MULTI-STATE MEDIUM- AND HEAVY-DUTY ZERO-EMISSION VEHICLE ACTION PLAN

A Policy Framework to
Eliminate Harmful Truck and Bus Emissions

Draft for Public Comment
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MULTI-STATE ZEV TASK FORCE

NESCAUM

CONTENTS

Some Definitions

This *Action Plan* uses the following terms to refer to certain types of on-road vehicles:

Medium- and heavy-duty (MHD) refers to vehicles with a gross vehicle weight rating (GVWR) greater than or equal to 8,500 pounds (3,860 kilograms) regardless of how they are powered.

Zero-emission vehicles (ZEVs) include:

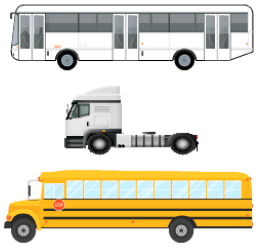
- **Battery electric vehicles (BEVs)** powered solely by an electric motor and battery;
- **Plug-in hybrid electric vehicles (PHEVs)** powered by a combination of an electric motor and a fossil-fueled internal combustion engine; and
- **Fuel cell electric vehicles (FCEVs)** powered by an electric motor fueled by hydrogen.

I. INTRODUCTION

Earth's climate is changing faster than it has at any point in the history of modern civilization, driven primarily by greenhouse gas (GHG) emissions from human activities. The impacts—including more frequent and intense precipitation and wind events, flooding, heat waves, drought, wildfires, retreating snow and ice pack, ocean warming and acidification, accelerating sea level rise, and large-scale biodiversity loss—are being felt by communities across the globe and will worsen in coming years. Because GHGs can persist in the atmosphere for decades to centuries, how much worse these impacts will become depends on how deeply and rapidly humanity can decarbonize all economic sectors.[1]

The transportation of freight and people is the largest source of GHGs in the nation. Medium- and heavy-duty (MHD) vehicles—including large pickup trucks and vans, delivery trucks, box trucks, school and transit buses, and long-haul delivery trucks—are a significant component of these emissions and a major source of nitrogen oxides (NOx), particulate matter (PM), and hazardous air pollutants that harm public health. Widespread electrification of MHD vehicles is needed to avoid the worst effects of climate change and improve air quality and health outcomes, especially in frontline and overburdened communities near freight hubs, bus depots, trucking corridors, and other emissions sources, which are disproportionately impacted by pollution from diesel trucks and buses and more vulnerable to the effects of climate change. Given the mounting climate and public health consequences of truck and bus emissions, the extended turnover times associated with MHD fleet vehicles, and the potential to create substantial economic and job growth by transitioning to ZEVs, the time for bold action is now.

Figure 1: MHD Vehicle Classification by Gross Vehicle Weight Rating (GVWR)

Weight Class	Class 2b	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8
Example Vehicles							
GVWR	8,500 – 10,000 lb 3,856 – 4,536 kg	10,001 – 14,000 lb 4,536 – 6,350 kg	14,001 – 16,000 lb 6,351 – 7,257 kg	16,001 – 19,500 lb 7,258 – 8,845 kg	19,501 – 26,000 lb 8,846 – 11,793 kg	26,001 – 33,000 lb 11,794 – 14,969 kg	> 33,000 lb > 14,969 kg

[1] *See* Intergovernmental Panel on Climate Change (IPCC), Climate Change 2021, The Physical Science Basis (Aug. 2021), https://www.ipcc.ch/report/ar6/wg1/#FullReport; IPCC, Climate Change 2022, Impacts, Adaptation and Vulnerability (Feb. 2022), https://www.ipcc.ch/report/ar6/wg2/.

Recognizing this urgent need for action, a diverse coalition of 18 jurisdictions in the United States and Canada has committed, through the Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding (MOU),[2] to work to slash GHG emissions and harmful air pollution by accelerating the market for zero-emission trucks, vans, and buses. The participating jurisdictions include the states of California, Colorado, Connecticut, Hawaii, Maine, Maryland, Massachusetts, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont, Virginia, and Washington, the District of Columbia, and the province of Quebec.[3] To achieve a timely transition and ensure near-term progress, the participating jurisdictions committed to strive to make at least 30 percent of sales of new MHD vehicles ZEVs by 2030, and 100 percent of sales ZEVs by no later than 2050.

Electrifying MHD trucks and buses promises to deliver widespread GHG reductions and health benefits as well as new economic and employment opportunities. While manufacturers and fleets are working toward electrifying the MHD vehicle sector, achieving the pace and scale of vehicle adoption needed to meet the goals of the MOU will require well designed public policies and programs and a concerted effort by all stakeholders to address market barriers, such as the need for charging and fueling infrastructure, the higher up-front purchase price of MHD ZEVs, and electricity rates not designed for commercial charging.

To translate commitment into action, the MOU directed the participating jurisdictions to develop this *Multi-State MHD ZEV Action Plan* to recommend policy options to support the rapid, equitable, and widespread electrification of MHD vehicles. With a focus on near term strategies, the *Action Plan* includes a host of recommendations for state policymakers to foster a self-sustaining market for zero-emission trucks, vans, and buses.

Development of the Action Plan

Building off the success of a similar multi-state initiative for light-duty ZEVs,[4] the participating jurisdictions worked through the existing Multi-State ZEV Task Force to develop this *Action Plan*. Formed in 2013, the Task Force includes dozens of representatives from state environmental, energy, and transportation agencies across the country and serves as a unique forum for galvanizing state leadership on transportation electrification policy through research

[2] *See* Multi-State Medium- and Heavy-Duty Zero-Emission Vehicle Memorandum of Understanding (July 2020), https://www.nescaum.org/documents/multistate-truck-zev-governors-mou-20200714.pdf/.
[3] This *Action Plan* uses the terms "jurisdictions" and "states" interchangeably to mean the participants in the MHD ZEV initiative, including the District of Columbia and Quebec.
[4] *See* State Zero-Emission Vehicles Program Memorandum of Understanding (Oct. 2013), https://www.nescaum.org/documents/zev-mou-10-governors-signed-20191120.pdf/; *see also* Multi-State ZEV Action Plan 2018-2021: Accelerating the Adoption of Zero Emission Vehicles, https://www.nescaum.org/topics/zero-emission-vehicles/multi-state-zev-action-plan-2018-2021-accelerating-the-adoption-of-zero-emission-vehicles.

and analysis, information sharing, and coordinated action on shared priorities. The Task Force is led by the Northeast States for Coordinated Air Use Management (NESCAUM).

The Task Force began by building knowledge and understanding of the MHD vehicle market and the barriers to widespread fleet electrification. The Task Force heard from public and private sector experts about the current truck and bus market, new ZEV technologies, the operational needs of MHD fleets, opportunities to advance equity, and other issues that must be understood to prioritize and develop well-designed market-enabling policies and programs. Input from many stakeholders—including environmental justice and community-based organizations, truck and bus manufacturers, industry, and technology experts, charging and fueling providers, utility companies, public and private sector fleet representatives, and commercial financing experts—helped shape and refine the *Action Plan's* recommendations.

NESCAUM's Mission and Role

NESCAUM is the regional non-profit association of air quality agencies in the six New England states, New York, and New Jersey. For over 50 years, NESCAUM has catalyzed, guided, and supported state initiatives to improve air quality and address climate change, such as states' adoption and implementation of California's Low- and Zero-Emission Vehicle regulations. NESCAUM spearheaded the formation of the Multi-State ZEV Task Force in 2013 and supported its work to develop and implement two Action Plans for light-duty ZEVs.

With the completion of this *MHD ZEV Action Plan*, NESCAUM looks forward to assisting the participating jurisdictions, through coordinated and individual state actions, to implement *Action Plan* policy recommendations to overcome the barriers to widespread truck and bus electrification.

Organization of the Action Plan

The *Action Plan* is organized as follows:

- Section II describes the need to ensure a just and equitable transition to zero-emission trucks and buses and provides principles to guide states as they engage with frontline and overburdened communities and workers;
- Section III explains why bold action to accelerate market transformation is needed now to protect public health, especially in frontline and overburdened communities, and to maximize and equitably distribute the economic benefits of the transition;
- Section IV provides an overview of the developing zero-emission truck and bus market, with a focus on electrification of transit buses, school buses, and commercial fleets;
- Section V discusses sector-wide opportunities, including advances in technology, declining battery costs, and favorable economics; and barriers, including higher up-front costs, issues for small fleets, lack of knowledge and awareness, the critical need for

charging infrastructure, production issues, commercial electricity rate design, lack of financing options, and other challenges;

- Section VI recommends strategies for state policymakers and key partners to support the rapid, equitable, and widespread deployment of MHD ZEVs , including sales and fleet purchase requirements, vehicle and infrastructure purchase incentives, electric utility and utility regulator actions, innovative financing mechanisms, outreach and education, economic equity and workforce development, community air monitoring, long-haul and community infrastructure planning and deployment, and areas for ongoing research and evaluation; and

- Appendix A includes recommendations for local and U.S. federal government policymakers to accelerate the transition to MHD ZEVs.

While the participating jurisdictions committed in the MOU to achieve 100 percent MHD ZEV sales by 2050, implementation of the strategies in this *Action Plan* could enable an even more rapid transition and accelerate the substantial environmental, public health, and economic benefits associated with the widespread deployment of MHD ZEVs.

NESCAUM assisted the participating jurisdictions with development of the *Action Plan* and the solicitation of stakeholder input on draft recommendations. A jurisdiction's participation in the initiative should not be interpreted as endorsement of all the policy recommendations included in the *Action Plan*. Each jurisdiction is expected to promote MHD ZEV market growth in ways that best address its unique needs and opportunities.

II. SUPPORTING A JUST AND EQUITABLE TRANSITION TO ZERO-EMISSION TRUCKS AND BUSES

For decades, low-income communities and communities of color located near freight hubs, bus depots, and trucking corridors have been directly and disproportionately impacted by air pollution from on- and off-road transportation and other emissions sources. (*See* Section III.) These frontline and overburdened communities should be the first to benefit from truck and bus electrification. The ZEV Task Force has endeavored to develop an *Action Plan* that centers equity, reflects the voices and expertise of communities overburdened by air pollution, and prioritizes delivery of air quality, public health, and economic benefits where they are needed most.

Key Concepts

This Action Plan frequently uses the terms "frontline community" and "overburdened community." Specific definitions for these terms may vary depending on the context. In some jurisdictions, these and other terms are defined by law or regulation. The *Action Plan* does not prescribe uniform definitions to be applied in connection with any particular policy or program. Each jurisdiction should engage with its communities to develop appropriate terminology. As used in this *Action Plan*:

Frontline community means a community proximate to sources of GHG emissions and air pollution that often bears the "first and worst" impacts from air pollution and climate change.

Overburdened community means a community that bears a disproportionate share of the climate, air quality, public health, and economic consequences of GHG emissions and air pollution.

To encourage collaboration in the *Action Plan* development process, NESCAUM and the Task Force engaged with nationally recognized equity and environmental justice organizations and community-based groups in the participating jurisdictions to understand the issues facing frontline and overburdened communities and collaborate on the development of equitable MHD vehicle electrification strategies. Invaluable contributions from the Moving Forward Network,[5] Better World Group, the BlueGreen Alliance, EVNoire, Green For All, and other national and community-based organizations are reflected in the equity principles below and throughout the *Action Plan*.

These organizations identified several priorities for state action, including the need to develop and expand community air monitoring programs to better assess and address air pollution "hot-spots"; identify frontline and overburdened communities through outreach and analysis of localized air quality and health data; implement policies that prioritize electric vehicle (EV) and

[5] *See, e.g.*, Moving Forward Network, Multi-State Advanced Clean Truck Rule Action Plan Equity and Environmental Justice Recommendations (Sept. 2021), https://www.nescaum.org/files/mhdzev-attachments/NESCAUM_%20Multi-State%20Advance%20Clean%20Truck%20Rule%20Equity%20and%20Environmental%20Justice%20Recommendations.pdf; *see also* Moving Forward Network, Making the Case for Zero-Emission Solutions in Freight: Community Voices for Equity and Environmental Justice (May 2021), https://www.movingforwardnetwork.com/wp-content/uploads/2021/10/MFN_Making-the-Case_Report_May2021.pdf.

charging and fueling infrastructure investment and deployment to directly benefit frontline and overburdened communities; and reduce emissions from diesel powered vehicles while the market transitions to ZEVs. These priorities are reflected throughout the strategies and recommendations in Section VI and Appendix A.

These organizations emphasized the critical importance of ensuring a just and equitable transition for workers across the transportation sector, including workers needed to support the widespread electrification of MHD vehicles. The subsection titled *Economic Equity for Workers* in Section VI recommends that states partner with communities, labor groups, and others to develop workforce development programs to ensure that workers are prepared to fill new jobs created by the transition.

This subsection also discusses several important issues confronting transportation sector workers—including low wages and inadequate benefits, working conditions, and driver misclassification[6]—that are outside the scope of the MOU, which is focused on the climate, air quality, and public health benefits to be achieved by electrifying trucks and buses, and by extension the scope of this *Action Plan*. These issues are also beyond the expertise and jurisdiction of the state agencies participating in the Task Force and intersect with policies and programs of other government agencies, including departments of health, labor, education, and economic and community development. The *Action Plan* discusses these important issues to raise awareness and promote collaboration with other parts of government whose expertise and engagement are needed to address conditions for workers.

New Jersey's "Whole-of-Government" Approach to Environmental Justice

Pursuant to an Executive Order signed by the Governor of New Jersey in 2020, and detailed guidance issued by the New Jersey Department of Environmental Protection, all executive branch agencies in the state are charged with working together to build a stronger and fairer New Jersey for all by advancing environmental justice as a core principle of all state policies and programs. The Order requires executive branch agencies to apply principles of environmental justice to their operations, participate in the newly formed Environmental Justice Interagency Council (EJIC), and create assessments and action plans to improve the effects of agency policy on environmental justice communities. The EJIC will help agencies to adopt the principles, complete initial assessments, participate in workshops and trainings, and develop action plans; and will oversee a transparent process for setting milestones and evaluating action plan implementation progress.

