CPRG Implementation Grant Technical Appendix
Massachusetts Comprehensive Fleet Electrification Initiative

Section 1. Overview of Medium- and Heavy-Duty Transportation Sector Emissions in Massachusetts

Medium- and heavy-duty (MHD) diesel vehicles contribute heavily to air pollution; on-road diesel vehicles are the third largest NOx emissions source in the Northeast and Mid-Atlantic and contribute the majority of on-road tailpipe-related PM2.5 emissions.[1] In Massachusetts specifically, MHD vehicles represent 5% of the vehicles on the road but contribute 20% of transportation greenhouse gas (GHG) emissions and 40% of particulate matter pollutants such as volatile organic compounds and nitrogen oxide (NOx) emissions.[2] While these MHD vehicles represent a smaller number of vehicles, they have a disproportionately larger impact on air quality emissions and health outcomes compared to the sector at large. In addition, emissions from diesel vehicles are concentrated in urban areas and Environmental Justice and low income and disadvantaged communities (see Figure 1).

In its analysis of potential strategies to meet the directive for a net zero economy by 2050, the Massachusetts Clean Energy and Climate Plan[3] modeled that one means of achieving net zero emissions in the transportation sector would include 93% electrification of the MHD sector by 2050. Accelerated electrification of this sector is a key component of the 2050 net zero target and furthermore achieves significant benefits including reduced air pollution, GHG emissions, and noise pollution.

FIGURE 1. High Variation in Exposure to $PM_{2.5}$ Pollution from On-Road Vehicles in Massachusetts

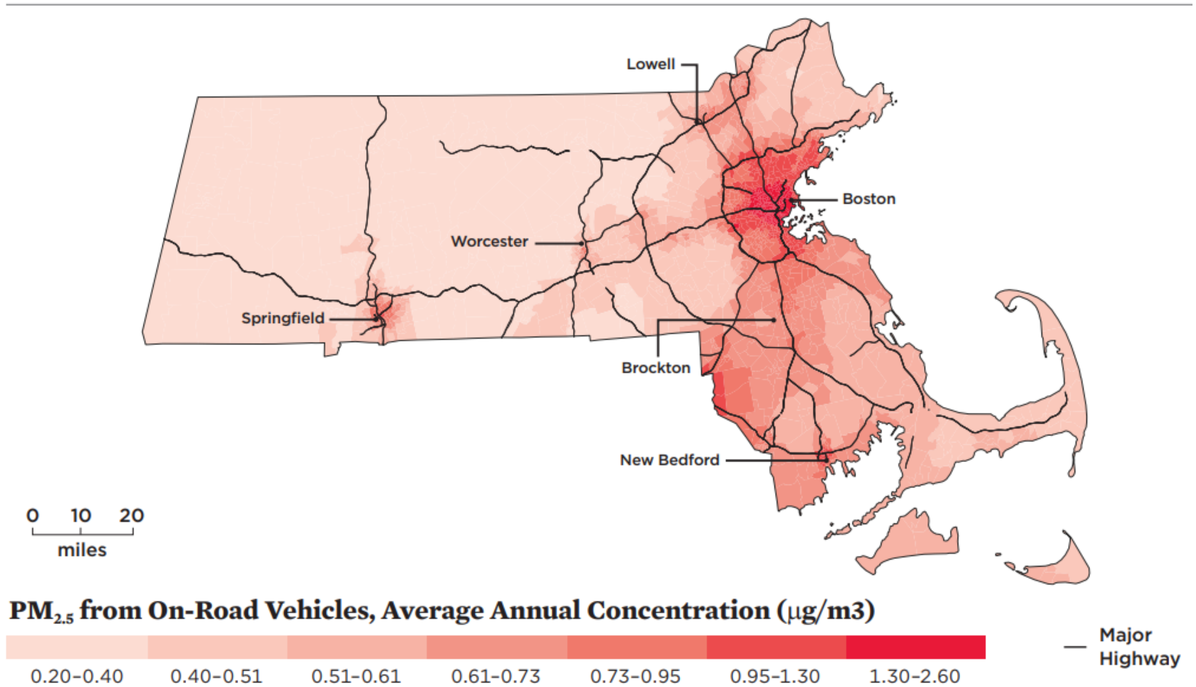

Figure *1* Source: https://www.ucsusa.org/sites/default/files/attach/2019/06/Inequitable-Exposure-to-Vehicle-Pollution-MA.pdf

On-road vehicle registration data from the Massachusetts Registry of Motor Vehicles demonstrates the current state of MHD electrification, as shown in Table 1.

