

# Zero Emission Bus Transition Strategy



future **transport**  
technology

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## Abbreviations and Acronyms

Term	Description
BEB	Battery electric bus
CNG	Compressed natural gas
DPIE	Department of Planning, Industry and Environment
DSAPT	Disability Standards for Accessible Public Transport
FCEB	Hydrogen fuel cell electric bus
GHG	Greenhouse gas emissions
TfNSW	Transport for NSW
ZEB	Zero emission bus



# Executive summary

The NSW Government is committed to reaching net zero greenhouse gas (GHG) emissions by 2050 and achieving net zero public transport emissions is an essential part of this agenda. This strategy sets out a response to the challenge to transition the NSW bus fleet to zero emissions by 2030 and establishes a pathway to achieve this.

NSW operates a fleet of over 8000 buses which are under Transport for NSW's (TfNSW) direct control and provide a significant opportunity for us to show leadership in the transport sector's transition towards zero emissions. Most importantly, transitioning to zero emission buses (ZEBs) will be great for our customers and communities, who will see improvements in air quality, urban amenity and passenger comfort. This transition will also boost the development of local skills and capabilities in zero emission technologies and we are committed to ensuring that the broader NSW economy benefits from increases in investment, jobs and advances in technology.

TfNSW is actively progressing a program of work to commence the transition in partnership with industry. While further technical planning work will continue to scope details for the full fleet transition, it is critical we start acting now to build momentum and industry readiness ahead of an acceleration point in vehicle deployments from 2023.

With buses operating for up to 25 years, we know that the vehicles we invest in today will need to meet our evolving environmental, operational and net zero energy requirements. Together with our partners we have already commenced the roll-out of ZEBs and have approved seven models on the NSW Bus Procurement Panel to date. These vehicles are available for operators to order and over 89 vehicles are scheduled for delivery by mid-2022.

This strategy also recognises that ZEB technologies are evolving rapidly and there are challenges for a rapid transition. The pathway has therefore been designed with the flexibility to accommodate alternate transition sequencing and the ability to pivot the transition in response to changes in technology and operational requirements.

The ZEB roll-out will progress across all geographies in parallel and ramp-up quickly to meet fleet transition requirements. The initial stages of the transition will focus on battery electric vehicles while undertaking scaled trials of hydrogen fuel cell electric vehicle technologies to support the establishment of a mature hydrogen sector. In Metro areas, the transition will prioritise areas where TfNSW has long-term access to key depots and bus fleets are relatively standardised. In Outer Metro and Regional areas, the transition will prioritise operations that are best suited to current battery electric technology, and we will trial both battery electric and hydrogen fuel cell technologies to understand what best suits more challenging regional and remote operations. Given the diversity of regional bus operations and fleet types the opportunity for operators to "opt-in" for transition will be considered and the initial phases of the transition will be weighted towards Metro areas, with a heavier focus on Regional areas in the latter years following a strategic review of emerging technologies and learnings from early regional deployments.

The first two years of the transition (2021-22 calendar years) will focus on short term replacement opportunities, aimed at meeting natural replacement needs while building industry readiness for an increased take up of vehicles from 2023. Meeting the 2030 challenge will require peak vehicle deliveries of 1200 - 1300 buses per annum in later years. While this will provide great opportunities for current and future suppliers and support local industry development, it may also put strain on manufacturers and result in a significant fall in annual deliveries after 2030.

TfNSW is committed to working in partnership with industry to deliver sustainable and customer focused outcomes for our community across the whole of NSW and we encourage your feedback on this transition approach.

# 1.

## Introduction

A challenge has been set to transition the full NSW bus fleet of 8000 plus buses to ZEBs by 2030. This Transition Strategy sets out a pathway to transition NSW's fleet of diesel and CNG-powered buses to ZEBs as part of the NSW Government and TfNSW commitment to transition the transport sector to net zero GHG emissions by 2050.



TfNSW is committed to improving the environmental, economic and social sustainability of our transport system. Transitioning to a net zero transport system enables us to tackle climate change, create liveable places and a productive economy, reduce congestion, and support the better health and wellbeing of our communities. A transition of the bus fleet enables us to put customers first by providing cleaner and quieter bus services that will deliver significant economic benefits and emissions reductions for NSW.

The transport sector represents one of the largest and fastest growing sources of greenhouse gas emissions globally, and accounts for approximately 20 per cent of NSW's carbon dioxide emissions. TfNSW's direct emissions account for around 6 per cent of transport sector emissions. Diesel and compressed natural gas buses make up almost half of TfNSW's direct emissions, so transitioning our fleet will be an important contribution to delivering on the NSW Government's commitment to net zero emissions by 2050. The transition will also allow NSW to demonstrate its leadership in climate action and lead the way for the broader transport industry to adopt zero emissions technologies.

To date, a number of initiatives have been undertaken to understand the most effective way to transition our bus fleet with a growing number of ZEBs being rolled out across NSW roads.

The transition of the NSW bus fleet to ZEBs powered by green energy also provides a unique opportunity for local industry to drive innovation and local production, as well as greater financial sustainability for bus operators over the longer term. This strategy recognises the potential challenges inherent with an accelerated transition, and accommodates alternative transition scenarios to manage these challenges and pivot the transition in response to changes in emerging technology.

This document has been developed to provide an overview of the transition approach and form the basis for industry engagement and feedback in several areas including:

- > ZEB technology and infrastructure requirements
- > Transition sequencing and contracting considerations
- > Supplier readiness and capacity



## 2.

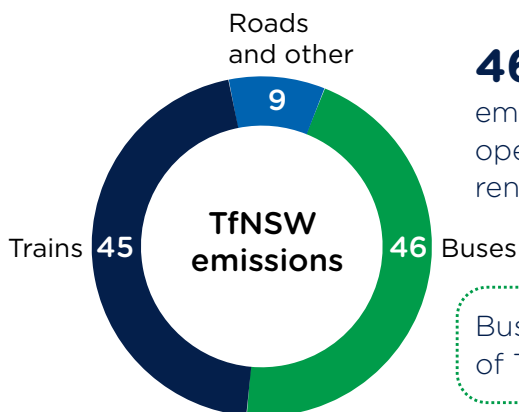
# Strategic context

The transition to ZEBs is a key initiative under the TfNSW Future Energy Strategy and the NSW Government's commitment to reach net zero GHG emissions across the NSW economy by 2050.



