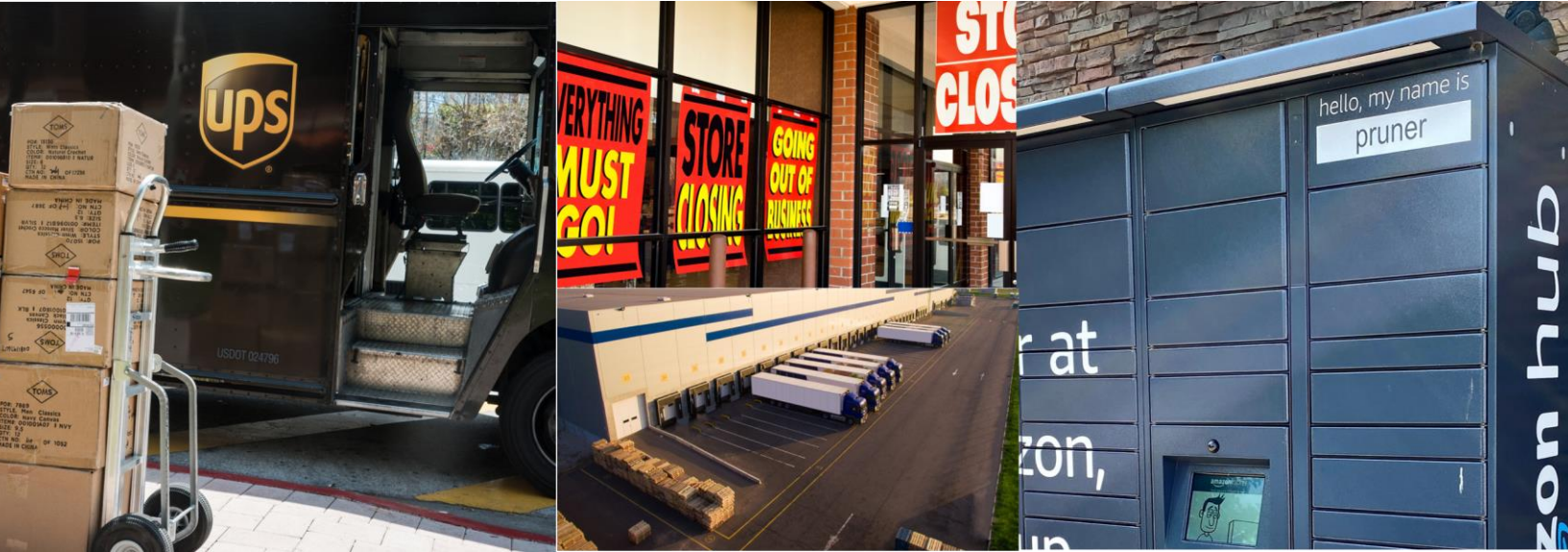


URBAN FREIGHT DISTRIBUTION STUDY

Curbside Management & New Technologies for Last-Mile Deliveries Memo



Prepared by:



In association with:

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October 4, 2023

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Acronyms / Abbreviations

ADR	Autonomous Delivery Robots
API	Application Programming Interface
ATCMTD	Advanced Transportation Congestion Management Technologies Deployment
AV	Autonomous Vehicle
CO2	Carbon Dioxide
CVLZ	Commercial Vehicle Loading Zone
USDOT	United States Department of Transportation
EV	Electric Vehicle
FAA	Federal Aviation Administration
FAST Act	Fixing America's Surface Transportation Act
FY	Fiscal Year
GHG	Greenhouse Gas
GIS	Geographic Information System
GM	General Motors
GPS	Global Positioning System
HD	High Definition
LACI	Los Angeles Cleantech Incubator
MPO	Metropolitan Planning Organization
NLZ	Neighborhood Loading Zone
PDD	Personal Delivery Device
PLZ	Passenger Loading Zone
PUDO	Pick Up/Drop Off
RPI	Rensselaer Polytechnic Institute
SDOT	Seattle Department of Transportation
SMART Grant	Strengthening Mobility and Revolutionizing Transportation Grant
TEP	Transportation Electrification Partnership
TNC	Transportation Network Company
T4A Grant	Transportation for America Grant
UFL	Urban Freight Lab
UPS	United Parcel Service
USDOT	United State Department of Transportation
USPS	United States Postal Service
UW	University of Washington
VMT	Vehicle Miles Traveled
ZE	Zero Emission

Executive Summary

Curbside management, including to better accommodate goods deliveries, is an increasingly important theme throughout North American cities. Cities have been exploring and implementing new programs to better understand the usage of the curb and to manage curb space in a time of growing demand from all modes.

The Twin Cities can refer to the many ongoing curbside management programs and initiatives in other cities across the continent, for examples and best practice guidance.

Our review of curbside management practices focused on programs or policies that address commercial vehicles and urban freight issues in particular. Key findings include:

- Successful curbside management requires a holistic approach that considers various stakeholders and multiple planning tools.
- Collecting data on curb allocation and curb use are critical steps to inform effective curbside management.
- Establishing partnerships between government, industry, and other stakeholders can foster innovation, facilitate the execution of pilot programs, and inform cities about the effectiveness of different curb management strategies.
- Formulating policies that are adaptable and flexible and ensuring alignment between policies and objectives are also crucial.

New last-mile delivery technologies bring some challenges, but also opportunities to improve the flow of goods and reduce emissions and the dependence on vehicles.

There has been a significant advancement in last-mile delivery technologies in recent years. Our review of new and emerging last-mile delivery technologies focuses on understanding the potential for reducing vehicles miles traveled (VMT) and overall emissions of CO₂ and other greenhouse gases (GHG), as well as the extent to which the benefits of these technologies vary in different urban settings (e.g., urban centers versus suburban or exurban communities). Key findings include:

- There is a wide variety of **technological maturity**. Technologies like electric delivery vehicles and cargo e-bikes are relatively mature. More nascent technologies such as air-based drones, sidewalk delivery robots, and autonomous delivery vans are in the early stages of development, undergoing pilot testing or prototyping, and facing regulatory and infrastructure challenges.
- **Alternative fuel vehicles** may hold the highest promise for GHG emission reduction. Their key advantages include scalability and versatility, allowing for easy adoption by freight carriers for a wide range of uses. They leverage existing road infrastructure, are more efficient operationally due to their ability to cover longer distances and carry heavier loads and are adaptable to both urban and suburban settings.
- There is variety in terms of **contextual suitability**. Technologies such as e-carts, cargo e-bikes, e-scooters, and sidewalk delivery robots are more suited to urban settings due to higher demand density and shorter delivery distances. Technologies like autonomous delivery vans and electric delivery vehicles could be more appropriate for suburban and rural settings. Air-based drones have the potential for both, depending on regulatory acceptance and infrastructure.

Regional policy recommendations cover three themes: 1) preparing for the future, 2) promoting efficient curbside use, and 3) leveraging new technology. More information on some of the examples is available within the body of the report.

These findings can inform the Met Council as it updates its foundational documents for transportation and land use planning in line with its wider policy objectives. Because of how local and context-specific curbside issues and solutions can be, it is the municipal governments that are typically at the front lines of planning and implementation. Our policy recommendations are therefore intended to have a regional focus and to be broadly applicable throughout the region, rather than being tailored to specific municipalities or contexts.

Theme 1: Prepare for the growing demand for e-commerce deliveries

1.1: Promote the establishment of curbside use inventories. An inventory, at a minimum, includes a geocoded shapefile or digital repository of road segments that includes information on the nature of any locational rules or restrictions on curbside use such as signed or permitted areas.

Example from Minneapolis: Loading zones in Minneapolis used to be established primarily upon requests by businesses, sometimes involving a fee, and in other instances being provided free of charge. The city has significantly advanced in systematically cataloging loading zones through the development of a comprehensive geospatial database that details the entirety of these zones on a street-by-street basis, an effort that is still ongoing.

1.2: Promote data collection and sharing on curb usage. Municipalities in the region should leverage new technologies for the collection of data on curb usage and share any findings or strategies to begin building a local knowledge base.

Example from Minneapolis: Minneapolis recently was the successful recipient of a US Department of Transportation (USDOT) grant under the SMART (Strengthening Mobility and Revolutionizing Transport) program for an open data approach to curbside management. The project will allow Minneapolis to develop a collection of multifaceted, open-source APIs to communicate the City's policies and regulations, document real-time changes to curb usage, and provide a historical view of curb usage, impacts, and efficiencies. This program could provide valuable insight for local communities that are interested in curbside management initiatives.

1.3: Facilitate industry engagement and coordination. Harnessing industry perspectives in resolving curbside challenges can be valuable, as these stakeholders are on the front lines operationally and often bring a pragmatic perspective.

Example from New York City: As part of the city's commercial loading zone expansion efforts, the City DOT's Freight Mobility Unit uses a public outreach and survey team to gauge the need among business owners for Commercial Vehicle Loading Zones (CVLZs) and traffic management. Regular surveys and an online feedback form allow couriers and business owners to request additional CVLZs, as well as changes to loading/unloading policies in their neighborhoods. New York City can use these responses to inform neighborhood or street-by-street prioritization for expanding commercial parking and mitigating public concerns.

1.4: Prepare organizationally by assigning freight leads. Larger municipalities can designate individuals or teams to be responsible for important freight issues, such as curbside deliveries. Smaller municipalities can ensure that freight planning is noted as an assigned area of responsibility.

1.5: Monitor key trends and developments over time. This includes tracking national-level e-commerce trends, staying up to date on the results of studies and programs in other cities nationwide, following relevant developments across the region, and tracking changes at a local level. Coordinating and sharing these types of information can help to support adaptable and pragmatic policies.

Theme 2: Ensure efficient use of curbside space

2.1: Promote smart prioritization of curbside space. Good prioritization combines a grounding in policy priorities with solid information on supply, demand, and usage needs. Effective prioritization is also tailored to the local context, such as having different typologies (with different prioritization hierarchies) for different types of roads and neighborhoods.

Example from Seattle: Seattle developed a Curbside Prioritization Framework that is based on surrounding land use (residential, commercial and mixed-use, and industrial), for six major function categories, including access for commerce, access for people, mobility, activating vibrant social spaces, greening, and storage. Curb access for commercial purposes is ranked in the top-3 for all three land use types.

2.2: Properly prioritize truck loading and unloading spaces. Allocating sufficient space for loading and unloading activities is particularly important in space-constrained areas where freight receivers do not have dedicated off-road space such as a driveway or loading dock. Good solutions can be quite pragmatic and location-specific, taking account of the particular shipping and receiving needs of businesses and the availability of unloading space both on the curbside and elsewhere in the vicinity (e.g., alleyways, shared off-street areas).

Example from Seattle: Seattle has a dedicated curbside management team which supports the City's planning processes and street redesigns, including with analysis and outreach. For transportation and roadway projects over \$500,000, the City DOT employs a checklist to incorporate considerations for commercial curb access.

2.3: Ensure delivery needs are integrated into complete streets. Wholistic designs that accommodate both delivery vehicles and cyclists/pedestrians are mutually beneficial, whereas suboptimal designs can exacerbate conflicts, such as unloading trucks blocking bike or bus lanes, or trucks circling the block to find parking (with more turning movements across bike lanes and crosswalks).

Example from New York: The Complete Streets Considerations for Freight and Emergency Vehicles Guidebook developed for the New York State Energy Research and Development Authority identifies design, regulatory, and operational strategies to address common challenges that freight operators face on compact, mixed-use streets.

2.4: Consider opportunities to monetize the curbside to promote efficient use. Truck deliveries are usually efficient uses of the curbside, compared to private automobiles which may park for a longer duration and/or have more flexibility in where to park. Pricing can be done at a block-by-block level to target a certain level of utilization, such as 70% usage.

Example from Seattle: Seattle Department of Transportation collected data on curb use at selected curbside segments to train a mathematical model estimating curb occupancies from historical parking transactions, and partnered with the University of Washington Urban Freight Lab to study commercial vehicle parking behavior in the city. This information is used to inform pricing and determine how much curb space should be dedicated to commercial vehicles.

2.5: Encourage flexible and creative solutions for loading and unloading. Flexible and creative solutions can include time-of-day allocation of uses, and new types of loading zones tailored to emerging uses (such as short-duration zones for pickup of food deliveries or parcels by customers or last-mile delivery companies).

Example from Philadelphia: Philadelphia implemented a six-month pilot that established 21 Smart Loading Zones in the city center. Delivery drivers download the Pebble Driver App that maps the available Smart Load Zones, allows for reservations, gives directions to the zone, and accepts a preferred payment method based on the length of visit.

Theme 3: Promote new technologies to fulfill regional objectives

3.1: Facilitate private-sector trials and pilot projects. Pilot projects and trials are an important first step to establishing technical, operational, and commercial viability. This can include both delivery technologies themselves, as well as data-gathering technologies such as sensors.

Example from Bellevue: With funds from a T4A grant in 2019, Bellevue conducted a pilot study to test the accuracy of video-based curbside monitoring technology solutions and identify a scalable system that could detect high-volume curb areas accurately for future enforcement and payment. Five technology vendors were selected, each deployed its technology and shared data with the City, and its performance was evaluated.

3.2: Pursue joint pilot programs with partners. Pilot projects in coordination with public agencies, private stakeholders, and the academic community can be a valuable approach for testing new technologies and models, collecting data, and leveraging the diverse strengths of different partners.

Example from The Knight Autonomous Vehicle (AV) Initiative. The initiative is a multi-year collaborative effort between the Urbanism Next Center at the University of Oregon, Cityfi, the cities of Detroit, Pittsburgh, and San José, and Miami-Dade County (the “cohort”). The initiative recently tested sidewalk delivery robots in partnership with Kiwibot for food and goods delivery from local restaurants and stores to residents who chose to participate. This collective effort allowed participating municipalities to share findings from deployment in each unique setting and make shared requests of the private partner that might not have been possible individually.

I. Curbside Management Best Practices

KEY TAKEAWAY

A comprehensive review of curbside management policies and programs in diverse cities highlights key factors to consider when establishing new or refining current strategies. These include adopting a holistic approach that considers various stakeholders, employs multiple planning tools, formulates policies that are adaptable and flexible, capitalizes on opportunities to pilot or test new initiatives, and fosters collaboration and engagement with industry and community members.

A. Introduction

1. Background

Curbside management to better accommodate goods deliveries among other curbside users of multiple transportation modes is an increasingly important topic across North American cities. Cities have been exploring and implementing new programs to better understand curb usage and to manage curb space in ways that address the rapidly growing demand for space from all modes. These initiatives are driven by several trends and factors:

- **Demand:** Companies like Amazon, Uber Eats, and Grubhub have shaped consumer expectations for faster and more flexible delivery of products, meals, and other goods. Consequently, evolving consumer habits are fueling demand for innovative delivery models.
- **Supply:** The availability of curbside space, particularly in dense urban centers, is limited. Depending on the location, this valuable resource may be in demand for various uses such as parking, driving lanes, bike lanes, public transit, freight unloading, pick-up/drop-off zones, expanded sidewalks, or lively public or private spaces like restaurant patios.
- **Technology:** Technological innovations, both on the ground (e.g., new types of delivery vehicles) and virtually (e.g., mobile applications) are creating opportunities and challenges that have not traditionally been considered by urban and transportation planners.
- **Planning priorities:** As planning priorities evolve, a greater focus is being placed on transit and cycling in many cities, diverging from the traditional emphasis on car travel. Concepts like “complete streets” prioritize increased safety and mobility for a diverse range of users, although the movement of goods can sometimes be overlooked.

This section synthesizes findings from research on best practices and lessons learned on curbside management for goods deliveries from cities with varying population density levels. The focus is particularly on the aspects of curbside management that deal with commercial vehicles and urban freight. The following section details the methodology used for selecting cities for a detailed review of their curbside management programs, followed by a summary of findings for 12 cities, covering a total of 21 programs. This chapter ends with conclusions from the review.

2. Methodology

There are a range of curbside management initiatives across cities in North America, with varying areas of focus. For example, some cities have well-developed frameworks to prioritize curbside space, while others pursue one-off projects such as pilot projects of new technologies. All curb management programs selected for review are focused on or have implications for commercial vehicle operations.

Our approach to the curbside review consisted of the following key steps:

Key Steps in Approach

1. Selected key criteria for the review
2. Developed a long list of cities and programs
3. In addition to the City of Minneapolis, selected two cities for an in-depth review (including one-hour interviews with city staff)
4. Developed summaries for an additional nine cities, covering 13 programs

a) *Key Criteria for Program Identification*

Figure 1 shows the key criteria used for identifying a list of curbside management programs and policies. These key criteria were selected in collaboration with the Met Council staff to highlight elements that are most relevant for regional planning and policy-making purposes.

Though there are other factors that cities need to consider when planning for and implementing curbside management programs for goods delivery, only the factors depicted in Figure 1 were the focus of this review exercise. Some of these other factors include program costs (such as hardware/software costs, ongoing operation costs, and staff hours), funding sources, utilization of third-party partners/vendors, and the logistical details of implementation (such as training required for staff or timeline for deployment).

