An Assessment of Connecticut's Need to Adopt California's Medium and Heavy-Duty Vehicle Emission Standards

Connecticut Department of Energy and Environmental Protection

Executive Summary

For almost forty-five years, Connecticut has failed to comply with the National Ambient Air Quality Standards (NAAQS) for ozone (smog). Today, Connecticut fails to meet both the 2008 and 2015 ozone NAAQS. To comply with the ozone standard and meet Connecticut's greenhouse gas (GHG) reduction targets, Connecticut needs to achieve emission reductions from the transportation sector, which is responsible for over 67% of ozone-forming precursor emissions in Connecticut. Failing to meet these health-based standards has subjected generations of Connecticut residents to adverse health and economic impacts. This past year, Connecticut experienced twenty-one days of unhealthy levels of ozone, and documented some of the highest monitored values on the East Coast.

Additionally, the 2018 Connecticut Greenhouse Gas Emissions Inventory, issued by DEEP in 2021, determined that the State is not on track to meet its 2030 and 2050 Global Warming Solutions Act targets.[1] Transportation sector GHG emissions for 2018 (the latest year for which data is available) comprise 37.4% of economy-wide emissions,[2] the single largest contributor, and continue to increase; by contrast, transportation emissions must decline by roughly one-third in this decade if the State is to meet the economy-wide GHG emission reduction target for 2030 established by the Global Warming Solutions Act.[3]

Reducing emissions from the medium- and heavy-duty (MHD) vehicle sector is an essential component of any successful strategy to meet our air quality and greenhouse gas (GHG) emission goals. Of all mobile source emissions, MHD vehicles — including trucks, buses, and smaller delivery vehicles account for as much as 53% of emissions of nitrogen oxides (NOx, an ozone precursor), despite being only 6% of the vehicle fleet (by weight).[4] MHD vehicles are also responsible for 25% of greenhouse gases emissions from the transportation sector.

Adoption of vehicle emission standards will ensure that manufacturers are producing lower-and emission-free MHD vehicles and offering them for sale in Connecticut. Under the federal Clean Air Act, Connecticut cannot independently set its own new vehicle emission standards. Accordingly, Connecticut has two options to reduce emissions from MHD vehicles:

1. Adopt California's MHD vehicle emission standards, which were formally adopted last year in California, and will go into effect as early as 2024; or
2. Wait for EPA to adopt new federal standards, which even when proposed, could not be implemented until 2027 at the earliest. The existing federal standards are outdated and do not meet Connecticut's air quality, climate mitigation and public health needs.

A review of economic, air quality and public health impacts associated with reducing air pollution from new medium and heavy-duty (MHD) vehicles conclusively demonstrates that proactively implementing the suite of California emission standards for new MHD vehicles rather than relying on outdated federal regulations will yield

[1] https://portal.ct.gov/-/media/DEEP/climatechange/GHG_Emissions_Inventory_2018.pdf
[2] Id. at page 4.
[3] See Conn. Gen. Stat. Section 22a-200a, Chapter 446c - Air Pollution Control (ct.gov)
[4] Southern New England Clean Trucks Program, Connecticut Fleet Share p. 36

significant benefits in Connecticut and help the State meet health-based federal air quality standards and state required climate mitigation targets. These benefits are detailed in the following two pages.

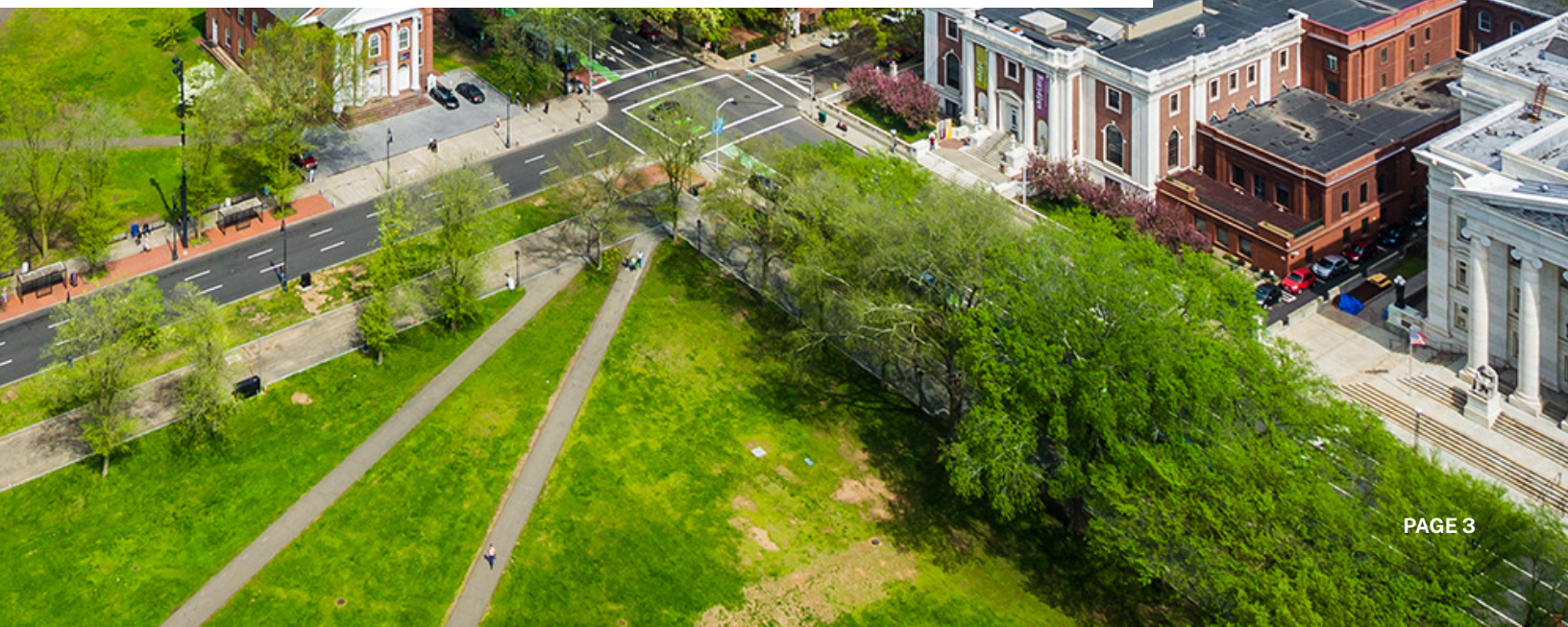
As of January 2022, in addition to California five States including New York, New Jersey, Massachusetts, Oregon, and Washington, have adopted the California standards, and three additional States have also joined an MOU indicating intent to do so. On December 16, 2021, Governor Lamont issued Executive Order No. 21-3 directing state agencies to mitigate GHG emissions.[5] Among the twenty-three actions, the Department of Energy and Environmental Protection (DEEP) was tasked with assessing the need to adopt the California MHD vehicle emissions standards to meet air quality standards and emission reduction targets as part of Connecticut's efforts to address climate, health, equity and environmental justice. Given the long-term policy commitment associated with controlling MHD emissions, DEEP should not adopt the California standards unless authorized by the General Assembly to do so.

DEEP staff have reviewed several sources in order to determine the emissions and economic benefits associated with these two sets of standards. These include: "**Southern New England Clean Trucks Program**", a report by M.J. Bradley and Associates, commissioned by Union of Concerned Scientists; health benefits modeling using the U.S. Environmental Protection Agency (EPA) CO-Benefits Risk Assessment tool (COBRA) and economic modeling platform; air quality modeling using the EPA MOVES model; and evaluation of the expected benefits provided in two separate CARB regulatory documents[6] paired with scaling factors for Connecticut. This analysis specifically considers the environmental, economic and health benefits of adopting California's MHD emissions standards applicable to new Class 2b-8 vehicles[7] in Connecticut and concludes the adoption of these standards will deliver significant environmental benefits to Connecticut residents, especially the most vulnerable, and reduce health costs for Connecticut's population.

