Transport for NSW should consider what charging infrastructure would work best for journeys within regional centres and between regional towns.

¹³⁷ Submission 35, Australian Bus Corporation, p6

¹³⁸ Ms Laskowski, Mr O'Brien, Transcript of evidence, 18 March 2020, pp5-6

¹³⁹ Submission 9, ClimateWorks Australia, p6; Submission 29, Transdev Australasia Pty Ltd, p11; Ms Laskowski, Mr O'Brien, Mr Mead, Mr Evans, Transcript of evidence, 18 March 2020, pp5, 6

¹⁴⁰ Submission 5, ARCC Pty Ltd, p1; Submission 24, Dr Jake Whitehead, pp20-24; Submission 29, Transdev Australasia Pty Ltd, pp11-12; Mr Oliveri, Transcript of evidence, 18 March 2020, p13; Mr Balkin, Transcript of evidence, 18 March 2020, p14; Ms Forbes, Transcript of evidence, 18 March 2020, p30

¹⁴¹ Australian Government, Department of Industry, Science, Energy and Resources, [Australia's National Hydrogen Strategy](#), November 2019, accessed 24 July 2020; Submission 29, Transdev Australasia Pty Ltd, p11

Recommendation 8

That as part of the transition plan, Transport for NSW considers what charging infrastructure would be suitable for travel between regional areas and within regional centres.

- 2.63 We heard that introducing electric buses raises similar issues regardless of whether they are rolled out in regional or metropolitan areas. Issues like grid connections and energy supply will need to be addressed on a case by case basis, regardless of location. TfNSW told us they recognise this and will learn from the introduction of electric buses in Sydney before rolling buses out in regional areas. This will include understanding what services people want, and what charging options are best suited to each area. However, the greater distances in regional travel is an issue that will require careful attention.¹⁴²
- 2.64 We heard that distance may be the biggest issue to consider when introducing electric buses in regional areas. However, it was made clear to us that not all regional bus routes are long distance. There is variation in the distances covered on bus routes in regional NSW. For example, the size and layout of the city of Broken Hill means that electric buses could be used within the city. Routes could be set up to meet the needs of residents in a similar way to those in Sydney metropolitan areas. However, providing a service between regional centres that are hundreds of kilometres apart will be different.¹⁴³
- 2.65 For routes between regional cities and towns, it will be necessary to examine the specific requirements of the locations and routes to be serviced. While the buses used in the Sydney bus trial have the capacity to travel hundreds of kilometres on a single charge, some regional routes may be longer. Also, the speed of the bus and if it's travelling on a highway can influence the type of battery needed, and its performance.
- 2.66 We heard that for some routes larger batteries may be needed. Other routes may need charging infrastructure along the route, with set breaks for battery charging. Another option is for buses to terminate at major passenger interchanges, before turning around and going back. As previously mentioned, as hydrogen becomes more available, it may become a better option over such longer distances.¹⁴⁴
- 2.67 For regional bus depots space to house onsite solar panels and battery storage may not be as restrictive as in metropolitan areas. We heard that with less population density and more open space, regional areas can have more space for

¹⁴² Ms Cassidy, Transcript of evidence, 20 March 2020, p5; Ms Mildwater, Mr Issa, Transcript of evidence, 20 March 2020, pp30, 36-37

¹⁴³ Ms Katelyn Purnell, Centre for Energy and Environmental Markets, UNSW, Transcript of evidence, 20 March 2020, p20

¹⁴⁴ Mr Roxburgh, Transcript of evidence, 18 March 2020, p29; Mr Jafari, Transcript of evidence, 20 March 2020, p5; Mr Li, Transcript of evidence, 20 March 2020, p12; Ms Purnell, Ms Nadolny, Transcript of evidence, 20 March 2020, p20; Mr Issa, Transcript of evidence, 20 March 2020, pp36-37

bus depots to house on site renewable power generation and charging infrastructure.¹⁴⁵

- 2.68 We heard that the capacity of the electricity grid in some regional areas may already allow for the increased energy demands of electric buses. The NSW Government has identified three areas of the state as renewable energy zones. The Central-West Orana, New England, and south-west regions of NSW are expected to provide large-scale renewable energy and storage projects. These projects include new infrastructure capable of handling increased energy production and distribution.¹⁴⁶
- 2.69 As previously noted, shared use of charging infrastructure by several bus operators is an option. We were told this could be used for regional services. A number of operators could use infrastructure provided by a third party. We heard that if the route and requirement are specified, industry can invest in a solution. Victoria has looked at three operators charging at one park and ride facility.¹⁴⁷

¹⁴⁵ Mr Todd, Transcript of evidence, 20 March 2020, p9

¹⁴⁶ Ms Purnell, Transcript of evidence, 20 March 2020, p20; NSW Government, Energy NSW, [Renewable Energy Zones](#), accessed 27 July 2020

¹⁴⁷ Submission 36, InvertedPower Pty Ltd, p2; Mr Roxburgh, Transcript of evidence, 18 March 2020, p29

Chapter Three – Ensuring buses are safe and accessible

Noise emission to improve safety

Requiring automated noise emitters

Summary

Electric buses should have automatic noise emitters fitted to alert pedestrians and road users. Audible alerts would reduce the risk of collision with passengers and pedestrians, especially those with vision impairment.

Recommendation 9

That Transport for NSW requires an automated alert or noise emitter to be installed on electric buses.

- 3.1 We consider that electric buses should have noise emitters, to ensure the safety of all passengers and pedestrians. While the low noise of electric buses is one of their benefits, it can be a danger to people who are vision impaired or have low vision, as well as to pedestrians.
- 3.2 Vision Australia said that people who are blind or have low vision rely on sounds including traffic noise for orientation and to work out when it's safe to cross a road. Without these cues, people can walk in front of a silent vehicle that they are unaware of, leaving the driver with no time to avoid a collision.¹⁴⁸ Blind Citizens Australia told us that the silent nature of electric or hybrid vehicles poses a significant risk to the safety of pedestrians who are blind or vision impaired.¹⁴⁹
- 3.3 Vision Australia referred to research conducted by Monash University, which found that 35 per cent of people who are blind or have low vision have had a collision or near-collision with an electric or hybrid vehicle. Seventy five per cent indicated that they had less confidence to walk and cross roads because of electric vehicles.¹⁵⁰
- 3.4 We heard that acoustic vehicle alert systems could help reduce this risk. These systems emit sounds when a vehicle is idle and travelling between zero and 20 kilometres per hour, either forward or in reverse. Vehicles travelling over 20 kilometres per hour are audible because of wind resistance. Blind Citizens Australia argued that vehicle alert systems would 'increase the safety of someone who is preparing to cross the road because they would be able to hear it even in

¹⁴⁸ Submission 15, Vision Australia, pp3-4; Ms Sally Aurisch, NSW/ACT Coordinator, Blind Citizens Australia, Transcript of evidence, 18 March 2020, p35

