Bus Association of Victoria

Management Forum

21 September 2021

Zero Emission Buses

Service Planning and Scheduling Considerations

PBA Transit Planning

Service Planning and Scheduling Considerations

Objectives

- Identify the key factors in planning and scheduling your services
- Begin to consider how they might impact your own plans

Context

- Electric Vehicles only
- Up to today's technology and EV maturity – things *are* changing rapidly
- Current governmental thinking - things *can* change rapidly

Australian State Governments – current EV Strategies

- **New South Wales:**
  - TfNSW policy requires **transition of all 8,000 buses to ZEBs by 2030**
  - More than 50 new EVs currently in-service in 2021 in the inner west, southwest and north
  - No commitment to any on-road charging or other non-depot infrastructure yet, large-scale procurement program underway which will contribute to achieving targets
  - Trials now maturing – for example Custom Denning **'Element'** e-buses run between Bondi and Bronte for up to 16 hours or 450 kilometres with up to 80 passengers
- **Queensland**
  - The Department of Transport and Main Roads in Queensland has announced **all buses purchased by 2030 will be ZEBs**
  - Several electric bus trials have been announced including 10 new electric buses to be operated between Broadbeach and Gold Coast Airport in South East Queensland on route 777 for 12 months in 2021 . The Bustech trials will be run in collaboration with local bus companies Clarks and Kinetic Group

- **Victoria**
  - Victoria legislated commitment of **zero net emissions** by its bus fleet by 2050, with $20M committed in 2021 for a **three-year trial of EVs**
  - There are more than 60 hybrid buses operating now and Victoria's first fully electric bus has saved 61 tonnes of carbon dioxide emissions after 300 days on the road
  - Transdev trialled the state's first locally-built and fully electric bus in 2019 on Route 246 between Elsternwick and Clifton Hill before expanding the capability across other routes
- **South Australia**
  - South Australia will transition its **entire fleet to low and zero emissions vehicles** powered by hydrogen and battery-electric technologies by 2040
  - Adelaide Airport is set to become the first in Australia to electrify its bus fleet with new electric buses to be in service from 2022
  - In 2019, Scania Australia was awarded the contract to supply approximately 340 new buses over 10 years, with the majority being manufactured locally by South Australian business Precision Buses
- **Western Australia**
  - From early 2022 battery-electric buses will operate on the 5 km Joondalup CAT service
  - Overnight charging at Transperth's Joondalup Bus Depot for the new Volvo electric buses to and $800K was committed for charging stations in government buildings

International Case Studies – Foothill Transit California

- Trialled **12 BEBs** and fully electrified route 291
- **Fast charged** at a mid-route charging station which fully charges a bus in **around 5 minutes**
- Foothill built a layover time into the schedule to allow enough time for charging
- Bus availability ranges from a high of **98% to a low of 62%**
- Mid-route lay-overs resulted in passengers become frustrated and reacting negatively

BEB parked at the charging station. The building that houses the chargers and equipment is on the left.

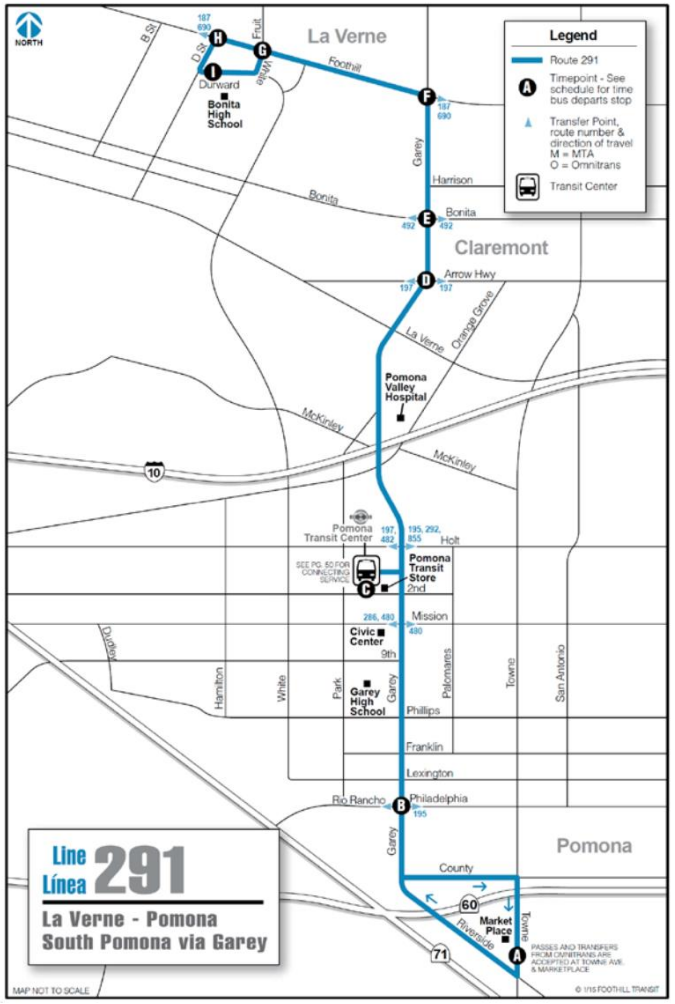
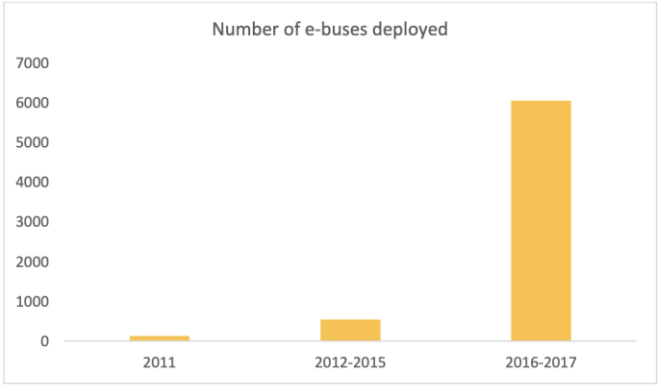


