Curb Enthusiasm

Deployment Guide for On-Street Electric Vehicle Charging

WXY

Barretto Bay STRATEGIES

NEW YORK STATE OF OPPORTUNITY. NYSERDA

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NEW YORK CITY DOT

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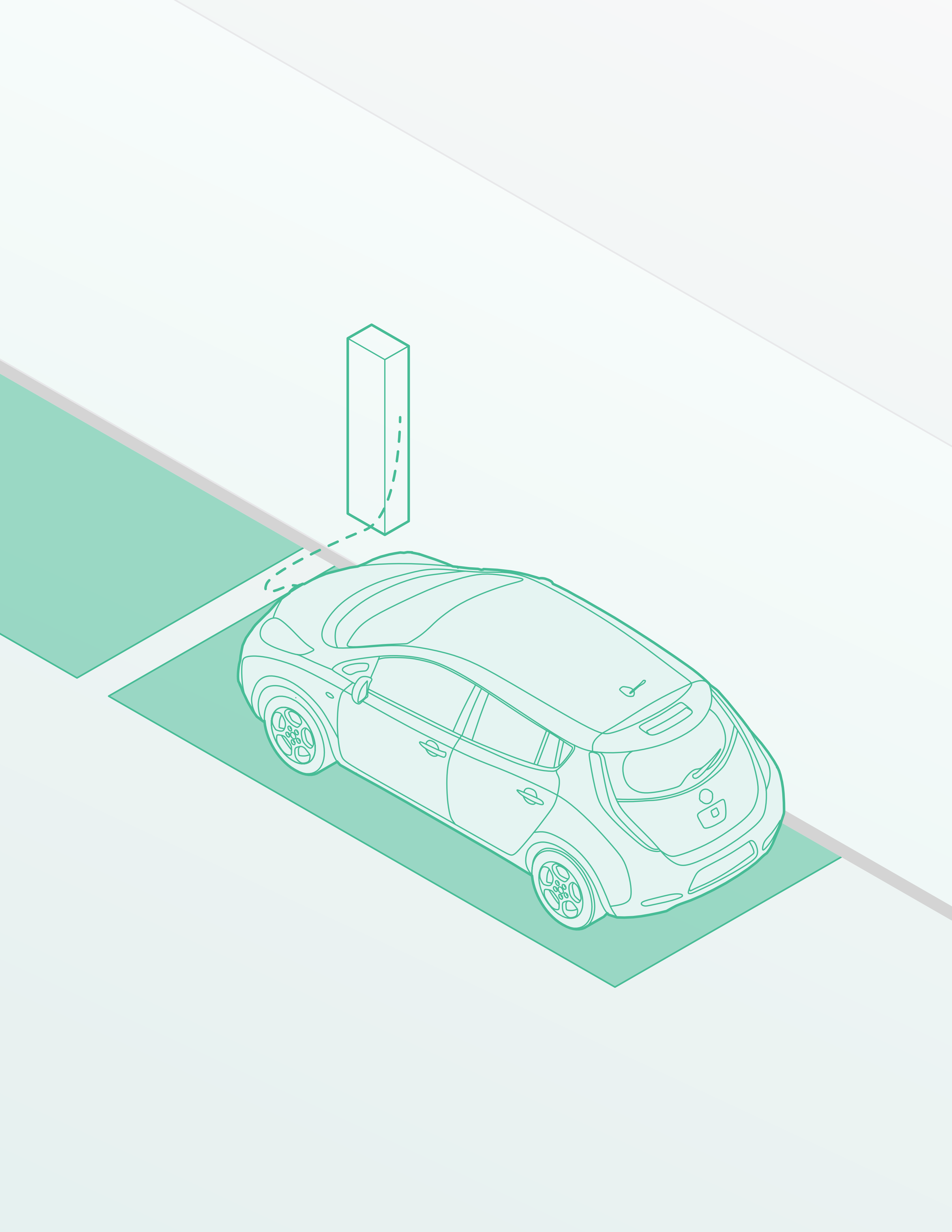

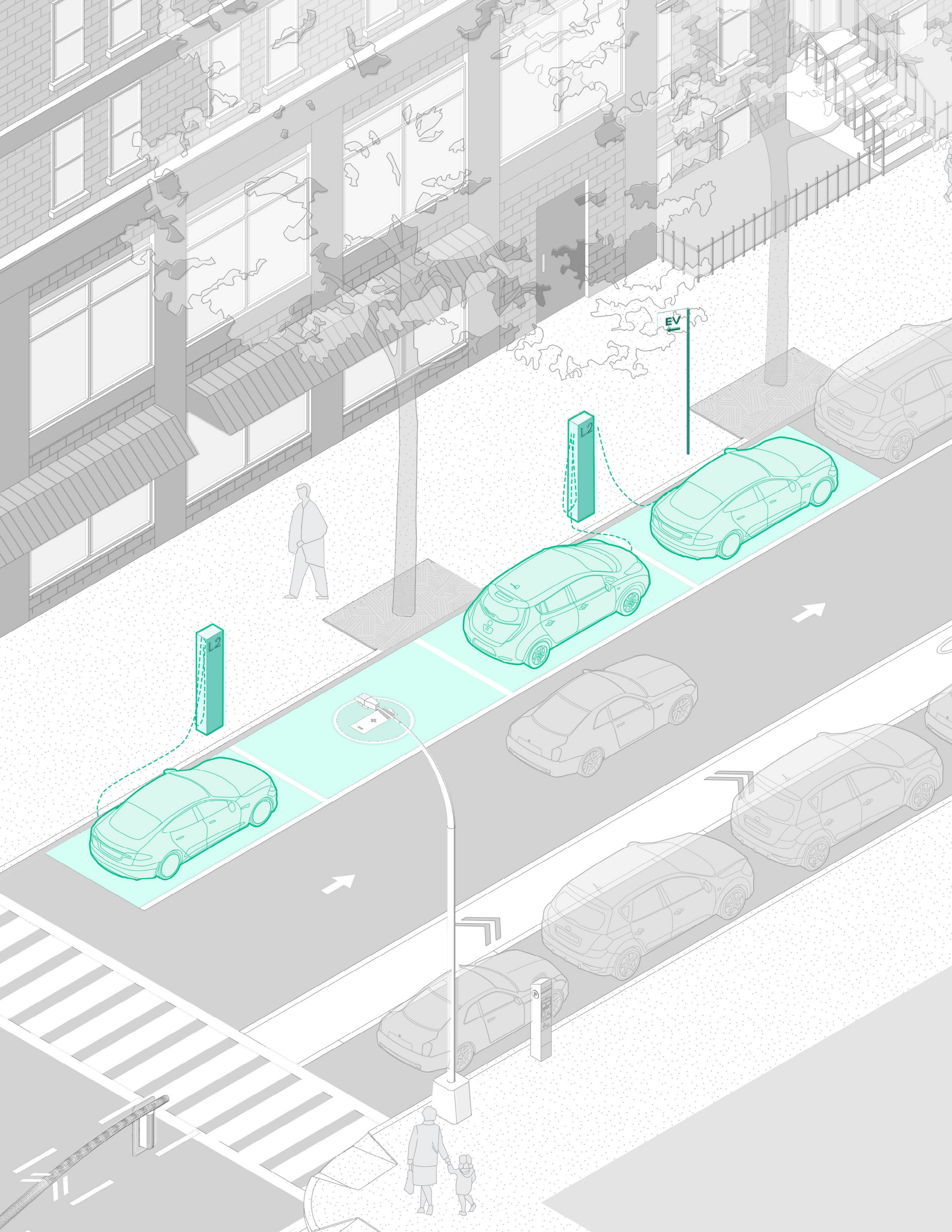
EV
L2
L2

Curb Enthusiasm: On-street Deployment Guide for Electric Vehicle Charging was independently produced by WXY architecture + urban design and Barretto Bay Strategies, based on stakeholder interviews, data and geographic analysis, and independent research. The report was produced in partnership with New York City Department of Transportation and the New York City Mayor's Office of Sustainability. The statements, designs and recommendations presented in the publication are not necessarily those of contributors or their affiliates.

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EV	Electric Vehicle
BEV	Battery-Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
ZEV	Zero-Emissions Vehicle
EVSE	Electric Vehicle Supply Equipment
GHG	Greenhouse Gas
ICE	Internal Combustion Engine
VMT	Vehicle Miles Traveled
A	Amps
kWh	Kilowatt-hour
kW	Kilowatt
V	Volts
SF	Square Foot, Square Feet

Agencies

AASHTO	American Association of State Highway and Transportation Officials
ADA	American With Disabilities Act
Con Edison	Consolidated Edison
DSNY	City of New York Department of Sanitation
FDNY	New York City Fire Department
MTA	Metropolitan Transportation Authority
NYCDCA	New York City Department of Consumer Affairs
NYCDCP	New York City Department of City Planning
NYCDEP	New York City Department of Environmental Protection
NYCDOB	New York City Department of Buildings
NYCDOE	New York City Department of Education
NYCDOT	New York City Department of Transportation NYC
LPC	Landmarks Preservation Committee
NYC Parks	New York City Department of Parks and Recreation
NYCMOS	New York City Mayor's Office of Sustainability
NYPD	New York City Police Department
NYSDOT	New York State Department of Transportation
NYSERDA	New York State Energy Research and Development Authority
PDC	New York City Public Design Commission

Executive Summary


T·Mobile·
metro
STORE
FOR RENT
212-239-8580
Mirage
NEW YORK
metroPCS
Authorized Dealer
OPTICAL
DENTAL
NO STANDING
Anytime
TATTOOS
PAWN SHOP
OPTICAL
DENTIST
B38
9501

A critical barrier to the successful large-scale adoption of battery electric vehicles in metropolitan areas is the availability of public access charging infrastructure. Charging electric vehicles in areas with limited off-street parking, where charging equipment is typically installed, becomes a perceptual and logistical barrier for prospective electric vehicle drivers who primarily park on-street. The targeted deployment of curbside Level 2 charging stations is one of the most catalytic ways that local governments can support a shift toward electric vehicles in cities.

With mounting public and private sector support for clean transportation alternatives, there has never been a more opportune time to develop a comprehensive electric charging ecosystem in New York City. Building out a robust public access charging network could set the City on track to achieve a goal of 20% electric vehicle (EV) market share of new car registrations by the year 2025.[1] This goal has been established in two guiding policy documents: the Mayor's Office 1.5° Climate Action Plan; and the New York City Department of Transportation (NYCDOT) Strategic Plan, which champions sustainable mode share and congestion mitigation.

Since private passenger vehicles alone are responsible for roughly 90% of New York City's transportation-related greenhouse gas (GHG) emissions, even a small uptick in EV adoption can create significant benefit. Policymakers should look for opportunities to replace passenger internal combustion engine (ICE) miles driven with EV miles, while also prioritizing a broader shift toward public transit, biking, and walking. Any new EV infrastructure program should be in alignment with a strategy to reduce the number of cars on the road and overall vehicle miles traveled (VMT) in the City. Such a strategy will relieve congestion, reduce GHG emissions, and set the City on track to reach an 80% sustainable mode share by 2050.[2]

To this end, Mayor de Blasio recently committed to invest $10 million in fast charging stations across the five boroughs, with plans for 50 fast charging stations citywide by 2020. Governor Cuomo has also announced a $250 million dollar initiative to expand electric vehicle supply equipment (EVSE) statewide.

Leading the charge from the private sector, Consolidated Edison (Con Edison), New York City's largest electric utility provider, has earmarked up to $20 million for demonstration projects that will support EV adoption in the region. Perhaps most catalytic in the near-term is Con Edison's

1 1.5° Climate Action Plan; NYC DOT Strategic Plan 2017 Progress Report

2 1.5° Climate Action Plan; NYC DOT Strategic Plan 2017 Progress Report

three-year pilot program in partnership with NYCDOT to install up to 60 dual-cord Level 2 curbside charging stations across the City starting in 2019. This opportunity for supporting changes in consumer behavior is significant for NYC, which has yet to deploy any charging infrastructure in the public right-of-way.

Even with rapid market growth and supportive initiatives, EVs still represented less than 2% of all vehicles in New York State in 2017. As EVs approach price-parity with conventional vehicles, the EV cost-savings case is likely to resonate with cost-conscious consumers and these vehicles will increasingly enter the mainstream. While owning an EV has never been more affordable, with new models rapidly entering the market at lower price points with greater range, continued EV market growth will hinge on the availability of adequate charging infrastructure.

Who are we planning for?

A curbside public access charging network in New York City would support:

1. Current and future EV drivers living in the five boroughs without access to private parking garages, lots, or driveways, and who currently store their vehicles on-street (known as "garage orphans").
2. Car-dependent commuters and visitors to the five boroughs.
3. Current and future public fleet vehicles that have on-the-go charging needs, and/or that cannot be accommodated in EVSE-equipped municipal parking facilities or depots.
4. Current and future private fleet vehicles and commercial passenger vehicles that have on-the-go charging needs and/or who store their vehicles on-street (e.g. taxis, carshare, rideshare).

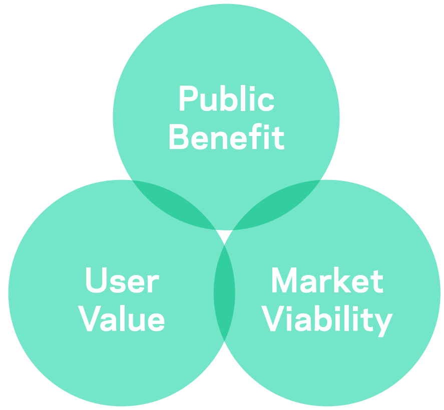


Figure 1: There are intersecting benefits for a public access charging network.

Level 2 charging is an economical way to jumpstart EV adoption. Level 2 stations present an advantage over other charging options in that they require less power than fast charging alternatives, and align with typical parking habits, allowing users to get an adequate charge in diverse contexts.

Curbside charging models using Level 2 EVSE have been piloted in a number of North American cities including Los Angeles, Indianapolis, Montréal, and Jersey City. However, New York City faces unique challenges in bringing power to the curb. A high premium for curbside space, as well as regulatory issues, liability concerns, and installation costs, all add a layer of complexity that is less present in other cities.

Determining the optimal pilot deployment zones, street sites, and design guides for EVSE infrastructure will help to overcome planning and implementation challenges and support pilot success. Taken alone, the value proposition of offering EV-only access to the curb, in a city where residents often lack off-street parking and compete for limited on-street parking spaces, creates a powerful incentive for prospective EV owners.

The guidelines that follow offer a roadmap for a citywide pilot deployment of Level 2 charging stations across New York City, addressing the specific market forces, policy imperatives and physical conditions that will govern any local EV infrastructure project of this scale.

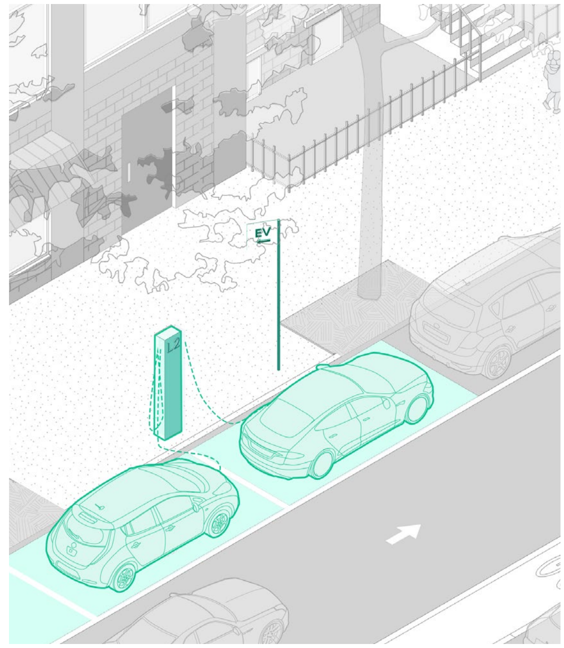


Figure 2: Curbside Level 2 EVSE is an economical way to jumpstart EV adoption in New York City.

Using the Guide

This guide, its recommendations, and case studies are the culmination of a year-long, broad-based feasibility study. Original research and conversations with national and international leaders in EVSE deployments, EVSE manufacturers, and local New York City policymakers have informed its recommendations for introducing Level 2 charging at the curb. The guide is intended to be a resource for New York City agencies as well as local governments looking to pilot curbside EVSE as the first step in a broader strategy to build an EV ecosystem.

The **Planning Framework** provides a scan of the EV market, planning principles to guide citywide roll-outs, and a cluster-based targeting approach for identifying high utilization deployment areas.

The **Deployment Guidelines** provide a scalar approach for identifying deployment sites starting with a citywide analysis, filtering for street types that can support Level 2 chargers, and then providing urban design guidance for seamlessly integrating chargers into the streetscape.

Together, the Planning Framework and Deployment Guidelines offer a strategy for balancing market considerations, geographic distribution concerns, technical feasibility, and urban design implications. While the recommendations in this report are tailored to New York City, they have broad applicability for other national and international cities.

Elements in an EV Ecosystem

An EV ecosystem incorporates the right EVSE into the urban environment in the right places.

1. **Level 1:** A basic charge standard (120 volts) that provides a slow charge of 2-5 miles of electric range per hour. Slow charge limits this charger's application to uses with long charge times.
2. **Level 2:** A more powerful electrical current (208 or 240 volts) that can charge 10-20 miles of range per hour. The fast charge rate and affordability of hardware and installation make Level 2 a viable option for all settings, including commercial and public access.
3. **Fast Charging Stations:** The most powerful widely available charge option provides 480 volts (direct current) charging, which can provide an 80% recharge for most battery electric vehicles in 30 minutes or less. Fast chargers are well-suited for public, commercial and fleet settings. However, high hardware and installation costs will limit curbside deployments.

Planning Framework


SHOE
BUG
DUNKIN' DONUTS
DENTAL
SUB
OPTICAL
LANE BRYANT
NYPD
POLICE

Replacing traditional internal combustion engine vehicles with electric alternatives offers an opportunity to immediately reduce greenhouse gas emissions and increase energy independence without drastic behavior change. Providing public access charging infrastructure is a critical step toward supporting this technology transition. Careful planning is also needed to facilitate the successful integration of new charging infrastructure into the public right-of-way, particularly in a dense urban context where curb space is highly constrained. The Planning Framework that follows offers an approach to identifying optimal zones for Level 2 charging station deployments in New York City with the goal of maximizing both utilization and community acceptance.

State of the EV Market

As of August 2018, there were an estimated 5,888 electric vehicles (EVs) registered in New York City, including an estimated 2,637 battery electric vehicles (BEVs).[1] Of the total EVs, 1,700 were registered to the Department of Citywide Administrative Services (DCAS), making New York City the cleanest municipal government vehicle fleet in the country.[2] Year-on-year growth of EV registrations in New York City has averaged 169% over the last four years, with 175% growth between 2016 and 2017, as shown in Figure 3.[3]

EV adoption is expected to accelerate further in the coming years with continued support from public incentives, new electric vehicle supply equipment (EVSE) networks, and improved battery technology. While estimates vary widely, it is predicted that EVs will achieve mass adoption in the United States within the next 15 years, and will soon cost the same as their internal combustion engine counterparts.