¹⁴⁹ Submission 8, Blind Citizens Australia, p2

¹⁵⁰ Submission 15, Vision Australia, pp3-4; Monash University & Vision Australia, The impact of electric / hybrid vehicles and bicycles on pedestrians who are blind or have low vision, October 2018, p12

circumstances where one cannot see it.¹⁵¹

- 3.5 Vision Australia said that it was imperative for all electric buses in NSW to have the systems. They argued that the blindness and low vision sector would be concerned about 'systemic failure to protect their right to safety and security when travelling in the community' if the systems weren't required.¹⁵²
- 3.6 Inquiry participants told us that the United States and Europe require all electric and hybrid vehicles to be fitted with acoustic vehicle alert systems. It will also be mandatory for electric buses in London to emit a minimum level of noise.¹⁵³
- 3.7 The European Union standard for noise emittance by hybrid and electric cars makes it mandatory for an acoustic vehicle alert system to be installed in these vehicles. Implementation of the standard began on 1 July 2019.¹⁵⁴
- 3.8 Inquiry participants supported an automatic noise alert that wouldn't be manually operated by drivers. The TWU said that requiring drivers to activate a sound to alert road users would be fallible and risky. Blind Citizens Australia noted that off-switches for alert systems are prohibited under a UN regulation.¹⁵⁵
- 3.9 We note that noise emitters would also improve safety for other road users, as pedestrians are increasingly distracted and unaware of their surroundings.
- 3.10 TfNSW told us that while the quiet operation of electric buses is a benefit, it can be a risk to vulnerable road users. TfNSW said they will work with the Federal Government to update the Australian Design Rules to improve the safety of vulnerable road users where required. We also heard that the Federal Government is developing a regulatory impact statement on an alert system or minimum sound emission in hybrid and electric vehicles.¹⁵⁶
- 3.11 We heard that noise emitters should alert nearby road users and pedestrians, without sacrificing the benefits of reduced noise. The Electric Vehicle Council told us that it's possible to create acoustic sounds that mitigate safety issues without creating unnecessary sound. They observed that lower noise overall would make it possible to integrate sound into tools and services for the vision impaired. It would also be possible to 'create a sound that is heard by people directly on the roadside but, for instance, not somebody living in an apartment 200 metres away from the roadside.'¹⁵⁷

¹⁵¹ Ms Sally Aurisch, NSW/ACT Coordinator, Blind Citizens Australia, Transcript of evidence, 18 March 2020, pp31, 32-33, 35; Submission 8, Blind Citizens Australia, p2, 4

¹⁵² Submission 15, Vision Australia, p4

¹⁵³ Submission 15, Vision Australia, p4; Ms Aurisch, Transcript of evidence, 18 March 2020, p31

¹⁵⁴ Submission 8, Blind Citizens Australia, pp2-4

¹⁵⁵ Submission 28, Transport Workers Union, pp3-4; Submission 8, Blind Citizens Australia, pp2-4; Mr Todd, Transcript of evidence, 20 March 2020, p10

¹⁵⁶ Submission 7, Transport for NSW, p16; Mr Issa, Transcript of evidence, 20 March 2020, p32; Submission 8, Blind Citizens Australia, pp2-4

¹⁵⁷ Mr Jafari, Transcript of evidence, 20 March 2020, pp1-2

A safety campaign on electric buses

Summary

A safety and awareness campaign should be conducted about electric buses. The campaign should aim to improve the safety of pedestrians and road users who may be more vulnerable due to electric buses' quiet operations.

Recommendation 10

That Transport for NSW runs a safety and awareness campaign for pedestrians and road users about electric buses.

- 3.12 Inquiry participants told us that electric buses can be dangerous for pedestrians and road users who are distracted by their mobile phone or have headphones on. We consider that Transport for NSW should run a safety campaign to raise awareness about electric buses.
- 3.13 The TWU told us that bus drivers often face difficulties due to inattentive pedestrians and other road users. They observed that other vehicles, cyclists and pedestrians will be less aware of electric buses near them.¹⁵⁸
- 3.14 BusNSW and the TWU observed that accidents involving pedestrians and other road users could increase due to the quieter operation of electric buses. However, Nexport made the point that the broader issue of inattentive road users needs to be addressed: 'it is fine for us to introduce a noise, whether that is a ringing noise or some humming noise, into the vehicle but the wider problem in the community at the moment is people not being observant of the environment around them.'¹⁵⁹
- 3.15 Inquiry participants supported a public awareness campaign, similar to that for the opening of the Eastern Suburbs light rail. BusNSW noted that new technology and transport nodes need to be publicised. They told us that the Government and bus operators should 'make sure that communities understand their obligations to what a safe workplace will be for our employees.' Nexport supported a public awareness campaign, stating that it would be a 'worthwhile exercise'.¹⁶⁰
- 3.16 We heard that the Centre for Road Safety has run a Be Bus Aware campaign supported by the bus industry. BusNSW said that the campaign should be ongoing to ensure that people are aware of risks associated with electric buses.¹⁶¹

¹⁵⁸ Submission 28, Transport Workers Union, pp2-3; Mr Balkin, Transcript of evidence, 18 March 2020, p11

¹⁵⁹ Submission 28, Transport Workers Union, pp2-3; Submission 20, BusNSW, p10; Mr Todd, Transcript of evidence, 20 March 2020, p9

¹⁶⁰ Mr Matt Threlkeld, Executive Director, BusNSW, and Mr King, Transcript of evidence, 20 March 2020, p25; Mr Todd, Transcript of evidence, 20 March 2020, p10

¹⁶¹ Mr Threlkeld and Mr King, Transcript of evidence, 20 March 2020, p25

Support for passengers with disability

Consulting people with disability

Summary

People with disability should be consulted about ways to improve accessibility of electric buses. Consultation should happen at an early stage so that any feedback can be incorporated as part of the rollout of electric buses.

Recommendation 11

That Transport for NSW consults groups that represent people with disability on the accessibility of electric buses.