A "whole-of-government" approach is needed to ensure that state MHD vehicle electrification policies and programs advance equity and environmental justice for frontline and overburdened communities and for workers affected by the transition. States must engage

[6] *See* S. Appel and C. Zabin, UC Berkeley Labor Center, Truck Driver Misclassification: Climate, Labor and Environmental Justice Impacts (Aug. 2019), https://laborcenter.berkeley.edu/truck-driver-misclassification/.

directly and meaningfully with communities and worker groups with the most at stake and mobilize inter-agency coordination and collaboration as early as possible in the transition. To facilitate effective community engagement at all levels of government, training and additional resources and staff will be needed.

Principles for a Just and Equitable Transition

The principles below are intended to guide the participating jurisdictions as they engage with frontline and overburdened communities and workers in developing just and equitable MHD vehicle electrification policies and programs.

Just and equitable process. Inclusive, accessible, and transparent community engagement processes, which elevate the voices of frontline and overburdened community members and workers in all aspects of clean transportation planning and decision-making, are fundamental to improving air quality and ensuring a just and equitable transition to a zero-emission on-road transportation system.

- States should work with community groups to co-develop robust community engagement frameworks designed to institutionalize inclusive, accessible, and transparent community engagement practices that:
    - Recognize and elevate community knowledge, expertise, and leadership, and encourage open communication and collaboration;
    - Include community input in all aspects of policymaking, including resource allocation, needs assessment, planning, implementation, and evaluation;
    - Ensure opportunities to engage are regular and promote broad participation, with special consideration given to historically marginalized communities by:
        - Providing translation services to address cultural and language barriers to participation;
        - Holding meetings at times and locations that are convenient, familiar, and accessible to community members;
        - Distributing materials well in advance of meetings; and
        - Communicating complex matters in terms that are easy to understand;
    - Ensure community members have access to relevant information, research, data, and key agency staff and decision-makers;
- To identify frontline and overburdened communities, states should engage with communities to develop identification parameters, such as health metrics at the finest

geographic scales available, air pollution measurements from regulatory monitoring sites and local and regional monitoring networks, modeled air pollution estimates, locations of current and planned emissions sources, locations of sensitive populations, and truck counts;

- States should build knowledge and capacity within communities to provide input on community needs and priorities to inform the development of state clean transportation policies and effectively advocate for zero-emission technology by partnering with community-based organizations and representatives to:
    - Develop and implement MHD ZEV community outreach and education programs;
    - Provide technical assistance and materials on zero-emission truck and bus technologies, and the air quality, public health, and economic benefits associated with transportation electrification, through workshops, trainings, and dissemination of other resources; and
    - Explore additional ways to support community engagement with state policymakers; and
- States should establish or utilize existing environmental justice and equity councils and advisory bodies to ensure the integration of equity considerations and frontline and overburdened community voices in clean transportation policymaking processes.

Just and equitable outcomes. Policies to accelerate the transition to zero-emission trucks and buses must deliver direct benefits and ensure just and equitable outcomes for frontline and overburdened communities.

- States should prioritize and operationalize equity in all aspects of policymaking, including resource allocation, needs assessment, planning, implementation, and evaluation;
- State policies should prioritize delivery of direct benefits to frontline and overburdened communities; and
- States should consider the goals and strategies outlined in climate justice planning documents developed by the environmental justice community and develop state MHD vehicle electrification policies and metrics that support those goals and strategies.

III. WHY ZERO-EMISSION TRUCKS AND BUSES?

Figure 2: 2019 U.S. On-Road Vehicle Stocks by Vehicle Type

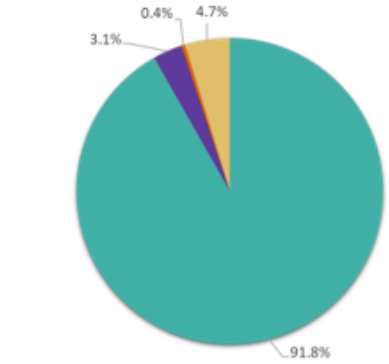


Figure 3: 2019 U.S. On-Road Annual VMT by Vehicle Type

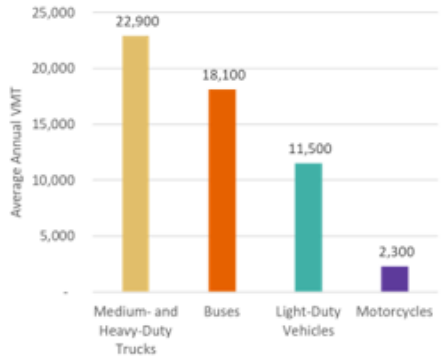
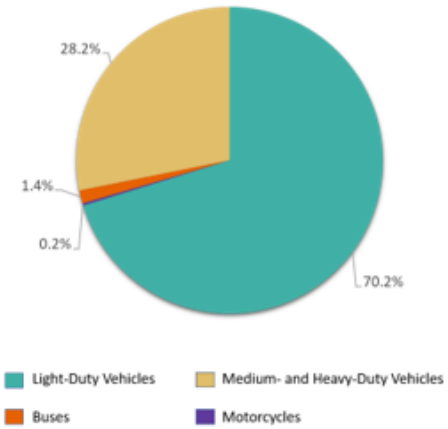


Figure 4: 2019 U.S. On-Road GHG Emissions by Vehicle Type



MHD vehicles play a critical role in the nation's transportation system and in everyday life. Each year, trucks of all sizes transport billions of tons of commodities and packages to and from ports, railyards, airports, warehouse distribution centers, and retail outlets across the country. Last-mile delivery trucks have become a familiar sight in our neighborhoods due to the rapid growth in e-commerce and home delivery of consumer goods. Public transit buses continue to serve as the primary mode of personal transportation for millions of Americans, logging billions of passenger miles every year, while roughly half a million school buses—the nation's largest fleet—transport 26 million children to and from school every day.[7]

While MHD trucks and buses comprise only 5 percent of the total number of on-road vehicles in the United States today (*see* Figure 2), their annual mileage per vehicle is significantly greater than that of passenger vehicles (*see* Figure 3) and they have an outsized impact on air quality and climate change. Powered predominantly by diesel engines, the trucks and buses that keep the economy running are among the most polluting vehicles on our roads.

After passenger cars and trucks, MHD vehicles are the second largest source of transportation sector GHG emissions in the United States (*see* Figure 4) and a major contributor to smog-forming pollutants and particulate matter that harm public health. MHD vehicles account for 28 percent of GHG emissions,[8] 42 percent of smog-forming NOx emissions (a precursor pollutant to ground level ozone), 51 percent of direct

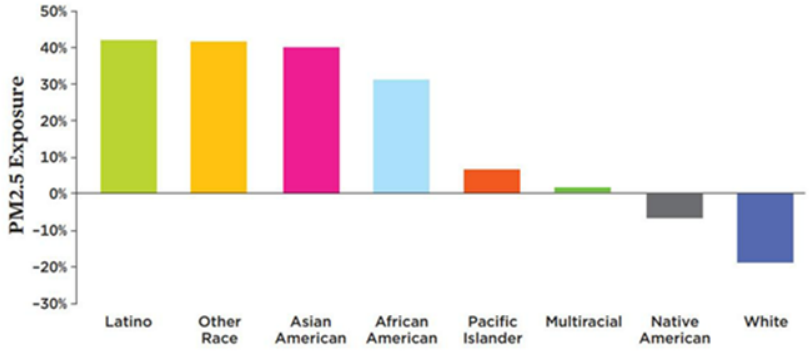
[7] A. De La Garza, U.S. School Buses May Never Be the Same Thanks to Biden's Infrastructure Plan, Time Magazine (Nov. 15, 2021), https://time.com/6117544/electric-school-buses/.
[8] U.S. Environmental Protection Agency, U.S. Greenhouse Gas Emissions and Sinks 1990-2019 (Apr. 2021), https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2019.

$PM_{2.5}$ emissions (PM less than 2.5 micrometers in diameter), and a significant source of hazardous air pollutant emissions from on-road vehicles in the United States.[9]

The Disproportionate Impact on Overburdened Communities

Decades of research confirms that exposure to ground level ozone, NOx, and $PM_{2.5}$ worsens asthma and other respiratory illnesses, especially in children and older adults, leading to additional trips to doctors and emergency rooms, missed days of school and work, and thousands of premature deaths each year. More recent studies establish a clear link between proximity to traffic pollution and adverse public health impacts. One study found strong evidence of a causal connection between long-term exposure to traffic-related air pollution and childhood asthma.[10] Low-income communities and communities of color that are often located near trucking corridors, ports, fleet garages, warehouses, and other truck distribution hubs[11] are hit hardest by this pollution burden and bear a disproportionate share of the associated health and economic consequences (*see* Figure 5).

Figure 5: $PM_{2.5}$ Pollution Exposure by Racial Group



In the Northeast and Mid-Atlantic, residents of color tend to have significantly higher exposure to $PM_{2.5}$ concentrations relative to the regional average, while white residents have the lowest exposure.

Source: Union of Concerned Scientists

[9] J. O'Day, Ready for Work: Now Is the Time for Heavy-Duty Electric Vehicles, Union of Concerned Scientists (Dec. 11, 2019), https://www.ucsusa.org/resources/ready-work.

[10] G. Thurston, et al., Outdoor Air Pollution and New Onset Airway Disease. An Official American Thoracic Society Workshop Report, Annals ATS Vol. 17, No. 4 (Apr. 2020), https://www.atsjournals.org/doi/full/10.1513/AnnalsATS.202001-046ST; R. Sheer and D. Moss, Breathe Wheezy: Traffic Pollution Not Only Worsens Asthma, but May Cause It, Scientific American (Jan. 9, 2013), https://www.scientificamerican.com/article/traffic-pollution-and-asthma/.

[11] Union of Concerned Scientists, Inequitable Exposure to Air Pollution from Vehicles in the Northeast and Mid-Atlantic: Who Bears the Burden? (June 2019), https://www.ucsusa.org/sites/default/files/attach/2019/06/Inequitable-Exposure-to-Vehicle-Pollution-Northeast-Mid-Atlantic-Region.pdf. For a national perspective, see A. Jbaily, et al., Air Pollution Exposure Disparities Across U.S. Population and Income Groups, Nature (Jan. 2022), https://www.nature.com/articles/s41586-021-04190-y.

With truck freight volumes expected to continue to increase over the next decade, pollution from trucks will remain an increasingly greater public health risk to frontline and overburdened communities located near heavy truck traffic. Rapid truck and bus electrification offers a transformative opportunity to address important equity and environmental justice issues and achieve large-scale reductions in diesel emissions needed to protect public health and stabilize the climate. This transition will take time, especially for heavy-duty trucks, which are on a longer path to commercialization and will benefit from further advances in ZEV propulsion technologies and the development of a robust charging and fueling infrastructure network. At the same time, states must continue to prioritize shifting to renewable energy sources as the fleet becomes more electrified to achieve even greater overall emission reductions and corresponding public health and economic benefits.

Quantifying the Public Health and Climate Benefits of Zero-Emission Trucks and Buses

Achieving the MHD ZEV sales targets will deliver deep reductions in emissions of NOx, PM, and GHGs. An analysis by the International Council on Clean Transportation (ICCT) concluded that achieving 100 percent MHD ZEV sales in 2050 would slash well-to-wheel carbon dioxide equivalent emissions from the MHD vehicle segment in the participating jurisdictions up to 73 percent below 2020 levels.[12] Fully decarbonizing the electric grid by 2050 would deliver even greater emission reductions. ICCT also projected a fleet-wide decline in NOx emissions between 78 and 98 percent below 2020 levels by 2050, depending on whether the jurisdictions adopt California's Heavy-Duty Engine and Vehicle Omnibus Regulation. In addition, emissions of fine particulate matter from MHD vehicles would drop by 73 percent below 2020 levels in 2050.

Maximizing the Economic Benefits of the Transition

With the right policies in place to boost investment in domestic MHD ZEV manufacturing and associated industries, transforming the MHD vehicle sector promises to deliver vast economic benefits and job creation. Macroeconomic analyses of MHD ZEV adoption find a large net benefit to households and businesses: each new dollar invested in ZEVs can generate nearly five dollars in gross domestic product growth.[13] Zero-emission trucks and buses cost less to fuel and

[12] J. Houck, et al., Benefits of State-Level Adoption of California Medium- and Heavy- Duty Regulations, Sonoma Consultants for ICCT, (Oct. 2021), https://theicct.org/publications/state-level-hdv-emissions-reg-oct21. This analysis does not include California, Hawaii, Virginia, and Quebec. ICCT's methods replicated those used by the California Air Resources Board to study the effect of the same regulation, which found similar results.

[13] P. Hibbard and P. Darling, Economic Impact of Stimulus Investment in Transportation Electrification, Analysis Group (June 2021), https://www.analysisgroup.com/globalassets/insights/publishing/2021-aee-electric-vehicle-stimulus-report.pdf.

maintain than conventional vehicles—perhaps $10,000 less per average vehicle lifetime.[14] With approximately 14 million MHD vehicles on the road today, the net lifetime operating savings at full electrification could be as high as $140 billion.[15]

Money spent purchasing MHD ZEVs and associated charging and fueling equipment cascades throughout the entire economy, boosted by other new spending generated by cost savings, creating jobs, and paying the salaries of thousands of workers over the life of each vehicle. Governments play a critical role in shepherding these impacts. Each dollar of public investment in MHD ZEVs generates almost three dollars of additional private investment that would not otherwise occur.[16] In seeking these benefits, governments should ensure that policies promoting MHD ZEVs rely on domestic labor to manufacture and service these vehicles wherever possible, or many of these benefits will accrue to markets overseas instead.[17]

Despite being a comparatively new technology, the transition to MHD ZEVs implicates traditional automotive employment skills. As with conventional vehicles, electric truck, van, and bus production employs thousands to design, manufacture, construct, and maintain vehicles and their supporting infrastructure. Jobs in these sectors include an assortment of assemblers, machinists, electrical technicians, and civil construction workers in addition to high-skill occupations in design and engineering; most are unionized vocations and pay supportive wages.[18] While some automotive and energy sector jobs may disappear due to industrial realignment, new direct job gains at similar skill levels in similar locations, and job opportunities in new business areas like battery logistics, will more than offset these losses provided there

[14] D. Lowell, et al., New York Clean Trucks Program: An Analysis of the Impacts of Zero-Emission Medium- and Heavy-Duty Trucks on the Environment, Public Health, Industry, and the Economy, M.J. Bradley and Associates (Sept. 2021), https://www.ucsusa.org/sites/default/files/2021-09/ny-clean-trucks-report.pdf.

