City of Seattle - Zero Emission Area Data Collection

Prepared for:
C40 Cities Climate Leadership Group & City of Seattle

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FEHR & PEERS

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Introduction

Transportation is a major contributor to greenhouse gas (GHG) emissions in Seattle. A collaborative effort by several city departments, including the Office of Sustainability and Environment, Seattle City Light, Seattle Department of Transportation, and the Office of Economic Development, calls for immediate action to address GHG emissions via Seattle's Transportation Electrification Blueprint. The blueprint outlines ambitious 2030 policy goals and near-term actions to electrify Seattle's transportation system.

As part of the blueprint's 2030 goals, the City intends to address GHG emissions resulting from the rapid growth in e-commerce and goods movement by ensuring that 30 percent of goods are delivered by a zero emissions trip by 2030—the "30 by 30" goal. This goal aims to spur the transition of private fleets to electric vehicles and support market transformation in freight and goods delivery over the next ten years.[1] The near-term action item is to designate at least one zero emission zone (ZEZ) or zero emission area (ZEA) in Seattle with support from C40 Cities Climate Leadership Group as part of the City's commitment to the C40 Green and Healthy Streets Declaration. Launched in 2017 by twelve C40 cities, the Green and Healthy Streets (GHS) Declaration now commits 35 global signatory cities to ensure a major area of their city is zero emission by 2030. C40 Cities Climate Leadership Group (C40) has a primary objective of positioning cities to tackle climate change and drive urban action that reduces greenhouse gas emissions and climate risks while increasing the health, wellbeing, and economic opportunities of urban citizens.

Key questions posed by the City of Seattle at the onset of the study were:

"What is the scale and type of freight activity within the city, and what would that mean regarding potential strategies and solutions to electrify 30% of freight activity by 2030?"

"What factors would help identify priority locations to implement ZEA/GHS by electrifying freight activity in those areas?"

The City of Seattle, in partnership and with funding from C40, sought to answer these questions by understanding the opportunity and feasibility for achieving the "30 by 30" goal for electrification of the freight sector. More specifically, it was important for Seattle to better understand freight and goods movement to help inform and evaluate potential zero emission areas. The study is meant to provide an assessment of how new data sources and analysis can help advance freight electrification planning not just within the City of Seattle, but for all partner cities in the C40 network. The analysis was conducted by Fehr & Peers on behalf of the City of Seattle, and this report provides a summary of the freight and goods movement data sources, the methodology applied, and key findings.

Similar to Seattle's efforts, the City of Los Angeles is piloting enforced zero emission commercial loading zones in the near-term to address increasing congestion and competing uses for curbsides. These zones are for the exclusive use and access by zero emission commercial delivery vehicles, including light electric

[1] Seattle's Clean Transportation Electrification Blueprint: Electrifying Our Transportation System, 2020

vehicles and e-cargo bikes.[2] Also, the City of Santa Monica partnered with the Los Angeles Cleantech Incubator in deploying a voluntary zero-emission delivery zone (ZEDZ) in the commercial activity core of Santa Monica to improve air quality.[3]

The City of Seattle case study was developed to enable other cities in the C40 Zero Emission Freight network to learn from Seattle's experience. The results of the study were shared with North American city peers at a workshop organized by C40 in June 2021. A synopsis of the "Zero Emission Freight (ZEF) and Zero Emission Delivery Zones (ZEDZs) - North American Cities' Deep Dive" event is provided in this report, which also sets the stage for the next steps in Seattle's planning efforts.

[2] https://clkrep.lacity.org/onlinedocs/2021/21-0147_ord_draft_06-09-21.pdf
[3] Santa Monica Zero Emissions Delivery Zone Pilot, 2020

Data Sources

To fully capture freight and goods movement in Seattle, the project team utilized various data sources, including video data collected along arterials and cordon counts from previous research work completed by the University of Washington (UW) Urban Freight Lab and Seattle Department of Transportation (SDOT). Additionally, the use of "Big Data"[4] informed freight activity at a granular level from location-based services data (LBS)[5] and navigation global positioning services (GPS) data.[6]

Video Count Sources

UW/SDOT Cordon Counts

UW and SDOT collected 24-hour traffic data at several locations in the Greater Downtown Area and Ballard-Interbay Area in 2018, 2019, and 2020 for a comprehensive research study.[7] The collected data include the day of the week, time of day, vehicle body type, vehicle use, and the number of axles. To document different vehicle categories, the UW research team developed a detailed vehicle typology consistent with the Federal Highway Administration (FHWA) and the U.S. Environmental Protection Agency (EPA) vehicle classifications. The typology also differentiates activity types denoting delivery vans, service providers, construction vehicles, delivery trucks, and several others. For this study, the cordon count locations are shown in yellow in **Figure 2**.

IDAX Video Data

To expand the geographic coverage of the UW/SDOT cordon counts, the project team collaborated with a data vendor, IDAX Data Solutions, and collected 12-hour video-based traffic counts at nine locations in West Seattle, Magnolia, and the Greater Downtown Area, as shown in green on **Figure 2**. The Magnolia location was chosen as a representative location because all three entry and exit points to the neighborhood could be captured and therefore, broader citywide trends could be inferred for many other areas of the city with a similar residential and commercial land use mix. The West Seattle locations were also chosen as key gateways into the neighborhood (West Seattle is also has relatively few access points), while the two Greater Downtown locations (in SODO and South Lake Union) were chosen as control locations to compare against the pre-COVID counts conducted by the UW research team. **Figure 1** shows the typology used by the IDAX Data Solutions team to categorize observed traffic.