- 3.17 We consider that Transport for NSW should consult with people with disability on the accessibility of electric buses. This should happen at an early stage of the trials and design of electric buses, to allow time for any changes to meet the needs of passengers with a disability.
- 3.18 Blind Citizens Australia called for public consultation and user-testing by people who are blind or vision impaired 'to achieve truly accessible outcomes for the implementation of electric buses across the transport network'.¹⁶²
- 3.19 The Disability Council NSW told us that TfNSW's Accessible Transport Advisory Committee should be used to discuss accessibility during the design process, when it's not too late to adjust or enhance design issues. They supported co-designing with people with disability and carers from conceptualisation to the finished product.¹⁶³
- 3.20 TfNSW told us that they work with disability groups before rolling out new services, to seek their feedback. We heard that TfNSW will engage with disability groups before the next phase of an electric bus rollout.¹⁶⁴

Audible stop announcements

- 3.21 We heard that audio and visual stop announcements are important for passengers who are blind and vision impaired to find the way to their destination. The announcements mean that passengers know where to get off without having to ask other passengers or the driver. Blind Citizens Australia said that the announcements should be automated and include cross sections and stops along the route, along with changes due to traffic conditions.¹⁶⁵
- 3.22 Vision Australia observed that the Disability Standards for Accessible Public Transport require all passengers to have access to accurate information on their location. This can be done through regular automated announcements about

¹⁶² Submission 8, Blind Citizens Australia, p2

¹⁶³ Submission 34, Disability Council NSW, p1; Ms Casey Gray, Member, Disability Council NSW, Transcript of evidence, 18 March 2020, p32; Mr Mark Tonga, Chair, Disability Council NSW, Transcript of evidence, 18 March 2020, p33

¹⁶⁴ Ms Mildwater, Transcript of evidence, 20 March 2020, p32

¹⁶⁵ Submission 8, Blind Citizens Australia, pp2, 4-5; Ms Aurisch, Transcript of evidence, 18 March 2020, pp32-33

recent and upcoming stops. Vision Australia said that it's not acceptable for passengers to rely on the driver or other passengers for this information. Relying on drivers to announce location details 'leads to inconsistent and unpredictable results that are often of little practical value.'¹⁶⁶

- 3.23 Vision Australia told us that the audible announcements have been installed on new buses and are working well. However they referred to cases of drivers disabling the announcements, and stressed that this should not be available to a driver. Blind Citizens Australia said that announcements should be installed on all buses, and drivers shouldn't be able to turn them off.¹⁶⁷
- 3.24 We heard that automated announcements will be installed on new buses, including the electric fleet. TfNSW said that 'passenger information displays and the audio announcements on the buses will be standardised across the bus fleet for any new purchase'. TfNSW also told us that in most cases drivers cannot turn the passenger next stop information system off. However, some can be turned off because of different systems. TfNSW said that it would ask bus operators to instruct drivers not to disconnect next stop information where it is fitted.¹⁶⁸

New technology to improve service information

- 3.25 Inquiry participants suggested innovative ways to improve access for people who are blind or vision impaired. We heard that an app based signalling system could let the driver of an approaching bus know that a passenger wants to board.¹⁶⁹
- 3.26 We heard that it's routine for bus stops to have several bus routes, meaning that passengers have to identify their bus from approaching buses on different routes. Transport interchanges and stops are often in noisy, high-traffic areas making it 'difficult or impossible even to know if and where a bus is stopped, let alone identify one particular bus out of several.'¹⁷⁰
- 3.27 Vision Australia supported an app-based system to help passengers who are blind or have low vision find the bus they want. They told us about the trial of the Halo app. A person who wants to catch a bus could use the app to send a signal to the driver of the bus that they want to board. The driver then gets an alert on their dashboard indicating that the person wants to catch the bus. Vision Australia said that choosing the right bus at stops with several routes is a 'significant problem'. They told us that an app like Halo 'if it is found to be successful in the trial, may well offer a solution to what has so far been a very intractable problem to solve.'¹⁷¹
- 3.28 While TfNSW is not working with the Halo app, they have endorsed the Stop Announcer app. This app helps passengers with vision impairment navigate public

¹⁶⁶ Submission 15, Vision Australia, p3

¹⁶⁷ Mr Bruce Maguire, Lead Policy Advisor, Government Relations and Advocacy, Vision Australia, Transcript of evidence, 18 March 2020, p33; Ms Aurisch, Transcript of evidence, 18 March 2020, pp32-33

¹⁶⁸ Mr Issa, Acting Transcript of evidence, 20 March 2020, p32; Answers to questions on notice, 20 March 2020 public hearing, Transport for NSW, p2

¹⁶⁹ Mr Maguire, Transcript of evidence, 18 March 2020, p32

¹⁷⁰ Submission 15, Vision Australia, pp2-3

¹⁷¹ Submission 15, Vision Australia, pp2-3; Mr Maguire, Transcript of evidence, 18 March 2020, p33

transport. It has a clear, high-contrast display and uses GPS to track device location and announce stops along the user's route. Users can save stops and regular trips, find the closest stop, and listen to stop information.¹⁷²

- 3.29 TfNSW told us that they are aware of the development of apps that aim to give passengers information about approaching buses. They noted that announcement technology will give passengers information on when buses are approaching their stop. TfNSW are monitoring the development of new apps and will aim to improve services to meet customers' needs, make them more accessible and make sure customers are informed.¹⁷³

Driver training on the needs of passengers with a disability

Summary

Bus drivers should be given training on the needs of passengers with disability. This will help improve access to buses, and also have benefits for passenger and pedestrian safety.

Recommendation 12

That training be provided for bus drivers on the needs of passengers with disability.

- 3.30 We consider that bus drivers should be trained on the needs of passengers with disability. This would help drivers to gain awareness of the challenges people with disability face with accessing transport.
- 3.31 We note that driver training could also help improve the safety of pedestrians with disability. Vision Australia referred to research conducted by Monash University on the impact of electric vehicles on pedestrians who are blind or have low vision. Participants in the study were asked about ways to improve their safety. They highlighted raising public awareness and educating drivers and road users as an important measure.¹⁷⁴
- 3.32 BusNSW told us that passengers with vision impairment can be reliant on bus drivers to let them know that a bus has arrived at their stop. They observed that driver training is 'something that will need to be addressed moving forward with this new technology.'¹⁷⁵
- 3.33 We note that bus operators have developed programs to improve access for people with vision impairment. BusNSW told us about a program they run in the Illawarra region with the Blind Society. According to BusNSW, the program means that operators can communicate with their drivers about people with vision impairment who are using local routes. It also helps people with vision impairment who need help with accessing buses: 'if they feel that they need some assistance, they come to the depot, we show them how to load, how to

¹⁷² Answers to questions on notice, 20 March 2020, Transport for NSW, p3

¹⁷³ Mr Issa, Transcript of evidence, 20 March 2020, p39

¹⁷⁴ Monash University & Vision Australia, The impact of electric / hybrid vehicles and bicycles on pedestrians who are blind or have low vision, October 2018, p11

¹⁷⁵ Mr Threlkeld and Mr King, Transcript of evidence, 20 March 2020, p26

offload, if they need assistance with the ramps, and that just follows through into the network and training.¹⁷⁶

¹⁷⁶ Mr King, Transcript of evidence, 20 March 2020, p27

Chapter Four – Promoting bus production in NSW

Interest in local manufacturing

Summary

NSW has the skills and capability to create new business and employment opportunities in the manufacture of electric buses. This includes promoting the repurposing and recycling of electric bus technology.

Finding 5

There is interest in local manufacturing of electric buses.

