

**Submission  
No 27**

**ELECTRIC BUSES IN REGIONAL AND METROPOLITAN PUBLIC  
TRANSPORT NETWORKS IN NSW**

**Organisation:** Electromotiv

**Date Received:** 20 December 2019



*Renewable Transport Today*

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

## Executive Summary

Electromotiv is a Canberra based, Australian owned company delivering Green, reliable and low-risk, low cost renewable refilling stations.

We provide a zero emission direct diesel replacement solution (electric or hydrogen) as detailed in Appendix A – Electromotiv Brochure.

We completely support the transition to electric buses for regional and metropolitan transport networks. Electric buses are now clearly cheaper, have had successful NSW trials and have a range of bus options and manufacturers to choose from.

Electrical infrastructure upgrades are affordable on a bus-by-bus basis and companies such as Electromotiv are available to undertake the work.

In some instances, for very long routes in regional areas gas batteries (using hydrogen) could also be used on the electric buses (hydrogen and electric buses both have electric batteries and electric drive trains so are similar). Today in 2019 an electric bus is:

- the same price as a diesel bus (excluding the batteries)
- 10-15% cheaper to fuel than a diesel bus (including the batteries, renewable energy, on-site power and infrastructure upgrades)
- 60-80% cheaper for maintenance than a diesel bus

## 1. Benefits of electric buses and factors that limit their wider uptake

### Benefits:

- Emissions reduction
  - Electric buses have zero-tailpipe emissions
  - If connected with renewable power (rooftop PV, batteries, wind) only – net zero emissions – Electromotiv provide this with all contracts as standard
  - Each electric bus is equivalent of removing 23 cars from the road each year (Chicago Transit Authority, 2014), or an estimated 40 cars in NSW.
- Health benefits
  - Electric Vehicle Council (EVC) has concluded health benefits worth \$7,110 per IC engine vehicle in NSW annually for a 10-year lifetime (Electric Vehicle Council, 2019)
  - Chicago Transit Authority concluded a US\$ 55,000 annual savings in health benefits or US\$660,000 over a 12-year life span (Chicago Transit Authority, 2014)
  - We estimate \$58,450 and \$11,860 in health benefits per electric bus in NSW (see appendix 2 for working)
- Fuel, maintenance and total cost of ownership (TCO) savings
  - Travels between 1.2-2.3 km/kWh (GHD, 2014, Vepsäläinen et al., 2019)
  - Chicago Transit Authority: US\$25,000 annual savings in fuel (Chicago Transit Authority, 2014)

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- Nowra trial reports \$0.28/km for EB and \$0.42/km for diesel buses (Cotter, 2019)

NOTE: with government or larger scale pricing then this is reduced further; i.e. Electromotiv can help deliver substantially lower costs/km with large-scale pricing

- Not many moving parts or lubricated mechanical parts hence 50-80% lesser costs on maintenance over the lifetime (Aber, 2016, MišaŸović et al., 2018)
- TCO lower than diesel buses 18-23% over 20-year lifetime (Vepsäläinen et al., 2019)

Bus component	Diesel bus	Electric bus
Internal combustion engine	YES	No
Engine lube system	YES	No
Engine oil	YES	No
Oil filter	YES	No
Air filter	YES	No
Strap	YES	No
Engine cooler	YES	No
Antifreeze	YES	No
Intercooler	YES	No
Starter	YES	No
Turbocompresor	YES	No
Fuel injection system	YES	No
Fuel tank	YES	No
Fuel filter	YES	No
Exhaust system	YES	No
SCRT system	YES	No
AD-blue,	YES	No
Gear box	YES	No

Figure 1: Electric vs diesel bus components (MišaŸović et al., 2018)

- Economic benefits
  - Estimated 500 new jobs to be created through transition (Patterson, 2019)
    - Re-training of old skilled staff to adapt to new tech – curtailing job losses
    - University/ TAFE courses for new recruits/graduates
    - Construction, manufacturing, assembly of buses/infrastructure
  - Investment in regional and metropolitan NSW
  - Encourage more patronage, thus reducing traffic in metropolitan areas (Stephens, 2019)
  - NSW emissions targets achievable through electrification of PT (Roads and Maritime Services, 2019)
  - Learning experience for energy retailers and utilities for increase in load demand and management through peak/off-peak times
- Efficient, productive and sustainable
  - Quiet, smooth, comfortable, vibration-free, smell-free
  - Quick in acceleration and more torque over diesel

