2040FREIGHT

FREIGHT GREENHOUSE GAS REDUCTION BEST PRACTICES

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PORTLAND BUREAU OF TRANSPORTATION

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TABLE OF CONTENTS

LIST OF FIGURES

Picture 1.1: Pedestrains crossing a busy intersection in Portland. A white TriMet MAX light rail is in the center of the image. Three TriMet buses are driving to the right of the MAX. Various passanger vehicles are driving to the left of the vehicle. Tree canopys surround tte street, [Source: unknown]

EXECUTIVE SUMMARY

Transportation is the fastest growing sector of greenhouse gas (GHG) emissions[1] and freight is a substantial contributor – compounded further by the COVID-19 pandemic and the subsequent increase in e-commerce sales[2]. In the state of Oregon alone, transportation is the largest single source of GHG emissions, primarily from direct combustion of petroleum products. Approximately 62 percent of the emissions are generated from passenger cars and trucks, while 27 percent are from heavy-duty trucks[3].

The purpose of this white paper is to provide a concise summary of freight GHG reduction best practices. The urgency is in response to the Governor's Executive Order 20-04 directing several state agencies to take immediate actions to address climate change, as well as the City of Portland's climate change goals and commitments, including the recent Climate Emergency Declaration.

This paper is organized into two parts: (1) Sustainable Supply Chain Strategies – encompassing technologies, demand management, and operations, and (2) Benefits and Costs – including performance measures, monitoring and evaluation, and lessons learned.

1 USEPA, 2020. "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2018." EPA 430-R-20-002

2 USDOC, 2020. "U.S. Census Bureau News: Quarterly Retail E-Commerce Sales 3rd Quarter 2020." U.S. Department of Commerce. November, 2020. Accessed on 1/17/21, www.census.gov/retail/.

3 Biennial Energy Report, 2020. "Energy by the Numbers." Oregon Department of Energy. Accessed 1/17/21, www.oregon.gov/energy/

TOP RECOMMENDATIONS

The following is a summary of the top recommendations for reducing GHG emissions from freight. These recommendations are discussed in further detail throughout the report.

- **Technologies**
    - Promote the deployment of near-zero and zero-emission trucks, first for urban deliveries and port drayage trips (where operations are more favorable), and then for regional, and long-haul trips. Near-zero emission trucks include plug-in hybrid electric vehicles (PHEV), natural gas vehicles (NGV), and liquefied petroleum gas (LPG) vehicles. City can promote these technologies by leveraging funding sources for building charging/refueling infrastructure, working with the private sector to disseminate information technology best practices and experience, developing a pilot project to provide targeted financial assistance, and provide incentives and regulatory exceptions where feasible. Alternatively fueled trucks could serve as a pathway towards full electrification. City should consider best practices from neighboring examples, including the Advanced Clean Trucks program, and New York City Clean Truck Program.
    - ncentivize use of fuel saving technologies, such as aerodynamic deflectors and low rolling resistance tires, through knowledge exchange, financial support, and regulations.
    - Promote use of idling reduction technologies, such as Auxiliary Power Units (APUs) and electric and AC hookups, by tightening idling regulations, giving preferential treatment to trucks with these capabilities, and leveraging existing funding sources to expand hook-up technology at truck parking facilities.

- **Management and Operations**
    - Promote off-peak delivery pilots in the central city with interested businesses that will help evaluate the benefits, and build and disseminate knowledge about the right locations and conditions for its successful implementation.
    - Improve the ability of commercial vehicles to find parking, particularly in dense areas, as this avoids commercial vehicles circling/cruising around to find a spot, or parking in a travel lane and causing congestion/safety conflict. This could be achieved through a detailed commercial vehicles parking needs assessment that considers total delivery demand by location and compares it to available curbside delivery zones and off-street truck parking availability. The implementation of a real-time delivery zone reservation system may provide a long-term solution. Additional parking capacity dedicated for commercial vehicle, and the pricing of this capacity, could also help resolve parking availability challenges.
    - Implement a Low Emission Zone (LEZ) in the downtown urban core or pilot a Zero Emissions Delivery Zone (ZEDZ) [4], similar to Santa Clara California. Make voluntary, initially, but provide incentives for sustainable technologies and practices, for example, providing priority curb access. Focus attention and investment in area to demonstrate benefits.
    - Encourage delivery lockers (Parcel Port, Amazon Locker/Hub) and other consolidation solutions, such as microhubs, through new residential/commercial building codes and adjacent to high volume pedestrian locations, such as transit stations.
    - Address land use and regulatory impediments that impede the growth in urban consolidation centers that allow freight to be transferred onto vehicles that are better sized for urban delivery. Incentivize charging and refueling capabilities in urban consolidation centers to enable rapid deployment of near-zero and zero emission trucks in the future.
    - Incentivize, and address regulatory barriers to, the use of cargo bikes in denser urban areas for the first-/last-mile delivery, particularly in dense areas downtown and inner Eastside. Support cargo bike developments with expansion of bike-ped infrastructure.
- **Performance Measures / Monitoring & Evaluation**
    - Improve the existing GHG emissions inventory for the City to estimate emissions from different freight sources, ideally providing a breakdown by mode, type of vehicle (i.e., size, year, fuel type, and technology), and geography. This would facilitate the tracking of progress and identification of reduction opportunities.
    - Adopt performance measures that are tied to a specific goal/target, in order to measure and quantify the effectiveness of the various implementation measures. The metrics should be documented and shared with the public as a way of being transparent with the community being served. Several measures are proposed later this in this report, depending on the types of strategies adopted.
    - Quantifying the benefits can help justify the costs for implementing the GHG reduction strategies, and a robust monitoring & evaluation system can help achieve accountability.

Picture 2.1: *A white and blue freight truck turning on an intersection. Green trees are visible in the background. [Source: PBOT]*

4 https://laincubator.org/zedz/ pilot studies have recently started in several cities in the US such as Santa Monica. Further information is available here: 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

1. INTRODUCTION

This memorandum describes best practices that improve the sustainability of urban freight transportation. These best practices were identified through a review of the literature and relevant examples throughout the world, focusing on North America. Best practices were divided into those relating to the implementation of emerging or existing green technologies, and the implementation of implements to urban freight management and operations (using existing technologies more efficiently). The description of the strategies includes specific recommendations for what the City could do, within their preview, to catalyze or accelerate the implementation of the strategy. This memorandum then describes performance measures that can be used to track progress in reduce emissions and assess the implementation of strategies.

There is no simple, singular, "silver bullet" solution to reducing GHG emissions. Both the public and private sector play a role in achieving a sustainable freight ecosystem. On the one hand, the private sector will continue to seek the most cost-effective solutions, driven by economic efficiencies and customer needs. Private operators and logistic companies often place emphasis on technology and direct supply chain decisions. On the other hand, the public sector can help create the environment for private logistics to capitalize on system efficiencies through a regulatory authority role, and/or an incentive-based policy framework. For example, GHG is a negative externality and cost that is not currently considered in market decisions. In Portland, multiple agencies have a role in regulating and supporting the freight industry. City of Portland Bureau of Transportation (PBOT) and Bureau of Planning and Sustainability (BPS), , Metro Oregon Department of Transportation (ODOT) and other agencies each have slightly different policies that form the framework for the region. The sections below describe some of these previous and ongoing efforts.

1.1 STAKEHOLDER INPUT

The analysis and recommendations contained in this memorandum reflect the input received from two stakeholder meetings. The findings were first presented to the Technical Advisory Committee (TAC) on September 8, 2021 followed by a presentation to the Community Advisory Committee (CAC) on October 14, 2021. These represent opportunities for providing input in the identification of GHG reduction opportunities and discussion of implementation barriers that need to be overcome. The input received was also helpful to prioritize the opportunities.

1.2 PORTLAND BUREAU OF TRANSPORTATION (PBOT)

One of the key goals in the City of Portland's Transportation System Plan (TSP) is that the transportation system is environmentally sustainable. The plan encourages the use of energy efficient and clean commercial vehicles and managing on- and off-street load/unload spaces to minimize pollution and other negative impacts on neighborhoods related to the urban freight movement.

The Central City Sustainable Freight Strategy[5] laid forth the foundation for green policy recommendations based on advice and participation from the community – especially the freight carriers and logistics companies. The following list of actions were recommended for application in Portland:

- Prepare a truck parking and loading plan
- Create a street design guide for freight movement
- Encourage "last mile" solutions, such as unattended delivery depots
- Create freight distribution districts and increase industrial employment opportunities through updated zoning
- Pilot an off-hour delivery program for the central city

5 PBOT, 2012. "City of Portland Central City Sustainable Freight Strategy: Report and Recommendations." Portland Bureau of Transportation (PBOT). October, 2012.

