



Northeast Freight Corridor Charging Plan

Roadmap Report

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Acknowledgments

The authors would like to thank the subject matter experts and reviewers from the following organizations for their contributions in enhancing the analysis, recommendations, and overall quality of the study, including:

Matilda Olsen, National Grid
Nick Watson, National Grid
Ryan Wheeler, National Grid
Matt Miccioli, RMI
Yi He, NREL
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New York Power Authority
PPL
PSEG
Rhode Island Energy
Orange & Rockland
Versant
Daimler
Tesla

An aerial, high-angle photograph of a complex multi-level highway interchange. Several cars are visible on the roads, appearing as blurred streaks due to motion. The roads are marked with white dashed lines and yellow solid lines. The concrete structure of the overpasses and ramps is visible, creating a geometric pattern of intersecting lines. The overall scene conveys a sense of fast-paced movement and infrastructure.

Executive Summary

Executive Summary

The Department of Energy's Vehicle Technologies Office is funding seven projects under its Innovative Medium and Heavy Duty EV Charging and Hydrogen Regional Fueling Corridor Infrastructure Plans grant. These projects aim to accelerate infrastructure development for electric medium- and heavy-duty vehicles (MHDVs) along key corridors in the Northeast, the Southwest, Northern and Southern California, the Eastern Seaboard, and the Midwest. This study focuses on the development of the Northeast Freight Corridor Charging Plan (NFCCP), led by National Grid and supported by partners including RMI, Northeast States for Coordinated Air Use Management (NESCAUM), Clean Communities of Central New York, National Renewable Energy Lab (NREL), and CALSTART.

The NFCCP is a roadmap for developing a highway corridor charging network to support electric MHDV adoption in Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. The focus of the NFCCP is facilitating the development of corridor-based charging for MHDVs, and it does not consider development of overnight charging sites at depots. This roadmap will help states, utilities, charging infrastructure providers, and industry align on key priority sites for development; coordinate site planning and associated grid upgrades; and implement several measures to accelerate corridor charging in the region. The plan also includes an assessment of power demand from drayage trucks at the Port of New York and New Jersey, given their

significant contribution to regional truck traffic. The NFCCP is a one-of-a-kind, collaborative process made possible through direct inputs from states, utilities, industry, and local communities.

Taking the Port of New York and New Jersey as a starting point and working north and west from there, NFCCP analyzed 140 potential sites for charging infrastructure development across eight regionally significant interstates: I-80, I-81, I-84, I-87, I-90, I-91, I-93, and I-95. The sites were evaluated based on four distinct criteria to shortlist the best locations to kick-start development of the corridor charging network in the Northeast. This included:

- **State criteria:** Plentiful truck parking availability, presence of nearby fleets, and proximity to highways
- **Utilities criteria:** Low required investment costs and existing plans for utility upgrades
- **Local site impact:** Average level of asthma, diesel particulate matter, and economic indicators
- **Load forecasting:** High peak power demand at each site for 2030 and 2050

Based on this assessment, 39 high-priority sites were identified (see Figures ES-1 and ES-2) to facilitate an efficient buildout of a minimum viable MHDV corridor charging network that balanced stakeholder needs and priorities.

Figure ES-1. Site identification process

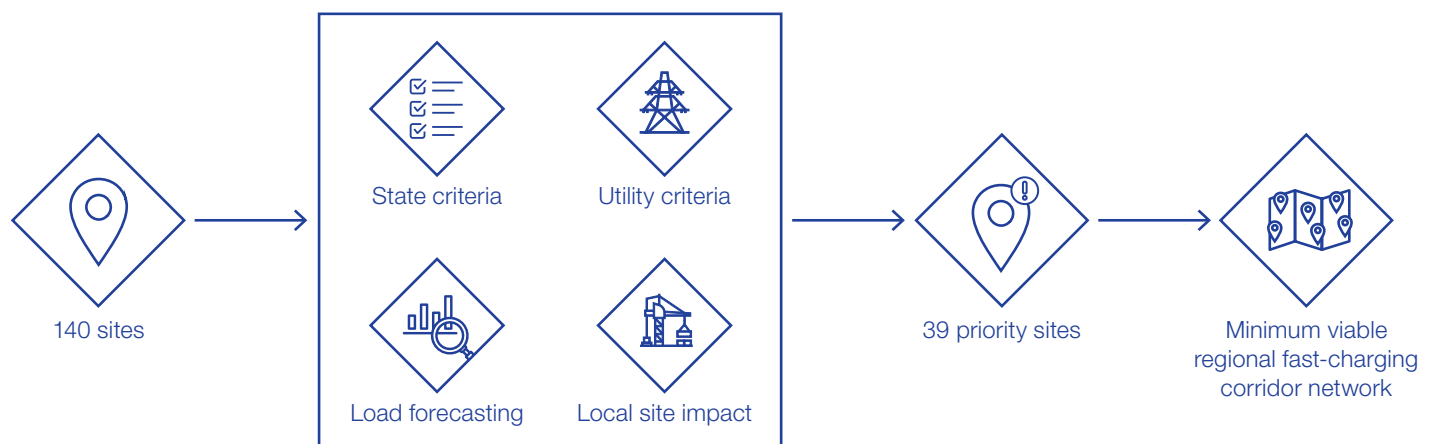
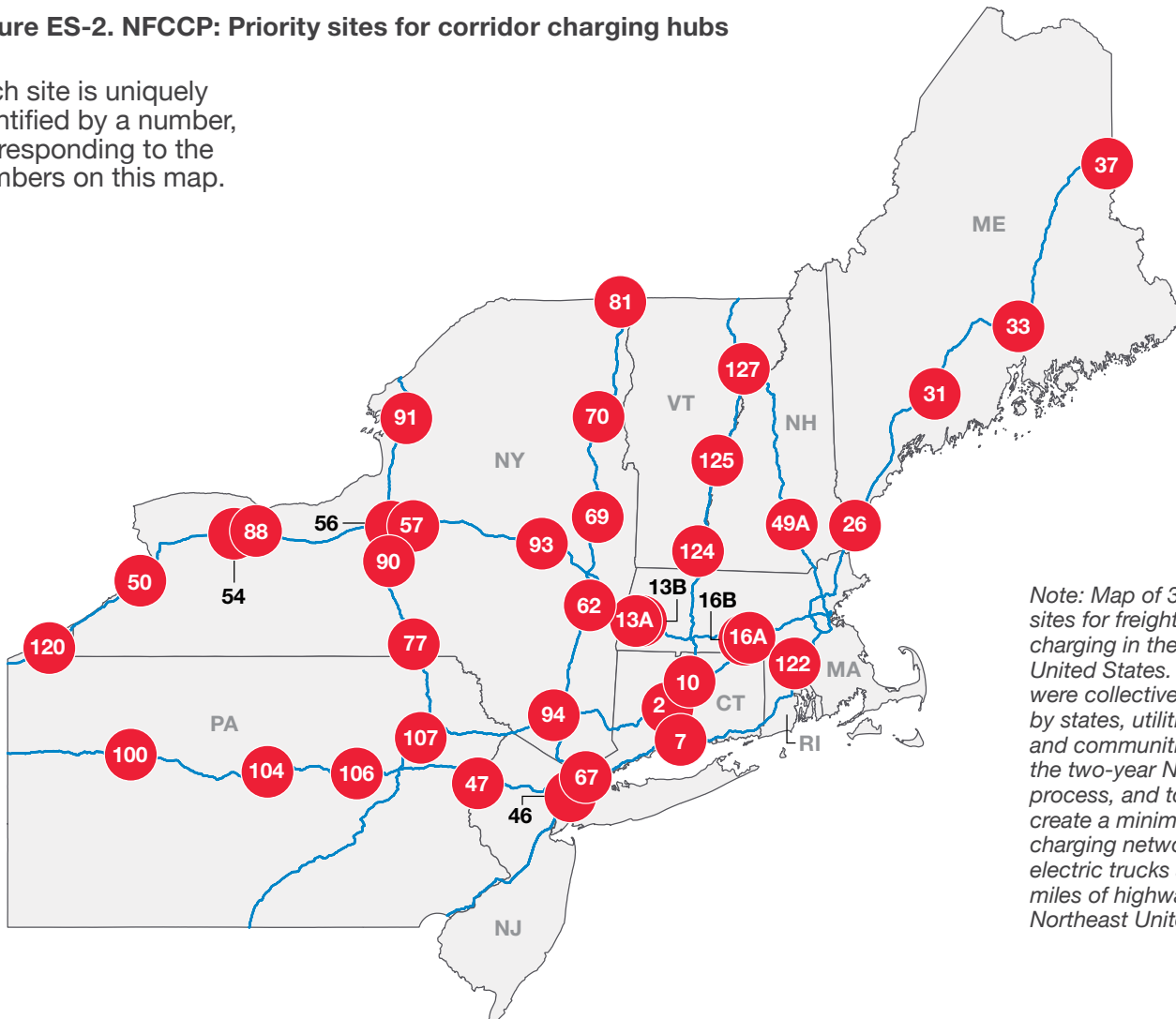


Figure ES-2. NFCCP: Priority sites for corridor charging hubs

Each site is uniquely identified by a number, corresponding to the numbers on this map.



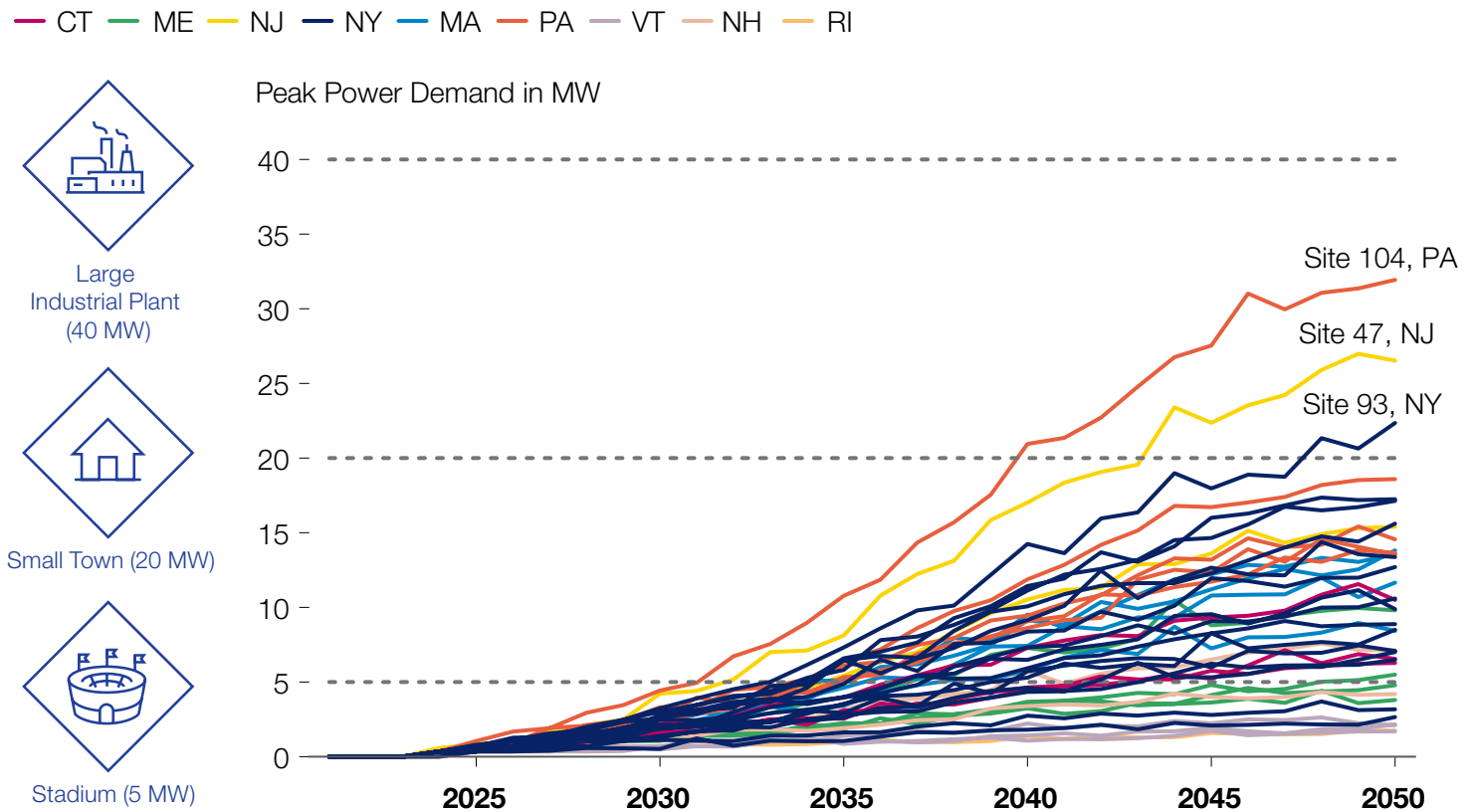
Note: Map of 39 prioritized sites for freight fast charging in the Northeast United States. These sites were collectively prioritized by states, utilities, industry, and communities through the two-year NFCCP study process, and together create a minimum viable charging network for electric trucks across 3,000 miles of highways in the Northeast United States.

If these sites are successfully built out, electric trucks would have consistent access to freight fast charging every 100 miles across these Northeastern corridors. For simplicity, this study refers to these sites as *priority sites for corridor charging hubs*. Although these priority sites are critical to kick-start electrification of freight movement in the region, additional site development will still be needed (such as for light-duty vehicle charging) to serve electric MHDV traffic at more frequent intervals (e.g., 50 miles), or to serve local traffic.

Power demand across the priority sites will rise substantially over time (see Figure ES-3). By 2030, around half of the sites will cross 2 megawatt (MW) peak demand, solely for MHDVs. By 2035, approximately 80% will surpass 2 MW, with one-third exceeding 5 MW. By 2050, more than 75% of the sites are projected to exceed 5 MW and half will experience peak loads of more than 10 MW. Power

needs of this magnitude necessitate significant investments in grid upgrades, which may include transmission-level interconnection. Such upgrades are time-consuming; for example, transmission-level substations can take 5–10 years to build. Therefore, proactive planning for these power needs is critical and must begin immediately to avoid delays and cost overruns.

Power demand varies by site, depending on factors such as location, truck traffic volumes, and travel patterns. Sites in Massachusetts, New Jersey, New York, and Pennsylvania have the highest peak power demands over time. For example, the three sites highlighted in Figure ES-3 showcase the highest demand due to high truck traffic and elevated refueling needs due to the longer distances trucks travel before stopping at these sites, indicating the significance of these sites as major corridor hubs within freight networks.

Figure ES-3. Power demand from the priority sites over time

Beyond the corridor analysis, the study also included the assessment of electrification requirements of drayage fleets serving the Port of New York and New Jersey. One of the biggest port areas in the United States, the Port of New York and New Jersey handle around 7 million loaded twenty-foot equivalent units annually and serves as a critical gateway for international trade on the East Coast. There are approximately 9,000 drayage trucks servicing the ports, traveling to and from them each day.¹ Given the limited space for charging at the ports itself, it is important to better understand the impact electrification of nearby fleets will have in both the depots around the port and throughout the corridors studied in this project.

Analysis shows that as electric drayage truck adoption increases through 2048, peak depot charging demand around the Port of New York and New Jersey could reach 20 MW. During this period, electrified trucks will likely serve shorter routes and primarily rely on depot charging. However, beyond 2043–45, rising electric MHDV adoption — especially among owner-operators

without access to central depots — will drive the need for more corridor charging. By 2050, when nearly all trucks are expected to be electric, peak demand at key travel plazas along the corridors near the port could reach 20–30 MW.

The results underscore the substantial future power demand from electric MHDV corridor charging in the Northeast and mid-Atlantic regions. Stakeholders must begin planning for site development and implementation immediately. Entities including federal, state, and local governments, utility regulators, and industry players will play a crucial role in energizing early-mover sites, ensuring the Northeast and greater region are prepared for an electrified freight future.

The following tables outline the key recommendations for government (Table ES-1) and industry stakeholders (Table ES-2) that would help facilitate development of the minimum viable freight charging network at the priority sites and development of corridor charging more broadly.

Table ES-1. Key recommendations for government stakeholders

Categories	Recommendations
1. Collaborating and coordinating within and across state borders to identify and prioritize sites	a. States could coordinate the development of freight plans and charging sites to ensure a strategic regional network that avoids redundancy in publicly funded infrastructure along corridors through highway-specific working groups or existing multistate initiatives. b. States could form or strengthen cross-agency working groups within their governments to coordinate freight electrification efforts. c. States could leverage requests for information to guide priority site development. d. States could collaborate with utilities to align on core assumptions for state-specific load forecasts, as was done for this project.
2. Enhancing grid capacity near priority sites	a. Utility regulators could consider new proceedings that allow utilities to propose proactive investments in corridor charging infrastructure, while also encouraging the use of innovative load forecasting techniques. b. State, federal, and other regulators could enable more cost-effective power delivery by revisiting rules around electrical infrastructure crossings on highways.
3. Energizing and building scalable MHDV charging infrastructure at priority sites	a. Utility regulators could approve make-ready programs to support the costs of preparing and building publicly accessible MHDV corridor charging sites. b. State and federal agencies could develop financial incentive programs to help reduce the cost of site construction. c. States and utility regulators could allow utilities and developers to future-proof site-level infrastructure (e.g., trenching for conduit) to accommodate anticipated future load. d. The federal government could consider modifying the prohibition on commercial activity in the Interstate System rights-of-way in 23 U.S.C. Sec 111(a) to enable corridor charging at rest areas. e. Local governments could use NFCCP load forecasts to evaluate future truck parking demand.

Table ES-2: Key recommendations for industry stakeholders

Stakeholders	Recommendations
1. Utilities	a. Identify grid upgrade needs at selected sites and develop solutions to meet projected load requirements. b. Develop spot load forecasts, create financing structures and cost allocation for grid improvements. c. Consider implementing EV flexible connection pilots or standing up non-wires alternative offerings to leverage customer-owned flexible resources to help manage the related grid need.
2. Fleets	a. Assess existing travel patterns and evaluate electrification plans along routes that overlap with selected sites. b. Coordinate with utilities and infrastructure providers on site development timelines to align with truck procurement and deployment schedules. c. Share long-term plans with utilities to help them understand anticipated electric loads.
3. Infrastructure Providers	a. Prioritize sites for infrastructure development based on power demand, expected utilization, land availability, agreements with site owners, and coordination with utilities to align on grid upgrade process, timelines, and financial implications. b. Align site development with ongoing requests for proposals. c. Consider on-site storage solutions to manage peak demand and future-proof sites to accommodate high-powered chargers in line with the Megawatt Charging System. d. Coordinate with financiers to access innovative financing mechanisms including utilization-tied loan repayment schemes.

The Northeast states have a unique opportunity to take leadership in deploying truck charging along corridors and near key ports, paving the way for widespread electrification of the freight sector. With a history of collaboration on transport decarbonization, these states can maintain this momentum by channeling coordinated efforts toward developing a robust and reliable corridor infrastructure network. The NFCCP aims to catalyze immediate action by states, utilities, infrastructure providers, and fleets. And learnings facilitated through this plan can serve as the springboard for scaled deployment of electric MHDVs and associated infrastructure.



Introduction

Introduction

Context of the study

The Department of Energy’s (DOE’s) Vehicle Technologies Office (VTO) launched a high-impact opportunity aimed at developing essential infrastructure along heavily trafficked freight corridors across the majority of the United States.² The \$7.4 million in funding supports seven projects focused on infrastructure development across corridors in the Northeast, the Southwest, Northern and Southern California, the Eastern Seaboard, and the Midwest.³ This study focuses on the Northeast Freight Corridor Charging Plan (NFCCP), which targets infrastructure development along high-traffic highways in Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, Vermont, and portions of New Jersey and Pennsylvania used to transport freight to and from east–west and locations north of the Port of New York and New Jersey.¹ The two-year effort is led by National Grid, along with support from other implementing partners (see Table 1).

Table 1. NFCCP implementation partners

Organization	Type	Role
National Grid	Utility	Project lead, administering all activities under the grant and supporting engagement with other utilities in the Northeast region
RMI	Nongovernmental organization	Supporting load forecast analysis and roadmap creation
Northeast States for Coordinated Air Use Management (NESCAUM)	Nongovernmental organization	Supporting engagement with the nine states in the Northeast region and roadmap creation
Clean Communities of Central New York	DOE-supported coalition	Supporting engagement with local communities around local site impacts
National Renewable Energy Lab (NREL)	National lab	Supporting load analysis for the Port of New York and New Jersey
CALSTART	Nongovernmental organization	Coordination partner for knowledge sharing with a similar project along the East Coast and supporting engagement with industry stakeholders

i A complementary VTO-funded study in the Eastern United States targets infrastructure development along the I-95 freight corridor from Georgia to New Jersey, including interstate routes in New Jersey and Pennsylvania south of the Port of New York and New Jersey.

In addition, the project involved coordination and participation from various utility, state, and industry advisory committees. These committees provided feedback and input on the NFCCP and its policy recommendations to advance the planning and development of a freight corridor charging network in the Northeast.

Importance of corridor charging for medium- and heavy-duty vehicles in the Northeast

Electric medium- and heavy-duty vehicle (MHDV) adoption is accelerating in the United States.ⁱⁱ Electric MHDVs accounted for 7.4% of total MHDV sales in 2024, up from just 1.8% of sales in 2022.^{4,iii} To ensure continued adoption, a robust, accessible, and widespread infrastructure network is critical.

To date, early deployments have relied on depot-based charging with return-to-base operations. However, corridor-based charging equipped with high-powered chargers is equally essential to fully support the electric MHDV transition in the United States. Corridor charging complements depot charging by supporting trucks with limited downtime and enabling travel for longer distances within states and across state borders. Both strategies are equally important, but the focus of this study is corridor-based charging.

MHDVs that carry freight along the corridors are crucial for economic development but contribute significantly to criteria pollutants like particulate matter and nitrogen dioxide. Electrifying MHDVs along these corridors is one of the most impactful strategies to reduce pollution and instill confidence in stakeholders to embrace electrification.

The Northeast has a unique opportunity to take leadership in the development of necessary infrastructure along key corridors to support electrification of MHDVs for the following reasons:

- **Highly concentrated nature of truck travel:** The Northeast highways comprise just 8% of the US National Highway Freight Network but experience highly concentrated freight activity.⁵ A significant share of freight tonnage originating in the nine Northeast states ends within the region.⁶ State pairs of New Jersey–Pennsylvania, New Jersey–New York, and New York–Pennsylvania, rank first, second, and fourth, respectively, in terms of tonnage moved by trucks among state pairs in the United States.⁷ This dense, intraregional movement supports strong vehicle and infrastructure utilization, reduces investment risk, and helps lower infrastructure development costs.

- **Presence of key ports:** Ports are the gateway for goods moving in and out of the country and rely on frequent and high truck travel to facilitate timely movement of those goods. The Northeast is home to four of the top 25 US ports by container traffic, including the Port of New York and New Jersey, which are well connected to major truck corridors.⁸ The port has launched a Net-Zero Roadmap and is preparing a strategy to accelerate electric MHDV adoption.⁹ Aligning infrastructure development at ports and connected corridors will be an essential step toward trucking decarbonization in the Northeast.
- **Regional support for truck electrification:** Eight Northeast states have signed the Multi-State Medium- and Heavy-Duty Zero-Emission Vehicle Memorandum of Understanding, committing to work together to make 100% of all new MHDV sales zero-emissions vehicles (ZEVs) by 2050.¹⁰ In addition, a number of states in the Northeast are implementing regulations to increase the availability of zero-emissions trucks.¹¹ The Northeast states are also developing and implementing statewide transportation electrification plans and complementary policies, and collaborating through different forums including the following:
 - Rhode Island has developed the *2022 Freight and Goods Movement Plan* to identify potential electric MHDV charging needs and ideal locations.¹²
 - Maine's *Clean Transportation Roadmap for Medium- and Heavy-Duty Vehicles* charts a path to decarbonize within and through the state.¹³
 - The New York's State Public Service Commission — in July 2020 and through a modification in 2023 — approved more than \$1.2 billion in EV charging programs (Case 18-E-0138), with \$15 million for medium- and heavy-duty clean vehicle innovation grants, and \$58 million for medium- and heavy-duty make-ready charging infrastructure.¹⁴ Additionally, the commission opened a new proceeding (Case 23-E-0070) to address barriers to medium- and heavy-duty EV charging infrastructure with the goal of identifying areas where grid upgrades may be required to enable timely trucking electrification.

ii For the purposes of this report, “electric” technology includes battery electric vehicles and hydrogen fuel cell electric vehicles.

iii MHDV sales figures include all Class 2b-8 vehicles.

- Massachusetts Offers Rebates for Electric Vehicles (MOR EV), the New Jersey Zero-Emission Incentive Program (NJ ZIP) and the New York Truck Voucher Incentive Program (NYTVIP) provide financial incentives for the purchase and lease of electric MHDVs.¹⁵
- New Jersey's Regional Greenhouse Gas Initiative Medium- and Heavy-Duty Vehicle Charging Program provides rebates up to \$175,000 and \$225,000 for the installation of privately and publicly accessible DC fast chargers (150 kilowatts [kW] or greater), respectively, to support medium- and heavy-duty EV fleets.¹⁶
- Along with Delaware and Maryland, Connecticut and New Jersey are implementing a \$250 million federal grant from the Environmental Protection Agency (EPA) to support the planning and development of 24 truck charging sites along the I-95 corridor and adjoining freight corridors near the Port of New York and New Jersey. In total, the project aims to install more than 400 fast-charging ports to support freight electrification in the Northeast and mid-Atlantic states.¹⁷
- Massachusetts's Mass Fleet Advisor and New Jersey's Fleet Advisor are among the fleet advisory services programs providing comprehensive technical assistance and guidance to fleets interested in transitioning to EVs. Services include helping fleet operators understand the technology, total cost of ownership and potential fuel savings, EV models to match the fleet's needs, rebates and funding opportunities, utility resources, and charging solutions.¹⁸
- The Northeast states participate in several ongoing multistate forums that foster peer-to-peer learning, collaboration, and coordination on transportation electrification initiatives.^{iv} Discussions across these forums cover topics such as vehicle purchase and infrastructure incentives, innovative funding and financing strategies for charging infrastructure deployment, and new business models like trucking-as-a-service and charging-as-a-service. These forums will continue to catalyze and support state leadership in the Northeast.

Overall, the Northeast states can be the front-runners in developing an early network of supporting infrastructure to enable electric MHDVs and serve as an example for other regions to direct action and investments toward corridor electrification.

Scope of the NFCCP

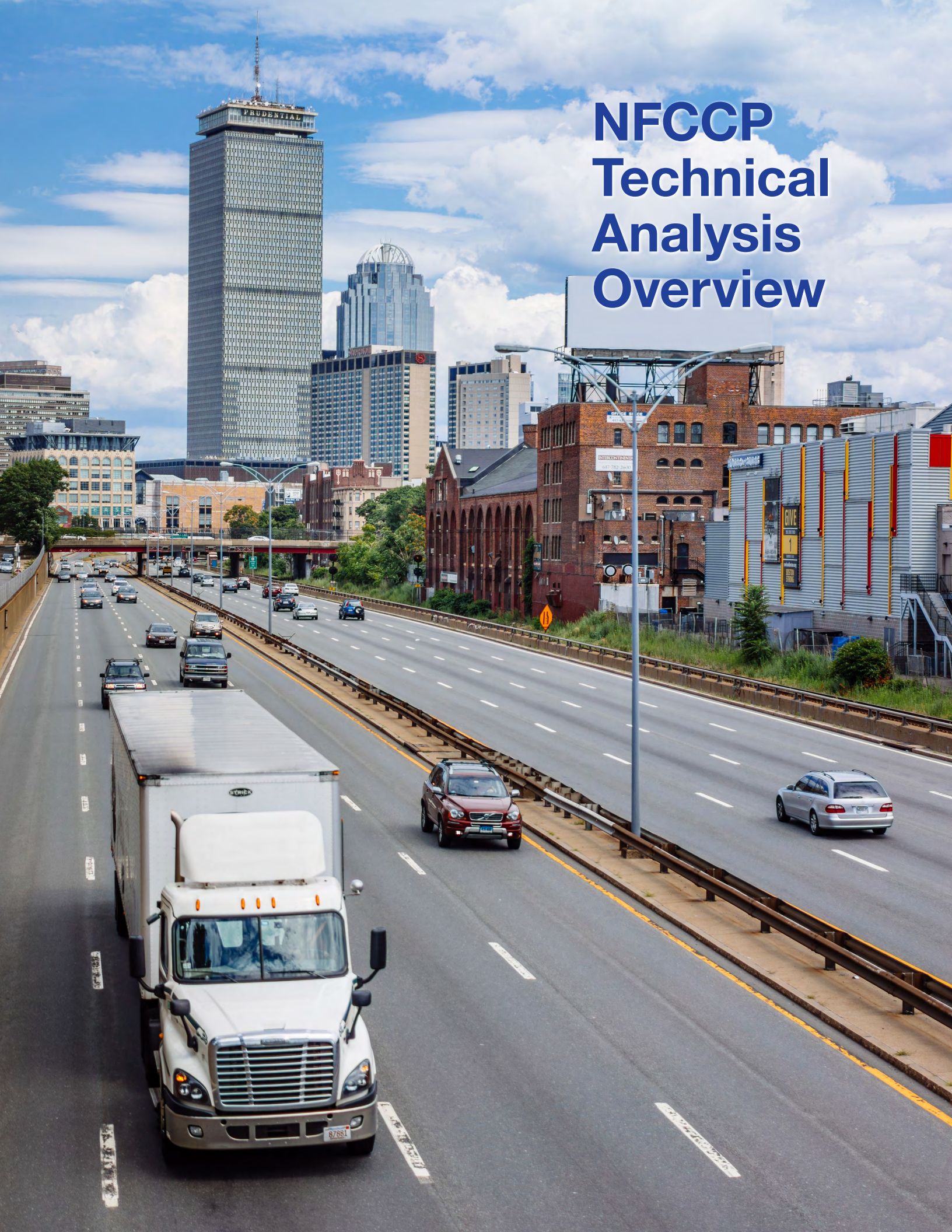
The NFCCP is designed to catalyze the development of a minimum viable corridor infrastructure network across the Northeast United States. The viable corridor will allow electric medium- and heavy-duty trucks to travel through the region knowing that at a minimum there will be one charging facility within 100 miles. The network prioritizes sites that can be built cost-effectively and provide coverage throughout the Northeast and that can be scaled over time to support widespread electric MHDV adoption. The plan analyzed 140 potential sites for infrastructure development along eight key highways (I-80, I-81, I-84, I-87, I-90, I-91, I-93, I-95) in the nine states (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont). Based on factors such as projected power demand from electric trucks, availability and accessibility of truck parking, air pollution impact, required investments, and utility plans for grid upgrades, 39 sites were identified as priority locations well suited for the initial stage of corridor development. The NFCCP provides detailed insights into power demand profiles and load curves at these sites, and offers recommendations for the public and private sectors to accelerate site activation. It also highlights the importance of integrating infrastructure planning at ports and along corridors. Ports like the Port of New York and New Jersey are advancing plans to reduce their Scope 3 emissions by facilitating adoption of electric drayage vehicles by third-party operators and port tenants, which utilize charging infrastructure along adjacent corridors.^v

The focus of the NFCCP is facilitating the development of corridor-based charging for MHDVs, and it does not consider development of overnight charging sites at depots.

iv The Multi-State Zero Emission Vehicle Task Force and the Northeast and Mid-Atlantic Clean Vehicles Workgroup are examples of such forums.

v Scope 3 emissions are greenhouse gas emissions that result from assets not directly owned by an organization, but that are upstream or downstream of the value chain of the organization. Because port authorities do not own any trucks, emissions from the drayage fleet are considered Scope 3 for them.

