Submission No 25

ELECTRIC BUSES IN REGIONAL AND METROPOLITAN PUBLIC TRANSPORT NETWORKS IN NSW

Organisation: Toshiba

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Ms Robyn Preston, MP
Chair
Legislative Assembly Committee on Transport and Infrastructure
Parliament House
6 Macquarie Street
Sydney NSW 2000

Dear Ms Preston

Re: Electric buses in regional and metropolitan public transport networks in NSW

Thank you for the opportunity to make a submission to this inquiry. We make this submission with the objective of sharing our experiences and knowledge with the NSW parliament where wide scale deployment of electric buses is being considered with the aim of achieving the best possible community outcome. Please note that the views and opinions expressed in this submission are the views of Toshiba International Corporation and are made solely for the purposes outlined in the inquiry.

Toshiba International Corporation Pty Ltd has a relevant background and knowledge in the subject matter. In particular we point out that Toshiba has

- developed leading edge Li-ion battery technology (SCiB™) providing outstanding characteristics for energy storage applications such as electric buses.
- formed a dedicated team of experts for heavy electric vehicles based in Sydney, and invested more than 13,000 hours of research and development time since 2016, specifically on the viable application of electric buses for Australia and Europe.
- performed in Sydney a successful distance endurance trial of a 12m electric bus in November 2018. Over 24 hour period, distance of 1,000 km in city conditions was achieved with uptime of 89.6%. This surpassed the typical range per day of 200 km to 350 km.
- developed a Super Fast Charger in Sydney capable of charging a 12m passenger electric bus within 10 -20 minutes.
- developed models to simulate electric bus fleet operation under Australian conditions.
- assisted Australian manufacturers and operators in readiness for electric bus introduction.

- developed in Australia, a 'Grid to eBus' solution designed for operators to support electric bus uptake and fleet conversion.

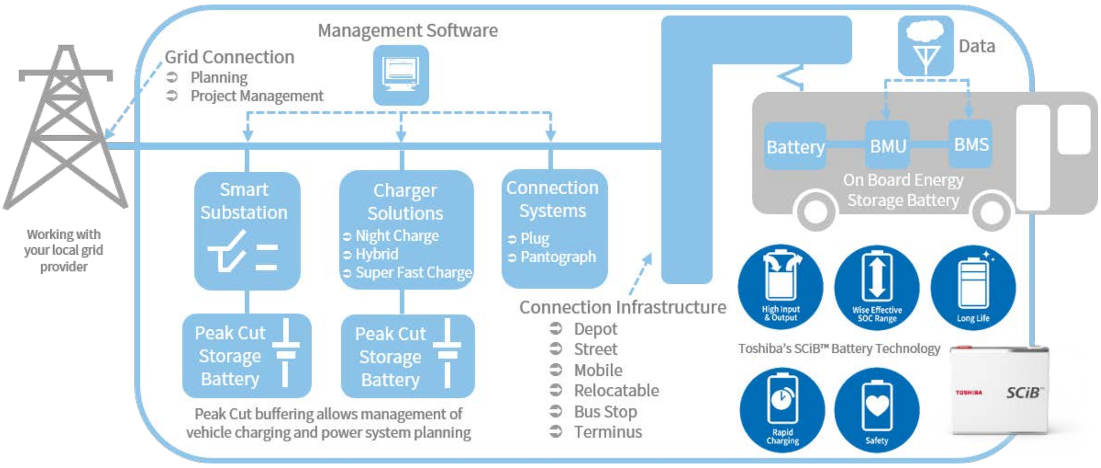

Figure 1 – Overview of Toshiba's capability of energy technology for electric buses (not including bus); 'Grid to eBus' solution

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

A) The main community benefits of electric buses are environmental, health and long term costs, as described below:

1.1 Environmental

1.1.1 Emissions

Our simulations show that there can be a significant reduction in harmful gases such as SOx, NOx and CO_2. About 50% reduction can be achieved by changing from diesel to electric buses, even if fossil fuels are partly used to make grid electricity. Emissions could possibly be reduced to zero if 100% certified renewable energy sources (such as solar or wind) are utilised for charging electric bus batteries.

1.1.2 Public perception of emissions

People are likely to notice much less fumes/smell, particulates and smog in areas of high bus intensity if electric buses were to be introduced.

1.1.3 Health

Whilst Toshiba is not an expert in health matters, we generally understand from public information that there are health benefits by reducing higher concentrations of particulates, emissions and noise through the use of electric buses.

1.1.4 Energy Usage

The energy (MJ/km) used by a 12m electric bus is equivalent to only about 40% of the energy consumed by a diesel bus. It is a fundamentally more efficient way to move people.

