NYC Zero-Emission Urban Freight and Green Loading Zone Market Research

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TABLE OF CONTENTS

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EXECUTIVE SUMMARY

In an effort to reduce emissions from last-mile deliveries and incentivize green vehicle adoption, The New York City Department of Transportation (NYC DOT) is seeking to implement a Green Loading Zone (GLZ) pilot program. A Green Loading Zone is curb space designated for the sole use of "green" vehicles, which could include electric and alternative fuel vehicles as well as other zero-emission delivery modes like electric-assist cargo bikes. To inform decisions about the program's siting and regulations, this study was conducted by the University of Washington's Urban Freight Lab (UFL) in collaboration with NYC DOT under the UFL's Technical Assistance Program.

The study consists of three sources of information, focusing primarily on input from potential GLZ users, i.e., delivery companies. An online survey of these stakeholders was conducted, garnering 13 responses from 8 types of companies. Interviews were conducted with a parcel carrier and an electric vehicle manufacturer. Additionally, similar programs from around the world were researched to help identify current practices. The major findings are summarized below, followed by recommendations for siting, usage restriction and pricing of GLZs. It is important to note that these recommendations are based on the survey and interview findings and thus on benefits to delivery companies. However, other important factors such as environmental justice, land use patterns, and budgetary constraints should be considered when implementing GLZs.

Literature Review Findings

Green Loading Zones are a relatively novel approach to incentivizing electric vehicle (EV) adoption. Two relevant pilot programs exist in the United States, one in Santa Monica, CA and the other one in Los Angeles, CA. Both are "zero-emission" delivery programs, meaning alternative fuel vehicles that reduce emissions (compared to fossil fuel vehicles) are not included in the pilot's parking benefits (dedicated spaces and free parking). Other cities including Washington, DC and Vancouver, Canada are also creating truck-only zones and dedicating parking to EVs in their efforts to reduce emissions. Bremen, Germany also has a similar program called an Environmental Loading Point.

Many cities in Europe are implementing low- or zero-emission zones. These are different than GLZs in that entire cities or sections of cities are restricted to vehicles that meet certain emissions criteria. London, Paris, and 13 Dutch municipalities are all implementing low-emission zones. These zones have achieved some success in reducing greenhouse gas emissions: in London, CO2 from vehicles has been reduced by 13 percent. Companies operating in those cities have opted to purchase cleaner vehicles or to replace trucks with alternative modes like cargo bikes.

In addition to demonstrating similar goals as NYC DOT, these programs provide insights to the siting and structure of GLZs. Loading zones have been selected based on equity concerns, delivery demand, and commercial density. Every city in the literature review has installed specific signage for the programs to clearly convey the regulations involved.

Survey and interview Findings

A range of company types replied to the survey: parcel carriers (large shippers), small shippers, e-commerce and retail companies, freight distributors, a truck dealer, a liquid fuel delivery company, and a logistics

association (answering on behalf of members). The majority of these companies will be increasing their fleet sizes over the next ten years, and most plan to increase the share of EVs in their fleets while doing so. A smaller share (4 of 13) also plans to increase their share of alternative fuel vehicles. The most cited reasons for increasing fleet size and green vehicle share are: 1) internal sustainability goals, 2) social responsibility, and 3) new vehicles/models coming to the market.

Green vehicle adoption is not without its challenges. For EV adoption specifically, companies identified three major barriers: 1) competition in the EV market, 2) electric grid requirements upstream of company-owned facilities, and 3) lack of adequate government-supported purchasing subsidies. To overcome these barriers, respondents would like larger or more government purchasing incentives and reduced toll or parking rates for EVs. However, the majority of companies also expressed a willingness to pay for GLZs at similar rates to other commercial loading zones.

As for area coverage, all respondents deliver to Manhattan, Queens, and Brooklyn. 11 of 13 deliver to Staten Island and the Bronx as well. All EV and cargo bike operators deliver to Manhattan, whereas only one EV operator and one cargo bike operator deliver to all five boroughs of NYC. Respondents deliver at all times of day, but the busiest times are between 9:00AM and 4:00PM (stated by 8 of 13 respondents). Peak periods are busiest for four companies in the morning (6:00AM-9:00AM) and six companies in the evening (4:00PM-9:00PM).

The interviews supported findings from the survey. Both interviewed companies have a vested interest in reducing their environmental footprint and plan to use or produce exclusively zero-emission vehicles by 2050 (carrier) or 2035 (manufacturer). However, they noted challenges to electrifying entire fleets for cities. Charging infrastructure needs to be expanded, but incentives are also needed (parking benefits, subsidies, expedited permitting) to make the market viable for many delivery companies.

Recommendations

The preceding findings informed four key recommendations:

1. GLZs should be made available to multiple modes: green vehicles and cargo bikes. Adequate curb space might be needed to accommodate multiple step-side vans plus a small vehicle and cargo bikes, but this should be balanced against curb utilization rates and anticipated dwell times to maximize curb use.
2. Explore piloting GLZs in Lower Manhattan and commercial areas of Midtown Manhattan; they could be the most beneficial locations for the pilot according to survey respondents.
3. The preferred layout for GLZs is several spaces distributed across multiple blocks.
4. DOT can charge for the GLZ use. It is recommended that rates not exceed current parking prices in the selected neighborhood, but some companies are willing to pay a modest increase over that rate to avoid parking tickets.

1

Introduction

1. INTRODUCTION

Freight accounts for 11 percent of New York City's greenhouse gas emissions (GHGs) [1]. GHGs are the main driver for climate change that is already affecting the City [2]. Increasing trends in e-commerce, home delivery, and population growth can lead to ever increasing urban freight demand and subsequent emissions. However, new low- and zero-emission vans and trucks are entering the market and there are opportunities to curb at least some freight emissions in the near future.

New York City (NYC) has a vested interest in reducing emissions from urban freight demonstrated by its recent emphasis on sustainability in Delivering New York, a smart truck management plan for New York [1]. As outlined in the plan, the New York City Department of Transportation (NYC DOT) is seeking to implement a Green Loading Zone pilot program. A "green loading zone" (GLZ) is a commercial vehicle loading zone at the curb that is specifically reserved for low- or zero-emission ("green") vehicles. These vehicles do not have to be limited to trucks and vans, but could include cargo bikes and other emerging technologies used for delivering goods and services.

The goal of the GLZ pilot is to determine if such curb management strategies can incentivize green vehicle adoption by the carriers, shippers, and logistics companies operating in NYC. This study was performed to gain insight into similar practices or projects in North America and Europe as well as to solicit information from NYC-area freight companies that can inform the most effective way to conduct the GLZ pilot program. Learning more about the interests and concerns of the freight industry and private sector stakeholders will improve NYC DOT's understanding of the obstacles and roadblocks in achieving zero emission urban freight in NYC.

In this study, the Urban Freight Lab (UFL) at University of Washington collaborated with NYC DOT to understand the barriers and motivations of the stakeholders in adopting green vehicles, as well as exploring the green loading zones applications. Information was gathered in three ways: a review of the literature, a survey of NYC delivery and logistics companies, and interviews with a few similar companies as responded to the survey. The literature was reviewed to help identify current practices, which include both government policy documents and academic publications that describe how similar programs have been adopted by cities in North America and Europe. We designed and implemented an online survey to understand the needs and preferences of goods delivery companies. A few individual interviews were also conducted to further learn about the stakeholders' barriers and willingness to use low/zero emission zones. The data gathered from the survey and interviews were analyzed to inform NYC DOT's approach to conducting a GLZ pilot.

The input from potential GLZ users, while important, is not the only factor in making decisions about siting and other aspects of the program. Certain neighborhoods could benefit more than others from the placement of Green Loading Zones. Environmental justice zones can benefit immediately from GLZs by reducing the number of fossil fuel delivery vehicles within these neighborhoods and the associated air (and noise) pollutants. Land use is also an important consideration. Major single destinations, mixed-use neighborhoods, or primarily commercial zones could variably benefit from the pilot. This study is primarily based on input from delivery companies, and does not capture these other factors in its recommendations.

This report is structured as follows. Section 2 provides definitions for key terminology used throughout the rest of the report. Section 3 covers a review of strategies implemented in North America, Europe, and Asia to support the adoption of green freight vehicles, as well as green vehicle strategies discussed in the academic literature. The methodology used for collecting data is provided in Section 4, followed by findings from the online survey and interviews with parcel carriers and vehicle manufacturers, respectively presented in Sections 5 and 6. Finally, Section 7 details recommendations for implementing and managing green loading zones.

2

Definitions

2. DEFINITIONS

The following section introduces the definitions for the terms Green Loading Zone (GLZ), electric vehicle (EV), alternative fuel vehicle, and cargo bike, as they are used in this report.

Green Loading Zones

Green Loading Zones (GLZs) are sections of curb reserved for the specific use of low- or zero-emission commercial vehicles. It is intended to be used by delivery vehicles for loading and unloading activities given a stated limit for parking duration and time of day established by the city. The policy application of GLZs is expected to support the goal of charting zero-emission freight policies in NYC by 2050.

Electric vehicles

In the context of this project we consider electric vehicles (EVs) as zero-tailpipe emission all-electric vehicles. Diesel-and gasoline-electric hybrids or plug-in hybrids are not included in this definition. EVs, also called battery electric vehicles, have a battery that is charged by plugging the vehicle into a charging equipment. EVs have typical driving ranges from 150 to 300 miles [3]. **Table A-1** (Appendix A) shows some of the currently available EVs in the U.S. and Canada to delivery companies [4].

Alternative fuel vehicles

Alternative fuel vehicles are considered those that use liquid or gaseous fuels other than diesel and gasoline (biodiesel, ethanol, natural gas, & propane) or those that use electric propulsion systems other than battery electric technology including hydrogen and hybrid electric vehicles.

- **Biodiesel** is a renewable fuel produced in the U.S. from vegetable oils, animal fats, or recycled restaurant grease. This fuel can be used in diesel vehicles. Biodiesel vehicles are the same as conventional fuel vehicles, and almost all conventional fuel vehicles can run on biodiesel.
- **Ethanol** is a renewable fuel made from corn and other plant materials. The use of ethanol is widespread and more than 98 percent of gasoline in the U.S. contains ethanol. Flexible Fuel Vehicles (FFVs), that are fueled by ethanol, are similar to their conventional gasoline-only counterparts, except from an ethanol-compatible fuel system and a different powertrain calibration.
- **Natural gas** is a fuel readily available through the utility infrastructure. Natural gas vehicles (NGVs) offer high-mileage, and can be used in centrally fueled fleets because they can provide similar fuel range support for applications not involved in long-haul routes where fuel stations can become sparse.
- **Propane**, also called liquid petroleum gas, has been used for decades to fuel light-, medium-, and heavy-duty vehicles. There are two types of propane vehicles: dedicated and bi-fuel. Dedicated propane vehicles are designed to run only on propane. Bi-fuel vehicles have two separate fueling systems, enabling the vehicle to run on either propane or gasoline.
- **Hydrogen** is a zero tailpipe emissions alternative fuel produced from diverse energy sources, when used in a fuel cell to provide electricity. Currently, light duty fuel cell electric vehicles (FCEVs) can fuel up at retail stations in less than 5 minutes with a range of more than 300 miles.
- **Hybrid vehicles** that use liquid fuels along with electricity are called either hybrid electric vehicles (HEVs), or plug-in hybrid electric vehicles (PHEVs) [3].

Cargo bikes

Cargo bikes can be defined as human powered vehicles with electric assist motors designed to carry parcels and goods within urban areas. The purpose of using cargo bikes is to avoid the traffic in dense urban areas, while being more flexible and causing less externalities [5]. **Table A-2** (Appendix A) shows some of the cargo bike models and manufacturers that are currently available to the market.

3

Literature Review

3. LITERATURE REVIEW

This section consists of three parts: 1) North American emissions-related curb management strategies, 2) International low-emission vehicle strategies, and 3) academic literature covering green loading zones.

3.1 North American Low Emission Vehicle Strategies

3.1.1 Freight Policies

3.1.1.1 Santa Monica, California

To date, the only U.S. city that has implemented a zero-emission zone for freight vehicles is Santa Monica, California. In 2021, the Los Angeles Cleantech Incubator (LACI) and partners in the city of Santa Monica launched a Zero Emissions Delivery Zone (ZEDZ) pilot [6]. The planned zone is a one-square mile, contiguous region in the downtown core of Santa Monica [6]. It is home to 15,850 residents and two distinct commercial districts (Downtown and Main Street).