Despite increasing penetration and an expanding product portfolio, the EV market is still in its infancy relative to the broader U.S. car market. Sales of light passenger EVs in 2017 hovered around 1% of national

Top Battery Electric Models in New York City[3]

1. **Tesla Model S**
2. **Tesla Model X**
3. **Nissan Leaf**
4. **Chevrolet Bolt**
5. **Kia Soul EV**

Source: NYSDMV (as of December 2017)

1 Charge NY, "Electric Vehicle Registration Map," 9/01/2018, https://www.nyserda.ny.gov/All-Programs/Programs/ChargeNY/Support-Electric/Map-of-EV-Registrations
2 DCAS, "City Fleet Vehicles get 100 Miles Per Gallon," NYC FLEET, 9/7/2018
3 See Appendix D for methods. NYSDMV, "Vehicle, Snowmobile, and Boat Registrations," VIN analysis by Energetics Incorporated.

auto sales.[4] EV registrations in New York City over the same period represented about 0.7% of all passenger vehicles.[5]

Leading automakers have responded to this opportunity and are rapidly expanding their EV offerings. General Motors, Toyota and Volvo have all declared a target of 1 million in EV sales by 2025. BMW has also stated that it will offer 25 electrified vehicles, of which 12 will be fully electric, by 2025. Other luxury auto manufacturers have committed to shifting to all-electric fleets in the next few years. These newer models tend to feature longer driving ranges, faster charging rates, and lower sticker prices.

Nonetheless, the EV industry still needs to overcome significant challenges related to battery capacity and charging infrastructure. Adopting a common standard for EV charging, deepening the collaboration between auto manufacturers and EVSE suppliers, and continuing the provision of incentives and subsidies will all support continued market growth. In dense urban centers where off-street parking is limited, the expansion of public access curbside charging infrastructure is critical to increased local adoption.

EV Growth in New York City 2008-2017

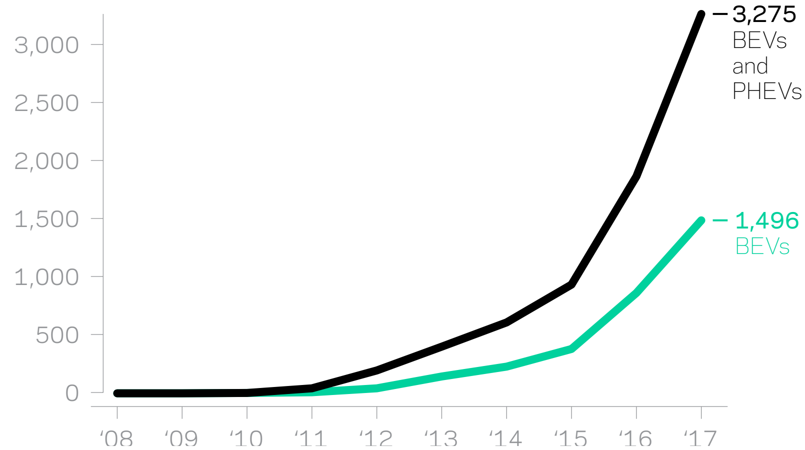


Figure 3: Passenger EV Registration Growth in New York City has averaged 169% over the last four years.

vehicles.[6] In order to achieve the City's sustainability goals, New Yorkers will need to further embrace EVs. EVs powered by New York City's grid emit only 30% - 43% of the GHGs emitted by conventional ICE cars.[7]

Benefits of Curbside EVSE

The strategic deployment of curbside EVSE promises a range of environmental, consumer, and market benefits.

REDUCE GHG EMISSIONS

Transportation accounts for nearly a third of all GHG emissions in New York City. More than 90% of emissions come from on-road vehicles.[6] In order to achieve the City's sustainability goals, New Yorkers will need to further embrace EVs. EVs powered by New York City's grid emit only 30% - 43% of the GHGs emitted by conventional ICE cars.[7]

PROMOTE EV ADOPTION

Building a robust and visible curbside charging network can reduce range anxiety and remove perceived barriers to EV ownership. Studies show that the availability of public access charging strongly encourages EV adoption.[8] Dedicating on-street parking for EV charging also creates a powerful incentive for prospective EV owners.

ADVANCE PUBLIC INITIATIVES

New York City's Local Law 160 (2016) established an EV Advisory Committee and a charging pilot program that mandates the installation of at least 25 EVSE in publicly accessible locations by 2020. Mayor Bill de Blasio has committed to investing $10 million in charging infrastructure citywide. Under Governor Cuomo's Charge NY initiative, New York State plans to deploy 3,000 new charging stations for an expected 30,000 new EVs statewide by the end of 2018. The New York State Zero Emission Vehicle (ZEV) Mandate sets aggressive clean vehicle sales requirements, and the Drive Clean Rebate Program offers up to $2,000 off eligible EVs from registered auto dealers.

4 ICCT, "California's Continued EV Market Development," May 2018, https://www.theicct.org/sites/default/files/publications/CA-cityEV-Briefing-20180507.pdf
5 NYSDMV, "Vehicle Registrations," 2018.
6 NYCMOS, "Roadmap to 80x50," 2016.
7 National Research Council, "Transition to Alternative Vehicles and Fuels," National Academies Press: 2013.
8 Peter Slowik & Nic Lutsey, "Expanding the EV Market in U.S. Cities," ICCT, July 2017.

MAXIMIZE PUBLIC INVESTMENT

Research shows that the deployment of public access charging infrastructure offers the highest ratio of consumer benefit to state investment among all forms of government EV market support.[9]

Planning Principles

In order to support the planning and design of a curbside charging pilot program in New York City, the team undertook a strategic planning process that draws on the following planning principles. These principles represent the best practices demonstrated in other cities with successful curbside charging networks, as well as the specific constraints, opportunities and planning objectives found in New York City.

SUPPORT MULTIPLE USER GROUPS AND USE CASES

By identifying and supporting multiple user groups, public sector decision-makers can optimize the utilization of new curbside infrastructure and EV parking spaces, while also minimizing the likelihood of creating a "stranded asset." Thoughtful siting that factors in 24-hour users can also support the carbon mitigation efforts of other users at the curb, including fleets, food trucks and emergency vehicles with on-board power requirements. Refrigerated grocery delivery services and other businesses that employ a hub and spoke service model could also use the power at the curb.

9 Li, Shanjun and Tong, Lang and Xing, Jianwei and Zhou, Yiyi, "The Market for Electric Vehicles: Indirect Network Effects and Policy Design," May 2016, http://dx.doi.org/10.2139/ssrn.2515037

REPLACE ICE VEHICLE MILES TRAVELED WITH ZERO-EMISSION VMT

This study seeks to identify several cohorts of commuters who are typically auto-dependent, especially resistant to mass transit incentives and access, and whose daily travel is within the operational range of commercially available EVs. Instead of simply micro-targeting current or past EV drivers, this strategy offers the greatest likelihood of replacing ICE miles with BEV miles among the likely next wave of EV owners. This approach enables policymakers to facilitate EV uptake without inducing additional vehicle use for local travel, complementing other congestion mitigation efforts underway. Across each proposed deployment scenario, the objective is to never induce driving, but always to replace ICE miles with BEV miles.

IDENTIFY STREET CONDITIONS THAT OPTIMIZE LEVEL 2 UTILIZATION

To avoid extended dwell times at an EVSE-equipped parking space, the study seeks to identify street typologies where regulations encourage regular vehicle turnover and likely demand ensures optimal utilization. Once a week alternate side parking rules could, for example, result in week-long furloughs in a designated space by a single BEV. In contrast, regular street cleaning, metered curbside spaces, and other time-limited zones can help support favorable charging turnover. Vehicle turnover and optimization amplify the public benefit of EVSE and accelerate the return on investment for the EVSE operator.

PLAN FOR MAXIMUM INCLUSIVITY AND BROAD DISTRIBUTION

To ensure that access to public EVSE infrastructure is not limited to small groups of early adopters, the study seeks to identify deployment scenarios in underserved areas, environmental justice communities, and neighborhoods that have low levels of BEV ownership but a significant share of inbound car commuters, and hospitals, as examples. Recognizing that any charging station deployment can and should confer benefits to the broader public and not simply to the immediate user, the study highlightapproaches that maximize air quality benefits near vulnerable populations.

USE DATA-DRIVEN METHOD TO IDENTIFY DEPLOYMENT ZONES

While stakeholder interest, local consensus-building, and even online request forms can drive the site selection process in some jurisdictions examined by the project team, this study seeks to provide decision-makers with a data-driven approach to supplement other qualitative considerations.

MINIMIZE OVERALL DISRUPTION

In locations where on-street parking is at a premium, any repurposing of existing parking inventory can be disruptive to local stakeholders. Deployment scenarios should prioritize installations that residents, businesses, and institutional stakeholders support so that any pilot program has strong community acceptance.

Cluster-Based Targeting

A cluster-based approach to EVSE siting, described in Figure 4, prioritizes car-dependent users and incorporates a geographic understanding of where EVSE demand converges with potential partnerships that will make one type of place more successful than another.

Certain vocational cohorts are especially car-dependent and work set shift hours that therefore create opportunities for predictive demand at curbside locations near their workplaces. There are several dominant car-dependent vocational cohorts in New York City's workforce including healthcare workers and hospital personnel, certain higher education personnel and students, municipal workers, and public fleet operators. Residential areas where a majority of vehicles are parked on-street also create clusters of "garage orphans", where curbside charging would greatly benefit residents and remove barriers to further EV adoption.

Areas with multiple institutions that support a largely car-dependent workforce and accept a large volume of visitors, can be considered a "cluster" where utilization may be optimized.

In addition to specific vocational cohorts, planning for other users who stand to benefit from curbside power will help accelerate the return on infrastructure investment and improve the business model for utilities.

Potential users who stand to benefit from curbside power include:

- Public and Private Fleets
- Electric Carshare Vehicle Parking
- Auto Dealerships
- Pedal-Assist eBikes
- Emergency Vehicles
- Grocery Home Delivery Vehicles

In all cases, the City has an abiding policy interest in reducing GHG emissions, which can be supported with a switch to electric.

MEDICAL CAMPUS

Healthcare workers
Hospital visitors and services

Medical campuses tend have a largely car-dependent workforce amplified by shift workers who have fewer and less frequent off-hours public transit options. Often, parking for visitors and employees spills out of garages onto the curb.

HIGHER EDUCATION

Higher education personnel and students
School visitors and services

Post-secondary education is a significant driver of New York City's economy and draws employees and students from across the region. Outer borough campuses isolated from public transit have high proportions of auto commuters.

PUBLIC SECTOR

Municipal workers and visitors (e.g. DOE, FDNY, NYPD)

Municipal employees in New York City drive at higher rates than private sector employees. 30% of municipal workers live outside the City and that this sector has the third longest average commute time (according to "Fast City, Slow Commute," a March 2016 report on commuting patterns). Many municipal employees work shifts at workplaces far from transit options, contributing to their car dependency.

NEIGHBORHOOD CENTER

Residential "Garage Orphans"
Local commercial visitors and employees

Neighborhood centers are the most prevalent neighborhood type in NYC, with a mix of commercial and residential uses. Drivers in neighborhood centers with high car ownership, especially those without substantial new residential construction, tend to store their vehicles on-street. "Garage orphans" have fewer opportunities for EV ownership without charging where they park: on street.

LEISURE DESTINATION

Employees and visitors
Fleet needs

Parks, public pools, cultural institutions (museums and science centers), stadiums and other major institutions are examples of leisure destinations that offer a good opportunity for EVSE exposure and top-off charging. These destinations may also have EV fleet charging needs. While some of these destinations have dedicated garages or lots, many visitors, especially in denser areas of the City, spill over to the curb.

Figure 4: Optimal clusters of institutions and user cohorts for curbside Level 2 deployments.

Deployment Guidelines

The guidelines that follow offer a feasible and scalable strategy for deploying curbside Level 2 charging infrastructure across the five boroughs. These guidelines will provide design and siting guidance to safely integrate Level 2 into the streetscape, filters to guide both site and equipment selection, and recommendations on shared-use models to support optimal station utilization. This study assumes that a near-term curbside deployment in New York City will utilize dual-port stations to maximize the investment in bringing power to the curb.

Deployment Guidelines were developed to support the implementation of a curbside charging pilot program in New York City. This pilot deployment strategy aims to achieve maximum inclusivity and infrastructure utilization, as well as the highest possible aesthetic standards in accordance with the NYCDOT street design policies.

The guidelines are organized in four sections. Together, they make up a process for site selection, equipment selection, and streetscape integration that optimizes curbside charging infrastructure in adherence with the planning principles set forth in the preceding section. These sections include:

1. Identifying Deployment Zones
A data-driven methodology for identifying priority zones for near-term station deployments.

2. Selecting Street Sites
An urban design assessment of NYC street typologies that can support Level 2 charging.

3. Configuring Curbside Charging
Siting, technical and design guidance for seamless curbside integration.

4. Integrating Charger Equipment
Evaluation of off-shelf charging stations and required NYC approval processes.

All recommendations are tailored to a New York City context, but have broad applicability for other national and international cities.

1. Identifying Deployment Zones


VERNON BLVD
NO PARKING
Anytime
organic ★ sustainable ★
all·natural
STRAND

Overview

Identifying existing and projected demand for curbside infrastructure is complicated by the fact that New York City's EV market is rapidly growing and evolving. However, there are multiple indicators that can help identify neighborhood geographies where EVSE demand, utilization potential and community acceptance will be strong.

This section describes a methodology for identifying "high opportunity" deployment zones where demand for EVSE is demonstrated or latent, and where there are multiple intersecting use cases for the infrastructure. Given the evolving nature of the EV market, this section offers scenario planning strategies that can be customized to different City priorities and demand indicators.

EV Uptake Indicators

The following variables correlate to current and future EVSE demand and are assessed at the neighborhood tabulation area (NTA) level (see page 35 for more on NTAs). These variables indicate different kinds of demand which can be weighted in a composite indicator to produce different "high" to" low" metrics of opportunity. These metrics are considered "scenarios" which reflect different implementation priorities, described in the following pages.

NEIGHBORHOOD CHARACTERISTICS

These characteristics include demographic and land use indicators that correlate to potential EV ownership and adoption. Demographic data can be used to target deployments in neighborhoods with a range of median household incomes. Land use data is coded to sort between conducive and non-conducive uses, e.g. low-density areas of single-family housing (low opportunity zones due to potential for owner-installed EVSE in garages) and medium-density residential neighborhoods (high opportunity zones due to lack of off-street charging opportunities). Variables considered include:

- Area Population
- Residential Density (sq. mile)
- Median Household Income
- Metered Blocks (Blockface SF)
- Commercial Overlays (Blockface SF)
- "Medium Density" Residential SF

EXISTING EV ADOPTION

These variables correlate to existing levels of EV adoption within a neighborhood. Present EV ownership and infrastructure distribution patterns can help predict future EV demand.

- Number of EV Registrations (Passenger)
- Number Public Access Level 2 Stations

CURB CONSTRAINTS

These variables include measures of potential competition for curbside space due to on-street parking demand, off-street parking supply, and commuting patterns.

- % of Vehicles Stored On-street
- Number of Vehicles per Capita
- Residents that Own 1+ Vehicles
- % of Residents that Own 1+ Vehicles
- % Commute to Work by Car
- Number of Registered Garages & Lots
- Total Number of Garage Parking Spaces

COMPLEMENTARY USES

These variables measure the clustering of cultural destinations and workplaces that draw car-dependent commuters. A concentration of complementary uses can drive station utilization.

- Number of Higher Education Institutions
- Number of Hospitals
- Number of Cultural Institutions
- Number of Fire & Police Stations
- Number of Public Pools
- Number of DOE Zero Waste & Eco Schools

Scenario Planning for Key Objectives

In order to narrow the geographic scope of a curbside charging pilot, three deployment scenarios were generated for comparison. These priority-driven scenarios include:

A. High Utilization
B. High Demand
C. High Visibility + Turnover

All scenarios seek to maximize utilization and support pilot acceptance by factoring in current curb constraints, but they look at different tactics for achieving this – from serving car-dependent visitors and commuters to existing EV owners and potential EV adopters. The geographic targeting matrix allows for flexible hypothesis testing based on different goals and yields geographic zones of interest (at the NTA level).

Scenario A: High Utilization (Figure 5) is the favored strategy for a near-term Level 2 deployment. This strategy identifies NTAs with car dependent commuters and visitors, and is thus focused on:

- High mileage drivers (as opposed to residential areas where many drivers store their cars on-street and only use on the weekend)
- Not inducing more VMT through the provision charging stations
- Locations in or near low to moderate income neighborhoods where improving air quality should be prioritized as a commitment to environmental justice

Strategies presented in Scenario A for identifying zones of interest and potential clusters of opportunity can be used across the targeting scenarios presented.

Scenario A: High Utilization

Charging demand can be induced if there is adequate infrastructure available in convenient locations. This scenario focuses on a vocational microtargeting strategy, highlighting clusters of car-dependent employees, as well as destinations that draw car-driving visitors and residential areas with demonstrated EV demand.

Many healthcare employees, teachers, and FDNY and NYPD employees work non-traditional hours at locations outside of the City's main business districts, where transit access is less robust. Drivers in these groups typically take advantage of restricted parking zones, extended-time meters sited near their places of work, and other parking privileges such as city-issued placards.

These factors, along with access to parking placards or on-street restricted parking zones, contribute to a higher percentage of this group commuting to work by car. Since over 30% of all charging in the U.S. occurs at the workplace, a close examination of employment centers with auto-commuting employees can serve as a meaningful site-selection filter for curbside Level 2 deployment.

This scenario assumes that hospitals, universities, fire stations, police precincts and cultural institutions will attract a high number of car-dependent cohorts. By filtering for these cohorts and existing EV owners, we create a multi-user scenario that can drive station utilization from day to night.

Many of the top performing NTAs in Scenario A are located in transit-rich areas in Manhattan's inner core and downtown Brooklyn. However, less accessible clusters in northern Manhattan and the outer boroughs show promising opportunities for vocational targeting with fewer challenges at the curb.