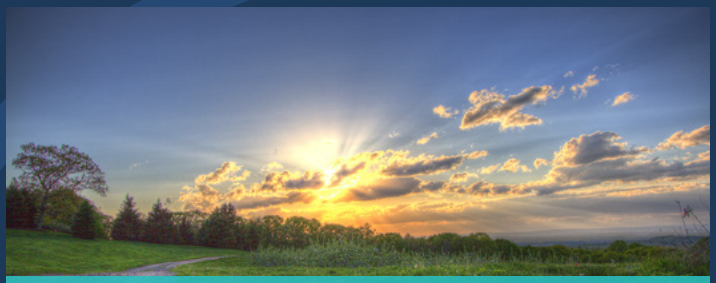
[5] The Executive Order's call-to-action outlined twenty-three actions in multiple areas including: Buildings and infrastructure, Clean transportation, Community climate resilience, Health, equity, and environmental justice, Jobs and the economy; and Natural and working lands.

[6] "Notice of Public Hearing to Consider the Proposed Heavy-Duty Engine and Vehicle Omnibus Regulation and Associated Amendments" and "Policy Update: California's Advanced Clean Trucks regulation: Sales requirements for zero-emission heavy-duty trucks."

[7] The California standards apply to new medium and heavy-duty (MHD) vehicles from 10,001 pounds gross vehicle weight rating (GVWR Class 2b) up through 33,001+ pounds GVWR (Class 8).



Benefits of adopting the California Advanced Clean Trucks (ACT) and Low NOx Omnibus Standards



Climate

Significant Reductions in GHG Emissions

Adopting the California standards will reduce carbon emissions by over 350,000 tons per year in 2050. MHD trucks account for 6% of on-road vehicles and account for 25% of economy-wide greenhouse gas emissions in Connecticut.

Air Quality

Significant Reduction of Harmful Pollutants Contributing to Unhealthy Air Quality

Adopting the California standards will reduce smog-forming air pollution by over 750 tons per year in 2035 and over 900 tons per year by 2050. MHD trucks account for 53% of NOx emissions, and 45% of particulate matter (PM) emissions. After light-duty vehicles, MHD trucks are the next largest source of transportation sector emissions.

Health Benefits

Significant Monetized Health Benefits

NOx and PM emissions reductions associated with MHD EV deployment will save Connecticut $270 million dollars in avoided health care costs over the period of 2020-2040, but could be as much as $500 million to $1.4 billion by 2050.

EV Market

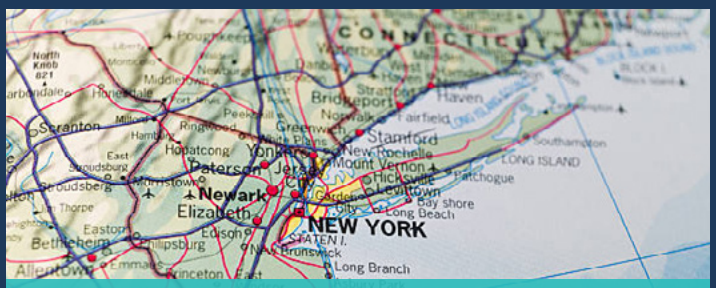
Early Access to an Emerging Market and Green Jobs

Connecticut's MHD EV market is in nascent stages, but EV buses, school and transit, have made early progress in the market. Growing the EV market through complimentary policies designed to support early adoption will lower initial cost of entry to this market and create economic opportunities in MHD EV sales, service and infrastructure support.

Charging

More Support for Vehicle Charging Infrastructure

Increased market penetration of MHD EVs will create greater demand, and consequent investment, in Connecticut's EV charging network. Additional infrastructure will be necessary to support the introduction of long-haul HD EVs designed for and destined to travel the I-95 Corridor through Connecticut.



Regional Coordination

The MHD ZEV Action Plan is Laying the Foundation for Regional Success

Connecticut will work with states signing the Multi-State Medium-and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding to identify and implement policies that reduce MHD emissions, aid the adoption of advanced technology vehicles, and improve regional pollution and economic outcomes.

Environmental Justice

Addressing Disproportionate Impacts from Air Pollution Associated with Transportation

Communities of color and other vulnerable populations located near highways, ports, warehouses, and distribution centers are disproportionately impacted by transportation related air pollution. Drastically reducing MHD emissions will result in more equitable distribution of health benefits associated with reduced tailpipe NOx and PM emissions from passing MHDs that now contribute to poor air quality in these areas.

Contents

Background

Figure 1 demonstrates the progress the State has made in reducing air pollution through the implementation of a wide variety of control strategies, represented here in the blue bars. The suite of measures implemented to date has resulted in a 75% decrease in the number of unhealthy days with regards to ozone. However, to be protective of public health and meet federal standards, Connecticut must eliminate all unhealthy air quality days. To achieve ozone attainment, Connecticut needs emission reductions from the transportation sector, which is responsible for over 67% of ozone-forming precursor emissions generated in Connecticut.[8] By 2045, if new emission standards are not adopted, MHD vehicles will contribute 57% of NOx related emissions.

Connecticut 8-Hour Ozone Exceedance Day Trends and Implemented Control Strategies

