

# FRA LOCOMOTIVE REPLACEMENT INITIATIVE FIRST YEAR EMISSIONS REDUCTIONS REPORT

In 2023, the Federal Railroad Administration (FRA) established the Climate and Sustainability Program (Program) to address FRA’s past, current, and future efforts to reduce harmful locomotive emissions, increase resiliency, and address sustainability and environmental issues on the U.S. rail network. As part of the Program’s efforts toward reducing emissions, FRA established the Locomotive Replacement Initiative (LRI).

The goal of the LRI is to encourage railroads to replace older, high-polluting, and less fuel-efficient diesel electric locomotives with newer low- and zero-emission locomotives. The LRI seeks to leverage FRA’s existing funding and research programs to support industry efforts. These efforts include: applied research, Consolidated Rail Infrastructure and Safety Improvements (CRISI) Grant Program funding, public and industry outreach, and information-sharing and partnerships for safety-testing and pilot projects. This report addresses the emissions reductions achieved through projects that received CRISI discretionary grant funding for fiscal year (FY) 2022.

## CRISI FY22 FUNDING RESULTS

A key component of the LRI is utilizing funding from the CRISI program’s provision<sup>1</sup> that allows the purchase of replacement locomotives that will result in significant emissions reductions.<sup>2</sup> CRISI primarily funds Class II and III railroad infrastructure but can also fund workforce development and research. CRISI is a popular competitive discretionary grant program at FRA and receives requests for funding that exceed the funding amount available. CRISI’s total allocation for FY 2022 was \$1,427,462,902 which included funding from annual appropriations and the Infrastructure Investment and Jobs Act (also known as the Bipartisan Infrastructure Law). The FY 2022 CRISI program provided the first year of funding for locomotive replacements under the LRI and supported the replacement of highly polluting locomotives through nine grant awards totaling \$60,375,260.<sup>3</sup> Recipients<sup>4</sup> averaged a 40 percent match for funding locomotive replacements, higher than the statutory minimum 20 percent match required for CRISI grant recipients.

FRA set rules for meeting CRISI requirements for locomotive replacements based on EA certification Tiers. FRA found that locomotives certified to less than Tier 2 standards were the worst polluting locomotives and is focusing on removing those locomotives from the rail network through the LRI. A Tier 3 locomotive can be replaced with a Tier 4 (the cleanest EPA certification standard) or a “zero-emission” locomotive that produces no tailpipe emissions, such

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<sup>1</sup> 49 U.S.C. § 22907(c)(16) (Eligible projects include “Rehabilitating, remanufacturing, procuring, or overhauling locomotives, provided that such activities result in a significant reduction of emissions.”).

<sup>2</sup> FRA defined “significant reduction of emissions” to focus on regulated EPA criteria pollutants and requires upgrades or replacement locomotives to meet at least EPA Tier 2 emissions standards and that more polluting locomotives are taken out of service and the engine destroyed. See “Frequently Asked Questions (FAQs) Regarding Locomotive Replacement Projects under FRA’s Consolidated Rail Infrastructure and Safety Improvements (CRISI) Grant Program,” at [https://railroads.dot.gov/sites/fra.dot.gov/files/2024-08/LRI%20FAQs%202024\\_PDFa.pdf](https://railroads.dot.gov/sites/fra.dot.gov/files/2024-08/LRI%20FAQs%202024_PDFa.pdf).

<sup>3</sup> At the time of developing this assessment, not all grants have been closed out. Changes may occur during the grant process. The figures in this document reflect current data as of November 5, 2024.

<sup>4</sup> See Appendix A for FY22 CRISI locomotive replacement projects and grant recipients.

as a battery-electric or hydrogen fuel cell unit. In the first year of the LRI, FRA funded the replacement of 39 switcher locomotives,<sup>5</sup> including 36 that were certified below Tier 2 standards (Table 1).<sup>6</sup> The funding included a record investment in 15 zero-emissions battery-switcher locomotives—a significant increase in the number of battery-switcher locomotives operating on the rail network. This funding demonstrates not only the availability of this transformative technology but also railroads’ interest in purchasing and operating zero-emission locomotives.