## Drivers for sustainable change

The creation of a net zero emissions NSW bus fleet will support the broader net zero target and deliver customer, environmental, economic and commercial benefits.



### 46% reduced

emissions across TfNSW's operations and prompt for renewable energy sources

Buses make up nearly half of TfNSW's carbon emissions



### Quieter

Less noise in residential areas and for passengers



### Cleaner and healthier

air quality and no harmful exhaust fumes, especially in urban environments



### Investment boost

and **new jobs**, particularly in manufacturing and depot upgrades



### Comparable

whole of life costs\*

\*indicative analysis comparing battery electric buses with diesel buses and includes 50% higher upfront capital cost



### Potential for up to \$1-2 billion saved

in environmental and health costs\*

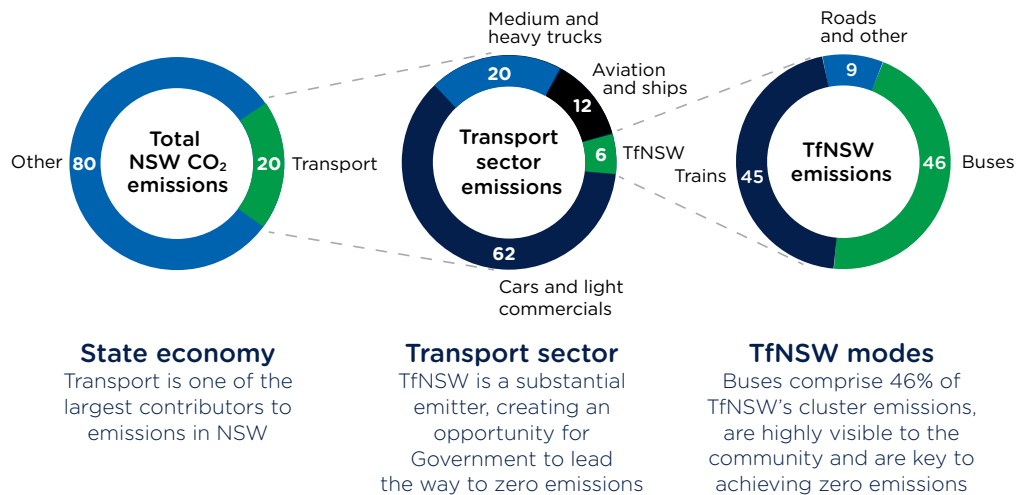
\*compared to diesel buses over 30 years



## Achieving net zero emissions by 2050

The transition of the NSW bus fleet to ZEBs powered by renewable energy is a key initiative to support the NSW Government's net zero commitments.

The transport sector is a large contributor to emissions in NSW, of which TfNSW and bus operations are a substantial portion and highly visible to the community.



The goal of net zero emissions must consider the whole-life carbon impact of buses, including manufacturing, operations, energy and disposal. ZEBs that are powered by renewable energy (whether powered by Battery electric or hydrogen fuel cell technologies) have significantly lower emissions than diesel buses.

### Total CO<sub>2</sub> emissions



- Scope 1: Emissions that "come out of tailpipe"**
- > Comprise up to 75% of total diesel bus lifetime emissions
  - > In addition to CO<sub>2</sub>, these can also impact the air quality of communities with particulate matter and noise pollution, depending on fuel type



- Scope 2: Emissions that result from energy production**
- > Comprise up to 15% of total diesel bus lifetime emissions
  - > This includes emissions as a result of the end-to-end extraction and refinement of crude oil (diesel), or emissions from electricity generation which is required to power batteries or hydrogen production (via electrolysis)



- Scope 3: Emissions that result from the full bus supply chain**
- > Comprise up to 10% of total diesel bus lifetime emissions
  - > This includes bus manufacture and assembly and disposal of end-of-life assets (e.g. shell, batteries, tires)
  - > These type 3 emissions will be higher for imported buses

To achieve net zero, TfNSW will need to replace the existing diesel / CNG fleet with electric and/or hydrogen buses, purchase "green" (zero emissions) energy and work with industry to reduce emissions from manufacturing and asset disposal

Source: Nordelof, Romare, and Tivander, "Life cycle assessment of city buses powered by electricity, hydrogenated vegetable oil or diesel", Transportation Research Part D: Transport and Environment, Volume 75 (2019); L.E.K. research and analysis



## 2.1 Benefits and context

The NSW Minister for Transport and Roads has challenged TfNSW to transition the State's bus fleet by 2030. This will support the NSW Government's commitment to net zero emissions by 2050.

Transitioning to ZEBs is expected to unlock a range of benefits:



### Environmental and health benefits

A fully ZEB fleet, powered by renewable energy, will **reduce TfNSW's emissions by c.46%**, generating environmental and **health benefits of c.\$1-2bn** over 30 years compared to diesel buses and support the delivery of net zero transport



### Noise, air quality and public amenity

ZEBs are quieter than diesel buses, offer a smoother ride and emit no harmful exhaust fumes, **improving public amenity and air quality**, particularly in urban environments



### Economic

The transition to ZEBs can create **investment and jobs**, particularly in bus manufacturing and depot upgrades



### Commercial

Battery electric ZEBs are approaching total cost of ownership parity with diesel buses. Preliminary analysis indicates that while more expensive up front, they will **provide a significant operating cost advantage** over diesel buses

Source: TfNSW Future Energy Strategy; Office of Environment & Heritage (2017). WHO Cares about the Environment? A survey of environmental knowledge, attitudes and behaviours of people in NSW in 2015; WSP; TfNSW 2020 ZEB EOI Bus Data

The transition must meet minimum requirements for safety and accessibility standards, enhance customer journeys and ensure technology is operationally fit for purpose. The transition must also balance competing objectives in terms of value for money, supporting local industry, speed of deployment and achieving environmental benefits. Importantly the transition must also support the effective delivery of services across all of NSW and consider the unique challenges and diverse operating requirements in regional and remote environments.