The pilot includes reserved curb spaces for zero-emission delivery vehicles and encourages scooter and cargo bike deliveries. Zero-emission delivery vehicles can reserve designated loading zones for up to one hour, using an online mobile app (**Figure 1**)[1]. The city will re-designate up to 20 curb spaces to provide 1-2 zero-emission loading spaces per location, demarcated by signage (**Figure 2**) [7]. Individual loading spaces within the zone were selected based on data from participating companies describing high-demand locations, providing spatial distribution of the spaces within the ZEDZ, and proximity to businesses that might use the loading zones. The allowable parking time varies by space; some are limited to 10 minutes, while others allow up to 60 minutes. It is unclear which spaces have the comparatively short and long durations, and so are the reasons behind the selection of durations. Monitoring of the zones is performed remotely via video camera and parking enforcement officers can be notified of infractions [7]. Exemptions to paying parking or meter fees exist for displaying California Department of Motor Vehicles placards (**Figure 3**) [8]. The city will issue their own stickers to participating companies. Parking in the zones will be free for participating companies with stickers, and there is no fee for obtaining the sticker [9].

Scooter and cargo bike deliveries are encouraged by the city providing road infrastructure (curb space, sidewalks or lanes) and charging (fixed and mobile) for their uses. LACI and Santa Monica have engaged with private sector partners (e.g. AxleHire, Circuit, and Tortoise) to provide the vehicles, fleet management services, maintenance, and customer interface [10].

The pilot is entirely voluntary, meaning companies can still operate fossil fuel vehicles in the zone [7], but the goal is to reduce pollution in the city's busiest area through providing incentives for green vehicles and to demonstrate that deliveries can be made with small, electric vehicles (EVs). Companies using the zero-emission vehicle spaces will only be issued warnings [11]. IKEA is a participant in the pilot and makes deliveries in the zone with electric delivery vans in lieu of their traditional large fossil fuel trucks [7]. More companies are expected to join in demonstrating electric delivery vehicle technology. UPS is also a participant, partnering with alternative delivery technology companies like URB-E, to deploy cargo e-bikes and e-scooters. Electric scooters

[1] Links to the mobile app: Google and Apple

Figure 1: Santa Monica, CA ZEDZ Parking App

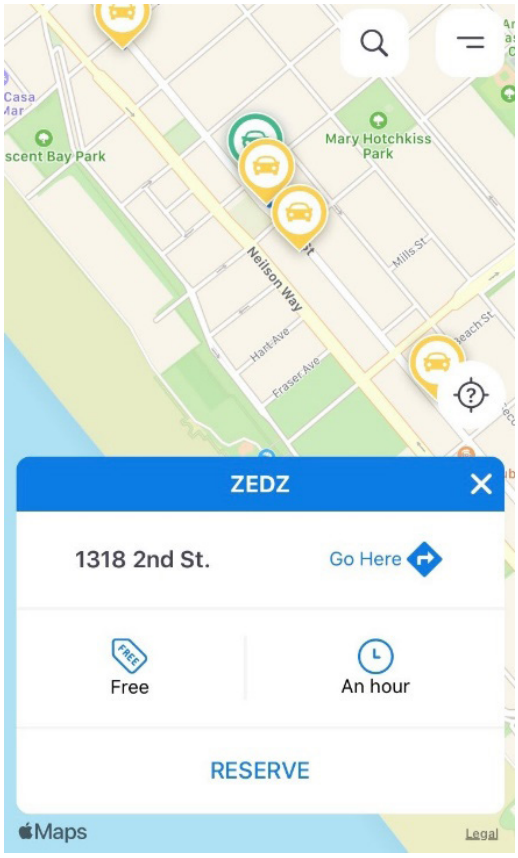


Figure 2: Santa Monica ZEDZ Curb Designation Signage

Figure 3: California Department of Motor Vehicles CAV Decals [8]. Different decals will be provided by the city of Santa Monica for the ZEDZ pilot.

Blue: valid until 2025 | Orange: valid until 2024 | Purple: valid until 2023 | Red: valid until 2022

and bikes will operate between restaurants to make food deliveries and from urban distribution centers located on the edges of the zone for parcel deliveries within the zone.

Additionally, a few remote-operated delivery robots which share sidewalks with pedestrians to make food and small parcel deliveries also operate in the zone. Some of these companies, including Cyan Robotics, are already operating in the larger Santa Monica area. To facilitate the use of autonomous technology like delivery robots, the City Council approved a revision to the municipal code that lifted a moratorium on allowing the devices to use public infrastructure, e.g., sidewalks [12]. Further details regarding operating parameters have not been made public. The pilot is focused on demonstrating the capabilities of micromobility delivery solutions (cargo e-scooters and e-bikes) and light- and medium-duty electric vehicles. Reducing the number of heavy-duty trucks in the zone is desirable, but few zero-emission options are currently available to replace these types of trucks.

Participating companies will share data with the city of Santa Monica and LACI. What data will be collected has not been made public, but it is reported that the company Automotus will use cameras positioned near the designated loading zones to evaluate how often the spaces are utilized both by participating companies and violators of the zero-emissions policy. Metrics for measuring success also have not been publicly stated.

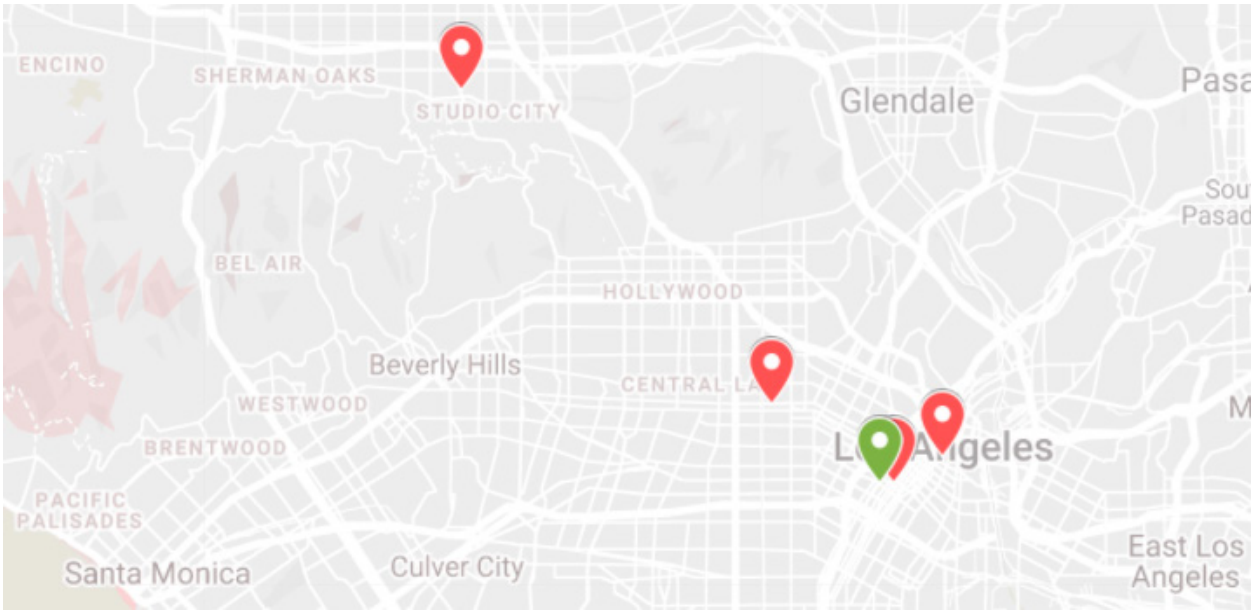
3.1.1.2 Los Angeles, California

In June 2021, the Los Angeles City Council approved an ordinance proposed by the Los Angeles Department of Transportation (LADOT) to create five "Zero Emission Delivery Zones" (ZEDZ) in the city [13]. The ordinance is a pilot program estimated to cost the city $10,000 for signage, curbside paint, and pavement markings (**Figure 4** [14]) [15]. LADOT contracted with the curb technology company Automotus to install cameras to monitor four of the five ZEDZs. The city is responsible for enforcing the zone restrictions, and can use the video footage to supplement on-the-ground observations and ticketing by parking enforcement officers. The fifth zone will be monitored by parking enforcement officers within the course of their typical daily duties. In addition to issuing tickets based on camera footage, Automotus will collect data about the users of the ZEDZ, occupancies rates, and utilization trends.

Figure 4: Los Angeles, CA ZEDZ curb designation signage & pavement markings [14]

Locations (**Figure 5**) were selected based on high curb space demand for commercial activity, high commercial or residential density, and Disadvantaged Community[2] status [16]. LADOT is responsible for evaluating the success of the pilot (with the aid of Automotus and the video data it collects) as well as creating a blueprint for expanding the program throughout the city if it is deemed a success. The LA zero-emission delivery zones are intended to incentivize the adoption of electric or other zero-emission vehicles by restricting access to the busy curbs for fossil fuel vehicles. The zones will be marked with signage different from existing loading zone signs and pavement markings, according to the LADOT budget request. The zones will be made available to alternative delivery modes like e-cargo bikes and scooters. Details for permitting, and the pilot evaluation methodology are not available at this time, but the pilot is underway as of Fall 2021.

Figure 5: Zero Emission Delivery Zone Locations in Los Angeles, CA. (Red designates locations monitored by Automotus, green solely by the city) [18]

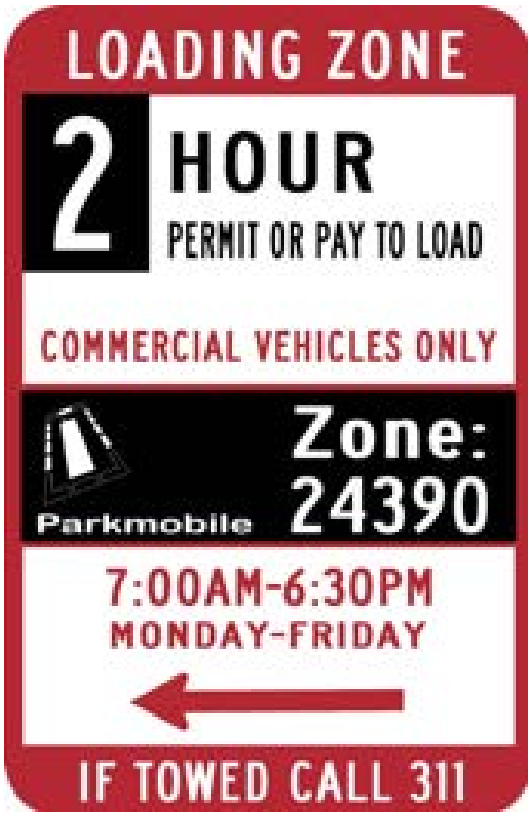


[2] "Disadvantaged communities are defined as the top 25% scoring areas from CalEnviroScreen…" Scoring includes water and air quality measures, demographic information, and hazardous site proximity. [17]

3.1.1.3 Washington, District of Columbia

In 2014, Washington, DC published a city-wide mobility action plan, MoveDC, that included a recommendation to create "Eco Loading Zones" for low emission delivery vehicles [19]. While a low-emission zone pilot has not been launched to date, the city did formalize a paid loading zone system at the curb [19]. Zones are marked by red "loading zone" signs (**Figure 6**) and are restricted to commercial vehicles 22 feet or greater in length that are actively making deliveries. The vehicle size is derived from the District's Official Municipal Regulations definition for commercial vehicles: "...any four-wheeled vehicle that is longer than twenty-two (22) feet; or used for transporting commercial loads or property; or described as a commercial vehicle on its certificate of title; or has an irremovable commercial advertisement or insignia" [20]. The definition likely helps enforcement officers identify non-commercial vehicles quickly rather than displaying the information for consumers. Since the beginning of the paid loading zone system and with the aid of an interactive map displaying available truck loading zones, the District reduced double parking violations and non-truck parking in loading zones by 50 percent [21]. The map[3] displays the length of each loading zone, so that drivers can easily identify curb spaces long enough for their vehicles.