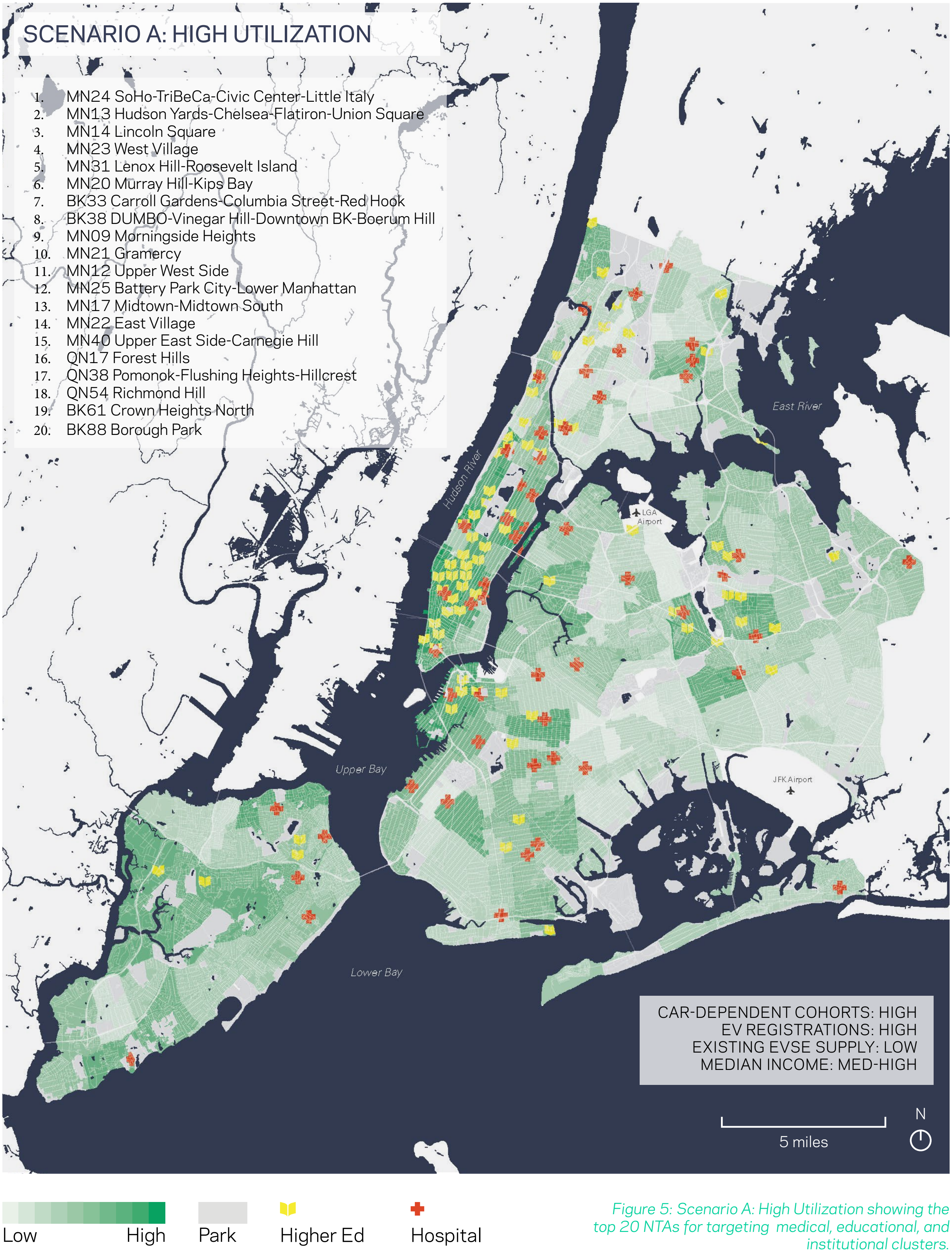


Figure 5: Scenario A: High Utilization showing the top 20 NTAs for targeting medical, educational, and institutional clusters.

Analytic Approach

There are a number of public datasets that can help in evaluating key indicators. Analysis in New York City (NYC) included datasets from U.S. Census, U.S. Alternative Fuels Data Center, NYS Department of Motor Vehicles, NYC OpenData, PLUTO, NYC Department of City Planning, NYC Department of Transportation, NYC Department of Education, Fire Department of New York, New York Police Department, NYC Department of Parks and Recreation, NYC Department of Education, and Department of City Planning Facilities Database (FacDbB).

PUBLIC USE MICRODATA SAMPLE (PUMS) is a U.S. Census American Community Survey (ACS) product. PUMS analysis can be used to identify detailed occupation groups (teachers, higher education teachers, healthcare practitioners, healthcare support), and tabulate their residence with a full profile of commuting variables. PUMS provides the most comprehensive and detailed analysis of the specific vocational cohorts in question for curbside targeting. It allows for cross-tabulation for travel times to work which helps to identify zones sending or receiving shift workers and aids in planning for station calendaring.

CENSUS TRANSPORTATION PLANNING PRODUCTS (CTPP) is a U.S. Census ACS product that describes the means of transportation to work for all workers based on detailed residential and workplace locations. This dataset can be used to identify which institutions overlap with the highest number of sent and received commuters to that geography.

INSTITUTIONAL CLUSTERS

Because higher education institutions are often co-located with other institutional anchors, intersecting labor pools, and institutional partners, they will often yield dense clusters of auto-dependent commuters in certain zones.

Figure 6 shows the number of auto commuters to census tracts with either a medical campus or a higher education campus. This analysis assists in prioritizing clusters of auto-dependent commuters who could stand to benefit from curbside charging. For many of the larger institutions or clusters of institutions, the campus spans the entire census tract.

AVOIDING LOW PRIORITY ZONES

In New York City, there are also clear constraints on deployment areas, seen as "low priority zones". A robust transit network, high congestion rates, a high density of EVSE in garages, and high curb constraint make the area South of 110th Street in Manhattan a low priority zone for near-term deployment.

Long-term planning for EVs, imagining a future with electric fleets (public and private), could consider strategic deployments in these areas to serve New York City fleets domiciled at their home areas, private fleets charging on the go, EV drivers needing top-off charge, and transit poor areas where residents park their vehicles on-street.

Brooklyn Cluster

Bronx Cluster

Queens Cluster

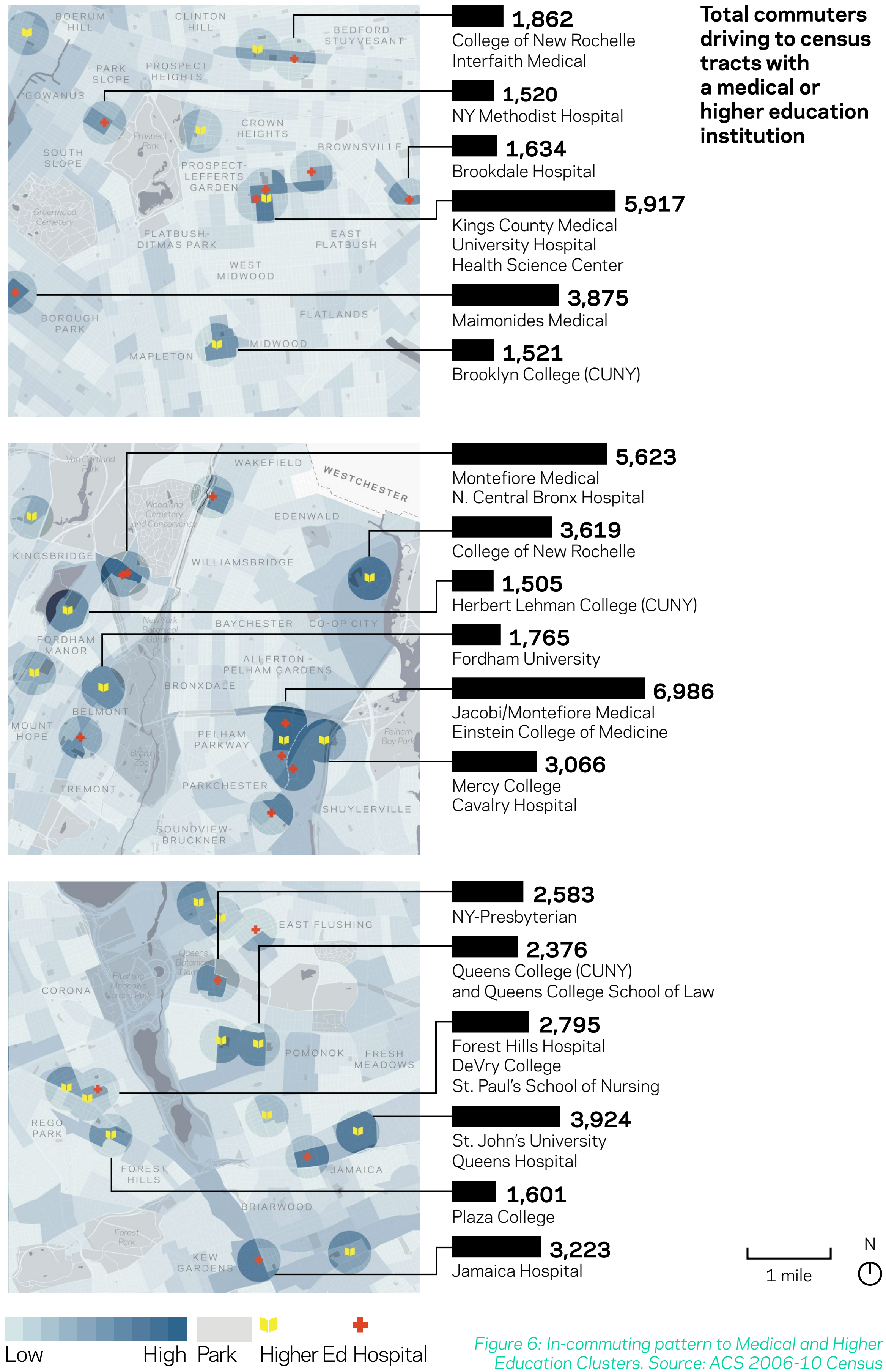


Figure 6: In-commuting pattern to Medical and Higher Education Clusters. Source: ACS 2006-10 Census Transportation Planning Products. A302103 and B302104 flow tables, data processing by NYCDCP

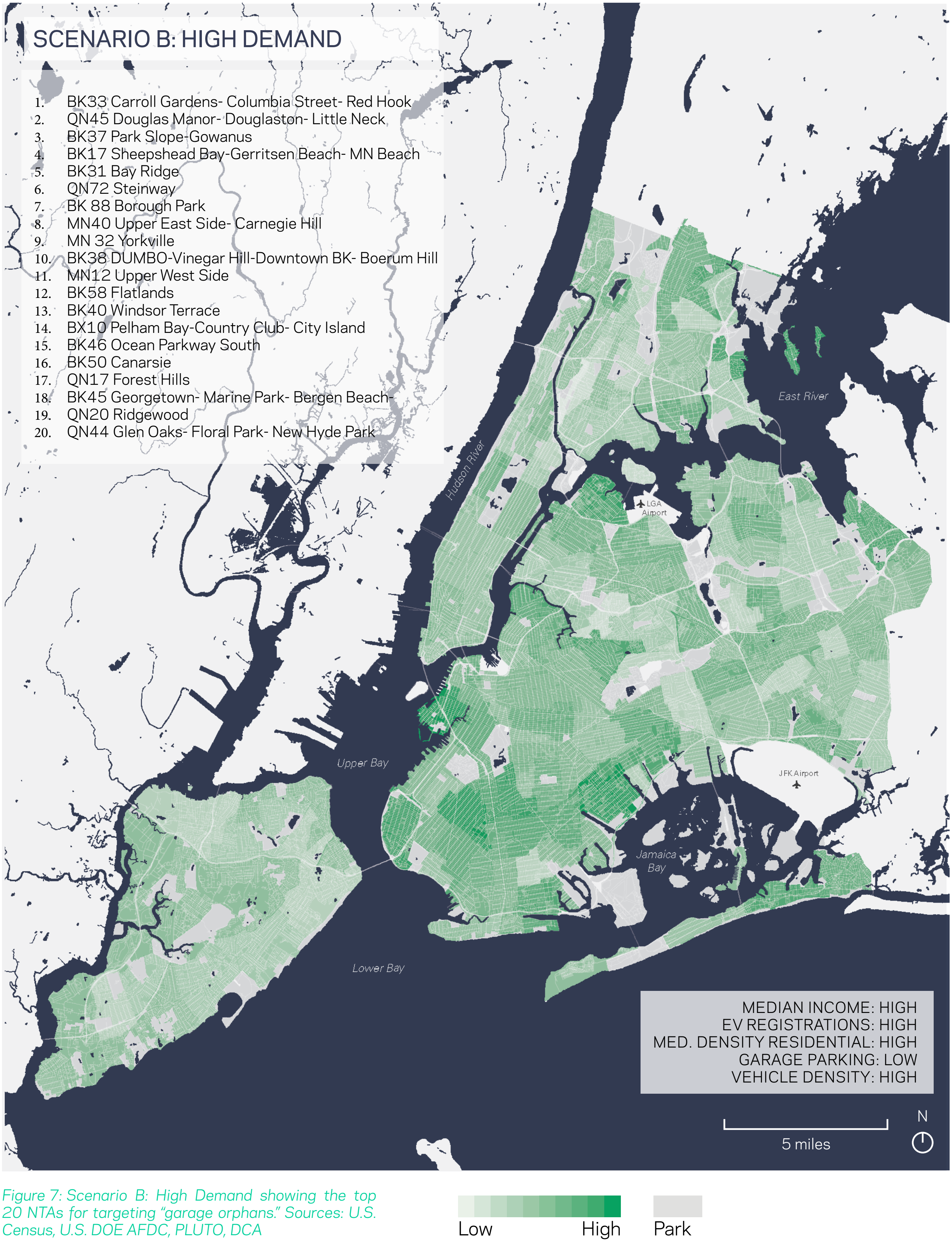


Figure 7: Scenario B: High Demand showing the top 20 NTAs for targeting "garage orphans." Sources: U.S. Census, U.S. DOE AFDC, PLUTO, DCA

Scenario B: High Demand

About half of New York City residents with access to a vehicle store their car on-street, rather than off-street in a private parking garage, lot, or driveway (see Appendix B for Percent Stored Vehicle Map). Meanwhile, all of the City's public access charging stations are located in garages or lots. Given this trend, residents with access to private off-street parking make up the majority of current EV owners.

Scenario B identifies existing EVSE demand by neighborhood using passenger EV registrations combined with median household income as key proxies for demand. It does so while also filtering for "garage orphans", or EV owners without access to private parking who would need to park their vehicles on-street. Neighborhood zones with a clustering of current EV owners, the potential for EV uptake, and "garage orphan" conditions are identified as "high demand opportunity zones." Many hot spots are situated in medium density residential areas where residents have access to one or more vehicles but where the garage parking is limited. (Current demographic data shows a relationship between high household income and EV ownership, but this trend is likely to change as more affordable electric models enter the market.)

Figure 7 shows the NTAs well-suited for a "high demand" deployment scenario, serving existing and potential EV garage orphans.

Analytic Approach

Zone analysis is computed based on Neighborhood Tabulation Areas (NTAs). NYC Department of City Planning created NTAs in order to better project populations at a small area level. NTAs are aggregations of census tracts with a minimum of 15,000 residents that allow for population projections at a granular level. NTAs do not necessarily align with historical neighborhood boundaries, although they are often close. New York City has 195 NTAs with an average population size of 43,160 people.

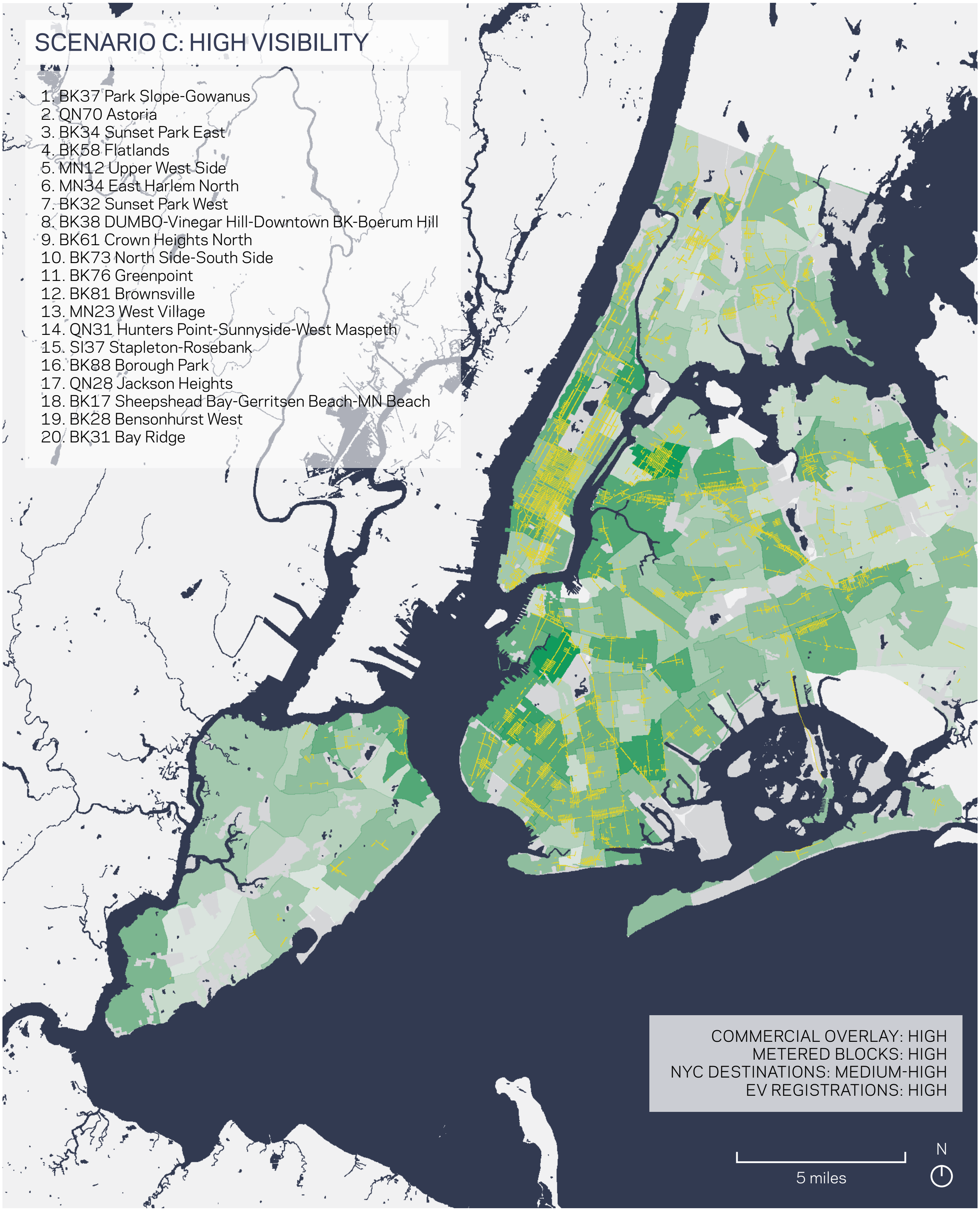


Figure 8: Scenario C: High Visibility and Turnover. Sources: U.S. DOE AFDC, Energetics Incorporated, PLUTO, NYCDOT, DCP FacDB

Scenario C: High Visibility + Turnover

Commercial "main streets" are streets with a local commercial overlay and offer a high visibility and high turnover opportunity for station siting. Commercial main streets are often zoned within residential neighborhoods where there is a concentration of daytime to nighttime uses, as well as multiple user cohorts. These zones have more restrictions on the curb—metered parking, time-limited parking, or loading zones—making them an attractive option for supporting high charging station turnover.

Metered commercial districts typically have 1-hour or 2-hour restrictions suitable for high-turnover top-off charging. Metered zones near workplaces may have commuter regulations that allow for 6-hour or 10-hour parking. In both cases, charging stations can turn over for nighttime residential use.

Prioritizing these zones will generate activity for local businesses from EV drivers fulfilling top-off charging needs during the day, when parking restrictions are typically in effect. At night, when restrictions are often lifted, they serve charging needs for residential garage orphans. Along with the benefits of high utilization and high turnover, station siting on commercial streets may garner community acceptance more easily if local businesses are involved in the planning and siting of infrastructure.

