URBAN FREIGHT LAB

UNIVERSITY *of* WASHINGTON

Urban Freight Lab Members

Public Sector

City Transportation Departments

- Seattle Department of Transportation
- City of Bellevue, Washington
- New York City DOT

Private Sector

Retailers

- amazon

Shippers/Carriers

- UPS
- NET ZERO LOGISTICS
- Uber

Vehicle Manufacturers

- Michelin
- FH Fernhay

Infrastructure and Technology Providers

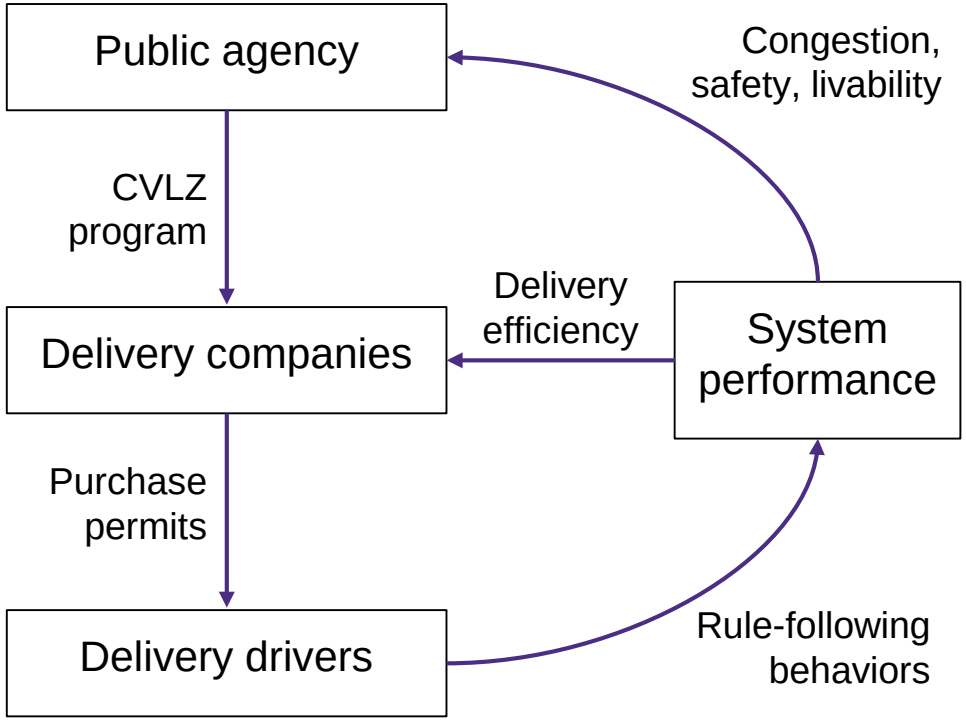
- LAZ Parking
- Terreno
- quadient

A behavioral perspective of urban freight

Develop scientifically based design principles and tools that support and balance efficiency, sustainability and equity in urban goods movements

- Dalla Chiara & Goodchild (2020) Do commercial vehicles cruise for parking ? Empirical evidence from Seattle
- Dalla Chiara et al. (2020) A Policy-Sensitive Model of Parking Choice for Commercial Vehicles in Urban Areas
- Dalla Chiara et al. (2021) Understanding Urban Commercial Vehicle Driver Behaviors and Decision Making
- Dalla Chiara et al. (2022) Providing curb information to delivery drivers reduces cruising for parking
- **Dalla Chiara & Goodchild (2025) The role of walking in last-mile deliveries**
- **Simoni & Dalla Chiara (2025) The Hidden Cost of Parking and Walking in Urban Last-Mile Delivery: Estimation through Inverse Optimization**

Seattle CVLZ permit program



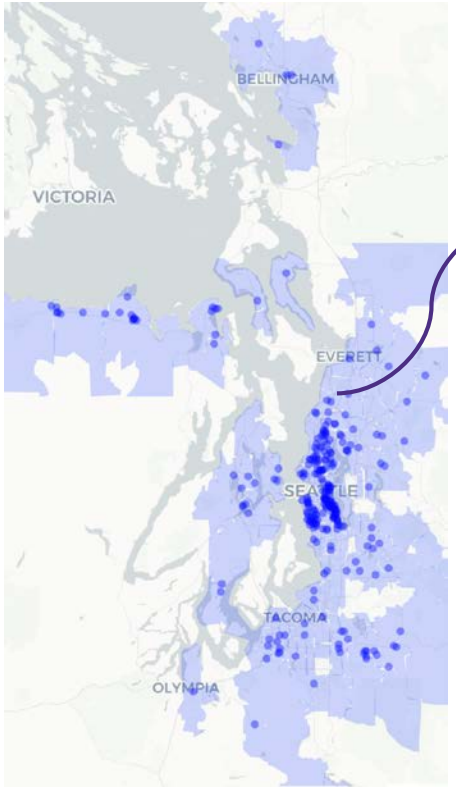
“Active” modes of urban goods movements

Delivery “walking routes” in NYC

Cargo bikes

Shopping & electro-mobility

Urban food emergency system



Mapped 275 community food micro-pantries

→ estimated 1.8 mil. kg food/Y

National Science Foundation

Pedaling Relief Project

cascade BICYCLE CLUB

PRP Pedaling Relief Project

Food bank home delivery program through cargo bike volunteers

Freight behaviors in infrastructure design & planning

NCHRP 08-176

Integrating freight and goods movements in Complete Streets design, policy and management

NCHRP NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Digitizing the Last -Mile of Urban Goods to Improve Curb Access and Utilization

Research objective: Improving curbside access and parking permit structure for commercial vehicles.

Data analysis: Including parking transactions, purchased permits, issued citations, video, interview, and survey.

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Biking the Goods

How North American Cities Can Prepare for and Promote Large-Scale Adoption of **Cargo e-Bikes**

Giacomo Dalla Chiara
Rishi Verma
Kelly Rula
Anne Goodchild

peopleforbikes™

MICHELIN

BOSCH

UFL website

Goods Movement 2030 Blog

Traffic-related Air Pollution (TRAP) Effects of E-commerce Warehousing:

Scenario equity analysis of technology and land use strategies

Co-PIs: Anne Goodchild and Julian D. Marshall,
Investigative team: Travis Fried, Sarah Dennis-Bauer, Giacomo Dalla-Chiara, and Oliver Olmedo

The Urban Freight Lab (UFL)
Dept. of Civil and Environmental Engineering, University of Washington (Seattle, USA)

Introduction and Research Aims

Source:[1] EIA (2018); [2] Wang & Zhou (2015); [3] Sakai et al. (2022)

In 2018, warehouses and distribution (W&D) surpassed retail, office, and manufacturing as the dominant commercial land use in the U.S. [1]

E-commerce was and continues to be a major driver of this growth. Residential delivery accounts for 25 -50% of urban freight trips. [2,3]