Table 1: Composition of Massachusetts On-Road MHD Vehicles

Vehicle Class	Gas/Diesel		Battery Electric	
Class 3	70,837	38.34%	35	0.02%
Class 4	15,859	8.58%	0	0.00%
Class 5	21,891	11.85%	0	0.00%
Class 6	20,077	10.87%	2	0.00%
Class 7	18,171	9.83%	18	0.01%
Class 8	37,856	20.49%	27	0.01%
TOTAL	*184,691*	*99.96%*	*82*	*0.04%*

There are an additional 655 hybrid electric and 2 plug-in hybrid electric Class 3-8 vehicles registered in Massachusetts. The Massachusetts CPRG proposal is focused on replacing gas and (primarily) diesel vehicles with all-electric models, also referred to here as zero-emission vehicles (ZEVs). ZEVs include both fully battery electric (BEV) and hydrogen fuel cell vehicles (HFCV), and this analytical exercise assumes emissions impacts from BEVs only since there are not currently any MHD HFCVs registered in the state.

Existing rebate and incentive programs through Massachusetts state agencies and utilities, and regulations such as Advanced Clean Trucks, are priming the MHD vehicle space for a zero-emission future, and the CFEI is critical for reducing emissions as quickly as possible.

Section 2. Description of GHG Reduction Measures

According to its 2022-2026 Strategic Plan[4], U.S. EPA seeks to reduce GHGs from the largest sources of GHG emissions in the transportation sector (including medium- and heavy-duty vehicles), which is a critical goal shared by the Commonwealth of Massachusetts. The proposed "Massachusetts Comprehensive Fleet Electrification Initiative" (CFEI) is designed to directly reduce emissions from GHG and criteria pollutants as well as pave the way for continued adoption of MHD ZEVs well beyond the Climate Pollution Reduction Grant performance period.

The proposed CFEI has five key components:

1. **Enhanced fleet advisory services** designed to provide a one-stop-shop experience for fleets that need technical assistance and guidance on vehicles, charging infrastructure, incentives, vehicle operation, etc.

2. **Increased rebates for Class 3-8 ZEVs**, including rebate adders for fleets impacting federally designated low-income and disadvantaged communities (LIDACs), small businesses, community-based fleets, and the scrappage of diesel vehicles.

3. **Financial support for the deployment of electric vehicle charging equipment** (EVSE) not covered by existing utility make-ready programs or other funding opportunities.

4. **Community-based outreach** program that will partner directly with community-based organizations with direct connection to LIDACs and the fleets within them; additional outreach to fleets is planned through dealership and trade associations.

5. **Electric vehicle technician training programs** (as an alternative to traditional diesel technician training) that will ensure that multiple automotive programs in the Commonwealth have the

equipment and training necessary to support an ongoing pipeline of technicians that can maintain and repair electric trucks far into the future.

Section 3. Methodology for Calculating Emissions

The U.S. DOE's Argonne National Laboratory developed the Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool[5] to help estimate GHG emissions and air pollutant emissions for multiple vehicle types, including MHD assets. For its light-duty ZEV rebate program, the Massachusetts Department of Energy Resources utilizes the AFLEET Tool to communicate corresponding emissions savings achieved through the program; for consistency, the AFLEET Tool (2023 edition) was also used as the basis for CFEI MHD emissions calculations based on the ZEV rebate measure of the program. There may be additive emissions benefits accrued from CFEI-funded charging infrastructure, such as providing charging for additional ZEVs beyond those funded through the CFEI program, or the added benefit of the program paying for pre-wiring to ensure additional ZEV charging use in the future, but those benefits have not been quantified herein.

The AFLEET tool was first filtered for Massachusetts, using Suffolk County as a proxy for the state. Representative baseline vehicles were then selected for each class, and the following assumptions outlined in Table 2 for annual vehicle miles traveled (VMT) and vehicle lifetime from AFLEET were also used in the analysis:

Table 2: Vehicle Assumptions

Vehicle Class	Representative Vehicle Type	Annual Vehicle Miles Traveled	Vehicle Lifetime
Classes 3 & 4	Gas/Diesel Medium-Duty Pickup Truck	24,000	15 years
Class 5	Diesel Delivery Step Van ("Single Unit Short-Haul Truck")	16,500	
Class 6	Diesel Delivery Straight Truck ("Single Unit Long-Haul Truck")	23,000	
Class 7	Diesel School Bus	15,000	
Class 8	Diesel Refuse Truck	23,400	

The reference scenario (also referred to herein as the baseline scenario) used to quantify GHG emission reductions assumes that Class 3-8 fossil fuel vehicles will be replaced in-kind at the end of the vehicle lifetime.

a. Estimate of Well-to-Wheels GHG Emission Impacts of MHD ZEVs vs. Baseline Vehicles

CFEI is focused on primarily replacing diesel vehicles and/or reducing the VMT by diesel vehicles as fleets start to transition to ZEVs-only. AFLEET was utilized to determine the Year 1 baseline GHG emissions from internal combustion vehicles, as well as the well-to-wheels emissions (all emissions related to fuel production, processing, distribution, and use) for an equivalent ZEV alternative. The ZEV emissions were subtracted from the baseline emissions to determine the Year 1 GHG savings in short tons. Calculations in short tons are later converted to metric tons using a conversion factor of 0.907185; see results in Table 3 below.