Figure 6: Washington, DC Loading Zone Signage



Carriers have demonstrated a willingness to pay for access to reliably available loading zones, which both offsets parking fines and improves delivery efficiency [20]. Each zone is metered, and the standard maximum allowable parking time is two hours. Meter rates vary by payment method and location within the city (downtown core is more expensive than outlying regions). In addition to pay-by-phone or credit card payment options at the meters, companies can opt to pay for an annual commercial loading zone permit ($323 decal fee per vehicle plus $55 permit processing fee) [22]. The annual permit also allows decaled vehicles to occupy up to two metered parking spaces outside of loading zones between the hours of 10:00 AM and 2:00 PM. These permits are limited to freight carriers and delivery vehicles. Other commercial vehicles cannot apply. One-day commercial loading zone permits are also available for a $25 fee. Similar to the annual permit, one-day permits allow decaled vehicles to park in any metered parking spaces between 10:00 AM and 2:00 PM [22]. The intent of one-day permits is to allow companies that occasionally lease vehicles or swap out vehicles due to maintenance to continue normal operations as annual permits cannot be transferred between vehicles.

[3] "The interactive map: DC Truck and Bus Map

3.1.2 Non-freight policies

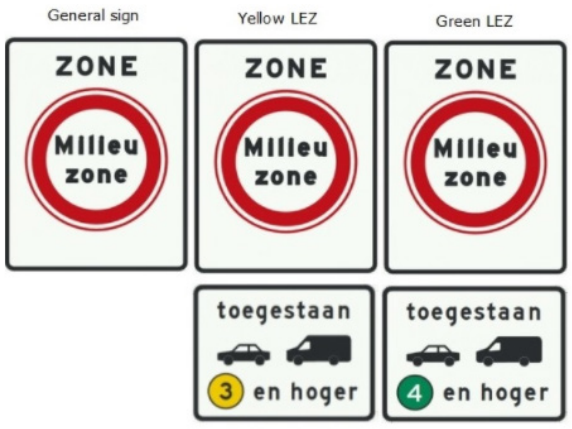
A handful of U.S. and Canadian cities are using curb space provision/restriction to incentivize the purchase of electric and zero-emission vehicles. These policies are generally geared towards passenger vehicles or residents of the city rather than commercial uses. Los Angeles, CA [23] and Boise, ID [24] have both enacted provisions that allow drivers of zero-emission vehicles (ZEVs) to apply for parking permit fee waivers. Los Angeles charges $34 per year for residential parking, and households can hold permits for up to four vehicles [25]. The resident or household must apply for the permit every year so the waiver can be submitted at this time or at the time of vehicle purchase. The permit can be used at any metered or residential zone parking space within the resident's home district. Boise's zero-emission vehicle parking permit allows for free parking up to the maximum posted time at any metered space within the city [24]. Vehicle owners pay $10 per year for the permit and an inspection by Boise City Fleet Services is required to verify the vehicle is, in fact, a ZEV. Neither city has publicly available data about the number of permits issued.

Vancouver, BC provides designated parking for ZEVs in lots operated by public entities, but not at curbs [26]. Drivers of electric vehicles in British Columbia (BC), Canada are issued a province decal that allows the vehicles access to reserved ZEV parking spaces in Vancouver and high occupancy vehicle (HOV) lanes throughout the province regardless of the number of passengers and free of charge. Ten percent (174 parking stalls) of all off-street parking in the city is dedicated to ZEV use. These decals are not limited to passenger vehicles, but the benefits to delivery companies are likely minimal as they more often use curbside parking than off-street parking.

3.2 International Zero-emission Vehicle Strategies

Thirteen Dutch municipalities have created low-emission zones (LEZs) [27][28]. These were created in response to a commitment made by the Netherlands in 2019 to implement zero-emission zones in the 30 to 40 largest cities in the country by 2025 [29]. In most cases, these zones allow for trucks with emission class of Euro IV or higher (Euro emission class standards are provided in Appendix B, Tables B-1, B-2). Euro standards are set for diesel and gasoline vehicle emissions. This means that diesel vehicles are not prohibited from entering the zone, unless they fail to display a decal noting the vehicle meets Euro IV standards [30]. Signage is placed along every road entering the zone showing drivers the minimum Euro standards allowed in the zone by way of color coded symbols (yellow and green) that match vehicle decals (Figure 7). The zones are monitored by cameras and patrol vehicles, both of which are used to issue tickets for infractions or failure to display a decal [27]. It is not clear if patrol vehicles also have the authority to remove violators from the zones in real time. Over time, the municipalities will incrementally increase the emission standards within the zone until only ZEVs are allowed [30].

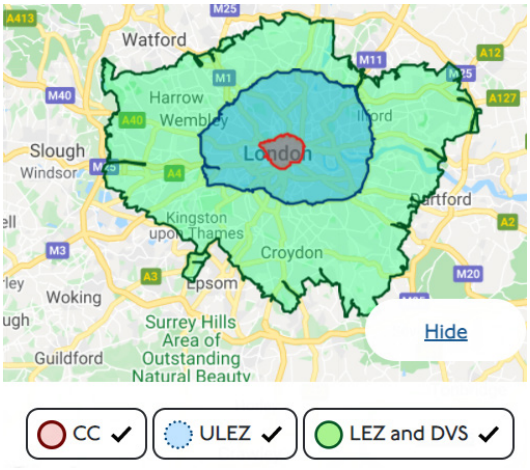
Figure 7: Figure 7: Netherlands Low Emission Zone Signage (used nation-wide)



Exemptions are given nationally and at the local level [31]. Nationally, certain types of equipment that are less than 13 years of age, including fire engines, cranes, and concrete mixers can enter any zone and are provided a special decal. Local municipalities can issue one-time use exemptions if the vehicle will not enter

the zone more than 12 times in a calendar year. In 2020, the daily exemption cost €29.05 ($32.72). The air quality improvements after a year of implementation (2007-2008) were between 0-2μg/m³ [32].

Figure 8: Extent of London Low Emission Zone (Green), Ultra Low Emission Zone (Blue) and Congestion Charging zone (Red).



London's implementation of the citywide LEZ (**Figure 8**) is an example of the same process. London's LEZ was created in February 2003 and allowed medium- and heavy-duty vehicles meeting Euro III standards or better into the zone. Standards have been increased at intervals up until March 2021, when Euro VI standards were adopted for the entire zone [11][28][30]. In the first six months, the Ultra LEZ implemented in London resulted in NO2 reduction by 32 μg/m³, traffic reduction by nine percent, and CO2 reduction by 13 percent [32]. London installed cameras and air quality monitors at entrances and points throughout the zones. Violators receive tickets in the mail and have 14 days to provide payment or the fine doubles. The base fines for vehicles over one metric ton (e.g. cargo vans) is £250 ($335), for trucks over 3.5 metric tons failing to meet NOx standards is £500 ($669), and for trucks over 3.5 metric tons failing to meet NOx and PM standards is £1,000 ($1,338). Few exemptions exist, but they include specialized farm equipment, vehicles built before 1973, those with classic vehicle tax status, and those operated by the Ministry of Defense [33].

Companies operating in Dutch cities with LEZs and in London have responded to the restrictions by purchasing cleaner vehicles, but also by finding alternative means of delivery. In Rotterdam, many large delivery companies have opted to open urban distribution centers at the edges of the LEZ and use small electric vans or cargo bikes to make last-mile deliveries. In the London LEZ area, there were 225,000 delivery trucks operating in 2012, compared to 725,000-860,000 in 2007 (estimated by Transport for London).

Bremen, Germany created an Environmental Loading Point (ELP) in 2007 [35]. This strategy example is the most closely related one to Green Loading Zones. Located near Bremen's pedestrian-only inner-city commercial area, the ELP reserves two loading spaces within a parking lot (**Figure 9**) for vehicles that either comply with Euro V standards or are classified as an "Enhanced Environmentally Friendly Vehicle"

Figure 9: Bremen, Germany Environmental Loading Point [34]

(EEV). An EEV is simply a fossil fuel vehicle classification that falls somewhere between Euro V and Euro VI standards (depending on model year). Manufacturers can voluntarily elect to meet the EEV emission standards to achieve the classification, but they should not be confused with ZEVs. Vehicles with permits to use the ELP are marked with a decal [35] (**Figure 10**) and transponder used for the automated enforcement of the spaces. Vehicle authorization is checked automatically and a traffic light adjacent to the ELP turns red if the vehicle is not authorized to park [35]. Loading times are unrestricted.

Figure 10: Bremen, Germany ZEV sticker (left) & LEZ signage (right)

Paris and 31 other French cities have adopted ZEV stickers similar to Germany's to identify low emission vehicles and allow their access into low emission zones [36]. Stickers have different colors based on the vehicle size and Euro emissions vehicle classification. Paris has four environmental zones, each with different restrictions depending on the vehicle emission classification and the time of day [37]. Those four environmental zones are described below.

The ZFE (Zone a Faibles Emissions) (**Figure 11**) is an environmental zone for the greater Paris area that is active 8am-8pm every day. Vehicles with a badge class 4 (**Figure 12**) are permanently banned from this zone Monday to Friday, 8am-8pm. The ban is in effect on weekends and holidays, 8am-8pm, for trucks and buses. The ZPA (Zone de Protection de l'Air) (**Figure 11**) is another environmental zone for the greater Paris area, which might temporarily ban vehicles without a badge and those with a badge class not allowed in the zone, depending on the level and duration of the air pollution peak. The other two zones, A86 (inside) ZFE and A86 (outside) ZFE, are active 8am-8pm daily for all vehicles. The A86 road is a ring around the ZFE area shown in Figure 6(a), and is exempt from the green zone regulations. The A86 (inside) ZFE and A86 (outside) ZFE are in effect in 47 out of 79 municipalities in Paris. The fines for all the zones range from 68 to 450 euros [38].

Figure 11: (a) Greater Paris ZFE environmental zone (b) Greater Paris ZPA environmental zone [38]

(a)

(b)

Many cities have joined C40, a consortium of municipal governments meant to share best practices and advance global warming-related policies at the city level. One of the main commitments some C40 members (35 cities in total) have made is designating a major area of the city as a zero-emission area by 2030 [39]. The C40 is a network of cities (97 cities) around the world that has the goal to address climate change by collaborating and sharing knowledge. This action is a part of the Green and Healthy Streets Declaration that aims to have the C40 cities use only zero-emission buses by 2025, ensuring a major area of our city is zero-emission by 2030. Barcelona is one of the C40 members and it has introduced a 95 squared-km low emission zone in 2020, based on pedestrian friendly Superblocks. The goal of this low emission zone is to gradually reduce the use of fossil fuel vehicles [40].

Figure 12. French environmental sticker classification (Certificat qualité de l'Air) [37]

Certificat qualité de l'air - Classification

Class	Mopeds	Motorbikes, light quad bikes	cars, vans, campers ≤ 3,5 t		Bus, truck, motorhomes >3,5 t	
E	Hydrogen- and electric vehicles					
1	Gas, plug-in hybrid vehicles					
Class	Diesel/ petrol		Diesel	Petrol	Diesel	Petrol
1	Euro 4 from 01.01.2018	Euro 4 from 01.01.2017	-	Euro 5 - 6 from 01.01.2011	-	Euro 6 from 01.01.2014
2	Euro 3 from 01.01.2007		Euro 5 - 6 from 01.01.2011	Euro 4 from 01.01.2006	Euro 6 from 01.01.2014	Euro 5 from 01.10.2009
3	Euro 2 from 01.07.2004		Euro 4 from 01.01.2006	Euro 2 and 3 from 01.01.1997	Euro 5 from 01.10.2009	Euro 3 - 4 from 01.10.2001
4	Euro 0 - 1 from 01.06.2000		Euro 3 from 01.01.2001	-	Euro 4 from 01.10.2006	-
5	-		Euro 2 from 01.01.1997	-	Euro 3 from 01.10.2001	-
	Euro 0 - 1 to 31.05.2000		Euro 0 - 1	Euro 0 - 1	Euro 0 - 2	Euro 0 - 2
exceptions: Agricultural and forestry machinery (class T)						

A white paper by the International Council on Clean Transportation (ICCT) lists Chinese cities with commercial vehicle ZEV incentives [41]. Tianjin has a target to offer 21 charging stations for commercial electric vehicles, but not loading zones. Six other cities in China (Shenzhen, Yichun, Xi'an, Nanchang, Taiyuan, and Hefei) have adopted a parking fee incentive for EVs, by charging them a reduced fee for parking [28][41]. The local authorities of Xi'an and Yichun also created dedicated parking spaces for EVs (at least 5 percent of the parking spaces must be reserved for EVs) [41].

3.3 Academic Literature Scan

Table 1 lists the low emission freight strategies discussed in academic studies that have been applied in different cities or countries.