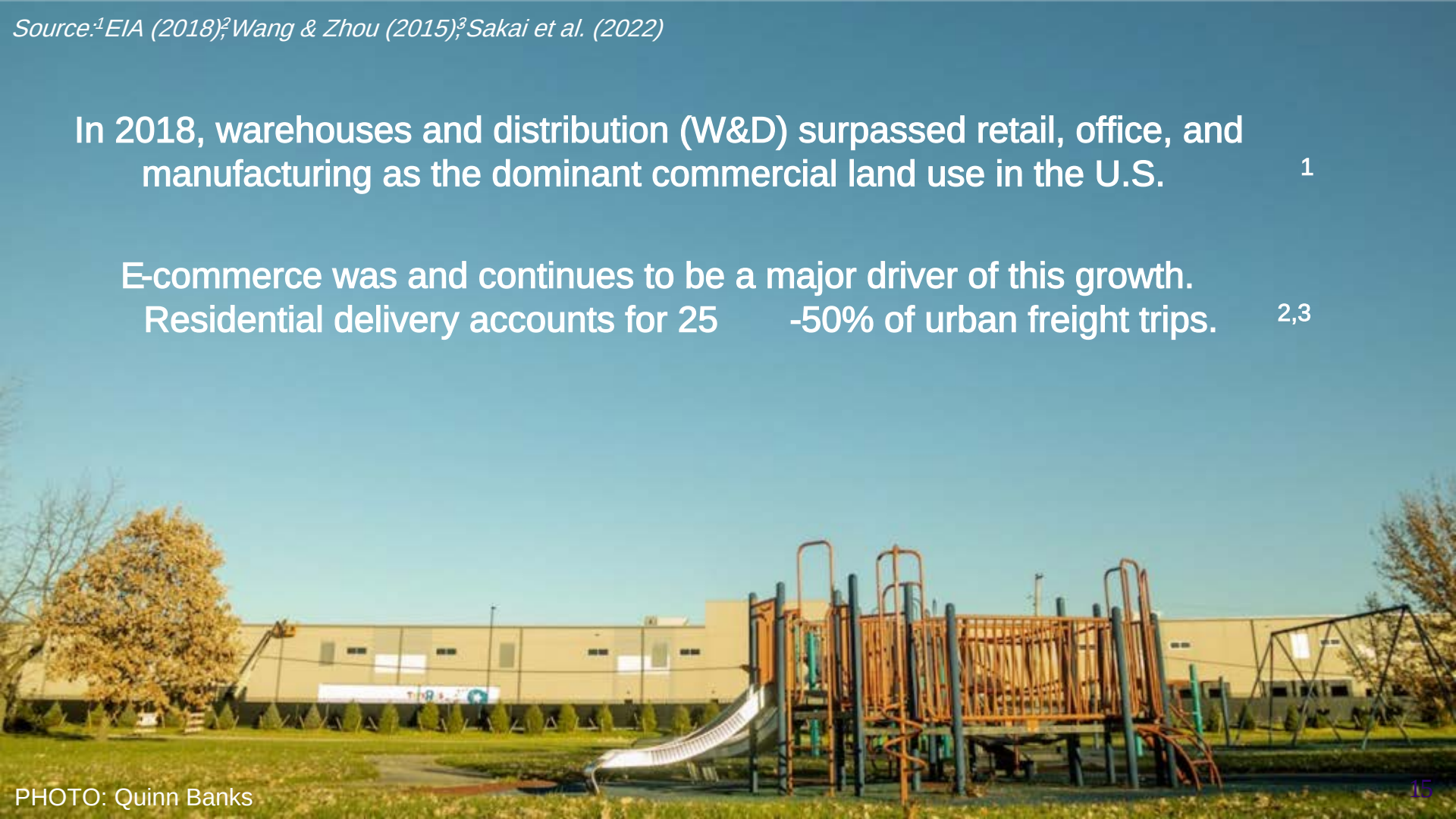


PHOTO: Quinn Banks

Source: [4] Kerr et al. (2024); [5] HEI (2025); [6] Yuan et al. (2018)

One study finds proximity to W&D enhances NO_2 exposure by 20% on average, [4] a pollutant attributable to 25,000 premature deaths annually. [5]

Among the most affected are Black and Hispanic populations, whose neighborhoods disproportionately host the highest share of facilities. [6]

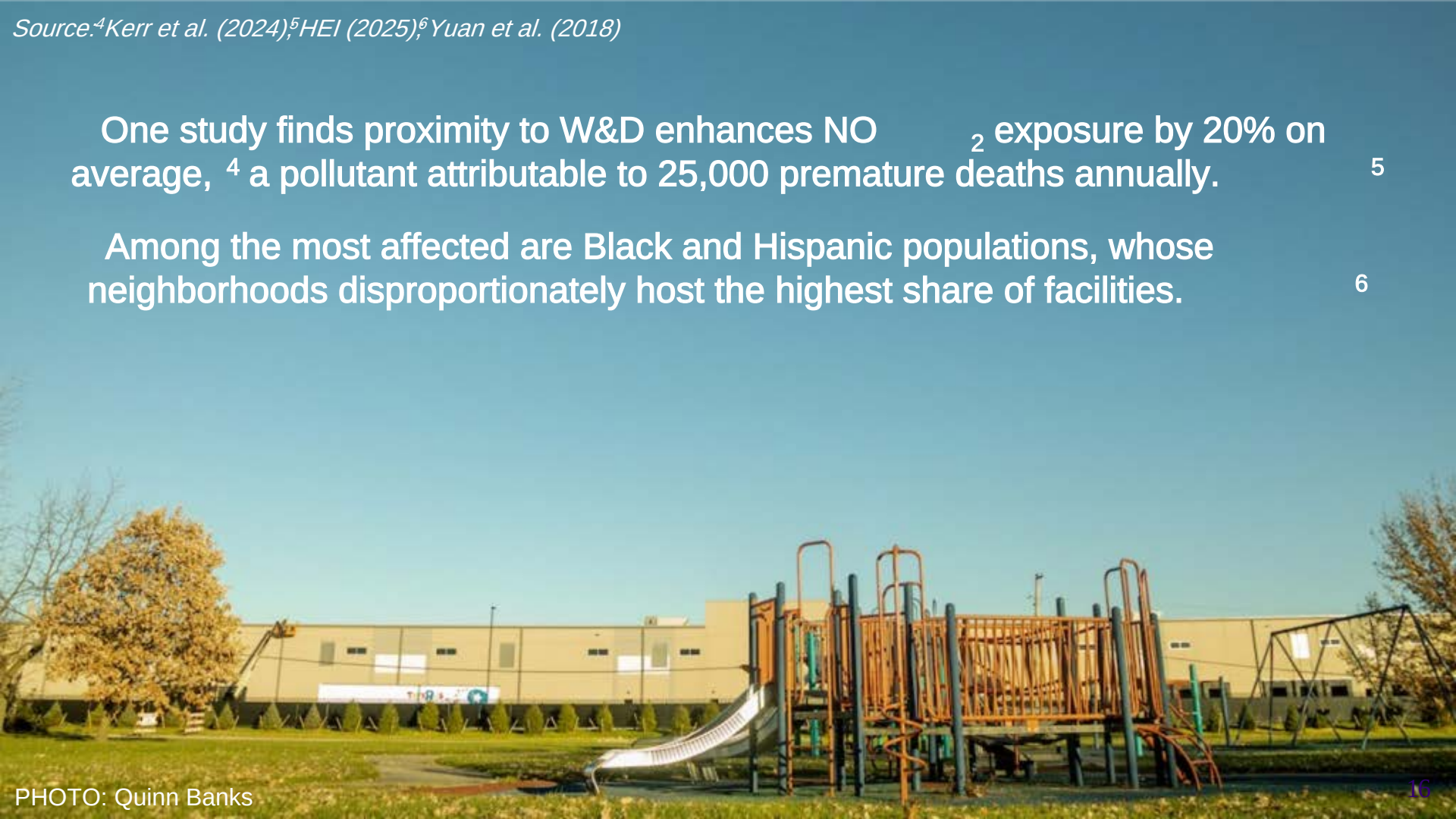


PHOTO: Quinn Banks

Source:[7] Fried et al. (2024);[8] Koolik et al. (2024);[9] Ramirez-Ibarra & Saphores (2023);[10] Fried et al. (2026)

Research Motivation

- Rise of e-commerce surfaced new(ish) forms of environmental inequity.
  - Delivery traffic frequently concentrates in neighborhoods that order the least, **but live near intensive e-commerce warehousing.** [7]

- Prevailing technological strategies (e.g., electrification) reduced vehicle emissions and exposure, **not disparities.** [8, 9]
  - Whereas **land use strategies,** which affect e-commerce facility location, are unexplored.[10]

[11] Buldeo Rai et al. (2022);[12] Katsela et al. (2021)

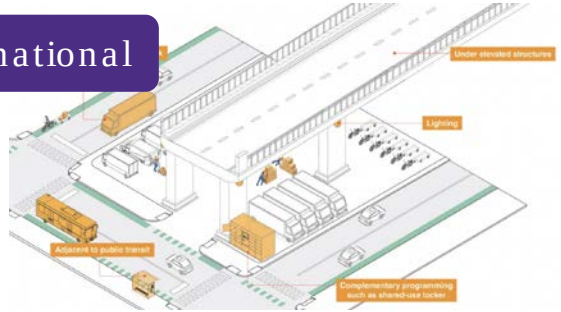
Future land use for e -commerce delivery?

> Promising **Proximity Logistics** models in Europe and **microhub pilots** in North America,[11,12] but their limited scale raises questions around policy barriers.

Logistics Sprawl (BAU)	Proximity Logistics	Microhubs

Some interviewees observe growing markets in Nevada and Arizona that serve SoCal

Multi-story, mixed-use **Logistics Hotel** in Paris repurposes abandoned railway depot



Off-street **microhubs** in NYC fostered by proposed freight and "**City of Yes**" policies

Microhubs & Urban Consolidation Centers

- Last-mile facilities that operate in Zipcodes with **high delivery demand**
- Facilitate the adoption of low impact vehicles, such as **cargo e -bikes**
- **Focus group identified challenges:**
  - High densities required to offset land costs (also possible incentives).
  - Permissive **zoning regulations** that allow off-street operations.
  - Efficient operations still require upstream urban consolidation **(UCCs)**

Cargo bike microhub in city -owned parking garage (Portland, Oregon)

Research Aims

- RA 1: How do shifts in operations, fleet technologies and e-commerce related land use affect TRAP, attributable health effects and disparities?
  - RA 1.1: Do land use-based strategies show greater potential to reduce health disparities?
  - RQ 1.2: Given the mismatch in deliver demand and traffic concentration, how does demand growth affect results?