Figure 1: Criteria for Curbside Management Policies/Programs Review

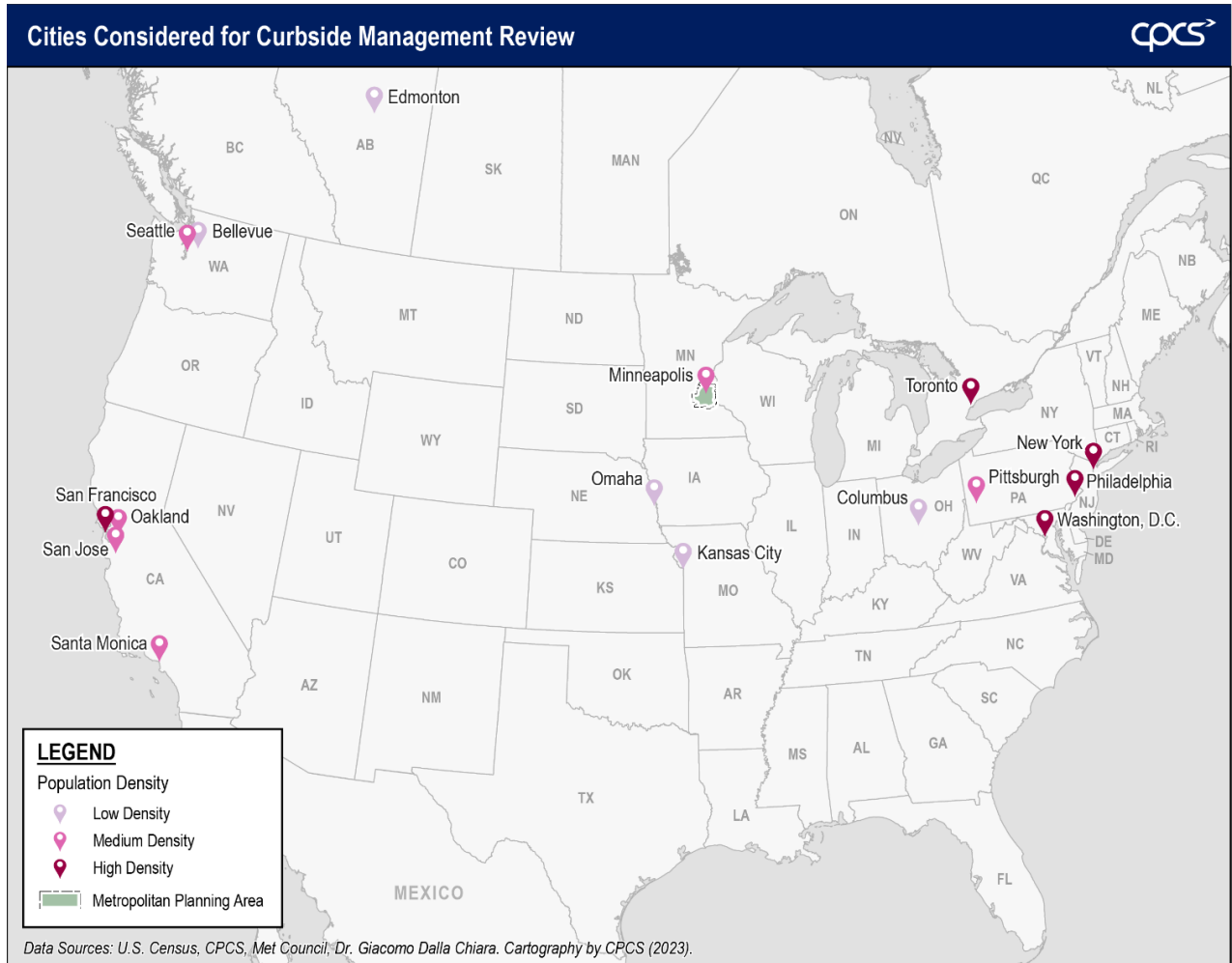
Criterion	Description	Examples
Objectives	What are the objectives or evaluation criteria?	<ul style="list-style-type: none"> • Improving productivity and efficiency of goods delivery • Reducing VMT and/or emissions • Enhancing safety • Enhancing user satisfaction • Demonstrating feasibility
Program approach	What was the program approach?	<ul style="list-style-type: none"> • Regulatory/policy: Programs that are implemented through regulatory and enforcement measures or through incorporation with metro planning documents • Pricing/permits: Initiatives using pricing or a permitting system • Technology: Programs driven by the development or incorporation of new technologies, including cameras, license plate readers, curb sensors, and mobile apps
Stage of adoption	How mature is the program or type of project?	<ul style="list-style-type: none"> • Pilot program/trial/study • Implementation/expansion • Established program • Post-implementation review
Setting	Where is the program implemented?	<ul style="list-style-type: none"> • Urban arterials; dense urban core • Suburban neighborhoods • Mixed-use districts • Commercial districts

Source: CPCS and Dr. Giacomo Dalla Chiara

b) *The Long List of Cities and Programs*

A desk review was conducted of existing curbside management programs for goods deliveries across North American cities. In general, metropolitan areas were considered that were a) contextually similar to the Twin Cities, and/or b) notable as best-practice leaders or for certain specific programs that may have relevance to the Twin Cities. Figure 2 shows a map of the cities identified in this review.

Figure 2: Cities Considered for Curbside Management Review



Source: CPCS and Dr. Giacomo Dalla Chiara, 2023

Figure 3 lists the cities by total population, land area, and population density, alongside the Cities of Minneapolis and St. Paul, and the Met Council MPO region. The selected cities span a range of population densities and exhibit varying degrees of sophistication in their curbside management practices. This selection includes high-density cities like New York City (NY) known for their innovative solutions in addressing urban goods delivery challenges at the curbside. Insights from these cities can provide valuable lessons for dense urban areas within the Twin Cities region, particularly in accommodating curbside goods delivery.

Additionally, cities with medium population densities that have implemented curbside management programs for goods delivery, such as Seattle (WA) and Pittsburgh (PA), are included. These cities, bearing similarities to Minneapolis and St. Paul—two of the largest cities in the MPO region—provide

pertinent insights into potential initiatives or programs that could be immediately relevant for the Twin Cities in the near term.

Furthermore, cities with lower population densities, like Kansas City (MO), or those serving as suburban communities to larger cities, such as Bellevue (WA), were chosen to inform suburban or exurban communities within the MPO region about relevant best practices.

Figure 3: Population, Land Area, and Population Density of Cities Considered*

Rank	City/Region (State)	Total Population	Area (sq. mi)	Population Density	Population Density Type
1	New York City (NY)	8,804,190	300	29,302	High density
2	San Francisco (CA)	873,891	47	18,629	High density
3	Philadelphia (PA)	1,603,845	134	11,937	High density
4	Toronto (ON, CAN)	2,794,356	243	11,484	High density
5	Washington, DC	689,545	61	11,281	High density
6	Santa Monica (CA)	93,076	16	11,067	High density
7	Seattle (WA)	737,015	84	8,775	Medium density
8	Minneapolis (MN)	429,954	54	7,962	Medium density
9	Oakland (CA)	440,646	56	7,879	Medium density
10	San Jose (CA)	1,013,240	180	5,812	Medium density
	St. Paul (MN)	311,527	56	5,717	Medium density
11	Pittsburgh (PA)	302,970	58	5,461	Medium density
12	Bellevue (WA)	151,854	33	4,538	Low density
13	Columbus (OH)	905,748	220	4,110	Low density
14	Omaha (NE)	486,051	127	3,824	Low density
15	Edmonton (AB, CAN)	1,010,899	296	3,420	Low density
	Met Council MPO Area	3,153,879	2,974	2,594	Low density
16	Kansas City (MO)	508,090	319	1,460	Low density

*The Cities of Minneapolis and St. Paul and the MPO area are highlighted in colored cells. The City of St. Paul and the MPO area are not numbered in the Rank column as they do not have an official commercial vehicle-focused curbside management policy/program.

Source: CPCS and Dr. Giacomo Dalla Chiara analysis of 2020 Census Demographic Data¹, 2023

c) Cities and Programs for Detailed Review

This long list of cities and their distinctive strategies served as a foundation for the MPO staff to identify suitable cities for a detailed review through desktop research and consultation with city staff. Besides the City of Minneapolis, Seattle and New York City were chosen for a thorough examination. To better comprehend the lessons learned, one-hour interviews were conducted with city staff. An additional nine cities, encompassing 13 programs, were chosen for a more focused but less intensive review.

Figure 4 itemizes the programs in each and indicates the corresponding sections where these programs are discussed in further detail. This collection of cities and programs represents a diverse

1 2020 Census Demographic Data Map Viewer, <https://mtgis-portal.geo.census.gov/arcgis/apps/MapSeries/index.html?appid=2566121a73de463995ed2b2fd7ff6eb7>. Accessed June 2023

spectrum of curbside management programs for goods delivery, covering a range of objectives, program methodologies, settings, and stages of adoption.

Figure 4: List of Programs Reviewed

City	Programs	Section
Seattle (WA)	<ul style="list-style-type: none"> Commercial Vehicle Load Zone (CVLZ) Program SMART Grant Mapping and Data Collection Collaboration with UW Urban Freight Lab 	1.2.3
New York (NY)	<ul style="list-style-type: none"> Neighborhood Loading zones (NLZ) program Off-peak hour delivery program Commercial cargo bicycle pilot program Loading Zone expansion Microhub pilot 	1.2.2
Philadelphia (PA)	<ul style="list-style-type: none"> Loading Zones Reservation Partnership 	1.2.4
Washington (DC)	<ul style="list-style-type: none"> Strategic Delivery and PUDO Zone Data Collection Delivery Microhub Feasibility Study 	1.2.4
Oakland (CA)	<ul style="list-style-type: none"> Smart Loading Zones Program 	1.2.4
Santa Monica (CA)	<ul style="list-style-type: none"> Zero Emission Delivery Zone Pilot 	1.2.4
San Jose (CA)	<ul style="list-style-type: none"> Neighborhood Delivery Hub Initiative 	1.2.4
Pittsburgh (PA)	<ul style="list-style-type: none"> Oakland Neighborhood Commercial Plan 	1.2.4
Bellevue (WA)	<ul style="list-style-type: none"> Curbside Management Plan and Video-Based Curbside Management Technology Testing 	1.2.4
Edmonton (AB, CAN)	<ul style="list-style-type: none"> Curbside Management Plan and CVLZ Designation 	1.2.4
Kansas City (MO)	<ul style="list-style-type: none"> Midtown Complete Streets Plan Crossroads District Parking Study Overland Park, KS Parking Plan 	1.2.4

Source: CPCS and Dr. Dr. Giacomo Dalla Chiara, 2023

Results of cities’ curbside management practices as related to goods deliveries are detailed in the following section.

3. Minneapolis

a) Background and context

Minneapolis is the largest city in Minnesota and is situated within Hennepin County, the most populous county in the Twin Cities metropolitan area. Minneapolis recently was the successful recipient of a US Department of Transportation (USDOT) grant under the SMART (Strengthening Mobility and Revolutionizing Transport) grants program, valued at \$1.98M, for an open data approach to curbside management. This project was one of about 50 selected nationwide in 2022 and the only one in Minnesota.²

² More information about grant recipients under the SMART program is available here, from USDOT: <https://www.transportation.gov/sites/dot.gov/files/2023-03/FY22%20SMART%20Project%20List.pdf> . Accessed June 2023.

b) Priorities and objectives

Met Council requires cities, counties, and townships to undertake a comprehensive plan. The most recent plan for Minneapolis is called Minneapolis 2040.³ As one of its plan policies, Minneapolis highlights the importance of “safe, efficient, and reliable movement of freight to a healthy local and regional economy”. The Plan calls out the need to adapt to the changing needs of freight, e-commerce, and urban logistics as one of its Action Steps. In addition, Minneapolis 2040 calls for the adaptation of urban-centered freight innovation and technology, both for shipment into Minneapolis and last-mile distribution. The Plan also encourages “smaller delivery vehicles that are more compatible with an urban environment, centralized drop-off and pick-up zones, and other innovations that make freight delivery more convenient for the customer with less of an impact on the transportation network”.

The Minneapolis Transportation Action Plan⁴ (TAP) also highlights several strategies related to curbside management for freight deliveries:

- Utilize land-use tools to improve the efficiency of deliveries.
- Improve the safety and efficiency of freight movements and integrate freight into the Complete Streets framework.
- Implement dynamic freight loading zones into citywide curbside management efforts.
- Regulate new delivery technologies that use the public right of way.

Discussions with representatives of Minneapolis’s Street Operations arm of the Public Works Department revealed that some of the city’s challenges in implementing some of the action items laid out under these strategies, in part due to the tendency for curb access for commercial vehicles to be overlooked.

The City’s Vision Zero and Street Design Guide have been primarily developed to prioritize modes of transportation other than freight, essentially reducing the availability of short-term stopping zones. This has resulted in issues such as illegal stopping and loading in bus or bike lanes, complicating the situation further. Moreover, the City’s enforcement capability is limited by current technology, making it challenging to prevent such infractions on a larger scale. The City representative is hopeful, however, that a formal curb policy based off of the City’s TAP and comprehensive plan will begin development later in 2023 to better address these challenges.

c) Initiatives and findings

Commercial loading zone program. The City of Minneapolis has established commercial vehicle loading zones which can be used by authorized commercial vehicles. Trucks must either be registered with the State or through a special program with the City (e.g. for certain personal vehicles also used for business). Registered vehicles can park for 30 minutes during the time the loading zone is in effect.

Figure 5: Minneapolis Commercial Loading Zone Sign



Source: City of Minneapolis. Loading and limited-time curb zones. 2023

³ For more information on Minneapolis 2040 see: <https://minneapolis2040.com/>

⁴ City of Minneapolis Transportation Action Plan Freight Strategies and Actions. December 4, 2020. https://go.minneapolismn.gov/application/files/3016/0753/2048/TAP_Final_FREIGHT.pdf. Accessed June 2023.

Outside of the signed times, any vehicles can use these spaces. In addition, the City has a unique provision whereby commercial vehicles can use any metered parking space for free for loading or unloading, before noon. Overall, there are few or no instances where commercial vehicles pay for curb space. In addition, Minneapolis has a network of alleys that are limited-use streets that provide property access and serve as primary locations for freight loading.

Audit of loading zones. The City has made substantial progress in mapping loading zones. Traditionally, loading zones had been established at the request of businesses, in some cases paid and in other cases for free. However, over time there was no single record of these spaces, outside of paid ones that were billed to businesses. The City moved to build up a geospatial database in house containing the full inventory street-by-street; the effort is ongoing. There are around 400 to 500 such zones in the city for commercial vehicles and other uses such as valet.

SMART grant for curbside management. The objectives of the project are: “Develop a collection of multifaceted, open-source application programming interfaces to communicate Minneapolis’ policies and regulations, real-time changes to curb usage, and provide a historical view of curb usage, impacts, and efficiencies.”⁵ The project is focused on Nicollet Avenue in an area known as “Eat Street” due to the concentration of restaurants. There are four major components of the project: 1) stakeholder outreach to users of the corridor; 2) data collection to understand usage; 3) analysis of the data; and 4) developing an API to enable open access. The key metrics that will be assessed include the types of vehicles using the space, activities performed, dwell time, and peak demand times. It is hoped that this will provide insights that will also be applicable more widely in the City. The SMART grant is awaiting formal execution as of the time of writing.

d) Takeaways and lessons learned

Need for prioritization. Minneapolis’s primary last-mile concern is the competing uses for curbside space and policy dilemmas related to prioritization. Currently, Minneapolis has street design guidelines that have considerations for freight and other curbside uses. However, there is presently no policy that specifically regulates curbside uses. As a result, prioritization is effectively done using high-level guidelines which can result in issues such as spaces for temporary stopping activities being excluded in street redesign projects. Consequently, commercial stopping and loading activity are increasingly taking place in non-authorized locations (e.g., including newly built bike lanes and dedicated bus lanes) thereby blocking traffic and increasing the likelihood of crashes. The City has limited ability to enforce such violations and these conflicts also impede the efficient delivery of goods. The City is interested in best practices for prioritization of curbside uses and approaches to integrating freight needs.

Data collection mechanisms. The City is considering its options for data collection mechanisms. There are a variety of options such as cameras, sensors, location-tracking, or digital permits. One challenge is that in Minnesota, license plate recognition tools are permitted only for criminal enforcement matters; this limits the types of technology that can be used. The City is interested in understanding other cities’ approaches to data and technology.

Other. The City is also interested in understanding other emerging technologies for last-mile deliveries. There was a planned cargo bike delivery pilot program, but this is not active now.

⁵ Strengthening Mobility and Revolutionizing Transportation (SMART) Grants Program, Fiscal Year 2022 Planning and Prototyping Grants by State, 2023. <https://www.transportation.gov/sites/dot.gov/files/2023-03/FY22%20SMART%20Project%20List.pdf>. Accessed June 2023.

e) *References and resources*

- Strengthening Mobility and Revolutionizing Transportation (SMART) Grants Program, and FY 22 awards
- Minneapolis 2019 Comprehensive Plan: Minneapolis 2040⁶

4. **New York City**

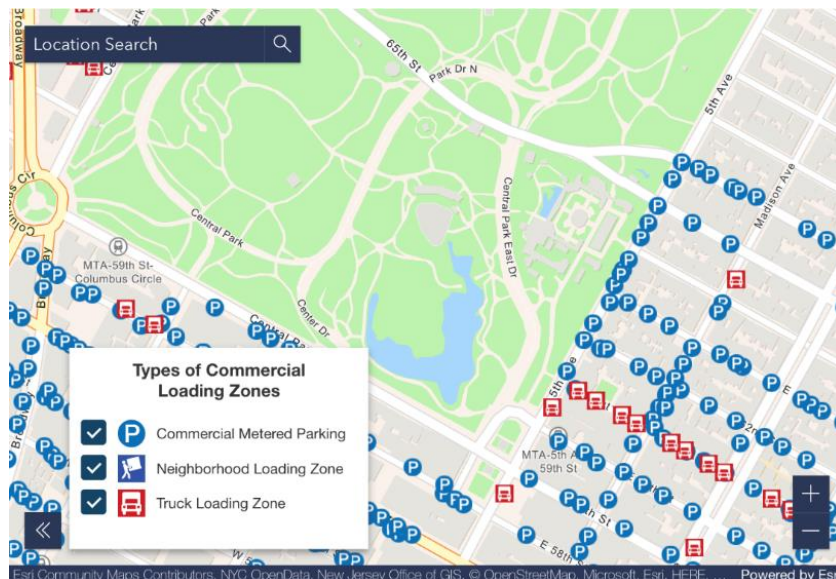
a) *Background and context*

Since 2007, the New York City DOT (NYCDOT) has had a dedicated Freight Mobility Unit responsible for advancing programs to mitigate the externalities produced by commercial vehicles on communities and the infrastructure while guaranteeing a functional and efficient urban logistics system supporting the City's economy.

Over the last decade, the Freight Mobility Unit has implemented numerous curb management programs that developed and expanded the existing network of curb load zones, supported low- and zero-emission freight vehicles adoption, and reduced truck vehicle miles traveled.

NYC is characterized by very high densities of population and commercial establishments. NYC had to manage commercial traffic from an early stage to avoid continuous road blockages caused by delivery activities. In NYC, there are 7,853 signs designating commercial loading zones. Of these signs, 2,055 are used to identify Commercial Metered Parking locations, 361 are used to identify Neighborhood Loading Zone locations, and 5,437 are used to identify Truck Loading Only locations. Figure 6 shows a snapshot of the map tool motorists can use to locate the three different types of loading zones.

Figure 6: New York Commercial Loading Zone Map Tool



Source: NYCDOT, 2023⁷

⁶ City of Minneapolis. Welcome to Minneapolis 2040. The City's Comprehensive Plan. <https://minneapolis2040.com/>. Accessed June 2023.