[15] Federal Highway Administration, Highway Statistics 2019: Annual Vehicle Distance Traveled in Miles and Related Data by Highway Category and Vehicle Type (Table VM-1), https://www.fhwa.dot.gov/policyinformation/statistics/2019/vm1.cfm (accessed Mar. 4, 2022).

[16] P. Hibbard and P. Darling, Economic Impact of Stimulus Investment in Transportation Electrification, Analysis Group, (June 2021), https://www.analysisgroup.com/globalassets/insights/publishing/2021-aee-electric-vehicle-stimulus-report.pdf.

[17] J. Barrett and J. Nivens, The Stakes for Workers in How Policymakers Manage the Coming Shift to Electric Vehicles, Economic Policy Institute (Sept. 22, 2021), https://www.epi.org/publication/ev-policy-workers/.

[18] S. Chandler, J. Espino, and J. O'Dea, Delivering Opportunity: How Electric Buses and Trucks Can Create Jobs and Improve Public Health in California, Union of Concerned Scientists and the Greenlining Institute (May 2017), https://www.ucsusa.org/sites/default/files/attach/2016/10/UCS-Electric-Buses-Report.pdf; see T. O'Connor and J. Mathers, Charged-Up: Analysis of the Jobs, Investments and Companies in the Zero Emissions Medium and Heavy Duty Vehicle Supply-Chain Economy, Environmental Defense Fund (Oct. 2021), https://www.edf.org/sites/default/files/documents/National%20MHD-ZEV-Supply-Chain-Analysis%2010.27.21_0.pdf.

are strong policies to ensure growth in North American manufacturing and support workers in the transition.[19]

Government and private sector cooperation in the transition will be essential. With adequate training, workforce policy safeguards, and a focus on North American value chains, workers in automotive, civil infrastructure, and related secondary industries will be able to transition in place without sacrificing their livelihoods. Working in concert with federal actions, states are uniquely poised to adopt policies and programs to maximize and ensure the equitable distribution of the economic and employment benefits of the transition to MHD ZEVs in their jurisdictions.

The climate, public health, and economic benefits of a widespread shift to zero-emission trucks and buses are helping to drive a developing market for these vehicles. As the next section explains, electric powertrain technology has a strong foothold in the MHD vehicle market.

[19] A. Phadke, et al., 2035: The Report: Transportation, Goldman School of Public Policy, University of California at Berkeley (Apr. 2021), http://www.2035report.com/transportation/wp-content/uploads/2020/05/2035Report2.0.pdf; J. Barrett and J. Nivens, The Stakes for Workers in How Policymakers Manage the Coming Shift to Electric Vehicles, Economic Policy Institute (Sept. 22, 2021).

IV. THE ZERO-EMISSION TRUCK AND BUS MARKET TODAY

Today, electric trucks and buses account for a small fraction of sales of new Class 2b-8 MHD vehicles (*see* Figure 1). However, increasing numbers of electric models are coming to market and providing public and private fleet operators with a more diverse selection of vehicles that meet their needs and duty cycles. As electric powertrain technologies further improve, supportive government policies and programs will help lower initial entry costs and create the conditions necessary for significant growth of the zero-emission truck and bus market in the coming decade.

More than 125 different zero-emission models are currently available across Class 2b-8 vehicle segments in North America, and this number is anticipated to exceed 240 models by 2023.[20] Altogether, more than 55 manufacturers have announced plans to produce battery 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.

In addition, several manufacturers have announced plans to develop Class 4-8 hydrogen FCEV trucks and buses. Using hydrogen fuel pumps, these trucks and buses can be refueled in a manner similar to fossil fuel powered vehicles and may be well suited for high mileage transit bus routes and heavy-duty long-haul trucking applications. Penetration of FCEV technology has advanced furthest in the transit bus segment: nearly 200 hydrogen-fueled buses were deployed in the United States in 2021.[21]

Early Progress on Zero-Emission Fleets

A growing number of public and commercial fleets are piloting electric trucks and buses. By matching duty cycles with vehicle capabilities, these early deployments are serving as a proving ground for technology. To date, the largest EV deployments have targeted replacement of urban delivery vans, drayage trucks, and transit and school buses. These applications are well suited for early deployment of electrification because they serve predictable routes, generally travel less than 100 miles per day roundtrip, and return to a centralized fleet depot, which enables fleet operators to strategically deploy vehicles and manage vehicle charging operations.

[20] CALSTART, Global Commercial Drive to Zero, Zero-Emission Technology Inventory Tool, Version 5.9 (2020), https://globaldrivetozero.org/tools/zero-emission-technology-inventory/.
[21] CALSTART, Zeroing in on ZEBs: 2021 Edition (Dec. 2021), https://calstart.org/wp-content/uploads/2022/01/2021-ZIO-ZEB-Final-Report_1.3.21.pdf.

Transit Buses

Among all MHD vehicles, zero-emission transit buses have achieved the most widespread adoption, with more than 3,500 combined battery electric and hydrogen fuel cell transit buses in operation or on order in the U.S. and more than 600 in Canada.[22]

Early leadership in zero-emission transit bus deployment has been driven by a combination of local, municipal, and state government fleet purchase mandates; federal grant programs; state vehicle purchase incentives[23]; and the availability of a diverse group of battery electric and hydrogen fuel cell models from both traditional and zero-emission only bus manufacturers.

School Buses

The pace of electric school bus adoption has accelerated in recent years as school districts across the U.S. have funded, ordered, delivered, or deployed more than 1,700 electric school buses.[24] More than 250 electric school buses currently serve schools in Quebec. Many electric bus manufacturers are planning to ramp up production in the coming years to meet the increasing demand.

Electric School Buses: A Quebec Priority

The widespread adoption of electric school buses is a top priority for the Quebec government. In response to a request for proposals in 2016, Quebec selected its first project, which resulted in the production of the first North American electric school bus. Since then, Quebec has adopted several additional measures to accelerate zero-emission school bus fleet adoption, including a regulation requiring all new school bus purchases to be electric by 2023. Quebec is striving to achieve an all-electric school bus fleet by 2040 and has set an interim goal to electrify 55 percent of its school buses by 2030.

Some school districts are exploring the potential for electric school buses to provide vehicle-to-grid (V2G) services.[25] During periods when electric school buses sit idle in the evenings and summer months, the batteries can be used to store and discharge electricity back to the grid during periods of peak demand when electricity is costlier. Providing V2G services benefits

[22] CALSTART, Zeroing in on ZEBs: 2021 Edition (Dec. 2021), https://calstart.org/wp-content/uploads/2022/01/2021-ZIO-ZEB-Final-Report_1.3.21.pdf.
[23] Using Volkswagen settlement funding, states have invested over $189 million for electric and hydrogen transit buses nationwide. *See* Atlas Public Policy, VW Settlement Funding Dashboard, https://www.atlasevhub.com/materials/vw-environmental-mitigation-fund-tracking/ (accessed March 4, 2022).
[24] CALSTART, Zeroing in on Electric School Buses: 2021 Edition (Dec. 2021), https://calstart.org/wp-content/uploads/2022/01/ZIO-Electric-School-Buses-2021-Edition.pdf.
[25] *See, e.g.*, School Transportation News, Lion Electric Announces Successful Electric School Bus Vehicle-to-Grid Deployment with Con Edison in New York (Dec. 14, 2020), https://stnonline.com/industry-releases/lion-electric-announces-successful-electric-school-bus-vehicle-to-grid-deployment-with-con-edison-in-new-york/. For a recent compilation of current and proposed electric school bus V2G project, see TheCityFix, 3 Design Considerations for Electric School Bus Vehicle-to-Grid Programs (Feb. 14, 2022), https://thecityfix.com/blog/3-design-considerations-for-electric-school-bus-vehicle-to-grid-programs/.

school districts and utility ratepayers by generating revenue that improves the economics of fleet electrification while reducing electricity distribution system costs for ratepayers.

Commercial Fleets

Large corporate fleets are responsible for much of the early momentum in commercial MHD fleet electrification. These early adopter investments are largely driven by corporate sustainability commitments and a desire to achieve operational savings. Collectively, commercial fleets have pre-ordered more than 100,000 electric MHD ZEVs and begun deploying the first vehicles.[26]

Most last-mile delivery vehicles travel urban and suburban routes of less than 100 miles per day and present the greatest near-term opportunity for electrification.[27] Many of these routes can be served by zero-emission models that are commercially available today. In the growing e-commerce and parcel delivery space, companies like Amazon, DHL, FedEx, IKEA, and UPS are among the earliest adopters of electric delivery vans, and together have placed orders for more than 100,000 commercial medium-duty ZEVs for last-mile deliveries.

Volvo LIGHTS Project in Southern California

Led by the South Coast Air Quality Management District and Volvo Group North America, the Volvo Low-Impact Green Heavy Transport Solutions (LIGHTS) project brought together 14 diverse partners—private fleets, government agencies, ports, community colleges, equipment suppliers, a utility, and others—to develop and test a model for successful deployment of Class 8 battery-electric trucks. The $90 million project was funded by California Climate Investments, a statewide initiative that puts billions of cap-and-invest dollars to work reducing GHG emissions, strengthening the economy, and improving public health and the environment. The project deployed 25 Volvo VNR Electric trucks 25 freight handling vehicles, 58 chargers, and local site solar power generation. The Volvo LIGHTS project also launched innovative programs to train the specialized workforce needed to support, maintain, and repair battery-electric trucks. The three-year collaboration showed that heavy-duty, battery-electric trucks and equipment can be successfully integrated into commercial fleets moving freight with less noise and zero-tailpipe emissions.

Battery electric Class 7 and 8 short- and long-haul trucks are on a longer path to commercialization, but several pilot projects demonstrating their viability are underway. Today, there are more than 28 different battery electric and hydrogen fuel cell Class 7 and 8 truck

[26] Environmental Defense Fund, Electric Fleet Deployment & Commitment List, https://docs.google.com/spreadsheets/d/1l0m2Do1mjSemrb_DT40YNGou4o2m2Ee-KLSvHC-5vAc/edit#gid=2049738669 (accessed Mar. 4, 2022).
[27] California Air Resources Board, Advanced Clean Trucks Fact Sheet (Aug. 20, 2021), https://ww2.arb.ca.gov/sites/default/files/2021-08/200625factsheet_ADA.pdf.

models in various stages of development and production. Most are expected to come to market over the next three years.[28]

Short-haul drayage trucks, which transport freight loads between ports, warehouses, and distribution facilities, sit idle for periods while the container units are loaded and unloaded. This idle time is ideal for charging battery electric drayage trucks. The duty cycle and more favorable business case for short-haul battery electric drayage trucks has led to pilot deployments along routes connecting port facilities, distribution centers, and railyards.

Early experiences with electric truck and bus deployment illustrate the important environmental, economic, and equity benefits that electrification of the MHD sector can deliver, while providing valuable insights into the challenges associated with taking commercial fleet electrification to scale. As discussed in the next section, a rapid transition from small-scale deployments by leading early adopters to a self-sustaining market across all vehicle classes requires overcoming a set of key barriers to widespread fleet electrification.

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

V. BUILDING MARKET MOMENTUM AND ADDRESSING BARRIERS

Positive Market Developments

The market for MHD zero-emission vehicles is primed for rapid growth. The fast pace of technology development, sharply declining battery costs, and the potential for significant operational cost savings are generating growing interest in truck and bus electrification by fleets of all types.[29]

Bipartisan Infrastructure Law

Signed into law on November 15, 2021, the historic Infrastructure Investment and Jobs Act, also known as the Bipartisan Infrastructure Law (BIL), provides critical funding for states to accelerate MHD vehicle electrification. The BIL provides more than $15 billion in funding for MHD vehicle electrification-eligible investments, including $250 million for projects that reduce truck emissions at port facilities; $5 billion for clean school bus purchases; and over $10 billion for clean transit buses, refueling infrastructure, and bus facility upgrades. This large infusion of federal funding will spur market development and greater demand for zero-emission trucks and buses as state and local governments accelerate their fleet transition efforts.

Rapid Technology Advances

Many components of electric powertrains are the same across multiple platforms. Investment in first-to-market applications, like transit buses and urban delivery vans with shorter, fixed daily duty cycles, are speeding the transfer of technology to more challenging and less market-ready applications, like regional freight trucks and long-haul tractor trailers. Significant investment in research and development is resulting in continuous improvements in battery capacity, longer ranges, and faster charging. Nearly all the major truck manufacturers and suppliers offer electric models, are running MHD ZEV demonstration projects, or have announced plans to commercialize electric options for an expanding number of fleet applications.

Declining Battery Cost

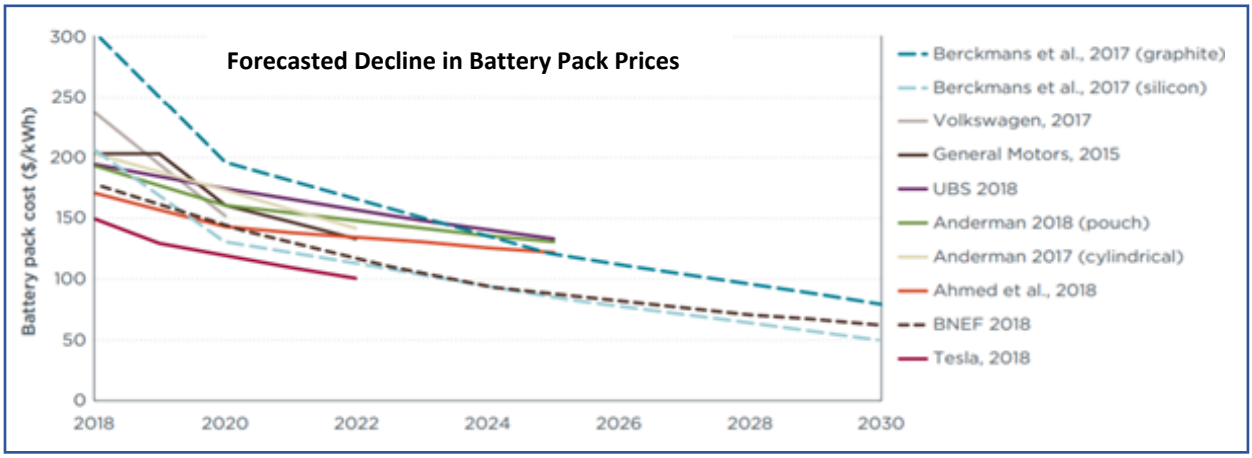
Battery costs continue to be the single largest factor influencing EV purchase prices. However, rapid advances in battery chemistries, increasing energy density, and more efficient pack design are driving sharp reductions in battery costs. During the last decade, battery prices declined by nearly 90 percent, falling from more than $1,100 per kilowatt hour (kWh) to an average of $137 per kWh.[30] With further advancements in battery technology expected and growing market

[29] *See* Environmental Defense Fund, Electric Fleet Deployment & Commitment List, https://docs.google.com/spreadsheets/d/1l0m2Do1mjSemrb_DT40YNGou4o2m2Ee-KLSvHC-5vAc/edit#gid=2049738669 (accessed Mar. 4, 2022).