- RA 2: What is the current state e-commerce related land use policies?
  - RA 2.1: Are they aligned with reforms likely needed to permit enable more equitable proximity logistics?

Research Aims

- RA 3: Land use decisions result from complex interactions between **private, public, and community actors**. How do these stakeholders describe conflicts and consensus pertaining to key freight issues…
  - RA 3.1: Uncertainty surrounding freight traffic generation and impacts
  - RA 3.2: Supply chain complexity and fragmentation
  - RA 3.3: Entitlement processes, development costs, and land use constraints
  - RA 3.4: Enviro-economic trade-offs and political exclusion

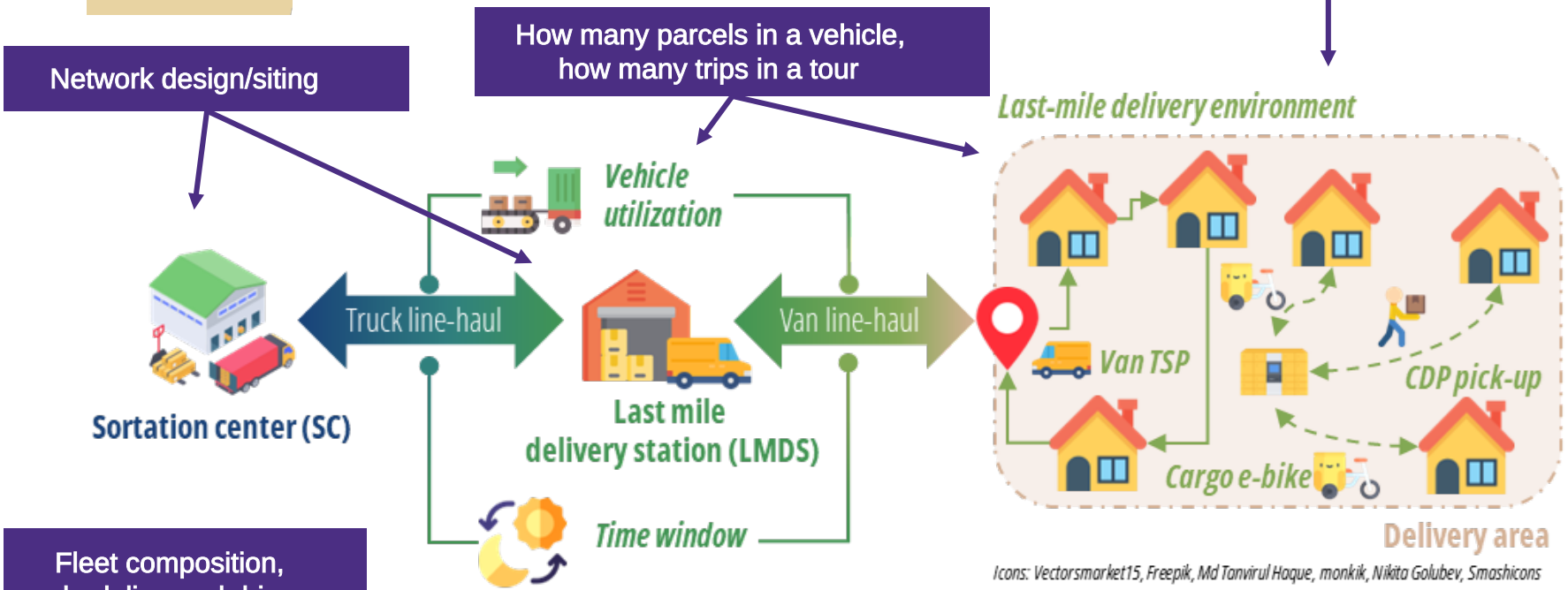
Background and Overarching Approach

Modeled delivery environment

Last -mile efficiency adaptations
(e.g., parcel locker or workplace pick -up)

Network design/siting

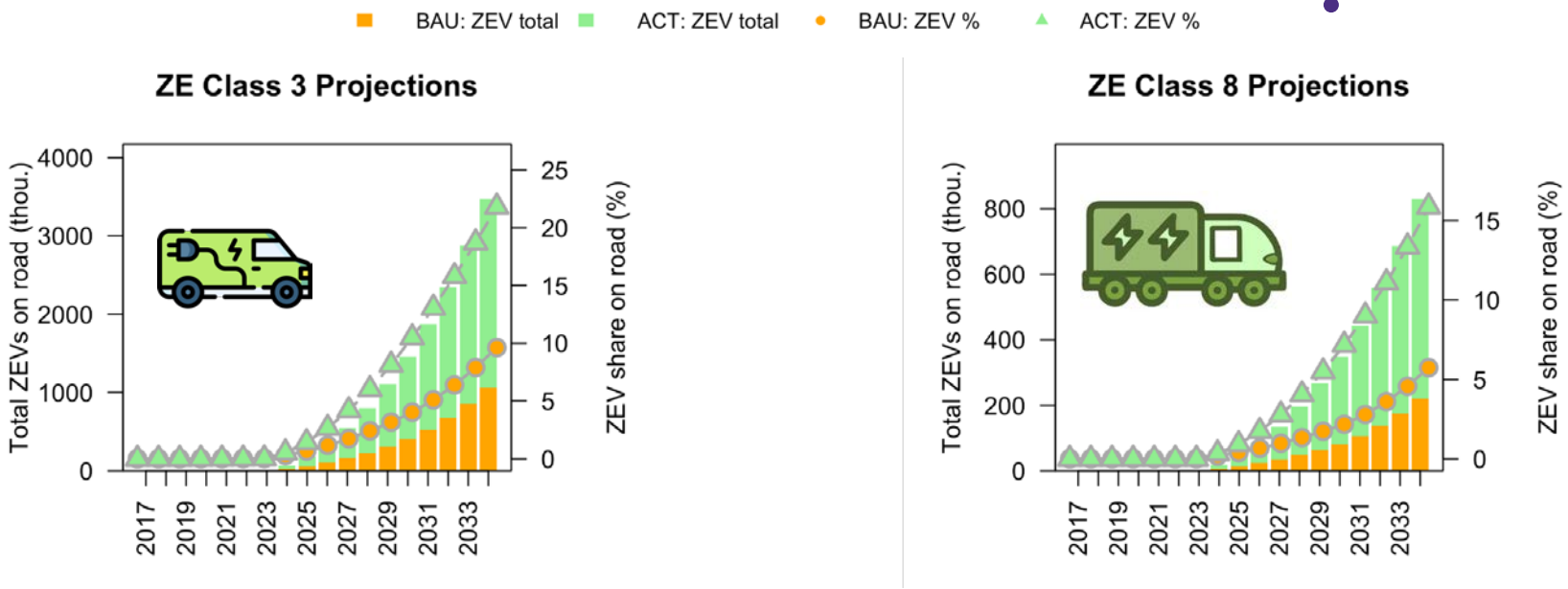
How many parcels in a vehicle,
how many trips in a tour



Fleet composition,
scheduling and drive -
train technology

Fleet electrification scenarios

VISION (2022) diesel vehicle disadoption model



BAU: IEA and BNEF projections, assumes **38% and 22% EV sales-share** for vans (Class 3) & trucks (Class 8) by 2034

ACT: California targets, assumes **70% and 48% EV sales-share** for vans (Class 3) & trucks (Class 8) by 2034

Fleet electrification scenarios

- **Advanced Clean Fleet (ACF):**
  - 100% Class 3 EV fleet share
  - 49% Class 8 EV fleet share

Table 1

Zero-emission vehicle fleet stock requirements under the ZEV Milestones Option by group

Percentage of all vehicles that must be ZEVs	10%	25%	50%	75%	100%
Milestone Group 1: Box trucks, vans, buses with two axles, yard tractors, and light-duty package delivery vehicles	2025	2028	2031	2033	2035 and beyond
Milestone Group 2: Work trucks, pickup trucks, day cab tractors, and buses with three axles	2027	2030	2033	2036	2039 and beyond
Milestone Group 3: Sleeper cab tractors and specialty vehicles	2030	2033	2036	2039	2042 and beyond

Sources: California Air Resources Board, "Advanced Clean Fleets Regulation - ZEV Milestones Option," December 13, 2023, https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-fleets-regulation-zev-milestones-option. For vehicle definitions, see California Air Resources Board, "Advanced Clean Fleets Regulation – ZEV Milestones Option Details," January 2, 2024, https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-fleets-regulation-zev-milestones-option-details.