The transition to renewable energies and ZEBs is happening in the context of significant operational and technological change in the bus and transport industry, including innovations in mobility as a service, connected and automated vehicles, and improved data analytics. The ZEB transition presents an opportunity to incorporate elements of future mobility technologies to improve the safety, convenience and productivity of our transport networks. The move to ZEBs also presents an opportunity to incorporate further elements of the NSW Future Transport Technology Roadmap 2021-2024 including utilising sensors and intelligent systems to accelerate benefits for customers.

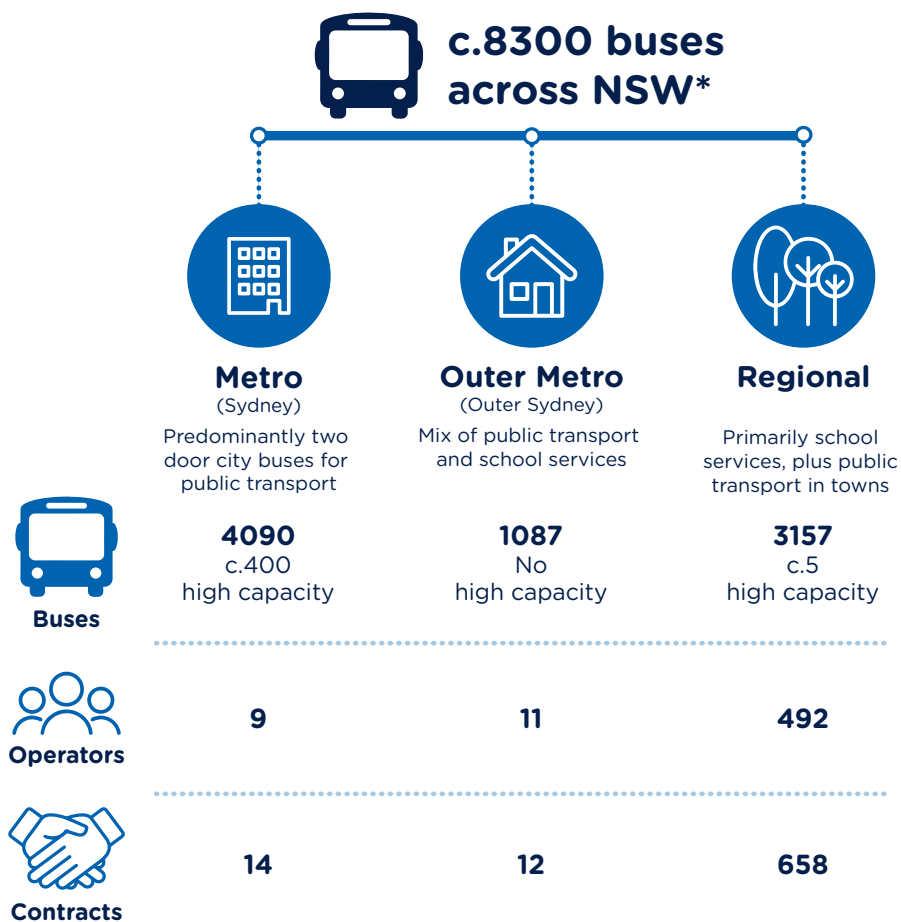
## 2.2 About the NSW bus fleet

The NSW bus fleet is made up of over 8300 largely diesel buses of varying sizes, operated by over 500 private contractors across the state.

Half of the state's buses are in Metro Sydney, with the other half spread across Outer Metro and Regional areas. Metro and Outer Metro contracts tend to be significantly larger than Regional contracts, due to population density:

- > 60 per cent of buses are run by the 20 largest operators in Metro and Outer Metro
- > 40 per cent of buses are run by around 500 smaller operators, primarily in Regional


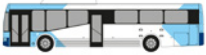


The Regional network includes a few larger operators with over 100 buses, but is primarily made up of small, family-owned operators with fewer than five buses. In regional areas, school services constitute the vast majority of operations, and given the necessity of car ownership in many rural and regional areas, regular public transport services tend to be limited to larger towns.



Note: \*As of May 2021 includes NSW TrainLink coaches and On Demand

There are also significant differences in the range of buses that operate across the state, particularly in regional areas. The current fleet profile is shown below and includes a representation of vehicle types currently available for purchase by NSW transport operators. The first phase of the transition focuses on increasing the ZEB fleet type available in NSW, including smaller format buses used in regional areas. As more models become available they will be progressively included into the NSW Bus Procurement Panel.








## Greater Sydney Fleet

	Bus configuration	Seating capacity (per bus)	Qty	Procurement method	ZEB option currently available**
	Midi	8 - 18	29	NSW Government Motor Vehicle Pre-qualification Scheme (SCM0653), or Bespoke procurement	Not available
	Standard*	44+	3719	TfNSW Bus Procurement Panel	Available
	Articulated	52 - 64	251	TfNSW Bus Procurement Panel	Not available
	Double Decker	85 - 93	91	TfNSW Bus Procurement Panel	Not available
	<b>Total</b>		<b>4090</b>		

Note: \*Standard buses include 3,332 low floor 12.5m rigid, 107 low floor 14.5m rigid, and 280 non-low floor one and two door buses.

\*\*Indicates availability on the NSW Government Motor Vehicle Pre-qualification scheme or TfNSW Bus Procurement Panel as at July 2021

## Regional and Outer Metro Fleet

	Bus configuration	Seating capacity (per bus)	Qty	Procurement method	ZEB option currently available**
	Category 1	8 - 14	118	NSW Government Motor Pre-qualification Scheme (SCM0653)	Not available
	Category 2	15 - 28	569	NSW Government Motor Pre-qualification Scheme (SCM0653)	Not available
	Category 3 High Floor School Bus	29 - 43	262	TfNSW Bus Procurement Panel	Not available
	Category 4 High Floor School Bus	44+	2122	TfNSW Bus Procurement Panel	Not available
	Articulated	52 - 64	5	Bespoke procurement	Not available
	One door Urban* / two door City (Low floor accessible bus)	44+	1068	TfNSW Bus Procurement Panel	Available
	<b>Total</b>		<b>4144</b>		
	TrainLink Coaches	42	100	Bespoke procurement	Not available

Note: \*One door urban bus availability is subject to discussions with manufacturers as only two door models are listed on the current bus panel.

