**NUFRIEND Insights**

**ENERGY TECHNOLOGIES - BIODIESEL VS E-FUEL**

Northwestern University Freight Rail Infrastructure & Energy Network Decarbonization (NUFRIEND) is a comprehensive industry-oriented tool to simulate the deployment of new energy technologies across U.S. freight rail networks. Scenario-specific simulation and optimization modules provide estimates for carbon reductions, capital investments, costs of carbon reductions, and operational impacts for any given deployment profile.

**WHY ARE DROP-IN FUELS PROMISING FOR RAIL?**

- Drop-in fuels require little to no investments in asset or infrastructure upgrades for their deployment.
- Liquid hydrocarbon fuels are very energy dense and do not require additional fuel storage tender cars for locomotives.

This NUFRIEND Insights analyzes the potential benefits of drop-in fuels such as biodiesels and e-fuels in terms of their costs, emissions, and supply forecasts.

**TRADING OFF EMISSIONS AND COSTS OF DROP-IN FUELS**

Drop-in fuels can provide significant emissions reductions, but are high cost as demand exceeds their current production. 3 billion gallons of diesel were consumed by the seven Class I railroads in 2020.

**Biodiesel:**
- Produced from organic waste matter.
- Constrained to substitute at most 40% diesel for current locomotives.
- 1.8 billion gallons produced in the US in 2020.
- Cost of avoided emissions in line with forecast carbon credit pricing range.

**E-fuel:**
- Produced using electricity to convert captured carbon.
- Able to substitute diesel fully in current locomotives.
- Near zero-emissions fuel requires renewable zero-carbon electricity is used for production.

**SUMMARY**

- Drop-in fuels provide an opportunity to decarbonize energy-intensive line-haul routes with little to no capital investment.
- Testing on locomotives and refueling stations is needed to determine the impacts of any differences in chemical composition on equipment operations and lifetime.
- Aggressive steps to scale up production of biodiesel and e-fuels are needed to make them cost-competitive with diesel.

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1 The cost of avoided emissions measures the average cost required to reduce emissions by one ton of CO2 and serves as a strong evaluation and policy metric.  
2 EIA

**NUFRIEND Insights for:**

**RAILROADS**
- Benefit of testing different fuel blends in operations.
- Importance to forecast future fuel needs and prices.
- Drop-in fuels provide flexibility for combinations of fuel technologies.

**OEMS**
- Benefit of testing different fuel blends on locomotive powertrains and operations.
- Development of emissions measurement tools.

**FUEL & ENERGY PROVIDERS**
- Need for scaling up production of alternative drop-in fuels.
- Collaboration with utility companies to ensure sourcing of green electricity.

Visit [transportation.northwestern.edu](http://transportation.northwestern.edu) for more NUFRIEND Insights.

This work is funded under the LOwering CO2: Models to Optimize Train Infrastructure, Vehicles, and Energy Storage (LOCOMOTIVES) project by the Advanced Research Projects Agency - Energy (ARPA-E) of the U.S. Department of Energy under Award Number DE-AR0001469. The views and opinions of the authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.