Submission No 31

ELECTRIC BUSES IN REGIONAL AND METROPOLITAN PUBLIC TRANSPORT NETWORKS IN NSW

Name: Dr. Pedro Orbaiz and Prof. Michael Brear

Date Received: 22 December 2019

Submission to the New South Wales Parliament's
Inquiry into Electric buses in regional and metropolitan public transport networks in NSW

by

Dr. Pedro Orbaiz, CTO and Managing Member of LOGIOS,
Honorary Fellow, Department of Mechanical Engineering, University of Melbourne
and
Prof. Michael Brear, Director, Melbourne Energy Institute, University of Melbourne

General comments

The incorporation of electric buses and other, zero emission vehicles into a public transport system can realise significant environmental, social and economic benefits *if this is done properly*. However, whilst incorporating a few electric buses into a traditional bus fleet for demonstration purposes is relatively straight forward, implementation of a widespread electric or zero emission fleet is a complex and major task. If this is attempted without proper analysis and careful management, significant technical and economic problems are likely to result with public amenity also compromised.

As one example of the challenges, Figure 1 shows the energy consumption of an electric bus operating in the historic centre of the City of Panama [1]. Whilst the manufacturer's proposed energy consumption was 0.8 kWh/km, the vehicle actually consumed on average 2.5 kWh/km and up to 5 kWh/km when operating at very low mean speeds. This was mainly due to the use of the air conditioning system, but was also influenced by the route slope and the number of passengers using the bus. Using the manufacturer's specifications, the bus would have completed close to 200 km on one battery charge. However, under real operating conditions, the vehicle was only achieving about 70 km per charge after which it had to return to base for a 3 hour recharge. This of course resulted in a considerable increase of the total system cost and a significant fall in the expected service performance.

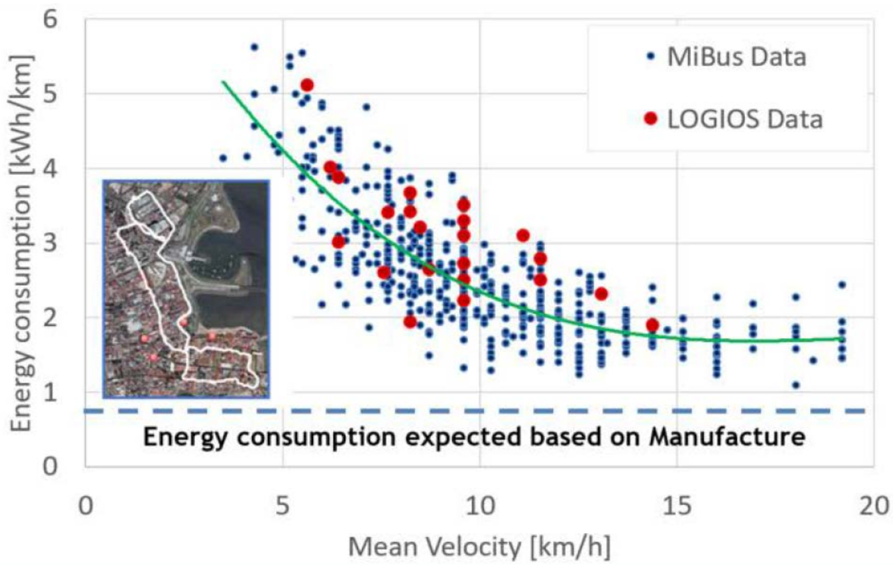

Figure 1: A comparison of the measured and manufacturer's specified energy consumption of a bus operating in Panama City as a function of vehicle mean speed [1]

Whilst NSW is not tropical like the City of Panama, it does have hot summers and steep slopes. It is also a very considerable area. As a first step, it is therefore imperative to evaluate the different bus routes a priori to identify the 'most electrifiable' and consequently determine the minimum requirements electric buses and other zero emission buses might need to operate on each route. This includes specification of the best electric bus technology to serve specific purposes and the required installed charging capacity and infrastructure at terminal stations, amongst others.

Specific responses to the Inquiry's Terms of Reference

1. ***Benefits of electric buses and factors that limit their wider uptake.***
   The incorporation of electric buses into a city´s public transport system can improve the overall greenhouse gas emissions of the transport fleet, whilst also reducing the emission of toxic pollutants such as particulate matter and nitrogen oxides. It also reduces the noise pollution since these vehicles are considerably quieter than conventional diesel buses.

   In terms of the reduction of greenhouse gas (GHG) emissions, this is primarily dependent on the carbon intensity of the electricity contracted to supply the buses. If this is so-called 'green electricity', then the electric buses operational and lifecycle greenhouse gas emissions are very low. However, if electricity is purchased without regard to its emissions intensity, Australia's heavy dependence on coal generation will mean that a transition from conventional diesel vehicles to electric would be expected to have marginal greenhouse benefits. Since the total operating costs of electric buses is relatively insensitive to the price of contracted electricity, the requirement of using 'green electricity' should not significantly compromise the vehicles' financial performance.