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[4] "Big Data" are millions of location records created by mobile or GPS devices that can be used to inform vehicle activity.

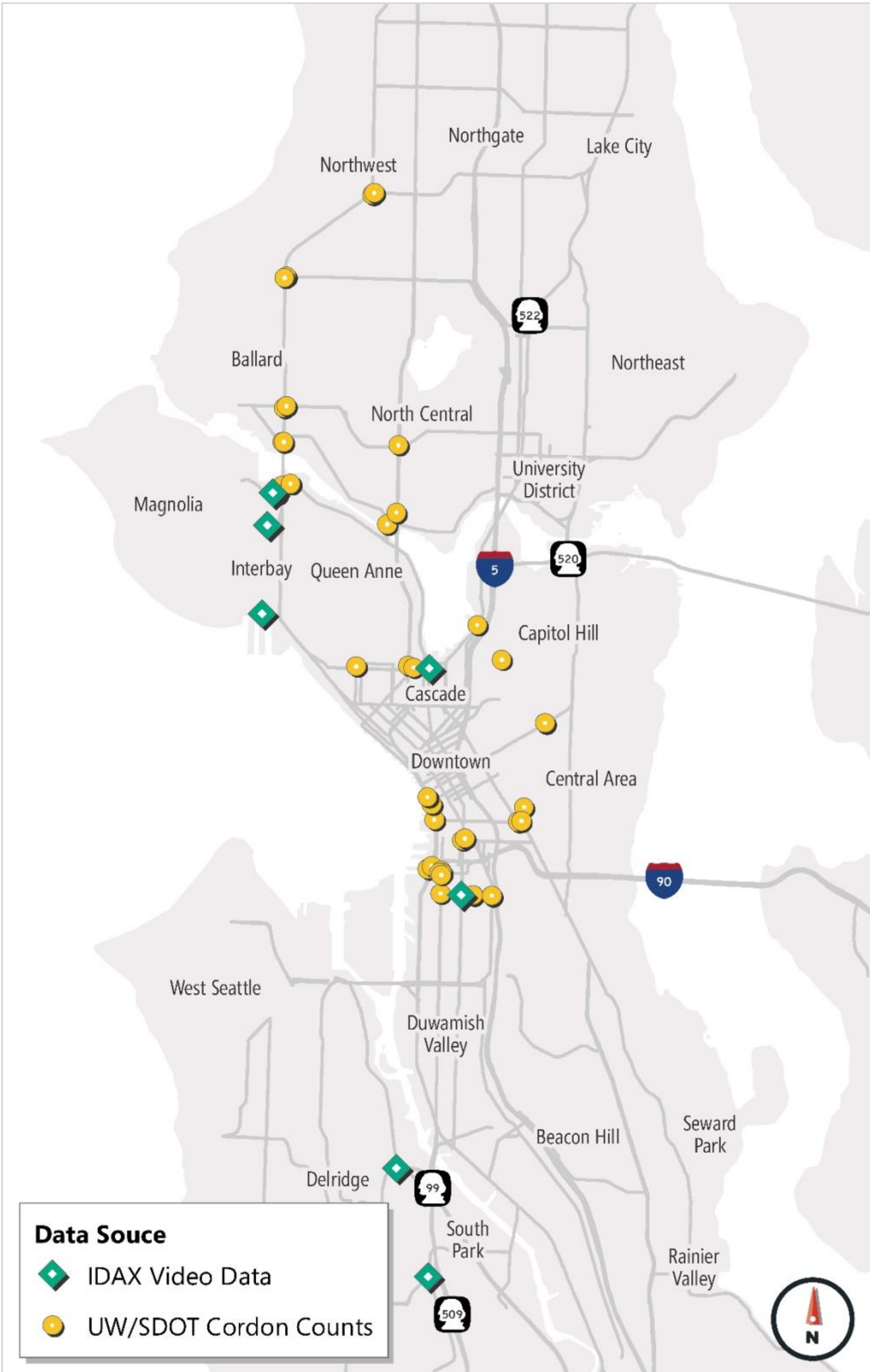
[5] LBS data is data from software services or mobile applications which utilize geographic data and information to provide services or information to users.

[6] GPS data is data obtained from GPS devices installed in vehicles to provide navigational information.

[7] Girón-Valderrama, G., and Goodchild, A. Characterization of Seattle's commercial traffic patterns: A Greater Downtown Area and Ballard/Interbay vehicle count and evaluation. 2021

Figure 1: Vehicle Typology

Figure 2: Study Cordon and Video Counts



"Big Data" Sources

StreetLight Data

StreetLight Data offers several trip-making metrics from LBS and GPS data from anonymized smartphones and navigation devices in vehicles. LBS and GPS data are complementary resources as they provide unique and valuable travel pattern information for transportation planning. The StreetLight Data platform capitalizes on the massive volume of geospatial information across the country and then algorithmically transforms the data points over time into normalized travel patterns.[8] The data represent a sample of the actual on-road traffic, which is validated using numerous traffic counters and sensors to provide origin-destination patterns, trip length, and other metrics. StreetLight Data provides sample trip and travel trends for all vehicles, with a breakdown by medium-duty and heavy-duty trucks, as defined by FHWA. For this study, StreetLight Data provided pre-pandemic (2019) granular data on origin-destination patterns by vehicle type, trip length estimations, and pass-through trips utilizing the zone system presented in **Figure 3**.