Scenario C uses metered blocks (blockface square foot) in commercial overlay zones as a proxy for high turnover parking spaces. It differs from the previous scenarios in that it selects for shorter parking events and "top-off" charging. This presents a high turnover strategy for deployments in high visibility zones. Using existing regulations and meters (on main streets and spur streets) is one way to help regulate charging stations. It also assumes that Level 2 charging stations can be co-located with metered parking spaces and high-traffic destinations such as cultural institutions, environmentally-focused K-12 public schools, and public pools or parks.

Figure 8 shows the NTAs well-suited for a "high visibility and turnover/enforcement" deployment scenario.

Demand-Driven Siting

Up to this point, our methodology for identifying deployment zones has been largely data-driven. However, soliciting input on station siting from stakeholders who are positioned to promote and use the infrastructure is critical to the pilot's success.

City officials should solicit input from:

- Residents
- Elected officials
- Community Boards
- Not-for-profits and community organizations, particularly those advocating for alternative fuels
- Business Improvement Districts
- Workplaces & organized labor

These stakeholders are positioned to play a big role in shaping the public perception and acceptance of a burgeoning EV ecosystem. This is particularly relevant in New York City, where EV ownership is still relatively low and where the culture of car ownership is such that there will likely be great sensitivity to any change in parking availability.

Government should use tools to directly engage stakeholders and solicit ideas for station siting. The CityRacks request process, for example, along with the nomination protocols for the CityBench and Street Seats programs, offers an analog for community-scale engagement in the deployment of curbside infrastructure. Internationally, cities including Amsterdam and Copenhagen rely on direct stakeholder engagement to guide the siting process.

Technical feasibility, cost and complexity of installation, and neighborhood planning considerations will ultimately drive much of the site selection methodology, but baseline demand should be at the core of any site selection model.

Case Study: NYCDOT Carshare Pilot

NYCDOT Carshare Pilot designated 230 on-street parking spaces across 4 boroughs for carshare vehicles. In planning locations, NYCDOT developed an informational website and map portal for space request, discussion, and reactions.

Figure 9: NYCDOT Carshare Pilot regulatory signage (Image: NYCDOT)

Case Study: CityRacks

Stakeholders can nominate a location for free sidewalk bicycle racks via a simple online form on NYCDOT's website. DOT performs an "on-site evaluation" for all requests. They also encourages "bulk requests" from Business Improvement Districts, civic associations or other groups of community members".

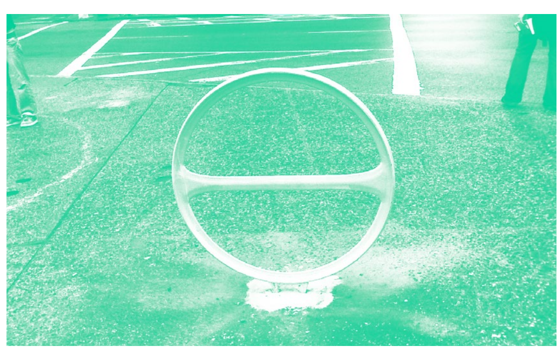


Figure 10: CityRack Installation on New York City sidewalk.

Local Impediments

Relatively low levels of EV penetration represents the single most significant barrier to wider deployment of EV charging infrastructure in the public right-of-way. New York's culture of car ownership present significant challenges to the efficient use of curbside space with competing demands for parking, loading, and other activities.

Car owners who do not use their vehicles to commute typically incur long dwell times in the same parking space, moving a vehicle only to comply with alternate side regulations. In neighborhoods with one day alternate side regulations, this use pattern can result in vehicles furloughed for up to seven days at a time. Existing parking regulations can be used as an important lever to reinforce turnover. Co-locating Level 2 units in already regulated spaces with regular turnover both reduces the perception of general parking being taken away while offering a powerful incentive for drivers to replace an ICE vehicle with an EV.

Beyond these foundational challenges, the potential barriers to success for curbside deployment can be segmented into four broad categories: public perception, aesthetic concerns, technological and jurisdictional challenges, and technological change.

Business owners, residents, and merchants who depend on ready access to on-street parking may be resistant to a change perceived as limiting or reducing the inventory of available parking spaces. Similarly, businesses may fear that EV-designated spaces will increase parking pressures and result in a decline in sales and other business activity.

Stakeholders may also have aesthetic concerns about the appearance, especially in or around historic districts since they add another element of street furniture. They may also have concerns about maintaining clear passages and risks associated with the equipment.

While NYCDOT has jurisdictional purview over the sidewalk and roadbed, placement of curbside EVSE may involve interagency reviews for approval. Technical issues around signage, including visual symbols and language will also need to be addressed.

Finally, technical specifications for batteries on-board in EVs continue to evolve. Increased battery efficiency, improvements to charging equipment, the emergence of wireless charging, as well as enhancements to the grid and connectivity, will all likely transform the process of EV charging, reducing charge times and enhancing ease of use for the motorist, which may prove disruptive to near-term efforts for Level 2 deployment.

2. Selecting Street Sites

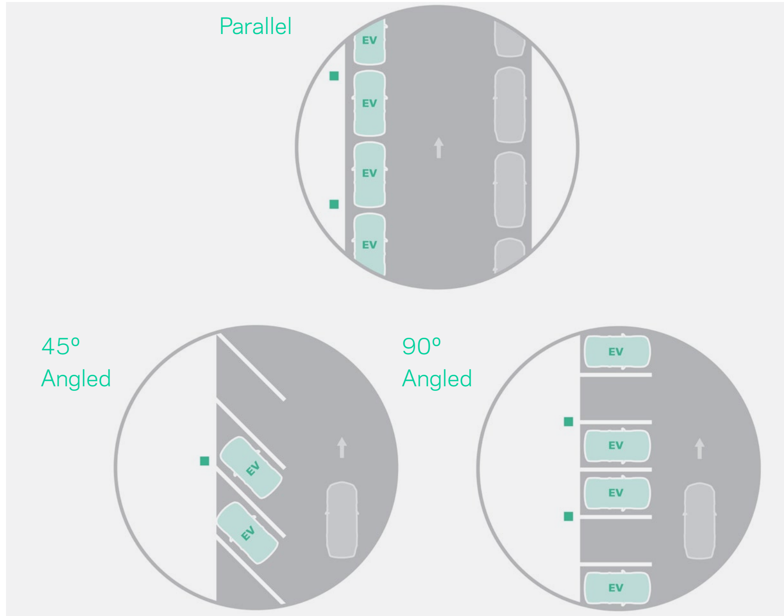


Figure 11: Parking variations on New York City streets.

Overview

Level 2 charging stations have physical and operational considerations that make them compatible with certain street typologies and not others. Since the installation context for charging stations can contribute greatly to the station's utilization, matching charging infrastructure to the right streets is critical.

Evaluating Street Suitability

Every dual-port charging station installed on New York City streets will need two dedicated parking spots and signage to communicate the EV-only parking regulations. Several factors play in to identifying the optimal streets for a curbside pilot deployment that maximizes utilization and minimizes disruption.

VISIBILITY

Level 2 placement should maximize station visibility. Siting in the first legal parking spaces after the intersection should be prioritized, where feasible.

STREET DIRECTION

In order to minimize drivers entering the right-of-way to plug in, and due to the market trend for driver's side ports, one-way streets with opportunities for driver's side (left-hand) installations should be prioritized (page 53).

PARKING

Figure 11 illustrates three parking configurations that should be prioritized when possible:

- Parallel (driver's side/left-hand priority)
- 45º Angled (head-in priority)
- 90º Angled (head-in priority)

Parallel parking on both one- and two-way streets is the dominant parking configuration in New York City. As with driver's side parallel parking, angled parking (typically only installed on one side of the street) presents an opportunity to prevent drivers from having to enter the right-of-way. Low visibility and vehicle overhang add a crash risk to back-in parking. Bollards should be installed to protect units in these settings.

SIDEWALKS & FURNISHING ZONES

Streets with full sidewalks[1] more than 15 feet wide can accommodate pedestrian traffic, furnishing and fixtures and should be prioritized. Street selection should avoid sidewalks with cluttered furnishing zones—the area closest to the curb where fire hydrants, bike parking, and other fixtures are typically installed. Streets should have minimal curb cuts, which can lead to difficult siting.

BUS LANES & BIKE LANES

Charging spots should not be located in curbside bus lanes nor along protected bike lanes to ensure that charging cables do not interfere with safe operation.

1 "Full sidewalks" extend from the building lot line to the curb and are used in dense areas (R6+). "Ribbon sidewalks" have a vegetated or planting strip between the sidewalk and curb and are used in less dense (R1-R6) districts. DOT Urban Design Manual Section 2.2.1

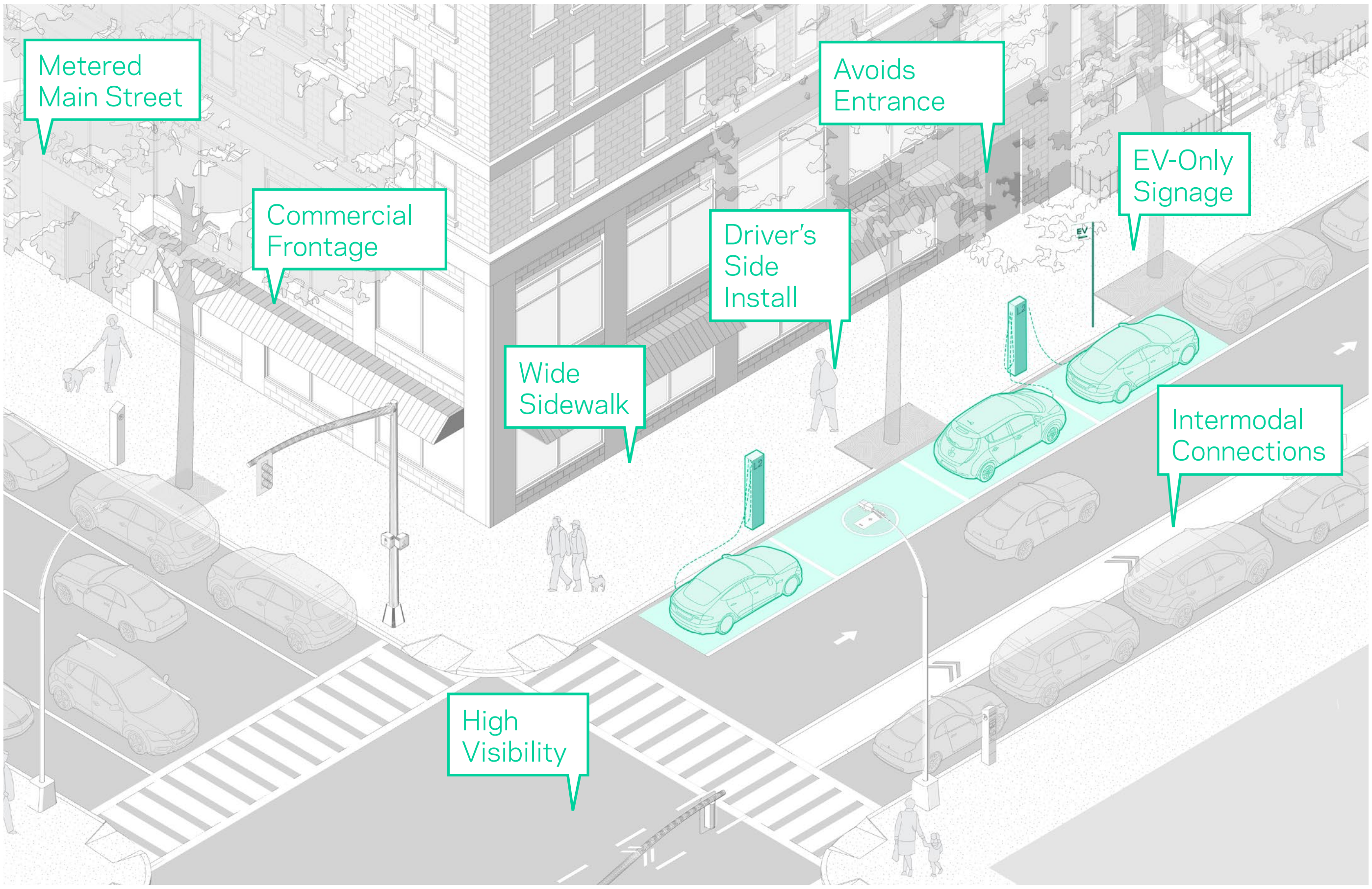


Figure 12: Priority siting on a one-way Spur Street.

REGULATION

Metering, frequent street cleaning, and use restrictions (e.g. medical zones) can complement and reinforce Level 2 turnover and minimize the likelihood that EV-only parking spaces will be monopolized by one vehicle. Locating units on metered blocks should be prioritized where possible. Such siting will support top-off charging in short metered zones where frequent daytime turnover is necessary for local business success. A short-term pilot should locate units at a minimum 5′ from a Muni Meter. A longer-term strategy should build parking fees into the payment structure for charging use.

LANDMARKS AND HISTORIC DISTRICTS

Units proposed in historic districts or close to landmark properties will be subject to review by the Landmarks Preservation Commission (NYCLPC) and may have additional scrutiny with regards to siting and unit design. NYCLPC should be consulted prior to proposing installations in areas under their purview.

Identifying Feasible Street Typologies

The following priority street typologies have been identified as the best opportunities for curbside charging in New York City:

1. Local Streets
2. Spur Streets
3. Unique Conditions: Angled Parking
4. Unique Conditions: Under Viaducts and Elevateds

The section that follows describes the priority street typologies and then offers tools for evaluating urban design elements and contextual conditions that will lead to the best deployment sites.[2]

2 The photos included in this section are for illustrative purposes only and do not reflect current street conditions. Street Views are the copyright of 2018 Google, and are used per Google's noncommercial and academic use permission.

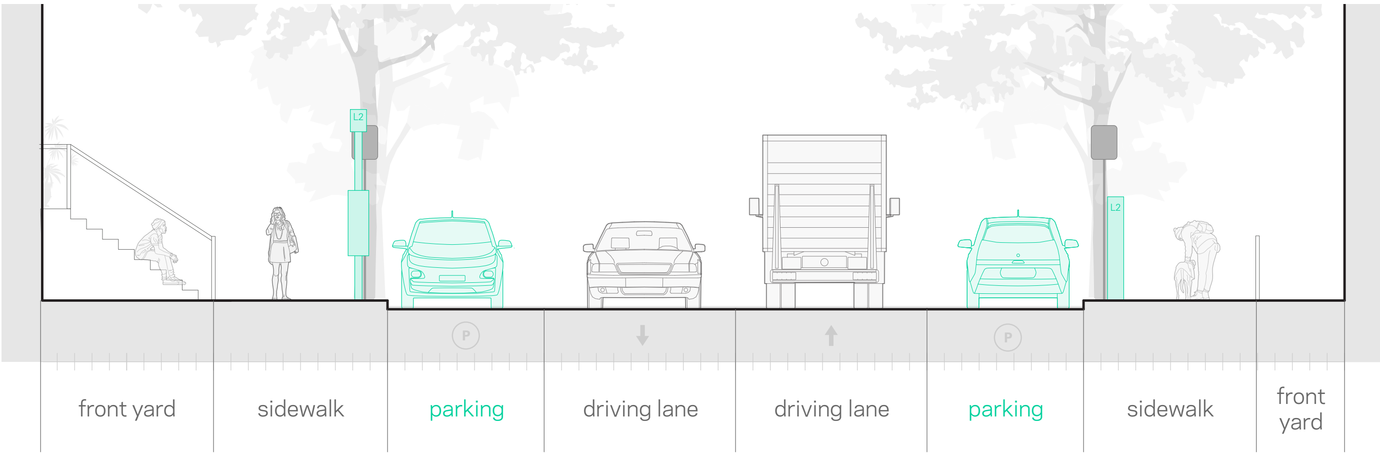


Figure 13: Typical two-way Local Street street section depicting right-side charging station installations. Local Streets can also be one-way.

1. LOCAL STREETS

Local Streets primarily serve local trips to residences and businesses. They have lower volumes of traffic at slower speed than higher-capacity collectors or arterial roads. Local Streets are typically flanked by parking on both sides. While parallel parking dominates, these streets can sometimes have angled parking.

Local streets in medium and high-density areas will have fewer curb cuts than low-density areas where there is a higher prevalence of off-street parking in garages, driveways, or lots. Local Streets near medical or educational clusters may have time-limited restricted zones for employees.

There may be sensitivity in dedicating EV-only parking, especially in Neighborhood Centers with high car ownership.

- Direction: one-way, two-way
- Parking: parallel dominates, angled used occasionally
- Sidewalks: full, ribbon
- Furnishing Zone: fire hydrants, street trees, planters, bike racks, benches, bus shelters
- Regulation: alternate side (1x, 2x or 3x weekly), restricted zones for DOE, FDNY, NYPD, or medical use

Figure 14: Local Street, Willoughby Street at Ashland Place, Fort Greene, Brooklyn (Streetview ©2018 Google)

Figure 15: Local Street, Willoughby Avenue at Carlton Avenue, Brooklyn (Streetview ©2018 Google)

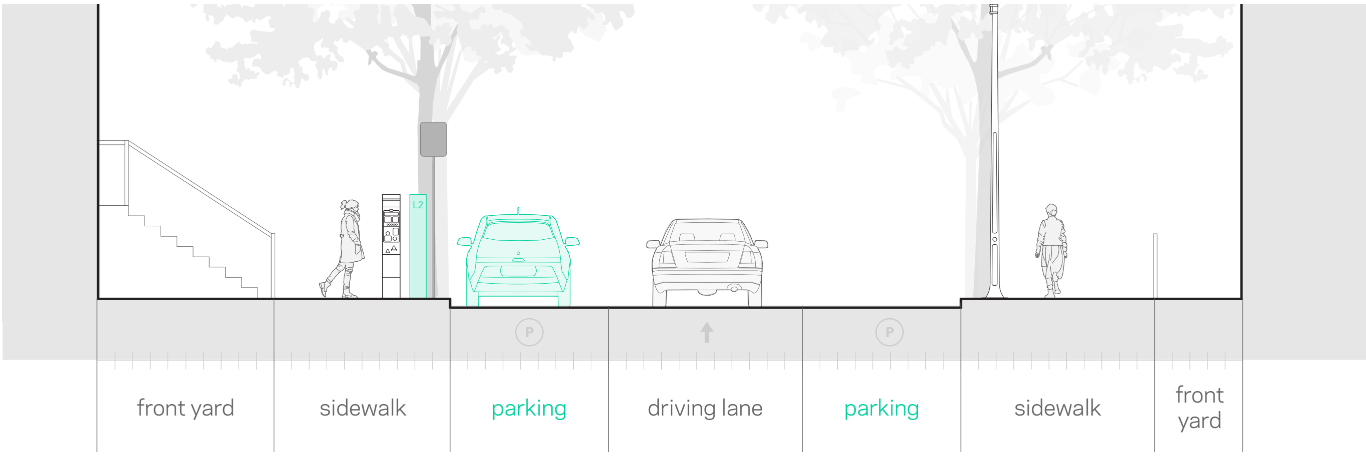


Figure 16: Typical one-way Spur Street section depicting a driver's side (left-hand) charging station installation.

