

PROGRESS RAIL

Advanced Energy Developments

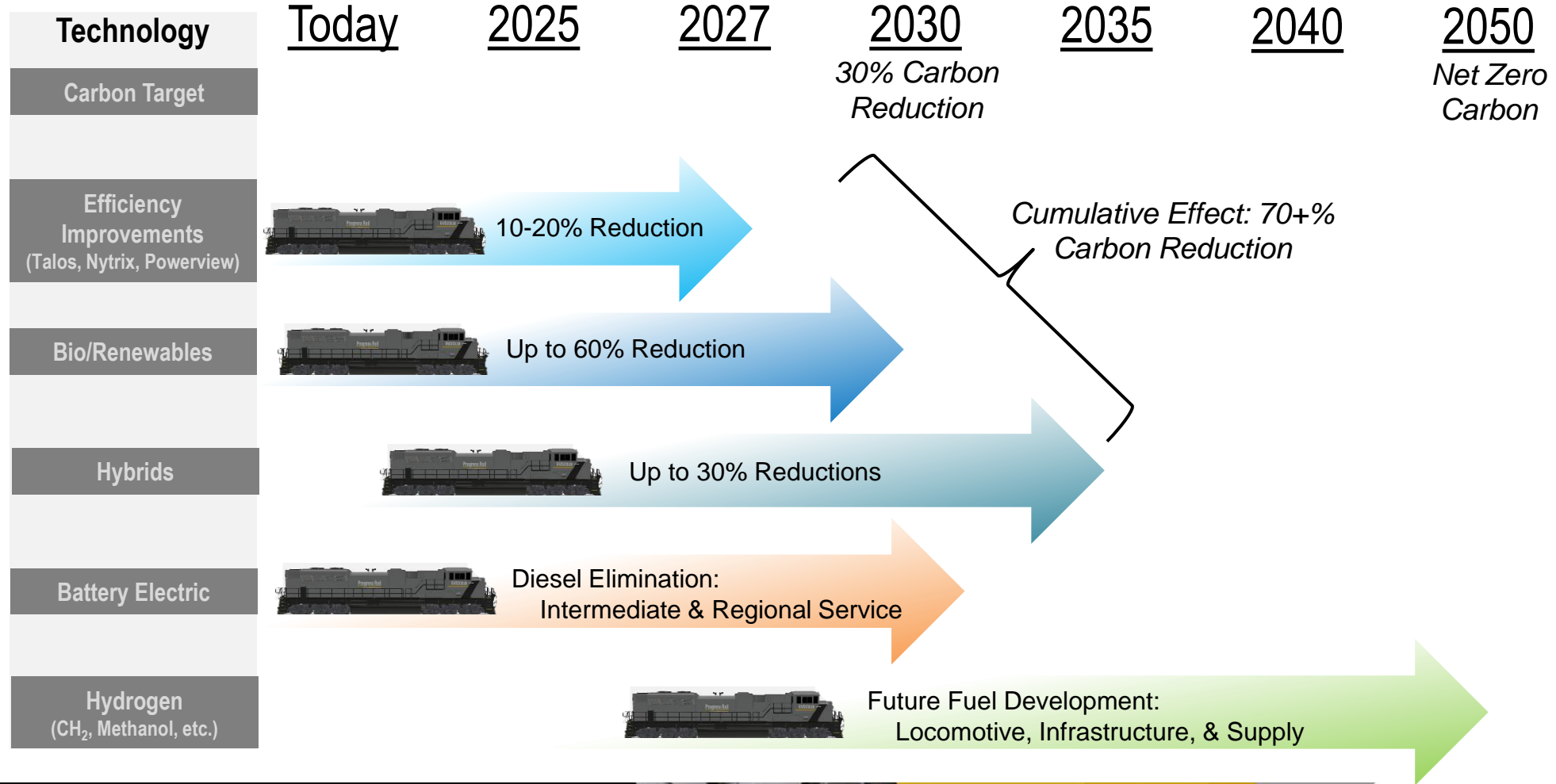
May 2023



EMD[®] Joule family of locomotives

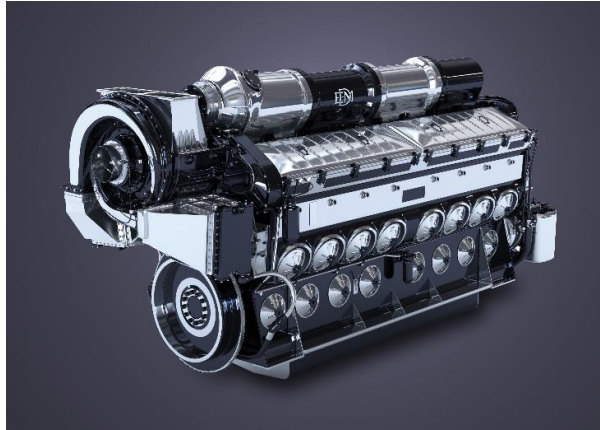
Emissions Reduction Solutions

Technologies ready to meet carbon targets



Exhaust Emissions Reductions

Progress Rail Key Focus Areas



Renewable Fuel Development

- Approval of B20 for use in all EMD[®] 710 engines
- Testing of up to B100 and R100



EMD[®] Joule Battery & Hybrid Locomotives

- Zero exhaust emissions operations of Vale EMD[®] Joule
- Partnerships with PHL, FMG, BHP, BNSF and others



Hydrogen Fuel Cell Development BNSF and Chevron

- Demonstration of a locomotive powered by hydrogen fuel
- Partnership for technology demonstration & development