[30] Bloomberg New Energy Finance, Battery Pack Prices Cited Below $100/kWh for the First Time in 2020, While Market Average Sits at $137/kWh (Dec. 16, 2020), https://about.bnef.com/blog/battery-pack-prices-cited-below-100-kwh-for-the-first-time-in-2020-while-market-average-sits-at-137-kwh/.

demand, multiple market analysts forecast a continued steady decline in battery prices through 2030 (*see* Figure 6).[31]

Figure 6. Update on EV Costs in the U.S. Through 2030 (ICCT Apr. 2019)



Declining battery costs will be reflected in lower prices and longer ranges for vehicles, leading to an improved business case for electrification and making zero-emission trucks and buses more affordable for a wider range of commercial fleets.

Emerging Favorable Economics for Battery Electric MHD Vehicles

The economics of electrification factor heavily in commercial fleet purchasing decisions. Battery electric MHD vehicles have the potential to deliver significant lifetime operational savings over diesel trucks and buses through lower fuel, maintenance, and electric powertrain costs. A recent analysis by the U.S. Department of Energy's Lawrence Berkeley National Laboratory (LBNL) illustrates the substantial opportunity for operational costs savings even with fleet applications that are the most challenging to electrify. The LBNL analysis compared the total cost of operation (TCO) of a Class 8 long-haul battery electric truck with its diesel counterpart and projected a 13 percent lower TCO per mile for the battery electric truck, leading to a net savings of $200,000 over an assumed 15-year lifetime of the electric truck.[32]

[31] N. Lutsey and M. Nicholas, Update on electric vehicle costs in the United States through 2030, ICCT (Apr. 2, 2019), https://theicct.org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf.
[32] A. Phadke, et al., Why Regional/Long-Haul Trucks are Primed for Electrification Now (Mar. 2021), https://energycentral.com/system/files/ece/nodes/471683/2103_lawrence_livermore_lab_e_trucks.pdf.

Significant cost savings will be possible for a wide range of fleet applications in the next few years.[33] Market analysts project favorable TCO for certain medium-duty ZEV applications without government subsidies for applications in many weight classes by 2025, and for applications in all weight classes by 2030.

To build on these positive technological developments, bold leadership and early action by policymakers and other key partners are needed to increase model availability and overcome initial cost and charging infrastructure barriers.

Existing Sector-Wide Barriers

Higher Upfront Cost of MHD ZEVs

Among the primary barriers to commercial zero-emission fleet adoption are the incremental upfront purchase cost of zero-emission trucks and buses and associated infrastructure compared to internal combustion (e.g., diesel or gasoline) vehicles. For example, according to a 2019 survey by the Vermont Energy Investment Corporation, the average cost of an electric Class C school bus without charging infrastructure ranged from $265,000 to $400,000[34] versus $110,000 for a diesel bus. It is expected that prices for electric buses will decline substantially, so that the lower maintenance and fuel costs for an electric bus should more than make up for the higher purchase price, but that future return on investment does not help school districts reduce the initial capital outlay. Results from an analysis supporting the adoption of California's Advanced Clean Trucks regulation projected favorable TCO for BEVs over diesel and FCEVs in nearly all classes leading up to 2030 without government subsidies.[35]

Barriers for Small Fleets

Small trucking companies operating with six or fewer trucks make up 90 percent of carriers in the United States.[36] Instead of purchasing new trucks to replace older trucks that have reached the end of their useful lives, many smaller fleets, independent owner/operators, and contract drivers buy used trucks on the secondary market. Because these smaller fleets and contract drivers often have slimmer profit margins, fewer capital resources, and less certain access to

[33] *See, e.g.*, S. Stone, V. Nair, and G. Rogers, Roush Industries, Technical Review of Medium- and Heavy-Duty Electrification Costs for MY 2027 – 2030: Final Report (Feb. 2, 2022), http://blogs.edf.org/climate411/files/2022/02/EDF-MDHD-Electrification-v1.6_20220209.pdf.
[34] VEIC, Electric School Buses Available for Service, https://www.veic.org/Media/Default/documents/resources/reports/types-of-electric-school-buses.pdf (accessed Mar. 4, 2022).
[35] ICF, Comparison of Medium- and Heavy-Duty Technologies in California Total Cost of Ownership Technology Analysis (Dec. 2019), https://caletc.com/comparison-of-medium-and-heavy-duty-technologies-in-california/.
[36] TruckInfo.net, Trucking Statistics, https://www.truckinfo.net/trucking/stats.htm (accessed Mar. 4, 2022).

credit,[37] there is less capacity to assume the inherent risks and uncertainties associated with adoption of new technology. Enhanced incentives can help overcome the upfront cost barrier.

The Need for Fleet Outreach and Education Programs

Many fleet operators—especially small fleets and independent owner/operators—lack knowledge and awareness of zero-emission technology and its benefits. This is a threshold barrier to a successful and timely sector-wide transition. A robust fleet outreach and education effort targeted to small fleets and independent owner/operators that provides information on the public health impacts of diesel emissions on overburdened communities and drivers, zero-emission technology, government incentive programs, tools to calculate operational costs, installation of charging infrastructure, and other considerations, is essential to give fleets the information they need to make the shift to electric trucks.

Critical Need to Deploy Charging Infrastructure

Rapid deployment of depot, public, and highway corridor charging infrastructure to serve commercial fleets with a variety of charging needs is vitally important and will require strategic planning and coordinated action between states, utilities, fleet managers, and property owners who lease space to delivery companies, warehouses, and other facilities that are integral to the goods movement sector. While most MHD fleets have extended downtimes and will be able to utilize lower-powered 50 kW to 150 kW DC fast charging, or even Level 2 overnight depot charging, the duty cycles of some MHD fleets with larger batteries will require much higher-powered DC fast charging and a significant additional upfront capital investment. A fleet of transit buses, for example, could easily require several megawatts of electrical capacity and significant physical modifications to existing parking facilities that may be located in space constrained urban areas.

Depending on the size of the fleet and the type of vehicles, upgrades to electrical panels and power lines at the facility may be needed, along with utility upgrades to power lines and other distribution infrastructure that will often require expensive trenching. Determining how these costs will be allocated, along with the timing and other logistics of charging infrastructure deployment, can add significant complexity to the fleet electrification process, particularly for fleets that lease their facilities.

In addition to facility depot charging infrastructure, an accessible public fast charging network along regional and long-haul trucking routes is needed to fully electrify MHD fleets. The

[37] S. Appel and C. Zabin, UC Berkeley Labor Center, Truck Driver Misclassification: Climate, Labor and Environmental Justice Impacts (Aug. 2019), https://laborcenter.berkeley.edu/truck-driver-misclassification/.

buildout of a charging network along major trucking corridors will require sustained private sector financial support, leveraged by public funding, and clear direction from utility regulators to ensure inclusive long-term utility planning.

Production Issues

While there is a steady increase in the number of MHD ZEV product offerings, more electric options with longer ranges are needed for long-haul applications in particular. Low production volumes are also limiting more widespread deployment of electric trucks and buses and making it more difficult to establish a successful performance record for new models. Importantly, rapid growth of the electric truck and bus market will require the development of a robust supply chain and skilled workforce.

Electricity Rates

Commercial electricity rates are not designed specifically for electric MHD vehicle charging—particularly the high-power charging required for certain MHD vehicle applications. In addition to energy charges for actual electricity use, commercial facilities are also assessed demand charges for the maximum power used during a billing cycle. Demand charges associated with EV charging can dwarf the energy charge and make the cost of electricity prohibitive. Rate reform is needed to mitigate demand charges and incentivize fleet charging during lower cost off-peak periods and periods of high renewable energy generation. Managed charging strategies, although not a substitute for improved rate design, will be essential to ensure that electricity rates are competitive with the cost of diesel fuel over the long term. Co-locating battery storage at fleet depots can also help to manage demand and electricity costs.

Lack of Financing Options

Widespread commercial fleet electrification will not happen without private sector capital investment. While financiers have indicated a strong interest in commercial fleet electrification, actual investment today has been limited[38] by the perceived risks and uncertainties associated with electric trucks and buses and the need for economies of scale to leverage private capital.

[38] CALSTART, Taking Commercial Fleet Electrification to Scale: Financing Barriers and Solutions (Mar. 2021), https://calstart.org/wp-content/uploads/2021/03/Taking-Commercial-Fleet-Electrification-to-Scale-Executive-Summary.pdf.

Different Charging Standards

The interoperability of vehicle charging stations is important to maximize vehicle flexibility and convenience. Manufacturers of transit and school buses equipped with plug-in connectors all use the SAE-approved J1772 CCS Type 1 charger. While the SAE J3068 three-phase AC standard can accommodate overnight charging of any MHD vehicle and DC charging up to 500kW, MHD ZEV manufacturers have not yet widely adopted this standard. A common open charging standard for trucks is needed to make public charging seamless, achieve economies of scale, avoid stranded assets, and minimize the need for future modifications to charging connectors. A high-powered charging standard to serve the power and charge time needs of multiple MHD vehicles—the Megawatt Charging System (MCS)—is under development by the Charging Infrastructure Initiative (CharIN) Task Force comprised of industry, utility, and government agency representatives.[39] Once finalized, the MCS is expected to become the industry standard for high powered heavy-duty vehicle fast charging.

Lithium-ion Battery Production and Recycling

Today's EV batteries require lithium, cobalt, nickel, manganese, copper, and other critical minerals to generate and store the electricity that powers the vehicle. Extraction of these minerals, some of which are located in a small number of developing nations without adequate regulatory protections, causes damaging environmental impacts and is linked to public health risks and associated with child labor, poverty wages, and dangerous working conditions.[40] Moreover, most of the production of batteries is presently based in Asia. North America must develop its own battery supply chain in order to minimize the risk of disruption to its automotive and other industries. The need to address the social, environmental, and economic implications of battery production and recycling is widely acknowledged.

Lithium-ion Battery Recycling in Quebec

Lithion Recycling in Montreal uses an innovative, efficient, and cost-effective hydrometallurgical process to recycle lithium-ion batteries, the most widely used batteries for electric vehicles and portable electronics today. Its process can recover 95 percent or more of lithium, nickel, cobalt, and other critical minerals for reuse in new batteries. By enabling the battery manufacturing industry to maximize its production scrap value and efficiently recycle end-of-life batteries, this technology is helping to close the battery life-cycle loop.

At the other end of the battery life cycle, there is growing interest in finding end-of-life solutions through re-manufacturing, repurposing, and recycling that could reduce reliance on virgin raw materials, cut the costs of battery production, and lower life cycle battery emissions.

[39] CharIN, Megawatt Charging System, https://www.charin.global/technology/mcs/ (accessed Mar. 4, 2022).
[40] Center for Law, Energy & the Environment, Natural Resources Governance Institute, Building a Sustainable Electric Vehicle Battery Supply Chain (Apr. 15, 2020), https://resourcegovernance.org/analysis-tools/publications/building-sustainable-electric-vehicle-battery-supply-chain-faqs.

Other Challenges for Battery Electric Truck and Bus Deployment

Expert technical assistance and close coordination with utilities will be needed for individual fleets to assess the overall costs and benefits of electrification, understand charging options, and properly sequence infrastructure deployment with vehicle purchases. Lengthy permitting and utility interconnection processes add complexity and costs to infrastructure deployment. Battery weight presents a potential obstacle for heavy-duty long-haul applications. Without revisions to state transportation laws, the weight of the batteries needed to increase electric range could cause a fully loaded truck to exceed vehicle weight limitations, thereby limiting its cargo carrying capacity.

Other Challenges for Hydrogen Truck and Bus Deployment

While hydrogen trucks and buses are being piloted in small numbers across the country, the current TCO for fuel cell vehicles and costs for constructing and commissioning hydrogen fueling stations are significantly higher than for battery electric MHD vehicles. The average hydrogen station carries a median capital cost of $1.9 million,[41] and hydrogen fuel averages over $16 per gasoline gallon equivalent.[42] Increasing uptake of hydrogen trucks and buses will depend on hydrogen fuel becoming cost competitive with electricity and other transportation fuels and the ability to scale vehicle manufacturing, fuel production, and fueling infrastructure network development. According to industry experts, demand from trucking alone will not be enough to drive down hydrogen fuel production and transportation costs; demand will also be needed from a broad range of industrial and commercial applications.

Another challenge for hydrogen trucks and buses relates to the GHG emissions associated with fuel production. Today, hydrogen fuel is mostly produced using natural gas. Only a small fraction of hydrogen fuel produced today is “green” fuel, produced by an electrolytic process powered by renewable energy, because it is currently more expensive to produce.

All levels of government have important roles to play to accelerate the market transformation needed to achieve state climate, air quality, and equity goals. The next section offers a series of recommended actions for state policymakers to overcome key market barriers and speed the transition to a zero-emission transportation sector. Recommended actions for local and U.S. federal government policy makers are included in Appendix A.