- Explore opportunities for the city to create incentives for electric/hybrid delivery vehicles and charging stations
- Identify opportunities to shift cargo from trucks to rail, barge, and other multimodal freight options.

In 2020 the City of Portland passed a Climate Emergency Declaration that contained the goal of reducing GHG emissions by 50% by 2030, and 100% (net-zero) by 2050.[6] This declaration has brought urgency and attention to this issue, which the City could leverage to implement strategies that improve freight sustainability.

1.3 METRO'S CLIMATE SMART STRATEGY

The Climate Smart Strategy [7] is a set of policies, strategies and near-term actions to help guide how the region moves forward to integrate reducing GHGs with ongoing efforts. This action plan fulfills a 2009 mandate by the Oregon Legislature, requiring Metro to develop and implement a strategy to reduce the region's per capita GHGs from cars and light trucks at least 20 percent by 2035. The short list of actions include: (1) transportation funding, (2) advancements in clean fuels and vehicle technologies, and (3) collaboration to implement transportation projects that combine the most effective GHG reduction strategies. It also includes a toolbox of additional actions, along with a performance monitoring approach

1.4 ODOT'S CLIMATE OFFICE

In March 2020, Governor Brown issued Executive Order 20-04 directing several state agencies, including the Oregon Department of Transportation (ODOT), to take immediate actions to address climate change. ODOT is required to add a GHG reduction lens to project investment decisions and conduct a needs analysis for transportation electrification charging infrastructure. The ODOT Climate Office was formed to help consolidate efforts into a strategic approach to help Oregon achieve a cleaner transportation future[8] . The Office is also charged with helping ODOT prepare for, and respond to, the impacts of extreme weather.

One of the overall objectives of the ODOT Climate Office is to consolidate work and better connect transportation-related climate efforts across the State. There are many laws, directives, orders, and initiatives that include distinctive work items but that relate to other efforts. Staff will also work with other state agencies and local agency partners to find collaborative approaches and solutions, connect with stakeholders, and learn best practices from other states. The Office has five key program areas: (1) Mitigation, (2), Transportation Electrification, (3) Adaptation, (4) Sustainability (such as the Solar Highways Program), and (5) Climate Impact Analysis.

Portland's Sustainable Freight Strategy is connected to the ODOT Climate Office agenda through shared principles, plans, and programs, specifically:

- The three core elements of Portland's Sustainability Strategy, (1) Economy, (2) Environment, and (3) Equity, coincide with the ODOT Climate Office's balanced considerations for equity, safety, and the economy.
- Delivery vehicle electrification. Both the City and State wish to explore opportunities to promote the electrification of light-duty, delivery vehicles, including charging infrastructure. The state (ODOE) has already started tracking this effort via the EV Dashboard, which is built on ODOT's Department of Motor Vehicle (DMV) data.
- The 2050 Statewide Transportation Strategy (STS), a multi-agency transportation GHG reduction roadmap, with key objectives to support the use of cleaner vehicles and fuels, as well as consider GHG emissions in decision-making.
    - With regards to freight, roadmap actions include a truck alternative fuels study, along with an EV charging needs study for all vehicle groups.

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6 https://www.portland.gov/bps/climate-action/climate-emergency/news/2020/7/1/city-council-adopts-climate-emergency

7 https://www.oregonmetro.gov/climate-smart-strategy.

8 https://www.oregonmetro.gov/climate-smart-strategy.

2. PART 1 – SUSTAINABLE URBAN FREIGHT BEST PRACTICES

This section describes best practices for reducing GHG emissions in Portland through sustainable urban freight practices. This section focuses on on-road commercial vehicles (heavy, medium, and light) and urban delivery, although it touches on strategies that could shift freight to more sustainable modes, such as water and rail. The strategies covered in this section are organized into the following two categories: (1) Technologies, and (2) Demand Management and Operations. Recommendations are also provided for how the City of Portland could accelerate the deployment of implementation of these strategies, recognizing the constraints faced.

As shown in **Figure 1**, a variety of strategies exist to reduce emissions at all steps of the delivery chain. Some are implemented at the City-level, and have significant implications on how is moved to, from, or within the city, while others are implemented at the neighborhood and building level.

Figure 1. Examples of Sustainable Supply Chain Strategies Best Practices for Reducing GHG Emissions at Different Stages in the Urban Area

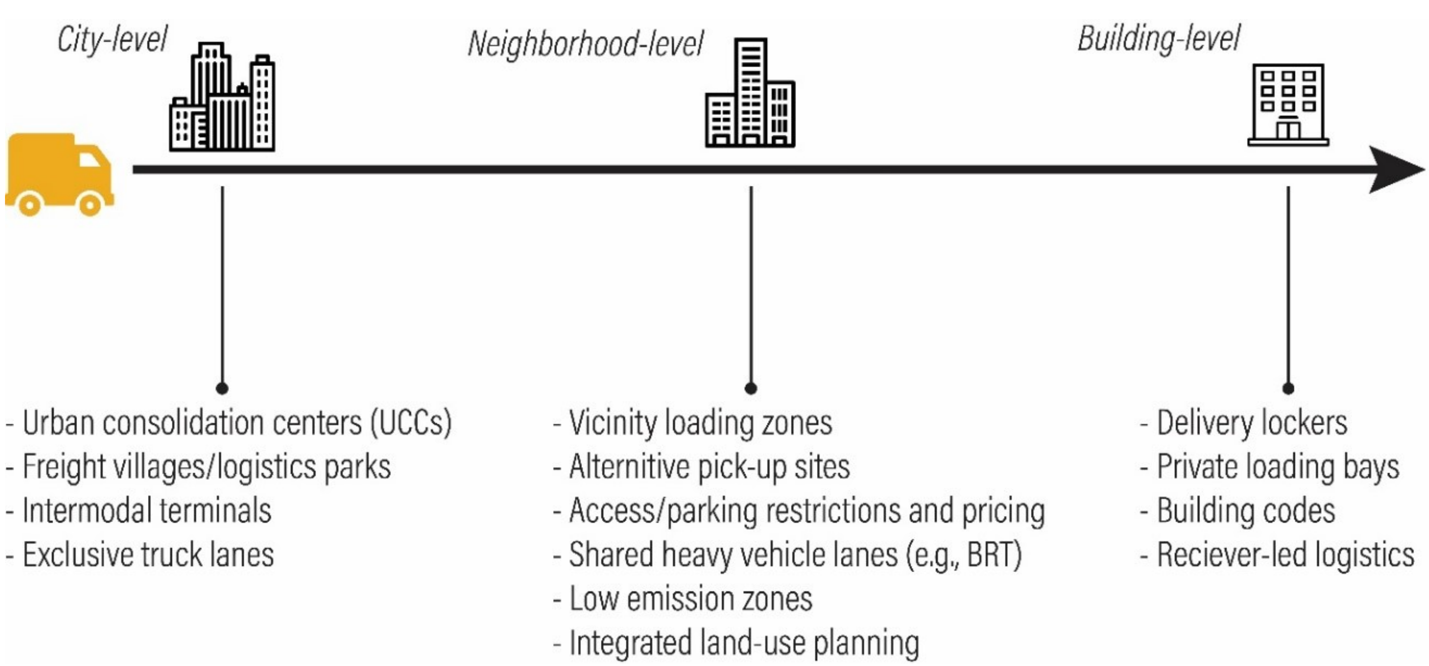


Image source: World Resources Institute, adapted from José Holguín-Veras, 2015 and GIZ, 2013

2.1 TECHNOLOGY

The Technologies category comprises of six elements that aim to reduce GHG emissions across the supply chain through the direct application developed (or developing) technology. They include:

1.Electrification

2.Alternative fuels

3.Fuel saving technologies

4.Idling reduction technologies

5.Smaller size, energy efficient delivery vehicles

The use of efficient technologies typically rest on the private logistics operators to make investments that deploy them, however, their use can be accelerated through either regulatory policies or incentive programs adopted by the City. The City could, for example, introduce charging infrastructure programs, upgrade its fleets, and support state legislation -including testing/piloting of new technologies on public roads. Much of the effort by the industry to date has focused on testing and assisting original equipment manufacturers (OEMs) on commercialization and deployment, as well as assessing fueling or recharging infrastructure needs. Portland's Central City Sustainable Freight Strategy already includes charging infrastructure in its list of recommended actions.