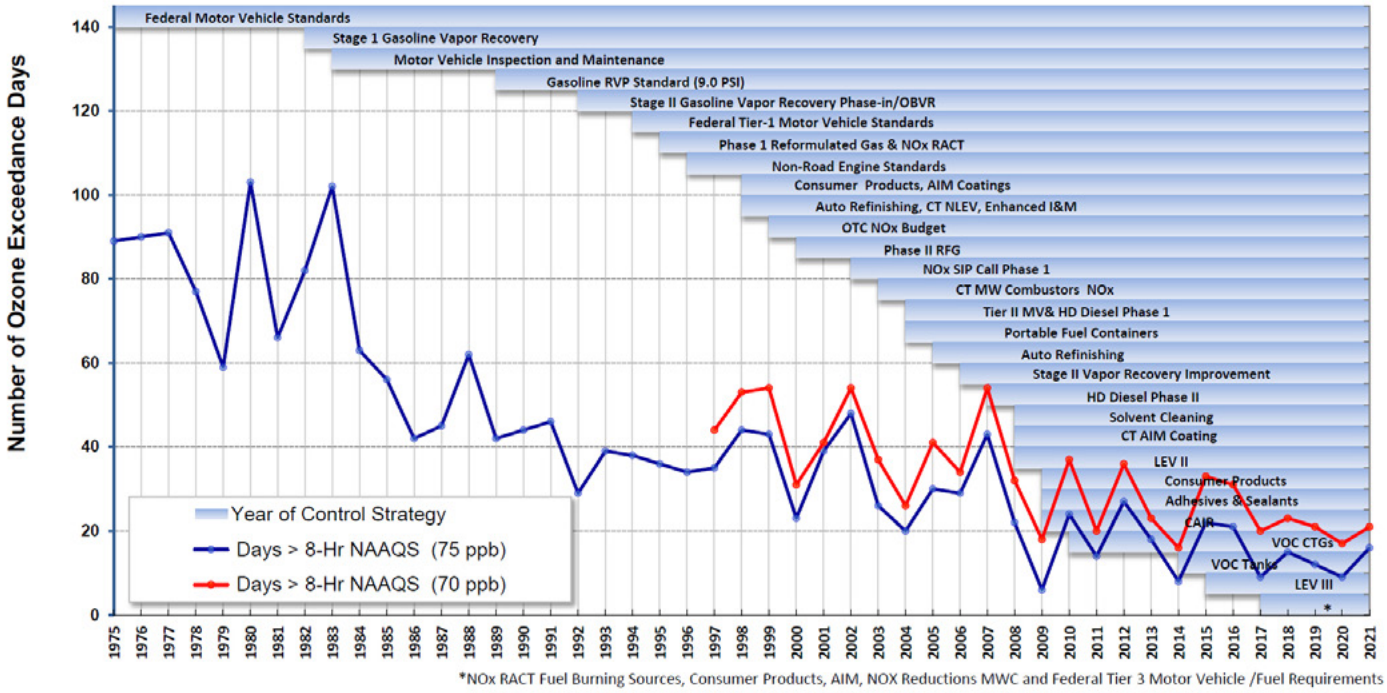


Figure 1: Ozone Control Strategies and Ozone Exceedance Days

In addition to achieving emission reductions of criteria pollutants to address Connecticut's ozone challenges, the State must reduce GHG emissions from the transportation sector to achieve Connecticut's economy-wide GHG reduction targets of at least 45 percent below 2001 levels by 2030, and 80 percent below 2001 levels by 2050, as required by the 2008 Global Warming Solutions Act (GWSA) and the 2018 Act Concerning Climate Change Planning and Resiliency.[9]

Connecticut's transportation sector is the largest source of statewide GHG emissions, responsible for 37 percent in 2018, the most recent year for which data is available.[10] The transportation sector was also responsible for 66 percent of the emissions of nitrogen oxides (NOx) in 2017, a key component of ground level ozone (smog).[11]

[8] Combined NOx+VOC Transportation Sector Contribution taken from 2017 NEI. NOx MHD Contribution taken from Feb 2020 MOVES2014b run.

[9] Public Act 18-82, An Act Concerning Climate Change Planning and Resiliency, sec. 7, codified at Conn. Gen. Stat. § 22a200a. Public Act 08-98, An Act Concerning Global Warming Solutions, sec. 2, codified at Conn. Gen. Stat. § 22a-200a.

[10] https://portal.ct.gov/-/media/DEEP/climatechange/GHG_Emissions_Inventory_2018.pdf

[11] https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data

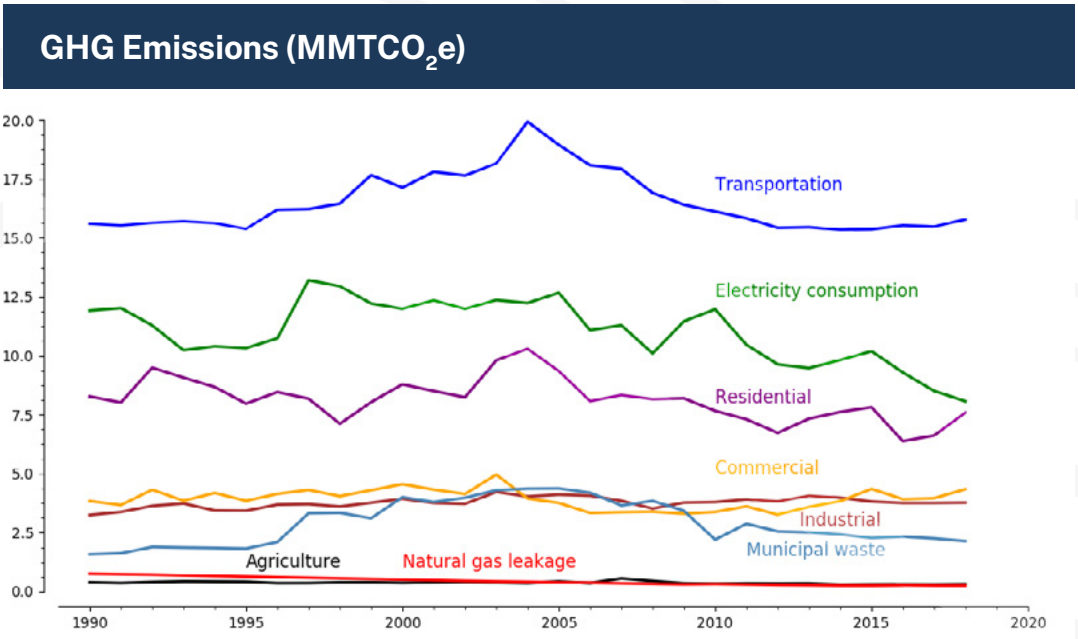
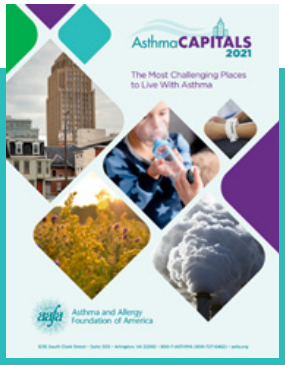


Figure 2: Connecticut Greenhouse Gas Emissions by Sector. 2018 Connecticut Greenhouse Gas Emissions Inventory.

Connecticut has again failed to meet both the 2008 and 2015 National Ambient Air Quality Standards (NAAQS) for ozone within the timeframe prescribed by EPA. Resultantly, DEEP expects EPA to begin the process necessary to reclassify Fairfield, New Haven and Middlesex Counties to "severe" nonattainment under the 2008 ozone NAAQS. This means DEEP will be required to amend its clean air regulations and identify additional strategies to reduce emissions. This potentially could include new and more stringent requirements on stationary sources of air pollution that could affect many large and small businesses in these areas — depending on the level of emission reductions achieved in the transportation sector. The remaining five counties in Connecticut will be redesignated to "moderate" nonattainment under the 2015 ozone NAAQS.

Exposure to poor air quality exacerbates acute and chronic respiratory problems such as asthma, Chronic Obstructive Pulmonary Disease, and other lung diseases. Furthermore, the immediate health impacts of mobile source related air pollution (both direct and indirect) are felt in areas within and along transportation corridors that have borne a disproportionate impact from this pollution for decades. A recent national report, Asthma Capitals 2021, ranked New Haven (#5) and Hartford (#17) among the 100 largest U.S. cities where it is most challenging to live with asthma.



Mobile sources are the most significant source of emissions linked to both ozone formation and climate change. Connecticut, however, lacks independent authority to set standards for mobile sources and must either follow standards set by the federal government or adopt standards identical to those adopted by the state of California as authorized by section 177 of the federal Clean Air Act (CAA).[12]

[12] States are generally preempted by the CAA from adopting emission standards for new vehicles, however CAA section 209 authorizes California to obtain a waiver of preemption for new vehicle emission standards. CAA section 177 allows other states to adopt and implement the California regulations.

Connecticut has experience implementing vehicle standards adopted by California. In 2004, the General Assembly directed DEEP adopt and implement California's emission standards for light-duty vehicles, including greenhouse gas emission standards and the zero-emission vehicle (ZEV) program. The ZEV program directs manufactures to produce and sell, or offer for sale, an increasing percentage of electric vehicles[13] in Connecticut and the other 13 states[14] that have adopted the California program for light-duty vehicles.

In Connecticut, no such corollary requirement exists for MHDs and DEEP has relied on the federal government to regulate these classes of vehicles. However, the federal government has not updated its regulations on MHD in over twenty years, with the most recent requirements going into effect in 2007. California has adopted greenhouse gas standards for MHD vehicles: the Phase 2 GHG rule. California's Advanced Clean Trucks (ACT) rule will begin phasing in increasing percentages of MHD ZEVs beginning with the 2024 model year (MY) and delivering emission reductions far sooner than a federal program where program adoption for some pollutants would not occur until 2027 at the earliest.[15] The class of MHD vehicles that are the subject of this whitepaper are depicted in Figure 3 and include large pickup trucks and vans, delivery trucks, box trucks, school and transit buses, and long-haul tractor-trailers. Powered predominantly by diesel engines, these high-mileage vehicles are some of the most polluting on our roads.