[41] U.S. Department of Energy, Hydrogen Fueling Stations Cost (Feb. 11, 2021), https://www.hydrogen.energy.gov/pdfs/21002-hydrogen-fueling-station-cost.pdf.
[42] Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy, Clean Cities Alternative Fuel Price Report (Oct. 2021), https://afdc.energy.gov/files/u/publication/alternative_fuel_price_report_october_2021.pdf

VI. STRATEGIES AND RECOMMENDATIONS

There is considerable diversity in the economic base, population density, settlement patterns, resource availability, and other key characteristics that shape the unique policy needs of the jurisdictions participating in the MHD ZEV initiative. Accordingly, participation in the initiative should not be interpreted as endorsement of all the policy recommendations included in this *Action Plan*. The recommendations discussed below are not intended to provide a uniform pathway for states to follow, but rather to guide inter-state coordination and inform state-specific actions. Each jurisdiction is expected to promote MHD ZEV market growth in ways that best address its unique needs and opportunities. Further, to implement many of these strategies and achieve the goals of the MOU, considerable resources, new and sustainable sources of funding, and strong and enduring partnerships will be required.

Sales and Fleet Purchase Requirements

Regulations requiring manufacturers to sell increasing percentages of zero-emission trucks and buses, such as California's Advanced Clean Trucks (ACT) regulation, are one of the most effective tools available to rapidly advance the market for MHD ZEVs. Under the ACT regulation, manufacturers of Class 2b-8 vehicles must sell an increasing percentage of ZEVs. Adopting the ACT regulation will provide significant reductions in diesel emissions and support local economic development and job growth. Moreover, pairing the ACT regulation with other policies can ensure ZEV deployments are prioritized in communities near trucking corridors, fleet garages, ports, railways, and distribution hubs.

California's Fleet Purchase Requirements

To complement the ACT regulation, California is developing the Advanced Clean Fleets (ACF) regulation to require fleets that are well suited for electrification (i.e., drayage fleets, public fleets, federal fleets, and other high priority fleets) to transition to MHD ZEVs. These fleet purchase requirements will further accelerate the uptake of MHD ZEVs and the benefits they offer to those communities most impacted by harmful truck emissions. The ACF regulation builds on California's Innovative Clean Transit regulation, which requires public transit agencies to transition to a 100 percent zero-emission bus fleet, and its Zero-Emission Airport Shuttle regulation, which requires airport shuttle operators to transition to zero-emission shuttles.

While market-enabling programs such as incentives are also important, regulatory requirements mandating MHD ZEV sales provide market certainty needed to drive investments in zero-emission technologies and charging and fueling infrastructure at the pace and scale required for rapid electrification. Indeed, the ZEV sales mandate for passenger vehicles, established by California and adopted by other states, has prompted unprecedented investment in light-duty zero-emission technologies and substantial growth in the market share of light-duty ZEVs. The ACT regulation may be an even more important driver of electrification of the MHD vehicle sector given the costs and characteristics of trucks and buses.

While the Clean Air Act preempts every state except California from establishing motor vehicle emissions standards that are more stringent than U.S. federal standards, most states may "opt-in" to California's standards. In addition to California, 14 states have adopted California's ZEV regulation for passenger vehicles, helping to drive the market and create economies of scale that lower the overall cost of electrification. Quebec was the first Canadian government to adopt a similar regulation. Likewise, many of the MHD ZEV MOU states have adopted, or are considering adopting, California's ACT regulation to accelerate the widespread deployment of MHD ZEVs.[43]

States can also play an important leadership role by being early adopters of zero-emission trucks and buses. Government fleet electrification targets, like zero-emission school bus targets adopted by New York and Quebec, provide quantifiable emission reductions and, at the same time, build confidence in MHD ZEVs by publicly demonstrating the viability of zero-emission technologies. Some use cases, such as emergency response, will be more difficult to transition. State agency responses to extreme weather events can require extended duty cycles, rapid refueling, or positioning vehicles where charging or specialized fueling facilities may not be available. In addition to leading by example, setting requirements for private fleets that are well positioned to transition to MHD ZEVs can also help to transform the market.

Recognizing the critical role ZEV sales and purchase requirements play in driving MHD vehicle electrification, and the importance of ensuring emissions reductions in communities most affected by pollution from diesel trucks and buses, the Task Force offers the following recommendations:

1. States should consider adopting:
    a. The Advanced Clean Trucks regulation to establish zero-emission sales requirements for trucks, along with a one-time fleet reporting requirement for large entities to collect data on fleet operations;
    b. Corresponding fleet purchase requirements, such as the Advanced Clean Fleets regulation and the Zero-Emission Airport Shuttle regulation; and
    c. California's Heavy-Duty Engine and Vehicle Omnibus regulation to reduce NOx and PM emissions from heavy-duty trucks while the market transitions to ZEVs.[44]

2. States should set MHD ZEV fleet purchase and annual reporting requirements for publicly owned, controlled, and contracted fleets designed to achieve 100 percent zero-emission

[43] As of the date of publication, in addition to California, Massachusetts, New Jersey, New York, Oregon, and Washington have adopted the ACT regulation.
[44] *See* California Air Resources Board, Heavy-Duty Low NOx, https://ww2.arb.ca.gov/our-work/programs/heavy-duty-low-nox (accessed Mar. 4, 2022).

MHD fleet vehicle purchases where technically feasible by no later than 2040, and sooner for applications better suited for electrification in the near term. States should prioritize electrifying public fleet vehicles operating in communities disproportionately affected by air pollution.

3. States should support continuous progress toward public sector MHD fleet electrification targets by:
    a. Performing a rigorous analysis to identify the best opportunities in state agency fleets for MHD zero-emission replacement vehicles;
    b. Requiring that all fleet acquisitions consider operation and maintenance costs and account for the savings associated with lower operation and maintenance costs of ZEVs; and
    c. Streamlining and, wherever possible, aggregating MHD ZEV and charging infrastructure procurement processes across states and regions.

Washington's Plans for Fleet Transition

In 2021, the Governor of Washington issued an Executive Order outlining a comprehensive strategy for transitioning the state's MHD and light-duty vehicle fleets to BEVs. The Order establishes fleet conversion targets for 2030, 2035, and 2040 and requires 24 state agencies to purchase EVs when vehicles with internal combustion engines need to be replaced. When a battery-powered model is not available, agencies must acquire "the lowest-emission, cost-effective option," such as a PHEV. A state-wide strategy is being developed to recommend policies and charging infrastructure investments to support the transition. Individual state agencies will develop and update their own implementation plans and publicly report on their progress.

4. States should adopt purchase and reporting requirements for publicly owned, controlled, and contracted transit fleets, such as California's Innovative Clean Transit regulation, and require transit agencies to develop and periodically update transition plans to meet zero-emission purchase and contract requirements. States should prioritize electrifying public transit vehicles operating in communities disproportionately affected by air pollution.

5. States should establish zero-emission purchase and reporting requirements for publicly owned and contracted school bus fleets designed to achieve 100 percent zero-emission purchases and contracts by no later than 2040. States should provide school districts with resources to develop and periodically update transition plans and provide technical assistance to school districts in communities disproportionately affected by air pollution.

6. States adopting MHD ZEV sales and purchase requirements and other regulatory programs should work together to coordinate on adoption and implementation issues and share their experience and expertise.

Vehicle and Infrastructure Purchase Incentives

Providing purchase incentives to reduce or eliminate the purchase price differential for MHD ZEVs and the cost of charging and fueling infrastructure are among the most important actions that states can take to accelerate electric truck and bus adoption in this early market. This is particularly true for smaller fleets, independent owner/operators, and minority-owned fleets in low- and middle-income communities that may not have sufficient capital or access to affordable financing sources to front load the cost of higher priced electric vehicles and fueling infrastructure. Incentives should phase down over time as the market matures and affordable private sector financing becomes more widely available.

Incentive programs can take several forms—tax credits, sales tax waivers, low-interest loans, rebates, or point-of-sale voucher programs. The most effective incentive programs are point-of-sale programs that provide "cash-on-the-hood" at the time of purchase. Data collection and reporting requirements required by incentive programs should be structured to minimize the administrative burden on fleets.

The MHD ZEV MOU directs the signatories to accelerate the deployment of zero-emission trucks and buses to benefit communities that have been historically burdened with higher levels of air pollution. This can be achieved by designing incentive programs to prioritize the electrification of fleets operating in communities that are disproportionately impacted by diesel emissions and to support the goals and strategies outlined in climate justice planning documents developed by environmental justice communities.

States should also be mindful that scrappage requirements, a common feature of truck and bus incentive programs, could preclude some large and small fleets from participating in incentive programs because they may not have older vehicles to scrap. Sound asset management practices often encourage large fleets to keep new trucks for three to five years before selling them into a secondary market for purchase by smaller fleets. Consequently, fleets that do not have older, more polluting vehicles to scrap, or that do not want to forego the sales proceeds of the vehicle to be replaced, may not be eligible for incentive programs with scrappage requirements. Scrappage requirements are also a disincentive to fleet operators that are expanding their operations and to those that prefer to lease, rather than purchase vehicles. Thus, as currently structured, incentive programs that require the scrappage of older vehicles (e.g., pre-2010) could slow the pace of electric truck and bus adoption.

Stable and sustainable sources of funding are needed to support state incentive programs and provide the market certainty needed to drive industry and private sector capital investment in zero-emission transportation technology. In addition to general fund appropriations, other potential funding sources include utility system benefit charges, motor vehicle registration fees,

and "feebate" programs or other transportation-related fees or taxes. Market-based GHG emission cap-and-invest programs operating in California, Quebec, and the Northeast and Mid-Atlantic states generate steady and significant sources of funding used to support a variety of climate programs, including EV incentive programs. States could also explore opportunities to co-fund incentive programs with local governments.

The Task Force offers the following recommendations for design of vehicle and infrastructure incentive programs to improve the economics of electrification for fleets and prioritize electrification of trucks and buses that operate in frontline and overburdened communities:

1. States should establish MHD ZEV point-of-sale or other equally effective fixed reimbursement vehicle and infrastructure incentive programs that:
    a. Subsidize a portion of the total incremental cost differential between an electric and diesel or gasoline truck and bus or conversion to a zero-emission powertrain where appropriate;
    b. Are available to fleets and businesses operating under a variety of charging models, including fleets that lease their facilities or charge off-site and businesses that do not own their own fleets;
    c. Integrate seamlessly with other programs that support onsite renewable energy generation and battery storage;
    d. Operate in coordination with programs that provide funding for planning, fleet audits, and technical assistance;
    e. Require compliance with open communications standards;
    f. Require reporting on vehicle and infrastructure utilization and sharing charging data with utility providers upon request; and
    g. Decline over time based on an evaluation of fleets and applications needing the most assistance to electrify.

State Truck and Bus Purchase Incentive Programs

In 2009, California launched the first state MHD zero-emission vehicle point-of-sale voucher program—the Hybrid and Zero–Emission Truck and Bus Voucher Incentive Project. Since then, more than 1,400 fleets have received funding from the program for 7,000 zero- and near-zero-emission trucks and buses. The program served as a model for New York's Truck Voucher Incentive Program. Both programs offer funding for new vehicle purchases and internal combustion vehicle conversions. Other state programs include the Massachusetts MOR-EV Truck Program, New York City's Clean Trucks Program, and New Jersey's pilot Zero-Emission Incentive Program for medium-duty trucks operating in designated overburdened communities in the Camden, Newark, and New Brunswick areas. These programs are providing important early lessons about effective purchase incentive design and implementation.

2. To deliver early benefits to communities historically exposed to higher levels of air pollution, state vehicle and infrastructure incentive programs should:
    a. Reserve a percentage of funding for deployments that will benefit state-defined frontline and overburdened communities;
    b. Offer increased incentives that cover a larger portion of the cost differential to fleets that are domiciled or operate in frontline and overburdened communities such as ports and drayage trucks, fleets operating near warehouse and goods distribution hubs, and school and transit buses; and
    c. Provide technical assistance to help fleets that are domiciled or operate in frontline and overburdened communities apply for incentives and understand financing and infrastructure deployment options.

3. To support small fleets, minority-owned fleets, and independent owner/operators, state vehicle and incentive programs should:
    a. Reserve a percentage of funding for applications from these fleets;
    b. Offer increased incentives that cover a larger portion of the cost differential;
    c. In collaboration with other key partners, provide technical assistance to help these fleets apply for incentives and understand financing and infrastructure deployment options; and
    d. To simplify the application process for fleets, consider requiring zero-emission truck manufacturers or dealers to complete and submit application forms on behalf of fleets.

4. As a condition of receiving incentive program funding, states should consider requiring applicants to certify compliance with state and federal tax and labor laws and to ensure in-state registration for a fixed period following acquisition of the vehicle.

5. States should work through the ZEV Task Force to form a workgroup to consider the role of scrappage in state purchase incentive programs and design options for incentive programs that can maximize fleet participation while securing emission reductions where they are needed most through the retirement of older, more polluting trucks in a way that minimizes equity impacts to small fleets and independent owner-operators.

6. States should strive to establish sustainable sources of funding to support vehicle and infrastructure incentive programs.

7. States should consider providing exemptions (or reductions) from sales tax and registration fees for zero-emission trucks and buses until overall cost parity is achieved.

8. States should consider how to evolve incentive programs to support growth of a secondary market for MHD ZEVs.

Electric Utility and Utility Regulator Actions

Widespread electrification of trucks and buses will present a new set of grid management challenges and opportunities for utilities. Many fleets will require fast high-powered charging to reduce refueling time for their electric trucks and buses, along with localized grid upgrades to serve the increased power load. While the prospect of significantly lower fuel costs and resulting lower TCO is a key driver of fleet electrification, MHD vehicle charging costs can be adversely affected by commercial electricity rates not specifically designed for ZEV charging.

Utilities and utility regulators must play a central role in MHD fleet electrification to ensure a smooth and rapid transition. Strategic long-range planning, close coordination and consultation with truck and bus fleets, properly sequenced utility investment in "make-ready" charging infrastructure, and development of beneficial commercial electricity rates designed to incentivize fleet charging during low-cost and low-demand periods are vital to achieving MHD fleet electrification at the pace and scale necessary to meet state electrification goals.