NFCCP Technical Analysis Overview



NFCCP

Technical Analysis Overview

Overarching approach

The primary objective of the plan was to identify top sites for corridor infrastructure development and to highlight power demand projections at these locations through the year 2050. The analysis began by evaluating load forecasts for power demand across an initial set of 140 sites using truck telematics data. In addition to the load forecasts, three other criteria — based on input from states, utilities, and local communities regarding public health — were used to evaluate each site. This comprehensive assessment resulted in a final list of 39 priority sites for further analysis.

Load forecasting modeling method overview

The assessment of charging demands for MHDVs was conducted using a methodology based on telematics data from Geotab, a company specializing in telematics hardware and software for motor vehicles. This approach assumed that the future driving behavior of electric MHDVs can be reasonably predicted from the current driving patterns of their internal combustion engine (ICE) counterparts.

The analysis focused on four main segments, defined by the combination of two vehicle weight classes (medium and heavy duty) and two vehicle activity types (return-to-base and long-haul). The weight classes determined characteristics such as fuel efficiency, while the activity types determined driving behavior patterns, including distance traveled and stop durations.

This study includes two primary powertrain types: battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs). The analysis spans the projection period from 2024 to 2050. Additionally, to account for seasonal variation, we assessed the impact of cold weather on battery efficiency and adjusted the calculations to reflect cold weather-specific power demands.

Future scenario coefficients in the form of daily coefficients for the whole projection period, reflecting trends in vehicle population growth, powertrain distribution, and public charger usage, were applied

to both BEVs and FCEVs. These coefficients were integrated with Geotab's stop summary statistics, adjusting for the proportion of vehicle stops anticipated to utilize public charging. Each resulting stop at the study's site locations was then assumed to correspond to a charging event.

The detailed methodology can be found in *Appendix A*.

Input assumptions

The following simplifying assumptions directionally informed our methodology, results, and conclusions:

1. Current behavior of ICE vehicles informs future power load demands for electric MHDVs

Our analysis assumed that electric MHDVs will operate similar to ICE vehicles today, using observed ICE vehicle behavior as the basis. This approach, therefore, assumed that EV supply equipment will be deployed to meet charging demand at all sites that currently draw MHDV stops. We do not know enough about how the change from ICE to electric will impact freight operations, so we kept driving behavior the same.

2. Most electric MHDVs have a battery electric powertrain

The projections assumed a predominant share of BEVs in the future stock of electric MHDVs. However, FCEVs may also play an increasing role in the future population of electric MHDVs, especially among heavy-duty vehicles.

3. Each weekday/weekend day has an identical distribution of expected stop times, trip distances, and stop durations

It is possible that highway traffic and electric demand will tend to be higher during certain weeks and days of the year, such as around holidays. This assessment did not explicitly account for these variations and considered average needs across all weekdays and weekend days of the year. As such, where the analysis considered annual peak demand, it did so for the peak of the model days and was not adjusted for holiday traffic.

Scenario design

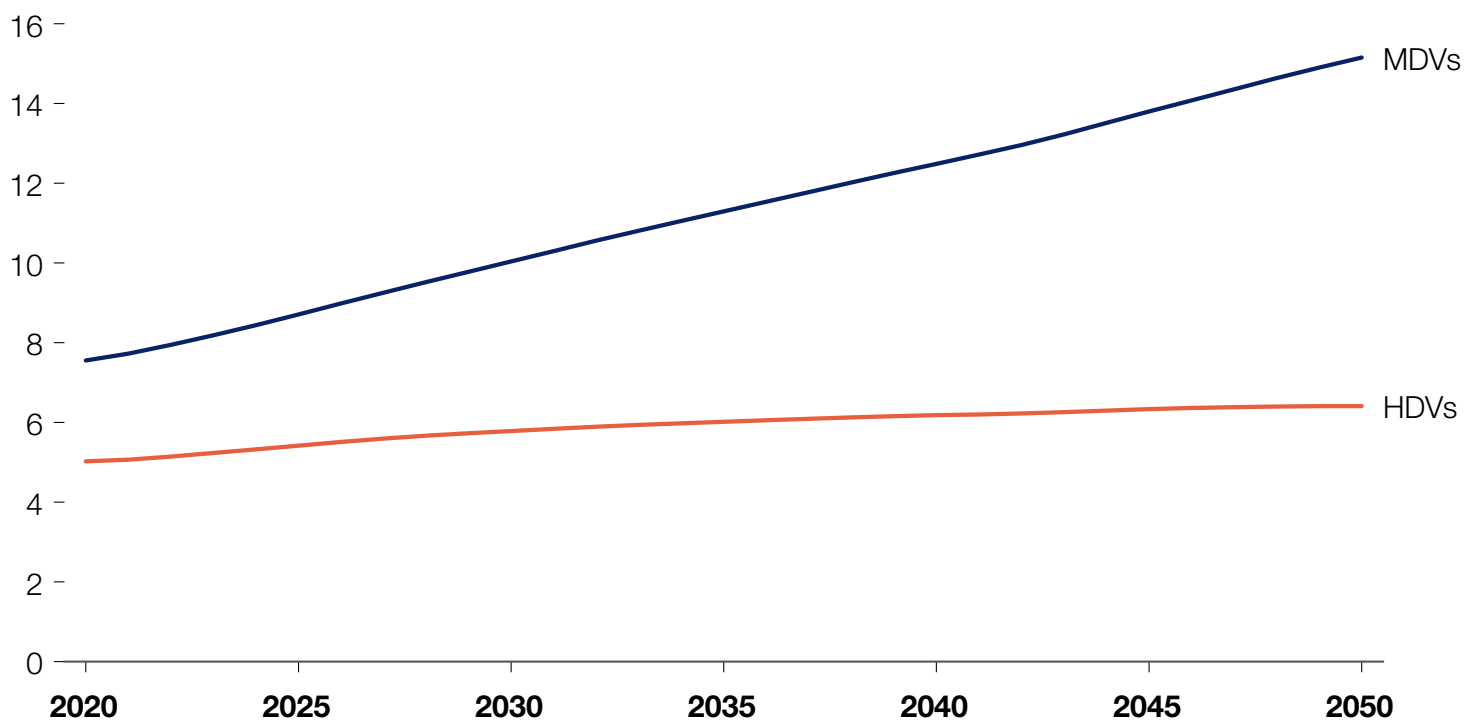
The scenario development is based on four key input assumptions that represent projections for MHDV population growth, electrification trends, adoption of electric powertrains, and utilization of public chargers. These inputs are outlined below.

Truck population growth

Projections from the US Energy Information Administration's *Annual Energy Outlook* indicate continued growth in commerce that drives an increased truck population,^{vi} leading to substantial growth in MHDVs across various weight classes over 30 years (see Figure 1). These projections form the foundation for estimating future truck population trends.

Figure 1. Population growth of MHDVs over the projection period

Truck Population (Millions)



^{vi} To maximize compatibility with findings of National Grid's 2022 electric highways study (<https://www.nationalgrid.com/us/EVhighway>), we used 2021 projections from the US Energy Information Administration (*Annual Energy Outlook 2022*, <https://www.eia.gov/outlooks/aeo/>).

Electric MHDV adoption

Our scenario assumes a transition to around 30% electric MHDV sales by 2030 and 100% by 2045 (see Figure 2). These proportions are not differentiated

by vehicle weight class, activity type, or electric powertrain. Instead, they represent the overall trend of increasing electric truck sales alongside the gradual decline in ICE truck registrations.

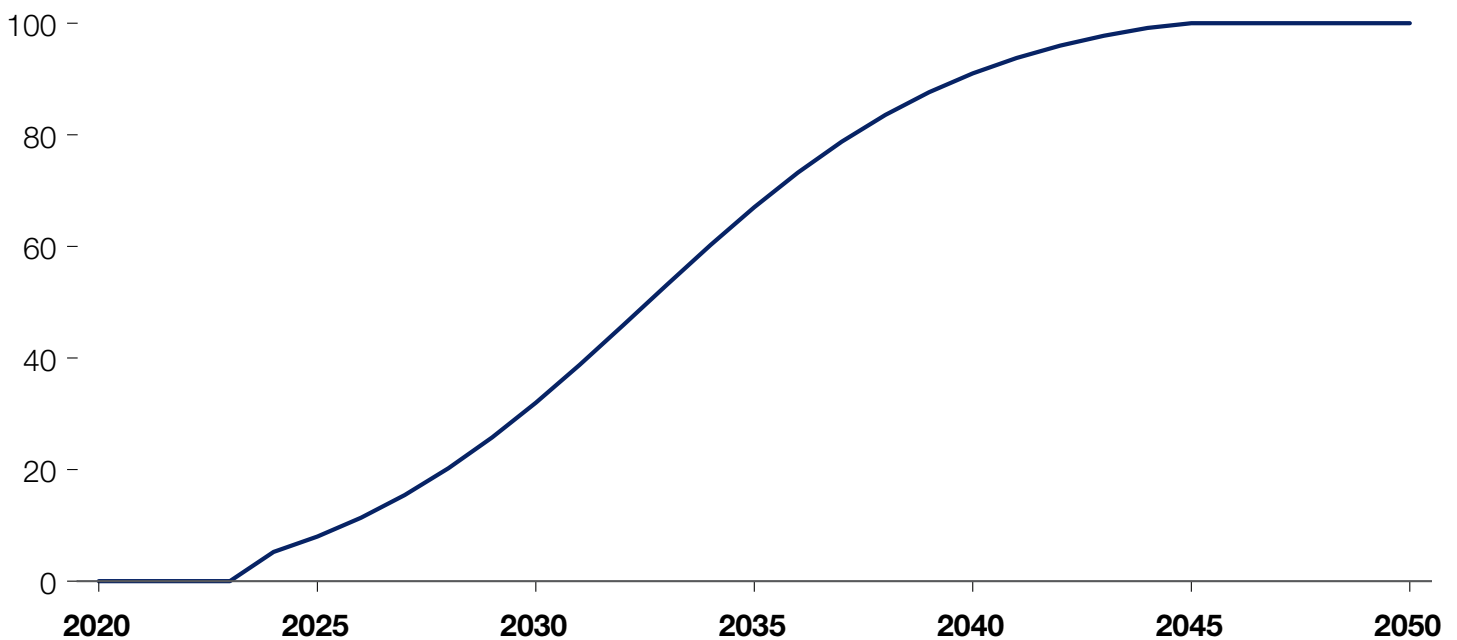
Box 1: What if the pace or scale of electric truck adoption is different from what is assumed in this study?

This study assumes achieving 100% electric sales of MHDVs by 2045. While acknowledging that the actual rate and scale of electric adoption may diverge from current assumptions, the analysis identifies a set of priority sites that need proactive planning to serve as the foundational framework for a viable charging network in the Northeast. To meet the high power charging needs of MHDVs, the

study evaluates scenarios incorporating megawatt (MW)—capable direct current (DC) chargers, especially 350 kW and 1 MW configurations, with the 1 MW option resulting in even greater power demand. Anticipated site-level power demands in similar studies for MHDV charging hubs range from 3 to 10 MW during the 2030–35 period, consistent with model projections developed in this analysis.¹⁹

Figure 2. Assumption of electric MHDV sales over the projection period

% Electric MHDV Sales



Powertrain share

Different committees (industry, state, and utility) provided input assumptions featuring the predominant purchase and adoption of BEVs. However, the scenario also accounts for increasing adoption of FCEVs over time, depending on vehicle type and activity. FCEV adoption varies by segment, ranging from 5% for medium-duty vehicles in 2050 to 21% for heavy-duty

vehicles involved in long-haul vocations. This is in line with recent studies that highlight BEVs having a higher share than FCEVs due to superior economics across most segments and activity type.²⁰ Table 2 reflects assumptions about powertrain composition of electric MHDVs, pointing to dominant shares of BEVs, but also considerable shares of FCEVs, particularly in long-haul heavy-duty vehicles.

Table 2. Input assumptions about electric powertrain composition

Vehicle Type	Vehicle Activity	% BEV Share (2030)	% BEV Share (2050)	% FCEV Share (2030)	% FCEV Share (2050)
Medium-Duty	Return-to-Base	100	95	0	5
Medium-Duty	Long-Haul	100	95	0	5
Heavy-Duty	Return-to-Base	91	86	9	14
Heavy-Duty	Long-Haul	87	79	13	21

By applying our assumptions on adoption rates and powertrain shares to vehicle stock projections and using a 12-year average turnover value, the composition of MHDVs shifts from being predominantly ICE vehicles to BEVs by 2050 (see

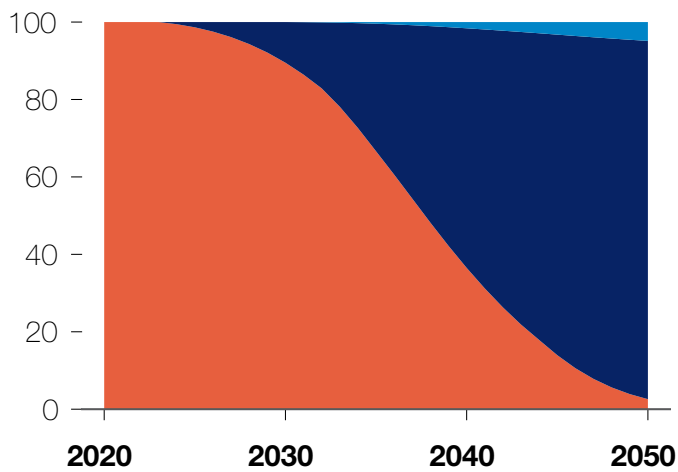
Figure 3). Additionally, due to a moderately significant share of FCEVs projected for heavy-duty vehicles, a considerable portion of the heavy-duty vehicle stock is also expected to transition to FCEVs.

Figure 3. Projections of stock composition of MHDVs by vehicle type, activity, and powertrain

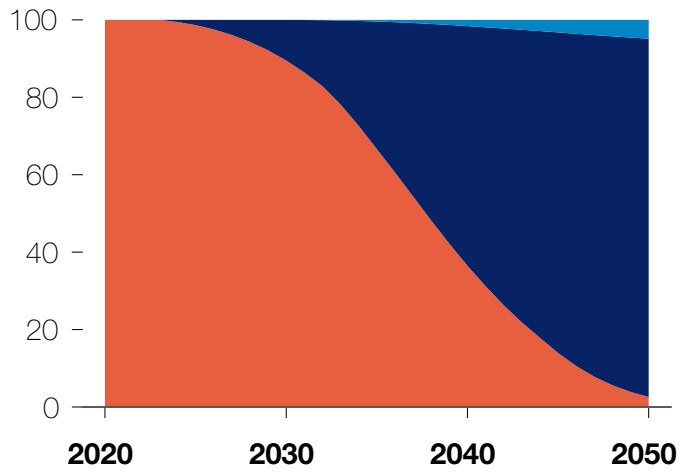
ICE BEV FCEV

% Population

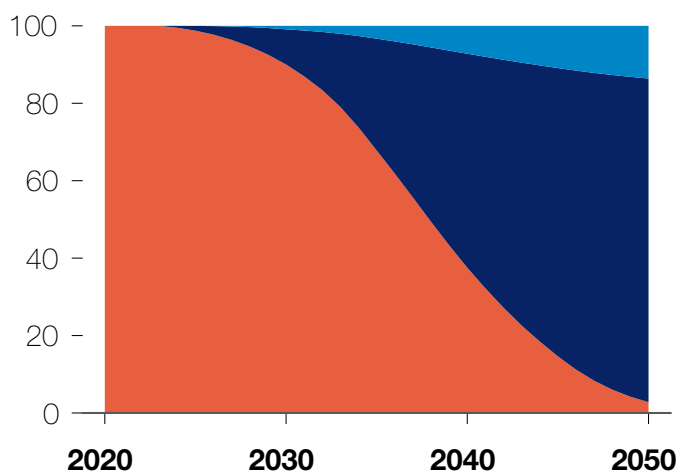
Medium-Duty Vehicle, Return-to-Base



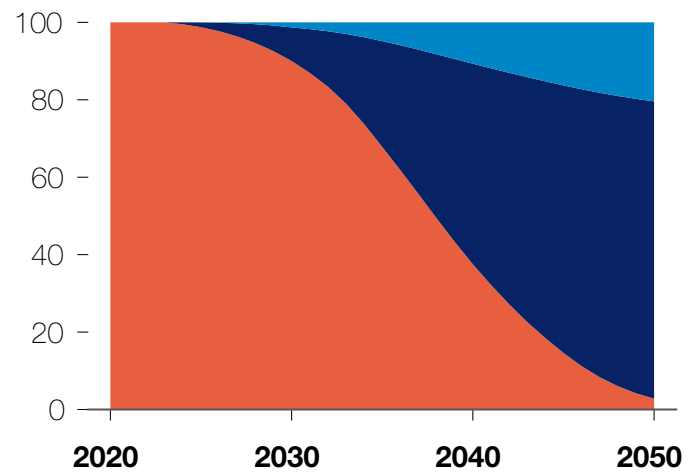
Medium-Duty Vehicle, Long-Haul



Heavy-Duty Vehicle, Return-to-Base



Heavy-Duty Vehicle, Long-Haul



Public charger utilization

The assumptions recognize that not every stop at highway plazas will result in a charging event to account for other strategies such as managed depot charging during off-peak hours. Public charger utilization — the rate at which vehicle stops lead to charging — vary by vehicle type and activity, from 18%

in 2050 for medium-duty vehicles engaged in return-to-base operations to 75% for heavy-duty vehicles in long-haul vocations.

Table 3 presents the input assumptions about public charger utilization across the four segments of our analysis.

Table 3. Input assumptions about electric powertrain composition and public charger utilization

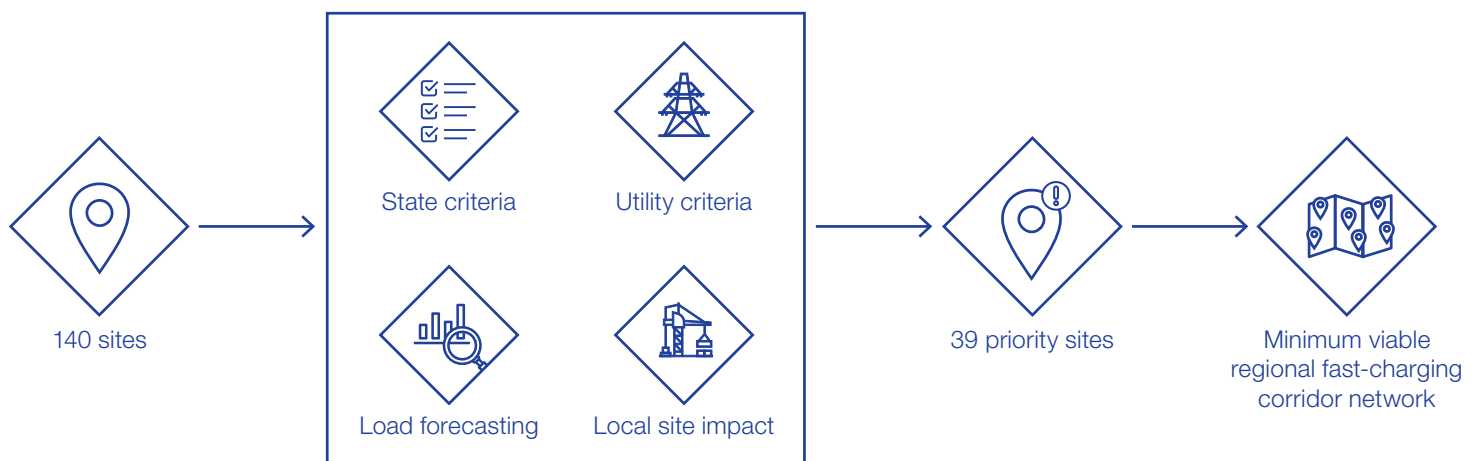
Vehicle Type	Vehicle Activity	% Public Charger Use (2030)	% Public Charger Use (2050)
Medium-Duty	Return-to-Base	10	18
Medium-Duty	Long-Haul	33	39
Heavy-Duty	Return-to-Base	10	19
Heavy-Duty	Long-Haul	50	75

The detailed methodology to calculate final power demand figures can be found in *Appendix A*.

Site selection prioritization

The study analyzed 140 sites across different criteria to select the 39 priority sites for corridor charging hubs in the Northeast (see Figure 4).

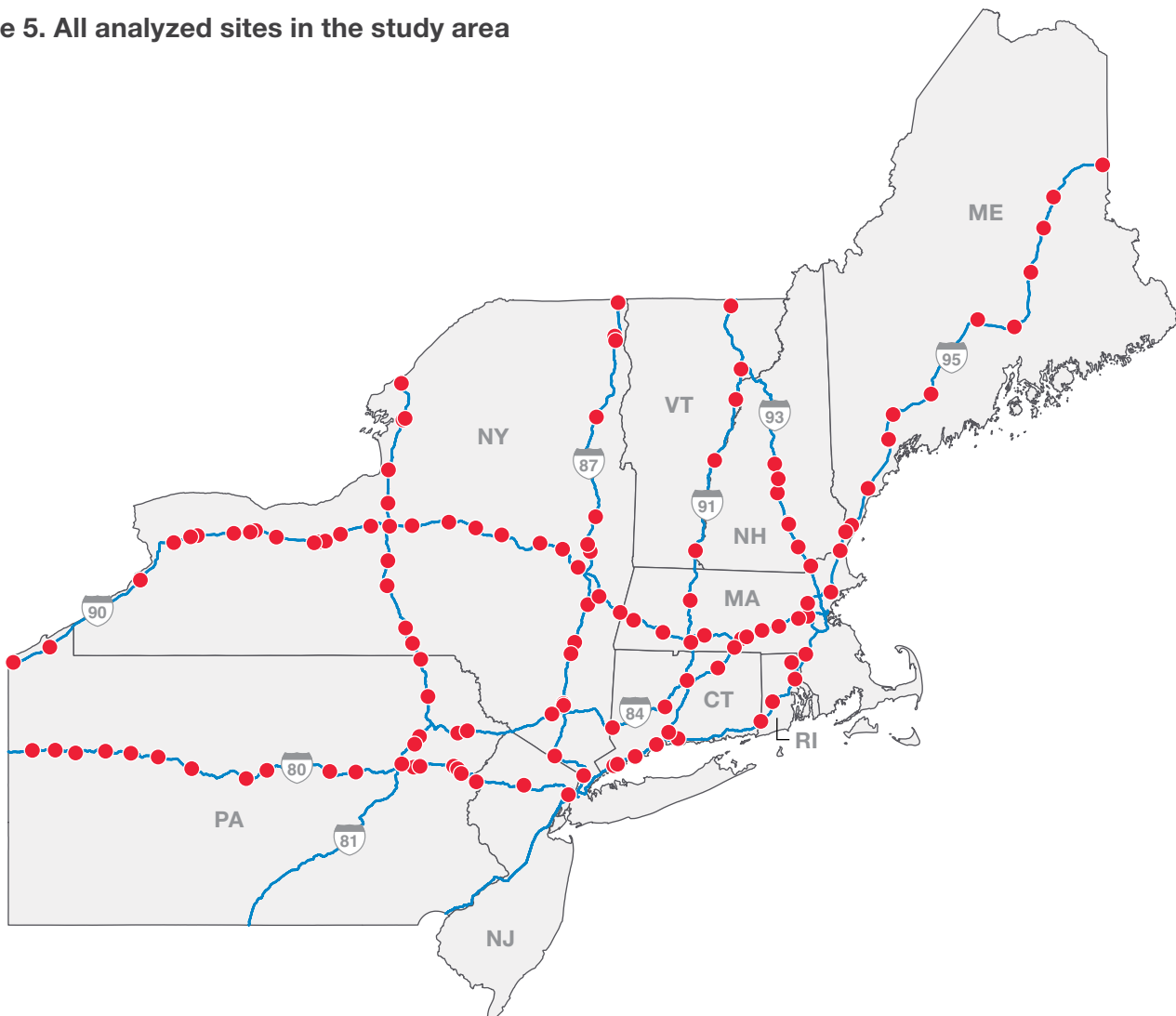
Figure 4. Process flow for site selection



The 140 sites were initially selected based on inputs provided by state energy, environment, and transportation agencies and utilities serving the Northeast region. Site selection focused on locations spaced approximately 30–50 miles apart and situated within 1 mile of a highway exit, aligning with the Federal Highway Administration’s National Electric Vehicle Infrastructure Formula Program Guidance.²¹ The

selection process prioritized existing service plazas and established truck stops, followed by additional off-highway sites with on-site commercial services. Such amenities improve the driver experience during charging sessions and encourage greater vehicle turnout. Figure 5 shows a map of all sites analyzed in this study.

Figure 5. All analyzed sites in the study area



These sites were evaluated against the following four criteria:

- 1. State criteria:** Truck parking availability, presence of nearby fleets, and proximity of sites to highways and additional consideration of investment for grid upgrades by utilities
- 2. Utilities criteria:** Investment needed for grid upgrades to service 2030 loads and existing utility plans near site area

- 3. Local site impact:** Level of air pollution, asthma rates around sites, and economic indicators

- 4. Load forecasting criteria:** Load requirements by 2030 and 2050 to meet site charging needs

This section dives deeper into the methodology of the site selection approach, specifically for each scoring criterion.

State criteria

The state criteria for site selection were developed based on inputs from the State Agency Advisory Committee (SAAC). The committee members included representatives of multiple agencies in each of the nine states in the study area, such as state transportation, environment, and energy agencies, and one statewide planning agency.

The committee members outlined four key criteria for site selection:

- 1. Site has physical space to accommodate truck charging.** This criterion was used to assess which sites have relatively more space to add additional parking spaces for electric MHDV charging, recognizing that (1) it will be easier to build pull-through spaces and chargers at locations where parking is less constrained, at least in the short term; and (2) site hosts and truckers will be more likely to support charger installation if parking is not already in short supply for conventionally fueled trucks.
- 2. Site is close to local trucking fleets that could benefit from/use chargers.** This criterion was used to assess which sites might be best positioned, based on their geographic location (not their site attributes), to meet charging needs not only for long-haul fleets but also for local fleets domiciled or traveling freight routes near the site. For example, sites located near fleet depots, major warehouse distribution hubs, intermodal facilities, and key secondary freight corridors were scored highly based on this criterion.
- 3. Site is accessible, serving both directions of highway traffic and close to a highway exit.** This composite criterion was used to assess how accessible and convenient sites would be for electric MHDVs traveling highways. It recognized that although the 140 sites to be ranked were almost all existing rest areas and truck stops within 1 mile of an exit, the difference between 0.5 miles and 1 mile could significantly affect the convenience of a charging location. Guidance for applying this criterion suggested measuring distance from the beginning of exit ramps.
- 4. Cost to electrify.** This criterion, which is based on the Utility Advisory Committee's (UAC's) metric of investment requirement for grid upgrades at sites, was highly recommended by committee members. More details of this criterion are covered under the *Utilities criteria* section.

Once these criteria were finalized, weighted scoring was used to produce a total score for each of the 140 sites based on the committee's criteria. Details of the scoring approach are given in *Appendix C*.

Utilities criteria

The utilities criteria were selected by the UAC, which has members from 11 utilities serving electrification needs in the nine states.

