PROGRESS RAIL

Advanced Energy Developments

May 2023

EMD® Joule family of locomotives
# Emissions Reduction Solutions

Technologies ready to meet carbon targets

<table>
<thead>
<tr>
<th>Technology</th>
<th>Today</th>
<th>2025</th>
<th>2027</th>
<th>2030</th>
<th>2035</th>
<th>2040</th>
<th>2050</th>
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<tbody>
<tr>
<td>Carbon Target</td>
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<td>30% Carbon Reduction</td>
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<td>Net Zero Carbon</td>
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<td>Efficiency Improvements</td>
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<td>Up to 60% Reduction</td>
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<td>Cumulative Effect: 70+% Carbon Reduction</td>
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<td>(Talos, Nytrix, Powerview)</td>
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<td>Bio/Renewables</td>
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<td>Hybrids</td>
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<td>Up to 30% Reduction</td>
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<td>Battery Electric</td>
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<td>Diesel Elimination: Intermediate &amp; Regional Service</td>
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<td>Hydrogen (CH₂, Methanol, etc.)</td>
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<td>Future Fuel Development: Locomotive, Infrastructure, &amp; Supply</td>
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Exhaust Emissions Reductions
Progress Rail Key Focus Areas

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

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

- 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
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