Figure. Route 291 (as of January 2019); *BEB for Foothill Transit Proterra*

International Case Studies – Shenzhen City China

- Shenzhen Bus Group (SZBG) deploys more than 6,000 electric buses:
  - 4,964 heavy-duty / more than 70 passengers capacity
  - 1,089 medium-duty (shorter than 10 meters) buses
- SZBG deploys over **1707 charging terminals at 104 stations** at terminals and depots
- Buses and infrastructure chosen to specifically **minimise impacts** on Operations and Scheduling – quick charge, long range, reliable, depot structures optimised for high capacity and quick turn-around
- SZGB have a **fully integrated operational platform** that can monitor and manage vehicle allocations and charging requirements dynamically during the day
- Over 8 years transition with **strong Governmental funding** and support right across the supply chain

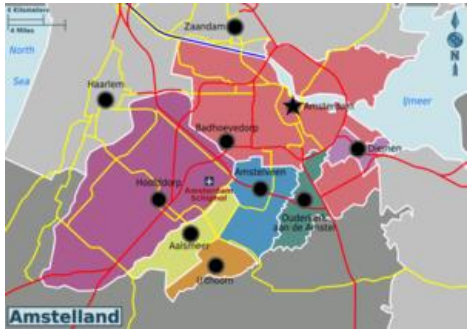
Dominant bus model BYD K8



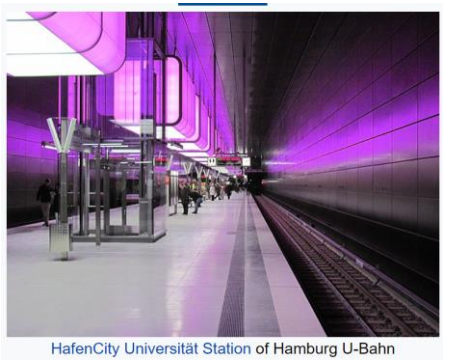
Charging terminal with four chargers

International Case Studies – Rapid Transit models

- **Connexxion (Netherlands)**
- 16 Routes, including 5 with 24/7 operations serving Amsterdam Airport Schiphol
- 30,000 km per day / 30 million boardings per annum
- 100 articulated EVs up to 228 by end of 2021
- ‘Futuristic’ BRT design with four doors
- Overnight slow charge supplemented by fast charging pantographs on-route
- 80 km range boost with fast 20 minute charge during layovers, with buses recharged over the day to maintain 24/7 coverage of 5 routes
- Very flat topographies