Table 1: Low emission freight strategies adopted by cities discussed in the academic literature

LOCATION	STRATEGIES	SOURCE
Amsterdam, Netherlands	• No congestion charges, parking fees, or road taxes for electric vehicles • Allowing electric vehicles to enter low-emission zones, pedestrian zones, and bus lanes • Allowing electric vehicles to park at non-loading areas • Wider time access for electric vehicles	Quak et al., 2016 [42]
Germany	• Restrict vehicles based on the pollutant emission level • Identify green vehicles with stickers (color based on the Euro standard)	Cruz & Montenon, 2016 [43]
London, United Kingdom	• Restrict vehicles based on the pollutant emission level • Identify green vehicles with cameras (based on vehicle plates) • All HGVs must comply with Euro IV PM standard; vans with unladen weight over 1205 kg must comply with the Euro 3 PM standard • Noncompliant vehicles must pay 200 pounds (£) per day for vehicles 3,500 kg and heavier, and 100 pounds per day for 1,200-kg vehicles. • Phased introduction of emission restrictions (4 phases) • LEZ minimum emission standards for heavy vehicles operating through-out greater London (600 mi2), and enforced 24 hours a day every day of the year	Broaddus at al., 2015 [30]; Cruz & Montenon, 2016 [43]; Dablanc & Montenon, 2015 [44]
Milan, Italy	• Urban toll where charges vary according to Euro standards (Ecopass).	Dablanc & Montenon, 2015 [44]

Quak et al. [42] present the strategies that were applied in Amsterdam, Netherlands for the adoption of electric freight vehicles. The goal of this research is to examine the feasibility of using electric freight vehicles in the urban environment from the carrier's perspective. The authors use data from the European FP7 project FREVUE, which includes over 100 electric vehicles in Amsterdam, Lisbon, London, Madrid, Milan, Oslo, Rotterdam, and Stockholm. The strategies that were applied in Amsterdam were for electric freight vehicles to not pay congestion charges, parking fees, road taxes, and to be able to enter low emission zones, use bus lanes, park at non loading areas, have wider time access, and the possibility to enter pedestrian zones. These

strategies reduced cruising time and walking time, increased deliveries during the time-window period, and as a result reduced the number of required delivery vehicles in the city. The new strategies also created a decrease in stress for drivers, better performance, and fewer mistakes.

Cruz and Montenon [43] examined two major cities to compare the local (London, UK) and national (Berlin, Germany) type of governance. Germany is one of the few countries that have implemented low-emission zones nationally. Restrictions are applied based on vehicle pollutant emission level, which was identified by a colored sticker on the vehicle, showing the European emission level standard. The restriction of vehicles based on their pollutant emission levels in Germany resulted in freight operators investing in cleaner vehicles, while many companies sold their conventional vehicles to countries without restrictions. London restricted vehicles based on their emission levels, which was identified through cameras reading the vehicle plates. While larger carriers that operate nationally in the UK changed their fleets to comply with London's Low Emission Zone restrictions, smaller carriers disappeared due to the lack of sufficient freight to survive. Additionally, the implementation of the Low Emission Zone in London resulted in fewer vehicles in the city, decreased speeds, and increased goods traffic.

Broaddus et al. [30] investigated the impacts of two sustainability policies applied in London, LEZ and congestion charge zones, on freight traffic and operations. The authors mention that the London restrictions include LEZ minimum emission standards for heavy vehicles operating through greater London (600 square miles). The restrictions are enforced 24 hours a day every day of the year [30][33]. The green vehicles are identified using automatic cameras (e.g., photographing vehicle plates). Noncompliant vehicles must pay 200 pounds (£) per day for vehicles of 3,500kg and heavier, and 100 pounds per day for 1,200-kg vehicles. The restrictions were introduced in 4 phases and resulted in overall speed reduction and change of fleet composition to include more low emission vehicles. Phase 1 required Euro III emission standards for heavy goods vehicles (HGVs) of over 12,000kg. Phase 2 (implemented in July 2008) extended Phase requirements to 3,500-kg vehicles, buses, and coaches. Phase 3 (originally planned for October 2010 but implemented in January 2012) extended the Euro III standards to all diesel-powered vehicles in London, including light goods vehicles (LGVs) and a range of other commercial, civic, and personal vehicles: minibuses up to 5,000 kg; ambulances, fire trucks, garbage trucks, and motorhomes over 2,500 kg; large vans, pickup trucks, and 4×4 utility vehicles over 1,200 kg. Vehicles registered as new after January 1, 2002, automatically met this standard, as that was the date for manufacturer compliance. Phases 3 and 4 were introduced simultaneously and raised emissions standard for HGVs over 3,500 kg to Euro IV.

Dablanc and Montenone [44] identified the role of goods vehicles in the European low-emission zones and analyzed the impact of access restrictions on activities of transport and logistics firms. The authors present the case studies of London and Milan. In London all trucks have to comply with Euro IV PM standard, while vans with unladen weight over 1205 kg have to comply with the Euro III PM standard (**Tables B-**1 and **B-2**). Milan has introduced Ecopass, an urban toll that varies for vehicles based on their Euro emission level standards. All Euro IV and Euro V HGVs vehicles were exempt from the toll payment, while older vehicles paid between €2 ($2.25) and €10 ($11.26) per day. In the first year of implementation, the Ecopass reduced emissions from traffic in terms of PM10 by 19 percent, NOx by 11 percent, and CO2 by nine percent [32].

4

Data Collection

4. DATA COLLECTION

To understand the needs and preferences of goods delivery companies, we designed and implemented an online survey around GLZs. We also scheduled a few interviews with parcel carriers, retailers, and vehicle manufacturers.

4.1 Online Survey

The survey was conducted online and was distributed to potential respondents via NYC DOT's social media and through the Department's industry listservs. The survey was sent directly to UFL contacts who are known to operate in New York City. A snowball sampling method was used as well to increase the response rate whereby companies were asked to send the survey to other members of industry associations. At least one company distributed the survey to the New York State Messenger Courier Association (NYSMCA) and Customized Logistics and Delivery Association (CLDA). The target audience were manager-level employees with knowledge of day-to-day fleet operations within NYC and the company's current or planned sustainability efforts. The survey asked questions to obtain the following information and took on average 10-15 minutes. A complete list of survey questions is included in Appendix C.

- Which and what type of companies would utilize the proposed GLZ;
- Contextual information such as the size of fleets, which boroughs they operate in, the company's sustainability goals (if any), challenges to fulfilling those goals, and incentives required to achieve them;
- The most beneficial location and structure for the GLZ pilot; and
- Companies' willingness to pay for the specialized curb space.

The survey was open for a period of 1.5 months from mid-September to early November 2021, during which period weekly reminders were sent out to the invited listservs and the survey link was reposted on NYC DOT and UFL's social media channels. A total of 30 responses were collected. After cleaning and processing the data, 13 responses were deemed valid. A summary of survey findings can be found in Section 5.

4.2 Interviews

In order to learn more about the needs of industry stakeholders with respect to the proposed GLZ pilot program, two online interviews were also conducted by the NYC DOT team. Interviewees include representatives from parcel carriers, EV manufacturers, and companies focused on sustainability, and worked in EV operations and/or sustainability. Interview questions focused on visions and goals with respect to use of EVs, experience with EVs (operations, fleet composition, etc.), and challenges with regard to using EVs particularly in New York City. Guiding questions were provided to stakeholders in advance and interviews were structured in a way that allowed stakeholders and the DOT staff to openly discuss the proposed pilot program framework. Guiding questions are listed below.

1. Please tell us about your corporate sustainability goals, any associated milestones and how your company's sustainability goals can apply to New York City.
2. What experience does your company have with electric vehicles (EVs)? Have you worked with charging equipment and/or service providers? How do you see EVs fitting in with your company's business model?

3. With regard to your fleet, if you are using any EVs, please describe them (including: type, model/make/year, size, etc.). Are there specific neighborhoods where you would look to use green vehicles for deliveries?
4. Outside of NYC, is there any other city where electric vehicles are used by your company and if so, are there specific incentives that exist within those cities? What types of incentives would encourage your company to further explore increasing use of EVs?
5. What barriers exist with respect to incorporating electric vehicles into your company's fleet? Do you have plans in the near future to invest in electric trucks, cargo bikes or other EVs?
6. How much control do you have with regard to decisions on deployment of EVs?
7. What costs would your company endure by incorporating more EVs into its fleet (costs associated with restricting/adapting to a business model focused more on EVs)?

5

Survey Findings

5. SURVEY FINDINGS

Thirty NYC-area companies responded to the online survey. Of these, thirteen completed the entire survey and were considered valid responses. Valid respondents, henceforth "respondents," are summarized by company type in **Table 2**. Shipping companies include parcel carriers, prepared food or grocery delivery services, and couriers. Generally, these deliveries are smaller in volume and lighter in weight than palletized freight, which would be carried by the freight distributors. The e-commerce company is differentiated from the retailer in that their sales are primarily completed online and the goods are not located at any point in a store. A logistics company is one that may specialize in other markets, i.e. parking or infrastructure, but that offers delivery service in some capacity. Truck dealers operate delivery vehicles to move parts and tools as well as to provide service to vehicles. The logistics association is an industry group that answered the survey on behalf of some of its member companies.

Table 2: Survey Respondents by Company Type Category

COMPANY TYPE	NO. RESPONDENTS
Shipping company	5
Freight distributor	2
E-commerce company	1
Retailer	1
Logistics company	1
Truck dealer	1
Liquid fuel delivery	1
Logistics association	1

5.1 Fleet information

Responding companies use a range of vehicle types (**Figure 13**) and represent a wide range of fleet sizes. **Table 3** shows these ranges according to the company type. Large shipping companies use the highest number of medium-duty step-side vans (MD step vans) and heavy duty trucks (HD trucks), but they also use multiple hundreds of cargo vans and medium-duty box trucks (MD box trucks or MD trucks). They do not use passenger vehicles and only one uses a single cargo bike. The next largest fleet, the e-commerce company favors cargo vans (77 percent) to step-side vans and box trucks. They do not currently deliver with heavy duty trucks, passenger vehicles or cargo bikes. Two of the three small shipping companies use cargo bikes in combination with cargo or step-side vans.

Figure 13: Common delivery and freight vehicle types [4]

Table 3: Quantity and Type of Vehicles in Respondents' NYC-area Fleets

COMPANY TYPE (NO. IN THE SAMPLE)	CARGO VANS	MD STEP VANS	MD BOX TRUCKS	HD TRUCKS	PASSENGER VEHICLES	TOTAL	CARGO BIKES	EV SHARE OF FLEET
Large shipping companies (2)	200-293	600-3,500	455-500	0-2,200	0	1,347-6,400	0-1	0-1%
Small shipping companies (3)	0-15	0-32	0	0-8	0	0-40	0-250	0%
Freight Distributors (2)	0-1	0	5-50	15-100	0	21-150	0	0-2%
E-commerce company (1)	2,000	400	200	0	0	2,600	unknown	0%
Retailer (1)	5	0	35	0	0	40	0	10%
Logistics Company (1)	8	0	26	0	0	34	55	25%
Truck dealer (1)	5	0	10	0	0	15	0	0%
Liquid Fuel Company (1)	10	1	5	1	1	18	0	0%
Logistics Association (1)	100+	100+	100+	100+	0	400+	0	0%

Table 4: Area Coverage and DC location for EV & Cargo Bike Operators[4]

COMPANY	DC LOCATION	OPERATE EVS?	BOROUGHS EVS DELIVER TO	OPERATE CARGO BIKES?	BOROUGHS CARGO BIKES DELIVER TO
Large Shipper A	All five boroughs	Y	Manhattan	N	N/A
Large Shipper B	Brooklyn, Manhattan, Queens, Staten Island	N	N/A	Y	Manhattan
Small Shipper A	Bronx, Brooklyn, Manhattan, Queens	N	N/A	Y	Bronx, Brooklyn, Manhattan, Queens
Small Shipper B	Manhattan	N	N/A	Y	Brooklyn, Manhattan, Queens
Logistics co.	Bronx	Y	Brooklyn, Manhattan	Y	Brooklyn, Manhattan, Queens
E-commerce co.	All five boroughs	N	N/A	Y	Unknown
Retailer	Staten Island	Y	All five boroughs	N	N/A
Freight Distributor	Bronx, Brooklyn, Queens	Y	Bronx, Manhattan	N	N/A

[4] This table only includes companies that currently have EVs or cargo bikes in operation, and does not include all thirteen survey respondents.

Four of 13 respondents currently use EVs (**Table 4**). Five companies have at least one cargo bike in operation: two small shipping companies (5 and 250 bikes), a large shipping company (1 bike), and the logistics company (55 bikes). Only the logistics company is operating both EVs and cargo bikes. Four of the five companies own and operate their cargo bikes but the e-commerce company contracts with multiple carriers to provide the service. The total number of cargo bikes used by this company is unknown. Three companies that operate cargo bikes deliver to all five boroughs: the large shipper, e-commerce retailer, and one small shipper. The logistics company and other small shippers deliver to Brooklyn, Manhattan, and Queens only.

Respondents were asked if their fleet size and make-up will change in the next ten years. Most companies (10 out of 13) anticipate growth in overall fleet sizes. Two -- a large shipper and a distributor -- projected no change to their overall fleet size, while one small shipper expects a decrease. The larger shipper and distributor, however, expect an increase in EVs and alternative fuel vehicles. The large shipper also plans to expand its cargo bike fleet. Of the ten companies expecting fleet growth, one is exclusively a cargo bike delivery company, which expects to add more bikes to its fleet, but not any other vehicle type. The eight of the nine remaining companies expect to add electric vehicles to their fleets in the next ten years. Five of nine expect to purchase alternative fuel vehicles in addition to electric vehicles. Notably these companies tend to have larger fleets (100+ vehicles) than companies that do anticipate adding alternative fuel vehicles. Six companies anticipate increasing the number of cargo bikes used; these are the same five companies currently using cargo bikes plus one large shipping company.

5.2 Reasons for changing fleet size and makeup

Most of the companies that participated in the survey have sustainability goals. Specifically, the company goals include increasing walkability and reducing motor vehicles on the road, as well as achieving carbon neutrality within a certain timeline (e.g. within 15 years or by 2035) by replacing fossil fuel vehicles with EVs and alternative fuel vehicles.

Internal sustainability goals are not the only motivating factor behind changing fleet sizes and make-up though. When asked to select the reason(s) for why fleet size and/or makeup has changed in the last ten years, companies selected all that applied from the list provided options, which are listed below.

- Internal sustainability goals are those made by the respondent company.
- Social responsibility means the company feels obligated to limit their contribution to climate change because of the societal costs.
- External sustainability goals are those made by customers, NYC, the State of New York, neighboring jurisdictions of the federal government.
- Economic initiatives included federal tax credits, and new finance options for green vehicles.
- Efficiency is considered as the reduced cost per package or reduced delivery time with the use of green vehicles.
- Infrastructure availability includes public charging stations and capacity added by utilities at the companies' facilities.
- Cost savings are reductions to operating or capital cost observed by the respondent.
- Companies did not submit any additional reasons under the "Other" option.

For the one company (small shipping company) that reported decreasing their fleet size over the next ten years, the only selected reason was efficiency, suggesting that the company was able to deliver more packages with fewer vehicles. Both companies that reported maintaining the same fleet size also plan to increase the shares of electric and alternative fuel vehicles. Their reasons for doing so included internal sustainability goals and the introduction of new vehicle models, but the freight distributor also listed social responsibility, economic initiatives and cost savings as motivating factors. The large shipper listed external sustainability goals (likely from customers) and efficiency as additional reasons. Internal sustainability goals, social responsibility, and new vehicle availability were listed by the majority of companies increasing fleet size, electric vehicle share of the fleet, and alternative fuel vehicle share. Cargo bike operators were most likely to list efficiency as a motivation in addition to internal sustainability goals and social responsibility.

Companies were also asked to select operational constraints to using electric vehicles specifically. The seven constraints selected by respondents are listed below along with the number of companies that selected each option in parentheses. It is worth noting that an "Other" category was included and all three companies that used this option described a lack of available vehicles to purchase due to high demand and a supply deficit. Cost of electricity (being higher than fuel costs) was also provided as an option, but no company selected that.

- Lack of public charging stations (1);
- Lack of access to additional electrical capacity at vehicle depot (2);
- Available purchase incentives do not offset the cost difference between EVs and fossil fuel vehicles (2);
- Lack of other incentives to reduce EV life cycle cost (lower toll rates, special parking zones, etc.) (2);
- EV range compared to fossil fuel vehicles (1);
- Competition in the EV market: demand is higher than supply (3).

One company, a small shipper, selected all reasons except the cost of electricity and EV range. The logistics company listed lack of capacity at their vehicle depot(s) and market competition. One large shipper selected the purchase and "Other" incentive options. A freight distributor was the only company to select EV range constraints. The retailer selected EV market competition, making it the most common constraint with three respondents. Respondents were also asked to select policies that would incentivize their company to add electric fleets. These findings are summarized in **Table 5**.

Table 5: Policies that would incentivize EV adoption by respondent companies

COMPANY TYPE (NO. IN THE SAMPLE)	PUBLICLY AVAILABLE CHARGING STATIONS	ALLOW EVS TO RESERVE CURB SPACE	PROVIDE EV-ONLY LOADING SPACES	INCREASE GOVERNMENT PURCHASING INCENTIVES	REDUCED TOLL OR PARKING RATES FOR EVS	NYC CONGESTION PRICING	STRICTER ENFORCEMENT OF ANTI-IDLING RESTRICTIONS	CHARGE LOWER ELECTRICITY RATES FOR EVS
Large shipping companies (2)	1	2	2	1	2	2	1	1
Small shipping companies (3)	1	-	-	2	1	-	2	1
Freight Distributors (2)	-	1	1	2	2	2	-	1
E-commerce company (1)	1	1	1	1	1	1	1	1
Retailer (1)	-	-	-	-	-	-	-	-
Logistics Company (1)	1	-	1	1	1	1	-	1
Truck dealer (1)	-	-	-	1	-	-	1	1
Liquid Fuel Company (1)	-	-	-	-	-	-	-	-
Logistics Assoc (1)	-	-	-	1	1	-	-	-
TOTAL	**4**	**4**	**5**	**9**	**8**	**6**	**5**	**6**
PERCENT	**31%**	**31%**	**38%**	**69%**	**62%**	**46%**	**38%**	**46%**

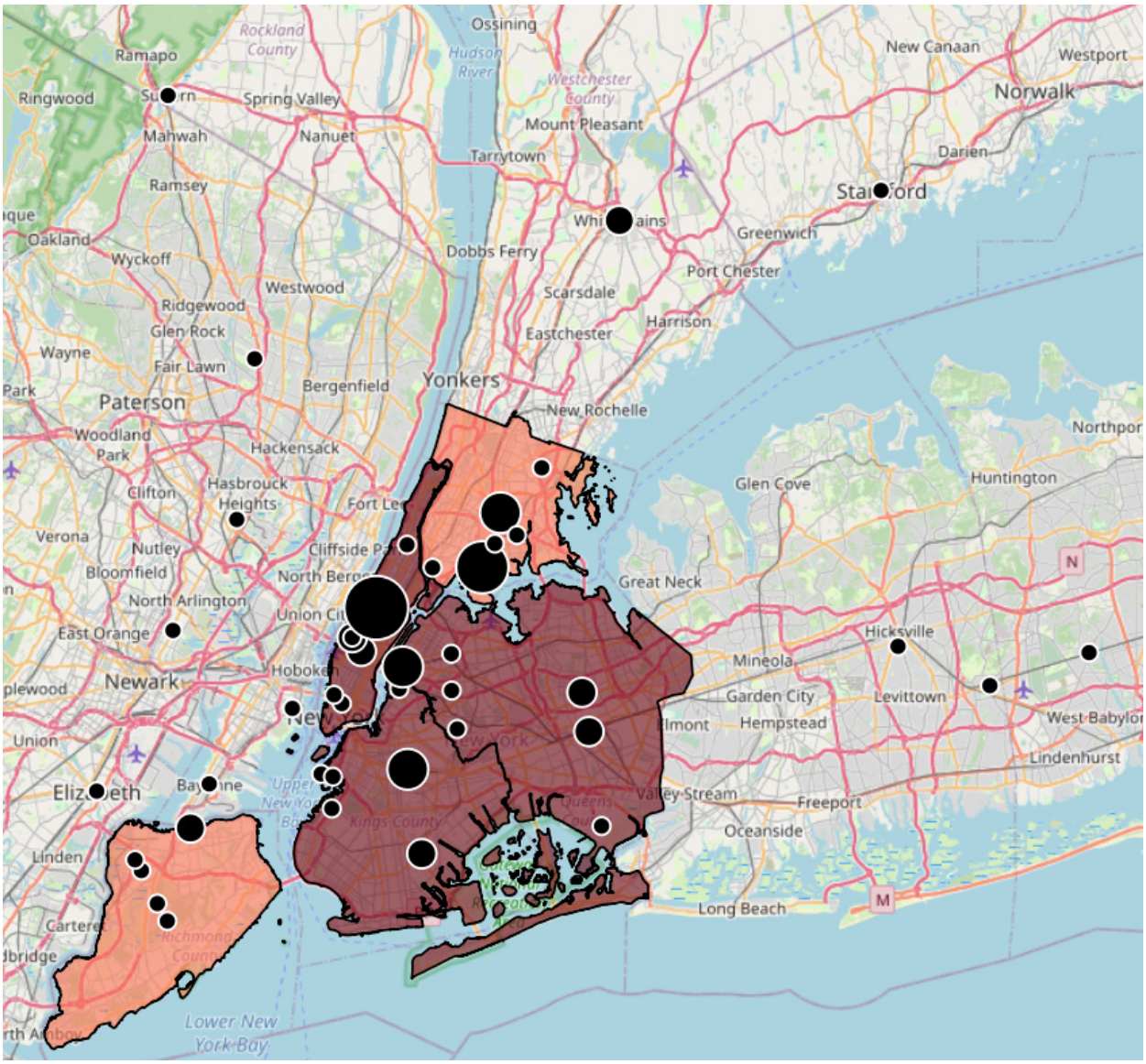
5.3 Area coverage and distribution centers

All thirteen companies deliver to the Boroughs of Brooklyn, Manhattan, and Queens. Except for two companies - one that uses both medium duty vehicles and cargo bikes and another that exclusively operates cargo bikes - the rest deliver to the Bronx and Staten Island. All five companies that currently operate electric vehicles use them to deliver to Manhattan. Only one, the retailer, makes deliveries in all five boroughs with EVs. The logistics company and the freight distributor also make deliveries with EVs in Brooklyn and the Bronx, respectively.

Companies that operate EVs were asked if they use different routes for those vehicles than fossil fuel companies. The retailer and large shipper both responded that the same routes are used. The reason the logistics company selected for using different routes was time efficiency. They operate low-speed battery-electric vehicles, meaning they select the shortest routes based on time rather than distance. The freight distributor uses different routes to conserve electric power or to maximize fuel (electricity) efficiency.

Eight of the 13 companies operate out of multiple distribution centers located in and outside of the city. The respondents listed 52 distribution center locations total; in Queens (14), the Bronx (12), Brooklyn (10), Manhattan (9) and Staten Island (7). Distribution center locations were listed throughout the greater metropolitan area as well, in northern New Jersey, Suffolk County, and Connecticut. These distribution center locations as well as area coverage are shown in **Figure 14**.

Figure 14: Survey Respondent Distribution Center Locations and area coverage. Dot size shows the number of responses, which ranges from 1 to 5. Shading shows number of companies delivering to the borough, with red=13, and orange=11.



5.4 Delivery patterns

We found that the busiest time windows for loading and unloading operations in NYC are 9am-12pm (8 respondents), 12pm-4pm (7 respondents), 4pm-7pm (6 respondents). Four companies stated that they have the largest need for loading/unloading in NYC during the time window 6am-9am. These companies include a large shipping company, the liquid fuel company, the logistics association (reporting for the members of the association), and the logistics company. Specifically, the large shipping company stated that the busiest time windows for them span between 6am and 7pm, meaning that they start operating three hours earlier from the majority of the respondents. The liquid fuel company mentioned that the busiest time window for them is 6am-9am. While the industry association stated that their members are loading/unloading from midnight until 7pm, since they represent different types of companies that operate different hours in the city. The logistics company stated that the busiest loading/unloading time window for them is between 6am and 12pm.