The MHD Vehicle Fleet in Connecticut

There are two predominate ways to analyze the fleet size of MHD vehicles in Connecticut, either by weight category or by use-case. By weight, MHD vehicles are vehicles that weigh between 10,001 pounds GVWR (Class 2b) and include vehicles weighing up to and over 33,001 pounds GVWR (Class 8). According to the M.J. Bradley report (table 2 below), by weight, MHD vehicles make up 6% of the Connecticut state fleet, with the rest being light-duty vehicles.

Use-case analysis looks at the how the vehicles are used (i.e. bus, tractor trailer). This method can be helpful when weight classes of vehicles are not reported in registration data or are otherwise unavailable. DEEP has used use-case analysis to further inform the analysis of vehicle fleet size and current and future emissions.

Connecticut DMV data shows a breakdown of MHD by weight class for which data is known. The types of vehicles comprising each class are provided in Figure 4.

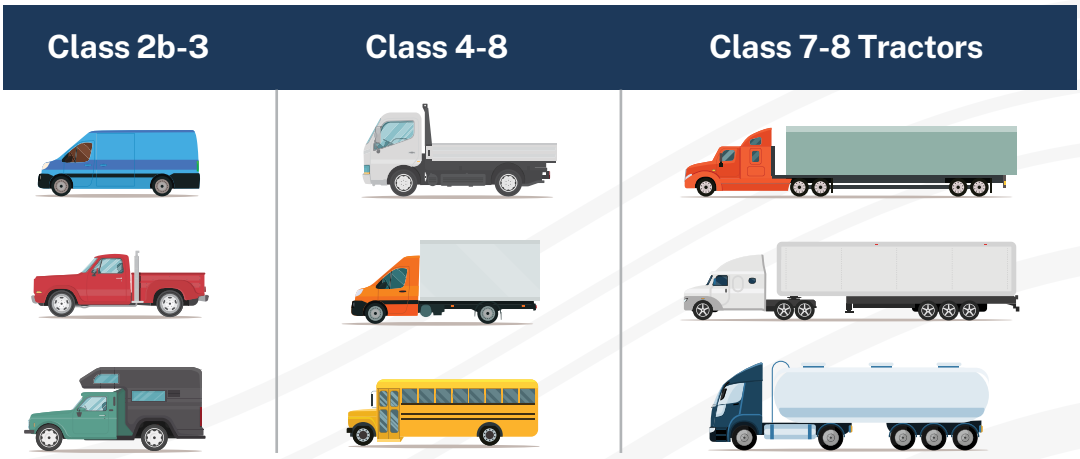


Figure 3: Summary of MHD vehicle weight classes.

[13] Electric vehicles include battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and fuel cell electric vehicles (FCEVs).

[14] CA, NY, MA, NJ, VT, ME, RI, MD, VA, CO, OR, WA, HI, Washington D.C, CT. https://www.theclimategroup.org/our-work/news/why-us-states-should-adopt-californias-zero-emission-vehicle-program

[15] See Potential Federal MHD Regulation, page 14.

Heavy Duty Vehicle Current and Projected Emissions

DEEP utilized EPA's Motor Vehicle Emission Simulator (MOVES) model to estimate mobile source emissions at the national and county level for various criteria air pollutants, greenhouse gases, and air toxics. MOVES incorporates the latest data on vehicle populations, travel activity, emission rates, and fuel supply information provided by the EPA, the Connecticut Department of Transportation (DOT), and various other sources.

In addition, DEEP reviewed MOVES modeling runs from the 2021-2024 State Transportation Plan (STIP). The STIP is developed by the Connecticut DOT and is a planning tool used for determining compliance with the federal General Conformity requirements. The MOVES2014b model was utilized to project the total statewide annual emissions between 2020-2045 using use-case analysis. This process provided the annual emissions of NOx, Volatile Organic Compounds (VOC), CO2, and PM 2.5 for Connecticut's light duty and heavy-duty vehicle populations for those years.[16] The emission totals described above were used to estimate the share of emissions from the MHD sector and are shown in Tables2 and 3 and in and Figures 5 and 6.

Emissions from the MHD sector are a significant portion of overall NOx, Particulate Matter (PM)[17] and-GHG emissions. These emissions contribute to non-attainment and unhealthy air quality which unproportionally impacts communities proximate to highways, warehouses, and distribution centers despite making up a smaller percentage of the mobile source fleet. In the coming decades, MHD vehicles will become a bigger proportion of total mobile source emissions due to strong emission limits on light-duty vehicles.[18]

CT MHD Vehicle Population by Class

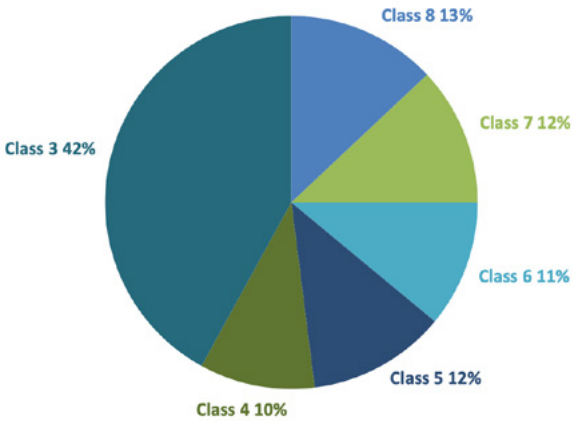


Figure 4: Population breakdown of medium-and heavy-duty vehicles in Connecticut by weight class

M/HDV Share of Total On-Road Fleet	
Greenhouse Gas Emissions	25%
NOx Emissions	53%
PM Emissions	45%
Share of On Road Vehicles	6%

Table 2: Current Connecticut MHD Fleet's Share of Total Transportation Emissions. M.J. Bradley and Associates Report "Southern New England Clean Trucks Program" https://www.ucsusa.org/sites/default/files/2021-11/southern-ne-clean-trucks-report.pdf

Projected Annual Emissions 2020-2045 (TPY)				
	2020	2025	2035	2045
NOx - HD	5749	4035	3390	3387
Total Mobile Source Emissions	15811	10596	6597	5981
PM2.5 - HD	78	31	12	12
Total Mobile Source Emissions	170	100	50	35

Table 3: Projected Emissions of NOx and PM 2.5. MOVES 2014b Analysis

[16] Light duty vehicles in MOVES consist of motorcycles, passenger cars, passenger trucks, and light commercial trucks. Heavy duty vehicles include intercity buses, transit buses, school buses, refuse trucks, short haul trucks, long haul trucks, and motor homes.

[17] PM refers to a mixture of solid particles and liquid droplets found in the ambient air, which includes inhalable particles (PM10) and fine inhalable particles (PM2.5).

[18] See CT Low Emission Vehicle and Zero Emission Vehicle Program, 22a-174-36c

Based on the M.J. Bradley and Associates report, Table 2 captures the current emissions produced from the MHD share of Connecticut's on-road fleet. This data was derived from MOVES3 runs performed by M.J. Bradley and Associates. Similarly, Table 3 displays DEEP's projected baseline annual emissions in tons per year or a "business as usual" case resulting from MHD vehicle operation in Connecticut.

The comparative contribution of heavy-duty only emissions to all on-road NOx emissions is further illustrated in Figures 5 and 6 below, based on MOVES runs by DEEP, which analyzed future emission of a smaller subset of medium and heavy-duty vehicles than the M.J. Bradley and Associates analysis.

In 2020, on-road HD emissions accounted for 36% but are projected to increase to 57% of total NOx emissions by 2045, without considering the larger subset of medium duty vehicles. While model outputs may vary based on model version or whether national or state-specific inputs are incorporated into the runs, the significance of MHD emissions as a percent of total emissions is clear in both analyses.

