White Paper

Investment Strategies to Accelerate Clean Transportation in the Northeast

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May 31, 2022

Acknowledgments

This report is derived from the generous support of the Energy Foundation. The authors would like to thank all companies and organizations that provided feedback for this report, as well as key CALSTART staff for their critical review of and additions to this report, including Robyn Marquis, Amy Gower, Sara Stith, Jimmy O'Dea, Cesar Hernandez, Mateo Henderson, Jessica Olson, and Emily Varnell. Any errors are the authors' own.

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Table of Contents

List of Acronyms

CalCAP	California Capital Access Program
CALeVIP	California's Electric Vehicle Infrastructure Project
CARB	California Air Resources Board
CEC	California Energy Commission
CMO	Clean Mobility Options
CPCFA	California Pollution Control Financing Authority
DAC	Disadvantaged Community
DCFC	Direct Current Fast Charger
DOT	U.S. Department of Transportation
EDF	Environmental Defense Fund
EnergIIZE	Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles
EPA	U.S. Environmental Protection Agency
GHG	Greenhouse Gas
HVIP	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project
ICEV	Internal Combustion Engine Vehicle
IIJA	Infrastructure Investment and Jobs Act of 2021
kW	Kilowatt
kWh	Kilowatt-hour
LACI	Los Angeles Cleantech Incubator
LCFS	Low Carbon Fuel Standard
MassCEC	Massachusetts Clean Energy Center
MHDV	Medium- and Heavy-Duty Vehicle

MTCO2e	Metric Tons Carbon-Dioxide Equivalent
MW	Megawatt
NESCAUM	Northeast States for Coordinated Air Use Management
NOx	Nitrogen Oxide
NYSERDA	New York State Energy Research and Development Authority
OEM	Original Equipment Manufacturer
PM	Particulate Matter
RGGI	Regional Greenhouse Gas Initiative
TCI-P	Transportation and Climate Initiative Program
TCO	Total Cost of Ownership
ULEZ	Ultra Low Emission Zone
VIP	Voucher Incentive Program
VZEZ	Voluntary Zero-Emission Zone
ZEV	Zero-Emission Vehicle

List of Figures

List of Tables

Executive Summary

The transportation sector is the largest contributor to greenhouse gas (GHG) emissions and air pollution in the United States, accounting for 29% of total GHG emissions (EPA, 2020). Diesel-powered medium- and heavy-duty vehicles (MHDVs) deserve particular attention; MHDVs comprise less than 10% of vehicles on the road yet account for over 60% of tailpipe nitrogen oxide and particulate matter emissions from on-road vehicles (MJB&A, 2021).

Despite major technological advancements and market acceleration initiatives in the region, Northeast states still lag behind first-mover state California in zero-emission technology adoption. The Infrastructure Investment and Jobs Act of 2021 (IIJA) will allocate close to $7 billion to Northeast states to reduce emissions from the transportation sector (U.S. DOT, 2021). This funding offers an unprecedented opportunity to prioritize clean transportation investments that will achieve states' emissions reduction goals. States must ensure that the transportation funding available is effectively and equitably directed toward clean mobility priorities, while at the same time exploring additional revenue sources and mechanisms to animate private sector investments. To the extent that Northeast states invest IIJA funds in a coordinated manner toward similar programs and efforts, IIJA presents an immense opportunity to realize the potential of the entire region to become a national leader in clean and equitable mobility.

The authors of this white paper have identified 10 promising investment strategies to accelerate equitable zero-emission transportation adoption in the Northeast (see **Table ES-1**). For each of these strategies, the authors offer a description, comparative strengths and weaknesses, design recommendations, potential impacts based on previous implementations, and an example of the investment in practice.

Industry members most often signaled voucher incentive programs and depot charging incentives as critical investments to accelerate zero-emission adoption. Neighborhood needs assessments and project implementation grants, hyperlocal air quality monitoring systems, workforce development programs, and point-of-sale voucher incentives stood out due to their potential to improve transportation equity by prioritizing emissions reductions in communities most affected by air pollution. Publicly accessible urban charging hub incentives, set-asides within point-of-sale voucher incentives, and fleet assessment services were considered most promising to reach smaller fleets with reduced access to capital. Finally, publicly accessible corridor charging and refueling incentives and first loss protection products were considered promising to electrify long-haul deliveries and improve vehicle financing products, but these two strategies are best

positioned for a market where zero-emission vehicle (ZEV) technology costs have further decreased.

Table ES-1. Investment Strategies for Zero-Emission Transportation

	Investment Strategy	Improvement Areas	Market Readiness	Direct Emission Reduction Potential	ZEV Market Acceleration Potential
1	Point-of-sale Voucher Incentives		▲▲▲	■ ■	● ● ●
2	First Loss Protection Products		▲	■ ■ ■	● ●
3	Needs Assessments and Project Implementation Grants		▲▲▲	■	● ●
4	Zero Emissions Zone Pilots		▲▲	■	● ●
5	Depot Charging Incentives		▲▲▲	■	● ● ●
6	Publicly Accessible Corridor Charging and Refueling Incentives		▲	□	● ●
7	Publicly Accessible Urban Hub Charging and Refueling Incentives		▲▲▲	□	● ●
8	Hyperlocal Air Quality Monitoring Systems		▲▲▲	□	●
9	Workforce Development Programs		▲▲▲	□	● ●
10	Fleet Assessment Services		▲▲▲	□	●

	Vehicle costs	▲▲▲	Established	■ ■ ■	>10,000 $MTCO_2e$ per $1M	● ● ●	Critical
	Operations and maintenance costs	▲▲	Emerging	■ ■	>1,000 $MTCO_2e$ per $1M	● ●	Highly supportive
	Infrastructure costs	▲	Nascent	■	Variable	●	Supportive
	ZEV ecosystem			□	Indirect		

The most impactful strategies for each state to invest in will depend on the characteristics of their transportation systems at the time of investment, the priorities of the communities they serve, the amount of funding available, and the conditions set forth by their funding sources.

I. Introduction

This white paper aims to support state governments in making resource allocation decisions to accelerate zero-emission technology adoption. To do so, CALSTART analyzed multiple public investment strategies that can be implemented by states through funding made available by the Infrastructure Investment and Jobs Act of 2021 (IIJA), as well as additional revenue streams like cap-and-invest programs. CALSTART interviewed companies across the zero-emission technology supply chain, including original equipment manufacturers (OEMs), electric vehicle charging station providers, innovative mobility companies, and vehicle fleets. The authors also relied on case studies, third-party assessments, and exploratory conversations with other nonprofit organizations.

As a result, the authors identified 10 promising investment strategies for Northeast states[1] to consider. For each investment strategy, the authors offer a summary of strengths and weaknesses compared to similar strategies, lessons learned from previous iterations, an example of the investment strategy in practice, and an estimation of potential benefits based on impact reporting from existing programs. The research is not intended as a cost-effectiveness analysis on diesel emissions reduction strategies, nor a prescriptive list of strategies that all states should adopt. Rather, the research is intended as a starting point for a high-level comparison of investment alternatives known to advance the cause of clean and equitable mobility, which should be further explored by government agencies in collaboration with impacted communities and industry members.

Transportation in the Northeast

The transportation sector is the largest contributor to greenhouse gas (GHG) emissions and air pollution in the United States, accounting for 29% of total GHG emissions (EPA, 2020). Diesel-powered medium- and heavy-duty vehicles (MHDVs) deserve particular attention; MHDVs comprise less than 10% of vehicles on the road yet account for over 60% of tailpipe nitrogen oxide (NO_X) and particulate matter (PM) emissions from on-road vehicles (MJB&A, 2021). Because of NO_X and PM emissions, diesel pollution has serious health impacts for communities, including lung and heart ailments, asthma, diabetes, and premature death. Reducing these emissions is critical for the United States to achieve its climate change goals and protect the health and quality of life of its communities.

[1] Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

Furthermore, air pollution is not experienced equally by everyone. On average, non-white residents in the Northeast and Mid-Atlantic are exposed 66% more to PM2.5 from vehicles than white residents (Pinto de Moura, 2019). White residents represent 63% of the regional population yet comprise 85% of people living in areas with the lowest PM2.5 concentrations (U.S. Census Bureau, 2020). Reducing exposure to air pollutants will require coordinated action to phase out diesel from on-road transportation, starting with those communities who have been most affected.

Despite major technological advancements and market acceleration initiatives in the region, Northeast states still lag behind first-mover state California in terms of zero-emission technology adoption. As of late 2021, California alone had two times more zero-emission trucks and buses than all Northeast states combined (Al-Alawi, 2022; Hamilton, 2021). Under a memorandum of understanding organized by Northeast States for Coordinated Air Use Management (NESCAUM), 17 states, the District of Columbia, and the Canadian province of Quebec have set the goal to reach 100% zero-emission MHDV sales by 2050, with an interim target of 30% by 2030 (NESCAUM, 2021). Doing so will require an efficient allocation of funding that supports early adopters, accelerates market penetration of clean transportation technologies, and creates the ecosystem necessary to animate private investment to fully transform the Northeast's transportation landscape.