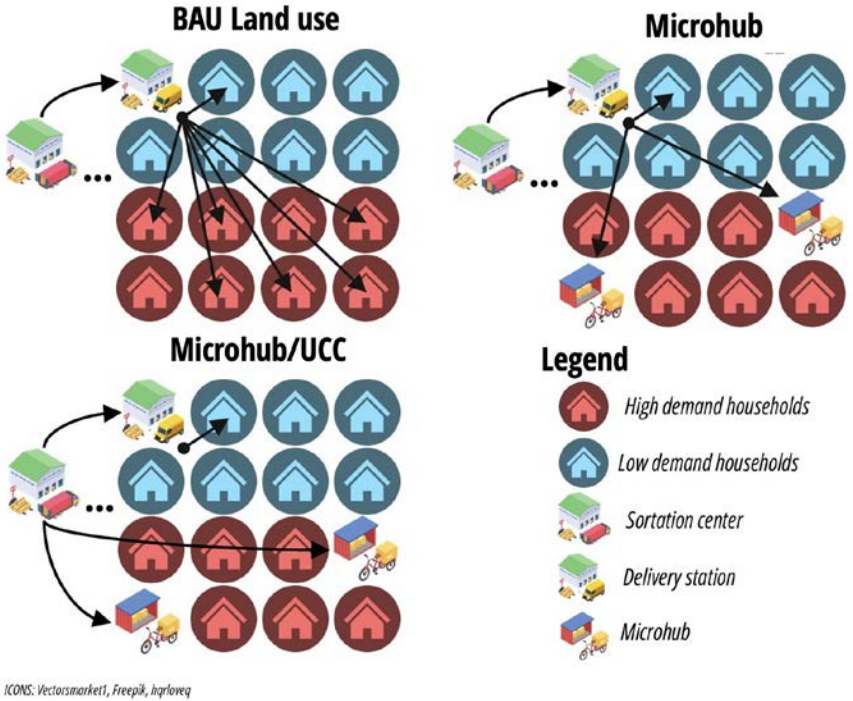
Source:[13] *ICCT (2025)*

[9] *Facility data validated from MWPVL (2024)*

Land use scenarios

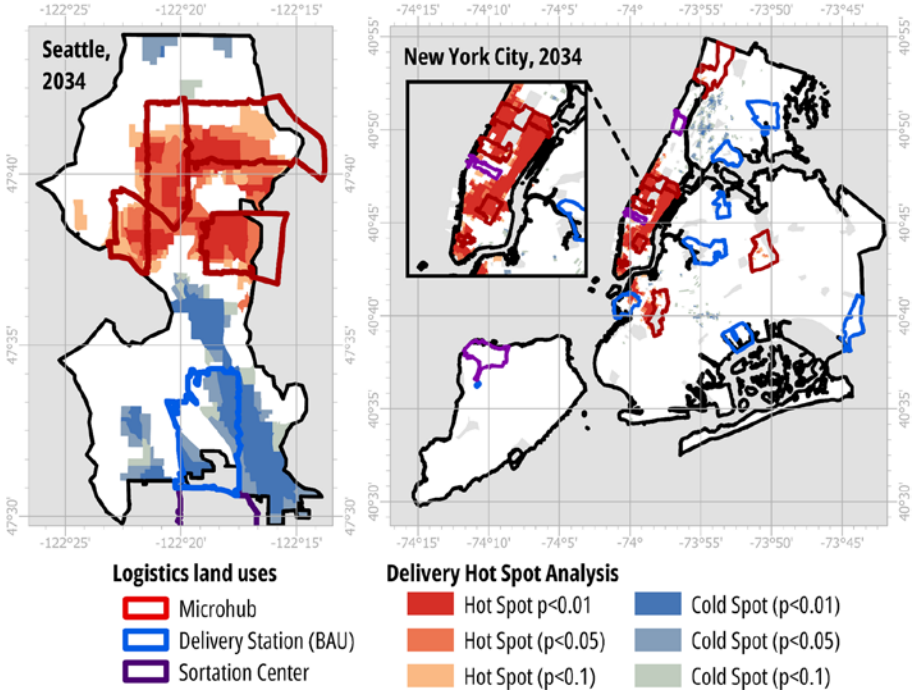
> 3 identified depot configurations

- **BAU (L=1):** intensification in Zipcodes containing at least one Amazon, Target or Walmart facility in 2024.[9]
- **Microhub (L=2):** Class 3 vehicles serve closest hub from delivery station.
- **Microhub + UCC (L=3):** additional consolidation at sortation center.



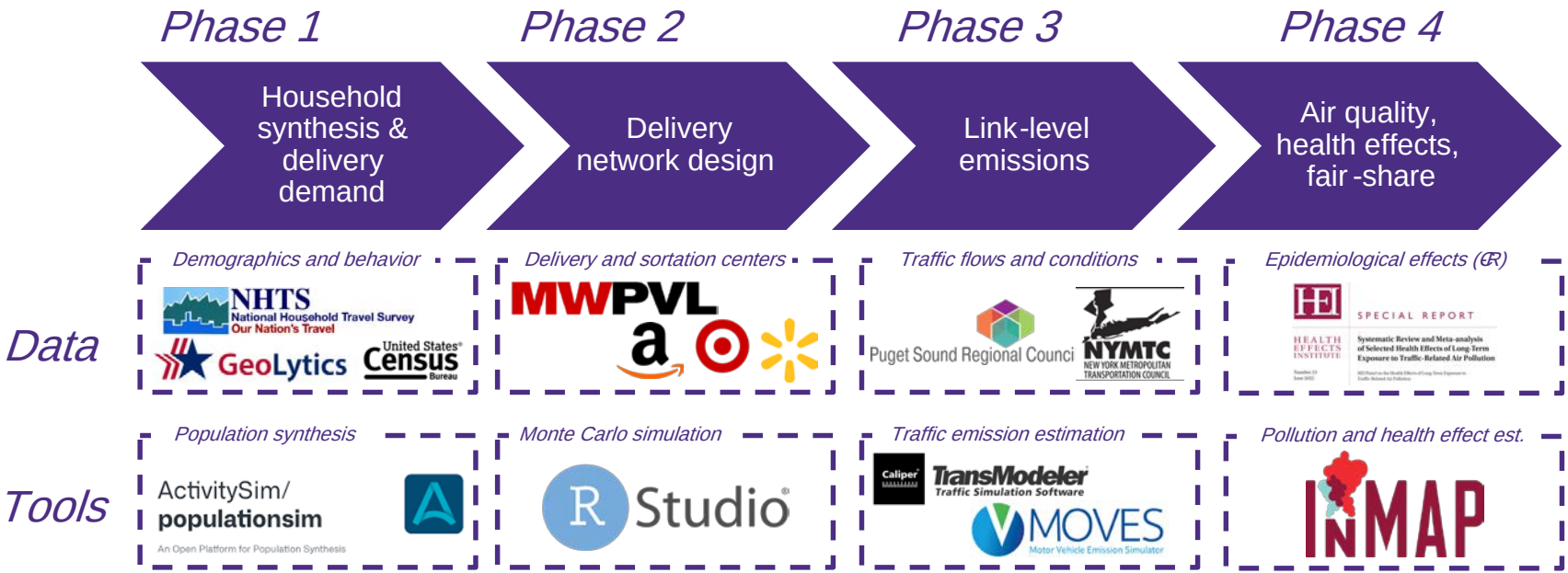
Microhub selection criteria

- Significant density in demand for deliveries (Getis -Ord Gi*).
- Zoning could permit off -street micro -distribution.
- Microhubs are 3 -miles apart, the maximum radius of cargo bike/light EV operating model.



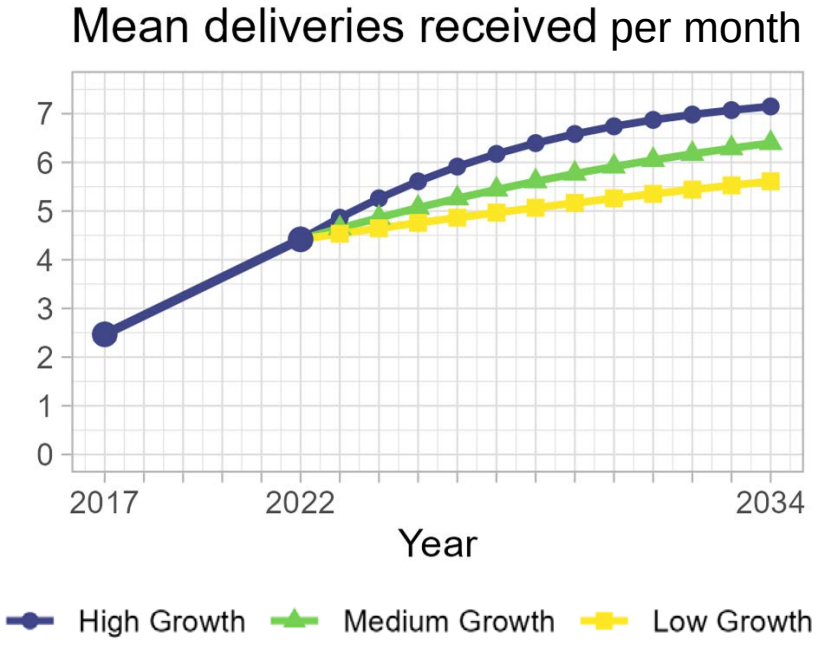
Analysis of technology and land use scenarios

Four - phased methodology



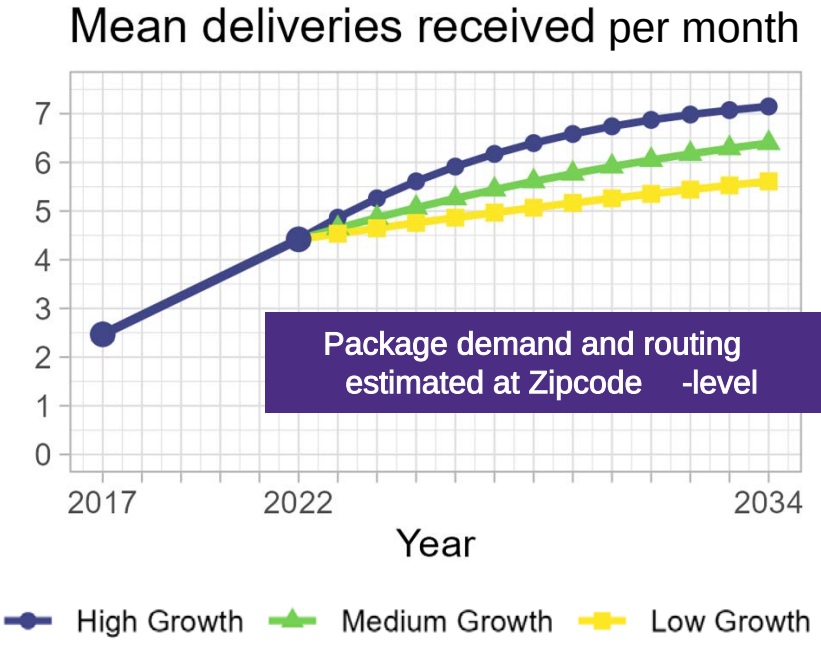
[13] *Assumes fastest period of ecommerce growth occurred between 2017 and 2022, and upper limit does not surpass linear extrapolation of the mean CAGR (4.5%) (USPS, 2024)*

Household delivery demand

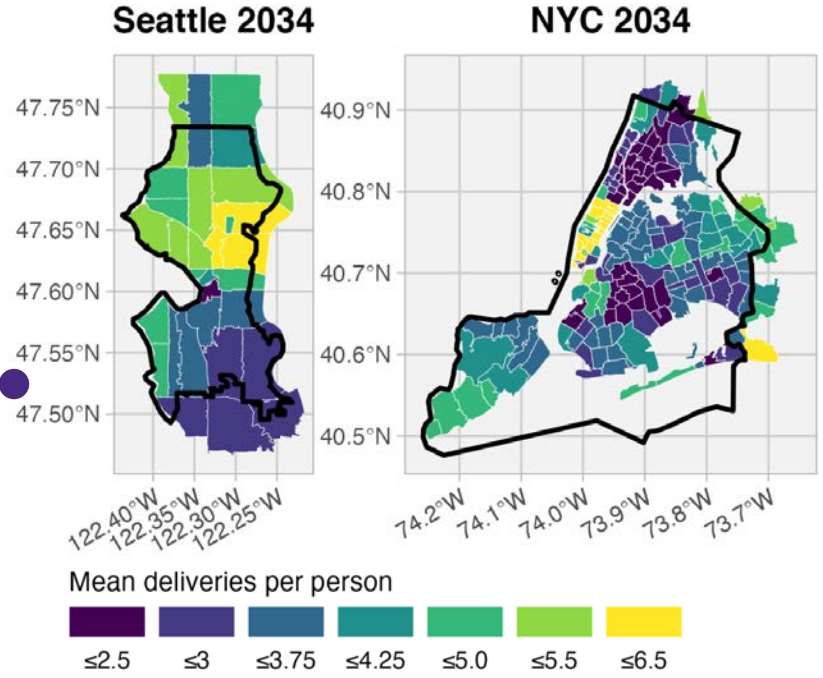


- Projections and model fitting based on 2017 and 2022 NHTS
- Considers survey -weighting, over -dispersion and zero -inflation
- Growth assumes max saturation at 7.5 mean deliveries/mo. [13]

Household delivery demand



Package demand and routing estimated at Zipcode -level



Facilities aggregated to Zipcode centroid and serve nearest destination

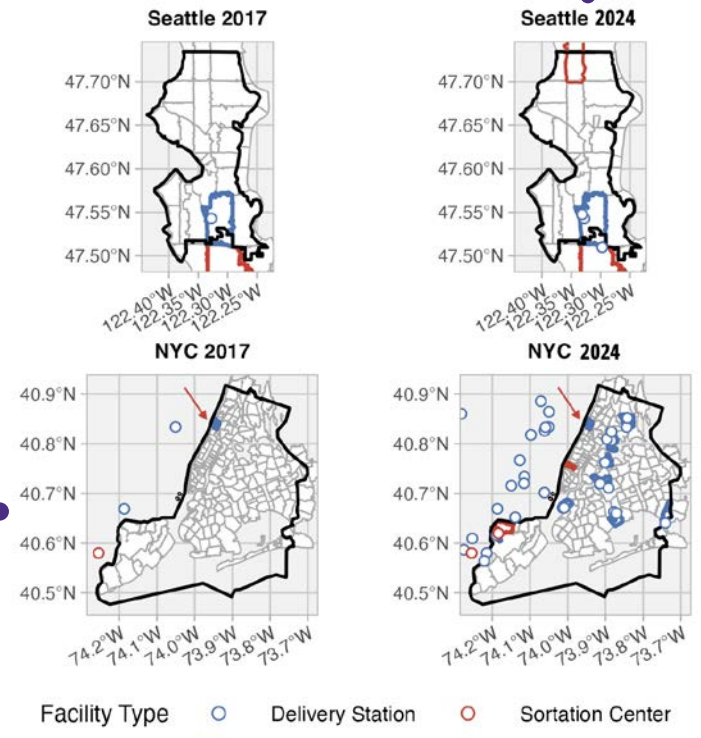
Delivery network and operations

> Vehicle load factor distributions:

- **Base:** 50% mode utilization
- **Boost:** 100% mode utilization

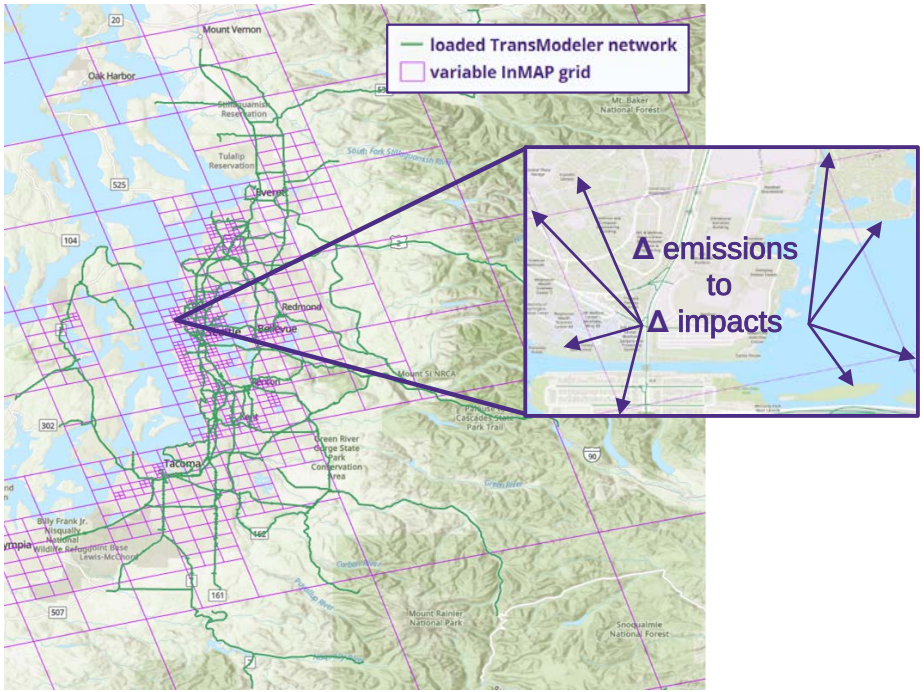
NYC's logistical urban form changed substantially between 2017 and 2024…