The criteria used by the UAC included:

- 1. Level of investment required to meet loads at each site:** Utilities evaluated costs to meet 2030 load forecasts for each site developed as part of this study. The 2030 loads were assessed to understand upgrade requirements, which can include those limited to the local distribution system, any needs for new substations, or needs for sub-transmission- or transmission-level support. The costs were accordingly estimated to meet the upgrade needs and categorized as low, medium, or high investment required.
- 2. Near-, medium-, and long-term investment plans around site areas:** Utilities evaluated their existing upgrade plans around areas that include sites under contemplation in the study. If the site is part of the substation that might undergo upgrades under existing plans, this can help lower costs. The investment plans were evaluated for near-term (less than 5 years), medium-term (5–10 years), and long-term (more than 10 years) implementation times.

Based on these criteria, utilities provided inputs for scoring to get the total utilities criteria score for each site. More details on the scoring approach are given in *Appendix C*.

Local site impact criteria

The local site impact committee engaged with regional and local groups to share information about the 140 sites in the nine states. Based on more than 140 responses from surveys through different outreach meetings and local communities, the following criteria were finalized:

1. **Health**, including analyzing the existing average level of asthma rates within a 5-mile radius of the potential site locations.
2. **Air quality**, including analyzing average diesel particulate matter within a 5-mile radius of the sites.
3. **Economic indicators**, including analyzing those indicators in the census tract where each site is located.

These criteria were assigned different weights to get the final score; see *Appendix C* for more details.

Load criteria

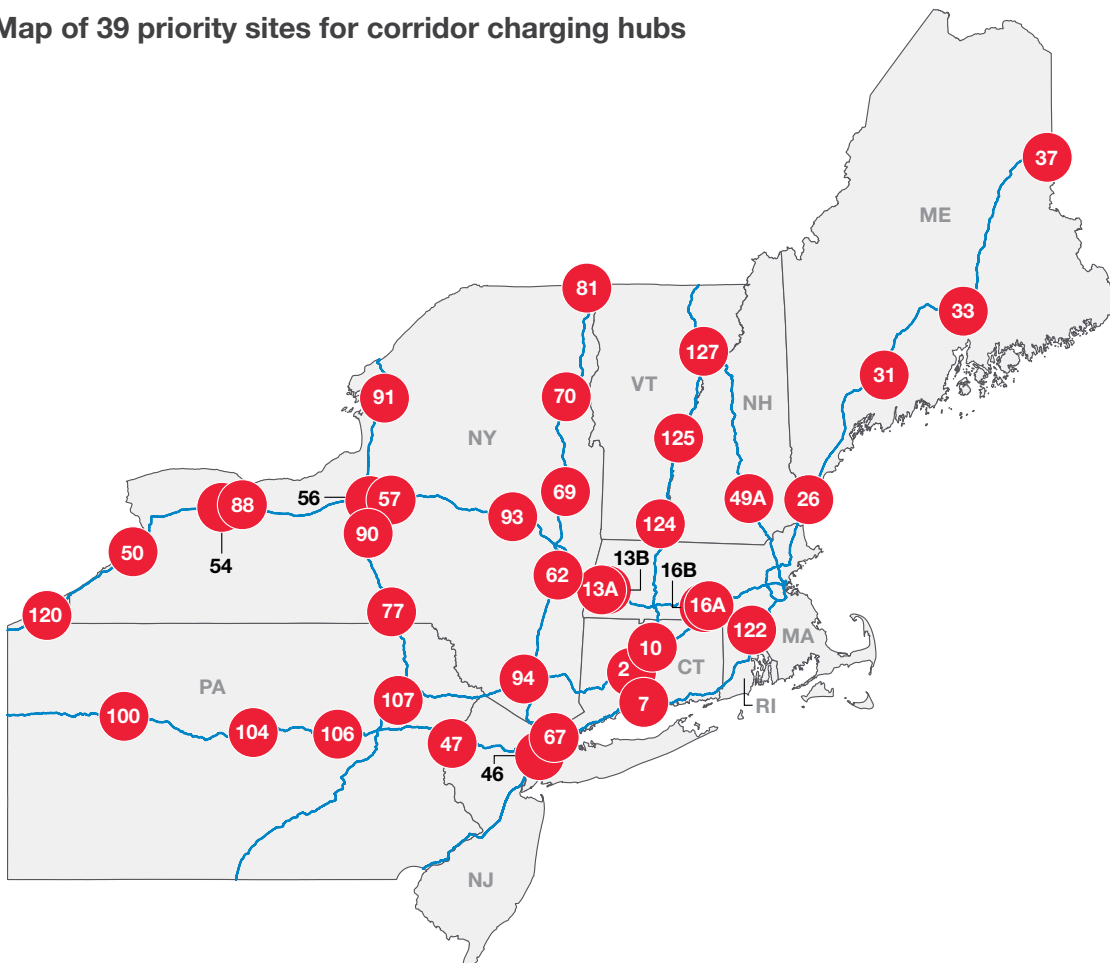
The load criteria included peak demand estimates for each site based on the load forecasting methodology described above and in *Appendix A*. Peak demand was estimated for each site for 2030 and 2050. Equal weighting was given to 2030 and 2050 loads to estimate overall load score for each site. More details on scoring are in *Appendix C*.

Selection of top 39 priority sites for corridor charging hubs

Each criterion was scored out of 25 maximum points, and for each site the scores from the four criteria were added up for the final site score. Sites were ranked from highest to lowest total score and final site selections were based on those scores and the ability to cover the Northeast corridor network feasibly with at least one site per 100 miles.

Based on this diverse and extensive approach, the 39 priority sites were selected, forming the backbone for the NFCCP (see Figure 6). Specific site locations are not being shared in this roadmap. Sites are undergoing further analysis by states and utilities. Sites are shown at their approximate location for illustrative purposes in Figure 6 and throughout the roadmap.

Figure 6: Map of 39 priority sites for corridor charging hubs



Port of New York and New Jersey analysis methodology overview

The assessment of charging demands for a drayage electric fleet was conducted using National Renewable Energy Lab's (NREL's) Electric Vehicle Infrastructure Projection Tool (EVI-Pro) along with ports statistics from the Port Authority of New York and New Jersey (PANYNJ), telematics data from Geotab, and parcel-level land-use data from Lightbox.²² This approach follows the same assumptions from the general corridor freight modeling in terms of the electric MHDV adoption rate and stock turnover. However, additional factors — such as fleet growth rates, daily truck travel itineraries, prioritization of electric MHDV adoption, and charging load profiles — were modeled specifically to reflect the characteristics of PANYNJ's drayage fleet, as detailed below.

Drayage truck population growth by powertrains

The analysis revealed that approximately 75% of daily

PANYNJ drayage truck itineraries cover distances of 150 miles or less, while around 20% span 400 to 600 miles. Drayage truck population growth was estimated based on PANYNJ's container volume projections in the Port Master Plan 2050.²³ High and low container volume projection were used to define the upper and lower bounds of growth, corresponding to annual port traffic growth rates of 3.4% and 2.1%, respectively, according to the port's master plan.

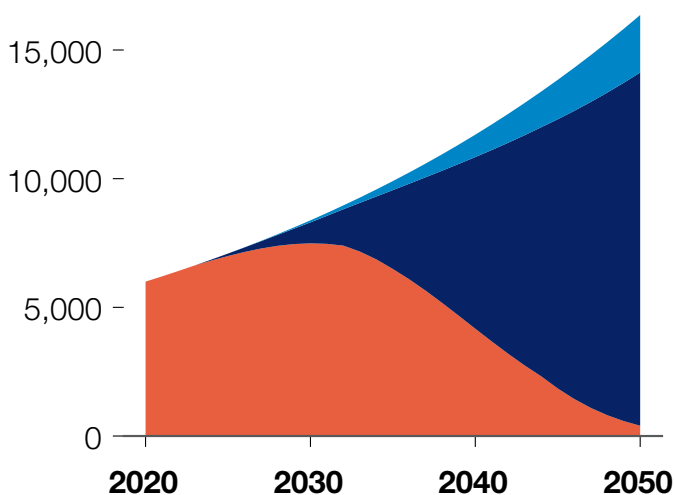
The drayage fleet evolution follows the same electric MHDV sales trajectory and truck fleet turnover rate as described in the *Scenario design* section of this report. For the purposes of this study, the drayage analysis focuses solely on BEV fleet adoption and associated charging demand. With the same vehicle registration modeling used for the general freight, the drayage BEV fleet reaches 13,725 vehicles in 2050 using the high port annual growth rate and 9,376 vehicles with the lower port projection. The population of drayage fleet by power train for the two growth scenarios is presented in Figure 7.

Figure 7. Drayage fleet size projection by powertrain for (a) high port growth projection and (b) low port growth projection

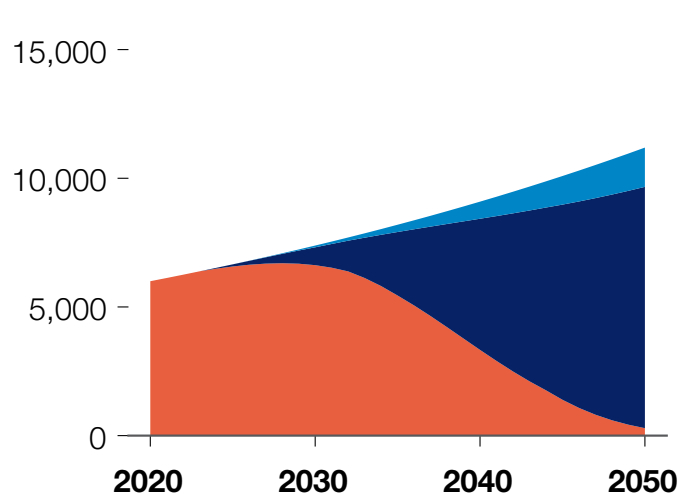
ICE BEV FCEV

Projected Size

a.



b.



Daily drayage truck travel itinerary estimations

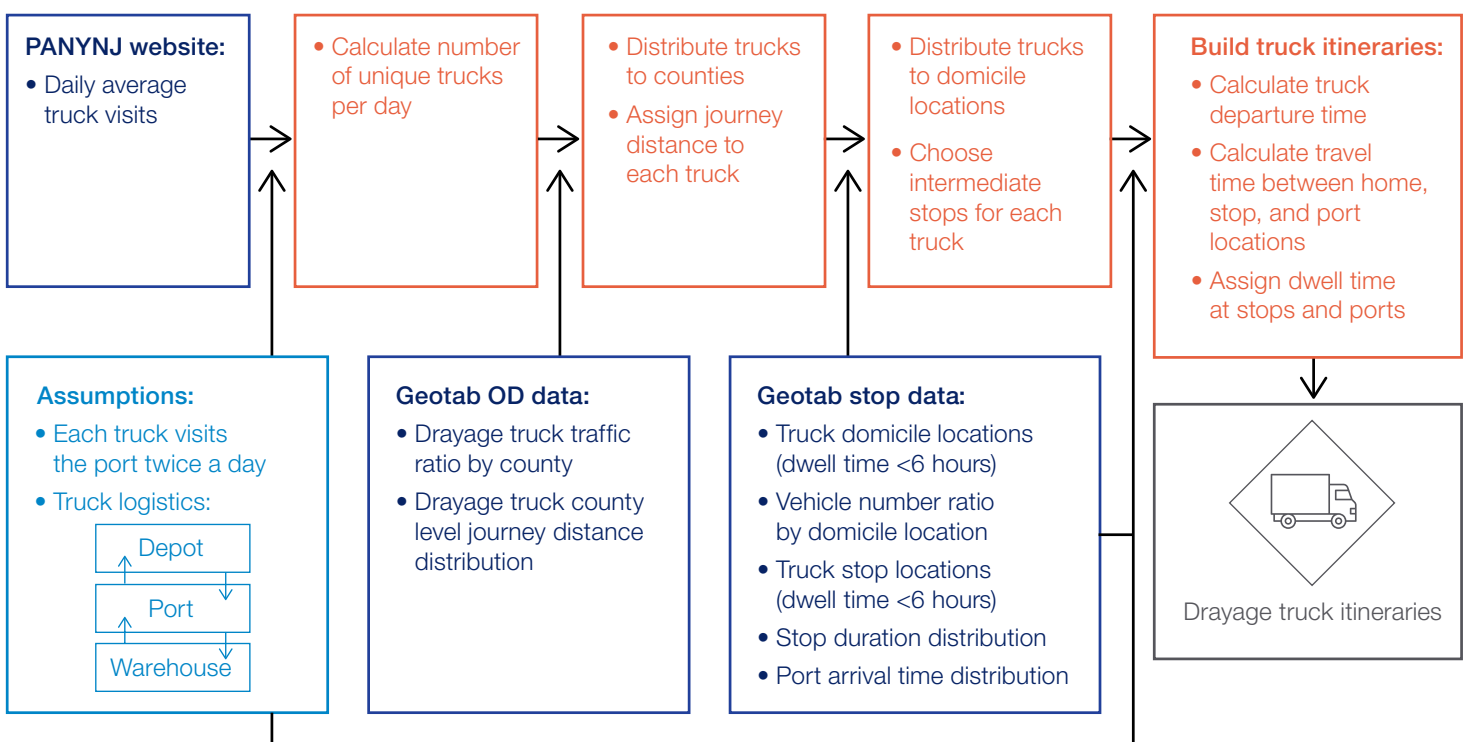
A key component of this analysis involved generating a comprehensive estimate of daily drayage truck travel itineraries. Data published by PANYNJ was used to quantify daily truck volumes along key routes within the study area. In parallel, Geotab telematics data was used to analyze origin–destination (OD) patterns, stop

locations, and associated stop durations of drayage trucks.

Using these data sources, NREL developed a modeling framework to generate synthetic drayage truck itineraries, as shown in Figure 8. Additional details on this methodology can be found in *Appendix B*.

Figure 8. Modeling framework for drayage truck itinerary generation

■ Input Data ■ Processing ■ Assumptions ■ Result



Prioritization of BEV adoption for drayage trucks

To estimate fleet activity and charging requirements, a statistical process was used to sample the number of drayage BEVs each year from the synthesized itinerary dataset based on the projected vehicle population. Two adoption scenarios were modeled:

- The **Randomized Journey** scenario, in which drayage itineraries were randomly selected from the entire set of possible itineraries for conversion to BEVs.
- The **Short Journeys First** scenario, which prioritized shorter itineraries for early BEV adoption.

Further details about the sampling process and energy consumption comparisons for these scenarios are available in *Appendix B*.

Description of off-port charging forecasting

The final step of the analysis involved estimating charger requirements for the drayage fleet based on population projections, travel itineraries, and BEV adoption scenarios. This included determining the number of stations, port locations, utilization rates, and charging load profiles.

NREL's EVI-Pro tool was used to simulate depot, opportunity, and en route charging for the drayage fleet. Additional details on the EVI-Pro methodology and modeling framework are provided in *Appendix B*.



Results

Results

Corridor site selection

Overview

We presented the results at three geographical levels and across multiple subject areas. At the first level, we provided results for individual sites, focusing on load curve projections. At the second level, we analyzed state-level results, comparing load curve forecasts and utilization rates across all sites within each state. Finally, at the regional level, we aggregated load curves and the projected number of chargers across states, and map utilization rates for candidate sites, offering a comprehensive view of the study area.

This section covers power demand projections for BEVs and FCEVs, the two primary electric powertrains analyzed in this study. Additionally, we examined the impacts of the winter season on BEV efficiency and its subsequent implications on power demand projections.

Central scenario and projection year

We analyzed BEV-related results across two charging time scenarios, time-constrained (full recharge is limited by the average stop duration of vehicles, as reported by Geotab) and time-unconstrained (full recharge allowed regardless of average stop duration from Geotab), as defined in the *Power demand calculations for BEVs* section in *Appendix A*, and two charger power levels, 350 kW and 1 MW. This resulted in four combinations of charging time scenarios and charger power levels evaluated in this study. Load curves are presented annually from 2024 to 2050. Although results were generated for all four combinations, the primary focus of this study is the scenario with a time-unconstrained charging event and 350 kW charger power (i.e., the central scenario). Accordingly, visualizations that emphasize a single combination were based on these central parameters. For visualizations showing results tied to a specific year, 2035 was used as the representative projection year.

Sample sites

We selected four sample sites to present site-level results and highlight key findings. The sample sites are numbered 100, 26, 16A, and 69.

- Site 100 (remote coverage site): Located in western Pennsylvania, this site represents a location a site location necessary to maintain reliable coverage for more remote areas.

- Site 26 (regional connector site): Located in Maine near the borders of New Hampshire and Massachusetts, it could serve MHDVs crossing state lines and thus highlights the importance of regional collaboration to advance infrastructure development.
- Site 16A (multicorridor site): Located along I-90 in Massachusetts, with proximity to other highways and major roads, this site serves multiple transportation corridors.
- Site 69 (major corridor site): Located in New York, it represents the largest truck stop between New Jersey and New York all the way to Canada.

Site-level results

BEV-based load curve projections

Peak daily demand projections over time

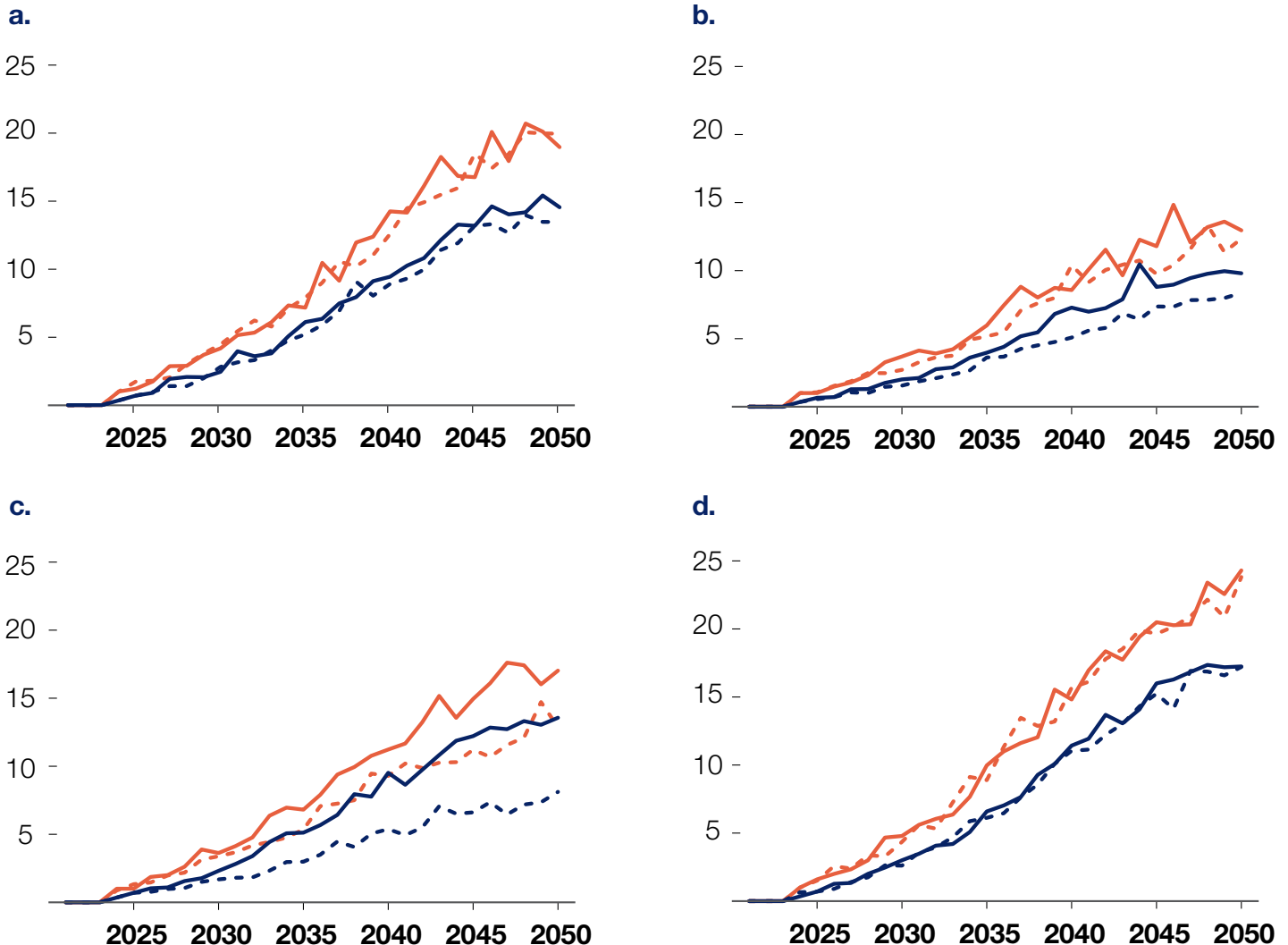
For each combination of charging time and charger power rate, we estimated power demands at 15-minute intervals for the entire projection period, enabling us to visualize maximum daily peak demands in each year over time. Figure 9 illustrates load curve projections for the four sample sites of this study. The vertical axis reflects the maximum power demand at each site for the corresponding year. All four sites are projected to experience significant future power demands, with site 69 (major corridor site) standing out as the highest, driven by its critical role in serving north-south truck traffic in the Northeast region.

The estimated power demand and input charger power can then be used to calculate the required number of chargers for each site, ensuring sufficient capacity to prevent shortages during truck charging.

Figure 9. Maximum daily peak power demand projections for BEVs at sites (a) 100, (b) 26, (c) 16A, and (d) 69

-- Constrained (350 kW) — Unconstrained (350 kW) - - Constrained (1 MW) — Unconstrained (1 MW)

Power Demand (MW)



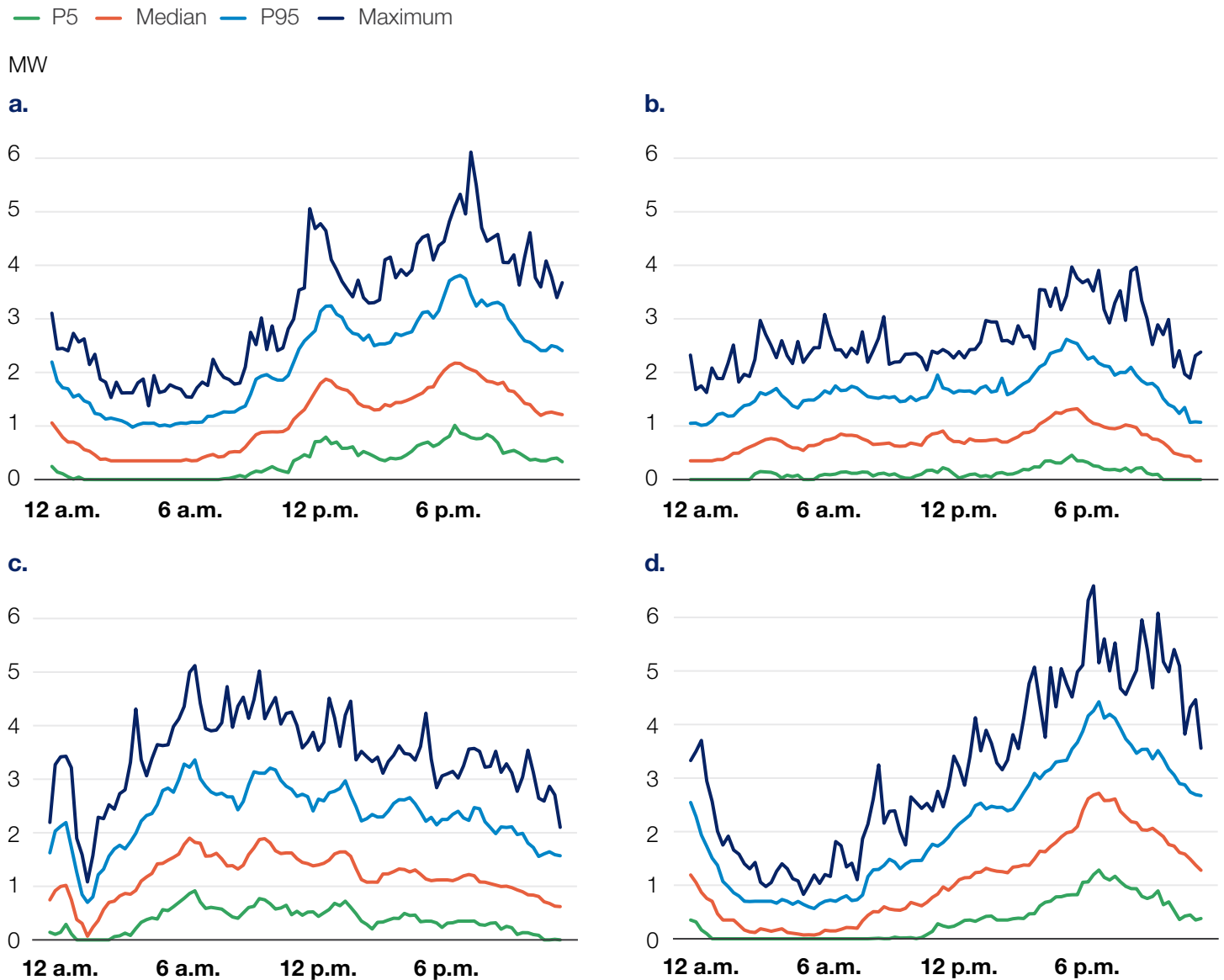
In each graph, the central scenario is represented by the solid blue line. The maximum power demand typically corresponds to the combination of time-unconstrained charging event and 1 MW of charger power. Time-unconstrained charging allows for full recharges during all charging events, while the 1 MW charger power imposes higher peak demands on the grid. All line plots show a growing demand volume over time, driven by increased electrification in the future. The occasional dip in demand in some curves is explained by the Monte Carlo simulation sampling process that is part of the study's methodology. Differences between the time-unconstrained and time-constrained charging scenarios are largely driven by Geotab's reported average stop durations. For instance, site 16A (multicorridor site) has the shortest

average stop duration among all four sites, which likely contributes to a more pronounced divergence between the two scenario outcomes. Shorter stops limit available charging time, amplifying the impact of time constraints on projected charging demand.

Hourly projections of peak power demand

Figure 10 illustrates the distribution of power demand within a given day in 2035 for the central scenario. Power demand is estimated at 15-minute intervals for each day of the year, resulting in a distribution of 365 values per interval. This enables the extraction of various percentiles of power demand corresponding to each interval.

Figure 10. Projected distributions of daily power demand in 2035 for BEVs at sites (a) 100, (b) 26, (c) 16A, and (d) 69 based on the central BEV scenario (time-unconstrained charging event and 350 kW charger power)



Each plot demonstrates the upper and lower extremes of the daily power demand distribution. The dark blue line indicates the maximum power demand recorded for each 15-minute interval, while the orange line represents the median demand levels exceeded on half of the days throughout the year. Similarly, the light blue and green lines correspond to power demand values exceeded on 95% and 5% of days, respectively. The dark blue line represents the maximum power demand required to ensure that all trucks stopping at the site on a given day receive sufficient power to fully recharge their batteries, based on the specified charger power level (350 kW). In contrast, the orange line reflects lower power demand values, but with a trade-off: there is a 50% chance that daily power demand will exceed the available capacity at the site. A similar interpretation

applies to the green and light blue lines, where each reflects different power demand levels and associated trade-offs between available capacity and the likelihood of meeting daily charging needs.

With the exception of site 16A (multicorridor site), which displays a relatively uniform distribution of power demand throughout the day, the plots in Figure 10 show peak demand typically occurring between the late afternoon and evening. This trend is likely driven by increased traffic at highway plazas during those periods. Trucks are charging as they continue with their journey. In contrast, demand is relatively lower during the late-night and early-morning hours, a pattern that differs from what would be expected under a managed depot charging strategy.