- 4.1 We were told that a large order for electric buses could attract investment in the local bus manufacturing industry. TfNSW has 3000 buses in its regional fleet, with many of these in major regional cities. We heard that 1000 of these buses are less than five years old, and newer buses are cleaner and more efficient than older models. The Sydney and outer metropolitan fleet has 8000 buses.¹⁷⁷
- 4.2 We also heard that once a commitment has been made in terms of the number of electric buses required, and the rate of adoption, businesses will have the certainty they need to invest in local manufacturing. Inquiry participants said that electric bus manufacturers are keen to supply a domestic market. We heard that replacing 8000 buses could create a long term business opportunity of more than 15 years for manufacturers to supply buses.¹⁷⁸
- 4.3 As other states and territories also begin trialling, and expanding their fleet of electric buses, competition to attract investment in electric bus manufacturing will grow. The Government of South Australia has given a \$2 million grant to Precision Buses to build two electric and two low emission diesel buses. In 2018, the Victorian Government announced it was funding SEA Electric to help them set up a manufacturing plant in the state. Given a large, long-term order, we were told that manufacturers could be persuaded to move their operations from one state to another. It was argued that it would be unrealistic to expect manufacturers to have an operation in every state.¹⁷⁹
- 4.4 Southern regional NSW was suggested as a good location for electric bus manufacturing. We heard that Queanbeyan's closeness to existing Defence manufacturers and suppliers, and a skilled workforce, could make it an attractive

¹⁷⁷ Submission 20, BusNSW, p4; Submission 26, Nexport Pty Ltd, p8; Submission 35, Australian Bus Corporation, p4; Mr Brown, Transcript of evidence, 18 March 2020, pp23; Mr Jafari, Transcript of evidence, 20 March 2020, pp1, 4; Mr Todd, Transcript of evidence, 20 March 2020, p8; Ms Mildwater, Transcript of evidence, 20 March 2020, p30

¹⁷⁸ Submission 17, Electric Vehicle Council, p9; Submission 25, Toshiba International Corporation Pty Ltd, p5; Mr Brown, Transcript of evidence, 18 March 2020, pp23, 24

¹⁷⁹ Submission 7, Transport for NSW, p13; Mr Roxburgh, and Ms Forbes, Transcript of evidence, 18 March 2020, p26; Mr Jafari, Transcript of evidence, 20 March 2020, p4

base for bus manufacturers. We were also told that buses made in Victoria come in to NSW via southern areas such as Queanbeyan.¹⁸⁰

- 4.5 Australia has the capability and expertise to manufacture electric buses. We heard that high-end technology and manufacturing jobs could be created as part of encouraging the development of an electric bus industry. We were told that developing this type of local industry has the potential to become internationally competitive.¹⁸¹
- 4.6 The Australian Bus Corporation and their manufacturing entities – Precision Buses and Bustech – are Australia's second largest bus manufacturer by volume. We heard that they currently produce around 300 buses per year. They developed the country's first electric bus from scratch; not using an imported chassis. They also maintain partnerships with other industry stakeholders to develop electric bus products.¹⁸²
- 4.7 Nextport told us of their plans to partner with the Chinese manufacturer, BYD, to set up a manufacturing and assembly facility in Nowra. An advanced manufacturing facility, using components from international and local supply chains to build buses, it could grow to create around 100 jobs. We were told the facility would also focus on research and development aiming to design and engineer the next generation of electric buses.¹⁸³

Local content requirements

- 4.8 During the inquiry we heard arguments for and against local content requirements. We were told that government procurement models in Victoria, Tasmania, South Australia, and Queensland have or are developing a local content requirement when buying new buses. Under this model a set percentage of the vehicle's value must be locally sourced. The requirement is different in each state – in South Australia it's 40 per cent and in Victoria it's 60 per cent.¹⁸⁴
- 4.9 We heard arguments that this model can help support local industries by having a minimum requirement for locally sourced parts to be included in the vehicle. However we also heard that local content requirements can put limits on the industry. It can restrict the procurement process to a certain type of vehicle or technology. Access to more technologically advanced parts could be limited if they are only available from outside the state or country. We heard that not having access to imported technology could limit manufacturers from keeping up to date with new technology.¹⁸⁵
- 4.10 Inquiry participants said that some bus bodybuilders may have to remove parts from an imported bus body and replace them with locally sourced parts to

¹⁸⁰ Submission 27, Electromotiv, p6; Mr Roxburgh, Transcript of evidence, 18 March 2020, pp25, 26

¹⁸¹ Submission 17, Electric Vehicle Council, p9; Submission 35, Australian Bus Corporation, pp4, 5; Mr Brown, Transcript of evidence, 18 March 2020, pp22, 23

¹⁸² Mr Brown, Transcript of evidence, 18 March 2020, pp22, 23

¹⁸³ Submission 26, Nextport, p8; Mr Todd, Transcript of evidence, 20 March 2020, p8

¹⁸⁴ Mr Roxburgh, Transcript of evidence, 18 March 2020, p25; Mr Brown, Transcript of evidence, 18 March 2020, p26; Ms Forbes, Transcript of evidence 18 March 2020, p27

¹⁸⁵ Ms Forbes, 18 March 2020, Transcript of evidence, p27; Mr Todd, Transcript of evidence, 20 March 2020, p8

comply with content requirements. There can also be issues with identifying genuine locally sourced products. Parts that are invoiced and supplied from a local manufacturer or wholesaler could actually have been made overseas.¹⁸⁶

- 4.11 It was suggested that placing orders with local manufacturers and allowing them to source the materials freely could be more effective than prescribing a local content requirement. We were told that local manufacturers would likely support other local businesses and suppliers who were price and service competitive with international competitors.¹⁸⁷

Reuse and recycle batteries

Summary

Electric bus batteries have a lifespan of around 10 years. This means that ways to reuse and repurpose batteries will need to be developed.

Finding 6

Limited shelf life dictates the need to reuse and repurpose electric bus batteries.