Revenue Sources for Clean Transportation Investments

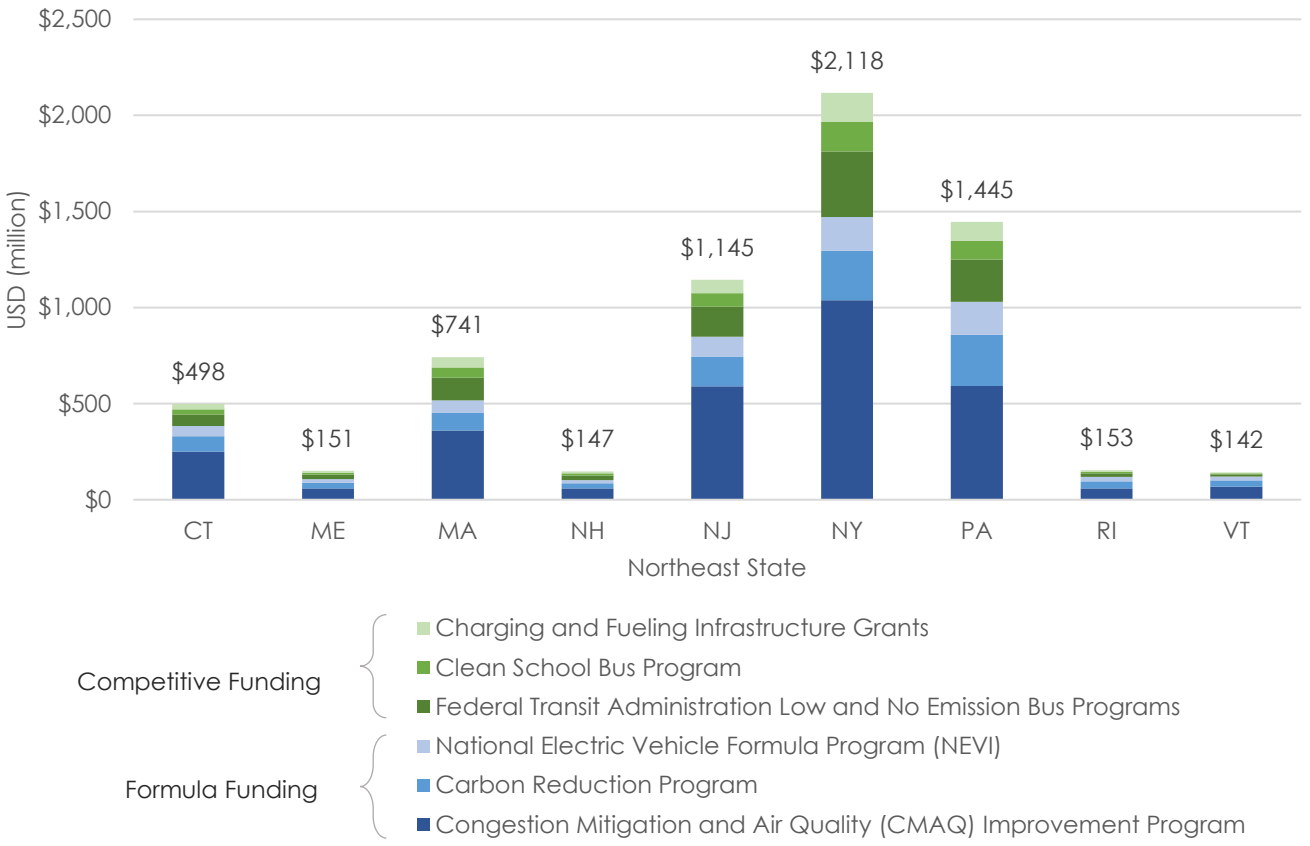
Technological innovation and economies of scale are bringing down the prices of zero-emission vehicles (ZEVs) and infrastructure. Lithium-ion battery pack prices were above $1,100/kilowatt-hour (kWh) in 2010; by 2020, prices had dropped down to $137/kWh and are expected to reach $100/kWh by 2024 (BloombergNEF, 2020). Most MHDVs will likely reach total cost of ownership (TCO) parity with internal combustion engine vehicles (ICEVs) between 2025 and 2030, which is expected to vastly accelerate technology deployment (MJB&A, 2021). Market-based policies like clean fuels standards can accelerate TCO parity even further. However, until TCO parity is achieved, and in the absence of widespread innovative financial products, the costs of zero-emission technology will remain a significant barrier to adoption, particularly for small, less capitalized fleets that tend to purchase trucks from the secondary market.

Public funding will be needed to stimulate early adoption of clean transportation technologies. IIJA, also known as the Bipartisan Infrastructure Law, is a historic investment to improve transportation options and accelerate equitable transportation decarbonization. Close to $35 billion out of IIJA's $1.3 trillion dollars have been earmarked for investments related to lowering transportation emissions.[2] Out of the $35 billion, roughly $7 billion will be distributed to Northeast

[2] IIJA funding considered exclusive for transportation emissions reductions includes the following formula funding programs: National Electric Vehicle Infrastructure Formula Program (NEVI) ($5 billion), Carbon Reduction Program ($6.4 billion), and Congestion Mitigation and Air Quality (CMAQ) Improvement Program ($13.2 billion). It also includes population weighed competitive grant funding for the following programs: grants for charging and fueling infrastructure ($2.5 billion); Federal Transit Administration's Low and No Emission Bus Program ($5.6 billion); and the Clean School Bus Program ($2.5 billion). Other programs such as the Surface

states and local governments through formula funding and competitive grants (*see* **Figure 1**). Additional IIJA funding may be used to lower transportation emissions but is not specifically reserved for this purpose.[3]

Figure 1. IIJA Funding Allocation Exclusive for Transportation Emissions Reductions by State



Formula funding values are based on U.S. Department of Transportation (DOT) estimates and may change based on updated factor data each fiscal year (U.S. DOT, 2021). Competitive funding is based on population weighed funding at the federal level (U.S. Senate, 2021).

To put these funds into perspective, one of the pivotal funding sources for clean transportation for states, the Environmental Mitigation Trust Agreement for State Beneficiaries that resulted from the Volkswagen Settlement, allocated $534 million to Northeast states (EPA, 2017). This allocation amounts to a mere 7.8% of IIJA's expected funding for the region.

Transportation Block Grant and the Rural Surface Transportation Grant can be used to cover electric vehicle charging infrastructure; these programs also cover other types of investments so actual allocations are uncertain (U.S. Senate, 2021).

[3] Additional IIJA programs that can cover but are not reserved for transportation emission reduction initiatives include: National Highway Performance Program, Surface Transportation Block Grant Program, National Highway Freight Program, Rebuilding American Infrastructure with Sustainability and Equity, Infrastructure for Rebuilding America Grant Program, Advance Transportation and Technologies and Innovative Mobility Deployment, Rural Surface Transportation Grant Program, Reduction of Truck Emissions at Port Facilities Program, State Infrastructure Banks, and Transportation Infrastructure Financing and Innovation Act (U.S. Congress, 2021).

The Georgetown Climate Center analyzed the potential effects that IIJA's surface transportation provisions can have on GHG emissions. Their analysis indicates that while IIJA could be an important element in the U.S. climate change strategy, it could also lead to an increase in GHG emissions depending on how state, federal, and local governments allocate IIJA funding (Georgetown Climate Center, 2021). Their assessment shows that within five years, a low-emission scenario could cut emissions by 1.6% below the country's current trajectory, which is equivalent to removing the annual emissions from 4.5 million passenger vehicles. However, under a high-emission scenario, IIJA would have marginal GHG emissions reductions up to 2026, after which emissions would start to trend upward and lead to an increase of 1.6% by 2032, driven by induced demand from highway expansions (Georgetown Climate Center, 2021).

States will be responsible for ensuring IIJA funding maximizes emissions reductions. At the same time, states cannot rely exclusively on the federal government as the only source of funding for transport decarbonization. According to a recent analysis by McKinsey & Company and Vivid Economics, close to $900 billion in annual public and private spending will be required for the United States to achieve net zero emissions from road transportation by 2050 (Krishnan, 2022). IIJA funding earmarked for this purpose amounts to $7 billion in annual public spending over the next five years (White House, 2022). States must ensure that available transportation funding is effectively directed toward equitable decarbonization priorities, while at the same time exploring additional revenue sources and mechanisms to encourage private sector investments.

Market-based mechanisms like California's AB32 cap-and-trade program and its Low Carbon Fuel Standard (LCFS) as well as the Regional Greenhouse Gas Initiative (RGGI) in the Northeast have demonstrated potential for market-based programs across the country that bring the costs of alternative fuels including zero-emission technologies in line with petroleum products while creating sustainable revenue sources (CARB, 2022; RGGI, 2022). The Transportation and Climate Initiative Program (TCI-P),[4] while currently stalled due to lack of political support, remains a powerful strategy to generate up to $3 billion in revenues to invest in transport decarbonization (Kiely, 2021). Governments must consider such market-based strategies to meet 2030 emissions reduction targets.

Bonds offer another alternative for states to obtain short-term funding, particularly when faced with limited operating budget flexibility and the need for additional resources to meet the

4 TCI is a regional collaboration of 14 Northeast and Mid-Atlantic jurisdictions: Connecticut, Delaware, the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, Vermont, and Virginia. Through it, signatory jurisdictions seek to improve transportation, develop the clean energy economy, and reduce carbon emissions from the transportation sector. TCI-P aims to reduce GHG emissions from the transportation sector by 26% between 2022 and 2030 and generate over $3 billion dollars over 10 years for jurisdictions to invest in equitable, less polluting transportation options. TCI-P will "cap" or limit CO2 emissions from gasoline and on-road diesel fuel and require fuel suppliers to purchase "allowances" for the amount of carbon emissions produced by fuel covered under the cap. The cap will decline over time, guaranteeing emissions reductions. Depending on how jurisdictions decide to allocate TCI-P revenues, a Harvard School of Public Health study (updated in 2021) estimated that the health benefits from all TCI jurisdictions implementing the TCI-P could result in up to 1,360 deaths avoided, 230 incidences of childhood asthma avoided, and tens of thousands of childhood asthma exacerbations avoided. The monetized benefits of health outcomes derived from TCI-P implementation could reach $13.5 billion by 2032 (TCI, 2021; Harvard School of Public Health, 2021).

matching funding requirements set out by IIJA. In March 2022, Massachusetts filed a $9.7 billion infrastructure bond bill that will allow the state to issue and sell bonds to meet IIJA's matching funding (Massachusetts Governor's Press Office, 2022). New York's Clean Water, Clean Air, and Green Jobs Environmental Bond Act will channel $500 million from bond resources to support school districts in purchases of zero-emission buses and related charging infrastructure (New York State Governor's Press Office, 2022).

Faced with limited resources, state governments must ensure that the resources available are used judiciously, by allocating them toward investment strategies that maximize social, economic, and environmental impacts, and building on lessons learned from previous experiences.

II. Investment Strategies

Investment strategies in this paper refer to programs and projects that state governments can fund to advance clean equitable transportation. Examples of investment strategies include purchase incentive programs, grants to deploy infrastructure, or investments in hyperlocal air quality monitoring systems. Regulatory interventions that do not require public funding, such as cap-and-trade programs or mandatory zero-emission zones, are not included within this scope of analysis. While this research focuses exclusively on investment strategies, achieving states' emissions reduction targets will require both investment strategies *and* regulatory interventions.

For each of the 10 investment strategies proposed, the authors include a description of the strategy, its comparative strengths and weaknesses vis-à-vis other strategies that pursue similar outcomes, its potential impact based on previous experience, strategy design recommendations based on previous implementations and industry feedback, and an illustrative example of the strategy in practice.

Table 1 below summarizes the investment strategies proposed, alongside the key areas within the ZEV landscape that they improve, their market readiness to be adopted, their ZEV acceleration potential identified, and an order of magnitude categorization for their direct emissions reduction potential per $1 million investment.