Interesting fact: unlike a Diesel or CNG bus, an electric bus can recover the braking energy when it slows down or stops, which recovers up to 30% of total energy.

1.1.5 Noise

Electric buses are significantly quieter (up to 10 dBA) than their diesel counterparts, making a much more pleasant journey for passengers, people near bus stops and along the roads. In one measured example, sound levels were reduced from 80-85 dBA to 72-75 dBA.

(It should be noted that 10dBA is a significant reduction from a human perspective, equivalent to a perceived halving in the sound.)

1.2 Cost

In the future, costs of electric bus fleets have the potential of lower 'operating life costs' even if capital costs are higher initially. This is likely to improve over the following years.

Whilst the full potential for cost saving is still emerging, it is our opinion, based on our studies over the last few years that electric buses are more cost effective than diesel if deployed in an efficient manner. The electric bus cost position could progressively improve if the social cost of carbon emissions were to be included in the analysis.

We would like to point out specifically that in circumstances of high interest rates and/or for situations with lack of credit availability, the large initial capital investment of an electric bus could be a less attractive option.

B) Factors that affect their wider uptake

Our understanding is that uptake of electric buses may not occur naturally in all situations as they generally have a higher initial investment and there is a need for industry to understand the new technology. Also, benefits are realised over the longer term.

We list below possible challenges affecting the wider uptake of electric buses in view of the fact that the NSW Government is considering a program to deploy a large fleet.

Challenge	Toshiba Comment / Observation
Justification of the higher capital cost of electric buses	As operating cost is lower, the total cost of ownership will be lower. Hence, long term evaluation should be used.
Uncertainty over magnitude of lower operating costs and future interest rates	Our careful modelling and referencing to the existing base of European experience indicates this should start to become less of an issue.
Perceived difficulty in obtaining the necessary grid connections at the charge points which usually require long term planning	Australia's electrical industry is mature and capable. We believe this challenge can be mitigated with long term planning. Difficult connection locations can be possibly managed better by the application of innovative charge solutions to enable smaller grid connections e.g. peak management solutions.

Clarity over government policy Australia does not seem to have a policy on avoiding carbon emissions from buses like other countries. In markets that do, their take up currently seems faster, e.g. Europe, China.	This may have been a factor in the past, however this is now changing in NSW. Policies such as Future Transport 2056 are important as the signals they send to industry influence preparation investment decisions and hence capability to deliver and support electric bus solutions to the reliability standards expected for public transport.
Uncertainty as to whether the duration of operating contracts will be sufficient to ensure the necessary planned return on investments	This can be considered in the structure of bus operating contracts.
Overreliance on overseas suppliers who could prioritise larger markets, resulting in lower priorities for Australian implementation	Encouraging local manufacturers could mean better and customised solutions for Australia.
Concerns relating to new technologies, for example: a) Range anxiety, b) Uncertainty of battery life time	Education around new technologies will ease concerns in many cases. Where there is a genuine issue, examples of innovative solutions are available: a) to eliminate day range anxiety, large power FFC (Frequent Fast Charge) technique b) long life battery chemistries are available

2. Minimum energy and infrastructure requirements to power electric bus fleets.

One challenge for the implementation of large numbers (4,000-8,000) of electric buses in NSW will be the electrical energy supply connection and charger infrastructure.

As a general guide, an electric bus depot for 200 electric buses would need a grid connection of about 10-15 MVA and that might typically need a 2-3 year implementation process. (Although this number could vary depending on the exact type of technology deployed.)

As this might represent a significant investment, it will be important to plan and deploy carefully. Locations of bus depots need to be more on 'long term location' thinking than shorter term, as grid connections cannot be easily moved.

In the case of the possible total fleet for NSW, it would seem that the deployment of 8,000 electric buses would not likely exceed 5% of the state's current power demand or 1.8 - 2.0 % of the state's energy (kWh) generation capacity. If deployed in line with the natural retirement of old buses in a structured way, the progressively increased load on the grid over 10 – 20 years should be manageable.

In addition to the charging infrastructure at the bus depots, the total system efficiency can be improved by careful deployment of a limited number of bus chargers in public spaces e.g. at bus layovers etc. This could reduce the total overall investment and dead running times on the network.

Despite the potential investment challenge for the grid connection and charger infrastructure, there is significant potential for overall energy bill reductions. Some of our simulations suggest electrical cost to be around 30-50% of the fuel cost of a diesel bus.

3. Other renewable, emissions neutral energy sources.

The electric bus fleet could be powered by the state grid (noting its trend of increasing renewables). This would have the benefit of reliability compared to a stand-alone energy system.

In the case of NSW, it would seem that the deployment of 8,000 electric buses would only need approximately 1.8 - 2.0% of the state's energy (kWh) generation capacity. So it would be highly possible to have energy sourced from 100% renewables.