***Picture 3.1:** A row of three white freight trucks parked in a buisness center parking lot. [Source: unknown]*

2.1.1 Electrification

There are few fully electric trucks in operation today, but demand exceeds supply and they are anticipated to become a significant portion of the truck fleet over the next twenty years. At the end of 2019, there were approximately 2,000 electric trucks operating on U.S. roads, and one study estimate that number is expected to grow to over 54,000 by 2025 [9]. Industry practices currently include equipment retrofits and/or accelerated replacement. In recent years, California's regulatory requirements (see CARB's Advanced Clean Trucks regulation) and incentive programs have driven investment into new zero-emission technologies, most notably all-electric and hydrogen fuel cell. With the advent of fast-charging and the design of new types of vehicles by major OEMs, the potential for conversion of heavy-duty truck fleets is becoming more of a reality in the near-term. In November of 2021 the Oregon Environmental Quality Commission approved the Clean Truck Rule, which requires manufacturers of medium and heavy-duty vehicles to sell a certain percentage of zero-emissions electric vehicles, starting with the 2025 model year. This rule, which follows California's Advanced Clean Trucks (ACT) Rule, will improve the availability of electric trucks and accelerate the adoption of these technologies in the fleet.

Charging infrastructure is also advancing. For example, In California, major public utilities providers have been engaged in assessing future demand, identifying deficiencies in the electricity grid, and developing future improvements to meet anticipated demand. In early 2019, Penske Truck Leasing opened the nation's first Direct Current (DC) fast-charging stations (14 total, with 6 more planned) at four locations in Southern California designed specifically for heavy-duty commercial electric vehicles. Utilizing 50-150 kW chargers, the stations can fully charge an all-electric class 8 tractor in less than half a shift (or 7 hours, assuming a maximum daily 14-hour shift).

Companies like Tesla, Volvo, BYD and Freightliner, currently have fully-electric heavy-duty trucks in limited production. PepsiCo announced in October 2019 that 15 Tesla Semi electric trucks will replace all

9 woodmac.com/reports/power-markets-electric-heavy-duty-trucks-and-charging-infrastructure-a-grid-edge-case-study

of the existing diesel-powered freight trucks at its Modesto, California manufacturing site. The first two battery electric eCascadia tractors from Freightliner were shown to have a range of 250 miles on a full charge, which is adequate for many local and intercity trips. One test driver of the Tesla Semi electric truck that transported an almost full load of 75,000 pounds said that the vehicle was meeting or even "exceeding" range expectations

Several barriers remain in the electrification of the truck fleet. While companies are currently able to order electric trucks, production volumes are so low that deliveries of these vehicles are many years away. Additionally, the cost of these electric trucks are currently many times higher than the costs of conventional trucks, even after incentives. This has slowed the adoption of these vehicles to pilot programs and niche operations where the vehicles are profitable over their service life. The current range of electric trucks also favors drayage operations, where trucks serve a fixed set of destinations that can be retrofitted with high-speed charging equipment.

Finally, while electric trucks are often described as zero-emission vehicles, it is important to recognize that emissions are involved in the manufacturing of the trucks and the generation of the electricity used to recharged batteries. Emissions from the generation of electricity can significantly lower or comparable to that of diesel trucks, depending on the mix of generation sources.

Picture 4.1: *Multiple freight trucks with and without trailors idling at a port. [Source: unknown]*

The strategies the City could implement to accelerate the electrification of the truck fleet include:

- Leverage local, state, and federal funding to build-out charging infrastructure.
- Work with private sectors to disseminate information on electric trucks and establish peer knowledge exchanges. Knowledge sharing across the public, private, and non-profit sectors could improve state and local knowledge needed to inform stronger and more pointed legislation with better understanding of barriers and potential solutions
- Develop pilot program to provide financial assistance in the acquisition of electric trucks
- Provide incentives or regulatory exceptions for electric trucks. Streamlined Permitting and Building Requirements for EV Charging Infrastructure. Current process for charging installation at fleet facilities can be laborious and vary based on local regulations. State Public Utility Commissions (PUCs) could work with utility companies to streamline permitting process, reducing development timelines.

Both the TAC and CAC were eager to see a faster electrification of the truck fleet, to decarbonize the transportation of freight. However, in the CAC there was input from a few motor carriers and other private sector companies indicating the current costs and challenges in acquiring and using electric trucks, consistent with the assessment provided above.

2.1.2 Overcoming Clean Vehicle Purchasing Barriers

Overall, there are three main barriers to purchasing clean vehicle technologies: (1) capital cost, (2) fueling availability, and (3) operational constraints (number of miles that can be traveled on one tank of fuel or one charge). At the time of this report, the estimated purchase price of a new diesel heavy-duty Class 8 truck is approximately $130,000, whereas a comparable battery-electric truck starts at $450,000 and a comparable hydrogen-fuel cell truck starts at $650,000. Not only are they 3-4 times more expensive than diesel trucks, but the travel range for electric is less, the unloaded weights of both electric and hydrogen fuel cell trucks are greater (reduces cargo carrying capacity), and the fueling infrastructure is not yet developed to support the charging/refueling of these new technologies. Some of the lessons learned from other agencies when overcoming the high cost and purchasing barriers of clean vehicles and charging infrastructure include:

- Cost sharing mechanisms between public and private sectors.
- Implementing a tax increment for new land development projects, such as the Utah Inland Port Authority, and reinvesting those dollars in electrified truck parking, charging, and refueling infrastructure
- Instead of purchasing brand new vehicles, look at acquiring previously owned vehicles (such as the case in Mexico City) or leasing the vehicles directly from the manufacturer.
- Leverage new funding pathways via local/state public health initiatives, such as the case in California with AB 617 (Community Air Protection Program, or CAPP) and SB 856, which provides supplemental funding for zero-emissions charging infrastructure for trucks. From 2017-2019, AQMD received nearly $300 million for these programs. The Clean Truck Voucher Incentive Program (VIP) is another good example.

The barriers to the implementation of electric trucks are likely to be less insurmountable for the smaller trucks that perform urban deliveries. The range required in these operations is more compatible with prevailing EV technology, and the truck is able to return to home base to recharge, which is much more problematic with most Class 8 combination trucks that provide interstate service

2.1.3 Alternative Fuels

The Ports of Long Beach and Los Angeles have increased the use of cleaner diesel and natural gas trucks. The two ports have also advanced zero-emission truck technologies (electric and hydrogen fuel cell) through their Technology Advancement Program (TAP) that provides funding in partnership with CARB for pilot projects. In support of both natural gas and hydrogen fuel cell deployments, the ports have also been investing in the fueling infrastructure. There are three critical factors for industry when deciding to invest in these new technologies: 1) cost, 2) reliability and travel range, and 3) fueling infrastructure. The fueling and recharging network is a critical piece that public agencies can affect.

2.1.4 Clean Trucks Program

On the testing and implementation front, the Ports of Long Beach and Los Angeles have been able to influence the conversion of older diesel trucks serving the ports to newer, less polluting engines through tariffs that set requirements for terminal operators who lease from the ports. Launched in 2008, the Port of Long Beach's ground-breaking Clean Trucks Program bars older, polluting diesel trucks from entering the port, which led to a 90% reduction in truck-related emissions.

Additionally, what made the Clean Trucks Program sustainable was the partnerships and collaborations established prior to its inception, which enabled wide-scale support for the program – especially from private logistics operators and trucking companies. Finally, the surrounding communities of the Clean Trucks Program also experienced improvements in air quality given their proximity to the port harbor facilities and local freeways. One relevant effort by the state of Oregon where the Clean Trucks Program could be applicable includes the 2050 Statewide Transportation Strategy (STS), a multi-agency transportation GHG reduction roadmap, with key objectives to support the use of cleaner vehicles and fuels. With respect to freight, one action of the program includes a truck alternative fuels study -which could be utilized to consider the feasibility of a Clean Trucks Program.