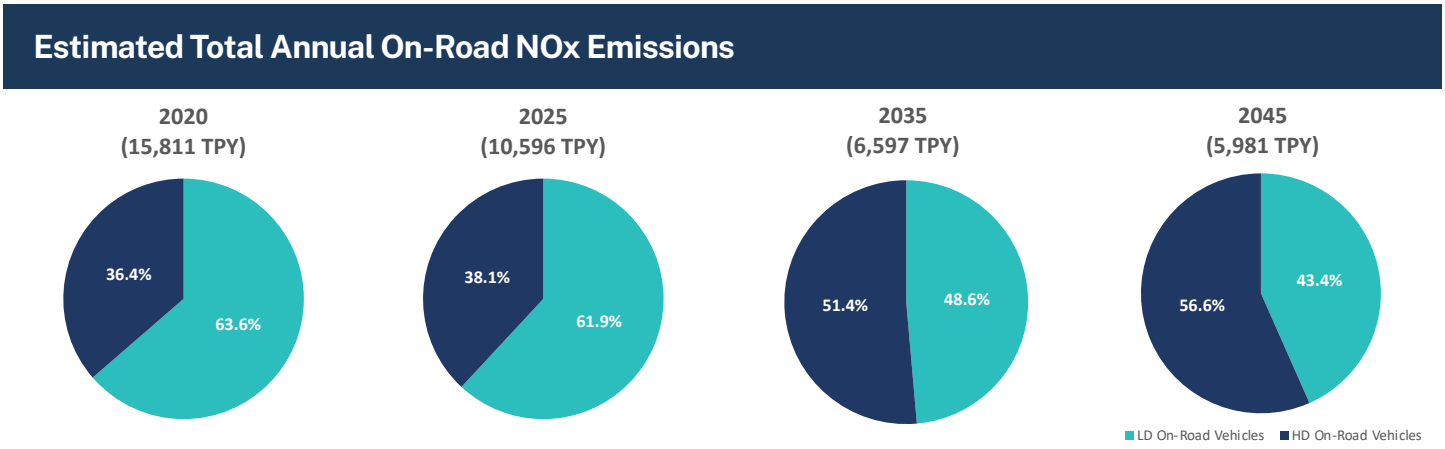


Figure 5: On-Road NOx Emissions 2020-2045

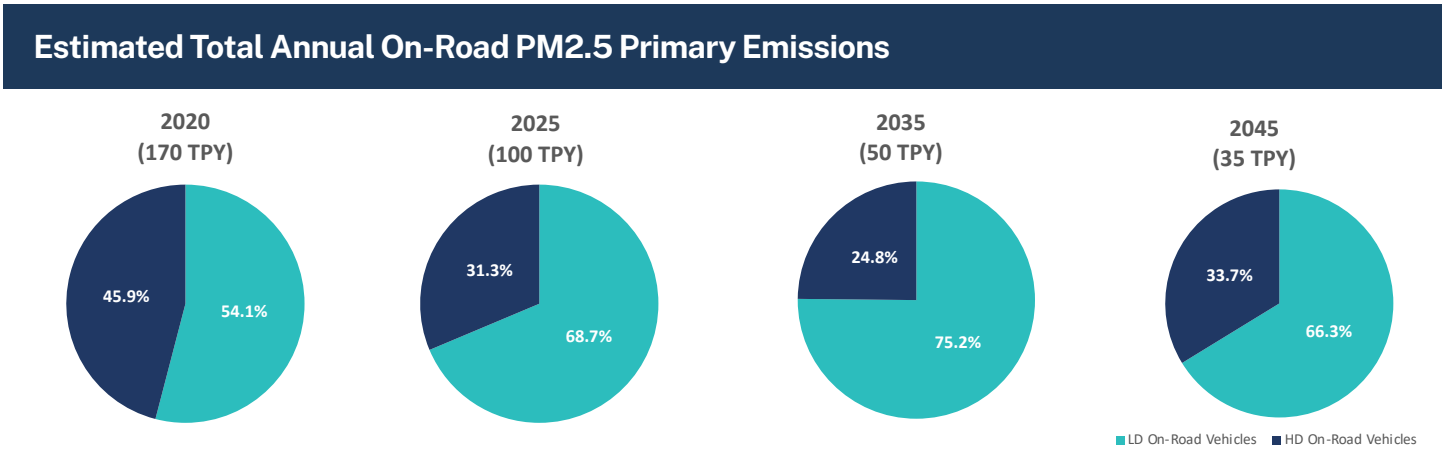


Figure 6: On-Road PM 2.5 Emissions 2020-2045

As light duty vehicle emissions continue to decrease at a steady rate, the relative impact of MHD emissions becomes more apparent. This trend is demonstrated in Figure 6 by the increased percentage of HD on-road vehicle emissions between 2035 and 2045 from 25% to 34% of total annual on-road PM2.5 emissions respectively. By 2045, the rate of emission reduction for MHD vehicles drops off considerably due to a lack of existing standards resulting in MHD emissions accounting for a larger percentage of total emissions.

California Standards

California is the only state authorized by the federal Clean Air Act to adopt and implement emission standards applicable to new MHD vehicles. The California Air Resources Board (CARB) has recently adopted standards for MHD vehicles including the ACT Rule and the Low NOx Omnibus Rule.

As seen below, **adoption of these standards would not mandate that Connecticut business purchase these vehicles, nor do would it place affirmative requirements on those businesses. The standards apply solely to the Original Equipment Manufacturers (OEMs).** The engines produced by OEMs subject to the regulation must be up to 90% cleaner than current standards and they must deliver advanced technology zero emission MHD vehicles to Connecticut.

Advanced Clean Truck (ACT) Rule [19] [20]

In October 2019, CARB initiated the process of adopting the ACT rule by publishing a public notice, initial statement of reasons and associated regulatory materials.[21] The notice and associated materials include the proposed regulation, environmental impact statements, and economic impact statements, along with other statutorily mandated analysis such as a small business impact statement. CARB held a public hearing on December 12, 2019, followed by a second public hearing in June 2020. The Board adopted the proposal on June 1, 2020, and it was submitted to the California Office of Administrative Law (OAL) for final approval in January 2021 and finalized February 3, 2021. All regulatory materials as well as responses to comments received can be found on the CARB regulatory page.[22]

The ACT rule requires an increasing percentage of new trucks sold in California to be ZEVs beginning in the 2025 model year. The percentage of new vehicles that must be ZEV varies by vehicle type, but for all vehicle types the required ZEV percentage increases each model year between 2025 and 2035 and will reach 30% by 2030. Additional details follow below.

Under the ACT, manufacturers will be required to sell zero-emission vehicles at incrementally increasing percentages of their annual sales. This follows the same structure as the light-duty vehicle Zero Emission Vehicle (ZEV) rule Connecticut adopted in 2004. Figure 7 is taken from CARB regulatory documents (designated as Table A-1) and identifies the percentage requirements for delivery of each class of vehicles for the entire program.

