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The Only Technology to Build Affordable, Zero Emissions Line Haul Locomotives that is Commercially Available Today Uses Cummins HELM[™] X15N[™] Engines Running RNG

Battery-Electric and Hydrogen Are Not Viable Options



CAF AC Traction System Inverters with AC Traction Motors and Gearbox Combos - ALREADY TESTED BY NS and UP in LINE HAUL OPERATIONS TMV Locomotive Controls, NYAB LEADER® System, NYAB CCBIIe, Bathroom, and Crashworthy Cab

All Subsystems in OptiFuel's Total-Zero[™] 5,600 hp RNG Hybrid Line Haul Locomotive have DOT Certification and/or FRA Concurrence and are Currently in Production. The Entire Operational System of Locomotives and 11,800 DGE RNG Tenders is Expected to have FRA Concurrence by 2027 and Completion of Million Mile Operational Testing with 10 Locomotives and 5 Tenders by End of 2028.

BEAUFORT, SC – July 16, 2024 – In a recent press article, the Association of American Railroads points out that *"The technology needed for zero-emission locomotives is not commercially available today"*. AAR is absolutely correct with that statement, but only because CARB will allow only electric or green hydrogen solutions for line haul operations, two non-existent solutions.

From a pure technology and availability perspective, it is straight forward to build zero-emission

battery-electric, green hydrogen- hybrid, or RNG-hybrid switcher locomotives now using off-theshelf components. Given the duty-cycle, operating scenario, and refueling approach for a given railroad, one or more of the three switcher solutions can be optimized to meet the affordability requirements of the short line railroads, especially using grant funding. The only exception is if the fuel needs to be Green Hydrogen, which may never be available in quantity or be affordable.

The main problem is with zero emission line haul locomotives, which generate 85% of all criteria and GHG emissions in the US. Line haul operations are the foundation of the U.S. railroad system. American railroad operators understand that a one-size-fits-all approach to locomotive power is not just a solution—it's the only solution. This unwavering commitment to standardization and efficiency has been pivotal in making American railroads the best in the world.

Converting the US line haul locomotive fleet to zero criteria emissions and zero GHG CI requires two things – a new **prime mover power source** with a new **onboard energy storage** and **one or more energy storage tenders** for long range operations. The AC traction systems on current line haul locomotives will not have to change. Physics, range, affordability, availability and operations considerations eliminate battery-electric and hydrogen hybrid as a solution for line haul locomotives. Even with a national 100% Overhead Catenary Train Systems (OCS) system for line haul operations, the OCS system cannot guarantee 24 hours a day, 365 days-a-year operations, so the locomotives must carry battery tenders as backup. That leaves only two available technical solutions for line haul - RNG Hybrid and OCS. However, one is affordable, and the other is not.

OptiFuel is committed to spearheading the sustainable revolution with locomotives and refueling solutions that make fleet transitions smooth and affordable. Unique to OptiFuel's locomotive designs is the use of modularity consisting of standard Quick Disconnect (QD) modules using standardized ISO corner locks (see video). About 90% of the same components are used for OptiFuel's 1000 hp to 5600 hp RNG or hydrogen switchers and line haul locomotives, and our RNG standard and powered tenders.

The 4th Generation Cummins X15N[™], 500 hp RNG engines Have Over 2 BILLION Miles of Operation on the Road Over Four Years on Over 40,000 Trucks.



OptiFuel's proprietary 500 hp RNG Quick-Power[™] QD Module integrates Cummins' most advanced HELM[™]X15N[™] RNG engines, which are now in production. Using a simple passive 3-way catalyst system aftertreatment system, there is **no requirement for a Selective Catalyst Reduction (SCR) system** requiring Diesel Exhaust Fluid (DEF) or an active particulate filter.

In the 3rd generation, 400 hp engines, OptiFuel's achieved EPA certification for locomotives in 2020 with criteria emissions of 0.00 g/bhp-hr NOx and PM, and, running RNG, achieves zero or negative Carbon Intensity (CI). We expect to get the same EPA rail certification for the X15N[™].

OptiFuel's engine partner, Cummins, has invested over \$500 Million to support the production capacity of 25,000 X15N engines per year at their Jamestown, NY facility. This robust production capacity ensures that OptiFuel can meet the near-term delivery schedules of 2,000 line haul locomotives a year required for Class 1 railroads to achieve their emission targets by 2040.

OptiFuel's Onboard Fuel Storage Modules Have Already Achieved FRA Concurrence in 2019 and Have Been Used in Daily Operations on Multiple Locomotives for Over 5 Years in Both Switcher Operations and on Main Track Operations.



Each OptiFuel Total-Zero[™] Onboard Fuel Storage QD Module can carry 1,750 DGE of RNG. Already approved by the Department of Transportation (DOT) for rail usage, the Type 4 natural gas storage cylinders used in OptiFuel's fuel storage module have been in production for over 40 years and have a 30-year lifespan. U.S. production of these cylinders exceeds millions of units annually from a variety of U.S. manufacturers. OptiFuel's only remaining readiness benchmarks include completing the required FRA crashworthiness testing, which is scheduled to begin in 2025 and completed in 2026.

RNG Locomotive Refueling Stations are Modular, and the Equipment is Off-the-Shelf Allowing the Building of 60 to 80, 260,000 DGEs/day Refueling Stations Over a 5 Year Period - All Connected to the Existing Natural Gas Pipelines Across the US.



In 2013, OptiFuel was awarded a contract with Indiana Harbor Belt railroad to develop four CNG Tier 4 dual fuel switcher locomotives and integrate CNG refueling systems into the existing diesel refueling station. The project was highly successful, with the locomotives achieving EPA approval & FRA concurrence, operating without failures for over five years. Refueling is seamless at the on-site CNG locomotive refueling station engineered and built by OptiFuel. Railroad employees received training and have managed all <u>refueling</u> with zero safety incidents.

It will require building around sixty 260,000 DGEs/day, RNG refueling stations to refuel all 25,000 RNG hybrid line haul locomotives and RNG tenders around the US. That approach will provide over 15.5 million DGEs of RNG daily and over 5.5 billion DGE a year. That cost will be absorbed in the cost of a DGE of RNG over 10 years, requiring no CAPEX by the Class 1s.

Traditionally, US railroads have funded their own refueling infrastructure. However, by owning the RNG production and fuel infrastructure, OptiFuel can leverage federal and state alternative fuel tax credits to offset infrastructure and equipment costs and offer railroads a low, fixed price for zero-emission RNG. Co-investment and direct ownership opportunities are available for railroads interested in participating in infrastructure ownership.

Starting in 2029, it would take approximately 13 years to complete the transition and replace the 25,000 haul locomotive fleet with Total-Zero™ 5600 hp RNG hybrid locomotives. OptiFuel plans to leverage use of Federal D3 RIN credits to effectively offset equipment costs over a ten-year period, making the transition financially viable for railroads to pay \$3 per DGE, inclusive of the locomotive, tenders, locomotive refueling stations, mobile refuelers, and fuel with only a single \$1.1 million down payment.

More Resources on this topic are available at: OptiFuel Systems News & Resources

About OptiFuel Systems LLC

<u>OptiFuel Systems</u> designs and manufactures Total-Zero[™] emission products and services for transportation and industrial markets. With expertise in RNG and hydrogen fuels, OptiFuel works as a systems integrator with strategic partners and offers innovative, low-risk, and modular solutions, including locomotives, tenders, refueling systems, and generators for primary, emergency and back-up power needs.