

Progress Rail
A Caterpillar Company

Decarbonization Solutions



EMD[®] Joule Family of Locomotives

A CATERPILLAR COMPANY

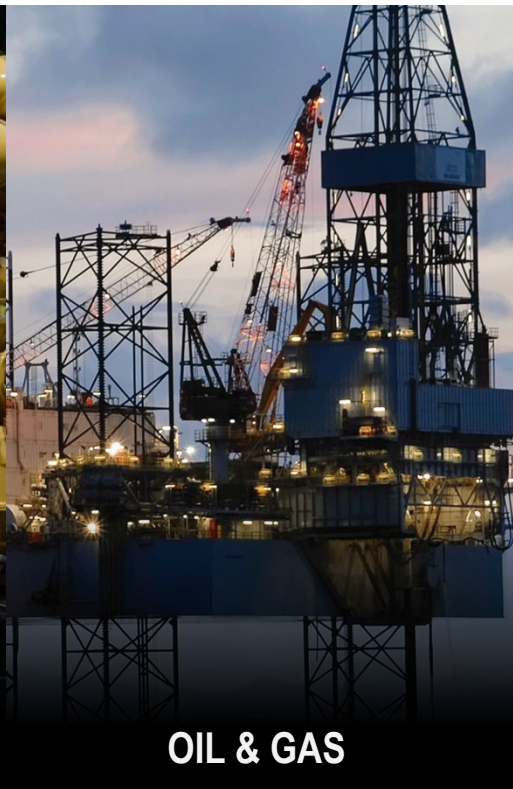
- Progress Rail is one of the world's **largest integrated and diversified suppliers** of railroad solutions
- Part of Caterpillar's Energy & Transportation Division



TRANSPORTATION



POWER GENERATION



OIL & GAS



INDUSTRIAL



CAT MACHINES

OUR VALUES IN ACTION



Sustainability The Power of Endurance

WE ARE COMMITTED TO BUILDING A BETTER WORLD

Sustainability is part of who we are and what we do every single day. We recognize progress involves a balance of environmental stewardship, social responsibility and economic growth. We consider this as we work toward a vision of a world in which people's basic needs – such as shelter, clean water, education and reliable energy – are fulfilled. We provide work environments, products, services and solutions that make productive and efficient use of resources as we strive to achieve our vision. We believe this commitment supports the enduring success of our customers, stockholders, dealers and our people.

22 Years

Dow Jones
Sustainability Indices,
World & North America



#21

Wall Street Journal
100 Most Sustainably Managed
Companies 2021



reduction in absolute
**GHG emissions from
2018 through 2021**



of electrical energy
was obtained from
**Renewable or
Alternative Energy
Sources**



of sales from products, services
and solutions demonstrated an
**Improved
Sustainability Benefit**
over prior offerings