UberMedia

Similar to StreetLight Data, UberMedia makes use of LBS data, but makes it available in a more granular form that allows for the evaluation of individual devices.[9] For this study, UberMedia data provided insights on the 'Day in the Life of a Delivery Truck' at three freight hubs in Seattle. The project team used 2019 weekday (Tuesday, Wednesday, Thursday) data focusing on the 7 am to 5 pm window between March and October.

[8] Yang, H., Cetin, M., and Ma, Q. Guidelines for Using StreetLight Data for Planning Tasks. 2020

[9] UberMedia. Understanding Mobile Location Data.

Figure 3: StreetLight Data Zone System for the Seattle Zero Emission Freight Study[10]

[10] The StreetLight Data Zone System was developed using census tracts, aggregating zones from 131 to 38 based on land use assumptions.

Methodology

Understanding freight and goods delivery patterns within a city is challenging. The most readily available information—Freight Analysis Framework (FAF) data from the United States Department of Transportation—is well suited for regional, state, or national analysis.[11] However, the FAF dataset lacks granularity, and the most recent data is from 2017. Private truck fleet data are either incomplete (e.g., they do not cover small parcel deliveries) or prohibitively expensive to obtain. Historically, cities have often relied on freight models to identify truck travel patterns, but again, these data are geared toward large facilities (ports, warehouse districts) and commercial goods movement, not small parcel or residential deliveries. Given these limitations, the project team utilized a unique approach to integrate the different data sources to infer citywide freight activity patterns. While StreetLight Data provided broader vehicle travel trends at a citywide scale, such as truck trip distribution, average trip lengths, and vehicle type, the video counts of the traffic data offered a method to further delineate the StreetLight data trends by separating truck trips by freight and non-freight (e.g., commercial services, municipal) activity types. UberMedia data provided the next level of detail by capturing sample trips originating from key small parcel distribution centers. The process map in **Figure 4** outlines the steps used by the project team to integrate the data sources to understand freight activity in Seattle.

The study was conducted within a short time frame of six weeks; therefore, several data assumptions were made. These assumptions can be further refined in additional studies as noted below:

- The vehicle type and freight activity composition developed for the Magnolia neighborhood was assumed to be representative of other residential neighborhoods in Seattle. This assumption was made because of the relatively limited video count locations, which may bias overall findings of vehicle and activity type assumptions. Adding more count locations may address this limitation, particularly in Northeast, Southeast, and West Seattle.
- All passenger vehicles were counted as private vehicles during the data collection process, regardless of potential commercial purpose. As a result, the potential undercounting of unmarked deliveries in passenger vehicles is unknown at this time. A curbside activity study can potentially shed light on this.
- StreetLight Data portal defines a "trip" once a device has dwelled for at least five minutes at a given location. However, dwell times vary based on various characteristics, including land use. Therefore, StreetLight Data's dwell time assumptions may bias trip count totals toward medium and heavy-duty truck activity since small parcel deliveries from light duty vehicles often take less than five minutes. A potential mitigation strategy would be additional sensitivity tests with the StreetLight data to test different dwell time assumptions.
- The average trip length estimates from StreetLight Data may be biased based on how trips are defined by the data provider. As noted in the previous bullet, this can also be addressed by testing additional assumptions with the StreetLight data.

[11] https://ops.fhwa.dot.gov/freight/freight_analysis/faf/

- Medium-duty and heavy-duty trucks sample counts were extrapolated to total vehicle population estimates, while the StreetLight Data portal provides population estimates for light-duty vehicles. Different assumptions based on updated or more comprehensive vehicle count data may point towards different extrapolation factors.

Figure 4: Methodology Outline

Developing Vehicle Typologies

- Review count data and categorize vehicles based on attributes such as body type, activity type, and the number of axles to identify vehicles typically used for freight and goods movement.
- Freight vehicles considered include light-duty commercial vehicles, medium-duty trucks, heavy-duty trucks.
- Develop vehicle type and freight activity composition profiles from video data for various areas in Seattle including Duwamish Valley, Greater Downtown Area, and Magnolia and apply those estimates citywide.

“Big Data” Analysis and Integration

- Review and post-process 2019 "medium-duty/heavy-duty truck trips" and "all vehicles" data extracted from the StreetLight Data portal.
- Apply the vehicle type and freight activity compositions to the StreetLight data to develop population-level estimates of freight activity.
- Assess metrics (per vehicle type) that inform freight activity in Seattle: trip counts, average trip length, and vehicle miles traveled.

"Day in the Life of a Delivery Truck"

- Focus on the Duwamish Valley freight activity hotspot identified through the StreetLight Data.
- Identify major freight distribution centers in the area: United States Postal Service (USPS), United Postal Service (UPS), and Amazon.
- Utilize UberMedia data to trace typical trip patterns of delivery trucks. Related insights on trip patterns help inform utility infrastructure planning.

Key Findings

Vehicle Composition

While the video counts do not capture all areas of the City of Seattle, the data provided insights into the percent breakdown of vehicle types and activity types, particularly freight-related activities for a representative set of locations. As shown in **Table 1**, over 50 percent of medium-duty trucks were freight-related, while a range of 6 to 23 percent of light-duty commercial vehicles were associated with freight activities. The Duwamish Valley had the highest proportion of freight-related light-duty commercial vehicles (23 percent), which matches expectations as that area has a high proportion of distribution centers for freight and goods delivery, such as UPS, FedEx, USPS, and Amazon. Consistent with previous vehicle counts, the percent of all vehicles that are medium or heavy-duty trucks is relatively low, between one and four percent. Combining all location counts found that an estimated almost 60 percent of freight trips are in medium-duty trucks, while 20 to 25 percent are in light commercial, as shown in **Figure 5**.

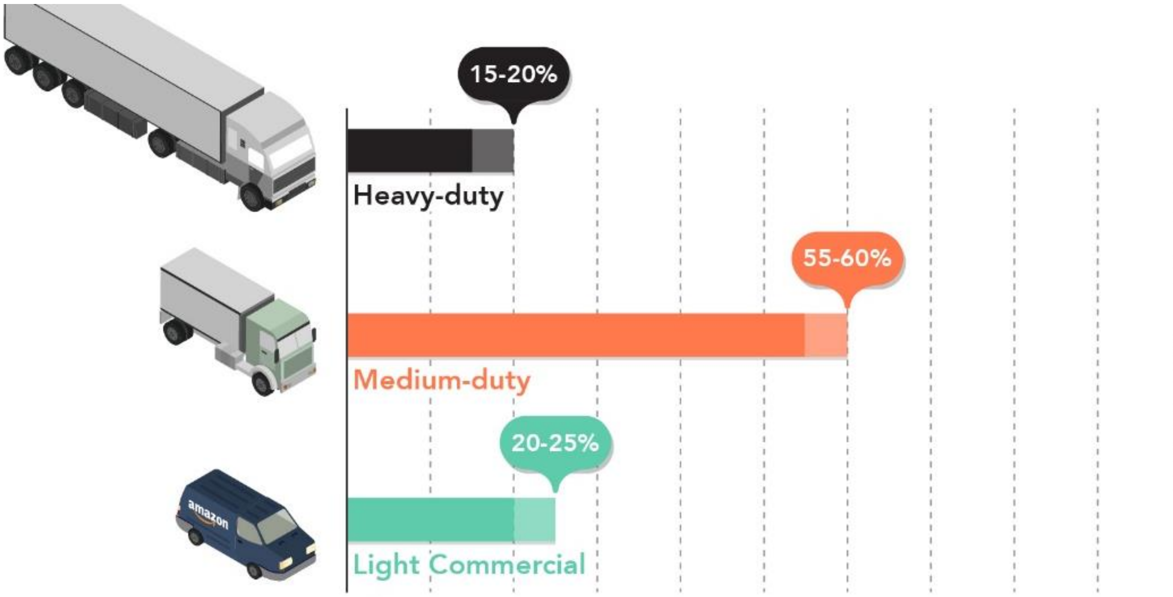
Unrelated to freight activity but important to note, between 30 to 60 percent of light-duty commercial vehicles were identified as service vehicles (work vans, bucket trucks, service provider pick-ups) in the video counts. The share of service vehicles varies depending on land use designation (residential, downtown core, industrial). These types of vehicles are typically used by maintenance or service providers, including electricity, plumbing, internet, telecommunication, catering, gardening, public utilities, and pest control. In other words, while freight makes up a substantial proportion of the light-duty commercial vehicle fleet, there are often more light-duty service vehicles on the road. This class of vehicles therefore contributes substantially to Seattle's transportation GHG emissions and should also be considered as Seattle transitions to a zero emissions future.

Table 1: Vehicle Type and Freight Activity Composition Profiles

Land Use Designation	Vehicle Type Composition (Percent of All Vehicles)			Freight Activity (as a Percent of Vehicle Type)		
	Light-Duty Commercial	Medium-duty Trucks	Heavy-duty Trucks	Light-Duty Commercial	Medium-duty Trucks	Heavy-duty Trucks
Duwamish Valley	6%	4%	2%	23%	56%	78%
Greater Downtown Area	4%	2%	1%	12%	52%	45%
Other Areas in Seattle	3%	2%	1%	6%	46%	47%

Source: Seattle Department of Transportation, University of Washington, IDAX Data Solutions, Fehr & Peers.

Figure 5: Percent of Freight Trips by Vehicle Type



Freight Distribution in Seattle

An analysis of the StreetLight data for intracity and intercity medium-duty and heavy-duty truck trips found that over 60 percent of all truck trips remain within the city limits. While this comparison does not specify whether the trips are for freight and goods movement, it reveals policy implications and strategies that the City may consider in planning for vehicle electrification due to the majority of trips that remain within the City.

While the average trip lengths were generally higher for heavy-duty trucks as compared to medium-duty trucks, the distribution of trip lengths for all truck trips is relatively short as shown in **Figure 6.** Almost 70 percent of medium-duty trips are under 10 miles in length, and only four percent of heavy-duty truck trips that start or end in Seattle are over 100 miles.[12] Additional trip length distributions for representative areas within the city are included in **Appendix C**.

Figure 7 shows the average daily freight trips by vehicle type in various parts of the city. Geographically, there is a relatively higher concentration of freight activity in Duwamish Valley, where most of the city's warehouses, distribution centers, and port activities reside. Notable freight activity is also observed in the Downtown area, likely because of the high density of commercial activity in that part of the city. A review of the average trip lengths indicated higher trip lengths for medium-duty truck trips in the Duwamish Valley compared to citywide estimates.

[12] An important note is the manner in which "trips" are defined by StreetLight Data. A trip is defined once a vehicle dwells for at least five minutes. Therefore, the "tour" length of a vehicle that makes multiple deliveries may in fact be much higher than the individual trip lengths.