Table 1. Investment Strategies for Zero-Emission Transportation

	Investment Strategy	Improvement Areas	Market Readiness	Direct Emission Reduction Potential	ZEV Market Acceleration Potential
1	Point-of-sale Voucher Incentives		▲▲▲	■ ■	● ● ●
2	First Loss Protection Products		▲	■ ■ ■	● ●
3	Needs Assessments and Project Implementation Grants		▲▲▲	■	● ●
4	Zero Emissions Zone Pilots		▲▲	■	● ●
5	Depot Charging Incentives		▲▲▲	■	● ● ●
6	Publicly Accessible Corridor Charging and Refueling Incentives		▲	□	● ●
7	Publicly Accessible Urban Hub Charging and Refueling Incentives		▲▲▲	□	● ●
8	Hyperlocal Air Quality Monitoring Systems		▲▲▲	□	●
9	Workforce Development Programs		▲▲▲	□	● ●
10	Fleet Assessment Services		▲▲▲	□	●

	Vehicle costs	▲▲▲	Established	■ ■ ■	>10,000 $MTCO_2e$ per $1M	● ● ●	Critical
	Operations and maintenance costs	▲▲	Emerging	■ ■	>1,000 $MTCO_2e$ per $1M	● ●	Highly supportive
	Infrastructure costs	▲	Nascent	■	Variable	●	Supportive
	ZEV ecosystem			□	Indirect		

Table 2 below illustrates alignment between the investment strategies proposed and the eligible expenses included in programs funded through IIJA. In addition to IIJA, investment strategies can also be funded through government sources at the federal, state, and city level, as well as market-based mechanisms such as cap-and-trade programs and LCFSs.

Table 2. Investment Strategy Compatibility with IIJA Programs

	Investment Strategy	Advanced Transportation and Technologies and Innovative Mobility Deployment	Carbon Reduction Program	Congestion Mitigation & Air Quality Improvement Program (CMAQ)	Congestion Relief Program	Discretionary Grant Program for Charging and Fueling Infrastructure	Infrastructure for Rebuilding America Grant Program	National Electric Vehicle (NEVI) Formula Program	National Highway Freight Program	Rural Surface Transportation Grant Program	State Infrastructure Banks	Surface Transportation Block Grant Program	Tribal Transportation Program
1	Point-of-sale Voucher Incentives		X	X					X				X
2	First Loss Protection Products		X	X					X		X		X
3	Needs Assessments and Project Implementation Grants	X	X	X	X				X				X
4	Zero Emissions Zone Pilots	X	X	X	X				X			X	X
5	Depot Charging Incentives		X	X					X	X			X
6	Publicly Accessible Corridor Charging and Refueling Incentives	X	X	X		X	X	X	X	X		X	X
7	Publicly Accessible Urban Hub Charging and Refueling Incentives	X	X	X		X	X	X	X	X		X	X
8	Hyperlocal Air Quality Monitoring Systems		X	X					X				X
9	Workforce Development Programs		X	X		X		X		X		X	X
10	Fleet Assessment Services		X	X					X				X

Funding compatibility accurate as of May 10th, 2022, based on eligible projects and use of funds descriptions stated in the U.S. Code. (U.S. Congress, 2021; 23 U.S. Code §129, §133, §149, §167, §503, §202, §173, §117, §151, §175, §610; 49 U.S. Code §5339, §5302; U.S. DOT, 2022a; U.S. Congressional Research Service, 2022).

Point-of-sale Voucher Incentives

Description

Point-of-sale voucher incentive programs (VIPs) for clean MHDVs use public funds to cover part of the incremental cost of a ZEV compared to an ICEV. By doing so, vouchers bring down the cost of vehicle procurement to a point in which payback periods are acceptable for fleets (Welch, 2019).

VIPs typically require vendors to register their vehicle offerings with the sponsoring agency. Vehicle vendors then sell a voucher-approved vehicle to a fleet, subtracting the voucher amount from the vehicle price at the point of sale. Once the vehicle is delivered to the fleet and all documentation has been submitted to the sponsoring agency, the vendor is reimbursed by the agency for the pre-defined voucher amount.

The maximum value of each voucher may vary according to different factors, including the weight class and vehicle type of the ZEV, the incremental cost of the ZEV, the location of the vehicle (i.e., whether in a disadvantaged or environmental justice community), and size of the fleet receiving the voucher (i.e., whether considered a small fleet).

Comparative Strengths

VIPs are well-structured, highly transparent tools that stimulate demand by reducing vehicle costs at the point of purchase. They clearly lay out the program's requirements, operation, and level of funding available for fleets, streamlining responsibilities and processes to simplify the application process for fleets as well as engagement from vehicle manufacturers and vendors. VIPs also provide support and certainty of outcome to participants through the instrument's ability to reserve funding while reducing the administrative effort required by sponsoring agencies, compared to other funding channels like grants and loans.

VIPs are highly customizable, which allows jurisdictions to adapt them to unique clean energy goals, prioritized communities' interests, and specific requirements of available funding sources. Most frequent customizations include promoting or excluding certain fuels or technologies, adjusting funding caps by gross vehicle weight or technology, reserving incentives or offering additional benefits to vehicles domiciled in or serving areas identified as environmentally or socially disadvantaged, and reserving incentives or offering additional benefits to fleets meeting certain characteristics.

VIPs tend to be more effective than tax rebates in speeding up adoption because they accelerate access to funding, provide certainty at the point of sale, and pass on the administrative burden from fleets to dealers and sponsoring agencies.

Comparative Weaknesses

Compared to investment strategies that spread out upfront costs throughout the vehicle's lifetime (such as loans), VIPs can be resource intensive when cost differentials are high.

Industry members have signaled that the administrative process to access voucher funding still requires a high level of effort and administrative sophistication from fleets, particularly when a high degree of coordination is required between fleets and vendors. Small- and medium-sized fleets are not usually equipped to deal with the processes required to satisfy information and documentation requirements for their vendors, particularly in programs involving or requiring vehicle scrappage. In addition to increasing the amount of funding and cost items that can be covered for small fleets, this weakness may be tackled by simplifying the application process and facilitating access to voucher dollars for innovative service providers such as fleet-as-a-service companies (e.g., Ryder, Penske, Zeem Solutions, Fluid Truck), which often cater to small- and medium-sized fleets as their end users. For programs funded with Volkswagen Settlement or similar dollars requiring scrappage, allowing fleets to purchase a scrappage vehicle from another fleet in the state—recently introduced in New York—is a promising approach to enhance access but may require a marketplace to streamline such transactions and simplify the process for fleets.

Potential Impact

Based on California's Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP), **a $1 million investment** in a VIP **can leverage over $4 million** in additional public and private investment in clean transportation[5] and lead to:

- Over 2,600 metric tons of carbon dioxide equivalent (CO_2e), 260 pounds of PM2.5, and 14,000 pounds of NOx avoided[6]
- Over $1.1 million in monetized health and ecosystem benefits[7]
- Over 28 jobs created[8]

Benefits can be allocated to disadvantaged communities (DACs) through earmarking a percentage of the budget to specific areas or applicant profiles. HVIP has distributed close to 60% of vouchers to deployments in DACs. Similarly, the New York Truck Voucher Incentive Program has funds specifically set aside for transit and school bus fleets operating in DACs (CARB, 2022a).

[5] Additional funding leveraged represents purchases redirected from traditional technologies to clean technologies (CARB, 2022a).

[6] Emissions based on HVIP program-wide reporting (California Climate Investments, 2021).

[7] Monetized damage values reflect impacts of air pollution on human health (mortality and morbidity), crop and forest damage, ecosystem damage, damage to buildings and materials, and reduced visibility (TCI, 2020).

[8] Job creation potential approximated through the total investment leveraged and the potential job creation per investment amount (Veeder, 2019).

Strategy Design Recommendations

1. Award additional funding for preferred project types instead of restricting access to only those projects. For example, the New Jersey Zero Emission Incentive Program offers vouchers to any type of business registered in New Jersey and awards an additional 25% bonus to small businesses (rather than offering funding to small businesses only). Doing so can speed up adoption and maximize the pool of potential applicants while still targeting specific applicants or areas.
2. Focus voucher funding on ZEVs in Classes 2b through 8. Even if certain technologies (such as those needed by heavier duty cycles) are still at an early stage, providing incentives will create a strong market signal and economic opportunity for manufacturers to develop these ZEVs and for fleets to deploy them.
3. Design incentives with values that step down overtime, following a predefined schedule. Doing so encourages early adoption, enables longer-term planning, and allows for a judicious disbursement of government funding. As technology development progresses, the cost differential between ICEVs and ZEVs will decrease, driven by technology advancements. With lower cost differentials, lower incentive amounts are needed to achieve cost parity. For example, Massachusetts's MOR-EV Trucks Program structures available funding into a declining block schedule. Once a block is fully subscribed, the next block becomes available and incentive values decline by 15% (Commonwealth of Massachusetts, 2021). Industry members have signaled that incentive step downs must be based on justifiable metrics that align incentive amounts to actual market prices. This will ensure fleets can access the funding amounts needed to electrify.
4. Provide targeted and supplemental support to small fleets. Small fleets often have less experience with funding applications, lower access to capital, lower risk mitigation capacity, and higher capital need since they frequently purchase vehicles from the secondary market. Options for supplemental support include reserving a portion of total program funding for small fleets, augmenting incentive amounts, covering additional electrification-related expenses, technical assistance, and credit enhancements that unlock access to finance. California's HVIP Innovative Small e-Fleets set-aside provides $25 million in funding to implement innovative mechanisms including flexible leases, peer to peer truck sharing, truck-as-a-service, infrastructure support, and technical assistance (CARB, 2021).
5. Separate ownership requirements from operational requirements. Innovative business models relying on short- and long-term electric vehicle leasing can be a powerful tool to speed up adoption and tackle most of the barriers affecting smaller fleets, but they are currently not eligible for voucher funding under most programs, which require the assignment of a static operator to a voucher-funded vehicle for a minimum of three to five years. California's HVIP Innovative Small e-Fleets set-aside exemplifies how this operational flexibility can be integrated into voucher funding structures.
6. Tax exemptions, rebates, and clean fuel standards should be considered as an additional support mechanism. The disparity in sales taxes and the 12% federal excise tax for heavy-duty trucks have been signaled by industry members as a key barrier, since they further increase the cost of zero-emission trucks compared to diesel-powered trucks. Mechanisms like clean fuel standards can significantly mitigate electricity costs for fleets and reduce payback periods for fleet conversions, thus substantially improving the business case for fleets to electrify.

California's Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)

HVIP has accelerated deployments of zero- and near-zero-emission technologies by providing point-of-sale vouchers on a first-come first-served basis since 2009 (CARB, 2022b).

Sellers and vehicles must be authorized by the California Air Resources Board (CARB) to participate in the program. Vehicle purchasers buy an eligible vehicle at an authorized dealer and receive a discount for the value of the voucher at the point-of-sale. Voucher support ranges from $20,000 to $240,000, depending on the vehicle purchased.

Vehicles domiciled in DACs receive a 15% increase on the voucher amount (CARB, 2021). HVIP also includes set-asides for public transit and school buses, drayage trucks, and Innovative Small e-Fleets. Since its launch in 2009 through 2021, the program has deployed over 9,000 clean vehicles with voucher requests exceeding $600 million (CARB, 2022a).