- 4.12 As previously discussed, bus batteries have a useful lifespan of nine to ten years. When a battery is replaced, the old battery can still be used. Batteries that can achieve at least a 65 per cent charge can have a useful second life.¹⁸⁸
- 4.13 While the batteries may have a reduced charge rate or capacity, they can be used in a static role where this is not a performance issue. Bus depots with solar panels generating renewable energy can use second life batteries for stationary energy storage. The batteries could also be used in other commercial settings. We heard that 7-Eleven convenience stores in Japan use old bus batteries to power their refrigeration systems. Similarly, batteries can be used in residential settings for energy storage. In these situations batteries can be useful for about five years.¹⁸⁹
- 4.14 It was suggested that there might be potential for batteries to have a third life of some kind, or be recycled rather than go into landfill. We were told that breaking down batteries for recycling could be expensive and energy intensive. Electromotiv said they recycle batteries when battery capacity is down to about ten per cent. Nexport said it recycles end of life transport grade batteries to use in the manufacture of residential battery storage units. It's also looking at recycling the interior components of lithium batteries by turning them in to a powder to make new lithium batteries. While the cost of recycling the lithium

¹⁸⁶ Mr Brown, Transcript of evidence, 18 March 2020, p26; Ms Forbes, 18 March 2020, Transcript of evidence, p27; Mr Todd, Transcript of evidence, 20 March 2020, p8

¹⁸⁷ Mr Todd, Transcript of evidence, 20 March 2020, p8

¹⁸⁸ Mr Mead, Transcript of evidence, 18 March 2020, p4; Ms Forbes, Transcript of evidence, 18 March 2020, p24

¹⁸⁹ Submission 35, Australian Bus Corporation, p6; Mr Mead, Transcript of evidence, 18 March 2020, p4; Ms Forbes, Transcript of evidence, 18 March 2020, p24; Mr Li, Transcript of evidence, 20 March 2020, p12

batteries is high, we heard that costs should reduce as the volume of batteries increases.¹⁹⁰

- 4.15 We were told that a national approach to deal with the volume of batteries that need to be recycled should be considered. This could avoid having to rely on bus operators or individual manufacturers to manage the repurposing and recycling of batteries.¹⁹¹
- 4.16 It was also suggested that the cost of buying a new battery could include an amount to cover future repurposing or recycling. We heard that the World Economic Forum has agreed to best practice standards and approaches for whole of life issues for batteries. This includes setting up regulatory frameworks to improve the recycling and end-of-life management of batteries.¹⁹²

¹⁹⁰ Submission 26, Nexport Pty Ltd, p10; Submission 27, Electromotiv, Appendix A – Electromotiv brochure, p3; Mr Edmunds, Mr Roxburgh, Transcript of evidence, 18 March 2020, pp30, 31

¹⁹¹ Ms Forbes, Transcript of evidence, 18 March 2020, p24; Mr Edmunds, Transcript of evidence, 18 March 2020, p31

¹⁹² Mr Li, Transcript of evidence, 20 March 2020, p12; World Economic Forum, [Global Battery Alliance](#), accessed 29 July 2020

Appendix One – Terms of reference

That the Committee on Transport and Infrastructure inquire into and report on electric buses in regional and metropolitan public transport networks in NSW, including:

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.

Appendix Two – Conduct of inquiry

Adopting terms of reference

On 23 October 2019 the Committee resolved to inquire into and report on electric buses in regional and metropolitan public transport networks in NSW. The terms of reference for the inquiry are at Appendix 1.

Call for submissions

The Committee called for submissions through a media release and wrote to key stakeholders inviting them to make a submission. Information about the inquiry was posted on the Legislative Assembly's Facebook page and Twitter feed.

Submissions closed on 20 December 2019. Thirty six submissions were received from the community, bus companies, research bodies, energy companies and Transport for NSW.

A list of submissions is at Appendix Three. Submissions are available on the Committee website.

Hearings

The Committee held two hearings at Parliament House in March 2020 with witnesses representing bus manufacturers and operators, research centres, energy companies, disability advocacy and support groups, and Transport for NSW.

Appendix Four is a list of witnesses who appeared at the hearings. Transcripts of evidence taken at the hearings are on the Committee webpage.

Site visit

In August 2020 the Committee attended a site visit to the Leichhardt bus depot, to view electric buses and discuss issues related to their operation.

The site visit report at Appendix Five outlines the issues covered during the site visit.

Appendix Three – Submissions

No.	Author
1	Mr Rory Keyes
1a	Mr Rory Keyes
2	Interline Bus Services
3	Confidential
4	Volvo Bus Australia
5	ARCC Pty Ltd
6	Ms Marghanita da Cruz
7	Transport for NSW
8	Blind Citizens Australia
9	ClimateWorks Australia
10	Beyond Zero Emissions
11	Transit Systems Pty Ltd
12	Scania Australia Pty Ltd
13	Centre for Air pollution, energy and health Research (CAR)
14	Mr James Godschalk
15	Vision Australia
16	Climate Change Balmain-Rozelle
17	Electric Vehicle Council
18	Local Government NSW
19	AGL Energy Ltd
20	BusNSW
21	Ausgrid
22	Siemens Ltd
23	Gemilang Australia Pty Ltd
24	Dr Jake Whitehead
25	Toshiba International Corporation Pty Ltd
26	Nexport Pty Ltd
27	Electromotiv
28	Transport Workers' Union of New South Wales
29	Transdev Australasia Pty Ltd
30	Centre for Energy and Environmental Markets, UNSW
31	Dr. Pedro Orbaiz and Prof. Michael Brear

No.	Author
32	Anna Nadolny
33	Mr Wade Bowmer
34	Disability Council NSW
35	Australian Bus Corporation
36	InvertedPower Pty Ltd

Appendix Four – Witnesses

18 March 2020 - Macquarie room, Parliament House, Sydney, NSW

Witness	Position and Organisation
Mr David Evans	Director of Engineering and Production, ARCC Pty Ltd
Mr Trevor O'Brien	Product Manager, Scania Australia Pty Ltd
Ms Olivia Laskowski	Promoter of Electric Vehicle Charing Infrastructure, Siemens Ltd
Mr David Mead	Vice President, Volvo Bus Australia
Mr Joe Oliveri	Director, Operations and Maintenance Manager, Interline Bus Services
Mr Gus Defalco	Compliance, Training and Policy Manager, Interline Bus Services
Mr Greg Balkin	General Manager, New Technology and Innovation, Transit Systems Pty Ltd
Mr Alan Smith	Member, Transport Workers' Union
Mr Nimrod Nyols	NSW Lead Official, Transport Workers' Union
Ms Sarah Forbes	Executive Manager, Gemilang Australia Pty Ltd
Mr Mark Edmunds	General Manager, Energy Storage and eMobility Solutions, Toshiba International Corporation Pty Ltd
Mr Toby Roxburgh	Managing Director, Electromotiv
Mr Damien Brown	Commercial Director, Australia Bus Corporation
Ms Sally Aurisch	NSW/ACT Coordinator, Blind Citizens Australia
Mr Bruce Maguire	Lead Policy Advisor, Government Relations and Advocacy, Vision Australia
Mr Mark Tonga	Chair, Disability Council NSW

Witness	Position and Organisation
Ms Casey Gray	Member, Disability Council NSW
Ms Elizabeth Molyneux	General Manager, Energy Market Regulation, AGL Energy Limited
Ms Jane Butler	Manager, New Business Distributed Energy, AGL Energy Limited