…this will be relevant in the equity analysis

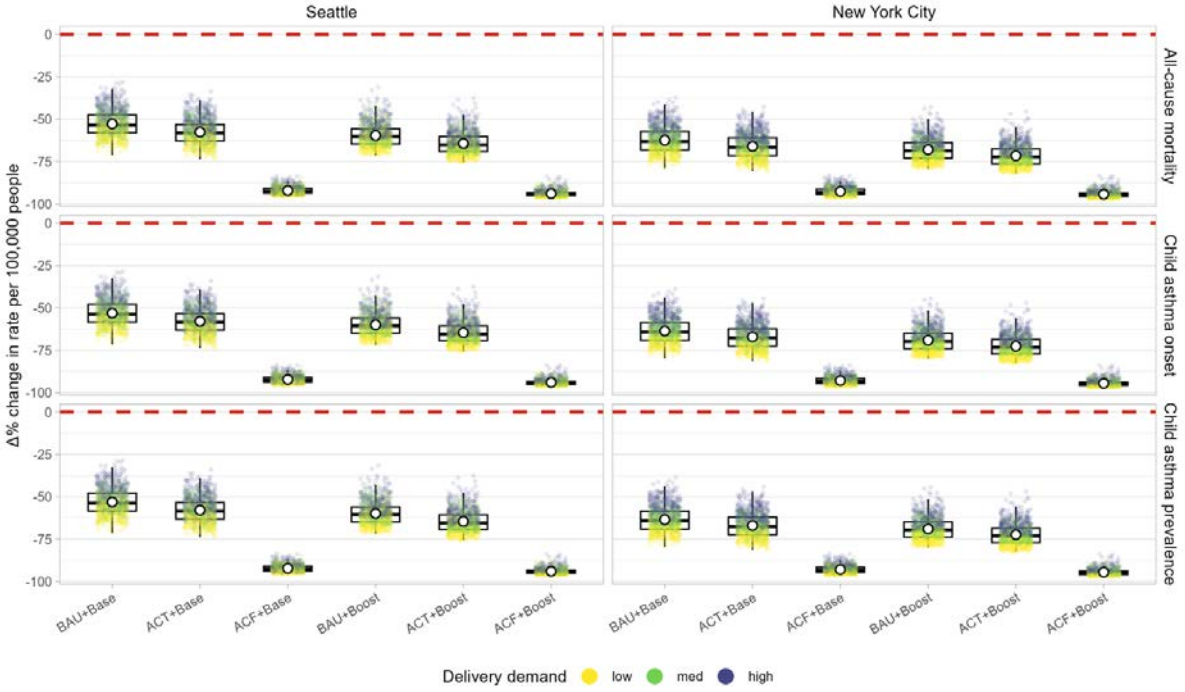


Link - level emissions

- Dynamic Traffic Assignment conducted using PSRC and NYMTC activity-based models
- Validated with state DOT AADT data, at ~60% accuracy
- Path incidence and vehicle op modes input into EPA MOVES5



Effects of operations and electrification



ACF electrification reduced all health outcomes by **92-94% on average** regardless of operations.

Racial equity, fair -share (FS), and excess cases (EC)

- Do racially marginalized groups bear higher share of health burdens relative to their delivery share?

FS for group a =

$$\frac{Health\ burden_a / Health\ burden_{tot}}{Deliveries_a / Deliveries_{tot}}$$

FS_a=1.0, *relative health burden is proportional to delivery share.*

Racial equity, fair -share (FS), and excess cases (EC)

> How much excess health burden does that (un)fairness equate to?

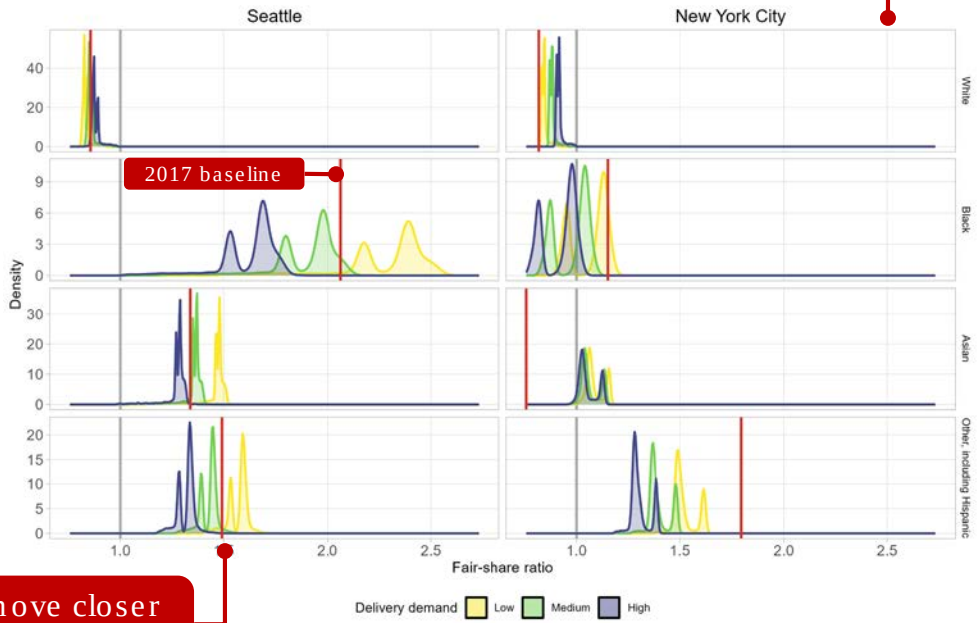
$$EC \text{ for group } a = Health\ burden_a - \left(\frac{Deliveries_a}{Deliveries_{tot}}\right) * Health\ burden_{tot}$$

EC_a= 0, *absolute health burden is proportional to delivery share.*

NYC: 95% of simulations move closer to parity relative to 2017 baseline

Racial FS improved under *most* scenarios

	Delivery demand	Mean FS [White]	Mean FS [Black]	Mean FS [Asian]	Mean FS [Other, Hispanic]
Seattle 2034	High	0.88	1.62	1.46	1.32
	Med	0.86	1.90	1.35	1.43
	Low	0.84	2.29	1.46	1.57
NYC 2034	High	0.92	0.92	1.05	1.31
	Med	0.88	0.98	1.07	1.40
	Low	0.84	1.07	1.09	1.52