⁷ NYCDOT, Motorist & Parking Loading Zones. <https://www.nyc.gov/html/dot/html/motorist/loading-zones.shtml>. Accessed June 2023.

b) *Priorities and objectives*

The NYCDOT staff from the Freight Mobility Unit reported the following curbside objectives:

- Reduce traffic congestion and improve mobility
- Enhance safety
- Enhance the efficient movement of goods in the city
- Promote the adoption of low and zero-emission vehicles

c) *Initiatives and findings*

Neighborhood Loading Zones (NLZ)

program. NYCDOT expanded the pool of commercial loading zones via the NLZ program, which added 361 loading zones in front of residential buildings to facilitate the increase in demand for residential deliveries due to e-commerce. The program's objective is to reduce the amount of double-parking taking place in residential areas. Typically, neighborhood loading zones are 40 feet long and are signaled by the sign in Figure 7.

Figure 7: Sign Designating Neighborhood Loading Zone



Source: NYCDOT, 2023⁸

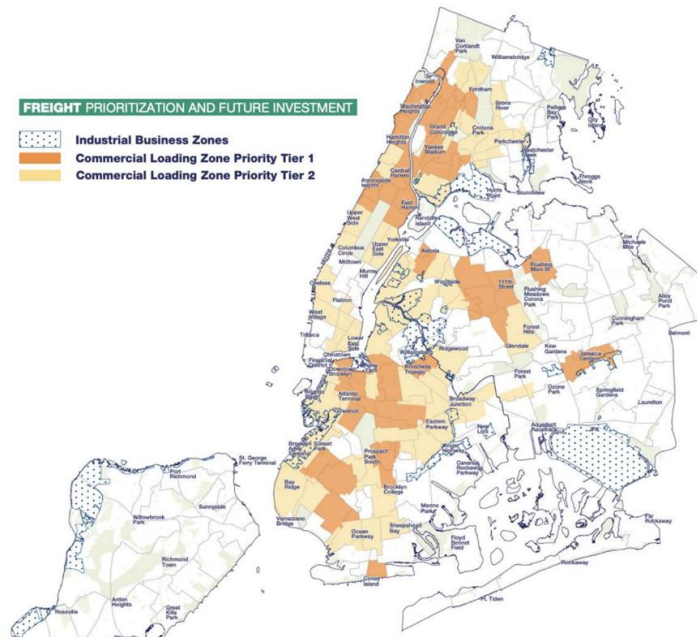
Loading zone expansion. Passed in 2021, the Loading Zone Expansion Law requires NYCDOT to create a methodology for loading zone allocation. The law mandates the installation of at least five loading zones annually in every neighborhood, and at least 500 zones annually across the City between 2023 and 2026. As part of the ordinance, the NYCDOT had to develop a methodology to identify blocks that require loading zones. NYCDOT used datasets (e.g., land use, population density, existing loading zones, bus stops, and bike lanes) as well as public engagement to identify three tiers of priority locations to create new loading zones (see Figure 8). NYCDOT reported that some residents do not always welcome new loading zones, especially in areas that are lacking parking spaces.

Off-peak hour delivery program. Between 2009 and 2010, NYCDOT piloted and deployed an off-peak hour delivery program. The program incentivized off-peak commercial deliveries (between 7 pm and 6 am) to reduce curb demand and traffic during daytime hours. A total of 25 businesses and 8 carriers participated in the pilot. NYCDOT reported an increase in delivery speed (130% higher) and a decrease in parking dwell times.

Commercial cargo bicycle pilot program. The Commercial Cargo Bicycle Pilot Program, launched in December 2019, encourages the use of cargo bikes for commercial purposes in the City. Commercial cargo bicycles enrolled in the pilot can load and unload wherever commercial vehicles can and at designated cargo bike corrals. Cargo Bike Corrals are cargo bike loading areas marked by bike racks, flexible bollards, and markings in the curbside lane (Figure 9).

⁸ NYCDOT, "DOT is working to combat double parking by developing Neighborhood Loading Zones, a demonstration project to dedicate curb space", NYCDOT Twitter, October 2019. https://twitter.com/NYC_DOT/status/1164554031634817026. Accessed June 2023

Figure 8: Loading Zone Expansion Prioritization Map



Source: NYCDOT, 2023⁹

Figure 9: NYC Curbside Cargo Bike Corrals



Source: NYCDOT, 2021¹⁰

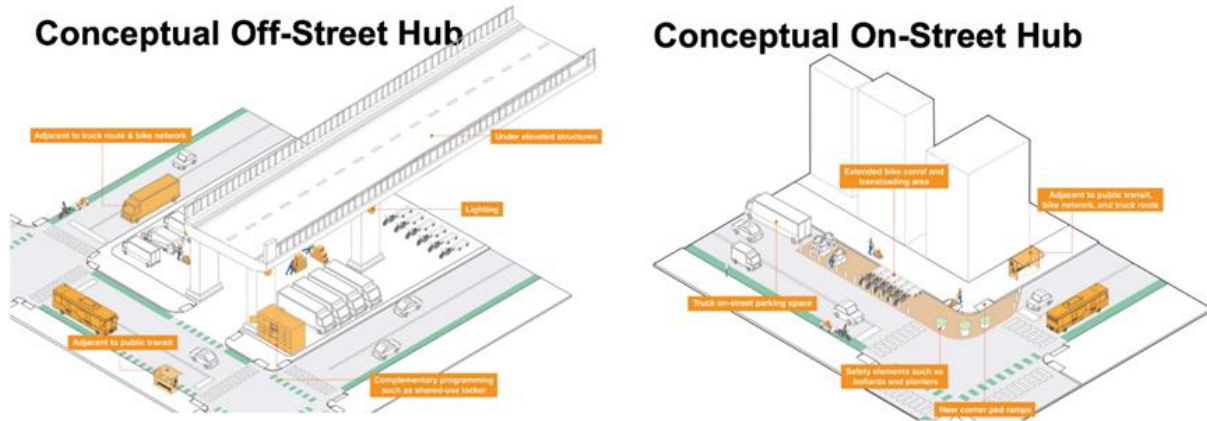
Microhub pilot. In the summer of 2023, NYCDOT will start the first phase of a microhub pilot. Microhubs are defined as spaces located near delivery customers, where goods are loaded from large freight vehicles to smaller, low-emission, or human-powered vehicles for the final leg of the delivery process. The first phase aims at establishing twenty microhub sites throughout NYC, establishing operating agreements and contract mechanisms with the microhub operators. Figure 10 shows two

9 NYCDOT, Loading Zone Expansion Progress Report, April 2023. <https://www.nyc.gov/html/dot/downloads/pdf/loading-zone-expansion-progress-report.pdf>. Accessed June 2023.

10 NYCDOT, Commercial Cargo Bicycle Pilot, May 2021. <https://www.nyc.gov/html/dot/downloads/pdf/commercial-cargo-bicycle-pilot-evaluation-report.pdf>. Accessed June 2023.

conceptual types of microhubs: an on-street hub that has curb space (similar to the cargo bike corrals) and unloading spaces in off-street locations.

Figure 10: NYCDOT Conceptual Off-Street and On-Street Microhub Rendering



Source: NYCDOT, 2023¹¹

d) *Takeaways and lessons learned*

Monitoring and engaging public opinion. With its significant expansion of curbside management policies and commercial parking space, NYCDOT has closely monitored the public’s reception to the changes in parking availability. NYCDOT has employed a survey team and online feedback form to regularly measure the efficacy of DOT strategies in addition to data analysis. It is important to educate the public as well as DOT staff that providing loading zones does not mean reducing paid parking space and revenues, but instead, it improves the livelihood of neighborhoods, reduces congestion, and supports the local economy. Mitigating public pushback while also gauging demand and concerns through public surveys can guide the loading zone prioritization process and improve the speed of implementation.

Data-driven approach. NYCDOT’s approach to determining locations of loading zones, cargo bike corrals, and microhubs is heavily data driven and uses quantitative and qualitative performance measures after implementation. Proactive data-driven planning for loading zone allocation is preferred over responding to ad-hoc requests from the public, as demand can be assessed quicker and with greater detail. This approach is particularly crucial for unmetered spaces for which transaction data are not available to monitor utilization.

Regulatory enforcement. Neighborhoods and city entities are often responsible for implementing DOT guidelines and ensuring compliance with NYCDOT’s goals and timelines. Political will supporting the loading zone expansions by mandating them was essential to support the freight programs. Under a mandate, NYCDOT can enforce compliance with curbside use designation and ensure that unsafe or illegal parking is reduced.

e) *References and resources*

- Loading zone expansion report¹²

11 NYCDOT, Microhubs Pilot, April 2023. <https://www.nyc.gov/html/dot/downloads/pdf/microhubs-pilot-report.pdf>. Accessed June 2023.

12 NYCDOT, Loading Zone Expansion Progress Report, April 2023. <https://www.nyc.gov/html/dot/downloads/pdf/loading-zone-expansion-progress-report.pdf>. Accessed June 2023.

- Commercial cargo bike pilot report¹³
- Microhub pilot plan¹⁴

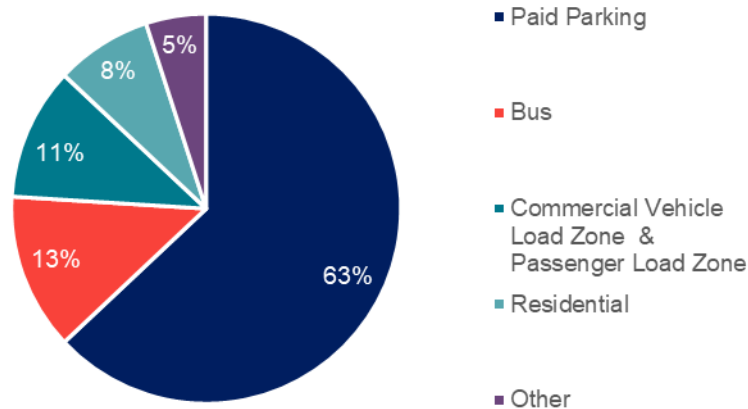
5. Seattle

a) Background and context

Seattle is the largest city in the Pacific Northwest with a population of over 3 million (urban area). It is one of the fastest-growing cities in the US.¹⁵

Over the past 15 years, the curb management team of the Seattle Department of Transportation (SDOT) has taken a pro-active data-driven approach to map, monitor, and monetize curb space. There are approximately 53 miles of curb space allocated to on-street parking in downtown Seattle which represents roughly 63% of total curb space. about 11 percent of the allocated curb space in the downtown area is reserved for commercial vehicle and passenger load zones (Figure 11).

Figure 11: Curbside allocation in the Seattle Downtown Core



Source: Seattle Department of Transportation, 2020¹⁶

The following types of curb space are allocated to commercial vehicles (Figure 12):

- Truck-only load zones: spaces restricted to vehicles licensed as trucks.
- Commercial vehicle load zones (CVLZ): spaces for commercial service delivery vehicles.
- Passenger load zones (PLZ): space reserved for 3-minute pick-up and drop-off, where drivers are required to stay in their vehicles.

13 NYCDOT, Commercial Cargo Bicycle Pilot, May 2021. <https://www.nyc.gov/html/dot/downloads/pdf/commercial-cargo-bicycle-pilot-evaluation-report.pdf>. Accessed June 2023.

14 NYCDOT, Microhubs Pilot, April 2023. <https://www.nyc.gov/html/dot/downloads/pdf/microhubs-pilot-report.pdf>. Accessed June 2023.

15 U.S. Census Bureau. 2010-2018 American Community Survey 5-year Estimates.

<https://data.census.gov/table?q=Population+Total&tid=ACSDT1Y2021.B01003>. Accessed June 2023.

16 Seattle Department of Transportation, Curbside Management Team 2019 Annual Report, May 2020.

https://www.seattle.gov/Documents/Departments/SDOT/ParkingProgram/CurbsideManagementTeam_2019AnnualReport.pdf. Accessed June 2023.

- 5-minute priority pick-up zones: space reserved for 5-minute loading and unloading (can include designated Food Pick-Up spaces).

Figure 12: Typologies of Commercial Curb Parking Signs in Seattle



Source: Seattle Department of Transportation, 2016¹⁷

b) Priorities and objectives

In 2023, SDOT released the Curbside Management Climate Plan¹⁸, aligning the curbside management programs and strategies with the City’s climate goal to reduce 58 percent of greenhouse gas (GHG) emissions by 2030. SDOT also identified the need to manage curb access for commerce as one of the top three functions for all types of land use (residential, commercial and mixed-use, and industrial), therefore pro-actively allocating commercial vehicle load zones across the city.

c) Initiatives and findings

Commercial vehicle loading zone (CVLZ) program. The CVLZ program was established in 1989 to provide designated space for service delivery vehicles. A CVLZ permit or payment at nearby pay stations or by phone payment is required to park at CVLZs, and vehicles can park for up to 30 minutes. Parking permits cost \$250, is valid for a year from the time of purchase and are issued to persons or entities having a valid City of Seattle business license.¹⁹

SMART grant. In 2023 SDOT was awarded a USDOT grant under the SMART program, valued at \$1,975,000. The grant will be used to modernize the CVLZ permit program to pilot test a “digital permit” based on a vehicle-to-curb communication system. The new permit will provide visibility for SDOT on the use of the CVLZ spaces, enabling future operational functions such as seamless pay-per-use, data collection and monitoring, and zero-emission zone enforcement, among others.²⁰

Mapping and data collection. SDOT has maintained a detailed GIS data layer recording curb allocation, parking signs, and other parking-related data, and made it available to the public through an open data portal and APIs. The SDOT has also recurrently collected data on curb use at selected blockfaces²¹ to train a mathematical model estimating curb occupancies from historical parking transactions and used the obtained information to adjust parking prices seasonally.

17 Seattle Department of Transportation, Can I Park Here?, November 2016 https://www.seattle.gov/documents/Departments/SDOT/ParkingProgram/CanIParkHere_Brochure_English_20161101.pdf, accessed May 2023.

18 Seattle Department of Transportation, Curbside Management Climate Plan, 2023 https://www.seattle.gov/documents/Departments/SDOT/ParkingProgram/Curbside%20Climate/Curbside_Climate_Plan_Report.pdf. Accessed May 2023.

19 Seattle Department of Transportation, Annual Truck Permits – Commercial Vehicle Load Zone Conditions of Uses. <https://www.seattle.gov/transportation/permits-and-services/permits/atp-commercial-vehicle-load-zone>. Accessed May 2023.

20 Ethan Bancroft, We Applied for a \$2 Million Federal Grant for Data-Driven Curb Space Management, SDOT Blog, November 2022. <https://sdotblog.seattle.gov/2022/11/22/federal-smart-grant-freight-curb-management/>. Accessed May 2023.

21 SDOT defines a blockface to be the length of city infrastructure abutting a roadway, bounded between two roadway intersections.

Collaboration with the Urban Freight Lab. The SDOT has collaborated with the Urban Freight Lab (UFL) on several research projects aimed at studying curbside usage by commercial vehicles and at pilot testing new technology. The UFL within the Civil and Environmental Engineering Department of the University of Washington, is a public-private partnership bringing together public sector and private companies to delve deeper into urban logistics challenges. In 2020 the UFL and SDOT collaborated on a US Department of Energy-funded project to test the first curb availability information system for delivery drivers. Curb proximity sensors were deployed in a 10-block study area. The sensors detected the presence of vehicles and reported in real-time the information to delivery drivers in the area.²²

d) Takeaways and lessons learned

The City has been pro-active in prioritizing curb access for commerce and in developing programs for commercial vehicles. The three key features of this approach are:

- Collaboration with the private sector and the local communities, through public engagement and collaboration with the Urban Freight Lab;
- Applying a data-driven approach, starting with mapping and making publicly accessible their curb allocation, signage, and parking regulations, followed by more data collection on curb uses and development of data-driven strategies; and
- Pilot testing new technologies, including curb proximity sensors and cargo bikes.

SDOT Curbside Management Team staff highlighted the need to incorporate and prioritize curbside access for commercial vehicles during planning and street redesigns. To this end, SDOT created a checklist for projects over \$500,000 to incorporate considerations for commercial curb access. When curb usage is affected, SDOT Curbside Management Team staff assists the project team with stakeholder outreach to discuss critical building access and other loading needs.

Figure 13 shows the Curbside Prioritization Framework the City uses that is based on surrounding land use. Curb access for commercial purposes is ranked in the top-3 for all three land use types.

Figure 13: Seattle Curbside Prioritization Framework

	Residential	Commercial & Mixed Use	Industrial
1	Support for Modal Plan Priorities	Support for Modal Plan Priorities	Support for Modal Plan Priorities
2	Access for People	Access for Commerce	Access for Commerce
3	Access for Commerce	Access for People	Access for People
4	Greening	Activation	Storage
5	Storage	Greening	Activation
6	Activation	Storage	Greening

Source: City of Seattle, 2023²³

22 Dalla Chiara, G., Krutein, K.F., Ranjbari, A. et al. Providing curb availability information to delivery drivers reduces cruising for parking. *Sci Rep* 12, 19355 (2022). <https://doi.org/10.1038/s41598-022-23987-z>. Accessed June 2023.
 23 City of Seattle, Flex Zone/Curb Use Priorities in Seattle. <https://www.seattle.gov/transportation/projects-and-programs/programs/parking-program/parking-regulations/flex-zone/curb-use-priorities-in-seattle>. Accessed June 2023.

Some of the items on the checklist include:

- “Are there critical building access needs that don’t seem to be met by existing regulations? (Y/N) (e.g., This could be via seeing trucks using the center left turn lane, which is not legal, and an indication of insufficient curbside loading area) If yes, please describe areas/locations.”
- “Describe recommendations for curbside lanes that maintain or mitigate critical access needs.”

Other challenges the City is facing include defining and coding a delivery vehicle. With an increasing number of carriers employing delivery service partners who use not only trucks but also personal vehicles for deliveries, this challenge has been magnified.

References and resources

- Curbside Management 2023 Climate Plan²⁴
- Commercial Vehicle Load Zone conditions of use²⁵
- SMART grant application announcement²⁶
- Department of Energy funded a project on curbside availability information system²⁷ and published paper²⁸
- Curbside GIS layer and other data²⁹

6. Other Cities

a) *Philadelphia, Pennsylvania*

Background and context

As the most populous city in Pennsylvania and a major city center in the mid-Atlantic, Philadelphia’s metro area is dealing with several traffic-related issues exacerbated by the pandemic. In the last few years, Philadelphia’s transit ridership has decreased, while the number of traffic deaths and hours of delay have increased.³⁰ Philadelphia’s increasing population is looking for ways to reduce commuting drivers and provide efficient routes that reduce the need for unsafe and illegal parking.