20 March 2020 - Macquarie room, Parliament House, Sydney, NSW

Witness	Position and Organisation
Ms Larissa Cassidy	Manager of Policy, Electric Vehicle Council
Mr Behyad Jafari	CEO, Electric Vehicle Council
Mr Luke Todd	Managing Director, Nexport Pty Ltd
Mr Michael Li	Senior Project Manager (Cities and Policy), ClimateWorks Australia
Mr Guy Marks	Principal Investigator and Lead, Centre for Air Pollution, energy and health Research
Ms Anna Nadolny	Research Officer, 100% Renewable Energy Research Group, Australian National University
Ms Katelyn Purnell	Centre for Energy and Environmental Markets, University of NSW
Dr Iain MacGill	Associate Professor, Joint Director (Engineering), Centre for Energy and Environmental Markets, University of NSW
Mr Matt Threlkeld	Executive Director, BusNSW
Mr John King	President, BusNSW
Mr Elizabeth Mildwater	Deputy Secretary, Greater Sydney, Transport for NSW
Mr Steve Issa	Acting Executive Director, Services, Greater Sydney, Transport for NSW

Appendix Five – Site visit

Leichhardt bus depot – Balmain Road

Meeting with: Jamie Sinclair, Area Manager; Len Kidd, General Manager, Transit Systems; Rob Rachwal, Maintenance and Facilities Manager; Rachel Byrnes, Acting Area Manager North; Andrew Dundas, Maintenance Engineer; Azad Dammerel and Susan Angove, bus drivers; Steve Issa, Acting Executive Director, Services; Elizabeth Midwater, Deputy Secretary, Greater Sydney

Tour of depot, covering:

- Overview of electric buses (Yutong and BYD Gemilang models)
- Comparison of electric and diesel buses
- Inspection of charging infrastructure used to power and charge the electric buses
- Inspection of buses, including steering and driving controls and electric motors.
- Experience of drivers and operation/maintenance staff with driving and servicing vehicles.

The following issues were discussed:

Metropolitan services & electric bus trials

- TfNSW will trial electric buses in Sydney bus regions to work out how they run on routes with different operating conditions, for example, routes with long stretches on motorways. Expressions of interest for these contracts closed on 3 August.
- Rollout requires consideration of fleet age and type, and routes. Bus contracts are being renewed over the next 4 years.
- Rollout strategy will be developed. TfNSW recognises need to work in partnership with bus operators and energy suppliers.
- Electric buses in Leichhardt trial have performed well. Buses are exceeding performance requirements set out in the contract with Transit Systems.

Charging infrastructure

- Leichhardt depot has around 250 buses, 5 of which are electric. The depot has 2 chargers.
- Installing pantographs for opportunity charging would be more costly – it's not likely to be needed in Sydney.
- Power used for buses needs to be renewable to be zero emissions. Transit Systems are seeking to focus on clean energy to power buses.
- Batteries can be repurposed, for example, to charge buses at depots through solar power. Repurposing for charging could reduce energy costs and reliance on grid.

Regional services

- Opportunity charging may be suitable for long distance journeys in regional areas – the heavy rail network could be used for charging. New developments could incorporate opportunity charging.

Driver experience

- Drivers enjoy driving electric buses. They find them responsive, easy to drive and like the regeneration. They enjoy driving brand new buses and take pride in keeping the vehicles clean. It takes time to adjust to new buses, but many drivers now prefer to drive the electric buses.
- Every new bus requires training, including new diesel buses, and CNG buses. Each vehicle has a different layout and characteristics, meaning that drivers and maintenance staff have to be trained to operate and service them.

Passengers with disability

- TfNSW is seeking to learn from international experience. There is work underway on white noise emitters – they are used in London.
- On board stop announcements are standard with new buses, they've been well received by passengers. Announcements include automated audio and display screens.
- Drivers are sensitive to the needs of passengers with disability, eg. they pull up at stops and tell vision impaired passengers which bus they are driving. They are trained in assisting passengers with disability, and Transit Systems does guide dog training.
- Pedestrian safety is also a concern, for example, headphones, and general distraction. TfNSW has run safety campaigns to raise community awareness.

Members took part in a short journey on an in service electric bus.

Appendix Six – Extracts from minutes

MINUTES OF MEETING No 2

1:34 pm, 21 August 2019

Room 1043

Members present

Ms Preston, Mr Singh, Ms Petinos, Mr Minns

Apologies

Mr Warren

Officers in attendance

Dora Oravec, Kieran Lewis, Ilana Chaffey

1. Committee membership

The Chair noted the change in Committee membership with Mr Minns replacing Ms McKay, discharged (Legislative Assembly Votes and Proceedings, 6 August 2019, entry 9).

2. Confirmation of minutes

Resolved, on the motion of Ms Petinos, seconded by Mr Singh: That the minutes of the meeting of 19 June 2019 be confirmed.

3. Possible inquiry topics

The Chair noted the briefing note on the Committee's role, circulated to members.

The Chair proposed that the Committee consider conducting an inquiry into the use of electric buses in NSW.

Mr Minns proposed that the Committee consider conducting an inquiry into funding of the western metro.

Discussion ensued.

The Committee agreed to conduct an inquiry into the use of electric buses, covering:

- minimum baseload for buses
- energy infrastructure required
- capacity for local manufacturing of buses
- other renewable, emissions neutral options for buses
- services in regional and metropolitan areas.

The Committee agreed to consider draft terms of reference to be circulated before the next meeting, to be held on a Wednesday at 1:15 pm in the September sitting weeks.

4. Next meeting

The meeting adjourned at 1:40 pm to a date and time to be determined.

MINUTES OF MEETING No 3

1:18 pm, 23 October 2019

Parkes Room

Members present

Ms Preston, Mr Singh, Ms Petinos, Mr Minns, Mr Warren

Officers in attendance

Elaine Schofield, Dora Oravec, Ilana Chaffey

5. Confirmation of minutes

Resolved, on the motion of Ms Petinos, seconded by Mr Singh: That the minutes of the meeting of 21 August 2019 be confirmed.

6. Proposed inquiry – electric buses in regional and metropolitan public transport networks in NSW

The Chair noted the draft terms of reference, briefing note, stakeholder list and indicative timeline, circulated to members.

Terms of reference

The Committee discussed the draft terms of reference.

Mr Minns moved: That a new point be added to the draft terms of reference, to include bus routes servicing the North West rail and the soon to be opened Eastern Suburbs light rail.

Discussion ensued.

Question put.

The Committee divided.

Ayes 2 [Mr Minns, Mr Warren]

Noes 3 [Ms Preston, Ms Petinos, Mr Singh]

Question resolved in the negative.

Discussion ensued.

Mr Minns moved: That point 4 of the draft terms of reference be amended to include local manufacture of ferries.

Discussion ensued.

Question put.

The Committee divided.

Ayes 2 [Mr Minns, Mr Warren]

Noes 3 [Ms Preston, Ms Petinos, Mr Singh]

Question resolved in the negative.

Mr Warren moved: That point 4 of the draft terms of reference be amended by adding the words 'in NSW' at the end of the point.

Discussion ensued.

The Committee agreed to amend point 4 of the draft terms of reference by omitting the word 'local' before the word 'manufacture' and inserting the words 'in NSW' at the end of the point.