FCEV-based load curve projections

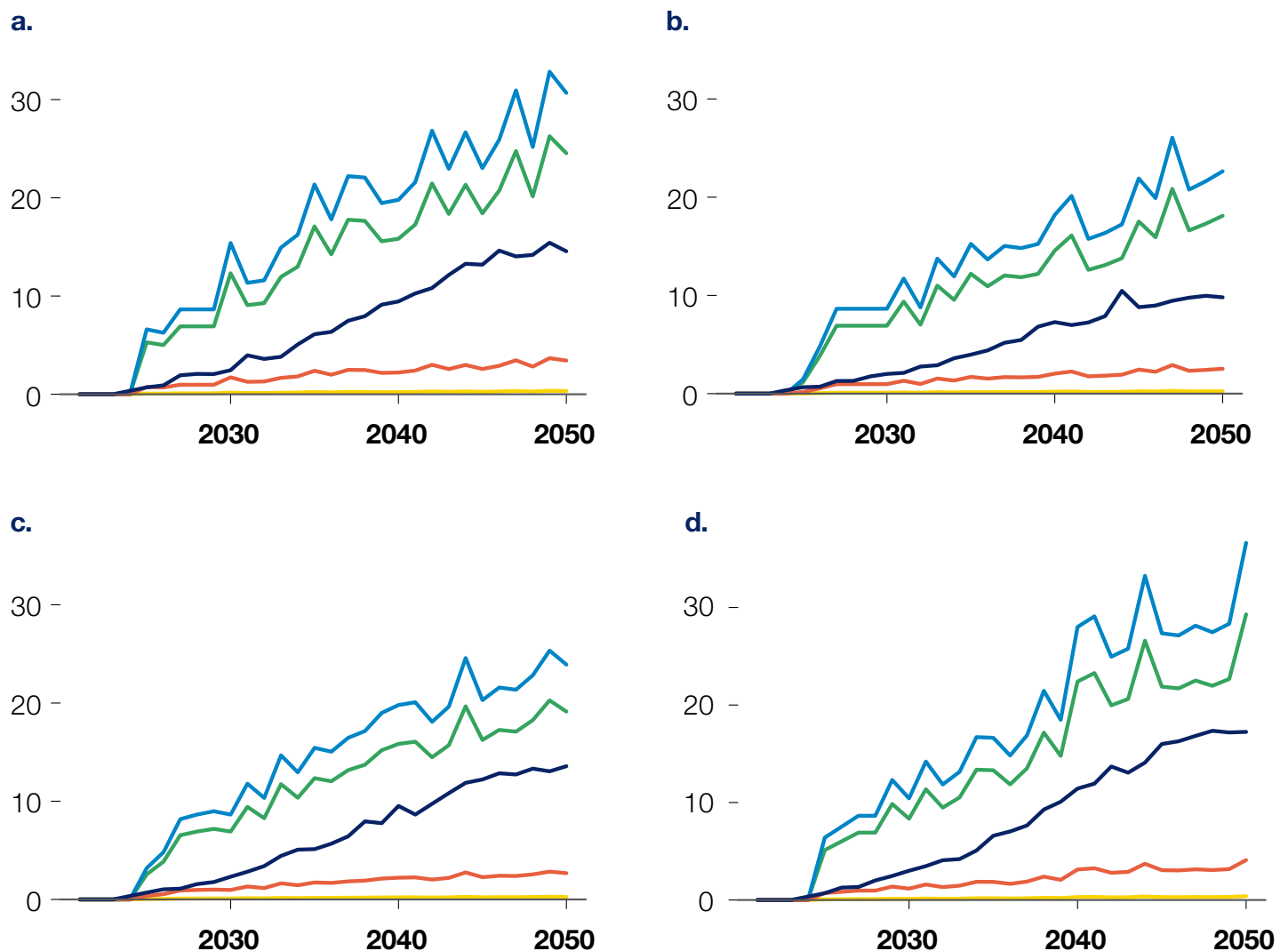
Figure 11 presents projections of annual maximum daily peak power demand at the sample sites associated with different methods of hydrogen supply for FCEVs alongside those associated with the central scenario in BEVs. There is a significant disparity in power demand depending on whether a site relies on transported hydrogen supply or utilizes on-site

hydrogen generation. The power demand associated with transporting liquid and gas supplies primarily comes from compressors, pumps, refrigeration, and heat exchange systems that consume significantly less power than electrolysis in on-site hydrogen generation scenarios. The least power-intensive approach is a liquid hydrogen supply, with power demands that are almost negligible compared with on-site generation.

Figure 11. Maximum daily peak power demand projections for FCEVs alongside the central BEV scenario (time-unconstrained charging event and 350 kW charger power) at sites (a) 100, (b) 26, (c) 16A, and (d) 69

— Liquid Supply — Gas Supply — On-Site Generation (Current Technology)
— On-Site Generation (Future Technology) — Battery Electric

Power Demand (MW)



In contrast, on-site hydrogen generation imposes substantial power demands on the grid due to the high energy requirement of current electrolysis technologies, estimated at around 50 kilowatt-hours (kWh) per kilogram of hydrogen generated. Although future advancements in electrolysis technology are expected to reduce energy demand, unless these reductions are much more pronounced than our current assumption of 20%, their power demand will remain much higher than liquid or gas hydrogen transport. Considering the utilization rates of FCEVs, as outlined in Table 2 in the

Powertrain share section, which show a maximum of 21% in 2050, the peak power demand for on-site generation of hydrogen surpasses the demand for BEVs, despite BEVs having significantly higher utilization rates. In contrast, scenarios involving hydrogen transportation — whether as liquid or gas — impose much smaller site-level power demands that are more proportionate to the limited number of projected visiting FCEVs.

Our findings support hydrogen supply methods that utilize centralized hydrogen generation hubs, with hydrogen distributed to sites within their service areas. This approach helps maintain a more manageable power load on the grid as FCEV utilization grows. Notably, our evaluation focuses solely on the feasibility of these methods from a utility grid perspective, without addressing other logistical considerations, such as potential upgrades to transportation infrastructure required to deliver increasing quantities of hydrogen to sites.



Adjusting BEV power demands for winter conditions

Figure 12 evaluates the adjusted BEV-related annual maximum daily peak power demands after accounting for winter effects on battery efficiency (30% reduction²⁴) according to the central scenario. By applying the reduced battery efficiency to Geotab's traffic data from

January, this study's representative winter month, winter effects on power loads can be evaluated. As expected, peak power demand increases across all four sample sites due to the reduced efficiency of batteries in cold weather. This highlights the critical importance of factoring seasonality into proactive planning for grid upgrades in the Northeast region.

Figure 12. Maximum daily peak power demand projections for BEVs before and after winter adjustment at sites (a) 100, (b) 26, (c) 16A, and (d) 69 based on the central BEV scenario (time-unconstrained charging event and 350 kW charger power)

— All Seasons — Winter

Power Demand (MW)

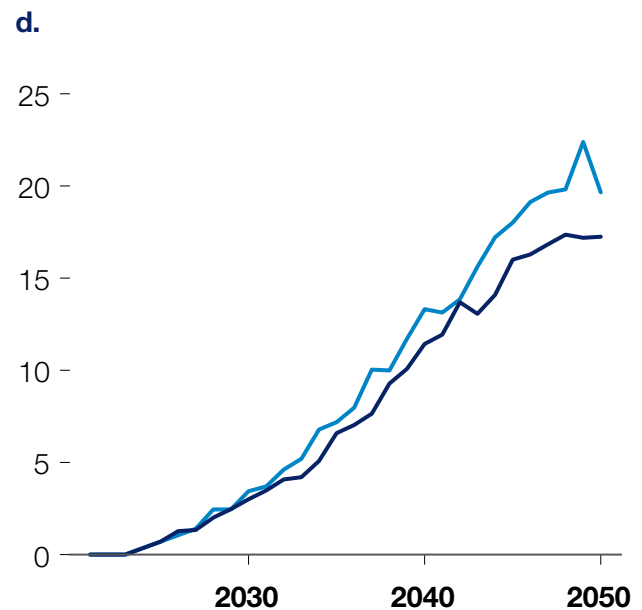
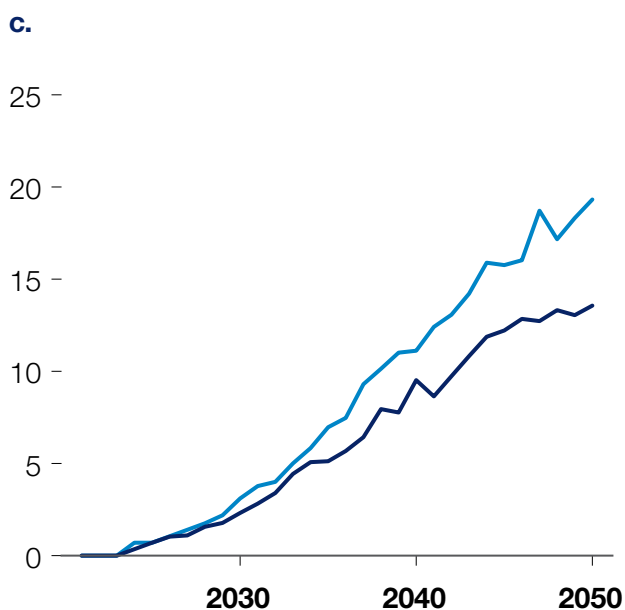
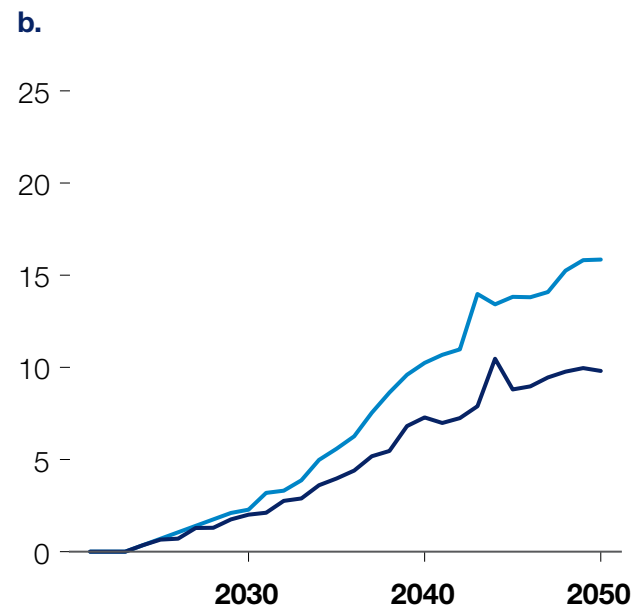
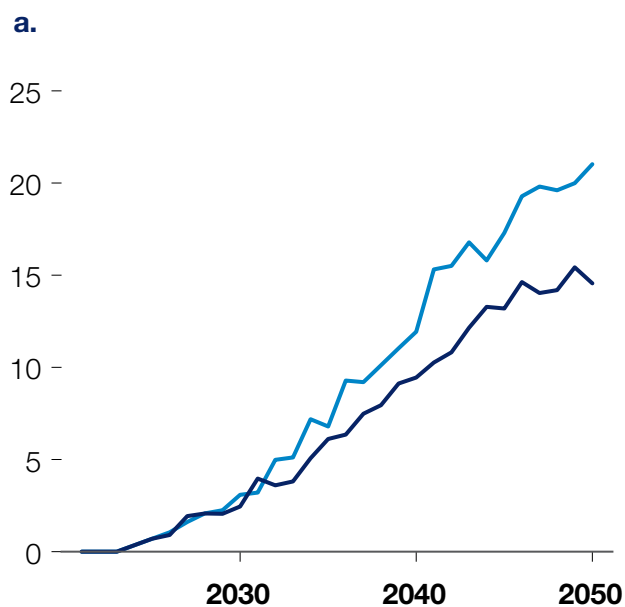


Figure 13 shows the distribution of changes in maximum daily peak demand after accounting for winter adjustment in 2035. For each state, the analysis compares winter peak demands against peak demands from all seasons across all sites within the state and visualizes the resulting distribution. The results show a wide range of differences, with most changes being positive, indicating a higher load on the grid during winter.

However, some sites exhibit negative changes in peak demand after winter adjustments. This decrease in peak demand can partly be attributed to the Monte Carlo simulation sampling process in the study's methodology and differences in site-specific patterns during winter months compared to the rest of the year. For example, site 116 in Pennsylvania shows the largest reduction in maximum peak demand, at 50%, after winter adjustments. According to Geotab data, the daily number of stops in January is only half the average daily stops across all three months

(August 2023, October 2023, and January 2024). This significant drop in daily traffic in winter outweighs the 30% reduction in battery efficiency across all vehicle types, leading to lower power demand projections.

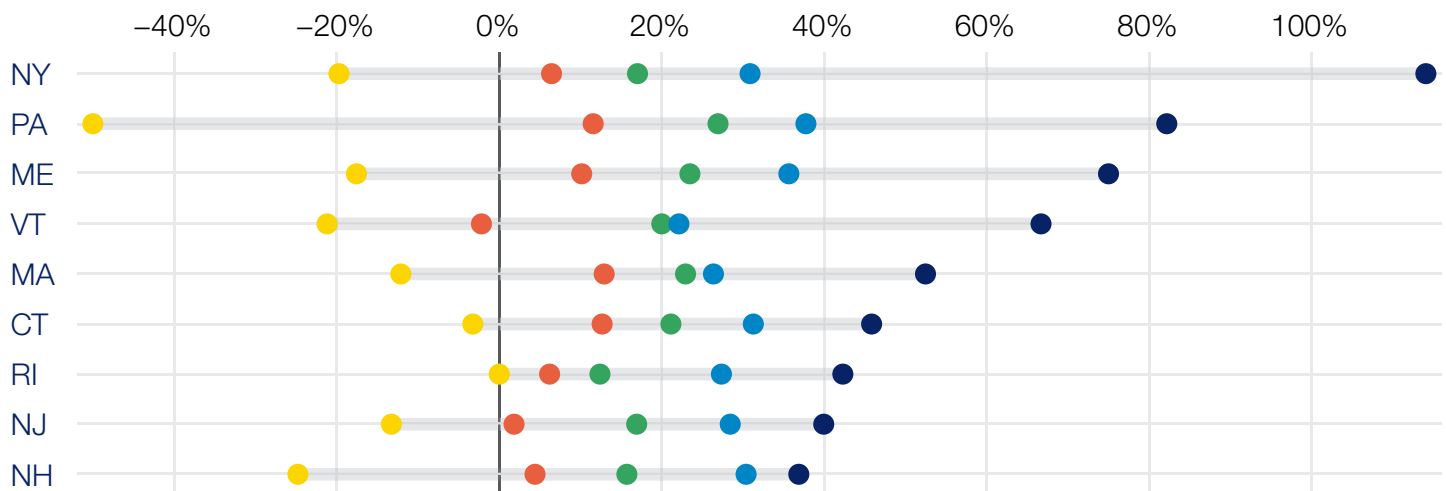
In contrast, site 91 in New York shows a 114% increase in power demand during winter. At this site, the number of daily stops in January is 2.8 times higher than the average daily stops across all three months. This substantial increase in winter traffic amplifies the effects of reduced battery efficiency, resulting in a power demand that significantly exceeds the 30% efficiency reduction.

These findings underscore the importance of considering both battery efficiency changes and seasonal traffic variations when planning for power demand impacts in cold weather. In general, lower battery efficiency in winter leads to higher demands, but reductions in seasonal traffic offset that effect at some sites, resulting in lower demands in winter.

Figure 13. Change in maximum daily peak power demand for 2035 after accounting for winter adjustments based on the central BEV scenario (time-unconstrained charging event and 350 kW charger power)

● Minimum ● 25th Percentile ● Median ● 75th Percentile ● Maximum

Change in Peak Demand



State-level results

We further evaluated the results of this study at the state level to compare power requirements across all sites within each state. For brevity, we present state-level results for New York, which has the highest number of sites among the study states. Similar results for other states are provided in the *State-level results* section of *Appendix D*.

State-level power demand projections

Figure 14 shows power demand projections for the central BEV scenario of this study across all 49 sites in New York, with its 15 prioritized sites highlighted. Table 4 also summarizes these values in five-year intervals. Peak power demand varies significantly among the sites, ranging from 350 kW to approximately 9.3 MW in 2035 and from around 570 kW to around 29 MW in 2050. This disparity is also evident among the finalized sites, reflecting the varying influence of the different selection criteria used in the process. In 2035, the finalized site with the lowest peak power demand is site 88, at 1,050 kW, while the highest demand is observed at site 93, at approximately 7.3 MW.

Figure 14. Peak power demand projections for all sites in New York, with its priority sites highlighted, based on the central BEV scenario (time-unconstrained charging event and 350 kW charger power)

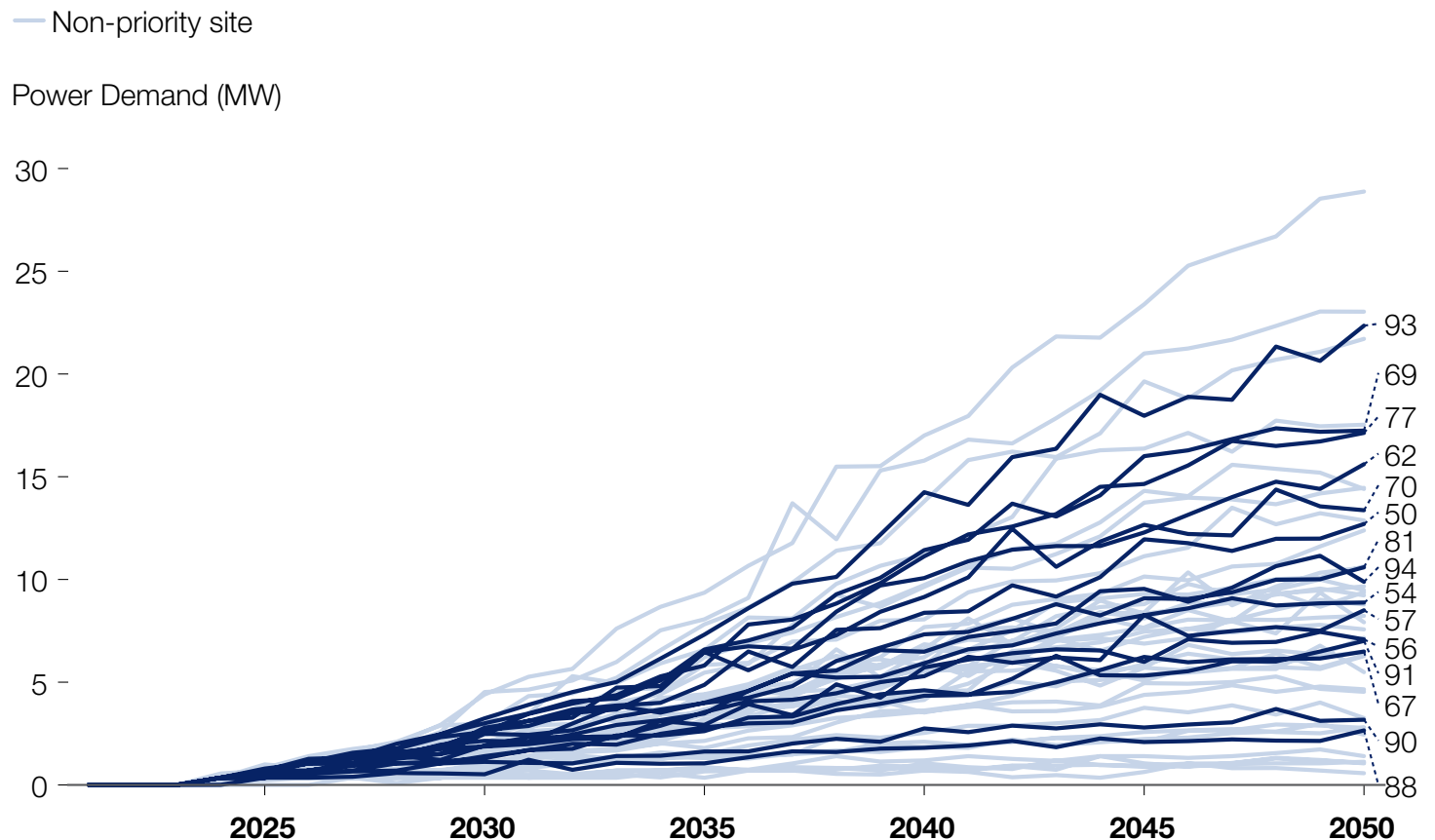


Table 4. Maximum daily peak demand projections (kW) based on the central BEV scenario for all seasons for the priority sites in New York

Site	Interstate	Load (2030)	Load (2035)	Load (2040)	Load (2045)	Load (2050)
50	90	2,785	4,871	8,378	11,954	12,699
54	90	1,890	3,477	5,923	8,260	8,877
56	90	1,870	2,921	5,717	5,987	7,082
57	90	1,921	3,545	5,293	8,263	8,499
62	87	2,540	6,466	10,068	12,286	15,609
67	87	1,297	2,618	4,605	6,229	6,491
69	87	3,001	6,589	11,428	16,001	17,243
70	87	2,670	6,471	9,148	12,659	13,369
77	81	2,581	5,811	11,125	14,646	17,132
81	87	2,487	3,983	7,329	9,083	10,595
88	90	519	1,050	1,806	2,088	2,652
90	81	1,122	1,626	2,749	2,794	3,172
91	81	1,400	2,800	4,339	5,318	7,009
93	90	3,240	7,316	14,247	17,965	22,352
94	84	2,146	4,003	6,484	9,542	9,885

Power utilization

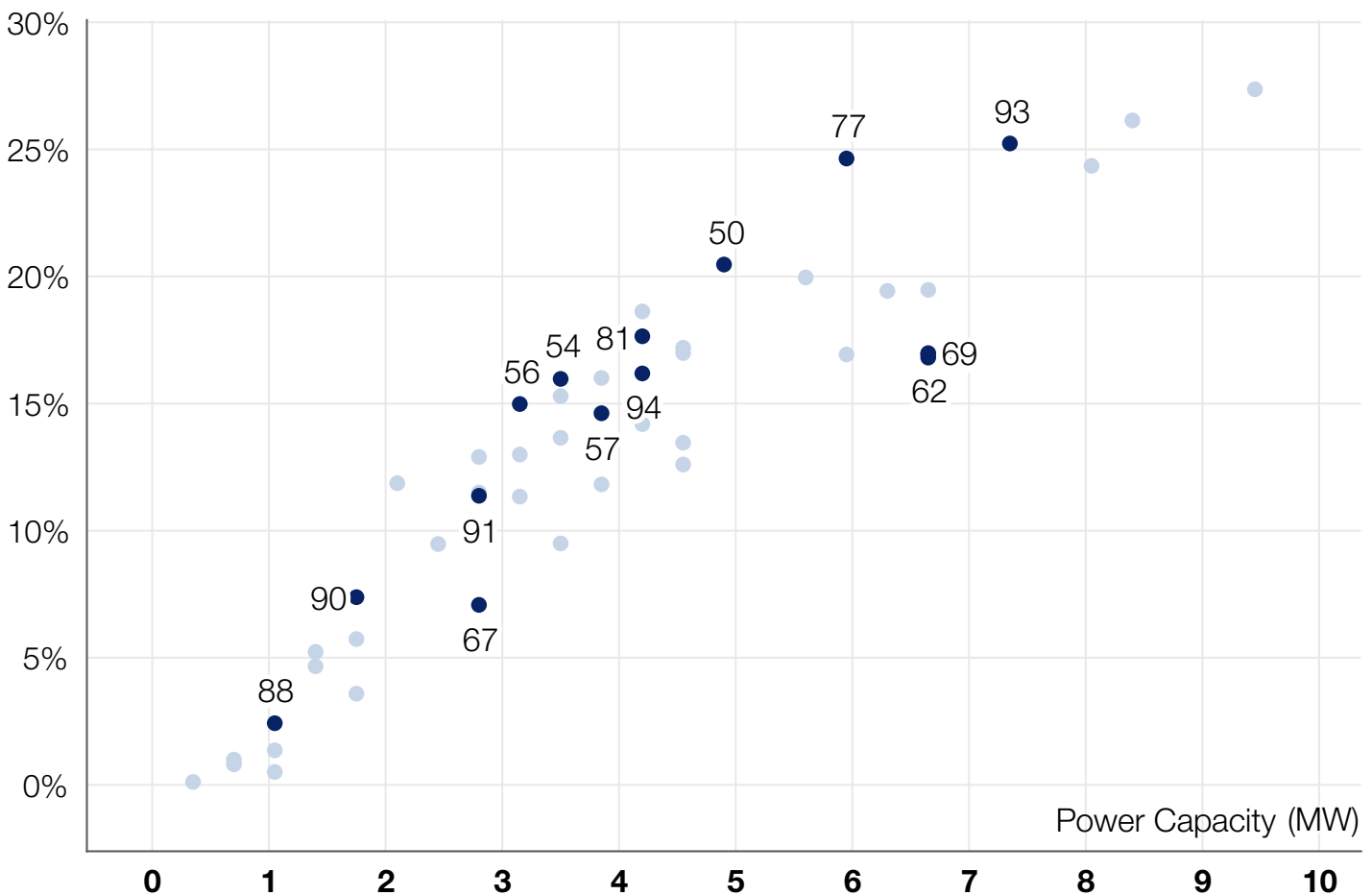
Figure 15 depicts the power capacity and energy utilization rates of all sites in New York for 2035, with the priority sites labeled and highlighted. The horizontal axis represents the power capacity, defined as the maximum achievable daily power based on the charger power (350 kW in the central scenario) and the estimated number of chargers at each site. The vertical axis represents the energy utilization rate, calculated from the estimated daily energy demand driven by site

traffic on a given day and the site's planned maximum daily energy capacity, attainable by its estimated number of chargers and their power rate.

Figure 15 highlights the proportional relationship between power capacity and utilization rates, indicating that sites with larger power capacities generally exhibit higher utilization rates. Priority sites with lower power capacities and utilization rates reflect locations where the effect of other criteria (i.e., state, utilities, and local impacts) is larger than the load criteria.

Figure 15. Utilization rates and total power capacities for all sites in New York in 2035 based on the central BEV scenario (time-unconstrained charging event and 350 kW charger power)

Utilization



Region-level results

The final set of results in this section evaluates our findings at the regional level. It provides insights into projected peak power demands across states and the distribution of required chargers within the Northeast region. It also includes a comprehensive overview of the utilization of the prioritized sites of this study.

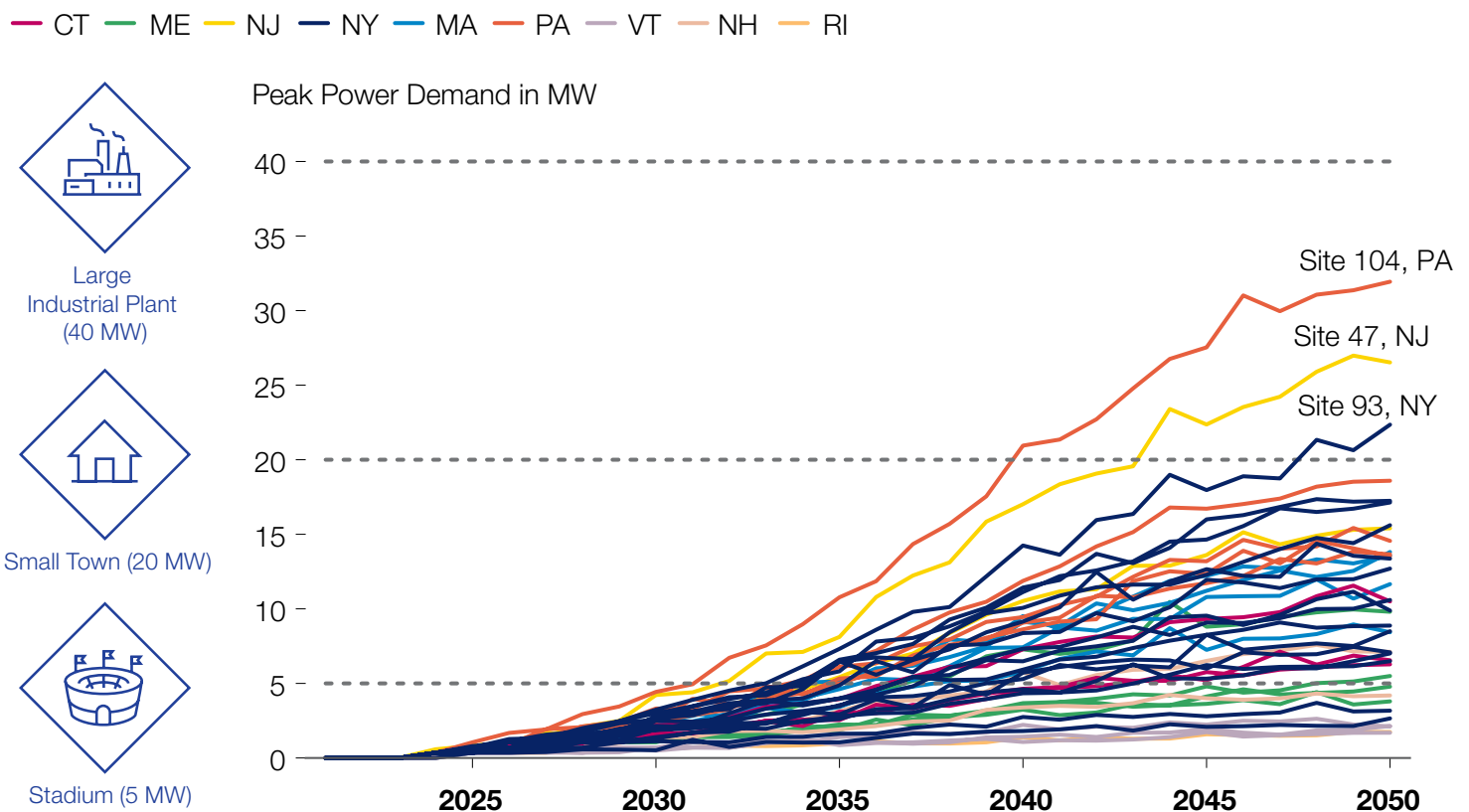
Peak power demand across states

Figure 16 shows the evolution of peak power demands for the priority sites across the nine states according to the central BEV scenario. These line plots are color-coded by state to highlight state-level differences within the region and provide insights

into the power requirements of each state. The two sites with the highest peak power demands are located in Pennsylvania and New Jersey. Overall, sites in New York, Pennsylvania, and Massachusetts demonstrate the highest peak power demands over time, while Rhode Island and Vermont show the lowest projections.

By the early 2030s, peak power demand at some sites begins to exceed the 5 MW threshold, a typical limit for distribution-level interconnection. As demand continues to rise, several highway fast-charging sites serving trucks could require as much power as a sports stadium, with a few approaching the levels seen at large industrial facilities. This underscores the significant new loads introduced by freight electrification.