The strategies the City could use to accelerate the adoption of alternative fuel trucks include:

- Support the establishment of a Clean Truck Program at the Port of Portland
- Leverage local, state, and federal funding to build-out alternative refueling infrastructure
- Work with private sectors to disseminate information and establish a peer knowledge exchange
- Develop pilot program to provide financial assistance in the acquisition of alternatively fueled trucks
- Provide incentives or regulatory exceptions to the use of alternatively fueled trucks

2.1.5 Fuel Saving Technologies

There exist several off-the-shelve technologies that trucks can implement to improve fuel economy and reduce greenhouse gas emissions. These include: aerodynamic deflectors on the cab and trailer (including trailed side skirts and tail flaps), low rolling resistance tires, low viscosity lubricants, and many more. Research has found that many of these technologies are cost effective and can pay for themselves in just a couple of years from reduced fuel consumption[10]. Currently, the trucking sector underinvests in these technologies, however, several states and localities are introducing regulations mandating or incentivizing their adoption. Examples include regulations introduced by the California Air Resources Board mandating the use of certain aerodynamic deflectors and tires, and the voluntary SmartWay Program of the Environmental Protection Agency which certifies fleets that uses these technologies.

10 https://www.sciencedirect.com/science/article/abs/pii/S1366554513001452

The strategies the City could use to accelerate the adoption of fuel saving technologies include:

- Work with the private sector to disseminate information on urban freight technologies and benefits and establish a peer knowledge exchange similar to the EPA's SmartWay program.
- Develop pilot project to provide financial assistance in the acquisition of fuel saving technologies
- Support efforts to mandate the use of certain high return-on-investment technologies statewide, as done in California.
- Provide incentives or regulatory exceptions for trucks that include specific fuel saving technologies

Picture 5.1:

A diagram of a blue freight truck with a white trailer. The diagram demonstartes the back of the trailer. Tails flaps, side skirts, and low resistance tires are visible. [Source: unknown]

2.1.6 Idling Reduction Technologies

Phase 2 of the joint EPA and United States Department of Transportation (DOT) National Highway Traffic Safety Administration (NHTSA) Heavy-Duty Greenhouse Gas (HDGHG) rule sets the rules for original equipment manufacturers with respect to idle reduction requirements. This rule requires idle reduction technology, such as Auxiliary Power Units (APUs) for model year 2021 new Class 7 and 8 trucks with sleeper cabs. As assumed in the latest EPA Motor Vehicle Emissions Simulator (MOVES 3), the use of APUs for extended idling is projected to reach 40 percent by 2021, 50 percent by 2024, and 55 percent by 2027. There are two main types of APUs: diesel-powered APUs and battery-electric APUs. Therefore, to ensure the maximum GHG reduction benefits, battery-electric APUs should be encouraged.

Other technologies can also be used that reduce the need for trucks to idle at parking facilities. This includes electric hook-ups, where the driver can plug in and receive power for in-cab electronics, including air conditioning. Air conditioning can also be provided by the parking facility, through cold air that is piped into the cab. This can be used in combination with electric hook-ups to reduce the need for idling. However, both hook-ups of electricity and air conditioning are rare in existing truck parking facilities.

The Utah Inland Port Authority recently applied for Congestion Mitigation and Air Quality (CMAQ) funding for a new (publicly owned and operated) plug-in, truck parking facility in the inland port. The facility would include charging infrastructure for trucks to plug-in, provide power, and help avoid overnight idling on neighboring streets.

The City could take the following steps to accelerate the use of APUs and other technologies that reduce unnecessary truck idling:

- Restrict truck access to public facilities, including parking lots, to vehicles equipped with APUs only. While potentially useful, this could have the unintended side effect of increase the frequency of undesignated parking and making it harder for trucks to abide by hours-of-service regulations.
- Work with the state legislature and/or ODOT to allow for reduced vehicle registration fees and operating licenses for trucks equipped with APUs.
- Leverage local, state, and federal funding to build-out anti-idling technologies such as electrical and air conditioning hook-ups.
- Tighten anti-idling laws and enforcement in certain areas of the city, such as residential areas.

Picture 6.1:
"Auxiliary Power Units"
Cables connected to a steel plated machine near a freight tractor.
[Source: unknown]

Picture 6.2:
"HVAC Hookup"
Two white freight tractors connected to an external HVAC system. The HVAC system is yellow and enters through the windows of the freight vehicles.
[source: unknown]

Picture 6.3:
"Electric Hookup"
A red freigt truck connected to an electric vehicle charger. The charging system is white, the charing cord is yellow.
[Source: unknown]

2.1.7 Energy Efficient, Smaller, and More Maneuverable High-Visibility Trucks

Smaller, lighter, and more fuel-efficient delivery trucks/vans with lower profiles and fewer driver blind spots significantly improve safety while also reducing emissions. Common in many European cities where small roadways cannot accommodate large trucks, companies like UPS, FedEx and DHL have been using smaller delivery vehicles, many of which are natural gas or electric vehicles. In the U.S., most streets have been designed to accommodate all vehicle modes from automobiles to large trucks. These wider corridors often promote higher speeds, larger vehicles, and longer crossing times for pedestrians.

As cities begin to rethink multimodal accessibility and mobility, delivery companies are moving towards near-zero and zero-emission, right-sized delivery vehicles. With respect to road safety implications, evaluations in Trondheim, Norway (right) revealed collisions between cyclists and trucks occurred mainly due to blind spots during turning maneuvers[11]. The high-profile of heavy-duty trucks and low profiles of bicycles prevent the truck drivers from being able to see the bicyclists. Designing highly visible bikeways, creating buffers and bike boxes can help, but the use of smaller and more maneuverable trucks significantly improve safety, while cutting emissions.

11 Pitera et. al. 2017.

2.2 MANAGEMENT AND OPERATIONS

Strategies that improve the efficiency of the urban freight system could also involve using existing technologies in smarter ways, reducing inefficiencies. Some of these strategies are likely to reduce costs as well as emissions, benefiting the companies involved, however they are currently not implemented because of barriers that the City should seek to lower. Other strategies might have exclusively a sustainability objective, in which case the City could use a combination of regulations and incentives to achieve the desired outcome.

The strategies considered in this section include:

1. Off-hour deliveries

2. Lower emission mode for medium- and long-haul shipments

3. Cargo bikes

4. Truck parking management

5. Curbside loading/unloading operations

6. Urban consolidation

7. Low-Emission Zones

At the end of this section other best practices are covered which could have an impact on emissions.

New York City OHD Pilot

- Delivery times reduced by 75%
- Carriers reported less stress and savings on fuel costs
- Potential savings of $200 million per year for carriers, shippers, and receivers
- Late-night noise has potential to draw negative perceptions

Picture 7.1: Two workers unloading cargo off a freight truck at night. The truck is parked on the side of a street. [Source: unknown]

2.2.1 Off-Hour Deliveries

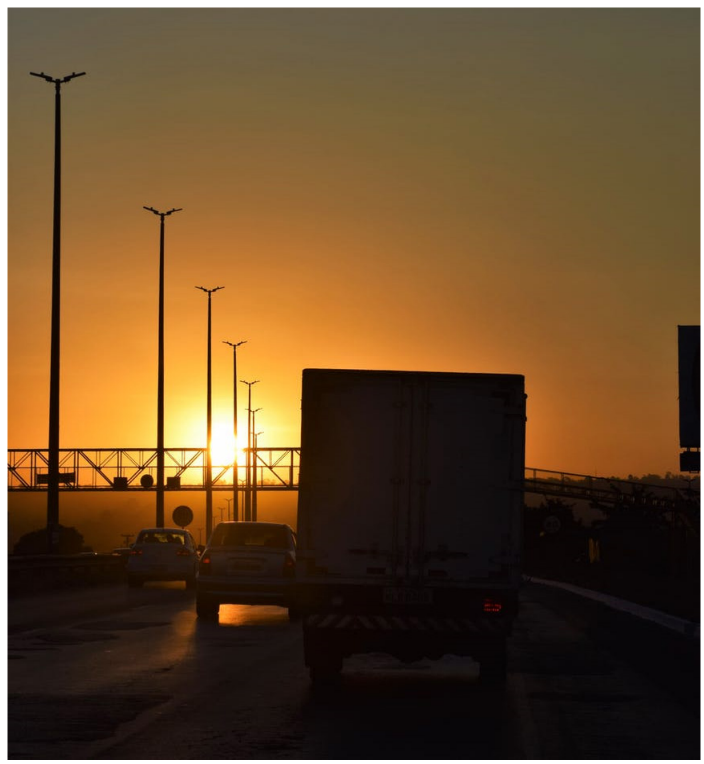
Off-hour deliveries (OHDs), typically defined as being between 7:00 p.m. and 6:00 a.m., are an effective tool for managing freight demand. By improving traffic flow OHD can reduce emissions and reduce conflict between commercial vehicles, general traffic, and vulnerable road users[12]. In some situations, OHD has the potential to reduce operating expenses for businesses. Implementing OHD pilots requires local businesses to change receiving behaviors. OHD programs have been implemented in New York City and Los Angeles, as well as in parts of South America and Europe[13].