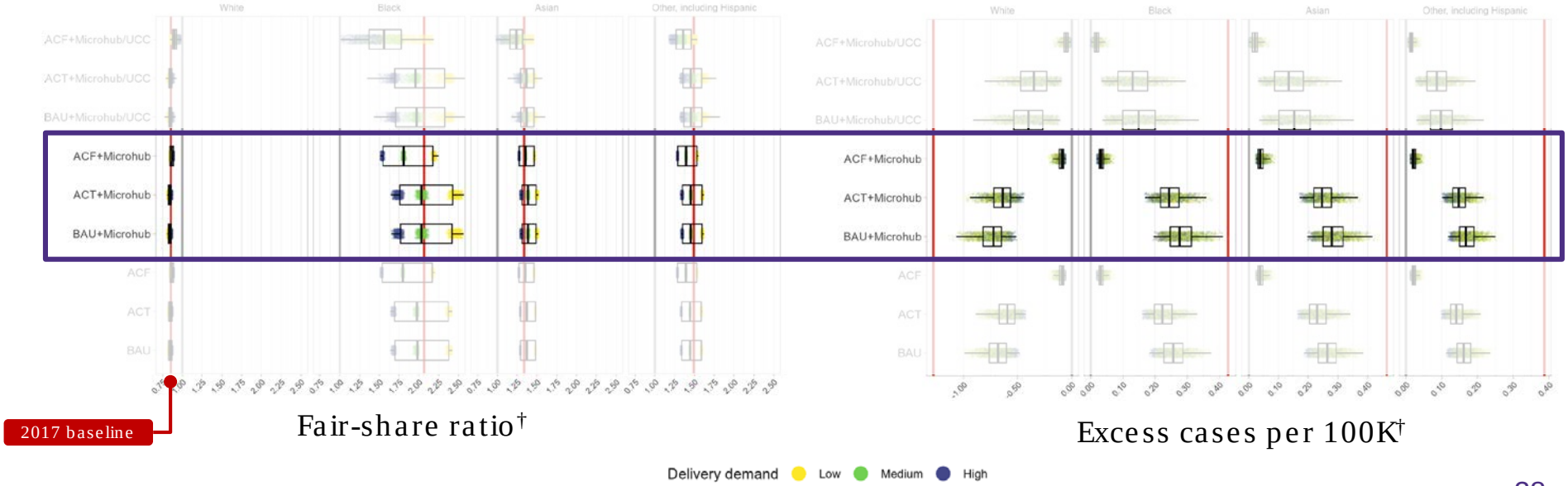


SEA: 58% of simulations move closer to parity relative to 2017 baseline

†*All-cause mortality per 100,000 people*

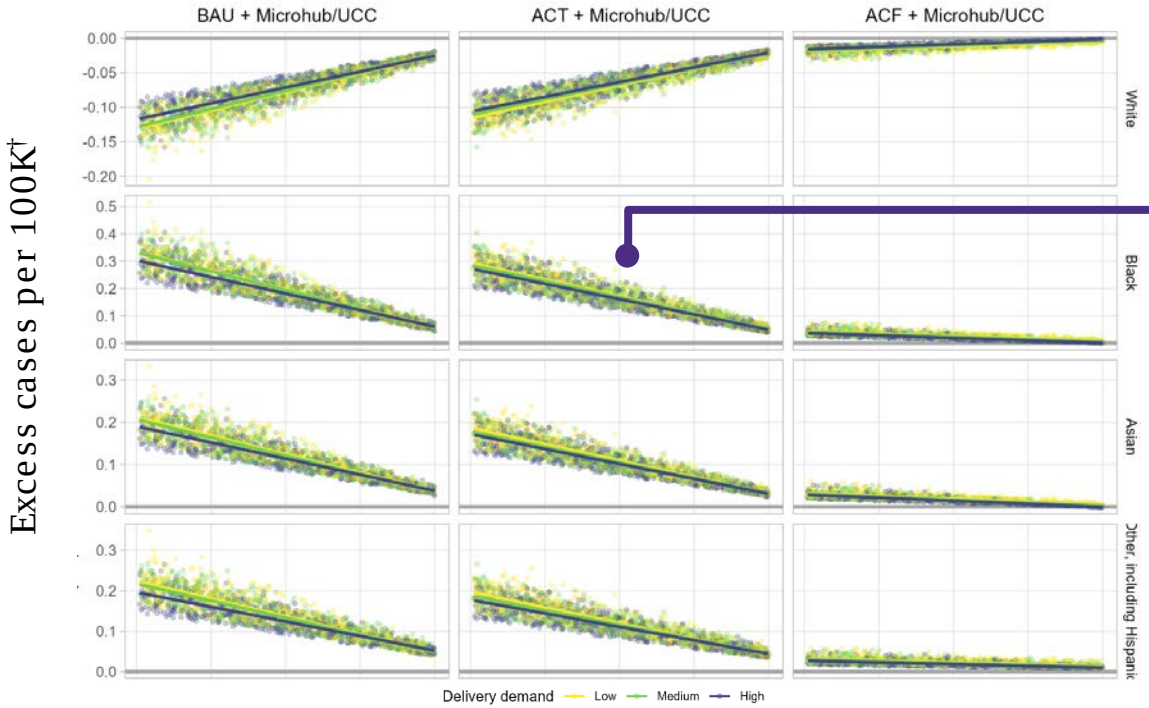
Effects of land use on FS and EC in Seattle

> Microhubs without UCCs did not improve health equity



†*All-cause mortality per 100,000 people*

Increased Microhub+UCC utilization improves health equity in Seattle



0.2 excess mortality (per 100K) reduction per 10% increase in Microhub/UCC utilization

Conclusion —It all matters

- Electrifying fleets —particularly, diesel cargo vans—reduced all-cause mortality, childhood asthma onset and prevalence compared to BAU.
- Operational efficiencies can offer significant improvements compared to electrification and landuse changes
- Landuse strategies can also contribute to improvements, particularly when applied with upstream consolidation

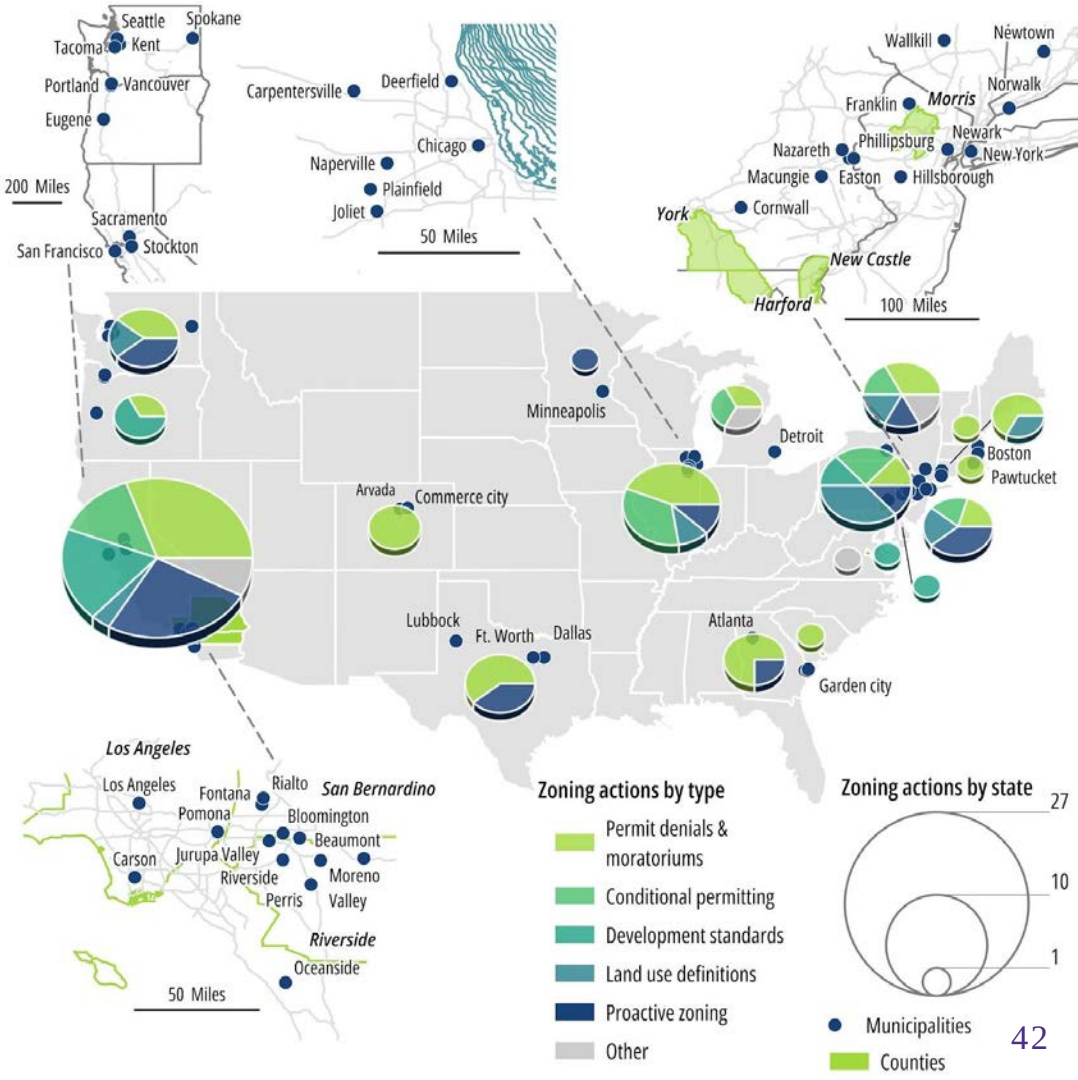
State of E -commerce Land Use Policy*

* Findings published in the Journal of the American Planning Association (JAPA)