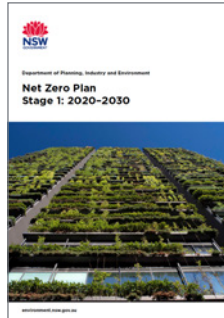
\*\*Indicates availability on the NSW Government Motor Vehicle Pre-qualification scheme or TfNSW Bus Procurement Panel as at July 2021

The NSW bus fleet includes a number of smaller format vehicles which are not currently manufactured locally or supplied to the Australian market. This presents a development opportunity for the local industry to potentially supply vehicles to other customers beyond the NSW public transport bus fleet, as demand for private and commercial fleet vehicles also increases.



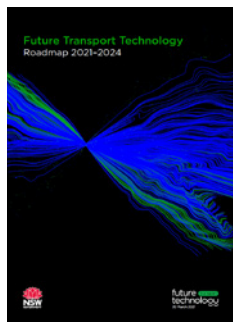
## 2.3 Alignment with Government policy objectives

The transition to zero emission buses is aligned with NSW and Federal Government policy objectives and strategies, including:



### NSW's Net Zero Emissions Plan

Outlines a mandate and pathway to net zero emissions, including the TfNSW bus fleet and operations.



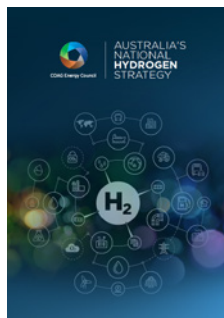
### TfNSW Future Transport Technology Roadmap

The ZEB transition can help enable or accelerate many elements of the TfNSW Future Transport Technology Roadmap and form the foundation for more sustainable and connected buses, including emerging modes (electric and hydrogen) using intelligent systems, intelligent sensors and real-time digital twins.



### TfNSW Future Transport Strategy 2056

The Future Transport 2056 Strategy is focused on six key principles for the future of mobility in the state, which together aim to positively impact the economy, communities and environment of NSW. The ZEB transition will help deliver this vision for more sustainable and customer focused transport.



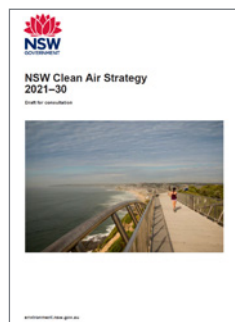
### Australia's National Hydrogen Strategy

Aims to position Australia as a top hydrogen exporter and develop a hydrogen supply chain that could enable ZEBs.



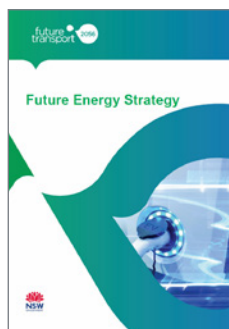
### NSW Hydrogen Strategy

Currently under development - will aim to grow a commercial clean hydrogen economy in NSW.



### NSW Clean Air Strategy

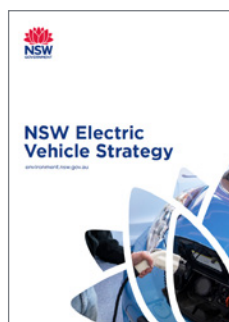
Aims to progress policies and incentives to increase uptake of zero and low exhaust emission vehicles, which the ZEB roll-out will support.



### TfNSW Future Energy Strategy

Identifies the transition to zero emission public transport powered by renewable energy as a priority area for action.

As the metropolitan rail network is largely electrified, the ZEB transition is the only major capital program identified in the Future Energy Strategy with the potential to significantly reduce TfNSW emissions.



### NSW Electric Vehicle Strategy

The NSW Electric Vehicle Strategy outlines the NSW Government's commitments to increasing the uptake of electric vehicles in New South Wales.

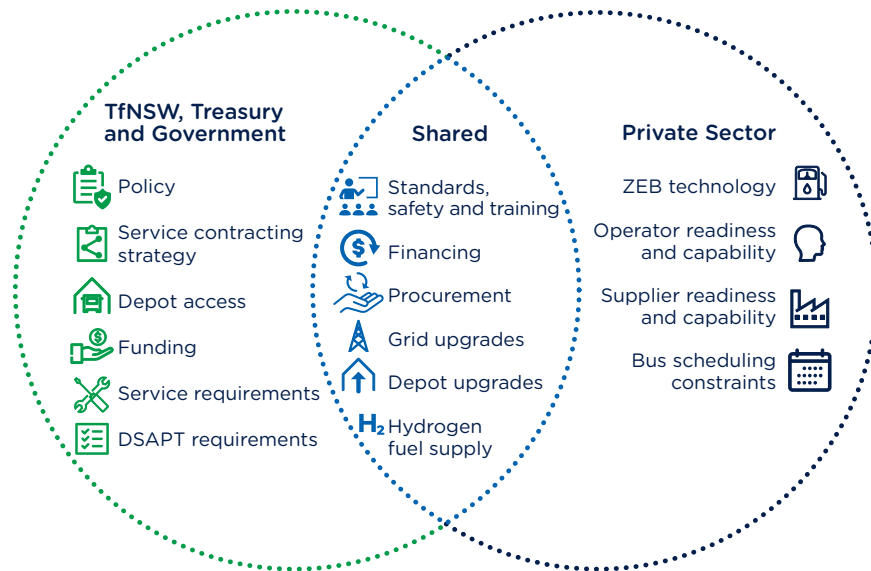
The Strategy includes a \$490 million package of new incentives, tax cuts and spending on new fast-charging infrastructure for electric vehicles.

# 3. Key considerations





There are a range of factors that drive, influence or otherwise impact the ZEB transition strategy. This section considers the most important factors that TfNSW, operators and industry partners will need to consider to meet the transition challenge.