New York's original Off-Hour Truck Delivery (OHD) Pilot program ran from 2009 to 2010, funded by USDOT, and led by Rensselaer Polytechnic Institute (RPI) with a goal of demonstrating feasibility and benefits of OHDs while reducing truck traffic during periods of highest congestion. USDOT was the lead coordinating agency for the pilot and worked with trucking industry representatives, NYSDOT, PANYNJ, and NYMTC to develop an approach and address concerns of carriers and receivers regarding the shift to OHD. The NYC OHD program was subsequently expanded by NYCDOT to include 400+ partnerships with commercial establishments in NYC to accept OHD without supervision.

The successful implementation of OHD programs requires trust to be built between the shipper, receivers, and motor carrier. To reduce costs, many establishments prefer not to have staff present at night when the deliveries take place, which means that they need to entrust delivery staff to have access to their premise. Security systems can alleviate security issues. In previous examples, implementing OHD is easier in some industries than others, because of the cargo involves or how they operate. OHD simply does not work for some types of businesses. In general, larger businesses or establishments that receive large quantities of freight in a centralized location are more likely to implement OHD because they benefit from the efficiencies and can afford the fixed costs of receiving freight at night. In the New York example, financial incentives were required to overcome some of these hurdles, however once the financial incentives ended, many businesses ended their participation in the program.

The City could encourage the use of OHD by:

- Working with private sector to disseminate information on benefits of OHD and strategies to overcoming barriers
- Developing an OHD pilot with large/centralized establishments that attract significant quantities of freight in congested high-density areas.



Picture 8.1: A freight truck driving on a highway during sunset. The image is mostly dark. A yellow and orange hazy sun illuminates the image. [Source: unknown]

12 Off-Hour Deliveries Program, New York City DOT. https://ohdnyc.com/sites/default/files/business-admin-files/Home/ohd-final-report.pdf & https://ohdnyc.com/benefits

13 https://www1.nyc.gov/html/dot/downloads/pdf/truck-deliveries-ll189.pd

2.2.2 Lower Emission Modes for Medium and Long-haul Shipments

Shifting freight from a high emission mode, such as trucking, to a lower emission mode, such as rail and water, has the potential to reduce total emissions. The U.S. EPA estimated that in aggregate trucks generate 13 times more emissions per ton-mile moved than water, and 3 times more emissions per ton-mile than rail. [14] However, achieving these mode shifts is complex, and often very difficult. Truck, rail and water modes typically serve different markets because of their different operating characteristics and performance. A shipper that pays a premium for the speed and flexibility of trucking is unlikely to readily shift to using rail to reduce emissions, given that the shipment is likely to be much slower.

Having said this, there are specific markets for which rail can be competitive with trucking. Intermodal service was developed by the railroads to provide faster and more frequent service between important origins and destinations of freight in North America. The Portland region has 3 rail intermodal terminals (BNSF Lake Yard, Port of Portland Terminal 6, UP Brooklyn) where containers can be transloaded from trucks to rail and moved on intermodal trains to their destination. This type of service is most competitive relative to trucking on shipments of over 1000 miles in length. Shifting just one shipment from truck to this type of rail service would eliminate thousands of miles of truck travel, resulting in a substantial reduction of GHG emissions.

The shifting of long-distance shipments from truck to rail can be encouraged by promoting the competitiveness of those rail terminals within the City's boundaries, by ensuring that access roads have adequate capacity and designs to accommodate the flow of trucks. Additionally, the separation of at-grade crossings can further improve operations and eliminate conflicts, making rail more competitive, while eliminating emissions from automobiles and trucks from frequent crossing closures. Several members of the CAC agreed that at-grades crossings are currently a significant source of congestion and emissions along some corridors. While rail is significantly cleaner from a GHG perspective, steps should be taken to reduce emissions of other pollutants at rail terminals. In total, rail emits less of these pollutants than trucking per freight moved, however rail emissions are concentrated at terminals and along railroads, and therefore could result in high concentrations for nearby residents.

While moving freight by water generates even less emissions than rail, it is usually much more difficult to attract freight from truck to water because the markets served and operating characteristics are even more dissimilar than rail. Most of the volume moving through the Port of Portland constitute trans-oceanic imports. However, there are certain bulk commodities that are currently moving through the Columbia River and using terminals in and around the City of Portland. While trucking is significantly more expensive to transport these types of bulk commodities, there are specific bulk commodity markets for which water is competitive in the region. The City could encourage the continued use of water to transport these bulk commodities, and improve the competitiveness of water, by improving access to water terminals and ensuring they are well connected to the rest of the transportation system.

Picture 9.1: *" At-grade rail crossing congestion"*
A line of cars stalled at a rail crossing. A red and black train is seen passing through.
[Source; unknown]

14 https://www1.nyc.gov/html/dot/downloads/pdf/truck-deliveries-ll189.pd

A single electric cargo bike could save
13 tons per year in CO2 emissions.
(Conway, 2014)

2.2.3 Cargo Bikes

Maneuvering and parking large trucks on congested, narrow city streets can be hazardous for drivers, cyclists, and pedestrians. Non-motorized or electric-assisted cargo bicycles have been gaining popularity in North American and European cities for last-mile deliveries. Small-sized goods are typically consolidated at an Urban Consolidation Center (UCC) or vicinity loading zone and transported to the final market destination. B-Line is an example of this type of service operating in Portland.[15] B-Line "at the Redd" is a UCC that serves regional producers and local businesses. Part of the company's mission is to help reduce congestion and GHG emissions by developing more local, green-collar jobs.

Cargo bikes offer the following advantages over small delivery vans and light trucks making short trips:

- Reduced emissions and noise levels, where they are permitted to operate on public roads.
- Increased route flexibility and door-to-door service, since they can utilize both vehicle and bicycle infrastructure -assuming the latter is permitted by the City for human-powered cargo bikes.
- Improved road safety due to greater compatibility with pedestrians and cyclists, assuming cargo bikes travel at appropriate speeds.
- For shorter trips, there is potential for faster delivery times than traditional trucks in congested city centers.
- Cargo bikes deliveries are more effective in neighborhoods with high urban density and suitable bicycle and pedestrian infrastructure. They are not viable in less dense areas where average trip distances increase substantially, or where bicycle and pedestrian facilities are not provided as mixing with vehicular traffic could put the safety of the cargo bike rider at risk.

Companies like DHL, UPS and FedEx are just starting to implement delivery tricycles in North American and European cities (right). Places where traffic congestion in the urban core is prevalent, such as Seattle, Downtown Pittsburgh, Portland and New York City, are allowing cargo bikes on roads -including even offering free parking as an incentive. Emerging cities like Addis Ababa and Beijing have traditionally used non-motorized hand-carts, bikes, and animal-drawn carts to provide cheap, door-to-door delivery services where poor roads, traffic and parking conditions limit the use of large trucks.

The City could increase the use of cargo bikes by:

- Working with private sector to identify barriers to the wider adoption of cargo bikes and work to lower infrastructure or regulatory barriers. be.
- Working with private sector to disseminate information on cargo bikes and establish peer knowledge exchanges

The CAC and TAC agreed that cargo bikes are a promising way of reducing emissions associated with last-mile deliveries, particularly in Downtown and the inner Eastside. The expansion of bike infrastructure in these areas would support cargo bike operations, benefit bicyclists, and improve safety.

Picture 10.1:
A UPS employee riding a brown UPS cargo bicycle in the rain. [Source: Byron, Bike Hugger Magazine]

15 B-Line, a local cargo delivery bike company, accessed on 2/17/2021 at: https://b-linepdx.com/

2.2.4 Truck Parking Management

Most heavy trucks need to park for long-term periods, especially on long-haul trips, to rest and meet federal Hours of Service regulations. The Oregon Commercial Truck Parking Study described the difficulties that truck drivers have in finding parking in and around the Portland metro area. This leads to parking in undesignated locations, or on public roadways/parking lots, where trucks need to keep their engines idling in order to maintain power in the cabin to keep the electrical system on, including heating. However, these idling activities contribute to increased air emissions, including GHGs. Emissions generated from trucks idling to heat and cool the trucks as drivers take federally-mandated breaks can significantly contribute to poor air quality and GHGs in the region.

Reduction of these impacts could be achieved through a detailed commercial parking needs assessment that considers total delivery demand by location and compares it to curbside delivery zones and off-street truck parking availability. Ways that commercial parking availability can be improved include:

- Implementation of a real-time delivery zone reservation system
- Promotion of parking and load/unload facilities on underutilized property
- Development of public-private partnerships with retailers, and other establishments that could potentially accommodate commercial vehicle parking
- Incentivize additional commercial vehicle parking on private property, through tax credits and exceptions.

Picture 11.1: *Three B-Line employees in yellow jackets posing next to three yellow and silver cargo bicylces. [Source: Byron, Bike Hugger Magazine - Portland locally owned B-line: pedal-powered cargo bike]*

2.2.5 Loading/unloading facilities operations

As consumers become more accustomed to fast, convenient home-delivery of goods, the growth in e-commerce and related urban freight activity is anticipated to increase, which will in turn, exacerbate the demand for providing adequate infrastructure to meet parking, load and unload operational needs of commercial vehicles as many other municipalities are already experiencing today. A trend that has only increased with the consumer demand growth of e-commerce goods due to COVID-19. For example, one recent study presented at the 100th Transportation Research Board annual meeting in January, 2021 by Cara Wang showed that while person trips to/from stores have decreased during COVID-19 across the United States, there has been a significant increase in vehicle trips for Courier Network Services (CNS), which is associated with higher demand for truck parking.

Lastly, improvements in the ability of commercial vehicles to find parking, particularly in dense areas, could potentially yield significant GHG reduction benefits. Increased availability of commercial vehicle parking where needed avoids commercial vehicles circling/cruising around to find a spot, or parking in a travel lane and causing congestion/safety conflict.

The stakeholder input from the TAC and CAC agrees that commercial vehicle parking was an area where improvement is needed to streamline operations and reduce emissions. The use of pricing tools was discussed favorably as a way of managing demand, as well as increasing parking capacity dedicated for commercial vehicles and load/unload operations, so they don't park on the streets or compete with other vehicles for parking space. It was also suggested that priority could be given to the electric commercial fleet.

Steps could also be taken at the building/curbside level to ensure that commercial parking operations are quick, efficient, and limit impact on the traffic stream. Most buildings and businesses accept deliveries daily. Although some businesses offer off-street loading bays, most depend on the provision of load/unload space at the curb to receive their goods. Parked and double-parked trucks are a major contributor to urban congestion and the obstruction of pedestrian infrastructure, along with truck and delivery vans idling and emitting pollutants and GHGs. One recent study from the Urban Freight Lab (UFL) at the University of Washington[16] found that there is insufficient data to assess the effectiveness of restricting vehicle dwell time -a common practice to manage commercial vehicle behavior. As a result, this makes it challenging for policymakers to account for the complexity of commercial vehicle parking behavior. The study identified key factors that influence dwell time, including types of packages being delivered, whether a front office/security personnel is present, and number of deliveries made to the occupants in the same building. The Institute of Transportation Engineers published a technical resource guide that could also help PBOT efficiently manage the curb for loading/unloading operations.[17] The guide considers regulatory, operations, and technology strategies to optimize curb access and usage, and features case studies for quick reference.

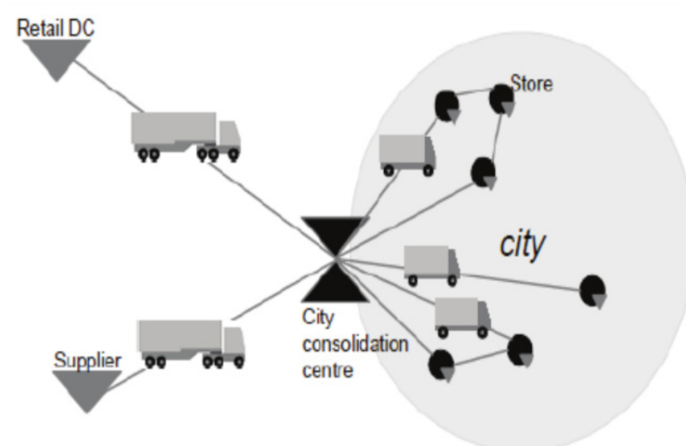
2.2.6 Urban Consolidation

Consolidating freight loads at strategic geographic stages could have an important impact on reducing the number of trucks that enter a city, the distances they travel, and time spent dwelling. Fehr & Peers conducted a study in 2020 on truck VMT for different fulfillment centers in the United States, both in urban and rural areas. The study found that average trip lengths were significantly shorter for fulfillment centers located in urban areas, versus rural areas, and that having a concentrated network of fulfillment centers played a role in reducing the average trip length[18].

One trend that is emerging is that private, online retail companies such as Amazon, Walmart, and Staples, are moving closer to the urban core (i.e. customers and for-hire drivers) to enable same-day delivery options to remain cost and time-competitive. This is leading to a growing need for consolidation of shipments in urban areas, close to customers and households, in order to improve the speed and reliability of home-delivery shipments. This could help eliminate the need for automobile trips to stores if e-commerce continues to gain market share.

Urban consolidation can also help reduce emissions by providing a point where freight can be moved onto cleaner trucks. Cleaner trucks, such as those powered by electricity, are better able to operate in urban areas, as described previously. Consolidation centers could serve as the place where freight is transferred from long-haul combination trucks to electric trucks and also provide a place for recharging.

The strategies that agencies can implement to facilitate urban consolidation that is sustainable depend on the local context. In Europe, public agencies have been extensively involved in the development and operation of consolidation centers, primarily as a way of transferring freight onto vehicles that can better navigate dense historic neighborhoods and meet local regulations (such as low-emission zones). In the U.S., with lower levels of government involvement and subsidy, these types of approaches unworkable. Therefore, the City of Portland is best served by introducing incentives or tweaking regulations to facilitate the type of sustainable urban consolidation that will reduce emissions. This could include reviewing land use regulations and making it easier to locate consolidation facilities closer to customers. Additionally, incentives could be provided for new consolidation developments that facilitate green technologies, such as electric truck recharging.



Picture 12.1: "*Function of Consolidation Centers*"
A diagram displaying the routes and networks of a consolidation center. [Quak, 2008]

16 im, H., Goodchild, A., & Boyle, N.L. "Empirical analysis of commercial vehicle dwell times around freight-attracting urban buildings in downtown Seattle." Journal of Transportation Research Part A: Policy and Practice. 147 (2021) 320-338.

17 https://www.ite.org/technical-resources/topics/complete-streets/curbside-management-resources/

18 Contreras, S. et el. "Travel Efficiency of Fulfillment Centers." Presented at the 100th Transportation Research Board Annual Meeting. Washington, DC. January, 2021.

2.2.7 Low-Emission Zones

Low-Emission Zones are another proven tool available to PBOT that could directly influence the vehicle fleet composition on public roadways. In London for example – clean air was a top priority/agenda for the Mayor and public, because of the growing body of evidence that linked poor air quality with negative health outcomes; especially for children. The Low-Emission Zone (LEZ) concept puts immediate pressure on high polluting, heavy trucks to upgrade their fleets more quickly (in addition to passenger vehicles). However, it can also be a burden on industry and result in negative economic impacts to certain geographic areas if it is not strategically implemented. In addition, caution must be taken when designing the cordon area (including its size) to avoid vehicles attempting to bypass the LEZ by cutting through neighborhoods or taking longer, alternative routes as that would increase VMT.

There are currently around 200 LEZs around the globe, mostly concentrated in Europe, with reported improvements in local air quality. For example, in London, between 2017-2020, roadside measurements within the LEZ showed an estimated reduction in NO2 emissions of approximately 44%[19]. The City of Santa Monica, California recently became the first City in the United States to pilot a Zero Emissions Delivery Zone (ZEDZ) [20]. Although it is only a voluntary program, it is a good example of how to successfully build sustainable partnerships between public, private, and community stakeholders. To support the pilot and encourages new participants, this pilot provides priority curb access for zero-emission delivery vehicles in selected locations in the zone.

The creation and adoption of zero-emission goals can be an effective instrument for setting an agenda and catalyzing clean mobility. Net-Zero Emission initiatives, and climate emergency declarations, such as the one introduced in Portland, can also be useful tools. Such declarations can have a resonating effect on the surrounding community and can also help move climate action goals to the top of the governing body's agenda (i.e., funding). It can also notify key stakeholders and private companies doing business in the region that they must be held accountable for their carbon footprint.