Figure 16. Peak power demand over time for the priority sites (MW) based on the central BEV scenario (time-unconstrained charging event and 350 kW charger power)



Mapping power utilization in the region

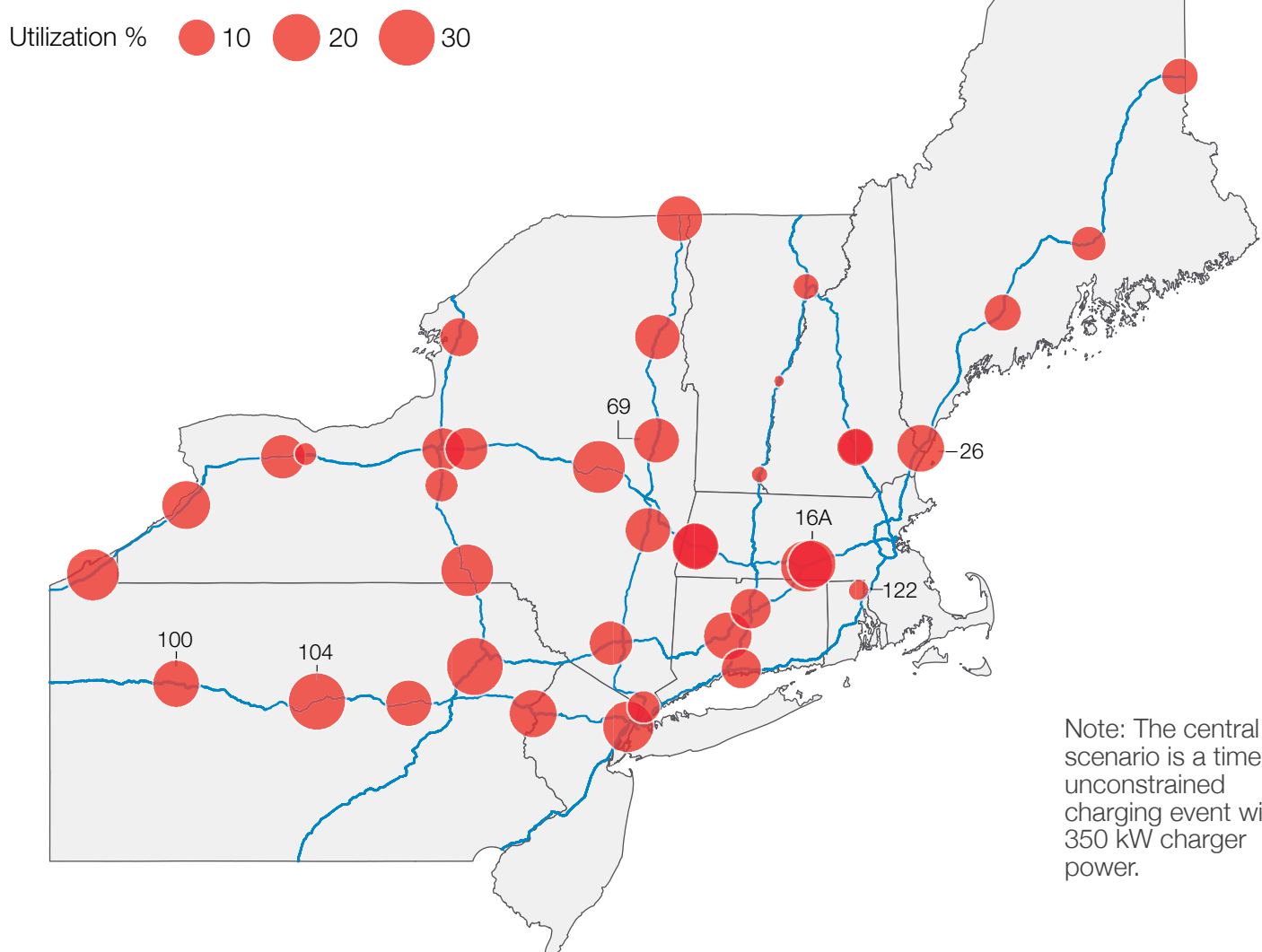
Figure 17 presents an overview of the utilization rates for the 39 priority sites in 2035 across the Northeast region based on the central BEV scenario, with several sample sites labeled. The variation in utilization rates reflects the impact of additional factors at some sites such as proximity to transportation corridors, the need for uniform spatial coverage, and other local criteria.

Site 100 (remote coverage site) in western Pennsylvania is pivotal for maintaining power availability for truck recharging, with a projected utilization rate of approximately 18%. Site 26 (regional connector site), with a utilization rate of 19%, underscores the necessity of infrastructure upgrades near state border regions. Site 16A (multicorridor site), with an approximately 24% utilization rate, highlights the strategic importance

of investment in locations serving multiple corridors, a pattern further emphasized by the presence of the nearby site 16B (not labeled in the map) in the finalized sites. Additionally, site 69 (major corridor site), with a utilization rate of 17%, stands out as a critical location for future upgrades due to its key role in serving the north-south truck traffic in the region.

The variation in utilization rates, as depicted in the map, reflects the influence of multiple factors considered during the selection process. For example, site 104 in Pennsylvania, which has the second highest utilization rate at approximately 30%, ranks prominently in both load demand and state-related criteria. In contrast, site 122 in Rhode Island, with a projected utilization rate of around 2%, stands out primarily due to its alignment with this study's local impacts criteria.

Figure 17. Map of utilization rate for the priority sites in 2035 based on the central BEV scenario



Port of New York and New Jersey analysis results

Overview

The drayage analysis results focused on charging demand for BEVs. Activity of drayage trucks serving the Port of New York and New Jersey was estimated at the 39 priority corridor charging sites and more than 200 depot sites based on synthetic itineraries of the drayage truck fleet. In addition to corridor energy demand, depot energy demand was analyzed for return-to-depot drayage operations. Given that a majority of daily driving distances are less than 150 miles, we prioritized a BEV early adoption scenario referred to as Short Journeys First, where fleet operators deploy BEVs on shorter journeys first. This makes it possible to support the majority of drayage operations with depot charging prior to 2043.

Region-level drayage-specific depot charging results

Depot charging is an important source to charge the drayage BEV fleet. The nature of the drayage operation (return-to-depot) makes depot charging a reasonable and accessible choice as the preferable type of charging. The majority of the drayage itineraries are less than 150 miles, which can potentially be

accommodated by depot charging, especially in earlier years with lower penetration levels of BEV drayage trucks.

The modeling of depot charging was aggregated at the census tract level to be in compliance with data privacy requirements. Figure 18 shows the peak demand for drayage depot charging in 2050 at the census tract level. Most of the tracts with depot charging demand are around the ports in New Jersey. The map also shows the relative location of the corridor charging site 46. There are some additional depot charging demands scattered in Massachusetts, New York, and Pennsylvania, but the demands are significantly less compared with the clusters around the ports.

The highest peak demand among all the census tracts is 4.8 MW in 2044 (see Figure 19). The peak demand drops after 2045. This is likely a result of introducing corridor charging to the drayage BEV fleet. The depot charging can fully support the itineraries that are shorter than the BEV range or supplement the corridor charging for longer itineraries. Using a different BEV range assumption could change this peak demand plot, where BEV with a longer range could potentially require a higher peak demand at depot locations but push the timeline when corridor charging is needed.

Figure 18. Location and peak demand for drayage BEV depot charging in 2050 at census tract level, high port growth projection

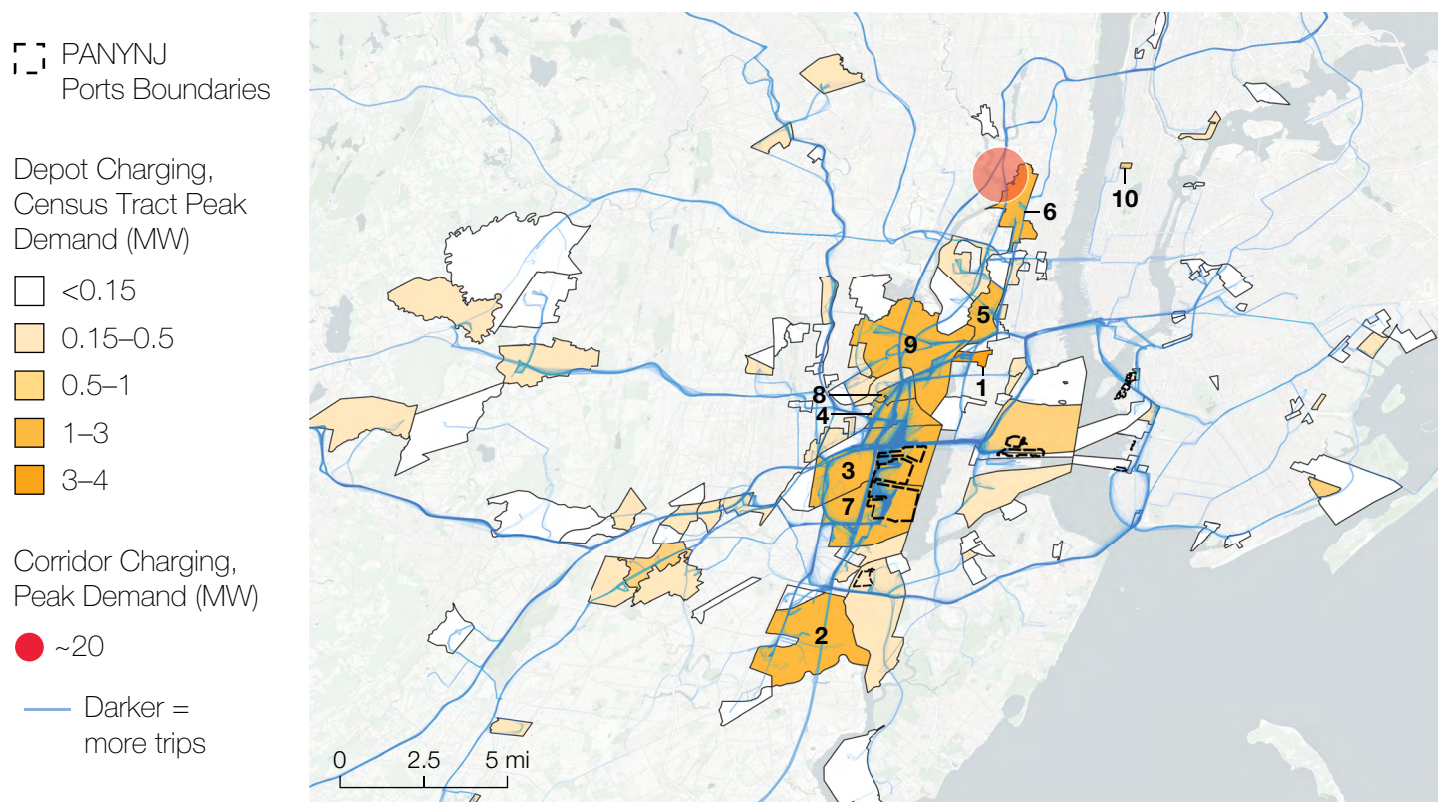
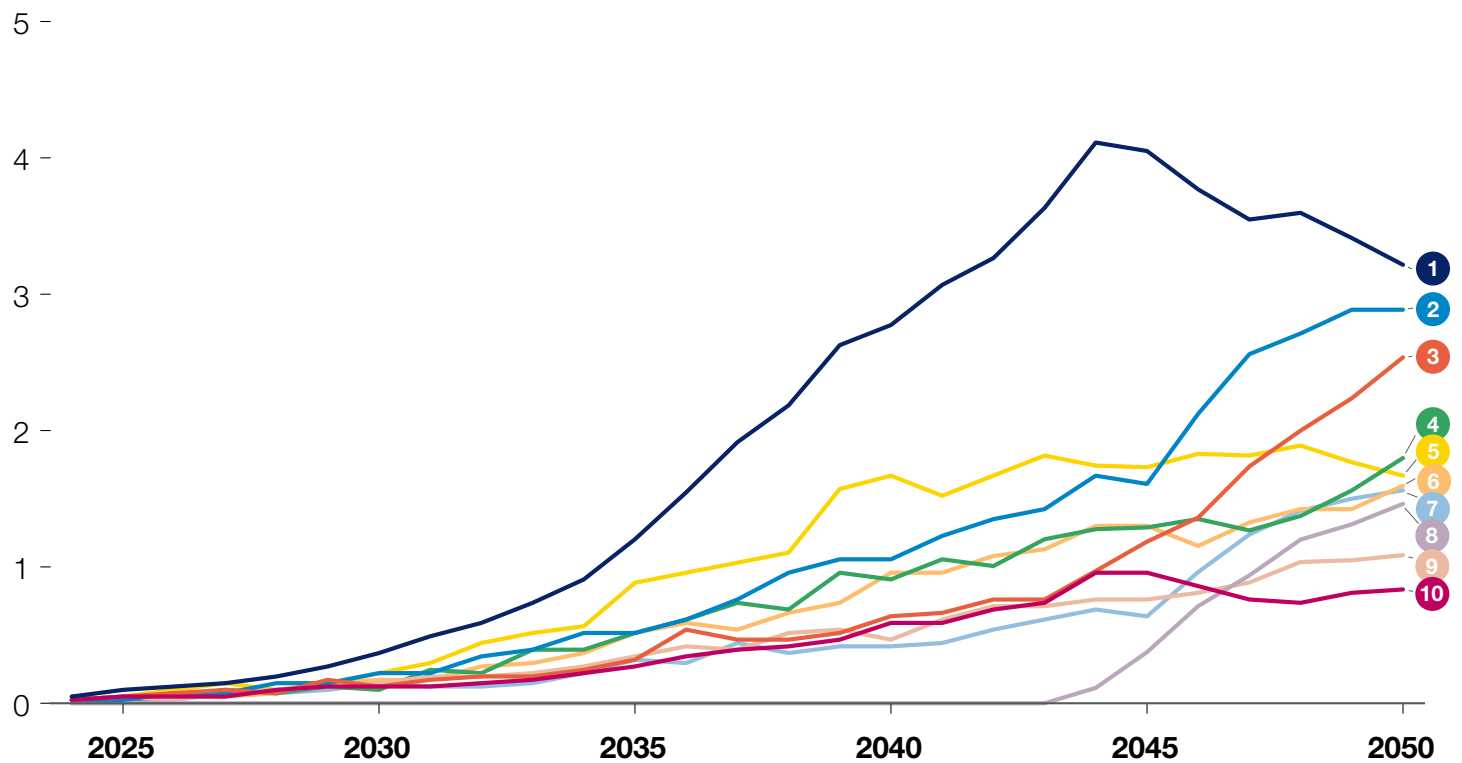


Figure 19. Depot peak power demand from top 10 census tracts

The census tracts are ordered by the peak demand in 2050

- | | | | |
|---|---|----|--|
| 1 | 34017002700: Northeast of Port Newark | 6 | 34017014600: North of North Bergen, NJ |
| 2 | 34039035400: Southwest of Elizabeth, NJ | 7 | 34039980000: Near Port Elizabeth |
| 3 | 34013980200: Near Port Newark | 8 | 34013007502: Northeast of Port Newark |
| 4 | 34013007400: Northeast of Port Newark | 9 | 34017012700: Northeast of Port Newark |
| 5 | 34017006900: Southeast of Secaucus Junction | 10 | 34017005802: Near Port Jersey |

Peak Demand (MW)



Region-level drayage-specific corridor charging results

In later years (beyond 2043), as EV adoption reaches very high penetration levels, the need to accommodate longer trips is likely to require the addition of corridor charging for drayage trucks. The peak power demands at each of the corridor truck sites projected for years 2044–50 are presented in Figure 20. Both the high and low port growth scenarios are illustrated. Using 350 kW chargers versus 1 MW chargers at the corridor truck stops have similar trends over the years. The peak demand from the 1 MW chargers case is not significantly higher than the 350 kW case. This is a result of not limiting the number of charging ports at a site. For example, multiple trucks could charge

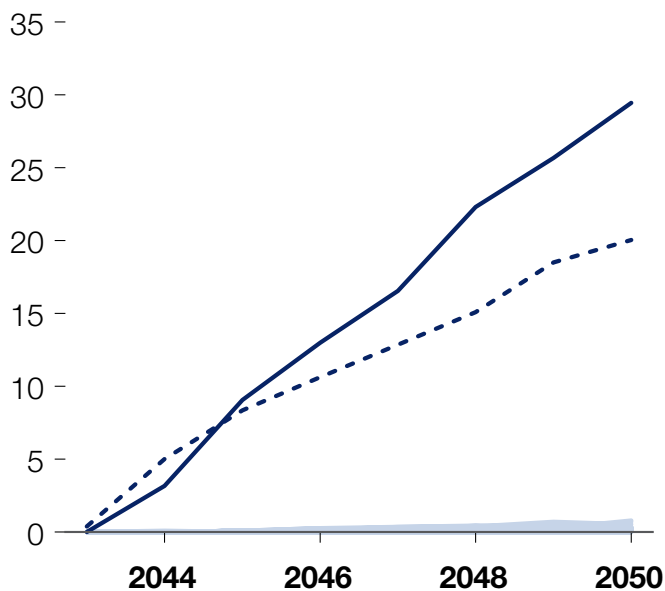
simultaneously at the site with multiple 350 kW chargers, resulting in a high peak demand. Or they could charge in sequence at the site with only one 1 MW charger. Site 46 is the closest and most critical corridor charging site to support the drayage BEV fleet servicing the Port of New York and New Jersey in the year 2043. If shorter itineraries are prioritized for electrification as described in the Shorter Journeys First scenario, then prior to 2043, the Port of New York and New Jersey's drayage BEV fleet can be fully supported by depot charging. The peak demand at site 46, between 20 and 30 MW by 2050, is significantly higher than the rest of the sites. Apart from site 46, there are other minor drayage BEV demands scattered across 39 total corridor locations in the study area.

Figure 20. Peak demand of each corridor site for corridor charging equipped with (a) 350 kW chargers, and (b) 1 MW chargers

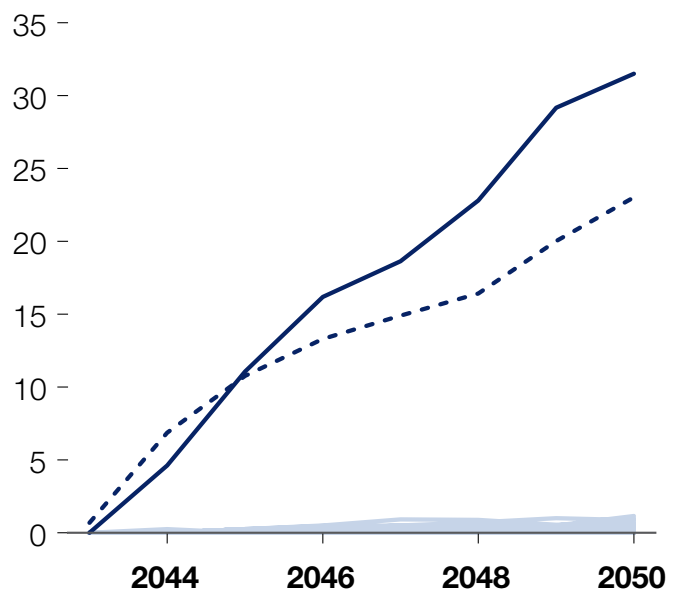
— Other sites — Site 46 High Port Growth scenario - - Site 46 Low Port Growth scenario

a. 350 kW charger

Power Demand (MW)



b. 1 MW charger



Site-level drayage-specific corridor charging results

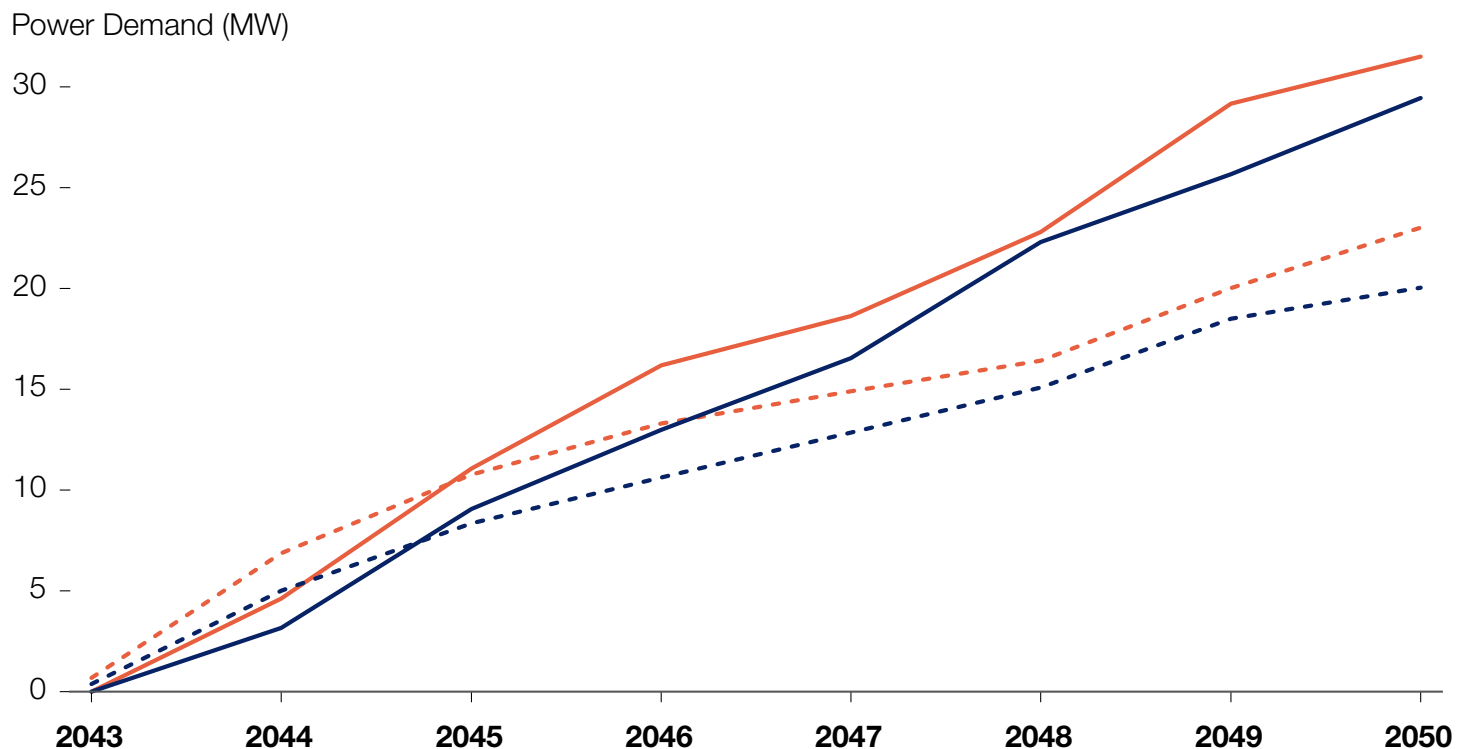
BEV-based load curve projections

With the high port growth projection of drayage trucks, the peak demand at site 46 to support drayage operations increases from 0 in 2043 to 29.4 MW (with 350 kW chargers) and 31.5 MW (with 1 MW chargers) in 2050 (see Figure 21). Although there are no assumptions on the number of charging ports at a site nor port sharing, multiple trucks at the site could charge in parallel at the lower speed of 350 kW, or charge in sequence at the higher speed of 1 MW. Both result in a similar peak demand at the site level. Calculating the peak demand at 15-minute intervals could also potentially reduce the peaking effect of using 1 MW chargers. Therefore, the peak demands of using 1 MW chargers versus 350 kW chargers are not significantly different at the site level. But the numbers of charging ports needed to support

demand are significantly different using 1 MW or 350 kW chargers. See *Appendix D* for more details on the hourly projections of peak power demand and number of ports at each site. With the low port growth projection, the peak demand increases from 0 in 2043 to 20.0 MW (with 350 kW chargers) and 23.0 MW (with 1 MW chargers) in 2050. The peak demand with 1 MW chargers is always higher than the peak demand with 350 kW chargers for all years, where a more spread-out demand can be observed in the daily electricity demand plot (see *Appendix D*). It is noticeable that the high port growth projection scenario has lower peak demand in 2044 compared to the low port growth projection scenario. This is due to the stochasticity of the sampling process, where the low port growth projection scenario uses a slightly larger sample of longer trips.

Figure 21. Peak demand at site 46, with high and low port growth projections in solid and dashed lines, and 350 kW and 1 MW corridor charging level assumptions in blue and orange lines

-- Low, 350 kW - - Low, 1 MW — High, 350 kW — High, 1 MW



Drayage fleet peak demands compared with overall corridor charging demand

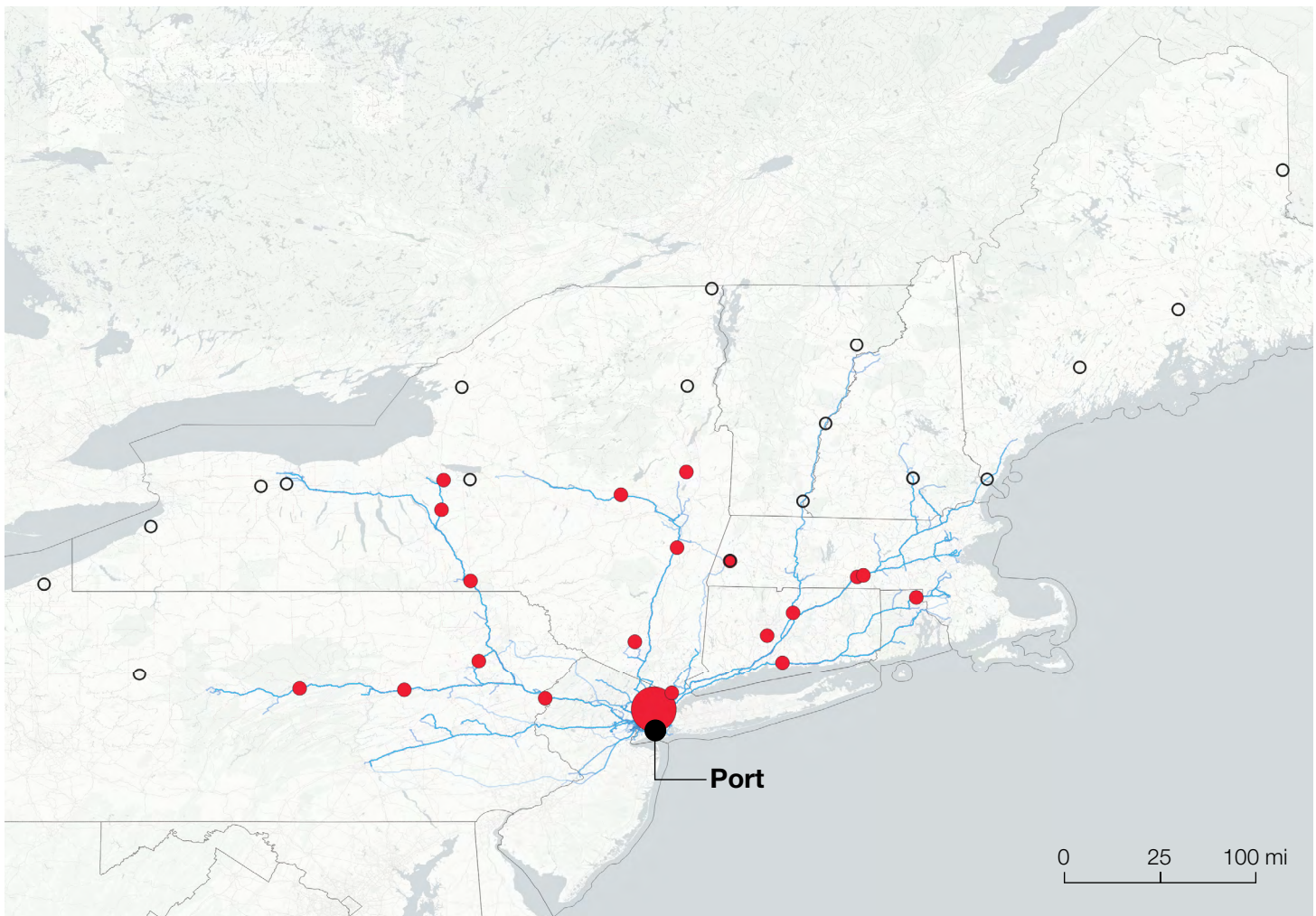
Not all 39 sites from the corridor analysis have demand from drayage operations. Figure 22 shows the peak demand from a drayage fleet in these priority sites. Except for site 46, where the drayage peak demand is above 20 MW and higher than the demand projection from the freight corridor analysis, drayage peak demands are below 1 MW and marginal compared with the freight corridor estimates in 2050. With the same BEV adoption trajectory, the higher drayage demand at site 46 is mostly a result of more aggressive growth in the drayage sector based on the containers

volume growth projection from PANYNJ's Port Master Plan 2050. While fleet size projections for the corridor analysis are moderated by state- and region-level trends, the growth of drayage total fleet size, targeted at specific sites, follows a different trajectory, which affects the higher peak demand to accommodate the electrified drayage operation at site 46. Table 5 presents the peak demand at the top 10 corridor sites based on the peak demand from a drayage fleet in 2050, compared with the corresponding demands from freight corridor analysis in the same year. A complete list of corridor site peak demand can be found in *Appendix D*.

Figure 22. Map of the drayage peak demand (in red) at the 39 priority sites in 2050

2050 drayage peak demand (MW)

○ No drayage demand ● < 1,000 ● ~ 20,000 ○ No drayage demand



Note: The traces of drayage BEV are in shades of blue, where darker represents more intense operations.