Grid energy sources could be supplemented by embedded solar or new dedicated renewable power plants.

It is recognised that Hydrogen is one energy medium that may contribute to the overall solution in the future, however it appears that electric battery bus technology is currently more advanced for wide scale deployment. It should be noted that battery electric buses and Hydrogen fuel cell buses are not incompatible technologies. Hydrogen buses will still have batteries and electric drive systems.

Also, technologies for conversion of Hydrogen to electricity could be vehicle based or ground based (i.e. depot). For example, electric bus chargers powered by Hydrogen are possible. Therefore, the implementation of battery electric buses does not prohibit the utilisation of Hydrogen energy sources in the future.

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

To ensure a stable and sufficient yearly volume of electric buses, one suggestion would be to procure such quantities that industry and supply chain can make the necessary investments in local skills development, equipment and facilities.

It is our view as a general guide, more than 100 units p.a. per manufacturer would be needed to achieve the desired efficiency and economies of scale. Therefore in a competitive based economy, at least 3-5 manufacturers may be needed to reach yearly volumes of 300 – 500 units.

Given the goal of 8,000 electric buses, full deployment could take 15 to 25 years, creating a long term opportunity for Australian manufacturers.

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

Toshiba's experience allows us to observe other jurisdictions and we have the view that some jurisdictions have not implemented in any significant way, while others are now procuring in hundreds or more. The main motivation for implementation appears to be environmental.

NSW's path/direction would seem not to be first, but also not lagging in any way.

The major noteworthy comment to observe and learn from is that technology approaches for small test trials are not necessarily the most appropriate for larger operations. NSW could easily take into consideration prior learnings of other jurisdictions.

In most cases we recognise that the deployments have resulted in positive outcomes.

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

6.1 Opportunities

6.1.1 NSW has an opportunity to become a leading state for electric bus technology. With availability of good skills and given the size of the global electric bus market, NSW could take a position beyond just a technology user. Export possibilities exist for Australian companies.

6.1.2 As electric buses provide a significant improvement in users' experience, the opportunity would exist to increase the percentage of public transport users, thus reducing the dependency on cars and liquid fuels.

6.1.3 Electric buses may well provide a welcome load for renewable energy sources such as solar or wind. As the percentage of renewables increases on the grid, stability can be a challenging point unless there are grid friendly loads to use the energy at the time of production. Electric buses with smart battery chargers could allow a greater penetration of renewables.

6.1.4 The opportunity of transitioning the entire fleet to electric buses naturally represents a contribution to the environment in a more significant way.

6.1.5 An entire deployment may reduce transport interruption risk related to liquid fuel.

6.2 Challenges

6.2.1 The challenge for the entire deployment is that there might be some arduous routes that electric buses are challenged to easily match the performance of diesel (exceptionally long routes) or where very low km per year may be encountered. It is our belief that this could be scheduled later in the deployment and considered as technology matures over time.

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7. Any other related matters.

End of Life Considerations
Careful consideration of future battery waste into recycling streams is warranted during the procurement of batteries and buses. Our simulations show that there can be a significant variation in the amount of battery waste over the life time for different battery technologies. Emerging new long life batteries may have 30% to 50% of the waste as compared to conventional batteries. This is application specific so it needs to be studied during the deployment planning phase for individual situations.
Conventional batteries may have a cycle life expectancy of around 1,000 to 4,000 charge/discharge cycles, whereas there are new technologies with much longer life expectancies. For example, LTO (Lithium Titanate Oxide) battery chemistry has as much as 5 times the life expectancy. In our case, the Toshiba SCiB™ LTO Battery has a cycle life expectancy of more than 20,000 cycles.

To summarise

Electric buses are a great approach to reduce emissions from public transport and deliver superior customer experience.

The technology is sufficiently mature to deploy. Whilst there is much industry training needed to make the transition, NSW is generally well educated across the required disciplines and, we believe, is capable to make the transition effectively in a progressive manner.

For your convenience, we have communicated our thoughts and key points in 7 pages, despite having accumulated thousands of pages of learning over the last 3 years.

We are happy to provide clarification or more detailed information should that be helpful.

Yours faithfully
Toshiba International Corporation Pty Ltd

Mark Edmunds
General Manager
Energy Storage and e Mobility Solutions

Suggested further reading:

- ISO 37158:2019 Smart community infrastructures – Smart transportation using battery-powered buses for passenger services; published July 2019
- UITP Policy Brief (The Impact of Electric Buses on Urban Life 6/19)
- EV Council & Asthma Australia 'Cleaner and Safer Roads for NSW' 6/19
- UITP Report: Bus Tender Structure 3rd Edition includes Tendering for E-Buses