19 https://www.london.gov.uk/sites/default/files/air_quality_in_london_2016-2020_october2020final.pdf

20 https://laincubator.org/zedz/

2.2.8 Other Best Practices

Other last-mile solutions are being deployed throughout the world to improve the efficiency of urban freight transportation and have the potential to positively impact GHG emissions. These include:

- Micro-hubs: these are small stationary or mobile locations where freight can be transferred from one type of freight vehicle to another, which is better able to complete last-mile delivery. Micro-hubs can enable the use of cargo bikes, as can be seen in the photo on the right. These schemes can help reduce emissions by allowing more sustainable modes to be used for the part of the shipment they are better able to complete. The City could encourage the use of micro-hubs by coordinating with small package integrators (such as UPS and FedEx) and designating curbside locations for this activity to occur.

- Delivery lockers: These are lockers that can be used in different contexts to allow people access to their packages without requiring delivery to their homes. Delivery lockers could be located in public areas, residential or office buildings, high-traffic commercial establishments (such as grocery stores), or at the establishments of package integrators (such as UPS and FedEx). The advantage of these lockers is that they help eliminate trips to deliver or pickup packages at people's homes, which reduces truck travel and greenhouse gas emissions

Picture 13.1: A UPS worker unloading cargo from a UPS trailor onto a UPS cargo bike. [Source: unknown]

- Delivery Drones and Robots: These represent technologies that are currently being explored to streamline last-mile deliveries. Delivery robots are currently active in some controlled settings, such as at a few universities, making deliveries by using pedestrian infrastructure. These robots can be cost effective in some cases, as it eliminates the need for people to be involved in the delivery, however the ultimate implications on GHG emissions and the sustainability of the system are unknown. If they replace employees using bikes, then the delivery robots could potentially increase emissions. If they replace trucks, then they would have the effect of decreasing emissions. Delivery drones are another technology that has been touted in recent years as being able to improve the efficiency of the last-mile. However, it is not likely that drones will be widely used in dense urban areas the near future because of logistical and technological reasons. Operating in an urban environment, including having safe landing locations, poses several challenges that remain unresolved. The impact of these technologies on greenhouse gas emissions are also uncertain as the energy requirements to operate a drone can be substantial, especially considering their low weight capacity.
- It is not likely that delivery drones or robots will have significant positive impact on GHG emissions in Portland. Their operating profiles and adoption rates are highly uncertain. Moreover, there remain policy and regulatory questions about how these new technologies should be operated and how they should interact with other modes of transportation and people.

***Picture 14.1**:*
"Residential/offices building common delivery lockers"
A person holding a brown package in a common deivery locker. The lockers are black
[Source: unknown]

***Picture 14.2**:*
"FedEx In-store pickup"
An adult and a child exiting a FedEx store. The child and adult are smiling at each other. The child holds a medium sized brown package. [Source: unknown]

***Picture 14.3**:*
"Carrier lockers"
A yellow Amazon locker. The locker is large. The locker has a touch screen in the center.
[Source: unknown]

3. PART 2 – METHODS FOR ESTIMATING THE BENEFITS AND COSTS OF SELECTED GHG REDUCTION STRATEGIES

The GHG reduction strategies previously described in Part 1 provide a menu of options for PBOT to consider. The list of best practices, though not exhaustive, were selected based on their applicability and relevance to the Portland context. While each of the selected GHG reduction strategies has an associated benefit, including emissions reduction and efficiencies, there are costs to consider. For example, the transportation of goods becomes costlier as it approaches its urban destination, or the "last-mile." The 'last-mile' refers to the final phase of the transportation chain where the goods enter the city and are typically delivered to the hands of the final recipient. These activities traditionally cause additional congestion (including emissions) and obstruct pedestrian infrastructure as vehicle operators unload/load deliveries on the curb. There is a congestion factor that is salient for the last mile, which brings forward the concept of "city logistics" that seeks to mitigate the complexities of moving freight within metropolitan areas. An effective 'last-mile' solution should reduce costs for both shippers and receivers while mitigating urban freight's negative externalities, including congestion, air pollution, greenhouse gases, and collisions.

The bell-shaped, concave-upward cost curve shown in Figure 2 should be factored into the benefit-cost ratio when considering GHG reduction strategies. The first mile begins at the shipper's origin/warehouse center, where it is then transferred via line-haul (rail/long-haul truck) and shipped to a distribution center where it is sorted and transferred to its last mile delivery vehicle (smaller size vans, and medium size trucks). The line-haul costs are relatively low compared to the last mile given the economies of scale, and the reliable movement along rail/rural highways that are typically not as congested as the last mile/urban areas.

The methods for estimating and evaluating the benefits and costs of the identified best practices are organized into the following three categories: (1) Performance Measures, (2) Monitoring & Evaluation, and (3) Lessons Learned.

Figure 2. First and Last Mile Unit Cost Structure (Rodrigue, 2020)

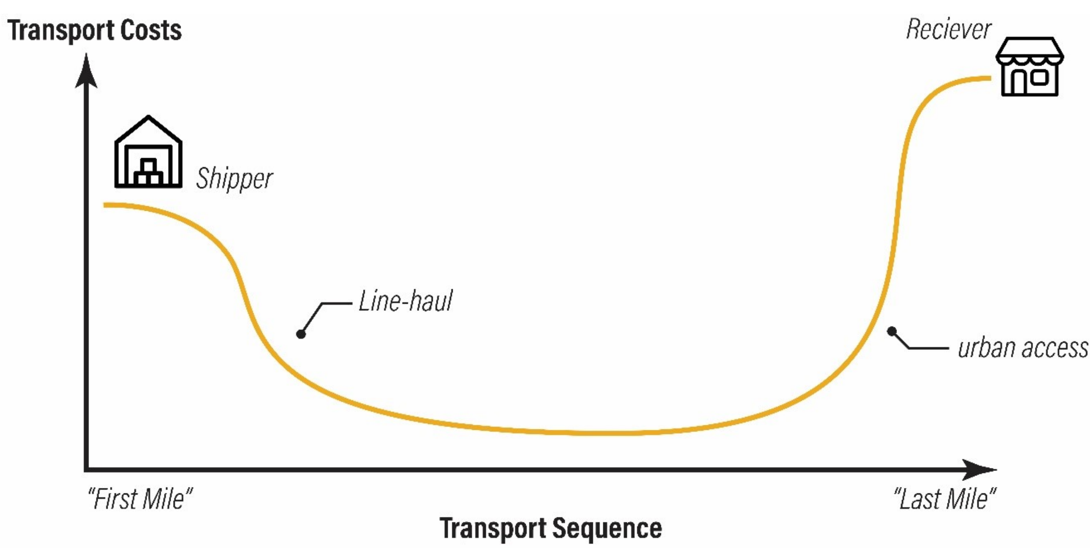


Image source: World Resources Institute

3.1 PERFORMANCE MEASURES

This section provides an overview of performance measures utilized by various agencies, including ODOT's EV dashboard. The performance measures should be tied to a specific goal or target, in order to measure the implementation measures and gauge whether the agency is meeting their goal. The performance measures, or metrics, should be measurable, documented, and shared with the public as a way of being transparent with the community being served. Some good examples of performance measures may include:

- Truck VMT (from regional model)
- Total freight GHGs and emissions per capita (focus on commercial vehicles), improving on Multnomah County inventory. This will allow the tracking of whether freight emissions are being reduced for different types of activity.
- Performance measures tied to specific strategy targets
  - % of electric trucks
  - % of alternative fuel trucks (natural gas, etc.)
  - Number of installed Auxiliary Power Units
  - Number of cargo bikes
  - Reduced truck hours of delay on roads that provide access to intermodal facilities in 2040 (2018 RTP)

Tracking the percentage of the truck fleet that are is with battery-powered APUs, along with the total number of cargo bikes in use. Both measures would enable PBOT to maintain open lines of communication with truck fleet operators and private businesses, especially if the frequency of reporting is conducted on a quarterly or semi-annual basis. PBOT could then closely assess the trends in adoption/usage, and work directly with the entities to discuss partnerships and funding opportunities as they arise over time.