Priorities and objectives

Philadelphia’s first and foremost concern is the reduction of traffic-related deaths. Encouraging public transportation ridership and reducing unauthorized curbside usage are two of multiple means to achieve the city’s “vision zero.”

²⁴ Seattle Department of Transportation, Curbside Management 2023 Climate Plan, March 2023.

https://www.seattle.gov/documents/Departments/SDOT/ParkingProgram/Curbside%20Climate/Curbside_Climate_Plan_Report.pdf, accessed June 2023.

²⁵ Seattle Department of Transportation, Annual Truck Permits – Commercial Vehicle Load Zone Conditions of Use, N.D..

<https://www.seattle.gov/transportation/permits-and-services/permits/atp-commercial-vehicle-load-zone>. Accessed May 2023.

²⁶ Ethan Bancroft, We Applied for a \$2 Million Federal Grant for Data-Driven Curbside Management, SDOT Blog, November 2022.

<https://sdotblog.seattle.gov/2022/11/22/federal-smart-grant-freight-curb-management/>. Accessed May 2023.

²⁷ University of Washington Urban Freight Lab, Urban Freight Lab Uses AI to Show, Forecast Available Parking, November 2021.

<https://www.youtube.com/watch?v=f0wl411pDwM>. Accessed June 2023.

²⁸ Dalla Chiara, G., Krutein, K.F., Ranjbari, A. et al. Providing curbside availability information to delivery drivers reduces cruising for parking. *Sci Rep* 12, 19355 (2022). <https://doi.org/10.1038/s41598-022-23987-z>. Accessed June 2023.

²⁹ Seattle Department of Transportation, Maps and Data, N.D.. <https://www.seattle.gov/transportation/projects-and-programs/programs/parking-program/maps-and-data>. Accessed June 2023.

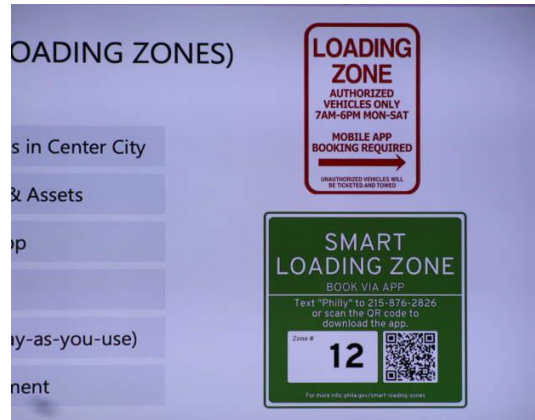
³⁰ City of Philadelphia, 2022 Safety and Congestion Omnibus Action Plan, 2022. https://www.phila.gov/media/20220624114025/2022-OmnibusPlan_Updated.pdf. Accessed June 2023.

In addition to making driving in Philadelphia safer for all drivers and pedestrians, the city’s press release announcing the partnership emphasized the need to improve delivery vehicle parking by allowing them to easily locate and reserve available curb space. This could potentially reduce driving time while improving safety.

Initiatives and findings

Loading Zones Reservation: Philadelphia implemented a six-month pilot that established 21 Smart Loading Zones in the city center. Delivery drivers download the Pebble Driver App that maps the available Smart Load Zones. Drivers were able to reserve a Smart Load Zone within 15 minutes of arrival, get directions to the zone, and pay via a preferred payment method for the length of time stopped in the zone. The city would also penalize any driver that was not using the spaces for loading/unloading purposes or failed to reserve for the \$3 fee.

Figure 14: Signs at a Smart Loading Zone in Philadelphia



Source: Cory Sharber. 2022³¹

Takeaways and lessons learned

Philadelphia recently concluded the 6-month study and has yet to release any related findings. However, the stated goals for the project were to provide a safer and more efficient means for loading and unloading and reduce the amount of unsafe and illegal parking throughout the city. In addition to creating a public-private partnership with the Pebble app, the pilot study tested a pay-as-you-use price model for load zones. The pilot also outfitted areas in the Center City District with specific signage and numbering to designate smart loading zones for the future.

Resources and references

- City Pilot Project Press Release and Program Summary³²

b) *Washington, DC*

Background and context

Washington, DC has a population of 5.3 million people and is home to 13% of jobs in the mid-Atlantic region. As a result, DC accommodates thousands of commuters each day by commuter rail, cars, and public transport in addition to traffic generated by local commerce and residents. With \$26 million in funds awarded under the FAST Act in 2016, DC has implemented a series of programs aimed at improving freight traffic flows within city limits.

³¹ Cory Sharber. Philadelphia to launch 'Smart Loading Zones' pilot program. WHYY. October 2022. <https://whyy.org/articles/smart-loading-zones-pilot-program/>. Accessed June 2023.

³² Kelsey Hubbell, City Announces New SmartCityPHL Pilot Project Focused on Loading Zones in Center City, Philadelphia Office of Innovation and Technology, October 2022. <https://www.phila.gov/2022-10-03-city-announces-new-smartcityphi-pilot-project-focused-on-loading-zones-in-center-city/>. Accessed June 2023.

Priorities and objectives

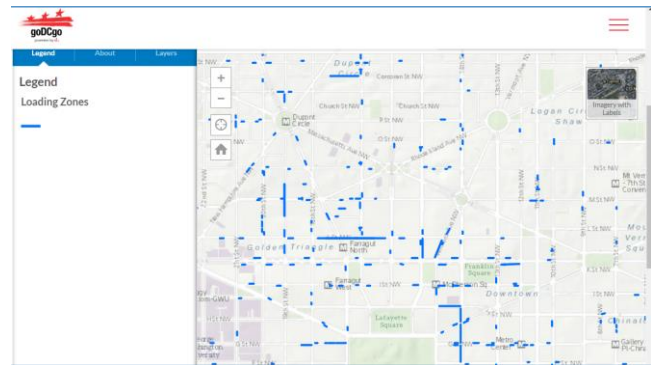
With 600 commercial loading zones across the city, DC has explored methods over the last seven years to monitor and improve their availability through better enforcement. Strategies identified in the district's freight investment plan have suggested gathering data to draw time-sensitive curb pricing strategies, increasing penalties for illegal parking, and encouraging switches to smaller delivery vehicles.

Initiatives and findings

MoveDC Strategic Delivery and PUDO

Zones: Drawing on transportation network company (TNC) activity data from Shared Streets, the nonprofit Open Transport Partnership's geographic data-referencing project, DC DOT created dedicated commercial vehicle pick-up/drop-off (PUDO) zones equipped with in-ground sensors and license plate recognition devices. Those zones are then priced to incentivize shorter stays.

Figure 15: DC's Interactive Truck and Bus Map Display Commercial Loading Zones



Source: Washington DC Department of Transportation, 2023 33

Delivery Microhub Feasibility Study: DC DOT is researching eco-friendly delivery mechanisms that reduce the reliance on vehicles powered by internal combustion engines for last-mile deliveries. The objective of this project is to gain a more comprehensive understanding of how delivery micro hubs can facilitate the use of bicycles, e-cargo bicycles, and/or pedestrian methods for final-stage deliveries within the District of Columbia. This endeavor will involve detailed case studies concerning the utilization of delivery microhubs, pinpointing essential micro hub requirements, and identifying the traits of delivery zones and District neighborhoods that conform to these requirements. The findings of this feasibility study are set to be released in the summer of 2023.

Takeaways and lessons learned

Implemented in 2018, MoveDC has accomplished most of the strategies listed in the freight plan addendum. After examining the current demand-based parking policy, DC DOT was able to designate use types for curbside segments and develop an implementation plan for new policies. Data on commercial zone utilization informed dynamic pricing and the re-allocation of curb space from paid parking for private vehicles to commercial loading/unloading. Since the strategy's implementation in 2017, the District has established 30 PUDO locations and 47 individual zones. Seven more locations are pending installation in the next two years.

Resources and references

33 Washington DC Department of Transportation. DC Truck and Bus Map. 2023. <https://godcgo.com/dc-truck-and-bus-map/>. Accessed June 2023.

- District of Columbia Freight Plan Addendum³⁴
- MoveDC Snapshot³⁵
- Curbside Management Programs³⁶
- DC Truck and Bus Map³⁷

c) *Oakland, California*
Background and context

Oakland is the largest city and the county seat of Alameda County, California. It has a population of 441,000 people and a density of 7,900 people/squared mile. The City of Oakland DOT dedicates portions of the curb to passenger and material loading and unloading between 7 am and 6 pm. Any vehicle with a registered commercial license plate can park for at most 30 minutes.

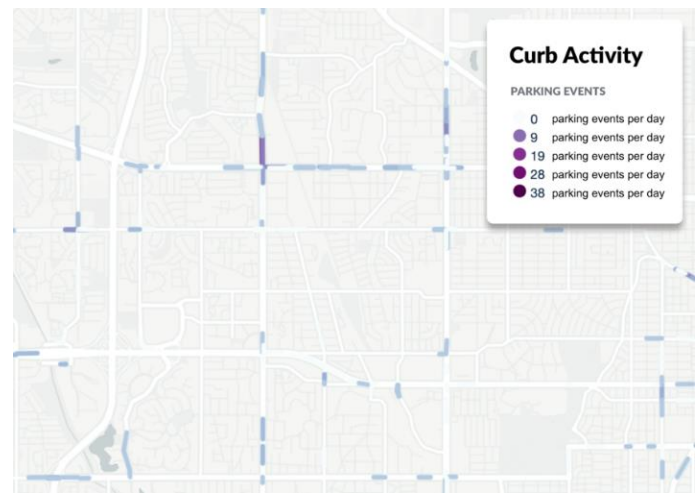
Priorities and objectives

The Oakland DOT aims at automating the payment of parking meter fees for commercial vehicles parking at the yellow curb loading zones. The program's objectives are (1) to reduce vehicles misusing commercial vehicle load zones by introducing parking meters while (2) improving delivery vehicle access to safe parking, and providing a seamless payment method.

Initiatives and findings

Smart Loading Zone Permit Program: The city of Oakland started a collaboration in 2023 with Populus, a curb-technology provider, to launch a smart loading zone permit program. The permit costs \$3. Registered vehicles must agree to share their GPS data with Populus every month. The data is used to identify parking stops and bill the vehicle owner directly according to their stop dwell time on a per-minute basis.

Figure 16: Populus Occupancy Data Interface



Source: Populus, 2023³⁸

34 District Department of Transportation, DDOT Freight Plan Addendum and 2014 Freight Plan, October 2017. <https://ddot.dc.gov/sites/default/files/dc/sites/ddot/publication/attachments/District%20Freight%20Plan%20Addendum.pdf>. Accessed June 2023.

35 District Department of Transportation, moveDC Snapshot, January 2021. <https://movedc.dc.gov/apps/abe15342d9a348d4bc781d15b12eabfe/explore>. Accessed June 2023.

36 District Department of Transportation, moveDC Curbside Management, January 2021. <https://movedc-dcgis.hub.arcgis.com/pages/curbside-management>. Accessed June 2023.

37 Washington DC Department of Transportation. DC Truck and Bus Map. 2023. <https://godcgo.com/dc-truck-and-bus-map/>. Accessed June 2023.

38 Populus, Curb Manager, <https://www.populus.ai/products/curb-manager>. Accessed June 2023

Takeaways and lessons learned

The program has just started in early 2023, and no performance metrics are available at the time of this report. The stated objectives are to allow for a per-minute payment system without the need for operators to use cash or credit cards at parking meters, as well as to avoid the deployment of infrastructure that could be hard and costly to maintain and operate (e.g., parking meters and curb sensors for payment and vehicle detection). The main risks of this program include (1) dependence on a private operator; (2) legal issues related to the detection of parking stops and payment; (3) unwillingness of delivery operators to share GPS data; and (4) unavailability of resources for collecting and sharing GPS data.

Resources and references

- Oakland DOT portal to apply for a loading zone permit³⁹
- Populus announcement⁴⁰

d) *Santa Monica, California*

Background and context

Santa Monica, CA is a city in Los Angeles County, situated along Santa Monica Bay on California's South Coast. Its downtown is home to 15,850 residents and two commercial districts—downtown Santa Monica and Mian Street—which employ more than 28,000 workers. The area receives millions of annual visitors and tourists annually.

Priorities and objectives

In 2018, the Los Angeles Cleantech Incubator (LACI) launched the Transportation Electrification Partnership (TEP). This public-private collaboration aims to chart a course for the reduction of greenhouse gas emissions and air pollution. The collaboration aims to have 60% of medium-duty and 40% of heavy-duty trucks to be zero emissions by 2028, among other goals.

Figure 17: Santa Monica Zero-Emission Delivery Zone Map Rendering



Source: City of Santa Monica, 2021⁴¹

³⁹ Oakland DOT Parking and Mobility Division, Apply for a Commercial Vehicle Loading Zone Permit, N.D..

<https://www.oaklandca.gov/services/apply-for-a-commercial-vehicle-loading-zone-permit>. Accessed June 2023.

⁴⁰ Populus, Oakland, California Approves New Smart Loading Zones to Better Manage Their Curbs, January 2023.

<https://www.populus.ai/latest-news/oakland-california-approves-new-smart-loading-zones>. Accessed June 2023.

⁴¹ City of Santa Monica, LACI Launches First-In-Nation Zero Emissions Delivery Zone With City of Santa Monica and Partners including Nissan, IKEA, February 2021. <https://www.santamonica.gov/press/2021/02/25/laci-launches-first-in-nation-zero-emissions-delivery-zone-with-city-of-santa-monica-and-partners-including-nissan-ikea>. Accessed June 2023

Initiatives and finding

Zero Emission Delivery Zone: The LA Cleantech Incubator (LACI) partnered with the City of Santa Monica to pilot test a zero-emission delivery zone in a one-square-mile area in the commercial downtown core. The pilot was voluntary, ran through December 2022, and incentivized the use of clean and electric delivery vehicles by reaching out to the private sector and offering priority curb space through zero-emission curb loading zones.

The parking spaces are marked by signage and are monitored by video cameras that track how the spaces are being used. Any zero-emission vehicle is eligible to park and load-unload for at most 10 minutes. A similar curbside strategy has been deployed in the City of Los Angeles.

Takeaways and lessons learned

The ZE delivery zone initiative, although voluntary, enabled a private-public collaboration to test and implement zero-emission modes of urban goods transportation, accelerating the development of charging infrastructure, analyzing the availability and efficacy of different zero-emission vehicles, and assessing the grid capacity. The curbside played a key role in incentivizing and prioritizing the use of zero-emissions delivery vehicles.

Resources and references

- Los Angeles Cleantech Incubator (LACI) transportation electrification partnership⁴²
- 2021 curbside management ordinance allowing for the creation of five zero-emission commercial loading zones⁴³
- Transport Decarbonization Alliance report on Zero Emissions delivery zones⁴⁴

e) *San Jose, California*

Background and context

San Jose is the largest city in the Bay Area and all of Northern California. Given its proximity to other major urban centers, only a fifth of San Jose's workforce stays within the city each day. As a result, San Jose has traditionally struggled to provide enough public transit and major roadways to accommodate drivers during peak commuting hours. Lately, however, the city's remote work culture has left San Jose with an abundance of parking infrastructure that is going unused on weekdays. Post-pandemic working conditions and a resurgence in commercial activity have required San Jose to adjust its traffic and parking management strategies and accommodate varying levels of demand.

Priorities and objectives

In addition to creating a complete streets initiative, San Jose's curbside and traffic management goals have focused on reducing the physical and environmental footprint of transportation networks. San

42 Los Angeles Cleantech Incubator, Transportation Electrification Partnership, May 2018. <https://lincubator.org/transportation/>. Accessed June 2023.

43 City of Los Angeles, Ordinance 187117, 2021. https://clkrep.lacity.org/onlinedocs/2021/21-0147_ord_187117_08-07-21.pdf. Accessed June 2023.

44 Transport Decarbonization Alliance, Zero-Emission Zones in the City: Don't Wait to Start with Freight!, March 2023. <https://tda-mobility.org/wp-content/uploads/2023/05/Zero-Emission-Zones-in-the-City-Dont-Wait-to-Start-with-Freight.pdf>. Accessed June 2023.

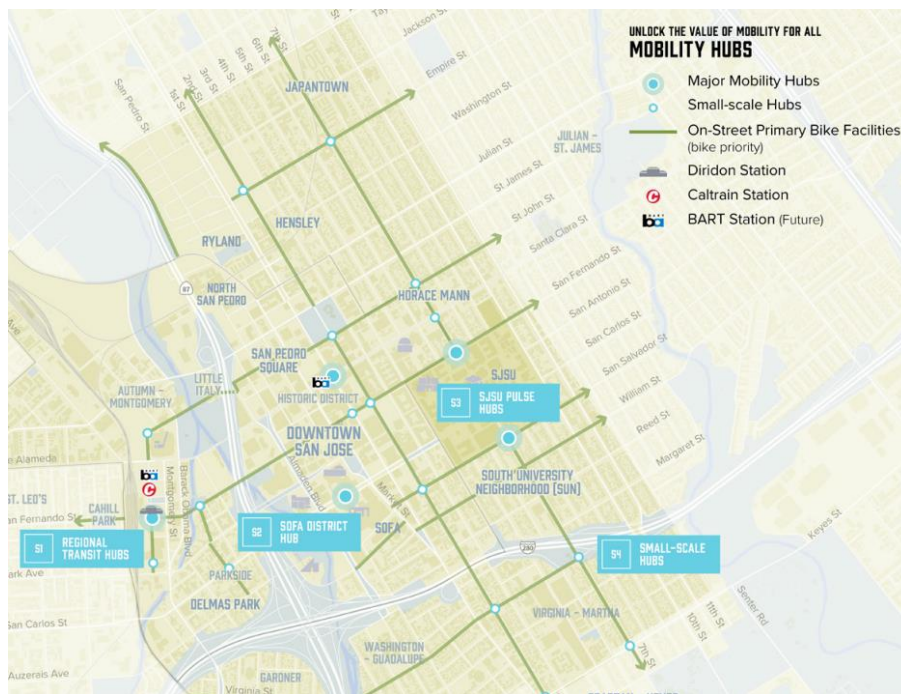
Jose’s primary strategy, therefore, centers on the creation of mobility hubs and the reduction of mandatory parking minimums.