Figure 17: One-way Spur Street, 79th Street and 37th Avenue, Jackson Heights, Queens (Streetview ©2018 Google)

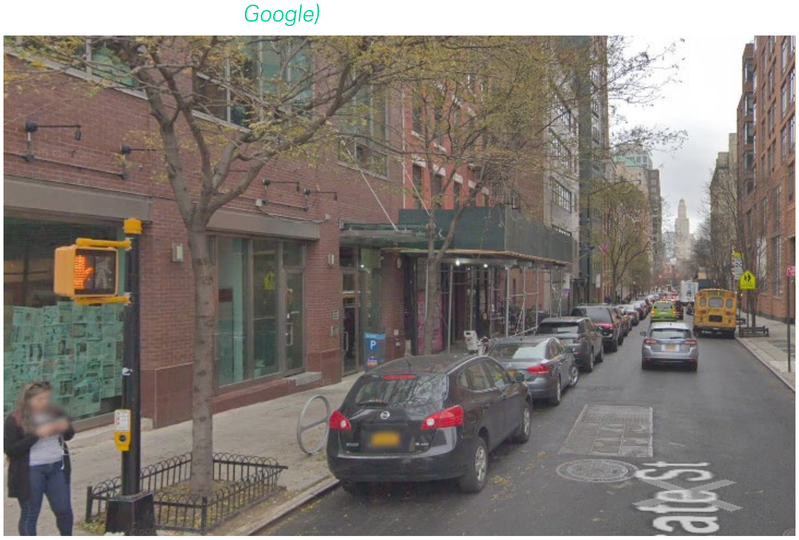


Figure 18: One-way Spur Street, State Street at Court Street, Brooklyn (Streetview ©2018 Google)

2. SPUR STREETS

Spur Streets are segments of Local Streets that intersect perpendicularly with higher volume metered commercial corridors. In order to provide additional, time-limited parking for businesses along the corridor, NYCDOT will sometimes meter two to four spaces (or the length of the commercial entity) along the Local Street. Muni Meters regulate the metered parking spaces in one, two, or four-hour restrictions. Parking along the Spur is typically parallel.

Spurs Streets are buffer zones that can service the charging needs of both commercial establishments, their visitors and vendors, and residents.

- Direction: one-way
- Parking: parallel
- Sidewalks: full
- Furnishing Zone: fire hydrants, street trees, planters, bike racks, benches
- Regulation: Muni Meter, alternate side (1x, 2x or 3x weekly)

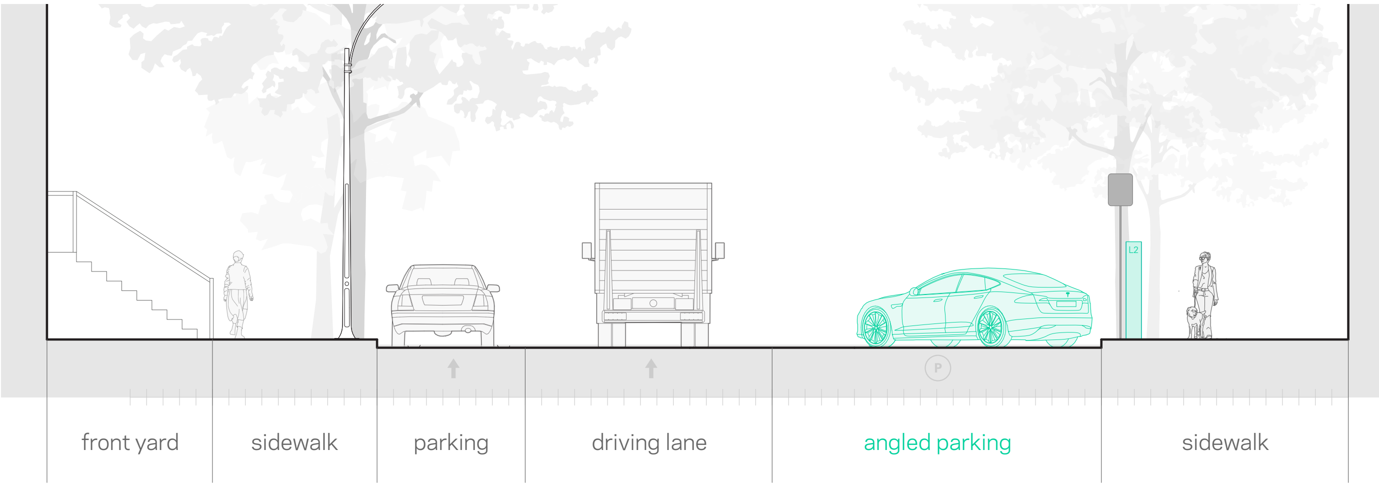


Figure 19: Typical one-way Local Street with back-in angled parking.

3. ANGLED PARKING

Angled parking (45° or 90° perpendicular) will typically appear on one side of a Local Streets in proximity to dense residential developments or an institution such as a school or museum. Depending on the context, parking can be front-in only, back-in only, or without regulation. Front-in parking offers greater charging station visibility, preventing it from being hit accidentally. Back-in parking, while offering a better opportunity for reaching driver's side rear ports, has an increased crash risk as drivers back into the spots. As such, front-in only angled parking should be prioritized. Bollards are recommended for back-in on-street parking.

- Direction: one-way
- Parking: angled on one side
- Regulation: alternate side (1x, 2x or 3x weekly), Muni Meter
- Furnishing Zone: fire hydrants, street trees, planters, bike racks, benches, bus shelter

Figure 20: Back-in angled parking in front of Brooklyn Children's Museum, St. Mark's Avenue, Brooklyn (Streetview ©2018 Google)

Figure 21: Front-in angled parking between Manhattan College and Van Cortlandt Park, Morris Park Avenue, Bronx (Streetview ©2018 Google)

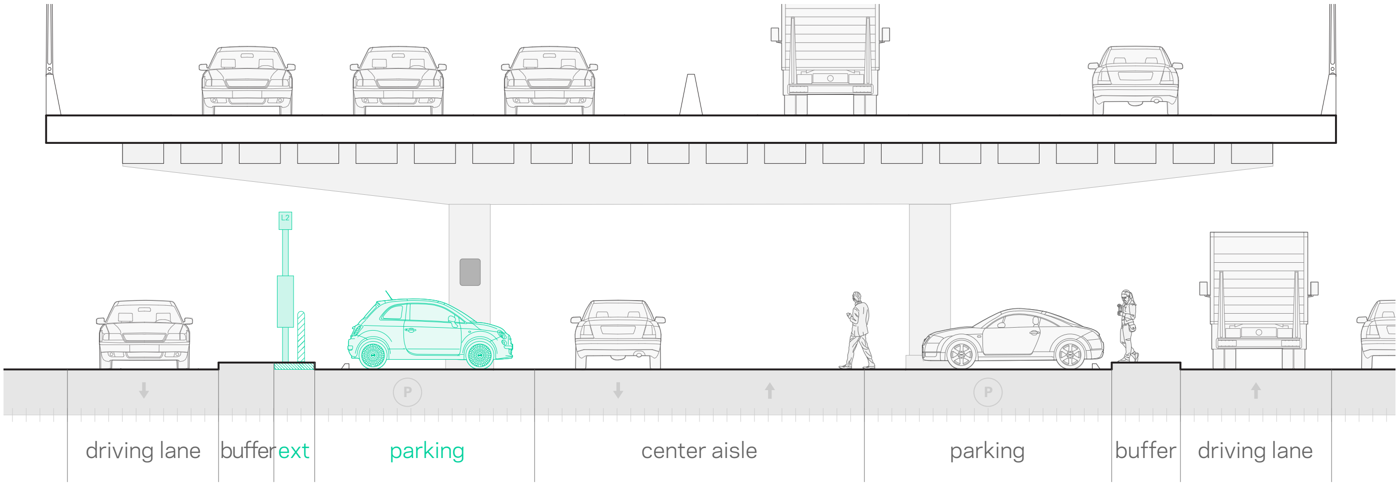


Figure 22: Typical cross-section under the Brookyn-Queens Expressway. EVSE can be installed level with the roadbed or on footing for added protection.

Figure 23: Front-in parking under the Brooklyn-Queens Expressway, Park Avenue at Navy Street, Brooklyn (Streetview ©2018 Google)

Figure 24: Front-in, metered parking under MTA 7 train, Queens Boulevard and 34th Street, Queens (Streetview ©2018 Google)

4. UNDER VIADUCTS

Parking is common on New York City's atypical roadbeds below its 700[3] miles of elevated highway and public transit infrastructure, and bridges—often referred to as "elevateds" or "viaducts." Areas such as those under the Brooklyn-Queens Expressway, the Gowanus Expressway, Van Wyck Expressway, and FDR Drive are often treated more like parking lots with 90˚angled front or back-in parking than a traditional street. These areas tend to be dark and create physical barriers to the neighborhoods on both sides.

NYCDOT is responsible for the roadways, sidewalks, parking, and lighting elements under viaducts. These spaces have additional jurisdictional review and responsibilities, including:

- NYSDOT: responsible for maintenance and inspection of viaduct structures
- NYCDEP: responsible for the downspouts
- FDNY: responsible for the pipes beneath the roadbed.

NYSDOT Region 11 requires a minimum 3 feet clear around the columns for inspection and 10 feet clear for maintenance.

- Parking: 90º Angled (front-in, back-in)
- Regulation: alternate side, Muni Meter

3 Design Trust for Public Space, "Under the Elevated," March, 2015

	Least Opportune	Opportune	Most Opportune
	○	◑	●

Criteria	Local Street	Spur Street	Unique Conditions
STREET DIRECTION & PARKING			
One-way, Left Side Opportunity	◑	●	○
Front-in Angled	◑	○	●
PHYSICAL CONSIDERATIONS			
Station Visibility	◑	●	○
Clustering (Opps for 2+ EVSE)	◑	◑	●
Full Sidewalk	◑	◑	○
PHYSICAL CONSTRAINTS			
Minimal Bus Lanes	◑	●	●
Minimal Curb Cuts	○	●	●
Minimal Streetscape Clutter	◑	○	●
ACCEPTANCE			
Ease of Resident Acceptance	○	●	●
Ease of Business Acceptance	●	◑	●
Opportunities for Maintenance Partnerships	◑	●	○

Figure 25: Summary matrix evaluating street typology key opportunities

Additional Selection Considerations

DEMAND TYPE (USER BEHAVIOR)

Streets should have multiple potential user cohorts and should identify daytime to nighttime charging opportunities.

INTERMODAL CONNECTIONS

Streets that facilitate intermodal connections and should be considered.

OTHER STREET OPPORTUNITIES

The following street typologies can support Level 2 units in New York City. However, the high-volume nature of these streets make them ideally suited for short top-off charging events, better matched with Fast Charging Stations—a core ingredient in building a supportive EV ecosystem.

Neighborhood "Main Streets": highly visible streets with local commercial uses that service residents.

Highway Exits & Gateways: high-traffic collector streets that serve as entrances and exits from neighborhoods.

Commercial Corridors: larger through streets, often with car-oriented commercial establishments (e.g. gas stations) that service local and regional customers.

Recap: Site Selection Approach

Establish minimum street selection criteria.

Identify suitable street typologies within zones.

Evaluate key opportunities across selection criteria.

Rank options based on criteria performance.


AC842
STOP
STOP

3. Configuring Curbside Charging

Figure 26: Chevrolet Bolt charging on-street in Jersey City, New Jersey (Photo credit: Michael Mazur, Greenspot)

Overview

Quality of urban design shapes the livability of a city. New York City's urban realm is carefully considered and planned in accordance to design principles set forth by NYCDOT, Department of City Planning (DCP), the Public Design Commission (PDC), and other agencies working together to ensure the urban, social and public experience of moving through New York City is optimized.

In accordance with DCP's Principles of Urban Design and NYCDOT's Street Design Manual, the siting principles in this section were developed with attention to:

1. Reinforcing a sense of place.
2. Equitably distributed assets.
3. Attention to detail at multiple scales.
4. Siting to promote accessibility and support street-life.

This section offers guidance on the placement of chargers, siting priorities and minimum clearances, and special considerations based on the four street typologies presented in Section 2.

Charge Port Locations

There is no fixed port location for automakers in North America or abroad. Nissan and Audi place ports on the front and center of the vehicle. Tesla, the leading OEM with approximately 50% of the domestic EV market, places ports on the rear driver's side. Ford and GM's ports are all on the front driver's side, and still others, such as BMW, place ports on the rear passenger side.

Variability in charge port location means that planning for curbside EVSE must consider accessibility and safety for multiple plug configurations, with the understanding that some users will have to enter the right-of-way to plug in.

Approximately 68% of BEV units sold nationwide in 2016 and 2017 have charge ports on the driver's side (Figure 28), indicating that a short-term curbside pilot should prioritize planning for driver's side ports. These trends are highly variable and may shift as new vehicle models come on to the market and as charging technology advances.

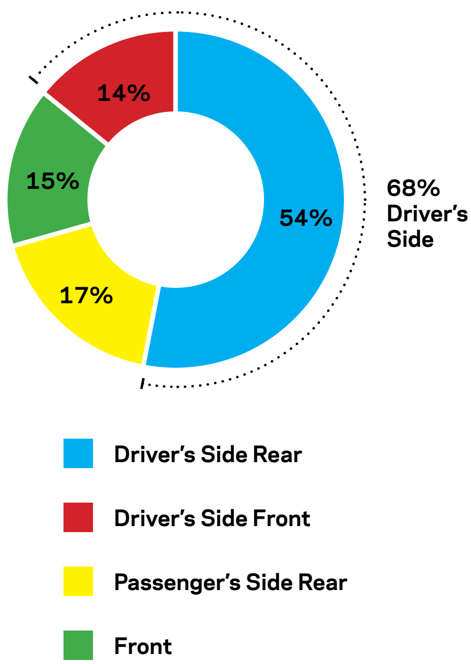


Figure 27: Port location for battery-electric vehicles sold nationwide from 2016-2017.

Driver's Side Port

Chevrolet Bolt

Tesla Model S

Ford Focus Electric

Hyundai Ioniq

Mercedes b250e

Tesla Model X

Passenger's Side Port

BMW i3

Volkswagen e-Golf

Mitsubishi i MiEV

Fiat 500e

Smart Electric Drive

Front Port

Nissan Leaf

Kia Soul

Figure 28: Port location for battery-electric vehicles available for New York State Drive Clean Rebate as of August , 2018.

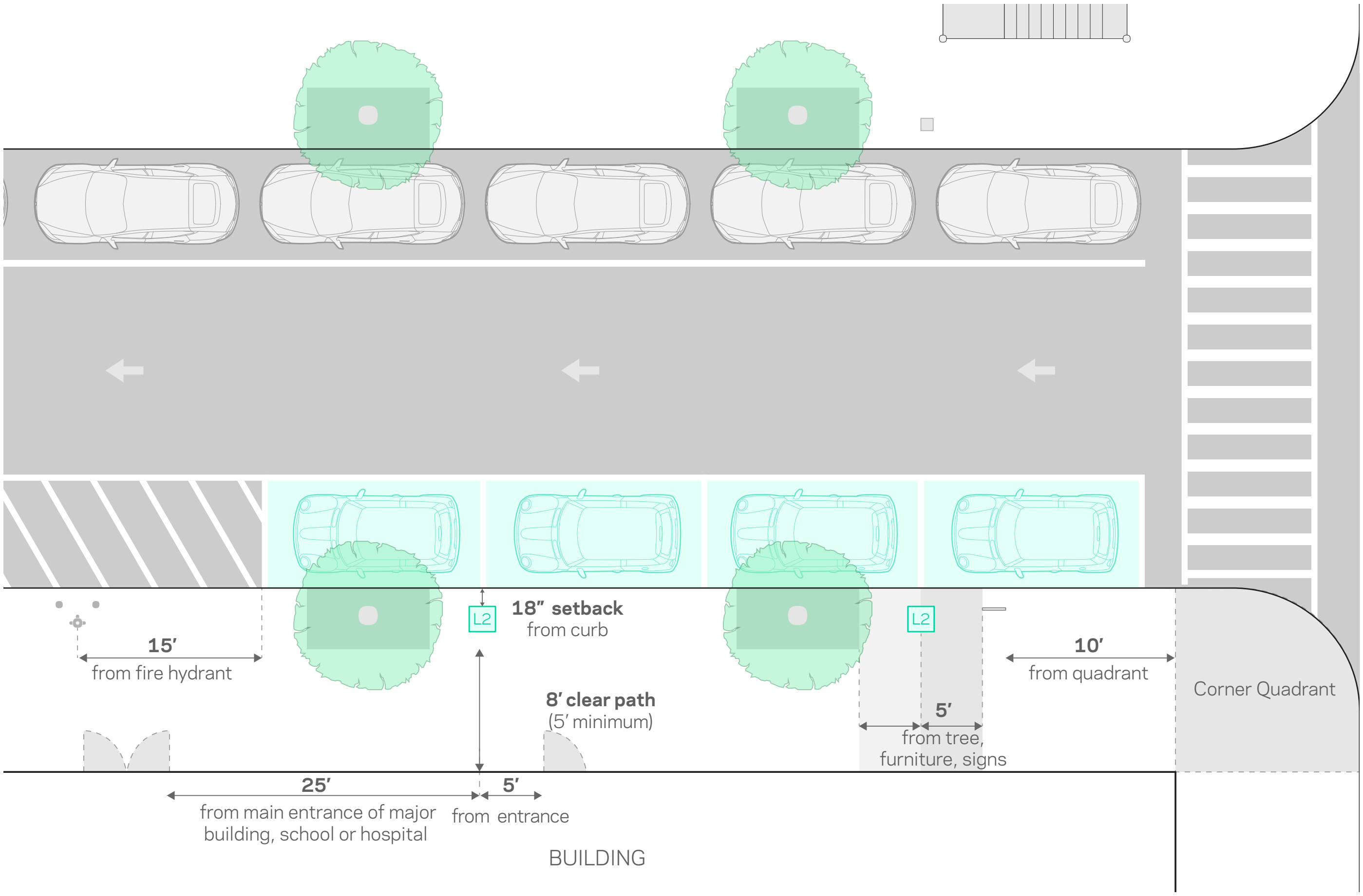


Figure 29: Siting plan for a typical street.

Siting Priorities

NYCDOT will be responsible for exact location approval for siting. Charging stations should be installed in compliance with existing NYCDOT Guidance documents:

- NYCDOT Street Design Manual (SDM)
- Manual on Uniform Traffic Control Devices (MUTCD)
- AASHTO Policy on Geometric Design of Highways and Streets ("the Green Book")
- American With Disabilities Act (ADA) Standards for Accessible Design

FDNY, NYCDEP, NYC Parks, NYCDOB, and other relevant agencies should be consulted as part of the planning process for curbside Level 2 units.

