



U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy

# Improving Delivery Efficiency and Understanding User Behavior through Common Carrier Parcel Lockers

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**PennState**



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# INTRODUCTION

- