



# Clean Freight Corridors Planning Study

NEW YORK METROPOLITAN TRANSPORTATION COUNCIL  
**FINAL REPORT**





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## **Clean Freight Corridors Planning Study**

# Final Report



*draft final report*

# Clean Freight Corridors Planning Study

*date*

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## List of Acronyms

|          |                                                                 |
|----------|-----------------------------------------------------------------|
| AC       | Alternating Current                                             |
| ACE      | Alternative and Clean Energy (Pennsylvania)                     |
| AFIG     | Alternative Fuels Incentive Grant (Pennsylvania)                |
| AFV      | Alternative Fuel Vehicle                                        |
| AV       | Autonomous Vehicle (alternatively "automated vehicle")          |
| BEV      | Battery Electric Vehicle                                        |
| CMAQ     | Congestion Mitigation and Air Quality                           |
| CNG      | Compressed Natural Gas                                          |
| C-PACE   | Commercial Property Assessed Clean Energy (Connecticut)         |
| DC       | Direct Current                                                  |
| DCED     | Department of Community and Economic Development (Pennsylvania) |
| DCFC     | Direct-Current Fast Chargers                                    |
| DEEP     | Department of Energy and Environmental Protection (Connecticut) |
| DOE      | Department of Energy (United States)                            |
| EIA      | Energy Information Administration (United States)               |
| EJ       | Environmental Justice                                           |
| EV       | Electric Vehicle                                                |
| EVSE     | Electric Vehicle Supply Equipment                               |
| FAST Act | Fixing America's Surface Transportation Act (2015)              |
| FCEV     | Fuel Cell Electric Vehicle                                      |
| FHWA     | Federal Highway Administration                                  |
| GHG      | Greenhouse Gas                                                  |
| GPS      | Global Positioning System                                       |
| HD       | Heavy Duty                                                      |
| HDVARM   | Heavy-Duty Vehicle Adoption Rate Model                          |
| HPMS     | Highway Performance Monitoring System                           |
| IBZ      | Industrial Business Zones (New York City)                       |
| ICE      | Internal Combustion Engine                                      |
| IIJA     | Infrastructure Investment and Jobs Act (2021)                   |
| INS      | Inertial Navigation System                                      |
| kWh      | Kilowatt-hours                                                  |
| LD       | Light Duty                                                      |
| LNG      | Liquified Natural Gas                                           |
| LPG      | Liquefied Petroleum Gas                                         |
| MAP      | Metropolitan Area Planning                                      |
| MD       | Medium Duty                                                     |
| MOU      | Memorandum of Understanding                                     |
| MPGDE    | Miles Per Gallon of Diesel Equivalent                           |
| NAICS    | North American Industry Classification System                   |

|         |                                                          |
|---------|----------------------------------------------------------|
| NHTSA   | National Highway Traffic Safety Administration           |
| NJ ZIP  | New Jersey Zero-Emission Incentive Program               |
| NJBPU   | New Jersey Board of Public Utilities                     |
| NJDEP   | New Jersey Department of Environmental Protection        |
| NJEDA   | New Jersey Economic Development Authority                |
| NOx     | Nitrogen Oxides                                          |
| NYCCTP  | New York City Clean Trucks Program                       |
| NYCEDC  | New York City Economic Development Corporation           |
| NYMTC   | New York Metropolitan Transportation Council             |
| NYSDEC  | New York State Department of Environmental Conservation  |
| NYSDOT  | New York State Department of Transportation              |
| NYSERDA | New York State Energy Research and Development Authority |
| NYTVIP  | New York Truck Voucher Incentive Program                 |
| O&M     | Operating and Maintenance                                |
| OME     | Original Engine Manufacturer                             |
| PANYNJ  | Port Authority of New York and New Jersey                |
| PEV     | Plug-in Electric Vehicle                                 |
| PFAC    | Program, Finance, and Administration                     |
| PPP     | Public-Private Partnership                               |
| PURA    | Public Utilities Regulatory Authority (Connecticut)      |
| RFEI    | Request for Expressions of Interest                      |
| RGGI    | Regional Greenhouse Gas Initiative                       |
| SSC     | Study Steering Committee                                 |
| TAC     | Technical Advisory Committee                             |
| TCO     | Total Cost of Ownership                                  |
| USD     | United States Dollars                                    |
| VW      | Volkswagen                                               |
| ZEV     | Zero-Emission Vehicle                                    |

## Executive Summary

The New York Metropolitan Transportation Council (NYMTC) initiated a Clean Freight Corridors Planning Study to advance high-efficiency, low-emission alternative transportation technologies in the region's freight fleet. The objectives of the study were to:

- Inventory existing alternative fuel infrastructure in the region;
- Review current and emerging alternative fuel technologies;
- Identify gaps between existing alternative fuel infrastructure capacities and future needs;
- Analyze trends and forecasts; and
- Develop a list of recommended clean freight corridor designations, and define the steps needed for developing additional infrastructure, based on forecasted growth in the development and usage of clean technologies.

## Key Findings

### *Policy*

The states and some municipalities in the greater New York metropolitan region have, to varying extents, pursued emissions reduction opportunities in the transportation sector to slow climate change and improve air quality. This has led to enactment of numerous legislative, regulatory, and administrative actions intended to increase use of all-electric technology and/or alternative fuels such as hydrogen, natural gas and propane (LPG). The states in this region are also active participants in regional efforts to curb transportation sector emissions.

While there is significant policy support for diesel alternatives within the study region, additional actions must be taken to achieve the policy objectives (for greenhouse gas emissions, air quality, and zero-emission sales) of the states and cities in this region.

The policy outlook is brightest for zero-emission, non-combustion technologies—battery electric vehicles and hydrogen fuel cell vehicles. Each of the four states discussed in this technical memo has signed onto the Multi-State Medium- and Heavy-Duty Zero-Emission Vehicle Memorandum of Understanding, which sets new and aggressive targets for a 30% zero-emission share of M/HD sales by 2030 and 100% by 2050.

### *Technology Adoption Scenarios*

While diesel is the near-universal fuel used in trucks currently, its market share will be eroded significantly and irrevocably beginning as soon as the middle of this decade through 2050 and beyond. As alternative fuel vehicle technologies improve, operating costs decline, and cities and states promulgate decarbonization and air quality policies that favor cleaner fuels, diesel alternatives—especially BEV and FCEV propulsion systems—will become increasingly favored by freight fleets.

The modeling demonstrates that the total cost of ownership (TCO) for the various alternative fuel vehicle types relative to diesel is a function of purchase price (including applicable incentives), operating and maintenance (O&M) costs, and duty cycle. Under a range of projections for vehicle adoption in the study area across vehicle segments, diesel is projected to hold the largest sales share until the early 2030s and follow a downward trajectory to less than 10% by 2050 (and likely less than 2%). In its place, BEV, FCEV, and CNG will compete for market share with BEV taking the largest proportion by 2050 (38-60%), followed by FCEV (28-33%) and CNG (4-29%). Because of the poor TCO of LPG, this model does not project significant levels of LPG adoption in any vehicle segments or states.

## Freight Demand

The vast majority of freight moving in the MAP Forum region (88 percent of freight tons) is carried by trucks. According to the Transearch forecast, the volume of freight moved in the MAP Forum region, when measured by tonnage, is expected to increase by approximately 37 percent between 2018 and 2045, from 655 million tons to 900 million tons.

The region has a larger truck mode share than the nation due to a number of factors, including the large consumer market served by last-mile truck deliveries, intraregional interplant and distribution moves, and the under-developed freight rail network east of the Hudson. For these reasons, trucks and the roads where trucks travel, are crucial elements of the region's freight system. Alternative fuels are therefore an important means of reducing emissions and associated effects attributable to freight transportation.

Highway corridor segments carrying the greatest volume of commodity truck flows include:

- I-95 in Union County, NJ (7 million truck units in 2018);
- I-95 at George Washington Bridge, NY/NJ (6.8 million truck units in 2018);
- I-495 east of I-295 in Queens, NY (5.4 million truck units in 2018);
- I-84 in New Haven County, CT (4.4 million truck units in 2018); and
- I-78 in Lehigh County, PA (4.3 million truck units in 2018).

## Recommendations

### Recommended Corridor Designations

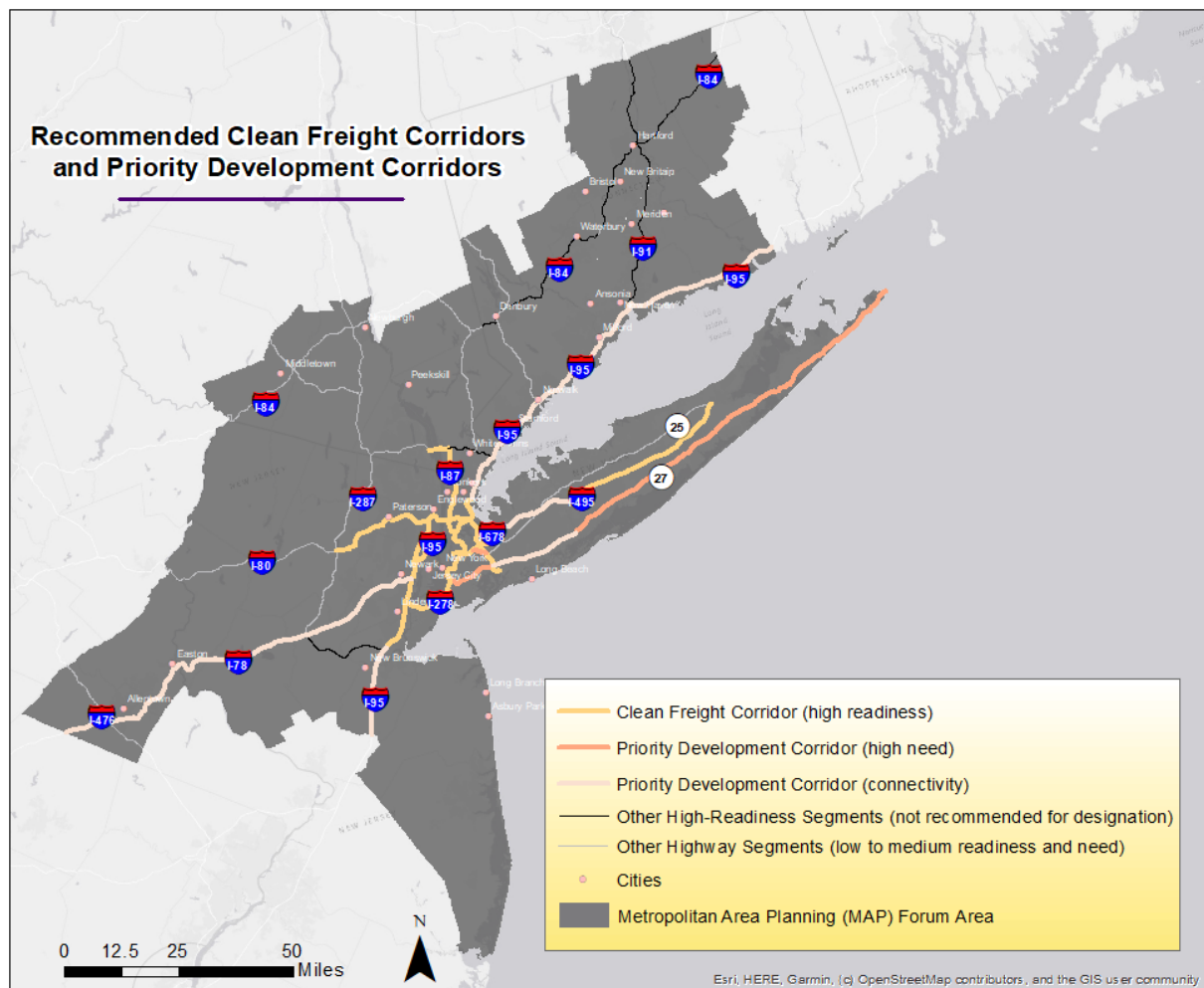
Clean freight corridor recommendations were developed by calculating a **readiness** score for each fuel type. The readiness scores are drawn from three weighted variables: fuel station coverage, proximity to freight demand clusters, and existing truck volume (see Table 7-1). In addition to the readiness score, a score was developed to estimate each corridor's **need** for clean fueling infrastructure. The need score included projected demand for each fuel type in 2045, as well as air quality in census tracts adjacent to the segment, based on diesel particulate emissions.

Table ES-1 lists the seven top-priority recommended clean freight corridors. These corridors received high readiness and need scores. The full list of recommended corridor designations is presented in Table ES-1 and mapped in Figure ES-1.

Table ES-1. Top-Priority Recommended Clean Freight Corridors

|                                                          | Highway | Segment                       | High Readiness |    |     |     | High Need |    |     |
|----------------------------------------------------------|---------|-------------------------------|----------------|----|-----|-----|-----------|----|-----|
|                                                          |         |                               | EV             | H2 | CNG | LPG | EV        | H2 | CNG |
| Clean Freight Corridor<br>(High Readiness,<br>High Need) | I-278   | Total length                  | X              | X  |     |     | X         | X  | X   |
|                                                          | I-495   | Queens                        | X              | X  | X   |     | X         | X  | X   |
|                                                          | I-495   | Suffolk                       | X              | X  | X   | X   | X         | X  | X   |
|                                                          | I-678   | Total length                  | X              |    | X   |     | X         | X  | X   |
|                                                          | I-80    | New Jersey (east of 287)      | X              | X  |     | X   |           |    |     |
|                                                          | I-87    | Westchester and Bronx         | X              | X  | X   |     | X         | X  | X   |
|                                                          | I-95    | New Jersey (north of Exit 10) | X              | X  | X   | X   | X         | X  | X   |
|                                                          | I-95    | Manhattan and Bronx           | X              | X  | X   |     | X         | X  | X   |

Figure ES-1. Recommended Clean Freight Corridors and Priority Development Corridors



## Implementation Guidance

The considerations shared in this report include the recommendations and guidance on the following implementation topics and needs:

1. **Finalizing the list of designated clean freight corridors and priority development corridors.** Work remains to refine this list based on strategic priorities and the context of the broader freight network. In particular, NYMTC should align with adjacent state and regional agencies to ensure cross-jurisdiction continuity of clean fuel infrastructure, and determine the relative roles of electric, hydrogen, and compressed natural gas fuels given current policy trajectories.
2. **Developing a signage and communications plan.** Signage and proactive communications regarding Clean Freight Corridors can promote use of fueling/charging infrastructure and also serve to induce demand for alternative fuel vehicles by increasing operator confidence that their duty cycles can be met reliably;
3. **Corridor-specific recommendations.** A list of recommendations specific to each recommended clean freight corridor is provided in Section 8 (Table 8-1);
4. **Federal, state, and local policy considerations** to support the implementation of the clean freight corridor designations and development of charging and alternative fueling infrastructure for medium and heavy duty vehicles along the designated corridors are listed in Section 8.4. Highlights include:
  - a. Federal Policy:
    - i. NYMTC partner agencies should be prepared to capitalize on federal funding opportunities for clean fuel infrastructure planning and development built into the Infrastructure Investment and Jobs Act (IIJA), among other potential funding opportunities.<sup>1</sup>
    - ii. The IIJA directs the U.S. Department of Transportation (DOT) to coordinate and consult with other federal agencies to develop guidance for new programs relating to decarbonization of on-road vehicles. However, IIJA ties funding to current FHWA corridor designations, which could present challenges to directing funds to corridors not designated by FHWA as “signage pending.”
    - iii. Some federal regulations designed before the availability of clean fuel technology could stand in the way of clean fuel infrastructure development. For example, one regulation (23 U.S.C.A. §111(a)) prohibits states from permitting automotive service stations or other commercial establishments to be located on interstate rights-of-way. This prevents states from capitalizing on existing assets (e.g., safety rest areas) to expand the clean fuel network.
  - b. State and Regional Policy:

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<sup>1</sup> For state-by-state opportunities associated with implementation of the IIJA, see <https://www.transportation.gov/briefing-room/usdot-releases-state-state-fact-sheets-highlighting-benefits-bipartisan>

- i. New York, New Jersey, Connecticut and Pennsylvania have all signed on to the Multi-State Medium- and Heavy-Duty Zero-Emission Vehicle Memorandum of Understanding (MOU) and should continue to contribute to the development and implementation of recommended actions, including those outlined in the forthcoming Multi-State Medium- and Heavy-Duty Zero-Emission Vehicle Action Plan, which will be released for public comment in early 2022.
  - ii. In December 2021, New Jersey and New York State adopted California's Advanced Clean Trucks rule, which will accelerate the adoption of electric trucks in these states by requiring manufacturers to participate in a credit/deficit program to increase the percentage of electric truck sales beginning in model year 2025. The adoption of ACT in these states will increase the demand for zero-emission charging and fueling infrastructure not only in New York and New Jersey, but in neighboring states along key regional corridors.
  - iii. The expansion of "make-ready" utility infrastructure programs throughout the region lays the groundwork for utilities to prepare sites for large-scale electric system expansion and reinforcement without burdening site hosts with the full upgrade costs.
  - iv. Hydrogen fuel cell technology may face regulatory challenges such as New York City's prohibitions on the transportation of compressed gases and the ban on operation of fuel cell vehicles for certain regionally important crossings such as the Hugh L. Carey Tunnel. Similarly, both hydrogen and compressed natural gas fueling may require expensive HVAC upgrades to meet ventilation requirements for if deployed in indoor facilities in some jurisdictions.
- c. Local Policy:
- i. Local regulations in New York City pose a challenge for hydrogen, CNG, and LPG fuel site development there, but also through the wider network as fleets seek to adopt technologies where fuel availability is widespread and reliable. Moratoriums on new facilities and prohibitions on the transportation of hydrogen, compressed natural gas, and propane fuels (namely propane in New York City) pose challenges to their adoption at scale. Perhaps more importantly, despite being significantly cleaner burning than diesel, these fuels systems still involve combustion of fossil fuels. As such, these combustion alternative fuels are not receiving the same beneficial policy emphasis as energy sources that do not require direct combustion.
  - ii. Local zoning, permitting regulations, and other local policies are critical issues for siting and developing specific fuel stations. Zoning in particular may preclude the development of fuel infrastructure from otherwise optimal locations. Many of these restrictions were developed to address problems specific to diesel fuel, and should be revisited and updated to reflect the growth of near-zero and zero-emission fuels.

5. **Fuel station siting.** At a network level, fuel stations should be adequately spaced to ensure reliability and ease range anxiety, but also maximize the utility of the investment. Existing assets should be leveraged where possible, for example by siting clean fuel infrastructure on existing rest

stops, fueling stations, and truck parking locations where possible. Large-format sites should also be prioritized for their ability to host fueling infrastructure for a greater quantity of freight vehicles. Local utilities should be engaged early in the site selection process to ensure adequate fuel capacity can be provided (e.g., sufficient electrical supply) and that as applicable, demand charges can be managed and mitigated.

6. **Truck-compatible site development considerations.** During site selection and design, it is critical to understand the unique needs and specifications of heavy-duty vehicles. Whether a site is developed for use by freight vehicles only, or by a mix of light-, medium-, and heavy-duty vehicles, the ingress and egress points should be designed with adequate clearance and turning radii to accommodate the target design and control vehicles. As NYMTC continues industry engagement to develop fueling sites on priority corridor segments, engagement with truck companies in addition to utilities is critical.
7. **Considerations for engaging local communities.** Working with local stakeholders, including residents and the business community, is an essential step in overcoming local regulatory issues, and a best practice even in the absence of these hurdles. Providing education about the local air quality improvements that come with clean fuel development, as well as the potential economic benefits of siting a new fuel station in a given community, can prepare communities for the new development, minimize opposition, and secure buy-in for changing zoning and permitting rules.
8. **Infrastructure funding considerations.** Funding alternative fuel infrastructure development along corridors will require a combination of public and private resources, particularly for sites where demand is initially projected to be low. For sites with high traffic and demand estimates, private capital will likely be the main source of funding. For sites where traffic and demand estimates are low, which characterizes most sites in the near-term while alternative fuel truck adoption remains low, federal and state governments can support the business case for infrastructure deployment through incentive programs.

## 1.0 Introduction

The New York Metropolitan Transportation Council (NYMTC) initiated a Clean Freight Corridors Planning Study to advance high-efficiency, low-emission alternative transportation technologies in the region's freight fleet.

Part of the Regional Freight Plan component in NYMTC's Plan 2045 Long Range Transportation Plan, the study will develop a strategic plan to launch alternative fuel technologies for goods movement by identifying roadway corridors suited to be designated as Clean Freight Corridors.

Even with improved fuel efficiency, the diesel-powered engines of most equipment used to transport freight on the United States' highways and rail lines emit pollutants and greenhouse gases. But market forces, environmental concerns, and state policies demand more clean and efficient ways to curb the emissions.

The objectives of the study were to:

- Inventory existing alternative fuel infrastructure in the region;
- Review current and emerging alternative fuel technologies;
- Identify gaps between existing alternative fuel infrastructure capacities and future needs;
- Analyze trends and forecasts; and
- Develop a list of recommended clean freight corridor designations, and define the steps needed for developing additional infrastructure, based on forecasted growth in the development and usage of clean technologies.

### 1.1 Study Area and Participants

The study area included all of the metropolitan planning organizations (MPO), and councils of government (COG), in the Metropolitan Area Planning (MAP) Forum region, which spans from north-central Connecticut through southern New York, northern New Jersey, and into eastern Pennsylvania. Figure 1.1 shows a map of the MAP Forum region.

The study was performed by a Project Team composed of NYMTC staff and a consultant team consisting of Cambridge Systematics, Inc., CALSTART, and Arch Street Communications.

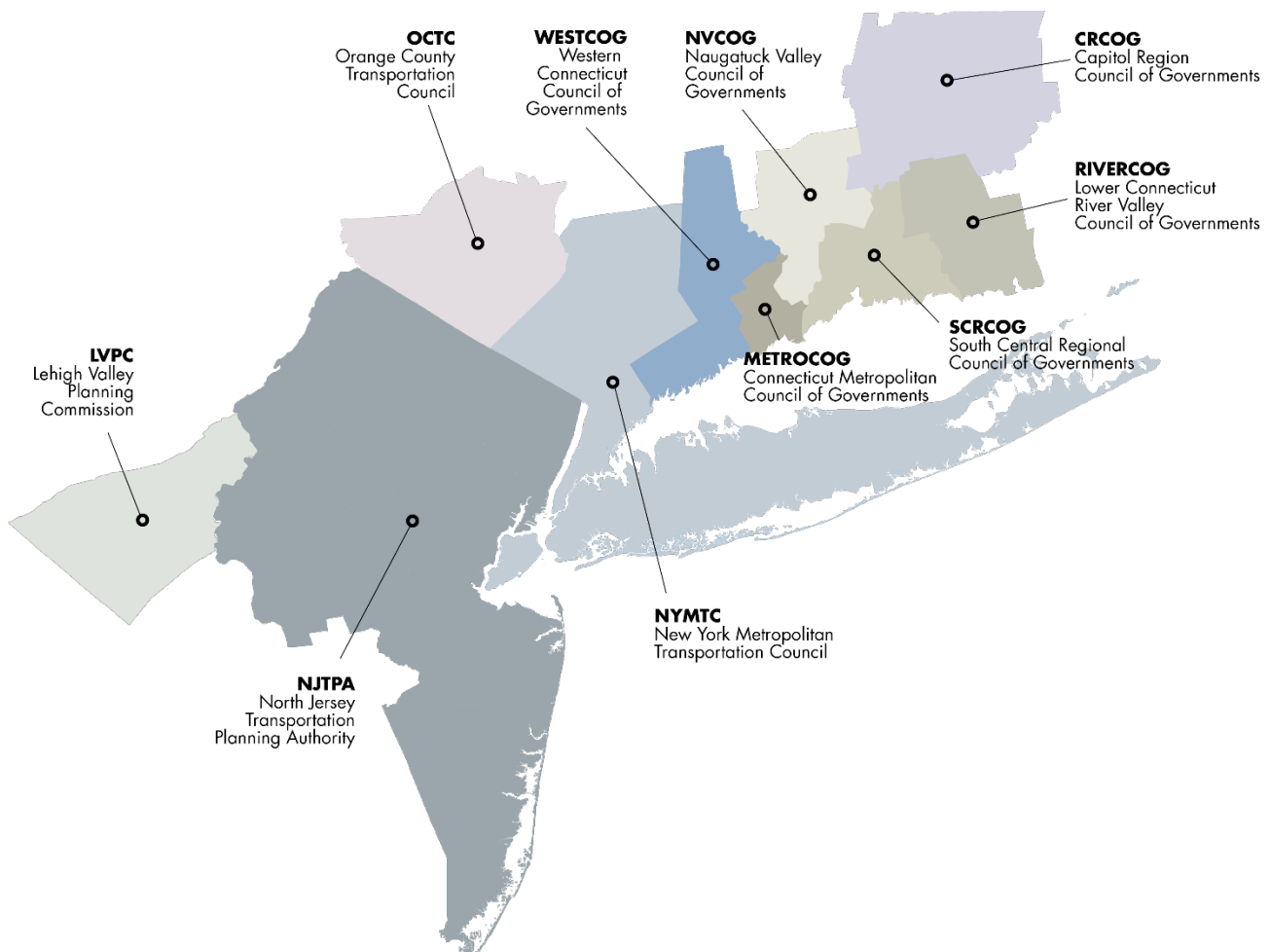
NYMTC's Program, Finance, and Administration (PFAC) Freight Subcommittee served as the Study Steering Committee (SSC). The SSC received regular status updates during PFAC Freight Subcommittee meetings, including results of work completed since the previous meeting, and an overview of the scope and approach of tasks that are underway and/or forthcoming. The SSC offered suggestions and comments on completed and forthcoming work steps, offered to connect the project team with stakeholder or agency contacts and relevant data and information, as needed. The SSC also reviewed draft and draft-final versions of milestone deliverables.

Technical Advisory Committee (TAC) included representatives from the Metropolitan Area Planning (MAP) Forum and the Multi-State Freight Working Group, and other key representatives of public- and private-

sector interests in clean freight technologies, trucking, environmental protection, among other disciplines. The TAC was briefed less frequently than the SSC, but were engaged at key decision points over the course of the project.

In addition, the Project Team engaged a broader array of stakeholders to participate in an online virtual workshop in October 2021 to review preliminary findings and recommendations of the study. The workshop engaged public sector planners, motor carriers, truck stop operators, and alternative fuel suppliers, each of whom have key roles to play in the development of alternative fueling and charging capacity for heavy duty vehicles in the study area.

**Figure 1-1. Metropolitan Area Planning (MAP) Forum Region, the Study Area for this Study**



Source: NYMTC

## 1.2 Organization of this Report

This report contains 8 chapters and 4 appendices. The remaining chapters include:

- **Chapter 2: Regional Assessment for Clean Freight Corridors** provides an inventory of existing alternative fuel and electric charging infrastructure in the study area, by fuel type, and Title VI/environmental justice analysis of the relationship between emissions and communities of concern in the NYMTC planning area.
- **Chapter 3: Alternative Fuel Technology and Infrastructure Regulatory Landscape Assessment** provides an overview of multi-state and state-specific regulations affecting alternative fuels and electric charging.
- **Chapter 4: Alternative Fuel Vehicle Technology Scan and Projections** uses a model to estimate the potential future adoption of alternative fuel and electric heavy duty trucks in the study area.
- **Chapter 5: Freight Demand** evaluates freight travel demand regionally, and freight characteristics on each of the major freight highway corridors in the study area.
- **Chapter 6: Stakeholder Workshop** describes the approach and outcomes of a workshop held in 2021 to gather input from a variety of public- and private-sector stakeholders.
- **Chapter 7: Recommended Clean Freight Corridors for Designation** presents the methodology and results of the approach used to prioritize corridors for designation as clean freight corridors, based upon their readiness and need.
- **Chapter 8: Implementation Considerations for Clean Freight Corridors** includes implementation recommendations and various policy considerations intended to help guide the processes of designating clean freight corridors and developing alternative fueling and charging infrastructure in those corridors.
- The technical **Appendices** include corridor freight travel demand profiles described in Chapter 5 (Appendix A), and material supporting Chapter 6, including the list of stakeholder workshop invitees (Appendix B), stakeholder workshop discussion guide (Appendix C), and comments gathered during the stakeholder workshop (Appendix D).



## 2.0 Regional Assessment for Clean Freight Corridors

This section is an assessment of roadway corridors for this purpose in the New York City multi-state metropolitan region. The assessment is comprised of an inventory of existing locations of alternative fuel/electric charging infrastructure and the designation status of alternative fuel corridors by the Federal Highway Administration (FHWA). The fuel types and energy sources assessed herein are those supported under Section 1413 of the federal Fixing America's Surface Transportation (FAST) Act: electricity, hydrogen, liquefied petroleum gas (LPG or propane), compressed natural gas (CNG) and liquefied natural gas (LNG).

This assessment leveraged planning tools developed by the U.S. Department of Energy (DOE) and FHWA to identify existing alternative fuel/electric charging infrastructure and current designation status of roadway corridors, respectively. This assessment within the study area will lay the foundation for subsequent tasks intended to identify opportunities to strategically expand alternative fuel/electric charging infrastructure to support the integration of lower-emitting technologies to power on-road goods movement.

Under Section 1413 of the FAST Act, FHWA is responsible for designating roadway corridors as either “Signage Ready” or “Signage Pending” for alternative fuels/electric charging based on the availability of publicly accessible fueling/ charging infrastructure along those routes. The mileage parameters for corridor designation are as follows: 50 miles or less between stations for electric, 100 miles or less between stations for hydrogen, 150 miles between stations or less for propane and compressed natural gas, and 200 miles or less between stations for liquefied natural gas. For all energy sources, except electric, only stations located within five miles of the nominated roadway may be considered for purposes of FHWA's designation evaluation. Corridors designated as “Signage Ready” are deemed to have met or exceeded these parameters, while corridors designated as “Signage Pending” are deemed not to have sufficiently frequent infrastructure to meet the parameters. For electric vehicle corridor designations, a “corridor-ready” segment is defined as one in which EV charging occurs no greater than 1 mile from Interstate exits or highway intersections along the corridor, effective February 10, 2022; this represents a change from prior rounds in which the allowable distance was 5 miles.<sup>2</sup>

It is important to note that the FHWA's alternative fuel corridor designation program evaluates fueling/charging stations without regard to which vehicle types they can accommodate, as long as the stations are not for private use (e.g., exclusively for a particular vehicle fleet). Therefore, the designations presented below incorporate fueling/charging stations that may service light-duty, medium-duty, and/or heavy-duty vehicles.

### 2.1 Existing Alternative Fuel Infrastructure in the Study Area

The maps in Figures 2-1 through 2-5 display locations of existing fueling/charging stations and FHWA corridor designations in the study area for each of electric charging, hydrogen, LPG, CNG, and LNG. While FHWA corridor designation information is presented without modification, infrastructure station data were filtered to exclude sites not reasonably accessible by M/HD vehicles. In particular, a majority of electric charging stations in the DOE database were developed for use by light-duty (LD) passenger vehicles, and some that cannot reasonably be used by freight vehicles were screened out of the geospatial analysis (see

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<sup>2</sup>“Round 6 Request for Nominations, Alternative Fuel Corridors, FHWA, available from: [https://www.fhwa.dot.gov/environment/alternative\\_fuel\\_corridors/nominations/2022\\_request\\_for\\_nominations\\_r6.pdf](https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/nominations/2022_request_for_nominations_r6.pdf) (accessed March 14, 2022).

“Electric Charging Landscape” below for further detail on screening methodology). Conversely, most existing fueling infrastructure for LPG and CNG is already designed for M/HD vehicle usage owing to the greater likelihood of those fuels being used by commercial vehicles (or buses) than passenger vehicles. Accordingly, the station data for those energy sources did not necessitate as much modification to screen out locations inappropriate for freight usage.

The sections below briefly present and discuss the current state-of-play for the infrastructure supporting each of the above-named energy sources for on-road freight vehicles in the greater New York metropolitan region.

### *2.1.1 Electric Charging Landscape*

The study area contains 197 electric charging sites in total, with numerous corresponding Signage Ready corridor designations throughout the study area. Many of the major highways in the study area have been designated either Signage Ready or Signage Pending for electric vehicle charging; most notably, I-95 is Signage Ready for the entire length of the study area from New Jersey through Connecticut. Other Signage Ready corridors include:

- I-495 and NY-25 on Long Island;
- Portions of I-84, I-87, I-287, and I-684 in the Lower Hudson Valley;
- Portions of I-80, I-78, and I-287 in New Jersey;
- I-84 and I-91 in Connecticut; and
- I-476 in Pennsylvania.

Notable corridors that are Signage Pending include portions of I-78, I-80, and I-287 in New Jersey and NY-27 on Long Island.

However, while highly useful to LD drivers, Signage Ready corridor segments for EVs may not have charging stations that are able to service M/HD vehicles, so these corridor designations may not bear equal relevance for freight applications. When assessing suitability of these facilities for freight vehicles, the following criteria were weighed to determine the number of such sites that could be appropriate for electric freight vehicles: charging speed, charger type, and charger quantity.

Because M/HD vehicles are heavier than LD vehicles, they require larger battery packs that charge more slowly at a given power level than do passenger cars. Accordingly, many chargers that are appropriate for LD charging along routes will not charge M/HD vehicles quickly enough to be suitable for M/HD charging along routes. Accordingly, sites that do not contain direct-current fast chargers (DCFC or “Level 3”), which are rated at 25 kilowatts or greater, were omitted from the assessment.

Charger type is also a concern, as chargers must be broadly compatible with a wide array of vehicle types in order to be appropriate for use by commercial vehicle fleets. Tesla chargers, which constitute a significant portion of the Level 3 inventory in the study area, are proprietary and thus only compatible with Tesla

vehicles. As such, Tesla Superchargers are not suitable for use by any M/HD vehicles that are currently on the market.<sup>3,4</sup>

Furthermore, because of longer charging times required for M/HD vehicles and the need for public chargers to be reliably available, charging sites with only one charging dispenser would not be practical facilities for freight vehicle fleets to incorporate into an operational plan. Accordingly, electric charging sites with fewer than two DCFC non-Tesla dispensers were omitted from the assessment.

This screening approach reduced the number of electric charging sites in the study area from 197 to just 45 (see Figure 2-1). These stations are most densely clustered in New York City and Northern New Jersey.

A final criterion not reflected in this screening process is vehicle accessibility. Because many electric stations were developed for LD vehicles as noted above, some may not be reasonably accessible to larger-format M/HD vehicles. For example, many of these stations are in commercial parking lots with small and dense parking spaces or located in parking structures with low clearance. Because the DOE dataset does not contain information regarding vehicle class accessibility or physical dimensions for electric charging locations, site format and geometry is not accounted for in this assessment. However, this practical consideration will be addressed in future deliverables offering recommended Clean Freight Corridor designations so as to ensure that existing and future charging locations can be made conducive to use by a variety of freight vehicles.

### *2.1.2 Hydrogen Fueling Landscape*

Hydrogen station availability is limited compared to other energy sources in the study area. The lone hydrogen station currently available in the study area, located in Wallingford, Connecticut, was built in 2010 and dispenses up to 65 kilograms of hydrogen per day. Although this volume is suitable for LD use,<sup>5</sup> 65 kg per day is likely insufficient throughput to fuel multiple M/HD vehicles each day. Accordingly, that station has been omitted from the assessment.

While additional stations are planned and under development on Long Island, in the Bronx, and near Hartford, the lack of existing stations means that the study area does not have any Signage Ready corridors. Still, several corridors have been nominated and designated as Signage Pending, including I-84, I-80, I-91, I-95, and a portion of I-87 north of Exit 15 (see Figure 2-2). As pending hydrogen filling stations are completed, Signage Pending segments can be reevaluated as they meet the minimum distance criteria for Signage Ready designation.

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<sup>3</sup> Tesla is reportedly exploring options to open up its Supercharger network for use by other manufacturers' vehicles, which would make the Supercharger network more relevant for this study. However, physical dimensions for these sites would still likely limit applicability of these stations to commercial vehicles.

<sup>4</sup> The Tesla Semi is expected to become commercially available in 2021 and will be used exclusively in freight applications. The Tesla Cybertruck is similarly slated for commercial release in 2021 but will be sold as a consumer-facing product; it is conceivable that the Cybertruck will be deployed in light commercial vehicle fleet applications. To the extent either vehicle can charge at Tesla Superchargers, these stations could become relevant as freight corridor charging sites.

<sup>5</sup> For example, the Toyota Mirai has a fuel capacity of 5 kg hydrogen to support an estimated driving range of 500 miles.

### 2.1.3 Liquefied Propane Gas (LPG) Fueling Landscape

After electric charging, LPG is the most well-represented alternative fuel in the study area with 39 existing fueling stations. Because the vast majority of available propane vehicles in the marketplace are M/HD vehicles, all existing stations are assumed to cater to M/HD vehicles and therefore none were omitted from the assessment.

The LPG stations are well dispersed throughout the study area, which is conducive to corridor-based (e.g., long-haul) fueling. The only Signage Ready designation is a large stretch of I-84 in Connecticut, but segments of I-95 and I-91 in Connecticut, I-80 in New Jersey, and portions of I-84, I-87, and I-95 in New York, are designated Signage Pending (see Figure 2-3).

Because of the relative density of LPG stations in the study area, additional corridor nominations can be submitted that would likely result in additional designations based on existing infrastructure, particularly on Long Island and in Northern New Jersey.

### 2.1.4 Compressed Natural Gas (CNG) Fueling Landscape

In the study area, there are 32 existing CNG stations. Although there have been modest attempts to commercialize CNG passenger cars in recent decades, the DOE database showed just one station accessible only to LD vehicles. The rest of the CNG stations are identified as accessible by M/HD vehicles, which constitute the bulk of the on-road CNG market. Accordingly, there are 31 freight-accessible CNG stations in the study area.

The CNG stations are somewhat concentrated in and around New York City, with some stations located by I-95 in Connecticut and I-78 in New Jersey (see Figure 2-4). New York and Connecticut contain most of the Signage Ready corridors in the study area, including:

- I-87, I-495, and NY-27 in New York;
- I-91 and I-95 in Connecticut; and
- Portions of I-78 and I-476 in Pennsylvania.

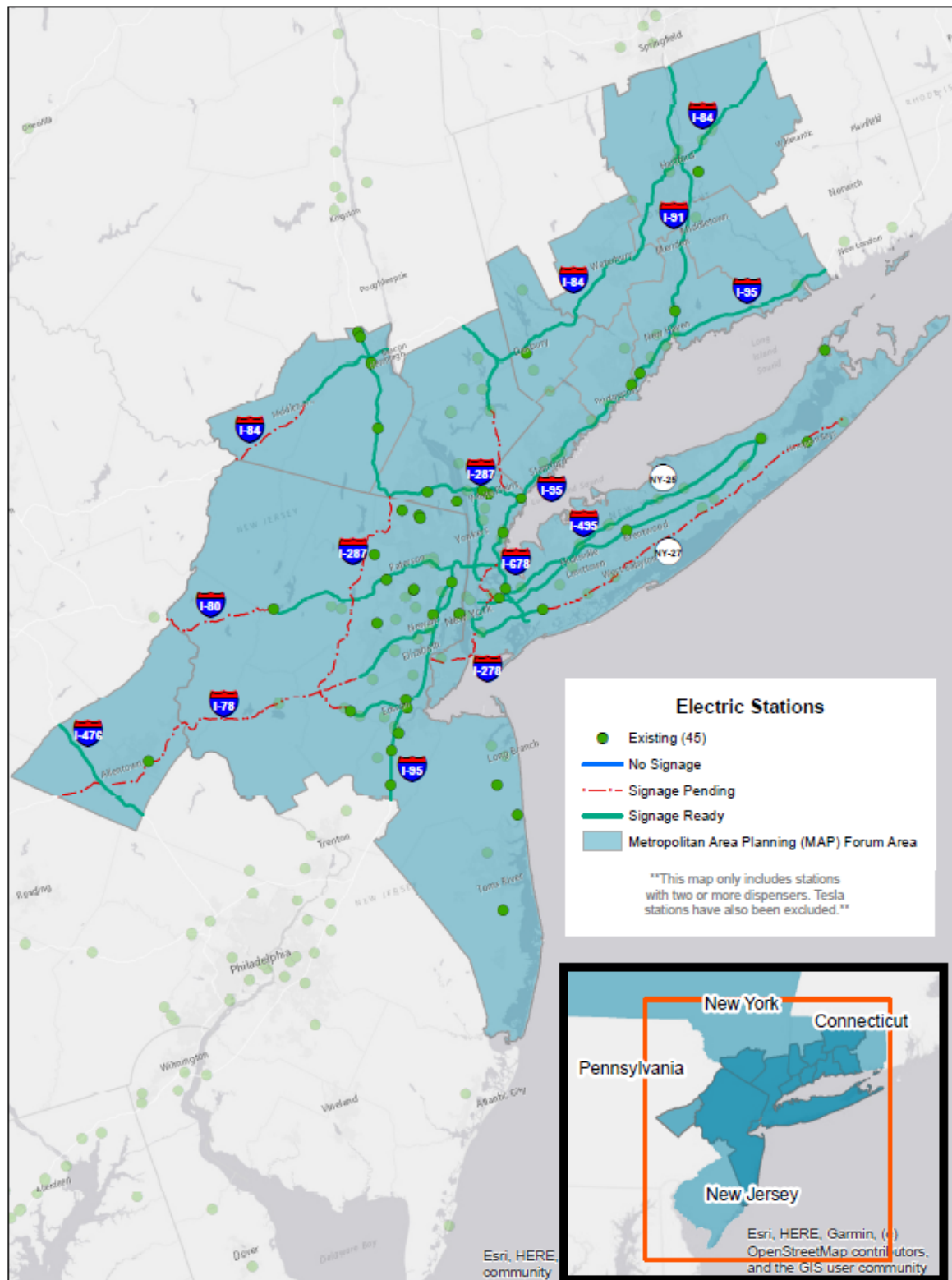
Significant stretches of Signage Pending corridors include I-84 in Connecticut and New York, I-80 in New Jersey, and portions of I-278 in New York and I-78 in Pennsylvania.

### 2.1.5 Liquefied Natural Gas (LNG) Landscape

There is only one LNG station in the study area, located near Allentown, PA (see Figure 2-5). This site is accessible to M/HD fleets. Because of the sparseness of LNG infrastructure, however, the study area does not contain any Signage Ready corridors. However, there are a few Signage Pending corridors, such as I-84, I-80, and I-95 (New York and Connecticut portions), I-87 in Rockland and Orange counties in New York, and I-80 in New Jersey.

Figure 2-1 displays the existing M/HD-accessible electric charging station locations (45) and FHWA corridor designations in the study area.

### Figure 2-1. Electric Stations and Corridor Designations<sup>6</sup>



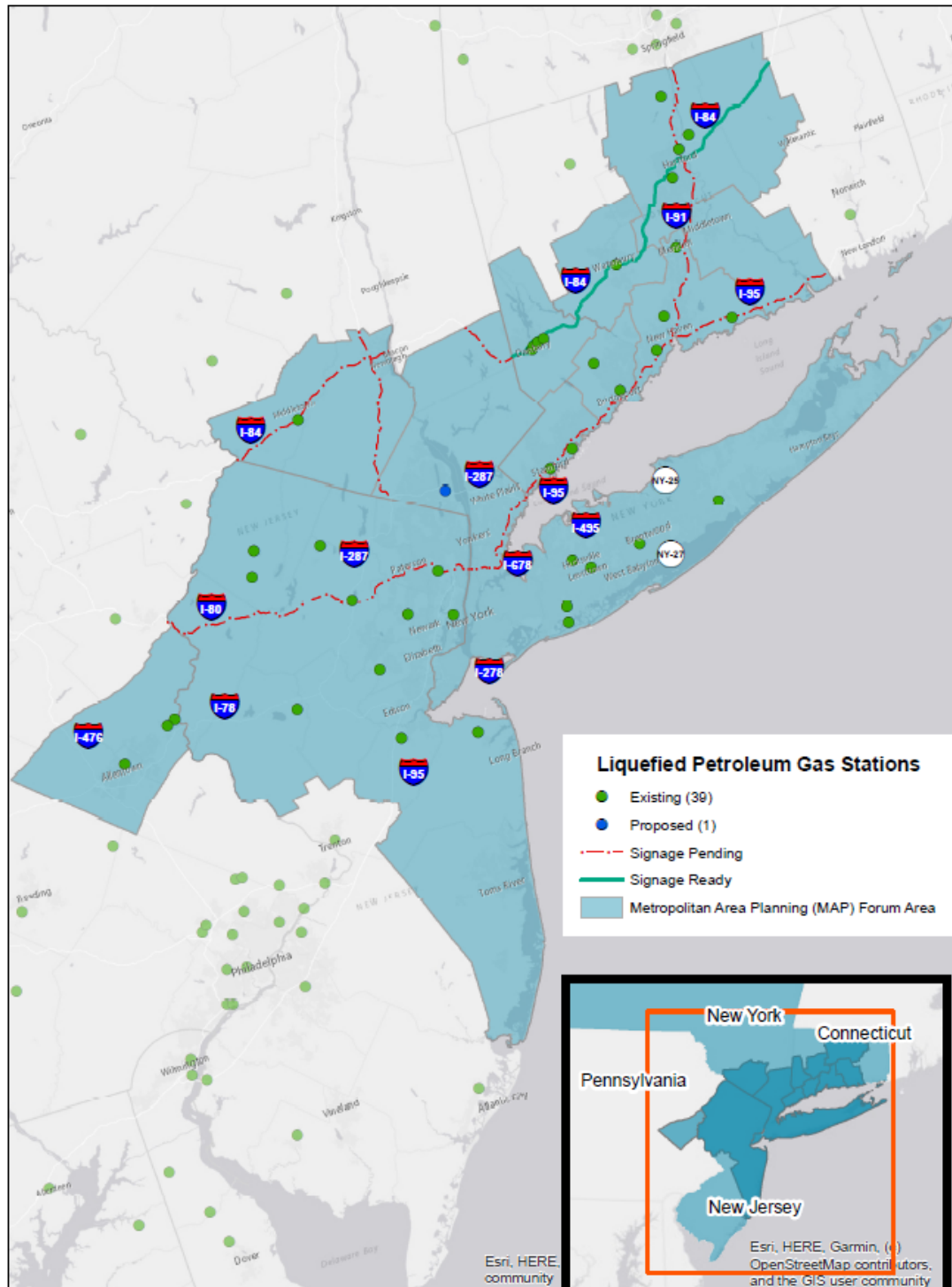
<sup>6</sup> This map shows corridor designations effective in 2021.

This map displays the New York City Metropolitan Area Planning (MAP) Forum Area, which is shaded in light blue. The area includes parts of New York, New Jersey, and Connecticut. Major highways are shown with their respective shields (e.g., I-84, I-91, I-85, I-287, I-495, I-678, I-276, I-78, I-476, I-80, I-95). The map also shows various cities and towns, including Springfield, Hartford, Meriden, Danbury, New Britain, Plainville, Middletown, West Hartford, Westbury, West Babylon, West Nyack, New York, Yonkers, White Plains, Pleasantville, Paterson, Newark, Elizabeth, Edison, Long Branch, Toms River, Trenton, Philadelphia, Wilmington, Camden, and Dover. The Delaware Bay is visible to the south. A legend in the bottom right corner indicates that blue dots represent 'Proposed (4)' hydrogen stations, red dashed lines represent 'Signage Pending', and the light blue area represents the 'Metropolitan Area Planning (MAP) Forum Area'. An inset map in the bottom right corner shows the location of the MAP Forum Area within the larger context of the New York City Metropolitan Area, including New York, Connecticut, Pennsylvania, and New Jersey. The map is credited to Esri, HERE, Garmin, and the OpenStreetMap contributors.

<sup>7</sup> This map shows corridor designations effective in 2021.

Figure 2-3 displays the existing M/HD-accessible LPG stations (39) and FWHA corridor designations in the study area.

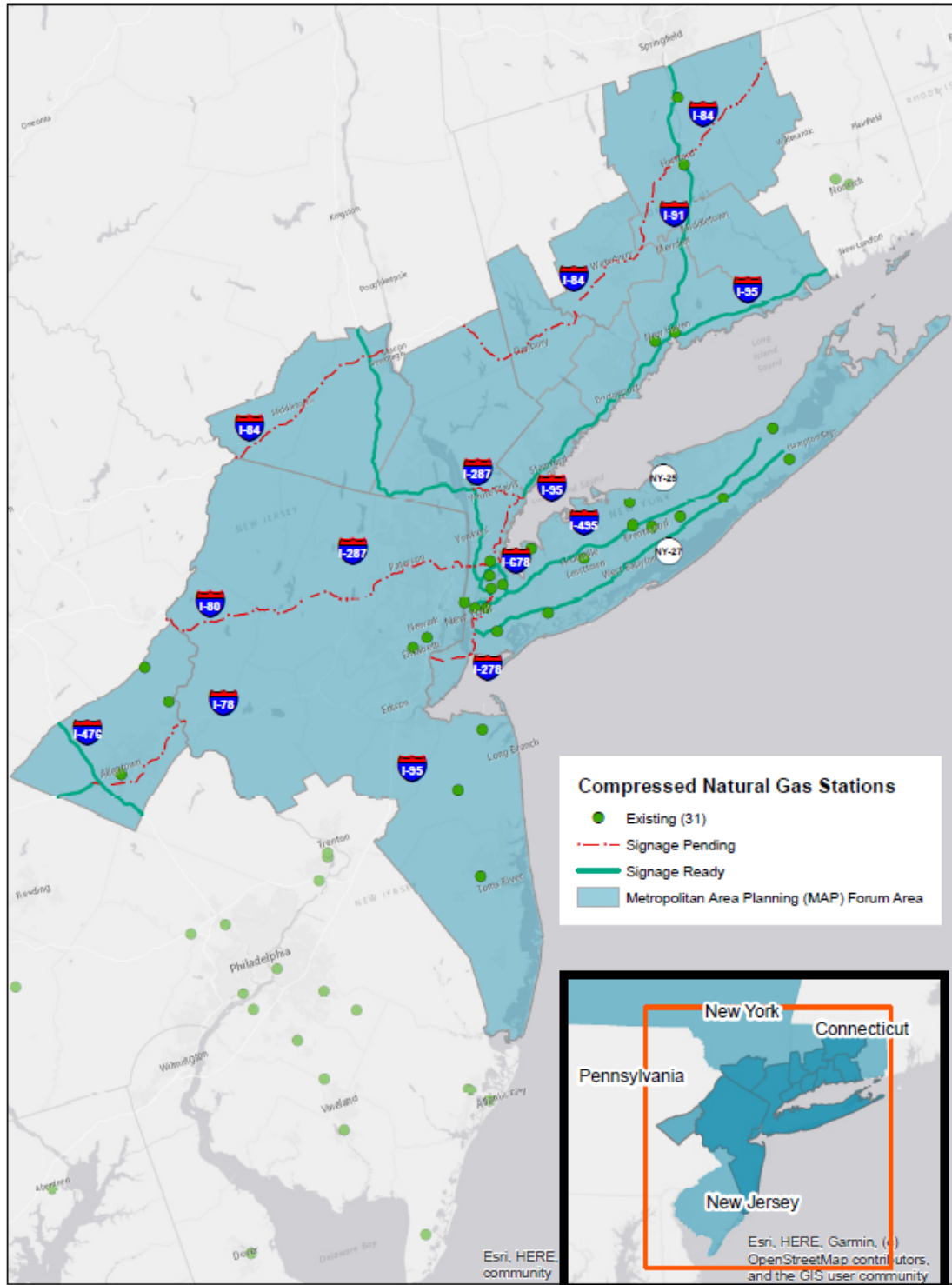
### Figure 2-3. Propane Fueling Stations and Corridor Designations<sup>8</sup>



<sup>8</sup> This map shows corridor designations effective in 2021.

Figure 2-4 displays the existing M/HD-accessible CNG stations (31) and FHWA corridor designations in the study area.

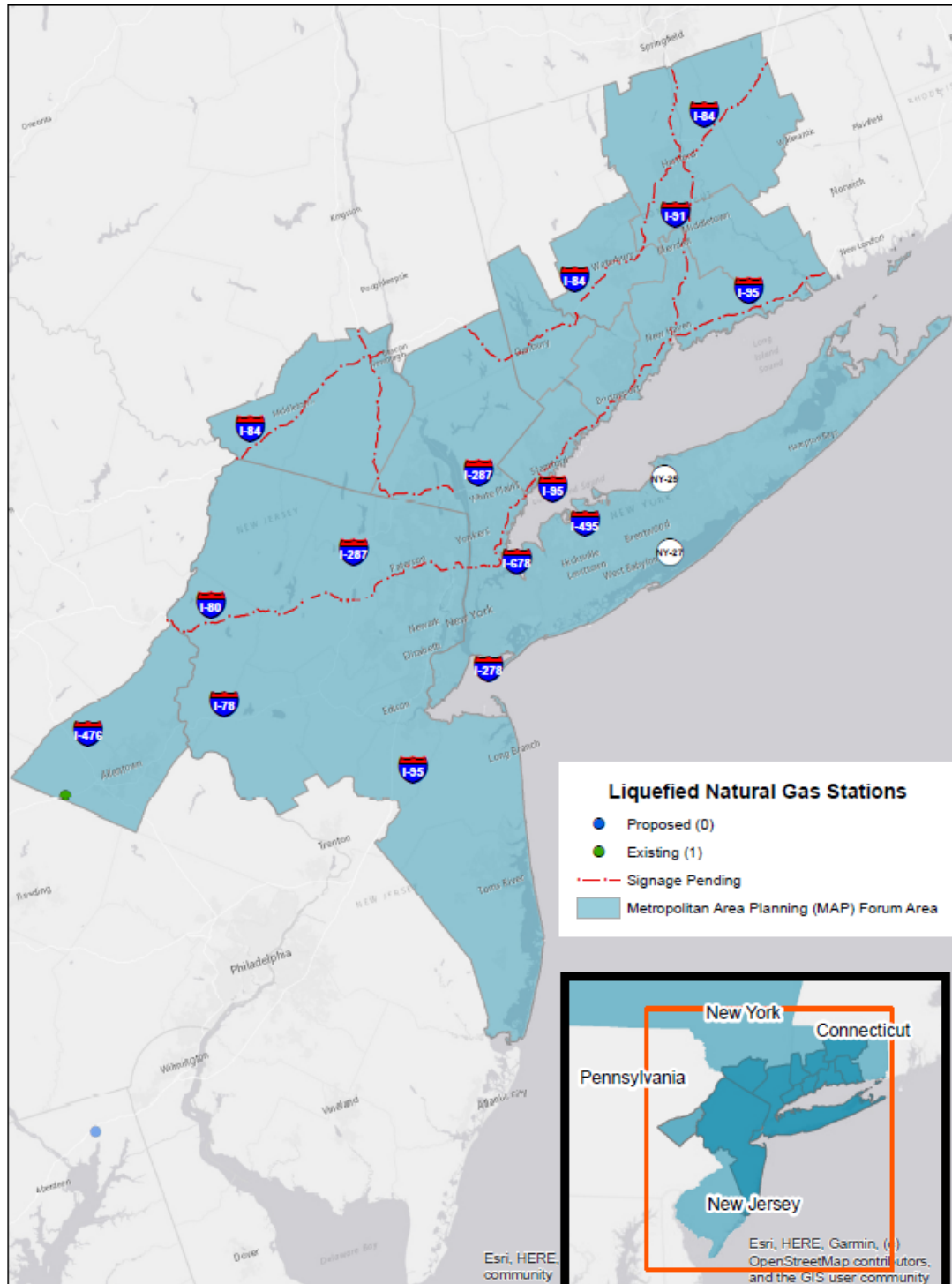
**Figure 2-4. CNG Fueling Stations and Corridor Designations<sup>9</sup>**



<sup>9</sup> This map shows corridor designations effective in 2021.

Figure 2-5 displays the existing M/HD-accessible LNG station (1) and FHWA corridor designations in the study area.

**Figure 2-5. LNG Fueling Stations and Corridor Designations<sup>10</sup>**



<sup>10</sup> This map shows corridor designations effective in 2021.

## 2.2 Title VI/Environmental Justice

Freight vehicles have run predominantly on petroleum diesel for decades and have therefore contributed to pockets of high pollution exposure in communities near major freight corridors.<sup>11</sup> Environmental Justice (EJ) communities are those that are disproportionately burdened by these emissions, suffering higher rates of pollution exposure without necessarily benefiting economically from the freight activity that generates the emissions burdens. As planners devise strategies to shift a portion of current and future freight activity from on-road trucks to other inherently more efficient modes like rail and barge,<sup>12</sup> most freight activity is likely to be transported by trucks for the foreseeable future. This fact makes especially imperative the transition of freight vehicles to non-diesel energy sources.

Compared to the rest of the nation, the greater New York City metropolitan region has high concentrations of diesel pollution, which have a strong and negative impact on the health of its citizens largely owing to the fine particulate matter in diesel exhaust. Figure 2-6 demonstrates the average annual levels of diesel particulate matter in the study area. The most impacted areas appear as pollution “hotspots” corresponding to the most urbanized and/or port areas, namely New York City, Newark, New Haven, Hartford, and Bridgeport.

In compliance with Title VI of the Civil Rights Act of 1964, NYMTC works to ensure that all its plans, programs, procedures, policies, and activities do not have disproportionate adverse effects on minority and low-income populations. To identify these priority EJ areas, NYMTC designates census tracts with at least 57% minority population and 14% of persons below the poverty line as “Communities of Concern.” Figures 7-9 display the spatial relationships between these Communities of Concern and diesel emissions within the NYMTC planning region. New York City contains the greatest density of Communities of Concern in the region, and these census tracts in the five boroughs of New York City tend to be concentrated in and around diesel particulate hotspots (see Figure 2-7). This likely reflects the proximity of these communities to freight hubs, including Hunts Point in the South Bronx, Maspeth and the area surrounding JFK International Airport in Queens, and Southwestern Brooklyn including Red Hook and Sunset Park, as well as the presence of dense, heavily trafficked and often intersecting major highways and crossings throughout Brooklyn, Queens, the Bronx, and Northern Manhattan. In general, the areas with the heaviest and most concentrated diesel emissions are highly correlated with the presence of Communities of Concern in New York City.

On Long Island, the relationship between communities of concern and diesel particulate matter is less clear (see Figure 2-8). Not only do Nassau and Suffolk Counties contain fewer Communities of Concern than the New York City boroughs, but the particulate concentrations from diesel emissions are significantly lower as well. As such, there is less interaction between Communities of Concern and diesel particulate matter in these counties. The highest levels of diesel particulate matter are seen near the border of Nassau with Queens, near the JFK Industrial Business Zone and several major New York City highways, but only two Communities of Concern are located near the pollution hotspot (in Elmont and Inwood).

The same largely is true in the Lower Hudson Valley, apart from the southern portion of Westchester County closest to New York City—particularly in Yonkers and Mount Vernon (see Figure 2-9). Those communities overlap starkly with high concentrations of diesel particulate matter associated with emissions centered in the

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<sup>11</sup> See, e.g., Kheirbek et al. (2016) at <https://doi.org/10.1186/s12940-016-0172-6>

<sup>12</sup> See, e.g., *Freight NYC* from the New York City Economic Development Corporation at <https://edc.nyc/freight-nyc>

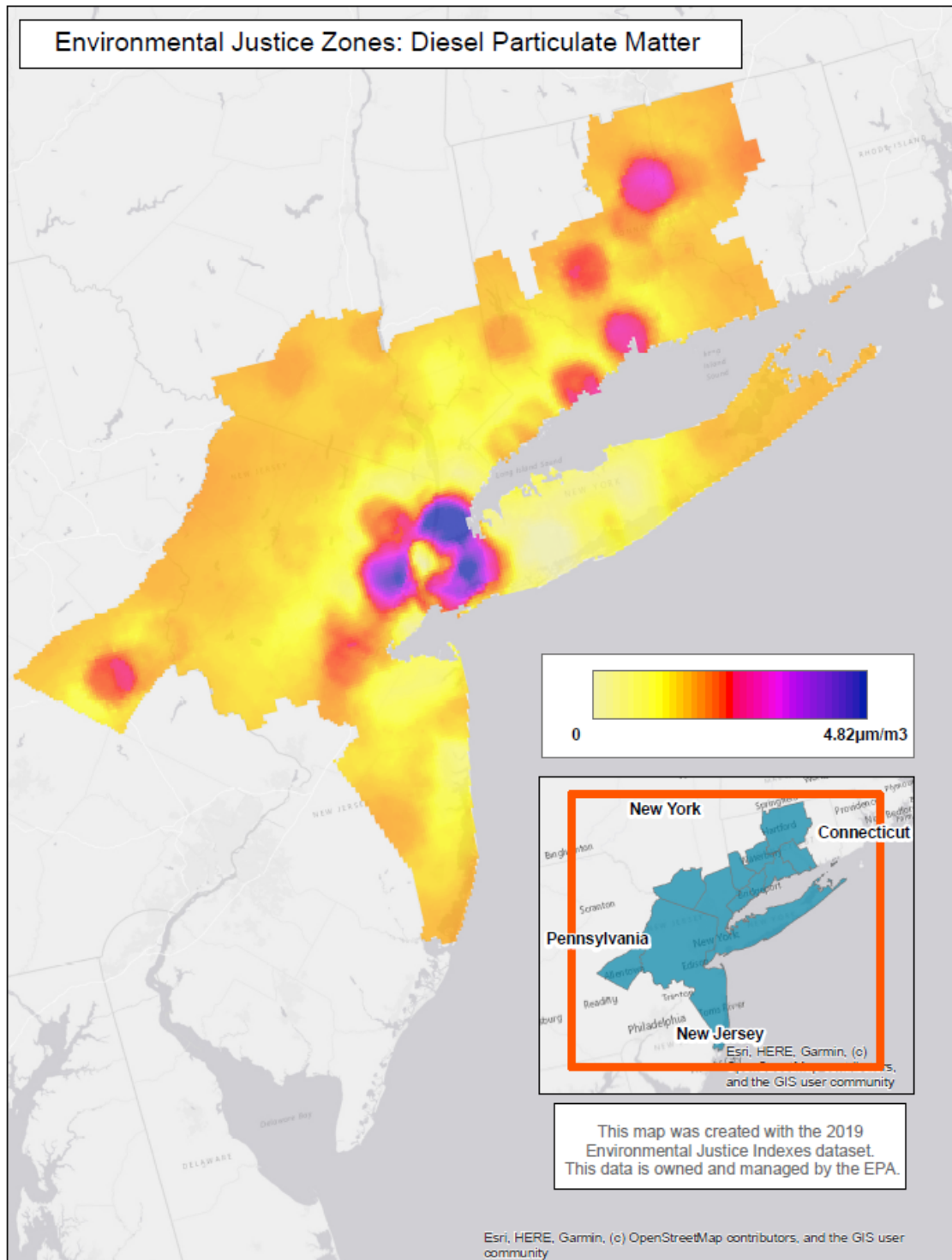
Bronx and Northern Manhattan. As the distance from New York City increases, there are fewer Communities of Concern and lower levels of diesel particulate matter in most of Westchester as well as in all of Putnam and Rockland counties.

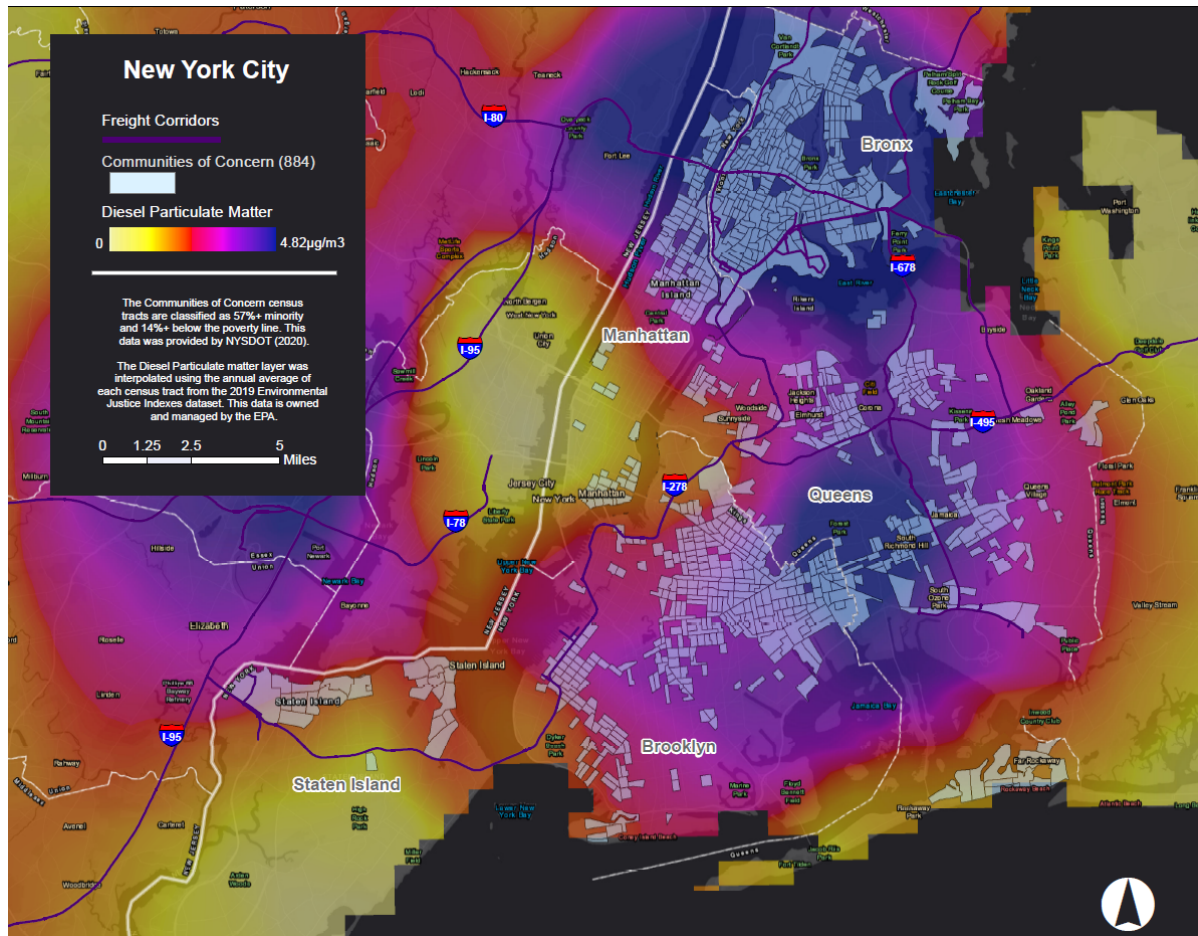
In the NYMTC planning region, denser and more highly urbanized areas tend to have greater concentrations of Communities of Concern as well as significantly higher concentrations of diesel particulate matter. Consequently, as NYMTC freight planning proceeds, measures to reduce diesel emissions in the most highly urbanized and polluted areas of its planning region, such as recommending the placement of alternative fueling infrastructure in industrial zones within New York City, will have the greatest potential to mitigate impacts of freight-sourced air pollution on Communities of Concern.

The following figures show the relationship between diesel particulate matter concentrations and communities of concern within the 10-county NYMTC planning area:

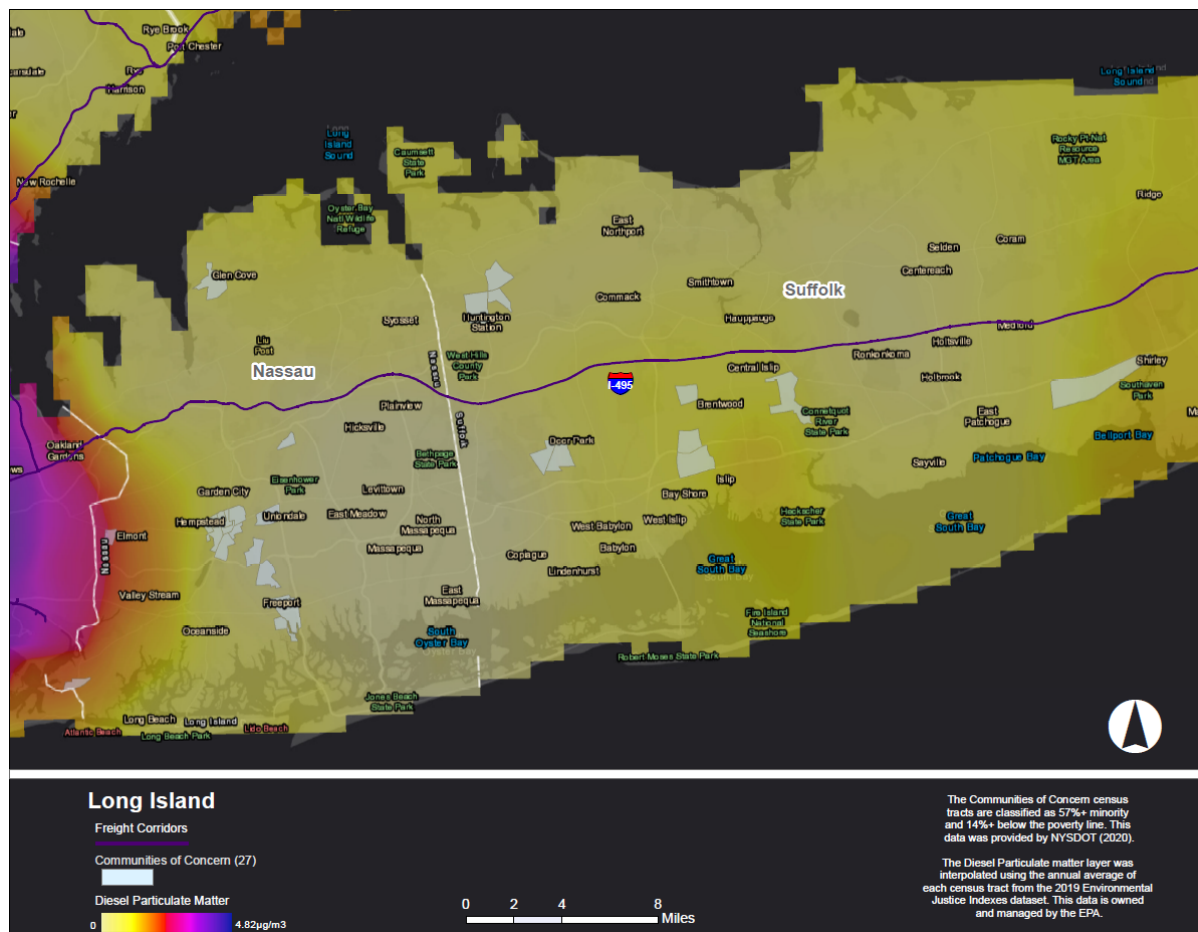
- Figure 2-6 displays annual average Diesel Particulate Matter concentrations within the study area.
- Figure 2-7 displays levels of Diesel Particulate Matter over designated Communities of Concern in the five boroughs of New York City.
- Figure 2-8 displays levels of Diesel Particulate Matter over designated Communities of Concern on Long Island (Nassau and Suffolk Counties); and
- Figure 2-9 displays levels of Diesel Particulate Matter over designated Communities of Concern in Lower Hudson Valley (Westchester and Rockland Counties).

**Figure 2-6. Environmental Justice Zones: Diesel Particulate Matter**

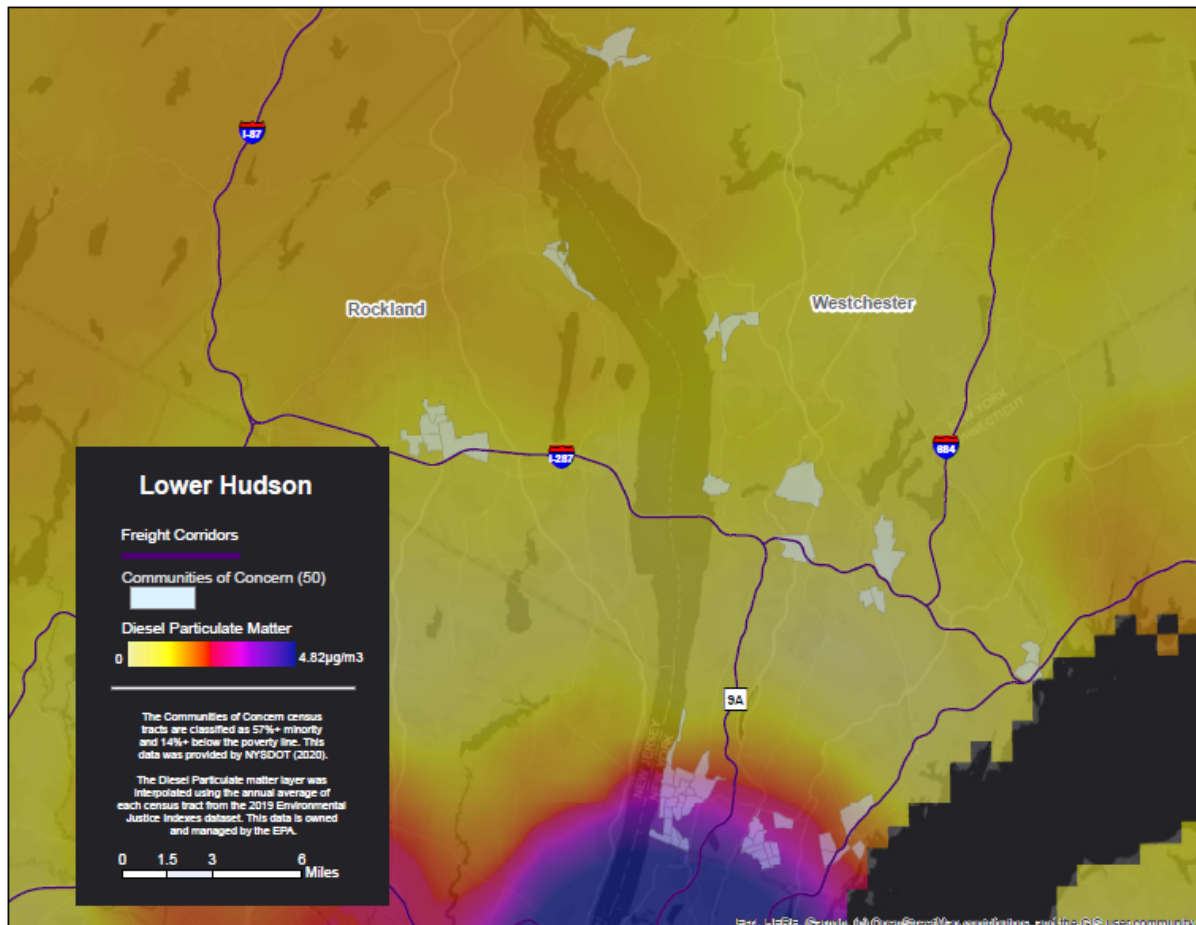


**Figure 2-7. Communities of Concern and Diesel Particulate Matter: New York City**

**Figure 2-8. Communities of Concern and Diesel Particulate Matter: Long Island**



**Figure 2-9. Communities of Concern and Diesel Particulate Matter: Lower Hudson Valley**





## 3.0 Alternative Fuel Technology and Infrastructure

### Regulatory Landscape Assessment

As NYMTC and study partners formulate recommendations for strategic additions of alternative fueling and charging infrastructure to boost adoption of non-diesel energy sources in on-road applications, it is critical to do so in context of the policy and regulatory environments within its planning region. The states and some municipalities in the greater New York metropolitan region have, to varying extents, pursued emissions reduction opportunities in the transportation sector to slow climate change and improve air quality. This has led to enactment of numerous legislative, regulatory, and administrative actions intended to increase use of all-electric technology and/or alternative fuels such as hydrogen, natural gas and propane. The states in this region are also active participants in regional efforts to curb transportation sector emissions.

This section outlines the current policy environments in New York, New Jersey, Connecticut, and Pennsylvania for all-electric and alternative fuel technologies for use by on-road M/HD vehicles, as well as the outlook based on policy measures currently under development.

### 3.1 Multi-State Zero-Emission Vehicles Task Force

In 2013, New York, Connecticut, and New Jersey were among a group of states that signed a memorandum of understanding (MOU) to form a Zero-Emission Vehicles (ZEV) Program Implementation Task Force to work toward a collective goal of 3.3 million light-duty ZEVs in service across participating states by 2025.<sup>13</sup> There are currently ten states that participate in the ZEV Task Force—California, Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, and Vermont. Northeast States for Coordinated Air Use Management (NESCAUM) administers the Task Force and works with member states to publish periodic Action Plans (most recently in 2018) recommending implementation of national and global best practice for encouraging adoption of zero-emission passenger cars. These best practices include investments in public and multi-user charging infrastructure such as at retail and workplace locations, utility programs and rate designs specific to electric vehicle (EV) users, increasing consumer awareness, and adopting public fleet ZEV procurement requirements.<sup>14</sup>

In July 2020, the ten ZEV Task Force states along with Colorado, Hawai'i, Pennsylvania, North Carolina, Washington, and the District of Columbia signed an MOU to advance the deployment of M/HD ZEVs.<sup>15</sup> The signatory states constitute approximately one-third of the nation's M/HD vehicle registrations, nearly 40% of the goods moved by truck, and almost half of the U.S. economy. In the MOU, signatories committed to develop strategies to reach a 30% ZEV share of M/HD vehicle sales by 2030 and 100% by 2050. Currently, signatories are in the process of developing a collaborative Action Plan of strategies to achieve these ambitious targets, such as vehicle incentives, infrastructure investments, utility actions, and regulatory

<sup>13</sup> Multi-State ZEV Task Force. (2013). *State Zero-Emission Vehicle Programs: Memorandum of Understanding*. Retrieved from <https://www.zevstates.us/about-us/>

<sup>14</sup> NESCAUM. (2018). *ZEV Task Force Multi-State ZEV Action Plan 2018-2021: Accelerating the Adoption of Zero Emission Vehicles*. Retrieved from <https://www.nescaum.org/documents/2018-zev-action-plan.pdf>

<sup>15</sup> Multi-State ZEV Task Force. (2019). *Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Initiative Statement of Intent*. Retrieved from [https://ww2.arb.ca.gov/sites/default/files/2019-12/Statement%20of%20Intent\\_ZEVI.pdf](https://ww2.arb.ca.gov/sites/default/files/2019-12/Statement%20of%20Intent_ZEVI.pdf)

standards. A draft of the Multi-State Action Plan was released for public comment in March 2022 and is expected to be finalized in mid-2022.<sup>16</sup>

## 3.2 New York

Transportation is the largest individual sector contributing to GHG emissions in New York State, accounting for 36% of all emissions in 2016.<sup>17</sup> The majority of GHG emissions come from fuel combustion in New York, and the transportation sector accounts for 44% of fuel combustion emissions.<sup>18</sup> The emissions from the transportation sector are dominated by combustion of gasoline and diesel fuel for the purpose of powering internal combustion engines.<sup>19</sup> To reduce emissions from these sources, New York has enacted a series of policies and programs aimed at encouraging all-electric and alternative fuel vehicle adoption. New York's participation in the Multi-State ZEV Task Force calls for 850,000 ZEVs on state roads by 2025, which serves as the basis for Charge NY, the state's multi-agency effort to accelerate adoption of electric cars and trucks which encompasses many of the incentive programs and administrative actions outlined below.<sup>20</sup>

### 3.2.1 Statutes and Legislation

The Climate Leadership and Community Protection Act of 2019 (CLCPA) is a recent legislative achievement that sets the most aggressive clean energy and climate targets to date in New York.<sup>21</sup> The CLCPA sets ambitious goals for the state's energy consumption and emissions reductions, in particular 100% zero-emission electricity by 2040 and reducing GHG emissions 85% below 1990 levels by 2050. The CLCPA notes that zero-emission transportation options for communities are key to fresher air and cleaner communities. The CLCPA is also distinctive in its explicit recognition of the disproportionate historic burden of emissions on frontline communities and directs that disadvantaged communities receive at least 40% of the benefits associated with investments resulting from mitigation planning.

In September 2021, New York Governor Kathy Hochul signed legislation to set zero-emission vehicle sales goals of 100% of light-duty cars and trucks statewide by 2035 and 100% of MHDV sales by 2045, where feasible.<sup>22</sup> This law also directed the New York State Department of Environmental Conservation (NYSDEC) to develop regulations in pursuit of these targets; NYSDEC subsequently proposed a regulation to adopt California's Advanced Clean Trucks (ACT) program, which requires manufacturers of medium- and heavy-duty vehicles (>8,500 lbs GVWR) to sell an increasing number of zero-emission vehicles in New York State.

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<sup>16</sup> NESCAUM. (2022). *Multi-State Medium- and Heavy-Duty Zero-Emission Vehicle Action Plan, Draft for Public Comment*. Retrieved from <https://www.nescaum.org/documents/mhd-zev-action-plan-public-draft-03-10-2022.pdf>

<sup>17</sup> New York State Energy Research and Development Authority. (2019). *New York State Greenhouse Gas Inventory: 1990-2016 Final Report July 2019* at S-4. Retrieved from <https://www.nyserda.ny.gov/About/Publications/EA-Reports-and-Studies/Greenhouse-Gas-Inventory>

<sup>18</sup> Ibid. at S-3 and S-5

<sup>19</sup> Ibid. at S-5

<sup>20</sup> New York State Energy Research and Development Authority. (n.d.). *Charge NY*. Retrieved from <https://www.nyserda.ny.gov/All-Programs/Programs/ChargeNY>

<sup>21</sup> New York State Department of Environmental Conservation. (2020). *New York's Climate Leadership and Community Protection Act*. Retrieved from <https://climate.ny.gov/>

<sup>22</sup> A.B. A4302, 204<sup>th</sup> Legislature, 2021-2022 Reg. Sess. (N.Y. 2021). Retrieved from <https://www.nysenate.gov/legislation/bills/2021/a4302>

NYSDEC adopted the ACT regulation in late December and the sales requirements will take effect in truck model year 2025.<sup>23</sup>

Pending bills also have the potential to impact the landscape for alternative fuels adoption. In particular, Senate Bill S2962<sup>24</sup> and Assembly Bill A862<sup>25</sup> are companion bills that would mandate the development of a low carbon fuel standard across the state with the goal of reducing the carbon intensity of on-road transportation by 20% by 2030. The regulation would be phased into different sectors, likely giving priority to the heavy-duty transportation sector with heavy-duty trucks and buses. This legislation would promote GHG emissions reductions in the transportation sector by requiring more carbon-intensive fuels to support development of less carbon-intensive fuels through a credit generation and exchange mechanism. Clean Fuels NY, an advocacy coalition led by New York League of Conservation Voters, is pushing for enactment of a low carbon fuel standard in New York either through passage of this pending legislation or executive action by the Governor.<sup>26</sup>

### 3.2.2 Grant and Incentive Programs

In 2018, the New York State Department of Environmental Conservation (NYSDEC) prepared a Beneficiary Mitigation Plan to reduce nitrogen oxide (NOx) emissions using Volkswagen (VW) Environmental Mitigation Trust Funds. The principal goal of the Beneficiary Mitigation Plan is to improve New York's air quality by accelerating the market for cleaner vehicle technologies. The Mitigation Plan allocated \$127.7 million in VW Settlement funding to sponsoring agencies or departments to administer for various incentive programs. Importantly, the Mitigation Plan directs up to \$20 million toward freight vehicles (Class 4-7 local freight trucks and Class 8 local freight and port drayage trucks).<sup>27</sup>

To meet its objectives, the Beneficiary Mitigation Plan prioritizes funding to existing incentive programs sponsored by other agencies in the state. The largest such program is the New York Truck Voucher Incentive Program (NYTVIP), administered by NYSERDA, which combines VW Settlement and federal Congestion Mitigation and Air Quality Improvement Program (CMAQ) funds to reduce the incremental cost for fleets by up to 95% to replace diesel M/HD vehicles with new all-electric or alternative fuel vehicles, with incentives up to \$185,000 per truck.<sup>28</sup> As of April 1, 2022, all remaining NYTVIP funds will be dedicated to zero-emission propulsion technologies (i.e., BEV and FCEV).<sup>29</sup> At the municipal level, the New York City Clean Trucks Program (NYCCTP), administered by the NYC Department of Transportation, provides

<sup>23</sup> 6 NYCRR Part 218, Emissions Standards for Motor Vehicles and Motor Vehicle Engines. Express Terms Summary (2021). Retrieved from [https://www.dec.ny.gov/docs/air\\_pdf/adopted218.pdf](https://www.dec.ny.gov/docs/air_pdf/adopted218.pdf)

<sup>24</sup> S.B. S2962, 204<sup>th</sup> Legislature, 2021-2022 Reg. Sess. (N.Y. 2021). Retrieved from <https://legislation.nysenate.gov/pdf/bills/2021/S2962>

<sup>25</sup> A.B. A862, 204<sup>th</sup> Legislature, 2021-2022 Reg. Sess. (N.Y. 2021). Retrieved from <https://legislation.nysenate.gov/pdf/bills/2021/A862>

<sup>26</sup> Clean Fuels NY. Retrieved from <https://cleanfuelsny.org/>

<sup>27</sup> New York State Department of Environmental Conservation. (2019). *Clean Transportation NY: Using the Volkswagen Settlement to Drive Clean Transportation in New York*. Retrieved from [http://www.dec.ny.gov/docs/air\\_pdf/vwcleantransportplan19.pdf](http://www.dec.ny.gov/docs/air_pdf/vwcleantransportplan19.pdf)

<sup>28</sup> New York State Energy Research and Development Authority (NYSERDA). (n.d.). *New York Truck Voucher Incentive Program*. Retrieved from <https://nyserda.ny.gov/truck-voucher-program/>

<sup>29</sup> NYSERDA. (2022). *NYTVIP Bulletin: Going 100 Percent Zero Emissions*. Retrieved from <https://mailchi.mp/4fe06f3f909a/nytvip-telematics-773214?e=fe6c938334>

identical truck vouchers as those offered under NYTVIP but for truck operating or domiciled in one of New York City's 20 Industrial Business Zones (IBZs).<sup>30</sup> Similarly, the Port Authority of New York and New Jersey's (PANYNJ) Truck Replacement Program provides vouchers for the replacement of the oldest, highest-emitting drayage trucks servicing port facilities with newer, cleaner-burning diesel engines or alternative fuel trucks.<sup>31</sup> All programs funded using VW Settlement funds require scrappage of the vehicle being replaced to ensure the removal of the oldest, dirtiest diesel engines from circulation.<sup>32</sup>

In its initial iteration from 2014 through 2018, NYTVIP disbursed more than \$14.5 million across 60 fleets for 594 vehicles—including 86 compressed natural gas (CNG) trucks and 65 EV trucks and buses.<sup>33</sup> As of February 2021, NYTVIP now has a total incentive budget of \$53.9 million, of which \$18.4 million can be used for BEV, FCEV, CNG, LPG, and hybrid trucks, and is actively accepting and processing voucher requests.<sup>34</sup> NYCCTP is a continuation of the Hunts Point Clean Trucks Program, which had replaced or converted more than 500 diesel trucks in the South Bronx to newer diesel, hybrid, or natural gas technology, and launched in mid-2020 with an initial budget of \$9.8 million.<sup>35</sup>

In addition to these voucher programs, grant funding is available through programs such as NYSERDA's Clean Transportation Program, in addition to hosting incentive programs to accelerate the market for alternative fuel vehicles, provides competitive grant funding for projects conducting the research and development of advanced technologies.<sup>36</sup> This program also seeks to accelerate the use of underutilized technologies and to scale up the use of promising alternative fuels.

### 3.2.3 Administrative Actions and Regulation

The New York Power Authority's (NYPA) EVolve NY program allocates \$250 million to support EVs by filling infrastructure gaps in New York. Phase 1 of EVolve NY committed \$40 million for development of a statewide direct-current fast charger (DCFC) network and the creation of EV model communities statewide.<sup>37</sup>

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<sup>30</sup> New York City Department of Transportation (NYCDOT). (n.d.). *New York City Clean Trucks Program*. Retrieved from <https://www.nycctp.com/>

<sup>31</sup> Port Authority of New York and New Jersey. (n.d.). *Truck Replacement Program*. The Port Authority of New York and New Jersey. Retrieved from <https://www.panynj.gov/port/en/our-port/sustainability/truck-replacement-program.html>

<sup>32</sup> Supra note 27

<sup>33</sup> NYSERDA. (2018). *New York Truck Voucher Incentive Program (NYT-VIP) Final Report*. Retrieved from <https://nysl.ptfs.com/awweb/pdfopener?sid=7AD020375572B8FC34C1DA38DBB8BDAD&did=136065&fl=%2FLibrary1%2Fpdf%2F1096438923.pdf>

<sup>34</sup> Supra note 28

<sup>35</sup> NYCDOT. (2020). *NYC DOT in Partnership with the NYCDEC Announces Launch of the New York City Clean Trucks Program*. Retrieved from <https://www1.nyc.gov/html/dot/html/pr2020/pr20-023.shtml>

<sup>36</sup> NYSERDA. (n.d.). *Clean Transportation Program*. New York State. Retrieved from <https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Transportation-Program>

<sup>37</sup> New York State Governor's Press Office. (2018). *Governor Cuomo Announces \$250 Million Initiative to Expand Electric Vehicle Infrastructure Across New York State*. Retrieved from <https://www.governor.ny.gov/news/governor-cuomo-announces-250-million-initiative-expand-electric-vehicle-infrastructure-across>

Phase 2 of EVolve NY targets M/HD vehicle electrification, and has begun by providing infrastructure assistance to public transportation fleets statewide to aid adoption of battery electric buses.<sup>38</sup>

The New York City Economic Development Corporation (NYCEDC) released the Freight NYC plan to overhaul and reduce the impacts associated with freight movement in and around New York City.<sup>39</sup> The main idea of the plan is to emphasize key investments that modernize NYC's approach to shipping. One of the key elements of this program is the promotion and incentivization of clean-technology trucks for last-mile delivery.<sup>40</sup> Subsequently, in April 2019, NYCEDC issued a Request for Expressions of Interest (RFEI) for the development and operation of electric charging stations throughout the city that are available and accessible to trucks.<sup>41</sup> The initiative attempts to advance low-and-zero-emission trucks and accelerate their adoption. The application period for this RFEI extended through the end of 2019 and NYCEDC is still in discussions with developers regarding responses and development plans.

There are also regulations that need to be kept in mind in proceeding with alternative fuel infrastructure in New York, such as the NYSDEC regulations on liquefied natural gas (LNG) transportation and facility management.<sup>42</sup> This regulation is consistent with New York City's moratorium on new LNG facilities. New York City also has a prohibition on the transportation of liquefied gases<sup>43</sup>—including hydrogen and propane—stemming from a 1973 explosion at a liquefied natural gas pipeline in Staten Island that killed 40 people. In the aftermath of this event, New York City imposed strict limits on storage, dispensing, and transportation of liquefied gases including natural gas and propane.<sup>44</sup> However, most gaseous fuels must be compressed in order to be economically transported, so the NYC prohibition on liquefied gases hampers the supply of these fuels to dispensing sites. Similarly, PANYNJ has banned the operation of hydrogen fuel-cell vehicles in its crossings, with the exception of some top decks of bridges under its control owing to flammability concerns.<sup>45</sup> These regulatory barriers have impeded fleet integration of propane and hydrogen fuels in New York City and its immediate surroundings.

<sup>38</sup> New York Power Authority. (2020). *EVolve NY: A Vision for an Electric Future*. Retrieved from <https://www.nypa.gov/-/media/nypa/documents/document-library/evolveny/nypa-a-vision-for-an-electric-future.pdf>

<sup>39</sup> New York City Economic Development Corporation. (2018). Freight NYC: Goods for the Good of the City. Retrieved from [https://edc.nyc/sites/default/files/filemanager/Programs/FreightNYC\\_book\\_DIGITAL.pdf](https://edc.nyc/sites/default/files/filemanager/Programs/FreightNYC_book_DIGITAL.pdf)

<sup>40</sup> NYCEDC Public Affairs. (2018). "New York Works: De Blasio Administration Launches Freight NYC, A \$100M Plan to Modernize New York City's Freight Distribution System." Retrieved from <https://edc.nyc/press-release/new-york-works-de-blasio-administration-launches-freight-nyc-100m-plan-modernize-new>

<sup>41</sup> NYCEDC Public Affairs. (2019). "NYCEDC Lays Groundwork for Developing Truck-Accessible Electric Charging Stations Throughout City." Retrieved from <https://edc.nyc/press-release/nycedc-lays-groundwork-developing-truck-accessible-electric-charging-stations>

<sup>42</sup> New York State Energy Planning Board (1998). Report on Issues Regarding the Existing New York Liquefied Natural Gas Moratorium. Retrieved from <https://www.nyserda.ny.gov/-/media/Files/EDPPP/Energy-Prices/Current-Outlook/Presentations/LNG-Moratorium-Issues-report.pdf>

<sup>43</sup> New York City Fire Code, Chapter 27 Hazardous Materials—General Provisions § 270710.1 Prohibited compressed gases (2009). Retrieved from [http://www.nyc.gov/html/fdny/pdf/firecode/2009/fire\\_code\\_l126\\_2008\\_amended\\_l137\\_41\\_64\\_2009\\_final\\_complete.pdf](http://www.nyc.gov/html/fdny/pdf/firecode/2009/fire_code_l126_2008_amended_l137_41_64_2009_final_complete.pdf)

<sup>44</sup> SI Live. (2019). "Staten Island liquefied natural gas explosion in 1973 led to decades-long ban in New York." Retrieved from [https://www.silive.com/news/2015/01/staten\\_island\\_liquefied\\_natura.html](https://www.silive.com/news/2015/01/staten_island_liquefied_natura.html)

<sup>45</sup> Automobile Magazine. (2008). *BMW Hydrogen 7 Banned from Tunnels in New York, New Jersey*. Automobile. Retrieved from <https://www.automobilemag.com/news/bmw-hydrogen-7-banned-from-tunnels-in-new-york-new-jersey-134691/>

### 3.2.4 Utility Infrastructure Programs

On July 16, 2020, the New York Public Service Commission (PSC) issued an EV Infrastructure Make-Ready Order, which included several resources for M/HD fleets.<sup>46</sup> In this order, the PSC authorized utility companies to facilitate the construction of EV infrastructure by their customers statewide and socialize 50-90% of eligible costs of qualifying projects to their ratepayers. The \$701 million authorization includes a \$15 million Medium- and Heavy-Duty Fleet Make-Ready Pilot Program across the state for fleets participating in either the New York Truck Voucher Incentive Program (NYTVIP) or the New York City Clean Trucks Program (NYCCTP). Incentive program participants are eligible to receive up to 90% of covered make-ready infrastructure costs from their electric utility. Additionally, Fleet Assessment Services will be made available to medium- and heavy-duty fleets by utilities and will include site feasibility and rate analysis for fleets interested in vehicle electrification. This utility-sponsored service will better prepare fleets to adopt EVs in various fleet segments and also enhance coordination between fleet and utility that is so critical to being able to scale up vehicle electrification as fleet comfort with the technology increases and technology improves. Finally, the order also instructs NYSEDA to develop a \$20 million competitive Medium- and Heavy-Duty Vehicle Innovation Prize competition to accelerate the deployment of underutilized M/HD EV technology with an emphasis on improving air quality in environmental justice communities.

This statewide make-ready program complements existing authorizations or proposals for individual utilities. In January 2020, Con Edison's three-year electric rate plan was approved by the PSC and included \$39 million in EV make-ready funding, of which \$9 million is reserved for fleets (including M/HD vehicle fleets).<sup>47</sup> Con Edison also offers a voluntary off-peak charging incentive program called SmartCharge NY, which was expanded to include M/HD EVs in 2018 and was extended in the 2020 rate case approval. These programs are accessible for customers in Con Edison's electric service territory, which includes New York City (minus the Rockaway Peninsula) and Westchester.<sup>48</sup>

## 3.3 New Jersey

In early 2020, New Jersey released its Energy Master Plan to lay out strategies for achieving the state's goals to electrify the transportation sector and achieve 100% carbon neutral electricity by 2050. The Energy Master Plan identifies transportation as the top sector to prioritize for emission reductions and provides guidelines for deploying EVs and electric vehicle supply equipment (EVSE), educates consumers and fleet owners, transitions state fleets to EVs, partners with the industry to incentivize M/HD EVs, and explores

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<sup>46</sup> State of New York Public Service Commission. (2020). *Order Establishing Electric Vehicle Infrastructure Make-Ready Program and Other Programs*. Retrieved from <http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={6238DD07-3974-4C4E-9201-3E339E311916}>

<sup>47</sup> State of New York Public Service Commission. (2019). *Case 19-E-0065 and Case 19-G-0066 Joint Proposal*. Retrieved from <http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={E68C7E36-2811-4999-8145-0CB3577F549C}>

<sup>48</sup> Fleetcarma (2020). *SmartCharge New York*. Retrieved from <https://www.fleetcarma.com/smartchargenewyork/>

further policies.<sup>49</sup> New Jersey also recently established a Fuel Cell Task Force to increase fuel cell use in the state.<sup>50</sup>

### 3.3.1 Statutes and Legislation

The legislature is intimately involved with emissions reductions efforts in New Jersey, as is apparent in the development of EV and EVSE deployment goals and guidelines by the State Senate in the Plug-In Vehicle (PIV) Act.<sup>51</sup> This legislation sets broad and ambitious goals for ZEV deployment in New Jersey, codifying the state's commitment to 330,000 ZEVs by 2025, 2 million ZEVs by 2035, and 80% of sales to be ZEVs by 2040. The PIV Act further stipulates that 100% of new buses purchased by New Jersey Transit must be zero-emission by the end of 2032. Further, the law requires the New Jersey Board of Public Utilities (NJBPU) to establish goals for transportation electrification and infrastructure to replace M/HD diesel vehicles, as well as the New Jersey Department of Environmental Protection (NJDEP) to develop a public education program about EVs and EVSE.<sup>52</sup> This type of planning extends down to the municipal level, as additional legislation requires municipal master plans to promote the installation of EVSE along corridors and in other public locations.<sup>53</sup> New Jersey's Electric Vehicle Charging Station Law (enacted in 2021) defined EV charging stations as permitted accessory uses in all zones and do not require a variance to be included in any development application.<sup>54</sup>

Beyond goal-setting and planning, New Jersey Statutes 27:1B-22 requires that all buses purchased by New Jersey Transit to either be equipped with pollution controls or run on alternative fuels approved by the U.S. Environmental Protection Agency.<sup>55</sup> Similar requirements exist in allowing trucks access to PANYNJ facilities, as vehicles with diesel engines not meeting per the Port Authority's policy.<sup>56</sup>

### 3.3.2 Grant and Incentive Programs

New Jersey has also developed multiple grant incentive programs to support the purchase and adoption of all-electric and alternative fuel vehicle technologies by fleets across the state. One such example is the State's VW Settlement program, administered by NJDEP, with \$72.2 million from the VW Environmental Mitigation Trust to disburse to NOx reduction projects statewide. DEP has made two rounds of competitive

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<sup>49</sup> New Jersey Board of Public Utilities. (2020). 2019 New Jersey Energy Master Plan: Pathway to 2050. Retrieved from [https://nj.gov/emp/docs/pdf/2020\\_NJBPU\\_EMP.pdf](https://nj.gov/emp/docs/pdf/2020_NJBPU_EMP.pdf)

<sup>50</sup> A741, 219th Legislature, 2020 Reg. Sess. (N.J. 2020). Retrieved from [https://www.njleg.state.nj.us/2020/Bills/A1000/741\\_I1.PDF](https://www.njleg.state.nj.us/2020/Bills/A1000/741_I1.PDF)

<sup>51</sup> S2252 (Plug-In Vehicle Act), 218th Legislature, 2019 Reg. Sess. (N.J. 2020). Retrieved from [https://www.njleg.state.nj.us/2018/Bills/S2500/2252\\_U2.HTM](https://www.njleg.state.nj.us/2018/Bills/S2500/2252_U2.HTM)

<sup>52</sup> Ibid.

<sup>53</sup> S606, 219th Legislature, 2020 Reg. Sess. (N.J. 2019). Retrieved from [https://www.njleg.state.nj.us/2020/Bills/S1000/606\\_I1.PDF](https://www.njleg.state.nj.us/2020/Bills/S1000/606_I1.PDF)

<sup>54</sup> DCA Model Statewide Municipal EV Ordinance. (2021). Retrieved from <https://www.nj.gov/dca/dlps/home/modelEVOrdinance.shtml>

<sup>55</sup> New Jersey Transportation Trust Fund Authority Act of 1984; amended 2006 P.L.2006, New Jersey Statutes § 27:1B-22 (2006).

<sup>56</sup> Port Authority of New York and New Jersey. (2014). Clean Air Strategy (2014 Update). Retrieved from <https://www.panynj.gov/port/en/doing-business/tariffs.html>

funding available to projects that can demonstrate NOx reductions by displacing diesel consumption in mostly on-road vehicle applications.<sup>57</sup> In the first funding round, DEP approved funding for 11 projects encompassing 10 electric refuse trucks, 18 electric yard/terminal tractors, 39 pieces of electric ground support equipment, five electric last-mile delivery trucks and five electric drayage trucks; the second round of applications closed in July 2020.<sup>58</sup>

In January 2021, New Jersey Economic Development Authority (NJEDA) announced a new incentive program for zero-emission medium-duty trucks called New Jersey Zero-Emission Incentive Program (NJ ZIP). This program provides point-of-sale incentives from \$25,000-\$100,000 for zero-emission class 2b-6 trucks. As of December 2021, the incentive pool was \$44.25 million for truck fleets operating in or near Camden, Newark, New Brunswick, or the Greater Shore areas.<sup>59</sup>

In addition to vehicle purchase grants and vouchers, there are a number of EVSE and alternative fuel infrastructure grants. NJDEP sponsors It Pay\$ to Plug In: New Jersey's Electric Vehicle Charging Grant Program, part of the Energy Master Plan and Drive Green NJ.<sup>60</sup> This program reimburses employers, government and educational facilities, multi-unit dwellings, and other organizations for the cost and installation of EVSE. NJBPU also provides grant funding for both the purchase of EVs and installation of EVSE for municipal and county government entities through the Clean Fleet Electric Vehicle Incentive Program, which may be applicable toward the purchase of M/HD EVs.<sup>61</sup>

New Jersey has implemented tax incentive strategies to advance alternative fuel vehicle technology usage. One such statute is the ZEV Sales Tax Exemption (not including hybrids) overseen by the New Jersey Department of the Treasury.<sup>62</sup> Another is the reduced fuel tax on propane to make it more competitive against petroleum fuels.<sup>63</sup>

### 3.3.3 Administrative Actions and Regulation

NJDEP, NJBPU, and the New Jersey Economic Development Authority (NJEDA) also signed a memorandum of understanding to create the New Jersey Partnership to Plug-In to more strategically channel revenues from New Jersey's reentry into the Regional Greenhouse Gas Initiative (RGGI) toward clean

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<sup>57</sup> New Jersey Department of Environmental Protection. (n.d.). Volkswagen Settlement Information. Retrieved from <https://www.state.nj.us/dep/vw/>

<sup>58</sup> Supra Note 31

<sup>59</sup> New Jersey Economic Development Authority (NJEDA). (2022). NJ ZIP: New Jersey Zero Emission Incentive Program. Retrieved from <https://www.njeda.com/njzip/>

<sup>60</sup> Drive Green. (n.d.). It Pay\$ to Plug-In. Air Quality, Energy & Sustainability. Retrieved from <https://www.drivegreen.nj.gov/plugin.html>

<sup>61</sup> New Jersey Board of Public Utilities. (2019). Clean Fleet Electric Vehicle Incentive Program Application. Retrieved from <https://www.nj.gov/bpu/pdf/publicnotice/Clean%20Fleet%20Electric%20Vehicle%20Incentive%20Program%20Application.pdf>

<sup>62</sup> New Jersey Division of Taxation. (2020). Sales Tax Exemption - Zero Emission Vehicle (ZEV) (N.J.S.A. 54:32B-8.55). Official Site of the State of New Jersey. Retrieved from <https://www.state.nj.us/treasury/taxation/zevnotice.shtml> \I":~:text=Sales%20Tax%20Exemption%20%2D%20Zero%20Emission%20Vehicle%20(ZEV)%20(N.J.S.A.,standards%20for%20the%20model%20year

<sup>63</sup> L.2010, c.22, s.3; amended 2010, c.79, s.2, New Jersey Statutes § 54:39-103 (2010).

transportation initiatives.<sup>64</sup> The purpose of the Partnership is to increase the number of ZEVs in the state and meet ZEV adoption registration goals set by the state. In order to achieve this, the Partnership will map existing and potential locations for EVSE, evaluate financing strategies, develop a rebate program, and expand consumer education, among other initiatives.

In early 2020 the three agencies together released a RGGI Strategic Funding Plan as New Jersey prepared to reenter that program and invest auction revenues in priority clean energy areas, with transportation electrification identified as a key strategy. The plan specifies that NJEDA will receive 60% of the state's RGGI revenues and that the electrification of M/HD vehicles operated by commercial and industrial businesses in the state. NJEDA's emphasis on M/HD vehicle electrification is also intended to stimulate local supply chain capacity for green job creation.<sup>65</sup>

The New Jersey Department of Environmental Protection (NJDEP) was the first state to propose regulations to adopt California's Advanced Clean Trucks (ACT) program in April 2021, and adopted this regulation in December 2021 so that sales requirements will take effect in truck model year 2025.<sup>66</sup>

### 3.3.4 Utility Infrastructure Programs

Electric utilities in New Jersey have not yet developed or been approved for assistance programs specific to M/HD vehicle fleets to facilitate EV adoption. However, a recent order from NJBPU adopts a framework for utilities in the state to cover the costs of make-ready investment associated with EV infrastructure for light-duty applications.<sup>67</sup> An analogous NJBPU straw proposal for utility programs to support M/HD applications was released in mid-2021 and a revised straw proposal is anticipated in early 2022. This M/HD straw proposal will provide structure for New Jersey's programs to provide utility assistance for truck fleet electrification, such as utility investment in fleet make-ready infrastructure and rate design for fleet use-cases.

## 3.4 Connecticut

Connecticut Executive Order 2019-1 created a Steering Committee on State Sustainability to direct executive branch agencies to reduce GHG emissions from vehicle fleets by expanding the state's existing "Lead by Example" program. The Committee will develop an action plan to achieve emissions reduction goals set by the Governor.<sup>68</sup> In April 2020, the Connecticut Department of Energy and Environmental Protection (DEEP)

<sup>64</sup> New Jersey Partnership to Plug-In. (2019). Memorandum of Understanding Among the New Jersey Department of Environmental Protection, the New Jersey Board of Public Utilities and the New Jersey Economic Development Authority. Retrieved from [https://drivegreen.nj.gov/pdf/MOU\\_6.3.19.pdf](https://drivegreen.nj.gov/pdf/MOU_6.3.19.pdf)

<sup>65</sup> New Jersey, State of. (2020). *Regional Greenhouse Gas Initiative Strategic Funding Plan: Years 2020 through 2022*. Retrieved from <https://nj.gov/rggi/docs/rggi-strategic-funding-plan.pdf>

<sup>66</sup> N.J.A.C. 7:21-31 and 33. Advanced Clean Trucks Program and Fleet Reporting Requirements. Notice of Adoption (2021). Retrieved from [https://www.nj.gov/dep/rules/adoptions/adopt\\_2021220a.pdf](https://www.nj.gov/dep/rules/adoptions/adopt_2021220a.pdf)

<sup>67</sup> New Jersey Board of Public Utilities. (2020). *In the Matter of Straw Proposal on Electric Vehicle Infrastructure Build Out. Order Adopting the Minimum Filing Requirements for Light-Duty, Publicly-Accessible Electric Vehicle Charging* (Docket NO. QO20050357). Retrieved from <https://www.nj.gov/bpu/pdf/boardorders/2020/20200923/8F%20-%20ORDER%20Electric%20Vehicle%20MFRs.pdf>

<sup>68</sup> Conn. Exec. Order No. 2019-1 (Apr. 24, 2019). Retrieved from <https://portal.ct.gov/-/media/Office-of-the-Governor/Executive-Orders/Lamont-Executive-Orders/Executive-Order-No-1.pdf>

published its final Electric Vehicle Roadmap for Connecticut to accelerate electric vehicle adoption across the state, including recommendations for actions to assess the success of incentive programs and regulations in other jurisdictions (namely California and New York) that are advancing M/HD vehicle electrification.<sup>69</sup>

### *3.4.1 Statutes and Legislation*

Unlike in New York and New Jersey, Connecticut requires legislative authorization to adopt California vehicle regulations. In early 2022, the Connecticut legislature held a hearing for House Bill 5309, which instructs the Connecticut Department of Energy and Environmental Protection (DEEP) to adopt California's medium- and heavy-duty vehicle regulations, which include the Advanced Clean Trucks rule.<sup>70</sup> If adopted, the legislation would go into effect on July 1, 2022.

Connecticut has implemented numerous laws and regulations related to the acceleration of all-electric and alternative fuel vehicle adoption and GHG emissions reductions from transportation. Connecticut General Statute 16-19ggg, for example, requires owners and operators of public EVSE to allow multiple payment options, not require subscription to use services, as well as require the disclosure of the location and characteristics of each site to the U.S. Department of Energy Alternative Fuels Data Center.<sup>71</sup> This same statute requires DEEP to develop building standards that include EV charging stations.

The Connecticut Department of Administrative Services also demonstrates price preference in the bidding of state contracts for the purchase of alternative fuel vehicles or for conversion technology of conventional vehicles. That is, when evaluating bids for contracts, the awarding authority commissioner may give a ten percent price preference when determining the lowest responsible qualified bidder for the project. This encourages bidders for state contracts to include the provision for clean vehicles in their application even if this raises their bid, which can include either purchasing clean vehicles or purchasing and converting other vehicles to allow the use of clean fuels.<sup>72</sup>

### *3.4.2 Grant and Incentive Programs*

Connecticut sponsors several financial incentives aimed at incentivizing all-electric and alternative fuel vehicle adoption and emissions reductions. In particular, DEEP allocates funds from the VW Environmental Mitigation Trust to support the replacement or repowering of heavy-duty vehicles with alternative fuel vehicles for both public and private entities.<sup>73</sup> The Connecticut Green Bank has also sought to make it easier for commercial properties to install EV chargers, whether for retail, employee, or fleet use. In early 2020, the CT Green Bank announced Charge Up CT Buildings, a limited-time initiative that provided free Level 2

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<sup>69</sup> Connecticut Department of Energy and Environmental Protection (DEEP). (2020). Electric Vehicle Roadmap for Connecticut. Retrieved from <http://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d>

<sup>70</sup> Connecticut HB5309, An Act Concerning Medium- and Heavy-Duty Vehicle Emission Standards. (2022). Retrieved from <https://www.cga.ct.gov/2022/TOB/H/PDF/2022HB-05039-R00-HB.PDF>

<sup>71</sup> Public Act 16-135, S. 7, Conn. General Statutes § 16-19ggg (2016).

<sup>72</sup> Public Act 91-179, Conn. General Statutes 4a-59 § (1991).

<sup>73</sup> Connecticut DEEP. (n.d.). VW Grant Information. Connecticut's Official State Website. Retrieved from <https://portal.ct.gov/DEEP/Air/Mobile-Sources/VW/VW-Settlement---Grants>

charging stations to commercial properties utilizing at least \$150,000 in Commercial Property Assessed Clean Energy (C-PACE) financing through the Green Bank for other energy improvements.<sup>74</sup>

Financial incentives also include the stipulation that emissions reduction credit programs must allow credits for alternative fuel conversions for vehicles, to ensure that such technologies remain competitive compared to conventional vehicles, even if the conversion took place before the program began.<sup>75</sup> Lastly, The Connecticut Department of Revenue Services issues a reduced CNG and propane tax to incentivize their usage.<sup>76</sup>

### *3.4.3 Administrative Actions and Regulation*

Per the above-referenced legislation (HB5309), CT DEEP may be required to adopt California's emissions standards for medium- and heavy-duty vehicles in mid-2022, which would include zero-emission truck sales requirements under the Advanced Clean Trucks program.

### *3.4.4 Utility Infrastructure Programs*

DEEP is required to deliver a biennial report in consultation with electric distribution companies on the potential for EVs to provide energy storage and other services to the grid with defined strategies to keep up with EV adoption in the state.<sup>77</sup> The Public Utilities Regulatory Authority (PURA) also requires that utility companies include contingencies with EV charging load projections in electricity distribution planning.<sup>78</sup> Utility companies are likewise required to implement EV time-of-day rates for both residential and commercial customers.<sup>79</sup> In late 2021, PURA opened a new regulatory docket on medium- and heavy-duty electric vehicle charging but no activity has taken place in this docket as of March 2022.<sup>80</sup>

## *3.5 Pennsylvania*

In 2019, Executive Order 2019-01, 2019 set ambitious goals for Pennsylvania's state agencies to replace 25% of their passenger car fleets with plug-in electric vehicles (PEVs) by 2025 and make evaluations about fleet composition to reduce vehicle miles traveled. This executive order also required the Governor's Green Government Council to help oversee the actions and procedures required of state agencies. Pennsylvania,

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<sup>74</sup> Connecticut Green Bank. (2020). "Free EV Charging Stations for Commercial Properties Financing Efficiency Projects through C-PACE." Retrieved from <https://www.ctgreenbank.com/charge-up-ct-buildings-ev-campaign/>

<sup>75</sup> Public Act 94-170, S. 4, 5, Conn. General Statutes § 22a-174i (1994).

<sup>76</sup> Public Act 07-199, Conn. General Statutes § 12-458 (2007).

<sup>77</sup> Public Act 16-135, Conn. General Statutes § 16a-3e (2012).

<sup>78</sup> Public Act 16-135, Conn. General Statutes § 16-19fff (2016).

<sup>79</sup> Public Act 13-298, Conn. General Statutes § 16-19f (2013).

<sup>80</sup> Connecticut Public Utilities Regulatory Authority (PURA). (2021). 21-09-17: PURA Investigation into Medium- and Heavy-Duty Electric Vehicle Charging. Retrieved from [http://www.dpuc.state.ct.us/DOCKCURR.NSF/\(Web+Main+View/All+Dockets\)?OpenView&StartKey=21-09-17](http://www.dpuc.state.ct.us/DOCKCURR.NSF/(Web+Main+View/All+Dockets)?OpenView&StartKey=21-09-17)

as such, is embracing electrification in the near-term future with the goal of reducing emissions and energy usage.<sup>81</sup>

### 3.5.1 Statutes and Legislation

There are no statutes or legislation relevant to alternative fuel freight vehicles in Pennsylvania.

### 3.5.2 Grant and Incentive Programs

Driving Pennsylvania Forward offers competitive reimbursement grants for heavy-duty trucks and transit buses, for both replacements and repowers. In addition, the program offers competitive grants for EVSE and hydrogen fuel cell infrastructure along transportation corridors, at destination locations, and at community charging/fueling hub locations.<sup>82</sup> The Alternative Fuels Incentive Grant (AFIG) Program offers grants for various relevant causes. One of these, which closed to new applications in March 2020, was the Pennsylvania FAST Act Corridor Infrastructure Grant, which sought to reimburse the installation of public electric, hydrogen, propane, and CNG fueling infrastructure along “Signage Ready” and “Signage Pending” highway corridors. Municipal authorities, political subdivisions, non-profits, corporations, and limited-liability companies or partnerships all qualify for the application.<sup>83</sup> AFIG also offers grants aimed at incentivizing the expansion of AFV technology usage for those same entities. Finally, the Alternative and Clean Energy (ACE) Program, sponsored by the Pennsylvania Department of Community and Economic Development (DCED), provides both grants and loans to applicants involved in the utilization, development, and construction of compressed and liquefied natural gas fueling stations.<sup>84</sup>

In addition to setting benchmarks for electrification success for state agencies, Pennsylvania administers and offers various financial incentive programs intended to facilitate the transition to cleaner vehicles, including M/HD vehicles. One such example is the Driving Pennsylvania Forward program, sponsored by the Pennsylvania Department of Environmental Protection (DEP) funded by the state’s portion of the settlement from the VW Environmental Mitigation Trust.<sup>85</sup> This program includes rebates for M/HD vehicle replacement or repower projects using all-electric, alternative fuel (natural gas, propane, or hydrogen), or cleaner diesel technologies, and includes a scrappage requirement. In addition to the rebates for vehicle replacement, the program also offers rebates for the purchase, installation, operation, and maintenance of EVSE (Level 2) for publicly accessible government- or privately-owned land, workplaces, or private multi-unit dwellings. Other opportunities include Pennsylvania’s Alternative Fuel Vehicle Rebate Program, which reduces the

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<sup>81</sup> Penn. Exec. Order No. 2019-01 (Jan. 8, 2019). Retrieved from <https://www.governor.pa.gov/newsroom/executive-order-2019-01-commonwealth-leadership-in-addressing-climate-change-and-promoting-energy-conservation-and-sustainable-governance/>

<sup>82</sup> Driving Pennsylvania Forward. (n.d.). Grant and Rebate Programs. Pennsylvania Department of Environmental Protection. Retrieved from <http://www.depgis.state.pa.us/DrivingPAForward/>

<sup>83</sup> Pennsylvania Department of Environmental Protection. (n.d.). Alternative Fuels Incentive Grant Program (AFIG). Commonwealth of Pennsylvania. Retrieved from <https://www.dep.pa.gov/Citizens/GrantsLoansRebates/Alternative-Fuels-Incentive-Grant/Pages/default.aspx>

<sup>84</sup> Pennsylvania Department of Community and Economic Development. (n.d.). Alternative and Clean Energy Program (ACE). Commonwealth of Pennsylvania. Retrieved from <https://dced.pa.gov/programs/alternative-clean-energy-program-ace/>

<sup>85</sup> Supra note 82

incremental cost of such vehicles for eligible state residents. This program includes an additional rebate if the recipient qualifies as low-income.<sup>86</sup>

In early 2022, Pennsylvania Department of Environmental Protection (DEP) published a request for information regarding development of a medium- and heavy-duty zero-emission vehicle pilot grant program. If implemented, this program would be funded using Volkswagen Settlement funding. RFI responses are being accepted until March 28, 2022 and decisions regarding program implementation will be made thereafter.<sup>87</sup>

### 3.5.3 Administrative Actions and Regulation

There are no administrative actions or regulations relevant to alternative fuel freight vehicles in Pennsylvania.

### 3.5.4 Utility Infrastructure Programs

Pennsylvania does not have any statewide utility regulatory approvals or programs in place for EVs, but there is precedent for investor-owned utilities offering resources to facilitate fleet electrification for commercial customers. PECO, Philadelphia's main electric utility, offers a Level 2 charger rebate of up to \$500 per charger for commercial customers, up to a maximum benefit of \$1500 per customer.<sup>88</sup> None of the state's major utilities, including PECO, offer make-ready infrastructure assistance for commercial fleets and information on EV rate design for fleets is not available. There is also no information regarding utility resources for DC fast charger installations.

## 3.6 Policy Outlook

While there is significant policy support for diesel alternatives within the study region, additional actions must be taken to achieve the policy objectives (for greenhouse gas emissions, air quality, and zero-emission sales) of the states and cities in this region. Diesel fuel is a well-established norm for freight vehicle fleets in this region with familiar systems and patterns for fueling, operations, and maintenance. Scaling up adoption of diesel alternatives requires a robust and holistic policy environment that supports fleet procurement (e.g., through vehicle and infrastructure purchase incentives) and operation (e.g., through utility investments and accommodating rate design) to enable all-electric and alternative fuel technologies to better compete with diesel technology on a total cost of ownership basis.

The policy outlook is brightest for zero-emission, non-combustion technologies—battery electric vehicles and hydrogen fuel cell vehicles. Each of the four states discussed in this technical memo has signed onto the Multi-State Medium- and Heavy-Duty Zero-Emission Vehicle Memorandum of Understanding, which sets new and aggressive targets for a 30% zero-emission share of M/HD sales by 2030 and 100% by 2050. Meeting these lofty goals will require concerted action by signatory states above and beyond the resources

<sup>86</sup> Pennsylvania Department of Environmental Protection. (n.d.). Alternative Fuel Rebates for Consumers. Commonwealth of Pennsylvania. Retrieved from <https://www.dep.pa.gov/Citizens/GrantsLoansRebates/Alternative-Fuels-Incentive-Grant/Pages/Alternative-Fuel-Vehicles.aspx>

<sup>87</sup> Pennsylvania Department of Environmental Protection. (2022). Proposed Medium and Heavy-Duty Zero Emission Vehicle Pilot Grant Program; Request for Information. Retrieved from <https://www.pacodeandbulletin.gov/Display/pabull?file=/secure/pabulletin/data/vol52/52-9/324.html>

<sup>88</sup> PECO. (2018). *PECO Commercial Level 2 Electric Vehicle Charger Rebate*. Retrieved from <https://www.peco.com/SiteCollectionDocuments/PECOL2EV.pdf>

currently in place. Recommended actions are outlined in the draft Multi-State Action Plan, to be finalized in mid-2022. The states discussed above currently have funding programs in the form of grants, rebates, vouchers, or tax incentives to emphasize electrification of M/HD vehicle fleets, but these programs likely will need to be extended, deepened and harmonized to have sufficient impact. The incentive programs in New York and New Jersey are some of the strongest in the nation and with the possibility of zero-emission incentives in Pennsylvania can build a robust regional market for zero-emission trucks. Overall, there is a clear trend toward greater electrification of M/HD vehicles across the region, with new legislation and agency actions indicating this momentum should continue and expand.

The emergence of structures for utility involvement and investment in fleet electrification, led by utilities in New York, lays a groundwork for expanding EV infrastructure and can be replicated by other utilities and states in the region. Hydrogen fuel cell technology is not as mature as electric vehicle technology in the Northeast region, and its growth may face regulatory challenges such as New York City's prohibitions on the transportation of compressed gases and the ban on operation of fuel cell vehicles for certain regionally important crossings such as the Hugh L. Carey tunnel connecting Lower Manhattan and Western Brooklyn.

While there are also measures in place to support the adoption of compressed natural gas and propane use for M/HD vehicles in the study region, these fuels share some of the same regulatory hurdles as hydrogen fuel cell technology. As with hydrogen fuel, New York and Pennsylvania have programs to incentivize CNG and propane M/HD vehicles and Pennsylvania also incentivizes refueling infrastructure. In addition, New Jersey and Connecticut have tax incentives for these fuel types. Still, moratoriums on new facilities and prohibitions on the transportation of these fuels (namely propane in New York City) pose challenges to their adoption at scale. Perhaps more importantly, despite being significantly cleaner burning than diesel, these fuels systems still involve combustion of fossil fuels. As such, these combustion alternative fuels are not receiving the same beneficial policy emphasis as energy sources that do not require direct combustion. In New York, for example, natural gas and propane trucks can qualify for incentive funding, but at a significantly lower amount than zero-emission trucks. New Jersey's truck funding program focuses exclusively on zero-emission technologies, and upcoming modifications to New York's program will shift all remaining funding for zero-emission technologies. Taken together, natural gas and propane are viable fuel types in the near-term but appear unlikely to receive sufficient policy support to reach critical mass in the years ahead as zero-emission technologies receive the bulk of policy attention.

## 4.0 Alternative Fuel Vehicle Technology Scan and Projections

The task objective for the marketing projection analysis was to assess opportunities for the development of the Clean Freight Corridors in the multi-state study area (including Connecticut, New Jersey, New York, and Pennsylvania) that are integrated within the larger Multi-State Metropolitan Region. This section of the report aims to provide brief assessments of the present technological outlook for each alternative fuel technology, including regional adoption rates, the role of autonomous vehicle (AV) technology, and several brief case studies of fleets that have adopted these technologies for long-haul, warehouse, and delivery applications.

### 4.1 Alternative Fuels Technology Scan

While alternative fuel vehicle (AFV) options are continually expanding and the underlying technologies are rapidly improving, these technologies still face fundamental barriers to adoption. Some of these barriers persist as constraints to adoption, including the characteristically higher upfront capital cost and the lack of adequate or accessible fueling infrastructure. Other barriers are more a function of perception than current reality, such as the belief that AFV technologies cannot provide needed levels of performance (e.g., driving range or payload capacity) or that AFV model availability is insufficient to support viable fleet operations.

To better assess the extent to which these barriers continue to impede fleet adoption, and how the technologies are evolving to overcome past shortfalls, it is necessary to understand the current market conditions of various alternative fuel vehicle types. The subsections that follow characterize the efficiency, performance, cost, manufacturer offerings, and infrastructure considerations for the vehicle propulsion technologies that use each of the major alternative fuel types covered by this study: battery electric vehicles, hydrogen fuel cell electric vehicles, liquefied petroleum gas vehicles, and compressed natural gas vehicles. This section closes with an assessment of the state of play for autonomous vehicle technology and its potential to improve overall truck freight efficiency.

#### 4.1.1 Battery Electric Vehicles

Recent advances in battery electric vehicle (BEV) technology have helped to highlight the benefits of electric charging as an alternative to diesel fueling, in turn raising commercial fleet demand for these products. One key factor is the high energy efficiency and low cost of fueling that BEVs offer. According to the U.S. Department of Energy (DOE), BEVs propulsion systems productively use 77% of the electricity consumed by their batteries, as opposed to conventional internal combustion engine (ICE) vehicles, which convert between 12-30% of the primary energy stored in gasoline.<sup>89</sup> In addition to the energy conversion factor, BEVs are able to recapture a significant amount of the energy they use through regenerative braking; depending on the drive cycle, this feature can further extend the driving range by 10-25%<sup>90</sup> and increase overall efficiency. The advantages in energy efficiency and fuel economy (measured in miles per gallon of diesel equivalent (MPGDE) or kilowatt-hours (kWh)) for

<sup>89</sup> U.S. Department of Energy Office of Energy Efficiency & Renewable Energy: All-Electric Vehicles. Retrieved from <https://fueleconomy.gov/feg/evtech.shtml>

<sup>90</sup> Jha, S. (2020, August 27). Fast and Agile Regenerative Braking is Redefining Vehicle Dynamics. Retrieved from <https://www.electronicdesign.com/markets/automotive/article/21140424/global-marketing-insights-fast-and-agile-regenerative-braking-is-redefining-vehicle-dynamics>

BEVs relative to diesel vehicles can result in significant operating cost savings; the cost to operate a HD BEV is an average of \$0.24 (USD) per mile as opposed to the comparable diesel cost of \$0.50 (USD) per mile.<sup>91</sup> EVs also have fewer moving parts, which results in lower maintenance costs; the electrical systems of EVs typically require less attention and regenerative braking extends brake life, while the absence of fluids such as engine oil minimizes the need for scheduled maintenance.

EVs provide a quieter, smoother, and quicker acceleration compared to conventional ICE vehicles. Although EVs have higher upfront costs compared to conventional ICE vehicles, mostly attributed to battery cost, the total cost of ownership (TCO) is still lower for EVs in high-mileage applications and where electricity costs can be effectively managed.

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<sup>91</sup> Welch, D., Facanha, C., Kroon, R., Jousma, F., & Weken, H. (2020). *Moving Zero-Emission Freight Toward Commercialization*. CALSTART. Retrieved from <https://globaldrivetozero.org/publication/moving-zero-emission-freight-toward-commercialization/>

Table 4-1. Comparison of Alternative Fuel Types

| Fuel Type  | INFRASTRUCTURE COST                                                                                            | Fuel Cost                                                                                                                                                           | Pros                                                                                                                                                                                                                                                                                               | Cons                                                                                                                                                                                                                                                                                                                                                  |
|------------|----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>EV</b>  | Level 3 (DC Fast Charging) material and installation costs can vary from \$14,000 to \$91,000.                 | Fuel costs are highly variable between states and utilities. Some utilities have produced special rate programs for commercial EVs to lower fuel costs.             | <ul style="list-style-type: none"> <li>Cheaper TCO compared to ICE vehicles.</li> <li>Zero tailpipe emissions and reduced lifecycle GHG emissions.</li> <li>High energy efficiency.</li> </ul>                                                                                                     | <ul style="list-style-type: none"> <li>Long charging times.</li> <li>Most public fast charging not designed for trucks.</li> <li>High upfront vehicle cost.</li> <li>Limited vehicle model availability for certain duty cycles.</li> </ul>                                                                                                           |
| <b>H2</b>  | Average of ~\$4 million per filling station.                                                                   | The average price for open retail hydrogen fuel is \$13.99/kg. Price parity is expected to occur when hydrogen is priced at \$8/kg assuming \$3.50/gasoline gallon. | <ul style="list-style-type: none"> <li>Lower TCO at high production volumes.</li> <li>Zero tailpipe emissions and reduced lifecycle GHG emissions.</li> <li>Significantly greater energy efficiency (compared to ICE vehicles) makes hydrogen fuel suitable for long-haul applications.</li> </ul> | <ul style="list-style-type: none"> <li>Large fuel throughput needed to justify station costs.</li> <li>Limited fueling availability currently.</li> <li>Regulatory restrictions on transport and storage of compressed gases.</li> <li>Limited vehicle model availability.</li> <li>Most hydrogen is currently produced with fossil fuels.</li> </ul> |
| <b>LPG</b> | Small propane station averages around \$65,000. Larger stations can cost up to \$2 million.                    | Fuel costs are variable but typically fall between the cost of regular gasoline and natural gas.                                                                    | <ul style="list-style-type: none"> <li>Infrastructure can be relatively affordable.</li> <li>Existing fueling network is already widespread.</li> </ul>                                                                                                                                            | <ul style="list-style-type: none"> <li>Produces tailpipe emissions.</li> <li>Lower energy content per diesel gallon equivalent.</li> </ul>                                                                                                                                                                                                            |
| <b>CNG</b> | Costs of installation vary widely with CNG stations ranging from \$1 to \$4 million with fast-fill dispensers. | Heavy-duty CNG trucks can carry a 40 to 80% price premium over diesel alternatives.                                                                                 | <ul style="list-style-type: none"> <li>Despite higher premiums, heavy-duty trucks can save ~\$30,000 per year in fuel and maintenance costs in some applications.</li> <li>Most common alternative fuel in the study area</li> </ul>                                                               | <ul style="list-style-type: none"> <li>Tailpipe emissions.</li> <li>Lower energy content per diesel gallon equivalent.</li> </ul>                                                                                                                                                                                                                     |

Furthermore, the batteries in BEVs are designed to last over the course of the lifetime of the vehicle (expected to be 7-10 years<sup>92</sup> as opposed to diesel trucks which are often able to run 10-15 years), limiting the need for replacements which can be especially costly if the vehicle warranty has expired.<sup>93</sup> Despite these benefits, a gap of BEV-specific training remains to be addressed in the automotive maintenance workforce.<sup>94</sup> A lack of familiarity with BEV charging, maintenance, and operation remains a barrier to some fleet customers as they consider transitioning away from more familiar diesel systems to BEV technologies.

EVs are often promoted for their environmental benefits. The vehicle's battery provides all the energy necessary for the drivetrain and additional onboard accessories, resulting in zero tailpipe emissions. In addition to the emissions reduction benefits associated with the BEV operation, there is a mounting opportunity to create a 100% zero emissions energy supply through the investment in wind, solar, and other renewable electricity sources.

The upfront purchase premium of BEVs over comparable diesel vehicles, driven primarily by their large battery packs, is a significant hurdle for many commercial fleets. Economies of scale have helped offset this concern in some circumstances, but the market is still expanding and evolving to meet the needs of many kinds of fleets. In cases of on-road accidents or malfunctions, the cost to replace the battery itself can be prohibitive. And the wear and tear of the battery over time results in capacity degradation, which may prevent the vehicle from reliably performing to its duty cycle standard and this reduced range may turn fleets away from this technology. However, with a variety of automakers working to develop so-called “million-mile” batteries that will support many years of high mileage use, capacity degradation is expected to fade from being a significant deterrent to integration of BEV technology for freight vehicles.<sup>95</sup>

Model availability and performance for BEV truck technologies has rapidly improved in recent years and EV offerings and capabilities are poised to continue expanding. As of fall 2020, the North American market for M/HD BEVs covered a wide range of vehicle platforms, including: cargo vans, box trucks, straight trucks, step vans, and heavy-duty trucks including drayage trucks and regional-haul tractors. A range of original engine manufacturers (OEMs) and upfit/retrofit manufacturers (URMs) have seeded the incipient market with offerings throughout the commercial vehicle spectrum but more concentrated at the lighter end; these pioneering brands include BYD, Chanje, Envirotech, Lightning eMotors, Lion Electric, Motiv Power Systems, Phoenix Motorcars, SEA Electric, Unique Electric Solutions, and Workhorse. Additional brands, ranging from well-established truck OEMs to startups, are expected to launch commercial production for additional BEV truck products in North America between now and 2023, including Arrival, Avevai, Emoss, Freightliner, Hyundai, International, Kenworth, Mercedes-Benz, Meritor, Neuron EV, Nikola, Peterbilt, Phoenix Motorcars,

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<sup>92</sup> <https://nacfe.org/emerging-technology/electric-trucks/>

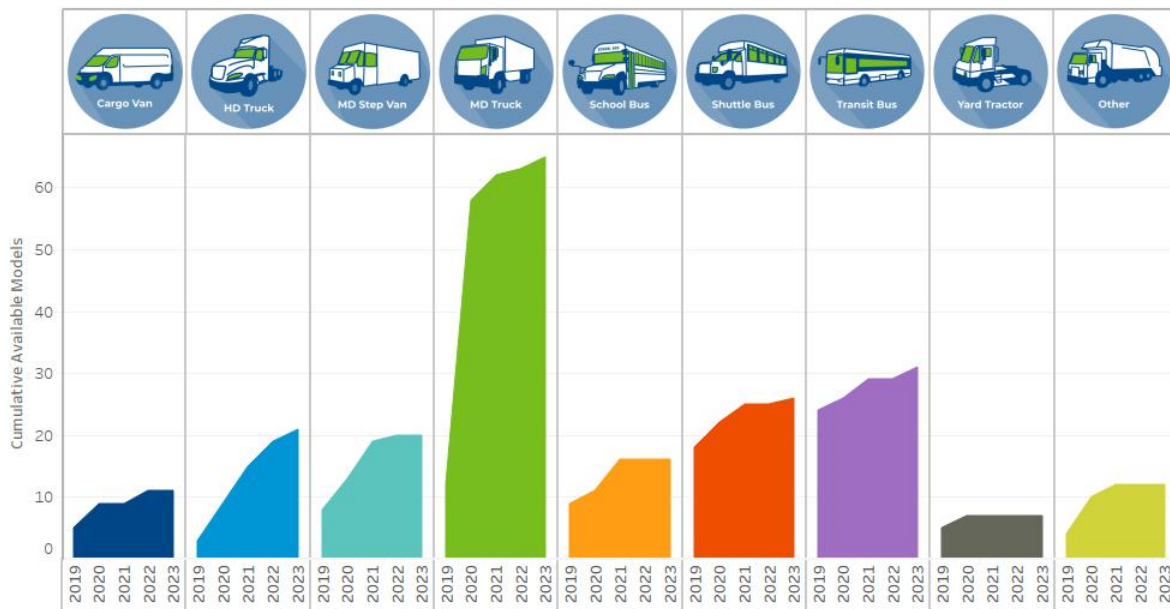
<sup>93</sup> Alternative Fuels Data Center: Maintenance and Safety of Hybrid and Plug-In Electric Vehicles. Retrieved from [https://afdc.energy.gov/vehicles/electric\\_maintenance.html](https://afdc.energy.gov/vehicles/electric_maintenance.html)

<sup>94</sup> Gilde, A., Norris, J., Scott, C., Okazaki, K., & Gordon, J. (2020). *Alternative Fuel Infrastructure Corridor Coalition (AFICC): Medium- and Heavy-Duty Alternative Fuel Infrastructure Strategic Development Plan*. CALSTART. Retrieved from <https://westcoastcollaborative.org/files/sector-fuels/wcc-aficc-mhd-infrastructure-development-plan-2020-03-12.pdf>

<sup>95</sup> See, e.g., <https://www.wired.com/story/what-happens-after-a-million-mile-battery-outlasts-the-car/>

Rivian, ROUSH CleanTech, SEA Electric, Tesla, Volvo, and Xos.<sup>96</sup> More OEMs are slated to join this market in the coming years as policy and legislation signal a more definitive transition toward zero-emission technologies in coming years. As of year-end 2019, the leading M/HD platform type in terms of commercially available BEV models was transit bus. However, urban delivery applications also provide a conducive environment for BEV technology through a combination of short duty cycle, back-to-base operation, and fairly fixed-route service. As such, model availability for BEV delivery formats, including medium-duty trucks, medium-duty step vans, and cargo vans, is projected to grow most dramatically in the next 1-2 years (see Figure 4-1).

**Figure 4-1. Zero-emission model availability by M/HD platform type, 2019-2023  
(CALSTART Zero-Emission Technology Inventory)**



<sup>96</sup> Zero-Emission Technology Inventory. CALSTART. Retrieved from <https://globaldrivetozero.org/tools/zero-emission-technology-inventory/>

## Driving Deliveries of the Future

*IKEA is a globally recognized retailer known for its ready-to-assemble furniture. Perhaps lesser known are IKEA's bold commitments to climate action and their vision of becoming "People & Planet Positive" by 2030. In addition to investments in renewable energy and installing electric vehicle charging stations for customers at every retail location worldwide, IKEA's environmental stewardship now extends to the technology it uses to deliver its goods to customers. In 2018, the Ingka Group, which owns the last-mile segment of IKEA's business, announced that 100% of its home deliveries globally will be made using zero-emission technology by 2025. It further identified New York, Los Angeles, Amsterdam, Paris, and Shanghai as its first priority markets for zero-emission truck deployments beginning in 2020.*

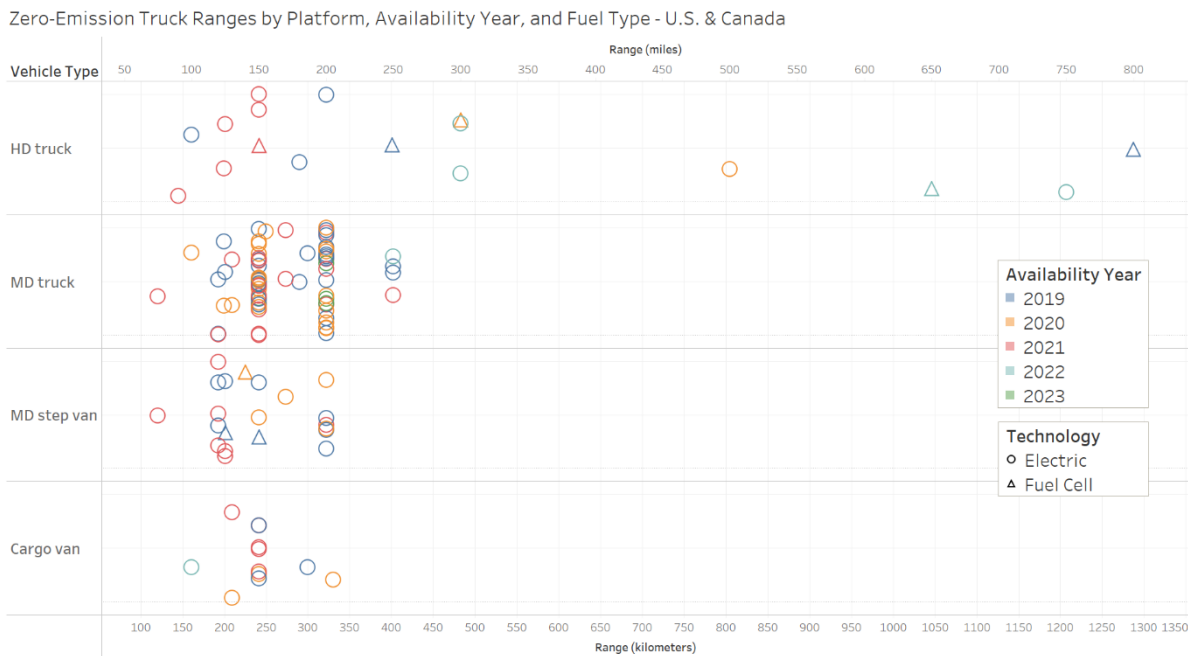
*In New York, the company has deployed ten battery electric vehicles (BEVs) thus far, including five Lightning eMotors Ford E-450 trucks and five Workhorse C1000 step vans, with plans for 34 more electric trucks to come later in 2021. Though these vehicles have been in service for just a few months as of this writing, the drivers of these BEVs have already indicated excitement and positive responses to the electrification transition. One challenge that IKEA has confronted is that it does not own its delivery vehicles. Therefore, these vehicles are procured and operated by contract carriers on behalf of third-party logistics providers, and many of the contract carriers are small fleets that own just a few trucks. For many of these fleets, the high upfront investment associated with BEVs is prohibitive. To make good on its last-mile commitment while making BEV technology accessible to its operators, IKEA has partnered with Fluid Truck to offer BEVs for daily and weekly rental at reasonable rates for contract carriers on an app-based platform.*

*Having successfully navigated the difficulties surrounding vehicle acquisition, the next largest obstacle is providing sufficient charging infrastructure. Steven Moelk, IKEA's Fulfillment Project Implementation Manager for zero-emission delivery, notes that his team is in "a race against the clock on the infrastructure side." His objective is to provide dedicated charging for all 44 vehicles at IKEA's Staten Island Customer Distribution Center, so that operators aren't responsible for installing and maintaining their own charging equipment for the rented trucks. However, Mr. Moelk acknowledges that public fast charging along corridors would be useful for IKEA's contract carriers to enable them to more confidently complete longer routes using BEVs. Part of his infrastructure plan involves coordinating with other fleets, charging providers, utilities, and potential site hosts to share and optimize multi-use charging hubs near existing IKEA distribution centers. This will also offer a range of benefits and opportunities to decarbonize more of the transportation system around such charging hubs. According to Mr. Moelk, "The only way we get to 100% zero-emission is to think beyond IKEA."*



Consistent with the formats dominating currently available BEV truck offerings, the maximum driving range for today's BEV trucks is clustered near or below 150 miles. As battery technology improves to become cheaper and lighter, longer-range models (particularly for heavy-duty tractors) have been slated for commercial production between 2021 and 2023 (see Figure 4-2).<sup>97</sup>

**Figure 4-2. Zero Emission Truck Model Availability by Truck Type and Estimated Driving Range (Expected Date of Commercial Availability Indicated)**



Many concerns surrounding BEV adoption—particularly for regional- and long-haul applications—can be eased with abundantly available high-power charging infrastructure located strategically along commercial or freight corridors. Even for urban freight vehicles, accessible high-speed public charging can supplement lower-speed depot charging and/or allow the purchase of lighter vehicles with smaller battery packs.<sup>98</sup> Level 1 and Level 2 deliver alternating current (AC) from a charging station to the vehicle's internal charging equipment, which converts it to direct current (DC) needed to charge the vehicle's battery. Level 2 is most common and charges at between 6-20 kilowatts (kW). Level 3, or DC fast charging (DCFC), delivers direct current energy straight into the vehicle's onboard battery at 480 volts and anywhere from 25-350 kW and can be advantageous for vehicles without long uninterrupted stretches (at least 8-10 hours) of dwell time in which to charge large battery

<sup>97</sup> The Zero-Emission Technology Inventory tracks commercial availability of both battery electric and hydrogen fuel cell electric commercial vehicle models; the vast majority of currently available models are BEV but Figures 1 and 2 characterize both technology types.

<sup>98</sup> Supra note 91

packs.<sup>99</sup> Depending on the fleet needs, battery size, charger type, and available charging windows, vehicles may take 3-12 hours to fully recharge.

Beyond charging speed, several other factors must be considered when configuring charging infrastructure projects. First is the upfront cost of equipment purchase and installation. Not including the EVSE material costs, DCFC stations are often the most convenient for commercial fleets needing to recharge quickly along their routes, but entail high upfront investments that can range between \$14,000 and \$91,000 including equipment and labor costs.<sup>100</sup> Another confounding variable is the lead time necessary for planning and obtaining permits. Depending on the location, electricity may or may not be available at the desired voltage for a charging station, or power service (maximum kW available) may be insufficient to add charging infrastructure without service upgrades. Fleet vehicles that return to depots for overnight storage may have longer charging windows that can be met with Level 2 chargers. Vehicles that operate around the clock may only have time for quick charges in-depot or along service routes and would be better suited to Level 3 charging. Grid and electrical upgrades require months of permitting approvals, preparation, and construction time before the chargers are commissioned. EVSE site hosts must also consider the financial impact of demand charges, a per-kilowatt charge based on the period of greatest power demand in a month.<sup>101</sup> For fleet managers unaccustomed to managing utility bills, demand charges can be an unexpected cost element, though “smart charge” management software or onsite battery energy storage solutions may enable fleets to manage power demand and mitigate demand charge cost impacts to an extent.

#### 4.1.2 Hydrogen Fuel Cell Electric Vehicles

The hydrogen fuel cell electric vehicle (FCEV) market is in a more nascent stage of commercialization compared to BEVs but shows promise to be as good a fit or better for specific commercial vehicle applications. Currently the only commercially available FCEV M/HD models are transit buses, though a handful of OEMs have announced that they will be bringing long-range FCEV tractors to market in the next 2-3 years. For example, Nikola Motors has announced multiple partnerships and raised over \$1 billion for the development and production of its HD fuel cell models, even securing a purchase commitment from Anheuser-Busch.<sup>102</sup> Others entering the market include Hyundai, Hyzon Motors, Toyota/Kenworth, Unique Electric Solutions, and US Hybrid.<sup>103</sup> Due to the novelty of the technology, with most companies still in the product development and prototyping phases of commercialization, and the lack of economies of scale in the use of fuel cells for vehicle propulsion, FCEVs are significantly more expensive than conventional diesel models.

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<sup>99</sup> Greene, D. L., & Baker, H. H., Jr. (2015, January). *Alternative Transportation Refueling Infrastructure in the U.S. 2014: Status and Challenges*. Retrieved from <https://energy.gov/epsa/downloads/alternative-transportation-refueling-infrastructure-us-2014-status-and-challenges>

<sup>100</sup> Smith, M., Castellano, J. (2015). *Costs Associated with Non-Residential Electric Vehicle Supply Equipment: Factors to consider in the implementation of electric vehicle charging stations*. Washington, D.C.: U.S. Department of Energy. Retrieved from [https://afdc.energy.gov/files/u/publication/evse\\_cost\\_report\\_2015.pdf](https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf)

<sup>101</sup> Ibid.

<sup>102</sup> Nikola. (2019). *Anheuser-Busch Completes First Zero-Emission Beer Delivery* [Press release]. Retrieved from [https://nikolamotor.com/press\\_releases/anheuser-busch-completes-first-zero-emission-beer-delivery-69](https://nikolamotor.com/press_releases/anheuser-busch-completes-first-zero-emission-beer-delivery-69)

<sup>103</sup> Supra note 96

Paired with the high cost of the vehicle itself, as of 2018 hydrogen fuel carried an average open retail price of \$13.99/kilogram (kg).<sup>104</sup> For reference, \$8/kg is believed to be the point at which FCEVs can reach total cost of ownership parity with diesel for commercial vehicles.<sup>105</sup> These factors, combined with the risks associated with earlier-stage technologies, has created a barrier to adoption for many fleets. While market barriers remain, several pilots and demonstration projects<sup>106</sup> are underway to test and validate early deployments of FCEVs to continue developing the technology.

Despite the initial barriers to mass adoption of FCEVs, they offer notable vehicle energy efficiency and greenhouse gas (GHG) emission reductions benefits. To start, FCEVs have a significantly higher efficiency rating than conventional ICE vehicles. The energy density of hydrogen is approximately 120 megajoules per kilogram (MJ/kg) compared to the diesel energy density of 45.5 MJ/kg.<sup>107</sup> These figures indicate that FCEVs may attain about twice the energy efficiency of a comparable diesel-fueled vehicle, which has implications for longer-range duty cycles. The U.S. DOE confirms that FCEVs are generally 40-60% energy efficient, compared to an average ICE vehicle's 25% efficiency.<sup>108</sup> Given these calculations, it is assumed that hydrogen will reach price parity with diesel when the price drops to \$8 per kg, which is projected to occur within the next decade.<sup>109</sup>

Similar to BEVs, FCEVs have additional environmental benefits. Hydrogen fuel cells themselves do not produce toxic emissions, thereby eliminating potential impacts on human health and atmospheric pollutants. A fuel cell itself is composed of a Proton Exchange Membrane (PEM) where hydrogen and oxygen combined to generate electricity and the only byproducts are water and heat.<sup>110</sup> Fuel cells, like battery packs, are readily scalable as they can be stacked to create systems for larger vehicles. These units do not have any moving parts and operate reliably without excess noise.

While over 99% of hydrogen is currently produced using fossil fuels (as of 2018),<sup>111</sup> it is possible to generate the fuel with renewable energy via electrolysis, a process that uses electricity to separate water into hydrogen and oxygen. Renewable, or "green," hydrogen can be made with wind, solar, or hydropower energy inputs into electrolyzers, though it is a very costly process that has not been built to a critical scale. Despite that, projections of future renewable energy generation indicate a decline in cost which may create a business case for harnessing excess energy supply for green hydrogen

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<sup>104</sup> Supra note 94

<sup>105</sup> California Fuel Cell Partnership. (n.d.). Cost to refill. In California Fuel Cell Partnership. Retrieved from <https://cafcp.org/content/cost-refill>

<sup>106</sup> Zero- and Near Zero-Emission Freight Facilities (ZANZEFF) Shore to Store Project. Retrieved from [https://sustainableworldports.org/wp-content/uploads/ZANZEFF\\_Factsheet\\_final.pdf](https://sustainableworldports.org/wp-content/uploads/ZANZEFF_Factsheet_final.pdf)

<sup>107</sup> Molloy, P. (2019). Run on Less with Hydrogen Fuel Cell Vehicles (FCEVs). Retrieved from <https://www.act-news.com/news/fcevs-run-on-less/>

<sup>108</sup> Plug Power. 5 Things You Should Know About Fuel Cells. Retrieved from <https://www.plugpower.com/fuel-cell-power/fuel-cell-benefits/>

<sup>109</sup> Supra note 94

<sup>110</sup> Supra note 108

<sup>111</sup> *Hydrogen Economy Outlook: Key messages*. (2020, March 30). Retrieved from <https://data.bloomberglp.com/professional/sites/24/BNEF-Hydrogen-Economy-Outlook-Key-Messages-30-Mar-2020.pdf>

production. One such outlook estimates that renewable hydrogen could be produced for \$0.7 to \$1.6 per kg in many parts of the world by the year 2050.<sup>112</sup>

The FCEV operational experience is similar to conventional diesel vehicles in some ways. The experience at the fueling station is virtually identical, with a nozzle similar to a traditional gas or diesel pump used to fill the onboard hydrogen tank and the process is complete in less than 15 minutes.<sup>113</sup> Likewise, as with gas or diesel hydrogen refilling stations are likely to be at large multi-user sites rather than at dedicated depot fueling sites. This eases the burden on fleets to retrain their drivers and allows them to maintain their daily route schedules without much interruption. And because heat is one of the fuel cell byproducts, FCEV are better suited to cold-weather operation than BEVs because they can circulate waste heat for cabin conditioning. However, if a mechanical issue does occur, it may be difficult to service the vehicle due to the low numbers of FCEVs on roads and limited access to replacement parts.

Hydrogen fueling station projects are unique in many ways and thus require additional considerations during the planning process. First, hydrogen supply and storage require a large infrastructure investment. Hydrogen can either be transported to a refueling station via pipeline, truck, or is produced onsite via steam methane reformation or electrolysis.<sup>114</sup> Oftentimes, existing pipeline infrastructure is not adequate to support the flow of hydrogen which may necessitate additional upgrades to the gas distribution system by the local utility company. There are many containers and physical states (e.g., gas, liquid, or solid state) in which hydrogen can be stored, but many of the low-cost options are bound by geographic or spatial limitations (e.g., salt or rock caverns, depleted gas fields, etc.).<sup>115</sup> The crucial point is that hydrogen must remain compressed on site and be ready to be dispensed through the proper equipment. The cost to build an average M/HD fueling station is estimated at approximately \$4 million, more than any one fleet can finance and therefore requires well-financed developers to construct the necessary fueling infrastructure.<sup>116</sup> This presents an additional risk in a market that is currently characterized by significant uncertainty in both supply and demand.

#### *4.1.3 Liquefied Petroleum Gas Vehicles*

Liquefied petroleum gas (LPG), otherwise known as propane, is a colorless, odorless liquid. It is produced during natural gas processing or crude oil refinement, or in some cases is generated from biomass (renewable propane).<sup>117</sup> It is the third most common transportation fuel type, after gasoline and diesel and is stored onboard vehicles in a pressurized tank. While it has been used in many different vehicle technologies, propane is commonly used in residential heating and cooking. Due to

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<sup>112</sup> Ibid.

<sup>113</sup> Supra note 107

<sup>114</sup> Supra note 99

<sup>115</sup> Supra note 111

<sup>116</sup> Supra note 94

<sup>117</sup> Alternative Fuels Data Center: Propane. Retrieved from <https://afdc.energy.gov/fuels/propane.html>

its widespread use in a range of applications, propane has a large and reliable supply network across the country, with more than 2,000 public or private vehicle fueling stations.<sup>118</sup>

There are two types of propane-fueled vehicles, either available as models from OEMs or ones that have been converted from other fuel types. Dedicated propane vehicles have been built with the exclusive ability to fuel with propane, while bi-fuel propane vehicles have two separate fuel tanks that enable it to run on propane and regular diesel or gasoline for added range.<sup>119</sup>

Similar to other alternative fuels, propane has environmental benefits. It is a cleaner burning, lower-carbon fuel than others derived from petroleum and Argonne National Laboratory's GREET model demonstrates that propane use can decrease GHG emissions by approximately 13%.<sup>120</sup> Additionally, propane can reduce NOx emissions by 15% compared to diesel.<sup>121</sup> It has a near-zero global warming potential, referring to the heat absorbed by GHGs in the atmosphere, unlike other GHGs such as CO<sub>2</sub> or methane.<sup>122</sup> These factors make propane an attractive option for commercial vehicles, particularly for operation in zones that have historically experienced poor air quality and disproportionate GHG emissions.

When compared to its diesel equivalent, propane offers some benefits and drawbacks. One benefit is that dispensing is relatively simple and comparable to traditional fueling. Oftentimes, propane dispensers are collocated at gas stations which makes them convenient stops for drivers. The national average retail fuel price for propane (April 2020) is \$2.73 per gallon compared to a diesel price of \$2.61/gal; however, when compared on an energy-equivalent basis, the cost of propane is \$4.20 per diesel gallon equivalent (\$/DGE).<sup>123</sup> Though the lower fuel economy presents some challenges to fleets hoping to save on fuel costs, some OEMs have mitigated this concern by developing optimized engines that capitalize on propane's high octane rating and significantly improve vehicle performance. Customers in small- or medium-sized fleets with a centralized fueling location may notice fuel cost savings benefits with particular vehicle types. Another benefit of propane vehicles is that they operate well in cold weather due to the fuel's gaseous form, thereby preventing cold start problems that often impede ignition in diesel-powered vehicles.<sup>124</sup> Finally, propane fleet owners can expect to save money in maintenance and repairs such as oil changes made necessary by an accumulation of diesel particulates in the engine.<sup>125</sup>

In the past, the propane vehicle market was limited to a couple OEMs or vehicle conversion kits but has recently grown in popularity. Manufacturers such as ROUSH CleanTech, Blue Bird, Thomas Built Buses, IC Bus, and Freightliner Custom Chassis have quickly expanded the vehicle selection for

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<sup>118</sup> Smith, M., & Gonzales, J. (2014, August). *Costs Associated with Propane Vehicle Fueling Infrastructure*. Retrieved from [https://afdc.energy.gov/files/u/publication/propane\\_costs.pdf](https://afdc.energy.gov/files/u/publication/propane_costs.pdf)

<sup>119</sup> Supra note 117

<sup>120</sup> Supra note 117

<sup>121</sup> *GHG and Criteria Pollutant Emissions Analysis*. (2017). Retrieved from <https://propane.com/wp-content/uploads/2019/06/20890-GTI-GHG-Emissions-Analysis-Final-Report.pdf>

<sup>122</sup> Sloan, M. 2016 *Propane Market Outlook: Key Market Trends, Opportunities, and Threats Facing the Consumer Propane Industry Through 2025*. Retrieved from [https://afdc.energy.gov/files/u/publication/2016\\_propane\\_market\\_outlook.pdf](https://afdc.energy.gov/files/u/publication/2016_propane_market_outlook.pdf)

<sup>123</sup> *Clean Cities Alternative Fuel Price Report*. (2020, April). Retrieved from [https://afdc.energy.gov/files/u/publication/alternative\\_fuel\\_price\\_report\\_april\\_2020.pdf](https://afdc.energy.gov/files/u/publication/alternative_fuel_price_report_april_2020.pdf)

<sup>124</sup> Supra note 117

<sup>125</sup> Ibid.

fleets, particularly in box truck, school bus, and shuttle van platforms.<sup>126</sup> ICF projects that the expansion of propane vehicle applications offers long term potential for the fuel. For example, it estimates that annual new propane vehicle sales will increase from 12,900 (in 2014) to 52,000 per year by 2025 with 40% in light-duty and 60% in medium-duty platforms. Similarly, ICF projects that total propane fuel sales will grow by 9% between 2014 and 2025, mainly due to technology and fuel efficiency advancements.<sup>127</sup> This presents a significant opportunity for commercial fleets that operate class 3-6 vehicles.

While propane infrastructure is comparable to conventional fueling stations in some ways, there are still specific considerations to keep in mind. As previously stated, propane production occurs ubiquitously in many parts of the country and distribution networks are already in place. In sum, propane is shipped from these production facilities to a distribution center which then transports the fuel by rail, ship, or truck to propane marketers. This node is then responsible for delivering the propane to end-user filling sites.<sup>128</sup> Since an efficient supply chain (similar to diesel) is already established, propane filling stations generally require less make-ready work to make them functional for fleet use. Building a new station usually requires the buildout of end-user equipment such as an above-ground storage tank, pump, nozzle, and metering system. In many cases, fuel suppliers may offer a low-cost lease of the equipment which greatly reduces the financial burden on fueling station owners. Additionally, many stations that already offer propane filling for residential use (e.g., grill tanks) may easily upgrade their dispensers to faster fill for vehicular use. The total cost to build a new propane station can range from approximately \$65,000 for a small station to up to \$2 million for larger stations.<sup>129</sup> The range in cost can be attributed to the desired number of storage tanks and dispensers, in addition to fleet profile (size, vehicle type(s), and duty cycle).

A challenge presented to the Northeast and other colder regions of the country during the wintertime is the inconsistency of propane production and distribution patterns. For example, regionally sourced propane is produced from the Marcellus Shale Point Pleasant-Utica formations in the Appalachian Basin which reduces the need to import supply from other locations.<sup>130</sup> Despite this advantage, cold weather sometimes forces changes in distribution schedules which may lead to supply constraints and potential fuel price volatility. Added capacity to existing storage sites will greatly reduce uncertainty in supply in the propane market and ensure the needs of commercial fleets can always be met.

#### *4.1.4 Compressed Natural Gas Vehicles*

Compressed natural gas (CNG) is an odorless gas composed primarily of methane (CH<sub>4</sub>). Like propane, it is a fossil fuel-derived gas that is extracted from wells or produced through crude oil processing and is mainly supplied by facilities in North America. Renewable natural gas (RNG), otherwise referred to as biomethane, can be harvested from landfill waste, sewage, animal manure, and food waste and then cleaned so that it can operate in CNG engines; once cleaned, RNG is

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<sup>126</sup> Supra note 122

<sup>127</sup> Ibid.

<sup>128</sup> Supra note 117

<sup>129</sup> Ibid.

<sup>130</sup> Supra note 122

chemically identical to CNG.<sup>131</sup> CNG currently fuels approximately 175,000 vehicles in the U.S. alone and there are more than 1,000 fueling stations offering both compressed (900+) and liquefied natural gas (LNG) (50+) in many parts of the country.<sup>132</sup> CNG vehicles are widely available across vehicle class sizes and duty cycles but are especially common for heavy-duty tractors and transit and school buses. The technology cost of an average CNG vehicle can run 40-80% higher<sup>133</sup> than a comparable diesel alternative which may present a barrier to purchase for some fleets. In spite of this, natural gas vehicles (NGVs) are a suitable technology option for fleets operating within limited areas or routes and have a central fueling location.

Fleets seeking vehicle performance and experience that is comparable to diesel often choose NGVs for their convenience, reliability, environmental benefits, and low fuel cost. The fueling station experience consists of using a nozzle to fill a tank and requires about the same length of time as fueling a diesel vehicle. This factor is crucial to fleets with busy schedules that may operate full days of service. The tailpipe emissions from CNG-fueled vehicles are similar to or better than modern gas or diesel vehicles that are in compliance with the latest emissions requirements. Standard CNG has the potential to emit up to 10% lower GHGs and half the particulate matter that a diesel vehicle would.<sup>134</sup> Furthermore, depending on vehicle type and duty cycle, fleets powered by RNG can prevent an additional 84% of GHG emissions over the course of the fuel's lifecycle due to the reduction of methane release into the atmosphere at sites such as landfills and livestock facilities.<sup>135</sup> It is important to note that methane (CH<sub>4</sub>) is a GHG with 25x more potent GWP than CO<sub>2</sub> and minimizing its release can result in significant environmental and community health benefits.

NGVs also offer similar driving experiences as diesel vehicles with respect to their power, acceleration, and speed but may have reduced range due to the lower energy content per diesel gallon equivalent. Some fleets compensate for this shortfall by adding more fuel storage tanks (CNG cylinders) to improve the driving range of larger vehicles. Fortunately, the cost of CNG fuel has trended downwards in recent years. A report published by the DOE Clean Cities in April 2020 compared a national average retail fuel price of \$2.47/DGE compared to a diesel baseline of \$2.61/gal,<sup>136</sup> making NGVs an economically feasible option in terms of their total cost of ownership. Relative to maintenance, a key concern for NGVs is regularly scheduled service to ensure that the onboard pressurized storage tanks are in working condition and are undamaged. Even small accidents can pose a severe hazard to the safety of the vehicle and its operator, so it is essential to keep up to date on service requirements. Other maintenance costs for NGVs are lower compared to

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<sup>131</sup> *Natural Gas Vehicle Basics* (2020, March). Retrieved from [https://afdc.energy.gov/files/u/publication/natural\\_gas\\_basics.pdf](https://afdc.energy.gov/files/u/publication/natural_gas_basics.pdf)

<sup>132</sup> *Ibid.*

<sup>133</sup> Dougherty, S.; Nigro, N. (2014). *Alternative Fuel Vehicle & Fueling Infrastructure Deployment Barriers & the Potential Role of Private Sector Financial Solutions*. Washington, D.C.: U.S. Department of Energy. Retrieved from

[https://afdc.energy.gov/files/u/publication/afv\\_fueling\\_infrastructure\\_deployment\\_barriers.pdf](https://afdc.energy.gov/files/u/publication/afv_fueling_infrastructure_deployment_barriers.pdf)

<sup>134</sup> Natural Gas. Retrieved from <https://www.fueleconomy.gov/feg/bifueltech.shtml>

<sup>135</sup> Alternative Fuels Data Center: Natural Gas Benefits and Considerations. Retrieved from [https://afdc.energy.gov/fuels/natural\\_gas\\_benefits.html](https://afdc.energy.gov/fuels/natural_gas_benefits.html)

<sup>136</sup> *Supra* note 123

diesels due to the nature of a cleaner burning fuel which results in less particulate build up and necessary engine oil changes.<sup>137</sup>

As with other alternative fuels, a challenge for CNG fleets is access to readily available fueling infrastructure at convenient rest stops. While all CNG fueling stations function similarly, there are different types of stations to be aware of. Fast-fill stations are the closest to conventional diesel pumps where drivers can fill their vehicle tanks within minutes. This is convenient for fleets that operate their vehicles throughout the day and operate within range of a fueling corridor. In contrast, time-fill stations fuel vehicles over an extended time period, such as the course of several minutes or even a few hours, but are more affordable compared to fast-fill stations. This fueling mechanism is best for fleets that return their vehicles to a centrally located depot or base for overnight fueling, and in this sense is analogous to Level 2 charging as compared to DC fast charging in the BEV charging context. Combination-fill stations offer both a quick on-demand or extended fueling option and are optimal for fleets with a variety of vehicle types and duty cycles.<sup>138</sup>

In general, most CNG stations are connected to a utility pipeline that delivers depressurized gas which is then pressurized (i.e., compressed) onsite for fueling purposes.<sup>139</sup> In some cases this pipeline infrastructure may be preexisting, or it may need to be installed, requiring collaboration with the local gas utility to ensure the appropriate upgrades are implemented.

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<sup>137</sup> Alternative Fuels Data Center: Natural Gas Vehicle Maintenance and Safety. Retrieved from [https://afdc.energy.gov/vehicles/natural\\_gas\\_maintenance\\_safety.html](https://afdc.energy.gov/vehicles/natural_gas_maintenance_safety.html)

<sup>138</sup> Smith, M., & Gonzales, J. (2014, September). *Costs Associated with Compressed Natural Gas Vehicle Fueling Infrastructure* (Rep.). Retrieved from [https://afdc.energy.gov/files/u/publication/cng\\_infrastructure\\_costs.pdf](https://afdc.energy.gov/files/u/publication/cng_infrastructure_costs.pdf)

<sup>139</sup> Ibid.

### A CNG Success Story

**Manhattan Beer Distributors** is a major beer supplier for 14 counties across lower New York State and an early adopter of CNG trucks. Manhattan Beer has a sizable heavy-duty delivery fleet, of which approximately 200 are CNG class 7-8 trucks from Volvo and International. Most of Manhattan Beer's CNG trucks operate out of its headquarters in Hunts Point, a neighborhood in the Bronx with some of the highest levels of air pollution in the nation owing to high volumes of freight activity. Juan Corcino, Director of Fleet Operations for Manhattan Beer, helped grow its CNG fleet over the past twenty years, starting with CNG conversions and expanding to purpose-built CNG delivery trucks. Manhattan Beer is replacing its diesel straight trucks with CNG tractor-trailer combination trucks to reduce the number of vehicles necessary to complete deliveries, replacing diesel vehicles at a ratio of two CNG trucks to three diesel trucks. In addition, Mr. Corcino has experienced that CNG trucks are easier and cheaper to maintain, are more reliable, and are less expensive to fuel than their diesel counterparts. The company operates its own fast-fill CNG dispensing station, which allows for quick refuels throughout the day at 10 diesel gallon equivalents per minute. Manhattan Beer proudly displays this progressive technology, which has even led to at least one new deal with a distributor that was impressed with the fleet's use of clean vehicles and that also prioritizes sustainability as a company policy. Manhattan Beer has utilized vehicle incentives available for CNG trucks in New York City and State to cover a substantial amount of the incremental costs for many of these vehicle orders. Its positive experience with CNG has encouraged Mr. Corcino to explore other types of emerging technologies for classes 7 and 8 including battery electric trucks.



Due to these factors and preferences for fast- or time-fill dispensers, the cost of installation for CNG stations can vary from \$1-4 million. In addition to the initial build and installation, some stations require upgrades for compliance purposes (e.g., ventilation requirements per local fire codes), which can create an additional \$45,000 to \$100,000 in expenditures and can last 12-24 months, depending on the scale of the project.<sup>140</sup>

<sup>140</sup> Supra note 94

### 4.1.5 Automated Vehicle Technology

Automated vehicle technology is already active in mass market passenger and commercial vehicles and the technology is rapidly progressing from partial automation to more complete automation. Drivers already rely on automated features such as lane assist, backup sensors, blind spot detection, vehicle self-park, and others to get from point A to B in a safe and efficient manner. The development of these features has been intended to deliver greater safety benefits not only for the driver, but for pedestrians and cyclists as well in addition to improving the efficiency of transportation networks overall.

Automation takes on many forms and degrees of driver engagement, and has been defined in tiers by the Society of Automotive Engineers (SAE)<sup>141</sup> :

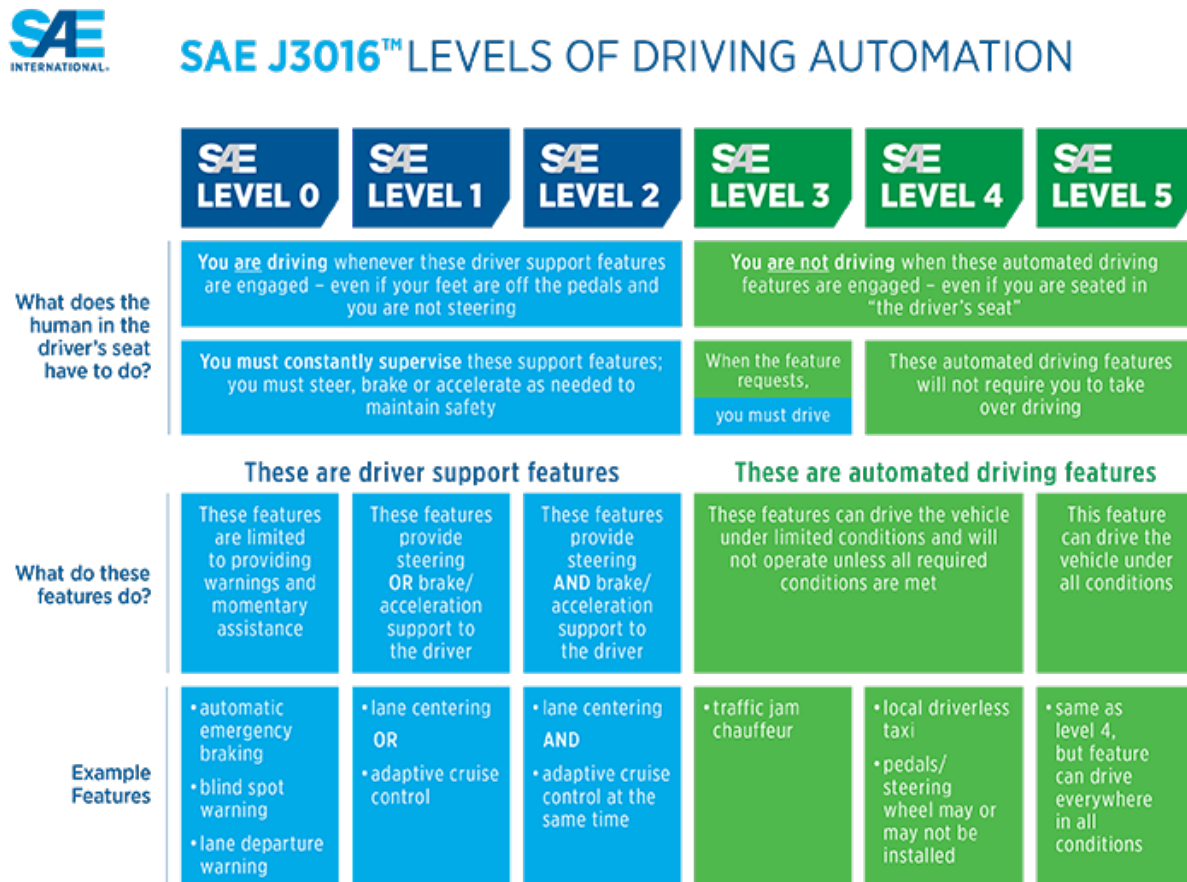
- **Level 0:** No vehicle automation and the driver performs all driving tasks.
- **Level 1:** The vehicle is controlled by the driver but some driving assist features may be included.
- **Level 2:** The vehicle is partially automated but the driver must remain fully engaged and monitor the environment at all times.
- **Level 3:** Conditional automation in which the driver must be present but is not required to monitor the environment at all times.
- **Level 4:** High automation in which the vehicle is capable of performing all driving functions under certain conditions and the driver may have the option to control the vehicle.
- **Level 5:** Highest level of automation where the vehicle is capable of performing all driving functions under all conditions and the driver may not have the option to control the vehicle. In some cases, the driver is not present.

AV technology is based on a “sense-plan-act”<sup>142</sup> design where a combination of sensors (e.g., lidar, radar, cameras, ultrasonic, and infrared) and localization technology (e.g., Global Positioning System (GPS) and Inertial Navigation System (INS)) to interpret the vehicle’s immediate environment, compute appropriate actions for the present moment and near future, and execute accordingly. These vehicles are expected to quickly assess and respond to changing conditions in weather, traffic, topography, and obstacles to deliver a seamless driver and/or passenger experience.

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<sup>141</sup> National Highway Traffic Safety Administration (NHTSA): Automated Vehicles for Safety. Retrieved from <https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety>

<sup>142</sup> Anderson, J., Kalra, N., Stanley, K., Sorensen, P., Samaras, C., & Oluwatola, O. (2016). *Autonomous Vehicle Technology: A Guide for Policymakers*. Retrieved from [https://www.rand.org/content/dam/rand/pubs/research\\_reports/RR400/RR443-2/RAND\\_RR443-2.pdf](https://www.rand.org/content/dam/rand/pubs/research_reports/RR400/RR443-2/RAND_RR443-2.pdf)

Figure 4-3. SAE-defined levels of driving automation<sup>143</sup>

The emergence of AV technology is expected to lead to significant economic and social/safety benefits. A study by the National Highway Traffic Safety Administration (NHTSA) reported that vehicular accidents in 2010 caused a nationwide loss of \$242 billion in economic activity, including workplace productivity losses, quality of life losses due to injury, and deaths.<sup>144</sup> It is estimated that a staggering 94% of these accidents are caused by human error. AV researchers hope to mitigate this element by integrating machine learning and decision making into vehicles to ease traffic congestion and boost productivity across all relevant sectors.

For commercial fleets, one of the most important breakthroughs in AV technology is the concept of platooning, or “road trains.”<sup>145</sup> Vehicles equipped with automated driving systems allow vehicle-to-vehicle information sharing and collection in order to coordinate movement and spacing. For example, platoon communications may affect a vehicle’s speed (slower or faster) or the distance at which it follows or is parallel to another vehicle. Platooning offers many advantages to the commercial

<sup>143</sup> SAE J3016 Levels of Driving Automation [Chart]. (2018). In *SAE International*. Retrieved from <https://www.sae.org/news/press-room/2018/12/sae-international-releases-updated-visual-chart-for-its-“levels-of-driving-automation”-standard-for-self-driving-vehicles>

<sup>144</sup> Supra note 141

<sup>145</sup> How an Automated Car Platoon Works. Retrieved from <https://www.transportation.gov/connections/how-automated-car-platoon-works>

sector, including higher energy efficiency and cost savings, right-sizing freight trips, and smoother traffic flows in cities.

This eco-driving technique is particularly compatible with BEVs due to the mechanical structure of the electric driveline and can be used to automate the vehicle docking and charging process.<sup>146</sup> By taking the driver out of the equation, AVs will not be required to locate a charge point that is en route to a convenient rest stop or destination and can be retrieved easily once fully recharged. The U.S. Energy Information Administration (EIA) forecasts that this technology will start increasing freight efficiency by 2025 and estimates a 10% reduction in fuel consumption attributable to automation of freight vehicles.<sup>147</sup>

## 4.2 Alternative Fuel Vehicle Adoption Projections

This section discusses forecasts for future sales of M/HD truck technologies in Connecticut, New York, New Jersey, and Pennsylvania to better understand the future need for fueling infrastructure to support vehicle demand across fuel types. Developing scenario forecasts for future fleet adoption of M/HD trucks is important to inform strategic infrastructure planning by illustrating the likeliest range of possible penetration levels for various vehicle and fuel combinations, as well as the sensitivities and contingencies that drive these forecasts. Projections of future market behavior are, by definition, speculative and will depend on the data used as inputs. While making forward-looking market projections based on present conditions and technologies can reasonably approximate how the market may evolve, it is important to bear in mind that the freight vehicle technologies landscape is dynamic. The adoption of the emerging diesel-alternative technologies, as modeled for this study, is not deterministic, but rather subject to the influence of many factors discussed in the coming sections.

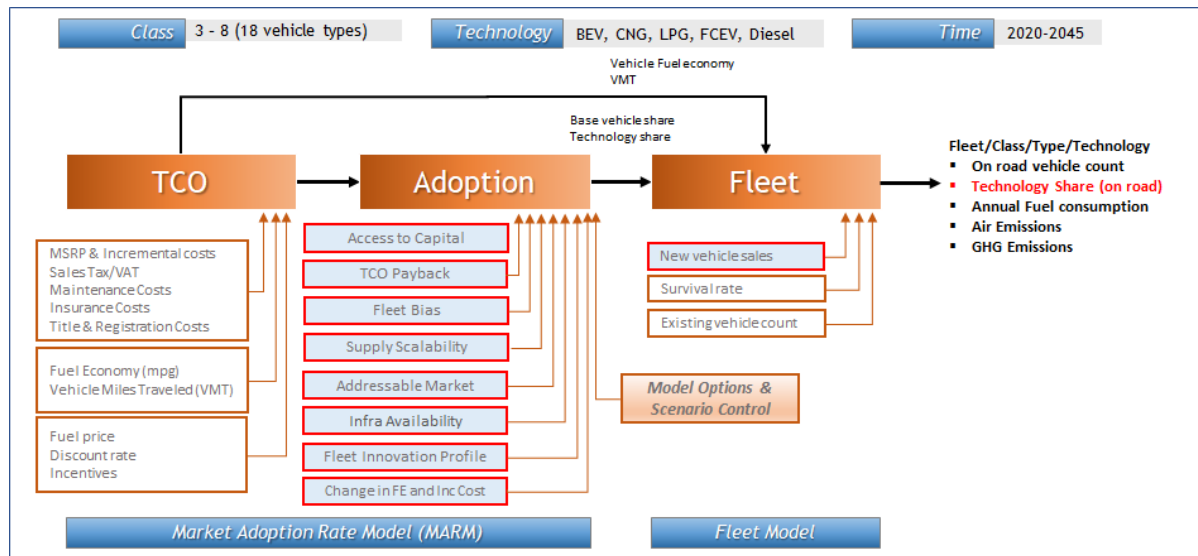
### 4.2.1 Heavy-Duty Vehicle Adoption Rate Model (HDVARM)

The goal of these projections is to simulate the adoption behavior of freight vehicle fleets for various fuel types over the next 25 years (2020-2045). The market projection is based on CALSTART's Heavy-Duty Vehicle Adoption Rate Model (HDVARM). HDVARM is an input/output model which estimates the share of on-road vehicle adoption across fuel types in specific vehicle segments (e.g., class 6 regional truck) and regions of interest (e.g., U.S. states). HDVARM can be used to support policy and infrastructure planning by simulating fleet adoption decisions quantitatively and qualitatively. A diagrammatic depiction of HDVARM's input parameters and scoping conditions for this study is presented below in Figure 4-4.

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<sup>146</sup> *Taming the Autonomous Vehicle: A Primer for Cities*. (2017). Retrieved from <https://assets.bbbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDF.pdf>

<sup>147</sup> *Autonomous Vehicles: Uncertainties and Energy Implications* (2018, May). Retrieved from <https://www.eia.gov/outlooks/aeo/pdf/AV.pdf>

**Figure 4-4. Overview of Heavy-Duty Vehicle Adoption Rate Model (HDVARM)**

This modeling exercise includes 18 distinct types of on-road freight vehicles across gross vehicle weight rating (GVWR) classes 3-8 (i.e., >10,000 lbs).<sup>148</sup> The alternative fuel vehicle types modeled and compared to baseline (diesel) vehicles include battery electric (BEV), compressed natural gas (CNG), propane (LPG), and hydrogen fuel cell (FCEV). HDVARM projects fleet adoption decisions among these technology options based largely on total cost of ownership (TCO) simulations, which are determined on the basis of inputs that impact the upfront and ongoing costs associated with a designated vehicle-fuel combination.

As outlined in Figure 4-4, HDVARM simulates TCO for each vehicle-fuel combination and runs these intermediate results through a range of adoption profiles. Adoption profiles indicate how various fleets might respond to the TCO results; for instance, an early-adopter fleet adoption profile will have greater access to capital and allow alternative fuel vehicle technologies a longer payback period (relative to diesel vehicles), whereas a moderate or even a technology-averse profile will have less capital and be less patient with their required return on investment. These adoption profiles augment the purely financial TCO elements with more qualitative parameters that can determine how likely a fleet is to adopt a new truck technology through time. For instance, the addressable market for each vehicle segment in an adoption profile is a function of the suitability of various truck technologies for a fleet's operations; the more suitable a technology is assumed to be, the larger its addressable market and the more rapid the resulting adoption. The adoption profiles constructed for this modeling exercise are described in greater depth in a later section.

The results from the Market Adoption Rate Model (TCO simulation + adoption profiles) are then combined with a fleet model to determine how adoption decisions result in aggregate fleet purchases and overall fleet turnover, based on factors including existing vehicle counts and characteristic vehicle survival rates to gauge fleet turnover. These results provide a collective picture of the expected fuel technology share for new sales of a selected vehicle segment in a selected state. The

<sup>148</sup> Class 3 (cargo van, step van, regional truck), Class 4 (step van, regional truck), Class 5 (step van, regional truck), Class 6 (step van, regional truck), Class 7 (step van, regional truck, long haul truck, drayage), and Class 8 (long haul truck, regional truck, terminal tractor, drayage, heavy haul truck)

methodology and results from each model element are discussed in greater detail below and documented more thoroughly in the companion technical appendix.

### 4.2.2 Total Cost of Ownership (TCO) Model

#### TCO Model Inputs

TCO represents a range of possible values depending on sensitivity to uncertain parameters. Two of the most influential and uncertain TCO inputs are fuel cost and incentive levels. Current and projected fuel prices (in real dollars) for each state are used to model fuel consumption costs, with three scenarios to cover a range of possible price paths.<sup>149</sup> The reference scenario reflects states' current fuel prices with year-over-year trend projected in the U.S. Energy Information Administration's (EIA) Annual Energy Outlook 2020.<sup>150</sup> Hydrogen fuel prices are assumed to follow the downward trajectory seen in Argonne National Laboratory's VISION model.<sup>151</sup> The low and high fuel price scenarios apply different variations to the start at states' current average fuel prices but follow different trends. Under the "low" scenario, the diesel trend is ~50% lower, CNG and electricity are ~10% lower, and hydrogen is 40% lower. Under the "high" scenario, the diesel trend is ~50% higher, CNG is ~10% higher, and electricity and hydrogen are ~20% higher. Table 4-2 summarizes the fuel price trends for each scenario.

**Table 4-2. Year-Over-Year Fuel Cost Price Change Assumptions by Scenario**

| Scenario         | Fuel Type |       |       |             |          |
|------------------|-----------|-------|-------|-------------|----------|
|                  | Diesel    | CNG   | LPG   | Electricity | Hydrogen |
| <b>Low</b>       | 1.60%     | 1.50% | 3.20% | 2.20%       | -1.50%   |
| <b>Reference</b> | 3.10%     | 1.70% | 3.60% | 2.40%       | -2.50%   |
| <b>High</b>      | 4.70%     | 1.90% | 4.00% | 2.90%       | -3.00%   |

The analysis assumes that all four states will put in place strong purchase incentives to catalyze sales of cleaner alternatives to diesel trucks by 2025 and to varying levels through 2040. While New York already has point-of-sale voucher incentives in place for all four fuel types,<sup>152</sup> assumptions regarding incentive levels and timing of introduction and step-down/phase-out for incentives were constructed based on each state's policy signals and input from the study Technical Advisory Committee (see Table 4-3 for an overview of the assumed incentive levels across states and fuel types over time). It is assumed that incentive levels will decline gradually as market acceleration programs boost vehicle production volumes and allow these technologies to progress down the technology cost curve and require progressively less capital support through time.

<sup>149</sup> The analysis was performed in 2021, prior to the spike in energy costs observed in early 2022.

<sup>150</sup> *Annual Energy Outlook 2020*. (2020). Retrieved from <https://www.eia.gov/outlooks/aeo/>

<sup>151</sup> Argonne National Laboratory: VISION Model. Retrieved from <https://www.anl.gov/es/vision-model>

<sup>152</sup> New York Truck Voucher Incentive Program. Retrieved from <https://nyserda.ny.gov/truck-voucher-program/>

**Table 4-3. Vehicle Purchase Incentive Assumptions by State and Fuel Type Over Time**

| Class | Year | BEV / FCEV    |               |               |               | CNG/LPG      |              |
|-------|------|---------------|---------------|---------------|---------------|--------------|--------------|
|       |      | CT            | NJ            | NY            | PA            | NY           | PA           |
| 3     | 2020 | \$ -          | \$ -          | \$ 60,000.00  | \$ -          | \$ -         | \$ -         |
|       | 2025 | \$ 40,000.00  | \$ 40,000.00  | \$ 60,000.00  | \$ 40,000.00  | \$ -         | \$ -         |
|       | 2030 | \$ 20,000.00  | \$ 20,000.00  | \$ 40,000.00  | \$ 20,000.00  | \$ -         | \$ -         |
|       | 2035 | \$ 20,000.00  | \$ 20,000.00  | \$ 20,000.00  | \$ 20,000.00  | \$ -         | \$ -         |
|       | 2040 | \$ 10,000.00  | \$ 10,000.00  | \$ 10,000.00  | \$ 10,000.00  | \$ -         | \$ -         |
|       | 2045 | \$ -          | \$ -          | \$ -          | \$ -          | \$ -         | \$ -         |
| 4     | 2020 | \$ -          | \$ -          | \$ 100,000.00 | \$ -          | \$ 30,000.00 | \$ -         |
|       | 2025 | \$ 75,000.00  | \$ 75,000.00  | \$ 100,000.00 | \$ 75,000.00  | \$ 15,000.00 | \$ 15,000.00 |
|       | 2030 | \$ 50,000.00  | \$ 50,000.00  | \$ 75,000.00  | \$ 50,000.00  | \$ -         | \$ 7,500.00  |
|       | 2035 | \$ 50,000.00  | \$ 50,000.00  | \$ 50,000.00  | \$ 50,000.00  | \$ -         | \$ -         |
|       | 2040 | \$ 25,000.00  | \$ 25,000.00  | \$ 25,000.00  | \$ 25,000.00  | \$ -         | \$ -         |
|       | 2045 | \$ -          | \$ -          | \$ -          | \$ -          | \$ -         | \$ -         |
| 5     | 2020 | \$ -          | \$ -          | \$ 110,000.00 | \$ -          | \$ 40,000.00 | \$ -         |
|       | 2025 | \$ 80,000.00  | \$ 80,000.00  | \$ 110,000.00 | \$ 80,000.00  | \$ 20,000.00 | \$ 20,000.00 |
|       | 2030 | \$ 60,000.00  | \$ 60,000.00  | \$ 80,000.00  | \$ 60,000.00  | \$ -         | \$ 10,000.00 |
|       | 2035 | \$ 60,000.00  | \$ 60,000.00  | \$ 55,000.00  | \$ 60,000.00  | \$ -         | \$ -         |
|       | 2040 | \$ 30,000.00  | \$ 30,000.00  | \$ 30,000.00  | \$ 30,000.00  | \$ -         | \$ -         |
|       | 2045 | \$ -          | \$ -          | \$ -          | \$ -          | \$ -         | \$ -         |
| 6     | 2020 | \$ -          | \$ -          | \$ 125,000.00 | \$ -          | \$ 50,000.00 | \$ -         |
|       | 2025 | \$ 90,000.00  | \$ 90,000.00  | \$ 125,000.00 | \$ 90,000.00  | \$ 30,000.00 | \$ 30,000.00 |
|       | 2030 | \$ 65,000.00  | \$ 65,000.00  | \$ 90,000.00  | \$ 65,000.00  | \$ -         | \$ 15,000.00 |
|       | 2035 | \$ 65,000.00  | \$ 65,000.00  | \$ 65,000.00  | \$ 65,000.00  | \$ -         | \$ -         |
|       | 2040 | \$ 40,000.00  | \$ 40,000.00  | \$ 40,000.00  | \$ 40,000.00  | \$ -         | \$ -         |
|       | 2045 | \$ -          | \$ -          | \$ -          | \$ -          | \$ -         | \$ -         |
| 7     | 2020 | \$ -          | \$ -          | \$ 150,000.00 | \$ -          | \$ 55,000.00 | \$ -         |
|       | 2025 | \$ 110,000.00 | \$ 110,000.00 | \$ 150,000.00 | \$ 110,000.00 | \$ 35,000.00 | \$ 35,000.00 |
|       | 2030 | \$ 80,000.00  | \$ 80,000.00  | \$ 110,000.00 | \$ 80,000.00  | \$ -         | \$ 17,500.00 |
|       | 2035 | \$ 80,000.00  | \$ 80,000.00  | \$ 80,000.00  | \$ 80,000.00  | \$ -         | \$ -         |
|       | 2040 | \$ 55,000.00  | \$ 55,000.00  | \$ 55,000.00  | \$ 55,000.00  | \$ -         | \$ -         |
|       | 2045 | \$ -          | \$ -          | \$ -          | \$ -          | \$ -         | \$ -         |
| 8     | 2020 | \$ -          | \$ -          | \$ 185,000.00 | \$ -          | \$ 60,000.00 | \$ -         |
|       | 2025 | \$ 140,000.00 | \$ 140,000.00 | \$ 185,000.00 | \$ 140,000.00 | \$ 40,000.00 | \$ 40,000.00 |
|       | 2030 | \$ 105,000.00 | \$ 105,000.00 | \$ 140,000.00 | \$ 105,000.00 | \$ -         | \$ 20,000.00 |
|       | 2035 | \$ 105,000.00 | \$ 105,000.00 | \$ 105,000.00 | \$ 105,000.00 | \$ -         | \$ -         |
|       | 2040 | \$ 80,000.00  | \$ 80,000.00  | \$ 80,000.00  | \$ 80,000.00  | \$ -         | \$ -         |
|       | 2045 | \$ -          | \$ -          | \$ -          | \$ -          | \$ -         | \$ -         |

Importantly, while all four states are signatories to the July 2020 Memorandum of Understanding on Medium- and Heavy-Duty Zero-Emission Vehicles,<sup>153</sup> and therefore it is reasonable to assert that BEV and FCEV incentives will be introduced and remain in place for several years, only Pennsylvania, as a major producer of natural gas, is assumed to keep purchase incentives for CNG and LPG in place through 2030. New Jersey and Connecticut are assumed not to introduce CNG/LPG vehicle incentives during the study period as those states focus their market animation

<sup>153</sup> Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding (2020, July). Retrieved from <https://www.nescaum.org/documents/multistate-truck-zev-governors-mou-20200714.pdf/>

activities on zero-emission technologies.<sup>154</sup> It is plausible that as time goes on, states will transition vehicle purchase assistance from upfront cash grants to an alternative format such as a tax credit or a revolving loan structure, but for the time being the analysis assumes that states will apply the most direct form of assistance to address the persistent barrier to adoption, which is the more expensive purchase price.

## TCO Model Results

HDVARM evaluates the fixed and operational costs of each M/HD technology over a ten-year lifetime and compares the cost and payback period to that of the applicable base diesel vehicle. Four advanced vehicle technologies used in each M/HD vehicle type across each state are compared. Figure 4-5 illustrates the total cost of owning and operating each M/HD vehicle fuel technology in dollars per mile (\$/mi) over the course of the vehicle's lifetime. This is the blended average TCO for all included vehicle types across the study region (CT, NJ, NY, and PA). The TCO is further segmented into insurance and licensing costs, maintenance costs, fuel costs, and the base vehicle purchase cost to demonstrate which components are driving TCO disparities between the fuel types across time, through 2045; despite variations across fuel types in purchase/capital cost, the greatest driver of TCO differences at a given point in time appears to be the total lifetime fueling cost.

**Figure 4-5. TCO Composition (\$/mi) Across Fuel Types by Year, Class 6 Regional Truck in New York**

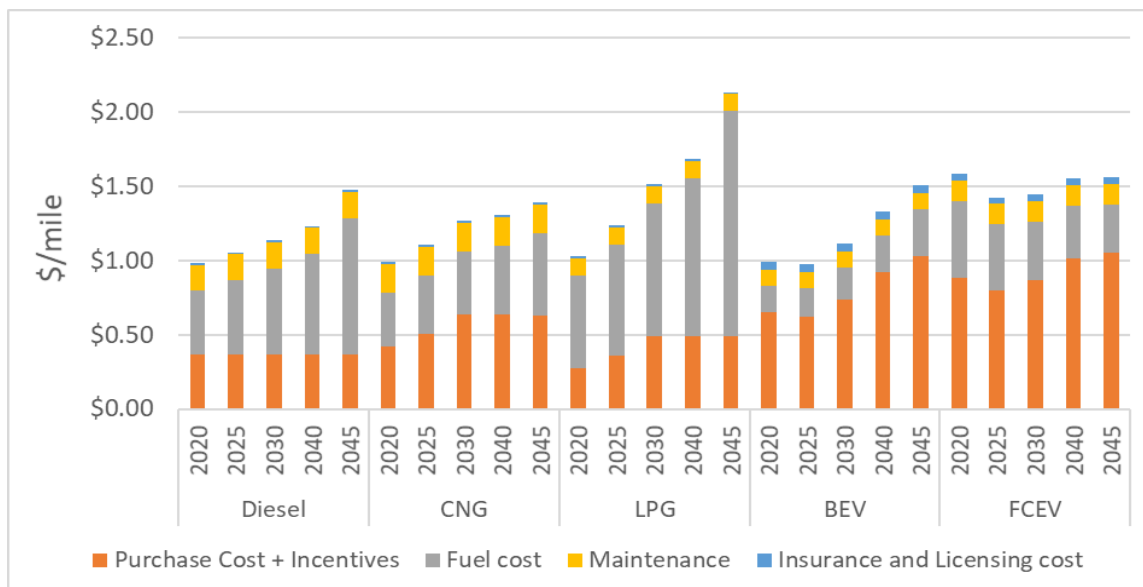


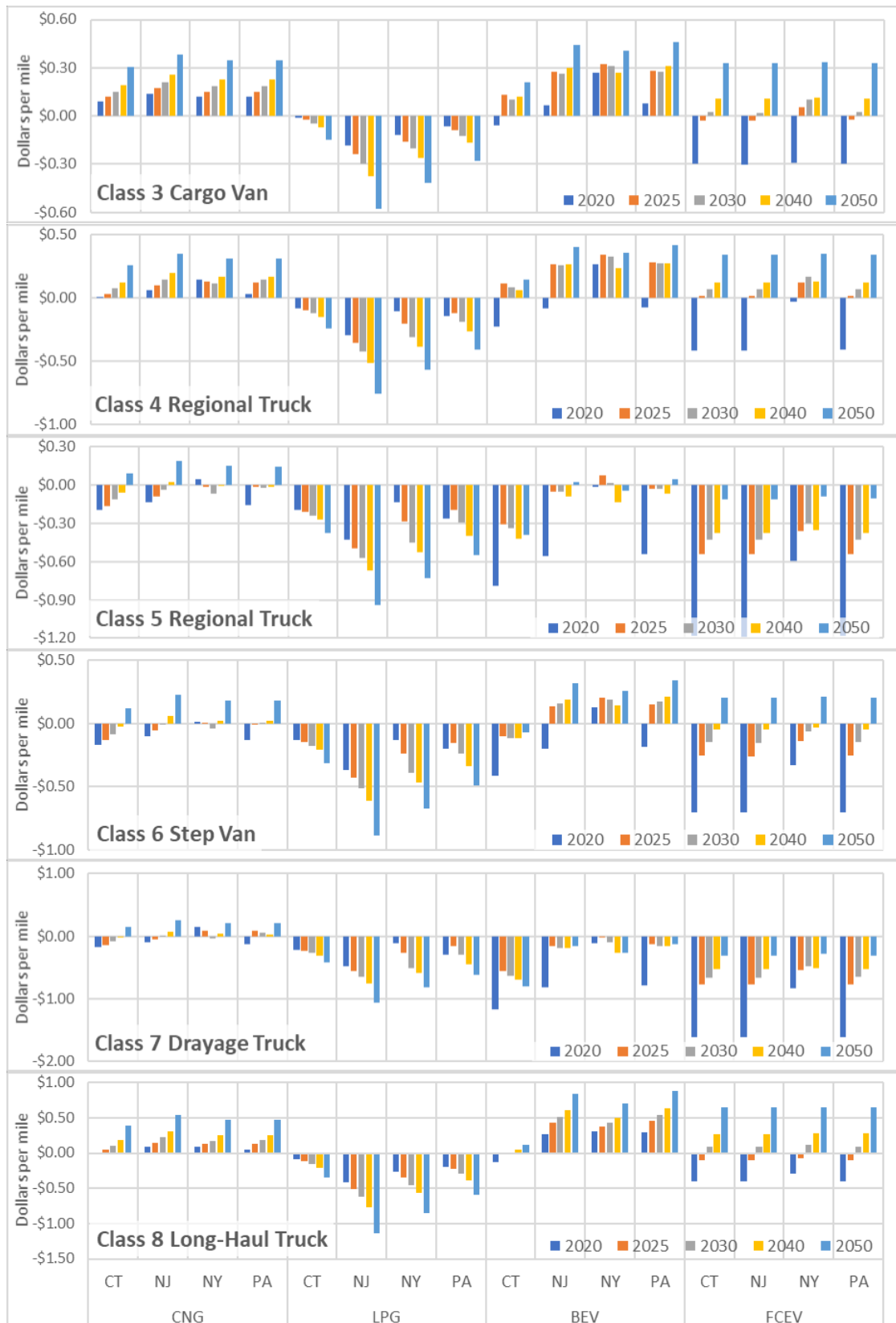
Figure 4-6 demonstrates how the overall TCO for each alternative fuel vehicle type compares to diesel vehicles over time and across states in each of vehicle classes 3-8 (assuming reference case pricing for fuel costs); note that a negative TCO indicates that the vehicle in question is more costly to own and operate than a diesel vehicle. At a high level, these results reflect whether the upfront cost premiums of alternative fuel trucks above comparable diesel trucks are offset by lower operating and

<sup>154</sup> NJ Energy Master Plan: [https://nj.gov/emp/docs/pdf/2020\\_NJBPU\\_EMP.pdf](https://nj.gov/emp/docs/pdf/2020_NJBPU_EMP.pdf) ; CT Electric Vehicle Roadmap: [http://www.dpuc.state.ct.us/DEEP/Energy.nsf/c6c6d525f7cdd1168525797d0047c5bf/f7ed4932eec438d0852585520001c81b/\\$FILE/EV%20Roadmap%20for%20Connecticut.pdf](http://www.dpuc.state.ct.us/DEEP/Energy.nsf/c6c6d525f7cdd1168525797d0047c5bf/f7ed4932eec438d0852585520001c81b/$FILE/EV%20Roadmap%20for%20Connecticut.pdf)

maintenance (O&M) costs during a vehicle's service life. This is a function of several factors, including not only the magnitude of the purchase premium and the amount of O&M savings on a per-mile basis, but also (and importantly) the duty cycle of the vehicle in question and therefore how quickly ongoing savings can offset upfront costs. Because CNG, BEV, and FCEV technologies are all assumed to have lower O&M costs than diesel trucks, the ultimate TCO for a given vehicle segment and in a particular model year in these fuel types is a matter of whether the assumed duty cycle entails sufficient mileage to offset the upfront cost premium. Broadly, the TCO advantages relative to diesel for CNG, BEV, and FCEV technologies trend upward as model years progress, a function of both declining vehicle costs (in some cases aided by incentives) and fueling costs that either fall outright (in the case of hydrogen) or that rise more slowly than diesel under the reference case scenario (in the case of CNG and BEV; see Table 4-2). Because LPG vehicles are assumed to have higher operating costs than diesel, they generally result in more expensive TCO compared to diesel despite characteristically very small vehicle cost premiums.

Beyond these general features of the TCO comparisons, the specific results hinge on tradeoffs between purchase price and operating cost. For low-mileage duty cycles, namely class 7 drayage, alternative fuels can only overtake diesel in TCO terms when purchase premiums are slim (as with CNG trucks). For more costly vehicle technologies like BEV and FCEV, the low-mileage duty cycle does not allow for operating savings to offset the upfront cost disadvantage. By contrast, these initially costlier vehicle technologies fare better in high-mileage duty cycles, in particular class 3 cargo van, class 4 regional truck, and class 8 long-haul, and do even better through time as successive model years bring diminished purchase costs which can be offset even more quickly and compellingly. In many instances, the TCO for CNG, BEV, and FCEV is negative relative to diesel toward the beginning of the period but crosses into positive TCO at some point during the study period.

**Figure 4-6. TCO Advantage Over Diesel Across States and Fuel Types for Selected Truck Segments**



## Modeling Scenario Construction

In addition to the uncertain elements of TCO, the interactions between TCO and fleet adoption are subject to significant uncertainty. Exogenous factors such as fleets' purchasing power, fleets' preferences and the technology-policy environment can evolve in a variety of ways ranging from those more conducive to aggressive uptake of high-efficiency technologies to those more consistent with low uptake of newer freight vehicle technologies. To capture the inherent uncertainty in how fleets will respond to the range of TCO results across time, adoption profiles were constructed from differing permutations of the following six parameters (discussed in greater detail in the technical appendix):

- Fleets' **access to capital** (ability to pay more upfront for vehicles)
- Fleets' tolerance for **payback period**
- Fleets' affinity toward new technology (**preference factor**)
- Size of **addressable market** for a vehicle type based on technology, location, and duty cycle
- Fleets' sensitivity to **refueling availability**
- **Technological improvement** (fuel economy and price decline over time)

Three adoption profiles—Aggressive, Moderate, and Slow—were developed to account for a range of possible preferences and adoption-influencing conditions, as captured by different values assigned to each of the above parameters. The values assigned to each parameter in each profile are summarized below in Table 4-4.

**Table 4-4. Composition of Adoption Profiles Used in Scenario Modeling**

| Profile           | Access to Capital | Payback Period  | Preference Factor  | Addressable Market | Refueling Availability | Technological Improvement |
|-------------------|-------------------|-----------------|--------------------|--------------------|------------------------|---------------------------|
| <b>Aggressive</b> | <i>Excellent</i>  | <i>≤4 years</i> | <i>Accelerated</i> | <i>Full</i>        | <i>Accelerated</i>     | <i>Advanced</i>           |
| <b>Moderate</b>   | <i>Great</i>      | <i>≤3 years</i> | <i>Average</i>     | <i>Moderate</i>    | <i>Average</i>         | <i>Above Average</i>      |
| <b>Slow</b>       | <i>Good</i>       | <i>≤2 years</i> | <i>Slow</i>        | <i>Niche</i>       | <i>Slow</i>            | <i>Average</i>            |

To capture a representative range of prospective adoption rate results, a total of nine model runs were developed, with each of the adoption profiles detailed in Table 4-4 matched with each of the fuel price scenarios outlined in Table 4-2. All nine model run permutations are shown in Table 4-5. However, the discussion of results will be confined to the subset of model runs using the reference fuel price inputs (i.e., 2A, 2B, and 2C); while varying the adoption profile (for a given fuel price scenario) drives significant differences in the sales shares across fuel types, varying the fuel price scenario (for a given adoption profile) does not drive significant differences in sales share.

**Table 4-5. Overview of Model Runs Used in HDVARM to Project Vehicle Adoption Rates of Various Fuel Types for Each Vehicle Segment**

| Model Run | Fuel Price Scenario | Adoption Profile |
|-----------|---------------------|------------------|
| 1A        | Low                 | Aggressive       |
| 1B        | Low                 | Moderate         |
| 1C        | Low                 | Slow             |
| 2A        | Reference           | Aggressive       |
| 2B        | Reference           | Moderate         |
| 2C        | Reference           | Slow             |
| 3A        | High                | Aggressive       |
| 3B        | High                | Moderate         |
| 3C        | High                | Slow             |

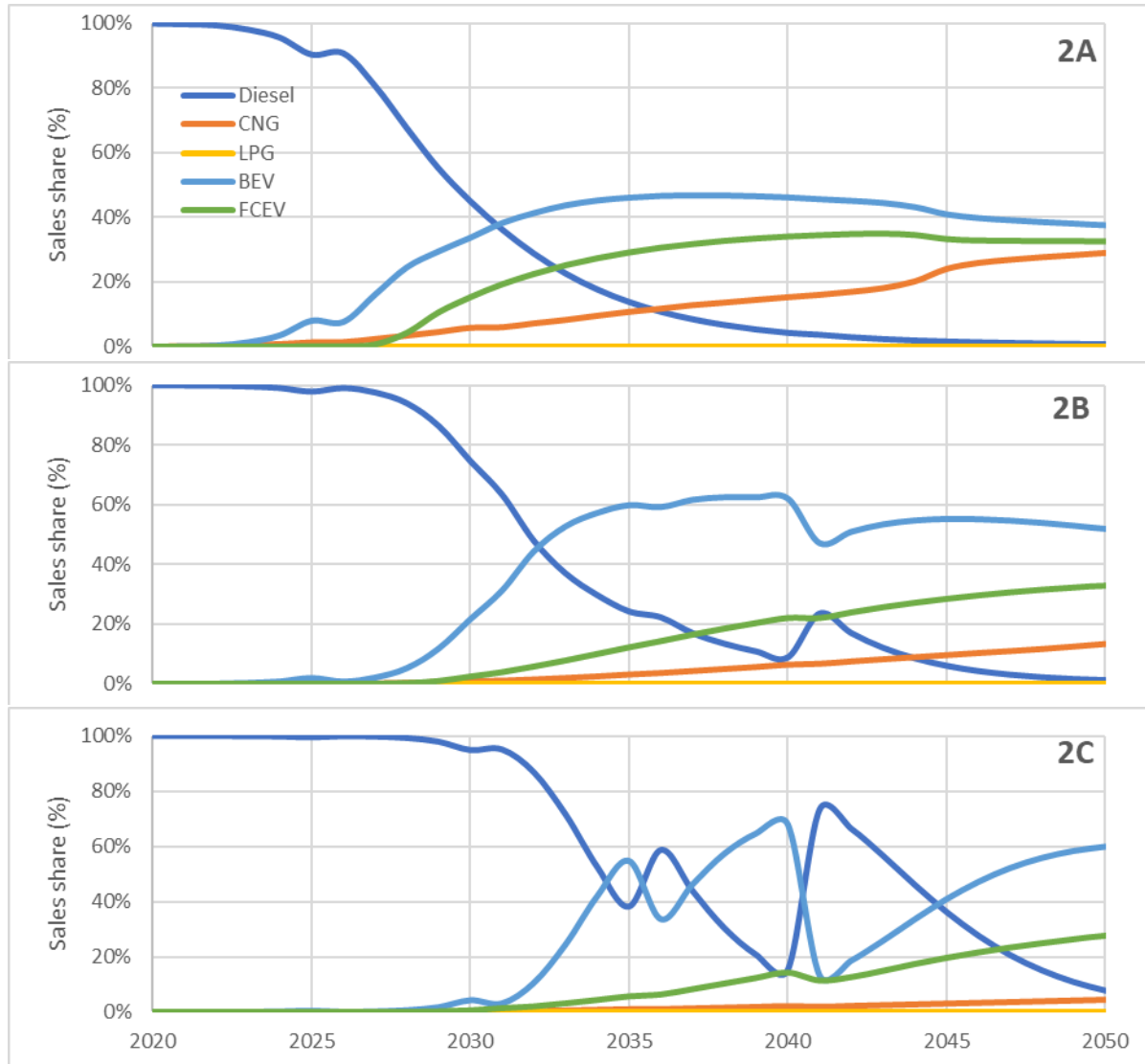
Figure 4-7 demonstrates an average regional outlook on uptake of alternative fuel vehicles, across all vehicle segments included in the study and over the entire study region through 2050. Under the aggressive run (2A, top panel), diesel drops under 50% of sales in 2029 as first BEV, then FCEV and later CNG technologies surpass diesel sales between 2031 and 2036. In this run, the alternative fuel technologies benefit from a more aggressive and patient fleet adoption profile to outperform diesel. CNG, BEV, and FCEV each settle in between 28-38% of sales by 2050, though the LPG share remains negligible throughout. Diesel ends the period with a sales share around 0.5%.

Under the midpoint run (2B, middle panel), diesel retains the majority of sales share a bit longer than in 2A (until 2032) but is shortly thereafter overtaken by BEV as the leading technology in sales share. BEV trucks settle just above 50% of sales after 2040, supported by declining costs and improving technology (e.g., greater fuel economy). The diesel sales share temporarily rebounds after 2040 at the expense of BEV sales share as purchase incentives—a critical determinant of BEV truck sales share—are assumed to cease after this date. The sales share for FCEV trucks grows slowly but steadily beginning after 2030, as hydrogen fuel costs decline and the technology continues to improve, before ending the period around a 33% sales share. The CNG share also ramps up slowly beginning around 2035 and ending the period under 15%. As in 2A, the LPG share remains negligible throughout the study period. Diesel ends the period below a 1.5% sales share.

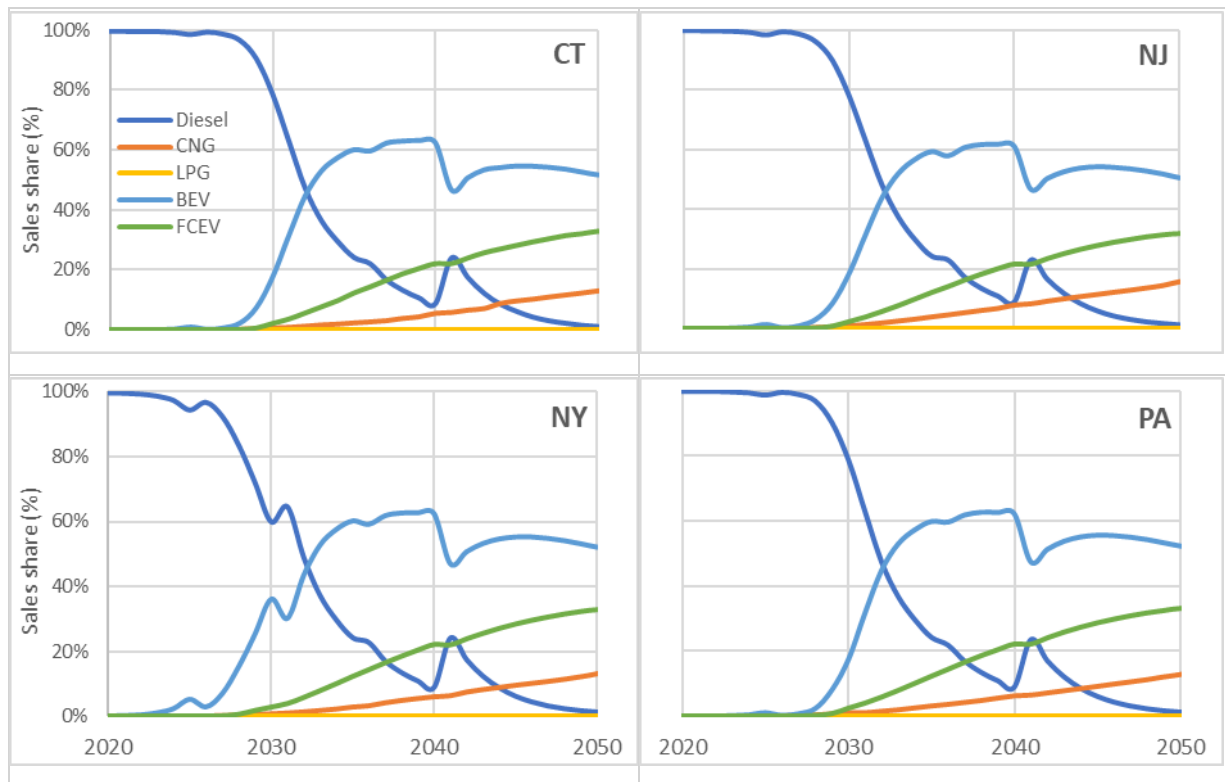
Finally, run 2C (bottom panel) reflects highly volatile responses to changing incentive levels, with large swings between diesel and BEV in particular. Diesel is not overtaken by any fuel type until 2034 and ends the period with a higher share than in the other two runs at 6%. Likewise, BEV ends the period with its

highest share of the three runs at 60%, while the shares for FCEV and CNG are far lower than under other runs. As in the others, LPG's share remains negligible throughout.

**Figure 4-7. Overall Sales Share for All Vehicle Types in the Entire Study Region Under Runs 2A-2C**



Individual state results under the midpoint run (2B) are illustrated in Figure 4-8; while all states show broadly similar shapes and end the study period in broadly similar positions, the diesel sales share remains effectively at 100% until states introduce purchase incentives for other fuel-type vehicles, which takes longer in CT and PA than in NY and NJ. The short-duration variations seen in 2025, 2030, and 2035 are primarily a function of assumptions regarding incentive step-downs for various alternative fuel vehicle types, which allows diesel to momentarily rebound before being overtaken by other market forces (namely fuel price and continued technological improvement for alternative fuel vehicles). In all jurisdictions, BEV is projected to be the dominant fuel type for class 3-8 freight vehicles before 2035 and to end the period with a majority of sales, while FCEV is projected to rise steadily and capture roughly 30% of sales and CNG rises more slowly to just roughly 15%.

**Figure 4-8. Overall Sales Share Over Time Across Vehicle Types by State (Run 2B)<sup>155</sup>**

#### 4.2.3 Conclusion

While diesel is the near-universal fuel used in trucks currently, its market share will be eroded significantly and irrevocably beginning as soon as the middle of this decade through 2050 and beyond. As alternative fuel vehicle technologies improve, operating costs decline, and cities and states promulgate decarbonization and air quality policies that favor cleaner fuels, diesel alternatives—especially BEV and FCEV propulsion systems—will become increasingly favored by freight fleets. Although the pace and extent to which freight operators transition from diesel to the variety of cleaner options discussed above is highly subject to the policy conditions and adoption environment, the directional outlook for these technologies is clear.

This technical memo uses a proprietary model, HDVARM, to project how sales of freight vehicles, across 18 distinct vehicle segments in classes 3-8, will change through time based on their TCO and how aggressive or slow fleets are to adopt alternative technology. The modeling demonstrates that the TCO for the various alternative fuel vehicle types relative to diesel is a function of purchase price, O&M costs, and duty cycle. CNG, BEV, and FCEV technologies can be more affordable than diesel throughout the study area as long as the duty cycle has enough miles to allow the O&M savings to offset the upfront cost premiums; this benefit will occur earlier in states that have robust incentives to shorten payback periods further. LPG trucks are slightly costlier to purchase but more expensive to operate than diesel, and this disparity in operating costs is

<sup>155</sup> While the TCO-based modeling analysis anticipates growth in demand for several alternative fuel sources for heavy-duty vehicles, New Jersey's Energy Master Plan prioritizes advancements in battery or fuel cell electric technology for heavy duty vehicle applications.

projected to grow through time. Accordingly, the TCO for LPG vehicles struggles across vehicle platforms and states as well as worsens with time.

Under a range of projections for vehicle adoption in the study area across vehicle segments, diesel is projected to hold the largest sales share until the early 2030s and follow a downward trajectory to less than 10% by 2050 (and likely less than 2%). In its place, BEV, FCEV, and CNG will compete for market share with BEV taking the largest proportion by 2050 (38-60%), followed by FCEV (28-33%) and CNG (4-29%). Because of the poor TCO of LPG, this model does not project significant levels of LPG adoption in any vehicle segments or states.

## 5.0 Freight Demand

This section summarizes a scan of available freight and business establishment data and analysis. The objectives of the scan were to:

- Describe recent and projected future volumes of freight in the multi-state region;
- Describe freight demand on key corridors that carry freight into, out of, through, and within the multi-state MAP Forum region; and
- Identify current and emerging “hubs” (i.e., major freight terminals and/or clusters of freight-generating establishments that generate freight demand). This information can inform the gap analysis regarding potential emerging sources of freight travel demand, and potential freight-focused development areas where fueling capacity could potentially be developed as well.

These analyses helped the Clean Freight Corridors Study to establish a current and future freight demand context for new clean freight corridor designations and, ultimately, investments in infrastructure to support clean freight in those corridors.

Information and data gathered and incorporated into this scan include the findings of recently-completed and some ongoing studies to describe recent and projected future volumes of freight, freight origins and destinations, and key corridors that convey freight. Business establishment data and qualitative information gathered from published plans and studies and interviews with NYMTC member agencies were used to identify existing and emerging clusters of freight-generating business establishments that are, or could become, major sources of freight travel demand across the multi-state region.

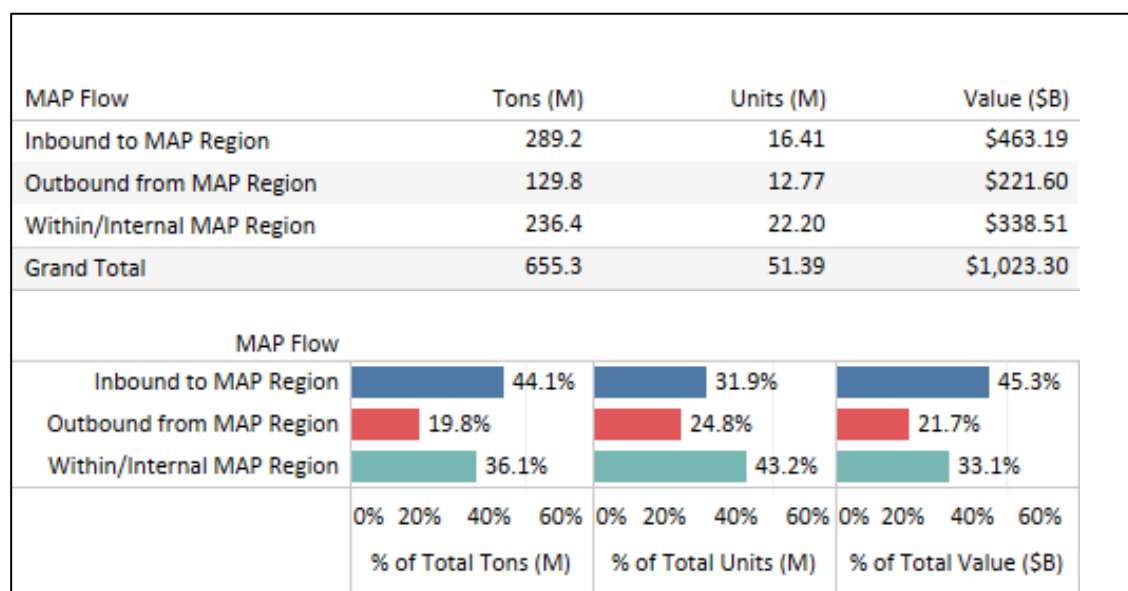
### 5.1 Regional Commodity Flow Analysis Highlights

NYMTC has prepared a commodity flow analysis to support the development of the Freight Element of Moving Forward, alternatively known as Plan 2050, its next Regional Transportation Plan. The geographic area covered in the commodity flow analysis includes the planning areas of metropolitan planning organizations and councils of government in the multi-state New York City metropolitan region which are members of the Metropolitan Area Planning (MAP) Forum. Using the 2018 Transearch commodity flow dataset acquired by the New York State Department of Transportation (NYSDOT), an analysis was performed with the following specifications:

- 2018 base year and 2045 forecast horizon year.
- Measures: tons, dollar value, units (trucks or railcars).
- Transportation modes: truck, rail, water, air, pipeline, or other/unknown. Freight trips via multiple modes (such as truck to rail or truck to water) are reported as separate modal trips. Truck volumes primarily reflect longer-distance moves by large trucks may not capture smaller local truck trips involved in redistributing goods for last-mile delivery.
- Commodity flows: inbound into the multi-state MAP Forum region, outbound from the region, or intra-regional flows between and counties. Directional attributes are not explicitly provided in Transearch but can be inferred through data analysis.

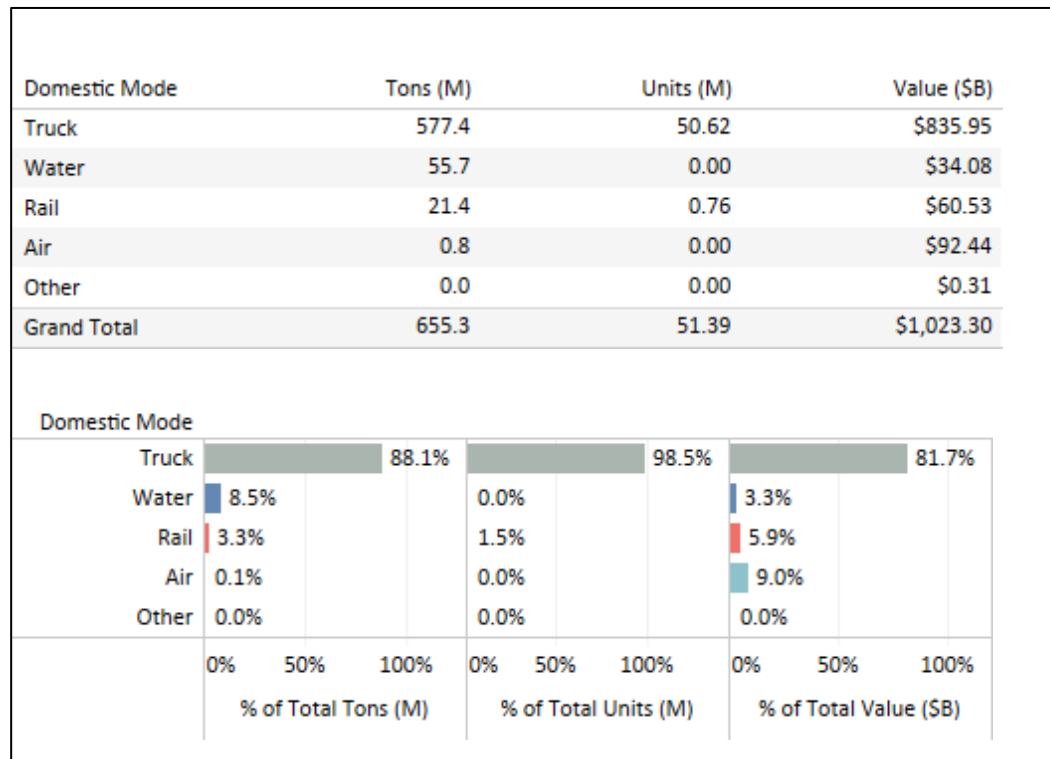
The Transearch analysis estimates a total of 655 million tons of domestic and North American trade freight, and 51 million units (trucks and railcars), with a value exceeding \$1 trillion dollars moving into, out of, and within the MAP Forum region in year 2018. The largest shares of tonnage and value moved inbound to the region, and the lowest are moving outbound from the region. The largest shares of units are moving within the region, reflecting the redistribution of goods between producers, warehouse/distribution facilities, and end users, with the inclusion of empty truck return moves reflected in the total. See Figure 5-1.

**Figure 5-1. MAP Forum Domestic Freight Flows (2018)**



Source: Analysis of NYSDOT Transearch database performed by WSP for the NYMTC Regional Freight Plan Update component of Plan 2050.

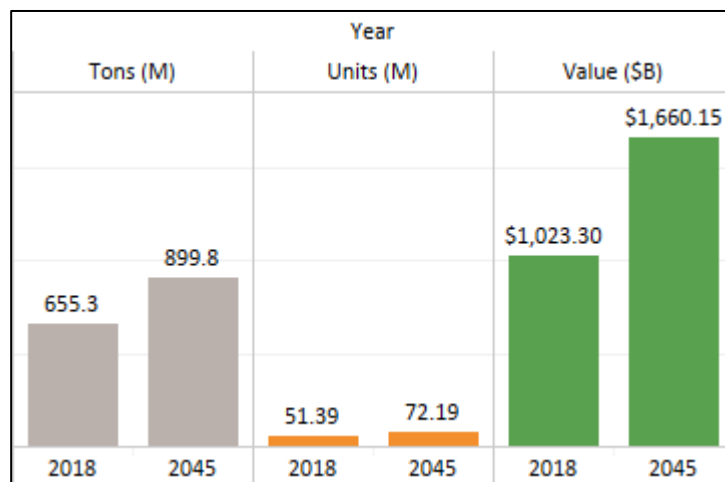
As shown in Figure 5-2, the vast majority of freight moving in the MAP Forum region (88 percent of freight tons) is carried by trucks. The region has a larger truck mode share than the nation due to a number of factors, including the large consumer market served by last-mile truck deliveries, intraregional interplant and distribution moves, and the under-developed freight rail network east of the Hudson. For these reasons, trucks and the roads and highways where trucks travel, are crucial elements of the region's freight transportation system.

**Figure 5-2. MAP Forum Region Domestic Freight Flows by Mode (2018)**

Source: Analysis of NYSDOT Transearch database performed by WSP for the NYMTC Regional Freight Plan Update component of Plan 2050.

According to the Transearch forecast, the volume of freight moved in the MAP Forum region, when measured by tonnage, is expected to increase by approximately 37 percent between 2018 and 2045, from 655 million tons to 900 million tons. See

Figure 5-3.

**Figure 5-3. MAP Forum Region Domestic Freight Flows (2018 and 2045)**

Source: Analysis of NYSDOT Transearch database performed by WSP for the NYMTC Regional Freight Plan Update component of Plan 2050.

The commodity flow analysis emphasizes the critical role trucks and highways play in conveying freight in the MAP Forum region, and suggests that the projected increase in freight demand through 2045 will lead to a greater number of trucks on the region's highways in the future. The next section of this memorandum explores truck trip characteristics on key highway corridors in the region.

The complete commodity flow analysis, which includes more detailed analysis of commodity groups, origin-destination pairs, and international import/export flows will be published as part of the freight element of Plan 2050.

## 5.2 Corridor-Level Freight Truck Flows

The following material was prepared for the Freight Element of NYMTC's next Plan. Figure A-3 through Figure A-23 following provide information on truck volumes, commodity types, origin-destination patterns, travel distance characteristics, and trip relationship to the NYMTC planning area, at different points in the region's primary truck network. The data source is the Transearch database for year 2018. Transearch is a commercial product of IHS Markit (now Standard & Poors), and provides modeled estimates of tonnage, value, and unit movements (trucks and railcars) by transportation mode, commodity type, and origin-destination routing. NYSDOT acquired Transearch for use in state and regional planning and made it available to NYMTC and its consulting team for analysis. The analysis consists of a set of "dashboards" developed using Tableau software, and focuses on truck unit movements (not tonnage or value) occurring at specified locations, in both directions. Each dashboard provides the following information:

- **Truck Flow Summary.** This pie chart shows the distribution of truck trip purposes relative to the ten-county NYMTC planning area. On any given roadway segment, trucks may be: inbound to the NYMTC planning area; outbound from the NYMTC planning area; moving within the NYMTC planning area; or "other." In cases where the roadway segment is in a NYMTC planning area county, "other" flows represent trucks passing through the NYMTC region. For other roadway segments, "other" flows are truck movements primarily unrelated to the NYMTC planning area, such as moves within or between New Jersey, Pennsylvania, Connecticut, and other states.
- **Truck Commodity Mix.** This bar chart shows the percentage share of different commodity groups, color-coded to show the Truck Flow type for each commodity group. Transearch includes empty trucks as a commodity group, so these moves are captured; MSW and waste moves are also captured.
- **Leading Truck Origins and Destinations.** These dot maps show the primary origins and destinations of truck trips. In many cases the two maps will be similar because empty truck return moves are included in the data.
- **Units and Shares by Distance.** These tables summarize the number of Transearch-reported truck unit units and how many are moving less than 100 miles, 100 to 400 miles, or over 400 miles. Note that Transearch estimates will not capture every truck, particularly for shorter-haul movements, so the reported units are likely to differ from HPMS or other available count data.

The corridor profiles are presented in Appendix A. Key findings of this analysis relevant to the Clean Freight Corridors Study include:

- Highway corridor segments carrying the greatest volume of commodity truck flows include:
  - I-95 in Union County, NJ (7 million truck units in 2018);
  - I-95 at George Washington Bridge, NY/NJ (6.8 million truck units in 2018);
  - I-495 east of I-295 in Queens, NY (5.4 million truck units in 2018);
  - I-84 in New Haven County, CT (4.4 million truck units in 2018); and
  - I-78 in Lehigh County, PA (4.3 million truck units in 2018).
- Short-distance commodity truck trips could be supported with alternative fueling and charging infrastructure within the MAP Forum region. The highway segments that carry the largest proportions of short-distance (less than 100 miles) commodity truck trips include:
  - NY Route 27 at the Queens-Nassau line (100%);
  - I-91 in New Haven County (55%);
  - I-287 in Somerset and Westchester counties (54-56%); and
  - I-495 in eastern Queens and Nassau counties (54-61%).
- To support longer-distance commodity truck trips, clean fueling and charging infrastructure investments may have to be coordinated with, or planned in a manner that considers, investments to be made in states outside the MAP Forum region. The highway segments that carry the largest proportions of long-distance (more than 400 miles) commodity truck trips include:
  - I-84 in Dutchess and Orange counties (63-65%); and
  - I-78 in Lehigh County (55%);
  - I-84 in New Haven County (40%); and
  - I-78 in Hudson and Somerset counties (36-39%).

### 5.3 Freight Demand Generators by Corridor

Analyzing the distribution of existing and potential future major generators of freight demand within the four-state MAP Forum region is relevant to the Clean Freight Corridors Study for several reasons, including:

- Origins and destinations of substantial numbers of freight shipments, contributing to the region's observed and projected freight travel demand, and to freight travel demand in key corridors;
- Emerging clusters of freight-generating establishments, such as new or expanding industrial parks, newly constructed or re-developing warehousing or distribution center facilities, and/or non-industrial buildings being redeveloped or repurposed for distribution represent potential growth and/or shifts in sources of freight travel demand; and

- Businesses and facilities that generate freight volumes, including motor carriers, warehousing and distribution facilities, and public terminals, are potential actors in implementing clean freight strategies, including transitioning fleets and/or developing charging and fueling infrastructure.

The primary source of business establishment data used for this analysis was a package of 2019 data produced by InfoUSA and acquired via NYSDOT, with permission from the data vendor. The InfoUSA data includes records on tens of thousands of business establishments in New York State and portions of northern New Jersey, northern Pennsylvania, western Connecticut, and other areas adjacent to New York State's boundaries. Key attributes include business name, industry classification code, number of on-site employees, geographic coordinates, and contact information.

The InfoUSA data package acquired via NYSDOT did not cover the Lehigh Valley in eastern Pennsylvania or portions of Connecticut outside of Fairfield or Litchfield counties. Zip Code Business Patterns data, acquired from the U.S. Census Bureau, was used to cover these parts of the study area. The Zip Code Business Patterns data includes the number of business establishments by industry sector and employment, expressed in ranges. Data for 2018 was acquired and used for this study.<sup>156</sup> There are no geographic coordinates or attributes that allow users to identify specific establishments, and where there are fewer than three businesses in a given zip code that meet the user's query criteria, the data are masked.

The InfoUSA and Zip Code Business Patterns data were queried in order to produce a list of "major freight generators" that are located within major freight highway corridors across the four-state MAP Forum region. The queries selected establishments in North American Industry Classification System (NAICS) codes 11-49, which represent "freight-intensive" industry sectors. A list of NAICS codes included in this query is provided in Table 5-1. These establishments were also filtered to select establishments with 100 or more employees and within five-mile buffers of the highway corridors reviewed in the Section 2 of this report.

**Table 5-1. "Freight-Intensive Industry Sectors" by NAICS Code**

| <i>2-Digit NAICS Code</i> | <i>Description</i>                                   |
|---------------------------|------------------------------------------------------|
| 11                        | <i>Agriculture, Forestry, Fishing, and Hunting</i>   |
| 21                        | <i>Mining, Quarrying, and Oil and Gas Extraction</i> |
| 22                        | <i>Utilities</i>                                     |
| 23                        | <i>Construction</i>                                  |
| 31-33                     | <i>Manufacturing</i>                                 |
| 42                        | <i>Wholesale Trade</i>                               |
| 44-45                     | <i>Retail Trade</i>                                  |
| 48-49                     | <i>Transportation and Warehousing</i>                |

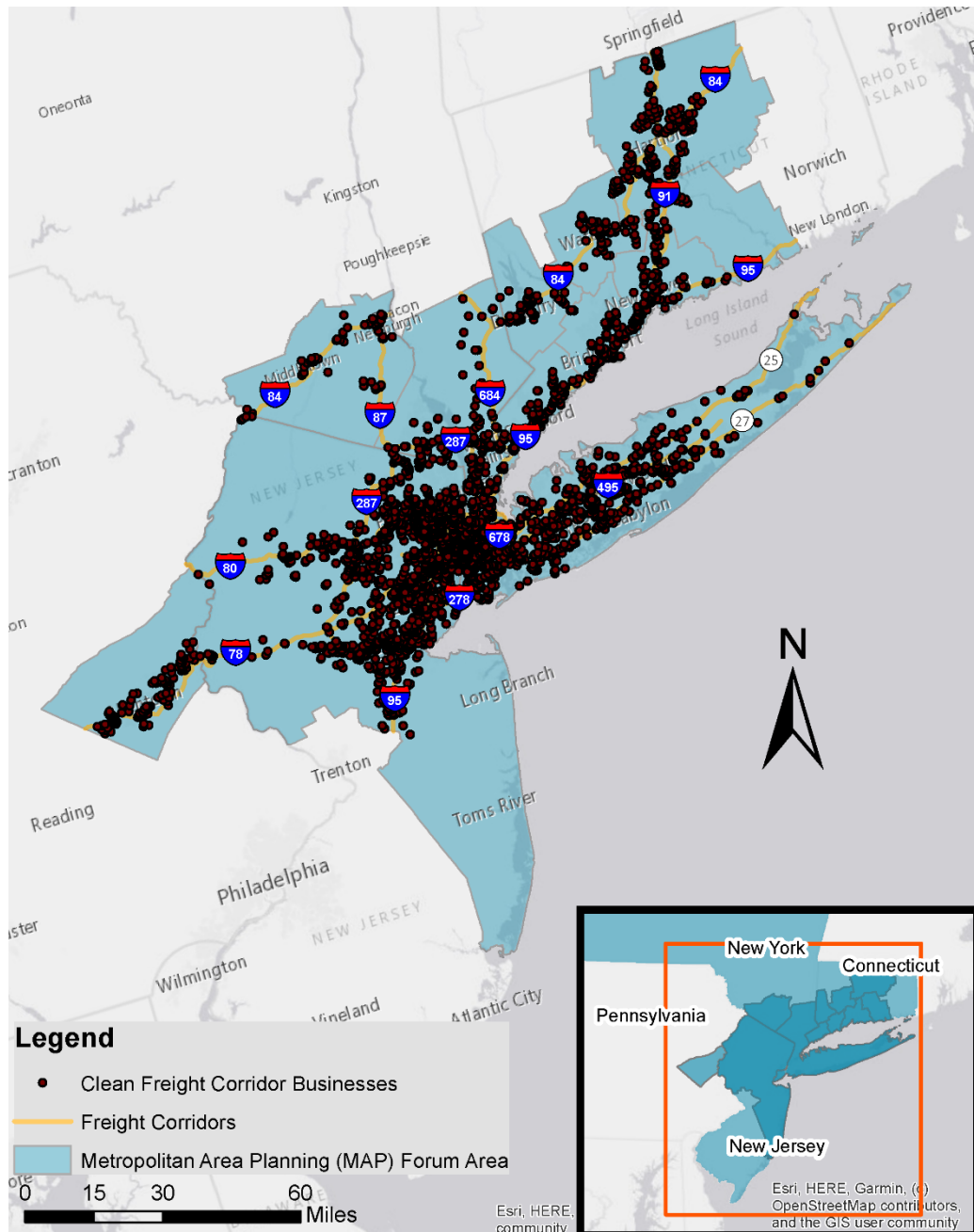
Figure 5-4 shows the locations of business establishments that represent "major freight generators" (establishments in the sectors identified in Table 5-1, with 100 or more employees) near major freight highway corridors across the four-state MAP Forum region. "Major freight highways" are highways identified

<sup>156</sup> Zip Code Business Patterns 2018, U.S. Census Bureau, available from: <https://www.census.gov/data/developers/data-sets/cbp-nonemp-zbp-zbp-api.html> (accessed December 17, 2020).

as regionally-significant in NYMTC's Regional Freight Plan due to volume of truck traffic, and role in various logistics chains that are important to the movement of goods in the region.

Table 5-2 is a companion to the map. It identifies the number of establishments, and identifies and describes key existing and emerging freight clusters, in each highway corridor. Additional information sources, including recently-completed freight and economic development plans and studies, internet research, and interviews completed with NYMTC member agencies during the Summer and Fall of 2020, were used to identify existing and emerging clusters, or activity centers, that generate substantial volumes of freight, or that are expected to generate substantial volumes of freight in the future, once they are further (re)developed.

**Figure 5-4. Business Establishments in Key Freight-Generating Industry Sectors, with 100 or More Employees, and Within 5 Miles of a Major Freight Highway**



Note: Freight-Generating Industry Sectors are identified in Table 5-3, and Major Freight Highways are described in the description of this figure in Section 5.3.

**Table 5-2. Corridor-Level Freight-Generating Business Establishments and Existing and Emerging Freight Clusters**

| Corridor    | Length (Miles) | Number of Freight Establishments (5 Mile Buffer) | Significant Freight Cluster (Listed as West-East/North-South) | Cluster Type        | Cluster Description                                                                                            |
|-------------|----------------|--------------------------------------------------|---------------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------|
| <b>I-78</b> | 102            | 557                                              | (PA) Exit 45 - Kutztown / Weisenberg Township                 | Growing             | Westward expansion of warehousing facilities along I-78 beyond urbanized portions of Lehigh County.            |
|             |                |                                                  | Exit 49 - Upper / Lower Macungie Townships                    | Established/Growing | Large warehousing area situated to the west of Allentown and the I-476 interchange.                            |
|             |                |                                                  | (NJ) Exit 3 - Phillipsburg / Lopatcong Township               | New                 | Development of Phillipsburg Logistics Center and additional planned rezonings along US-22.                     |
|             |                |                                                  | Union / Hillside / Newark (West Side)                         | Established         | Retail clusters along US-22 and multiple industrial clusters adjacent to I-78.                                 |
|             |                |                                                  | Port Jersey / Jersey City                                     | Established         | Established industrial clusters in Jersey City along Upper Bay.                                                |
| <b>I-80</b> | 68             | 552                                              | (NJ) International Trade Center / Mount Olive Township        | Growing             | Free-trade zone & office park gradually transitioning into more of a freight center.                           |
|             |                |                                                  | Parsippany                                                    | Established         | Mix of commercial and industrial sites within proximity to the I-80/I-287 junction.                            |
|             |                |                                                  | Fairfield - Wayne                                             | Established         | Mix of commercial and industrial sites in portions of Fairfield and Wayne, especially near US-46 and Route 23. |

|             |     |     |                                            |             |                                                                                                                                   |
|-------------|-----|-----|--------------------------------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------|
| <b>I-84</b> | 150 | 300 | Paterson - Clifton                         | Established | Mix of commercial and industrial sites in portions of Clifton and Paterson.                                                       |
|             |     |     | North Hudson / Bergen County South         | Established | Large warehousing and industrial area covering portions of North Bergen, East Rutherford, Carlstadt, Teterboro, and Moonachie.    |
|             |     |     | (NY) Middletown / Wallkill                 | Established | Commercial, medical, and industrial cluster centered around the I-84 / NY Route 17 interchange.                                   |
|             |     |     | Exit 5 - Montgomery                        | Growing     | Industrial clusters situated adjacent to Exit 5, between Middletown and Newburgh.                                                 |
|             |     |     | Newburgh / Stewart Airport                 | Growing     | Large commercial and warehousing area situated around the I-87 interchange and Stewart International Airport.                     |
|             |     |     | (CT) Danbury                               | Established | Mix of commercial and industrial sites, especially to the west of Danbury's central business district.                            |
|             |     |     | Waterbury                                  | Established | Mix of commercial and industrial sites, especially to the south of Danbury's central business district.                           |
| <b>I-87</b> | 60  | 505 | Hartford / East Hartford / Manchester      | Established | Mix of commercial and industrial sites around the Hartford and Manchester areas to the east.                                      |
|             |     |     | (NY) Exit 17 - Newburgh / Stewart Airport  | Growing     | Large commercial and warehousing cluster situated around the I-84 interchange and Stewart International Airport.                  |
|             |     |     | Bronx - Mott Haven                         | Established | Industrial cluster across the southern end of the Bronx in and around the Mott Haven neighborhood.                                |
| <b>I-91</b> | 58  | 232 | (CT) Windsor Locks / Bradley Int'l Airport | Growing     | Growing industrial cluster in the areas around Windsor Locks and Bradley International Airport, between Hartford and Springfield. |
|             |     |     | Hartford / East Hartford / Manchester      | Established | Mix of commercial and industrial sites around the Hartford and Manchester areas to the east.                                      |
|             |     |     | New Haven                                  | Established | Mix of commercial and industrial sites in and around New Haven.                                                                   |

|              |     |       |                                         |                         |                                                                                                                                |
|--------------|-----|-------|-----------------------------------------|-------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <b>I-95</b>  | 161 | 1,253 | (CT) New Haven                          | Established             | Mix of commercial and industrial sites in and around New Haven.                                                                |
|              |     |       | Bridgeport                              | Established             | Mix of commercial and industrial sites in and around Bridgeport.                                                               |
|              |     |       | Stamford                                | Established             | Mix of commercial and industrial sites in and around Stamford.                                                                 |
|              |     |       | (NY) Mt. Vernon                         | Established             | Industrial cluster along Eastchester Creek                                                                                     |
|              |     |       | Bronx - Hunts Point                     | Established/<br>Growing | Industrial cluster across the Hunts Point section of the Bronx. New multistory warehousing coming.                             |
|              |     |       | (NJ) North Hudson / Bergen County South | Established             | Large warehousing and industrial area covering portions of North Bergen, East Rutherford, Carlstadt, Teterboro, and Moonachie. |
|              |     |       | Exit 15X - Secaucus                     | Established             | Large warehousing cluster comprising the southern portion of Secaucus.                                                         |
|              |     |       | South Kearny                            | Established             | Industrial and warehousing cluster comprising South Kearny and the CSX South Kearny Intermodal Terminal.                       |
|              |     |       | Port Newark / Elizabeth                 | Established             | Very large industrial / energy cluster surrounding Port Newark and points south in Elizabeth.                                  |
|              |     |       | Exit 12 - Linden / Carteret             | Established             | Very large industrial / energy cluster to the south of Newark and Elizabeth.                                                   |
|              |     |       | Exit 10 - Raritan Center                | Established             | Very large industrial cluster comprising the Raritan Center of Edison Township.                                                |
|              |     |       | Exit 8A - Monroe / Cranbury Townships   | Established/<br>Growing | Very large warehousing cluster situated around Exit 8A, with continued expansion and development.                              |
| <b>I-278</b> | 35  | 439   | (NY) Bronx - Hunts Point                | Established/<br>Growing | Industrial cluster across the Hunts Point section of the Bronx. New multistory warehousing coming.                             |
|              |     |       | Queens - Maspeth                        | Established             | Large industrial cluster in the Maspeth section of Queens.                                                                     |

|              |    |     |                                             |                         |                                                                                                                                             |
|--------------|----|-----|---------------------------------------------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <b>I-287</b> | 99 | 631 | Brooklyn - Sunset Park / Red Hook / Gowanus | Established             | Cluster of industrial sites, especially along Upper New York Bay.                                                                           |
|              |    |     | Staten Island - Old Place / Mariners Harbor | Growing                 | Growing industrial cluster at the western edge of Staten Island, in proximity to the Goethals Bridge.                                       |
|              |    |     | (NJ) Bayway Elizabeth                       | Established             | Cluster of industrial sites, including energy producers, in and around Elizabeth,                                                           |
|              |    |     | (NY) Elmsford - White Plains                | Established/<br>Growing | Mix of commercial and industrial sites between Elmsford and White Plains, including conversions of some office buildings to industrial use. |
|              |    |     | (NJ) Mahwah                                 | Established             | Mix of commercial and industrial sites on and around Route 17 in Mahwah near I-287.                                                         |
|              |    |     | Parsippany                                  | Established             | Mix of commercial and industrial sites within proximity to the I-80/I-287 junction.                                                         |
|              |    |     | Franklin Township (Somerset County)         | Established/<br>Growing | Large industrial cluster, including conversions of some office buildings to industrial use.                                                 |
|              |    |     | Piscataway / South Plainfield               | Established             | Large industrial cluster comprising portions of Piscataway and South Plainfield, adjacent to I-287.                                         |
| <b>I-495</b> | 71 | 940 | Raritan Center                              | Established             | Very large industrial cluster comprising Raritan Center of Edison Township.                                                                 |
|              |    |     | (NY) Midtown Manhattan                      | Established             | Multiple commercial and warehouse facilities scattered throughout Manhattan.                                                                |
|              |    |     | Queens - Hunters Point                      | Established             | Mix of industrial sites scattered throughout the Hunters Point section of Queens                                                            |
|              |    |     | Queens - Maspeth                            | Established             | Large industrial cluster in the Maspeth section of Queens.                                                                                  |
|              |    |     | Hicksville                                  | Established             | Multiple industrial clusters around Hicksville.                                                                                             |
|              |    |     | Melville / Route 110 / Republic Airport     | Established             | Cluster of commercial and industrial sites scattered around Route 110 and Republic Airport.                                                 |

|              |     |     |                                                              |                                                                                                            |
|--------------|-----|-----|--------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
|              |     |     | Bayville / Established                                       | Mix of commercial and warehouse facilities around Bayville and Hauppauge.                                  |
|              |     |     | Bohemia - Established                                        | Large cluster of commercial and industrial sites scattered around Bohemia and the MacArthur Airport areas. |
|              |     |     | Brookhaven Growing                                           | Brookhaven Rail Terminal, developable industrial land                                                      |
| <b>I-678</b> | 14  | 241 | (NY) Bronx - Established                                     | Industrial cluster across the Soundview section of the Bronx.                                              |
|              |     |     | Queens - Willets Point / College Point Established           | Industrial and commercial cluster stretching from Willets Point to College Point in Queens.                |
|              |     |     | East New York / JFK Int'l Airport Established                | Multiple industrial areas around East New York and JFK International Airport                               |
| <b>I-684</b> | 29  | 102 | No Significant Freight Clusters N/A                          | N/A                                                                                                        |
| <b>NY-25</b> | 105 | 906 | (NY) Midtown Manhattan Established                           | Multiple commercial and warehouse facilities scattered throughout Manhattan.                               |
|              |     |     | Queens - Hunters Point Established                           | Mix of industrial sites scattered throughout the Hunters Point section of Queens                           |
|              |     |     | East New York / JFK Int'l Airport Established                | Multiple industrial areas around East New York and JFK International Airport                               |
|              |     |     | Hicksville Established                                       | Multiple industrial clusters around Hicksville.                                                            |
|              |     |     | Hauppauge Established                                        | Mix of commercial and warehouse facilities around Hauppauge.                                               |
| <b>NY-27</b> | 121 | 590 | (NY) Brooklyn - Sunset Park / Red Hook / Gowanus Established | Cluster of industrial sites, especially along Upper New York Bay.                                          |
|              |     |     | East New York / JFK Int'l Airport Established                | Multiple industrial areas around East New York and JFK International Airport                               |
|              |     |     | Freeport Established                                         | Cluster of commercial and industrial sites in the area of Freeport.                                        |

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|                              |   |             |                                                                                                                                  |
|------------------------------|---|-------------|----------------------------------------------------------------------------------------------------------------------------------|
| Amityville<br>Copiague       | - | Established | Cluster of commercial and industrial sites scattered around the Amityville and Copiague areas, to the south of Republic Airport. |
| Bohemia<br>MacArthur Airport | - | Established | Large cluster of commercial and industrial sites scattered around Bohemia and the MacArthur Airport areas.                       |

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## 6.0 Stakeholder Workshop

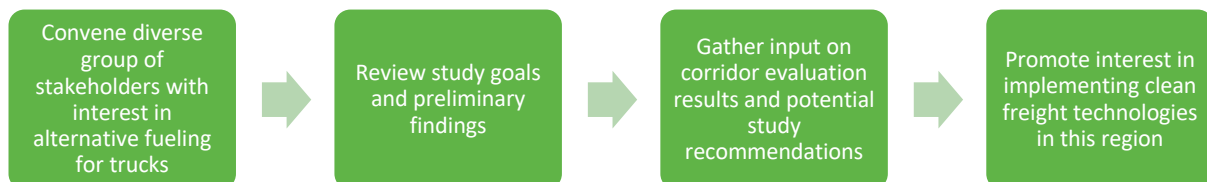
Implementing clean freight charging and fueling infrastructure in the region will require partnerships and/or coordination with a broad range of stakeholders in the public and private sectors. Gathering input from representatives of these stakeholder groups is an important input to the study, as it helps the team to affirm the preliminary findings of the study, identify other issues and needs that the study may not have uncovered thus far, and enhance the list of preliminary recommendations for implementing clean freight corridors.

To collect this input, the team prepared and implemented a virtual workshop, called the Clean Freight Corridors Study Planning Workshop. This technical memorandum summarizes the objectives, preparation steps, format, and outcomes of the virtual workshop. The workshop outcomes will be used to enhance the study's recommendations.

The objectives of the Clean Freight Corridors Study Planning Workshop, also shown in Figure 6-1, were to:

- Convene, in a virtual forum, a diverse group of public- and private-sector stakeholders with interests in alternative fueling for trucks;
- Review the goals and preliminary findings of the Regional Clean Freight Corridors Study with the virtual workshop participants;
- Gather input from participants, through facilitated discussion, on the corridor evaluation results and potential recommendations of the Regional Clean Freight Corridors Study; and
- Promote interest among participants in implementing clean freight technologies in the multi-state Metropolitan Area Planning (MAP) Forum region.

**Figure 6-1. Clean Freight Corridors Study Planning Workshop Objectives**



## 6.1 Workshop Participants and Recruiting

As mentioned in the previous section, the first objective of the workshop was to convene a diverse group of stakeholders from both the public and private sectors. In particular, the team intended to reach stakeholder groups who had not been reached through other means, including NYMTC's PFAC Freight Subcommittee or the study's Technical Advisory Committee. Private sector companies in the fueling, truck stop operations, equipment manufacturing, and utilities sectors, for example, will play critical roles in the implementation of clean freight charging and fueling infrastructure in the region. Their perspectives are necessary inputs into the Regional Clean Freight Corridors Study's recommendations. Also, community and advocacy organizations have important perspectives regarding the potential effects of clean freight corridor implementation, including emissions reductions, local area land use, and other issues of importance to their respective missions.

In an effort to achieve the participation of organizations across this broad spectrum of stakeholders, the team developed a long list of organizations, organized by stakeholder types. The list included organizations familiar to team members, organizations identified through internet searches, and suggestions received from members of the PFAC Freight Subcommittee and Technical Advisory Committee.

The full list of workshop invitees, including as Appendix B, includes organizations representing the following stakeholder groups:

- Motor carriers;
- Utility companies;
- Fuel infrastructure manufacturers/suppliers;
- Fuel suppliers;
- Truck stop operators;
- Industrial real estate companies; and
- Community and advocacy organizations.

Invitees were contacted via email and invited to participate in the workshop. The invitation included relevant information about the study's objectives, and the objectives of the workshop. Arch Street Communications sent the initial invitation email and followed up with e-mails and phone calls to remind participants to register and to forward the invite to others in their organization that might be interested in attending.

On the eve of the workshop, which was held on October 7, 2021, 46 individuals had registered to participate in the workshop. Twenty-one of those individuals logged in and participated. Table 1 lists the individuals who participated in the workshop on October 7.

**Table 6-1. Clean Freight Corridors Study Planning Workshop Participants**

| <b>Participant Name</b>    | <b>Organization Represented</b>                              |
|----------------------------|--------------------------------------------------------------|
| <i>Brett Barry</i>         | <i>Clean Energy Fuels</i>                                    |
| <i>Joy Gardner</i>         | <i>Empire Clean Cities</i>                                   |
| <i>Sacha-Rose Phillips</i> | <i>Environmental Defense Fund</i>                            |
| <i>Kevin Force</i>         | <i>Hudson County, NJ</i>                                     |
| <i>Tiffany Wlazlowski</i>  | <i>NATSO</i>                                                 |
| <i>Mark Nielsen</i>        | <i>Naugatuck Valley Council of Governments</i>               |
| <i>Richard Donovan</i>     | <i>Naugatuck Valley Council of Governments</i>               |
| <i>Eddy Nupoort</i>        | <i>Nel Hydrogen</i>                                          |
| <i>Susan McSherry</i>      | <i>New York City Department of Transportation</i>            |
| <i>Lori Clark</i>          | <i>North Central Texas Council of Governments</i>            |
| <i>Soria Adibi</i>         | <i>North Central Texas Council of Governments</i>            |
| <i>Jennifer Fogliano</i>   | <i>North Jersey Transportation Planning Authority</i>        |
| <i>Julie Richmond</i>      | <i>Orange County</i>                                         |
| <i>Tanja Grzeskowitz</i>   | <i>Port Authority of New York and New Jersey</i>             |
| <i>Charles Liou</i>        | <i>Port Authority of New York and New Jersey</i>             |
| <i>Bethann Rooney</i>      | <i>Port Authority of New York and New Jersey</i>             |
| <i>Nikolas Mirando</i>     | <i>Stevens University</i>                                    |
| <i>Rene Luciano</i>        | <i>Trucking Association of New York</i>                      |
| <i>Kendra Hems</i>         | <i>Trucking Association of New York</i>                      |
| <i>Michael Scarpino</i>    | <i>U.S. DOT Volpe National Transportation Systems Center</i> |
| <i>David Greenfader</i>    | <i>Wave</i>                                                  |

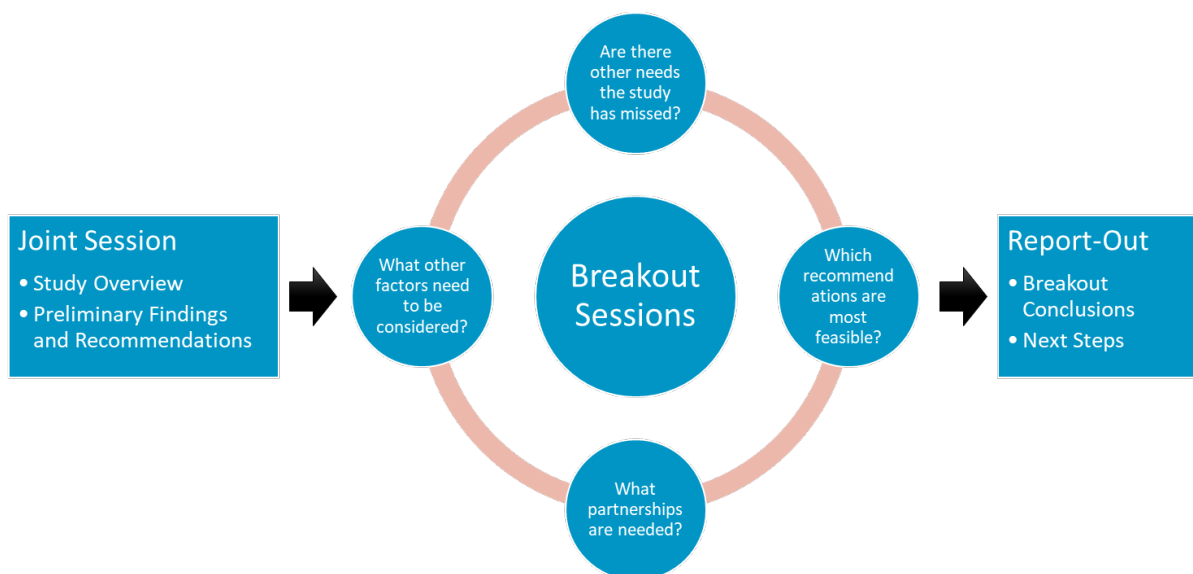
## 6.2 Workshop Agenda and Implementation

The workshop was held virtually using Microsoft Teams. In order to encourage discussion and knowledge transfer, and to acquire the input desired, the workshop was organized in a manner that promoted engaged participation.

As Figure 6-2 shows, the workshop began with an interactive presentation of the Regional Clean Freight Corridors Study's goals, objectives, technical analysis, and findings to date. The presentation

included three interactive polling questions, using Slido,<sup>157</sup> that aimed to gather input from participants on the material being presented, and to engage the participants with the presentation.

**Figure 6-2. Clean Freight Corridors Study Planning Workshop Agenda**



After the presentation portion of the workshop concluded, participants were separated into facilitated “breakout sessions.” The breakout sessions allowed participants, in small groups, to discuss the study’s findings and recommendations, and to offer additional input, recommendations, or identify other key issues the study may have not yet addressed. The facilitated discussion was held in Microsoft Teams breakout rooms, and Miro<sup>158</sup> was used as a whiteboard to collect comments and to write or mark suggestions on maps of the recommended regional clean freight corridors.

Each breakout session included up to 8 participants, and 3 members of the study team. Each of the three members of the study team in each breakout session had one of the following roles:

1. One member of the ASC staff served as the “Meeting Organizer,” who provided the technical support and control the breakout rooms. The Meeting Organizer also shared chat notifications indicating when it is nearly time to move to the next question.
2. One facilitator, the “Discussion Leader,” was responsible for guiding the group through the questions identified in the facilitation guide (provided as Appendix C). The facilitator was also responsible for starting the meeting recording under the settings of their individual breakout room

<sup>157</sup> <https://sli.do>

<sup>158</sup> <https://miro.com>

3. The other facilitator, the “Note Taker,” updated their group’s Miro frame to reflect the answers provided to the activities.

A PDF copy of the Miro board for this workshop is available upon request.

There were four breakout groups and the breakout sessions lasted 40 minutes. Once the participants were re-convened in the large group meeting room in Microsoft Teams, a representative from each group reported on portions of their respective findings and conclusions. The participants were then thanked for their interest and participation in the workshop and dismissed.

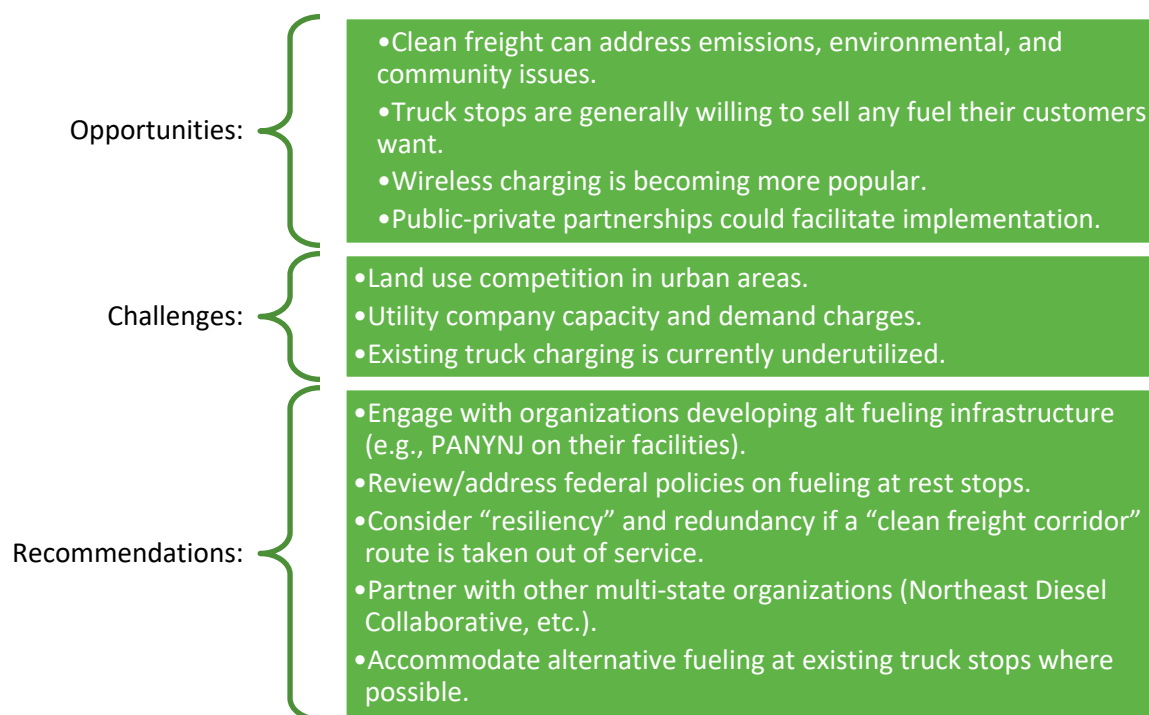
After the workshop had concluded, the workshop slides and a recording of the workshop were transmitted to participants and to NYMTC for distribution to other interested parties.

## 6.3 Workshop Outcomes

The breakout sessions included conversations regarding the perceived or desired meaning of a “clean freight corridor” designation, thoughts, or suggestions on the preliminary list of recommended corridors for each fuel type, the policies and other factors needed to implement clean freight infrastructure in the region, and next steps and other stakeholders that ought to be engaged.

Figure 6-3 includes highlights of the feedback received. A full list of comments gathered in each of the three breakout sessions is provided as Appendix D.

**Figure 6-3. Highlights of the Comments Gathered During the Breakout Sessions**



The Clean Freight Corridors Planning Study virtual workshop provided the study team with valuable information from the perspectives of stakeholder groups that had not been engaged over the course of the study prior. The input and recommendations gathered will be incorporated into the final recommendations of the Clean Freight Corridors Planning Study.

## 7.0 Recommended Clean Freight Corridors for Designation

This section describes the methodology and results of a new Clean Freight Corridor designation process, developed in partnership with NYMTC, the study's Technical Advisory Committee (TAC), and industry and public sector stakeholders.

### 7.1 Methodology

For the purposes of this analysis, clean fuels are defined as electricity, hydrogen, compressed natural gas (CNG), and liquefied petroleum gas (LPG). Draft clean freight corridor recommendations were developed by calculating a **readiness** score for each fuel type. The readiness scores are drawn from three weighted variables: fuel station coverage, proximity to freight demand clusters, and existing truck volume (Table 7-1). Weights were calculated from a ranking exercise conducted with the TAC in March 2021. Based on the readiness score percentile rank, corridor segments were grouped into three relative readiness levels (high, medium, low) for each fuel type, with 9-to-11 segments assigned to each level.

In addition to the readiness score, a score was developed to estimate each corridor's **need** for clean fueling infrastructure. The need score included projected demand for each fuel type in 2045 (based on a prior analysis conducted as part of this study), as well as air quality in census tracts adjacent to the segment, based on diesel particulate emissions (

Table 7-2). Notably, future demand for LPG is projected to be minimal, and need scores were not developed for LPG as a result.

This methodology was presented for review by industry, agency, and community stakeholders as well as the TAC.

**Table 7-1. Inputs to Weighted Composite Readiness Score**

| Variable Name                        | Variable Description                                                             | Data Source | Related Indicator from TAC Meeting      | Weight |
|--------------------------------------|----------------------------------------------------------------------------------|-------------|-----------------------------------------|--------|
| Fuel station coverage (by fuel type) | Percent of segment located within a 5-mile buffer of fuel station <sup>159</sup> | FHWA 2020   | Gaps in existing fueling infrastructure | 44%    |

<sup>159</sup> A five-mile buffer was used based on 2020 FHWA Clean Freight Corridor designation methods. FHWA methods were recently revised to measure fuel station coverage within a one-mile buffer.

|                         |                                                 |                                     |                                       |     |
|-------------------------|-------------------------------------------------|-------------------------------------|---------------------------------------|-----|
| Freight demand clusters | Number of nearby Major Freight Demand Clusters  | Cambridge Systematics analysis      | Proximity to major freight generators | 29% |
| Existing truck volume   | Number of freight trucks utilizing the corridor | Transearch and FAF network analysis | Freight volumes                       | 27% |

**Table 7-2. Inputs to Weighted Composite Need Score**

| <b>Variable Name</b>            | <b>Variable Description</b>                                                     | <b>Data Source</b>                   | <b>Related Indicator from TAC Meeting</b>              | <b>Weight</b> |
|---------------------------------|---------------------------------------------------------------------------------|--------------------------------------|--------------------------------------------------------|---------------|
| Projected demand (by fuel type) | Number of trucks projected to be domiciled in zip codes adjacent to the segment | CALSTART analysis                    | Alternative fuel vehicle technology adoption by fleets | 50%           |
| Air quality                     | Diesel particulate matter emissions                                             | EPA Environmental Justice Index 2019 | Particulate matter emissions                           | 50%           |

## 7.2 Results

Results from the readiness and need analyses are summarized in Table 3 and Figure 7-1, and presented in detail in Tables 7-4 through 7-7 and Figures 7-2 through 7-5. In total, 21 of the 31 highway segments evaluated rank as either high readiness or high need for at least one fuel type (Table 7-3). Of these, ten rank as high readiness for two or more fuel types. Eight of these also rank as high need for at least two fuel types (highlighted in yellow in Table 7-3). The combination of high readiness and high need across multiple fuel types on these eight segments make them the strongest candidates for Clean Freight Corridor designation. An additional three segments (NY25 and NY27, highlighted in red), should be considered for priority development as they rank high in need for electric, hydrogen, and CNG infrastructure, but low in readiness.

Additional segments should be considered for priority development to ensure a complete network of infrastructure. For example, I-495 in Nassau County ranks high readiness for only two fuel types and doesn't rank high need for any. However, it connects I-495 in Queens and Suffolk Counties (which are both high readiness segments) and should therefore be prioritized for EV and hydrogen infrastructure development to provide continuous reliable fueling opportunities. Based on stakeholder feedback, all segments of I-95 should also be prioritized for interstate connectivity in alternative fueling networks.

Further, NYMTC should consult with adjacent jurisdictions to ensure continuity of fueling infrastructure for longer-distance trips. For example, the Pennsylvania Department of Transportation plans to advance EV and CNG infrastructure along I-78<sup>160</sup>. Segments of I-78 in this study's focus area did not rank as high priority but could become more important in the future as connecting segments are developed.

**Table 7-3. Recommended Clean Freight Corridors and Priority Development Corridors**

|                                                                | Highway | Segment                       | High Readiness |    |     |     | High Need |    |     |
|----------------------------------------------------------------|---------|-------------------------------|----------------|----|-----|-----|-----------|----|-----|
|                                                                |         |                               | EV             | H2 | CNG | LPG | EV        | H2 | CNG |
| Clean Freight Corridor<br>(High Readiness,<br>High Need)       | I-278   | Total length                  | X              | X  |     |     | X         | X  | X   |
|                                                                | I-495   | Queens                        | X              | X  | X   |     | X         | X  | X   |
|                                                                | I-495   | Suffolk                       | X              | X  | X   | X   | X         | X  | X   |
|                                                                | I-678   | Total length                  | X              |    | X   |     | X         | X  | X   |
|                                                                | I-80    | New Jersey (east of 287)      | X              | X  |     | X   |           |    |     |
|                                                                | I-87    | Westchester and Bronx         | X              | X  | X   |     | X         | X  | X   |
|                                                                | I-95    | New Jersey (north of Exit 10) | X              | X  | X   | X   | X         | X  | X   |
|                                                                | I-95    | Manhattan and Bronx           | X              | X  | X   |     | X         | X  | X   |
| Priority Development Corridor<br>(High Need,<br>Low Readiness) | NY 25   | Queens                        |                |    | X   |     | X         | X  | X   |
|                                                                | NY 27   | Kings and Queens              |                |    | X   |     | X         | X  | X   |
|                                                                | NY 27   | Suffolk                       |                |    |     |     | X         | X  | X   |
| Priority Development Corridor<br>(Connectivity)                | I-95    | New Jersey (south of Exit 10) | X              |    |     | X   |           |    |     |
|                                                                | I-95    | Westchester                   |                | X  |     |     |           |    |     |
|                                                                | I-95    | Fairfield County              |                |    |     | X   |           |    |     |
|                                                                | I-95    | New Haven County              |                |    |     |     |           |    |     |
|                                                                | I-495   | Nassau                        |                |    | X   | X   |           |    |     |
|                                                                | I-78    | Pennsylvania                  |                |    |     | X   |           |    |     |
|                                                                | I-78    | New Jersey (east of 287)      |                |    |     |     |           |    |     |
|                                                                | I-78    | New Jersey (west of 287)      |                |    |     |     |           |    |     |

<sup>160</sup> [Final \(ver7-12-21\) PennDOT I81-I78 AFC Deployment Plan Report.pdf](#)

[illegible]

A notable gap in this analysis is the proximity of highway segments to environmental justice (EJ) communities. Air quality as measured by particulate matter emissions was used to approximate

exposure to pollution, but other pollutants and demographic factors such as race and income were not considered.

While the project team lacked a consistently defined, cross-jurisdiction dataset to address this gap under the project scope,<sup>161</sup> stakeholders highlighted this as a priority for future study of clean freight corridor development. As a next step, the clean freight corridor designations recommended in this report should be analyzed for proximity to EJ communities, and adjustments should be made to ensure that benefits are prioritized to the communities most historically afflicted by diesel pollution.

**Table 7-4. Electric (EV) Readiness and Need**

| Highway | Segment                       | EV Readiness Score | EV Readiness Level | EV Need Score | EV Need |
|---------|-------------------------------|--------------------|--------------------|---------------|---------|
| I-95    | New Jersey (north of Exit 10) | 0.98               | high               | 0.62          | high    |
| I-278   | Total length                  | 0.80               | high               | 0.98          | high    |
| I-495   | Queens                        | 0.79               | high               | 0.72          | high    |
| I-95    | New Jersey (south of Exit 10) | 0.69               | high               | 0.27          | medium  |
| I-495   | Suffolk                       | 0.69               | high               | 0.39          | high    |
| I-95    | Manhattan and Bronx           | 0.67               | high               | 0.57          | high    |
| I-287   | New Jersey (east of 78)       | 0.62               | high               | 0.26          | low     |
| I-87    | Westchester and Bronx         | 0.62               | high               | 0.49          | high    |
| I-80    | New Jersey (east of 287)      | 0.60               | high               | 0.38          | medium  |
| I-678   | Total length                  | 0.59               | high               | 0.48          | high    |
| I-287   | Rockland and Westchester      | 0.58               | medium             | 0.29          | medium  |
| I-95    | Westchester                   | 0.56               | medium             | 0.26          | low     |
| NY 27   | Kings and Queens              | 0.56               | medium             | 0.55          | high    |
| I-87    | Orange and Rockland (to 287)  | 0.52               | medium             | 0.20          | low     |
| I-84    | Orange                        | 0.50               | medium             | 0.14          | low     |
| NY 27   | Nassau                        | 0.50               | medium             | 0.37          | medium  |
| NY 25   | Queens                        | 0.50               | medium             | 0.50          | high    |
| I-495   | Nassau                        | 0.49               | medium             | 0.29          | medium  |
| NY 25   | Nassau                        | 0.49               | medium             | 0.38          | high    |
| I-95    | Fairfield County              | 0.45               | medium             | 0.26          | medium  |
| I-84    | Connecticut                   | 0.43               | low                | 0.29          | medium  |
| I-78    | Pennsylvania                  | 0.40               | low                | 0.26          | medium  |
| I-287   | New Jersey (north of 78)      | 0.39               | low                | 0.20          | low     |
| NY 27   | Suffolk                       | 0.38               | low                | 0.43          | high    |

<sup>161</sup> In compliance with Title VI of the Civil Rights Act of 1964, NYMTC designates census tracts with at least 57% minority population and 14% of persons below the poverty line as “Communities of Concern.” The study team does not have data on similar designations in portions of the study area outside of NYMTC’s planning region.

|       |                          |      |     |      |        |
|-------|--------------------------|------|-----|------|--------|
| I-80  | New Jersey (west of 287) | 0.35 | low | 0.19 | low    |
| I-91  | Connecticut              | 0.31 | low | 0.34 | medium |
| NY 25 | Suffolk                  | 0.29 | low | 0.26 | low    |
| I-78  | New Jersey (east of 287) | 0.29 | low | 0.27 | medium |
| I-95  | New Haven County         | 0.28 | low | 0.19 | low    |
| I-78  | New Jersey (west of 287) | 0.19 | low | 0.12 | low    |
| I-84  | Putnam and Dutchess      | 0.16 | low | 0.12 | low    |

**Table 7-5. Hydrogen (H2) Readiness and Need**

| Highway | Segment                       | H2 Readiness Score | H2 Readiness Level | H2 Need Score | H2 Need |
|---------|-------------------------------|--------------------|--------------------|---------------|---------|
| I-95    | Manhattan and Bronx           | 0.66               | high               | 0.57          | high    |
| I-95    | New Jersey (north of Exit 10) | 0.56               | high               | 0.63          | high    |
| I-278   | Total length                  | 0.42               | high               | 0.98          | high    |
| I-84    | Connecticut                   | 0.37               | high               | 0.30          | medium  |
| I-495   | Queens                        | 0.35               | high               | 0.54          | high    |
| I-87    | Westchester and Bronx         | 0.34               | high               | 0.49          | high    |
| I-495   | Suffolk                       | 0.34               | high               | 0.39          | high    |
| I-80    | New Jersey (east of 287)      | 0.29               | high               | 0.38          | medium  |
| I-95    | Westchester                   | 0.28               | high               | 0.26          | low     |
| NY 27   | Nassau                        | 0.28               | high               | 0.37          | medium  |
| I-287   | New Jersey (east of 78)       | 0.27               | medium             | 0.26          | low     |
| I-78    | Pennsylvania                  | 0.26               | medium             | 0.27          | medium  |
| I-84    | Orange                        | 0.26               | medium             | 0.14          | low     |
| I-95    | New Jersey (south of Exit 10) | 0.25               | medium             | 0.27          | medium  |
| I-91    | Connecticut                   | 0.25               | medium             | 0.34          | medium  |
| I-80    | New Jersey (west of 287)      | 0.23               | medium             | 0.19          | low     |
| I-287   | New Jersey (north of 78)      | 0.21               | medium             | 0.21          | low     |
| I-78    | New Jersey (west of 287)      | 0.19               | medium             | 0.13          | low     |
| I-495   | Nassau                        | 0.19               | medium             | 0.29          | medium  |
| I-87    | Orange and Rockland (to 287)  | 0.19               | medium             | 0.19          | low     |
| I-678   | Total length                  | 0.19               | medium             | 0.48          | high    |
| NY 25   | Nassau                        | 0.18               | low                | 0.38          | medium  |
| I-78    | New Jersey (east of 287)      | 0.17               | low                | 0.27          | medium  |
| I-95    | New Haven County              | 0.17               | low                | 0.19          | low     |
| I-95    | Fairfield County              | 0.17               | low                | 0.27          | medium  |
| I-287   | Rockland and Westchester      | 0.14               | low                | 0.29          | medium  |
| NY 25   | Suffolk                       | 0.14               | low                | 0.26          | low     |

|       |                     |      |     |      |      |
|-------|---------------------|------|-----|------|------|
| NY 27 | Suffolk             | 0.14 | low | 0.43 | high |
| NY 27 | Kings and Queens    | 0.12 | low | 0.55 | high |
| I-84  | Putnam and Dutchess | 0.10 | low | 0.12 | low  |
| NY 25 | Queens              | 0.06 | low | 0.50 | high |

Table 7-6. Compressed Natural Gas (CNG) Readiness and Need<sup>162</sup>

| Highway | Segment                       | CNG Readiness Score | CNG Readiness Level | CNG Need Score | CNG Need |
|---------|-------------------------------|---------------------|---------------------|----------------|----------|
| I-95    | New Jersey (north of Exit 10) | 0.78                | high                | 0.53           | high     |
| I-495   | Queens                        | 0.74                | high                | 0.72           | high     |
| I-95    | Manhattan and Bronx           | 0.73                | high                | 0.60           | high     |
| I-495   | Suffolk                       | 0.67                | high                | 0.47           | high     |
| I-287   | Rockland and Westchester      | 0.58                | high                | 0.29           | medium   |
| I-495   | Nassau                        | 0.52                | high                | 0.32           | medium   |
| NY 27   | Kings and Queens              | 0.51                | high                | 0.60           | high     |
| I-87    | Westchester and Bronx         | 0.51                | high                | 0.49           | high     |
| NY 25   | Queens                        | 0.50                | high                | 0.50           | high     |
| I-678   | Total length                  | 0.47                | high                | 0.48           | high     |
| I-95    | Westchester                   | 0.45                | medium              | 0.27           | medium   |
| I-78    | Pennsylvania                  | 0.43                | medium              | 0.27           | medium   |
| I-278   | Total length                  | 0.39                | medium              | 0.98           | high     |
| I-91    | Connecticut                   | 0.37                | medium              | 0.29           | medium   |
| I-84    | Connecticut                   | 0.37                | medium              | 0.33           | medium   |
| I-78    | New Jersey (east of 287)      | 0.33                | medium              | 0.26           | low      |
| I-95    | New Haven County              | 0.31                | medium              | 0.21           | low      |
| I-80    | New Jersey (east of 287)      | 0.29                | medium              | 0.34           | medium   |
| NY 27   | Nassau                        | 0.29                | medium              | 0.38           | medium   |
| NY 25   | Nassau                        | 0.28                | medium              | 0.39           | medium   |
| NY 27   | Suffolk                       | 0.27                | low                 | 0.59           | high     |
| I-287   | New Jersey (east of 78)       | 0.27                | low                 | 0.25           | low      |
| I-84    | Orange                        | 0.26                | low                 | 0.16           | low      |

<sup>162</sup> While the modeling analysis anticipates growth in demand for CNG for heavy-duty vehicles, New Jersey's Energy Master Plan prioritizes advancements in battery or fuel cell electric technology for heavy duty vehicle applications.

|       |                               |      |     |      |        |
|-------|-------------------------------|------|-----|------|--------|
| I-95  | New Jersey (south of Exit 10) | 0.25 | low | 0.25 | low    |
| I-80  | New Jersey (west of 287)      | 0.23 | low | 0.17 | low    |
| I-287 | New Jersey (north of 78)      | 0.21 | low | 0.20 | low    |
| I-95  | Fairfield County              | 0.20 | low | 0.26 | low    |
| NY 25 | Suffolk                       | 0.20 | low | 0.31 | medium |
| I-78  | New Jersey (west of 287)      | 0.19 | low | 0.12 | low    |
| I-87  | Orange and Rockland (to 287)  | 0.19 | low | 0.23 | low    |
| I-84  | Putnam and Dutchess           | 0.10 | low | 0.13 | low    |

**Table 7-7. Liquefied Petroleum Gas (LPG) Readiness**

| <b>Highway</b> | <b>Segment</b>                | <b>LPG Readiness Score</b> | <b>LPG Readiness Level</b> | <b>LPG Need Score</b> | <b>LPG Need</b> |
|----------------|-------------------------------|----------------------------|----------------------------|-----------------------|-----------------|
| I-95           | New Jersey (north of Exit 10) | 0.81                       | high                       | n/a                   | n/a             |
| I-80           | New Jersey (east of 287)      | 0.55                       | high                       | n/a                   | n/a             |
| I-495          | Suffolk                       | 0.54                       | high                       | n/a                   | n/a             |
| I-84           | Connecticut                   | 0.54                       | high                       | n/a                   | n/a             |
| I-495          | Nassau                        | 0.51                       | high                       | n/a                   | n/a             |
| I-95           | Fairfield County              | 0.50                       | high                       | n/a                   | n/a             |
| I-91           | Connecticut                   | 0.50                       | high                       | n/a                   | n/a             |
| I-78           | Pennsylvania                  | 0.49                       | high                       | n/a                   | n/a             |
| I-95           | New Jersey (south of Exit 10) | 0.47                       | high                       | n/a                   | n/a             |
| I-278          | Total length                  | 0.39                       | medium                     | n/a                   | n/a             |
| I-78           | New Jersey (west of 287)      | 0.39                       | medium                     | n/a                   | n/a             |
| I-95           | New Haven County              | 0.37                       | medium                     | n/a                   | n/a             |
| I-84           | Orange                        | 0.37                       | medium                     | n/a                   | n/a             |
| I-495          | Queens                        | 0.35                       | medium                     | n/a                   | n/a             |
| NY 27          | Nassau                        | 0.35                       | medium                     | n/a                   | n/a             |
| I-78           | New Jersey (east of 287)      | 0.35                       | medium                     | n/a                   | n/a             |
| I-287          | New Jersey (north of 78)      | 0.31                       | medium                     | n/a                   | n/a             |
| I-95           | Manhattan and Bronx           | 0.29                       | medium                     | n/a                   | n/a             |
| I-80           | New Jersey (west of 287)      | 0.29                       | medium                     | n/a                   | n/a             |
| I-287          | New Jersey (east of 78)       | 0.27                       | medium                     | n/a                   | n/a             |
| NY 25          | Nassau                        | 0.26                       | low                        | n/a                   | n/a             |
| I-87           | Westchester and Bronx         | 0.26                       | low                        | n/a                   | n/a             |
| I-87           | Orange and Rockland (to 287)  | 0.25                       | low                        | n/a                   | n/a             |
| NY 27          | Suffolk                       | 0.20                       | low                        | n/a                   | n/a             |
| I-678          | Total length                  | 0.15                       | low                        | n/a                   | n/a             |
| I-287          | Rockland and Westchester      | 0.14                       | low                        | n/a                   | n/a             |
| I-84           | Putnam and Dutchess           | 0.12                       | low                        | n/a                   | n/a             |
| I-95           | Westchester                   | 0.12                       | low                        | n/a                   | n/a             |
| NY 27          | Kings and Queens              | 0.12                       | low                        | n/a                   | n/a             |
| NY 25          | Suffolk                       | 0.06                       | low                        | n/a                   | n/a             |
| NY 25          | Queens                        | 0.06                       | low                        | n/a                   | n/a             |

### Figure 7-2. Electric Bivariate Map

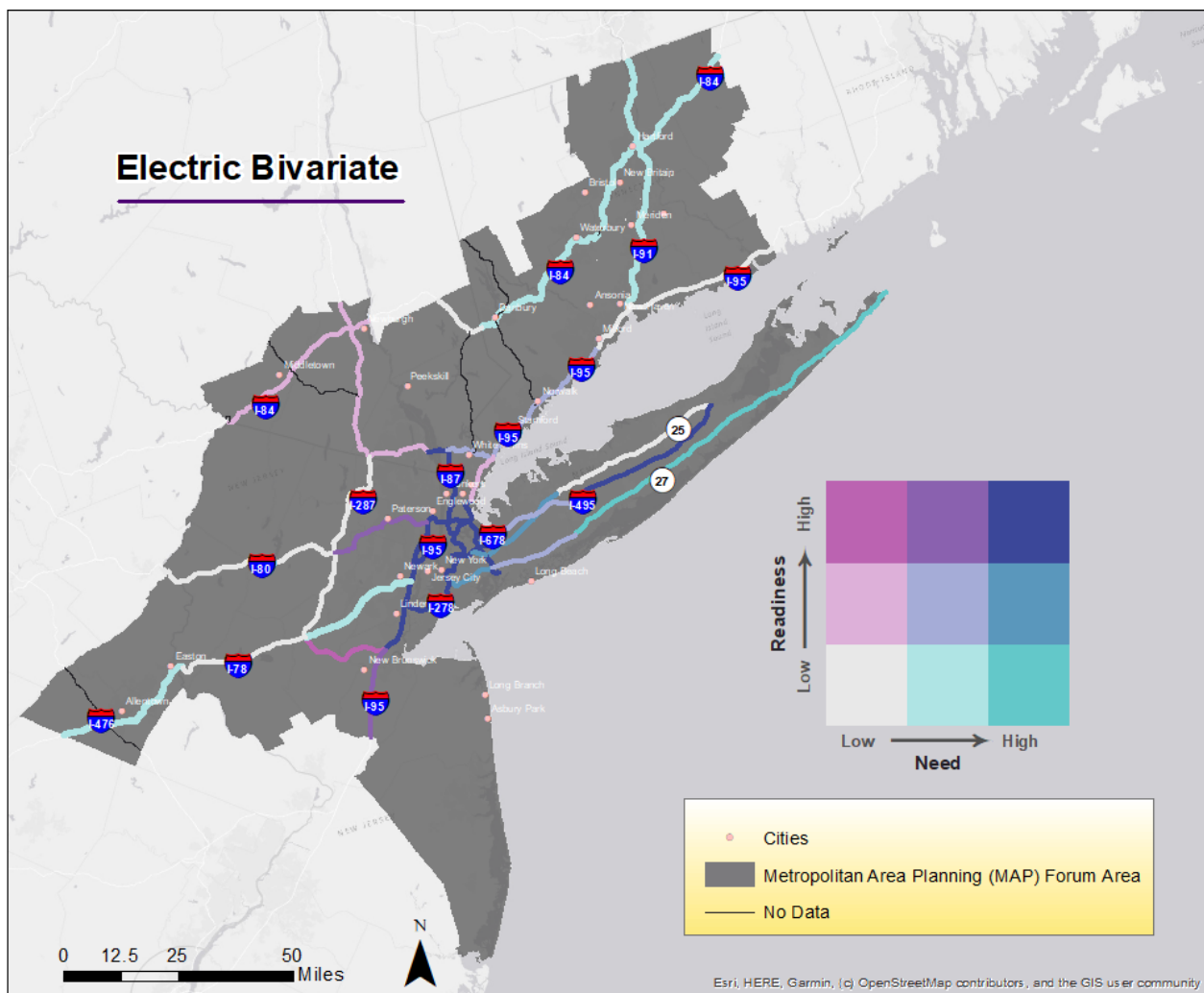
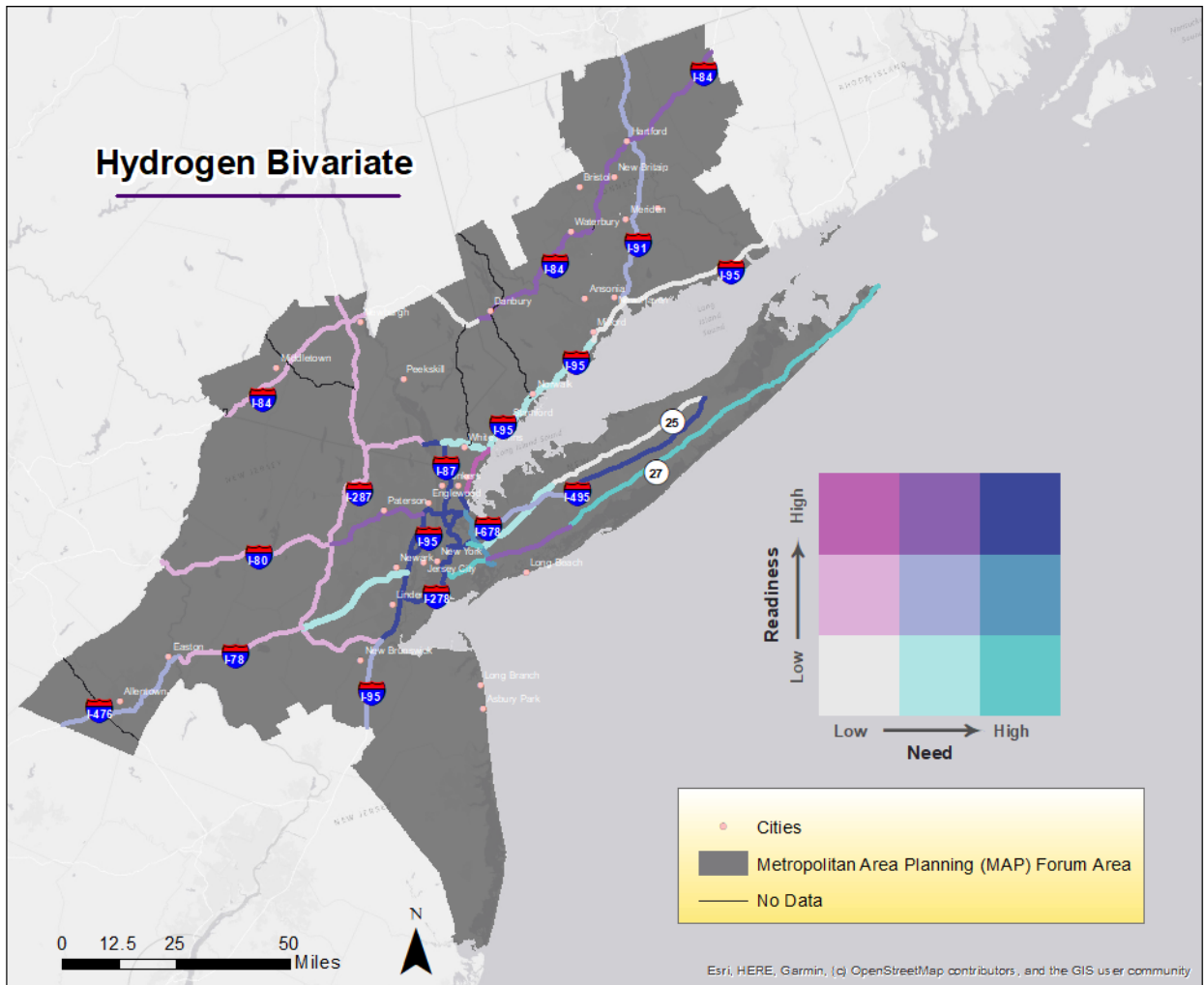
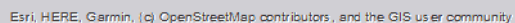


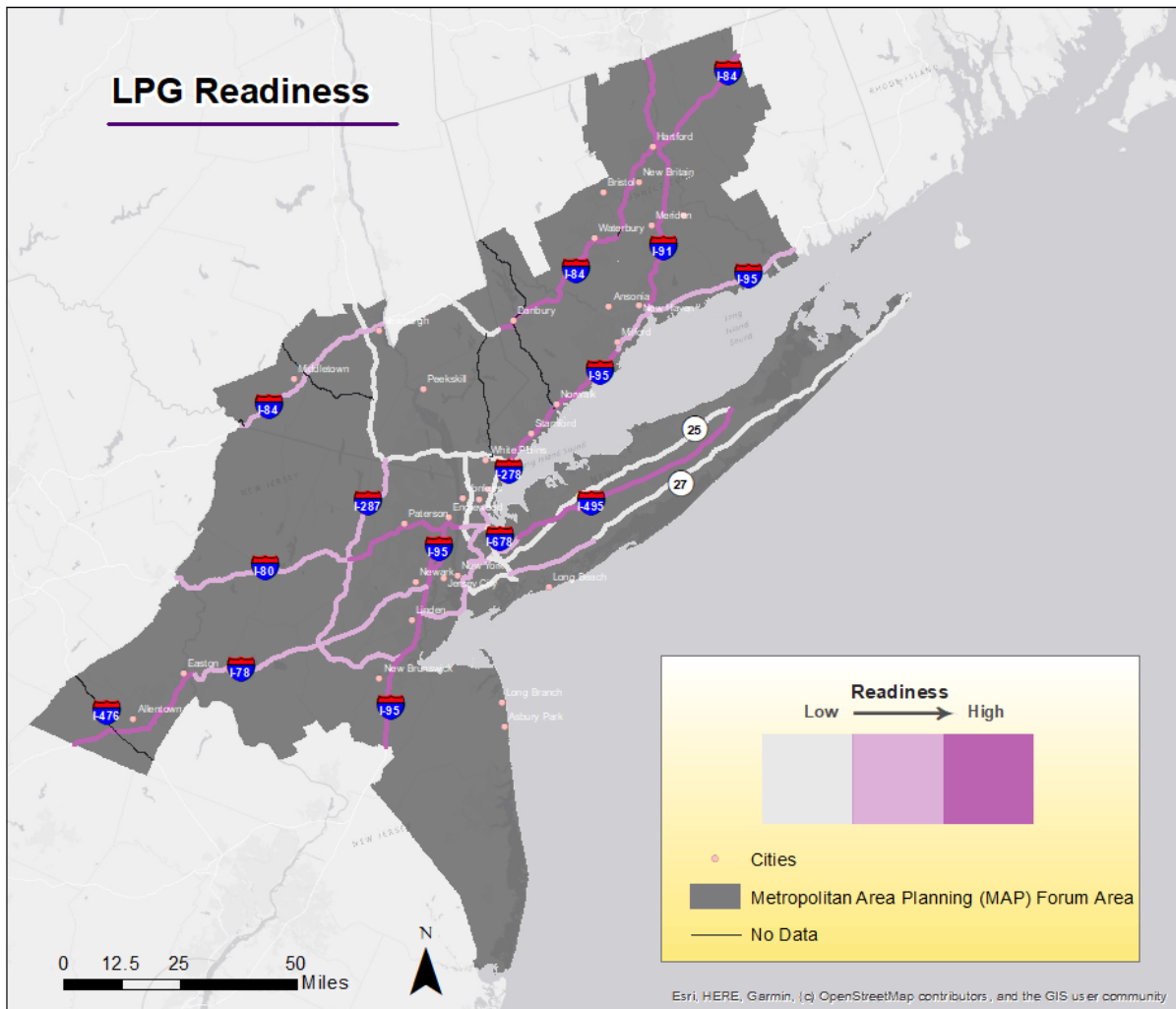
Figure 7-3. Hydrogen Bivariate Map





<sup>163</sup> While the modeling analysis anticipates growth in demand for CNG for heavy-duty vehicles, New Jersey's Energy Master Plan prioritizes advancements in battery or fuel cell electric technology for heavy duty vehicle applications.

Figure 7-5. Liquefied Petroleum Gas (LPG) Readiness Map





## 8.0 Implementation Considerations for Clean Freight Corridors

Section 7 described the methodology and results of a new Clean Freight Corridor designation process, developed in partnership with NYMTC, the study's Technical Advisory Committee (TAC), and industry and public sector stakeholders. The purpose of Section 8 is to outline policies and strategies for implementation of Clean Freight Corridors, including the process of designating and marking the corridors, as well as developing alternative fuel infrastructure along the designated corridors.

The considerations shared in this section include the recommendations and guidance on the following implementation topics and needs:

1. Finalizing the list of designated clean freight corridors and priority development corridors;
2. Developing a signage and communications plan;
3. A set of corridor-specific recommendations for each of the clean freight corridors;
4. Federal, state, and local policy considerations to support the implementation of the clean freight corridor designations and development of charging and alternative fueling infrastructure for medium and heavy duty vehicles along the designated corridors;
5. Fuel station siting;
6. Truck-compatible site development considerations;
7. Considerations for engaging local communities; and
8. Infrastructure funding considerations.

### 8.1 Finalizing the List of Designated Clean Freight Corridors and Priority Development Corridors

While the Clean Freight Corridors Planning Study has identified an optimal mix of new clean freight corridors, work remains to refine this list based on strategic priorities and the context of the broader freight network. In particular, NYMTC should align with adjacent state and regional agencies to ensure cross-jurisdiction continuity of clean fuel infrastructure. Some sections of I-95, as well as I-78, are examples of highway segments that did not rank highly in the designation exercise but may be significant in providing consistent fueling opportunities for long-haul drivers. As such, they have been included in the analysis results as priorities for future development.

Similarly, entities such as the Port Authority of New York and New Jersey that are developing their own clean fueling infrastructure should be consulted to ensure connectivity, and state-specific or

multi-state trucking associations (e.g., Bi-State Motor Carriers) as well as stakeholder groups such as the Northeast Diesel Collaborative should be engaged to better understand driver needs.

Additionally, the recommended network should be vetted against the location of environmental justice (EJ) communities (for example, areas defined as Disadvantaged Communities in New York State). While diesel particulate matter concentration was one of the major criteria for determining a segment's need for alternative fuel infrastructure in this study's analysis, this only provides a rough proxy for EJ community locations. Moreover, NYMTC's Communities of Concern designations are only defined for the counties in the NYMTC planning area, and are not in place throughout the broader Study Area. Prioritizing clean freight corridor designation and priority development in EJ communities emerged as a key next step during stakeholder outreach.

Finally, NYMTC and partner agencies should determine which fuel types should be developed along which corridors. Factors such as projected demand, policy trends, and safety issues should be taken into account in this decision. For example, the projected future demand for LPG is low, and may not warrant further development. Additionally, current policy trajectories favor electrification above LPG, CNG and hydrogen (see Task 3.3 memo). These latter fuel types also face regulatory hurdles in locations such as New York City, where the transportation of compressed gas is restricted for safety reasons. For these reasons, the role of LPG, CNG, and hydrogen along designated Clean Freight Corridors should be carefully evaluated.

## 8.2 Developing a Signage and Communications Plan

Once the designated network is finalized, a signage plan should be developed, also in coordination with contiguous transportation and planning agencies. Other means of communication with drivers and industry stakeholders should be explored, such as integration with driver navigation apps, to increase awareness of clean fuel infrastructure development and to route truck drivers to the appropriate fueling stations. Proactive communications regarding Clean Freight Corridors can also serve to induce demand for alternative fuel vehicles by increasing operator confidence that their duty cycles can be met reliably using a diesel alternative.

## 8.3 Corridor-Specific Recommendations

While many of the recommendations outlined in this memo are consistent region-wide, there are some considerations specific to each corridor, particular in siting fuel stations to support the overall network.

Table 8-1 outlines these considerations for the Clean Freight Corridors and Priority Development Corridors recommended in Section 7. For reference, station locations for each fuel type can be viewed on the project webmap: <https://arcg.is/0abSWK0>.

**Table 8-1. Corridor-Specific Implementation Considerations<sup>164</sup>**

|                                                          | High way | Segment      | Implementation Considerations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------|----------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Clean Freight Corridor<br>(High Readiness,<br>High Need) | I-278    | Total length | <p>As described in the Task 3.2 Visual Gap Analysis Tech Memo, there are several EV charging stations within 5 miles of this corridor, resulting in no major coverage gaps. However, because existing EV stations are not directly adjacent to the highway, they are likely inconvenient to reach for drivers as they must traverse congested city streets, and this also creates issues for local communities. Further, it is not clear whether these existing stations are accessible for heavy duty vehicles. A detailed inventory of EV stations near I-278 should be conducted including routing from the highway and heavy duty accessibility. From this inventory, 1-2 optimal locations for additional EV charging stations should be identified. Locations that also serve the intersecting I-495 and NY 27 corridors should be prioritized.</p> <p>CNG coverage is strong in northern Brooklyn and the Bronx. There is only one hydrogen station, located in the Bronx. An additional combined hydrogen and CNG station in Staten Island would improve total coverage.</p> |
|                                                          | I-495    | Queens       | <p>I-495 has fairly strong EV charging coverage in Queens and Nassau counties, as the Task 3.2 Visual Gap Analysis Tech Memo showed, but existing stations should be evaluated for heavy-duty accessibility. EV coverage is weaker in Suffolk county, where there may be opportunity to develop new stations for heavy-duty EV charging.</p> <p>CNG coverage is fairly strong, but hydrogen coverage is lacking. A hydrogen fueling site should be identified west of Medford.</p> <p>All fuel station development along I-495, NY 25, and NY 27 should be planned in tandem as these are parallel highways with similar service areas.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                                          | I-495    | Suffolk      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                                                          | I-678    | Total length | <p>I-678 has fairly strong EV station coverage, as the Task 3.2 Visual Gap Analysis Tech Memo showed, but existing stations should be evaluated for heavy-duty accessibility. There is one CNG station on the north end of the corridor,</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

<sup>164</sup> While the modeling analysis anticipates growth in demand for CNG for heavy-duty vehicles, New Jersey's Energy Master Plan prioritizes advancements in battery or fuel cell electric technology for heavy duty vehicle applications.

|                                                          | High way | Segment                       | Implementation Considerations                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------|----------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                          |          |                               | and there are no hydrogen stations. Adding combined EV, CNG, and hydrogen fueling at or near JFK airport for trucks connecting to air cargo services should be prioritized, as well as locations that also serve the intersecting I-495, NY 27 and NY 25 corridors.                                                                                                                                                                                                                  |
|                                                          | I-80     | New Jersey (east of 287)      | The section of I-80 between I-287 and I-95 has no hydrogen or CNG stations. While there are several EV charging stations within a 5-mile radius, only one is located in immediately adjacent to the highway. The existing station should be evaluated to determine whether CNG and hydrogen infrastructure can be added, and an additional 1-2 locations for combined fueling stations should be identified. Priority should be given to sites that could also serve I-287 and I-95. |
|                                                          | I-87     | Westchester and Bronx         | I-87 has fairly strong EV charging station coverage, but an additional station immediately adjacent to the highway in Westchester would enhance the network. There are no CNG stations immediately adjacent to I-87; 1-2 new CNG sites should be identified.                                                                                                                                                                                                                         |
|                                                          | I-95     | New Jersey (north of Exit 10) | This section of I-95 has fairly strong EV charging coverage, but existing stations should be evaluated for heavy-duty accessibility. High-volume sites such as the Vince Lombardi Service Plaza should be evaluated to determine how well the existing EVSE supply is meeting the demand.                                                                                                                                                                                            |
|                                                          | I-95     | Manhattan and Bronx           | <p>There is one existing CNG station, and one hydrogen station, both in the Bronx. Existing EVSE sites should be evaluated to determine if CNG and hydrogen fueling could be added.</p> <p>New sites that also serve I-80, I-87, I-678 and I-278 should be prioritized. The ability to develop hydrogen stations will be limited due to regulations in New York City.</p>                                                                                                            |
| Priority Development Corridor (High Need, Low Readiness) | NY 25    | Queens                        | NY 25 and NY 27 have fairly strong EV charging coverage in Kings and Queens counties, but existing stations should be evaluated for heavy-duty accessibility. EV coverage is weaker in Suffolk county, where there may be opportunity to develop new stations for heavy-duty EV charging.                                                                                                                                                                                            |
|                                                          | NY 27    | Kings and Queens              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                                                          | NY 27    | Suffolk                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

|                                                   | High way | Segment                       | Implementation Considerations                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------------------------|----------|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                   |          |                               | <p>CNG coverage is fairly strong along NY 27 but weak along NY 25. There are no hydrogen facilities immediately adjacent to either highway.</p> <p>All fuel station development along NY 25, NY 27, and I-495 should be planned in tandem as these are parallel highways with similar service areas.</p>                                                                                                                                                       |
| Priority Development Corridor<br>(Connectivity)   | I-95     | New Jersey (south of Exit 10) | EV charging infrastructure is minimal between Edison and Newark, NJ, and in Connecticut south of Bridgeport, and CNG and hydrogen stations are limited across these segments. Existing stations should be evaluated for heavy-duty accessibility, and new sites for combined EV, CNG and Hydrogen fueling should be identified along the entirety of I-95, particularly where they also serve intersecting highways and other high-demand areas such as ports. |
|                                                   | I-95     | Westchester                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                   | I-95     | Fairfield County              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                   | I-95     | New Haven County              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                   | I-495    | Nassau                        | This short segment of I-495 should be planned in tandem with the Queens and Suffolk segments as well as NY 25, NY 27 and I-678.                                                                                                                                                                                                                                                                                                                                |
|                                                   | I-78     | Pennsylvania                  | Development of fueling sites on I-78 should align with FHWA's <i>Alternative Fuels Deployment Plan for I-81 and I-78 in Pennsylvania</i> . <sup>165</sup> This document identifies potential sites in Pennsylvania; New Jersey locations should be planned in tandem.                                                                                                                                                                                          |
|                                                   | I-78     | New Jersey (east of 287)      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                   | I-78     | New Jersey (west of 287)      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                   | NY 27    | Nassau                        | This short segment of NY-27 should be planned in tandem with the Kings, Queens and Suffolk segments as well as I-495, NY 25, and I-678.                                                                                                                                                                                                                                                                                                                        |
| Other High Readiness Segments<br>(not designated) | I-84     | Connecticut                   | These segments were identified as having high alternative fueling readiness, but lower anticipated need. There are no recommendations for development at this time.                                                                                                                                                                                                                                                                                            |
|                                                   | I-287    | New Jersey (east of 78)       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                   | I-287    | Rockland and Westchester      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                   | I-91     | Connecticut                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

<sup>165</sup> [Final \(ver7-12-21\) PennDOT I81-I78 AFC Deployment Plan Report.pdf](#)

## 8.4 Policy Considerations

### 8.4.1 Federal Policy

Federal policy will impact the development of clean fuel infrastructure in two ways: through funding opportunities, and through regulatory hurdles.

NYMTC partner agencies should be prepared to capitalize on federal funding opportunities for clean fuel infrastructure planning and development built into the Infrastructure Investment and Jobs Act (IIJA).<sup>166</sup> The IIJA directs the U.S. Department of Transportation (DOT) to coordinate and consult with other federal agencies to develop guidance for new programs relating to decarbonization of on-road vehicles. One such program is the Charging and Fueling Infrastructure Program, intended for the strategic deployment of publicly accessible EV charging infrastructure and hydrogen, propane, and natural gas fueling infrastructure in designated alternative fuel corridors.<sup>167</sup> However, the design of IIJA ties funding to current FHWA corridor designations. For example, the designated “signage pending” network in each state must be built out before funding can be allocated to fueling infrastructure outside of that network. This may pose a challenge as some designated “signage pending” segments have limited economic viability and/or local interest in development. These low-viability segments could become obstacles to directing IIJA funding to high-viability segments that are not currently designated “signage pending” by FHWA. Additional guidance from FHWA on this matter, including a definition of what it means for the network to be “built out”, is expected in early 2022.

Additional funding streams for alternative fuel corridor development could become available through prospective legislative actions. On the other hand, some federal regulations designed before the availability of clean fuel technology could stand in the way of clean fuel infrastructure development. For example, one regulation (23 U.S.C.A. §111(a)) prohibits states from permitting automotive service stations or other commercial establishments to be located on interstate rights-of-way. This prevents states from capitalizing on existing assets (e.g., safety rest areas) to expand the clean fuel network. This regulation should be revised to enable the greatest penetration of clean fuel infrastructure along interstate highways.

### 8.4.2 State and Regional Policy

New York, New Jersey, Connecticut and Pennsylvania have all signed on to the Multi-State Medium- and Heavy-Duty Zero-Emission Vehicle Memorandum of Understanding (MOU) and should continue to contribute to the development and implementation of recommended actions, including those

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<sup>166</sup> For state-by-state opportunities associated with implementation of the IIJA, see <https://www.transportation.gov/briefing-room/usdot-releases-state-state-fact-sheets-highlighting-benefits-bipartisan>

<sup>167</sup> FHWA has issued a request for information (RFI) relating to new IIJA programs to be coordinated by U.S. DOT: <https://www.energy.gov/eere/articles/new-national-electric-vehicle-programs-release-requests-information>

outlined in the forthcoming Multi-State Medium- and Heavy-Duty Zero-Emission Vehicle Action Plan, which was released for public comment in March 2022.

Among measures explored in the Action Plan is the adoption of California regulations on vehicle sales by manufacturers. In December 2021, New Jersey and New York State adopted California's Advanced Clean Trucks rule, which will accelerate the adoption of electric trucks in these states by requiring manufacturers to participate in a credit/deficit program to increase the percentage of electric truck sales beginning in model year 2025. There is also pending legislation in Connecticut that, if enacted, would adopt zero-emission truck sales requirements beginning in model year 2026. The adoption of ACT in these states will increase the demand for electric charging infrastructure along key regional corridors.

The emergence of structures for utility involvement and investment in fleet electrification, such as the Medium- and Heavy-Duty EV Make-Ready Pilot offered by electric utilities in New York,<sup>168</sup> lays a groundwork for expanding EV infrastructure and can be replicated by other utilities and states in the region. In particular, the expansion of "make-ready" infrastructure programs lays the groundwork for utilities to prepare sites for large-scale electric system expansion and reinforcement without burdening site hosts with the full upgrade costs. The New Jersey Board of Public Utilities released an initial straw proposal on the infrastructure ecosystem supporting electrification of medium- and heavy-duty vehicles in August 2021, which included preliminary proposals for fleet make-ready assistance; an updated straw proposal is expected in early 2022.<sup>169</sup> Likewise, the Connecticut Public Utilities Regulatory Authority in September 2021 initiated a new proceeding for Medium- and Heavy-Duty Electric Vehicle Infrastructure, which is the forum through which a fleet make-ready program would be developed for Connecticut fleets.<sup>170</sup>

Hydrogen fuel cell technology is not as mature as electric vehicle technology in the Northeast region, and its growth may face regulatory challenges such as New York City's prohibitions on the transportation of compressed gases and the ban on operation of fuel cell vehicles for certain regionally important crossings such as the Hugh L. Carey tunnel connecting Lower Manhattan and Western Brooklyn. Similarly, both hydrogen and compressed natural gas fueling may require expensive HVAC upgrades to meet ventilation requirements for if deployed in indoor facilities in some jurisdictions.

While there are also measures in place to support the adoption of hydrogen, compressed natural gas and propane use for M/HD vehicles in the study region, these fuels share some of the same regulatory hurdles as hydrogen fuel cell technology. As with hydrogen fuel, New York and Pennsylvania have programs to incentivize CNG and propane M/HD vehicles and Pennsylvania also

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<sup>168</sup> <https://jointutilitiesofny.org/ev/make-ready/mhd-pilot-program>

<sup>169</sup> <https://www.nj.gov/bpu/pdf/publicnotice/Notice%20Medium%20Heavy%20Duty%20EV%20Straw%20Proposal.pdf>

<sup>170</sup> <http://www.dpuc.state.ct.us/DOCKCURR.NSF/60903cc7b9de44728525746b006e8ffb/bade076b20f0a90a85258752005efc87?OpenDocument&scrollTop=2256.800048828125>

incentivizes refueling infrastructure. In addition, New Jersey and Connecticut have tax incentives for these fuel types. Still, moratoriums on new facilities and prohibitions on the transportation of these fuels (namely propane in New York City) pose challenges to their adoption at scale. Perhaps more importantly, despite being significantly cleaner burning than diesel, these fuels systems still involve combustion of fossil fuels. As such, these combustion alternative fuels are not receiving the same beneficial policy emphasis as energy sources that do not require direct combustion. In New York, for example, natural gas and propane trucks can qualify for incentive funding, but at a significantly lower amount than zero-emission trucks. In New Jersey, the forthcoming truck funding program will focus exclusively on zero-emission technologies. Taken together, natural gas and propane are viable fuel types in the near-term but appear unlikely to receive sufficient policy support to reach critical mass in the years ahead as zero-emission technologies receive the bulk of policy attention.

### *8.4.3 Local Policy*

As described above, local regulations in New York City pose a challenge for hydrogen, CNG, and LPG fuel site development there, but also through the wider network as fleets seek to adopt technologies where fuel availability is widespread and reliable.

Additionally, local zoning, permitting regulations, and other local policies are critical issues for siting and developing specific fuel stations. Zoning in particular may preclude the development of fuel infrastructure from otherwise optimal locations. Many of these restrictions were developed to address problems specific to diesel fuel, and should be revisited and updated to reflect the growth of near-zero and zero-emission fuels.

## *8.5 Fuel Station Siting*

A number of factors must be considered when selecting fuel station locations on a given corridor.

At a network level, fuel stations should be adequately spaced to ensure reliability and ease range anxiety, but also maximize the utility of the investment. Sites should also be selected for redundancy, either by developing sites on a detour route parallel to the main corridor, or by designing fuel stations to be accessible both from the corridor and from parallel roadways. This provides a measure of resilience to the system and allows drivers to access fuel even if a clean freight corridor is temporarily closed.

As mentioned above, existing assets should be leveraged where possible, for example by siting clean fuel infrastructure on existing rest stops, fueling stations, and truck parking locations where possible. Large-format sites should also be prioritized for their ability to host fueling infrastructure for a greater quantity of freight vehicles, improving site redundancy and improving the user experience by increasing the fueling stations available to truck operators.

Finally, local utilities should be engaged early in the site selection process to ensure adequate fuel capacity can be provided (e.g., sufficient electrical supply) and that as applicable, demand charges can be managed and mitigated.

## 8.6 Truck-Compatible Development

During site selection and design, it is critical to understand the unique needs and specifications of heavy-duty vehicles. Whether a site is developed for use by freight vehicles only, or by a mix of light-, medium-, and heavy-duty vehicles, the ingress and egress points should be designed with adequate turning radii to accommodate the target design and control vehicles. Fueling station dimensions must also be designed to accommodate heavy vehicles, and the site should account for the safe and efficient flow of vehicles throughout (for example, how and where to separate heavy duty vehicles from light-duty).

While there are not many examples of public, high-capacity, truck-compatible fueling stations throughout the country, the Electric Island project designed, developed, and built by Black & Veatch in Portland, Oregon in partnership with Portland General Electric and Daimler Trucks North America offers precedent for truck-centered public charging (see Figure 8-1). This station provides up to one megawatt of power to charging stalls designed specifically for heavy-duty form factors of tractor-trailers, large school buses, and more.<sup>171</sup> Electric Island is located across the street from Daimler Trucks North America's headquarters in a district of Portland that contains a cluster of warehouses and other industrial buildings.

As NYMTC continues industry engagement to develop fueling sites on priority corridor segments, engagement with truck companies in addition to utilities is critical to ensure that the sites are not only located in areas convenient to trucking routes but also in a way that ensures a smooth and positive user experience based on the way trucks will navigate to and use fueling stations.

**Figure 8-1. Electric Island Heavy Duty Vehicle Charging Station, Portland, Oregon**



Source: Daimler Trucks North America

<sup>171</sup> <https://www.bv.com/news/black-veatch-leads-design-construction-electric-island-first-its-kind-high-capacity-public>

## 8.7 Engaging Local Communities

Working with local stakeholders, including residents and the business community, is an essential step in overcoming local regulatory issues, and a best practice even in the absence of these hurdles. Providing education about the local air quality improvements that come with clean fuel development, as well as the potential economic benefits of siting a new fuel station in a given community, can prepare communities for the new development, minimize opposition, and secure buy-in for changing zoning and permitting rules. Additionally, stakeholders from the communities surrounding preferred infrastructure development sites can provide information to inform and improve the project, such as opportunities to collaborate with local businesses to increase truck drivers' access to local services while fueling.

## 8.8 Financing Infrastructure Development

Funding alternative fuel infrastructure development along corridors will require a combination of public and private resources, particularly for sites where demand is initially projected to be low. For sites with high traffic and demand estimates, private capital will likely be the main source of funding. Businesses centered around retail (such as rest areas on highways) also invest in fueling infrastructure and provide fueling services to attract clients to their existing business activities. Increasingly, third-party ownership structures are available that can relieve the site host of potentially significant development costs as well as utilization risk while generating passive revenues (i.e., rent) for site hosts.

For sites where traffic and demand estimates are low, which characterizes most sites in the near-term while alternative fuel truck adoption remains low, federal and state governments can support the business case for infrastructure deployment through incentive programs—such as New York State's Direct Current Fast Charging (DCFC) program<sup>172</sup>—and public-private partnerships (PPPs). Under PPPs, the private sector is typically tasked with financing, developing, and managing the site, and the public sector supports the project through cost and risk sharing. Public funds can be used to pay the private developer to install and operate the site; subsidize a portion of the fees charged to users by the developer, or as viability gap funding (covering the funding gap between the expected project revenues and costs).<sup>173</sup> If authorized, utilities are also well positioned to buy down site development costs by utilizing rate payer dollars to cover the costs of make-ready electrical infrastructure.<sup>174</sup> Achieving the scale and coverage needed for robust alternative fueling networks will likely require a combination of mechanisms and capital providers in the years to come.

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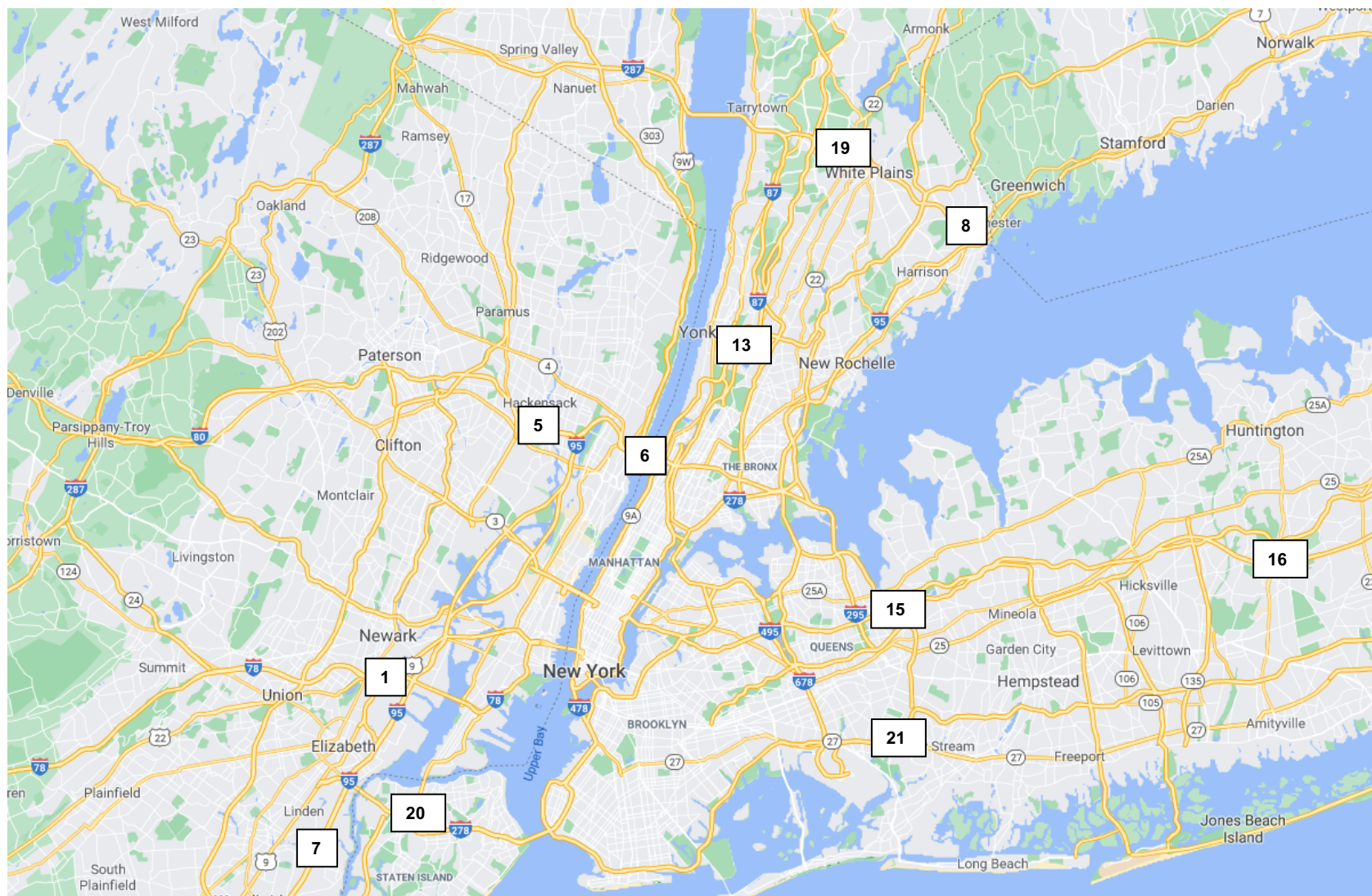
<sup>172</sup> NYSERDA's DCFC Program covers up to 80% of the costs of DCFC purchase, installation and some operation items. This program has emphasized sites catering to light-duty passenger vehicles to date, but future funding rounds could expand this focus. For more, see: <https://portal.nyserda.ny.gov/servlet/servlet.FileDownload?file=00Pt000000YDm19EAD>

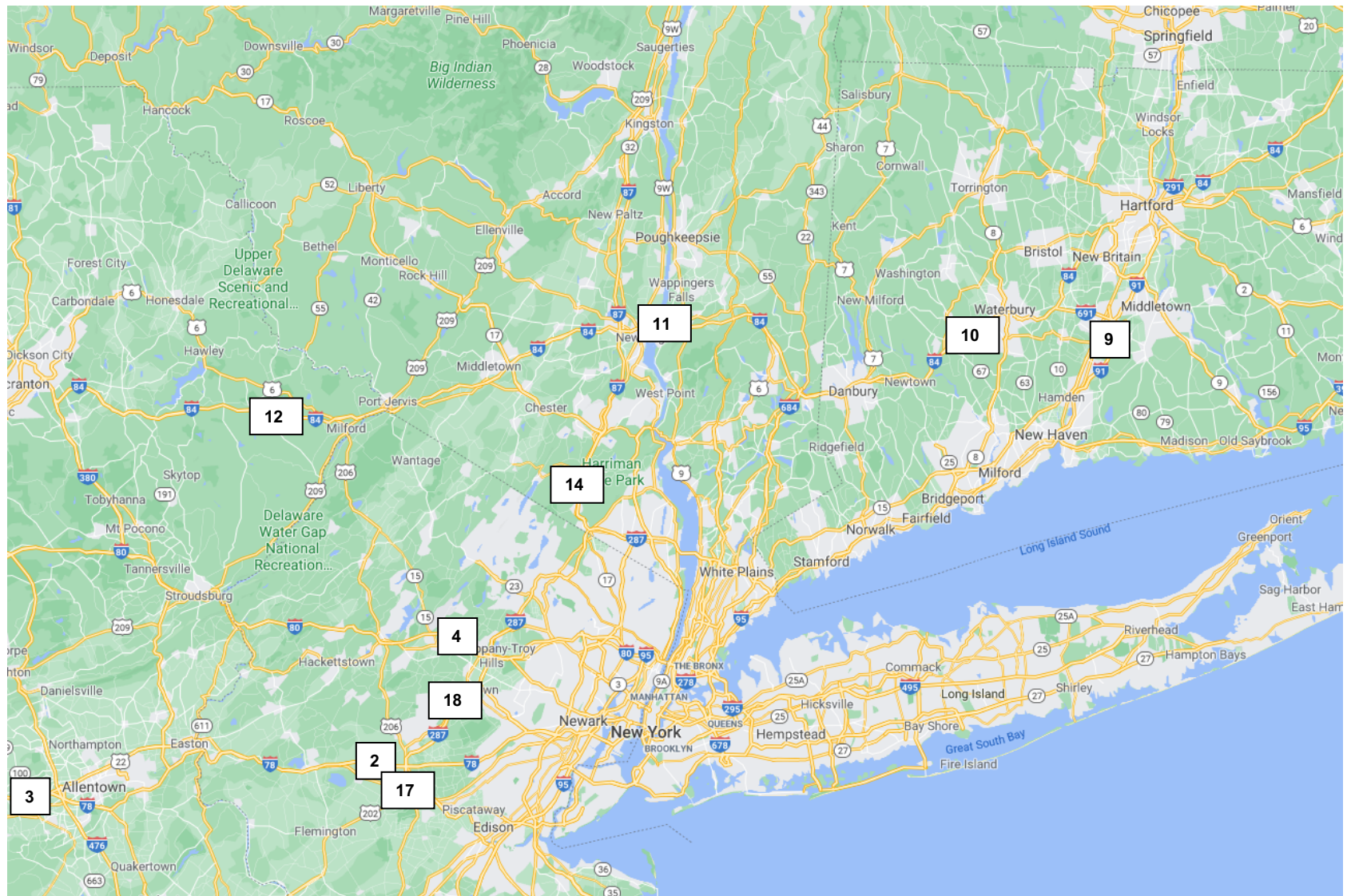
<sup>173</sup> <https://www.hindawi.com/journals/ace/2018/9061647/>

<sup>174</sup> See, for example, the utility make-ready program authorized by the New York Public Service Commission: <https://jointutilitiesofny.org/ev/make-ready>

## Appendix A. Corridor Freight Demand Profiles

**Figure A-1. Analysis Locations, Part 1 of 2**



**Figure A-2. Analysis Locations, Part 2 of 2**

**Figure A-3. Analysis Location 1: I-78 west of US 1/9, Essex County, NJ**

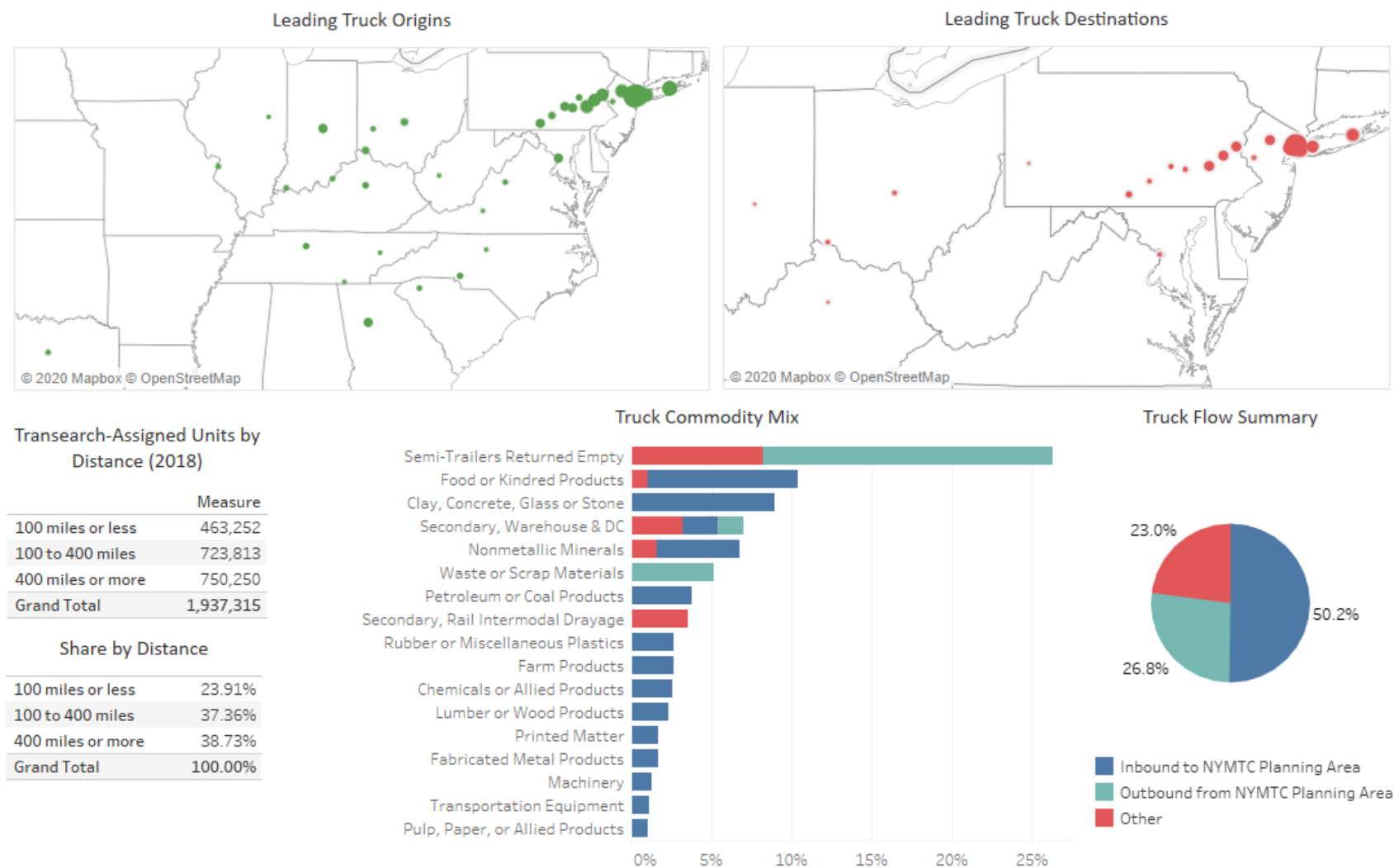
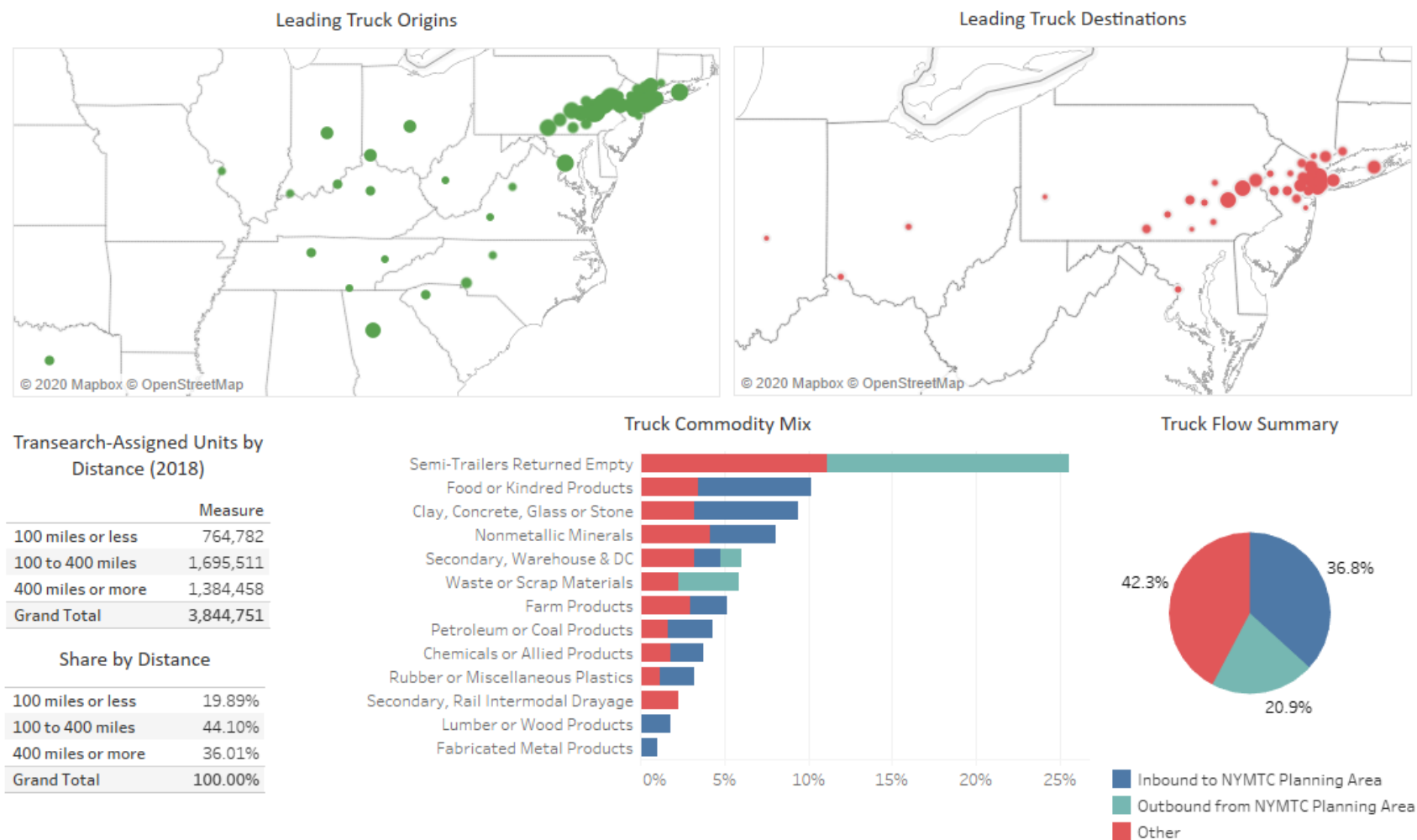


Figure A-4. Analysis Location 2: I-78 west of I-287, Somerset County, NJ



**Figure A-5. Analysis Location 3: I-78 west of I-476/US-22, Lehigh County, PA**

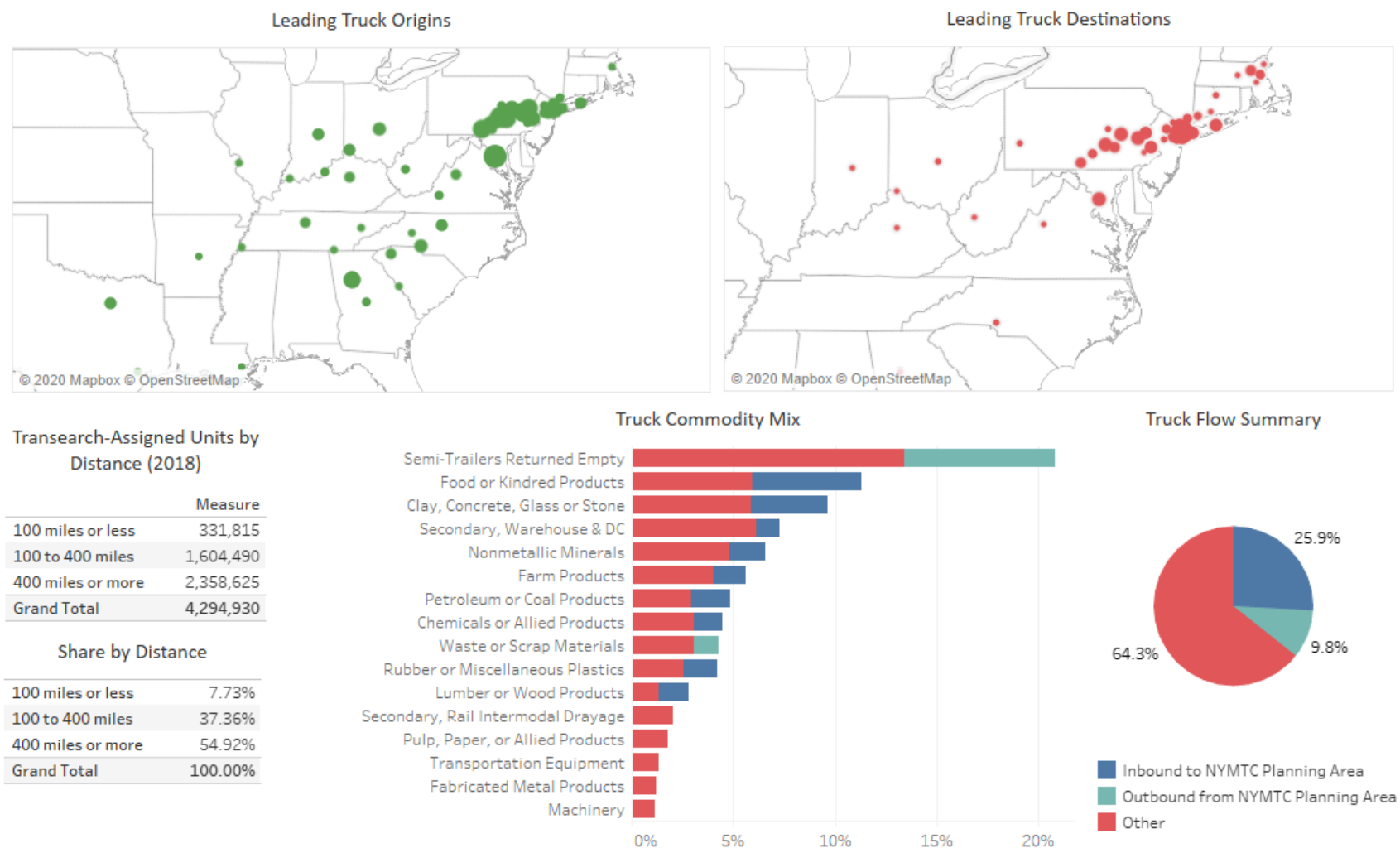
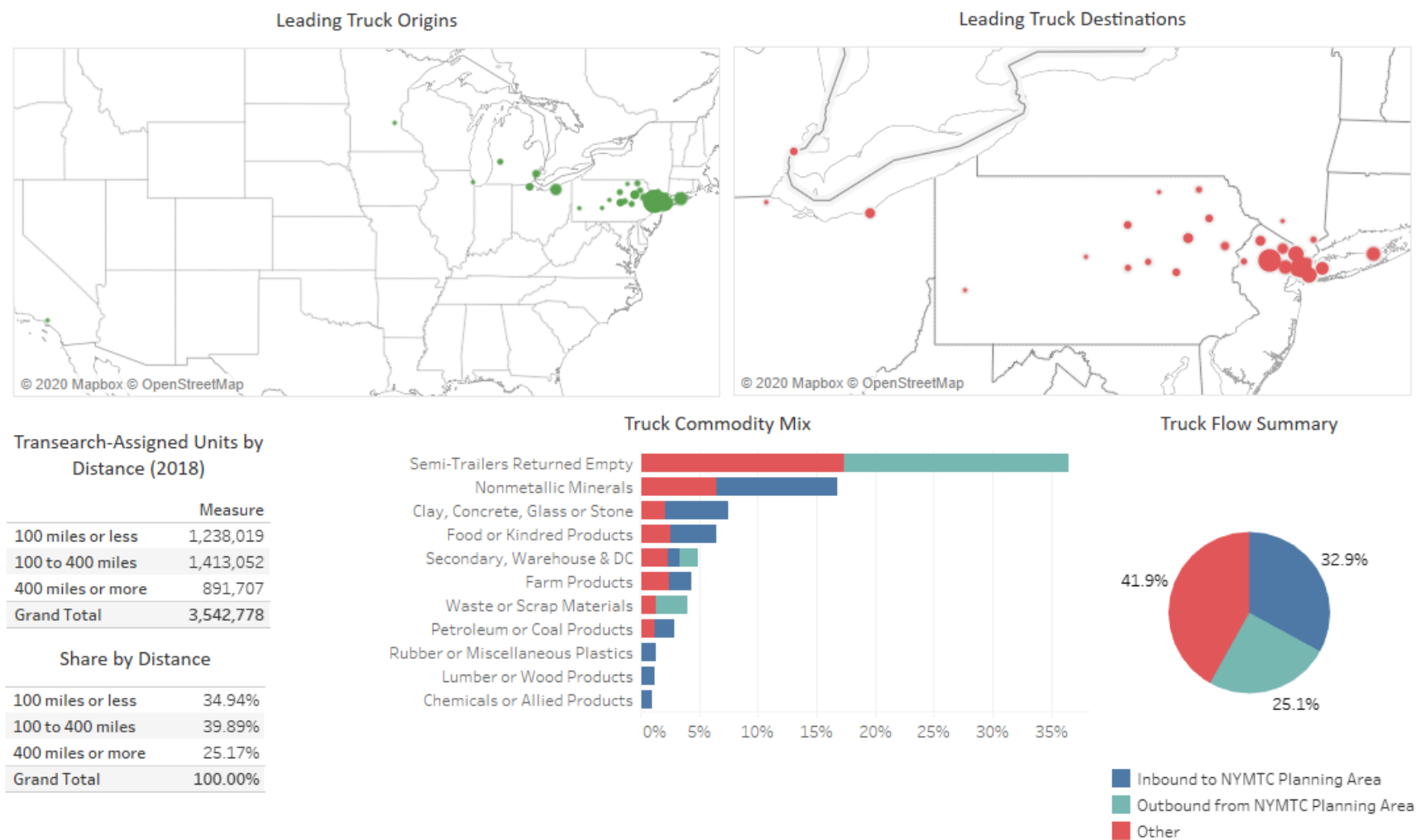


Figure A-6. Analysis Location 4: I-80 west of I-287, Morris County, NJ



**Figure A-7. Analysis Location 5: I-80 west of I-95, Bergen County, NJ**

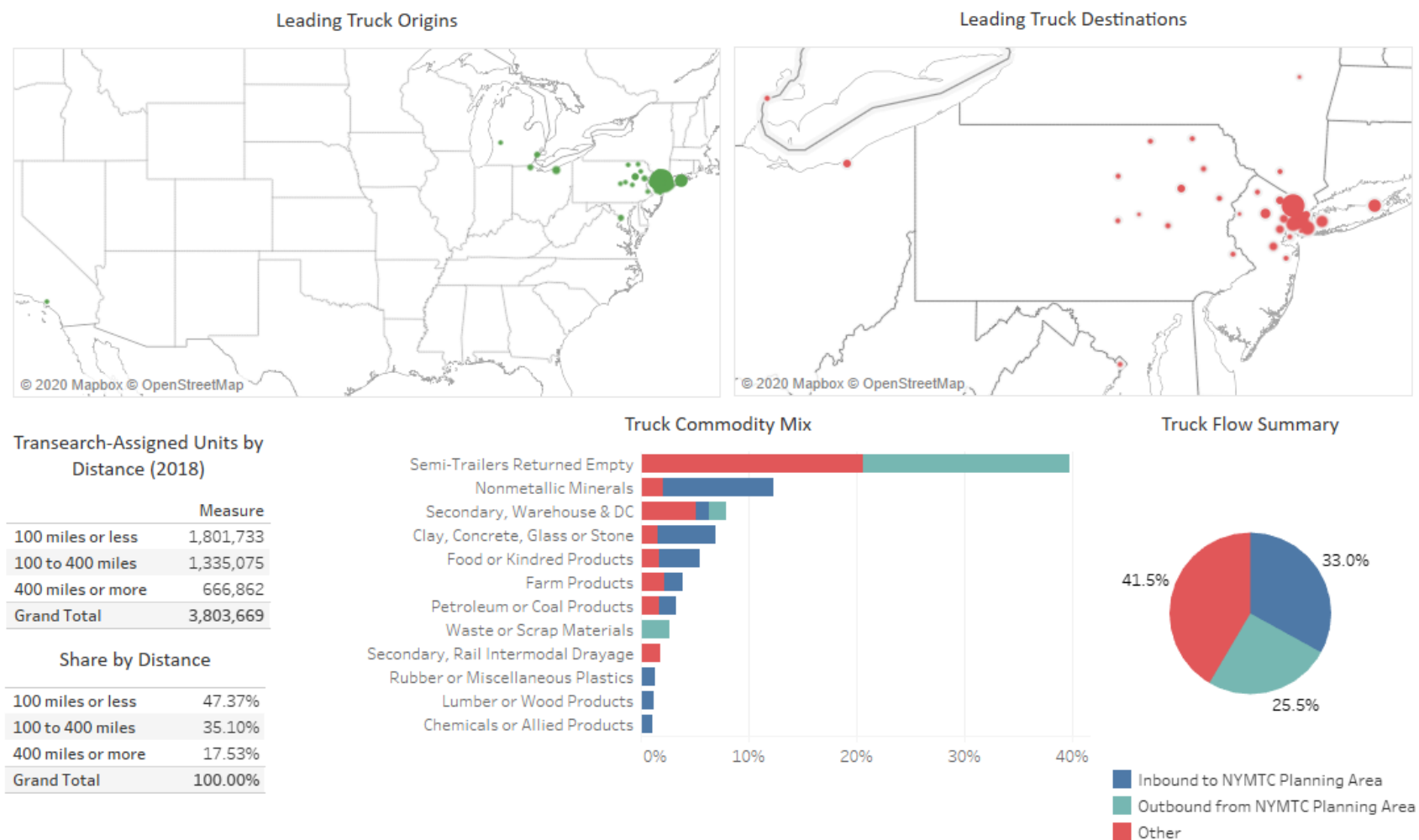
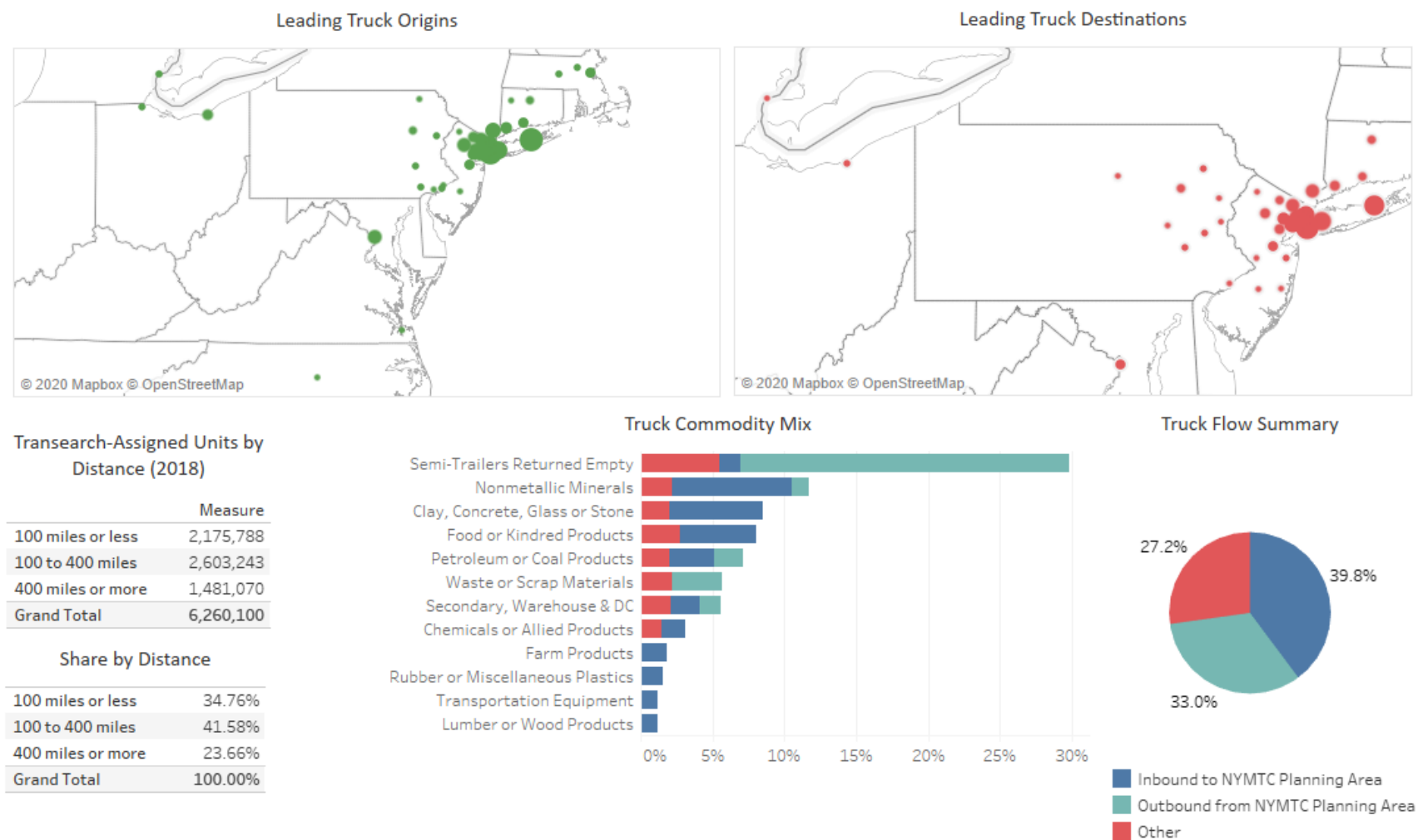
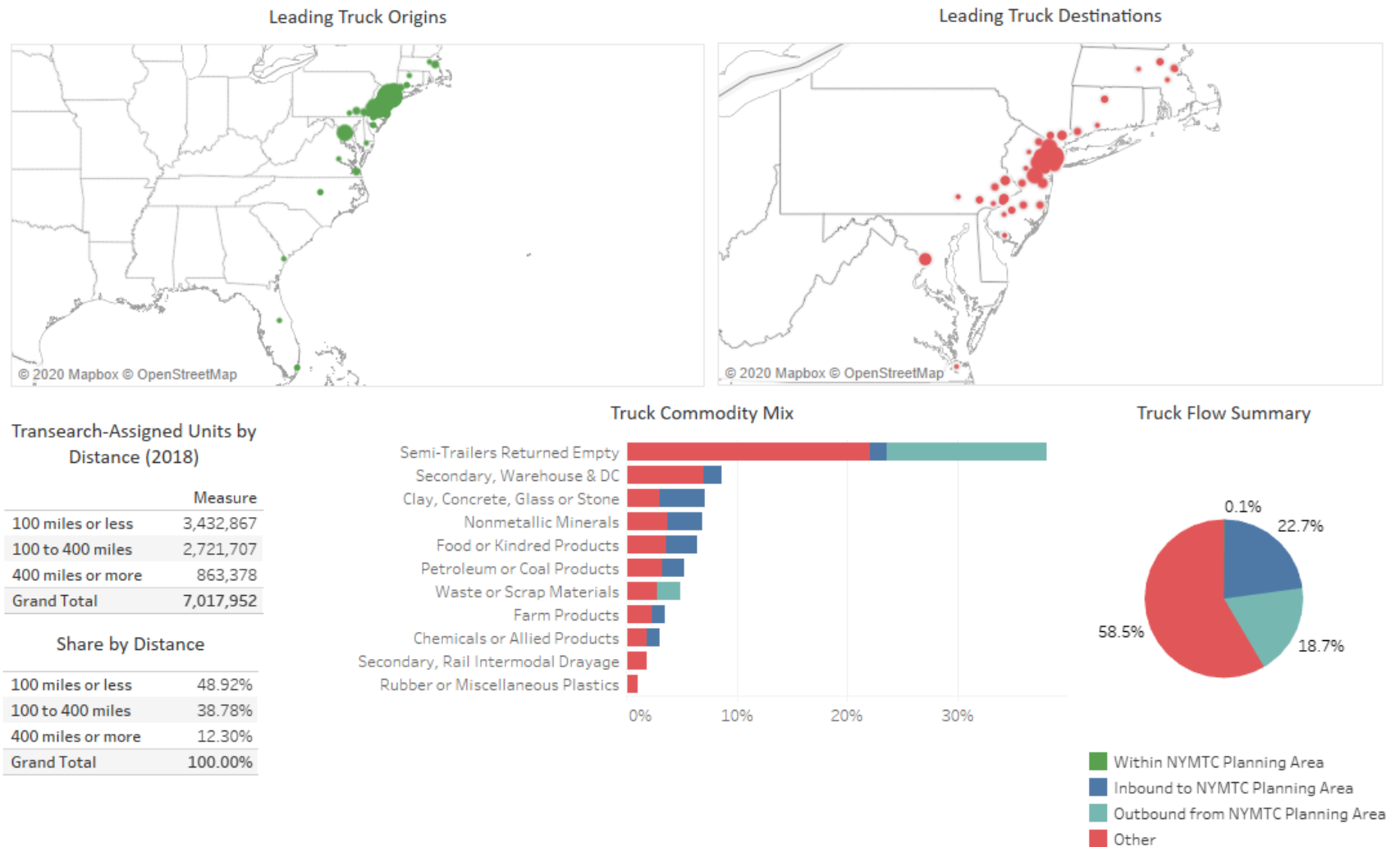
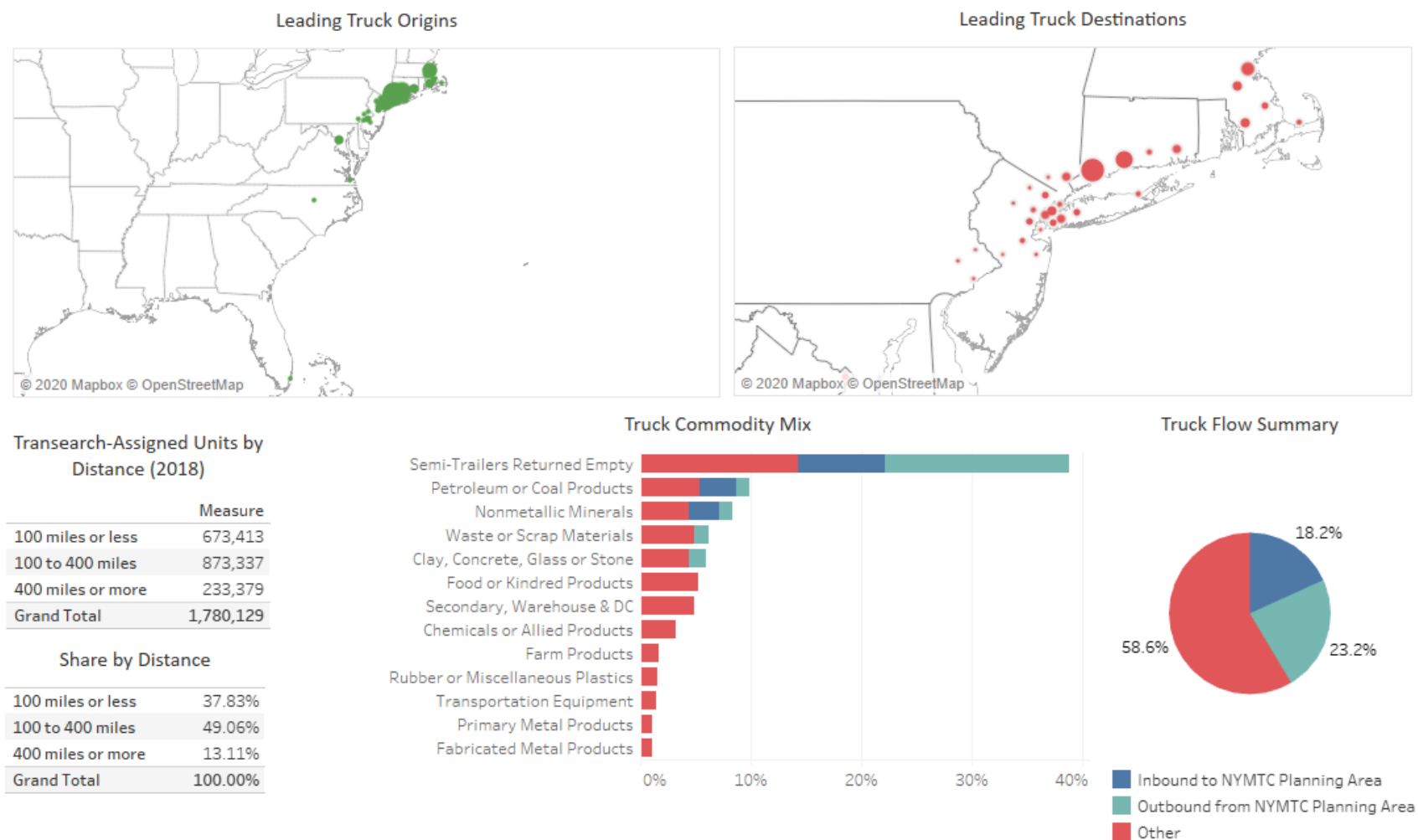


Figure A-8. Analysis Location 6: I-95 at the George Washington Bridge



**Figure A-9. Analysis Location 7: I-95 between NJ-35 and I-278, Union County, NJ**



**Figure A-10. Analysis Location 8: I-95 at the New York/Connecticut State Line**

**Figure A-11. Analysis Location 9: I-91 south of I-691, New Haven County, CT**

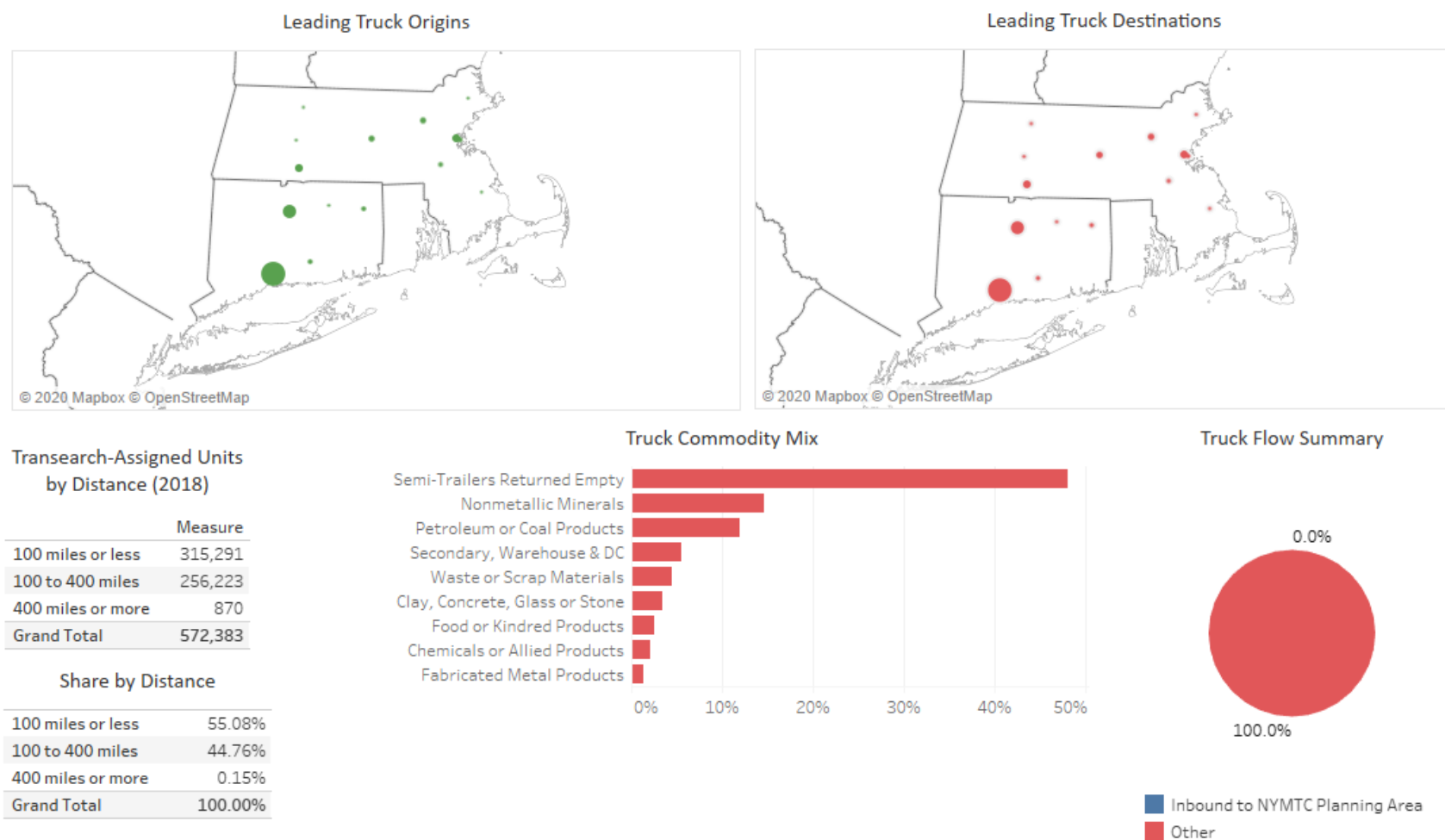
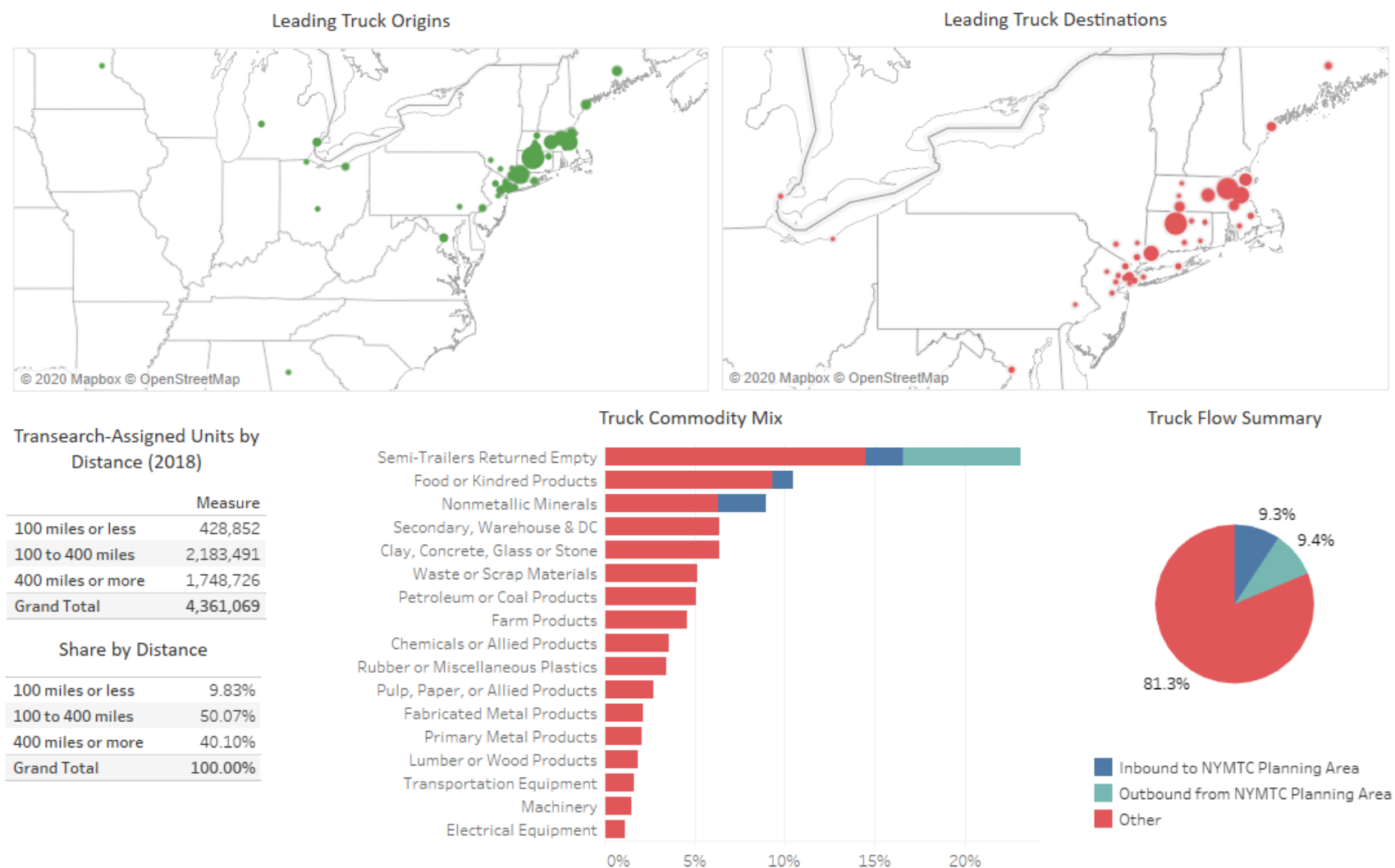


Figure A-12. Analysis Location 10: I-84 east of CT-63, New Haven County, CT



**Figure A-13. Analysis Location 11: I-84 at the Newburgh-Beacon Bridge**

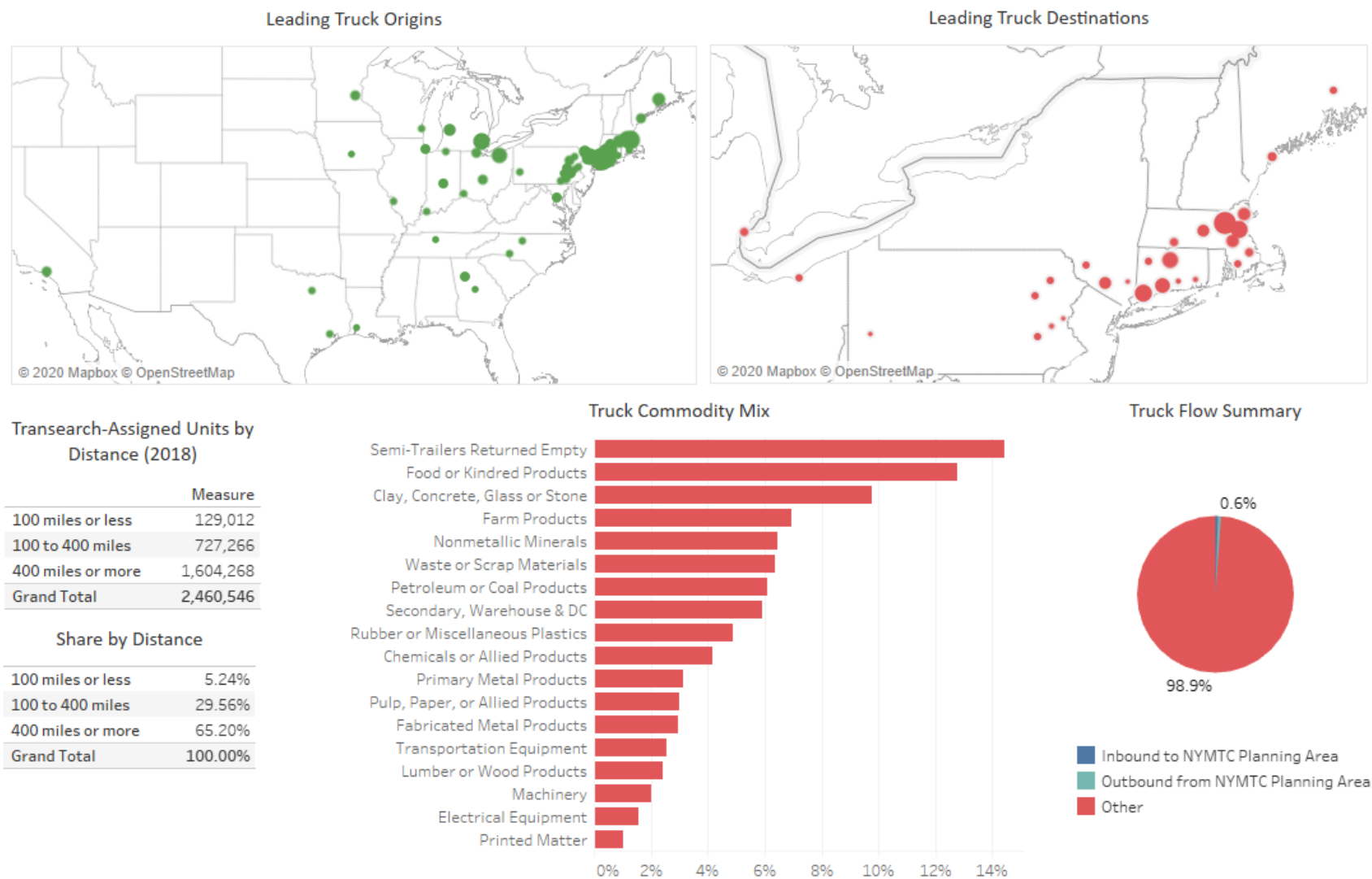
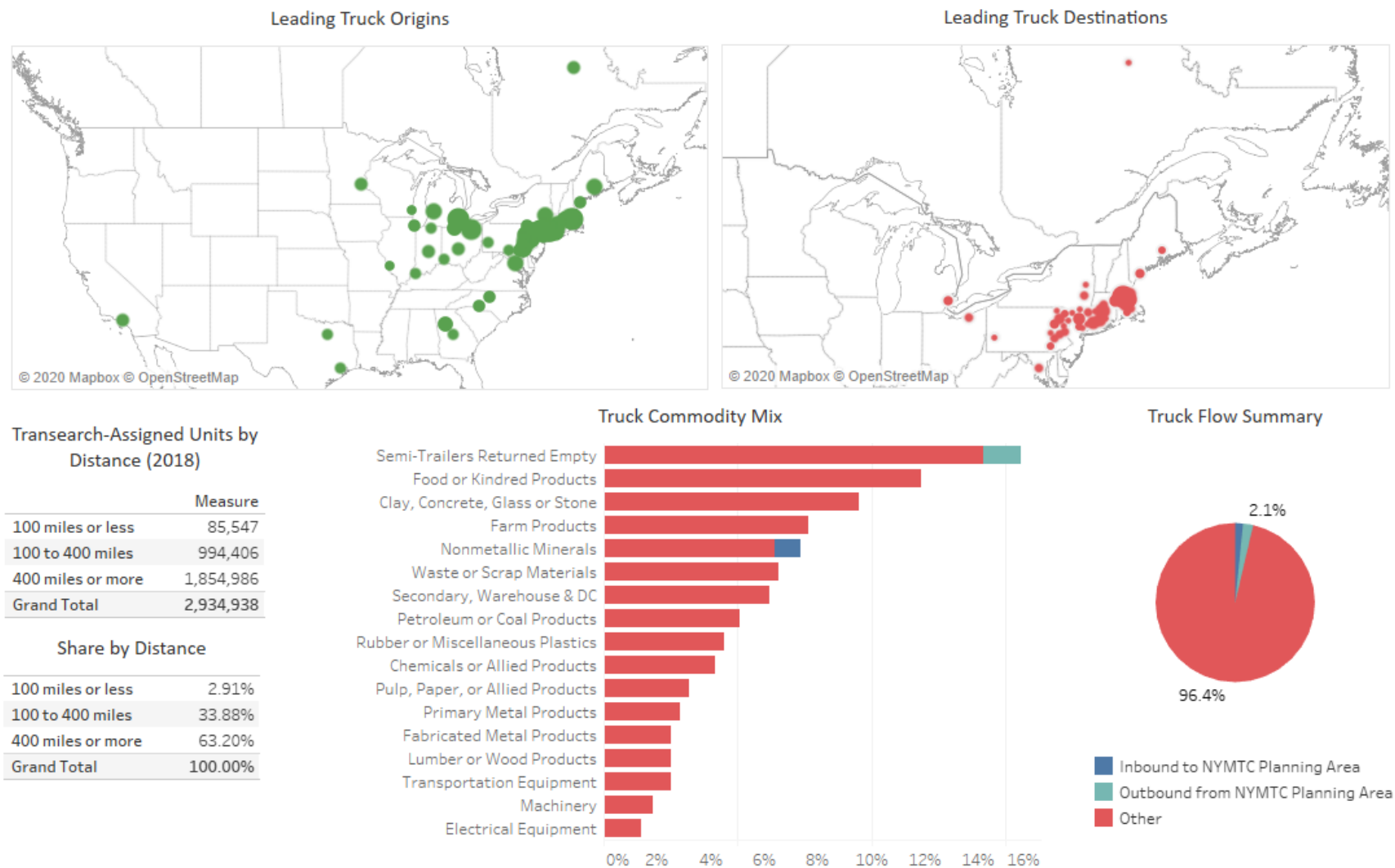


Figure A-14. Analysis Location 12: I-84 west of US-6, Orange County, NY



**Figure A-15. Analysis Location 13: I-87 north of Bronx, Westchester County, NY**

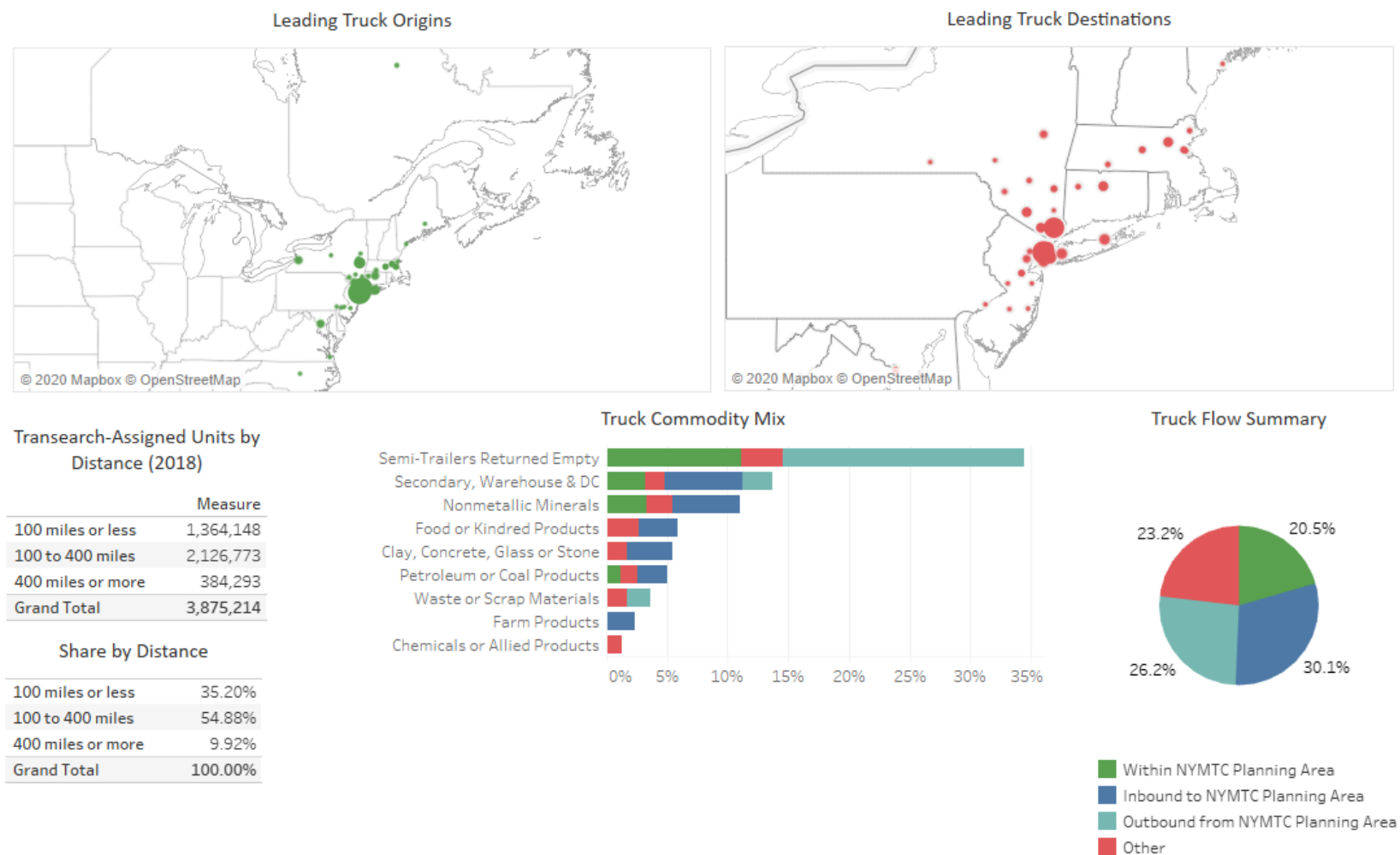
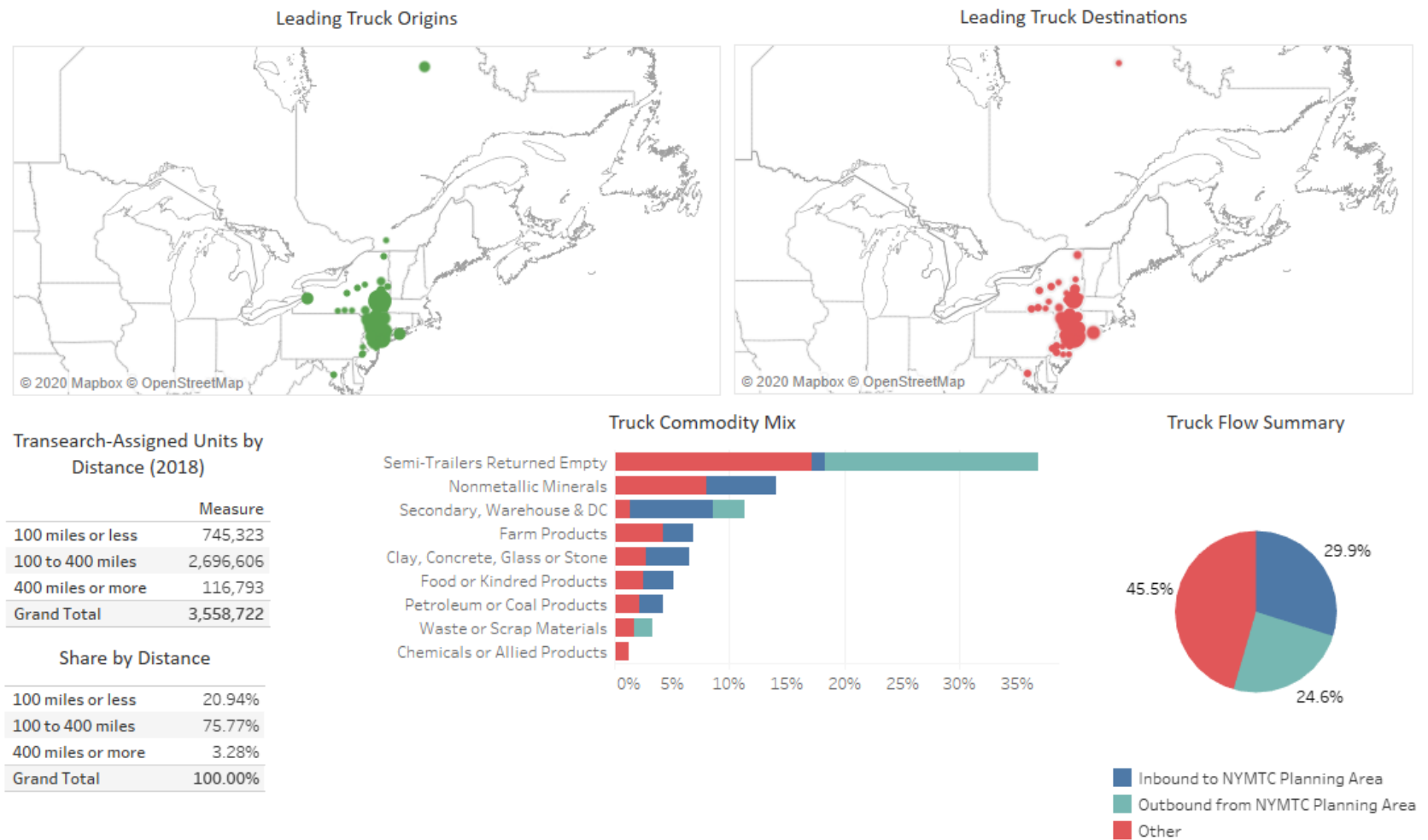


Figure A-16. Analysis Location 14: I-87 at the Rockland Co. NY / Orange Co. NY Line



**Figure A-17. Analysis Location 15: I-495 east of I-295, Queens County, NY**

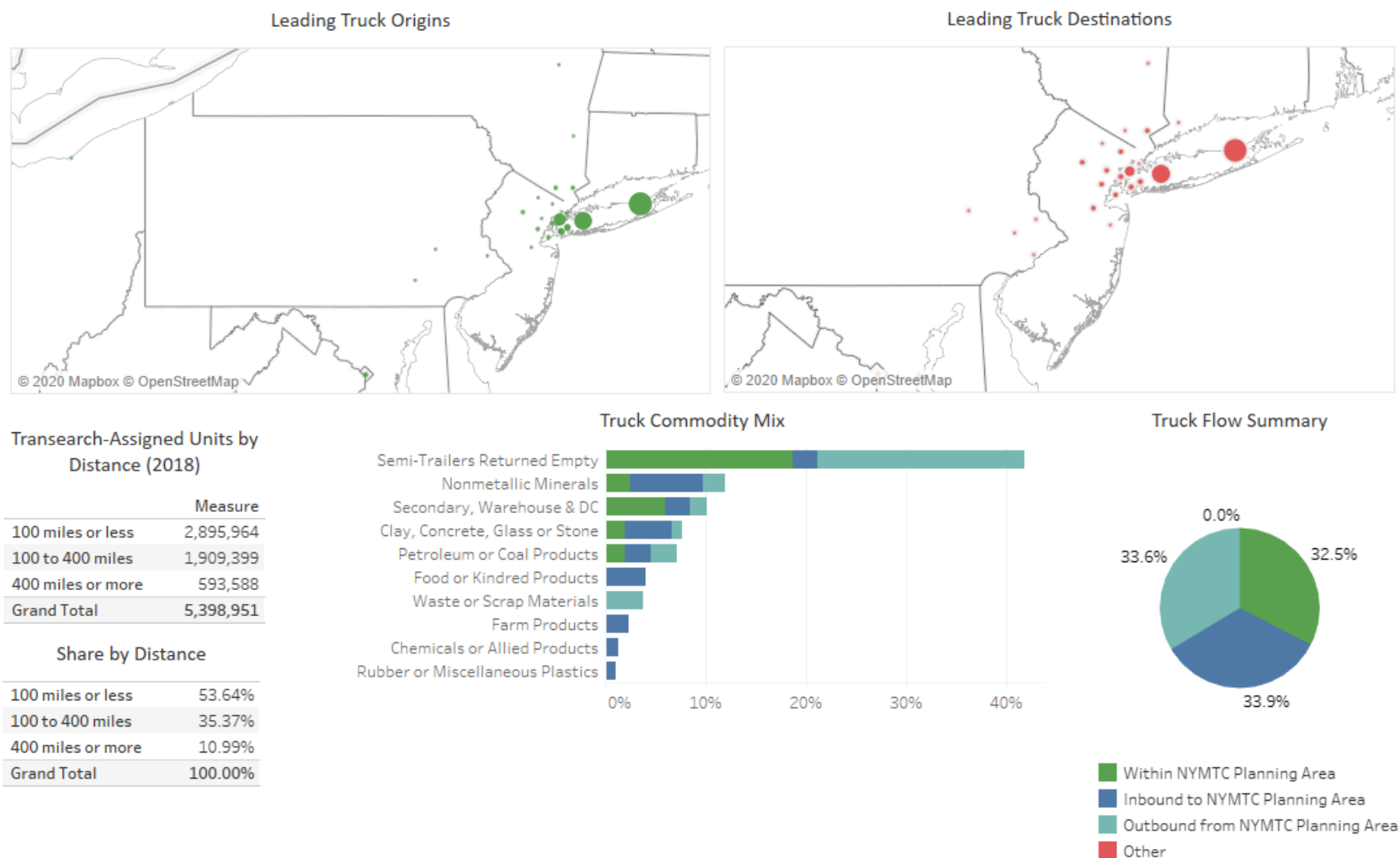
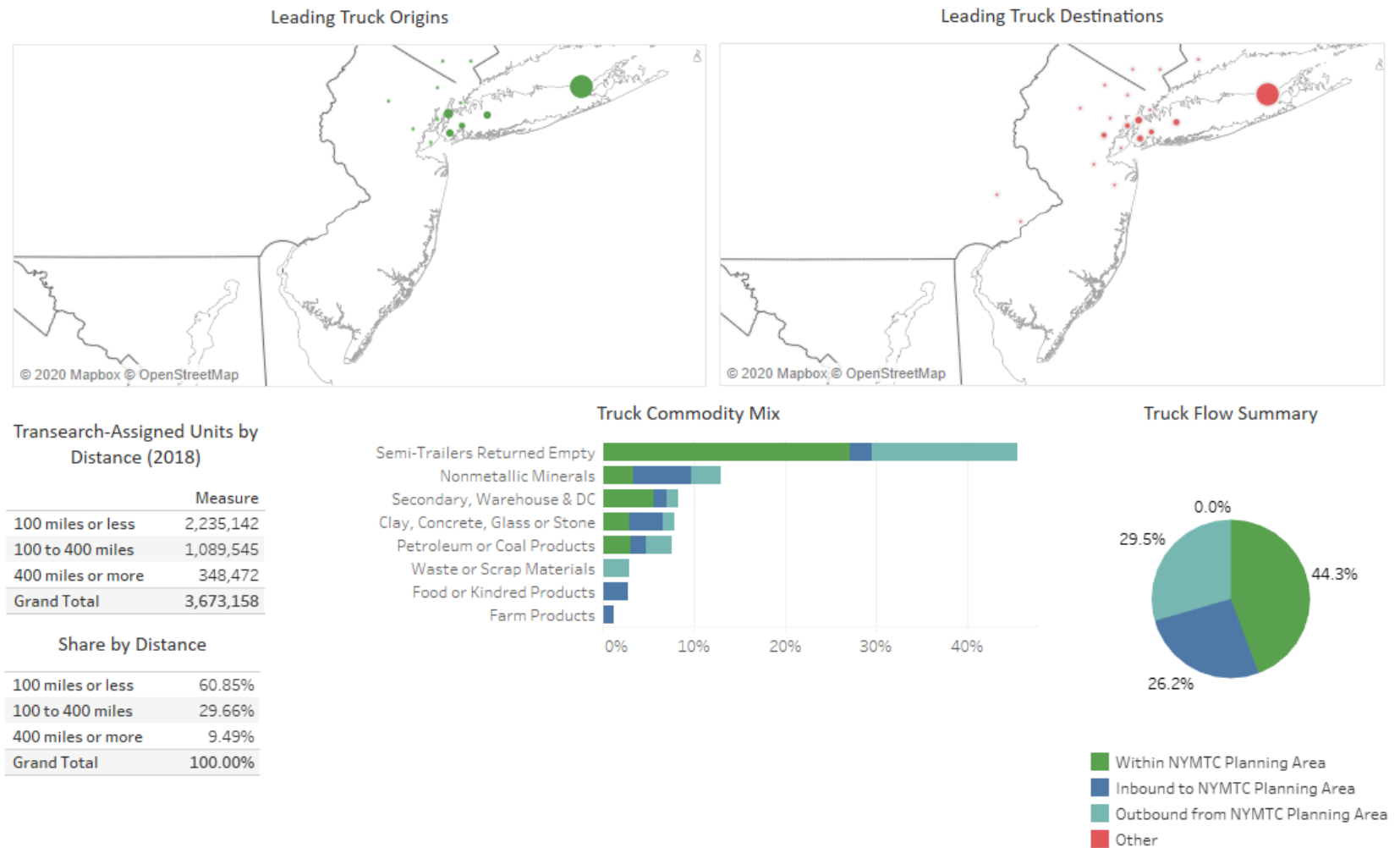
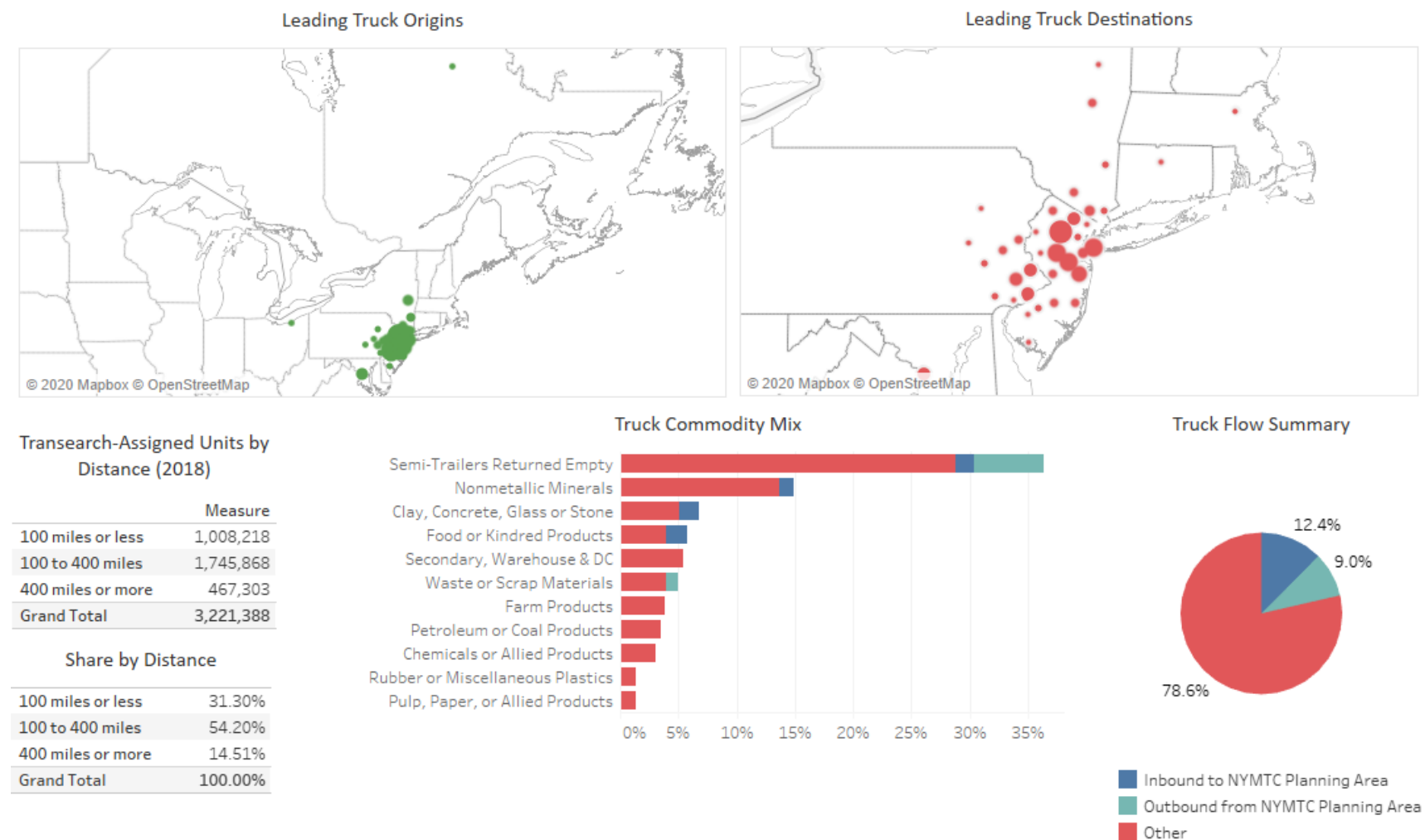


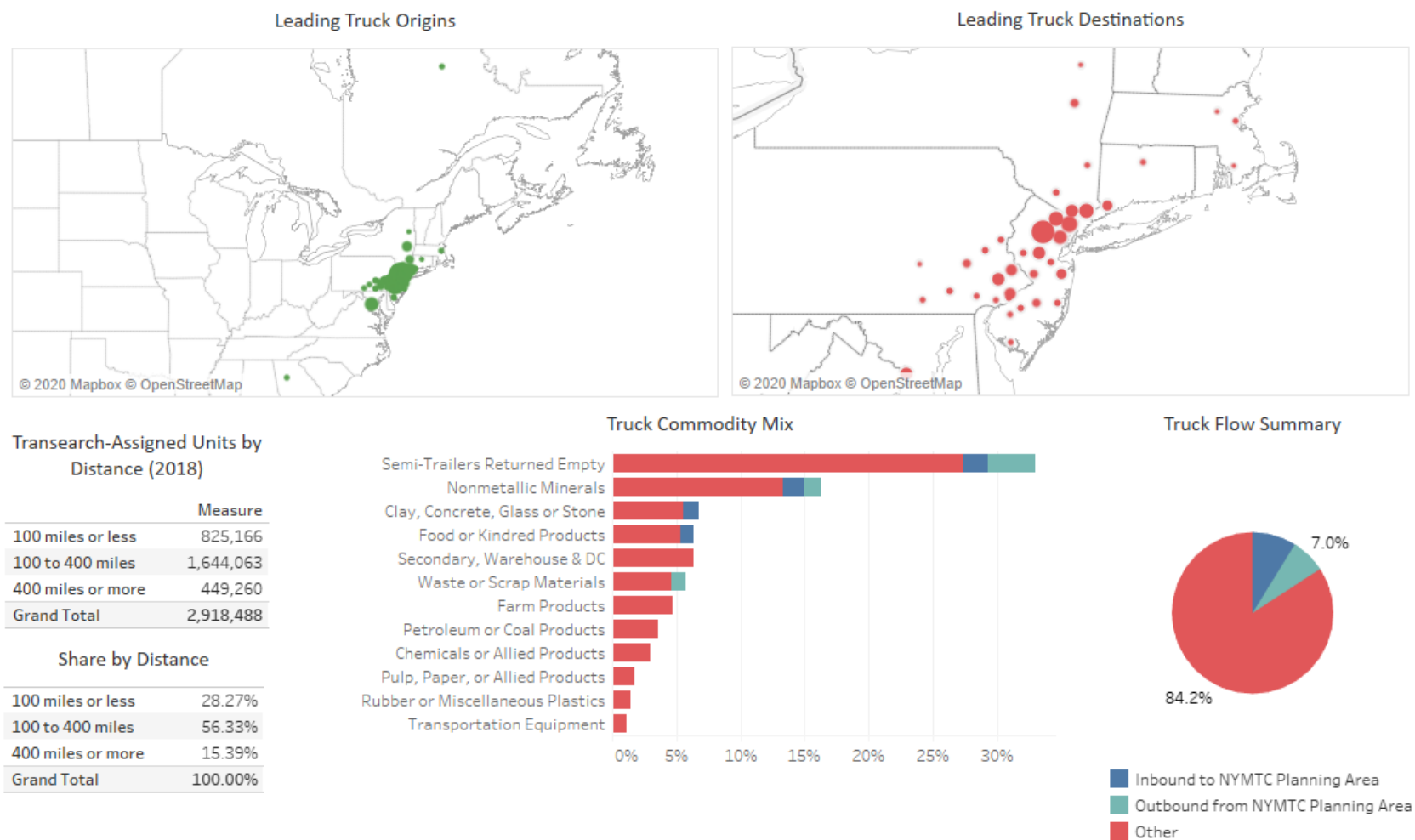
Figure A-18. Analysis Location 16: I-495 at the Nassau Co. NY / Suffolk Co. NY Line



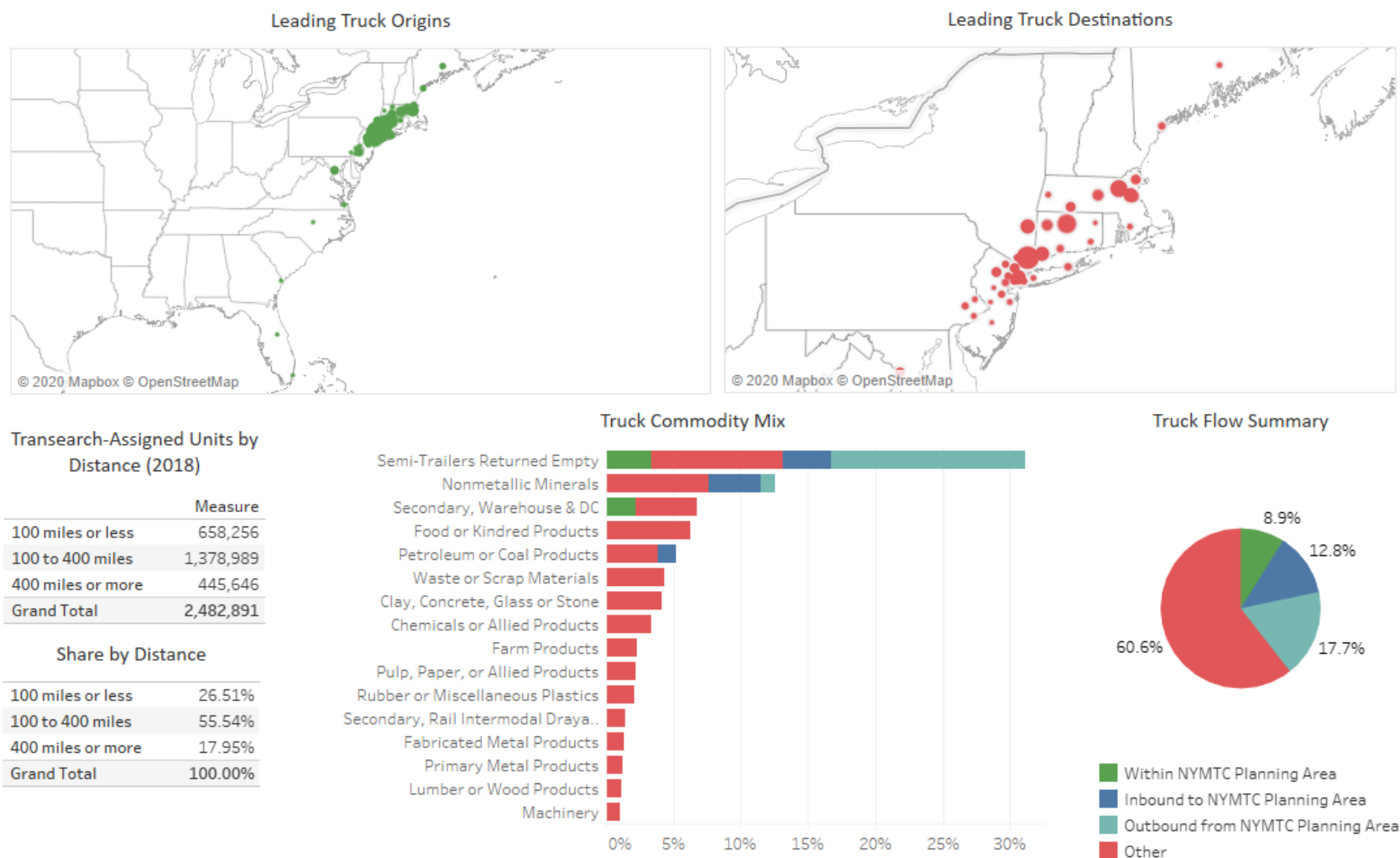
**Figure A-19. Analysis Location 17: I-287 between I-78 and US-202, Somerset County, NJ**



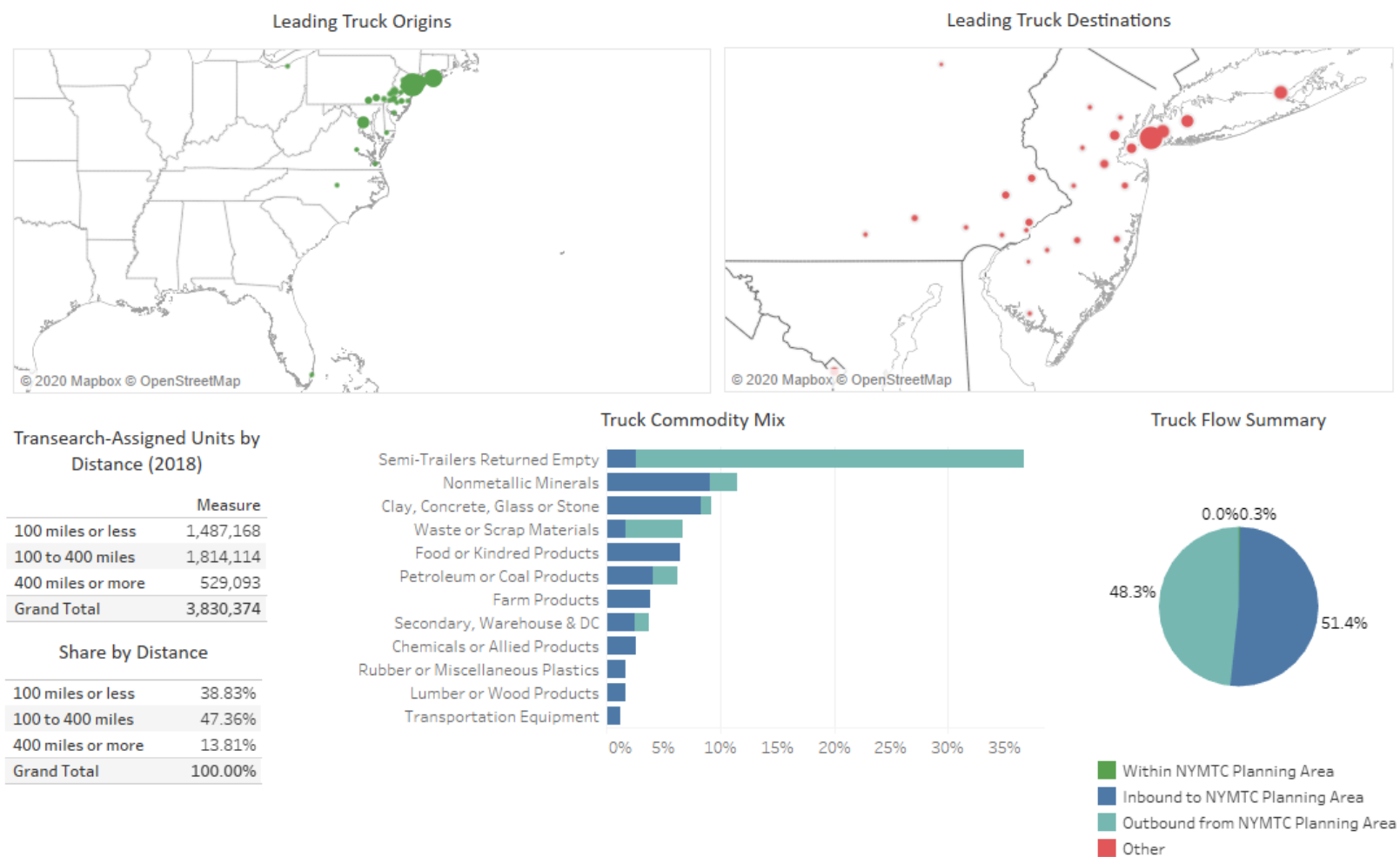
**Figure A-20. Analysis Location 18: I-287 north of US-202/US-206, Somerset County, NJ**



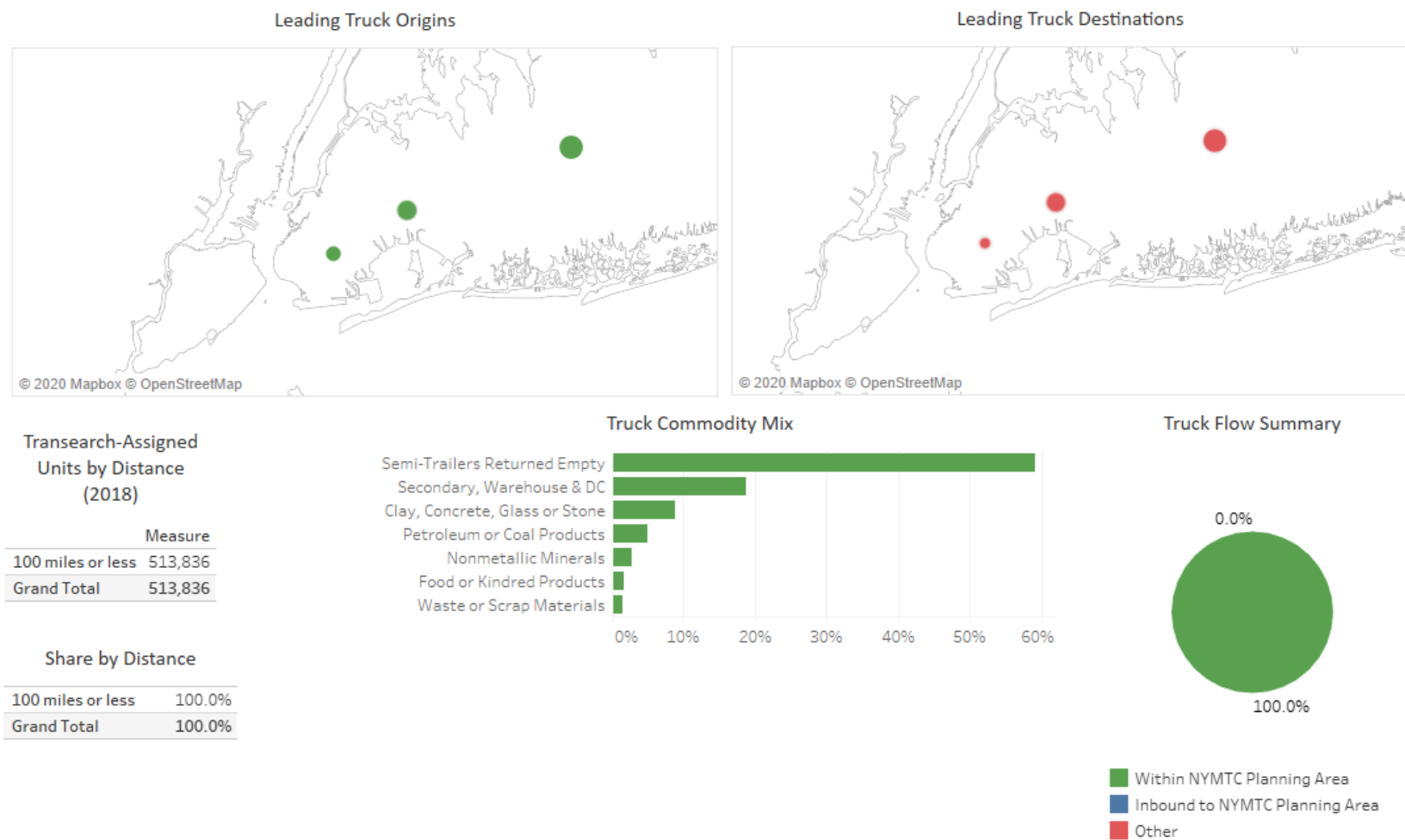
**Figure A-21. Analysis Location 19: I-287 east of NY-100, Westchester County, NY**



**Figure A-22. Analysis Location 20: I-278 east of Goethals Bridge and NY-440, Richmond County, NY**



**Figure A-23. Analysis Location 21: NY-27 at Queens/Nassau County Line, NY**



## Appendix B. List of Stakeholder Workshop Invitees

| <b>Category</b> | <b>Organization</b>                        | <b>Name</b>            | <b>Title</b>                                       |
|-----------------|--------------------------------------------|------------------------|----------------------------------------------------|
| Motor Carrier   | Trucking Association of New York           | Mark Giuffre           | Vice Chair                                         |
| Motor Carrier   | Trucking Association of New York           | Kendra Hems            | President                                          |
| Motor Carrier   | New Jersey Motor Truck Association         | Gail Toth              | Executive Director                                 |
| Motor Carrier   | Motor Transport Association of Connecticut | Joseph Sculley         | President                                          |
| Motor Carrier   | Bi State Motor Carriers Association        | Dick Jones             | Executive Director                                 |
| Motor Carrier   | XPO Logistics                              | William Ryan           | Vice President of Operations, Last Mile            |
| Motor Carrier   | XPO Logistics                              | Mohamed (Mike) Rashwan | Freight Operations Supervisor                      |
| Motor Carrier   | Quality Transportation                     | Hugh Thomas Cumby      | Senior Account Executive                           |
| Motor Carrier   | Tforce Logistics                           | Matt Camarda           | Regional Operations Director (Franklin Square, NY) |
| Motor Carrier   | Old Dominion                               | Eily Cummings          | Director of Communications                         |
| Motor Carrier   | Fedex                                      | Peggy Hon              | Operations Manager                                 |
| Motor Carrier   | Fedex                                      | William Roche          | Senior Manager Air Ground and Freight Services     |
| Truck OEM       | Volvo                                      | Dawn Fenton            | VP, Government Relations and Public Affairs        |
| Truck OEM       | Daimler                                    | Nathan Hill            | Head of Charging Infrastructure                    |
| Truck OEM       | BYD                                        | Vincent Pellecchia     | Strategic Account Manager                          |
| Truck OEM       | Navistar                                   | Ian Honauer            | Regional Truck Sales Manager                       |
| Utility         | New Jersey Utilities Association           | Christina Sweeney      | Manager of Administrative and Member Services      |

|                               |                                     |                           |                                                                               |
|-------------------------------|-------------------------------------|---------------------------|-------------------------------------------------------------------------------|
| Utility                       | Energy Association of Pennsylvania  | Donna M.J Clark           | Vice President & General Counsel                                              |
| Utility                       | IPPNY                               | Emily Shover              | Director, Operations and Membership                                           |
| Utility                       | PSE&G                               | Richard T. Thigpen        | Senior Vice President, Corporate Citizenship                                  |
| Utility                       | PSEG Long Island                    | Michelle Somers           | Program Support Manager — Electric Vehicles                                   |
| Utility                       | Con Edison                          | Britt Reichborn-Kjennerud | Section Manager - Electric Vehicles                                           |
| Utility                       | Jersey Central Power and Light      | James V. Fakult           | President, Jersey Central Power & Light Company                               |
| Utility                       | Orange and Rockland                 | MD Sakib                  | Section Manager - Utility Of the Future                                       |
| Utility                       | Eversource (CT)                     | Steven Conte              | Associate Energy Efficiency Consultant - Electric Vehicle Project Coordinator |
| Utility                       | United Illuminating (CT)            | John Mitchell             | Director, Electric Operations                                                 |
| Utility                       | PPL (Allentown, PA)                 | Kevin Amerman             | Corporate Communications Specialist                                           |
| Utility                       | UGI Utilities, Inc. (Bethlehem, PA) | Christopher Brown         | Vice President and General Manager - Rates and Supply                         |
| Utility                       | National Grid (NYC gas)             | Timothy Ferguson          | Senior Program Manager - Electric Vehicles                                    |
| Utility                       | Central Hudson Gas & Electric Co.   | T.J. Rizzo                | Senior Program Manager - Electric Vehicle Portfolio                           |
| Fuel Infrastructure Providers | ChargePoint                         | David Peterson            | Director, Fleet                                                               |
| Fuel Infrastructure Providers | Greenlots                           | Scott Fisher              | Vice President, Fleets and OEMs                                               |
| Fuel Infrastructure Providers | EVgo                                | Colin Murchie             | Senior Director, Business Development                                         |

|                                      |                           |                                  |                                                           |
|--------------------------------------|---------------------------|----------------------------------|-----------------------------------------------------------|
| <i>Fuel Infrastructure Providers</i> | <i>Marubeni</i>           | <i>Kanji Tsuchida</i>            | <i>Development Manager</i>                                |
| <i>Fuel Infrastructure Providers</i> | <i>eCAMION</i>            | <i>Himanshu Sudan</i>            | <i>Co-Founder</i>                                         |
| <i>Fuel Infrastructure Providers</i> | <i>Ideanomics</i>         | <i>Bryan Rubio</i>               | <i>Director of EV Solutions</i>                           |
| <i>Fuel Infrastructure Providers</i> | <i>Freewire</i>           | <i>Peter Olmsted</i>             | <i>Director of Regulatory Affairs</i>                     |
| <i>Fuel Infrastructure Providers</i> | <i>Freewire</i>           | <i>John Erdman</i>               |                                                           |
| <i>Fuel Infrastructure Providers</i> | <i>Mitsui</i>             | <i>Daisuke Yanagisawa</i>        | <i>General Manager</i>                                    |
| <i>Fuel Infrastructure Providers</i> | <i>Clean Energy Fuels</i> | <i>Brett Barry</i>               | <i>Policy and Regulatory Advisor</i>                      |
| <i>Fuel Infrastructure Providers</i> | <i>Air Liquide</i>        | <i>David Edwards</i>             | <i>Director of Technology Partnerships</i>                |
| <i>Fuel Infrastructure Providers</i> | <i>Electreon</i>          | <i>Stefan Tongur</i>             | <i>Managing Director</i>                                  |
| <i>Fuel Infrastructure Providers</i> | <i>WAVE</i>               | <i>Tom McDonald</i>              | <i>Sr. Director of Marketing and Business Development</i> |
| <i>Fuel Infrastructure Providers</i> | <i>WAVE</i>               | <i>David Greenfader</i>          | <i>Director of Sales</i>                                  |
| <i>Fuel Infrastructure Providers</i> | <i>Trillium CNG</i>       | <i>Kimberly Okafor</i>           | <i>Strategic Business Development Manager</i>             |
| <i>Fuel Infrastructure Providers</i> | <i>Black and Veatch</i>   | <i>Paul Stith</i>                | <i>Director, Global Transportation Initiatives</i>        |
| <i>Fuel Suppliers</i>                | <i>Linde</i>              | <i>Wladimir Sarmiento-Darkin</i> | <i>Business Development Leader, US West</i>               |
| <i>Fuel Suppliers</i>                | <i>BayoTech</i>           | <i>Scott Dyer</i>                | <i>Vice President of Business Development</i>             |

|                             |                                                                 |                          |                                                               |
|-----------------------------|-----------------------------------------------------------------|--------------------------|---------------------------------------------------------------|
| <i>Fuel Suppliers</i>       | <i>Nel Hydrogen Inc.</i>                                        | <i>Eddy Nupoort</i>      | <i>Director, Sales and Business Development</i>               |
| <i>Fuel Suppliers</i>       | <i>Plug Power</i>                                               | <i>Tim Cortes</i>        | <i>Chief Technology Officer</i>                               |
| <i>Fuel Suppliers</i>       | <i>TA/Petro</i>                                                 | <i>Ray De La Luz</i>     | <i>Regional Construction Manager</i>                          |
| <i>Port Operators</i>       | <i>PANYNJ</i>                                                   | <i>Charles Liou</i>      | <i>Manager, Environmental Initiatives</i>                     |
| <i>Port Operators</i>       | <i>PANYNJ</i>                                                   | <i>Tanja Grzeskowitz</i> | <i>Environmental Programs Principal &amp; Specialist</i>      |
| <i>Port Operators</i>       | <i>PANYNJ</i>                                                   | <i>Andrew Lo</i>         | <i>Principal Environmental Programs Specialist</i>            |
| <i>Port Operators</i>       | <i>PANYNJ Port Department</i>                                   | <i>Beth Rooney</i>       | <i>Deputy Port Director</i>                                   |
| <i>Port Operators</i>       | <i>CT Port Authority</i>                                        | <i>John Henshaw</i>      | <i>Executive Director</i>                                     |
| <i>Truck Stop Operators</i> | <i>Pilot-Flying J (multiple locations in region)</i>            |                          |                                                               |
| <i>Truck Stop Operators</i> | <i>Loves</i>                                                    | <i>Rick Shuffield</i>    | <i>Vice President, Real Estate</i>                            |
| <i>Truck Stop Operators</i> | <i>Loves</i>                                                    | <i>Gavin Gretter</i>     | <i>General Manager - Renewable Natural Gas (Trillium CNG)</i> |
| <i>Truck Stop Operators</i> | <i>Travel Centers of America (multiple locations in region)</i> |                          |                                                               |
| <i>Truck Stop Operators</i> | <i>New Jersey Turnpike Authority</i>                            |                          |                                                               |
| <i>Truck Stop Operators</i> | <i>New York State Thruway Authority</i>                         |                          |                                                               |
| <i>Truck Stop Operators</i> | <i>Johnny's Truck Stop (Clinton, NJ)</i>                        |                          |                                                               |
| <i>Truck Stop Operators</i> | <i>Penn Jersey Truck Stop (Phillipsburg, NJ)</i>                | <i>Joseph Santini</i>    |                                                               |

|                         |                                                            |                           |                                                                           |
|-------------------------|------------------------------------------------------------|---------------------------|---------------------------------------------------------------------------|
| Truck Stop Operators    | Tullo Truck Stop (Kearny, NJ)                              | Mr. Tullo                 |                                                                           |
| Truck Stop Operators    | Wheels Truck Stop (formerly Secondi Brothers), Milford, CT |                           |                                                                           |
| Truck Stop Operators    | NATSO                                                      | Tiffany Wlazlowski Neuman | Vice President, Public Affairs                                            |
| Industrial Real Estate  | CBRE                                                       | Matthew Van Buren         | President, New York Tri-State Division                                    |
| Industrial Real Estate  | CenterPoint Properties                                     | David Nenner              | Senior Vice President, Regional Manager                                   |
| Industrial Real Estate  | Colliers                                                   | Noah Balanoff             | Executive Managing Director, Logistics and Transportation Solutions Group |
| Industrial Real Estate  | Colliers                                                   | Michael Markey            | Executive Managing Director, Logistics and Transportation Solutions Group |
| Industrial Real Estate  | Cushman & Wakefield                                        | Toby Dodd                 | President, Tri-State Region                                               |
| Industrial Real Estate  | Heller Industrial Parks                                    | David Paster              | Vice President                                                            |
| Industrial Real Estate  | Majestic Realty Co.                                        | Ed Konjoyan               | Senior Vice President                                                     |
| Industrial Real Estate  | ProLogis                                                   | Nick Kittredge            | President, U.S. East Region                                               |
| Industrial Real Estate  | NAIOP                                                      | Michael McGuinness        | Chief Executive Officer                                                   |
| Industrial Real Estate  | CSCMP Lehigh Valley Roundtable                             | Fred Koeck                | President                                                                 |
| Industrial Real Estate  | CSCMP New England Roundtable                               | Tom McConnell             | President                                                                 |
| Industrial Real Estate  | CSCMP NY/NJ Roundtable                                     | Erik Holck                | President                                                                 |
| Community Organizations | The Point CDC (Hunts Point, Bronx)                         | Maria Torres              | President/Chief Operating Officer                                         |
| Community Organizations | The Point CDC (Hunts Point, Bronx)                         | Sharon De La Cruz         | Director of Sustainability                                                |
| Community Organizations | Civics United for Railroad Environmental Solutions (CURES) | Mary Parisen-Lavelle      | Co-Founder                                                                |
| Community Organizations | Tri-State Transportation Campaign                          | Rena Reynolds             | Executive Director                                                        |

|                                     |                                                               |                          |                                                                    |
|-------------------------------------|---------------------------------------------------------------|--------------------------|--------------------------------------------------------------------|
| <a href="#"><u>Organization</u></a> | <i>Tri-State Transportation Campaign</i>                      | <i>Darwin Keung</i>      | <i>Policy Analyst</i>                                              |
| <i>Community Organizations</i>      | <i>Ironbound Community Corporation</i>                        | <i>Maria Lopez-Nuñez</i> | <i>Director of Environmental Justice and Community Development</i> |
| <i>Community Organizations</i>      | <i>NYC Environmental Justice Alliance</i>                     | <i>Annel Hernandez</i>   | <i>Associate Director</i>                                          |
| <i>Community Organizations</i>      | <i>Coalition for Healthy Ports</i>                            | <i>Amy Goldsmith</i>     | <i>State Director, New Jersey, Clean Water Alliance</i>            |
| <i>Community Organizations</i>      | <i>WE ACT for Environmental Justice</i>                       | <i>Sonal Jessel</i>      | <i>Director of Policy</i>                                          |
| <i>Community Organizations</i>      | <i>South Ward Environmental Alliance</i>                      | <i>Kim Gaddy</i>         | <i>Founder and Director</i>                                        |
| <i>Community Organizations</i>      | <i>Connecticut Coalition for Environmental Justice</i>        | <i>Sharon Lewis</i>      | <i>Executive Director</i>                                          |
| <i>Clean Cities Coalitions</i>      | <i>Empire Clean Cities</i>                                    | <i>Joy Gardner</i>       | <i>Executive Director &amp; Clean Cities Coordinator</i>           |
| <i>Clean Cities Coalitions</i>      | <i>Greater Long Island Clean Cities Coalition</i>             | <i>Rita Ebert</i>        | <i>Program Coordinator</i>                                         |
| <i>Clean Cities Coalitions</i>      | <i>New Jersey Clean Cities Coalition</i>                      | <i>Chuck Feinberg</i>    | <i>Executive Director</i>                                          |
| <i>Clean Cities Coalitions</i>      | <i>Eastern Pennsylvania Alliance for Clean Transportation</i> | <i>Caroline McCallum</i> | <i>Program Director</i>                                            |
| <i>Clean Cities Coalitions</i>      | <i>Connecticut Southwestern Area Clean Cities</i>             | <i>Daphne Dixon</i>      | <i>Clean Cities Coalition Coordinator</i>                          |
| <i>Clean Cities Coalitions</i>      | <i>Greater New Haven Clean Cities Coalition</i>               | <i>Paul Wessel</i>       | <i>Clean Cities Coordinator</i>                                    |
| <i>Clean Cities Coalitions</i>      | <i>Capitol Clean Cities of Connecticut</i>                    | <i>Craig Peters</i>      | <i>Clean Cities Coordinator</i>                                    |
| <i>Government Agencies</i>          | <i>NYSERDA</i>                                                | <i>Jason Zimble</i>      | <i>Project Manager</i>                                             |
| <i>Government Agencies</i>          | <i>NYPA</i>                                                   | <i>Fabio Mantovani</i>   | <i>Vice President, e-Mobility</i>                                  |
| <i>Government Agencies</i>          | <i>Pennsylvania Energy Development Authority (PEDA)</i>       | <i>Allen Landis</i>      | <i>PEDA Executive Director</i>                                     |
| <i>Organization</i>                 | <i>Eastern Transportation Coalition</i>                       | <i>Marygrace Parker</i>  | <i>Director, Freight Program</i>                                   |
| <i>Organization</i>                 | <i>RPA</i>                                                    | <i>Dale Bryk</i>         | <i>Senior Fellow for Energy and Environment</i>                    |

|                                |                                |                          |                                                    |
|--------------------------------|--------------------------------|--------------------------|----------------------------------------------------|
| <i>Government<br/>Agencies</i> | <i>Maritime Administration</i> | <i>Jeffrey Flumignan</i> | <i>Director, North Atlantic Gateway<br/>Office</i> |
|--------------------------------|--------------------------------|--------------------------|----------------------------------------------------|

## Appendix C. Stakeholder Workshop Facilitation Guide

### NYMTC: Clean Freight Corridors

#### Draft Breakout Room Facilitation Guide for October 7 Workshop

##### Breakout Activities

*Following a presentation about the Clean Freight Corridors Planning Study, participants will be divided into breakout rooms, each with 6-8 participants and 2 facilitators from the study team.*

##### Facilitator Roles

*One member of the ASC staff will serve as the "Meeting Organizer," who will provide the technical support and control the breakout rooms. The Meeting Organizer will also share chat notifications indicating when it is nearly time to move to the next question. Before the groups go into their breakout rooms, the Meeting Organizer will remind the participants that they should not try to exit the breakout room by clicking "leave" – this will remove the participant from the entire workshop.*

*One facilitator, the "Discussion Leader," will be responsible for guiding the group through the questions identified in this facilitation guide. The facilitator will also be responsible for starting the meeting recording under the settings of their individual breakout room*

*The other facilitator, the "Note Taker," will update their group's Miro frame to reflect the answers provided to the activities.*

*The Miro board for this workshop is active at [miro.com/app/board/o9J\\_l5ZijOk=](https://miro.com/app/board/o9J_l5ZijOk=).*

*For reference, the project map is available at <https://calstartorg.maps.arcgis.com/apps/View/index.html?appid=9ec633625d7a4cf9a39ae6c041b7cb58&extent=-78.7222,38.5742,-68.1753,42.4845>.*

##### Group Staffing

###### Group 1:

- *Facilitator: Gerry Bogacz*
- *Technical: Lisa Destro*
- *Note Taker: Caroline Ibarra*

###### Group 2:

- *Facilitator: Leslie Fordjour/Nora Madonick*

- *Technical: Al Beatty*
- *Note Taker: Shawn Wallbillich*

*Group 3:*

- *Facilitator: Michael Henrich*
- *Technical: Christopher Lamm*
- *Note Taker: Karina Vangani*

*Group 4:*

- *Facilitator: Marisol Gonzalez*
- *Technical: Ben Mandel*
- *Note Taker: Joseph Smith*

**Introduction (2-3 minutes)**

*Once participants have entered the breakout room, the Discussion Leader will welcome the participants to the breakout room and encourage participants to introduce themselves to the full breakout group by sharing:*

- *Their names*
- *The organization they are representing.*

*The Note Taker will then share their screen of the Miro activity board with the breakout group.*

*One person in the group should be assigned to report out to the full group after the breakout activity.*

**Part 1: What should a “regional clean freight corridor” designation mean? (15 minutes)**

*The Note Taker will focus in on the Part 1 area of the Miro board, and the Discussion Leader will ask the following prompts:*

**5 minutes**

*Questions/Prompts:*

- *During the presentation, we shared some of the characteristics that we used in our analysis—including major freight demand clusters, fueling stations by type and any identified gaps in the corridor. Are there other characteristics that our analysis should include?*
- *How about the weight that we gave each characteristic? How would you have weighed the different characteristics?*

*As participants respond to the question, the Note Taker will use sticky notes on the Miro board to jot down the responses. As needed, the Discussion Leader will ask follow-up questions to clarify the response or to gather additional information.*

*About 5 minutes into this 15-minute period, once participants have had the opportunity to respond to the first question, the Note Taker will focus in on the project map on the right side of the Miro frame.*

*Once the map is in focus, the Discussion Leader will ask the following prompts:*

**10 minutes**

Questions:

- *We also shared our draft recommendations for clean freight corridors based on this analysis, shown in these maps for each fuel type. How well do you feel these recommendations reflect corridor readiness for each fuel type? (Facilitator should share each map on-screen and give participants time to respond.)*
- *Are there any segments that should be added or removed? (Facilitator should share each map on-screen and give participants time to respond.)*
- *Do you have any suggestions regarding potential clean freight corridor designations? Why would you recommend designating that corridor?*

*The Note Taker will use Miro's pen, connector (arrow) and sticky note tools to mark up the map reflecting participant feedback.*

*Once participants have responded to the initial question, the Discussion Leader will ask the following question.*

*As the 10-minute period ends, the Discussion Leader will move to part 2.*

**Part 2: What kinds of policies will be needed to use these designations to implement clean freight infrastructure and build networks of corridors? (10 minutes)**

*The Note Taker will focus on the Part 2 area of the Miro board, and the Discussion Leader will ask the following question.*

*As participants respond to the question, the Note Taker will use sticky notes on the Miro board to jot down the responses. If needed, the Discussion Leader can ask the following follow-up questions to guide the discussion.*

Questions/Prompts:

- *What are the most significant factors that need to be considered when implementing alternative fuel infrastructure in these corridors?*

- *What trends, if any, have you noticed in alternative fuel infrastructure in the region? How might these trends impact clean freight corridors in the region?*

*As participants respond to the question, the Note Taker will use sticky notes on the Miro board to jot down the responses. As needed, the Discussion Leader will ask follow-up questions to clarify the response or to gather additional information.*

*As this 10-minute period ends, the Discussion Leader will move to the final activity, part 3*

### **Part 3: What next steps should our team take? (10 minutes)**

*The Note Taker will focus in on the Part 3 area of the Miro board, and the Discussion Leader will ask the following question.*

#### Questions/prompts:

- *Which stakeholder groups need to be engaged in the implementation of the clean freight infrastructure recommendations?*
- *What would be the best way to engage the stakeholders that you have just mentioned? Is there anything we should keep in mind while meeting with these stakeholders?*
- *If you have any recommendations for a person or group we should be in touch with, please feel free to share in the chat of this breakout group.*
- *How can we make our final findings of the study most accessible to you and your peers?*

*As participants respond to the questions, the Note Taker will use sticky notes on the Miro board to jot down the responses. As needed, the Discussion Leader will ask follow-up questions to clarify the response or to gather additional information.*

*After the 10-minute period ends, the Discussion Leader will let the team know that they will close the breakout room and return to the main group.*

#### Close out announcement for each group

**Facilitator:** *Thank you for sharing your insights during this breakout room. In a few moments, this breakout room will close, and you will be brought back into the main presentation area. Please stay on for a few more moments for the close of today's workshop.*

### **Reporting Out (15 mins)**

*Assign each group one section to report back on. The person assigned in the beginning from each group will share their group's responses to the questions in that section.*

## Appendix D. Comments Gathered During the Stakeholder Workshop

The tables below capture the feedback received from workshop participants on each of the three discussion parts, and on the maps shown during the breakout sessions.

**Part 1**      **What should a "regional clean freight corridor" designation mean?**  
**We also shared our draft recommendations for clean freight corridors based on this analysis, shown in the maps for each fuel type (maps were shown on the screen). How well do you feel these recommendations reflect corridor readiness for each fuel type?**

| Group(s) | Comment                                                                                                                                                                                                                                          |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1        | The type of charging system is the most important, especially for charging in a very dense environment.                                                                                                                                          |
| 1        | Wireless charging is now commercially ready. There are agencies running almost exclusively on wireless. Not needing to go to depots for charging.                                                                                                |
| 1        | The availability is a key factor -- Hunts Point is a current area where this is an issue                                                                                                                                                         |
| 1        | Would other businesses have the same environmental issues?                                                                                                                                                                                       |
| 1        | Citing all of the NYC locations in corridors that have already been flagged poses a challenge -- where does funding come from for locations that make most sense for the city? Don't want to be shut out of the game for infrastructure funding. |
| 1        | NYC DOT: We don't even have places to think about siting infrastructure -- land use issues pose issue in urban area, and other land uses seem like a priority.                                                                                   |
| 1        | California is also having similar issues -- there's a third-party group evaluating future fueling sites. CNG models and P3 as creative ways to look at the issues.                                                                               |
| 1        | Making the clean freight corridor is an important first step -- PANYNJ has conducted its own study to evaluate infrastructure on/near group properties                                                                                           |
| 1        | There is a drayage area near port where truck charging is available -- but it's currently underutilized. Use will require significant changes.                                                                                                   |
| 1        | Some tenants are starting to bring in alt. fuel trucks due to funding, but they will probably continue to use their own charging infrastructure rather than CFC infrastructure. Outside infrastructure is more for as-needed                     |
| 1        | Biggest things: Optionality, Electrification and other new opportunities                                                                                                                                                                         |
| 1        | There are environmental issues and land use issues -- transit agencies and P3 are opportunities                                                                                                                                                  |
| 1        | Fueling as a Service                                                                                                                                                                                                                             |
| 2        | fuel station coverage, freight demand, truck volume                                                                                                                                                                                              |
| 2        | convenience of station itself                                                                                                                                                                                                                    |
| 2        | air quality ozone attainment                                                                                                                                                                                                                     |
| 2        | EJ areas and Minority populations                                                                                                                                                                                                                |
| 2        | freight consolidation areas                                                                                                                                                                                                                      |

|   |                                                                                                                                  |
|---|----------------------------------------------------------------------------------------------------------------------------------|
| 2 | high priority: Location/ Convenience of station                                                                                  |
| 2 | look at clusters and identify areas of overlap                                                                                   |
| 3 | Transfer freight                                                                                                                 |
| 3 | Origins and destinations of freight                                                                                              |
| 3 | Fuel that we would be able to provide. Amenities to the truck drivers (eat, shop)                                                |
| 3 | Electrification: Working with utilities. Charging levels                                                                         |
| 4 | Interest in learning more so that we can communicate with the DOT                                                                |
| 4 | Maybe focus on short-haul trucks first, easier to meet their needs more effectively                                              |
| 4 | Concern about where fueling stations would be. Existing service areas makes sense. New facilities could take 10 years to realize |
| 4 | Prioritize corridors using truck volumes as primary metric for need.                                                             |
| 4 | Trucks move probably 95% of freight in CT. Important to accommodate that mode                                                    |
| 4 | In general, the presented methodology accounted for important issues and policy changes that may be necessary                    |
| 4 | Need to include fueling at rest stops, but there aren't enough rest stops                                                        |
| 4 | High cost of land can be a challenge for acquiring new land for truck stops. Are there more possibilities in the ROW?            |
| 4 | Working with trucking companies and distribution centers could be an option                                                      |
| 4 | Need to identify funding                                                                                                         |
| 4 | Land use is the biggest problem to overcome. People don't want these facilities in their neighborhoods.                          |

**Part 2**

**What kinds of policies will be needed to use these designations to implement clean freight infrastructure and build networks of corridors?**

**What are the most significant factors that need to be considered when implementing alternative fuel infrastructure in these corridors?**

**What trends, if any, have you noticed in alternative fuel infrastructure in the region? How might these trends impact clean freight corridors in the region?**

| Group | Comment                                                                                                      |
|-------|--------------------------------------------------------------------------------------------------------------|
| 2     | Incentives                                                                                                   |
| 2     | Requirements of stations                                                                                     |
| 2     | Meet new and different standards                                                                             |
| 2     | Accommodating drivers' needs                                                                                 |
| 2     | Resiliency factor: building resiliency into the locations                                                    |
| 2     | EV charging to attract people to cities                                                                      |
| 2     | Federal policy: change the ability to sell fuel or anything at rest stops (interstate rest stop regulations) |
| 2     | Trend: A move toward electrification                                                                         |
| 2     | Encourage more people to buy cleaner-fuel vehicles                                                           |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3 | Truck driver perspective - have a seamless and transparent transition to alt. fuel vehicles                                                                                                                                                                                                                                                                                                                                                     |
| 3 | Established network of fueling locations with policies to ensure that the fuels they need are available                                                                                                                                                                                                                                                                                                                                         |
| 3 | No demand charges from utility companies!                                                                                                                                                                                                                                                                                                                                                                                                       |
| 3 | Needs to be a competitive marketplace and driven by private sector, not just grant money                                                                                                                                                                                                                                                                                                                                                        |
| 3 | Regulations are needed, but with guardrails to ensure fairness                                                                                                                                                                                                                                                                                                                                                                                  |
| 3 | Should look at emergency response and diversion route tactics - if a clean freight corridor route is taken out of service there need to be alternatives fueling locations on the detour route(s)                                                                                                                                                                                                                                                |
| 3 | Utilities can sometimes step in and skew the competition.                                                                                                                                                                                                                                                                                                                                                                                       |
| 4 | Recently learned that within the past few months, the state legislature in NJ passed a law that will apply to residential developments in all municipalities. Developments of a certain size (based on units) when they build parking spaces they have to include a certain percentage of those spaces as EV charging stations. Additional higher percentage they have to make ready for future EV charging stations. Takes effect immediately. |
| 4 | As a policy recommendation, similar requirements for commercial facilities or warehouse facilities and distribution center. If you build one, should there be a requirements that a certain number of EV charging stations or hydrogen fuel stations would have to be installed as part of the requirement for approval.                                                                                                                        |
| 4 | Trucks are not cars. This will be a big issue to overcome. Some towns in CT have approved zoning regulations that would prevent EV charging in certain areas. There is a different attitude for an 18 wheeler compared to a passenger car. Promotion of EV charging stations is intended to get people to buy EVs. Policymakers may not offer those same incentives for commercial truckers                                                     |
| 4 | Require warehouses or freight intensive facilities to require EV charging stations, however the incentives for policymakers may not be there. Might have to come from the private side                                                                                                                                                                                                                                                          |
| 4 | EV Charging is viewed as benign, some people are nervous about Hydrogen. That is another hurdle to overcome. Perceived safety problems will effect permitting.                                                                                                                                                                                                                                                                                  |

### Part 3 What next steps should our team take?

**Which stakeholder groups need to be engaged in the implementation of the clean freight infrastructure recommendations?**

**How can we make our final findings of the study most accessible to you and your peers?**

| Group | Comment                                                          |
|-------|------------------------------------------------------------------|
| 2     | Other clean cities coalitions in the Northeast and Mid-Atlantic  |
| 2     | Volpe Center                                                     |
| 2     | Coordinating with surrounding states to ensure connectivity      |
| 2     | Share the planning study with the Northeast Diesel Collaborative |

|   |                                                                                                   |
|---|---------------------------------------------------------------------------------------------------|
| 2 | Utilities that would prepare the grid or building-out the infrastructure in these corridors       |
| 2 | Rural chambers of commerce                                                                        |
| 2 | Communities in fueling center locations                                                           |
| 3 | Affected communities that the transportation corridors go through - get their input and buy-in    |
| 3 | Start with a list of stakeholders                                                                 |
| 3 | Disadvantaged/under-represented communities                                                       |
| 3 | Fleet owner-operators and small fleets                                                            |
| 3 | Fleet drivers vs. independent drivers have different patterns and needs                           |
| 4 | Trucking industry, transportation/freight companies                                               |
| 4 | More private sector. Reaching out to them is difficult unless companies see the benefit           |
| 4 | Engaging the Port Authority may be helpful in connecting with private companies                   |
| 4 | Asking private sector "from your perspective what are some of the technical, financial barriers?" |
| 4 | Reach out to companies that run distribution centers or other trucking facilities                 |
| 4 | Engage labor unions comprised of truckers to hear their experiences                               |
| 4 | Get more connected through other plans/studies (CT, Hudson County's upcoming study, etc.)         |

### Map Comments

| Map                | Comment                                                                                                                         |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------|
| CNG Readiness      | Where does CNG stand now? CLCPA and renewable fuel standards pose a major factor.                                               |
| CNG Need           | Environmental groups are suspicious of CNG. Price is a benefit, though.                                                         |
| CNG Need           | Real push for CNG historically - battery technology has moved much faster than anticipated                                      |
| CNG Need           | Industry needs to shift toward being RNG sellers.                                                                               |
| Electric Readiness | Wholesale shift to electric is going to cost a lot of time and effort                                                           |
| Electric Readiness | Where are the transmission lines located?                                                                                       |
| Electric Need      | Define threshold need level                                                                                                     |
| Electric Need      | All highways should be highlighted                                                                                              |
| Hydrogen Need      | CFC offers option for owner-operators to opt into alt. fuels. Union issue. 70% of the workforce can't afford as owner-operator. |

|                  |                                                                           |
|------------------|---------------------------------------------------------------------------|
| Hydrogen<br>Need | Ex. \$2 million in infrastructure isn't realistic for many.               |
| Hydrogen<br>Need | Many are splitting their fuel types. There are savings this way.          |
| Hydrogen<br>Need | Battery storage needs to be addressed, especially for battery operations. |