MINIMUM CLEARANCES

Level 2 units should be a minimum distance of:

18" minimum setback from curb and siting in the amenity strip

5' minimum clear path of travel (ADA)

8' preferred clear path of travel

10' from the trunk of a street tree or 5' from the edge of a 5' x 10' tree pit

5' minimum from sign and legal furniture

No parking within 15' of fire hydrant (FDNY)

5' from a building entrance (FDNY)

25' clearance from the main entrance of a major building, school, or hospital

10' clearance from corner quadrant

15' from the open side of a subway entrance

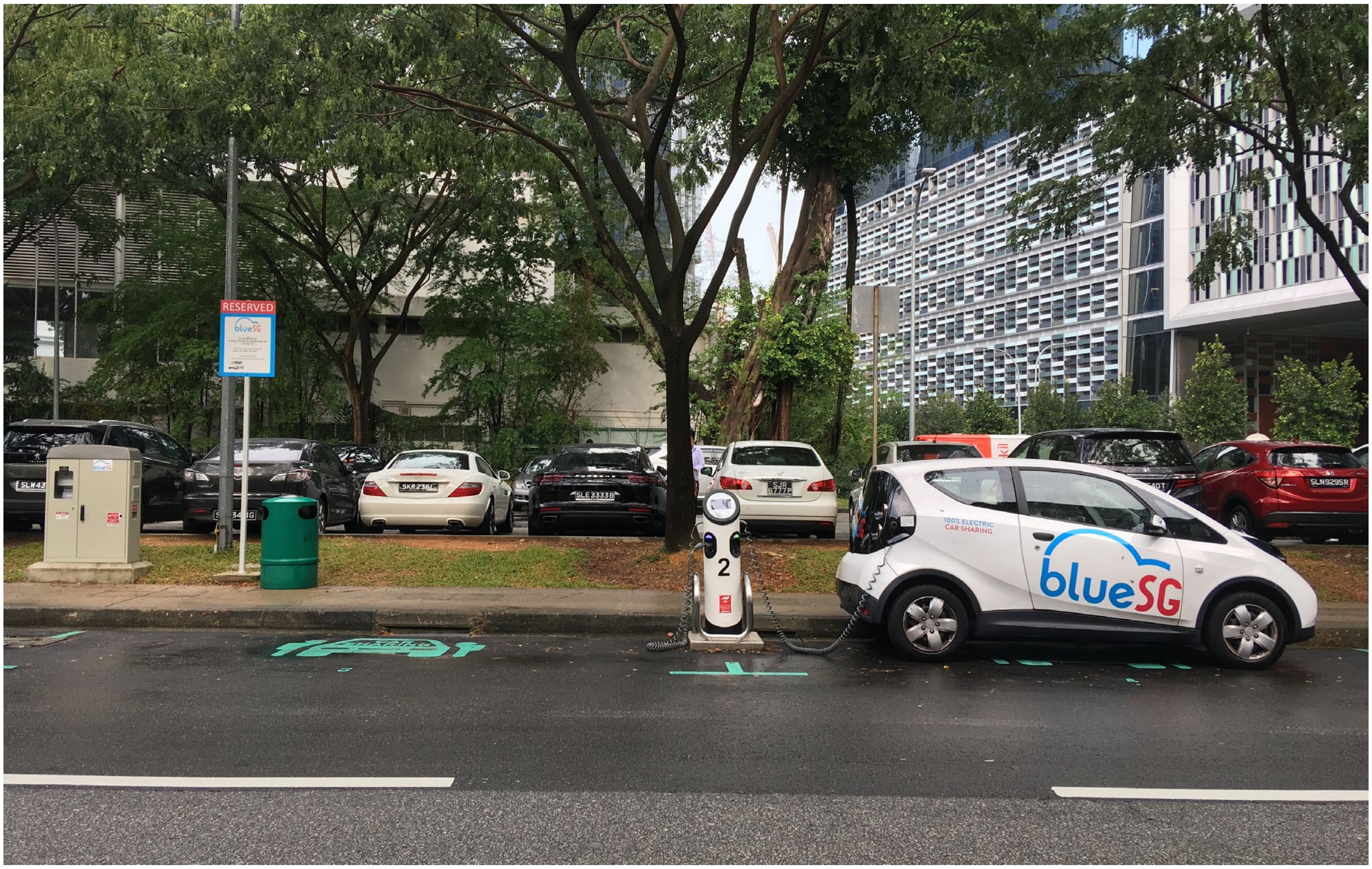


Figure 30: Siting best practices typically includes informational signage and street painting to demarcate EV-only spots, as seen in this example from BlueSG carshare in Singapore. (Image courtesy of Charlotte Ong)

PRIORITIES

Charging stations should prioritize:

Driver's side (left-hand) installations

Installations in the first legal parking space after the intersection

Maximum station visibility

Proximity to institutions

Opportunities to minimize visual clutter

Avoid blocking views of artwork or landmarked structures

Maintain sightlines to major parks, arcades, public plazas

STREET PAINTING & SIGNAGE

Parking associated with charging stations should be signed as "electric vehicle parking while charging only." EVs should be prohibited from parking if the EV is not actively charging. If signage alone does not adequately enforce EV-only spaces, then street painting should be considered to further demarcate EV-only spaces. Penalties for violations should be consistent with NYCDOT parking regulations and enforcement should be in cooperation with NYPD.

ACCESSIBILITY

The height of the user interface should be reachable by a person using a mobility device (preferred height of 42 inches and a maximum height of 48 inches). Accessibility strategies should also limit potential tripping hazard from station cords.

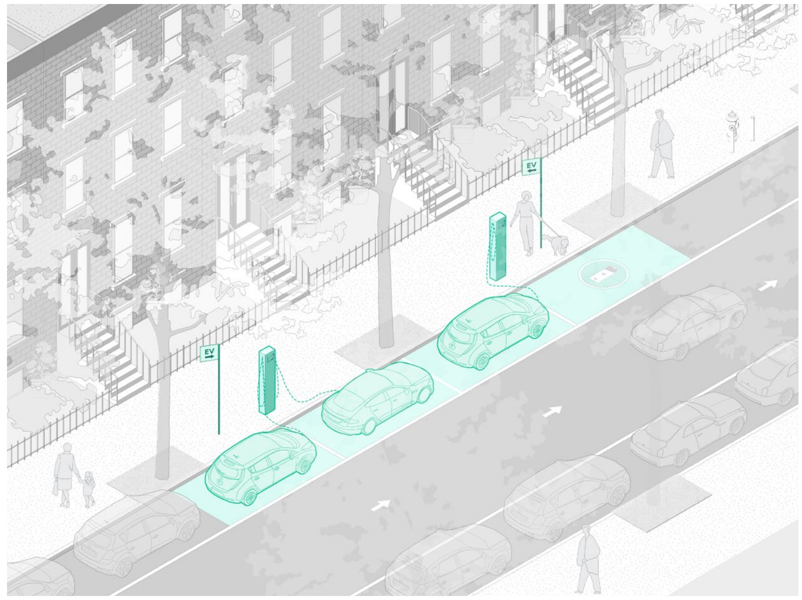


Figure 31: Mid-block installation on a one-way Local Street.

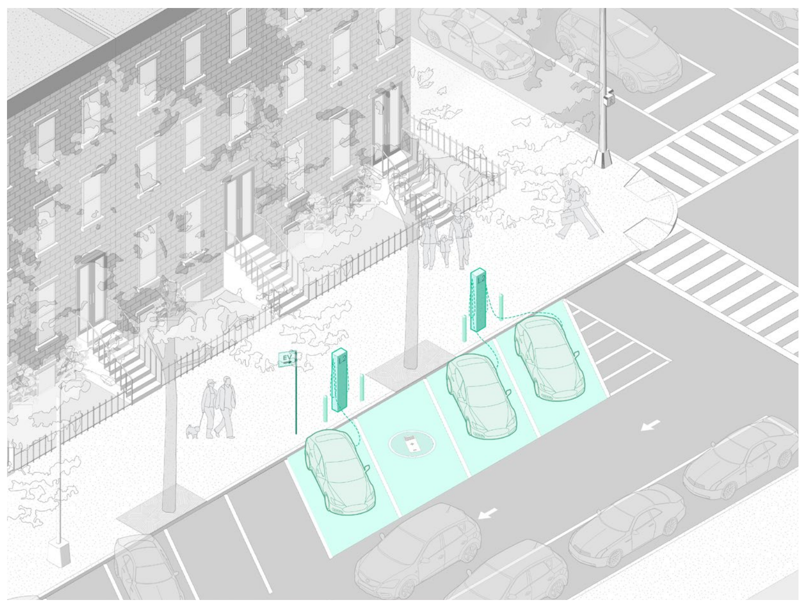


Figure 32: Back-in angled on a local street. Back-in parking may necessitate bollards to protect stations.

STATION PROTECTION

Each charging station installation should be designed to address vehicle collision. Bollards or bumper pipes can protect freestanding curbside units as necessary (protection not recommended for pole-mounted units). Stations should be designed and installed to safely break away from the sidewalk without risk of electrocution in a crash.

POWER REQUIREMENTS

Each Level 2 charging ports typically requires a dedicated single-phase electrical circuit (32A @ 208/240V) and a 40A circuit breaker at the electrical panel. Such service may require utility upgrades at installation. For many sites, availability of power will determine ultimate viability, therefore site surveying should be done in consultation with Con Edison. Whenever possible, sites with proximity to an electrical panel should be prioritized, as trenching and laying new conduit can greatly increase costs and render sites financially unfeasible. All electrical work should be done in compliance with the National Electrical Code and all local New York codes.

SUBSURFACE CONDITIONS

Level 2 stations can be installed on a pre-fabricated or cast-in-place concrete foundation. The depth of the foundation is a factor of the height and weight of the station anticipated wind load, and the frost line. Sites should be free of underground infrastructure to the extent possible, as some stations may necessitate excavation for a footing up to 6′ from the underside of the sidewalk or paving.

Given the complexity in sub-surface conditions in New York City and limited availability of sub-sidewalk surveys, many sites that look viable on the surface-level may be invalidated upon site survey, a consideration that should be factored into decision-making in site selection.

CELLULAR SIGNAL

Stations require 3G cellular activity. In places where there is low cell activity, a cellular signal booster (repeater) may need to be installed.

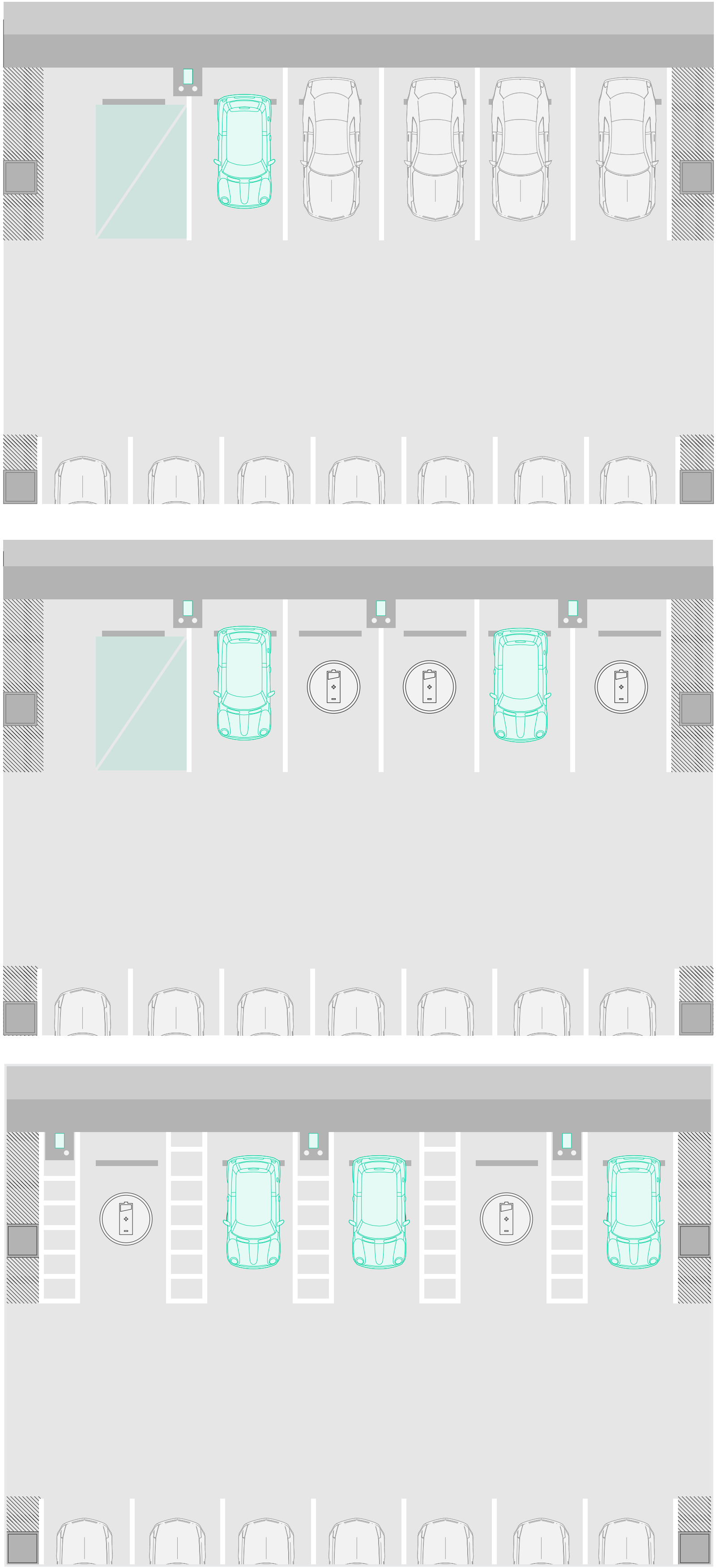


Figure 33: Potential variations on parking configurations under viaducts, where the roadbed operates similarly to a parking lot.

Parking Layouts

MID-BLOCK INSTALLATIONS

Mid-block installations (Figure 31) may offer greater access to power or preferable parking in proximity to key institutions. However, regulating these spaces may be more difficult than installations in the first legal parking space after the intersection. Demarcation of the EV-only spaces with street painting and clear regulatory signage is recommended for mid-block installations.

UNDER VIADUCTS & ELEVATEDS

Areas under viaducts allow for greater flexibility in parking configurations as long as minimum clearances required for viaduct maintenance are respected (Figure 33). For example, parking stops and bollards can be installed on the roadbed itself, a protective element that cannot be deployed in other on-street locations due to need for regular access for street cleaning. They also allow for greater flexibility in provision of aisles and wider than average clearances around vehicles. Finally, these areas offer an opportunity for piloting clusters of multiple charging stations.

4. Integrating Charging Equipment

Figure 34: ChargePoint dual-port instaallation in Los Angeles.

Overview

There are many different variations in commercially available Level 2 charging stations. Urban installations require a specific set of features related to public safety, durability, and ease of use which differ from features required for garage-sited stations.

The following section describes the key considerations in selecting optimal stations for a curbside charging pilot. Ultimately, NYCDOT and the PDC will be responsible for approving any charging stations to be installed on New York City streets.

Charging Station Variations

PORTS & CHARGING CONNECTORS

Charging stations can either have single or dual ports. The most commonly used charging connector standard for North America is the SAE J1772.

CORD MANAGEMENT SYSTEMS

Cord management systems range from a fully manual hook or cradle where the user is responsible for winding up the cord after use, to assisted cable management systems that automatically retract cords after use (Figure 36).

There is variability in the length of cords ranging from 18-25 feet. Given the lack of standardization in charge port locations, cords must reach all possible connection points on an EV. Cord material should remain flexible in all weather conditions.

The expected intensity of use, siting configurations, and weather conditions should all factor into decisions around which cord management system is best suited to a curbside pilot. Broad categories that should be considered include:

- Cord exposure: Cables kept outside the charging unit when not in use may suffer wear and tear from the elements, can become stiff in cold weather, and have potential risk of vandalism.
- Cord security: Most chargers have an automatic locking feature that prevents cords from being unplugged while charging.
- Damage risk: Cables and ports that drag on the ground can get caught in snow plows or be run over by vehicles.
- Hazard risk: Cables in the right-of-way can present a tripping hazard.
- Vandalism risk: Exposed cables can be cut, tied, or otherwise vandalized.
- Maintenance: Cord management systems may require added maintenance to keep up functionality.
- Cleanliness: Cables kept elevated are less likely to get dirty, improving user experience.
- Costs: Cord management systems are typically an add-on feature that can increase Level 2 charging station cost.
- Visual clutter: Small units with fewer exposed elements have a more minimal urban footprint and design impact.
- User responsibility: The level of user involvement in keeping cords organized during charging or after use can vary. Irresponsible users may create hazardous situations by leaving the cable unwound after use.
- User burden: Factors users have to be responsible for, including subscribing to networks or bringing their own cord.

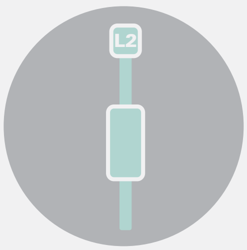
CURBSIDE CHARGING STATION TYPES

PEDESTAL

Free-standing charging stations with single or dual charge ports. Station footprints are typically similar to municipal meters, although pedestals range in height and bulk.

+ Precedent for size and bulk in approved New York City street furniture family
+ Wide variety of commercially available models among EVSE providers

– Costs can be high if trenching is required
– Visibility can be low, making it difficult for drivers to find stations



TOWER

Free-standing charging stations taller than pedestals to provide a built-in cord management system that keeps cords elevated. Modular elements such as lighting or WIFI infrastructure can also be paired with the tower.

+ High visibility (from height) means drivers can find stations more easily
+ Increased pedestrian safety with cord management that keeps cables elevated off the ground

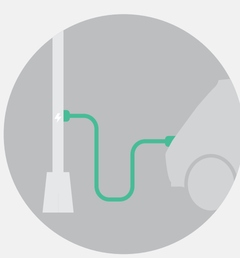
– Costs can be high if trenching is required
– Excavation for footing and subsurface conditions may increase complexity and cost in installation
– Larger footprint and bulk increases visual clutter

POLE-MOUNTED

Chargers installed on existing infrastructure such as a light pole. Unit heights are adjustable at the point of installation. While these chargers have a slimmer profile, they typically only have one charge port. Pole mounting in NYC may be challenging due to issues related to metering, conduit, maintenance and agency oversight.

+ Reduced clutter and sidewalk footprint
+ Unit can be installed at flexible heights
+ Low installation cost if power to the light pole is sufficient (trenching can be timed with planned streetlight upgrades)

– Installations are limited to existing pole locations, light pole standards, and further suitability assessments
– May give the impression of impermanence



USER-SUPPLIED CORD (PLUG & SOCKET)

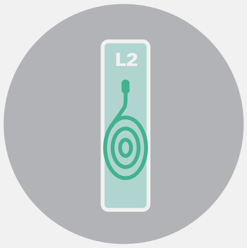
A standard EV socket is mounted onto a free-standing pedestal or light pole that delivers a slower charge appropriate for long dwell times. Users must bring their own cord with a compatible plug to charge. Metering for usage can occur within the charging unit or through metered power cables. This charging option is popular in Europe but is not currently used in North America.

+ Minimized trip hazard when not in use
+ Responsibility for cable maintenance for shifts to drivers
+ Good solution for nighttime charging and other contexts with long dwell times
+ Less vandalism risk
+ Financial savings in installation
+ Space saving

– Drivers must purchase compatible cables and may require significant consumer education
– Charge speed is limited by charge current to the light pole (slower charge)
– Light poles may require costly upgrades to support new stations
– Difficulty in sub-metering energy usage

Figure 35: Overview of charging station types..