The parking spaces where the company drivers are more likely to park (excluding cargo bikes) in NYC are truck loading zones (7 respondents), followed by commercial metered parking (6 respondents) and double parking (5 respondents). Specifically, the truck loading zones are used by the two large shipping companies, one freight distributor, the e-commerce company, the retailer, the truck dealer, and the logistics association. All above respondents, except the truck dealer, also mentioned using the commercial metered parking spaces. The companies that mentioned double parking as their response were the logistics company, the e-commerce company, one of the freight distributors, one of the large shipping companies, and the logistics association. The parking spaces that are less likely to be used are building garages or loading docks (4 respondents), alternate side parking (i.e. parking at the other side of the street due to street sweeping) (3 respondents), passenger metered parking (2 respondents), and alleys (1 respondent). The four respondents that chose building garages and loading docks as their response were a freight distributor, a large shipping company, the retailer, and the logistics association. The alternate side parking choice was selected by a freight distributor, a large shipping company, and the retailer. One of the large shippers and the retailer chose passenger metered parking as a parking option, and finally, parking in alleys was only chosen by the retailer.

The parking spaces where cargo bikes typically park in NYC are sidewalks (4 respondents), building garage or loading dock (2 respondents), and passenger metered parking (2 respondents).

5.5 Parking costs

Companies were asked how much they paid for parking in NYC during the COVID-19 pandemic (Apr 2020 to Apr 2021), and prior to that (Jan 1 to Dec 31, 2019), excluding parking tickets and operating costs. The responses varied for each respondent. The stated cost of parking during COVID-19 from two companies was $40,000 (a logistics company) and $1,050,000 (a large shipping company), while 3 companies stated that their contractors pay for parking and that the cost is unknown to them. These annual parking costs equals $1.23[5] per vehicle per day for the logistics company, and $2.13[6] per vehicle per day for the large shipping company, The rest of the respondents did not provide an answer to this question. The large shipping company that paid

[5] $40,000 / 365 days / 89 vehicles = $1.23/veh/day

[6] $1,050,000 / 365 days / 1348 vehicles = $2.13/veh/day

$1,050,000 during COVID-19 stated that their parking cost in the previous year (during 2019) was $1,200,000 ($2.44 per vehicle per day). Conversely, one respondent (a freight distributor) mentioned that the cost of the parking tickets exceeded the base parking fees during the COVID-19 period, but did not provide any cost information for 2019.

6

Interview Findings

6. INTERVIEW FINDINGS

Two interviews were completed with parcel carriers and manufacturers of electric delivery vehicles. Both types of companies express similar overarching goals with regard to sustainability and use of EV delivery vehicles. They also outlined similar challenges to deployment or use of EVs. There is a strong desire to reduce carbon emissions and use more electric vehicles where feasible. In particular, there is a high level of interest in using EVs in last-mile delivery operations. However, barriers to incorporation of EVs into company fleets and manufacturing these vehicles do exist, including fitting the vehicles in current operations and growing the demand for EVs. These findings help New York City to overcome several existing barriers when piloting the GLZ program. The pilot can provide more visibility to EVs, help to allocate dedicated curb access for EVs, and facilitate improvements in air quality.

6.1 Carrier interview

The carrier is interested in the GLZ pilot program and more broadly, working towards becoming carbon neutral by 2050. As stated by the interviewee, most parcel companies make residential deliveries 6 days a week, reflecting an increase in home deliveries and a need for focusing on last-mile delivery emissions in particular. EVs can help improve air quality on local streets and facilitate deliveries from an efficiency perspective One parcel carrier aims to use 40 percent alternative fuels across its entire ground fleet by 2025; while currently, 24 percent of their ground fleet utilizes alternative fuels. The carrier plans to purchase 10,000 EVs within the next few years and deploy them throughout the U.S. over a four-year time period. There are multiple variables that determine where EVs in particular are deployed by carrier companies. Climate, roadway conditions, and delivery mileage are all core variables that are considered. Most of their investments in EVs are concentrated in southwestern United States, particularly in California, due to existing incentives and general demand. With regard to EVs, there are more options available for delivery vehicles that are either vans or pick-up type vehicles. Around 30 percent of the existing fleet of one parcel carrier cannot be outfitted for EV operations.

The interviewed parcel carrier is willing to pay fair market value (i.e. current commercial parking rates) for curb access. For this carrier, 85 percent of its ticket liability is concentrated in New York City; changes to curb access can help offset this cost in the future (i.e. through designation of dedicated green loading zones for EVs). In turn, this off-setting of ticket liability could incentivize deployment of EVs to New York City. A reservation system is understood by the parcel carrier to be advantageous with respect to curb access. They also mentioned that creating systems that offer either monthly, quarterly or annual options would be ideal for larger companies. The carrier is highly willing to test new technologies if certain incentives like guaranteed curb access can be provided. GLZs can evolve to work synergistically with consolidation centers that involve cargo bike delivery options. Cargo bike operations are coming online faster than EV trucks and therefore should be considered eligible for using GLZs.

Several challenges to EV operations exist in New York City. Currently, return on investment in New York City is low. Expansion of an EV fleet within New York City by one major company is not considered feasible until at least 2050. There are also concerns with vehicle durability on NYC roads, during winter in particular (EVs may face challenges operating under winter weather conditions and extreme cold). There is also a need for more charging infrastructure for EVs in New York City. Vehicle deployment, staging and construction all must be considered when planning charging infrastructure. Currently, there is not enough widespread charging

infrastructure across New York City to justify increasing EV deployment. There is a critical need for utility resiliency for electric systems in order to minimize risks. Nevertheless, the survey findings do not provide a distinction between the need for additional on-street charging stations and more charging infrastructure at the companies' parking locations. In the latter case access to electric grid upgrades is the barrier to EV adoption as opposed to the lack of in-route charging capability provided by on-street chargers. More generally, there are two key factors that will be critical for the success of a green loading zones pilot program: double parking and environmental justice. Double parking, which can create safety hazards and inefficiencies, is important to consider in terms of GLZ location. GLZs, if effectively placed and enforced, can reduce instances of double parking, which in turn can reduce emissions from idling vehicles. Environmental justice geographies, which typically endure multiple air quality related issues, should also be given attention during siting of GLZs.

6.2 Manufacturer interview

EV manufacturers play a core role in helping EVs become more readily available for incorporation into company fleets. Smaller electric commercial vehicles (i.e. vans) are being produced in greater quantities as a result of greater demand. Many manufacturers partner with other companies (EV vendors) to produce electric vehicles on their behalf. The interviewee, which is a major US manufacturer, has experience with piloting EVs, and noted a decrease in curbside dwell time by EVs (likely a result of their smaller size and easier curb access) and an increase in overall vehicle efficiency with respect to deliveries (lower emissions, better mileage, etc.) compared to fossil fuel vehicles. The company plans to become carbon neutral by 2035 and introduce up to 30 new EV models by 2025. Included in this latter goal are EVs used for last-mile delivery (mostly FHWA class 1 and 2 vehicles) [46], as these are currently in greatest demand.

A key focus for the interviewed manufacturer with respect to EVs includes a focus on decoupling and use of microhubs. Decoupling involves using conventional vehicles (vans or trucks) to deliver during low congestion periods to drop off containers and then have foot carriers complete the final mile of delivery. The microhub concept involves use of cargo bikes or small vans to deliver from distribution centers. Incorporating EVs into these two types of models is a focus of some companies that work with one major producer of EVs; smaller EVs are easier to incorporate into a fleet and replace conventional delivery vehicles. With regard to GLZs, siting is important to consider along with side and rear loading/unloading needs by different carriers. GLZs should be placed in areas that do not pose safety concerns for operators and receivers, and focus on supporting last-mile delivery needs.

There are several notable barriers with respect to manufacturers increasing production of different types of electric vehicles. Charging infrastructure needs to be expanded along with upgrades to electrical systems. It would be beneficial to have more off-street charging stations where feasible to accommodate charging needs. Generally, it is easier to incorporate EVs (geographically) where no regulatory framework currently exists (allows flexibility with implementation and operations); certain regulations that exist within certain cities do make it challenging for EVs to be introduced into some markets. The permitting process for getting electrical system upgrades in particular can be lengthy. Having financial incentives in place to market at the point of sale is also critical for many large companies. Above all, sale and use of EVs is driven by customer demand; at this time, demand for EVs is greatest in California. Potentially, incentivizing rental of EVs may help to further push EVs to be used, especially by smaller companies.

7

Recommendations

7. RECOMMENDATIONS

7.1 Potential GLZ users

Based on the definition of a GLZ in this study, there are already companies that can benefit from spaces provided solely for the use of electric vehicles. The companies range from local goods operators with 30-150 vehicles in their fleets to national carriers and retailers with multiple thousands of fleet vehicles. Based on the respondents' reported share of EVs in their NYC fleets, this represents up to 40 potential GLZ users (vehicles) already operating in NYC. During their interview, the carrier expressed an interest in deploying EVs slated for other cities or states if the company can offset parking costs in NYC. In addition to EVs, three of the companies are known to operate alternative fuel vehicles (natural gas and biodiesel), with all but one respondent expecting to introduce these vehicles in the next ten years.

Cargo bike operators, too, would benefit from GLZs if cargo bikes are included in the vehicle types allowed in the zones. Five cargo bike operators reported parking on sidewalks regularly and two within the parking lane (two also reported using cargo bike corrals). Providing parking space for cargo bikes within the GLZ could remove these bikes from the sidewalk. We recommend NYC DOT consider including alternative fuel vehicles in the GLZ. While they are not all zero-emission, alternative fuel vehicles reduce emissions compared to fossil fuel vans and trucks. Also, 46 percent of respondents stated that they have plans to increase the number of alternative fuel vehicles in their fleets; it is less than the 70 percent expecting to increase the number of EVs, but a significant figure nonetheless.

7.2 Siting, Demarcation, and Enforcement

Respondents were asked where in the city, 1) it was most difficult to find parking, and 2) they were subject to the most parking fines. While the reason behind parking fines is unknown and they could be due to factors other than parking unavailability, in this report we deemed them as a potential indicator of parking unavailability (e.g. lack of authorized parking spaces in desired locations could result in illegal parking, and insufficient parking time could result in overstaying) and thus considered them as a factor in site selection for GLZs. Responses were collected at a neighborhood level, with companies listing up to three neighborhoods for each question. Two companies replied that the entire boroughs of Manhattan and Brooklyn are difficult to park in, and one extended that to the boroughs of Queens and The Bronx. The rest were more specific (**Table 6**). Almost 40 percent of companies have the most difficulty parking in commercial areas of Midtown Manhattan and Lower Manhattan. An additional response included Chelsea as a more specific neighborhood within Midtown. Neighborhoods in which companies were subject to the most parking violations reflected the emphasis on Midtown Manhattan and Lower Manhattan (both included in six of eleven responses). Outside Manhattan, the only neighborhood mentioned was Maspeth, Queens (1 response).

The responses suggest Lower Manhattan and **the commercial areas of Midtown Manhattan may be the best locations for the GLZ pilot** for companies, as they can benefit from the location in reduced parking fines and more available parking. All respondents make deliveries in Manhattan, suggesting that locating the GLZ pilot there would benefit the highest share of companies. The respondents all deliver to Brooklyn and Queens as well, which could make them secondary candidates, yet only two companies included neighborhoods in those boroughs in their parking unavailability responses. For that reason, the benefits would be less in those boroughs. All five companies with EVs already in their fleet are using those vehicles in Manhattan versus

only two making deliveries with EVs in the Bronx. Cargo bike operators also uniformly deliver to addresses in Manhattan. This suggests that the highest demand for the GLZ spaces is in Manhattan. Finally, although most of the respondents have distribution centers outside Manhattan, only a single response suggested EVs are too range-limited to service their entire routes. This argues against locating the GLZs near distribution hubs like Maspeth, Queens and Hunts Point, Bronx.

We would like to note that siting of GLZs should not depend solely on the benefits to delivery companies. As brought up during the carrier interview, special consideration should be given to environmental justice areas that are subject to multiple air quality issues. Additionally, other performance metrics important to the DOT, such as reducing double parking or increasing curb utilization, should be considered when siting GLZs. Double parking could be reduced by providing pricing incentives. In a metered area, the pricing incentives could include lower parking rates for commercial vehicles, and free parking for human-powered vehicles (e.g., cargo bikes). Additionally, in areas located in an outer borough that has fewer metered spaces, a pricing incentive could be charging for double parking with lower rates for EVs. Areas with residential customer density or proximity to high commercial density locations, like Chelsea Market, could have an impact on curb utilization rates and the number of companies making use of GLZs. Historic parking violation data could also be used to determine more specific block groups within the recommended neighborhoods in order to help reduce double parking. Double-parking violations could be an indicator of insufficient parking options, and therefore placing GLZs in areas with high rates of double-parking violations could act as an incentive to companies to adopt green vehicles.