**Table 1. Types of Locomotives Replaced and Replacement Locomotive Technologies Funded Under the FY22 CRISI Grant Program**

| Original Equipment                           |                   | Replacement Equipment |        |        |         |
|--|-------------------|-----------------------|--------|--------|---------|
| Under Tier 2                                 | Tier 2 and Tier 3 | Tier 2                | Tier 3 | Tier 4 | Battery |
| 36   | 3                 | 12                    | 6      | 6      | 15      |
| Total Replaced: 39                           |                   | Total Purchased: 39   |        |        |         |
| <b>Total Number of FY22 CRISI LRI Grants</b> |                   | <b>9</b>              |        |        |         |

Emissions reductions supported by CRISI funding were calculated using the Locomotive Emissions Comparison Tool (LECT) that FRA developed to standardize emissions reduction estimates.<sup>7</sup> The emissions reductions were reported on the applicant’s Categorical Exclusion document to meet requirements under the National Environmental Policy Act (NEPA). Table 2 highlights the total reduction in EPA-criteria pollutant emissions, greenhouse gas (GHG) emissions, as well as costs of the nine awarded grants.<sup>8</sup>

**Table 2. Summarized Results of FY22 CRISI Locomotive Replacement Initiative Grants: Annual Tailpipe Emissions Reductions and Total Project Costs**

| Total EPA-Criteria Pollutant Emissions Reductions (U.S. Short Tons) |                 |                   |                  |      | Total GHG Emissions Reductions (Metric Tons) |                    | Total Project Costs (Millions \$) |                 |       |
|---|-----------------|-------------------|------------------|------|--|--------------------|-----------------------------------|-----------------|-------|
| CO  | NO <sub>x</sub> | PM <sub>2.5</sub> | PM <sub>10</sub> | VOC  | CO <sub>2</sub>                              | CO <sub>2</sub> eq | CRISI Funding                     | Recipient Match | Total |
| 17.3  | 181.3           | 5.1               | 5.1              | 12.5 | 5844   | 5900               | 60.3                              | 39.8            | 100.1 |

Notes: All numbers are rounded, which may produce minor inconsistencies. For projects that also included activities not related to the purchase of a locomotive, the locomotive purchase costs were extracted from the grant proposals. Costs also include the installation of charging stations for battery locomotives. Emissions are measured at the tailpipe and do not include upstream emissions from fuel production or electricity generation elsewhere.

For perspective, the reduction in NO<sub>x</sub> emissions, which is a leading pollutant affecting health, is equivalent to removing 18,000 passenger cars from roads in the United States.<sup>9</sup> The CO<sub>2</sub>eq

<sup>5</sup> Switcher locomotives operate in rail yards or used for shorter trips and have a lower horsepower rating than locomotives used to travel long distances.

<sup>6</sup> The LRI requires that the locomotives taken out of service, if they are below Tier 2, have their engines rendered inoperable or donated to research. Parts from these locomotives may be sold or reused.

<sup>7</sup> The LECT and information about the tool can be found here: <https://railroads.dot.gov/elibrary/fra-locomotive-emissions-comparison-tool>.

<sup>8</sup> Grants may still be active. Data is taken from NEPA documents and applications. Any changes to the grant after the publication of this document may slightly alter the totals.

<sup>9</sup> In order to perform this estimate, the following calculation was used: For year 2021 rate of 0.678 grams NO<sub>x</sub> per mile – Refer to BTS 2023 at [Estimated U.S. Average Vehicle Emissions Rates per Vehicle by Vehicle Type Using Gasoline and Diesel | Bureau of Transportation Statistics \(bts.gov\)](https://www.bts.gov/publications/reports/2023/04/estimated-u-s-average-vehicle-emissions-rates-per-vehicle-by-vehicle-type-using-gasoline-and-diesel) and an average of 13,476 miles per year from FHWA statistics from <https://www.fhwa.dot.gov/ohim/onh00/bar8.htm> for a total of 9,136,728 grams of NO<sub>x</sub> per year for an average car. There are 164,472,593 grams in 181.3 U.S. short tons (999,746 grams per U.S. short ton).