### 3.1 Diversity of operating environments

The transition approach needs to cater for the diverse range of geographies and operating requirements which buses currently serve across NSW. Further, the transition needs to consider the local operating environment including road conditions, vehicle operating speeds, weather and environmental factors as well as the ability for infrastructure to support the selected ZEB technology.

As effectively servicing customer needs is a primary goal of bus operations, service reliability including having established electrical or hydrogen refuelling infrastructure as well as the supporting ecosystem of training, maintenance and repairers will be essential before some operations are able to transition. For this reason the transition approach prioritises operations that are better suited to current technology while working with operators and industry partners to develop solutions which will be suitable for our more challenging operating requirements in the latter stages of the transition.

NSW bus and coach operations can be broadly characterised by the following operating environments.

#### Metropolitan (Greater Sydney)

- > Predominantly metropolitan route, school and On Demand services, with wide hours of operation
- > Operating predominantly in city environments, sealed suburban streets and some high speed motorway corridors
- > Operators are typically larger international and local businesses
- > Depot sizes around 30-300+ buses, with the majority of depots having 100 or more buses
- > Average operating ranges of around 65,000km+ per year per bus
- > Predominantly standard two door city buses with mix of midi, articulated and double decker buses

### Outer metropolitan

- > Similar operating characteristics to Greater Sydney, with metropolitan route, school and On Demand services
- > Operating predominantly in city and large town environments, on sealed suburban streets and some high speed highway corridors
- > Operators are typically larger international and local businesses, with some smaller family owned operations
- > Depot sizes around 10-150 buses, with the majority of depots having 50 or less buses
- > Average operating ranges of around 60,000km+ per year per bus
- > Fleet varies and is predominantly standard one door urban buses

### Regional cities

- > Predominantly school services and town services with more limited hours of operation
- > Operating predominantly in regional city environments, on sealed suburban streets and some high speed highway corridors
- > Operators are typically larger local businesses and smaller family owned operations
- > Depot sizes around 45+ buses
- > Fleet varies and is predominantly standard one door urban buses and school buses

### Regional remote

- > Predominantly school services and town services with limited hours of operation
- > Operating predominantly in regional town environments, on sealed suburban streets, unsealed rural roads and high speed highway corridors
- > Operators are typically smaller family owned operations
- > Depot sizes around 1-10+ buses with the majority in depots with two or fewer buses
- > Fleet varies and is predominantly smaller format vehicles and school buses

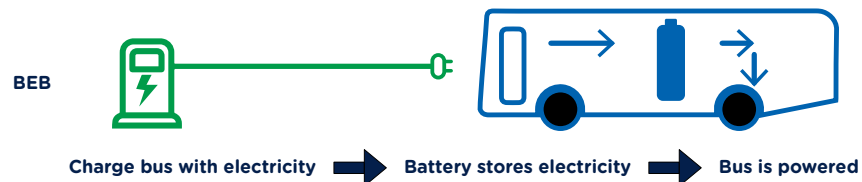
### Regional coach services

- > Timetabled regional coach services support inter and intrastate train services between major regional and metropolitan locations. Significant operating requirements including regular round-trip routes of around 500-1000km+
- > Operated by larger local businesses and smaller family owned operations on behalf of NSW TrainLink
- > Around 100 coaches distributed between around 20 depots
- > Average operating ranges of around 70,000km+ per year per coach
- > Predominantly 42 seat coaches with some smaller format (18-32 seat) vehicles

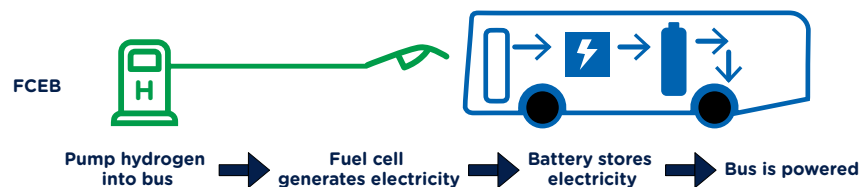
### 3.2 Technology: Battery electric vs. Hydrogen fuel cell electric

To deliver on the objective of net zero emissions, the transition needs to focus on advanced and emerging technologies, such as battery electric buses and hydrogen fuel cell electric buses.

Battery electric buses (BEBs) transfer energy to the vehicle via electric charging systems and store their energy in an on-board battery which is used to power the motors.



Instead of charging directly from the power grid, hydrogen fuel cell electric buses (FCEBs) store hydrogen in on-board tanks and use a chemical reaction between hydrogen and ambient oxygen to create electricity, which is stored in a battery and used to power the motors.



Battery technology has developed rapidly in recent years and BEBs have become both commercially viable and suitable for an estimated 80-90 per cent of uses in NSW. Hydrogen FCEB technology is emerging rapidly and should be a focus for scaled trials to support industry development but is unlikely to be cost competitive for wide scale transition for 5-10 years.

The transition will need to begin with a focus on BEBs as they are the only mature technology available at scale that can support a net zero transition in the immediate term. The rapid evolution of ZEB technology requires close monitoring and updating of this strategy in response to material changes in technology maturity and commercial viability.

Interoperability of technologies is also a critical part of this transition, and TfNSW will work closely with industry to establish performance requirements for buses and depot infrastructure to maximise flexibility, minimise cost and reduce longer term technology obsolescence risks.

While the transition will need to begin with BEBs, scaled trials of hydrogen FCEBs will be encouraged to build industry readiness for potential larger deployments beyond 2025. In the years ahead, hydrogen FCEBs may become the preferred choice for many operators, particularly in rural and regional areas. The commercial viability of hydrogen FCEBs will be reassessed throughout the transition through outcomes from trials and developments in the Australian hydrogen industry.

The ZEB transition is well placed to support broader Australian efforts to develop a hydrogen industry with supporting infrastructure and established supply chains. A commercially mature clean hydrogen industry will be critical to driving deep decarbonisation of NSW's transport sector and broader economy, as well as remaining competitive in decarbonised global markets. Developing a clean hydrogen industry could position NSW to capture the significant long-term opportunities in the manufacturing and export of hydrogen and hydrogen-based products. Hydrogen "hubs" are in planning and would support FCEB trials and the scale-up of the technology.