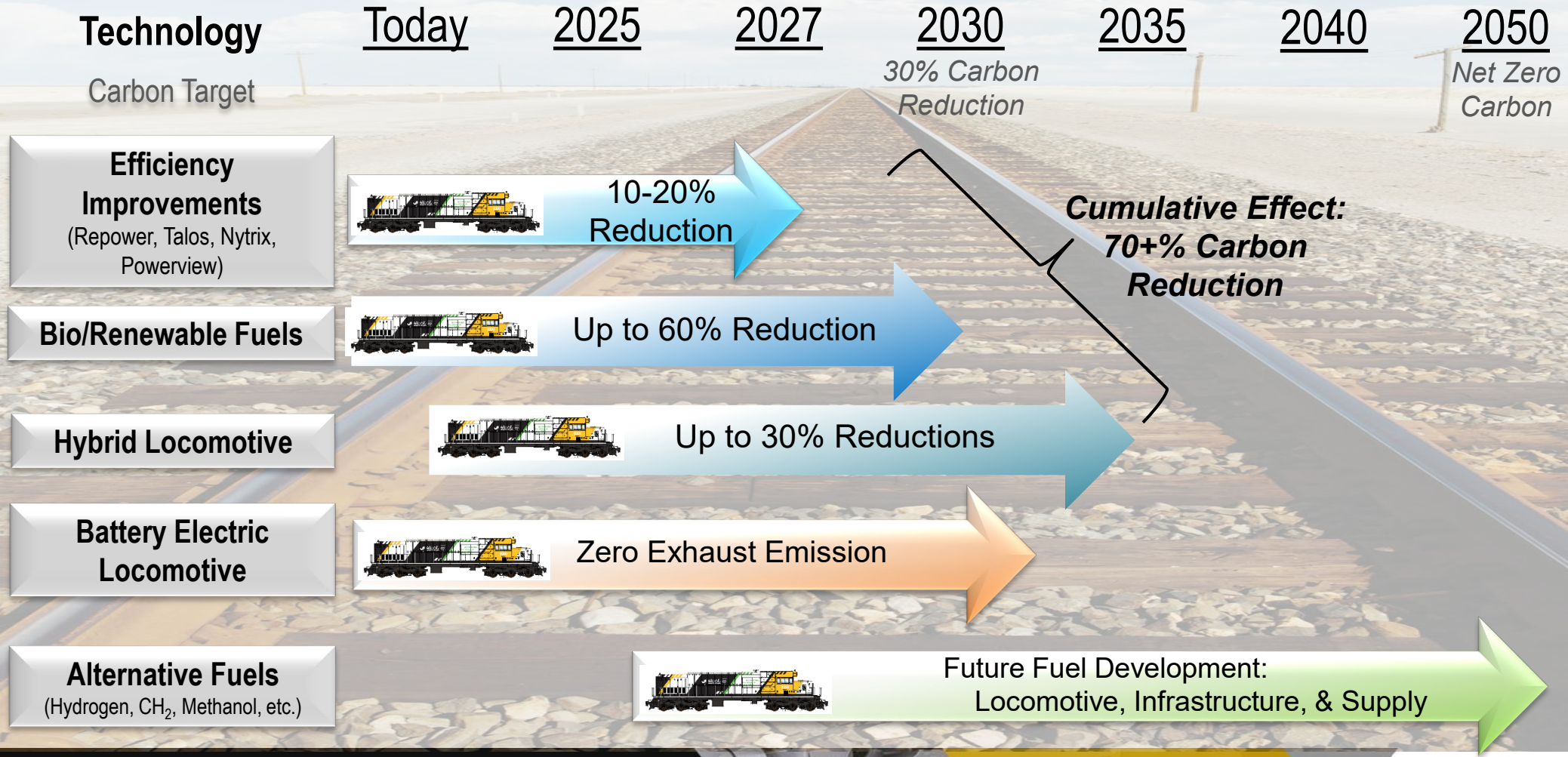


~\$30M
**Invested in Global
Communities by the
Caterpillar Foundation**



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Road to Decarbonization



CUSTOMER BENEFITS: AUTOMATION & SUSTAINABILITY

10-20%

Improvement in Fuel Efficiency

Reduce Driving Strategy Variability

Energy Management

- AutoControl - Throttle and DB
- Signaling integration (PTC)
- Air Brake prompting
- Locomotive idling/isolation

Next Generation

- Battery locomotive interface
- Horsepower management
- Low power EMD units



15%

Additional Fuel Savings

Significant Capacity Improvements

Network Optimization

- NitroMP Movement Planner
- **Pacing** (EM interface to a MP)
- Yard Optimization

Next Generation

- Moving block interface



5%

Fuel Savings

Supports Attended or Driverless

Automated Train Operation

- Air Brake control
- Zero-to-zero controller
- Sensor fusion, Lidar, Radar, GNSS, etc.
- **Supports 1 person crew** in U.S. and driverless for mining



EMD[®] Engines: Fuel Flexibility

Engines capable of accepting bio & renewable blends with minimal compromise

Biodiesel & Renewable Diesel are medium-term “bridge fuels”

- Substantial GHG reduction in “short time” with minimal impact to fuel infrastructure
- Less capital and operating cost impact; lower risk level to achieve GHG reduction targets
- Minimal impact to locomotive engines and fuel systems:
 - Development focused on emissions compliance, performance & reliability

Extensive testing & observation programs → Impacts are well understood

- Comprehensive stationary testing of 710 & 645 engines
 - Performance & emissions – done
- Field observations underway with up to 100% alternate diesel – 18+ month duration
 - Worldwide observation programs to ensure engine compatibility with whole fuel supply chain
- Testing partnership with Argonne National Lab to expand capabilities and progress future fuel