If managed well, fleet electrification could deliver important grid and ratepayer benefits. The additional revenues generated from truck and bus charging have the potential to put downward pressure on electricity rates for all ratepayers. Fleet charging at times of peak solar and wind generation paired with investments in energy storage could help increase integration of renewable energy sources into the electric grid.

The Task Force thanks M.J. Bradley and Associates for facilitating a robust utility stakeholder engagement process that provided expert input on the role of electric utilities and utility regulators in MHD vehicle electrification. Recognizing that utilities in the participating jurisdictions are subject to different regulatory frameworks that require flexible approaches to MHD vehicle electrification, the Task Force offers the following recommendations for utilities and utility regulators to address these challenges:

1. Utility regulators should:
    a. Consider adopting utility targets for deployment of "make-ready" and other charging infrastructure for MHD ZEVs that align with state air quality, climate, and transportation electrification goals and regulatory requirements for MHD ZEV penetration, and require utilities to develop plans to achieve those targets; and
    b. Support state electricity decarbonization and renewable energy targets to maximize air quality improvements and avoid shifting transportation emissions to fossil-fueled power plants.

2. To ensure transmission and distribution system capacity to serve new electric loads from battery electric MHD fleet charging, meet electrification targets, and inform utility, fleet, and government planning processes, utility regulators should consider directing utilities to:

a. Conduct an assessment of system capacity by identifying MHD vehicle customer fleets, fleet plans for electrification, and the need for and costs of system upgrades to serve new interconnections, giving consideration to resilience, reliability, and other grid impacts;
b. Proactively prepare for grid upgrades and be positioned to complete upgrades as needed to serve new load;
c. Streamline interconnection processes to the maximum extent possible to eliminate long interconnection wait times; and
d. Develop and make available to fleets, electric vehicle supply equipment (EVSE) providers, and planning agencies detailed hosting capacity maps that enable identification of preferable least-cost locations for charging infrastructure that optimize existing distribution system assets.

3. Utility regulators should consider adopting policies and guidelines encouraging utilities to:
    a. Provide all necessary service-line extension and make-ready electrical infrastructure on the utility side of the meter for all non-residential customers installing separately metered charging infrastructure at no cost to the customer;
    b. Require compliance with open communication standards for all utility-funded charging infrastructure;
    c. Offer commercial rates and customer incentive programs for charging that are designed to contain and recover utility costs while lowering charging costs, mitigating the economic barrier posed by demand charges, and providing clear grid-benefit focused price signals to commercial customers that are consistent for all utilities within the state to the maximum extent possible;
    d. Establish fleet services programs with a single point of contact to provide comprehensive technical assistance; advise fleets on incentive programs, rate options, infrastructure deployment, managed charging, and opportunities to provide grid services; coordinate data collection; and work with vehicle manufacturers, charging equipment providers, permitting authorities, and others as necessary to facilitate fleet electrification;
    e. Offer utility on-bill financing and repayment for MHD electric vehicles and charging infrastructure and prioritize financing for small fleets, transit agencies, and school districts with fewer capital resources;
    f. Offer revenue-generating V2G services and enable vehicle-to-building services for electric school buses and other MHD ZEV fleets that are valued consistent with traditional grid services; and
    g. Require notification from large fleets in advance of commencing vehicle electrification activities.

4. To ensure early emission reductions in frontline and overburdened communities, utility regulators should:
    a. Prioritize investments in overburdened and underserved communities by establishing requirements for deployment of make-ready infrastructure and investment of incentive funding to benefit fleets operating in or near these communities; and
    b. Support utility engagement with frontline and overburdened communities in their service territories in planning, developing, and implementing utility MHD ZEV programs.

New York State Public Service Commission's Equity-Focused MHD Utility Programs

In July 2020, the New York Public Service Commission issued a final order establishing a $701 million MHD ZEV charging infrastructure program with targeted elements designed to accelerate adoption of electric trucks and buses in designated environmental justice and low- and moderate-income communities. The order creates a MHD ZEV make-ready infrastructure pilot program ($15 million), a transit authority make-ready program ($10 million), a clean MHD innovation prize ($20 million), and a fleet assessment service. In particular, the order requires that MHD make-ready funding support diesel emission reductions in environmental justice communities and identifies projects operating or domiciled in such communities as being of heightened interest for the clean MHD innovation prize. Together, these programs and services will help advance and scale truck and bus electrification in alignment with equitably achieving New York's air quality and climate change goals.

5. Utility regulators should consider adopting a societal cost/benefits test adapted specifically for EV programs to ensure that all societal benefits are accounted for in cost/benefit analyses for utility transportation electrification projects.

6. When approving utility programs, utility regulators should provide utilities with the flexibility necessary to:
    a. Employ different charging infrastructure ownership models, including ownership of charging stations, to meet fleet needs;
    b. "Future-proof" make-ready charging infrastructure investments to serve anticipated future EVSE deployment and avoid costly incremental upgrades;
    c. Plan for and finance ongoing operations and maintenance expenses to support uptime; and
    d. Conduct clustering studies to develop a coordinated make-ready system to serve multiple fleets in a single geographic area.

7. Utility regulators should provide utilities with flexibility to offer commercial customer contracts that:
    a. Allow installation of charging infrastructure in advance of projected utilization;
    b. Avoid requirements for vehicle-to-charger ratios; and

c. Offer multiple metrics for completion of contract term-length requirements (e.g., fixed term, electricity usage, or the number of MHD ZEVs deployed).

8. Utility regulators should encourage utilities to adopt a range of commercial rate structures and customer incentive programs for MHD ZEVs that are tailored to meet fleet charging needs and designed to recover utility costs while lowering charging costs, mitigating demand charges, and providing clear grid-benefit focused price signals to fleet customers. Rate reform should be focused on long-term sustainable rate design solutions that offer time-variant rates, promote off-peak charging and charging during periods of peak renewable energy generation, avoid non-coincident peak demand charges, and are consistent for all utilities within the state to the maximum extent possible. Utilities and utility regulators should consider different rate reform models, including those described in the table below that have been implemented in other states.

Innovative Utility Rate Design Approaches to Lower Fleet Charging Costs				
Utility Provider	Pacific Gas & Electric Company (CA)	Hawaiian Electric Company (HI)	Southern California Edison (CA)	Xcel Energy (CO)
Program Name	Business High Use EV Rate	eBus Pilot Rate	TOU-EV-8, TOU-EV-9	Schedule S-EV
Program Type	Subscription and Volumetric TOU	Critical Peak Pricing	Volumetric TOU	Critical Peak Pricing and TOU
Description	Commercial fleet customers with over 100 kW in monthly charging demand pay a monthly subscription charge (based on maximum charging consumption) plus a three-tier volumetric TOU rate (per kWh). Overage charges apply if a customer's consumption exceeds subscription level.	For bus fleet customers, demand charges are eliminated from 9:00am-5:00pm when solar energy is abundant and 10:00pm-9:00am when electricity demand is low. Higher rates and demand charges apply during peak periods (5:00pm-10:00pm).	Commercial fleet customers with between 20-500 kW or over 500 kW in monthly charging demand pay a static monthly customer charge plus a volumetric TOU rate (per kWh) for energy used in designated TOU periods throughout the day. Demand charges are suspended for the first five years, then phased back in over the next five years.	For fleet customers, generation and transmission demand charges are replaced with TOU rates and critical peak pricing. Under the critical peak pricing, Xcel notifies customers to shift charging away from peak hours (12:00pm-8:00pm) up to 15 times per year for a maximum of 60 hours.

9. States should work together to create regional and national forums in which state agencies, utility regulators, and utilities can meet to discuss issues and needs related to MHD vehicle electrification, such as:

a. The scale of utility investment in grid transmission and distribution capacity needed to meet states' MHD ZEV sales and purchase requirements and electrification targets;
b. Sequencing utility investment priorities;
c. The performance of programs with respect to equity and environmental justice;
d. Ways of quantifying and communicating the long-term benefits of electrification for concerned stakeholders;
e. Strategies for providing transparent information and assistance to fleets to support evaluation of the total cost of electrification for operations extending across utility service areas; and
f. Long range planning for highway corridor electrification.

Mobilizing Private Capital to Finance Fleet Conversions

Unlocking private capital to finance commercial fleet conversions is essential to achieve fleet electrification at scale. While government incentives and ratepayer funded programs are important tools in today's early market to help offset the higher upfront capital costs of zero-emission trucks and buses and the associated infrastructure, they must be supplemented by complementary tools and policies that drive the private sector capital investment needed to finance electrification of the commercial fleet sector.

Although commercial lenders are following the emerging electric truck and bus market with great interest, low-cost commercial bank loans and other forms of conventional financing are generally not available to commercial fleets on favorable terms today,[45] particularly smaller fleets that may have a less favorable credit rating. This is due not only to higher upfront costs, but also because costs arising from risks and uncertainties associated with this new technology—referred to as the "total cost of electrification"—make financing prohibitively expensive for many fleets and deter capital markets from engaging.[46]

A primary risk factor for fleets and financiers is continuing uncertainty about the residual value of electric trucks and buses. Battery-powered trucks and buses do not yet have a well-established resale value in secondary markets, making it difficult for financiers to account for residual value in upfront financing terms. Other technology and policy risk factors include uncertainty about the efficacy of the technology; the costs of charging infrastructure; soft costs,

[45] CALSTART, Taking Commercial Fleet Electrification to Scale: Financing Barriers and Solutions (Mar. 2021), https://calstart.org/taking-commercial-fleet-electrification-to-scale-financing-barriers-and-solutions/.
[46] For a detailed explanation of the "total cost of electrification," see V. Rojas, et al., Financing the Transition: Unlocking Capital to Electrify Trucks and Bus Fleets, Environmental Defense Fund, M.J. Bradley & Associates, and Vivid Economics (Nov. 2020), https://www.edf.org/sites/default/files/documents/EDF_Financing_The_Transition.pdf.

including the need for regulatory permits and approvals, changes to business operations, and new maintenance practices; the availability and long-term stability of government incentive programs; and the adoption of regulatory requirements to drive new model availability and market demand.

The biggest hurdle to electrification that commercial fleets typically face is a limited capital budget. Shifting capital expenses to operating budgets can help fleet managers to reduce or avoid capital expenses altogether. Innovative financing tools, such as battery leasing programs, on-bill utility financing, first loss protection programs, zero-interest and revolving loans, charging services, electrification-as-a-service approaches, and novel business models that harness ongoing savings by treating electrification costs as more manageable operating expenses are gaining traction. Inter-agency and multi-state collaboration will be important to support the establishment of successful financing programs at scale.

The Task Force offers the following recommendations to support increased use of these innovative financing tools and business models to improve the economics for fleets and financiers:

1. Transit agencies and school districts should explore the cost benefits of fixed-price service approaches for charging services, infrastructure, or electrification. Electrification-as-a-service, the most comprehensive of the three approaches, provides leased buses, charging infrastructure, and managed charging and maintenance services for a fixed monthly fee or fixed dollar-per-mile rate. In conjunction with incentives and grants, savings from lower maintenance and fuel costs associated with battery electric buses offset the higher costs of electric buses and charging infrastructure, offering fleets a budget-neutral approach to electrification.

School Bus Electrification in Maryland

Montgomery County, Maryland, has a plan to electrify its entire fleet of 1,400 buses through an innovative public-private partnership using "electrification-as-a-service" financing to eliminate upfront capital costs for the county and create budget neutrality relative to the cost to own and operate new diesel buses over time. In the first phase of the three-phase plan, Highland Electric Transportation is providing turnkey electric fleet services that will bring in 326 electric buses and electrify five parking depots over a four-year period. Highland is directly financing the purchase of the electric buses and charging equipment, overseeing construction and engineering on site, training drivers and bus maintenance staff, providing managed charging, and paying for all repair and maintenance services. The county's savings from the lower fuel and maintenance costs of electric school buses, volume purchasing, tax depreciation, and a small amount of incentives are used to pay Highland over time, making the transition affordable for the county.

2. To lower the costs of financing, utilities should offer transferable utility on-bill financing and on-bill repayment to fleet customers. Under this "pay-as-you-save" approach[47] that builds on the successful energy efficiency model, the utility funds some of the capital acquisition costs and owns the vehicle battery and charging infrastructure. The fleet customer pays a fixed monthly charge on its utility bill out of the operational savings realized from lower maintenance costs and lower fuel costs associated with beneficial commercial rates.

3. To lower the upfront costs of fleet electrification at scale, transit agencies, state educational agencies, and school districts should consider bus and battery leasing models offered by several electric bus manufacturers as an alternative to purchasing the entire vehicle and as a means to achieve upfront cost parity with diesel buses. Fleets can lease an entire bus with little or no upfront cost, or lease only the battery.

4. Electric bus manufacturers and government agencies should consider the use of tax-exempt leases, which can further lower fleet electrification costs. Because interest earned on leases to government agencies is tax exempt, bus manufacturers and other lessors can pass the savings along to fleets in the form of lower interest payments.

5. To address residual value risk and insure against economic losses if vehicles lose more value than expected, or in the event of a foreclosure, state-chartered green banks should consider commercial fleet first loss protection programs,[48] which are designed to insulate commercial lenders from a pre-determined amount of financial loss. Adapting this commonly utilized instrument for financing fleet electrification would enhance the credit worthiness of an electrification loan. Some green banks have the capability to provide this service in the near-term, but in time it can and should transfer to private intermediaries, including commercial banks.

6. Green banks should consider offering loans with advantageous terms (e.g., wider access to finance for fleets with sub-optimal credit scores, lower interest rates, longer maturity, reduced collateral requirements, and grace periods) to fleets most in need and integrate the loans seamlessly with incentive programs.

7. To finance fleet conversions, states should consider establishing state innovative financing programs, such as California's new MHD ZEV Fleet Purchasing Assistance Program

[47] Clean Energy Works, Inclusive Utility Investments for Clean Transport – Q&A (Jan. 5, 2014), https://www.cleanenergyworks.org/2014/01/05/inclusive-utility-investments-for-clean-transport/.
[48] R. Gurman, Taking Commercial Fleet Electrification to Scale: Financing Barriers and Solutions, CALSTART, Global Commercial Vehicle Drive to Zero (Apr. 2021), https://globaldrivetozero.org/site/wp-content/uploads/2021/03/Taking-Commercial-Fleet-Electrification-to-Scale-White-Paper.pdf.

established by legislation in 2021[49] for administration by the California Pollution Control Financing Authority.