[19] https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/act2019/fro2.pdf
[20] https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-trucks-fact-sheet
[21] https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/act2019/notice.pdf
[22] https://ww2.arb.ca.gov/rulemaking/2019/advancedcleantrucks

California Final Regulation Order			
Model Year	**Class 2b-3 Group**	**Class 4-8 Group**	**Class 7-8 Tractors Group**
2024	5%	9%	5%
2025	7%	11%	7%
2026	10%	13%	10%
2027	15%	20%	15%
2028	20%	30%	20%
2029	25%	40%	25%
2030	30%	50%	30%
2031	35%	55%	35%
2032	40%	60%	40%
2033	45%	65%	40%
2034	50%	70%	40%
2035 and beyond	55%	75%	40%

Table 4: California Initial Statement of Reasons for the Advanced Clean Trucks Regulation

Heavy-Duty Low NOx Omnibus Rule

On June 23, 2020, CARB released the public notice and associated rule making materials for the Low NOx Omnibus Rule.[23] The public hearing was held on August 27, 2021, and the Board adopted the measure on September 29, 2020. Before the rule was submitted to the California OAL there were two modifications made and the regulation was finalized in December 2021. All regulatory materials can be found on the CARB regulatory page.[24]

The Low NOx Omnibus rule requires an additional 75 percent reduction in nitrogen oxide (NOx) emissions from the engines in new gasoline and diesel trucks sold between model year 2025 and 2026, and a 90 percent reduction for trucks sold beginning in the 2027 model year. Additional details follow below.

The California Low NOx regulation will adopt more stringent engine standards for heavy-duty Otto cycle (HDO) and heavy-duty diesel engines which will be implemented in two phases:

California Low NOx Regulation: Staggered Implementation Phases			
	Present Standard	**Low NOx Phase 1**	**Low NOx Phase 2**
Engine Model Years	2010 – 2023	2024 – 2026	2027 and Beyond
NOx Emission Rate (g/bhp-hr)	0.200	0.050	0.020
Percent Reduction	0%	75%	90%

Table 5: California Low NOx Regulation: Staggered Implementation Phases

The Low NOx Omnibus rule also enhances consumer protection by including stronger warranty requirements and longer useful life requirements.

[23] https://ww2.arb.ca.gov/rulemaking/2020/hdomnibuslownox
[24] https://ww2.arb.ca.gov/rulemaking/2020/hdomnibuslownox

Multistate MHD MOU and MHD Action Plan

On July 14, 2020, Governor Lamont, along with the Governors of 14 other states, signed on to the multistate Memorandum of Understanding (MOU) to take action to curb air pollution from MHD vehicles.

California Actions

ZEV supply: Advanced Clean Trucks Rule & ACF 2040 Benchmark
ZEV demand: Pending Advanced Clean Fleets
The ½M or so yet-to-be-sold CA engines: Heavy Duty Low NOx Omnibus, HD I/M, Tier 5

OZONE TRANSPORT COMMISSION

CALIFORNIA AIR RESOURCES BOARD

"Highest Priority – Medium and Heavy Duty Trucks"

CA, NJ, NY, OR, MA, & WA have adapted ACT. ME has issued a draft regulation, VT and RI are considering adoption during this calendar year.

15 States + DC & Quebec MHD ZEV MOU

Executive Order No. 21-3 Actions to Address Climate Change

The MOU committed the signatory states to the goal of reaching 100% zero emission MHD vehicles by 2050, with an interim target of 30% by 2030. As required by the MOU, the signatory states are in the process of developing a Multistate Action Plan. The plan will provide numerous strategies and complementary policies for states to consider adopting that are intended to support the transition to electrification for significant numbers of MHD vehicles, especially in areas that are historically overburdened and disproportionally impacted by MHD related air pollution.

Regional Coordination and Adoption

In addition to California, New Jersey, New York, Oregon, Massachusetts, and Washington have adopted the California ACT rules. Maine has issued a draft regulation, Vermont and Rhode Island are considering adoption during this calendar year. See Figure 8. Adopting California's MHD emission regulations, including the Low NOx Omnibus and ACT Rules, will significantly reduce harmful emissions that impact public health and contribute to Connecticut's intractable ozone problem as well as make significant progress towards meeting GHG reduction targets under Connecticut's Global Warming Solutions Act.

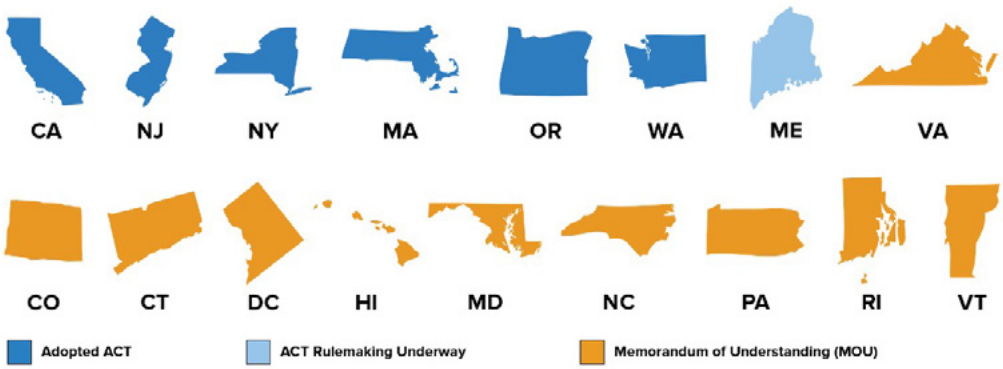


Figure 8: Status of state adoption of California ACT and low NOx Omnibus rules.

Potential Federal MHD Regulation

EPA has initiated efforts to develop a highway-heavy duty standard for NOx emissions, but EPA has not initiated the technical work to develop a rule similar to ACT; in 2018, **EPA solicited comments** on the potential regulation of MHD vehicles through the Clean Trucks Initiative (CTI) and initiated a rulemaking on March 7, 2022. However, EPA is still attempting to determine what form those standards will take and when they will be implemented. While EPA has taken critical and important steps to advance a rule to address heavy-duty NOx emissions from trucks, EPA is well behind California in completing the technical analysis for a MHD proposal, which will not contain a zero emission MHD standard.

Summary of Expected Benefits of Adopted California Regulations in Connecticut

Federal law generally preempts states from establishing new motor vehicle tailpipe standards, but the state of California has a special right to seek a preemption waiver under Section 209 of the federal Clean Air Act (CAA). Section 177 of the CAA authorizes any state to adopt the state of California's new motor vehicle emissions standards in lieu of less stringent federal requirements. As California has already adopted both the ACT and Low NOx Omnibus rules, Connecticut would begin to see cleaner MHDs entering its fleet after adopting the California regulatory framework, which must include a four-calendar year notice to manufacturers. Given the delays on the federal level, Connecticut would see cleaner MHDs sooner by adopting the California standards than by waiting for federal action.

As stated in the introduction DEEP analyzed three different sources of information regarding the potential benefits of adoption of these standards.

1 Scale Modeling of California Regulatory Documents

DEEP reviewed CARB documentation to estimate emission and health benefits that could result if Connecticut were to implement the ACT and Low NOx Omnibus regulations. The results of this review are presented in Tables 5 and 6. DEEP referred to regulatory documents published by CARB containing environmental and health benefit estimates for ACT and Omnibus for the state of California.

Using key data from the Federal Highway Administration's 2019 Highway Statistics,[25] DEEP interpolated parallel values for benefits in the state of Connecticut by adjusting for state population, the percentage of the population that lives in close proximity to major roads, and the total VMT of all trucks in the state. This scaling methodology emulates that which the NJ DEP used to estimate benefits for ACT in New Jersey.

[25] https://www.fhwa.dot.gov/policyinformation/statistics/2019

It is assumed that the rate of reduction of smog-forming air pollutants, namely NOx and particulate matter, compound over time as the makeup of heavy-duty traffic in the state becomes progressively cleaner. DEEP estimates that by the year 2040 Connecticut will achieve reductions of these smog forming pollutants exceeding 900 tons per year (tpy) following the implementation of ACT alone as well as prevent a cumulative total of 1.48 million metric tons (MMT) of CO2 from being released into the atmosphere, a yearly equivalent of the GHG emissions of 1,696,343 passenger vehicles – or just over half of Connecticut's total fleet. Within the same timeline, implementation of the Low NOx Omnibus regulation in Connecticut would yield a reduction of 1700 tpy of NOx by 2026, which would jump to nearly 2400 tpy of NOx reduced by 2050.