emissions avoided in the first year of LRI is equivalent to removing over 1,280 typical passenger cars from roads in the United States.<sup>10</sup> The U.S. Department of Transportation (DOT) has calculated the annual dollar value of the pollution benefits of emissions reductions and provides the cost of NO<sub>x</sub>, PM<sub>2.5</sub>, and CO<sub>2</sub> in its benefit-cost analysis guidance.<sup>11</sup> Table 3 details the monetized values of selected emissions reduced from the first year of the LRI, utilizing the values from the DOT guidance. The value of the prevented emissions from the two regulated pollutants and CO<sub>2</sub> is over \$9.1 million dollars. Note that these benefits are realized annually, and within five or six years, these benefits will exceed initial Federal investment. LRI investments become even more beneficial when spread over the life of the locomotive.

**Table 3. Annual Monetized Benefits of FY22 CRISI Locomotive Replacement Initiative Grants from Emissions Reductions**

| Pollutant or GHG   | Cost per Metric Ton <sup>12</sup> | Annual Monetized Benefit from FY22 CRISI LRI |
|--------------------|-----------------------------------|--|
| NO <sub>x</sub>    | \$20,100                          | \$3,305,899                                  |
| PM <sub>2.5</sub>  | \$963,200                         | \$4,456,382                                  |
| CO <sub>2</sub> eq | \$233                             | \$1,374,700                                  |
| <b>TOTAL</b>       |                                   | <b>\$9,136,981</b>                           |

Notes: Values are for 2024. The DOT guidance did not include values for PM<sub>10</sub>, CO, or VOC, thus the total emissions cost benefits are higher than reported in this table.

While the total of 39 new locomotives reflects a small percentage of the thousands of pre-Tier 3 and Tier 4 locomotives that operate on the national rail network, the first year of the LRI demonstrates the potential benefits of the program in reducing emissions and removing the oldest and dirtiest polluting locomotives from the rail network. The LRI was also considered “over-subscribed,” with more applications than available funding.

### ADDITIONAL BENEFITS

In addition to the quantified emissions reductions, the LRI provides several non-emissions benefits that could be viewed as significant on their own. Many of the retrofits (which entails keeping the frame and structure of the locomotive and replacing the engine and associated components), along with the newly manufactured locomotives, contain modern safety features that older locomotives lack. In addition, older locomotives are prone to diesel and oil leaks, and engine part fatigue and failure, and replacement parts are not easily available. In contrast, newer locomotives have a higher reliability rate and fewer breakdowns. Newer locomotives are also often quieter and exhibit less vibration than older locomotives, providing benefits to rail operators, railyard workers, and nearby communities. While the monetized values for pollution reduction are quantified in Table 3, the impacts of air pollution from switcher locomotives are often borne by nearby communities that meet the definition of a disadvantaged community

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164,472,593 total grams of NO<sub>x</sub> prevented / 9,136,728 grams of NO<sub>x</sub> of an average U.S. car per year = 18,001.3 cars.

<sup>10</sup> Refer to “Greenhouse Gas Emissions from a Typical Passenger Vehicle,” EPA, Office of Transportation Air Quality, June 2023, EPA-420-F-23-014; <https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle>. A typical car emitted 4.6 metric tons of GHG emissions a year.

<sup>11</sup> See *Benefit-Cost Analysis Guidance 2024 Update*, U.S. DOT, at <https://www.transportation.gov/mission/office-secretary/office-policy/transportation-policy/benefit-cost-analysis-guidance>.

<sup>12</sup> Short tons for EPA criteria pollutants have been converted to metric tons. There are 0.907 metric tons per U.S. ton (short ton).

within DOT’s Justice40 program. By targeting switcher locomotives in railyards, the LRI provides environmental justice benefits.

By retrofitting older locomotives with newer engines, railroads realize fuel savings since Tier 2, 3, and 4 locomotives are more efficient than lower-Tier locomotives (hence the reductions in CO<sub>2</sub>). Given the amount of CO<sub>2</sub> emissions avoided, this is equivalent to 574,067 gallons of diesel fuel saved.<sup>13</sup> As the price of diesel fluctuates, the fuel savings to the rail industry range from \$1.87 million to \$2.44 million annually, as shown in Table 4.