By creating centers for easy access to multiple transportation modes and reducing the amount of low-priced parking, the city hopes to increase the value of shared transportation methods and improve access to the city and the region’s most congested areas.

Initiatives and findings

Neighborhood Delivery Hubs: San Jose uses active curbside management and parking strategies to constantly modify parking availability and pricing based on demand. The city modeled its curbside management plan after Seattle’s and suggested two neighborhood delivery hubs that take advantage of underused surface lots along common freight routes. Four multimodal transportation hubs have been identified in the Curbside Management Plan, to be established by 2027, two of which explicitly provide commercial parking. These lots aim to direct and consolidate freight trips to off-street locations where dwell time would have minimal impact on other transportation modes. These would be used as a point of transition from larger delivery vehicles to micro freight (porters or cargo bikes) to reduce vehicle miles traveled and emissions.

Figure 18: San Jose Mobility Hub Map



Source: San Jose Downtown Association, 2022⁴⁵

Takeaways and lessons learned

The city has found that improving availability while shifting away from free and discounted parking improves utilization and decreases the amount of illegal/unsafe parking. Shared facilities are critical to San Jose’s curbside management plan. To create these hubs, the city encourages private parking to be

45 San Jose Downtown Association, Downtown Transportation Plan, October 2022. <https://www.sanjoseca.gov/home/showpublisheddocument/90619/638040474240370000>. Accessed June 2023

shared among adjacent buildings, public lots to allow for multiple uses, and private developers to allow commercial parking during times of lower demand.

Resources and references

- San Jose Downtown Transportation Plan⁴⁶

f) [Pittsburgh, Pennsylvania](#)

Background and context

With a population of roughly 2.35 million people, Pittsburgh is the most populous city in western Pennsylvania. Its unique geography has long caused issues for traffic flow in and around the city, making it the 7th most congested city in the U.S. based on hours of delay per driver.⁴⁷

In 2016, Pittsburgh received a \$10.8 million USDOT grant to implement advanced transportation and congestion management technologies (ATCMTD). Pittsburgh has used the funds over the last six years to invest in traffic detection and pollution sensors along “smart spine” corridors that connect residential areas with primary commercial centers and amenities.

Priorities and objectives

After receiving its Congestion Management Technology grant, the city of Pittsburgh prioritized its most congested neighborhoods in the city center, including Oakland and downtown. These areas are connected to several residential to commercial-corridors that have high levels of public transit and pedestrian traffic, presenting issues for safety and right of way. The Oakland neighborhood specifically is home to a university campus, hospitals, museums, and retail establishments.

Pittsburgh aims to make its commercial centers more accessible, incentivizing non-auto transportation and creating designated off-street parking areas that preserve the public right-of-way but have alternative uses during peak hours.

Initiatives and findings

Oakland Neighborhood Commercial Plan: The neighborhood of Oakland developed a curbside management plan after conducting a land use survey related to parking use and locations. The plan includes eliminating some metered parking and replacing them with rideshare and small delivery vehicle Pick up / Drop Off (PUDO) zones. It also plans to implement time restrictions to encourage off-peak (5 am-8 am) delivery times. During peak hours, delivery vehicles are directed to park a block down from buildings with high parking demand in other designated commercial spots. Delivery vehicles are restricted from parking outside of designated PUDO zones. The number of zones created and their pricing will be determined by street-by-street demand context.

Takeaways and lessons learned

The Oakland Plan was completed in mid-2022 and has yet to implement or present findings on most of its strategies. However, Pittsburgh has modeled its policies after plans in Seattle and Gilbert, Arizona,

⁴⁶ City of San Jose, Downtown Transportation Plan: Unlock the Value of Mobility for All, November 2022. <https://www.sanjoseca.gov/home/showpublisheddocument/90615/638040466452470000>. Accessed June 2023.

⁴⁷ CBS Pittsburgh, New Study Says Pittsburgh Traffic Ranks Among Worst in Nation, February 2019.

<https://www.cbsnews.com/pittsburgh/news/new-study-says-pittsburgh-traffic-ranks-among-worst-in-nation/>. Accessed June 2023.

that have identified a higher demand for commercial parking on congested city-center streets than the demand for private vehicle parking. The Oakland neighborhood has emphasized the need to increase the flexibility of their curb space to accommodate the parking demand of a university campus and commercial area at the same time. Therefore, Oakland plans to use a multi-pronged and street-by-street approach to adjust parking prices, time limits, and the number of spaces.

Resources and references

- The Oakland Plan, City of Pittsburgh⁴⁸
- Pittsburgh Advanced Transportation and Congestion Management Technologies (ATCMTD) Grant Announcement⁴⁹

g) *Bellevue, Washington*

Background and context

Bellevue is a city in the eastside region of King County, Washington, located across Lake Washington from Seattle. The city has been recently going through a rapid transformation. Bellevue's population grew by 10% between 2017 and 2022; many technology companies are opening offices in its downtown core; its public transit network is about to expand with the opening of new light rail stations connecting the city with the Seattle light rail network. The downtown core includes a total of 104,487 linear feet of curb supply, of which 60% is dedicated to travel lane only (no parking allowed), 7.4% to time-limited parking, and 3% for general loading/unloading (including commercial vehicles loading/unloading, bus and other vehicles passenger pick-up and drop-off).

Priorities and objectives

The City of Bellevue set itself to innovate its curbside management practices to accommodate future changes in curb demand, transitioning from the use of the curb for single-vehicle occupancy to increasing access for transit, office shuttles, delivery services, and active transportation.

Initiatives and findings

Curbside inventory program: In 2019, the City began creating a curbside inventory of the downtown core, recording curb allocation and regulations in digital format. The inventory was completed in June 2020.

Curbside Technology Assessment Pilot: In 2019, the City received a Transportation for America (T4A) grant to conduct a curb pilot program. The goal of the pilot was to test the accuracy of video-based curbside monitoring technology solutions and identify a scalable system that could detect high-volume curb areas accurately for future enforcement and payment. Five technology vendors were selected, each deployed its technology and shared data with the City, and its performance was evaluated.

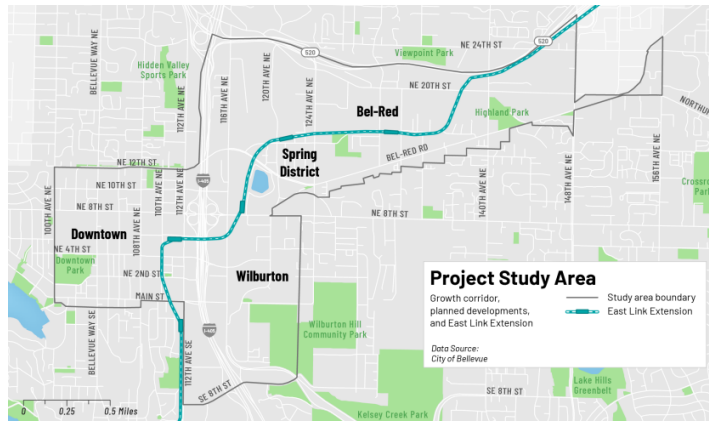
New Curb Management Plan: The drafting of the new curb management plan started with several initiatives to engage not only local community groups but also curb management experts through a

48 The City of Pittsburgh, The Oakland Plan: Mobility, March 2022. <https://engage.pittsburghpa.gov/oakland/oakland-mobility>. Accessed June 2023.

49 Nancy Singer, USDOT Announces \$10.8 Million Grant for SmartPGH in Pittsburgh, US Department of Transportation, October 2016. <https://highways.dot.gov/newsroom/usdot-announces-108-million-grant-smartpgh-pittsburgh>. Accessed June 2023.

series of public meetings. The plan created a framework defining four main curb functions: movement, access, place, and storage. Then, it identified 28 different curb practices recommendations, with 10 having higher priorities, including collecting and analyzing curb activity data, updating paid parking, on-street dining, and curbside vendor programs, and adding more resources for curbside enforcement.

Figure 19: Curbside Management Plan Study Area



Source: City of Bellevue, 2023⁵⁰

Takeaways and lessons learned

The City of Bellevue took a multi-strategy holistic approach to modernize its curb planning and practices. Over the past few years, the City initiated and completed several programs to map its curb, study its uses by testing video monitoring technology solutions, and created a new curb management plan to prioritize future pilots and strategies.

Resources and references

- The City of Bellevue New Curb Management Plan⁵¹
- Curbside Technology Performance Assessment Report⁵²

h) Edmonton, Alberta, Canada

Background and context

Edmonton has a population of 1.1 million and is among the least dense cities examined in this review. The city’s population has increased significantly in the last 10 years, challenging the city to identify the right amount of parking without exceeding what is necessary. In contrast with other major cities, Edmonton has no discernable relationship between land use/neighborhood context and the number of parking spaces provided and utilized. In 2020, the city eliminated parking minimums established in 1970 and developed a curbside management strategy in tandem with the city’s comprehensive plan.

⁵⁰ City of Bellevue, Curb Management Plan, 2023. https://bellevuewa.gov/sites/default/files/media/pdf_document/2023/Bellevue%20Curb%20Management%20Plan.pdf. Accessed June 2023.

⁵¹ City of Bellevue, Curb Management Plan, April 2023. https://bellevuewa.gov/sites/default/files/media/pdf_document/2023/Bellevue_CMP.pdf. Accessed June 2023.

⁵² City of Bellevue, Curbside Technology Performance Assessment Report, February 2022. https://bellevuewa.gov/sites/default/files/media/pdf_document/2022/curbside-management-pilot-assessment-report-020722_2.pdf. Accessed June 2023.

Priorities and objectives

Outdated parking minimum policies and an increasingly sprawled city have made the management of excess parking a priority for the city of Edmonton. The city's curbside management plan emphasizes the need to increase efficiency and reduce the footprint of public parking facilities, reducing and repurposing existing parking infrastructure. With the recent elimination of parking minimums, the city is working to reallocate on-street spaces to other modes of urban mobility, opening up commercial parking availability based on demand by street block, and minimizing spillover or excess where parking maximums do not exist.

Initiatives and findings

Curbside Management Plan and Designated CVLZs: Edmonton has a comprehensive plan with a curbside management strategy component outlining immediate, 2-year, and 5-year goals for opening curb space to zero and low-emission vehicles, bicycles, and commercial vehicles. The city has thus far implemented a wide network of commercial loading zones in congested areas.

Takeaways and lessons learned

The city's curbside management strategy was approved in August 2022. The document has detailed strategies concerning dynamic pricing, reallocation of spaces, and policy changes for higher-density neighborhoods. This document provides the city with a guide for parking reform under the recent elimination of parking minimums and increased flexibility for parking repurposing or elimination. The majority of programs and strategies listed in the document have yet to be implemented, though the CVLZ strategy has created 13 new zones for permitted vehicles and revealed that increased monthly rates and shorter time limits increase vehicle turnover in congested areas.

Resources and references

- Edmonton Curbside Management Strategy⁵³
- Edmonton Open Option Parking Policy⁵⁴

i) [Kansas City, Missouri](#)

Background and context

The Kansas City metropolitan area has a population of 2.3 million people and is the least dense city referenced in this review. Kansas City faces curbside management issues in a variety of areas, including outside their most dense districts. In addition to historical parking shortages in historical areas and the metro center, the city is experiencing rapid densification of suburban areas that have slowed the flow of traffic through suburban downtowns.

Priorities and objectives

In Kansas City's 2020 Curbside Management Plan, the city emphasized three principles to guide any curbside management strategies: (a) re-organizing the relocation of spaces while maintaining supply,

53 City of Edmonton, Curbside Management Strategy, 2022. <https://www.edmonton.ca/sites/default/files/public-files/Curbside-Management-Strategy.pdf?cb=1679936835>. Accessed June 2023.

54 City of Edmonton, Parking Rules for New Homes and Businesses, June 2020. https://www.edmonton.ca/city_government/urban_planning_and_design/comprehensive-parking-review?utm_source=virtualaddress&utm_campaign=makingspace. Accessed June 2023.

(b) narrowing spaces where possible, and (c) increasing flexibility in who can use each space at different times of the day. The city's surplus of free parking in some areas has also made metered parking and PUDO zone conversion a priority for the city. As the city's public transport network is sparse and there is a surplus of non-commercial parking, Kansas City has less concern for accommodating personal and public vehicles in on-street spaces and can free a significant amount of space for freight traffic.

Initiatives and findings

Overland Park, KS Parking Plan: The Kansas City suburb is looking to manage its downtown parking and rush hour traffic by offering financial incentives to private parking lot/garage owners to make their properties public during peak hours. In sharing private parking lots and garages, Overland Park hopes to increase parking supply while still minimizing the land and development necessary to accommodate the high parking demand.

Wayfinding methods and signage will be added to ensure that any garage or lot spaces that often go unused are filled on a regular basis. By increasing usage of off-street parking facilities near the downtown strip, Overland Park hopes to facilitate a "park once and walk" environment that encourages pedestrian traffic over searching for parking on the downtown strip. The plan also includes PUDO zones in and around the city's downtown strip, minimizing long-term parking along active roadways and increasing curbside parking supply on less congested streets in the downtown area. Tiered timing in public curb spaces near these PUDO zones would also create different time regulations based on customer versus employee parking patterns and avoid priced parking on the downtown strip.

Crossroads District Parking Study: The City's art district faces challenges with non-commercial loading/unloading for art galleries and high pedestrian traffic. The study suggested consolidating the existing private loading areas or lots into shared parking, extending the parking supply for commercial vehicles.

Midtown Complete Streets Plan: Kansas City is focusing on its widest and busiest streets in midtown as part of its curbside management plan and complete street efforts. The plan highlights the importance of trying creative solutions to integrate curb access for freight in complete streets. problematic, other strategies exist to address freight delivery issues.

Takeaways and lessons learned

After the implementation of the 2020 Curbside Management Plan, both Kansas City, Missouri, and surrounding suburbs have found that varying parking standards by neighborhood are essential to provide an ideal supply range and maximize flexibility for private parking providers. In Overland Park, the utilization of shared commercial and public spaces is at nearly 100% during peak hours and has reduced the distance from parking to delivery destinations to a ¼ mile or less. Though the Midtown and Crossroads district studies identified fewer action items, both codified better roadway access for multi-modal uses and pedestrians, while not disrupting existing commercial parking access. The studies also allowed for an increase in 15-minute, non-commercial loading zones that allow for increased turnover in central Kansas City and maintain 3-hour loading/unloading times for commercial vehicles.

Resources and references

- Kansas City Area Curbside Management Plan⁵⁵

⁵⁵ Mid-America Regional Council, Kansas City Area Curbside Management Resource and Guide, November 2020. <https://www.marc.org/sites/default/files/2022-06/curbside-management-resource-guide.pdf>. Accessed June 2023.

- Overland Park Parking Standards Update⁵⁶
- Overland Park Downtown Parking Plan⁵⁷

B. Conclusions on Curbside Management Best Practices

A review of the municipal curbside management policies and programs sheds light on important considerations for cities to consider when developing new policies or programs.



Holistic Approach

Successful curbside management requires a holistic approach, considering various stakeholders and multiple planning tools. Bellevue’s multi-strategy approach is a good example, where they mapped curb usage and tested monitoring technology solutions to inform the development of a new curb management plan. This detailed plan contains a Curb Practices Guide, a curb typology framework, and a curb pricing framework and identifies six pilot projects to test and refine the potential curb management practices.



Importance of Data

Data are crucial in effective curbside management programs. Several cities, including Seattle, New York, and more recently Minneapolis, have created and continued maintaining updated curb allocation datasets, mapping different typologies for curb allocations and their respective regulations, often making this data layer available through open-data portals and public APIs. However, fewer cities have established programs to monitor curb use, therefore not only recording where certain curb zones are but also documenting how different curb zones are used. Bellevue ran a pilot program aimed at testing different video technologies for curb-use monitoring. Curb use data not only inform cities on curb demand but also enable several policies, such as pricing and enforcement. Oakland’s smart loading zone permit program relies on GPS data to bill vehicle owners based on their parking duration.



Collaboration and Engagement

Businesses and residents are the final users of the public right-of-way. Therefore, establishing public-private partnerships and community involvement can foster innovation, facilitate the execution of pilot programs, and inform cities about the effectiveness of different curb management strategies. For instance, Santa Monica’s Zero Emission Delivery Zone was a result of a partnership between LA Cleantech Incubator and the City. The program incentivized the use of clean and electric delivery vehicles and tested the efficacy of such an approach. Bellevue’s strategy in drafting its new curb management plan also highlighted the importance of involving the local community and curb management experts in the decision-making process. During the development of regional and local transportation plans, from street/corridor level plans to city/county/MPO-level plans, incorporating the engagement with local businesses and freight delivery companies can also bring a localized understanding of the unique challenges businesses face.



Role and Risks of Technology

Technology plays a critical role in modern curbside management. From video-based curbside monitoring in Bellevue to in-ground sensors in Seattle, and automated license plate recognition devices in Washington DC, technology has been instrumental in monitoring and regulating

⁵⁶ City of Overland Park, Overland Park Parking Standards Update & Community Parking Strategy, September 2021. <https://www2.opkansas.org/files/dw/api/Docs/11527>. Accessed June 2023.

⁵⁷ City of Overland Park, Downtown Parking Plan, January 2014. <https://www2.opkansas.org/City-Government/Agendas-and-Minutes/Committee-of-the-Whole/Agendas/2014/2014-05-05/INF-1.pdf>. Accessed May 2023

curb use. While technological innovations can provide solutions, cities must also be mindful of the potential risks and challenges related to data sharing, privacy, and dependence on private operators.



Value of Pilot Programs and Evaluations

Pilot programs can serve not only as practical testing grounds for new initiatives and technologies but also as a means to collaborate with private stakeholders in the curb management process. The findings can guide the expansion or modification of the program. In addition, when implementing new technologies or strategies, a rigorous evaluation process is crucial. Bellevue's curbside technology assessment pilot tested the accuracy and scalability of different technology solutions, which is a crucial step before widespread implementation.



Incentives and Policy Alignment

Incentives can play a key role in encouraging specific behaviors. Santa Monica's initiative of offering priority curb space to zero-emission vehicles illustrates the potential of such incentives. Furthermore, ensuring alignment between various policies and objectives is also crucial, as seen in Edmonton's initiative to revise parking policies to better align with curbside management goals.