First Loss Protection Products

Description

First loss protection products improve the creditworthiness of loans by reducing lender risk for a pre-defined amount of financial loss due to a specific risk, such as uncertain resale value or payment defaults. For fleet electrification projects, residual value risk is an oft-cited financing concern that can be mitigated through first loss protection products that make up for losses between an expected resale value and the actual resale value, up to a certain percentage defined by the first loss protection agreement. Payment defaults represent an additional concern, particularly for fleets with low credit scores, which can be mitigated through first loss protection products that make up for losses due to loan defaults, up to a certain percentage defined by the agreement. While their use in the ZEV market is still in early stages, loan loss protections are widely available for energy efficiency and renewable energy projects as well as in numerous other lending contexts (EPA, 2011).

By mitigating the impact of potential risks, these instruments encourage lenders to expand the pool of applicants, allowing smaller fleets that do not fit within traditional lending programs to access financial products. They can also allow lenders to offer preferential borrowing terms such as lower interest rates, longer maturity, reduced collateral requirements, and grace periods (EDF, 2020; Gurman, 2020).

Comparative Strengths

Loans backed by first loss protection products can allow less capitalized fleets to adopt zero-emission technologies by distributing the costs of the vehicle over time. They center fleet's decision-making process around TCO rather than upfront cost constraints.

First loss protection products lower the risk of lending for private capital providers, who are able to allocate funding at higher orders of magnitude than the public sector. When protecting against payment defaults, protections encourage lenders to offer financial products to less capitalized fleets that may not have the credit score necessary to access traditional lending programs. When protecting against resale value, they can enable lenders to offer lower interest rates and longer maturity periods that make it easier for fleets to repay loans.

First loss protection products require small amounts of capital outlay compared to revolving loans, since they only cover a pre-specified portion of a specific risk and only disburse funds if that risk materializes. Finally, by reinforcing the residual value of ZEVs, first loss protection products can support the development of a robust secondary market by enhancing liquidity, as early adopters sell ZEVs into the secondary market with increased confidence in a robust resale value.

Comparative Weaknesses

If TCO parity has not been achieved, loans will require fleets to cover the cost differential between ZEVs and diesel-powered ones. Grants or voucher incentives will still be needed in the near term to stimulate adoption, although the costs covered by direct funding may be smaller than those of a stand-alone voucher program, since loans shift the conversation from upfront costs to TCO.

Loan loss protection products require buy-in from additional lenders willing to take on risks not covered by the protection product, and hence their success does not depend entirely on the sponsoring agency.

Potential Impact

Based on California's Truck Loan Assistance Program, **a $1 million investment** in a loan loss protection program **can leverage over $13 million** in additional private investment in clean transportation and lead to:

- Over 18,100 metric tons of CO_2e, 310 pounds of PM2.5, and 15,100 pounds of NO_X avoided[9]
- Over $8.7 million in monetized health and ecosystem benefits (Cambridge Systematics, 2020)
- Over 82 jobs created (Veeder, 2019)
- Recovery of 65-90% of the initial investment once loan portfolio matures (CPCFA, 2021)

Strategy Design Recommendations

1. Establish reporting mechanisms that allow the sponsoring agency to visualize and share anonymized data on actual residual values. Enhancing transparency around residual values will allow the market to better assess risk, price financing, and create first loss protection products without the need for government involvement.
2. Extend loan offerings supported by loss protections to small fleets applying for VIPs. Access to loan offerings should not be exclusive for voucher recipients, but administrative simplification can encourage small fleets to access both types of funding, which facilitates funding not only for vehicles but for the full project, including infrastructure and soft costs.
3. Establish a process to review leverage ratios (the amounts covered by the loan loss protection product) once evidence of actual loss rates within the program is available. If loss rates are below the initial expected amount, leverage ratios can also be lowered, thus expanding the total lending amount without increasing the loan loss protection budget (U.S. Department of Energy, 2010).

[9] Emissions reductions are based on Truck Loan Assistance Program, which was not limited to zero-emission technologies. PM2.5 and NO_X emission reductions for a zero-emission program are expected to be higher (CPCFA, 2021).

California Air Resources Board (CARB)/California Capital Access Program (CalCAP) Truck Loan Assistance Program

In 2009, CARB partnered with CalCAP to launch the Truck Loan Assistance Program (also known as Heavy-Duty Vehicle Air Quality Loan Program). The program supports loans made to small business owners to renew their heavy-duty fleets and meet the state's air quality regulations (CARB, 2022c). The program finances heavy-duty trucks (over 14,000 gross vehicle weight rating) equipped with engines certified to meet 2010 engine emissions standards, including diesel, compressed natural gas, liquefied natural gas, and zero-emission technologies.

Under this program, enrolled lenders award loans to small businesses. CARB contributes 10-14% of each loan to the lender's loan loss reserve account, which covers any potential losses resulting from loan defaults up to the amount available in the reserve. After five years or once the loan is fully repaid, the lender returns any remaining funding in the reserve to CalCAP/CARB. Recaptured contributions are recycled to support further loan enrollments (CPCFA, 2021).

The program allows lenders to establish their loan terms as long as the interest rate remains below 20%. To further accelerate vehicle replacement, the protected loans can be combined with grant funding awarded through the Carl Moyer Voucher Incentive Program or HVIP. Between 2009 and 2020, CARB has allocated $142.3 million to this program, resulting in close to 30,000 loans totaling an investment of $1.9 billion (CPCFA, 2021).

Needs Assessments and Project Implementation Grants

Description

Needs assessments and project implementation grants fund community organizations and public entities to identify local transportation needs and implement projects that address them. Mobility or transportation needs assessments are participatory, bottom-up analyses to identify the most pressing unmet transportation needs of communities (Greenlining Institute, 2018). They lay the groundwork for transportation planning and investments at the community level to ensure funding allocation effectively tackles community priorities. Needs assessments typically cover transportation access data analyses (from resident surveys, existing transportation data, and community's transportation accessibility indicators) and community engagement efforts (targeted audience engaged through community forums, workshops, house meetings, focus groups, interviews, among others) (CMO, 2022).

Once community needs have been identified, sponsoring agencies may award additional funding to implement community-proposed and backed solutions to address these needs. Funding items typically include project planning, infrastructure, vehicles, equipment, outreach, operations, and maintenance. Funding applicants typically must demonstrate that their solution will continue to operate for a certain amount of time once direct funding has been exhausted.

Comparative Strengths

Industry members indicated that project implementation grants can be more effective than voucher incentives to execute complex projects with multiple moving parts and cost components. The flexibility of funding allows applicants to concentrate on specific pain points that may not be covered by voucher incentives focused on a single component. This approach can also encourage transformational projects—as opposed to incremental ones—and best support earlier technologies that operate in markets where scale is temporarily limited. New York's Clean Transportation Prize is a strong example of how these implementation grants can offer the project design support and financial flexibility to aim for scale and replicability (NYSERDA, 2021).

Top-down transportation investments without community consultation have often reinforced unequal access to transportation and contributed to disproportionate health and economic impacts for DACs. Needs assessments and project implementation grants center social equity and community power as the core values sustaining transportation planning and investment.

By focusing on immediate transportation needs, communities can easily identify tangible benefits derived from transportation investments and are more likely to engage with the needs assessment and solution. Risks like low solution uptake, local opposition to the project and expectation management are mitigated through the needs assessment, which engages community members in the design process and captures local transportation priorities, preferred transport modes, and price sensitivity.

In contrast to transportation assessments that are not accompanied by implementation funding, this coupled approach offers a clear pathway toward material changes at the local level.

Comparative Weaknesses

Needs assessments and project implementation grants can be more administratively taxing to authorities and applicants compared to programs that focus on a specific and predetermined type of technology or approach, such as VIPs. Industry members indicated that they should not be viewed as a substitute for vouchers and rebates, since additional assessments can overcomplicate funding disbursements that may be well suited for simpler program mechanisms (such as traditional charging infrastructure rebates or vehicle replacements). However, when used appropriately, the expanded scope of eligible items that implementation grants can fund unlocks the potential of projects that could not be materialized through individual voucher programs.

Industry members signaled that microtransit deployments are a very promising alternative to reduce emissions using project implementation grants. However, certain vehicle types like shuttles, minivans, and wheelchair accessible vehicles have limited commercial availability. Exploring ways to accelerate supply of these segments can further encourage innovation in this space.

Potential Impact

Based on preliminary results and proposals for California's Clean Mobility Options (CMO) Program, a **$1 million investment** in mobility assessments can lead to (CMO, 2022a):

- 13-20 community assessments
- Creation of a pipeline for grant funding to launch and operate zero-emission solutions

Based on the South Los Angeles Universal Basic Mobility Pilot Program,[10] a **$1 million investment** in mobility project implementation grants can leverage close to $560,000 in public and private investment and lead to:

- Over 82 metric tons of CO2e avoided, 7 pounds of PM2.5, and 25 pounds of NOx avoided (CARB, 2021a)
- Over $20,000 in monetized health and ecosystem benefits (Cambridge Systematics, 2020)
- Over eight jobs created (CARB, 2021a)

Strategy Design Recommendations

1. Establish needs assessments as a requirement for project implementation grants. Doing so will improve solution capabilities to effectively address local needs and ensure community members are engaged from the outset. Assessments do not necessarily need to be funded by the same program or sponsoring agency as long as they meet the program's transportation focus and community engagement criteria.
2. Add an educational component to needs assessments. Viewing the assessment as a

[10] The South Los Angeles Universal Basic Mobility Pilot Program is being implemented by the Los Angeles Department of Transportation through a Sustainable Transportation Equity Project Implementation Grant. It offers a comprehensive set of strategies to improve mobility, including a mobility wallet and transportation subsidy pilot, an e-bike lending library, an on-demand electric shuttle pilot, a carshare program, public charging infrastructure, among others.

bidirectional knowledge exchange supports community members' understanding of the costs and benefits of different transportation modes and potential solutions. It can also improve the quality and applicability of inputs received and help manage expectations.

3. Ensure grantees engage with communities through multiple forms (surveys, in-person meetings, online forums, workshops, etc.) at multiple points in time.
4. Offer personalized technical assistance and training sessions to guide applicants through the grant application process. Lack of familiarity with funding applications can be a barrier to entry, particularly for small organizations. The New York Clean Transportation Prizes developed a webinar schedule with trainings focused on specific components of the proposal, which supports applicants in strengthening their projects by improving their community engagement, monitoring, and evaluation and risk assessment strategies (NYSERDA, 2021).