Resolved, on the motion of Mr Singh, seconded Ms Petinos: That the Committee inquire into and report on electric buses in regional and metropolitan public transport networks in NSW, including:

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.

Discussion ensued.

Call for submissions and timeline

The Chair noted the indicative timeline for the inquiry.

Discussion ensued.

Resolved on the motion of Ms Petinos, seconded Mr Singh: That the Committee call for submissions to be received by 20 December 2019 and write to the listed stakeholders.

Mr Warren suggested adding the Transport Workers Union and Electrical Trades Union to the stakeholder list.

The Chair noted that members could suggest additional stakeholders by email to Committee staff.

The Committee noted the indicative timeline for the inquiry.

The Chair noted that a media release announcing the inquiry would be issued.

Discussion ensued.

7. Next meeting

The meeting adjourned at 1:43 pm to a date and time to be determined.

MINUTES OF MEETING No 4

1.33pm, 5 February 2020

Room 1254

Members present

Ms Preston, Mr Singh, Ms Petinos, Mr Warren

Apologies

Mr Minns

Officers in attendance

Elaine Schofield, Dora Oravec, Kieran Lewis, Ilana Chaffey

1. Confirmation of minutes

Resolved, on the motion of Ms Petinos, seconded by Mr Singh: That the minutes of the meeting of 23 October 2019 be confirmed.

2. ***

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

3.1 Publishing submissions

Resolved, on the motion of Mr Warren, seconded by Mr Singh, in globo:

That the Committee publish submissions numbered 1 to 2, 6 to 11, 13 to 31 and 33 to 35 in full.

That the Committee publish submission number 4 with the cover letter redacted.

That the Committee publish submission number 5 without the attached publicly available documents, which will be listed at the end of the submission.

That the Committee publish submission number 12 with pages 7, 8, 15 and 16 redacted.

That the Committee publish submission number 32, without the attached journal article.

That submission number 3 remain confidential to the Committee and not be published.

The Committee noted a request from BusNSW to republish their submission in their newsletter.

3.2 Selecting witnesses

Resolved, on the motion of Ms Petinos, seconded by Mr Singh: That the Committee invite the listed witnesses to give evidence at public hearings to be held on Wednesday 18 March and Friday 20 March.

4. ***

5. Next meeting

The meeting adjourned at 1.42 pm until 18 March at 9.55am.

MINUTES OF MEETING No 5

9.58am, 18 March 2020

Macquarie Room

Members present

Ms Preston, Mr Singh, Ms Petinos, Mr Minns (via telephone for the deliberative meeting prior to the public hearing and the examination of the first four witnesses only), Dr O'Neill (substituting for Mr Warren)

Officers in attendance

Clara Hawker, Dora Oravec, Mohini Mehta, Ze Nan Ma

1. Deliberative meeting

1.1 Substitute member

The Chair noted the receipt of correspondence from Mr Warren advising that he is unable to attend the meetings on 18 and 20 March. Mr Warren nominated Dr Marjorie O'Neill to substitute for him at today's meeting (in accordance with standing order 273A(2)).

1.2 Confirmation of minutes

Resolved on the motion of Mr Singh, seconded Ms Petinos: That the minutes of the meeting of 5 February 2020 be confirmed.

1.3 ***

1.4 Publishing submissions

Resolved, on the motion of Ms Petinos, seconded by Mr Singh:

That the Committee publish submission 36 with the document attached redacted.

That the Committee amends its publication order for submission 26 to publish the submission with section 8, from pages 13 to 14, redacted.

1.5 Media orders

Resolved, on the motion of Mr Singh, seconded Ms Petinos: That the Committee authorises the audio-visual recording, photography and broadcasting of the public hearing on 18 March 2020, in accordance with the Legislative Assembly's guidelines for the coverage of proceedings for parliamentary committees administered by the Legislative Assembly.

1.6 Answers to questions taken on notice

Resolved on the motion of Ms Petinos, seconded Mr Singh: That witnesses be requested to return answers to questions taken on notice and supplementary questions within 1 week of the date on which the questions are forwarded to the witnesses.

The meeting concluded at 10.01am.

2. Public hearing: Inquiry into electric buses on regional and metropolitan public transport networks in NSW

Witnesses and the public were admitted. The Chair opened the public hearing at 10:09 am and made a short opening statement.

Mr David Evans, Director of Engineering and Production, ARCC Pty Ltd was affirmed and examined.

Mr David Mead - Vice President, Volvo Buses Asia Pacific, was affirmed and examined.

Mr Trevor O'Brien, Product Manager, Scania Australia Pty Ltd, was sworn in and examined via teleconference.

Ms Olivia Laskowski, Promoter of Electric Vehicle Charging Infrastructure, Siemens Ltd, was affirmed and examined via teleconference.

Mr Joe Oliveri, Director, Operations and Maintenance Manager, Interline Bus Services, was sworn in and examined.

Mr Gus Defalco, Compliance, Training and Policy Manager, Interline Bus Services, was affirmed and examined.

Mr Greg Balkin, General Manager - New Technology and Innovation, Transit Systems Pty Ltd, was sworn in and examined.

Mr Nimod Nyols, NSW Lead Official, Transport Workers' Union (TWU), was affirmed and examined.

Mr Alan Smith, Member, Transport Workers' Union (TWU), was sworn in and examined.

Ms Sarah Forbes, Executive Manager, Gemilang Australia Pty Ltd, was affirmed and examined.

Mr Mark Edmunds, General Manager - Energy Storage and e Mobility Solutions, Toshiba International Corporation Pty Ltd, was sworn in and examined.

Mr Toby Roxburgh, Managing Director, Electromotiv, was affirmed and examined via teleconference.

Mr Damien Brown, Commercial Director, Australian Bus Corporation, was sworn in and examined via teleconference.

Mr Mark Tonga, Chair, Disability Council NSW, was sworn in and examined via teleconference.

Ms Casey Gray, Member, Disability Council NSW, was affirmed and examined via teleconference.

Ms Sally Aurisch, NSW and ACT Coordinator, Blind Citizens Australia, was affirmed and examined via teleconference.

Mr Bruce Maguire, Lead Policy Advisor, Government Relations and Advocacy, Vision Australia, was affirmed and examined via teleconference.

Ms Elizabeth Molyneux, General Manager, Energy Market Regulation, AGL Energy Limited, was affirmed and examined via teleconference.

Ms Jane Butler, Manager, New Business Distributed Energy, AGL Energy Limited, was affirmed and examined via teleconference.

The Committee questioned the witnesses. Evidence concluded and the witnesses withdrew.

The public hearing concluded at 4.20pm.

3. Deliberative meeting

Resolved on the motion of Dr O'Neill, seconded Mr Singh: That the corrected transcript of public evidence given today be authorised for publication and uploaded on the Committee's website.