#### NSW Hydrogen Strategy - Currently under development

The NSW Hydrogen Strategy will set out the NSW Government's policy framework to support the development of a commercial clean hydrogen economy in NSW. Among a range of policy measures, the NSW Hydrogen Strategy will include the Government's hydrogen hub initiative, which will be supported by at least \$70 million of funding under the Net Zero Industry and Innovation Program. The hubs will help establish the foundational infrastructure, supply chains, knowledge and skills to enable rapid scaling of clean hydrogen industries in NSW.



### 3.3 Infrastructure requirements: A focus on electrical grid and depot upgrades

The ZEB transition will require investment in a range of supporting infrastructure upgrades which are critical in enabling scaled and reliable operations.

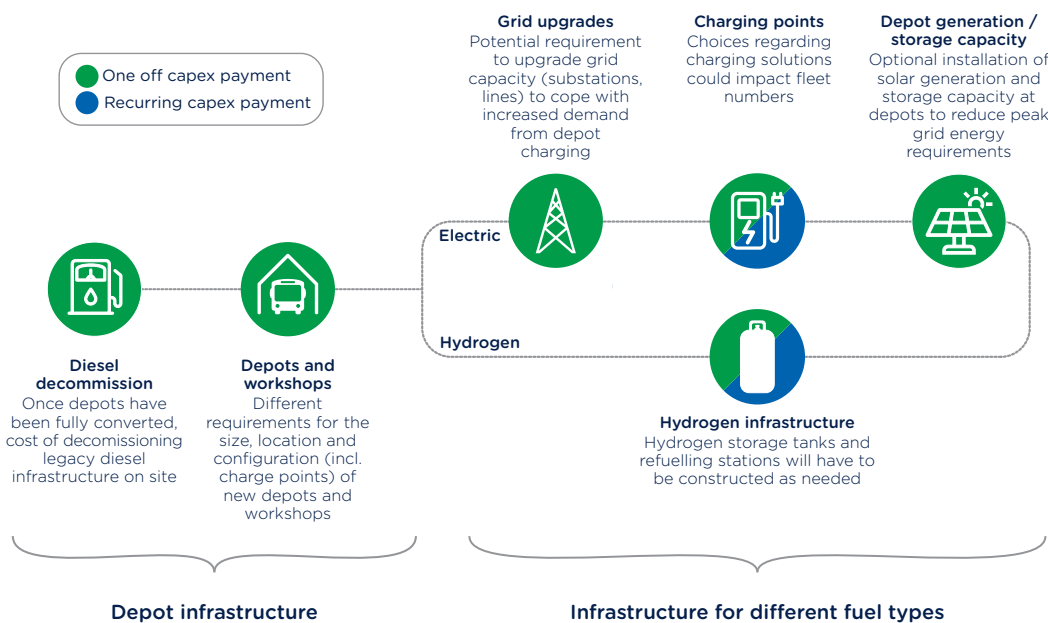
Two of the most significant infrastructure upgrades will be to the electrical grid and the individual bus depots. The long lead-times of such upgrades may limit the speed of transition if not considered and addressed in advance.

Depots that are smaller or more remote may experience greater challenges around access to electricity due to the distance from substations, longer lead-times for electrical upgrades and higher relative costs to upgrade both grid and depot infrastructure (e.g. small depots with few buses may face higher costs on a per-bus basis than larger depots in higher-population areas).

Transitioning depots provides significant development opportunities and greater placemaking outcomes for the community. However, BEBs may require more space than diesel buses to accommodate charging infrastructure, meaning that some depots may need to be redesigned, expanded, relocated or secondary sites may need to be established before they can fully transition.

TfNSW is undertaking technical analysis on depot design and electrical infrastructure requirements including electrical grid upgrades and will work closely with operators to support any required depot transitions. TfNSW will also work closely with operators, manufacturers, industry partners and other state jurisdictions to consider appropriate fleet and infrastructure performance specifications to maximise fleet interoperability and consistency across the Australian market.

#### Key infrastructure requirements of ZEBs



Source: L.E.K. research and analysis

### 3.4 Supply of ZEBs

Transitioning the bus fleet by 2030 requires vehicles to be replaced at approximately three times the natural replacement rate.

A 2030 transition would require peak deliveries of around 1200-1300 buses per year in later years of the transition period, creating a significant shift in the demand for new buses in NSW.

At present, Chinese manufacturers are the largest producers of BEBs, but European and Australian manufacturers are moving quickly to produce competitive BEBs. Local Australian manufacturers have commenced taking orders for vehicles and have indicated that they can re-tool to produce BEBs and ramp-up production capacity to meet local demand over the coming decade.

The transition presents both challenges and opportunities for bus manufacturers and supply chains:

### Opportunities

- > The scale of new bus orders will be a major near-term stimulus to the Australian bus manufacturing industry, driving job creation and higher levels of economic activity.
- > The scale of ZEB orders should allow Australian manufacturers to invest in upgrading capabilities and expanding offerings. Historically, Australian manufacturers have largely been assemblers and body-builders, with key components imported from overseas. This presents an opportunity for Australian manufacturers to make more components domestically and - if successful - to export these products and capabilities beyond the NSW ZEB market.
- > There are also opportunities for new local and international entrants into the market, potentially seeding greater investment into local supply chains, complimenting existing industries and supporting local technology research and development.

### Challenges

- > The first challenge is that the supply of ZEBs will need to ramp-up rapidly - both domestically and overseas - which may put strain on local manufacturers. Manufacturers will need as much visibility as possible (from TfNSW and operators) on the pipeline and timing of orders for each fleet type.
- > The second challenge is that Australian manufacturers may face a local “demand cliff” at the end of the transition (by 2030) as demand drops to only “growth” requirements (e.g. around 50 buses per annum state-wide to accommodate growth in public transport). As the entire NSW fleet will have turned over in around 10 years, rather than over the full asset life of a typical bus which is up to 25 years, this cycle of “rapid ramp-up” and “demand cliff” is set to repeat itself as the first generation of ZEBs reach end-of-life. As a result, local manufacturers may need to look beyond NSW to other markets including interstate and overseas, diversify manufacturing and product range to include other vehicle types or face periods of ramping-up and ramping-down production, with likely reduced demand for around 10 to 15 years between replacement cycles.