## *Renewable Transport Today*

- Can have multiple charging options – at depot, on the route and end of route
  - Making more trips
  - Higher patronage
  - Reliable and resilient
  - Showing up on time
- Innovative operational and financial models of ownership
  - Operators and transport authorities unsure about costs and reliability
  - Emerging businesses like Electromotiv offering operational lease model
    - Tackle high upfront costs
    - Risk-free warranted transition to electric
    - Packaged offering with bus, battery, infrastructure and energy supply lease
    - Easy \$/month or \$/km-based offering options
- Future scope
  - Inter-modal ops possible with integration through on-demand electric vans, light rail infrastructure could be used for charging
  - V2G technologies evolving to provide additional city/regional battery storage through bus batteries for demand response

### Limiting factors:

- Policy and lack of incentives
  - Lack of a mandate for operators to make the switch
  - No policy-based direction for emissions reduction or fleet replacement
  - High upfront costs but no incentives/subsidies in place for manufacture locally, thus lesser uptake
  - Not many manufacturers offering buses for Australian conditions/requirements due to unavailability of market
  - Electromotiv removes this barrier by allowing a direct diesel replacement with a full refilling station (battery lease, infrastructure lease and upgrade, renewable energy for under the price of diesel (around 42c/km currently)
- Infrastructure costs and concerns
  - New tech – utilities and operators unsure and unaware of costs and long-term returns
  - High upfront infrastructure and bus purchase costs
  - Ambiguity around battery life span and high costs of battery replacement
  - Electromotiv removes these issues by providing 20 year warranties, leasing, replacement and spreading costs along the life of the infrastructure

## 2. Minimum energy and infrastructure requirements to power electric bus fleet

- Electromotiv's estimates are based on our current projects in Australia/New Zealand
  - 100 – 1000 MWh annual energy requirements for a fleet of 5-100 electric buses (based on Cavbus - QLD, GoBus - NZ and Redbus – NZ proposed estimates)
- New Flyer- a bus OEM estimates 150 MWh daily for a fleet of 300 buses to keep them charged fully at the depot (Marshall, 2019)
- Govt should work with utilities to provide priority processing of these connection/upgrade requests

Electromotiv as an independent refilling company is investigating charging for multiple operators at a park and ride site, reducing costs for infrastructure and charging where it is needed. Electromotiv's Australian partner – Inverted Power, provide a battery and charger solution to fast charge with reduced infrastructure upgrades. Infrastructure can be wrapped by operators.

We optimized the Brisbane Metro charger placement and infrastructure to reduce costs. Electromotiv staff have also deferred a \$25m zone substation on another project through local use of batteries saving \$0.5m-\$1m a year.

## 3. Other renewable, emissions neutral energy sources

- On-site solar
  - Reduced grid dependence
  - Can be coupled with battery storage on-site for cost effectiveness
- Battery integrated charging stations
  - Charging stations enabled with battery storage provide fast DC charging capabilities
  - On-board charger on buses can utilize the stored battery energy for charging thus depending less on the grid
  - Can provide storage for demand management
  - Can be used as a backup during blackouts and high network pricing hours
  - Used batteries put to use for second-life use till end of life
  - Are provided by Electromotiv to support roll out and defer upgrade of depot infrastructure