Solution for performance, reliability, compatibility, and compliance



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

EMD® Joule Battery Electric Locomotives

Broadest range of battery electric options – solution for regional service

Capabilities

- Produces the same *or more* HP & TE as a diesel
- Range limited – focus on yard & regional operations
- Zero exhaust emissions & low noise
- Maintain existing 24/7 operation capabilities
 - Right sized batteries & opportunity charging

Accomplishments

- Industry leading capacity and capabilities
- Vale GT38JC operation – iron ore unloading service since 2019
- PHL SD40JR – in-service imminently
- Worlds largest battery electric vehicle to start construction this year



GT38J (B&C)



SD70J



SD40JR



SD70J-BB

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

Battery Electric Hybrid Consists

Talos – Consist Management & BEL

The complete solution for hybrid consist regional operations

“Virtual” hybrid consist with Joule locos using Talos as the energy system backbone

Consist Behavior Optimization:

1. Ensure trip completion
2. Maximize Joule contribution → Max fuel reduction

Two Successful Approaches:

- Joule as lead and Talos control
 - Trip completion → Joule contribution maximization
- Consist communication

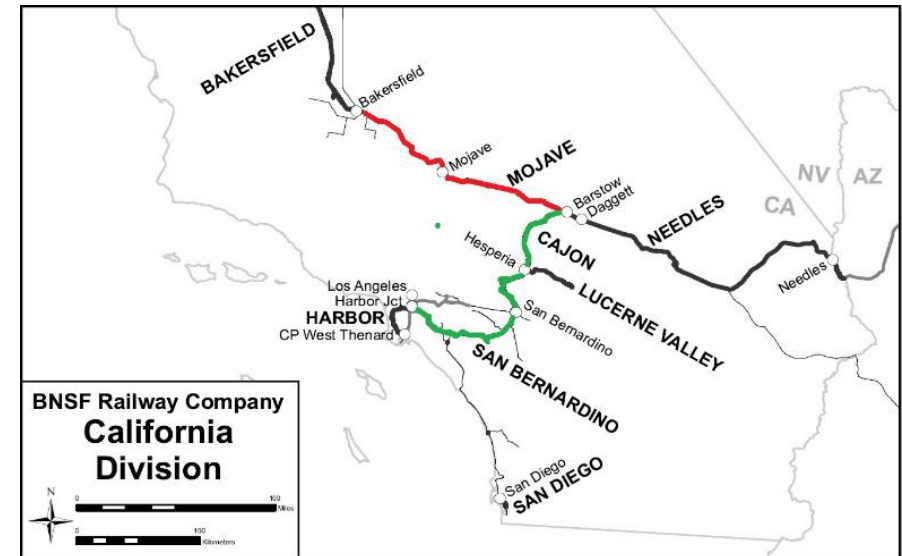
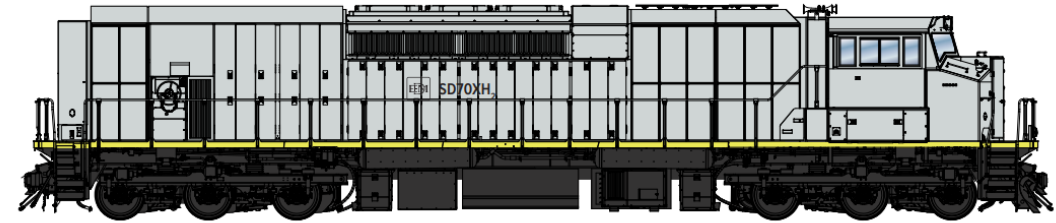


Talos lead unit has ability to leverage ICC routing (or trainline) to maximize consist effectiveness of DELs, BELs, or mixed operation.

Hydrogen Fuel Cell Locomotive Demonstration

Revenue service demo is foundation for future developments

- Demonstration Roles:
 - Progress Rail – locomotive development
 - Chevron – fueling infrastructure
 - BNSF – demonstration operator
- Project Objectives:
 - Feasibility of H₂ as a locomotive fuel
 - Explore fueling infrastructure
 - Demonstrate performance & capabilities
- Demonstration targeted to begin in 2024 – Barstow to Los Angeles, CA
- Locomotive configuration:
 - Battery & H₂ energy sources
 - Fuel cells provide lower throttle notch tractive effort and battery charging
 - Batteries boost power and tractive effort at higher throttle notches and provide transient response



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