Table 6: Table 6: Most common neighborhoods listed in the survey responses for difficulty with finding parking and respondents' delivery area (Borough totals bolded)

NEIGHBORHOOD	NO. OF COMPANIES LISTED DIFFICULTY IN FINDING PARKING	NO. OF COMPANIES LISTED AS AREAS WHERE THEY PAID MOST PARKING FINES	NO. OF COMPANIES DELIVERING TO AREA	NO. OF COMPANIES DELIVERING TO THIS AREA WITH EVS
Manhattan (All neighborhoods)	**17**	**18**	**13**	**5**
Harlem / Morningside	1	1	unknown	unknown
Upper East Side	1	2	unknown	unknown
Upper West Side	1	1	unknown	unknown
Midtown (includes Chelsea)	6	8	unknown	unknown
Lower East Side	1	2	unknown	unknown
Financial District	5	4	unknown	unknown
Brooklyn (includes Park Slope & Brooklyn Heights)	**4**	**0**	**13**	**2**
Queens (includes Maspeth)	**2**	**1**	**13**	**1**
Bronx (includes Hunts Point)	**2**	**0**	**9**	**2**
Staten Island (All neighborhoods)	**0**	**0**	**9**	**1**

Regarding demarcation of the GLZs, the survey and interview findings do not lead to a specific recommendation on issuing vehicle permits (monthly or yearly, window sticker or placard, etc.) or installing street signage. The literature suggests it is common practice to issue vehicle decals and install special signage (such as those in Santa Monica, CA, Bremen, Germany, and Paris, France), but survey respondents and interview subjects did not express a preference for either. Santa Monica and Los Angeles both use signage to differentiate zero-emission delivery zones from other loading zones (**Figure 15**). These signs clearly indicate the types of vehicles the spaces are restricted to as well as the time limit. Los Angeles also includes the time of day when the curb use exists. In addition to signage, Los Angeles uses yellow-painted curbs to designate commercial loading zones and stenciled pavement markings to differentiate zero-emission zones from other commercial loading areas. New York City has multiple parking zones that are dedicated or open to trucks and other delivery vehicles (Truck Loading zones and Neighborhood Load Zones). **The GLZ spaces should be separately designated, and signage should be provided that is distinctly different from those zones**.

Figure 15: Zero-emission parking signs in Santa Monica (left) [7] and Los Angeles (center). Curb paint and pavement markings in Los Angeles (right) [14]

There are three enforcement options highlighted by the literature: issuing tickets through traditional parking officers, video license-plate capture, and transponders. It is common for enforcement to be performed through technologies such as traffic cameras (Santa Monica, Los Angeles, Dutch cities, and London) or transponders (Bremen, Germany and Milan, Italy). Video footage can be used to verify the placement of a window decal or vehicle placard, or read license plates, which would be associated with a GLZ use permit. Due to the large number of commercial vehicles in NYC, the DOT staff believe that plate-based metering is likely to be more successful compared to a sticker-based approach. The city could use existing infrastructure for traffic monitoring, such as the infrastructure used for camera violations that occur when a vehicle is photographed going through a red light or when a vehicle parks or stands in a bus lane [47].

7.3 GLZ Layout

Survey takers were given three options for potential GLZ layouts, as shown in **Figure 16**. The majority (8 of 13) of companies preferred several spaces spread out over multiple blocks (Option A). These include one large shipper (of two), two small shippers (of three), the retailer, the truck dealer company, the logistics company, the e-commerce company and one freight distributor (of two). Four other respondents selected a multi-block GLZ (Option B). These include one large shipper, one small shipper, one freight distributor and the logistics association. This option is most similar to Santa Monica's Zero Emission Zone. No company selected multiple single-block Green Loading Zones (Option C), and the liquid fuel delivery company did not express a preference.

There was no discernable difference between cargo-bike only and vehicle-only delivery companies' selection of multi-block GLZ locations. All four companies that are currently operating EVs selected Option A. This means neither solution benefits one type of company over another. For that reason, **it is recommended NYC DOT provides several spaces spread out over multiple blocks**. These parking spaces could be spread out over multiple blocks that are located in low emission areas where a combination of reserved space and pricing incentives will incentivize the use of low emission vehicles. Similar to Santa Monica's ZEDZ, the GLZ in NYC can be a voluntary zero emission delivery zone, that provides space or pricing incentives for low or zero emission freight vehicles. Such a layout is useful for companies with short dwell times like food delivery services, but it also benefits parcel carriers who must make many stops lasting over an hour throughout the day. This layout can reduce parking violation risk with available parking spread further than the limits of a multi-block loading zone.

Figure 16: Proposed Green Loading Zone Layouts and Distribution

Option A: several spaces spread out over multiple blocks

Option B: multi-block GLZ

Option C: multiple single-block GLZ

The density or distance between of these spaces could not be derived from the survey findings. One study in London showed that parcel carriers walk between 220 and 475 feet per customer, or an average of 568 feet per stop (roundtrip to and from vehicle) [48]. In NYC, this equates to about 1 block in the East-West direction and 2-3 blocks in the North-South direction. So, for parcel carriers, a GLZ spacing of twice that distance (2 blocks N-S and 4-6 blocks E-W) should provide overlapping customer coverage areas. As indicated by the survey findings, though, parcel carriers are not the only potential GLZ users. Considerations should be made for freight distributors with heavier or bulky deliveries that cannot reasonably walk as far as parcel carriers.

A case can be made for the multi-block GLZ (Option B). The structure may motivate companies to purchase green vehicles because they will lose access to the zone or will be forced to walk farther to make deliveries, reducing efficiency. However, those same factors could also disenfranchise companies and consumers within the zone. Smaller companies and those delivering heavy or bulky goods like beverage distributors could find the zone a barrier to their operations. It is more difficult for small companies to purchase new vehicles owing to their high capital costs and the competition for the limited available models. Likewise, consumers may find it more difficult to receive goods and packages if operators are unwilling or unable to enter the zone.

7.4 Service and Dwell Time

To benefit the greatest number of companies, the GLZ pilot should be designed to accommodate the time of service (time of day a company makes deliveries) and vehicle dwell time. Most companies identified multiple times of day as their busiest, or having "the largest need for loading/unloading." These occur anywhere from the 6:00AM-9:00AM period to the 7:00PM-midnight period. Eight companies identified at least one of the two peak commuting periods as busy, with five of thirteen respondents listing the AM peak period and seven of thirteen listing the PM peak. Nine companies listed the entire midday period (9:00AM to 4:00PM) as their busiest. To avoid disrupting companies' typical delivery behaviors, NYC DOT should avoid placing Green Loading Zones on any street subject to switching the curb lane from a parking lane to a travel lane during rush hour. It may not be necessary to restrict the use of GLZ spaces to green vehicles for the entire day. This would reflect similar practices in Los Angeles Zero-Emission Delivery Zones, which are only restricted to zero-emission vehicles between 7:00AM and 6:00PM [14]. Other data sources collected by the DOT, such as utilization rate and parking violations would need to be analyzed to inform this decision.

Dwell time can be used to determine the appropriate size for the GLZ. Based on the survey responses, large companies (200 or more vehicles) have dwell times of longer than 60 minutes. Drivers are likely making multiple deliveries during each stop and walking to multiple destinations. Smaller companies, those that are making single deliveries per stop (such as furniture, prepared food, or beverage distributors), and those that rely primarily on cargo bikes reported spending less than 15 minutes per stop at the curb with one exception of 15-30 minutes. Existing loading zones are limited to two or three hours of parking time depending on the location. The survey findings do not indicate how long the dwell time is for the four companies that usually park longer than 60 minutes. While setting time restrictions beyond one hour for GLZs could accommodate these companies, existing restrictions (2-3 hours) could result in low curb utilization rates, given the average dwell time of 60 minutes.

The majority of delivery vehicles (assuming EVs are the same size as current fleet vehicles) will be medium-duty step side vans and cargo vans (**Figure 13**). Depending on NYC DOT's goals, GLZs could be sized large enough to accommodate multiple large carriers that could have overlapping stop time, plus one or two short-term deliveries and cargo bikes. Otherwise, smaller zones could be used to maximize curb utilization and minimize unoccupied GLZ time.

7.5 Willingness to pay

The carrier interviews and survey results suggest pricing for GLZ use can match, if not exceed, existing commercial vehicle parking rates. For those companies that directly answered the price questions, the maximum single use and hourly rates roughly reflected the current cost of parking in Manhattan ($10 per hour), where most companies also mentioned having the most difficulty finding parking. However, another way to approach this is to assume companies are willing to pay up to the cost of parking violations they are paying if it can be avoided by using the GLZ. Four companies mentioned paying more in parking fines than hourly rates. Smaller (based on fleet size) companies tended to respond with lower parking and GLZ permit rates than the largest carriers. Others demonstrated an unwillingness to pay for GLZ parking, one going as far to say the rate should be zero if the vehicle is a green vehicle. As shown in **Table 5**, six companies suggested lower parking rates for EVs would incentivize those companies to add EVs to their fleets. The DOT should consider accessibility to the GLZ when determining parking rate, if any. **Matching the current cost of parking in the pilot neighborhood is recommended, although charging a lower rate than the local commercial vehicle parking rate could attract more companies to participate in the pilot and pursue the purchase of green vehicles.** The suggested sites for the GLZ pilot - Lower Manhattan and Midtown Manhattan - are both subject to commercial rates. It is possible that fees could be charged in outer borough areas with typically free parking, but this may reduce the likelihood of spaces being utilized. The survey findings do not definitively indicate willingness to pay in outer borough neighborhoods.

Both the survey respondents and the interviewed carrier emphasized the need for parking enforcement in the GLZ pilot. When asked how much they would pay for a monthly permit that includes the ability to reserve a parking spot, one company pointed out that reservations were only worthwhile if the city could ensure the space would be available (i.e., unoccupied). Printed tickets and video enforcement cannot accomplish this in a pilot timeframe. The aforementioned company also discussed how a GLZ could offset parking violations by reducing the number of places vehicles must double park in the city. This would be true only if the GLZ was not frequently occupied by vehicles not intended to be served by the GLZ. To guarantee availability, DOT should consider constant monitoring of the GLZ and enforced towing. This could be achieved by utilizing a third party to monitor the GLZ to ensure that they are occupied only by authorized vehicles. The pay-by-plate could also be another viable option for NYC.

7.6 Considerations for cargo bikes

According to the survey, cargo bike operators tend to park their bikes in parking lanes or on sidewalks while making a delivery. Providing space within the GLZs for the occasional cargo bike might remove those bikes from the sidewalk. To achieve the most utility, the DOT may make the GLZ spaces large enough, so that it can accommodate a cargo bike and an EV at the same time. Cargo bike operators also demonstrated a willingness to pay for access to the GLZ, though at a lower single use and hourly rate than vehicle-dependent companies. Finally, all cargo bike operators in the survey stated they prefer to utilize the GLZ as mobile hubs

for dispatching cargo bikes to more parking spaces throughout the city or combine the GLZ with micro-consolidation centers. Some of these companies already operate in this fashion, parking a truck or van in a spot and dispatching cargo bikes from there to make deliveries. NYC DOT should consider whether allowing these mobile hubs to park in GLZs would maximize the benefits. Current hub vehicles are not green vehicles, but the benefit of increasing cargo bike utilization could outweigh the exception to the green-vehicle-only rule.

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APPENDIX A
AVAILABLE EV AND CARGO BIKE MODELS

Table A-1: Available EVs to delivery companies [4].