California's Clean Mobility Options (CMO) Voucher Pilot Program

California's CMO Voucher Pilot Program was launched in 2020 with a budget of $20 million, sourced from California's Cap-and-Trade program. CMO provides voucher-based funding for zero-emission carsharing, carpooling/vanpooling, bike sharing/scooter sharing, innovative transit services, and ride-on-demand services in California's historically underserved communities (CMO, 2022b).

The program awards up to $75,000 to conduct community transportation needs assessments, which must include transportation data analysis and community engagement. It also awards up to one million dollars to launch and operate clean mobility projects that bridge transportation gaps and provide connectivity between services and locations. To access project funding organizations must have conducted a Community Transportation Needs Assessment (not necessarily funded by CMO so long as it satisfies the program's assessment requirements) (CMO, 2022).

In its inaugural year, CMO awarded Mobility Project Vouchers worth $20 million to 20 awardees, with $18 million going to eligible under-resourced communities and $2 million to Native American tribal governments (CMO, 2022a).

Zero Emissions Zone Pilots

Description

Zero-emission zones or low-emission zones are areas within a city where vehicles with zero or low emissions are favored over their more polluting counterparts. Voluntary zero-emission zones (VZEZs) do so without relying on fees and fines that non-compliant vehicles must pay to circulate within the area. [11]

VZEZs provide operational benefits and financial incentives to businesses and local communities to test innovative technologies and operations that reduce localized emissions. Preferential access to curb space, parking, and loading bays are examples of operational benefits typically enacted through regulation (LACI, 2021). Financial incentives cover costs related to community engagement, vehicle and charging infrastructure deployment, parking subsidies, scrappage incentives, operational improvements, and monitoring and evaluation activities that provide ahead of the curve learnings for future replication and scaling (LACI, 2021; Energy Saving Trust, 2021). Use cases for financial incentives are broad and can include micromobility alternatives, last mile deliveries, refuse trucks, school buses, and off-road alternatives such as yard equipment. Hard restrictions and voluntary measures can be combined to ensure emissions standard compliance and support communities and businesses in adapting to the new requirements (Energy Saving Trust, 2021).

Comparative Strengths

VZEZs are not limited to specific technologies or projects and can offer a unique real world testing ground to pilot innovations before larger funding and regulation adjustments take place. The University of Washington's Urban Freight Lab and the City of Seattle piloted a Neighborhood Delivery Hub which, within 3.5 months, demonstrated that e-cargo bikes can replace trucks mile-for-mile and reduce emissions by 30% per package delivered (Urban Freight Lab, 2021).

Voluntary approaches are less likely to face opposition from drivers and fleets compared to mandated ZEZs, since enforcement mechanisms are more subtle. Preferential curb access, for example, favors ZEVs over their diesel counterparts and translates into improved operations and savings but does not tend to face the same amount of opposition as fees and fines.

When operating through incentives rather than regulation, ZEZs can support early adopters with technology deployment and concentrate environmental and health benefits on communities most affected by air pollution. By partnering with fleets, electric vehicle managers and businesses with larger national or global presence, learnings from a ZEV have a natural steppingstone for scaling.

[11] Traditional ZEZs do rely on regulation that limits entry to non-compliant vehicles. London's Ultra Low Emission Zone (ULEZ), for example, requires vehicles to meet the ULEZ emission standards or pay a $16.50 daily charge to drive inside the zone.

Comparative Weaknesses

VZEZs rely on fleets' willingness to participate. Since they are geographically constrained, operational benefits limited to a specific area may be insufficient to encourage fleet electrification when vehicles must also service areas outside of the VZEZ. Financial incentives do not necessarily face the same challenge if they allow some flexibility on operations outside of the VZEZ.

VZEZs require public funding and supportive regulation to encourage fleet engagement. Mandated zones, while harder to implement, ensure vehicle compliance and can create new sources of funding through fees and fines, thus positively impacting agencies' budgets as implementation costs shift from the public sector toward the private sector.

Potential Impact

Los Angeles Cleantech Incubator's (LACI) Voluntary Zero Emissions Delivery Zone was launched with an initial **$350,000 investment** and relied on participating companies to cover most of the costs associated with technology deployments (LACI, 2020). Expected impacts can vary widely depending on the types of technologies deployed. For potential impacts from a mobility-focused project portfolio, refer to the Potential Impact section within the Needs Assessments and Project Implementation Grants Investment Strategy.

Strategy Design Recommendations

1. Build strong local stakeholder support from the start. Community and industry buy-in can strengthen project design, mitigate risks, and ensure the right partnerships are in place to achieve the expected outcomes.
2. Pair public funding with private investment on technology acquisition, operational improvements, and business model development. By focusing funding in support of sponsorship models, governments can maximize private investment and offer proof of concept of highly scalable business models compatible with smaller fleets.
3. Include specific metrics and targets from the outset to define VZEZ permanence and scaling up process. Industry members signaled that a clear roadmap provides certainty to private sector actors and supports their long-term decision making, which encourages short- and long-term participation.

Santa Monica Zero Emissions Delivery Zone Pilot

LACI and the City of Santa Monica partnered to deploy a voluntary Zero Emissions Delivery Zone, a one-square mile area in the commercial activity core of Santa Monica. The zone is home to over 15,000 residents and 28,000 workers (LACI, 2021). The project will provide a blueprint and best practices for cities to adopt zero-emission delivery zones; it will provide ahead-of-the-curve learnings to delivery companies, generate immediate environmental benefits for the local community, and provide economic opportunity to small businesses and individuals through access to zone benefits. Technologies that will be deployed include:

- Micromobility for food and parcel delivery
- Electric delivery vehicles across all weight classes
- Commercial electric vehicle car sharing
- Priority zero-emission loading zones and curb management
- Mobile charging applications for delivery

Depot Charging Incentives

Description

Depot charging incentives are offered to private fleets to buy down the cost of procuring and installing charging equipment at their vehicle depots. Depot chargers are typically reserved for private use, ensuring infrastructure is readily available for overnight or daytime charging during downtime windows as needed by the fleet's duty cycle. While a variety of charging infrastructure incentives exist around the country, these have largely focused on publicly accessible charging stations for individually owned light-duty vehicles and do not meet the needs of depot-based fleets.

Public funds are deployed as grants or rebates to cover a percentage of the total cost of procuring and installing charging infrastructure up to a fixed amount per applicant and charger. Due to the variability of costs associated with infrastructure installation, which include installation services, permitting, utility distribution upgrades and site interconnection, and software subscription beyond the procurement of the charging station hardware, grants and rebates tend to be more common than point-of-sale voucher incentives.

In several states, led by California and New York, electric utilities have been authorized to invest ratepayer funds to build out "make-ready" infrastructure on the utility side of the meter for MHDV fleets (Joint Utilities of New York, 2021). While existing programs are a step in the right direction, industry members have signaled that more adaptability is required to incorporate a larger number of commercial vehicle sites. Depot charging incentives can complement utility make-ready programs by providing support on the customer side of the meter to facilitate fleets' self-sufficiency to fuel their own electric fleets.

Comparative Strengths

Industry members and publications by subject matter experts concur that depot charging must be prioritized by government agencies over other charging arrangements (Koehler, 2022; Furnari, 2020). First-success beachhead applications (such as transit buses and delivery vans) tend to rely almost entirely on depot charging to meet charging needs (Welch, 2020). While passenger vehicles may have the flexibility to rely on publicly accessible chargers, fleet vehicles with fixed schedules, constant routes, and strict performance requirements need the certainty offered by depot charging.

Depot charging provides certainty to fleets and enables them to charge on-location when needed without unexpected delays arising from shared infrastructure use. Depot charging requires lower power capacities than publicly available chargers since most fleets can take advantage of long overnight charging sessions. Lower powered chargers are more affordable, so the same amount of funding can cover a larger number of depot chargers compared to publicly accessible ones.

Since depot charging allows fleets to charge overnight when electricity prices are lower, it is the most cost-effective charging solution to date (Furnari, 2020). Overnight charging draws energy from the grid when demand is lower, so it can also rely on cleaner energy sources upstream, leading to higher emissions reductions. Also, since fleets typically have some control over their depot's real estate, it unlocks their ability to collocate distributed energy storage and renewable energy generation equipment that can further reduce emissions and costs of electricity generation while improving operational resilience.

Finally, as fleets gain more familiarity with depot charging, they may benefit from higher operational efficiencies by loading and unloading while the vehicle charges, or by not requiring drivers to be present during the entire charging session, both of which can reduce labor costs.

Comparative Weaknesses

Depot charging is well positioned to cover charging needs of fleets with back-to-base operations, which represent the lion's share of beachhead segments. However, it is unable to entirely satisfy charging needs of trucks used for regional travel or that cannot return to their base to charge overnight.

Depot charging does not support charging needs of passenger cars and fleets beyond those deployed by the specific fleet recipient. It has less visibility than public charging, so it may not contribute as much to range anxiety mitigation as publicly available chargers. However, zero-emission trucks operating on the road can signal to other fleets that zero-emission technology is ready for deployment.

Beyond the cost of infrastructure, industry members have signaled other barriers that complicate infrastructure deployment and electrification project design, such as long lead times for permitting, utility interconnection, inconsistent and complex local government and utility requirements, and uncertainty on electricity rates. Additional equipment to improve energy management such as managed charging software, onsite generation, and storage can also improve economics and help mitigate risks, but these can be expensive and are not typically covered by siloed voucher support.