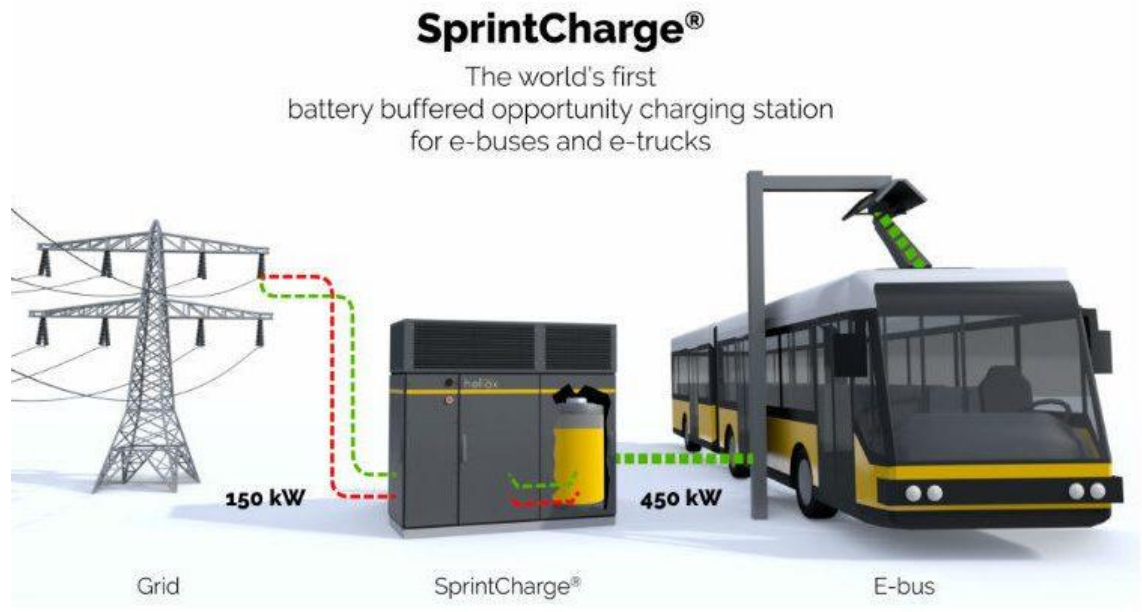


Figure 2: Heliox -IP Sprint charge battery integrated charging station (Image source: <https://www.newmobility.global/smart-infrastructure/heliox-showcase-sprintcharge-busworld/>)

- Wholesale pricing RE purchase through innovative retail solutions
  - Market and business optimization to and save money on the infrastructure
  - Need non-utility operators in this space, to avoid expensive infrastructure
  - Energy contracts through retailers providing wholesale capped prices for a peace of mind energy pricing
  - Electromotiv provides this and is disrupting the energy retail space with Flow Power to reduce energy costs
- Hydrogen
  - Hydrogen fuel cell buses for Australia are not as advanced as Electric but will make sense for long-range trucks and some buses in the future
  - Hydrogen refilling stations at depots, gas bottle swap and storage options available (provided by Electromotiv)
  - Integration with Jemena's new electrolyzer in Sydney being installed by ANT Solutions, Electromotiv's partner
  - Upgrade option later. Leasing using Electromotiv model allows operators additional flexibility.

## 4. Ways to support manufacture and assembly of electric buses in NSW

- Electromotiv have been discussing local assembly of electric and hydrogen buses and trucks in Australia. For example, based on volume of orders (a min 100), manufacturers like Yutong and Volgren can set up an assembly factory
- An Australian manufacturer – ARCC is already manufacturing in NSW producing electric, retrofit and hydrogen prototypes for the rapidly moving market
- Government and councils must initiate the by demonstrating a minimum level of demand thus encouraging OEMs to be willing to locate assembly onshore
- Governments should support the development of local assembly industries
  - to enable local assembly for when Australian-specific standards are required
  - to also meet local content procurement requirements
- Electromotiv would be interested in exploring assembly in south NSW (eg Queanbeyan) to support ACT, Defence and regional NSW jobs and services. This could be done in collaboration with operators such as Transit Systems. Electromotiv have worked with Volgren to deliver a Melbourne Electric bus (now in service in Victoria) and would be happy to assist further.

## 5. Experience with introducing electric bus fleets in other jurisdictions

- 425,000 electric buses exist worldwide, 90% of them are in China. 4000+ in Europe
- US projections to 5000 EBs by 2025
  - Seattle 2500 + buses to be electrified by 2030
- China projections 600,000 by 2025
  - 421,000 buses in China
  - 16,000 in Shenzhen alone <sup>1</sup>
- NZ – Auckland Transport bus trials and 2025 target for ZEBs
- Australia
  - ACT: 12-month Yutong bus trial with Electromotiv
  - NSW: Nowra trial with Premier Transport – Yutong
  - NSW: Sydney Transit Systems 6 bus trial – BYD and Yutong
  - ACT: 2016 electric bus trial – Carbridge Toro
  - QLD: Cavbus Yarabilba development
  - QLD: Carins Tropical Wings – Yutong
  - VIC: Transdev operating 1 BYD-Volgren

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<sup>1</sup> <https://www.scmp.com/business/china-business/article/2169709/shenzhens-all-electric-bus-fleet-worlds-first-comes-massive>

