The Seattle Neighborhood Delivery Hub Pilot Project:
An Evaluation of the Operational Impacts of a Neighborhood Delivery Hub Model on Last-Mile Delivery

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Project Details and Goals:

The forward-looking industry and government partners in the University of Washington's Urban Freight Lab (UFL), a leading source of cutting-edge urban freight solutions, jointly decided to create a space for members to test and evaluate the operational impacts of a neighborhood delivery hub in Seattle. The pilot project exemplifies the UFL goal of road-testing promising low-cost and high-value strategies to optimize operations in the urban goods delivery system.

Using e-cargo bikes to make deliveries, the UFL's Seattle Neighborhood Delivery Hub project is one of the nation's first zero-emissions, last-mile delivery pilots, serving as a testbed for innovative, sustainable urban logistics strategies on the ground in the dense Uptown neighborhood.

A neighborhood delivery hub is a central drop-off/pick-up location for goods and services at the neighborhood level that can be used by multiple delivery providers, retailers, and consumers. The hubs are designed to enable innovative, low-impact pickup and delivery models. Goods are trucked to the hub from nearby consolidation centers, then prepared for last-mile delivery within a short bike ride. Hubs often include onsite community amenities such as e-bike or scooter rentals, charging stations, parcel lockers (as in the Seattle pilot), and gathering spaces like parks or cafes (as in the Seattle pilot, a modular neighborhood kitchen operating as both a meal delivery hub and mobile app food pick-up service). By moving delivery operations closer to the end customer and offering onsite services, hubs can alleviate congestion, lower emissions, consolidate freight vehicle trips, reduce vehicle miles traveled, and enable transfer to low- or zero-emissions fleets for last-mile deliveries.

The Seattle project aimed to pilot new urban logistics technologies, vehicles, and delivery models to quickly bring to market new more fuel- and resource-efficient solutions; identify the benefits of neighborhood delivery hubs in urban delivery systems; and guide future development of similar sustainable city logistics solutions. As such, this work satisfies the aims of both the public and private sectors. Thanks to its public-private collaboration, the UFL was ideally positioned to take on this work on Seattle streets. Its private-sector members see the urgent need for market-ready, sustainable logistics solutions. One of its public sector members, the Seattle Department of Transportation, seeks both to achieve 30% zero-emission delivery citywide by 2030 and to better understand e-cargo bike delivery.

The Seattle project findings (pages 4-6) examine the operational and environmental benefits of a neighborhood delivery hub with e-cargo bikes as the delivery vehicle. The five key findings show that, on balance, neighborhood delivery hubs can enable productive and more environmentally sustainable urban last-mile delivery compared to traditional delivery trucks (specifically, cargo vans). Notably, this was a short-term pilot—running on the ground just shy of four months. With more time, the benefits would be expected to increase as the workforce becomes more experienced and refinements to the delivery model are made. And the neighborhood hubs may well accrue benefits beyond what this pilot was designed to measure, such as economic improvements for logistics companies moving away from traditional trucks and livability improvements for residents and entire communities.

Project partners and activities included:

REEF, the largest operator of mobility, logistics hubs, and neighborhood kitchens in the United States, manages the parking lot where the Seattle hub is located and operates an onsite neighborhood kitchen, offering a small-footprint local meal delivery option from which patrons can also pick up to-go food from mobile app orders.

AxleHire, a logistics startup providing route-optimization technology for last-mile service, coordinated e-cargo bike deliveries. Packages were distributed from the AxleHire coordination center warehouse on trucks servicing the neighborhood delivery hub and then loaded into BrightDrop's electric-assist pallet (EP1) which was carried by Coaster Cycles' e-cargo bike.

BrightDrop is a new business from General Motors, that developed an ecosystem of products, software and solutions designed to help reduce congestion and decarbonize last mile deliveries, including the EP1, an all-electric cart that replaces the age old dolly. BrightDrop's EP1 was loaded onsite with packages, attached to the e-cargo bike, and disengaged as needed for electric-assist hand pushing or pulling.

Coaster Cycles produces electric-assist cargo trikes. Their e-cargo trike, fitted with the EP1 attachment, delivered packages from the hub to the surrounding neighborhood.

University of Washington, the project convener and evaluator, also operated an onsite common carrier parcel locker providing neighbors and commuters a secure, automated, self-service system to pick up packages from multiple couriers, part of an ongoing three-year study.

Seattle Department of Transportation facilitated the use of city streets and data sharing, leveraging the pilot to better understand e-cargo bike delivery operations and the ways it may help the city achieve its goal of 30% zero-emission delivery by 2030.

