Dual fuel locomotive concepts unveiled

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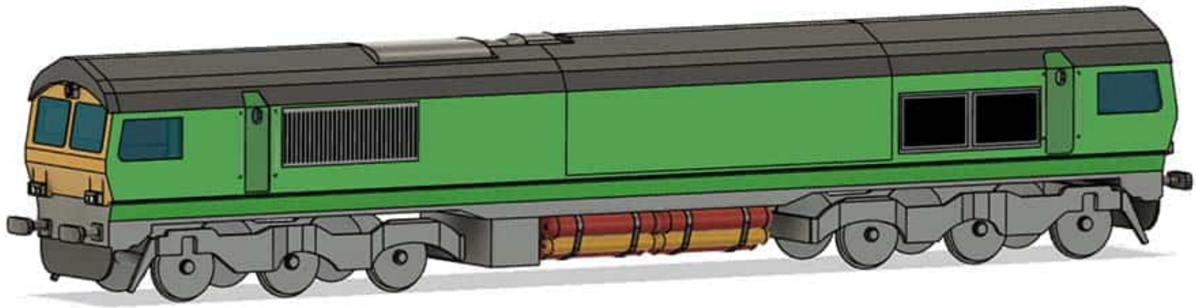

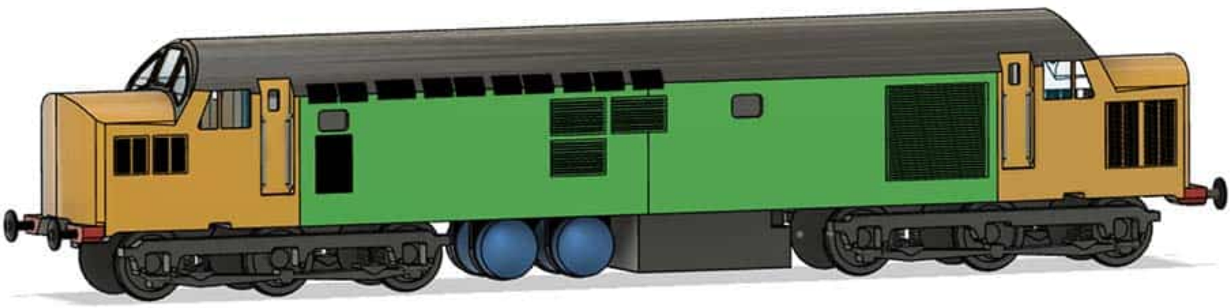

G-volution and SBL-Rail have completed a feasibility study and are now presenting dual fuel evolution concepts for Class 37 and Class 66 locomotives. These concepts are representative of Type 3 and Type 5 locomotives respectively and their operations.

Dual fuel engines use compression ignition and combust two fuels simultaneously, allowing diesel to be displaced by renewable net zero carbon emission fuels.

G-volution has been developing dual fuel engines since 2008 and now shows how this technology can benefit UK freight locomotives.

The concepts presented use diesel with biomethane, diesel with biopropane and diesel with hydrogen. The Class 37's English Electric 12CSVT engine and the Class 66's EMD 12-710 engines are replaced by a new dual fuel engine meeting the Stage V emission standard. A twin engine concept Class 66 using new dual fuel engines engines has also been developed as well as a dual fuel evolution of the existing EMD engine.

The original diesel tank/s of the locomotives are replaced with a smaller diesel tank and cylinders for biomethane or biopropane or hydrogen are installed in place of part of the original diesel tank. A range of fuel tank solutions were developed for each fuel, including using a number of smaller cylinders or instead using fewer larger cylinders. An example solution is shown in the figures below for each locomotive type.

Biomethane can be manufactured by anaerobic digestion of organic waste streams

e.g. food, farm and sewage waste and there are currently 670 such biomethane production plants in the UK. It is a renewable fuel replacement for natural gas. Biopropane can be manufactured through a number of different routes from biomass or through biological routes and is a renewable fuel replacement for LPG (Liquefied Petroleum Gas).

Route simulations were completed using OTMR provided by operators of these locomotives and in combination with dual fuel engine models based on G-volution's dual fuel combustion research to date. Results are shown in the table below. Hydrogen results assume green hydrogen is used.

Class 37 – new dual fuel engine	**Carbon savings (%)**	**Operating cost savings (%)**
Diesel-biomethane	67	58
Diesel-biopropane	64	55
Diesel-hydrogen	66	44
Class 66 – new dual fuel engine		
Diesel-biomethane	51	29
Diesel-biopropane	42	21
Diesel-hydrogen	49	7
Class 66 – EMD dual fuel evolution		
Diesel-biomethane	81	39
Diesel-biopropane	71	26
Diesel-hydrogen	79	-28

For the Class 66, the new 4 stroke dual fuel engine offers a 10% improvement in fuel consumption verses the original 2 stroke EMD engines. Whilst the dual fuel evolution of the EMD engine offers higher replacement rates of diesel, this 2 stroke engine is less efficient than the new 4 stroke dual fuel engine and also doesn't meet the latest Stage V emission standards.

On an energy equivalent basis, biomethane is 0.47 times the price of diesel and biopropane is 0.58 times the price of diesel. Hydrogen is currently 1.3 times (using natural gas) to 6 times (using electrolysis) the price of diesel for an equivalent amount of energy. Hence the negative cost savings for the EMD hydrogen dual fuel evolution. The new dual fuel hydrogen engines offer positive cost savings primarily due to these engines' improved efficiency over the original engine thus overall lowered operating costs. Biomethane and biopropane dual fuel engines offer significant carbon and cost savings verses diesel. Hydrogen also has the potential to do this once produced from renewable sources and once it is much cheaper than it is today.

Please note that this report is based on 2020 fuel prices. Whilst diesel prices are expected to rise in the future, biomethane and biopropane are disconnected from the crude oil price and their prices are expected to fall as production volumes continue to ramp up. Green hydrogen made through electrolysis relies on renewable electricity and requires electricity prices to fall (or diesel prices to rise even further) for it to offer operating costs savings over diesel.