Table 5. Top 10 corridor sites for drayage fleet and peak demand in 2050 (see Table A-4 in Appendix B for the complete list of charging peak demand at all corridor sites)

Site #	Interstate	State	2050 Drayage Peak Demand (kW), High Port Growth	2050 Freight Corridor Peak Demand (kW)
46	95	New Jersey	29,447	15,402
77	81	New York	788	17,132
67	87	New York	700	6,491
107	81	Pennsylvania	525	18,590
122	95	Rhode Island	315	1,742
94	84	New York	263	9,885
106	80	Pennsylvania	222	13,655
10	91	Connecticut	210	6,279
69	87	New York	198	17,243
16A	90	Massachusetts	175	13,563

Implementation

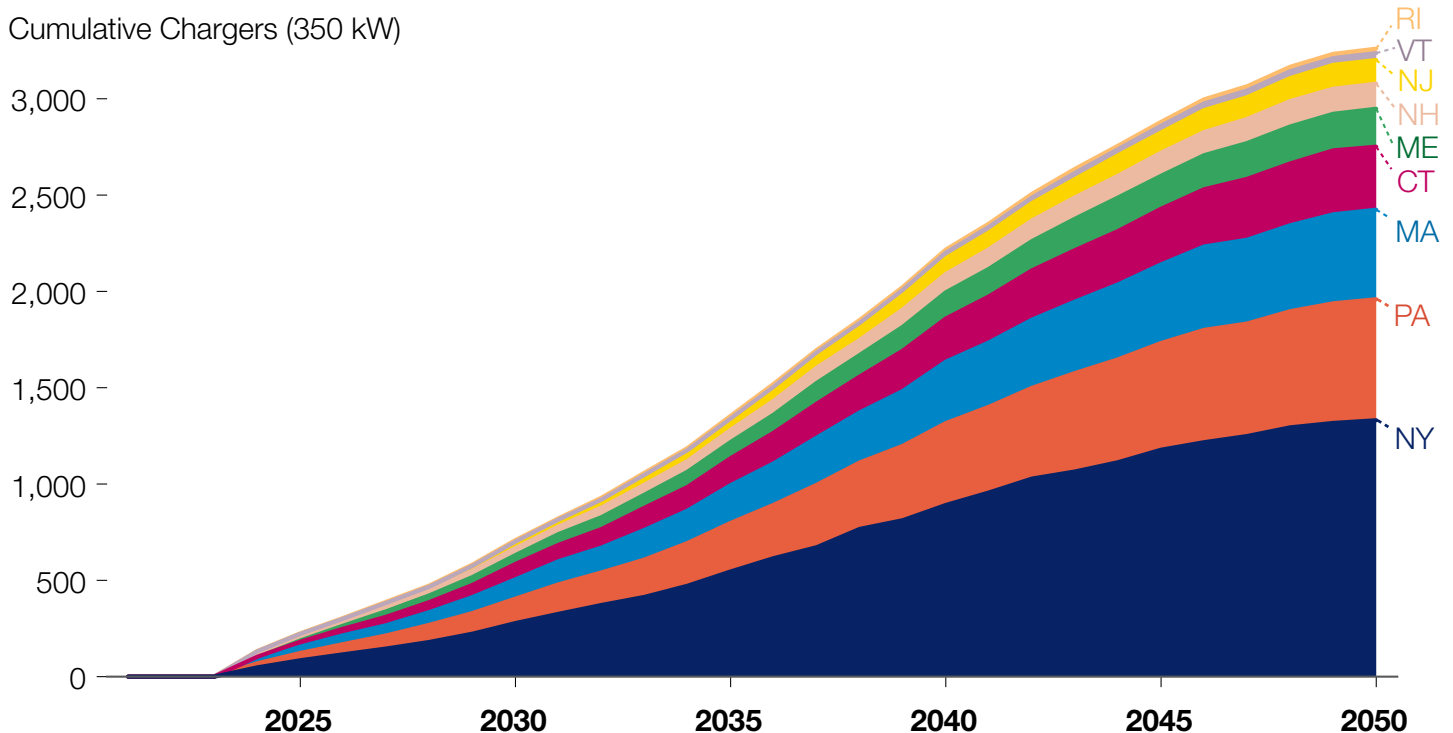


Implementation

Figure 23 shows the forecasted number of 350 kW chargers needed across Northeast states to support freight electrification. In total, more than 3,200 chargers

will be required by 2050, with New York, Pennsylvania, and Massachusetts accounting for the largest shares.

Figure 23. Cumulative projected number of chargers (350 kW) required to meet annual peak demand by state — and as a region — based on the study's main 350 kW charger power scenario



Overall, the analysis results highlight significant power demand from the 39 priority sites, which presents a unique opportunity for stakeholders to proactively coordinate and plan the development of priority sites. Figure 23 showcases the scale of the challenge in front of states and all other relevant stakeholders. Translating the peak power demand forecast into the number of chargers required to meet that annual peak shows that, by 2030, more than 500 fast chargers must be deployed in travel plazas in the region. That number passes the 3,000 threshold when looking at the forecasted demand holistically. Some states, mainly New York, Pennsylvania, and Massachusetts, need to play a central role in deploying a high number

of chargers to enable the development of a minimum viable freight corridor.

This section discusses the key elements for NFCCP's implementation. It begins by providing a broader understanding of barriers that might prevent site development. It then highlights recommendations that federal, state, and local governments and utility regulators can consider to address barriers and enable development of priority sites. Furthermore, it outlines opportunities for industry stakeholders and major actions they can take to start the site development process.

Barriers for site development

With most MHDV charging to date focused on depot-based solutions, corridor charging is in the early stages of development with limited operational projects. Given this nascency, key barriers must be addressed to facilitate site development for corridor charging. They include:

- **High power demands and associated grid upgrade needs:** Corridor charging for MHDVs entails large energy demands over short durations, resulting in high peak loads. Meeting these demands may require significant upgrades to upstream grid infrastructure, which can be costly and time-consuming. For example, transformer and switchgear upgrades can take 1–2 years, distribution substation upgrades may take 2–6 years, and transmission substation upgrades may take 5–10 years.²⁵ Delays in planning for these upgrades are at risk of compounding over time as demand for truck charging grows across the Northeast, potentially undermining efforts to build a reliable corridor charging network.
- **High charger costs:** Corridor charging requires high-powered chargers, typically 350 kW or greater. Hardware and installation costs for chargers in the 350 kW to 2 MW range can range from around \$250,000 to \$750,000 per unit, posing a substantial financial burden for infrastructure developers.²⁶
- **Interstate rest area restrictions:** Federal law prohibits most commercial activity in rest areas (not travel plazas) within the Interstate System right-of-way, including fast-charging services provided for a price paid by a user.²⁷ This further limits the land available for installing fast-charging stations along corridors, which could result in slower development of a corridor charging network in the Northeast.
- **Limited coordination among utilities, infrastructure developers, and fleets:** Effective corridor charging for MHDVs across the Northeast hinges on information sharing among infrastructure developers, fleets, and utilities. Utilities can lack visibility into infrastructure developers' long-term site plans, while developers and fleets may have limited understanding of utility upgrade timelines. This lack of alignment leads to delays in project development and hinders efficient planning.
- **Evolving conversations around standardization:** Ultra-fast-charging technology for MHDVs is still evolving, with multiple standards under discussion, including Combined Charging System and Megawatt Charging System (MCS). Infrastructure developers need assurance that a consistent, standardized charging approach will be implemented across the region to ensure high asset utilization and de-risk investments.

Recommendations

Key stakeholders including state and local governments, the federal government, utility regulators, and industry actors such as utilities, infrastructure providers, and fleets have a crucial role to play to address the barriers and accelerate corridor infrastructure site development. This section proposes relevant recommendations that each stakeholder can carry out individually and collectively to support the development of these sites.

Recommendations for government entities

Actions by federal, state, and local governments — along with utility regulators — will be critical to advancing solutions that drive market demand for corridor truck charging in the Northeast. Among these actors, states will play a central role by enhancing coordination (both inter- and intrastate) and facilitating programs that provide funding support and address barriers to expeditious and cost-effective site development. Federal and local actions can complement these efforts, particularly by enabling commercial charging along interstate rights-of-way and addressing truck parking needs. The recommendations include:

1. Collaborating and coordinating within and across state borders to identify and prioritize sites

- a. States could coordinate the development of freight plans and charging sites to ensure a strategic regional network that avoids redundancy in publicly funded infrastructure along corridors. This coordination could occur through highway-specific working groups or by leveraging existing multistate initiatives to advance high-priority site development.
 - Cross-border collaboration has been a cornerstone of this project and roadmap. Freight movement frequently crosses state lines in the Northeast, making it imperative for states, utilities, and other key stakeholders to plan beyond individual state borders. States should utilize existing forums to support regional collaboration without increasing administrative burdens or duplicating efforts. Establishing or enhancing highway-specific working groups within these forums would support holistic planning for corridor infrastructure.

- b. States could form or strengthen cross-agency working groups within their governments to coordinate freight electrification efforts.
 - Freight electrification and site planning require input from multiple state agencies, including transportation, energy, and environment. Ensuring that freight electrification planning is not siloed within a single agency can accelerate timelines and improve efficiency, thereby reducing costs. Some states are already facilitating such collaboration, including New York's newly announced Working Group to Accelerate Clean Vehicle Adoption and Charging Infrastructure Deployment.²⁸ This group brings together multiple state agencies to jointly advance EV infrastructure and adoption.
- c. States could leverage requests for information (RFIs) to guide priority site development.
 - States can individually or jointly launch an RFI to engage stakeholders and gauge interest in developing priority sites. This approach can help identify optimal locations for truck charging, key concerns, and site-specific requirements, and can generate early buy-in for the corridor plan. Insights from the RFI process can also be a valuable starting point for states to design funding programs and solicit project proposals for site development.
- d. States could collaborate with utilities to align on core assumptions for state-specific load forecasts, as was done for this project.
 - Differences in load assumptions can significantly affect projected site demand, influencing urgency, utilization, project size, and required investment. Early alignment on load considerations and forecasting methodology can prevent misallocation of resources and ensure more accurate, efficient planning.

2. Enhancing grid capacity near priority sites

- a. Utility regulators could consider new proceedings that allow utilities to propose proactive investments in corridor charging infrastructure, while also encouraging the use of innovative load forecasting techniques.
 - Given the projected scale of corridor charging demand in the Northeast, conventional rate cycles may not be fast enough to support necessary grid upgrades. Utility regulators could initiate proactive planning proceedings that empower utilities to respond more rapidly to electrification needs. For example, in 2024, the New York Public Service Commission launched the Proactive Grid Planning Proceeding, which encouraged utilities to develop granular load forecasts for high-demand areas and to identify future system needs and associated solutions.²⁹ One to three of the 39 priority sites identified in this study received approval in the commission's most recent Proactive Planning Order. The commission approved projects solving for short-term capacity relief in priority travel plazas on the New York State Thruway. Other states could adopt similar approaches to ensure that electrical infrastructure does not become a bottleneck to vehicle electrification. Additionally, Massachusetts approved its first Electric Sector Modernization Plan in 2024, covering investments for the next five years to enhance grid capacity for transportation electrification, among other things.³⁰
- b. State, federal, and other regulators could enable more cost-effective power delivery by revisiting rules around electrical infrastructure crossings on highways.
 - In some states, regulations require underground crossings, which can increase project costs up to 10-fold compared with overhead lines. Advances in pole and wire technology have made overhead crossings safer and more reliable. Regulatory bodies could consider updating these rules to reduce costs and accelerate site energization.

3. Energizing and building scalable MHDV charging infrastructure at priority sites

- a. Utility regulators could approve make-ready programs to support the costs of preparing and building publicly accessible MHDV corridor charging sites.
 - Make-ready programs help reduce the cost of site buildout and provide greater certainty for utilities, fleets, and infrastructure providers regarding where infrastructure will be built and when. States with existing make-ready programs could consider expanding them, while states without such programs could design new ones to include travel plaza locations along key freight corridors.
- b. State and federal agencies could develop financial incentive programs to help reduce the cost of site construction.
 - Developing the priority sites identified in the roadmap will involve significant costs due to high power demands, required grid upgrades, and the number of charging ports needed. State and federal agencies could accelerate site development by offering financial incentives or subsidies to infrastructure developers.
- c. States and utility regulators could allow utilities and developers to future-proof site-level infrastructure (e.g., trenching for conduit) to accommodate anticipated future load.
 - Cost estimates for upgrades at each site (Box 2 on Page 52) show the advantage of future-proofing sites. While average load at the priority sites jump from 2.2 to 11.4 MW, growing roughly fivefold, the average cost-to-serve solution goes up roughly threefold. Building once for long-term growth could be more cost-effective for utilities, states, and ratepayers. Such approval could be granted through proactive grid upgrade proceedings, make-ready programs, or state incentive programs.
- d. The federal government could consider modifying the prohibition on commercial activity in the Interstate System rights-of-way in 23 U.S.C. Sec 111(a) to enable corridor charging at rest areas.
 - To build a seamless charging and fueling network for electrified freight, some locations may need to include user-pay stations at

federal rest and parking areas. This could enable daytime opportunity charging or overnight charging where no alternative truck charging sites exist. Federal agencies could explore softening or revising this prohibition through legislation or regulatory updates.

- e. Local governments could use NFCCP load forecasts to evaluate future truck parking demand.
 - The Northeast is acutely affected by the national shortage of truck parking. This should be factored into site selection and planning. Some travel plazas may require expansion to accommodate both parking and charging needs. Sites with available real estate should be prioritized, and permitting processes could be streamlined to support these expansions.

Recommendations for industry stakeholders

Although public entities are critical to initiating the near-term push for corridor charging through supportive policies and programs, industry stakeholders play an equally important role in implementing projects and establishing a well-functioning corridor charging infrastructure network. Each stakeholder, including utilities, fleets, and infrastructure providers, brings unique motivations and opportunities that this plan can help advance. In addition, these stakeholders can take both individual and collective actions to initiate site development.

Recommendations for utilities

Freight movement along corridors can be variable and difficult to forecast. This makes it challenging for utilities to estimate where and how much power will be needed for corridor charging of MHDVs. The NFCCP's

site selection and demand projections provide utilities with a valuable opportunity to anticipate future demand locations and their associated load requirements.

Utilities can use these insights to proactively plan for power availability at key sites. Notably, the analysis indicates that one-third of the final selected sites are expected to exceed a peak demand of 5 MW by 2035 or earlier. Meeting this demand may require interconnection to 115-kilovolt or similar voltage transmission lines, which in turn would necessitate the installation of new substations. Given the long lead times required to plan, design, and construct these substations, the process for grid upgrades must begin immediately.

Utilities can take the following actions to spur site development:

- Assess existing power availability at selected sites, identify need for upgrades based on projected load requirements, and integrate proactive grid upgrade planning into current utility processes.
- Identify challenges related to energizing sites within their service territories and engage in proactive communication with stakeholders.
- Partner with infrastructure providers and fleet customers to understand their electrification plans and refine capacity forecasts as necessary.
- Clarify financing structures for grid upgrades with private sector infrastructure providers and align on expectations around cost allocation.
- Explore modernizing the interconnection process, by, for example, implementing flexible interconnection pilot programs.

Box 2: Cost estimates for grid upgrade solutions for corridor charging and the need for long-term planning

To meet the projected loads at the priority sites by 2030 and 2050, utilities in the Northeast conducted a high-level cost estimate for the grid upgrades required to energize these locations.^{vii} Estimating these costs is essential to better understand how costs vary across sites and time frames, and to emphasize the importance of early, proactive engagement with utilities during corridor charging site development.

Overall, grid upgrade costs across the 39 priority sites ranged from \$0 for sites requiring no upgrades to \$45 million in 2030. This wide variation is influenced by several factors, including the expected load, existing spare capacity in the electrical system, the type of upgrade needed, and the distance to existing infrastructure. The 2030 peak load requirements across the priority sites range from 0.5 to 4.5 MW. The varying load requirements necessitate different grid upgrade solutions; most sites require measures such as reconductoring or extending distribution lines, while a few require additional infrastructure like a second transformer. Additionally, higher loads at certain sites can trigger tapping onto transmission lines to supply power to substations serving the charging sites. Near-term alternatives, such as energy storage or other non-wires solutions, may also be viable, depending on regional regulations and whether utilities are permitted to own storage assets.

Another important consideration is that the load requirement and associated costs are not always directly correlated; a higher load does not necessarily translate to higher costs. For instance, one site with a 3 MW load requires no upgrades and therefore incurs no cost, while another site with a 2.7 MW load requires a \$28.6 million investment

in 2030, primarily driven by the larger distance to existing electrical infrastructure.

These findings highlight that each site is unique, and there is no one-size-fits-all approach to providing power. One site might be connected to a substation with no additional capacity, requiring significant upgrades even for a modest number of chargers. Another might be located near a large industrial project that has already exhausted the simpler, lower-cost upgrade options, leaving only expensive alternatives.

Moreover, except for a few cases, higher up-front investment in 2030 does not guarantee a site is future-proofed through 2050. In many instances, the solutions proposed for 2030 become obsolete between 2035 and 2050. For example, one site with a 4 MW load requiring \$45 million in 2030 for cable upgrades and a second transformer will need an additional investment by 2050 to build a new substation to meet a projected 25 MW load. These high costs for immediate and long-term solutions raise questions about planning timelines. Utilities are often incentivized to address immediate challenges and load requests, but a more holistic, long-term planning approach — anticipating 2050 needs — could reduce overall costs for ratepayers.

In conclusion, this exercise in evaluating grid upgrade needs and associated costs reinforces the importance of early coordination with utilities to ensure timely delivery of infrastructure solutions. Given the growing concern around interconnection queues, close collaboration among stakeholders is critical to enabling a smoother, faster interconnection process for the priority sites outlined in this plan.

^{vii} The high-level cost estimates do not include costs of chargers or any other site configurations.

Recommendations for fleets

Regional-haul and more importantly long-haul movement along highways have often been considered difficult to electrify due to the need for widespread fast-charging infrastructure. NFCCP's proposed initial network in the Northeast offers fleets a significant opportunity to begin electrifying corridor-based freight operations.

This network will support smoother truck operations with minimum downtime, enabling fleets to stay focused on their core business of goods movement and revenue generation. Additionally, the US trucking market is largely composed of small businesses; 91.5% of fleets operate six or fewer trucks.³¹ Many of these smaller fleets may lack access to overnight depot charging, making a publicly accessible corridor charging network particularly beneficial for them.

Fleets can take the following actions to ready themselves for corridor charging:

- Assess existing travel patterns of fleet vehicles along corridors in the Northeast, evaluate electrification plans for routes that intersect with selected sites, and share data and site preference information with states and utilities.
- Identify use cases and applications best suited for public charging, assess truck supply to meet operational needs, and plan for electric truck procurement accordingly.
- Coordinate with utilities and infrastructure providers on availability and readiness of the infrastructure at sites and align electric MHDV fleet deployment timelines.
- Work with utilities or charging-as-a-service providers to conduct suitability assessments to transition to electric MHDVs and prepare an electrification plan to access corridor charging network.

Recommendations for infrastructure providers

Infrastructure providers play a critical role in launching the NFCCP network because they will be responsible

for owning, operating, and maintaining the charging infrastructure. A key factor influencing their decision to invest in site development is the expected utilization, often clouded by uncertainty due to limited data on truck travel demand along specific corridors.

This plan offers realistic estimates of expected utilization at the selected sites, helping infrastructure providers better evaluate potential returns on investment. Developing corridor sites also creates an opportunity to pilot emerging business models, such as charging-as-a-service. Moreover, it positions providers to expand the corridor network beyond the initial 39 priority sites, laying the foundation for broader growth across the Northeast.

Infrastructure providers can take the following actions for site development:

- Prioritize site development based on power demand, expected utilization, land availability, and agreement and alignment with site owners.
- Leverage NFCCP findings to determine charger types and the appropriate number of chargers required at each site.
- Estimate capacity and power needs, and coordinate with utilities to identify where transmission-level interconnections may be necessary, along with associated financial implications.
- Align site development with ongoing requests for proposals to take advantage of possible incentives through federal and state programs.
- Explore the integration of on-site energy storage solutions to manage peak demand, which can be particularly high for corridor charging.
- Ensure site planning and design are future-proofed to accommodate high-powered chargers in accordance with the MCS.
- Coordinate with financiers to access innovative financing mechanisms to fund site development, including utilization-tied loan repayment schemes.

Conclusion



Conclusion

The Northeast states, like the rest of the United States, are on the cusp of a transition to the electrification of MHDVs. To enable widespread electrification, developing charging infrastructure along corridors and around key areas like ports is essential. The NFCCP provides an actionable roadmap for states, utilities, infrastructure providers, and fleets to begin to establish charging infrastructure along high-traffic corridors in the nine Northeast states and along the Port of New York and New Jersey.

The NFCCP was developed through a holistic and collaborative process, beginning with site selection for infrastructure development. Based on input from states, utilities, and local communities, and on load forecasts, 39 priority sites were selected from an initial pool of 140. The plan includes detailed assessments of power demand and load curves for each site through 2050 to support long-term infrastructure planning. The analysis shows that demand for corridor charging will rise swiftly in the coming years. By 2030, approximately half of the priority sites will cross the 2 MW threshold, equivalent to the power demand of a shopping mall or high-rise apartment complex. By 2035, about one-third of the sites will have more than 5 MW of demand, a load equivalent to a sports stadium. By 2050, more than 75% of the sites will exceed the 5 MW threshold.

Similarly, demand from the electric drayage fleet at the Port of New York and New Jersey will rise substantially. Peak demand for depot charging increases from 0.5 MW in 2030 to 3 MW in 2040 and about 4 MW in 2050. Although the majority of the demand through 2040 is met through depot charging, corridor charging will play a crucial role through 2050. Site 46, the most critical corridor charging site near the Port of New York and New Jersey — and the site closest to the ports — will experience peak demand of 20–30 MW by 2050.

These projected power demands highlight the need for proactive planning. These loads will materialize rapidly, and typical capital allocation time periods of a three-year rate-based adjustment cycle used by utilities will not suffice for the emerging needs of truck electrification. Stakeholders will need to accelerate the planning and development of these priority sites for MHDV charging infrastructure. Federal, state, and local governments and utility regulators can focus on measures to generate stakeholder interest in site development through proactive collaboration, facilitate solutions to get the necessary power to the sites, and encourage site development. Furthermore, the plan presents opportunities for various industry actors to

take leadership in corridor site development. Utilities can benefit from early insights into anticipated loads at specific sites and begin proactively planning grid upgrades. Fleets can deploy trucks along identified routes with increased confidence in highway charging availability, while smaller fleets with limited depot infrastructure will gain improved access to public charging. Fleets operating drayage trucks around ports can complement charging at depots with opportunity charging along key corridors, helping fleets and port authorities meet their sustainability goals. Infrastructure providers will have better visibility into long-term asset utilization, enabling more informed investment and faster site development.

To turn the NFCCP into reality and build an initial viable charging network along key corridors and ports in the Northeast, regional collaboration is critical from the outset. Corridor infrastructure development will require coordination across multiple agencies within and across states. These agencies must work closely together to align goals, timelines, and implementation strategies. States can begin leading by identifying potential funding sources, issuing requests for proposals (RFPs) for site development, and ensuring utilities and infrastructure providers are engaged early in site planning to optimize design and deployment. Early efforts along these lines are already underway in some Northeast states. A four-state coalition — comprising New Jersey, Connecticut, Delaware, and Maryland — is launching an initiative to build a foundational network of truck charging facilities along the I-95 corridor and adjoining freight corridors near the Port of New York and New Jersey. Funded by a grant from the EPA and led by the New Jersey Department of Environmental Protection, the project is expected to install more than 400 charging ports across 24 sites.³² The participating states will coordinate their efforts to develop and issue RFIs and RFPs and oversee construction of charging infrastructure. The early lessons through this initiative on coordinated RFP development, site prioritization, and design can serve as a blueprint for other Northeast states to accelerate market development for electric MHDVs across the broader region.

The NFCCP lays the foundation for large-scale infrastructure deployment in support of broader trucking electrification goals across the region. Insights from initial site deployments can inform the development of a connected corridor network, backed by accessible, reliable, and high-functioning infrastructure for medium- and heavy-duty truck electrification.



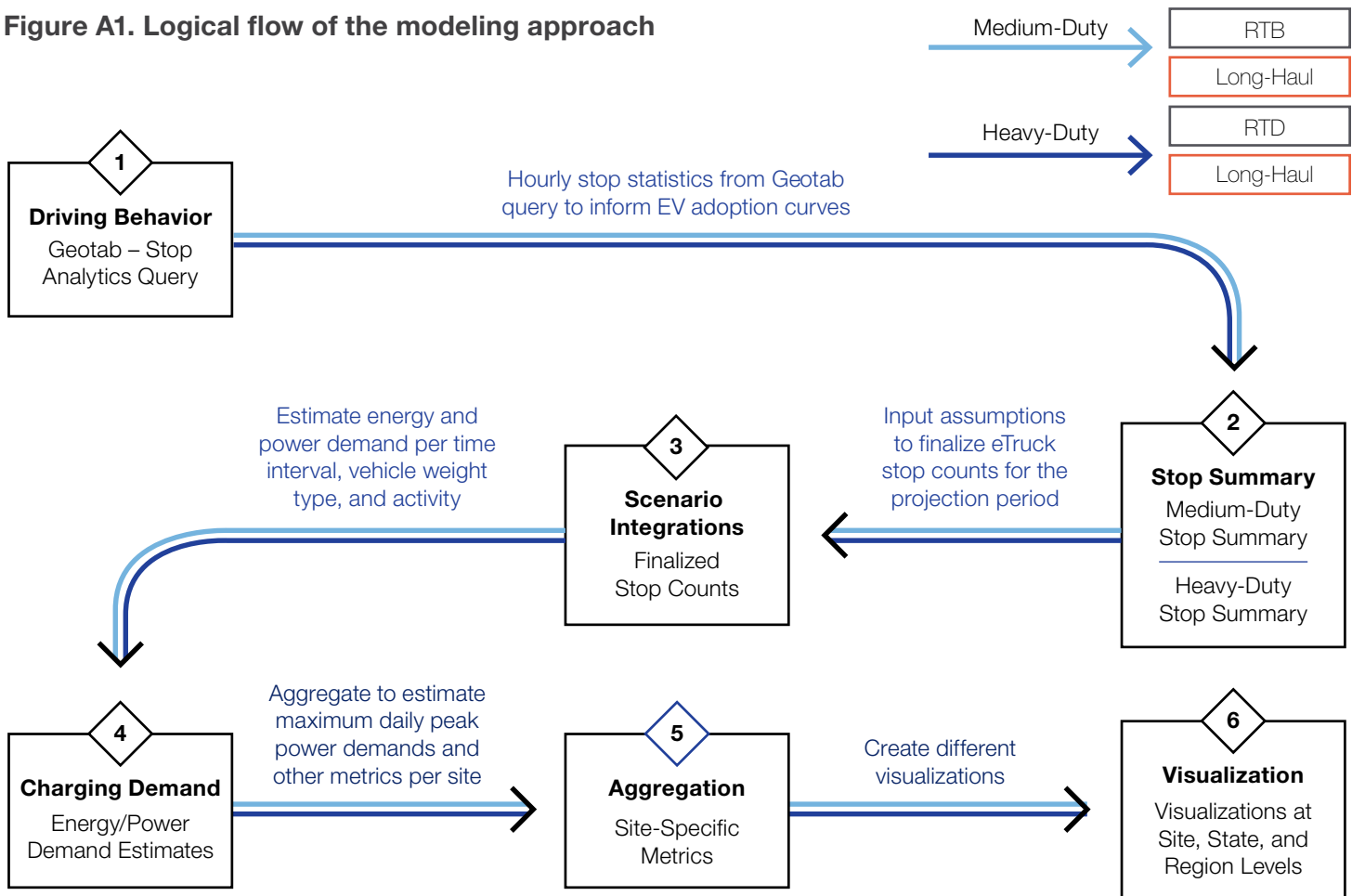
Appendices

Appendix A.

Corridor load analysis and forecasting

Figure A-1 presents the logical flow and modeling steps that form the basis of the study methodology.

Figure A1. Logical flow of the modeling approach



Input datasets

There are two primary inputs for projecting charging demands resulting from the electrification of MHDVs. The first is historical telematics data sourced from Geotab, and the second involves assumptions about future electrification scenarios. We first present a detailed overview of these two inputs, followed by an explanation of how they are utilized to estimate charging demands.

Historical telematics data from Geotab

For this project, we utilized Geotab data covering our study area for August and October 2023, as well as

January 2024. We extracted the stop summary data from the stop analytics module of the Geotab data platform. This module allows users to understand where vehicles are stopping and get contextual information regarding those stops. To ensure privacy, individual stops are not reported. Instead, stop summary data is aggregated over predefined (e.g., counties) or custom geographies. The steps to prepare Geotab data for analysis are as follows:

Defining zonal geographies

Using coordinates of site centroids, we established zonal geographies for each site. We carefully defined boundaries to prevent their overlap with nearby

commercial or residential areas. For sites with nearby facilities, we used precisely delineated polygons to define the service area boundaries. For more isolated sites, we applied 500-meter circular buffers to represent their geographical coverage.

Disaggregation based on vehicle type

We separately downloaded the Geotab stop summary data for medium- and heavy-duty trucks. Vehicle classification was guided by the US DOE's *Maps and Data Vehicle Weight Classes and Categories* document,³³ with classes 3–6 categorized as medium-duty trucks and classes 7–8 as heavy-duty trucks. For each vehicle weight class, stop summary data is reported separately across five vocation categories: Door-to-Door, Hub-and-Spoke, Local, Long-Distance, and Regional, with definitions provided in the Geotab documentation.³⁴ To align with scenario inputs, we aggregated stop summary outcomes into two broader vehicle activity types: Return-to-Base, combining Door-to-Door, Hub-and-Spoke, and Local, and Long-Haul, encompassing Long-Distance and Regional.

Data extraction and temporal resolution

For each site, vehicle weight class, and activity type, we extracted the following metrics:

- Number of stops
- Average and standard deviation of stop durations (in minutes)
- Average and standard deviation of pre-stop distances (in miles)

We retrieved the data at an hourly temporal resolution based on the hour that stop events occurred. The reported hourly numbers of stops pertain to the entire available 93 days. Therefore, we divided them by 93 to estimate the number of stops in each hour on a given day.