Potential Impact

Based on the cost-share requirements of California's Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles (EnergIIZE) Commercial Vehicles Program, a **$1 million investment** in charging infrastructure incentives for depot charging **can leverage an additional $1 million** in additional private investment in clean transportation and lead to (CEC, 2022):

- Deployment of 14-17 150-kilowatt (kW) direct current fast chargers (DCFC)[12] (utility-side

[12] Assuming $75,600 - $100,000 per charging station (RMI), plus $36,400 in soft costs and customer-side make ready (CALSTART, approximate sized-down on a kW basis from original estimate for 10 350 kW site). Utility-side make ready not included (HDR, 2020; Nelder, 2019).

make ready not included[13]), allowing electrification of a similar number of electric trucks

- 13 jobs created (Veeder, 2019)

Strategy Design Recommendations

1. Define charger incentive amounts based on charging station technology (L2 and DCFC) and power capacity (kW). L2 and DCFC chargers require substantially different levels of support, as do low- and high-powered DCFC chargers. Defining incentives in a way that accounts for diverse funding requirements will ensure all chargers, and particularly those required by heavier trucks, receive sufficient support. Programs can establish a funding cap based on a percentage of the total costs of purchasing and installing chargers of a specific power capacity (kW), which can be accompanied by a maximum dollar amount. Canada's Zero Emission Vehicle Infrastructure Program establishes tiered funding caps based on charging station technology and power capacity, differentiating between L2, DCFC 20kW to 49kW, DCFC 50kW to 49kW, DCFC 50kW to 99kW, DCFC 100kW to 199kW, and DCFC of 200kW and above (Natural Resources Canada, 2022).
2. Make charging infrastructure incentives and vehicle incentives compatible and streamlined where possible without requiring one to access the other. Some programs limit charging infrastructure incentives to applicants pre-approved to receive vehicle incentives, which risks leaving behind fleets that may be ineligible to receive vehicle incentives yet could still justify ZEV procurement if supported by cost-efficient charging stations. Industry members have signaled that the process of defining charging infrastructure and vehicle needs does not necessarily occur at the same time, which makes it critical for fleets to be able to access both types of incentives through independent applications. At the same time, industry members have signaled that the administrative burden of multiple incentive applications can limit fleet access, particularly for smaller fleets lacking familiarity with government applications. Where possible, simplifying the application process and improving back-end information sharing across agencies can encourage fleet uptake, particularly for smaller fleets that may have limited bandwidth to allocate to multiple application processes. This will also allow fleet operators to plan for their current and future depot charging needs, and to future proofing conduit and wiring installations to avoid the need to break concrete with every new charger installed.
3. Make incentives compatible with varying ownership and utilization structures to unlock innovative business models. Smaller fleets that may not have the financial capacity to cover large upfront costs can electrify more easily through third-party companies that spread out the costs over the fleet's operational expenditures. This can also unlock the potential of shared charging infrastructure and allow for economies of scale that avoid redundancies in make-ready investments.
4. Design programs in a way that helps mitigate make-ready costs (the costs related to bringing sufficient electrical capacity to the point of service, possibly including upgrades to transformers and distribution feeders). Make-ready costs vary considerably depending on each site's power demand and location. They can double the costs of charging station procurement and represent an additional barrier that requires mitigation. Incentive programs can link deployments to existing utility make-ready programs, such as New York's Medium- and Heavy-Duty EV Make-Ready Pilot (Nelder, 2019; Joint Utilities of New York, 2021). They can also supplement them when not readily available at location by allowing

[13] Utility-side make ready costs vary considerably depending on the power of the charging stations installed and the grid infrastructure available at the location. RMI found that for high-powered sites and remote sites, utility-side infrastructure costs can exceed $1 million per site (Nelder, 2019).

incentive programs to cover their associated expenses. A useful example on complementing utility make-ready programs is California's EnergIIZE program, which covers make-ready costs only for locations in which there is no utility funding available for this purpose (CEC, 2022). Another alternative to reduce make-ready costs is channeling funding to distributed energy resources, which can help right-size potential service upgrades through improved energy management. Industry members have indicated that expedited and efficient program applications are critical to ensure successful deployments.

California's Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles (EnergIIZE) Commercial Vehicles Program

The California Energy Commission's EnergIIZE Commercial Vehicles Program is a first-of-its-kind $50 million program aimed at accelerating the deployment of charging and fueling infrastructure for zero-emission trucks and buses (CEC, 2022). The program offers four distinct lanes of funding, each representing a key area of the commercial ZEV landscape:

- EV Fast Track: for EV commercial fleet users that have already purchased or ordered electric MHDVs, offered on a first come, first served basis.
- EV Public Charging: for applicants interested in deploying publicly available charging infrastructure for electric MHDVs, offered on a competitive basis.
- Hydrogen Refueling: for commercial fleet users and station owners seeking to deploy hydrogen MHDVs, offered on a competitive basis.
- EV Jump Start: for fleet users located in disadvantaged or low-income communities, offered on a competitive basis.

EnergIIZE will cover up to 50% of hardware and software costs of infrastructure deployments, capped at $500,000 per project under the EV Fast Track and EV Public Charging lanes, and $2 million for the Hydrogen Refueling lane. Under the EV Jump Start lane, the program will cover up to 75% of the aforementioned costs plus soft costs associated with construction labor and infrastructure planning, capped at $750,000 per project. EnergIIZE aims to provide at least 60% of project funds to infrastructure located in disadvantaged and low-income communities.

A notable element of this program is that funding can be used to cover customer side make-ready infrastructure at locations where there are no utility programs that cover this expense (CEC, 2022). This feature ensures fleets have the financial support needed regardless of their location, while leveraging additional funding sources that maximize program reach.

Publicly Accessible Corridor Charging and Refueling Incentives

Description

Publicly accessible charging and refueling corridor deployments install electric vehicle charging and hydrogen refueling stations along or in proximity to regional corridors. Corridor charging extends vehicle range and allows the electrification of duty cycles that cannot rely entirely on depot charging, such as inter-regional traveling or fleets without access to private charging facilities. Sites along a corridor can include one or more fast charging stations, typically with a power capacity of 150-350 kW, that can recharge a substantial percentage of the battery in one hour or less. While some light- and medium-duty trucks may be able to utilize the same charging infrastructure, heavy-duty trucks require independent, high-powered charging and site design that can accommodate their operational needs. As trucks with larger batteries become available, higher power capacities (up to 2 megawatts (MW)) will be needed to meet fleet demand (HDR, 2020).

Public funds can be deployed through grants or rebates that cover all or a portion of the costs to develop charging sites. Public funding is needed particularly in early stages of long-haul electrification when low charging demand does not offer a positive business case for private developers.

Comparative Strengths

Publicly accessible charging and refueling corridor deployments will be critical to enable regional travel. These applications will take longer to achieve commercial scale compared to beachhead applications; however, they are expected to gain traction as corridor charging becomes readily available and the economics of heavy-duty trucks improve.

Similar to gas stations, publicly accessible charging and refueling stations can attract demand to local businesses, generating additional revenue sources for site developers, such as truck stop operators. Publicly accessible charging sites have high visibility compared to depot charging infrastructure and can meet the needs medium- and heavy-duty trucks as well as passenger vehicles, thus contributing to mitigation of range anxiety for passenger ZEVs.

Comparative Weaknesses

While needed for long-haul applications, corridor charging alone will be insufficient to electrify the segment since most fleets will also require depot charging to satisfy most of their charging needs. Furthermore, long-haul applications are among the applications expected to take longer to achieve market readiness (Welch, 2020). In the short term, public funding will be more successful at accelerating MHDV electrification in market-ready segments by focusing on depot charging infrastructure.

Due to low expected usage in the short term, stronger public support is needed to stimulate development compared to depot and urban hub charging stations. New York State's DCFC Program covered up to 80% of deployment costs, while New Jersey's It Pay$ to Plug In Program covers up to 100% (NYSERDA, 2021a; NJDEP, 2022). Industry members have also indicated that local government and utility coordination, safety and security needs, regulations limiting electricity resale, and traffic considerations can further complicate deployment of publicly available charging stations.

Charging on publicly accessible corridors during the daytime will be more expensive for fleets compared to overnight depot charging due to time-of-use electricity prices, profit margins of site developers, and the need to cover labor costs during the charging session. While these are costs that fleets will need to absorb as long-haul applications electrify, they will likely shift fleet focus toward applications that do not rely on publicly accessible charging.

Potential Impact

Based on the cost-share requirements of New York's DCFC Program[14], a **$1 million investment** in charging infrastructure incentives for publicly available stations for corridor charging **can leverage $250,000** in additional public and private investment in clean transportation and lead to:

- Deployment of four to six 350 kW DCFCs (utility-side make ready not included)[15]
- Over eight jobs created (Veeder, 2019)

Strategy Design Recommendations

1. Engage multi-state government and planning agencies, fleets, utilities, charging station providers, hydrogen providers, truck stops, and communities to identify corridors best positioned for zero-emission deployments early on, even if funding for site development is yet to be secured. This will allow funds to be deployed faster and directed toward sites with larger demand and higher health and environmental benefits for local communities. The New York Metropolitan Transportation Council commissioned a study to identify clean freight corridors and developed a mapping tool to identify charging and refueling station development, which provides a good example of how to prepare for corridor deployment with small budget allocations (CALSTART, 2021).
2. Target locations that offer amenities (food retailers, restrooms, shopping, and open spaces) and are as close as possible to the interstate highway system.[16] Convenient location and amenities attract larger traffic volumes and provide a more comfortable charging experience for drivers. Off highway sites should avoid placements behind toll booths, when possible, to avoid creating additional costs for fleets.
3. Focus resources on developing sites that are compatible with MHDVs. Most corridor charging

[14] While this program focuses on passenger car charging, it can offer a useful example on how to structure a similar program for MHDVs. Under NYSERDA's DCFC Program (closed in 2021), proposers could apply for up to 80% of the purchase, installation, and certain operational costs of newly installed DCFC EVSE (NYSERDA, 2021).

[15] Assuming $128,000 - $210,000 per charging station, plus $85,000 in soft costs and customer-side make ready. Utility-side make ready not included (HDR, 2020; Nelder, 2019).

[16] The United States Code (Section 111 of Title 23) restricts any commercial activity at Interstate highway rest stops built after 1956, which includes charging infrastructure. While this restriction is still in place, drivers will be forced to exit the interstate highway to access both charging and amenities, which will increase range requirements for vehicles and lower charging station visibility.

infrastructure efforts to date have focused on passenger cars, which currently represent the largest demand source for this type of infrastructure. However, considering future demand growth over the next five to ten years can allow site developers to plan for and install anticipated on-site infrastructure during initial construction. This will allow developers to avoid future make-ready infrastructure expansion and install MHDV charging infrastructure when demand increases. Electric Island, the first-of-its-kind heavy-duty truck charging site developed by Daimler Trucks North America and Portland General Electric, was built with eight 150 kW and 350 kW charging stations but was designed with sufficient electrical capacity to replace existing chargers with 1+ MW chargers in the future. The site also has plans for future installation of on-site energy storage and solar power generation, which will improve energy management and reduce charging costs for fleets (DTNA, 2021). Locations near distribution substations can also be more cost-effective for adding substantial charging capacity.

4. Ensure site design elements are compatible with MHDV requirements. The physical dimensions of charging stalls, routes of ingress and egress, and sufficient turning radius dimensions are critical to for MHDVs to access public charging infrastructure. Engaging with fleets and industry members can allow government agencies to identify best practices for physical dimensions and power capacities of charging stations along corridors.
5. Include sufficient redundancy in charging stations for fleets to avoid technical disruptions and long waiting times once electric vehicle adoption has increased. The West Coast Clean Transit Corridor Initiative estimated 10 charging stations for medium-duty vehicles (350 kW) every 50 miles, and an additional 10 for heavy-duty vehicles (2 MW) every 100 miles (HDR, 2020). Rural areas require flexibility to define infrastructure spacing since less traveled secondary roads have different needs compared to major highways (American Association of State Highway and Transportation Officials, 2022).