CORD MANAGEMENT SYSTEMS



WIND UP

Users manually wind the cable on a hook or cradle after use.

+ Lower costs
+ Space saving

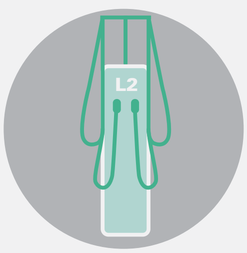
– User responsibility
– Cord exposure
– Cord cleanliness
– Tripping hazard
– Visual clutter

SELF-RETRACTING

A pulley system with in-built tension prevents the external cables from draping on the ground.

+ Keeps cord elevated
+ Reduced tripping hazard
+ Less user responsibility

– Cables may drag while charging
– Cord exposure
– Visual clutter

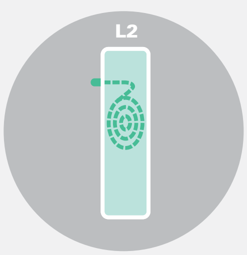


ELEVATED SELF-RETRACTING

A taller variation on the self-retracting system with an elevated lanyard that keeps the cable hovering around 3′ above ground at all times.

+ Keeps cord elevated
+ Cleaner cords
+ Ease of locating Level 2
+ Minimized damage
+ Reduced tripping hazard
+ Less user responsibility

– Added cost
– Visual clutter
– Cord exposure



REEL

A self-retracting system that automatically retracts the cable after use and stores it within the charging unit.

+ Cord only exposed when in use
+ Reduced wear and tear
+ Reduced risk of vandalism
+ Reduced visual clutter
+ Cleaner cords

– More maintenance
– Potential for stuck reels
– Takes more space inside Level 2 unit

USER-SUPPLIED CORD

No cord management system is provided. Instead, the pedestal or pole-mounted charger only has a socket for users to plug in their own cables which may drag on the ground.

+ Lower costs
+ Space saving
+ Users responsible for cable
+ Less hazard when not in use
+ Reduced visual clutter

– No cord management
– Burden on drivers to bring cable
– Cable security (risk of theft if users do not lock cables)

Figure 36: Overview of cord management systems.

HEIGHT SCALE COMPARISON

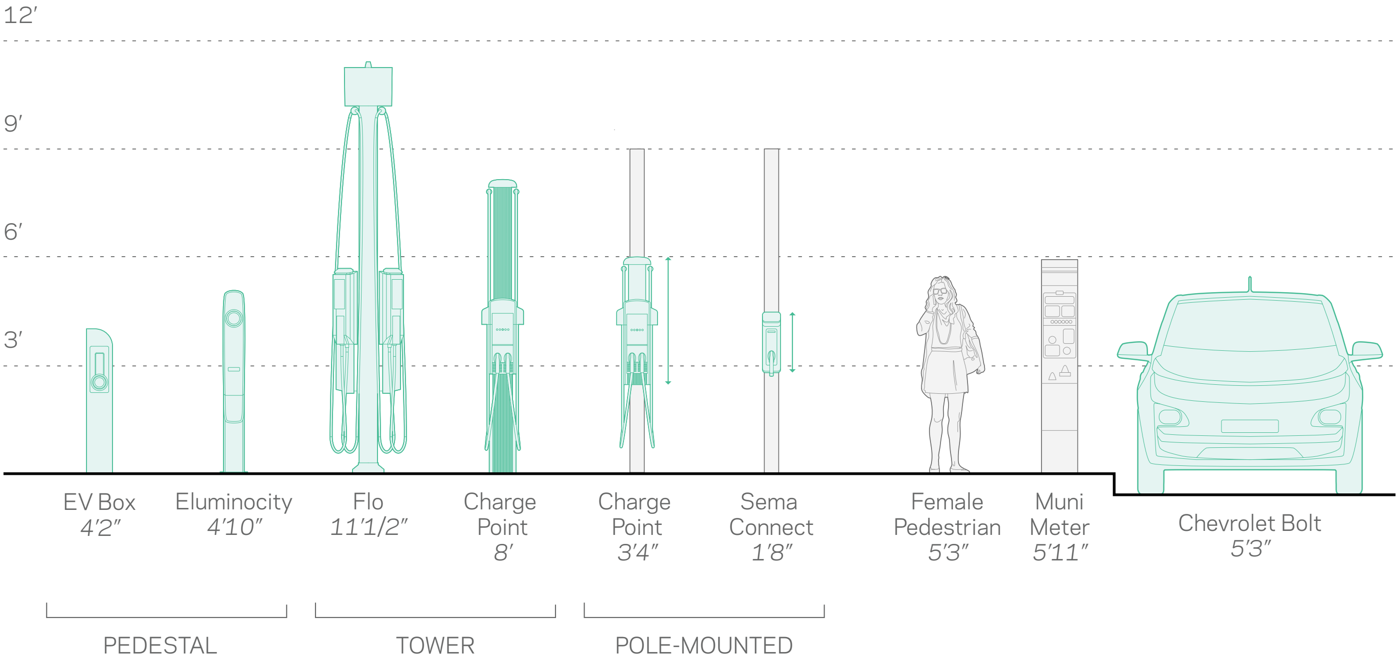


Figure 37: Height and scale comparison of select commercially available EVSE.

HEIGHT & SCALE

A sampling of charging stations available on the market today shows enormous variation in the height and scale of different products, largely variable due to the cord management system they deploy.

STATION CUSTOMIZATION

Station manufacturers offer customization options for off-shelf chargers. These are generally limited to color changes, decals, and station wrappers.

ADDITIONAL HARDWARE

Not all charging stations are networked with hardware and software to accept payments within the unit itself. Some providers require a standalone "master" hardware unit equipped with network connectivity, user interface, and payment system. These "master" units can typically control multiple charging units clustered on a street.

UPGRADES & SPECIAL FEATURES

Increasingly, charging station manufacturers have options for features that can support smart cities and urban design priorities. Modular lighting elements can aid in locating stations, enhance user experience, and minimize clutter by doubling up elements in the right-of-way. Station sensor technology with cloud connectivity has capabilities to collect data on motion, parking space availability, environmental conditions (temperature and other), and traffic. Some sensors are enabled to exchange information with other Internet of things (IoT) devices, which can feedback valuable information to station operators and policymakers. Energy storage systems can assist with peak and off-peak demand load management.

NETWORK INTEROPERABILITY

Planning for curbside charging station interoperability is a public policy consideration that should be addressed alongside planning for optimally placed charging stations. There is currently no payment standard for Level 2: some units require a membership card for network use, others can accept credit card payments, and still others can be unlocked with smart phones. Since EVSE providers have had minimal or no payment or back-end communications interoperability, users must have membership accounts and identification cards with different network providers to use public access units. Policymakers should work with network providers to set standards for maximum interoperability in curbside charging. The Netherlands, for example, uses radiofrequency identification cards (RFID) that allow users to charge anywhere with one payment system and membership card.[1] Some European user-supplied smart cord providers have bundled inter-utility payment networks to simplify payments.

COMMON CONCERNS

There are common concerns when introducing new elements into the urban streetscape. All units should be designed with user safety as a priority. Charging station manufacturers have offered direct feedback to clarify the following concerns:

- There is no risk of electrocution if a cord is cut while unplugged, and minimal risk of electrocution if a cord is cut while a vehicle is charging.
- Unless it interrupts the electrical circuit, physical vandalism will not be communicated to the network operator until someone reports the problem through their network application or a call.
- EVs are designed so they cannot drive while plugged in. In the event that someone is able to drive away while plugged in, most charging stations have a built-in breakaway system to minimize station damage.
- There is relatively low fire risk for Level 2 chargers. In the rare event of a fire, the unit casing acts as a fire enclosure. Some cities, such as London, include a fire assessment prevention plan part of their public procurement process.

WEATHER EVENTS, EMERGENCY SUSPENSIONS AND HOLIDAYS

Periodic emergency suspensions for weather events should not impede access to charging. Policymakers and network operators should establish provisions for snow removal services in consultation with DSNY or a third party operator.

1 Dale Hall, Nic Lutsey, "Emerging Best Practices for EV Infrastructure," (ICCT: 2017), https://www.theicct.org/publications/emerging-best-practices-electric-vehicle-charging-infrastructure

Figure 39: Single-port charging stations installed curbside in Indianapolis, Indiana. (Image courtesy of BlueIndy)

Figure 38: Dual-port curbside installation in Montréal, Canada, where harsh winter weather requires a durable charging solution. (Image courtesy of Flo)

Figure 40: FDNY Electric Ambulance pedestal (Move Systems; Rendering and design by Ignacio Ciocchini, Industrial Designer)

Design Approval and PDC

The Public Design Commission (PDC) is the New York City agency responsible for design review for architecture, street furniture, parks, signage, and public art proposed on city-owned property. Since most streets and sidewalks are city-owned property (under the purview of NYCDOT), PDC has the design jurisdiction over proposed new structures and furniture.

As of August 2018, the FDNY Ambulance Pedestal (Figure 40) was the only charger to go through a full PDC approval process. Ambulances, as emergency response vehicles, must always idle to keep communications systems ready and to keep medicine that requires constant refrigeration from spoiling. Grid electricity allows ambulances to plug-in, thereby offsetting 45 tons of annual emissions per ambulance. The FDNY Ambulance charger includes a weatherized power cable that fully retracts into the unit when it is not plugged in for more than two minutes. Other design features include: silver carbon steel shell with louvers for air flow; backlit LED beacon for unit location and status; color-coded status door light to indicate if the pedestal is functioning properly (blue for a good state; burnt orange for an electrical malfunction; violet for other states); base and mounting plate; information screen.

PDC has conditionally approved two additional charging stations for time-limited pilot programs:

1. MTA All-Electric Bus Pilot Program
2. NYSERDA Taxi of Tomorrow DC Fast Charge Pilot at Seward Park

PDC holds new street furniture to high design standards and typically only recommends a full approval process for permanent fixtures that will become a part of New York City's approved street furniture family. Submitters should anticipate that PDC review will scrutinize the Level 2 charging unit and the siting criteria for their aesthetic impact on proposed sites. Submitters should consider the following in preparing proposals for curbside Level 2 charging:

- Infrastructure alignment with approved family of DOT street furniture
- Siting strategy alignment with street planting objectives
- Minimizing street clutter (combining furniture elements, unit number)
- Coherent street and sidewalk design
- Minimal interference with pedestrian and traffic right-of-way

Submitters may have an added level of scrutiny for sites in the following areas:

- Sidewalks less than 15 feet wide (sidewalks narrower than 15′ need a layout for the street furniture)
- Historic districts
- Security hardening locations (require bollards)

PDC APPROVAL PROCESS

NYCDOT has jurisdiction over city sidewalks and streets, and it is responsible for preparing the submission to PDC. The PDC timeline for station approval hinges on the review process, which can vary depending on whether the agency requests a conditional approval for a time-limited pilot period (typically defined as one year) or a full approval for a permanent fixture

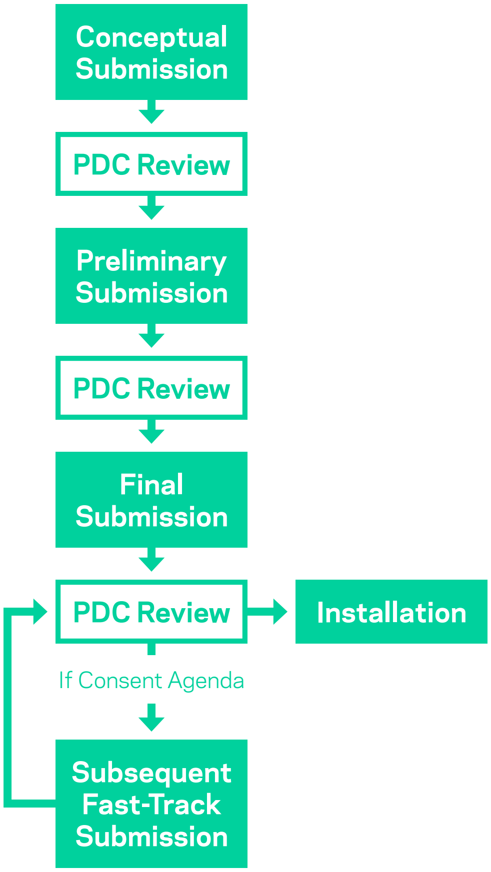


Figure 41: PDC approval process diagram.

installation. The review process typically takes a minimum of 12 weeks, however it can vary significantly depending on revisions and resubmissions required (Figure 41).

Prior to submitting to PDC, the submitter should anticipate coordination with multiple agencies for approvals.

There are two possible routes for securing PDC approval for new Level 2 curbside charging infrastructure in New York City.

OPTION 1: OFF-SHELF APPROACH

1. Conceptual Review – Develop early concepts for siting and design based on prototypical conditions
2. Preliminary Review – Introduce formal submission for siting criteria and design (site plans, photos, and rationale for siting criteria)
3. Final Review – submit 90% construction documents for site
4. Subsequent Submissions – Installations are added to a consent agenda and summarily approved if they meet the criteria set forth in Step 2 (1 month turnaround)

OPTION 2: FRANCHISE APPROACH

1. Conceptual Review – Develop early concepts for siting and design based on prototypical conditions and designs
2. Preliminary + Final Review – Formal submission for siting criteria and design
3. Subsequent Installs – Vendor installs in adherence with the established criteria without having to go to PDC for every subsequent location

Permitting Requirements

Installation of EVSE on City-owned land will require interagency coordination with NYCDOT, Con Edison, and other agencies, as needed. The checklist in Figure 42 is intended to help determine the agencies and regulators with review control in typical installation conditions. These actors will include:

- NYCDOT: Jurisdiction over streets, includes curbs and sidewalks.
- Con Edison: Provides electrical utility service and connection to the grid; reviews and approves meter installation and electric service.
- PDC: Design jurisdiction over city-owned property.

Installations may also trigger reviews from:

- NYSDOT: Jurisdiction over highway viaducts and entrance/exit ramps.
- NYCDOB: Enforces NYC electrical code, approves major electrical installations, and inspects completed electrical installations performed by private electricians.

1 Pre-Permitting Checklist

	Review Agency	Response
Before permitting, establish installation prerequisites: if the proposed Level 2 and installation site(s) adhere to agency standards and are financially feasible. If the answer is NO to any of the following, then you might not be ready to initiate a permitting process.		
Product Approval		
Is the charging station certified and meet standard for electrical safety?	UL	Yes
Load Letter & Feasibility		
All Level 2 installations will require a Con Edison load letter that will help determine costs associated with pulling power to the site.		
Is it financially feasible to pull power to the proposed site?	Con Edison	Yes
Site Approval		
Installations will likely trigger PDC approval and review to ensure adherence to siting and design guidelines set for the pilot program.*		
Has the Community/Borough Board approved the site?	Community/Borough Board	Yes
Is the EVSE PDC-approved (for pilot or permanent)?	PDC	Yes
Does the site adhere to PDC-approved siting criteria?	PDC	Yes
Submitter & Installer Credentials		
Is the person submitting construction plans for the site a New York State licensed Professional Engineer (PE) or Registered Architect (RA)?	PDC	Yes
Is my proposed installer a NYC-certified electrician?	NYCDOB (enforces National Electric Code)	Yes
Does my proposed installer carry the mandatory minimum insurance requirements?	NYCDOB	Yes

2 Non-NYCDOT Permitting Checklist

	Review Agency	Permit Req?
All NYCDOT permit applicants must have approval from all other agencies before submitting a completed application. If the answer is YES to the following questions, then additional permits are likely required.		
Is the installation "low voltage" (under 600 Volts of power)?	NYCDOB	Maybe
Will the installation require power other than DOT metered utility power?	NYCDOB	Maybe
Will any street trees or tree pits will be affected?	NYC Parks	Yes
Will any water or sewer line be affected?	NYCDEP	Yes
Is the site within an Historic District?	NYCLPC	Yes
Is the site under a viaduct?	NYSDOT	Yes

3 NYCDOT Permitting Checklist

	Street Works Manual Section	Permit Req?
The following permit classes will be required for curbside Level 2 charging station installations.		
Street Opening Permits	NYCDOT Street Works Manual (3.3.2)	Yes
Building Operations/ Construction Activity Permits.	NYCDOT Street Works Manual (3.3.3)	Yes
Sidewalk Construction Permit	NYCDOT Street Works Manual (3.3.4)	Yes
If the answer is yes to any of the following questions, then a NYCDOT permit is likely required.		
Is the proposed installation on a street in protected status? A street is considered protected 5 years form the date it was last resurfaced.	NYCDOT Protected Streets Listing and Street Opening Permits; Additional Requirements: Sections 2-02 and 2-11 of the Highway Rules	Maybe
Will a Building Vault be affected?	NYCDOT Street Works Manual (3.7.1)	Maybe
Will a Transformer Vault be affected?	NYCDOT Street Works Manual (3.7.2)	Maybe

Figure 42: Curbside Installation review agencies and permitting checklist.

PUBLIC AGENCY COORDINATION

The streamlined and expedient deployments of curbside EVSE will require that utilities, New York City agencies and New York State agencies work together. Key stakeholders include NYCDOT, Con Edison, PDC, and the Mayor's Office. Site-by-site deployments may trigger review by NYCDOB, NYSDOT, and NYC Parks. Planning for a curbside pilot program should also consult DEP, NYCLPC, NYPD, and FDNY.

Final Implementation Considerations

Setting aside charging station-equipped curb space for BEVs in this early stage of adoption offers policymakers a promising and relatively cost-effective strategy for encouraging zero-emission transport while preparing New York City for the emergence of mass market EVs.

The deployment of EV charging infrastructure in advance of critical market demand does, however, pose efficiency challenges for those entrusted with managing the public right-of-way. Urban transportation agencies typically face competing public and private interests in their management of city streets and regulations. Achieving the right balance requires careful and well-informed decision-making by agency staff, elected officials, and certain non-governmental entities with a stake in managing the curb. Making targeted investments in curbside EVSE will also require a thoughtful balance between market drivers, environmental equity, technical feasibility, and the public's appetite for disruptions to long-established parking protocols.

The return on this investment will be a meaningful reduction in New York City's fossil fuel consumption, as well as the GHG emissions associated with ICE vehicles across the City. Providing a network of curbside charging stations will add to the operational advantages of EV ownership, by offering both opportunistic and routinized charging for commuters, residents, visitors, and fleets. The emergence of smart charging may also enable municipal governments to better manage, monitor, and even monetize the curb.