Project partners chose a surface parking lot, managed by REEF, in Seattle's Uptown neighborhood (not far from the iconic Space Needle) to host the neighborhood delivery hub because it met all the partners' diverse requirements. This location's proximity to high-rise apartments, public transportation, the Seattle Center complex, and an onsite retail space made it ideal for customer access. Critically, it also provided an existing electrical connection and good access for vans/trucks.

Project Timeline:

UFL members across the logistics sector first identified the need for the project in February 2020. They then worked jointly to pilot their innovative technologies and strategies with operations beginning in March, 2021. As one of the nation's first zero-emissions last-mile delivery pilots, the effort garnered national media attention. The e-cargo bike pilot ran for 3.5 months.

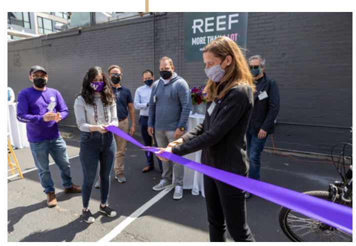
PROJECT TIMELINE

Summer 2020
Project partners established & site selected

April 5, 2021
E-cargo bike deliveries began

Early 2020
UFL members identify project

March 2021
UFL locker started operation



May 26, 2021
UFL hosted a kickoff event to launch the hub

July 23, 2021
Project closes

Five Key Findings:

Big picture: These findings focus on the Seattle hub operations to help inform future larger-scale operations. They compare operational performance of e-cargo bikes in a neighborhood hub with traditional delivery trucks (specifically, delivery cargo vans.) The five key findings below show that, on balance, neighborhood delivery hubs can enable productive and more environmentally sustainable urban last-mile delivery compared to traditional cargo vans. These findings are extremely promising, particularly since researchers expect operational efficiencies only to improve as the e-cargo bike model undergoes future larger-scale testing and refinement.

How data were captured and analyzed to reach these research findings: To analyze hub performance, researchers used cameras with vehicle recognition technology, GPS tracking sensors, parking occupancy sensors, and video footage of e-cargo bike delivery driver behavior. AxleHire, the delivery logistics provider, also shared GPS route data from the e-cargo bike routes for the comparison truck routes. From this, researchers gained a comprehensive understanding of delivery operations (miles traveled, number of packages delivered, number of stops per route, infrastructure usage, speed, battery usage, interaction with other vehicles, bikes, and pedestrians) and activities at the site itself (parking occupancy, parking duration, and distribution of vehicle types at the site).

Caveats: The short-term nature of this pilot, running roughly 3.5 months, has implications for operations. With more time, the benefits would be expected to increase as delivery drivers become more experienced and operations expand. Finding #5 has myriad caveats explained below.

KEY FINDING #1:
The e-cargo bike can replace a truck mile for mile

When e-cargo bike operations were compared with traditional truck routes operating in the same neighborhood by the same carrier, researchers found that e-cargo bikes traveled 50% less miles per package. Extrapolating these findings to a full-time e-cargo bike operation (completing 4 delivery routes per day within 8 hours), researchers found that e-cargo bikes could replace trucks mile for mile. Specifically, 1 e-cargo bike mile could replace 1.4 truck miles. This shows that e-cargo bikes can replace trucks more than mile-for-mile; reducing vehicles miles of travel and replacing large vehicles with smaller ones.

KEY FINDING #2:
The single neighborhood delivery hub reduced CO_2 by 30% per package delivered

Compared with the traditional truck routes in the area, researchers saw a 30% reduction in tailpipe CO_2 emissions per package delivered by e-cargo bike. With the e-cargo bike system, the only notable CO_2 emissions produced come from the internal combustion engine trucks re-supplying the hub. The electricity needed to charge the e-cargo bikes creates negligible carbon emissions. This demonstrates the potential for even a single hub to significantly reduce CO_2 in neighborhoods.

KEY FINDING #3:
Networked neighborhood delivery hubs can lead to even greater CO_2 reductions

Using the benefits shown from a single hub implementation, researchers were able to simulate the increased benefits of a networked (multiple) hub implementation. Depending on the number of hubs, their location, and volume of goods, CO_2 reductions per package could be increased from 30% to 40% or 50%. The carbon savings is even greater in a delivery network with multiple micro delivery hubs and dense customer demand because CO_2 from re-supply trips would be shared by multiple hubs; trucks would be fully loaded to serve an entire network route instead of a one-off hub. As noted in finding #2, the only emission-producing part of the hub model comes from the resupply truck; in a networked hub, those emissions then would be distributed across the entire network and the e-cargo bikes would remain at near zero tailpipe emissions.

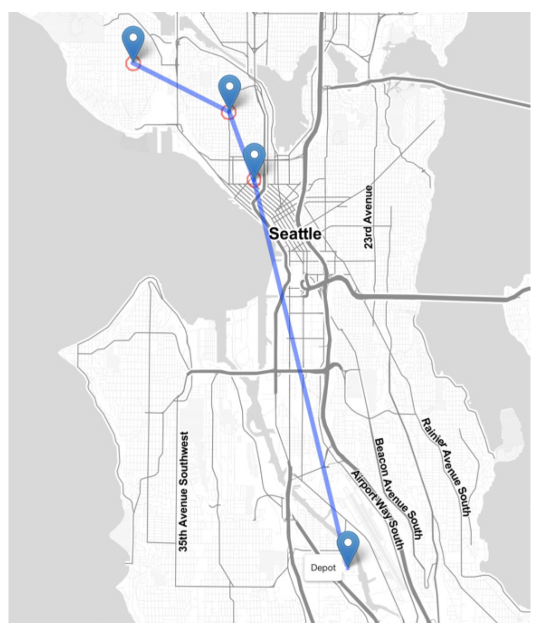


Image of simulated networked hub

KEY FINDING #4:

The e-cargo bike removed 0.65 truck miles per package delivered

The e-cargo bike removed 0.65 truck miles per package delivered, leading to an overall reduction of 356 truck miles in the Uptown neighborhood. Neighborhood delivery hubs using e-cargo bikes for last-mile delivery could help reduce congestion: They reduce truck miles per package and take up less space on the street than a truck. Less congestion could also improve traffic safety, air quality, noise pollution, and preservation of neighborhood cultural sites.

KEY FINDING #5:

The e-cargo bike delivered fewer packages per hour than traditional trucks

During the pilot, the e-cargo bike performed 8 deliveries per hour; a truck on a comparable route performed 19 deliveries per hour. With no further context, this suggests the e-cargo bike is less productive. But the researchers urge caution when interpreting this finding for myriad reasons. The main reason being the small scale and short operating period of the pilot.

The researchers expect to see improvement in this metric with refinement and expansion of the e-cargo bike delivery model including larger fleets of e-cargo bikes. As shown below, some specific caveats must be noted in relation to this finding because they slowed delivery. As such, these caveats help identify key areas where e-cargo bike delivery models can be improved going forward:

In this pilot, the e-cargo bike primarily used sidewalks.
Improvement: Use faster-moving bike lanes more frequently.

The pilot e-cargo bike driver was inexperienced in e-cargo delivery and spent significant time navigating building access challenges.
Improvement: Establish reliable access to buildings.

The pilot e-cargo bike driver used routing tools that did not provide the most efficient bike-friendly delivery route.
Improvement: Use e-cargo bike specific routing tools that encompass factors like grade.

The pilot e-cargo bike had to be manually locked to a nearby structure using a U-lock, taking valuable time during deliveries.
Improvement: Use faster locking and e-cargo bike storage mechanisms during deliveries.

Conclusion

This project shows both the significant operational benefits of a single neighborhood delivery hub implementation and the potential of networked hubs in helping solve the urban freight problems of CO_2 emission, congestion, and improved delivery efficiency. With its shared cost model across partners, the UFL's Seattle Neighborhood Delivery Hub project exemplifies a cost-effective and collaborative strategy to pilot new approaches and technologies that would not have been possible otherwise.

Each element of the hub—the common carrier parcel locker, neighborhood kitchen, and e-cargo bike deliveries—operated successfully on its own. In fact, the Seattle hub REEF neighborhood kitchen site is the company's top performer. And each operated without any conflict between vehicles serving the hub.

The UFL encourages local governments and private sector companies to pursue partnerships on neighborhood delivery hub implementation because they can address both operational efficiencies for carriers and issues important to communities, such as climate change and congestion. Cities should help make space available for hub activities off-street, which preserves limited shared public space and contributes to project cost savings. Including complementary activities at the hub also reduces operational costs and increases neighborhood amenities.

Although neighborhood delivery hubs are just one of many approaches to sustainable city logistics solutions, the myriad benefits they accrue make them a worthwhile investment. The UFL shares these findings to inform future decision-making and improve future hub projects. Many variables are at play in urban delivery logistics such as density, topography, and the type of product being delivered. The UFL encourages more pilots to allow for evaluation of the influence of these factors going forward.

Acknowledgments

The Urban Freight Lab is grateful to all the partners involved in this project that worked to create and operate Seattle's first neighborhood delivery hub pilot project. We would like to thank REEF, AxleHire, BrightDrop, Coaster Cycles, the UW STAR Lab, and the City of Seattle Department of Transportation for their efforts in this influential urban logistics pilot.

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