NUFRIEND Insights

RANGES OF BATTERY-ELECTRIC LOCOMOTIVES (BELS)

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 DO BEL RANGES MATTER?

- The ranges of BELs are much more limited compared to existing diesel-electric locomotives.
- They require charging stations between terminals for linehaul shipments, incurring significant capital costs.

This NUFRIEND Insights models future BEL deployment in an aggregated U.S. Class I railroad network under 200-mile vs 800-mile ranges, to analyze their costs and emissions.

HOW DO BEL RANGES AFFECT RAIL DECARBONIZATION?

Range is critical, as deploying charging stations in locations with no proximal railyards may be economically infeasible.

200-mile Range:
- Mass deployment of charging stations limited to regions with existing railyards.
- Limited linehaul corridor options to deploy BELs.
- High cost of avoided emissions from capital investment to build a lot of charging facilities.

800-mile Range:
- Few charging stations needed to decarbonize the high-volume linehaul routes.
- Flexibility to deploy BELs on easy-to-decarbonize routes.
- Cost of avoided emissions in line with potential U.S. carbon credit pricing.

SUMMARY

- Longer-range BELs require a smaller capital investment while attaining a higher carbon reduction.
- Longer ranges mean more flexibility for railroads to deploy BELs and leverage economies of scale in heavily trafficked corridors.
- For individual railroads and different BEL ranges, the NUFRIEND tool can optimize the deployment of charging infrastructure and offer more pointed insights.

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.

NUFRIEND Insights for:

RAILROADS
- BEL charging time causing high delay costs
- Significant benefits attainable from advanced rollout planning
- Potential gains from easy-to-decarbonize routes
- Value of accurate range estimates and forecasts

OEMS
- Value of range improvements
- Innovations in charging speeds
- Need for cost-competitive manufacturing relative to other fuel technologies

ENERGY PROVIDERS
- Coordination to ensure adequate electricity supply for connected charging infrastructure

Visit transportation.northwestern.edu for more NUFRIEND Insights. This work is funded under the LowEvolving 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.