## 3.5 Contracting

The transition to zero emission buses will not occur in isolation and the role of operators will continue to focus on the safe and customer-focused delivery of transport services for the community.

While current service contracts developed for diesel operations provide opportunities for zero emission bus deployments, future re-contracting activities will focus on developing a contractual foundation which is fit for purpose for large scale zero emission bus operations.

NSW holds approximately 700 service contracts which are renewed in cycles as they approach expiry. These natural re-contracting points offer an opportunity to work with operators to build an effective contractual foundation for the transition which appropriately addresses the changing cost and risk profiles of newer technology and supporting infrastructure.

#### Bus Pipeline Procurement

We are already seeking large scale ZEB submissions through the Greater Sydney Bus Services pipeline procurement, for example the Region 8 Bus Services contract soon to commence operations in Sydney’s north will deliver a minimum of 125 ZEBs over the eight year contract term, setting a strong basis for full fleet transition.

# 4. Transition strategy





## 4.1 Summary

### Commitment to transition the fleet to 'Net Zero'

TfNSW cannot meet its net zero commitments by 2050 without transitioning the bus fleet to net zero emissions. We are committed to transitioning the state's bus fleet to zero emission vehicles, powered by renewable energy, and will work closely with operators and industry partners to make this transition a reality.

### Our approach to responding to the 2030 challenge

The Transition Strategy sets out an approach to respond to the challenge of transitioning the NSW bus fleet to net zero by 2030.

It also recognises the potential challenges inherent in such an accelerated transition across diverse operating environments and includes the opportunity to pivot the transition in response to technology changes, emerging trends and learnings to ensure the transition is optimised.

Regardless of the transition target year TfNSW and its partners will need to move quickly and commence a range of activity streams in parallel

Activity Stream



## 4.2 Transition sequencing and roll-out principles

The ZEB roll-out will need to progress across all geographies in parallel and ramp-up quickly to meet the 2030 challenge. Key guiding principles of the transition are:

### Roll-out will need to occur in parallel across all areas of the state

In Metro areas, the transition will prioritise contract regions where TfNSW has long-term access to key depots and bus fleets are relatively standardised.

In Outer Metro and Regional areas, the transition will prioritise operations that are best suited to current BEB technology (e.g. bus range, proximity of depot to electricity substation) and required bus types (e.g. city-style buses versus smaller vehicles), as well as operator willingness to opt in for transition.

Due to the current fleet availability and variations of operating requirements in Regional areas, it is likely the first delivery phase will be weighted towards transitioning Metropolitan areas, with a heavier focus on Regional contract areas in the latter years following learnings from trials, initial Regional deployments and a strategic review of emerging technologies.

The strategy allows for the transition of whole depots, so that newer and less polluting diesel buses displaced in one depot can be transferred to facilitate the early retirement of older and more polluting diesel buses in another depot prior to the full transition of the fleet.

### Ramp-up will require many activities to run in parallel and will focus on building industry readiness prior to a 2023 acceleration point

The first two years of transition (2021-22 calendar years) will focus on short term replacement opportunities aimed at meeting natural fleet replacement needs, and depots where TfNSW has long term access rights will be prioritised.

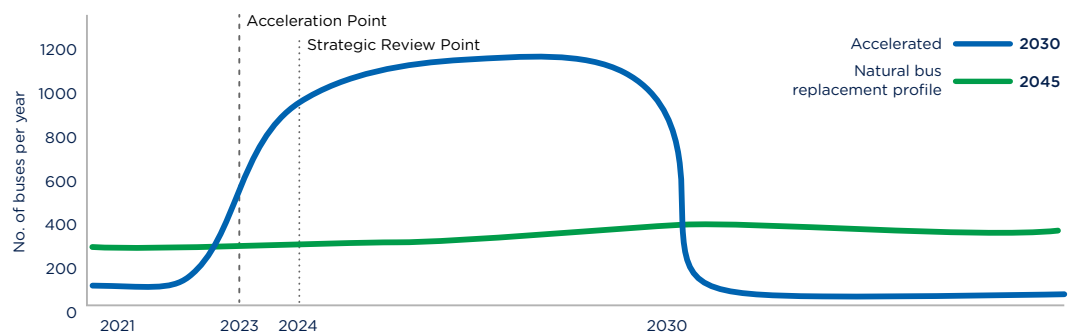
In circumstances where ZEBs are not able to be deployed to meet short term replacement requirements TfNSW may work with operators to explore short term life extensions to existing diesel buses.

In Regional NSW, vehicles required to meet commitments under the Seatbelt Program will be replaced with diesel buses. TfNSW will explore options to avoid the purchase of further diesel vehicles where appropriate and where fleet types are available.

## Peak deliveries and transition completion date

Meeting a 2030 transition will require peak deliveries of around 1200-1300 buses p.a. in later years. This would provide new opportunity for suppliers and economic development, however it may also put strain on manufacturers and potentially result in a significant downfall of annual deliveries after 2030 if other markets don't provide new demand.

The following graph shows indicative supply requirements per year to meet a 2030 transition compared with the natural fleet replacement profile. The approach includes lower numbers in the early years and a progressive ramp up to allow industry and operators to prepare for accelerated deployments following 2023. This indicative demand curve has been provided to seek feedback on the transition approach and will be further refined during business case development and technical planning activities.



### Key

- 1 Engage key partners and support industry readiness activities
- 2 Pursue 'no regrets' enabling activities to provide foundation for full transition
- 3 Deliver a first phase, followed by strategic review
- 4 Deliver at scale to target (from 2024) and move to business as usual

### Next steps

In line with the approach outlined in this Transition Strategy, TfNSW will commence the activity streams to build readiness for scaled transition across the state. A focus will be placed on the following next steps and milestones:

- > Completing business cases and technical planning activities
- > Progressing re-contracting activities
- > Planning grid upgrades to TfNSW owned depots
- > Developing Regional small format bus trials
- > Developing scaled hydrogen FCEB trials in partnership with DPIE
- > Progressing the replacement of diesel buses with ZEBs through end-of-life fleet replacement programs
- > Continuing industry engagement and industry readiness activities



# 5. Outcomes





TfNSW is committed to transition our bus fleet to ZEBs to realise a number of environmental, economic and operational outcomes, along with delivering more comfortable journeys for customers.