Flexibility and Adaptability

Cities have shown that flexibility and adaptability are keys to curbside management. Curbside management strategies that are more suitable in dense/urban settings may include:

- Demand-responsive pricing: In high-demand areas, dynamic pricing for curb space can help balance supply and demand, encouraging turnover and reducing cruising for parking. Prices can be adjusted based on the time of day, day of the week, or occupancy rates.
- Multi-modal loading zones: In dense urban environments with diverse transportation needs, flexible loading zones can accommodate different vehicle types – from delivery trucks to passenger vehicles to ride-hails.
- Time-restricted loading/unloading: To manage peak demand, cities can implement time restrictions for loading/unloading. For example, they could prohibit or limit curbside loading during rush hour in congested areas.
- Delivery hubs: For densely populated urban areas, creating designated delivery hubs can consolidate delivery activity, reducing congestion and emissions from freight traffic.
- Curbside management strategies that are more suitable in less dense/suburban settings may include:
 - Shared parking districts: Shared parking strategies can maximize the use of available parking resources in suburban areas. Underutilized parking spaces, such as those at offices, churches, or schools, can be shared with nearby businesses or residences.
 - Flexible parking regulations: Due to less demand pressure, suburban areas can afford more flexibility in parking regulations, such as longer parking durations or lower fees.

These key takeaways underline the importance of a comprehensive and innovative approach, and the need for Met Council and its local jurisdictions to continuously update their curbside management policies and strategies based on data and evolving circumstances.

II. Last-Mile Delivery Technologies

KEY TAKEAWAY

- Technologies like electric delivery vehicles and cargo e-bikes are relatively mature. More nascent technologies such as air-based drones, sidewalk delivery robots, and autonomous delivery vans are in the early stages of development, undergoing pilot testing or prototyping, and facing regulatory and infrastructural challenges.
- Technologies such as e-carts, cargo e-bikes, e-scooters, and sidewalk delivery robots are more suited to urban settings due to higher demand density and shorter delivery distances. Technologies like autonomous delivery vans and electric delivery vehicles could be more appropriate for suburban and rural settings. Air-based drones have the potential for both, depending on regulatory acceptance and infrastructure.
- Lessons learned from last-mile delivery technology pilots include familiarizing community members with the technology, continuous monitoring and evaluation, and partner selection.

A. Introduction

There has been significant development in last-mile delivery technologies in recent years. This chapter provides a summary of research findings on these new or emerging technologies, with a special focus on the impact on reducing VMT and overall emission of CO2 and other greenhouse gases as well as the extent to which the benefits of these technologies vary in different urban settings (e.g., urban centers versus suburban or exurban communities). Figure 20 provides an overview of the last-mile delivery technologies reviewed.

Figure 20: Overview of Last-Mile Delivery Technologies Reviewed

Category	Description	Examples
Micro freight	A general term referring to “micro-mobility for freight”. Small, low-emission, and space-efficient mode of transporting goods, including vehicles and non-vehicles (e.g., bikes)	<ul style="list-style-type: none"> E-walkers Cargo e-bikes E-scooters
Driverless vehicles	Last-mile delivery technologies that use driverless vehicles	<ul style="list-style-type: none"> Unmanned aerial vehicles: air-based drones Unmanned road vehicles: autonomous vehicles, sidewalk delivery robots
Alternative fuel vehicles	Vehicles that use alternative fuel for last-mile delivery purposes	<ul style="list-style-type: none"> Electric vehicles (EV) Hydrogen fuel cell electric vehicles

Source: CPCS and Dr. Giacomo Dalla Chiara, 2023

As listed in Figure 20, an introduction to the key features of each technology is given, followed by a discussion on technological maturity, potential impacts on VMT and GHG emission reduction, and key concerns for wide adoption. A few adoption examples and resources are also provided for technology for additional information.

Element	Description
Key features	Key features of the delivery technology, including operational efficiency and geographic suitability
Technology maturity and prerequisites	Technology maturity as of today and prerequisites for adoption including infrastructure and regulatory changes needed.
Potential Impacts and key concerns	Potential impacts to VMT reduction, safety, etc., and key concerns from existing adoptions
Adoption examples and resources	Links to adoption examples and additional resources

Source: CPCS and Dr. Giacomo Dalla Chiara, 2023

B. Review of Delivery Technologies

1. Micro freight

a) E-Carts

Key features

E-carts (also called e-walkers) refer to technology supporting on-foot-porters (delivery workers performing last-mile delivery routes entirely on foot) in urban areas with high-drop densities. This technology often takes the form of a four-wheeled electric-assist delivery cart/trolley that assists a delivery porter in walking and carrying goods. The maximum payload is typically around 440 lb. with the container at 110 lb.

Figure 21: A UPS E-Walker



Source: Fernhay,2023⁵⁸

Technology maturity and prerequisites

While the technology for e-carts is not new and several companies are producing e-carts, their adoption is still in its early stage. In particular, delivery carriers are still learning from pilot projects and how to include e-carts within their existing operations.

Potential impacts and key concerns

- **Agile last-mile delivery solution:** E-carts empower porters to transport larger loads over extended distances and through narrow spaces. Some e-carts can go through a standard-sized door.
- **Minimum driver requirements:** Unlike traditional delivery vehicles, they do not need specialized drivers (e.g., do not require a driver's license).

⁵⁸ E-Walker Sustainable Last Mile Delivery Access in Pedestrian Shared Spaces. FH Fernhay. <https://fernhay.com/ewalker/>, accessed June 2023

- **Pedestrian friendly:** Unlike sidewalk robots or other land-based drones (see Figure 25 for more detail), pedestrians can easily see over and maneuver around e-carts in busy city streets.
- **Zero emissions:** By mitigating the necessity for parking, e-carts contribute to the reduction of associated externalities such as emissions and congestion.
- **Infrastructure requirement:** Their effective deployment requires strategic infrastructure, including a depot near delivery customers—often in the form of a logistical microhub. Furthermore, their operation heavily relies on the availability of well-developed pedestrian infrastructure, comprising elements such as expansive sidewalks, ramps, and elevators

Adoption examples and resources

Several companies are producing and piloting e-carts:

- UPS piloting e-walkers in Europe⁵⁹
- Brightdrop is a branch of GM producing electric vans and e-carts⁶⁰
- FedEx uses electric vehicles to deploy e-carts and couriers in small neighborhood routes⁶¹

b) *Cargo E-Bikes* Key features

Cargo e-bikes are two, three- or four-wheel cycles with a cargo compartment and/or with an attached cargo trailer, often partially propelled via electricity, used to perform deliveries in urban areas. Cargo e-bikes with larger compartments can carry up to 400 lbs of cargo. The UPS cargo bike pilot in Seattle revealed that cargo e-bikes on average deliver 20 to 24 percent of the number of packages delivered by a truck during a single tour but have a lower failed delivery rate and quicker delivery routes.

Figure 22: Cargo E-Bike Delivery Pilot Test in Seattle



Source: Washington State Transportation Center, 2020⁶²

Technology maturity and prerequisites

Cargo e-bikes have been around for more than 50 years though fleet adoption has grown significantly in the last ten years. Cargo e-bikes have also increased exponentially in battery range and capacity. Dedicated lanes in dense geographies could help with safety and navigation concerns. They could also be accompanied by urban fulfillment/consolidation centers to facilitate the deliveries.

⁵⁹Walther Ploos van Amstel. UPS and Dublin innovate to reinvent sustainable last mile deliveries. City Logistics. July 16, 2020. <http://www.citylogistics.info/business/ups-and-dublin-innovate-to-reinvent-sustainable-last-mile-deliveries/>. Accessed June 2023.

⁶⁰BrightDrop Trace Move. <https://www.gobrightdrop.com/products/brightdrop-trace-move>. Accessed June 2023.

⁶¹Frank Holland, FedEx is testing electric carts for last-mile delivery in big U.S. and Canadian cities, CNBC, March 2022, <https://www.cnbc.com/2022/03/25/fedex-tests-electric-carts-for-last-mile-delivery-in-us-and-canadian-cities.html>. Accessed June 2023

⁶²Washington State Transportation Center. Cargo E-Bike Delivery Pilot Test in Seattle. September 2020. <http://depts.washington.edu/trac/research-news/freight/cargo-e-bike-delivery-pilot-test-in-seattle/>. Accessed June 2023

Potential impacts and key concerns

- **Efficient and sustainable:** Cargo e-bikes are flexible in the use of the urban infrastructure in urban areas, such as travel lanes, sidewalks (although it is not desirable due to safety concerns), and bike lanes. This makes them more resilient to road traffic congestion and lack of available parking.
- **Widely tested:** While not all delivery trips can be converted into cargo e-bikes, they have been used in many markets and contexts, from parcel delivery to grocery, food trucks, and landscape maintenance.
- **Infrastructure requirement:** Compared to delivery vans, the spatial range that they can cover is limited. Consequently, they need to access goods storage closer to where the deliveries are taking place.
- **Driver requirement:** Since they are also relatively new, many carriers that start using cargo bikes are facing labor issues, as drivers are more exposed to the weather and require more physical activity to operate them.

Adoption examples and resources

Cities in North America have seen a rise in the use of cargo e-bikes.

- New York City started an e-cargo bike pilot program after Whole Foods started delivering all their groceries in Manhattan using cargo e-bikes⁶³.
- B-line⁶⁴ operation in Portland (OR)
- Cornucopia Logistics⁶⁵ operation in NYC
- UPS ran several cargo bike pilots across the United States and in Europe (see for instance the UPS cargo bike pilot in Seattle⁶⁶)
- Denver residents can save up to \$500 on the sale of an e-cargo bike⁶⁷
- The Colorado Energy Office's eCargo Bike Commercial Delivery Pilot Program encourages disbursing eCargo bikes to low-income individuals that participate in the gig economy, where eCargo bikes are used to make deliveries through a delivery app service (e.g. Door Dash, Postmates, Instacart, etc)⁶⁸
- The Minnesota State Legislature recently passed an e-bike purchase credit of up to \$1,500.

63 Winnie Hu, Park It, Trucks: Here Come New York's Cargo Bike, New York Times, December 2019.

<https://www.nytimes.com/2019/12/04/nyregion/nyc-cargo-bikes-delivery.html>. Accessed June 2023.

64 B-Line Urban Delivery, Last-mile logistics, distribution and warehousing reimagined, N.D.. <https://b-linepdx.com/>. Accessed June 2023.

65 Cornucopia Logistics, Our Company, N.D.. <https://www.cornucopialogistics.com/>. Accessed June 2023.

66 University of Washington Urban Freight Lab, Cargo E-Bike Delivery Pilot Test in Seattle, 2020.

<https://depts.washington.edu/sctlctr/research/publications/cargo-e-bike-delivery-pilot-test-seattle>. Accessed June 2023.

67 City of Denver. Electric Bikes (E-Bikes). <https://denver.prelive.opencities.com/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Climate-Action-Sustainability-Resiliency/Sustainable-Transportation/Electric-Bikes-E-Bikes-Rebates#:~:text=Standard%20Rebate%3A%20As%20a%20Denver,of%20an%20e%2Dcargo%20bike>. Accessed June 2023.

68 Colorado Energy Office, eCargo Bike Commercial Delivery Pilot Program, <https://energyoffice.colorado.gov/ecargobike-pilot>, accessed September 2023.

c) *E-scooters*

Key features

E-scooters are electric scooters sometimes with small, attached compartments for one or two deliveries. The cargo platform out front typically loads up to 50 lb. The average distance of delivery is estimated to be 0.8 miles, mainly serving dense urban areas for food deliveries.

Figure 23: A Cargo E-Scooter



Source: ebiketips, 2022⁶⁹

Technology maturity and prerequisites

E-scooters have existed for over 30 years, though speed and battery life have improved significantly in the last 20 years. As a result, adoption for delivery purposes is growing more common in recent years. As with cargo bikes, dedicated lanes would improve efficiency and safety as would the incorporation of more urban fulfillment or consolidation centers.

Potential Impacts and key concerns

- **Safety concerns:** In the absence of dedicated lanes, e-scooters can pose safety concerns for both the scooter operators and vehicle drivers. Delivery drivers have found that a scooter with a range of less than 40 mile-per-hour is not an ideal choice for the type of short and quick deliveries needed.
- **Reliance on labor:** On the economic front, e-scooters present notable reductions in fuel and operational costs, although labor remains a significant expense.
- **Restricted capacity:** A limiting factor for this delivery method is the restricted capacity, allowing only a few deliveries per route, which in turn increases the frequency of returns to the fulfillment center. This creates additional logistics considerations and can potentially offset some of the economic and environmental benefits.

Adoption examples and resources

Though couriers have long used e-scooters without a cargo compartment for delivery, e-scooters with an attached compartment are new and emerging:

⁶⁹ Alex Bowden, Cargo e-scooter for delivery workers launched by New York micromobility subscription service, ebiketips, Sep 2022. <https://ebiketips.road.cc/content/news/cargo-e-scooter-for-delivery-workers-launched-by-new-york-micromobility-subscription>. Accessed June 2023.

- Beyond Cargo One is targeting operations in New York City⁷⁰
- University of Minnesota Facilities Management Department uses e-scooters with trailers during event setups

2. Driverless Vehicles

a) Air-based Drones

Key features

Air-based Drones are small, automated aerial vehicles that can avoid on-land obstacles to make short-distance (often singular) deliveries of smaller goods, regularly returning to the distribution hub. With a potential payload of up to 33 lbs., air-based drones can reach remote or difficult-to-access areas, bypassing traffic congestion and offering a significant advantage in urgent delivery situations, such as healthcare supplies.⁷¹⁻⁷²

Technology maturity and prerequisites

This technology has been used commercially since 2013 while permits application have tripled since 2016. According to the FAA, all drones that weigh more than 0.55 lbs. (250 g) and less than 55 lbs. (25 kg) must be registered⁷³. However, there are currently no standardized safety protocols, privacy regulations, or official guidelines for drone operation in urban areas and near-restricted zones in the US.

Figure 24: An Air-Based Cargo Drone



Source: Unmanned Airspace, 2019⁷⁴

Potential Impacts and key concerns

- **Potential for reducing VMT:** Drone technology for last-mile delivery has matured significantly. It does not interfere with on-road delivery traffic and can reduce vehicle trips needed for smaller goods and save fuel and labor costs.

⁷⁰ Alex Bowden, Cargo e-scooter for delivery workers launched by New York micromobility subscription service, ebiketips, Sep 2022. <https://ebiketips.road.cc/content/news/cargo-e-scooter-for-delivery-workers-launched-by-new-york-micromobility-subscription>. Accessed June 2023.

⁷¹ Eskandaripour, Hossein, and Enkhsaikhan Boldsaikhan. "Last-Mile Drone Delivery: Past, Present, and Future." *Drones* 7, no. 2 (2023): 77.

⁷² Miguel Figliozzi. Modeling the Sustainability of Small Unmanned Aerial Vehicles Technologies. Freight Mobility Research Institute College of Engineering & Computer Science, Florida Atlantic University, December 2018.

⁷³ What are the drone laws in the USA? Drones under 250 grams. April 2, 2022. <https://www.dronesunder250g.com/drones-under-250-grams/what-are-the-drone-laws-in-the-usa/>. Accessed June 2023.

⁷⁴ Drone delivery operations underway in 27 countries. Unmanned Airspace. April 7, 2019. <https://www.unmannedairspace.info/latest-news-and-information/drone-delivery-operations-underway-in-26-countries/>. Accessed June 2023.

- **Challenges for widespread adoption:** Key constraints include safety, noise pollution, privacy, and the environmental impact of producing and disposing of drone batteries. There are also concerns over dropping parcels or crashing in residential areas. Furthermore, ensuring secure delivery to inaccessible locations like apartments or locked mailboxes is another challenge that needs to be addressed.

Adoption examples and resources

- Amazon has started to deliver orders by drones in California and Texas⁷⁵
- Meituan flies drones between skyscrapers to kiosks around the City of Shen Zhen, China⁷⁶
- Drone delivery operations are underway in 27 countries⁷⁷

b) *Sidewalk Delivery Robots*

Key features

Also known as autonomous delivery robots (ADRs) or personal delivery devices (PDDs), sidewalk delivery robots are small, automated vehicles that can use sidewalks and roadways to make short-distance deliveries of smaller goods, regularly returning to the distribution hub. The storage capacity is around 1.5 cubic feet, or about two paper grocery bags, and can drive at a speed of approximately 3-6 miles/hr on sidewalks.⁷⁸

Figure 25: A Sidewalk Delivery Robot



Source: Tech Crunch, 2023⁷⁹

Technology maturity and prerequisites

These land-based drones have been used since 2014. Almost all have HD cameras, GPS, and object avoidance through ultrasound or lidar.

Infrastructure/condition requirements for robot operation include continuous, smoothly paved, and unobstructed sidewalks with sufficient width and pedestrian crossings that have sufficient time phased

75 Sheena Vasani. Amazon's started to deliver orders by drones in California and Texas. The Verge. December 2022. <https://www.theverge.com/2022/12/28/23529705/amazon-drone-delivery-prime-air-california-texas>. Accessed June 2023

76 Zeyi Yang. Food delivery by drone is just part of daily life in Shenzhen. MIT Technology Review. May 23, 2023. <https://www.technologyreview.com/2023/05/23/1073500/drone-food-delivery-shenzhen-meituan/>. Accessed June 2023.

77 Drone delivery operations underway in 27 countries. Unmanned Airspace. April 7, 2019. <https://www.unmannedairspace.info/latest-news-and-information/drone-delivery-operations-underway-in-26-countries/>. Accessed June 2023.

78 Pani, Agnivesh, Sabya Mishra, Mihalios Golias, and Miguel Figliozzi. "Evaluating public acceptance of autonomous delivery robots during COVID-19 pandemic." Transportation research part D: transport and environment 89 (2020): 102600.

79 Rebecca Bellan. Uber and Cartken are bringing sidewalk delivery robots to Virginia. Tech Crunch. April 20, 2023.

[https://techcrunch.com/2023/04/20/uber-and-cartken-are-bringing-sidewalk-delivery-robots-to-virginia/#:~:text=Uber%20did%20not%20specify%20what%20the%20delivery%20radius,identify%20objects%20and%20help%20them%20reach%20their%20destination](https://techcrunch.com/2023/04/20/uber-and-cartken-are-bringing-sidewalk-delivery-robots-to-virginia/#:~:text=Uber%20did%20not%20specify%20what%20the%20delivery%20radius,identify%20objects%20and%20help%20them%20reach%20their%20destination.). Accessed June 2023.

for crossing the intersection and do not require pushing a crosswalk button, among others.⁸⁰ This makes college campuses or commercial shopping and dining centers the ideal locations for operation.