Approximately 4,720,000,000 vehicle-miles-traveled (VMT)[13] were reported annually for all vehicles using 2019 StreetLight data, which is relatively comparable to 4,584,796,811, reported in Seattle's 2018 Community Greenhouse Gas Emissions Inventory.[14] Estimates of total VMT generated by freight activity were based upon integration of the vehicle count and StreetLight Data sources. Total VMT generated by freight trips that start or end within the city is approximately three to five percent of all VMT within Seattle. This does not account for pass-through trips via I-5 or other regional facilities that do not stop in the city. In the 2018 Community Greenhouse Gas Emissions Inventory report, almost seven percent of the total annual VMT was reported as freight truck VMT. The discrepancy in VMT generated by freight activity is attributed to the difference in granularity of the data and methodologies used for both studies (2018 VMT estimates were based on the Puget Sound Regional Council (PSRC) model[15], which does not have a clear freight vehicle breakdown to factor in non-freight trucks or light duty freight vehicles such as vans).

[13] Vehicle miles traveled (VMT) is a measure of the amount of vehicle travel in a geographic region over a given period of time, typically a one-year period. It is calculated as the sum of the number of miles traveled by each vehicle.

[14] https://www.seattle.gov/Documents/Departments/OSE/ClimateDocs/2018_GHG_Inventory_Dec2020.pdf

[15] The PSRC Model is a travel demand model system built for the Puget Sound Region to depict diverse human travel behavior and include travel sensitivity to land use and the built environment.

Figure 6: City-wide Average Truck Trip Lengths

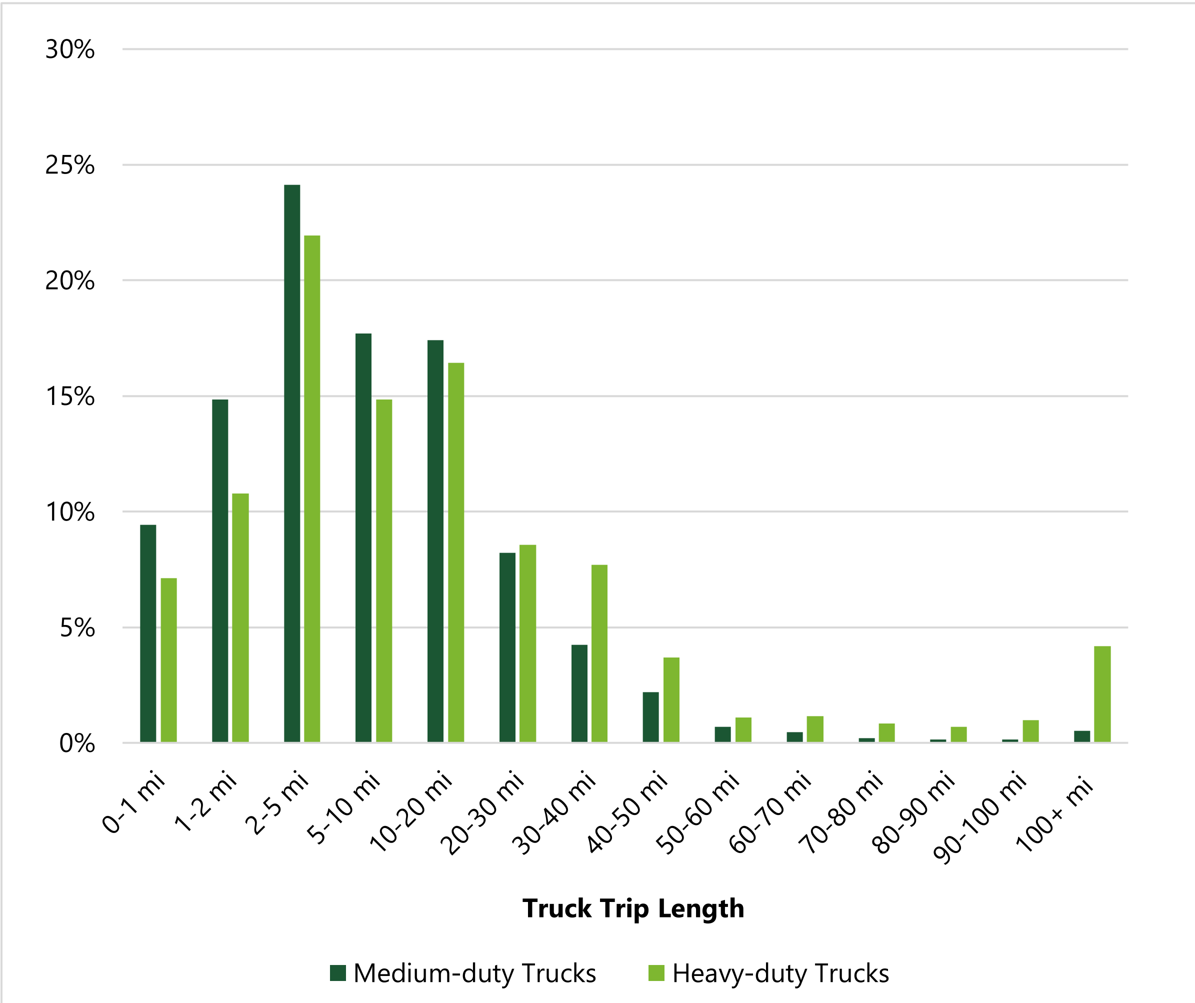
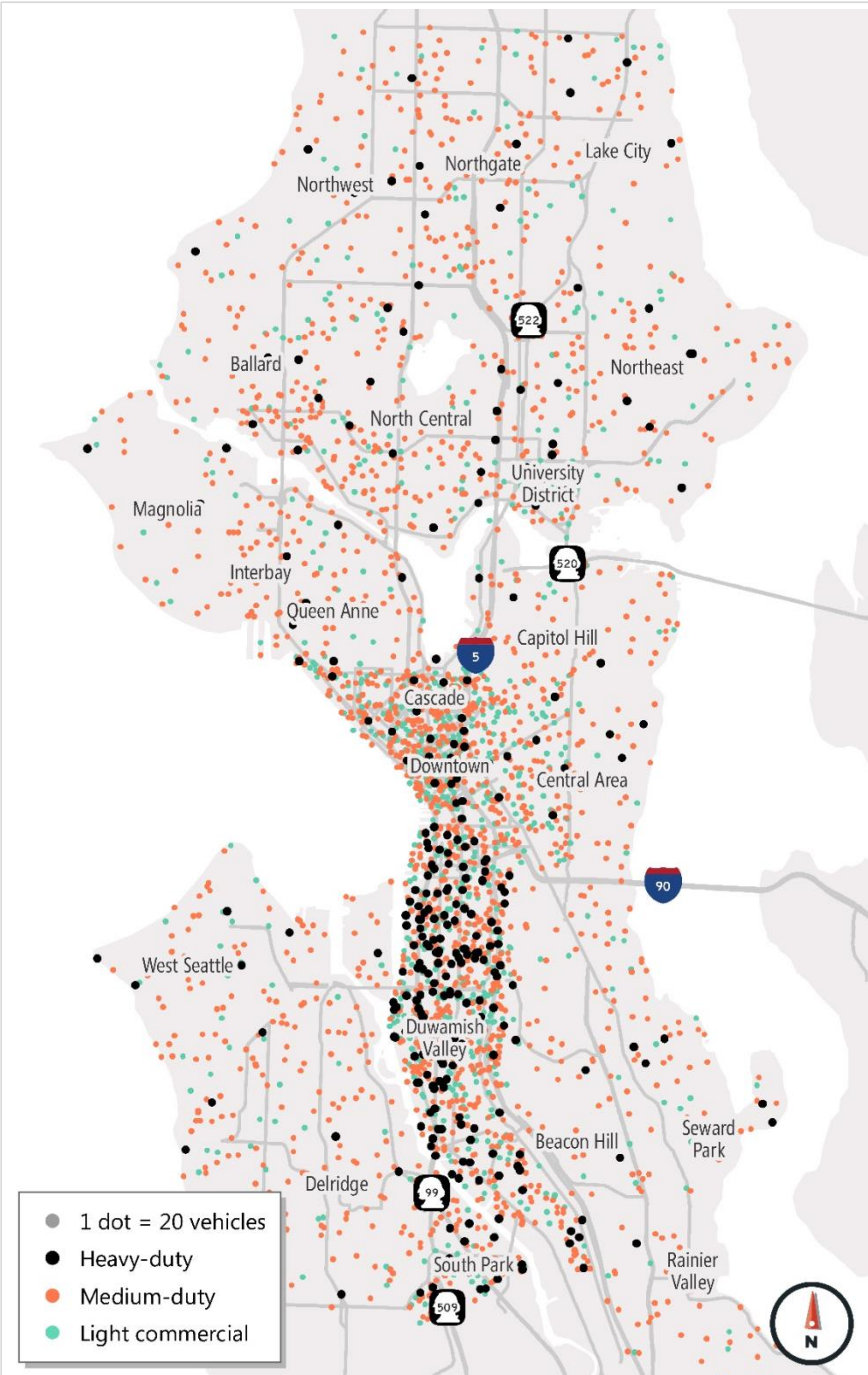