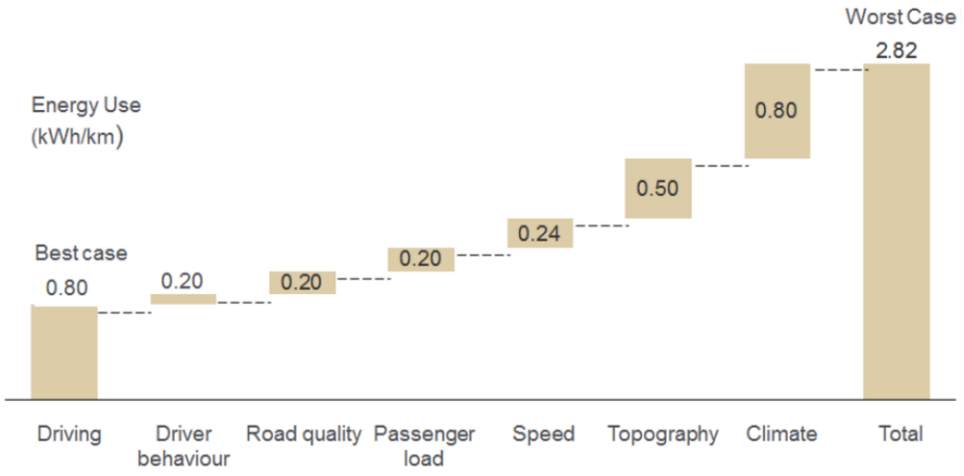
- **Hamburger Hochbahn (Germany)**
- 100% ZEB procurement since 2020, with 100 units procured in 2021 and 530 by 2025
- Dedicated and optimised EV depot in Alsterdorf with 96 charging points and 48 AC fast chargers, no on-route charging at the present time but may be introduced as fleet grows and depot exceed capacity
- High speeds and longer runs required for express services – inner city underground
- EV manufacturers must guarantee at least 200km range for rigids and 150km for articulated vehicles
- Close co-development between government and manufacturers (Mercedes, MAN)

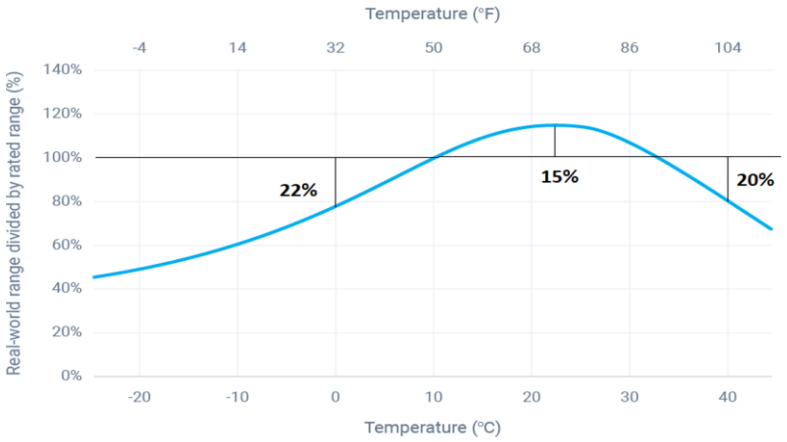


HafenCity Universität Station of Hamburg U-Bahn

Lessons Learned

- EV buses are better deployed on routes that are:
  - **Shorter** with regular charging options
  - **Flatter** so that batteries aren't discharged more quickly than expected
  - **Moderate temperatures** without a large fluctuation to maximise battery performance
  - **Lower passenger loads** (generally) to offset extra battery weight
  - **Low to moderate average speeds**, as vehicles perform better and batteries last longer
  - **Smoother speed patterns** & lower traffic light density across the journey, so that acceleration and braking is minimised





Key Scheduling Considerations

- Building and operating optimised Schedules will require consideration of:
  - **Vehicle attributes** such as range, capacity, charge rate, length
  - **Depot** capacity, layout, charging capability, hours of operation
  - **Climate** and **driving conditions** variation across time periods and day types
  - **Driver** skills and training, EA conditions such as shift length and break requirements
  - **On-Route Infrastructure** including layover points, changing stations and technology
  - **Fleet mix** as EVs increase in number and diesels decrease
  - **Route Design** including total journey length, topography, speeds
  - **Service Plans and Timetables** may need to adapt to EV constraints
  - **Vehicle allocation** to routes and depots

- As EVs increase in your fleet mix, (with today's technologies) beware of
  - Increased PVRs as more vehicles will be needed to deliver current timetables
  - Increased staff costs as drivers require training, driving time drops
  - Operational Performance KPIs as EV vehicle availability will vary from day to day
  - Increased requirement for dynamic management and monitoring
  - Managing expectations regarding **Passenger Experience**

Practical Implications for Victorian Operators

1: Develop a Long-Term Plan

- Manage your rate of change to suit:
  - New technologies
  - Governmental investment
  - Your operational cost budgets

2: Develop a Medium-Term Plan

- Identify your "EV-friendly" routes
- Map your EV acquisition timeline, location, vehicle type, routes
- Identify Depot uplifts to support EVs

3: Develop a Short-Term Plan

- Begin building the cross-functional skills and knowledge required
- Plan an EV trial to begin learning ?
- Prepare for DoT engagement

Questions and Observations