

## Case Study – UK, September 2023

### World's first dual fuel LNG powered passenger train

Grand Central is an open-access passenger train operator offering services that connect London Kings Cross to Yorkshire and the Northeast. In 2019, G-Volution and Grand Central entered into a Collaboration Agreement to convert a Cummins QSK19 engine on a Class 180 vehicle to dual fuel operation. This conversion was the first of its kind within the rail industry.

The project sought to modify a single Class 180 DMSL(B) vehicle to run in normal passenger service on a mixture of LNG and diesel fuels. Bio-LNG (Liquified Natural Gas) was chosen as the secondary fuel as at the time it was a cost advantageous substitute for diesel which would provide significant environmental and cost benefits. The trial was partially funded by RSSB to demonstrate the use of cleaner fuels on the UK rail network and to support the development of standards for the use of alternative fuels within UK rail.

G-Volution provided our patented control unit, the Optimiser, and developed a control strategy to deliver optimal Bio-LNG substitution rates while preserving the safety and durability of the engine. SNC-Lavalin were contracted to carry out the installation design works including installation and manufacturing drawings and a comprehensive modification procedure.

The equipment was installed on the vehicle by Alstom at their Crofton maintenance depot in accordance with the approved modification procedure. A temporary modular tank, consisting of a cryogenic ISO container in a frame and dispensing unit, was installed at Crofton Depot for the storage of LNG, see Figure 1. The long-term intention would be to utilise Bio-LNG, a near net zero carbon fuel from sustainable sources.



Figure 1 - LNG Fuelling System at Crofton Depot.

Once the conversion was complete, the Class 180 vehicle then underwent three stages of testing: Static, Slow Speed, and High Speed. Following the successful completion of static and slow speed testing, high speed test runs took place in September 2023 between Crofton Depot and Peterborough. Due to engineering works on the main line the south bound journey was via Lincoln, which limited the

maximum speed of the train. However, the return journey was on the main line which allowed operation at higher speeds. See Figure 2 for a comparison of normal diesel consumption along this route versus dual fuel.

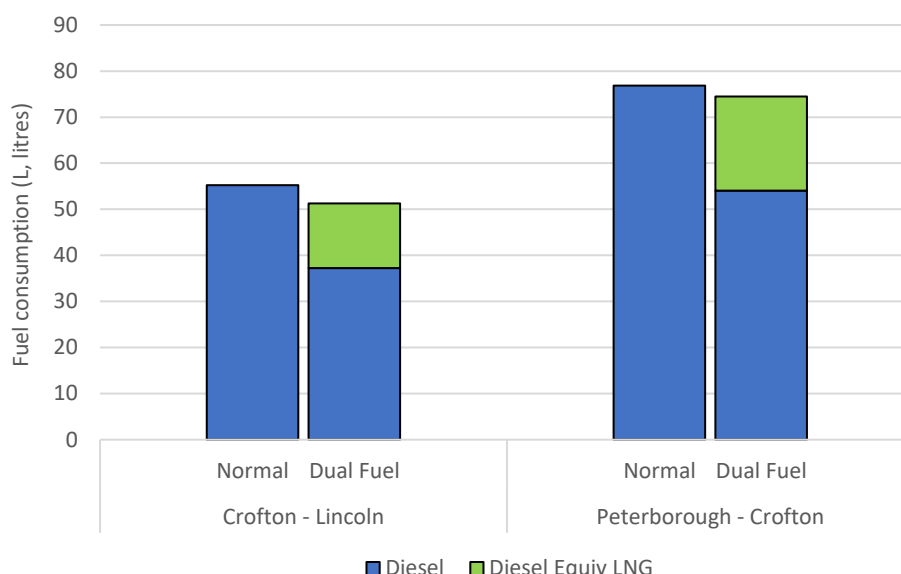


Figure 2 - A comparison of the fuel consumption by the Class 180 vehicle during normal and dual fuel operation along the southbound journey (Crofton - Lincoln) and the northbound journey (Peterborough - Crofton). From Crofton to Lincoln in normal operation there was a diesel consumption of 55.2L, whereas for dual fuel there was a consumption of 37.2L and 14.1L for diesel and diesel-equivalent LNG respectively. From Peterborough to Crofton in normal operation there was a diesel consumption of 76.9L, and for dual fuel there was a consumption of 54.0L and 20.5L for diesel and diesel-equivalent LNG respectively.

Despite the limited maximum speed on the southbound journey, an average substitution ratio of 29% was achieved across both routes, resulting in CO2e emission reductions of over 30%. This was equivalent to carbon savings of 44kg CO2e and 59kg CO2e for the southbound and northbound journeys respectively. In addition, emissions measurements have demonstrated a reduction in nitrogen oxides (NOx), particulate matter (PM), and particle number (PN) emissions.

The necessary approvals were obtained for the trial vehicle to enter into passenger service:

- ✓ Verification of Conformity of Engineering Change to Rail Vehicles (RIS-2700-RST)
- ✓ Common Safety Methods for Risk Evaluation and Assessment (CSM REA)
- ✓ Assessment of Compatibility between Vehicles and Infrastructure (RIS-8270-RST)

Unfortunately, passenger service was not possible for reasons outside of our control, but the high-speed testing demonstrated how decarbonisation of existing diesel-powered rail assets is achievable with dual fuel technology using alternative fuels that are available today. In addition to this, a pathway to fleet fitment and approvals for operation on the UK rail network have also been shown by this trial.

It was not possible to demonstrate positive cost savings through fuel price differentials due to the impact that the war in Ukraine has had on the price of LNG. However, G-Volution is confident that cost savings could be achieved by using the same dual fuel technology but with a different choice of secondary fuel, such as Bio-LPG.