New Jersey's It Pay$ to Plug In

Through It Pay$ to Plug In, the New Jersey Department of Environmental Protection (NJDEP) has invested $5.4 million from the Volkswagen Mitigation funding to develop publicly accessible DCFC stations. The program expects to fund installment of 36 charging stations at 18 locations. Funds are awarded through grants that cover up to 100% of site development costs depending on the site's location, capped at $200,000 per DCFC location with two ports minimum (NJDEP, 2022).

The program prioritizes corridor funding for DCFC stations that provide 150 kW or greater power and are located on priority corridors identified in New Jersey's Strategic Mapping for Electric Vehicle DC Fast Charging Station Locations (NJDEP, 2022a).

Publicly Accessible Urban Hub Charging and Refueling Incentives

Description

Publicly accessible urban hub deployments install electric vehicle charging and refueling stations in urban or peri-urban locations with high local traffic, concentrating multiple charging stations in a single site. Urban hub charging can include a mix of high- and low-powered DCFC that allow for on-route and overnight charging for light-, medium- and heavy-duty vehicles. Sites can also combine publicly available chargers with private or shared-use chargers to accommodate for varying fleet needs. Public funds are deployed through grants or rebates that cover all or a portion of the costs to develop charging and refueling sites.

Drayage trucks offer an ideal use case for urban hub deployments; they rely on modified back-to-base duty cycles that are conducive to electrification but are frequently owned by small fleets that may not be able to justify the costs associated with depot charging. Urban hub charging located on or near port facilities allows states and port authorities to unlock electrification in this segment.

Comparative Strengths

Due to their location and compatibility with a mix of beachhead applications, urban hubs will have more demand than corridor charging and offer a stronger business case to developers, particularly in the short term.

In contrast to corridor charging and refueling, urban hubs are better suited for beachhead applications that rely on back-to-base operations and shorter mileage requirements. They can also stimulate electrification of less capitalized urban fleets and independent owner-operators by removing the need to invest in private infrastructure, while allowing vehicles to charge on-route or overnight (HDR, 2020).

With the right configuration of publicly accessible and shared use charging, urban hubs can unlock the potential of electrification-as-a-service models. Electrification-as-a-service bundles together the costs of vehicle procurement, infrastructure installation, operation, and maintenance into a single monthly fee that fleets can pay for out of their operating expenses. The model reduces or eliminates the upfront cost barrier and allows less capitalized fleets to electrify. In 2022, Zeem Solutions launched its first transportation-as-a-service depot with 77 fast charging ports and 53 L2 chargers. The facility acts as an urban hub since it offers services to a wide variety of Zeem subscriber fleets, as well as opportunity charging for high-mileage fleets for last-mile delivery and rideshare services (Zeem Solutions, 2022).

Comparative Weaknesses

Real estate can be a larger constraint for urban hubs compared to corridor charging and refueling due to higher prices and smaller lot sizes (HDR, 2020). Innovative public-private partnerships to secure affordable real estate can strengthen the business case for urban hub charging development.

Fleets may not be willing to electrify and rely on urban hub charging if sites cannot guarantee reliable access to charging. Daytime charging may be more readily available at these sites but is likely to be more expensive due to demand charges, labor costs, and disruption of daily route completion. Government programs that allow for a combination of publicly accessible and private or shared-use charging can help mitigate these concerns.

Potential Impact

Based on cost-share data from California's Electric Vehicle Infrastructure Project (CALeVIP) Program, a **$1 million investment** in DCFC incentives for publicly available urban hub charging **can leverage over $610,000 dollars** in additional public and private investment in clean transportation and lead to (CEC, 2021):

- Deployment of five to eight 350kW DCFC (utility-side make ready not included)[17]
- Over 10 jobs created (Veeder, 2019)

Strategy Design Recommendations

1. Offer a variety of chargers with different power capacities that are compatible with MHDVs, both for overnight charging (lower power capacity) and on-route charging (higher power capacity).
2. Include sufficient redundancy in charging stations for fleets to avoid technical disruptions and long waiting times once electric vehicle adoption has increased.
3. Partner with local fleets that are interested in electrifying but limited due to charging and refueling infrastructure costs. While not directly contributing to the costs of the deployment, fleets can improve the economics of site development by providing usage guarantees that lower the risks for site developers. Additional regulatory benefits can be provided to fleets to make up for the increased cost of electrification, such as preferential access to curbside and parking space, or queueing preference for drayage operators.
4. Where real estate presents a barrier for private development, leverage government-owned real estate that can be leased to developers and provide charging services to government-owned fleets. Underutilized assets such as parking garages and industrial sites can provide real estate opportunities for urban hub development. Revitalizing brownfield sites can also be a promising alternative to secure real estate and channel additional government support, through EPA technical assistance and clean up grants (EPA, 2021).
5. Depending on location, urban hubs can also provide opportunities for multi-modal product transfer, such as transferring goods from heavy-duty regional trucks to smaller intra-urban delivery vans or cargo bikes, which can recharge before or during product loading. Doing

[17] Assuming $128,000 - $210,000 per charging station, plus $85,000 in soft costs and customer-side make ready. Utility-side make ready not included. (HDR, 2020; Nelder, 2019).

so would allow these sites to move beyond electricity supply and operate as microhub logistics facilities.

California's Electric Vehicle Infrastructure Project (CALeVIP)

CALeVIP provides rebates for L2 and DCFC installations. Funds are disbursed through region-specific projects with slight variations in maximum incentive amounts. On average, regional CALeVIP projects cap incentive amounts at $6,000 per L2 connector and $80,000 per DCFC connector (CALeVIP, 2021).

Rebates cover costs related to charger purchase, installation costs, make-ready infrastructure, network agreements, collocated energy storage, and solar generation equipment. Each regional program determines the percentage of funds that will be reserved to DACs and the incentive amounts that will be granted to projects in and outside of DACs. (On average DCFC incentives are capped at $80,000 in DACs and $70,000 outside DACs (CALeVIP, 2021a).) Applicants apply online prior to purchasing or installing chargers. Funds are reserved once eligibility has been confirmed and are disbursed upon submission of proof of installation documents.

CALeVIP has distributed close to 56% of incentives to deployments in disadvantaged and low-income communities. As of November 2021, CALeVIP has allocated $122 million to fund 1,195 DCFC connectors and 5,324 L2 connectors (CALeVIP, 2021).

Hyperlocal Air Quality Monitoring Systems

Description

Hyperlocal air quality monitoring systems monitor ambient air quality and GHGs by detecting presence of air pollutants at the street block or 100-meter radius level. They can identify concentrations of pollutants that a traditional, more dispersed monitoring network may fail to register. Hyperlocal monitoring is often identified as a promising solution to enhance the equitability of transportation investments by targeting the areas of greatest need, since air pollution is geographically concentrated and can vary up to 800% from block to block within a single neighborhood (Apte, 2017).

Funding for air quality monitoring is distributed as grants or contracts to local nonprofit organizations or air quality data providers to regularly monitor air quality within selected geographic regions. The data will identify pollution hotspots; allow for generation of equity maps that reflect localized air pollution by sociodemographic data (such as race, ethnicity, and income level); and provide critical information to prioritize investment, define emissions reduction objectives, and track success of implemented solutions.

Comparative Strengths

Hyperlocal air quality monitoring gives government agencies reliable data to localize efforts and measure success. Due to the high variation in air pollution from block to block, there are inherent risks to fall short of emissions reduction targets throughout an area if local interventions continue to operate at the neighborhood or city level. Through fingerprint analysis of pollutants, hyperlocal monitoring can identify and attribute sources of pollution, further maximizing efficacy of measures to reduce them.

While current government regulatory air monitoring systems are not designed to operate at a hyperlocal level, smaller and more affordable air quality sensors have become available in recent years, and governments are taking the first steps to create a community-level monitoring network.

Fleet operators have signaled that hyperlocal monitoring can also help first-mover companies track emissions reductions in proximity to their depots, generating valuable insights to track corporate sustainability objectives.

Comparative Weaknesses

Hyperlocal monitoring does not reduce diesel emissions directly. However, it can be a central piece of the monitoring, evaluation, and improvement processes that government agencies should undertake when allocating budget to air pollution reduction. Industry support is mixed. Some members considering it a core element of an equitable emissions reduction strategy. Others considering it of lower priority, since they feel that accurate data on where vehicles are operating could serve a similar purpose without the need for additional funding.

Potential Impact

Hyperlocal air quality monitoring supports evidence-based, equitable policy design that prioritizes emissions reduction where it is needed most. By allowing communities and policymakers to target high pollution areas, air quality monitoring maximizes health and environmental benefits of emissions reduction investments.

A **$3 million investment** in a hyperlocal air quality monitoring pilot allowed London to **install and analyze data from 100 lower-cost sensor 'pods'** (each with several air quality sensors) and **two Google Street View cars** equipped with seven reference-grade air pollution monitors. An additional $1 million investment will allow the city to maintain the project for four additional years (Mayor of London, 2020).

Strategy Design Recommendations

1. Determine air quality monitoring equipment selection and deployment approach based on the expected use case for the information. A structured step-by-step approach has been developed by the Environmental Defense Fund (EDF) to orient design and implementation (Craft, 2019).
2. Combine mobile and stationary sensors. Mobile sensors mounted on vehicles are highly effective for covering a large area but provide only a snapshot within a specific time of day. Stationary sensors register pollutant variation over time at a specific location. Mobile sensors can be deployed first to identify priority areas in which to install stationary sensors later on.
3. Collaborate with public health agencies and communities, particularly those located near truck and bus depots and corridors, to design air quality monitoring programs that engage local workforce and target areas identified by existing data and community input. In 2021 New York State announced the launch of a Hyperlocal Air Quality Assessment program through which New York State Department of Environmental Conservation and New York State Energy Research and Development Authority (NYSERDA) will collaborate with the state's Climate Justice Working Group and community leaders to identify priority areas and offer capacity building grants to ensure local input and participation (New York Governor's Press Office, 2021).
4. Develop geographical mapping systems that integrate hyperlocal air quality metrics with relevant data sources related to transportation and demographic information. These include vehicle population data, socio-economic and demographic community profiles, origin destination surveys, telematics, traffic safety data, and air-pollution-related health data, among others.
5. Make air quality data and spatial analysis products publicly available to facilitate public engagement and localize emissions reduction actions and investments. The New York City Community Air Survey, implemented by NYC Health and Queens College (CUNY) since 2008, is a useful example of how air pollution data can be gathered and socialized to guide emissions reduction interventions (NYC Health, 2022).

Breathe London

Breathe London is a project developed by the Environmental Defense Fund in partnership with the Mayor of London and other organizations to map and measure hyperlocal pollution across the city. The project installed 100 lower-cost sensor AQMesh 'pods' and two specially equipped Google Street View cars to for stationary and mobile air quality monitoring.