4. ***

5. Next meeting

The meeting adjourned at 4.50pm until 10.25am on 20 March 2020 in the Macquarie Room.

MINUTES OF MEETING No 6

10.27am, 20 March 2020

Macquarie Room

Members present

Ms Preston, Mr Singh, Ms Petinos, Dr O'Neill (substituting for Mr Warren)

Apologies

Mr Minns

Officers in attendance

Bjarne Nordin, Dora Oravec, Mohini Mehta, Ze Nan Ma

1. Deliberative meeting

1.1 Substitute member

Dr O'Neill substituting for Mr Warren at today's meeting (in accordance with standing order 273A(2)).

1.2 Confirmation of minutes

Resolved on the motion of Ms Petinos, seconded Mr Singh: That the minutes of the meeting of 18 March 2020 be confirmed.

1.3 Publishing submissions

Resolved, on the motion of Ms Petinos, seconded Dr O'Neill: That the Committee publish the amended version of submission 32 in place of the original version, with the document attached redacted.

1.4 ***

1.5 Media orders

Resolved, on the motion of Mr Singh: That the Committee authorises the audio-visual recording, photography and broadcasting of the public hearing on 20 March 2020, in accordance with the Legislative Assembly's guidelines for the coverage of proceedings for parliamentary committees administered by the Legislative Assembly.

1.6 Answers to questions taken on notice

Resolved on the motion of Dr O'Neill, seconded Mr Singh: That witnesses be requested to return answers to questions taken on notice and supplementary questions within 1 week of the date on which the questions are forwarded to the witnesses.

The meeting concluded at 10.31am.

2. Public hearing: Inquiry into electric buses on regional and metropolitan public transport networks in NSW

Witnesses and the public were admitted. The Chair opened the public hearing at 10:31am and made a short opening statement.

Ms Larissa Cassidy, Manager of Policy, Electric Vehicle Council, was affirmed and examined.

Mr Behyad Jafari, CEO, Electric Vehicle Council, was affirmed and examined.

Mr Luke Todd, Managing Director, Nexport Pty Ltd, was sworn in and examined.

Mr Michael Li, Senior Project Manager (Cities and Policy), Climate Works Australia, was affirmed and examined via teleconference.

Professor Guy Marks, Principal Investigator and Lead, Centre for Air pollution, energy and health Research (CAR), was affirmed and examined via teleconference.

Ms Anna Nadolny, Research Officer, 100% Renewable Energy group, ANU, was affirmed and examined.

Ms Katelyn Purnell, PhD Candidate, Centre for Energy and Environmental Markets, UNSW, was affirmed and examined.

Dr Iain MacGill, Associate Professor, Joint Director (Engineering), Centre for Energy and Environmental Markets, UNSW, was affirmed and examined.

Mr Matt Threlkeld, Executive Director, BusNSW, was sworn in and examined.

Mr John King, President, BusNSW, was sworn in and examined.

Ms Elizabeth Mildwater, Deputy Secretary, Greater Sydney, Transport for NSW, was affirmed and examined.

Mr Steve Issa, A/Executive Director, Services, Greater Sydney, Transport for NSW, was sworn in and examined.

The Committee questioned the witnesses. Evidence concluded and the witnesses withdrew.

The public hearing concluded at 4.14pm.

3. Deliberative meeting

Resolved on the motion of Mr Singh, seconded Dr O'Neill: That the corrected transcript of public evidence given today be authorised for publication and uploaded on the Committee's website.

4. General business

The Chair suggested that the Committee undertake a site visit to inspect the operation of electric buses.

Discussion ensued.

Resolved, on the motion of Mr Singh, seconded Dr O'Neill: That the Committee visit a location where electric buses are being trialled, if physically possible.

5. Next meeting

The meeting adjourned at 4.24pm until a date to be confirmed.

MINUTES OF MEETING No 7

9.07am, 23 September 2020

Room 1254

Members present

Ms Preston, Mr Singh, Ms Petinos (via telephone), Dr O'Neill, Mr Minns

Officers in attendance

Elaine Schofield, Dora Oravec, Kieran Lewis

1. Confirmation of minutes

Resolved on the motion of Mr Singh, seconded Dr O'Neill: That the minutes of the meeting of 20 March 2020 be confirmed.

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

2.1 ***

2.2 Publishing answers to questions on notice

Resolved on the motion of Mr Singh, seconded Ms Petinos: That the Committee publishes answers to questions on notice from Transport for NSW and AGL Energy.

2.3 Consideration of Chair's draft report

The Committee agreed to consider the report chapter by chapter.

Resolved on the motion of Mr Singh, seconded Ms Petinos: That chapters 1 to 3 stand part of the report.

The Chair proposed the question: That chapter 4 stand part of the report.

Dr O'Neill moved: That chapter 4 be amended by inserting the following finding after Finding 5.

Finding 6

That NSW is very good at building buses. NSW has the advanced manufacturing techniques including the robotics, design, engineering and assembly processes required to build electric buses and trains, the NSW Government must send an unambiguous message that advanced manufacturing of infrastructure is as good if not better than the rest of the world.

Discussion ensued.

Question put.

The Committee divided.

Ayes 2 [Mr Minns, Dr O'Neill]

Noes 3 [Ms Preston, Ms Petinos, Mr Singh]

Question resolved in the negative.

Dr O'Neill moved: That chapter 4 be amended by inserting the following recommendation after Finding 5.

Recommendation 13

As an urgent stimulus measure, Transport for NSW move to requiring all electric buses acquired for the NSW public transport system to be manufactured in NSW. This will ensure NSW taxpayer money is not sent overseas at a time when it is needed here to create jobs.

Question put.

The Committee divided.

Ayes 2 [Mr Minns, Dr O'Neill]

Noes 3 [Ms Preston, Ms Petinos, Mr Singh]

Question resolved in the negative.

Dr O'Neill moved: That chapter 4 be amended by inserting the following recommendation after Finding 5.

Recommendation 14

That Transport for NSW commit to the number of buses required and the rate of adoption to give certainty to the NSW manufacturing sector and to create a long-term business opportunity of more than 15 years for the manufacturers to supply buses.

Question put.

The Committee divided.

Ayes 2 [Mr Minns, Dr O'Neill]

Noes 3 [Ms Preston, Ms Petinos, Mr Singh]

Question resolved in the negative.

The Chair again proposed that chapter 4 stand part of the report.

Resolved on the motion of Ms Petinos:

1. That the draft report be the report of the Committee and that it be signed by the Chair and presented to the House.
2. That the Chair and committee staff be permitted to correct stylistic, typographical and grammatical errors.
3. That, once tabled, the report be posted on the Committee's website.

3. General business

The Chair invited members to discuss options for a future inquiry with her informally. She noted that a meeting to discuss options will be held at a date to be confirmed.

4. Next meeting

The meeting adjourned at 9.23am until a date to be confirmed.