**Table 4. Estimated Gallons of Diesel Saved and Estimated Savings to Industry at Various Price Points**

| Gallons of Diesel Saved | Price per Gallon of Diesel <sup>14</sup> | Annual Savings to Industry |
|-------------------------|--|----------------------------|
| 574,067                 | \$3.25                                   | \$1,865,718                |
|                         | \$3.50                                   | \$2,009,235                |
|                         | \$3.75                                   | \$2,152,751                |
|                         | \$4.00                                   | \$2,296,268                |
|                         | \$4.25                                   | \$2,439,785                |

Zero-emission locomotives do not require diesel fuel at all, removing the need for fuel deliveries and storage and eliminating the risk of diesel spills and associated costs and impacts. Battery switchers also lack other fluids and the maintenance needs of diesel locomotives, such as transmission fluid and oil changes, which can reduce maintenance costs. In addition, the purchase of battery locomotives supports innovative technology development and supports innovative locomotive manufacturing and job creation in the United States.

<sup>13</sup> Derived from CO<sub>2</sub> avoided. 10,180 grams of CO<sub>2</sub> per gallon of diesel are combusted. 5,844,000,000 grams (or 5,844 metric tons) CO<sub>2</sub> prevented/10,180 grams CO<sub>2</sub> per gallon of diesel = 574,067 gallons of diesel saved.

<sup>14</sup> Like all liquid fuels, the price can vary wildly in any given year. The rail industry often buys contracts at various price points, but those exact numbers are not publicly available. The range provided here is a reasonable per-gallon rate for diesel but may not be exactly what the industry paid.

## APPENDIX A: FY22 CRISI Grant Awards for the Locomotive Replacement Initiative

| Grantee   | Project Name  | Location(s)   | New Equipment       |
|---|---|---|---------------------|
| Maryland Department of Transportation           | Port of Baltimore Strategic Acquisition of Battery Electric Locomotives Project                               | Baltimore, Maryland   | 3 Battery Switchers |
| Kansas Department of Transportation             | kWat: Electrifying Watco Locomotives Project  | Nashville, Arkansas;<br>Jacksonville, Florida;<br>Savannah, Georgia;<br>East St. Louis, Illinois;<br>DeRidder, Louisiana;<br>North Kansas City, Missouri;<br>Vicksburg, Mississippi | 8 Battery Switchers |
| South Carolina Department of Commerce           | Procurement and Retrofitting of Two Zero-Emission Lithium-Ion Battery Electric-Powered Locomotives Project    | North Charleston, South Carolina  | 2 Battery Switchers |
| Tacoma Rail                                     | Tacoma Rail Battery-Electric Switcher Locomotive Replacement Project  | Puget Sound, Washington   | 2 Battery Switchers |
| Modesto and Empire Traction Company             | The Central Valley Rail Emissions, Logistics and Crossing Improvement Project                                 | Modesto, California   | 2 Tier 4 Switchers  |
| Bighorn Divide & Wyoming Railroad Inc.          | Strategic Acquisition of Efficient & Clean Tier 4 Locomotive Project  | Shoshoni, Wyoming   | 1 Tier 4 Switcher   |
| Livonia, Avon & Lakeville Railroad Corp.        | Livonia, Avon & Lakeville Systemwide Tier 3 Clean Locomotive Acquisition Project                              | Lakeville, Genesee Junction, Wayland, Painted Post, New York  | 6 Tier 3 Switchers  |
| Sonoma-Marín Area Rail Transit District (SMART) | SMART Healdsburg Green Rail Modernization Project - Freight Locomotive Replacement and Healdsburg PTC Systems | Sonoma-Marín, California  | 3 Tier 4 Switchers  |
| Paducah & Louisville RR <sup>15</sup>           | Fostering Economic Stability Throughout Kentucky Project  | Kentucky  | 12 Tier 2 Switchers |

<sup>15</sup> Note this grant included the rehabilitation of several locomotives that did not meet the requirements of the Locomotive Replacement Initiative.