Potential Impacts and key concerns

- **Potential for reducing VMT and emission:** Can replace trucks or personal vehicles to deliver short-distanced goods such as meals, and can reduce fuel, labor, and operating costs as a result.
- **Safety and accessibility concerns:** Sidewalk delivery robots can pose a tripping hazard for pedestrians with low mobility and or vision, as well as seniors and children.
- **Not yet ready for widespread use:** The limited storage capacity and delivery range of 1-1.5 miles for sidewalk robots limit the potential customer base.
- **Privacy and vandalism/theft concerns:** Sidewalk delivery robots can also be struck by vehicles on the road or be vandalized or stolen.

Adoption examples and resources

- Kiwibot's sidewalk delivery robots test operation in Santa Monica⁸¹, Pittsburgh, Miami-Dade County, Detroit, and San Jose in partnership with the Knight Autonomous Vehicle (AV) Initiative⁸²
- Uber and Cartken are bringing sidewalk delivery robots to Virginia⁸³
- Los Angeles looks to regulate the delivery of drones and devices through permit requirements⁸⁴

c) *Autonomous Delivery Vans*

Key features

Autonomous delivery vans are larger autonomous vehicles capable of transporting multiple deliveries in one trip. These vans can operate autonomously on public roads, navigating traffic and obeying road rules. They are equipped with sensors, lidar, and computer systems for navigation and may have a human safety driver for backup. They are bigger in cargo capacity (up to 500 pounds) when compared with sidewalk delivery robots and are built for on-road delivery.

80 Amanda Howell, Becky Steckler, Nico Larco, Urbanism Next Center, Knight Foundation, Piloting Sidewalk Delivery Robots in Pittsburgh, Miami-Dade county, Detroit, and San Jose, 2022, https://global-uploads.webflow.com/5d9f83b8b237fa6c07d5d69d/6310e6536ecf171b2d44871b_Knight%20AV%20Initiative%20PDD%20Report%20Final_Aug%202022.pdf. Accessed June 2023.

81 Ben Bergman. Delivery Robots Come to Santa Monica. Dot.LA. March 2021. <https://dot.la/delivery-robot-2651302336.html>. Accessed June 2023.

82 Amanda Howell, Becky Steckler, Nico Larco, Urbanism Next Center, Knight Foundation, Piloting Sidewalk Delivery Robots in Pittsburgh, Miami-Dade county, Detroit, and San Jose, 2022, https://global-uploads.webflow.com/5d9f83b8b237fa6c07d5d69d/6310e6536ecf171b2d44871b_Knight%20AV%20Initiative%20PDD%20Report%20Final_Aug%202022.pdf. Accessed June 2023.

83 Rebecca Bellan. Uber and Cartken are bringing sidewalk delivery robots to Virginia. Tech Crunch. April 20, 2023. [https://techcrunch.com/2023/04/20/uber-and-cartken-are-bringing-sidewalk-delivery-robots-to-virginia/#:~:text=Uber%20did%20not%20specify%20what%20the%20delivery%20radius,identify%20objects%20and%20help%20them%20reach%20their%20destination](https://techcrunch.com/2023/04/20/uber-and-cartken-are-bringing-sidewalk-delivery-robots-to-virginia/#:~:text=Uber%20did%20not%20specify%20what%20the%20delivery%20radius,identify%20objects%20and%20help%20them%20reach%20their%20destination.). Accessed June 2023.

84 Jamie Paige. Los Angeles looks to regulate delivery drones and devices. Santa Monica Daily Press. December 1, 2022. <https://smdp.com/2022/12/01/los-angeles-looks-to-regulate-delivery-drones-and-devices/>. Accessed June 2023.

Figure 26: An Autonomous Delivery Van



Source: Insider, 2019⁸⁵

Technology maturity and prerequisites

Driverless vehicles are the least commonly used among the technologies listed as most are still in the prototyping and safety testing phase. Larger company fleets have been used since 2019. For use outside of the pilot phase, a legal and liability framework must exist that accounts for potential damage to infrastructure or danger to pedestrians. While not required for implementation, dedicated corridors or lanes along major freight routes could reduce the congestion and safety concerns faced by these vehicles.

Potential Impacts and key concerns

- **Pedestrian and infrastructure security and safety concerns:** The technology has generated concerns over sidewalk, pedestrian, and road infrastructure safety due to computer programming errors, unauthorized use, and unpredicted obstacles. However, driverless vehicles could also improve safety by reducing crashes due to driver error and slower human reaction times.
- **Reduced fuel and operation costs:** While the reduction in VMT is not easily predicted, optimized routing and reduced driver navigational errors could potentially reduce costs for fuel and failed deliveries. Driverless vehicles also eliminate labor costs apart from vehicle maintenance.

Adoption examples and resources

- Domino's Pizza partners with Nuro to operate driverless vehicles in select cities⁸⁶
- Walmart's partner with Udelv for online grocery delivery⁸⁷

⁸⁵ Dennis Green. Walmart is launching its 3rd online grocery test with a self-driving car in just 6 months. Insider. Jan 8, 2019. <https://www.businessinsider.com/walmart-launching-autonomous-car-pilot-with-udelv-2019-1> Accessed June 2023.

⁸⁶ Kim Lyons, Nuro's self-driving robot will deliver Domino's pizza orders to customers in Houston, The Verge, March 2021. <https://www.theverge.com/2021/4/12/22379853/nuro-self-driving-robot-delivery-dominos-pizza-houston>. Accessed June 2023

⁸⁷ Dennis Green. Walmart is launching its 3rd online grocery test with a self-driving car in just 6 months. Insider. Jan 8, 2019. <https://www.businessinsider.com/walmart-launching-autonomous-car-pilot-with-udelv-2019-1>. Accessed June 2023.

3. Alternative Fuel Vehicles

a) Electric Delivery Vehicles

Key features

Electric delivery vehicles run partially or entirely on a battery and produce no tailpipe emissions. All-electric vehicles can typically go between 110 and over 300 miles on a single charge.⁸⁸ The length of charge for electric vehicles varies depending on the type of charger used. With a Level 2 charger, typically available in residential homes with a 7kW to 19kW power output, charging an electric truck can take 5 to 10 hours, while a rapid charger can charge 80% in around 45 minutes.⁸⁹

Technology maturity and prerequisites

Although electric vehicle (EV) models have been mass-produced since 2000, there has been a notable surge in EV adoption by companies. Key e-commerce parcel carriers are moving swiftly to electrify their fleet. For example, by 2025, 50% of FedEx Express committed to have global parcel pickup and delivery vehicle purchases be electric, rising to 100% of all purchases by 2030 (Figure 29).⁹⁰ US Postal Service also committed to only buying electric delivery vehicles after 2026.⁹¹ Similarly, UPS⁹² and Amazon⁹³ also committed to have more electric delivery vehicles on the road. Expanding the available charging infrastructure along critical freight routes and providing priority parking or reduced parking costs for EVs could further increase fleet adoption.

Figure 27: A FedEx Electric Delivery Van



Source: NPR, 2021⁹⁴

Potential Impacts and key concerns

⁸⁸ Department of Energy. At a Glance: Electric Vehicles. https://afdc.energy.gov/files/u/publication/electric-drive_vehicles.pdf. August 2023. Accessed September 2023.

⁸⁹ Richard Ingram. Driving Electric. Electric van charging guide. Jan 5, 2022. <https://www.drivingelectric.com/your-questions-answered/135/electric-van-charging-guide>. Accessed September 2023.

⁹⁰ FedEx Commits to Carbon-Neutral Operations by 2040. <https://newsroom.fedex.com/newsroom/asia-english/sustainability2021#:~:text=By%202040%2C%20the%20entire%20FedEx%20parcel%20pickup%20and,rising%20to%20100%25%20of%20all%20purchases%20by%202030>. March 3, 2021. Accessed September 2023.

⁹¹ Andrei Nedelea. InsideEVs. US Postal Service Says It Will Only Buy Electric Delivery Vehicles After 2026. <https://insideevs.com/news/627727/us-postal-service-announces-fleet-electrification-plan/#:~:text=The%20United%20States%20Postal%20Service%20%28USPS%29%20announced%20yesterday,of%20these%20around%2045%2C000%20vehicles%20will%20be%20fully-electric>. December 21, 2022. Accessed September 2023.

⁹² UPS. Electrifying our future. <https://about.ups.com/us/en/social-impact/environment/sustainable-services/electric-vehicles---about-ups.html>. May 23, 2022. Accessed September 2023.

⁹³ Amazon. Amazon's new electric vans will be making deliveries in over 100 U.S. cities this holiday season. Nov 7, 2022. <https://www.aboutamazon.com/news/transportation/rivian-amazon-van-expands-to-100-us-cities-by-end-of-2022#:~:text=With%20its%20commitment%20to%20have%20all%20100%2C000%20electric,millions%20of%20metric%20tons%20of%20carbon%20per%20year..> Accessed September 2023.

⁹⁴ Camile Domonoske, From Amazon To FedEx, The Delivery Truck Is Going Electric, NPR, March 2021. <https://www.npr.org/2021/03/17/976152350/from-amazon-to-fedex-the-delivery-truck-is-going-electric>. Accessed June 2023.

- **Potential for reducing air pollution:** Electric vans emit no tailpipe pollutants, positioning them as prime solutions for enhancing air quality, particularly in dense urban areas.
- **Lower running and maintenance cost:** The operational cost of electric vans is notably less than their diesel counterparts due to the lower per-mile expense of electricity. With fewer mechanical components and reduced brake wear, maintenance expenditures for electric vehicles are also curtailed.
- **Range anxiety and necessary infrastructure:** The concern of 'range anxiety'—the fear among EV drivers of the battery depleting before reaching a destination or charging station—remains prevalent for many. As battery technology progresses and offers extended ranges, those traveling longer distances may face less downtime. It's worth noting that the Bipartisan Infrastructure Law provides the largest-ever federal investment in EV charging infrastructure to accelerate the transition to electric delivery vehicles.

EV adoption examples and resources

- UPS operates a fleet of 13,000 alternative fuel and electric vehicles across North America⁹⁵
- FedEx advanced fleet electrification in 2022 with 150 electric delivery vehicles from BrightDrop⁹⁶
- Amazon expanded electric vehicle delivery to over 100 cities in 2021⁹⁷
- US Postal Service committed to only buying electric delivery vehicles After 2026⁹⁸

b) *Hydrogen Fuel Cell Electric Vehicles*

Key features

Hydrogen fuel cell electric vehicles use fuel cells to convert hydrogen into electricity to power an electric motor. Fuel cells are three times more efficient than internal combustion engines⁹⁹ and have a high potential to reduce GHGs when compared to other alternative fuel vehicles. Hydrogen-powered vehicles only emit water vapor and hot air. Compared to other electric vehicles, fuel cell EVs generally have a longer range at an average of 300 miles per charge and take less time to refuel (in 3 to 5 minutes).¹⁰⁰

⁹⁵ UPS, Electrifying our Future, May 2022, <https://about.ups.com/us/en/social-impact/environment/sustainable-services/electric-vehicles---about-ups.html>. Accessed June 2023.

⁹⁶ FedEx, FedEx Continues Advancing Fleet Electrification Goals with Latest 150 Electric Vehicle Delivery from BrightDrop, June 2022. <https://newsroom.fedex.com/newsroom/global/fedex-continues-advancing-fleet-electrification-goals-with-latest-150-electric-vehicle-delivery-from-brightdrop>. Accessed June 2023.

⁹⁷ Amazon, Amazon's electric delivery vehicles from Rivian roll out across the U.S., July 2022. <https://www.aboutamazon.com/news/transportation/amazons-electric-delivery-vehicles-from-rivian-roll-out-across-the-u-s>. Accessed June 2023.

⁹⁸ Andrei Nedelea. InsideEVs. US Postal Service Says It Will Only Buy Electric Delivery Vehicles After 2026. [https://insideevs.com/news/627727/us-postal-service-announces-fleet-electrification-plan/#:~:text=The%20United%20States%20Postal%20Service%20%28USPS%29%20announced%20yesterday,of%20these%20around%2045%2C000%20vehicles%20will%20be%20fully-electric](https://insideevs.com/news/627727/us-postal-service-announces-fleet-electrification-plan/#:~:text=The%20United%20States%20Postal%20Service%20%28USPS%29%20announced%20yesterday,of%20these%20around%2045%2C000%20vehicles%20will%20be%20fully-electric.). December 21, 2022. Accessed September 2023.

⁹⁹ Vehicle Technologies Office, Hydrogen's Role in Transportation, US Department of Energy, February 2022. <https://www.energy.gov/eere/vehicles/articles/hydrogens-role-transportation>. Accessed September 2023.

¹⁰⁰ California Air Resource Board. Drive Clean. <https://driveclean.ca.gov/hydrogen-fueling>. Accessed September 2023.

Figure 28: A Daimler GenH2 hydrogen-powered truck



Source: New York Times, 2023¹⁰¹

Technology maturity and prerequisites

Though only 50 US fuel stations provide hydrogen today, plans by carriers and automotive companies to expand the selection of hydrogen-powered vehicles are likely to be accompanied by an increase in availability and affordability of clean hydrogen.¹⁰² At the current hydrogen fuel cell production rate, the Department of Energy anticipates the cost of clean hydrogen to reach \$1/ kilogram (kg) in the next decade. Like EVs, the advancement in distance on a single charge depends on the size of the cell and is highly variable. The availability of charging infrastructure and battery construction materials is crucial to the eventual widespread adoption of this technology.

Potential impacts and key concerns

- **Reduction in noise and air pollution:** Vehicles powered by hydrogen fuel cells are eco-friendly as they emit just heat and vapor. Additionally, the inherent efficiency of fuel cells means fewer moving parts in the vehicle, leading to reduced vibrations and a quieter ride than combustion-engine vehicles.
- **Allows for longer distance travel with less refueling:** Hydrogen fuel cell–powered vehicles travel longer distances using less energy. While a kilogram of hydrogen offers energy equivalence to a gallon of gasoline, fuel-cell electric vehicles can journey about 60 miles on just 1 kg of hydrogen. In contrast, traditional vehicles average a mere 25 miles per gallon of gasoline.¹⁰³
- **Challenges in Infrastructure and Production Costs:** The journey to mainstream adoption of hydrogen-fueled vehicles faces two main challenges: high production costs and insufficient refueling infrastructure. Currently, over 12,000 hydrogen fuel cell–powered vehicles are being used in the US.¹⁰⁴ Yet, the growing interest from several automotive manufacturers and trucking fleets in hydrogen fuel cell technology holds promise. As production costs diminish and economies of scale become a reality, the prevalence of hydrogen-powered commercial vehicles is projected to surge.

Adoption examples and resources

¹⁰¹ Jack Ewing, New York Times, World's Largest Long-Haul Truckmaker Sees Hydrogen-Fueled Future, July 2021. <https://www.nytimes.com/2021/05/23/business/hydrogen-trucks-semis.html>. Accessed September 2023.

¹⁰² Vehicle Technologies Office, Hydrogen's Role in Transportation, US Department of Energy, February 2022. <https://www.energy.gov/eere/vehicles/articles/hydrogens-role-transportation>. Accessed September 2023.

¹⁰³ Vehicle Technologies Office, Hydrogen's Role in Transportation, US Department of Energy, February 2022. <https://www.energy.gov/eere/vehicles/articles/hydrogens-role-transportation>. Accessed September 2023.

¹⁰⁴ Vehicle Technologies Office, Hydrogen's Role in Transportation, US Department of Energy, February 2022. <https://www.energy.gov/eere/vehicles/articles/hydrogens-role-transportation>. Accessed September 2023.

- US Postal Service’s trucking carrier, AJR Trucking, plans to incorporate 50 new hydrogen fuel cell trucks in their California fleet and expand to other states in 2024¹⁰⁵
- Hydrogen-powered Daimler truck passes 1,000 km on a single fill.¹⁰⁶
- The world’s largest long-haul truck manufacturer, Daimler, starts testing for hydrogen-powered 18-wheelers and plan to convert entirely to hydrogen in the next 15 years.¹⁰⁷

C. Conclusions of Last-Mile Delivery Technology Review

Key findings from the review of last-mile delivery technologies are described below.



Some technologies are more mature than others

Technologies like electric delivery vehicles and cargo e-bikes are relatively mature with significant improvements in speed, battery life, and adoption rates over the past decade. More nascent technologies such as air-based drones, sidewalk delivery robots, and autonomous delivery vans are in the early stages of development, undergoing pilot testing or prototyping, and facing regulatory and infrastructural challenges. For example, staff who participated in Kiwibot’s test operation in partnership with the Knight Autonomous Vehicle Initiative concluded that more piloting of sidewalk delivery robots is needed before they are further deployed on city streets. Also, they require a street permit in many municipalities.



Last-mile delivery technologies have implications for land and curb access

Electric delivery vans, in addition to requiring traditional curb access, also necessitate charging infrastructure at least at their origin. Cargo e-bikes and e-scooters rely on well-developed bicycle and pedestrian infrastructure networks, as well as convenient access to the curb and potential package consolidation or pickup stations. The smaller carrying capacity of cargo e-bikes and e-scooters and their shorter operation distance would necessitate more frequent stations or consolidation facilities along urban delivery routes to restock or offload packages. Autonomous delivery vehicles also require curb access and designated loading zones to facilitate their operations effectively.



Alternative fuel vehicles may hold the highest promise for GHG emission reduction

The key advantages of alternative fuel delivery vehicles, particularly hydrogen fueled vehicles, are their potential to yield the biggest reduction in GHG emissions. A comprehensive "well-to-wheels" assessment of global warming emissions reveals that current hydrogen-powered fuel cell electric vehicles, even when deriving their hydrogen from natural gas, achieve a reduction in emissions of over 30% in comparison to traditional gasoline vehicles.¹⁰⁸ In regions like California, where there are stringent requirements for renewable hydrogen, this reduction exceeds 50%. As technologies evolve, it's anticipated that future fuel cell electric vehicles will offer even greater environmental benefits.

¹⁰⁵ Chuck Robinson, USPS, Drayage Carrier Puts in Order for Nikola Hydrogen Fuel Cell Trucks, Landline, May 2023. <https://landline.media/usps-drayage-carrier-puts-in-order-for-nikola-hydrogen-fuel-cell-trucks/>. Accessed June 2023.