Outreach and Education

Many fleet operators are not informed about the rapidly developing electric truck and bus market, especially small fleets and independent owner/operators. In addition, fleets and drivers would benefit from a better understanding of the hazards of long-term exposure to diesel emissions and the impacts of diesel truck traffic on overburdened communities. Therefore, robust fleet outreach and education initiatives are needed to increase consideration and adoption of zero-emission technology in the MHD vehicle sector.

The Task Force makes the following recommendations for outreach and education to public and private sector fleets:

1. States should work together with utilities, truck and bus manufacturers, charging and fueling providers, leading fleets, and other key partners to understand the primary considerations for fleets of different types and sizes, with particular attention paid to small fleets and independent owner/operators, and develop and implement outreach and education programs that are tailored to meet fleet-specific needs and concerns and improve understanding of the public health impacts of long-term exposure to diesel emissions.

2. States should develop educational materials that use plain language and avoid technical jargon and make materials available in non-English languages predominantly spoken in their respective jurisdictions.

3. States should consider working with partners to establish a "one-stop shop" for information on key topics associated with the transition to electric trucks and buses, including the environmental and cost benefits of electrification, available electric truck and bus models, incentives, and financing options for MHD zero-emission vehicles and fueling infrastructure, managed charging options, required permits and approvals, interconnection coordination with utilities, and other technical issues.

4. States should consider partnering with truck manufacturers, dealerships, EVSE providers, trucking associations, and other partners to provide demonstrations, test drives, and other

[49] S.B. 372, 2021 Leg. (Cal. 2021), https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220SB372.

peer-to-peer and hands-on learning opportunities, especially for small fleets, minority-owned fleets, and independent owner/operators.

Economic Equity for Workers

Workers employed in the transportation sector and related industries have an important stake in the transition to transportation electrification. As federal and state funding to accelerate MHD ZEV adoption and infrastructure deployment ramps up, policymakers have an opportunity to develop policies and leverage public investments to ensure just and equitable outcomes for workers. An overview of the key workforce and labor issues that the ZEV Task Force learned about from national equity-centered organizations is provided below.

Domestic Job Growth. Globally, job growth will result from the manufacture of ZEVs, charging infrastructure, batteries, and other advanced technology vehicle components. New jobs will also be created through the installation, commissioning, and maintenance of new electric distribution and charging infrastructure; the provision of planning services and technical assistance to fleets; the maintenance and repair of electric trucks and buses at dealerships and after-market repair shops; and end-of-life battery recycling and reuse services.

A central issue for workers is whether new manufacturing jobs will land in North America or other regions. Recent analyses shed light on the tremendous opportunity for workforce change and job growth in particular market segments and states, while emphasizing that without strong government policies to drive demand for North American manufactured products and to support the development of its industries, there is a risk of overall job loss in the North American automotive sector.[50]

Job Quality. Workers in an electrified transportation sector need high-quality, family-sustaining jobs that provide living wages, good benefits, career enhancement opportunities, scheduling predictability, and worker health and safety protections. High-quality jobs provide equitable access to upward mobility, improve worker retention, and enhance work quality.

[50] *See, e.g.*, Securing America's Future Energy, The Commanding Heights of Global Transportation, http://2uj256fs8px404p3p2l7nvkd-wpengine.netdna-ssl.com/wp-content/uploads/2020/09/The-Commanding-Heights-of-Global-Transportation.pdf (accessed Mar. 4, 2022); C. Veeder, How Battery-Electric Buses Can Benefit the Environment, the Economy, and Public Transit, Jobs to Move America, Transforming Transit, Realizing Opportunity (Jul. 18, 2019), https://jobstomoveamerica.org/resource/transforming-transit-realizing-opportunity/; J. Barrett and J. Nivens, The Stakes for Workers in How Policymakers Manage the Coming Shift to Electric Vehicles, Economic Policy Institute (September 22, 2021), https://www.epi.org/publication/ev-policy-workers/.

Job Access and Prevention of Job Loss. Many of the new, higher-quality jobs will require electrical and other specialized skills. Creating equitable access to job opportunities will require developing workforce training programs for workers from frontline, overburdened, and low-income communities. Pre-apprenticeships will be needed to address employment barriers and to provide participants with foundational skills, such as construction skills, that they can apply in a range of jobs as the labor market changes. Certified apprenticeships will also be needed to connect workers to high-quality job opportunities and careers and to support life-long employability. Current automotive sector workers will need customized support to upskill and navigate job transitions. The adoption of recruitment and hiring practices designed to expand access to job opportunities, such as partnerships with community-based organizations to conduct outreach in target communities and to prepare job applicants for the hiring process, will be as important as workforce development.

Just Outcomes for Drivers. When truck drivers in the freight system are misclassified as contractors rather than employees, they can be left bearing costs for leasing, operating, and maintaining vehicles that should be borne by companies hiring them. Addressing driver misclassification is an important step for avoiding an unjust allocation of electrification costs, particularly as states adopt new clean truck regulations.[51]

State governments that adopt a "whole-of-government" approach, mobilize early inter-agency discussion of these issues, and engage with labor organizations and frontline and overburdened communities early in the transition will be best positioned to proactively shape a just and equitable transition for workers. Accordingly, the Task Force makes the following recommendations:

1. States should establish or utilize existing inter-agency working groups to address economic and labor issues stemming from MHD vehicle electrification by, for example, developing measures to drive domestic economic development and job growth; leverage public funding to promote high-quality jobs with living wages and benefits, career enhancement opportunities, and worker protections; and deter worker misclassification.

2. States should partner with frontline and overburdened community leaders and members to understand and proactively address barriers that may prevent community access to training programs, jobs, and small business ownership opportunities, and to conduct outreach and education about new resources to locate and prepare for high quality jobs.

[51] *See* S. Appel and C. Zabin, UC Berkeley Labor Center, Truck Driver Misclassification: Climate, Labor and Environmental Justice Impacts (Aug. 2019), https://laborcenter.berkeley.edu/truck-driver-misclassification/.

3. States should engage and convene diverse partners—including industry groups, trade associations, labor unions, and transit agencies—to compile data and analyze anticipated labor market changes associated with MHD vehicle electrification; identify workforce development and training needs for an inclusive workforce; and track measurable outcome-based indicators of workforce diversity in employee recruitment, training, and retention.

4. States should provide funding for the development of education and training, pre-apprenticeship and apprenticeship programs and partnerships at high schools, community colleges, vocational and technical schools, training organizations, and government agencies to equip workers with the necessary skills for high quality jobs and careers in the clean transportation sector. Existing workers in the automotive sector at risk of job loss should be targeted for training to assist with upskilling.

California's Equity-Focused Workforce Development Efforts

A 2017 California state law (AB 398) calls for workforce interventions to ensure that the transition to a carbon-neutral economy creates high-quality jobs; prepares workers to adapt and master new low- and zero-emission technologies; broadens career opportunities for workers from disadvantaged communities; and supports workers whose jobs may be at risk. Through its High Road Climate Agency Partnership initiative, the California Workforce Development Board (CWDB) assists state energy and transportation agencies to improve economic equity by adopting labor policies and mobilizing existing or new workforce development initiatives. The CWDB also administers the High Road Construction Careers (HRCC) initiative, which funds partnerships among local building and construction trades councils, workforce boards, community colleges, and community-based organizations to help workers and job seekers from disadvantaged backgrounds build middle-class careers in the construction trades. Multi-craft pre-apprenticeship programs and support services delivered by these HRCC partnerships are helping build a diverse and inclusive clean energy workforce in California.

5. Training and apprenticeship programs should be developed with input and support from relevant industries. States should enlist employers to sponsor, participate in, and fund apprenticeship and training programs for vehicle manufacturing and assembly, deployment of charging and fueling infrastructure, the battery supply chain, and repair and maintenance of vehicle mechanical and electrical systems. Sponsoring employers should compensate trainees for their time and commit to offer jobs to a percentage of top graduates.

6. States should work together to advocate for significant increases in U.S. federal funding for workforce training and apprenticeship programs.

Community Air Monitoring

The regulatory air monitoring system used across the U.S. to measure compliance with federal ambient air quality standards is not designed for monitoring at the community level. Due to their size, complexity, and cost, regulatory air monitors are often augmented with lower cost sensors to assess community-scale air quality. Because air quality can vary significantly depending on proximity to sources, topography, and other local environmental factors, an accurate assessment of community air quality requires several monitors placed throughout study areas.

In recent years, smaller, easier to use, and lower-cost air quality sensors have become more widely available. These portable sensors make it easier to examine localized air quality trends and identify contributing pollution sources by providing reasonably accurate and cost-effective real-time data to interested parties.

Community air monitoring promises to become an increasingly important tool for regulators to assess air quality and, along with other data and information, to inform the development of emission reduction strategies to reduce harmful local air pollution in frontline and overburdened communities. Successful community air monitoring projects require a collaborative effort in which state environmental and public health agencies work together with community co-partners to define goals and design and implement all aspects of the monitoring program.

Addressing Truck Pollution in New Jersey's South Ward

A truck count carried out by trained volunteers showed that an estimated 4,500 heavy-duty trucks travel through the South Ward neighborhoods on their way to and from the Port of Newark and Newark International Airport each day. To better understand air pollution levels resulting from this constant truck traffic, the South Ward Environmental Alliance (SWEA) is collaborating with universities and community-based environmental justice organizations to gather local air monitoring data. Low-cost PurpleAir monitors are deployed at schools, day care centers, and churches, and trained community residents use hand-held portable air sensors to gather additional data at suspected pollution hot spots. SWEA is sharing results with the New Jersey Department of Environmental Protection to inform future air monitoring in the Ward's overburdened neighborhoods. Informed and empowered by local data, residents can advocate for actions to reduce emissions, such as establishing zero-emission zones and adjusting truck routes.

Identifying communities that are disproportionately exposed to diesel truck and bus pollution is essential for states to effectively address environmental justice issues, including prioritizing investments in zero-emission trucks and buses operating in and near these communities. Many government agencies have taken steps to define indicators that can be used in conjunction with geographic analysis tools to locate exposure "hot spots," the characteristics of the communities where they occur, and other available administrative data to

guide subsequent decision-making. While these actions do not replace regulatory monitoring programs, they can provide states with insights to inform future analysis and action.

To prioritize the delivery of air quality and public health benefits to communities disproportionately burdened by diesel truck and bus emissions, the Task Force makes the following recommendations for state action to implement community air monitoring programs:

1. State agencies should work with communities (and schools, day care facilities, nursing homes, hospitals, or other sensitive receptors as appropriate) located near ports, railyards, trucking distribution hubs, fleet depots, and major trucking corridors to design community air monitoring programs that deploy mobile or portable sensors to support reasonably accurate and cost-effective localized data to develop a more granular picture of air quality for more effective policy planning and evaluation. States may consider co-locating regulatory air monitors with portable air sensors when feasible.

2. States should work with U.S. federal partners to provide communities with funding, technical assistance, and basic training on air monitoring science to build community capacity and the knowledge necessary to support successful community-led monitoring programs, and to engage with states on the development and implementation of air pollution regulatory activities that impact their communities.

3. States should participate in community air monitoring peer-to-peer learning workshops or other training programs to share experiences and learn about best practices for design and implementation of successful community air monitoring projects.

Rhode Island Port of Providence Community Air Monitoring Project

Complaints about odors and air quality from residents of environmental justice communities located adjacent to the Port of Providence and nearby industrial facilities led the Rhode Island Department of Environmental Management (DEM) to seek an EPA grant for a community-scale air monitoring project to study ambient air pollution levels near residences, schools, hospitals, and other sensitive community locations surrounding the Port. Working with community representatives, DEM located five portable Clarity air sensors in the study area to collect a year's worth of data on ambient air quality levels of harmful air pollutants common to ports—$PM_{2.5}$, volatile organic compounds, and air toxics. DEM also plans to review fuel and chemical use data from multiple regulated industrial facilities operating in the Port area and conduct compliance inspections to assess the impact of emissions from these sources on community air quality. The final report will include findings and recommendations for follow-up to address identified air quality issues.

4. States should consider integrating data from community air monitoring programs with available vehicle noise pollution data and MHD vehicle traffic safety data, especially data on deaths and injuries.

5. States should work together to define technical specifications for portable air quality sensors, identify sensors that meet those specifications, and coordinate and share information on community monitoring programs.

6. Building on existing spatial analysis methods that may include vehicle population data, community and regional-scale modeling, and network data, and in consultation with local communities and health departments, states should develop a geographic mapping system for identifying frontline and overburdened communities. This should include rigorous indicators of potential disproportionate health impacts from transportation and other emission sources. States should publish the results online and use the results to facilitate public engagement and feedback, target enhanced incentives and utility investment; and identify the need for more specific risk assessment and mitigation actions.[52]

Planning for and Deploying Public Charging and Fueling Infrastructure

As manufacturers bring more zero-emission trucks to market, a reliable and accessible network of public charging and fueling infrastructure will be needed in community settings and along regional- and long-haul trucking corridors.

Battery-electric trucks that travel local and regional routes within and between communities and that neither park at a depot overnight nor have home base charging, such as drayage and delivery trucks and vans owned by small fleets and independent owner/operators, will need access to level 2 charging at overnight parking locations and DC fast charging near their daily routes. Planning for deployment of level 2 and DC fast charging infrastructure at locations that smaller fleets can conveniently access is an important step that states, utilities, EVSE providers, and other key partners can take to address the charging barrier for fleets without access to depot charging.

Zero-emission technologies for long-haul, heavy payload applications are not as market ready today as those with shorter duty cycles. As the technology for these applications matures, however, zero-emission trucks will need access to a robust network of DC fast chargers and hydrogen fueling stations at rest areas and truck stops along highway corridors. There are many important actions states and other partners should take now to prepare federal and state highways for zero-emission trucks. First and foremost, early strategic planning among state agencies in coordination with other states, fleets, utilities, charging and fueling providers, and

[52] Possible emission reduction strategies include geofencing, vegetative buffers, traffic light management, and traffic calming measures. *See* K. Boriboonsomsin, et al., Geofencing as a Strategy to Lower Emissions in Disadvantaged Communities (Dec. 2020), https://ww2.arb.ca.gov/sites/default/files/2021-01/17RD009_0.pdf.

other key partners is needed. Staff preparing long-range transportation infrastructure plans should recognize that a robust and interoperable network is needed to maximize utilization.