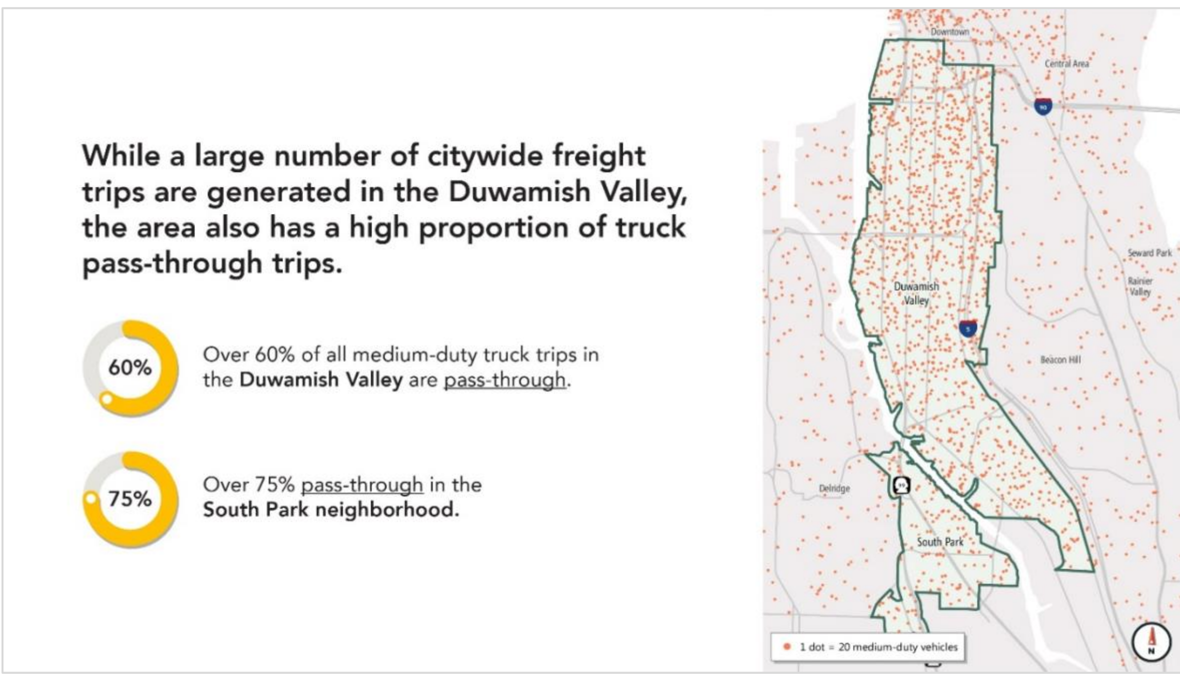
Figure 7: Freight and Goods Movement Distribution in Seattle by Vehicle Type