Emissions Reduction Solutions

EMD® Joule Battery locomotive deployments

VALE MINING OPERATIONS, South America

- 2.4 MWh, 120-ton LFP Battery Locomotive
- Pulling 9,000-ton trains @ 3-5 per day
- Recharging every other day
- 10% energy recovery in a regular pull
- Operating in revenue service



PACIFIC HARBOR LINE, Southern California

- Six-axle locomotive, zero exhaust emission, zero-idle and low-noise
- To be deployed in heavy haul switching service



Five configurations of battery electric locomotives to be delivered around the world. Including the largest battery electric vehicle, the SD70J-BB

Hybrid Locomotive Overview

Improved operational performance & emissions

Concepts Under Consideration

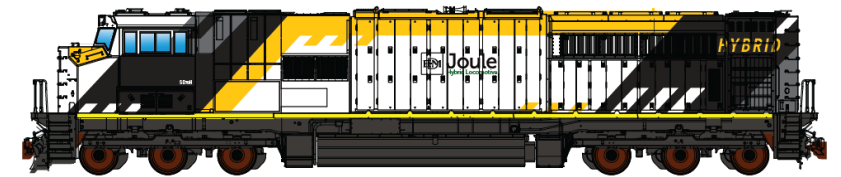
- Hybrid versions of freshly manufactured diesel locomotives
 - ✓ SD70H – Size, power, and tractive effort comparable to SD70 Tier 4 diesel
 - ✓ GT38H – Low-profile locomotive for switching and specialty services
- Conversion of existing diesel locomotives to hybrid

Hybrid Modes of Operation

- Power substitution
 - ✓ Substitute power supplied by the battery for a portion of the power that would normally be supplied by the engine
 - ✓ Maintains equivalent power and tractive effort performance of the diesel-only model
- Power boost
 - ✓ Supply battery power in addition to full engine power to exceed power and tractive effort performance of the diesel-only model



GT38H

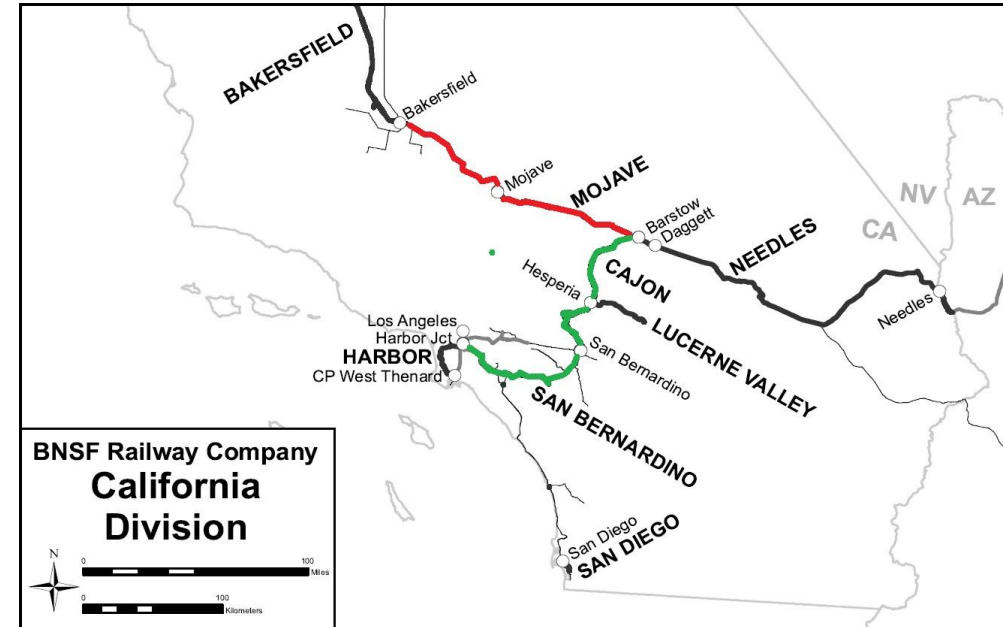
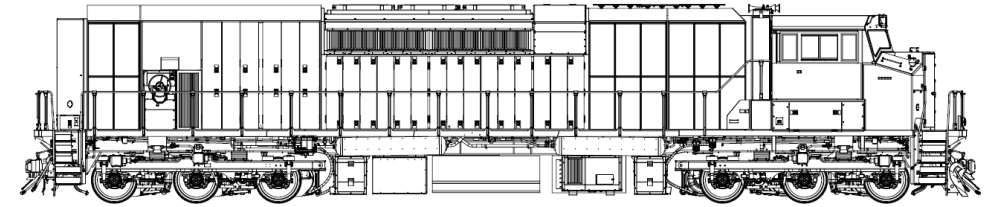


SD70H

Hydrogen Fuel Cell Locomotive Demonstration

Revenue service demonstration foundation for future development

- Chevron & BNSF partnership
- Project Objectives:
 - Evaluate technical and economic feasibility of H₂ as a locomotive fuel
 - Identify short/long term fueling infrastructure issues
 - Demonstrate H₂ fueled locomotive performance & capabilities
- Operations targeted to begin in 2024
 - Los Angeles, CA to Barstow, CA
 - Mixed manifest trains
 - Fueling in Barstow
- PR demo locomotive configuration:
 - Split of battery & H₂ energy sources
 - Fuel cells provide lower throttle notch traction power, tractive effort and battery charging
 - Batteries provide additional power and tractive effort at higher throttle notches and fast transient response



Closing & Discussion