The transition also has potential to support the development of the NSW Future Mobility Ecosystem with the strengthening of local skills, capabilities and capacity to deliver zero emission transport outcomes across other parts of the transport sector into the future. This will ultimately support freight, commercial and private vehicle fleets to transition towards net zero emissions and enable NSW to capture the economic, environmental and community outcomes associated with a more sustainable transport system.

The transition to ZEBs will realise a number of direct outcomes including:

- > Environmental and health benefits from reduced emissions and improved air quality
- > Economic benefits from a boost to the NSW economy, jobs and regional industry development
- > Lower noise pollution, especially in high transit urban areas
- > Skills growth in emerging technology research and development, manufacturing and deployment
- > Improved urban amenity around bus depots and transport corridors
- > Improve efficiency and safety on our roads by integrating smarter technology for bus operations
- > Greater financial sustainability from lower operating costs compared to diesel buses

## 5.1 Accelerating benefits

An accelerated transition will have challenges and risks, but also bring forward environmental and public amenity benefits and provide a significant stimulus to the industry.

A faster transition will drive an earlier reduction in greenhouse gas emissions and therefore increased environmental and health benefits for the community. The transition will also enable an earlier realisation of public amenity benefits, including quieter city streets, better air quality and more comfortable journeys. However, a faster transition also comes at a higher up-front capital cost with greater demand on operators and bus manufacturers, as well as greater technology uncertainty.

A slower transition would result in later realisation of emissions reductions, decreased environmental and health benefits, as well as delayed delivery of customer and public amenity benefits. In addition, a transition that is too slow may not sufficiently encourage investment in ZEB technology, renewable resource production and the local bus manufacturing ecosystem. However, a slower transition would also reduce strain on operators and manufacturers, reduce technology uncertainty, create a smaller drop in demand following the completion of the transition, and incur lower up-front capital costs.

## 5.2 Mitigating transition risks

While there are significant benefits to an accelerated transition there are also a number of risks and considerations that need to be managed.

The strategy and enabling work streams have been designed to mitigate these risks and include a strategic review in 2024 to assess opportunities to further optimise the transition approach.



Risks	Mitigations
Electricity Grid upgrades	TfNSW will continue to engage with electricity network suppliers and allow for time prior to an accelerated transition for key enabling works to be delivered at priority depots.
Depot upgrades / constraints	<p>TfNSW will work closely with operators to consider appropriate depot sites and requirements for transition.</p> <p>Technical planning activities will develop depot benchmark designs as well as fleet and infrastructure performance specifications.</p>
Supply of ZEBs	<p>TfNSW will provide early clarity over scale and timing of transition activities and engage regularly with industry partners.</p> <p>To support the required supply of vehicles and associated technology, TfNSW will continue working to develop the NSW Future Mobility Ecosystem and pursue investment attraction opportunities to support the growth of existing businesses and bring new capacity and capabilities into NSW.</p>
Operator readiness	TfNSW will actively engage operators and provide support with information and guidance throughout the transition. The strategy prioritises the transition of operators that demonstrate a willingness and capability to transition in earlier years.
Contracting and ensuring appropriate contestability	TfNSW will leverage natural recontracting events to set contractual foundations for transition. Contracts will include appropriate risk sharing and flexibility to support ZEB operations. A priority will be placed on securing long-term access rights to key depots if significant financial investment is required to establish the required infrastructure.
Technology	<p>TfNSW is aware of over-investing in a particular technology in early years and will work with operators and industry partners to establish fleet and infrastructure performance specifications which minimise future interoperability and technology obsolescence risks.</p> <p>TfNSW will also conduct trials of emerging technologies and monitor technology development throughout the transition.</p>
NSW Demand 'cliff'	TfNSW will provide clarity on orders, support industry efforts to secure a longer-term pipeline of sales and consider industry feedback in transition implementation planning. TfNSW will also work with manufacturers to consider opportunities in other local and international markets as well as the potential to diversify manufacturing to supply freight and other sectors as they transition to zero emission vehicle technologies.

Risks	Mitigations
Service continuity	Providing safe and reliable services to customers will remain our primary focus. TfNSW will work with operators, hydrogen supply chains and electricity network providers to invest in grid redundancies and develop back-up plans in the case of major disasters (e.g. widespread bushfires or long-lasting blackouts).
Diversity of regions	TfNSW will work with regional operators and industry partners to ensure appropriate technology is available to meet the specific operating requirements across regional NSW. The strategy sets out an approach to start with major regional cities, followed by larger regional depots with an opt-in approach for remaining depots as technology becomes more suitable.

# 6. Consultation and industry engagement





## Feedback, consultation and industry engagement

TfNSW recognises that the transition will need to be delivered in strong partnership with industry and welcomes feedback on all elements of the transition strategy.

In particular, feedback is sought on:

- > Transition timelines and sequencing
- > Operational and fleet diversity considerations
- > Funding and financing
- > Zero Emission Bus supplier capacity and capabilities
- > Risks and interdependencies
- > Training and support considerations
- > Short term fleet replacement opportunities

## Technical planning and performance requirements development

Detailed work has commenced on depot design benchmarking, power studies and design performance requirements for fleet, depots and supporting infrastructure. The next phase of this work involves working with industry to seek input and feedback.

## Commitment to collaboration

The transition to zero emission buses provides significant benefits and opportunities. TfNSW is committed to working in partnership with industry to deliver sustainable and customer focused outcomes for our community.

TfNSW has commenced work on the no regrets enabling activities and will continue working with operators and industry partners to commence the transition and deliver the approach set out in this strategy.

To provide feedback or get in touch with the project team, please contact [zeroemissionbuses@transport.nsw.gov.au](mailto:zeroemissionbuses@transport.nsw.gov.au)

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