Freight and Goods Movement in the Duwamish Valley

From a detailed analysis of the StreetLight data, the research team found that over 60 percent of medium-duty trucks in the Duwamish Valley and 75 percent in the South Park neighborhood were pass-through trips, implying that most of the truck trips observed in these areas do not start or end there. **Figure 8** shows a visual depiction of pass-through in the Duwamish Valley zones. It should be noted that the Duwamish Valley zone includes a portion of Interstate 5, thereby capturing various trips passing through the zone via the Interstate. This result was somewhat surprising for the Duwamish Valley zone, considering the relatively short trip lengths for trucks overall and the fact that this zone hosts a large concentration of truck trip generators. Further research is warranted to determine if this is a typical pass-through rate for Seattle, or if this is unique to this part of the city. These high pass-through rates show some of the challenges of identifying a discreet zero emission vehicle zone in Seattle, given the complex nature of truck traffic in the region.

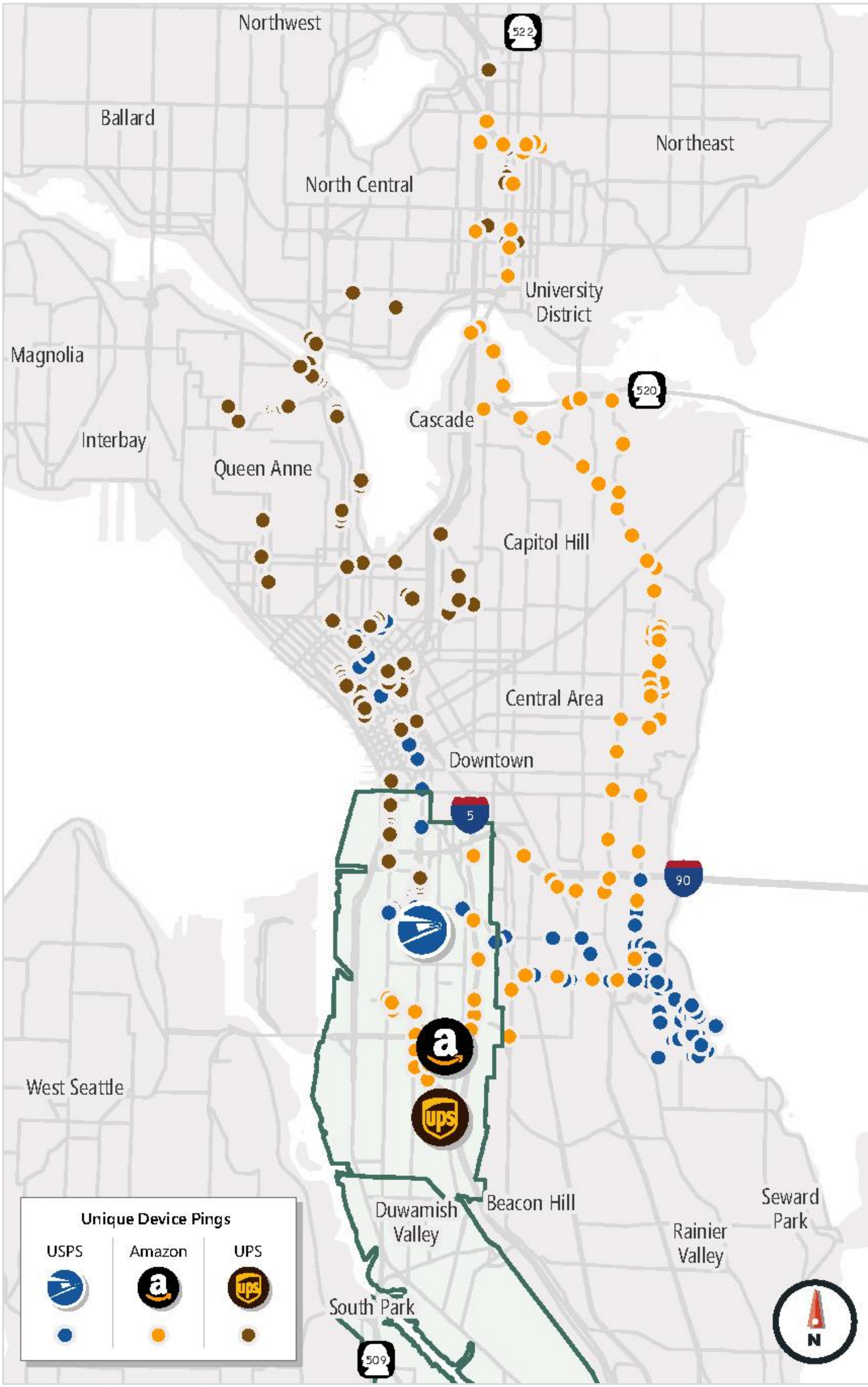
Figure 8: Medium-duty Freight Traffic in the Duwamish Valley