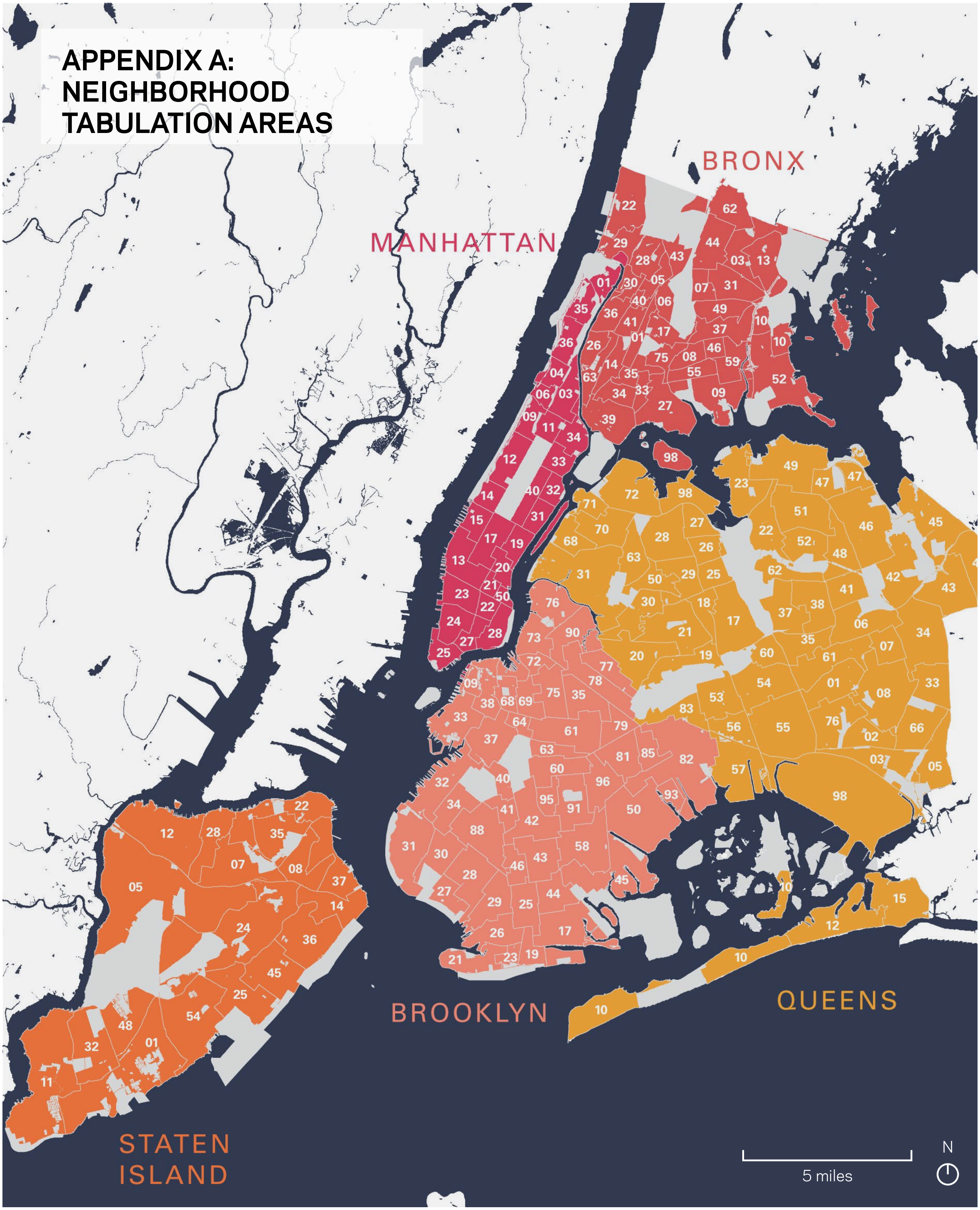
By bringing power to the public right-of-way, policymakers can facilitate an array of clean transportation solutions, including range extension for electric delivery trucks, charging for eBikes, and powering of electric refrigeration units, appliances on food trucks, and lifesaving equipment on emergency vehicles.

Even the best informed policymaking can, however, be overtaken by the pace of technological change. The technology for EVs and EVSE is still evolving. Changes in the size, weight, and energy density of EV traction batteries, improvements to charging equipment, emerging wireless charging capability, and enhancements to the grid will all impact policymaking in the future. But the revolution at the curb—the electrification of an array of mobility solutions—is likely to endure.

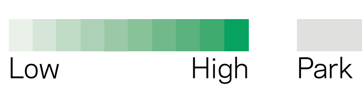

STOP

Appendices

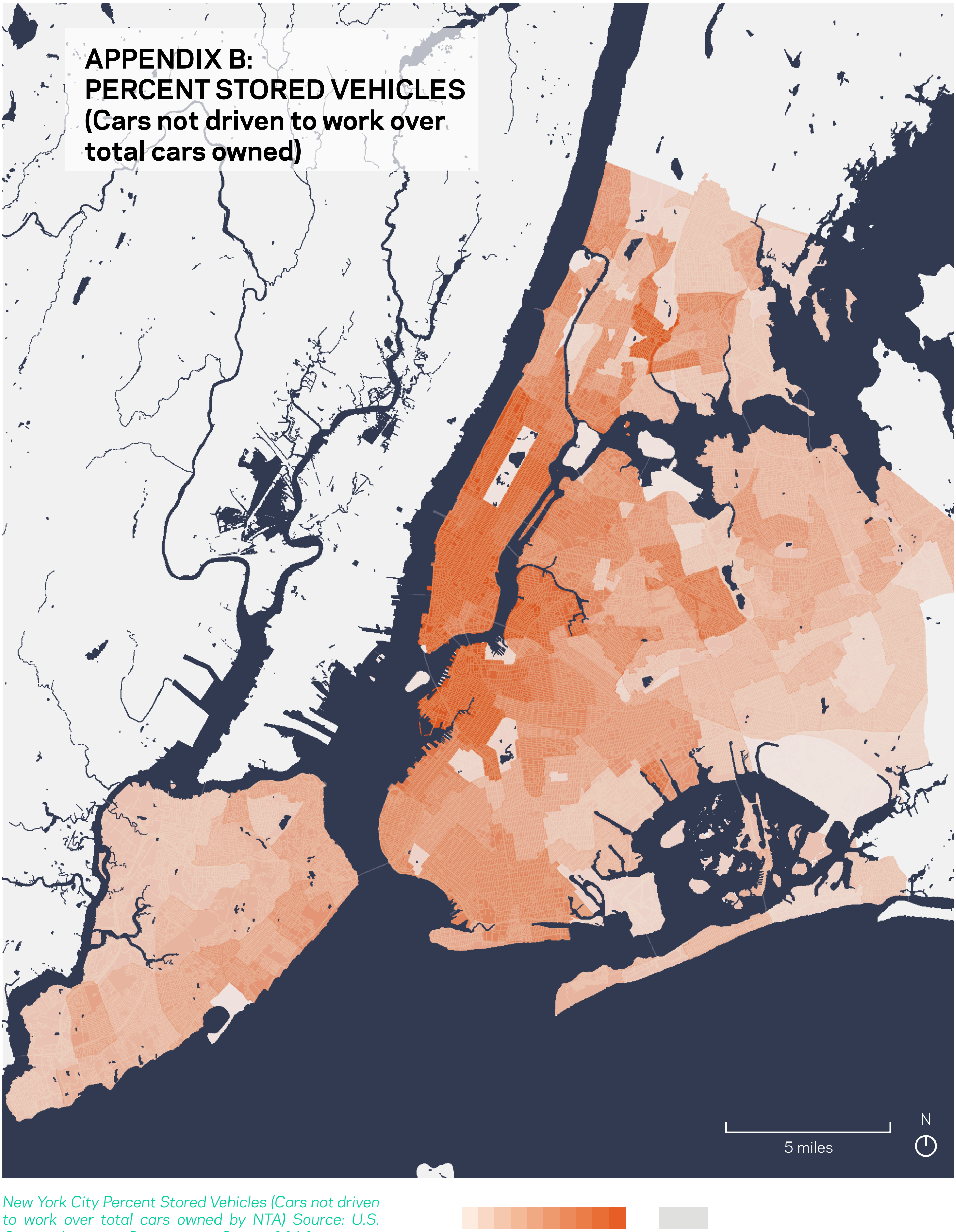
APPENDIX A: NEIGHBORHOOD TABULATION AREAS



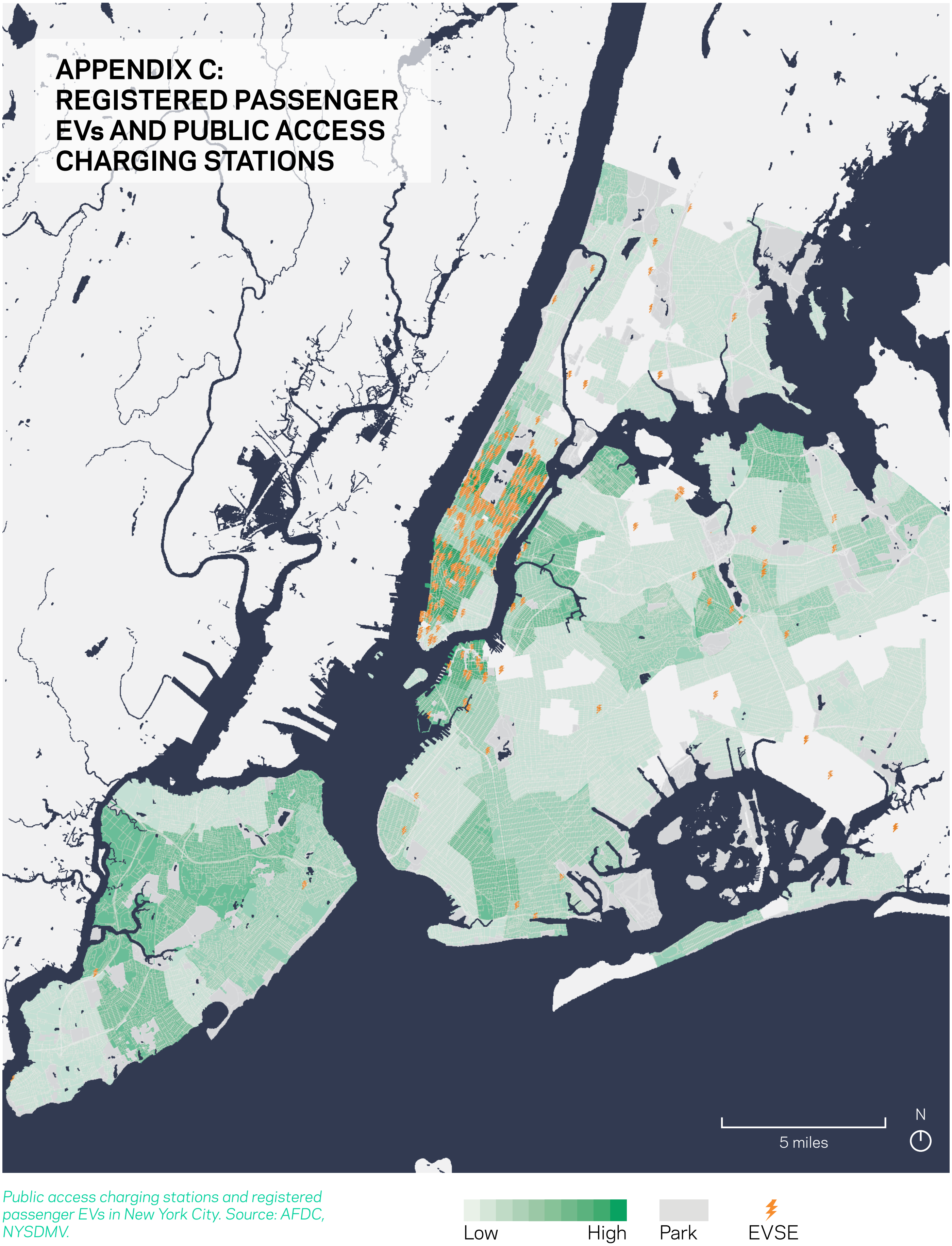
New York City Neighborhood Tabulation Area (NTA) Key



APPENDIX B: PERCENT STORED VEHICLES (Cars not driven to work over total cars owned)



New York City Percent Stored Vehicles (Cars not driven to work over total cars owned by NTA) Source: U.S. Census American Communities Survey 2016



Public access charging stations and registered passenger EVs in New York City. Source: AFDC, NYSDMV.

APPENDIX D: REGISTERED EVs METHODOLOGICAL NOTE

EV REGISTRATIONS

There are two steps to approximate the number of EVs registered to New York City's five boroughs:

1. Identify EV Models

NYS Department of Motor Vehicles (DMV) sometimes erroneously records fuel-types in the "Vehicle, Snowmobile, and Boat Registrations," the most reliable source for vehicle registrations statewide. A more reliable method for identifying EVs is by its "Vehicle Identification Number" (VIN). Every vehicle in the U.S. has a unique 17-character identifier on its dash. The first eight-characters denote: vehicle country of origin, manufacturer, model, make, year, and fuel-type.

Analysis for this guide uses a list of EV VINs compiled in September 2017 by Energetics Incorporated that included VINs for EV models through 2017. EV registration figures derived by this analysis underrepresent the total number of EVs at the time of writing, since it omits VINs for new EV models released in 2018.

2. Filter For Passenger Vehicle Registrations

The study team removed commercial vehicles, motorcycles, DCAS fleet vehicles, and a host of other vehicle-types to get a true count of passenger vehicle counts in New York City (identified as 'PAS' and 'SRF') .

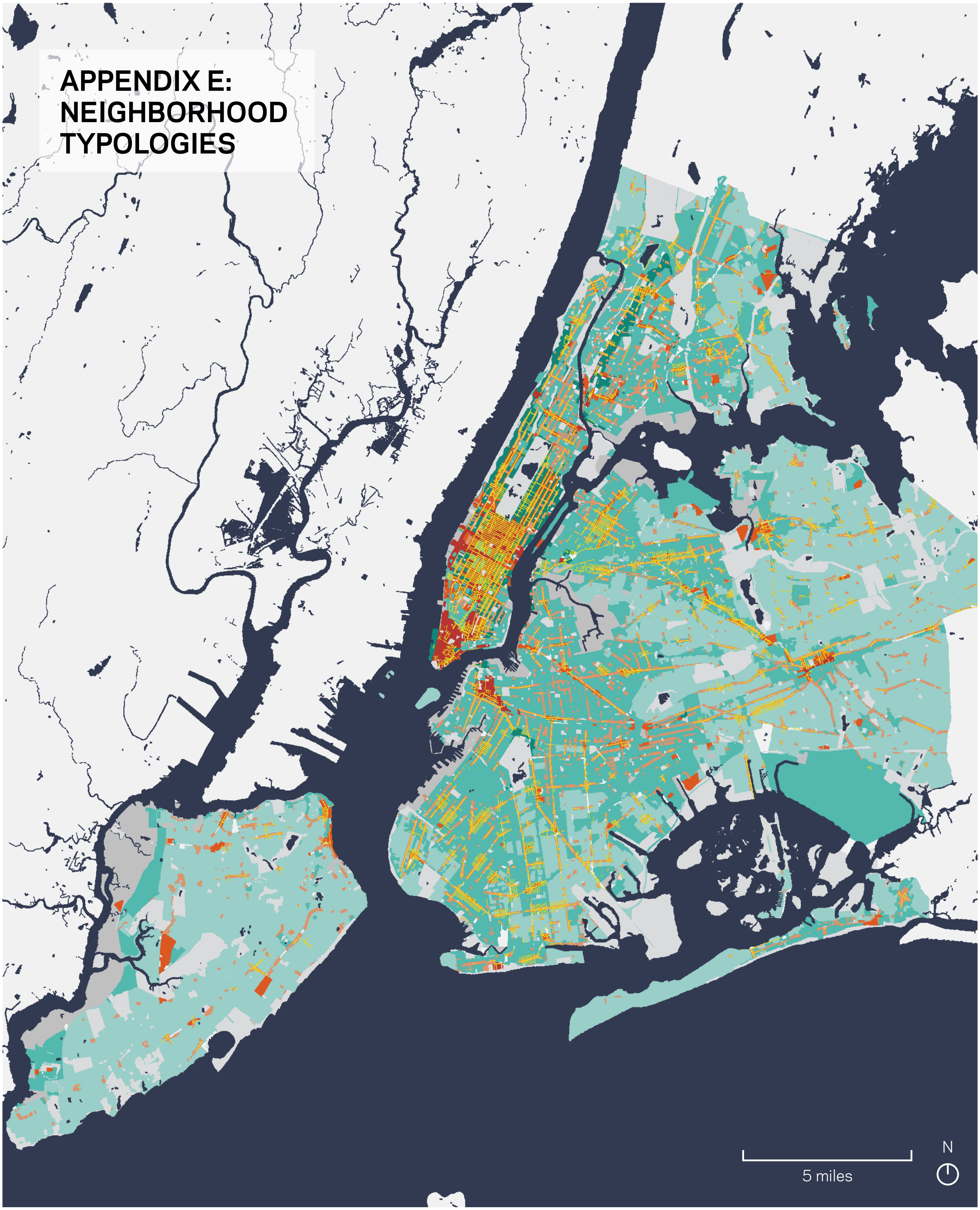
3. Narrow Geographic Scope

Analysis for this guide tabulated EV registered in the New York City's five boroughs: Bronx, Kings, New York, Richmond, and Queens counties.

EV GROWTH

EV registration data alone cannot be used to determine historical growth trends since EVs no longer registered are not reflected in registration datasets. The research team used EV model years as a rough proxy for date of purchase to approximate historical growth trends. The analysis does not include 2018 EV models, therefore 2018 EV growth is not estimated.

APPENDIX E: NEIGHBORHOOD TYPOLOGIES



New York City Neighborhood Types

Low Density Residential
Medium Density Residential
High Density Residential
Local Commercial
Commercial Center
Central Business District
Industrial
Park

APPENDIX F: LAND USE TYPES

Land Use	Level 2 Priority	Rationale	Zoning
Low-Density Residential	**Low**	Primarily residential, zoned for a mix of housing types, from single-family, detached housing to multi-family housing, all requiring minimum of 1 parking space per dwelling unit, with very limited exceptions. Our assumption is that EV owners in these areas will have access to at-home charging; therefore, there will be less demand for on-street Level 2.	R1-R4
Medium-Density Residential Mixed-Use	**High**	Primarily residential type allows for a variety of housing that ranges from multi-family units, with less than one off-street parking space per dwelling unit required. Prevalence of local commercial overlays and light-manufacturing districts with permitted residences, result in a density of services and people that make it a “sweet spot” for on street Level 2.	R5-R7, M1, C1, C2
High-Density Residential Mixed-Use	**Medium**	Residential zone that allows for mid-rise to high-rise construction, primarily zoned in Manhattan and in the Bronx along Grand Concourse.	R8-R10, C1, C2
Commercial Center	**Medium**	Primarily commercial zones situated within a residential neighborhood and more densely built areas. Located outside of the main CBD but may serve as regional commercial centers with larger car-dependent store that may generate more traffic, and including gas stations.	C4; C8; M1-5; M1-6; C7, C8
City Central Business District	**Low**	Zoned for high-density commercial activities in centrally accessible areas of the City and that generate significant congestion due to freight and deliveries, combined with highly constrained curb make these zones a low priority for Level 2.	C5-C6; Miscellaneous
Industrial (Non-Residential)	**Low**	Primarily zoned for heavy industrial uses that are isolated from residences and commercial hubs. These are a low-priority for Level 2 charging except in limited deployments based on demand-driven needs (fleets, workplaces, manufacturing).	M2-M3

Curb Enthusiasm

Deployment Guide for On-Street Electric Vehicle Charging