¹⁰⁶ John G Smith, Truck News. A Ride Around the Track in Toyota’s Hydrogen Fuel Cell Powered Semi Truck, September 26, 2023. <https://www.trucknews.com/sustainability/hydrogen-powered-daimler-truck-passes-1000-km-on-single-fill/1003178400/>. Accessed September 2023.

¹⁰⁷ Jack Ewing, New York Times, World’s Largest Long-Haul Truckmaker Sees Hydrogen-Fueled Future, July 2021. <https://www.nytimes.com/2021/05/23/business/hydrogen-trucks-semis.html>. Accessed September 2023.

¹⁰⁸ Union of Concerned Scientist. How Clean Are Hydrogen Fuel Cell Electric Vehicle? <https://www.ucsusa.org/sites/default/files/attach/2014/10/How-Clean-Are-Hydrogen-Fuel-Cells-Fact-Sheet.pdf>. 2014. Accessed September 2023.



Suitability for urban vs. suburban settings

Most technologies discussed are more suited to urban settings due to higher demand density and shorter delivery distances. These include e-carts, cargo e-bikes, e-scooters, and sidewalk delivery robots. Technologies like autonomous delivery vans and electric delivery vehicles, given their larger capacities and longer ranges, are well suited to serve suburban and rural communities in addition to serving more densely developed urban areas.

Air-based drones have the potential for both urban and suburban settings, depending on regulatory acceptance and infrastructure. In suburban settings, drones can be highly effective due to the larger distances between homes and businesses and the often more challenging terrain and less dense roadway networks. Suburban areas typically have less air traffic and fewer physical obstructions such as tall buildings, which make navigation easier for drones. By comparison, urban areas present unique challenges but also significant opportunities for drone deliveries. Higher development densities can pose navigational challenges and may increase the risk of accidents like collision with infrastructure or mechanical navigational errors. However, the high demand and frequency of deliveries in high-density urban areas, as well as the potential to bypass heavy traffic congestion, make air-based drones potentially a highly efficient mode for small parcel deliveries.



Lessons learned for piloting new last-mile delivery technologies

Knight Autonomous Vehicle (AV) Initiative's pilot of sidewalk delivery robots in Pittsburgh, Miami-Dade County, Detroit, and San Jose¹⁰⁹ has provided valuable lessons that can be applied to other test operations of last-mile delivery technologies:

- **Engage community members before deploying the technology:** Community involvement and acceptance are crucial for the successful integration of new last-mile delivery technologies. Organizing events, information sharing and demonstration sessions, and public engagement initiatives can help familiarize community members with the technology, address their concerns, and build trust.
- **Start with low-stake deliveries:** Pilot programs should initially start with delivering low-stake delivery items to test the system effectively. Opt-in models, where the recipient isn't reliant on the promptness and success of essential service deliveries, represent a responsible approach to introducing these technologies in their current developmental phase.
- **Choose the right partners:** Collaborating with the appropriate technology providers and local businesses is essential for achieving success in pilot programs. Selecting partners who have expertise in the specific technology being tested and establishing strong partnerships with local businesses that can benefit from the last-mile delivery solution are critical factors for a well-rounded pilot program.
- **Test in controlled environments before large-scale implementation:** If deploying testing pilots, cities benefit from starting from controlled built environment to allow the technology partners to resolve technical issues, like navigating challenging terrains, including wide intersections or poor sidewalk conditions. This also allows for monitoring, evaluation, and the ability to adapt the pilot program based on the insights gained.

109 Amanda Howell, Becky Steckler, Nico Larco, Urbanism Next Center, Knight Foundation, Piloting Sidewalk Delivery Robots in Pittsburgh, Miami-Dade county, Detroit, and San Jose, 2022, https://global-uploads.webflow.com/5d9f83b8b237fa6c07d5d69d/6310e6536ecf171b2d44871b_Knight%20AV%20Initiative%20PDD%20Report%20Final_Aug%202022.pdf. Accessed June 2023.

III. Conclusions and Recommendations

KEY CHAPTER TAKEAWAY

- Curbside management is a means to transform the last mile of freight delivery, and curbside access is a necessity for maintaining a vibrant local economy. New and emerging technologies have the potential to enhance the efficiency of last-mile delivery and help reduce GHGs.
- To inform the Met Council as it updates its transportation and land use-related policy plans, a series of regionally-focused policy recommendations that relate to planning for the curbside and new technologies are proposed.

A. Summary of Findings



Curbside management is a means to transform the last mile of freight delivery

Curbside management has emerged as a transformative approach to improve the last mile of freight delivery, drawing inspiration from its success in managing passenger vehicles. Just as curbside management strategies have been effective in reducing VMT from cars by influencing driver behavior,¹¹⁰ they can also play a crucial role in shaping more efficient and sustainable freight practices. Studies have shown that urban delivery drivers spend a significant amount of time loading and unloading goods and walking to their final delivery destinations. Approximately 80 percent of a driver's time is spent outside the vehicle. Therefore, parking availability is a critical factor for the last-mile leg in the freight logistics chain. Insufficient parking options can lead to detrimental consequences for the efficiency of urban delivery systems and can create negative impacts on road users and residents including air pollution, vehicle emissions, and increased traffic-related crashes. Drivers of delivery vehicles are often forced to park in unauthorized spaces, cruise for parking, reroute their vehicles, or wait for parking to become available. In turn, this results in increased VMT, longer delivery times, and greater GHG emissions.

Recognizing these challenges, cities across North America have implemented curbside management strategies to reduce VMT, enhance efficiency, and promote sustainable practices. With their varying levels of technological maturity and infrastructure requirements, new and emerging technologies also have the potential to further enhance the effectiveness of last-mile delivery. Some examples include incentivizing the use of zero-emission vehicles by providing free, unrestricted, and prioritized access to curbside space for these vehicles while restricting larger polluting freight vehicles during peak hours in dense urban cores.



Curbside access is a necessity for maintaining a vibrant local economy

Curbside access is not only important for optimizing freight operations but also essential for fostering a vibrant local economy. As the demand for curb space by residential and business establishments to receive and/or send their parcels continues to increase, providing adequate curbside access becomes increasingly critical.

110 Ranjbari, A., Luis Machado-León, J., Dalla Chiara, G., MacKenzie, D., & Goodchild, A. (2021). Testing curbside management strategies to mitigate the impacts of ridesourcing services on traffic. *Transportation Research Record*, 2675(2), 219-232.



Ongoing collaboration exists between government and the private sector in pilot demonstrations to test, adopt and deliver new and emerging technologies

Urban parcel delivery companies are actively testing new and emerging technologies for adoption to improve efficiency and reduce operating costs. Cities are also partnering with technology developers through pilot demonstration projects and testing operations to gain first-hand knowledge on the maturity of these technologies and prospects for their adoption, as well as a better understanding of the potential implications for safety, mobility, and regulatory requirements.

B. Recommendations

1. Policy Context

Met Council is in the process of updating its policy plans for transportation and land use planning, in line with the larger process of renewing its regional goals. Discussions with Met Council have revealed that key areas of importance may include equity, safety, climate, natural systems, and the economy. Because this work is currently under development, recommendations are not linked explicitly to the regional planning framework; instead, the anticipated key themes of this framework have been applied to assess the validity and general alignment for the recommendations proposed here.

2. Policy Recommendations for the Region

The following recommendations are for the region as a whole, as related to planning for the curbside and new technology. It is noted that many of the issues and policy tools are in the hands of local municipalities. The recommendations are intended to be broader in nature and encompass a regional focus.

Theme 1: Prepare for the growing demand for e-commerce deliveries



1.1 Promote the establishment of an inventory of curbside uses: Municipalities in the region should be encouraged to inventory their curbside uses, as the first step towards curb policy development. Minneapolis has largely done this already, but it is likely that many other municipalities also have urban corridors or main streets where the curbside is already regulated in some fashion (for example, through signage and/or parking metering). An inventory, at a minimum, includes a digital repository, such as a geocoded shapefile of road segments, that includes information on the nature of any locational rules or restrictions on curbside use. Ideally, municipalities in the region should coordinate to establish such geodatabases according to a standard format.



1.2 Promote data collection and sharing on curb usage: Municipalities in the region should be encouraged to investigate new technologies for the collection of data on curb usage, including by commercial vehicles involved in loading and unloading. This data should capture relevant items such as frequency and duration of use, time of day, and location of use, types of vehicles and activities, and pricing (if applicable). Municipalities should share findings to ensure that local data and trends are available to be harnessed as much as possible.



1.3 Facilitate industry engagement and coordination. Municipalities should be encouraged and supported in gathering industry input to resolve curbside challenges. Key industry stakeholders include urban parcel carriers (including established and emerging delivery companies), freight shippers and receivers (such as businesses and retail stores) and associations representing the trucking and shipping industries. Industry stakeholders are directly affected by curbside issues and often bring a pragmatic, front-line perspective. While industry stakeholders may not agree on all matters (such as on aspects of pricing and permitting issues) at a high-level, industry will

likely have similar goals as planners and policymakers, including ensuring effective and reliable curb space that is well-managed and relatively free of conflicts. Depending on how location-specific the analysis and policy measures are, the level of stakeholder engagement needed to accomplish beneficial outcomes can vary. Met Council could potentially play a coordinating or convening role for this function.



1.4 Prepare organizationally by assigning freight leads. Larger municipalities can designate individuals or teams to be responsible for important freight issues, such as curbside deliveries. Smaller municipalities can ensure that freight planning is noted as an assigned area of responsibility.



1.5 Track key trends and developments over time. Met Council and state and local governments should regularly track e-commerce trends and developments at the regional and local levels. This includes tracking national-level e-commerce trends, staying up to date on the results of studies and programs in other regions, following relevant developments across the region (such as locations of new facilities and curbside pinch points), and tracking changes in curbside use locally. An up-to-date understanding of e-commerce trends and issues is important for maintaining flexibility in a rapidly evolving discipline and for adjusting planning strategies accordingly.

Theme 2: Ensure efficient use of curbside space



2.1 Promote smart prioritization of curbside space. Effective prioritization goes beyond simply developing a one-size-fits-all hierarchy of desired curbside uses. If done well, prioritization brings together a clear grounding in policy priorities on the one hand, and solid information on supply, demand, and usage on the other. Effective prioritization is also tailored to the local context, such as having different typologies for different types of roads and neighborhoods. For example, the Twin Cities can consider the example shown in from the City of Seattle, which differentiates typologies based on land use.

Figure 29: Seattle Curbside Prioritization Framework

	Residential	Commercial & Mixed Use	Industrial
1	Support for Modal Plan Priorities	Support for Modal Plan Priorities	Support for Modal Plan Priorities
2	Access for People	Access for Commerce	Access for Commerce
3	Access for Commerce	Access for People	Access for People
4	Greening	Activation	Storage
5	Storage	Greening	Activation
6	Activation	Storage	Greening

Source: City of Seattle, Flex Zone/Curb Use Priorities in Seattle¹¹¹



2.2 Properly prioritize truck loading and unloading spaces. Freight deliveries, including delivery of e-commerce parcels, are a critical facilitator of local commerce. Trucks deliver food to restaurants, supplies to local shops, and time-sensitive packages to offices and homes. They thereby enable urban corridors, main streets, and other thoroughfares to sustain a vibrant and diverse mix of shops and businesses. Properly allocating sufficient space where loading

¹¹¹ City of Seattle, Flex Zone/Curb Use Priorities in Seattle. <https://www.seattle.gov/transportation/projects-and-programs/programs/parking-program/parking-regulations/flex-zone/curb-use-priorities-in-seattle>. Accessed June 2023.

and unloading activities can take place is particularly important in space-constrained areas where freight receivers do not have dedicated off-road space such as a driveway or loading dock. As an example of a good practice, the City of Seattle has a dedicated curbside management team that employs a checklist of commercial curb access considerations for road reconfiguration or redesign projects. Good solutions can be quite pragmatic and location-specific, taking into account the particular shipping and receiving needs of businesses and the availability of sufficient unloading space at the curbside and in the vicinity (for example, via alleyways).



2.3 Ensure delivery needs are integrated into Complete Streets planning. Complete Streets initiatives seek to prioritize safe access for a variety of different road users, including pedestrians and cyclists. Freight delivery vehicles are often not well considered in such processes and are (implicitly, if not explicitly) deprioritized along with single-occupant vehicles. This can be a significant oversight as freight deliveries are the lifeblood of local commerce and use the curbside in a manner quite different from private automobiles. While there may be a perception that trucks and pedestrians/cyclists are in conflict, wholistic designs that accommodate both are mutually beneficial while suboptimal designs can cause problems for both. Unloading trucks blocking bikes or bus lanes, or trucks having to circle the block to find parking, and trucks crossing bike lanes or crosswalks multiple times can all cause safety issues. Even in cases where there may be tradeoffs between designing for trucks and pedestrians – such as in the case of insufficient turning radii to accommodate truck movements – it pays to plan for truck needs to ensure they are suitably accommodated, if not necessarily prioritized (for example, by setting back the vehicle stopping line from the intersection, to allow more space for trucks to turn). The Complete Streets Considerations for Freight and Emergency Vehicles Guidebook¹¹² developed for the New York State Energy Research and Development Authority is an example of a good practice guide on design, regulatory, and operational strategies to address common challenges that freight delivery drivers face on compact, mixed-use streets.



2.4 Consider opportunities to implement curbside pricing to promote efficient use. Pricing of the curbside can take many forms and can serve different policy objectives such as prioritizing certain uses, generating revenue, or promoting efficient use of space. Promoting efficient use means charging a marginal price that is low enough so that the majority of space is effectively utilized, but high enough so that there is usually some free space available to accommodate variability in demand and avoid overcapacity (e.g., double parking, vehicles circling the block, etc.). For truck deliveries, it is important to consider that 1) these are generally quite efficient uses of the curbside in the duration of their use, as truck drivers seek to deliver as quickly and as safely possible; and 2) the practicality of suitable loading spaces drops substantially as the distance from the receiver increases (for example, a free space blocks away may not be suitable, viable or efficient). In contrast, other uses like parking for cars may not be as efficient, as drivers may occupy the spaces for long periods and may be more open to using alternative parking locations, such as on the next block or in parking garages. Effective pricing can be done on a block-by-block level to target a certain level of utilization. Prices can vary by time of day, day of week, or season. San Francisco and Seattle are two cities that successfully use pricing to achieve a goal of efficient utilization.



2.5 Encourage flexible and creative solutions to facilitate deliveries. Flexible and creative solutions can include time-of-day allocation (for example, allowing different uses at different times of day) and new types of loading zones tailored to emerging uses (such as short-duration zones for pickup of food deliveries or parcels by customers or last-mile delivery companies). Other examples include Kansas City, which in some cases has repurposed the roadway to

112 Alison Conway, et al. New York State Energy Research and Development Authority. Complete Streets Considerations for Freight and Emergency Vehicle Operations. May 2018. https://www.mettrans.org/assets/upload/complete%20streets%20freight%20booklet_v6_hires-0.pdf. Accessed June 2023.

reallocate space from center left turn lanes to delivery space. The demand for curb space is rapidly evolving and good planning accounts for changes in technology.

Theme 3: Promote new technologies to advance e-commerce efficiencies and move toward achieving sustainability goals



3.1 Facilitate private-sector trials and pilot projects. Pilot projects and trials are an important first step to establishing technical, operational, and commercial viability. With respect to new technologies, technology companies may be willing to contribute most or all of the funding for such trials to take place, in exchange for a supportive and facilitative environment provided by the public sector. Such demonstration projects can include the last-mile delivery technologies themselves, as well as data-gathering technologies such as physical, in-street sensors.



3.2 Pursue joint pilot programs with partners. Pilot projects in coordination with public agencies, private stakeholders, and the academic community can be valuable in particular situations where there is a desire to test out a new model or approach that may not yet be widely adopted, or where ownership of the data and process is highly valued. Government grants can also help to facilitate trials and test cases. This type of approach can help to leverage the diverse contributions of multiple, collaborating partners.

3. Reflections

In the past few years, the City of Minneapolis has started several initiatives to update its curb management system for commercial vehicles. It is creating an inventory database for its commercial loading zones, drafting its first plan for managing curb space, and launching a pilot program, funded by a federal Strengthening Mobility and Revolutionizing Transportation (SMART) grant, to digitally record curb space allocation and collect data on how curbs are used.

By creating a map of the existing loading bays, the city can use a more data-driven data approach to placing loading zones in areas where they are needed most. Both New York City and Seattle used to place loading zones based primarily on individual requests but have now switched to this more proactive method.

The issue of how to charge for the use of loading zones is something that Minneapolis and all the other cities are grappling with. Seattle has a system where vehicle owners buy yearly permits to use the loading zones. By comparison, NYC charges on a per-use basis, with loading zones metered in a similar way to passenger parking spaces at curbside pay stations. Once these fee mechanisms are put in place, all cities face challenges in ensuring these charges are paid and that drivers and delivery providers follow the rules.

While Minneapolis is used as an example, other cities in the Twin Cities region may be facing similar issues and challenges to varying degrees. Even in cities that are less densely developed, there are often commercial corridors or main streets that have curbside management issues. Cities that are transitioning to more mixed use and transit-oriented development may also see more competition of the limited curb space, highlighting the importance of considering delivery access during site plans. While the scale of planning and solutions may differ, good curbside management should not be seen as the purview only of larger cities. In fact, smaller cities may have excellent opportunities to pursue pragmatic, locally targeted, and context-specific solutions that focus on key streets or hotspots.

a) *Additional Resources:*

- Transportation Research Board Urban Freight Committee ¹¹³
- The International Parking and Mobility Institute (IPMI) annual conference¹¹⁴
- Urbanism Next annual conference¹¹⁵
- The University of Washington's Urban Freight Lab¹¹⁶
- POLIS: a network of European cities cooperating for innovative transport solutions¹¹⁷
- C40¹¹⁸: a global collaboration network of cities supporting climate action through urban transportation projects

113 Transportation Research Board Urban Freight Committee. <https://urbanfreight.tti.tamu.edu/>. Accessed June 2023.

114 The International Parking and Mobility Institute (IPMI) annual conference. <https://ipmi.parking-mobility.org/2023/>. Accessed June 2023.

115 Urbanism Next annual conference. <https://www.urbanismnext.org/events/2023-urbanism-next-conference>. Accessed June 2023.

116The University of Washington Urban Freight Lab. <https://depts.washington.edu/sctlctr/urban-freight-lab>. Accessed June 2023.

117 POLIS. <https://www.polisnetwork.eu/>. Accessed June 2023.

118 C40. <https://www.c40.org>. Accessed June 2023.



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