In this context, health benefits are defined as the value of all negative health outcomes that could be avoided with the potential improvement in air quality, such as respiratory illnesses, hospitalizations, and premature deaths. The adoption of California's regulations could save Connecticut residents over $271 million in healthcare costs by 2040.

Table 5: DEEP Scale Analysis: Projected Emission Reductions

Rule	Pollutant	Years(s)	Value	Units
Low NOx	NOx	2024	0.03	tons/day
		2031	1.98	tons/day
		2040	4.66	tons/day
		2050	6.49	tons/day
ACT	NOx	2020–2040 (cumulative)	2.38	tons/day
	PM2.5		0.073	tons/day
	Well-to-Wheel GHG		0.25	tons/day CO_2e
	GHG		1.48	10^6 MT CO_2e

Table 6: DEEP Scale Analysis: Projected Health Benefits[26] [27]

Rule	Description	Years(s)	Value	Units
Low NOx	Deaths Prevented	2024 – 2050	119	people
	Hospitalizations Prevented		40	people
	ER visits prevented		55	people
ACT	Avoided Premature Deaths	2020 – 2040	29	people
	Value of All Avoided Health Outcomes		271 M	dollars

[26] https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2020/hdomnibuslownox/isor.pdf

[27] https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/act2019/isor.pdf

2 NESCAUM COBRA Modeling

In support of DEEP's findings, NESCAUM used the EPA's CO-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool to quantify the potential health benefits within Connecticut associated with adopting both the ACT and HD Low-NOx Omnibus rules. NESCAUM found that by 2050, Connecticut could save a cumulative $413 million in health costs due to emissions reductions of 912 tons of NOx, 335,767 tons of CO2, and 4.7 tons of PM2.5.

NESCAUM utilized **EPA's CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA)** to approximate the health benefits and emission reductions that would accompany Connecticut's implementation of ACT. This model quantifies the frequencies of dangerous health outcomes that will be avoided with improved air quality in Connecticut, then it uses a valuation function to assign an economic value to these evasions. The adverse health outcomes that COBRA analyzes include: premature deaths, hospitalizations for cardiovascular illness, hospitalizations for respiratory illness, and ER visits.

Tables 7 and 8 below show the benefits associated with the adoption of ACT as a standalone rule (i.e., in isolation) as well as the benefits associated with the combined adoption of ACT and the Low-NOx regulation. In simulating Connecticut's uptake of California's MHD truck policies, COBRA output the following values:

Table 7: Environmental Benefits of ACT Implementation Emission Reductions (tons), year 2050

	ACT: Isolated	ACT & Low NOx
NOx	412	912
CO_2	355,767	355,767
PM2.5	5	5

Table 8: Health Benefits of ACT Implementation

Description		ACT: Isolated	ACT & Low NOx
Avoided Premature Deaths	Incidents	4 – 9	8 – 19
	Valuation	$47M – $106M	$103M – $233M
Avoided Hospitalizations for Cardiovascular Illness	Incidents	1	2
	Valuation	$40,000	$100,000
Avoided Hospitalizations for Respiratory Illness	Incidents	1	2
	Valuation	$30,000	$70,000
Avoided ER visits	Incidents	4	6
	Valuation	$2,000	$3,000
Total health benefits	-	$48M – $107M	$105M – $236M

3 MJ Bradley and Associates

The previously cited M.J. Bradley and Associates **report** additionally details the findings of a thorough investigation into the potential emission reduction benefits of Connecticut's adoption of California's MHD policies (see figure 9). MJ Bradley and Associates also used a sophisticated **methodology** involving multiple mathematical models to give a comprehensive overview of the benefits for Connecticut's environment and economy. The fiscal benefits discussed by the report go beyond the scope of the analysis by DEEP – in addition to health benefits, changes in fuel use, the job market, infrastructure investments, vehicle purchases, and utility revenues are all examined to quantify a net value for the economic impact that Connecticut could see. All things considered, the findings of this report state that by the year 2050, the MHD rules could deliver up to $893 million each year and Connecticut's population could cumulatively save up to $1.4 billion in health expenses.

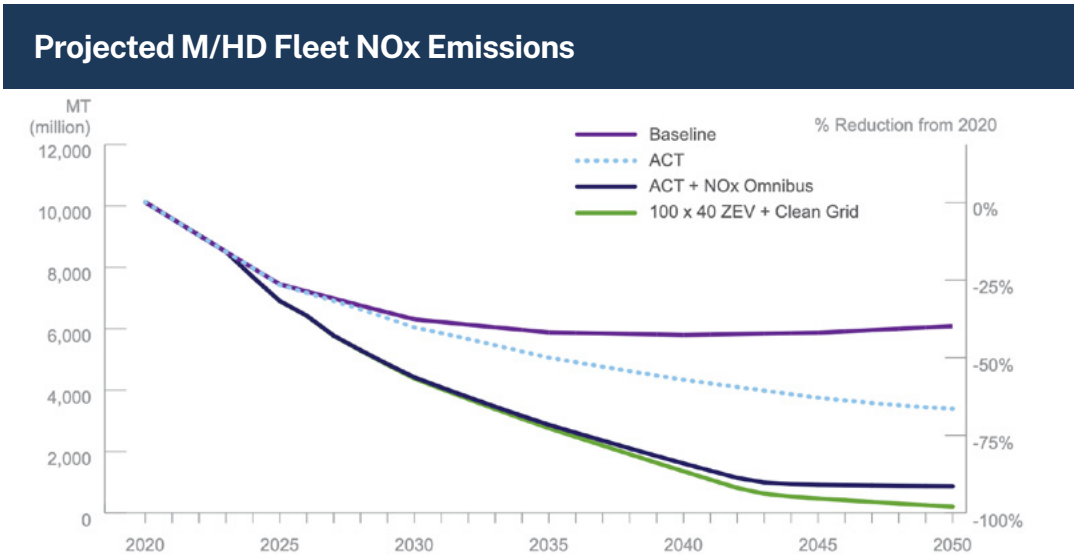


Figure 9: Projected Emission Reductions From Adoption of California Programs. MJ Bradley and Associates

Additional Economic Benefits

Macroeconomic analysis of ZEV adoption has shown that each public dollar invested in MHD ZEVs generates three dollars of novel private investment and five dollars of GDP growth.[28]

The wide scale electrification of the MHD vehicle sector will trail the light-duty vehicle sector by ten or more years and the economic influences and impacts should be similar. For example, a regulatory mandate to produce more electric MHD vehicles will lead to the creation of new jobs, as OEMs pivot to manufacture these vehicles. Likewise, the demand for charging infrastructure will stimulate the creation of jobs associated with the engineering design, manufacture and installation of needed charging infrastructure. A significant number of assemblers, machinists, electricians, construction workers, and engineers will be required to mass produce and maintain advanced technology MHD electric vehicles and their associated infrastructure.[29]

The transition to MHD ZEVs will also bring great savings to owners of large fleets. The US Department of Energy's Lawrence Berkeley National Lab (LBNL) conducted a **study** which estimated that a Class 8 long-haul battery electric truck would accrue a 13% lower total cost of operation (TCO) per mile than an equivalent diesel truck, producing more than $200,000 in savings over a single truck's lifetime.[30] Favorable TCOs are expected by market analysts in all weight classes without government subsidies by 2030.[31]

[28] https://www.analysisgroup.com/globalassets/insights/publishing/2021-aee-electric-vehicle-stimulus-report.pdf
[29] https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/act2019/appc.pdf at page 10
[30] https://energycentral.com/system/files/ece/nodes/471683/2103_lawrence_livermore_lab_e_trucks.pdf
[31] https://about.bnef.com/blog/electric-cars-reach-price-parity-2025

Wide-scale electrification of MHD vehicles, including school buses, will have a profound impact on the health of Connecticut's children, who will no longer be exposed to diesel school bus exhaust. Costs associated with school bus electrification could potentially be mitigated by exploring vehicle-to-grid (V2G) and vehicle-to-building (V2B) services that can utilize stored energy within buses to support the electric grid in times of need. Electric school buses are an ideal candidate to provide V2G/V2B services because they have long dwell times and remain inactive during summer months at the conclusion of the academic year. Electric school buses can be configured to charge their batteries overnight when electricity is cheapest and discharge this stored electricity back to the grid during peak demand periods. Moreover, school buses are not stationary, and with proper configuration, could be dispatched as mobile backup power supply during emergency situations or other events.