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

- Opportunities
  - Emissions reduction
  - Costs savings: fuel, maintenance, TCO
  - Economic and health benefits
  - Risk-free operational and innovative ownership models
  - Private sector - Govt partnership
  - Inter-modal transit options can be integrated seamlessly
  - NSW state leadership
  - Bus operators to be able to sustain their business in longer run
- Challenges
  - Upfront costs
  - Technology not mature enough for Australia
  - Technology ambiguity – electric or hydrogen or a mix of both
  - Embodied carbon/emissions – buses, batteries infrastructure etc.
  - Limited end of life battery recycling options/facilities
  - Limited technical know-how
  - Limited equipment manufacturer options
  - Grid operator – bus operator – Govt relationship is complex; need a mediator like Electromotiv

## 7. Any other related matters

- Electromotiv leased out a fully-electric Yutong bus, battery, charging infrastructure for a 12-month trial to ACT government
- Partners with HESS-Volgren-ABB for Brisbane Metro delivery
- Actively involved in New Zealand delivery
- Renewable refilling stations provider both electric and hydrogen
  - Lower upfront costs
  - De-risking the transition to ZEBs
  - Package a monthly lease based on annual km for bus, infra and energy supply delivery
- Electromotiv would be happy to partner / support NSW government in their role out of electric buses and maximize local benefits and jobs. We do not believe there are any remaining barriers that need stop this transition happening immediately and quickly with the fleet replacement and growth.

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## 9. References

Appendix A - Electromotiv Brochure

Appendix B - working

Numbers based on Census data, Motor Vehicle Census 2019 and EVC report on Cleaner air for NSW

Assumptions:

- a. 1 electric bus removes 40 private vehicles from the road<sup>1</sup>
- b. 1 electric bus replaces 1 diesel or CNG bus
- c. Total 41 IC engines removed (averaged emissions)

*Table 1: Population, vehicle and emissions data*

	NSW
# ICE vehicles	4,840,000
Population	7,992,000
	Costs
Noise	\$ 1,400,000,000
Air	\$ 6,900,000,000
Noise costs /vehicle 10-year lifetime	\$ 2,892.56
Noise costs/capita/year	\$ 175.18
Air costs/vehicle 10-year lifetime	\$ 14,256.20
Air costs/capita/year	\$ 863.36
Average DB Emissions per person (g/C	17
Average emissions for 40 passengers/	680
Average bus km/year	80,000
Average DB Emissions per year (tonne	54.4
AU \$/tonne CO2e price	\$ 73
CO2e emissions price/year	\$ 3,958

*Table 2: Net health benefits annually per electric bus*

Noise Pollution health benefits annual per bus	\$ 11,860
Air pollution health benefits annual per bus	\$ 58,450

<sup>1</sup> <http://bic.asn.au/information-for-moving-people/climate-change-and-public-transport>



**ELECTROMOTIV**

**Green, reliable and low-risk**

*Turnkey electric charging solutions*

# *Australia's first turnkey electric charging provider*

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Electromotiv was founded in 2017 in response to a revolution.

That revolution will bring about a new era in transport technology – it will change forever the very energy sources we use to power transport.

Yesterday petrol, diesel and gas reigned supreme; tomorrow we will almost exclusively use renewable energy such as green electricity and hydrogen to fuel our vehicles. This is no longer an ambition or a hope – it's an inevitability.

## **Tomorrow's technology today**

Soon, green technology will dominate in the same way fossil fuels did last century. That moment is still in the future, but those who provide bus services – operators, governments and manufacturers – can join this revolution today.

Investing in high-quality electric vehicles is possible right now. Electromotiv makes certain that the charging system on which these vehicles rely can be cleaner, more reliable and more cost effective than it's ever been before.

In fact, today, running an electric bus is **less expensive than running a diesel or even a hybrid**. We guarantee it.

# What we do and who we do it with

Electromotiv partners with organisations like yours: those responsible for providing bus services. We help you to:

1. Plan for the transition from old bus technology to zero-emission technology
2. Establish an electric (and hydrogen) bus network: batteries, hydrogen fuel cells, battery-fuel cell hybrids, charging infrastructure and zero-emission energy generation
3. Maintain that network

We deliver substantial savings compared with diesel technology, as well as fixed costs, removing risk and uncertainty from the shift to electric technology.

We describe ourselves as 'bus agnostics'. We don't prefer one manufacturer over another. Instead, we've built the expertise to make certain that your electric (or hydrogen) system is seamless, no matter your vehicle choice, your route features or your location.

## Our partners

We are experts in making sure that your electric vehicle (or fleet of electric vehicles) works seamlessly with the grid. But we can't provide this without the expertise of others. That's why we've built a team of companies at the vanguard of zero-emission power and charging technology capable of delivering what your fleet needs:



InvertedPower is an Australian technology company that specialises in electric batteries and charging infrastructure.