The team gathered, analyzed, mapped, and published the data, which shows the concentration of NOx and PM2.5 from both stationary and mobile monitoring. Results evidenced higher exposure levels for DACs and will be used to evaluate impact of tightening standards of London's Low Emission and Ultra Low Emission Zones (EDF, 2021). Breathe London also resulted in a blueprint for other cities to benefit from lessons learned (EDF, 2021a). It was initially financed by foundation funding, but due to its success, London's Mayor approved additional funding to maintain and expand the project over the next four years (Mayor of London, 2020).

Workforce Development Programs

Description

Workforce development programs are critical to support the industry's growing labor demand and to ensure economic opportunities derived from transport decarbonization are accessible to underserved and low-income communities in the Northeast. Funds are deployed through government-led programs or partnerships with nonprofit organizations and industry members to identify workforce skill gaps; develop curricula; establish paid training programs and apprenticeships; recognize and certify workers' knowledge; and create networks to place workers in secure, future-proof, and good paying jobs.

High demand job types for a zero-emission transportation system include maintenance, battery cell manufacturing, electricity generation, manufacturing of charging equipment, operation, and grid connection, among others (Pek, 2020). According to LACI, 75% of green jobs are accessible to people without a bachelor's degree, which makes apprenticeships and training programs fundamental tools for workforce development (HR&A, 2021).

Comparative Strengths

Workforce development programs are uniquely positioned to actively engage community members in the transition toward electric vehicles through high-quality, good-paying jobs. At the same time, they can leverage transferable skills from workers in the traditional energy industry (i.e., oil/gas/utilities) and retrain/redirect their focus toward zero-emission transportation, ensuring no individuals or communities are left behind.

Skilled workforce (whether through traditional college degrees or through alternative routes) can attract private investment to states and speed up business development throughout the electric vehicle supply chain. Despite the increase in remote work during the pandemic, 95% of executives rate the availability of skilled labor as "very important" or "important" in their site selection factors. Availability of skilled labor outranks other siting factors such as energy costs, highway accessibility, incentives, and tax exemptions (Gambale, 2022).

Comparative Weaknesses

Workforce development programs do not target emissions reductions directly. However, they create the workforce backbone needed for the industry to grow and support the development of local manufacturing plants and electric vehicle-oriented businesses.

Potential Impact

Based on funding allocations and impacts of the Workforce Development Institute's 2020 project portfolio, a **$1 million investment** in workforce development programs **can leverage close to $3 million** in additional public and private investment and lead to (Workforce Development Institute, 2021):

- Over 770 jobs retained or placed
- Over 4,500 people developing relevant skills

Strategy Design Recommendations

1. Offer on-the-job training via internships or apprenticeships that expose trainees to potential employers under real-world job conditions, while providing the hands-on experience that employers value. In addition to benefitting trainees and employers, internships and apprenticeships strengthen existing relationships between employers and training providers, which benefits future trainees via increased placement opportunities (NYSERDA, 2013).
2. Lock-in commitments from industry to interview or hire high-performing program graduates. This increases program attractiveness for potential trainees, formalizes lasting partnerships with industry members, and can leverage additional industry engagement in curriculum design and on-the-job training (Laboissiere, 2017).
3. Create searchable catalogues of training centers and trainees that employers can access when seeking to hire or train current personnel. Data privacy protocols and outreach efforts are needed to protect trainee information and put these tools in the hands of employers (NYSERDA, 2013).
4. Provide paid training or include financial support for trainees in the way of scholarships, fee exemptions, reimbursements, and wages for apprenticeships. Cost of training (both from training fees and lost wages) tends to be the main barrier in terms of accessibility to training. When training locations are not in proximity to residential areas, such as with industrial parks, providing microtransit services can also improve accessibility and provide learning experiences if done through ZEVs.
5. Partner with community-based organizations and education institutions. Partnerships are critical to build connections between potential trainees and training centers, raise awareness around electric vehicle-related career pathways, and identify additional barriers limiting community members from participating in training programs and entering the job market. ChargerHelp!, an electric vehicle charger maintenance company, partners with local workforce centers to train and hire from the communities that they service (ChargerHelp!, 2022). Their model provides a noteworthy example of the type of collaborations that can be established between government agencies and industry members to boost workforce development efforts.
6. Partner with vehicle manufacturers, fleets, transport electrification businesses, utilities, and labor unions to identify labor market demands and revise learning curriculums. These partnerships can lead to workforce development program sponsorships and commitments to interview or hire program graduates.
7. Include general skills training (such as mathematics, science, and energy) and professional development skills training (such as interpersonal skills, effective communication, and leadership) alongside technical expertise. Non-technical skills improve trainees' abilities to find, retain, and excel at jobs, leading to professional growth (NYSERDA, 2013). Effective training programs integrate five key components: engage participants and deliver the exact skills required; include specialized training modules that integrate technical, behavioral, and mind-set skills; emphasize practical tasks; assess performance on a regular basis; and deliver instruction in many different ways (Laboissiere, 2017).

California's Workforce Training Career Pathways Program

The California Mobility Center deployed a $1.4 million program to retrain over 500 people in high-demand jobs within the mobility sector and place up to 100 interns at local advanced manufacturing companies (Education to Manufacturing, 2020). The program includes job-readiness and technical training for advanced manufacturing jobs, which offer higher than average wages to people in the Sacramento Region. The program partners with industry, government agencies, community-based organizations, universities, and community colleges to identify workforce skill gaps, tailor education offerings, and engage community members.

Fleet Assessment Services

Description

Fleet assessment services support public and private fleets with tailored assessments to electrify their fleets, including collection of data and analysis of fleet usage, TCO projections, purchasing policy adjustments, and access to vehicle and charging infrastructure purchase incentives and grants. Public funds are deployed through grants or contracts awarded to technical assistance providers, who offer assessment services to fleets free of charge. Fleet assessments are the first step toward electrifying fleets and, when funded by government agencies, can cover areas across utility territories and expose fleets to a wide range of vehicle and charging station providers.

In the absence of fleet assessment services provided by government agencies, assessments may be available to fleets through utility and industry offerings. For example, ChargePoint provides a free fleet assessment service aimed at helping fleet operators examine their operational footprint across locations to make informed infrastructure decisions based on cost modeling, route analysis, energy and utility requirements, and available incentives (ChargePoint, 2022).

Comparative Strengths

Gaining familiarity with the technology and understanding the cost structure of fleet transformation is a requirement for most fleets to seriously consider shifting to electric. By removing the initial soft cost of assessments, fleets can be encouraged to consider electrification and plan for a more cost-efficient electric vehicle deployment.

Publicly funded fleet assessments benefit from standardization and economies of scale that can reduce the incremental price of the services, compared to individualized assessments financed by particular fleets.

Fleet assessment services can also channel applications toward existing VIPs, accelerating funding disbursement and implementation timelines while making the vouchers accessible to fleets that may not have the technical expertise or resources to navigate the process on their own.

Comparative Weaknesses

Fleet assessment services generate the information needed for decision-making, but without incentives that bring down the cost of technology and electricity rates that ensure charging is affordable, fleets are unlikely to make the shift.

Potential Impact

Based on Massachusetts's Mass Fleet Advisor Program, a **$1 million investment** in fleet assessment services can lead to (MassCEC, 2022):

- 65 standard fleet assessments
- 15 detailed fleet assessments

- Procurement assistance and progress reporting for five fleets
- Training/upskilling for up to 20 fleet technicians
- Increased procurement of ZEVs supported by voucher funding

Strategy Design Recommendations

1. Simplify administrative processes for fleets by awarding grants to a vetted technical assistance provider for an open-enrollment program rather than disbursing funds on a case-by-case basis.
2. Define a tiered structure that increases support as fleet commitment to electrification materializes. This will maintain free access to the program to encourage participation, while maximizing budget to further support fleets willing to commit to electrification.
3. Make fleet assessment tools developed by technical assistance providers publicly available, to maximize outcomes from the investments.
4. Streamline fleet assessment findings with access to utility incentives and government-funded programs to reduce administrative burden for fleets that decide to electrify.

Mass Fleet Advisor

The Massachusetts Clean Energy Center (MassCEC) created Mass Fleet Advisor in 2021 to encourage utilization of Massachusetts' rebates for zero-emission trucks. MassCEC selected a technical consultant to provide free support to fleet managers throughout the electrification process.

- 65 fleets will be supported through cost savings and emissions savings modeling; guidance on data collection; a virtual site assessment to understand infrastructure needs; and a personalized fleet electrification report summarizing vehicle options, projected costs, infrastructure requirements, and recommendations for next steps.
- 15 fleets will advance for a more detailed analysis that includes a detailed transformation plan for truck replacement, analyses of cost savings potential from managed charging technologies, an in-person site assessment with detailed infrastructure review, a customized fleet, and infrastructure procurement plan.
- Five fleets will further qualify for additional ongoing support in procurement and deployment, such as preparation and review of requests for proposal, identification of financing and grant opportunities, driver and mechanic training to support deployments, and the development of standard operating procedures for drivers and mechanics.

III. Areas for Future Research

This white paper aims to support state governments in making resource allocation decisions to accelerate zero-emission technology adoption. It offers a high-level summary on 10 investment strategies but does not intend to be an exhaustive guidance document for project design and implementation. In developing this paper, the authors identified the following key areas as promising avenues for future research:

1. **Cost-benefit analysis of diesel emissions reduction investments**. Identifying impacts of previous investments is a helpful first step to assessing potential impact of new investments; however, the impacts highlighted here do not necessarily allow for cost-benefit or cost-effectiveness comparisons between different investment strategies. A rigorous cost-benefit assessment based on a larger data pool sourced from government agencies, fleets, and OEMs would allow agencies to accurately compare alternatives and identify the most effective ways to achieve their goals.
2. **State-specific investment recommendations to maximize emissions reduction using IIJA funding**. Determining the optimal investment strategies for specific states is highly context-specific since the needs and priorities of local communities, the goals of state governments, and the availability of technology and funding varies. Future research can build off this initial approximation and support state governments in collaboratively defining the right investment portfolio based on their specific needs.
3. **Investment strategies to improve transportation equity**. Due to its focus on accelerating zero-emission technology adoption, this research did not cover investments geared toward improving people's access to sustainable transportation, such as transit-oriented affordable housing, subsidized fares, and improved street design. Additionally, further research is needed to identify how equity can be mainstreamed as a deciding factor when comparing investment alternatives. Governments would benefit from identifying the potential of these opportunities, having a system in place to accurately quantify equity outcomes, and finding ways to blend funding sources to ensure sustainable transportation is accessible to everyone.
4. **Detailed case studies and impact assessments of pilot projects, particularly for VZEZs.** The quality of publicly available program data varies considerable across state agencies and programs, which limits the ability of governments to learn from each other. Much has been written about ZEZs; however, VZEZs are a more recent approach and data on funding requirements, cost share, participation levers, and scaling strategies is still lacking.

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