CFEI emissions calculations use the default GHG values from AFLEET for all years 2025-2050. For gasoline and diesel vehicle types, AFLEET uses the U.S. EPA MOtor Vehicle Emission Simulator (MOVES) to generate emission factors by state. For ZEVs, AFLEET utilizes regional grid generation mixes, specified as percentages, and applies default factors based on the proportions of the individual generation types. This analysis uses the grid information for the Northeast Power Coordinating Council (NPCC) as specified with AFLEET (see Figure 68 in the User Guide for AFLEET Tool 2023[6]).

For simplified calculations for the transition from gas or diesel to ZEVs, these estimates assume that the number of vehicle miles traveled will be equivalent to then identify the emissions reductions per ZEV before applying those emissions reductions to the assumed number and types of anticipated ZEVs displacing internal combustion vehicles; see Table 3.

Table 3: Baseline vs. ZEV Emissions Assumptions

Average Estimated Emissions per Vehicle	Year 1 Baseline GHG (short tons)	Year 1 ZEV GHG (short tons)	Year 1 GHG Savings (short tons)
Classes 3 & 4	20.1	5.3	14.8
Class 5	35.1	7.2	27.9
Class 6	55.2	11.3	43.9
Class 7	29.7	7.6	22.1
Class 8	186.1	43.1	143.0

Note: Massachusetts Registry of Motor Vehicle data demonstrates current Class 3 & Class 4 vehicles are a nearly even mix of gas and diesel, so an average of the two fuel types in AFLEET was used for the baseline GHG value.

Section 4. Other Underlying Assumptions and Variables

a. Number of ZEV Rebates by Class and Year

The CFEI has a target of electrifying 750 MHD vehicles through the program to increase the number of medium/heavy-duty EVs on the road by ten times the current amount. Due to program ramp-up time and long lead times for ordering MHD vehicles, MA DOER assumes that initial adoption will be lower in the first years of the program. The program is anticipated to run between calendar years 2025-2029.

The ultimate ZEV replacement types will have an impact on the overall emissions reductions, since the relative emissions and pollutants will vary by vehicle class, type, and VMT. While the exact breakdown of vehicles by class over the course of the performance period is not predictable, the relative proportion of rebates assumed by vehicle class is herein based on the corresponding proportion of currently registered gas/diesel vehicles by class that are ≥5 years old, which have a greater likelihood of replacement between 2025-2029 than vehicles that are <5 years old. The analysis further assumes that all program-incentivized vehicles are driven the same distances as the gas/diesel vehicles that they replace (i.e., VMT is held constant at the values shown in the table above for all vehicle classes).

The coalition partners anticipate launching CFEI in 2025; however, it is presumed that there will be variation among the rebates issued in 2025 in terms of when those vehicles enter operation, as shown in Table 4. Therefore, the emissions calculations do not account for emission reduction benefits from ZEVs until 2026, when all vehicles that received rebates in Year 1 would be considered “active.”

Table 4: Annual Rebate Assumptions

Estimated ZEV Rebates Issued by Class, by Year	Year 1 2025	Year 2 2026	Year 3 2027	Year 4 2028	Year 5 2029	*SUBTOTAL*
Class 3	30	40	60	80	90	*300*
Class 4	15	20	30	40	45	*150*
Class 5	7	10	15	20	23	*75*

Class 6	7	10	15	20	23	*75*
Class 7	7	10	15	20	23	*75*
Class 8	7	10	15	20	23	*75*
SUBTOTAL	*73*	*100*	*150*	*200*	*227*	***750***

b. Emissions Corresponding to ZEV Use within Fleets

For all vehicle classes across the performance period, CFEI assumes that:

- 80% of ZEVs replace existing fossil fuel vehicles in operation (i.e., existing vehicles are replaced by a ZEV rather than another gas or diesel model), calculated as avoided emissions.
- 10% of ZEVs are purely for fleet expansion (i.e., existing vehicles are still being driven), calculated as additional emissions.
- 10% of ZEVs cause a reduction in the emissions of existing vehicles (i.e., existing vehicles are driven less), calculated as a 50% reduction in baseline vehicle emissions.

c. Other Variables

The emissions calculations cannot fully account for dynamics outside the direct control of the CFEI, including the degree to which these external forces may impact projected uptake of the program offerings and if/how those dynamics then impact the magnitude and timeline of emission reductions (e.g., vehicle delivery delays). The coalition partners recognize that there are two primary variables in play:

- Vehicle availability: Generating sufficient demand for MHD ZEVs is critical for manufacturers to ramp up production and increase supply so that fleets can acquire vehicles they need in a timely manner.
- Rate of program uptake by fleets: Even with widespread outreach and community engagement, initial uptake of the program and sustained fleet engagement across the performance period is somewhat unpredictable.