As states and utilities begin planning for highway corridor charging facilities, they should consider how utility upgrades could be efficiently integrated into highway rights-of-way.[53] These improvements could expand grid capacity, provide high-capacity electricity access for DC fast charging stations, and serve other important needs such as transmission of solar or wind power generated in highway interchanges and in outlying areas. In some areas, placing high voltage DC transmission lines underground, along with other utility assets such as hydrogen pipelines and broadband fiber optic cables, may be an efficient way to utilize public rights-of-way, improve grid resilience, and support "next generation" highways serving zero-emission freight.[54]

A significant barrier to readying long-haul trucking corridors for zero-emission trucks is the current prohibition of most commercial activities at interstate rest areas and fringe and other corridor parking areas. Amending U.S. federal law to allow user-pay charging and fueling in these areas is a long overdue step that Congress should take to modernize the nation's interstate highway system and provide trucking fleets with the operational confidence and certainty needed to scale up fleet electrification.

Finally, state action is needed to establish appropriate weight limits for electric trucks. Current weight limitations can impact the payload capacity of battery-powered trucks, particularly long-haul freight trucks, because the additional weight of the battery system can result in reduced payload capacity. In 2019, Congress amended U.S. federal law to allow electric-powered trucks to exceed the maximum weight limit by up to 2,000 pounds on federal interstates. Similar changes are needed to state laws establishing weight limits for trucks operating on state roads that are not part of the federal interstate system.

The Task Force makes the following recommendations to foster the development of a robust public charging and fueling network for MHD ZEVs:

1. States should establish inter-agency and regional strategic infrastructure planning working groups that include representatives from environmental, energy, and transportation agencies, utility regulators, utilities, fleets, charging providers, frontline and overburdened communities, and other key stakeholders to begin long-range planning for public

[53] Utilities and contractors desiring to work within highway rights-of-way should coordinate with and secure required permits from the appropriate state and/or local department, agency, or authority.
[54] *See* The Ray, Next Generation Highways: Co-Locating the Transport of Vehicles, Energy & Information (Sept. 2020), https://theray.org/2020/09/19/next-generation-highways.

infrastructure deployment along highway corridors and in community settings. Infrastructure planning should include analysis to identify where and what level of infrastructure is likely to be needed, how to prioritize deployment in communities overburdened by air pollution, the potential need for grid upgrades and strategies to leverage planned street or highway projects to deliver needed transmission capacity, and solutions to address any identified interconnection or other siting barriers.

2. States should work together to consider how best to support development and implementation of a fast-charging network for MHD ZEVs that is standardized, interoperable, reliable, and accessible.

3. States should coordinate with utilities, municipalities, and charging providers to plan for public MHD vehicle charging facilities with a range of charging capacities for use by small and independent owner/operators along commercial truck routes and at convenient overnight parking locations for drayage and delivery trucks. States and municipalities should look for opportunities to dedicate under-utilized public parking areas and property lots to cost effectively host charging infrastructure.

West Coast Clean Transit Corridor

Sixteen investor-owned and municipal utilities serving California, Oregon, and Washington teamed up to accelerate development of corridor charging facilities for trucks between the Mexican and Canadian borders. The utilities recognized that early and coordinated investment would be needed to build out a robust and seamless charging network. An initial report proposes a phased approach to developing 27 multi-station charging sites along the 1300-mile Interstate-5 corridor at 50-mile intervals, and 41 sites on other major connecting highways, with stations designed to serve medium-duty trucks in the first phase and big rigs in the second phase. The report highlights the need for additional electric grid capacity to support interconnections in rural areas, recommends standardization of charging equipment, and calls for new and expanded federal and state programs to foster infrastructure development and ZEV truck adoption by commercial fleets.

4. States should advocate for amendments to 23 U.S.C. § 111(a) to allow user-pay EV charging stations and hydrogen fueling stations at rest areas and fringe and corridor parking facilities located on interstate rights-of-way or new, clarifying policy guidance from the Federal Highway Administration.

5. State environmental, energy, and transportation agencies should work with utilities to identify opportunities for commercial installation of solar arrays with integrated battery storage on publicly owned interstate and state highway interchange rights-of-way to power

DC fast chargers along highway corridors and generate a new source of revenue for infrastructure maintenance.[55]

6. To ensure consistency with U.S. federal weight limits for battery-powered vehicles, and to minimize potential issues related to how the heavier weight of such vehicles may affect payload capacity, states should amend applicable laws to increase weight limits by 2,000 pounds for zero-emission trucks.

Ongoing Multi-State Research and Policy Evaluation

Since the release of the first *Multi-State State ZEV Action Plan* to advance adoption of light-duty ZEVs in 2014, the Task Force states have collaborated with partners to fill gaps in the information needed to design and implement effective market-enabling policies and programs and to evaluate policy outcomes. In this regard, the Task Force provides an ongoing forum for states to identify research needs and share information.

The market for electric trucks and buses is much newer and state efforts to develop market-enabling policies and programs are just getting underway. Through multi-state collaboration and partnering with subject matter experts, the Task Force can proactively gather information needed to support the design of effective MHD ZEV policies and programs and pursue continuous learning about outcomes as new policies and programs are tested and mature.

With the expectation that needs for data collection, research, and peer-to-peer exchange will evolve, the Task Force offers the following recommendations:

1. States should partner with research organizations that advise commercial fleets and utilities on electrification initiatives to identify and collect regional and national data about the adoption of MHD ZEVs, barriers to adoption, charging infrastructure needs and deployment trends, and the impact of the MHD ZEV transition on small and minority-owned trucking fleets and independent owner/operators.

2. States should support research initiatives to inform the development of state and federal policies to promote sustainable ZEV battery manufacturing and supply chains, including policies designed to avoid adverse impacts to public and environmental health in the United States, Canada, and abroad resulting from the mining and processing of raw materials such as cobalt and lithium. States should consider a particular focus on sustainable refining, which could occur within the participating jurisdictions.

[55] *See* The Ray, Smart Powered Highways (Sept. 2020), https://19fgew3zyb632ma8181lw82b-wpengine.netdna-ssl.com/wp-content/uploads/2020/09/Transportation-and-energy-through-smart-powered-highways.pdf.

3. States should work with research partners to analyze the relative costs and benefits of different approaches to battery reuse, remanufacturing, recycling, and disposal to support consideration of state policies that could accelerate the most promising market opportunities.

4. States should work together to identify potential state government actions to support electrification of freight movement associated with port operations through direct engagement with municipalities, ports, port authorities, and drayage fleet owners and operators that are participating in current port electrification efforts.

5. To address emissions associated with freight movement in a more comprehensive manner, states should explore the adoption of inspection and maintenance programs for heavy-duty diesel trucks, development of indirect source rules for warehouses and other trucking distribution facilities, and local planning guides for new facilities.

6. States should work with research partners to collect, analyze, and widely distribute results from state, municipal, transit, and school bus fleet electrification, to improve fleets' understanding of the total cost of electrification, innovative charging and financing solutions, and best practices for V2G integration.

7. States should work with research partners to determine whether additional weight allowances are needed to ensure that MHD ZEV load capacity remains competitive with MHD diesel-powered vehicles.

8. States should engage with corporate shippers that do not own their own fleets and wish to procure zero-emission shipping services to identify existing barriers and opportunities for state action to facilitate third-party zero-emission shipping.

9. Through the ZEV Task Force and other multi-state *fora*, states should continue their well-established practice of coordinated research and analysis and state-to-state exchange of data and other information to evaluate early MHD ZEV policies and programs, identify models for recommended implementation, and ensure continuous improvement.

APPENDIX A. LOCAL AND U.S. FEDERAL GOVERNMENT RECOMMENDATIONS

The Local Government Role

Local governments, including municipal and county governments, have an important and unique role to play in facilitating the transition to zero-emission trucks and buses. Municipal and county governments exert considerable control over charging infrastructure deployment through zoning, construction ordinances, engineering design requirements, and permitting regulations. Compared to their state and federal counterparts, local jurisdictions typically have fewer resources but possess a much better understanding of their communities' needs and opportunities. As a result, local agencies are poised to make meaningful planning decisions and take targeted actions to advance MHD vehicle electrification.

The Task Force offers the following recommendations for local governments to advance MHD vehicle electrification:

1. Local governments should actively engage in EVSE planning for electric trucks and buses and incorporate charging and refueling needs into their transportation, climate, or energy plans as appropriate.

Santa Monica's Zero-Emissions Delivery Zone Pilot

The City of Santa Monica and the Transportation Electrification Partnership established a voluntary pilot zero-emissions delivery zone (ZEDZ) in one of its highest-traffic areas to combat air quality and public health impacts from truck emissions and to incentivize and test new ZEV delivery vehicles. Participating businesses operating ZEV delivery vehicles in the zone—including Ikea, Axlehire, Guyaki, Foodcycle, and Shopify—receive priority curb space in designated loading zones. Convenient deliveries and quicker turnaround times produce tangible benefits for participating businesses' bottom lines while also providing positive impacts from reduced diesel emissions.

Approaches to Low- and Zero-Emission Zones

Many cities around the world are reducing emissions and improving public health by implementing low emission zones (LEZs) that assess an entrance fee for vehicles that do not meet specified emissions standards. LEZs in European cities have proven highly effective at reducing emissions in high-traffic or high-density areas where pollution exposure risk is elevated. Zero-emission zones (ZEZs) are a type of LEZ where only ZEVs are allowed. A growing number of municipalities are demonstrating a pathway to the development of ZEZs by establishing LEZs along with a plan to tighten restrictions and expanding the zone over time. LEZs and ZEZs can also incorporate infrastructure for walking, biking, and other low-carbon mobility to enhance neighborhoods and improve public health.

2. Local governments should incentivize electric truck and bus adoption through non-monetary approaches, such as establishing low- or zero-emission zones, allowing off-peak delivery hours for zero-emission trucks, implementing micro-hubs, and giving zero-emission trucks priority or exclusive access to curbside loading zones.

3. Local governments should offer property tax credits to incentivize businesses without fleets to install charging infrastructure for trucks that serve their businesses.

4. Local governments should establish near- and long-term targets and plans for electrifying municipal and transit fleets—including transit buses and paratransit vehicles, refuse collection trucks, and MHD municipal vehicles—and should take immediate steps to make progress toward targets, including piloting vehicles and installing charging infrastructure in centralized depots where vehicles are parked.

5. Local agencies responsible for building codes, land use regulations, and engineering compliance should amend existing policies and rules to minimize administrative burdens for EVSE infrastructure planning, permitting, and construction. Local governments should also provide guidance documents and fact sheets that identify where to find applications and regulations, key steps and associated timelines, applicable fees, points of contact. These documents should be easily accessible to the public. Local governments should also work with utilities to offer electrification guidance and technical support to fleet operators.

New Jersey's Model EV Ordinance

In September 2021, New Jersey enacted a Model Statewide EV Ordinance that streamlines the local approval process for installing convenient and cost-effective charging infrastructure. The model ordinance establishes minimum requirements for EVSE and make-ready parking spaces and consistent guidance for electrification in each of the state's municipalities. Several sections of the model ordinance, including requirements for municipal approvals and permits, EV-ready development, and minimum parking requirements cannot be altered, while other sections related to health and safety can be modified by municipalities as needed. The model ordinance supersedes requirements in communities with existing EV charging ordinances.

6. Local governments should coordinate with utilities, charging providers, and states to plan for public MHD vehicle charging facilities for small fleets and independent owner/operators and to identify opportunities to site stations at publicly- and privately-owned parking lots and other properties located along commercial truck routes and at convenient overnight parking locations.

The U.S. Federal Government Role

Federal leadership is vitally important to set a national agenda that will align policy at every level of government, provide critically needed funding, and drive public and private sector action to support electrification of trucks and buses. In 2020, the Coalition Helping America Rebuild and Go Electric (CHARGE), a broad U.S. coalition of transportation, industry, environmental, labor, health, equity, and civic organizations, was formed to develop a set of principles and policy recommendations for federal action to support an equitable transition to a

zero-emission transportation sector. States should consider advocating for CHARGE's comprehensive suite of recommendations for federal action to enable truck and transit bus electrification.[56] The Task Force offers the following additional recommendations for federal agency and congressional action:

1. Given the demonstrated effectiveness of federal emission standards as a market driver of clean vehicle technology, the U.S. Environmental Protection Agency (EPA) should adopt increasingly stringent GHG and criteria pollutant emission standards for MHD vehicles.

2. The U.S. Department of Transportation (DOT) should create a streamlined process for eligible entities to suballocate funding and/or delegate project management responsibilities for certain transportation electrification projects.

3. Congress should amend 23 U.S.C. § 111(a) to allow user-pay EV charging stations and hydrogen fueling stations at rest areas and fringe and corridor parking facilities located on interstate rights-of-way.

4. EPA and DOT should provide states with additional funding to purchase low-cost community air quality sensors and develop and publish program guidance on the use of such sensors by residents to evaluate air quality in their neighborhoods, ensure modeled emission reductions materialize, and inform transportation and air quality planning.

5. DOT should take a leadership role to facilitate and encourage coordination and collaboration among federal, regional, state, and other entities to ensure a seamless network of public charging that will catalyze electrification of long-haul, drayage, and other MHD use cases.

6. Congress should establish a manufacturers' tax credit for the sale of MHD ZEVs.

7. Congress should expand the EV charging tax credit in 26 U.S.C. § 30C by eliminating the $100,000 cap on allowable expenses per site.

8. U.S. federal agencies should reserve a portion of federal infrastructure funding for high-capacity chargers to serve heavy-duty trucks.

[56] *See* CHARGE, Medium-and Heavy-Duty Vehicles Policy Recommendations, https://www.chargingusforward.com/recommendations/#md-hd-policy (accessed Mar. 4, 2022); CHARGE, Public Transit Policy Recommendations, https://www.chargingusforward.com/recommendations/#public-transit-policy (accessed Mar. 4, 2022).