Disaggregation of stop summary data across vehicle weight classes and activity types

All metrics are pre-disaggregated by the two vehicle weight classes. To aggregate these metrics into the two broader vehicle activity types, we first summed the number of stops across their constituent vocation categories. Using the resulting stop counts, we calculated weighted averages for stop duration and pre-stop distance values. Because standard deviations for stop durations and pre-stop distances are not provided at the vehicle activity type level, we assumed the reported overall standard deviations for all stop events could be applied to each vehicle activity type.

Alignment with actual traffic data

To scale the Geotab data to represent the entire MHDV population, we applied expansion factors provided by Geotab for 2022. These factors are specific to each vehicle weight class and state, representing the proportion of the truck population captured in the Geotab data. We used these expansion factors to approximate total numbers of stops by multiplying reported numbers of stops by corresponding factors.

Table A-1 presents the derived stop summary statistics for stop events at a sample site.

Table A-1. Hourly stop summary statistics for an example site on a given day

Vehicle Type	Vehicle Activity	Hour	No. of Stops	Average Duration (min)	Standard Deviation Duration (min)	Average Distance (miles)	Standard Deviation Distance (miles)	Expansion Factor	Scaled No. of Stops
Medium-Duty	Return-to-Base	10–11	0.18	31.1	107.3	21.2	44.5	26.71	5
Medium-Duty	Long-Haul	10–11	0.17	54.4	107.3	20.3	44.5	26.71	5
Heavy-Duty	Return-to-Base	10–11	2.8	16.6	81.4	4.2	51.3	7.92	22
Heavy-Duty	Long-Haul	10–11	4.8	27	81.4	33.8	51.3	7.92	38

Analysis

Using the data sources and scenarios described above, we projected load curves for each site by simulating charging loads for each 15-minute interval through 2050. To align historical stop statistics with their projection counterparts, we applied daily scenario coefficients to the historical stop counts. Below, we elucidate the key steps to derive these projections.

Scenario development

The scenario development process produced daily coefficients reflecting trends in truck population, the adoption of BEVs and FCEVs, and the utilization of public chargers. We calculated these daily coefficients separately for BEVs and FCEVs. In each distinct set, we differentiated the coefficients by the two vehicle weight classes and their respective activity types.

Building on the reported stop summary statistics, we estimated the proportions of vehicles engaged in return-to-base and long-haul operations. Assuming these proportions remain constant over time, we applied them to annual vehicle stock projections, categorized by the two weight classes. This approach

yielded yearly vehicle stock projections across the four main segments analyzed in this study. Scaling the vehicle population projections for each segment to start at 1, we calculated the annual population growth rates. Incorporating yearly projections of electric MHDV adoption rates, we estimated total registrations and retirements of both ICE and electric trucks over the projections period, assuming a vehicle lifespan of 12 years. Subsequently, we allocated yearly shares of BEVs and FCEVs to total electric MHDV registrations to differentiate the registrations between the two powertrains. To estimate these yearly shares, we used a linear interpolation informed by the scenario inputs summarized in Table 2. Finally, we used a second linear interpolation to convert yearly total registration values into daily registration estimates.

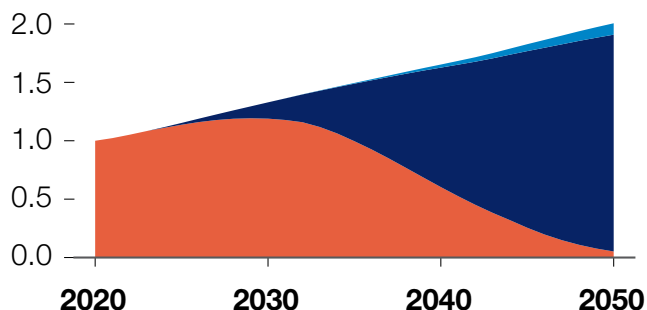
Figure A-2 shows the progression of total registration values and the powertrain split across the four segments analyzed in this study. Based on vehicle stock projections, sales scenarios, and electric powertrain split assumptions, the figure highlights the declining population of ICE vehicles being replaced by electric, particularly BEVs. Additionally, it captures the steady growth of FCEV population among heavy-duty vehicles.

Figure A-2. Total vehicle registration trends by powertrain

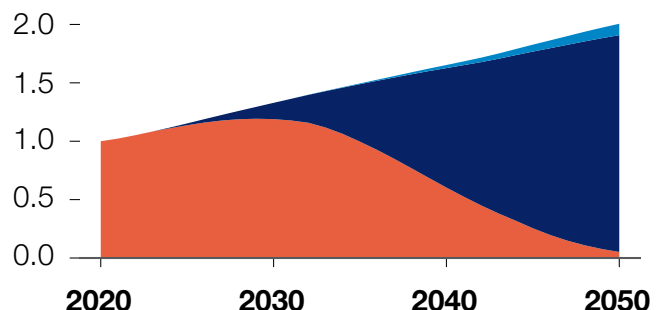
ICE BEV FCEV

Registration Coefficient

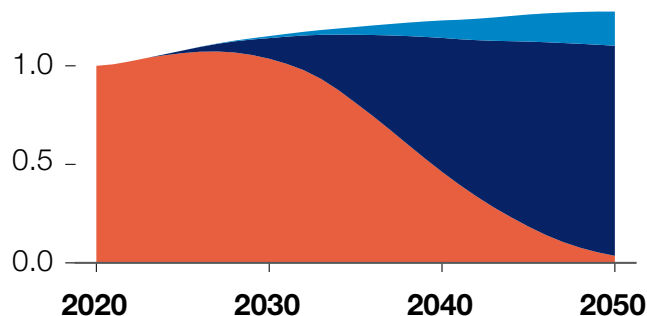
Medium-Duty Vehicle, Return-to-Base



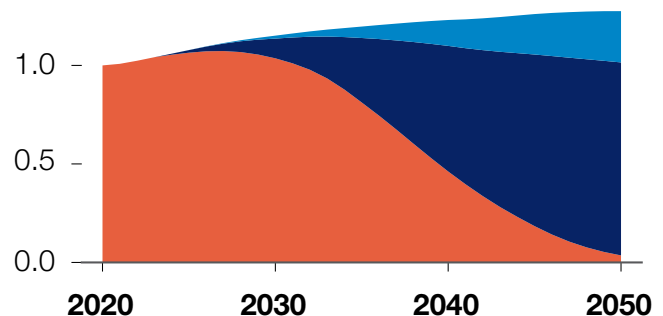
Medium-Duty Vehicle, Long-Haul



Heavy-Duty Vehicle, Return-to-Base



Heavy-Duty Vehicle, Long-Haul



Based on public charger utilization assumptions outlined in Table 3, we applied linear interpolation to estimate annual utilization proportions for the four segments. We then used a second linear interpolation to convert these annual proportions into daily values. By integrating these daily utilization proportions with daily total registration numbers, separated by BEVs and FCEVs, we derived two distinct sets of daily scenario coefficient values across the four segments.

Analytical approach

Power demand calculations for BEVs

Using the data sources and scenarios outlined above, we estimated the number of stops for each 15-minute interval across the projection period for the four main segments analyzed in this study. The estimation process began with the Geotab-reported hourly stop counts for each site. First, we applied state-level expansion factors, differentiated by vehicle weight classes, to approximate the actual number of stops, across both vehicle activity types, occurring at each site per hour. Next, we applied the BEV-related daily scenario coefficients to adjust stop counts to reflect future trends. Finally, assuming uniform distribution of stop counts within each hour, we allocated these counts evenly across the 15-minute intervals.

Using the stop counts for each 15-minute time interval and segment, we employed a Monte Carlo simulation approach to randomly determine the number of charging events. These events were modeled using a Poisson distribution, where the expected values of the distribution were set by the estimated stop counts.

For each charging event, we randomly sampled a distance value to the trip ending in the stop and a duration of the stop. The distributions of pre-stop trip distances and stop durations were assumed to follow lognormal distributions based on the parameters derived from Geotab data for the corresponding time interval.

Therefore, for each 15-minute time interval and segment, we estimated the number of charging events, and for each charging event we assigned a trip distance leading to the stop and the corresponding stop duration. Using these values, we explored two charge time variations: time-constrained and unconstrained. The time-constrained scenario limited the charge duration for each event to its assigned stop duration. Consequently, the power demand within the time interval was determined by the charger power rate and the portion of the interval during which the vehicle was stopped. In contrast, the unconstrained scenario allowed vehicles to remain at the charging site as long as necessary to fully recharge the energy depleted during the trip leading to the stop.^{viii} For each stop event, we calculated this energy requirement based on the pre-stop trip distance and the energy consumption rate, with assumptions of 1.3 kWh/mile for medium-duty vehicles and 2.5 kWh/mile for heavy-duty vehicles.³⁵

We examined two charger power rate variations — 350 kW and 1 MW — each directly affecting the amount of energy delivered during a given time interval. The future prevalence of these power ratings remains unclear because MHDV electrification continues to evolve. Although early MHDVs have been limited to more cost-effective 350 kW charging, 1 MW (or higher) is expected to become standard for long-haul class 8 trucks.^{36,ix}

For each site, we estimated power demands for all stop events, vehicle weight classes, and activity types across all time intervals throughout the projection period. We then aggregated these demands across the two vehicle weight classes and activity types to determine the total power demand for each time interval. This refined temporal resolution enabled the calculation of daily peak power demands and the identification of the maximum daily peak power demand for each year. By incorporating two charging time scenarios and charger power rates, we produced four distinct sets of annual maximum daily peak power demand projections.

^{viii} An alternative methodology to approximate en route charging was used by National Grid for England and Wales, where, based on industry insights, the authors modeled that between 70% and 90% of heavy-duty vehicle energy provision is done overnight at depot or destination, so the remaining 10%–30% could be provided by highway charging sites. National Grid (2022). Supporting the growth of clean transport. Retrieved from: <https://www.nationalgrid.com/document/146441/download>.

^{ix} eTRUC aims to develop and deploy innovative high-power (MW+) charging infrastructure along key freight corridors to promote the adoption of class 7 and 8 battery electric zero-emissions trucks.

Power demand calculations for FCEVs

To project power demand generations related to FCEVs, we explored four variations of hydrogen supply. Hydrogen is assumed to be dispensed in pressurized gaseous form (GH_2) at 700 bar because this approach can facilitate long ranges (up to 750 miles) and is at a higher level of commercial readiness than liquid fills.³⁷ The variations are:

1. Hydrogen is delivered to fueling stations via liquid tanker trucks. The general configuration for supplying liquid hydrogen includes a liquid hydrogen storage tank, cryogenic pump, evaporator, and dispensers. We assumed the energy cost per kilogram of hydrogen for a station with a throughput capacity of 4 tons per day to be 0.54 kWh/kg, which is related to pumping and evaporation.
2. Hydrogen is stored near the site location and supplied in GH_2 at 20 bar. The general configuration for this delivery type includes piping, compressor, high- and medium-pressure buffer storage, and dispensers. We assumed the energy cost for a station with the same capacity as above to be 5.59 kWh/kg, related to compression, pumping, refrigeration, and heat exchanger.
3. Green hydrogen is generated on-site by converting electricity and water to hydrogen via electrolysis. The process of splitting water into oxygen and GH_2 uses about 40 kWh of electricity to produce 1 kg of hydrogen, with the best commercial electrolyzes operating at around 50 kWh/kg of hydrogen.³⁸
4. Hydrogen is generated on-site using advanced technologies in electrolysis that will likely become more prevalent in the future, producing hydrogen at around 40 kWh/kg.³⁹

Drawing on the methodology developed for BEV-related power demand calculations, we first estimated the hydrogen required at each site (in kilograms). Using the four outlined hydrogen supply assumptions, we then calculated the corresponding power demands.

We calculated the hydrogen demand for each site using Geotab's stop summary data and FCEV-specific scenario coefficients. Because FCEVs have relatively short refueling times, we assumed an unconstrained refueling time scenario. For each refueling event, we assigned a pre-stop trip distance and start minute within the 15-minute interval.

Key inputs for fuel economy and tank capacity were provided by our team at NREL. Fuel economy values were set at 0.0334 kg/mile for medium-duty vehicles and 0.1070 kg/mile for heavy-duty vehicles. By combining these figures with pre-stop trip distances, we estimated the hydrogen consumption for trips leading to stops. To ensure accuracy, we capped the estimated hydrogen usage at the respective tank capacities: 6.64 kg for medium-duty vehicles and 43.20 kg for heavy-duty vehicles.

Winter effects of fuel efficiency

The Northeast region experiences cold winters, and winter affects the fuel efficiency of BEVs, primarily by slowing chemical reactions in batteries, which reduces their performance. Increased power consumption for heating the cabin and using defoggers further decreases efficiency. To assess the effect of cold weather on BEV-related power demands, we analyzed Geotab's stop summary records for January, selected as the representative winter month among the three available months. We adjusted our current battery efficiency values, in terms of energy consumption per mile, by increasing them by 30% for both medium- and heavy-duty vehicles. Applying the same methodology as before, we incorporated the revised fuel efficiency values to estimate the corresponding power demands.

Appendix B.

Additional ports analysis methodology

Drayage truck itinerary generation methodology

To assess the charging demand for drayage truck electrification, it is essential to understand the travel behaviors of these trucks. Key factors include fleet size, travel routes, daily mileage, stop locations, and dwell durations. These determine when and where the charging happens and how much energy the trucks need. This study utilizes two primary data sources: (1) daily truck visits from the website of PANYNJ, and (2) Geotab data.

Beyond visit counts, we used Geotab data to analyze OD patterns and stop behavior. For OD analysis queries, we geofenced PANYNJ ports as “zoneConnectors” to ensure journeys pass through them because other truck types typically do not.

The Geotab stop analytics identify vehicle stop locations and characteristics. We conducted two

queries: one with “maxStopDuration” set to two hours to identify stop locations for drayage trucks (these stop locations could be warehouses, distribution centers, rail yards, etc.), and another with “minStopDuration” set to six hours to determine their domicile locations (the locations where trucks shelter, which are potential sites for charging using lower-power chargers). Results included stop counts, unique vehicles, dwell time distributions, and hourly stop activity.

Using port visit data and Geotab OD/stop data, NREL developed a framework to generate synthetic drayage truck itineraries (see Figure A-3). Starting with 13,370 daily port visits, we assumed each truck makes two ports visits and four trips per day based on the National Cooperative Freight Research Program (NCFRP) (see Figure A-4),⁴⁰ following depot > port > warehouse > port > depot (see Figure A-5). Although some trucks may visit more often, we used this baseline, implying 6,685 unique trucks operate daily in 2024.

Figure A-3. Modeling framework for drayage truck itinerary generation

■ Input Data ■ Processing ■ Assumptions ■ Result

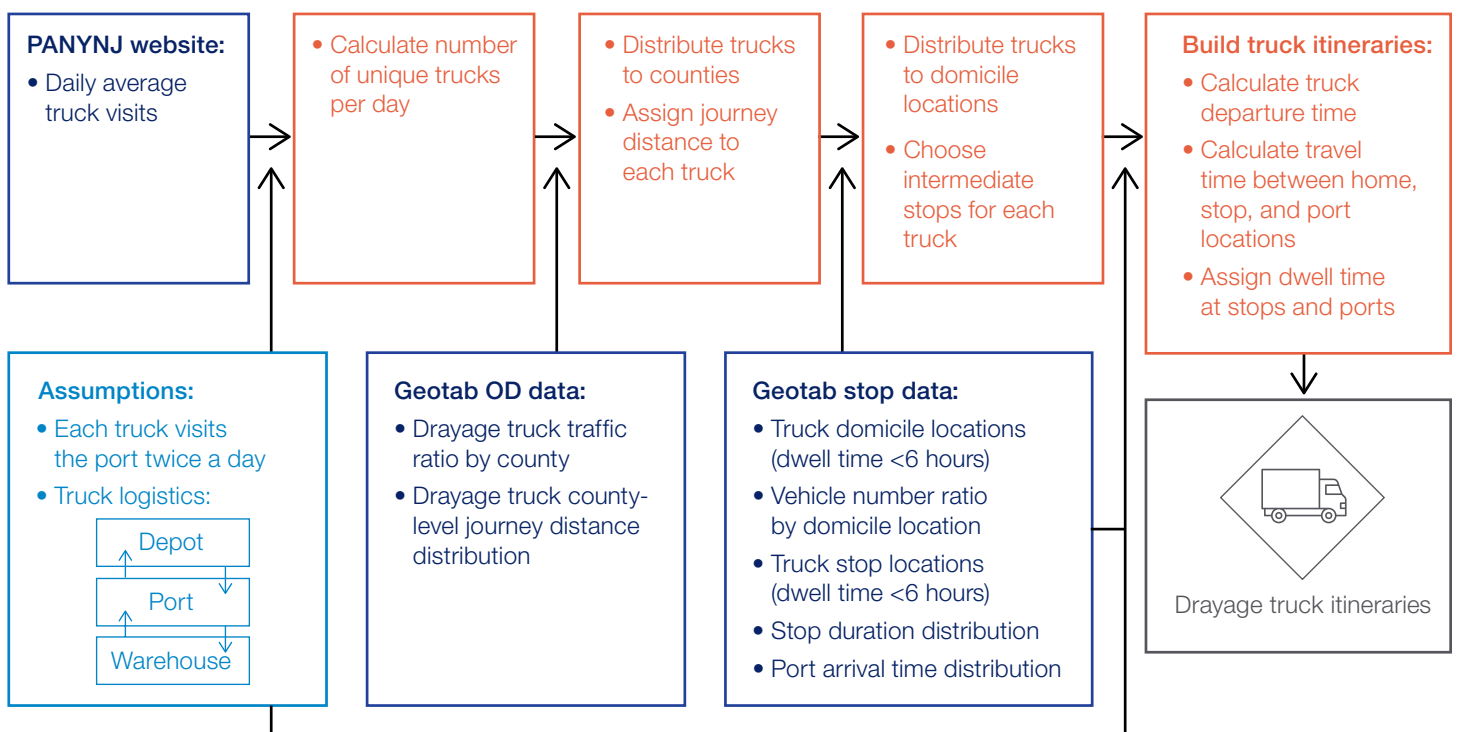
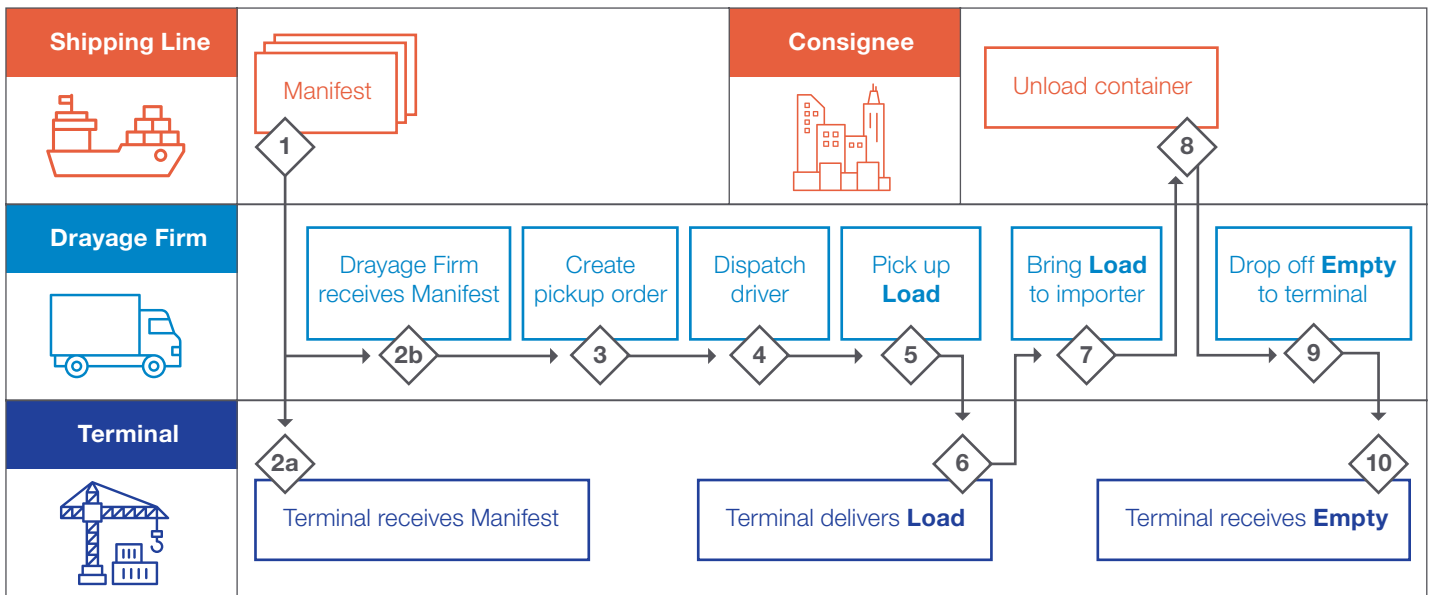


Figure A-4. (a) Import drayage process, and (b) export drayage process

(a) Import drayage process map



(b) General high-level export drayage process

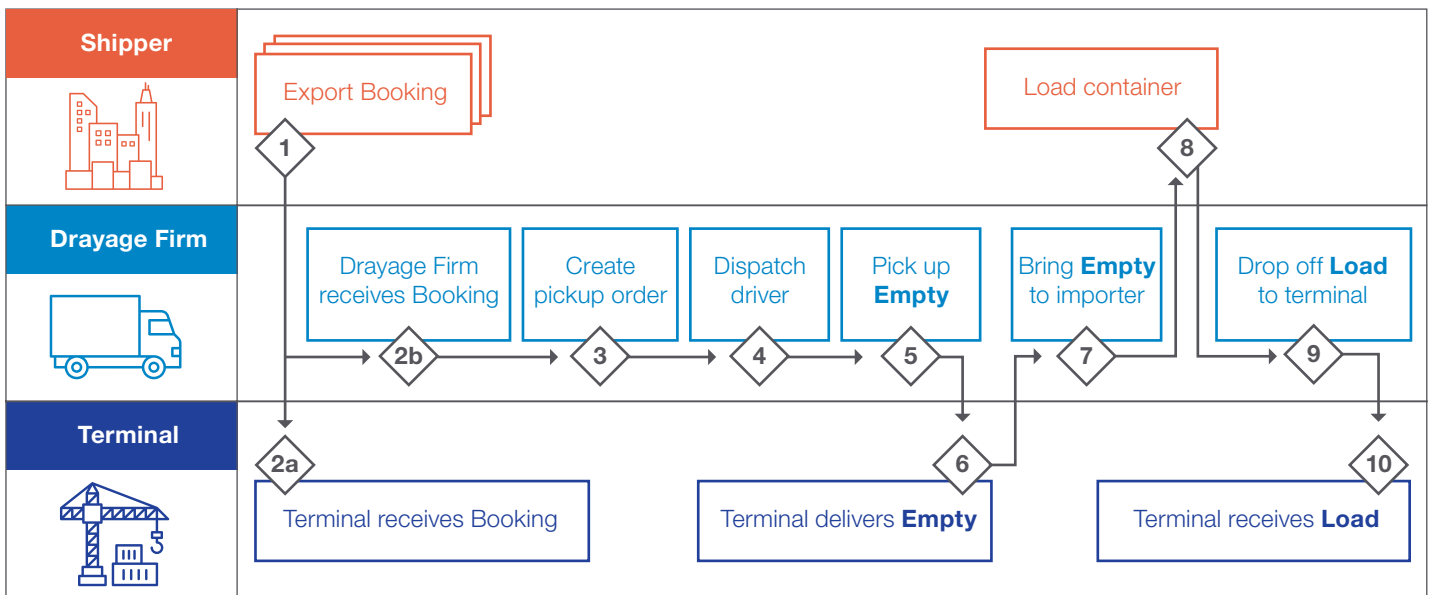
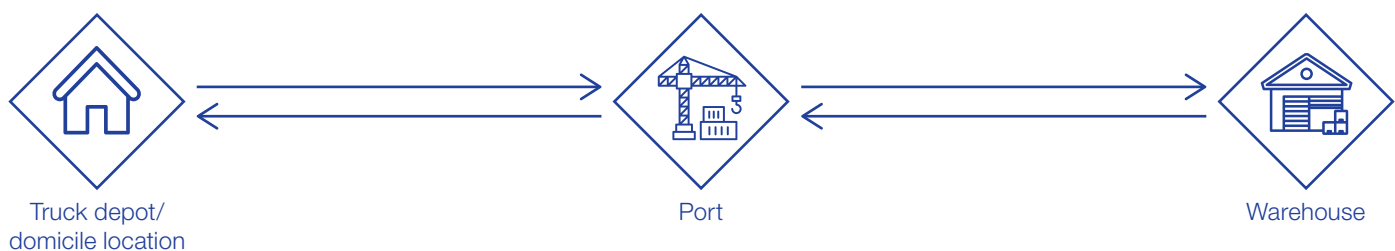


Figure A-5. A typical daily itinerary for a drayage truck



Because Geotab covers only part of the fleet, we scaled up using OD and stop distributions. Truck journeys were allocated by county using Geotab-derived ratios. Each truck was assigned a trip length based on its county's distribution.

Journeys were then assigned to domicile locations using Geotab stop data. With both domicile and distance defined, we added intermediate stops, drawn from Geotab-identified locations. To select feasible stops, for each drayage truck we:

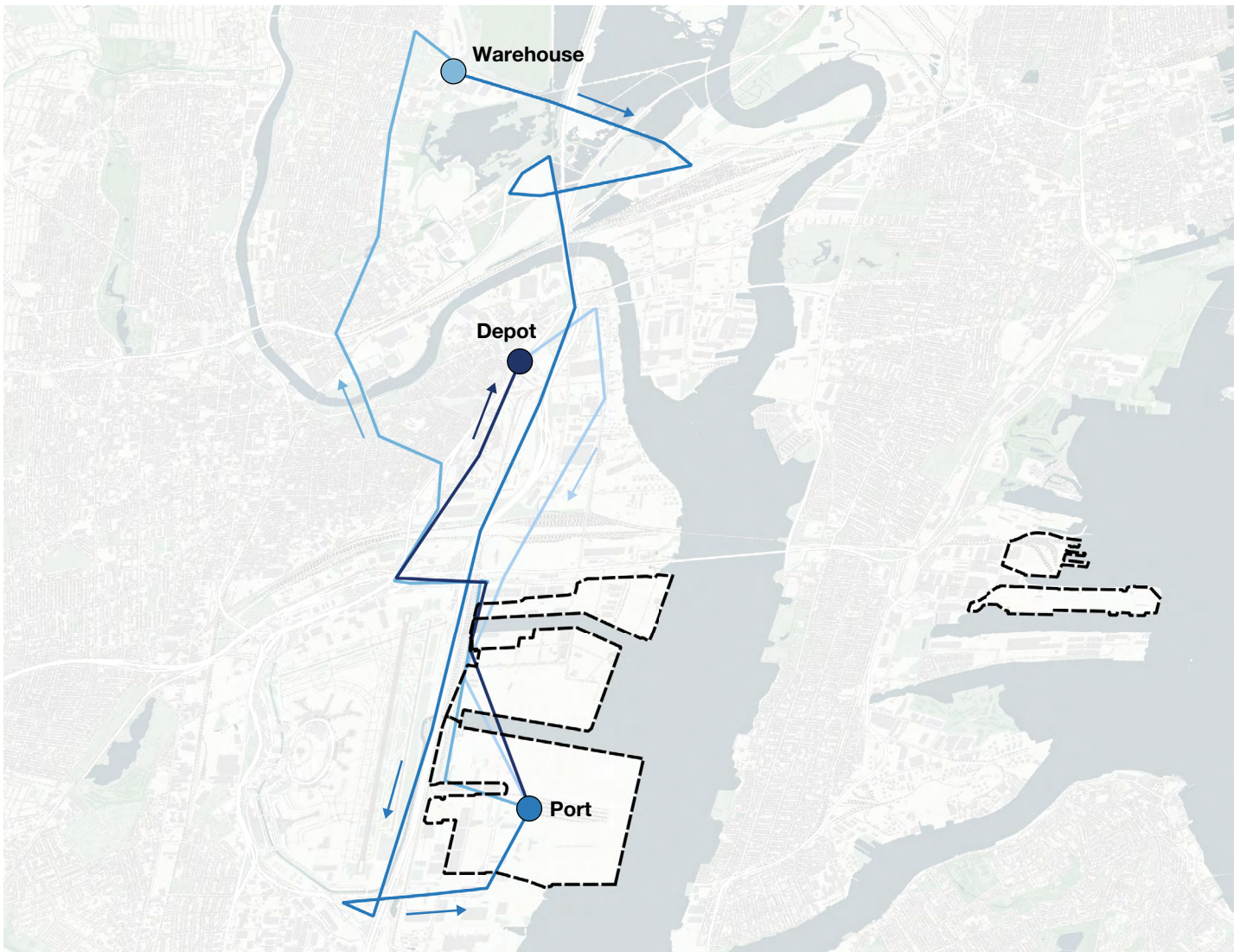
1. Calculated the distance between the truck's domicile location and the port.
2. Subtracted twice the domicile-to-port distance from the truck's total daily journey distance. This yields the remaining distance available for the intermediate

stop(s), assuming the first and last legs of the trip are between the domicile and the port.

3. Calculated the distance from each Geotab-identified stop location to the port.
4. Filtered out stop locations whose distance to the port is more than 20% longer or shorter than half of the remaining distance calculated in step 2.

Each final route includes four segments: depot > port > stop > port > depot. We estimated segment distances and travel times using Geotab speeds. Stop data informed arrival patterns and dwell durations at ports and intermediate stops. This produced a complete time-stamped itinerary for each truck (see Figure A-6).