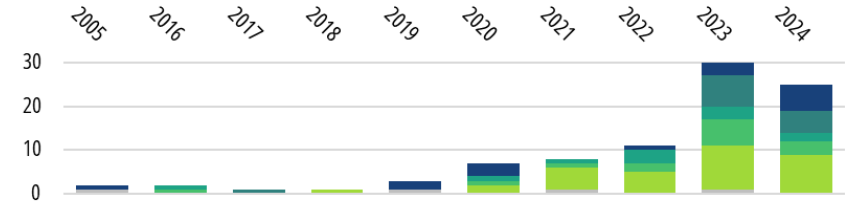
Sample overview

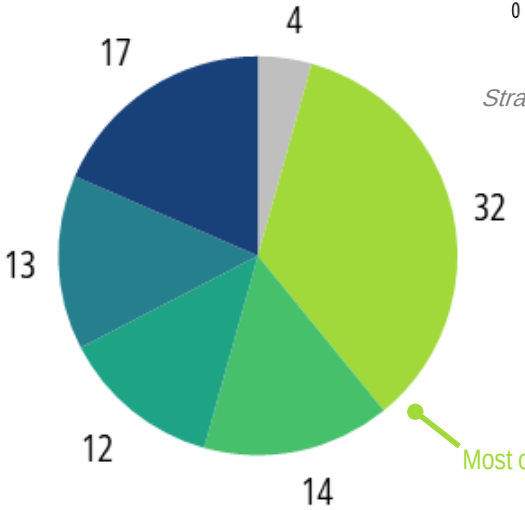
> Examines **92 zoning actions** across 3 jurisdiction levels:

- 52 municipalities
- 9 counties
- 7 states, including:
  - > W&D Best Practices (NJ)
  - > PennFuture's W&D Best Practices (PA)
  - > AB-98 (CA)
  - > AG Bonta's W&D Best Practices (CA)
  - > Clean Deliveries Act (proposed in NY)
  - > Warehouse Indirect Source Rules (ISRs)



Synthesizing a Zoning Action Typology





Most common response

Strategic

Long-term planning

Can include broad zoning reforms
(e.g., form-based codes, performance zoning)

Land use definitions

What zones permit or prohibit W&D

Development standards

Building and lot specifications
(e.g., buffers, EV charging, loading door orientation)

Conditional permitting

Public review/hearings and conditions for approval

Denials

Spot zoning/site permit denials and moratoriums

Regulatory

Discretionary

Conclusions

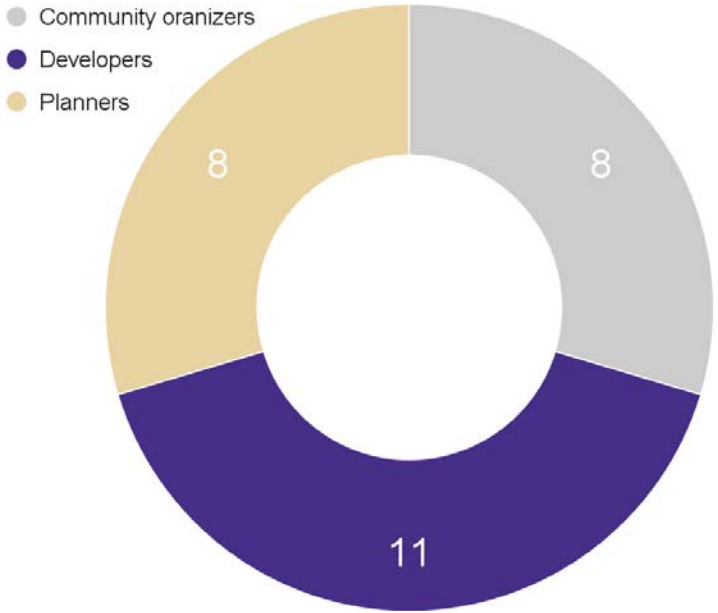
- The sample lacks a unified regulatory approach to W&D development.
  - Discretionary approaches offer opportunities for public participation and enhanced development standards, but comes with drawbacks.
- Zoning actions largely restrict W&D development
  - Only NYC's "City of Yes" reform offered considerations for micro-consolidation
- Equity is not a central feature in most observed discretionary and regulatory actions.
  - Most actions cite "community character" concerns unspecific to population subgroups.
  - Case jurisdictions not socio-demographically more vulnerable than residing state.
- Local jurisdictions with more equity-explicit actions have supporting long-term plans, as well as state pre-emptive policies and guidelines.

Multi-stakeholder Perspectives Concerning Land Use Policy Change*

* Findings submitted to Transportation Research Interdisciplinary Perspectives (TRIP)

Stakeholders interviewed

Interviews completed

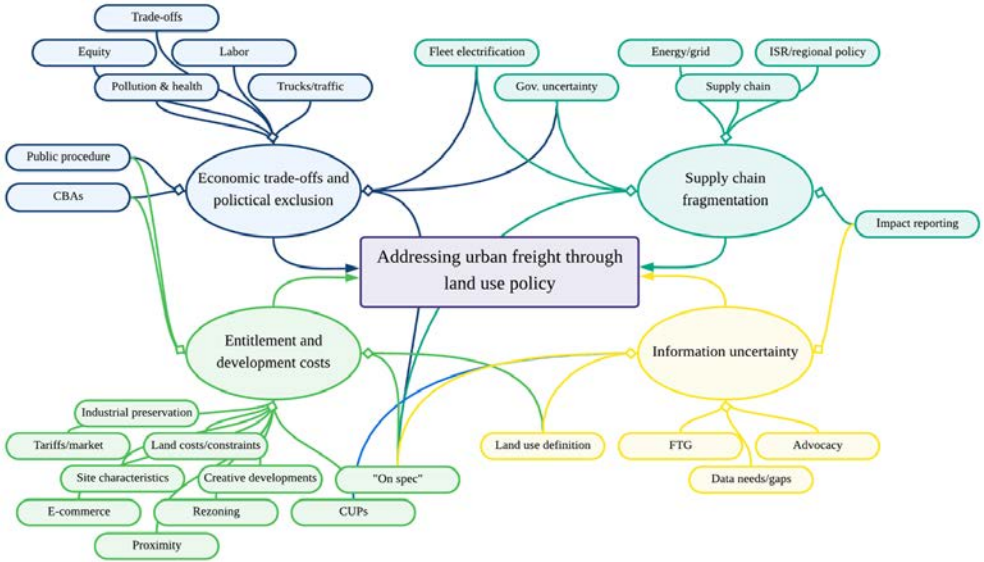


Topics discussed…

Community benefit agreements & public notices	Traffic impact reporting	Effects of zoning on investment & development
Public -private collaboration and “permit by right”	Indirect Source Rules and AB -98	EV charging readiness and building considerations
Conditional use permitting (CUPs)	Tariffs and the future of e - commerce	Warehouse owner, tenant, and fleet operator dynamics

Coding and thematic analysis

> Four themes of **conflict and consensus** identified across 40 topical codes



Areas of conflict and consensus

Themes	*Source of conflict*	*Areas of consensus*
Information uncertainty	• **Developers** : speculative projects lack tenant-specific data • **Planners** : existing FTG methods poorly predict facility operations • **CBOs**: traffic studies may understate impacts or selectively use data	• Improve freight data collection and FTG estimation methods • Combine quantitative modeling with context-specific knowledge and monitoring
Supply chain fragmentation	• **Developers** : limited control over fleets and jurisdictional differences in regulations affect compliance decisions • **Planners** : utility and infrastructure constraints hinder compliance • **CBOs**: compliance costs shifted onto workers and neighboring communities	• Regionally coordinate freight and environmental planning • Align regulations and incentives across supply chain actors.
Entitlement and development costs	• **Developers** : entitlement delays and industrial land scarcity deter investment • **Planners** : zoning poorly reflects freight needs and impacts • **CBOs**: development timelines outpace participatory procedures	• Establish regulatory expectations before entitlement • Zone proactively for freight land use needs and impacts
Economic trade -offs & political exclusion	• **Developers** : W&D supports economic activity and job creation • **Planners** : environmental mitigations may not fully address community concerns • **CBOs**: communities bear impacts without perceived proportional benefits or influence in land use decisions	• Incorporate participatory processes early in planning • Invest in trusted intermediaries to facilitate conflict resolution • Codify neighborhood benefits and investment in development agreements when relevant

Questions & Feedback?