2. ***Minimum energy and infrastructure requirements to power electric bus fleets.***
   As shown in Figure 1, the minimum energy and infrastructure requirements of an electric fleet are directly related to the operational characteristics of the total system. The traffic conditions, the route slope, air conditioning requirements and passenger demand all significantly impact energy and infrastructure requirements.

   When sizing on-board battery storage, and in addition to the above, buses must also be able to perform their required service whilst always maintaining some specified level of charge in the battery pack to preserve the battery and to absorb any unexpected operational requirements. Battery degradation must also be accounted for so that the vehicles are able to fulfil operational requirements throughout the expected battery life.

   Depending on several factors, fast or slow (i.e. overnight) charging might be more suitable, and this assessment does not only depend on the service requirements or vehicle characteristics. For example, the availability of land and distribution network capacity at the bus terminal and the electricity tariff structure over the day also come into play.

3. ***Other renewable, emissions neutral energy sources.***
   There are currently several, renewable-powered bus technologies capable of achieving near-zero GHG emissions as well as very low non-GHG pollutant emissions. Also, as we

discuss in response to point 6, the authors consider that several technologies are required to achieve a clean fleet in an affordable and reliable manner.

Other renewably-powered options usually use synthetic fuels, the most common of which is hydrogen. In this case, the vehicle powertrain is likely to feature either a fuel cell or an internal combustion engine, both as part of a hybrid powertrain, and with each having their merits and drawbacks that need to be examined in any careful assessment. Relative to electric buses, vehicle range and refuelling/recharging time are two attractive features of hydrogen fuelled buses.

Importantly, it is also plausible that renewable, *unsubsidised* hydrogen will be cost competitive with diesel in the next few years [2,3], suggesting that the trialling of hydrogen fuelled buses has merit in terms of both the learning obtained and the use of these trials in growing a domestic hydrogen market.

4. ***Ways to support manufacture and assembly of electric buses in NSW.***
   No comment.

5. ***Experience with introducing electric bus fleets in other jurisdictions.***
   Dr. Pedro Orbaiz is CTO of Logios, which is a consultancy working with local governments and interested companies to deploy electric vehicles and other sustainable transport initiatives in a technically, economically and environmentally sustainable manner. Logios has particular experience in working across Latin America and the Caribbean, with previous projects completed in Argentina, Antigua and Barbuda, Brazil, Chile, Colombia, Ecuador, Panama and Peru.

   Prof. Michael Brear has extensive experience working with industry, State and Commonwealth governments on the technical, economic and environmental analysis of transport and energy systems. Most relevant to this submission, this includes the design and assessment of a programme for correlating national bus testing facilities and a hybrid bus trial for the Commonwealth Government and several State Governments, including NSW, in 2010.

6. ***Opportunities and challenges of transitioning the entire metropolitan bus fleet to electric.***
   Large public bus fleets typically experience a wide range of average daily distances, average speeds, route slopes, heating/cooling requirements and passenger loads. It is very unlikely that a single type of zero emission bus will be able to accommodate such a wide range of demands in an economic and reliable manner. Slow charge electric buses, fast charge electric buses, biofueled buses and hydrogen buses are each plausible options for servicing subsets of these demands.

   For example, fast charging electric buses can be preferred for relatively short routes that are repeated more often each day, such as those around urban centres. Slow charge electric buses may be preferred for longer routes that are repeated less often each day. Hydrogen fuelled buses can outperform all electric buses on longer routes that are repeated more often each day, such as those from outer suburbs via freeway or arterial road to/from urban centres.

The combined use of fast charging electric buses and hydrogen fuelled buses is therefore one, more plausible means of servicing a range of bus routes without adding excessive vehicle complexity. As argued earlier, however, such findings need to be based on careful analysis to determine the minimum number of zero emission bus types required to service all requirements.

7. Any other related matters

We make two additional comments in this submission. First, supporting the development of the operator's capability to manage an electric or zero emission fleet is a key part of the transition to electric and zero emission buses. This includes their management of all aspects of vehicle servicing and maintenance, which is significant given the major change in the technologies that they are dealing with.

Second, careful tendering and procurement procedures is vital. Tenders must define the minimum required vehicle performance under local conditions and also establish vehicle baselines for the evaluation of warranties. The authors know of electric and zero emission bus projects failing at inception because they do not consider such matters. A blowout in investment and operational failures are common consequences.

References

1. Logios, 2019, "Accelerating the Transition to Sustainable Mobility and Low Carbon Emissions in Panama City", report for the United Nations' Clean Technology Centre & Network (CTC-N)
2. Australia's National Hydrogen Strategy, https://www.industry.gov.au/sites/default/files/2019-11/australias-national-hydrogen-strategy.pdf
3. Brear, M.J., 2018, "Hydrogen: has its time come?", https://pursuit.unimelb.edu.au/articles/hydrogen-has-its-time-come