3.1.1 Truck VMT Metrics

Truck VMT metrics are provided by regional travel demand models, including horizon year forecasts. The Metro travel demand model includes heavy and medium truck volumes and trip lengths so truck VMT can be calculated for current and future forecast years. At this time, it does not capture smaller commercial vehicles separately, so truck VMT estimates from the model are likely underestimating total truck VMT.

Big Data providers, such as StreetLight and INRIX, can provide tools and dashboards to help quantify truck VMT. SB 743 in California replaced LOS with VMT as the metric for assessing a project's transportation impact, but it did not cover freight related VMT. Fehr and Peers published a paper at the 100th annual meeting of the Transportation Research Board in Washington, DC, in January 2021 which assessed various travel efficiency performance metrics of freight fulfillment centers in the United States. The paper utilized cell phone data from the StreetLight data platform to estimate the average trip lengths of the delivery vehicles serving these facilities. Overall, the smaller the truck VMT performance metric, the better, with respect to GHG emissions. Replacing heavy duty truck VMT with smaller, more maneuverable high-visibility commercial vehicles could potentially increase VMT.

3.2 MONITORING AND EVALUATION

This category includes various types of GHG monitoring and evaluation systems, as well as reporting schemas. Monitoring and evaluation are an important components of implementing GHG reduction strategies. It assesses their effectiveness and provides agencies like PBOT with a sense of direction should certain measures need to be adjusted. These measures require a substantial amount of data collection and organization, as well as analyses and reporting. The most effective approaches tend to invest in data platforms, as well as visual communications in order to tell a story with the data, for example, story maps and infographics for the non-technical stakeholders. Moreover, many companies now employ a sustainability coordinator/manager to assist the logistics and accounting staff in helping to improve productivity and efficiency, and thus reduce overall operating costs.

3.2.1 ODOT EV Dashboard

The Electric Vehicle (EV) Dashboard was developed to share information about Oregon electric vehicle adoption rates, the most popular EV models, charging information, and more. This type of tracking system provides a good platform for measuring performance of ODOT's EV adoption goals, as well as provides transparency for residents of the state, utility providers, and private companies looking to advance their business lines.

The EV dashboard displays Oregon's total number of electric vehicles by type, such as battery electric vehicles and plug-in hybrid electric vehicles, and by county location. A deeper dive through interactive maps shows EVs by electric utility and by census tract. One can even calculate specific savings by EV model and electricity costs. It was a collaborative effort by ODOT to create the dashboard, and included ODEQ Clean Fuels Program, Portland State, and federal agencies.

3.2.2 GHG Inventories

Oregon Law requires that the Oregon Global Warming Commission deliver a report to the Legislature every two years. Generally, the Commission uses the reports as a platform to educate and inform legislators and the public about current critical climate facts, policies, and strategies. Such GHG inventory reporting has enabled the commission to conclude that in 2020, the state was not on track to meet its emission reduction goals.

3.2.3 GHG Reporting Schemas

ODOT developed a statewide model for quantifying GHGs. The 2050 Statewide Transportation Strategy (STS), a multi-agency transportation GHG reduction roadmap, lists key objectives and corresponding performance measures to support the use of cleaner vehicles and fuels, as well as consider GHG emissions in decision-making.

Metro's performance monitoring approach [21], identifies measures and performance monitoring targets for tracking the region's progress on implementing the STS. The monitoring and reporting system builds on existing performance monitoring requirements as required by state law and updates to the Regional Transportation Plan and Urban Growth Report [22].

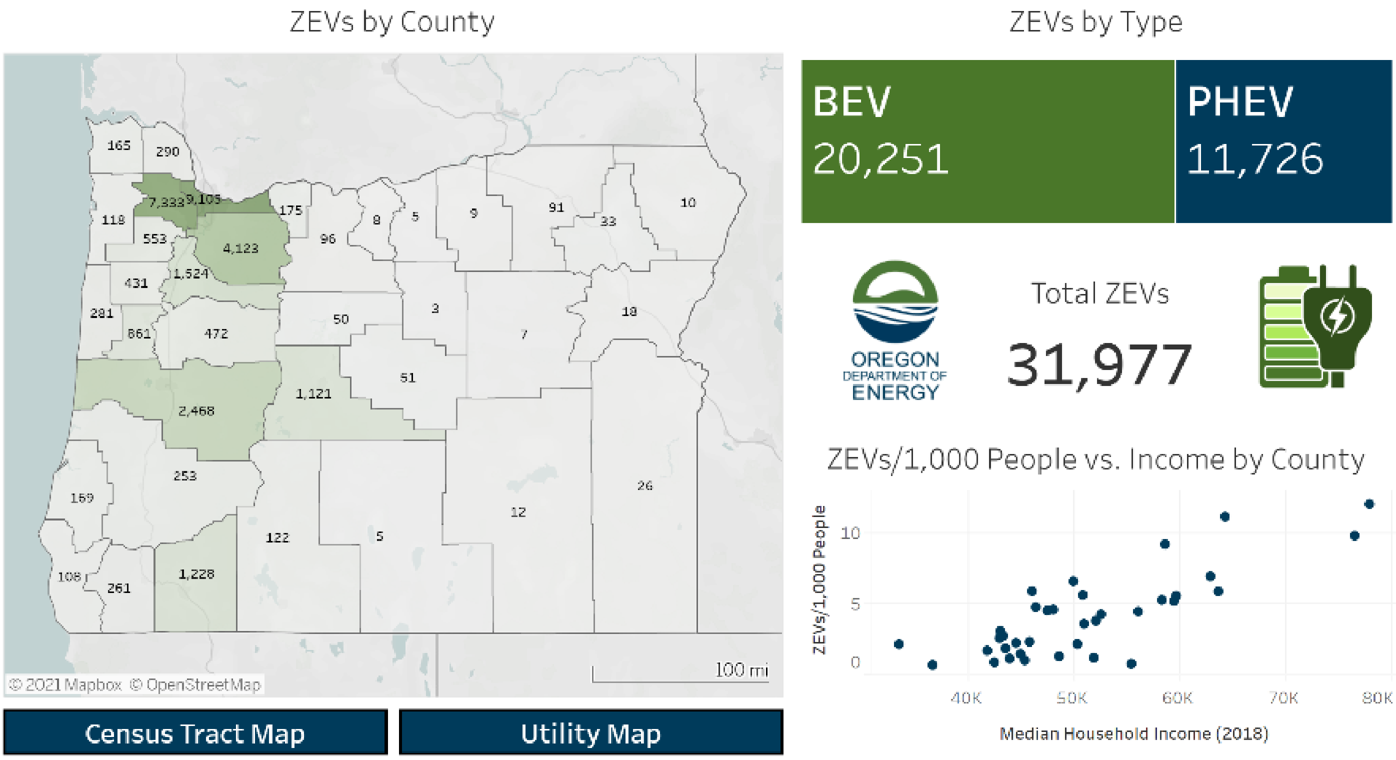
3.3 COSTS AND LESSONS LEARNED

A context sensitive approach is important when evaluating GHG reduction best practices. ODOT, for example, recommends placing an emphasis on early results, for general public awareness and stakeholder collaboration. The ability to learn from others' experiences, both positive and negative, could help save PBOT time and resources when considering GHG reduction strategies.

3.3.1 ODOT's GHG Reduction Toolkit

The toolkit presents several on-the-ground case studies and emphasizes their cost effectiveness: The strategies (such as the Westside Transportation Alliance & Nike) have a documented direct cost effectiveness of less than $200 per ton of CO2 reduced. This toolkit can help the City since it provides real world information that can be easily translated and reported out to other government agencies, private stakeholders, and the community at large. It places a dollar value on CO2, which the general public can relate to, and is already a proven mechanism utilized at the state level.

21 https://www.oregonmetro.gov/climate-smart-strategy
22 https://www.oregonmetro.gov/urban-growth-boundary



Picture 15.1: A map of zero emission zones (ZEZ) throuhout Oregon and a graph demonstarting ZEZ's per income by county. [Source: Oregon Department of Energy]

3.4 CONCLUSION

The purpose of this white paper was to provide a concise summary of freight GHG reduction best practices and performance measures. There are multiple strategies to select from, including technologies, demand management, and operations, based on the local context and level of public and private feasibility. It is also important to consider an effective means for estimating the benefits and costs of each strategy, establishing a transparent monitoring and evaluation system with appropriate performance metrics, and identifying sustainable funding mechanisms to support the efforts in the long run. Ultimately, the most effective sustainability freight transport strategies are likely to be those that meet economic, environmental, and social needs simultaneously.

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