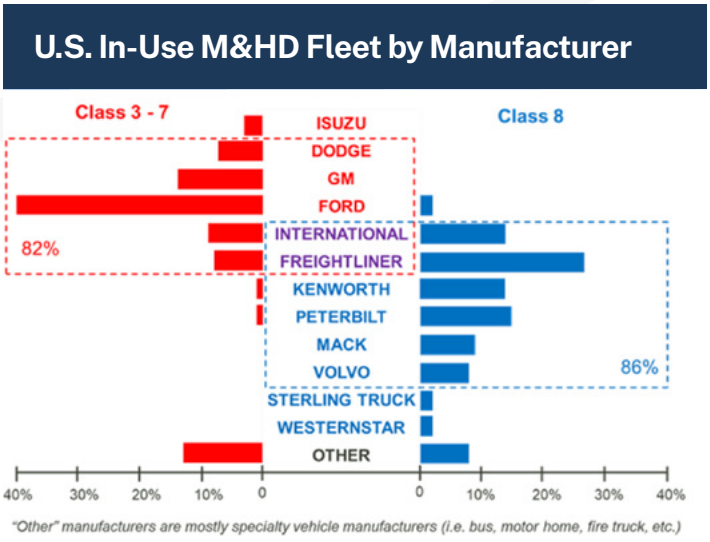


Figure 10: Fleet by Manufacturer, M.J. Bradley and Associates

With the introduction of V2G/V2B, other renewable energy sources, and a more decentralized energy grid overall, fleet electrification could bring great fiscal benefit to the average electricity customer. The additional revenues that bus and truck charging could provide will give utilities the option to lower electricity costs for all ratepayers without compromising returns on investment. The deployment of MHD ZEV vehicles also holds the potential to add an additional layer of resiliency to Connecticut's grid through the use of V2G/V2B services.

Market Readiness

In the past several years the market for MHD ZEV vehicles has accelerated rapidly. As shown in Figure 10, twelve companies account for approximately 90% of the fleet. The remaining 10% of the fleet is produced by small specialty manufacturers.[32]

Many manufacturers have launched new business units and to focus on electric mobility solutions including vehicles, software and services.[33] Currently, electric truck and buses account for a small fraction of the new MHD vehicle sales. However, product availability continues to expand as technologies continue to improve and more state and local jurisdictions adopt policies to lower the initial entry costs and create opportunities for market growth. More than 75 different zero-emission models are currently available across Class 2b-8 vehicle segments in North America, and this number is anticipated to exceed 210 models by 2023. Altogether, more than 50 manufacturers have announced plans to produce electric school, shuttle, and transit buses; drayage, long-haul, refuse, and work trucks; cargo and step vans; and yard tractors in the next few years.[34]

The Northeast States for Coordinated Air Use Management (NESCAUM) has combined recent information on manufacturer MHD vehicle announcements in the NESCAUM MHD Original Equipment Manufacturer Product Announcements.[35]

[32] Medium and Heavy-Duty Vehicles Market Structure, Environmental Impact and EV Readiness, MJB&A July 2021 p.12

[33] MJB&A. P. 16

[34] CALSTART, Global Commercial Drive to Zero, Zero-Emission Technology Inventory Tool, Version 5.9 (2020), https://globaldrivetozero.org/tools/zero-emission-technology-inventory/

[35] https://www.nescaum.org/documents/nescaum-mhd-zev-oem-product-announcements_20201125.pdf

Charging for MHD Vehicles

Charging infrastructure for MHD vehicles is a critical element of widespread adoption and to address the specific use cases associated with the charging MHD vehicles. In Connecticut, the Public Utilities Regulatory Commission (PURA) has opened a docket to consider the infrastructure needs specific to this market segment.[36] As with light duty vehicles, early charging for MHDs will be focused on overnight charging at garaging locations. As the need for charging expands to public areas necessary to support long-haul freight transport, then appropriately sized infrastructure must be developed and deployed. Figure 11, shows an estimation of charging needs by use case as evaluated by MJ & Bradley:

In Figure 11, "home base" charging is representative of use cases where the vehicle will return to a specific location at the end of its duty cycle for the day, while "public" is for vehicles that will require some level of public infrastructure due to not returning to a single depot every day, predominately because they are traveling through the state. Charger strength is based on vehicle battery size and available charging time.

Home Base, Level 2	Home Base, Level 3	Public
• Heavy-duty Pickup & Van • School Bus • Delivery Van • Service Van • Service Truck • Box Truck (Class 3–5) • Stake Truck (Class 3–5) • Stake Truck (Class 6–7)	• Heavy-duty Pickup • *Regional Haul Tractor* • Transit Bus • Shuttle Bus • Delivery Truck • Refuse Hauler • *Box Truck (Class 6–7)* • *Box Truck (Class 8)* • Dump Truck	• Long Haul Tractor • *Regional Haul Tractor* • *Box Truck (Class 6–7)* • *Box Truck (Class 8)*

Figure 11: Charging Use Case, M.J. Bradley and Associates

Environmental Justice

MHD ZEV regulations will greatly benefit the most vulnerable populations in the state. With truck freight volumes projected to increase 30% over the next decade, the already overburdened communities located near heavy truck traffic could face devastating public health consequences. The International Council on Clean Transportation found that achieving 100% MHD ZEV sales in all MOU signatory jurisdictions could produce fleet-wide reductions up to 73% and 98% for well-to-wheel CO2 and NOx emissions, respectively. Electrification of MHD vehicles could thereby provide an immense reduction in these two pollutants, which would be instrumental in mitigating the climate and health consequences of increased truck traffic in overburdened communities.

[36] https://portal.ct.gov/-/media/PURA/electric/PURA-Establishes-Statewide-Electric-Vehicle-Charging-Program.pdf

Conclusion/Recommendation

Connecticut cannot independently set its own new vehicle emission standards and has only two options – proactively adopt California's regulatory framework as authorized by the federal Clean Air Act or passively accept the federal regulatory framework, which is outdated and does not meet Connecticut's air quality, climate mitigation and public health needs.

A review of economic, air quality and public health impacts associated with reducing air pollution from new MHD vehicles while simultaneously moving to electrify increasing portions of these vehicles conclusively demonstrates that implementing the suite of California emission standards for new MHD vehicles rather than relying on outdated federal regulations will yield significant benefits in Connecticut and help the state meet health-based federal air quality standards and state required climate mitigation targets. The gravity of Connecticut's non-compliance with federal health-based clean air standards requires the adoption of the California framework to achieve emission reductions that are needed now. The protection of public health and welfare, particularly in overburdened communities across Connecticut demands it.

Adopting California's MHD emission regulations, including the Low NOx Omnibus and ACT Rules, will significantly reduce harmful emissions that impact public health and contribute to Connecticut's intractable ozone problem as well as make significant progress towards meeting GHG reduction targets under Connecticut's Global Warming Solutions Act.