MANUFACTURER	VEHICLE PLATFORM	VEHICLE MODELS	ESTIMATED AVAILABILITY
Arrival	Cargo Van	"Van" (Class 2b)	2022
Avevai	Cargo Van	IONA Van	2021
	MD Truck	IONA Truck	2021
Brightdrop	Cargo Van	EV600	2022
BYD	MD Truck	5F, 6F, T7	2021
Ford	Cargo Van	E-Transit	2022
Freightliner	HD Truck	eCascadia	2022
	MD Truck	eM2 106 – Class 6/7	2021
International	MD Truck	eMV Class 4/5/6	2022
Kenworth	MD Truck	K270E, K370E	2021
	HD Truck	T680E	2021
Peterbilt	MD Truck	220EV	2021
	HD Truck	579EV	2021
Rivian	Cargo Van	Delivery Van	2021
US Hybrid	MD Step Van	eCargo	2021
Volvo	HD Truck	VNR Electric	2021
Workhorse	MD Step Van**	E-100	2021

*MD: Medium-Duty

**HD: Heavy-Duty

Table A-2: Selection of cargo bike models and manufacturers [49].

MANUFACTURER	MODEL	LENGTH (CM)	WIDTH (CM)	HEIGHT (CM)	CAPACITY (M3)	PAYLOAD (KG)	MOTOR POWER (W)	RANGE (KM)	WHEELS (QTY)
Coaster Cycles	350 Venture	226	89	103	0.38		250	40-80	3
Coaster Cycles	350 Parcel	297	91	201	2.04		250	40-80	3
Coaster Cycles	480 Freighter	297	120	159	2.12	181	250	40-80	3
Flevobike	cubicycle	80	120	100	1.00				4
DHL*	parcycle				0.16				2
Cargo Cycling	Cargo Chariot	240	100		1.50		250		3
Cargo Cycling	Cargo Centurion		100		1.00		250		3
Rytle	MOVR (UPS bike)		120		2.00		250		3
CycleSpark	CBXL 1 VE	312	107	162	1.50	150	250	60	4
CycleSpark	CBXXL 2 VE	470	107	170	2.50	300	250	60	6
Rad Power Bikes Commercial	Radburro	130	89	114	1.60	315	750	64-130	3
Rad Power Bikes Commercial	Radburro xL	134	86	137					3
Velove	Armadillo		86		2.00	200	250		4
URB-E						363	750	16-23	6
Urban Arrow	Cargo XL	294	70	110	0.62	150	250		2
Urban Arrow	Cargo L	274	70	110	0.30	150	250		2
Cargo Cycling	Cargo Challenger	350	100		2.50		250		4

*Cargo bike operated by DHL by an unknown manufacturer.

APPENDIX B:
EURO EMISSIONS STANDARDS

Table B-1: Euro Emission Standards for Heavy-duty Vehicle Diesel Engines [44]

Tier	Date	Test	CO (g/kWh)	HC (g/kWh)	NOx (g/kWh)	PN (#/kWh)	PM (mg/kWh)	Smoke (m^{-1})
Euro I	1992 (< 85 kW)	R-49	4.5	1.1	8.0	–	612	–
	1992 (> 85 kW)		4.5	1.1	8.0	–	360	–
Euro II	October 1996		4.0	1.1	7.0	–	250	–
	October 1998		4.0	1.1	7.0	–	150	–
Euro III	*Voluntary EEV (October 1999 to January 2013)*	*ESC & ELR*	*1.5*	*0.25*	*2.0*	–	*20*	*0.15*
	October 2000	ESC & ELR	2.1	0.66	5.0	–	100	0.8
Euro IV	October 2005		1.5	0.46	3.5	–	20	0.5
Euro V	October 2008		1.5	0.46	2.0	–	20	0.5
Euro VI	January 2013	WHSC	1.5	0.13	0.4	8.0×10^{11}	10	–

Note: EEV – enhanced environmentally-friendly vehicles

Table B-2: Euro Emission Standards for Diesel and Gas Engines, Transient Test [44]

Tier	Date	Test	CO (g/kWh)	NMHC (g/kWh)	CH_4[a] (g/kWh)	NOx (g/kWh)	PN (#/kWh)	PM[b] (mg/kWh)
Euro III	*Voluntary EEV (October 1999 to January 2013)*	*ETC*	*3.0*	*0.40*	*0.65*	*2.0*	–	*20*
	October 2000	ETC	5.45	0.78	1.6	5.0	–	160
Euro IV	October 2005		4.0	0.55	1.1	3.5	–	30
Euro V	October 2008		4.0	0.55	1.1	2.0	–	30
Euro VI	January 2013	WHTC	4.0	0.16[c]	0.5	0.46	6.0×10^{11}	10[d]

Notes:
(a) For gas engines only (Euro III-V: NG only; Euro VI: NG + LPG).
(b) Not applicable for gas-fueled engines at the Euro III-IV stages.
(c) THC for diesel engines.
(d) PN limit for gas engines applies for Euro VI, Step B and later.

APPENDIX C:
SURVEY QUESTIONNAIRE

QUESTION	QUESTION TYPE	OPTIONS
Company Background Information		
1. What is the name of your company?	Open-ended	
2. What is your role in the company?	Open-ended	
3. Which boroughs in NYC does your company deliver to?	Multiple choice (select all that apply)	• Bronx • Brooklyn • Manhattan • Staten Island • Queens
4. For fleets that make deliveries in NYC, is your distribution center, vehicle depot or dispatch center located in NYC?	Multiple choice	• Yes, they are all within New York City • Some of them are within New York City • No, they are all outside of New York City
Distribution Center Location(s) in NYC		
5. Please list the borough and neighborhood in NYC where your distribution center, vehicle depot or dispatch center is located. (If more than one, please list all.)	Open-ended	
Distribution Center Location(s) outside NYC		
6. Please list the city/town and State where your distribution center, vehicle depot or dispatch center is located outside NYC. (If more than one, please list all.)	Open-ended	

QUESTION	QUESTION TYPE	OPTIONS
Fleet Information		
7. In the following text boxes, please let us know how many of each vehicle type currently make deliveries in NYC for your company. • Cargo vans? • Medium-duty step vans? • Medium-duty trucks (box trucks)? • Heavy-duty trucks with trailer? • Passenger-sized vehicles (e.g. sedan, SUV, etc.)? • Cargo bikes?	Open-ended	
8. Considering only the fleet that delivers to NYC, does your company plan to change (in the next 10 years) or have changed (in the past 10 years) any of the following? • Total number of vehicles • Number of electric vehicles (EVs) • Share of EVs in the total fleet • Number of alternative fuel vehicles (excluding EVs & cargo bikes) • Share of alternative fuel vehicles (excluding EVs & cargo bikes in the total fleet • Number of cargo bikes	Rating scale	• Increased • Decreased • No change • N/A

QUESTION	QUESTION TYPE	OPTIONS
9. If your company has changed or plans to change the number or share of EVs, alternative fuel vehicles or cargo bikes, please tell us about the reason(s). (Select all that apply)	Multiple choice (select all that apply)	• No change • Internal company sustainability goals • Social responsibility • External sustainability goals (e.g. goals made by customers, NYC, the State of New York or neighboring jurisdictions) • Economic initiatives (e.g. federal tax credits, new finance option) • New vehicles introduced to the market • Efficiency (e.g. reduced cost per package or reduced delivery time) • Infrastructure availability (e.g. public charging, capacity added by utilities at your facilities) • Cost savings (e.g. reduced operating or capital expenses) • Other (please specify)
10. What time(s) of day does your company typically have the largest need for loading/unloading in NYC? (Select all that apply)	Multiple choice (select all that apply)	• Midnight-6:00AM • 6:00AM-9:00AM • 9:00AM-12:00PM • 12:00PM-4:00PM • 4:00PM-7:00PM • 7:00PM-Midnight
11. Does your company own/lease and operate its own cargo bikes?	Multiple choice	• Yes, we own/lease all bikes and employ the operator • We own/lease the bikes but they are operated by a different company • No, cargo bikes are owned and operated by a different company • N/A (we don't have cargo bikes)
Cargo Bike Operators		
12. What is the company (or companies) that provide cargo bike operations for your deliveries.	Open-ended	

QUESTION	QUESTION TYPE	OPTIONS
Electric Vehicles		
13. Does your company currently operate electric delivery vehicles? (excluding cargo e-bikes)	Multiple choice	Yes or No
Electric Vehicle (EV) Fleet information		
14. What is the approximate percentage (%) of electric vehicles (EVs) in your fleet? (excluding cargo e-bikes)	Open-ended	
15. What boroughs in NYC do your EVs deliver to? (Select all that apply)	Multiple choice (select all that apply)	• Bronx • Brooklyn • Manhattan • Staten Island • Queens
16. Are there any operational constraints that your company faces with using EVs? (Select all that apply.)	Multiple choice (select all that apply)	• Lack of public charging stations for intermittent charging • Lack of access to additional electrical capacity at vehicle depot • Cost of electricity is higher than fuel costs • Available purchase incentives do not offset cost differences between EV and comparable fossil fuel vehicles • Lack of other incentives to reduce the cost of EVs (e.g. lower toll rates, special parking zones, etc.) • Other (please specify)
17. Do your EVs use different routes than your fossil fuel vehicles when delivering to NYC?	Multiple choice	• Yes, all of them • Some of them do • No, all routes are the same • N/A (our EVs deliver outside NYC)

QUESTION	QUESTION TYPE	OPTIONS
18. Why do your EVs use different routes than fossil fuel vehicles? (Select all that apply)	Multiple choice (select all that apply)	• to cover more stops during one full charge • Time efficiency • Fuel efficiency • To charge in between delivery stops • Other (please specify)
Curb Access		
19. Where are your drivers most likely to park during a delivery stop in NYC? (Select all that apply)	Multiple choice (select all that apply)	• Truck loading zone • Alley • Building garage or loading dock • Commercial metered parking • Passenger metered parking • Alternate side parking • Double park
20. If your company operates cargo bikes, where are they typically parked during a delivery stop in NYC? (Select all that apply)	Multiple choice (select all that apply)	• N/A (we don't operate cargo bikes) • Truck loading zone • Alley • Building garage or loading dock • Commercial metered parking • Passenger metered parking • Alternate side parking • Double park • Sidewalk • General bike rack • Cargo bike corrals
21. Approximately how much ($) did your company pay for parking in NYC during the COVID-19 pandemic (Apr 2020 to Apr 2021)?	Open-ended	
22. Approximately how much ($) did your company pay for parking in NYC in 2019 (Jan 1 - Dec 31)?	Open-ended	
23. In what neighborhoods or near what destinations do your delivery vehicles have the most difficulty finding parking spaces and/or curb access?	Open-ended	

QUESTION	QUESTION TYPE	OPTIONS
24. In what neighborhoods or near what destinations are your drivers and vehicles subject to most parking violations or fines?	Open-ended	
25. Which of the following Green Loading Zone (GLZ) options best suit your company's needs in terms of curb access?	Multiple choice	• -block GLZs • Single block GLZs • Several spaces for green vehicle spread over different blocks • Other (please specify)
26. On average how long are your vehicles parked at the curb when performing deliveries?	Multiple choice	• Less than 10 minutes • 10-15 minutes • 15-30 minutes • 30-45 minutes • 45-60 minutes • More than 60 minutes
Incentives		
27. What policies would incentivize your company to add electric vehicles (EVs) to your fleet? (Select all that apply.)	Multiple choice (select all that apply)	• Strategically placed and publicly available charging stations • Allowing EVs to reserve curb space • Provide EV-only loading/unloading spaces in areas with scarce parking and/or curb access • Increased government purchasing incentives (e.g. grants, loans, or tax credits) • Reduced toll or parking rates for EVs • NYC congestion pricing • Stricter enforcement of anti-idling restrictions • Charge lower electricity rates for EVs than typical commercial rates • Other (please specify)

QUESTION	QUESTION TYPE	OPTIONS
Willingness to pay		
28-32. In the following questions, please let us know the MAXIMUM amount ($) your company is willing to pay PER VEHICLE for the use of a Green Loading Zone? • For a single use? • Per hour? • Per month? (i.e. for unlimited access with a monthly permit) • Per year? (i.e. for unlimited access with an annual permit) • For a monthly permit that includes the ability to reserve a parking spot?	Open-ended	
33. Which of the following scenarios would your company prefer?	Multiple choice	• Park two blocks away from the destination for free and walk to the destination • Pay the standard parking rate for a space right in front of destination
34. Which of the following scenarios would your company prefer?	Multiple choice	• Establish GLZs only on the right side of the street • Allow parking at GLZs on alternative-side of the street
35. Which of the following scenarios would your company prefer?	Multiple choice	• Combine GLZs with low-emission and electric vehicle consolidation centers • More parking spaces throughout the city dedicated to low emission and electric vehicles • Use an EV truck as a mobile mini-depot (e.g. parked in a GLZ) that cargo bikes can deliver goods from

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