Figure A-6. Example of a complete drayage truck itinerary

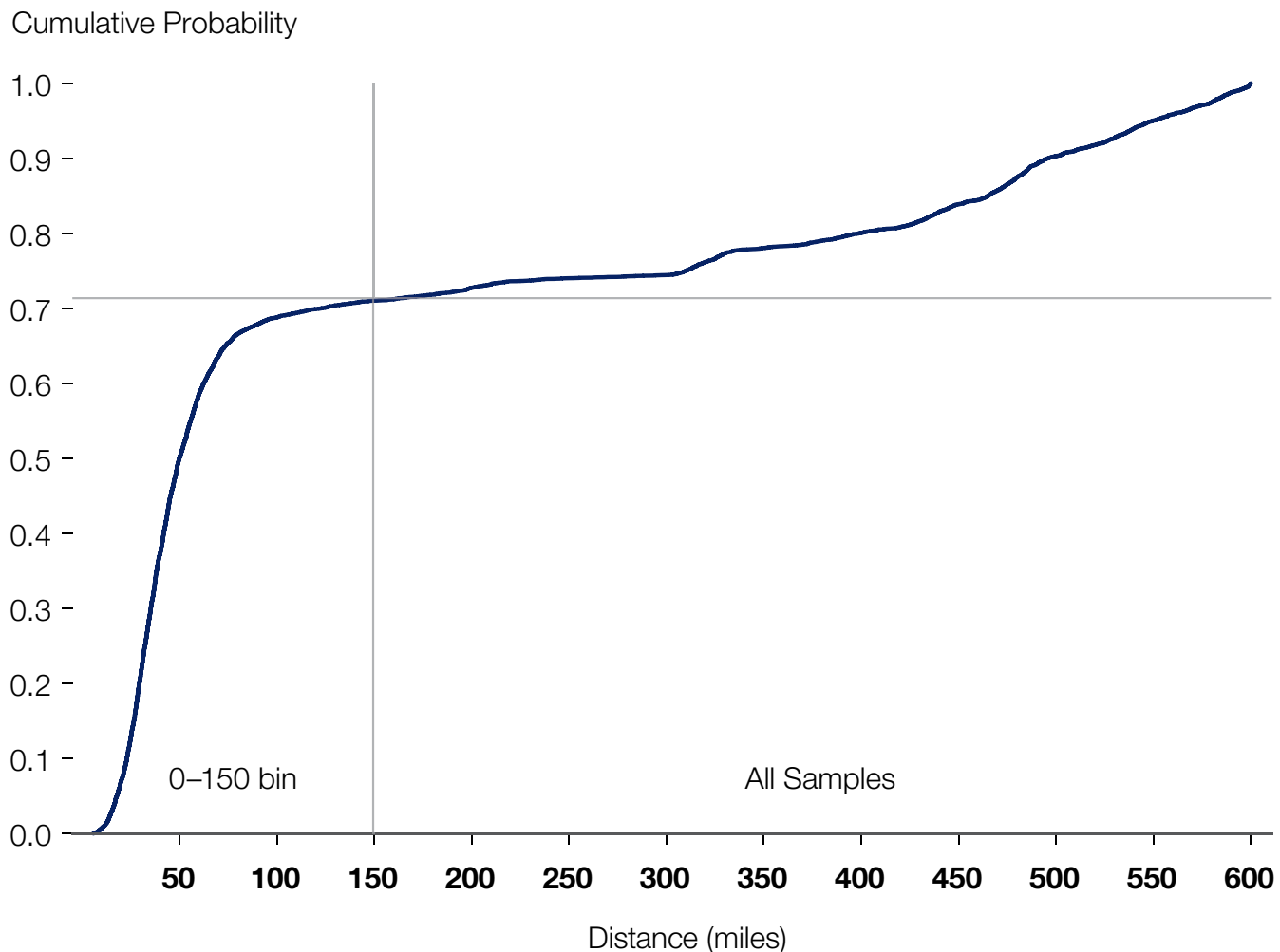


BEV adoption scenarios

The two sampling scenarios assumed for BEV adoption are the Randomized Journey and Short Journeys First scenarios. In the Randomized Journey scenario, drayage itineraries were randomly selected from the full set for BEV conversion. This maintained a consistent proportion of long and short trips over time, resulting in some very long-distance BEV itineraries from the start. In contrast, the Short Journeys First scenario prioritizes converting shorter journeys to BEVs to maximize early BEV asset utilization. The distance of the sampling bin gradually increased to reflect growing BEV adoption

as informed by registration modeling. For example, to estimate the itineraries for BEV drayage trucks in 2030, a 10% sample rate selects 815 itineraries. Figure A-7 illustrates the journey distance distribution and sampling bins. In the Randomized Journey scenario, the 0–600-mile area represents the full set from which 10% of itineraries were selected. In the Short Journeys First scenario, sampling begins in the 0 to 150 miles bin. As BEV penetration increases, sampling proceeds to the next bins (e.g., 150 to 250 miles) once earlier bins are exhausted. This ensures short journeys are prioritized while maintaining stochastic variation and injects stochasticity into the sampling process.

Figure A-7. Journey distance distribution from all drayage itineraries, and sampling bin for Randomized Journey electric adoption scenario and Short Journeys First electric adoption scenario



EVI-Grid National Framework: drayage vocation

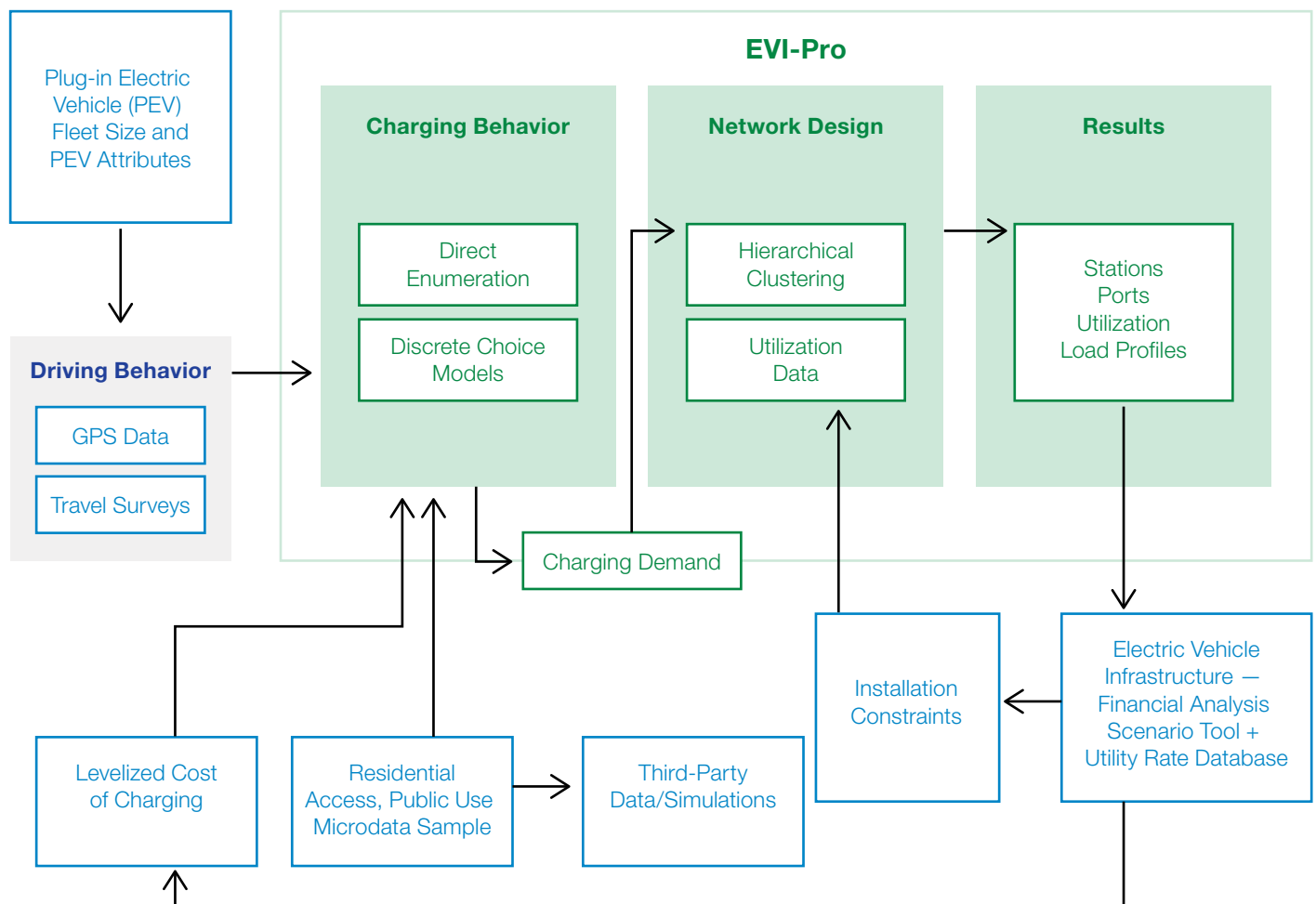
Drayage vehicle modeling with EVI-Pro was conducted through the EVI-Grid National Framework. EVI-Grid is a modular framework to streamline testing of customized scenarios within EVI-Pro. Taking vehicle itineraries as inputs, EVI-Grid matches charger definitions against vehicle dwell events and applies several data cleaning steps to travel itineraries. These data-cleaning steps include conversion of time steps to EVI-Pro's required format. For example, to help ensure each vehicle's starting state of charge (SOC) and ending SOC match, EVI-Grid determines which dwell event EVI-Pro should treat as the end of each vehicle's weekly schedule (typically the longest dwell event). Having conducted the required data cleanup, EVI-Grid is used to run EVI-Pro and writes its outputs to disk in a user-friendly format.

EVI-Pro uses high-fidelity data on vehicle operations, vehicle technology attributes, and charging

infrastructure characteristics to project network sizing and charging demand for various levels of EV adoption. Figure A-8 presents a block diagram illustrating the data flows within EVI-Pro. The model has been applied in several in-depth planning studies.⁴¹

For this study, EVI-Pro was used to simulate depot, opportunity, and en route charging for the drayage fleet. For drayage vehicle technology attributes, we assumed the deployment of BEVs with a 250-mile range and an average electricity consumption rate of 2.4 kWh/mile.⁴² For charging infrastructure deployment, we assumed the use of 150 kW DC fast chargers for depot charging and 350 kW or 1 MW DC fast chargers for en route charging. Long, predictable dwell times at the depot allow the use of 150 kW chargers to reduce up-front cost and high peak demand, compared with the higher-power chargers on the corridor charging locations, where a more stochastic dwelling behavior and shorter charging time are expected.⁴³

Figure A-8. EVI-Pro block diagram for charging behavior simulations and network design



Appendix C.

State, utility, local site impact, and load criteria scoring approaches

State criteria

SAAC members were asked to collaborate across agencies to develop a unified set of site rankings for each state. For every site, members assigned a rating of high, medium, or low for each state-specific criterion. To enable numerical analysis, these ratings were converted to values of 10 for high, 5 for medium, and 1 for low.

The final score based on state criteria, on a scale up to 25, was calculated by applying weighted values to each criterion and summing the results. Specifically, weights of 0.8 were applied to the site's physical space, 0.6 to proximity to fleets, 0.6 to site accessibility, and 0.5 to the cost to electrify from utilities.

Utilities criteria

UAC provided ratings for the investment cost and existing upgrade plans criteria. As with the state criteria, these ratings were assigned values of 1, 5, or 10, reflecting the relative favorability of each factor. Specifically, lower investment costs and inclusion in existing upgrade plans received higher scores.

The final score based on utilities criteria was calculated by summing the two ratings and multiplying the result by 1.25, aligning it with the same 25-point scale used for the state criteria.

Local site impact criteria

The initial values for each of the three local site impact criteria were scaled between 0 and 1, proportionate to the severity of each condition. This approach prioritized sites that would gain the most local impact benefits from electrification.

The final score was calculated using weighted contributions of 40% for health, 30% for air quality, and 30% for economic indicators, and was then scaled to a maximum of 25 points.

Load criteria

The 2030 and 2050 load forecasts for all sites were normalized by dividing each value by the maximum forecasted load for that year, resulting in values scaled between 0 and 1. These normalized values were then summed and scaled to a maximum of 25 points. This equal weighting across the two years ensured that both near-term and long-term load forecasts contributed equally.

Final score

Using an approach that assigned equal weight to each of the four criteria, the final score for each site, on a scale up to 100, was calculated by summing the individual scores from those criteria.

Appendix D.

Supplementary material for the results

State-level peak power demand and utilization results

Table A-2 summarizes the peak power demand in 2035 and 2050, along with the utilization rate

in 2035, for priority sites located in states outside of New York. Results specific to New York are presented separately in the *State results* section of the main text.

Table A-2. State-level peak power demand and utilization results of priority sites based on the central BEV scenario (time-unconstrained charging event and 350 kW charger power)

Site	State	Peak Power Demand, MW (2035)	Peak Power Demand, MW (2050)	% Utilization (2035)
2	Connecticut	4	10	20
7	Connecticut	3	7	12
10	Connecticut	3	6	13
26	Maine	4	10	19
31	Maine	2	5	10
33	Maine	2	5	8
37	Maine	2	4	10
13A	Massachusetts	3	8	17
13B	Massachusetts	5	14	19
16A	Massachusetts	5	14	24
16B	Massachusetts	5	12	19
49A	New Hampshire	2	3	9
49B	New Hampshire	3	7	11
46	New Jersey	5	15	23
47	New Jersey	8	27	19
100	Pennsylvania	6	15	18
104	Pennsylvania	11	32	30
106	Pennsylvania	5	14	18
107	Pennsylvania	6	19	31
120	Pennsylvania	5	14	25
122	Rhode Island	1	2	2
124	Vermont	1	2	1
125	Vermont	1	2	1
127	Vermont	1	2	4

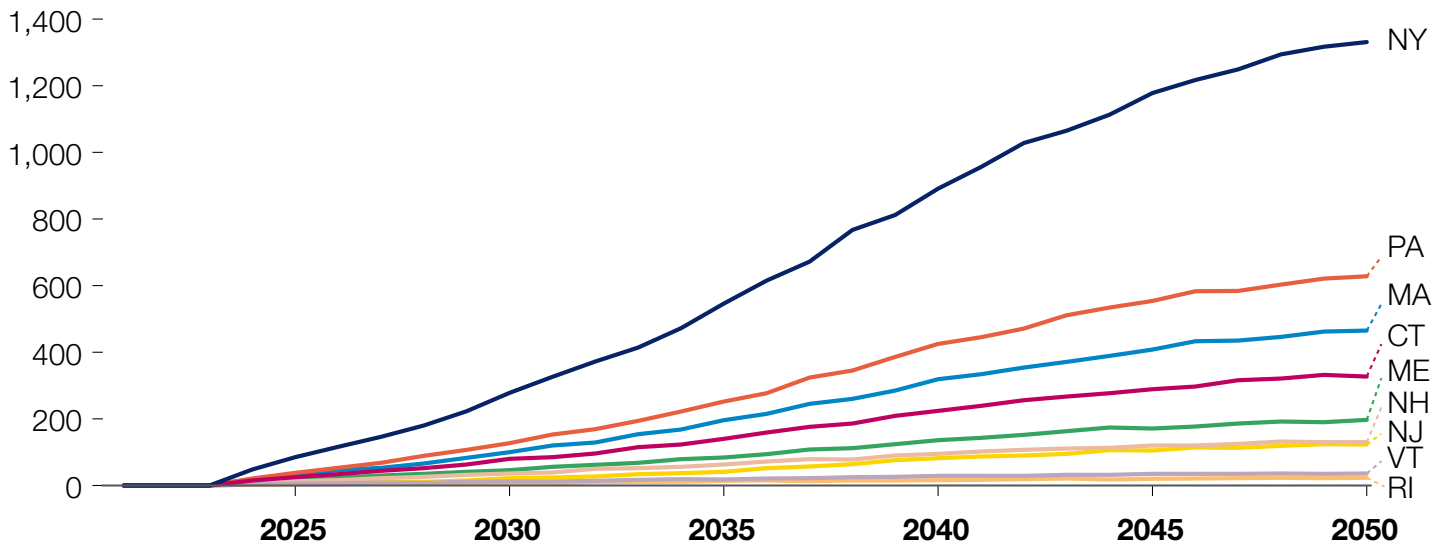
Charger requirements by state

Figure A-9 shows forecasts of the number of chargers required by state to meet annual peak demand based

on the central scenario. New York leads with more than 1,300 chargers at 350 kW power rate, followed by Pennsylvania and Massachusetts.

Figure A-9. Projected number of chargers (350 kW) required to meet annual peak demand by state based on the central BEV scenario (time-unconstrained charging event and 350 kW charger power)

Charger Counts (350 kW)



Overall electricity demand from the Port of New York and New Jersey drayage BEV fleet and comparison of adoption scenarios

The Randomized Journey BEV and the Short Journeys First BEV adoption scenarios produce very different energy demand estimates for corridors versus depots (see Figure A-10). In the Randomized Journey BEV adoption scenario where some long-distance drayage routes are electrified in the early years despite being longer than BEV range, corridor charging is required early and increases proportionally to the drayage fleet size. In the Short Journeys First scenario where BEV adoption is limited to the shortest drayage routes in early years, BEV drayage trucks can be charged at depots with a gradual increase of depot charging demand. Around 2043, electrifying longer drayage itineraries requires access to corridor charging. These two modeling scenarios provide an indication of potential electricity loads to accommodate drayage electrification based on current knowledge of technology and estimates of drayage operations. The actual load growth is likely to be somewhere in between these scenarios as fleet operations adjust

to actual rollout of charging infrastructure and BEV economics.

Summary data for the years 2030 and 2050 from these scenarios is listed in Table A-3. For the Short Journeys First scenario, the BEV drayage fleet could potentially be supported by depot charging in 2030 because all drayage itineraries selected for converting to BEV are under the 250-mile range. With more itineraries converting to BEV operations, longer trips that require corridor charging with 56% electricity consumption at the truck stops that provide corridor charging opportunities will be sampled in 2050.

Warehouse charging is observed with higher amount of BEV adoption. This represents the charging events happening when the drayage trucks are transloading at the warehouse locations. The total amount of energy consumed at warehouse charging locations is insignificant due to the limited time that the trucks are stopping there and the relatively low charging power level, 150 kW, assumed for warehouse charging (see Figure A-10).

Figure A-10. Projected electricity consumption for (a) Randomized Journey BEV adoption scenario, and (b) Short Journeys First BEV adoption scenario by the charging destination types, high port growth projection

■ Corridor ■ Depot ■ Warehouse

Energy (kWh)

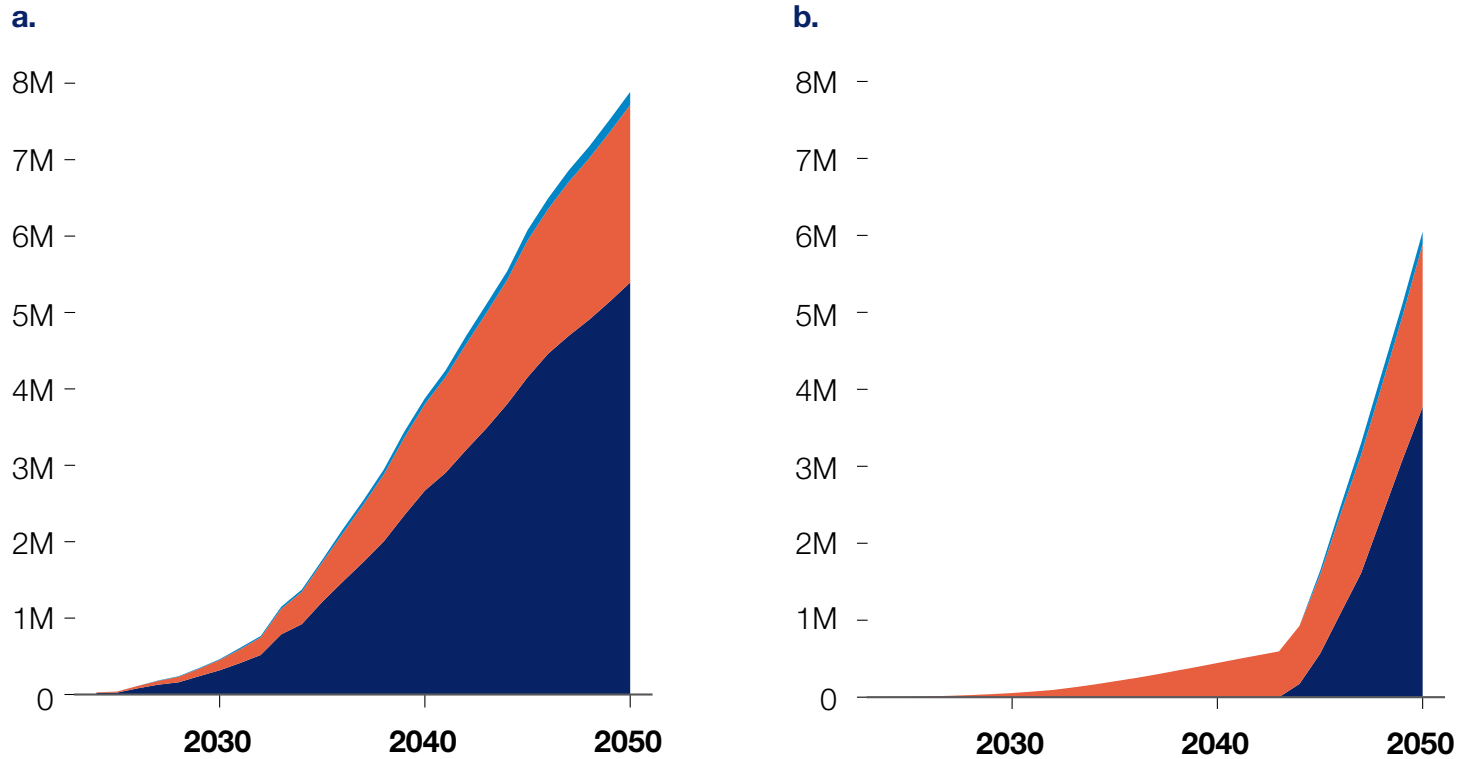


Table A-3. Projected daily electricity consumption by charging destination type, 2030 and 2050

Destination Type	Scenario 1: Randomized Journey		Scenario 2: Shorter Journeys First	
	Energy (kWh), 2030	Energy (kWh), 2050	Energy (kWh), 2030	Energy (kWh), 2050
Depot	135,869 (29%)	2,325,667 (30%)	53,815 (100%)	2,115,258 (35%)
Corridor	316,800 (69%)	5,392,848 (68%)	0	3,771,258 (62%)
Warehouse	9,610 (2%)	168,279 (2%)	0	162,327 (3%)

Table A-4: Drayage fleet peak demand in 2050 at 39 priority corridor sites

Site No.	Interstate	State	2050 Peak Demand (kW), Low Port Growth	2050 Peak Demand (kW), High Port Growth
46	95	New Jersey	20,037.5	29,446.67
77	81	New York	315	787.5
67	87	New York	350	700
107	81	Pennsylvania	309.17	525
122	95	Rhode Island	210	315
94	84	New York	87.5	262.5
106	80	Pennsylvania	87.5	221.67
10	91	Connecticut	175	210
69	87	New York	87.5	198.33
16A	90	Massachusetts	169.17	175
13B	90	Massachusetts	87.5	175
93	90	New York	87.5	175
62	87	New York	175	175
56	90	New York	87.5	175
47	80	New Jersey	87.5	140
16B	90	Massachusetts	175	87.5
104	80	Pennsylvania	0	87.5
90	81	New York	0	87.5
7	95	Connecticut	87.5	87.5
2	84	Connecticut	87.5	87.5

Note: The remaining 19 sites have “zero” drayage fleet peak demand.

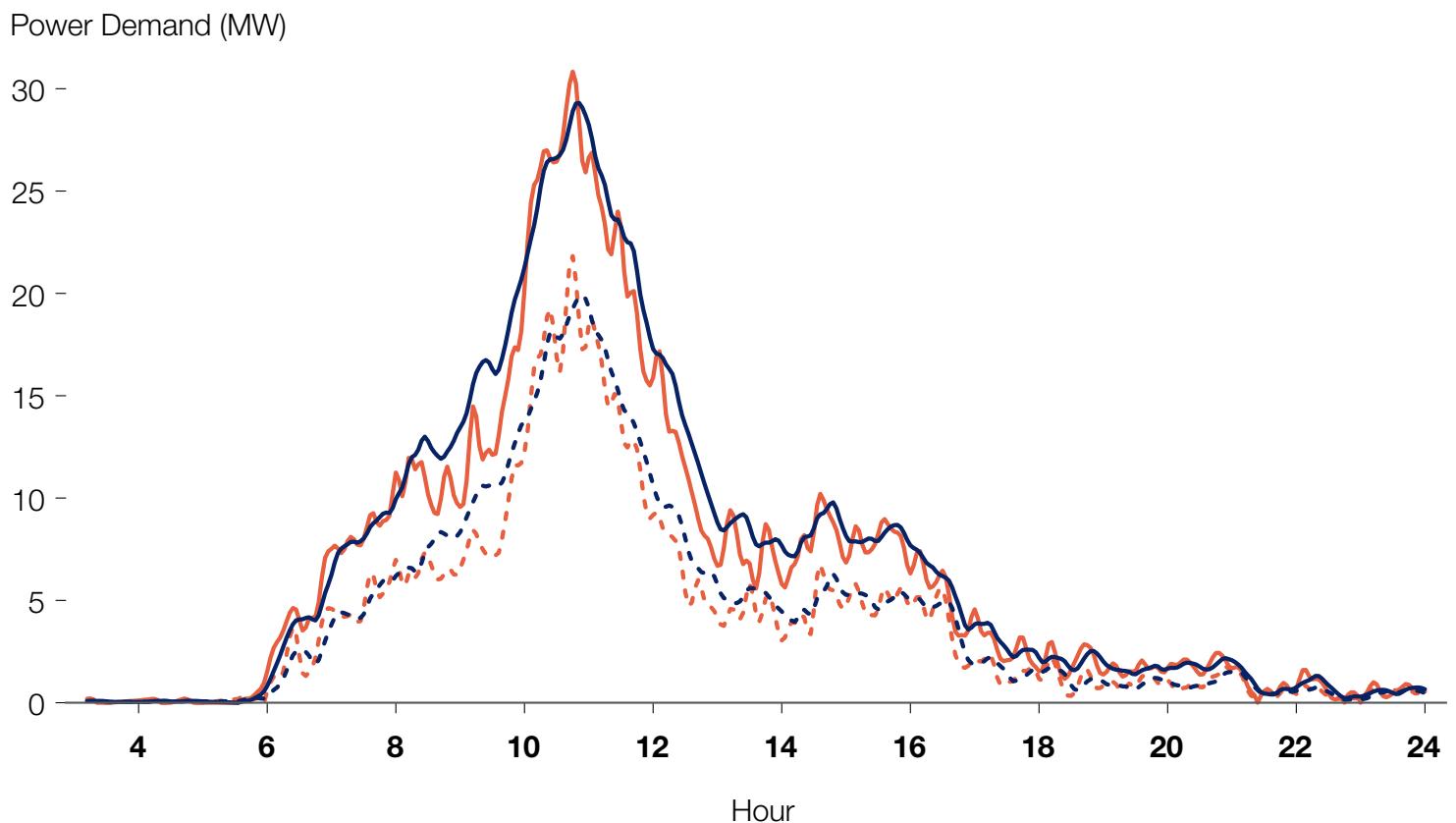
Hourly projections of peak power demand

Compared with the daily power demand distribution from the sample sites from the general freight corridor analysis, the daily power demand to support drayage operation at site 46 is less uniformly distributed (see Figure A-11). A large peak around 11 a.m. can be observed, followed by a smaller peak around 3 p.m. This is more correlated to the drayage trucks with

longer itineraries that approach the area near site 46 around those peak times. It is difficult to correlate this to the ports' operation time, but two peaks that are four hours apart may indicate the site could be used for inbound and outbound traffic in the morning and afternoon, respectively. A slightly higher peak with 1 MW chargers can be overserved compared to 350 kW. And the curve with 350 kW is slightly spread out to meet the same amount of total energy consumption.

Figure A-11. Daily electricity demand from drayage BEV charging demand in 2050

-- Low, 350 kW - - Low, 1 MW — High, 350 kW — High, 1 MW



Charger requirements to support drayage

Tables A-5 and A-6 provide projections of charging infrastructure requirements to support drayage operations across different contexts. Table A-5 presents

estimates of chargers needed at site 46, broken down by power level and port growth scenarios. Table A-6 shows the number of depot chargers required at the census tract level.

Table A-5. Projected corridor chargers needed at site 46 to support drayage fleet, by charging power level and port growth scenarios

Year	350 kW charger, High Port Growth	350 kW charger, Low Port Growth	1 MW charger, High Port Growth	1 MW charger, Low Port Growth
2030, 2040	0	0	0	0
2043	0	5	0	3
2050	337	229	127	93

Table A-6. Projected depot chargers needed at census tract level to support drayage fleet

Year	340170 02700	340390 35400	340139 80200	340130 07400	340170 06900	340170 14600	340399 80000	340130 07502	340170 12700	340170 05802
2030	10	6	3	3	6	5	4	0	4	3
2040	74	28	17	24	45	26	11	0	12	16
2050	86	77	68	48	45	43	42	39	29	22

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