CASE STUDY ENGINEERING, DESIGN AND ASSURANCE

New Traction Power Technologies to Improve the Melbourne Tram Network

Melbourne Tram

LOCATION

Melbourne, Victoria

CONTRACT VALUE

AUD11M

DURATION

Commenced: Aug 2018

Completed: Aug 2019

Project Description

The Melbourne Tram Network (MTN) is the largest in the world with 250 kilometres of double track and 490 trams. Due to strong population growth in recent years the network is now reaching capacity. Projections estimate that by 2051, Melbourne's current population of 5 million people will increase to 7.9 million. To support this level of growth, the public transport system must be upgraded to provide increased capacity and additional routes provided, to align with population growth areas.

The New Rolling Stock Program managed by the Department of Transport Victoria, will introduce 250 Next Generation Trams (NGT) to the network. To replace the existing high floor fleet which are approaching their end of life.

In addition to the introduction of new trams, to further increase network capacity service frequency will increase on high demand routes increasing energy consumption on these routes.

The Challenge

The introduction into service of new modern trams with increased service frequency will require a significant additional amount of energy to be delivered to the network. The main goal of the project was to identify the right solutions to achieve this in a sustainable and cost-effective way.

> Auxiliary power consumption

The high floor trams to be retired are fitted with minimal on-board equipment. In comparison, new modern trams are fully air-conditioned and fitted with modern on-board equipment. It represents an increase of 52% from the longer high floor trams to be retired.

> Traction power consumption

High floor trams have a maximum traction power of 420 kW for the short variant and 486 kW for the longer variant. In comparison, new modern trams with higher passenger capacity fitted with standard traction-braking technology would have a maximum power of 550 kW which represents an increase of 30% from the shorter high floor trams and 15% from longer high floor trams.

Our Solution

To ensure rolling stock can operate at full performance, the traction power supply network must be able to provide the required maximum power and energy. While this characteristic is available from tram supplier datasheets, the energy consumed by the rolling stock over the time is not readily available. As such the team had to establish these figures for the overall consumption of the network. Using the results of network simulation output from TrainOps® model of the Melbourne Tram Network, the energy consumption of the existing network has been evaluated and compared with the energy bill.

The energy consumption of all tram types used on the MTN was established. Single vehicle runs were simulated on the same chosen route, with traction and auxiliary consumption integrated and linearised per kilometre which enabled the maximum energy consumption for every tram class to be determined.

The whole network was simulated using the existing rolling stock and the Next Generation Trams to establish the energy consumption of the then present 2018 services. Simulation at a higher service frequency established the baseline energy consumption for complete low-floor fleet in the year 2031. Without implementing new technologiesthe consumption would increase by 30 per cent.

> Engineering approach

In order to run new modern vehicles on the network at increased service frequency, the maximum power and the energy consumption will increase, requiring costly upgrades to the network. In order to determine the preferred upgrade approach, an options analysis was conducted to analyse the benefits of new proven technologies and standard techniques to ensure upgrades were undertaken in a sustainable manner and cost effectively.

Technical Solution

Option 1: Standard Traction Power Supply Solutions

The standard base approach to increase power supply to a rail network is to install additional traction power substations which is a very difficult and costly task as it requires land acquisition and has long lead time to deliver the solution. To minimise the number of new substations required to meet the increase in power demand, other standard traction power technologies have been evaluated. In addition, primary technologies were also assessed: sectioning optimisation and side feeders.

Option 2: Alternative On-board Storage Solutions

Many tram manufacturers now supply their trams with On-board Energy Storage Systems (OESS). Several new tram or Light Rail Train lines, mainly in Europe and China, use OESS to run without being powered by overhead wires. While wire-free operation is the typical reason for implementing OESS, in the Melbourne context the primary purpose would be to reduce both energy consumption and peak power demand.

Option 3: Alternative Traction Power Supply Solutions

For routes that will not be operated with NGT but will see an increase of service frequency and tram size, voltage sags and peak power are issues would be solved by the installation of a Wayside Energy Storage System (WESS).The results of the simulations demonstrated that two routes would benefit from the installation of a WESS instead of a substation.

Key Outcomes

The proposed blended solutions will allow to increase the patronage and include the new trams with no increase of energy consumption. 2031 consumption is expected to reach 156 GWh while in 2018 the energy bill was 153 GWh.

Relevant Personnel

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