Day in the Life of a Delivery Truck

Analysis of the UberMedia dataset focused on the Duwamish Valley to shed more light on the make-up of freight deliveries and daily travel patterns of delivery trucks. **Figure 9** illustrates what a typical day for a delivery truck from USPS, UPS, and Amazon looks like by focusing on the Seattle locations shown. A review of millions of GPS data points indicated that UPS and USPS have far more unique devices with frequent visits compared to Amazon. Based on the sample data, approximately 220 percent more devices associated with the USPS and UPS facilities had at least five visitation days compared to the Amazon distribution center. This aligns with the varying business structures of the freight companies where USPS and UPS have more permanent employees compared to Amazon. These findings also have implications for how Seattle might want to partner with different delivery companies to electrify their fleets. For example, the more permanent set of employees and vehicles at USPS or UPS could be easier to electrify than a more gig-based workforce at Amazon. Anecdotal findings from **Figure 9** capture different trip patterns for the USPS truck route (connecting three different USPS centers), the Amazon vehicle (larger geographic coverage), and the UPS truck (concentrated in the Downtown area). While the data did not have a full representative sample of trips from these locations, additional analysis combining this dataset with other data sources (land use, census, etc.) may help evaluate different zero emission strategies for freight distribution hubs.

Figure 9: Day in the Life of a Delivery Truck (Amazon, UPS, USPS)



Workshop Synopsis

The Zero Emission Freight (ZEF) and Zero Emission Delivery Zones (ZEDZs) - North American Cities' Deep Dive brought together seven cities, including Los Angeles, Montreal, New York, Portland, Seattle, San Francisco, and Vancouver, to address the following discussion items:

- Transitioning Towards Zero Emission Delivery Zones (ZEDZs) and Data-Driven Zero Emission Freight (ZEF) policy
- Discussion Part 1: What are some of the first steps that cities can take toward implementing ZEDZs (Green & Healthy Streets/ZEAs)?
- Discussion Part 2: What other data and/or data tools are cities using to analyze freight movement and inform policy?

The City of Seattle and Fehr & Peers consulting team presented Seattle's research on Zero Emission Zones, outlining the City's intent to ensure that 30 percent of all goods delivery in Seattle is zero-emission by 2030 and to roll out one or more zero emission areas by the same year. Fehr & Peers shared key findings, data sources, and methodology used to obtain granular freight data in Seattle. The Seattle team concluded the presentation by sharing insights on the recently deployed Seattle Neighborhood delivery hub.

As a follow-up, the City of Los Angeles shared insights on the Department of Transportation's collaborative effort to address increasing congestion and competing uses for curbsides by piloting zero emission delivery zones throughout the City for one year. The test sites for the zero emission delivery curbside zones are currently being selected based on council-approved criteria formulated from data: high demand curbsides, areas burdened by pollution, feasible and not disruptive, and administratively realistic. The City of Los Angeles intends to scale up the curbside management strategy if proven effective.

The City of San Francisco expanded the discussion by sharing freight data collection efforts conducted by the San Francisco Municipal Transportation Agency (SFMTA). SMFTA shared three research and planning efforts: the 2018 Courier Network Services White Paper, 2019-2020 Curb Management Strategy, and 2020 Commercial Loading Corridor Study. SMFTA expressed the various challenges rooted in anti-tech bias that have limited private-public partnerships and funding in freight planning for the city.

As part of a MURAL collaboration activity, the participants noted shared challenges around collecting and analyzing holistic citywide data vs. project-specific data and managing related politics. City staff also highlighted that successful data collection has either been from third-party data sources such as StreetLight Data or private-public partnerships where companies voluntarily offer data. Lastly, the participants noted that data sharing is also in the best interest of freight companies to ascertain better operations within cities. Therefore, there is a need to set standards for data sharing.

Conclusion and Future Research

This data-intensive collaborative effort by C40 Cities Climate Leadership Group, City of Seattle, and Fehr & Peers offered an initial look at how different freight and goods movement data sources and methodologies could inform next steps in planning for the electrification of freight within the City of Seattle. Key findings from this research study include:

- Understanding the scale and geographic spread of freight activity is important before identifying zero emission delivery zones.
- "Big Data" provides new insights into truck patterns with observed vehicle data.
- Medium-duty trucks make up over 50 percent of freight trips in Seattle.
- 40 to 60 percent of light-duty commercial vehicles are service vehicles.
- Freight trips of all vehicle types have relatively short trip lengths.
- A "zero emission delivery zone" could focus on the Duwamish Valley given the density of freight trips that are generated within that zone and because a majority of the trips have relatively short trip lengths.
- There is a need to balance feasibility vs. opportunity for freight electrification because light-duty, medium-duty, and heavy-duty vehicles exhibit different opportunities for conversion and GHG reduction potential.
- Knowledge sharing with peer cities offers a collaborative platform to partner towards similar goals.

Exploring and analyzing the collected counts and "Big Data" sparked several questions beyond the scope of the study which prompted the following future research topics:

- Collect additional video counts to integrate with StreetLight Data to more accurately estimate citywide and neighborhood VMT generated by freight vehicle types.
- Continue additional research on service vehicle profiles and to understand the potential for electrification.
- Apply findings from a residential loading study currently underway with the City of Seattle to understand the percentage of unmarked passenger vehicles making deliveries.
- Expand the analysis of UberMedia data to identify additional travel pattern trends from distribution centers.