Flow Power is an Australian electricity retailer that allows businesses to buy power direct from the wholesale energy market.



InductEV specialises in developing high-quality custom electric vehicle technologies, including electric bus motors, battery management, custom chargers, driver feedback systems, DCDC converters, as well as battery and system designs.



Swiss company ABB is one of the world's greatest innovators in the discipline of electrical engineering. They have invented world-changing technology and are pioneers in the field of charging infrastructure for public transport.



Heliox is a global infrastructure company based in the Netherlands. They specialise in fast charge systems for public transport.



ANT is an Australian company whose expertise lies in hydrogen energy systems. ANT produces and utilises green hydrogen from water through the use of renewable energy.



## How our service works

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When we partner with organisations like yours, our central goal is to remove the risk from your transition to electric technology. From then on, we aim to make maintenance of the electric vehicle system as predictable and dependable as possible. We provide:

### The charging infrastructure

Every bus network is different, and Electromotiv will work with you to determine exactly what charging infrastructure you need to meet your individual needs.

We build (or upgrade) the infrastructure which you can lease from us – whether it be charging stations along a route, charging terminals at the end of a route, charging structures at your depot, or any combination.

We make sure the infrastructure is ready for your future fleet, and our flexible agreements mean you get your infrastructure upgraded when you need it, letting you focus on your vehicles.

### The battery

Technology in the area is advancing rapidly, but batteries don't yet last as long as high-quality buses. That makes outright ownership an off-putting

expense for some operators. It's why we offer long-term battery leases.

You pay a flat monthly rate, or a straightforward dollar-per-kilometre charge, and we simply install a new battery into the bus when the old one reaches between 80 and 70 percent of its capacity. That's when it becomes less useful in a vehicle; it's still extremely useful in many other situations, however.

We'll reuse the old bus batteries in the system, enabling more and cheaper electric bus chargers – that allows us to speed up the transition to zero emissions. We can use them at your depot, as well, enabling you to use the grid outside peak periods, when energy is less expensive.

Once they've finally reached around 10 percent of their capacity we recycle them, closing the loop.

### The energy

Our low-cost fuel sourcing allows us to provide you with low-cost renewable energy to power your bus network.

# What you get from our turnkey service

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Electromotiv provides you with precisely the combination of services, infrastructure and finance options to suit your requirements:



## The world's best charging infrastructure

Our relationships with global leaders in electric charging allow us to offer the very best charging stations available. And because we use international Combined Charging System standards, your choice isn't limited by plug types.



## Green, low-cost energy supply for buses

We can provide the energy that powers your network, offering zero-emission power at wholesale prices.



## Ability to create your own energy

By choosing to install batteries at your depot, you can reduce energy costs even further, combining grid power with power you generate on-site. We optimise your infrastructure, helping your to defer and often avoid costly upgrades.



## Battery financing and warranty extensions

Bus batteries are a big outright expense. By leasing them from Electromotiv, you avoid the outlay and remove the maintenance hassle. And we can extend the warranty up to 20 years.



## A completely closed loop

Once a battery comes to the end of its useable life on a bus, we can reuse it to support the electricity grid and reduce your energy costs. After it come to the end of its life, we recycle it.



## Vehicle support

We tailor solutions to your needs. Examples of the many additional services we offer include whole-of-bus leases, battery replacement or buyback options, hydrogen upgrades and optimisation analysis.

# *Radical simplicity*

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When we talk about electric vehicles, we're talking about complex technology that's relatively new to Australia.

We understand that the systems which make it work can seem complicated. With this in mind, we've designed our service, our pricing and our interactions with customers to be radically simple.

## **Designed for bus operators**

Our offers are designed with you in mind. We aren't interested in providing one-size-fits-all answers. Instead we aim to provide uncomplicated solutions that relate exactly to your particular circumstances.

## **Straightforward pricing**

We make our pricing easy to understand.

No hidden fees. No surprise fluctuations. No sudden changes due to energy price rises. You'll know exactly how much you can expect to pay each month and how much you can expect to save in comparison with previous-generation technology.



# A zero-emissions future

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Over the last few decades, electric vehicles have gone from far-off dream to mass market reality. Bus operators who stand still as the world turns to emission-free technology will be left behind.

Electromotiv provides a turnkey, low-risk solution that allows you to join the electric revolution.

## Why become an Electromotiv charging partner





# *Renewable Transport Today*

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