However, the CFEI itself has been designed to mitigate these potential uncertainties to the greatest extent possible, as further outlined in the Workplan (file name: Workplan_MA-DOER.pdf).

Section 5. Projected GHG Emission Reductions

For a more detailed view of the associated emissions reduction projections, please see the GHG Emission Reduction Calculations Spreadsheet (file name: GHGcalcs_MA-DOER.xlsx). As noted in Section 4, the associated emissions benefits are assumed to begin accruing in 2026.

a. The Magnitude of GHG Reductions from 2025 through 2030

The outputs below consider the additive emissions reductions from the CPRG portion of the program. The CFEI coalition partners have estimated $23.5M will be contributed from existing state programs between 2025-2030. With the total CPRG request of $95,100,619, this means that existing state programs account for 20% of the total investment and CPRG funds equate to 80% of that total. Therefore, these estimates assume that CPRG will directly enable 80% of the total emissions reductions between 2025-2030, which is 36,205 metric tons.

As shown in Table 5, marginal emissions represent the difference in emissions reductions as compared to the previous year. Total emissions are the emissions reductions in each single year (given the program-incentivized vehicles deployed up to and including that year), while cumulative emissions capture the sum of all emissions reductions up to and including each year.

Table 5: 2025-2030 Emissions Reductions (metric tons)			
Year	Marginal	Total	Cumulative
2025	0	0	0
2026	1,408	1,408	1,408
2027	1,973	3,380	4,788
2028	2,959	6,339	11,127
2029	3,945	10,284	21,411
2030	4,510	14,794	36,205

b. The Magnitude of GHG Reductions from 2025 through 2050

After 2045, which is 15 years following the final year of the performance period, there are no further emissions reductions included in the estimate because it is assumed that vehicles incented through CFEI will no longer be in use (see Section 3, vehicle lifetime assumptions).

As described above, marginal emissions in this table represent the difference in emissions reductions as compared to the previous year. Total emissions are the emissions reductions in each single year (given the program-incentivized vehicles deployed up to and including that year, minus any vehicles retired prior to or including that year). Cumulative emissions capture the sum of all emissions reductions up to and including each year, as shown in Table 6.

Table 6: 2025-2050 Emissions Reductions (metric tons)			
Year	Marginal	Total	Cumulative
2025	0	0	0
2026	1,408	1,408	1,408
2027	1,973	3,380	4,788
2028	2,959	6,339	11,127
2029	3,945	10,284	21,411
2030	4,510	14,794	36,205
2031	0	14,794	50,999
2032	0	14,794	65,793
2033	0	14,794	80,587
2034	0	14,794	95,381
2035	0	14,794	110,175
2036	0	14,794	124,969
2037	0	14,794	139,764
2038	0	14,794	154,558
2039	0	14,794	169,352
2040	0	14,794	184,146
2041	-1,408	13,387	197,532
2042	-1,973	11,414	208,946

2043	-2,959	8,455	217,401
2044	-3,945	4,510	221,912
2045	-4,510	0	221,912
2046	0	0	221,912
2047	0	0	221,912
2048	0	0	221,912
2049	0	0	221,912
2050	0	0	221,912

Section 6. Cost-Effectiveness of GHG Emissions

Total CPRG funding request: $95,100,619

2025-2030 emissions reductions attributed to CPRG funding: 36,205 metric tons

$95,100,619 ÷ 36,205 metric tons GHG = **$2,626.73 per metric tons GHG**

Section 7. Quantifying Emissions During the Performance Period

Based on the number and types of ZEVs placed into operation through the collective CFEI programs, as tracked through corresponding application and ongoing reporting data, GHG emissions and air pollutant reductions will be tracked overall and for LIDACs specifically. During the CPRG performance period and subsequent ongoing reporting to U.S. EPA, the CFEI will account for emissions potentially using both the original assumptions (i.e., AFLEET) as well as the most up-to-date Massachusetts-specific emissions factors for the corresponding year(s).

CFEI applicants will be required to provide data related to existing fleets, including but not limited to number and types of vehicles; annual miles driven by any vehicle to be replaced by a ZEV; typical vehicle operation location(s); and the extent to which ZEVs will be deployed only for fleet expansion versus full or partial gas/diesel replacement.

Fleets receiving ZEV funding will also be required to report annually on vehicle miles traveled (e.g., through submitting a vehicle inspection report) and any changes to operational location during the first five years post-incentives; the designated CFEI Outreach Manager will be responsible for ongoing data tracking for fleets that receive funding through CFEI.

References

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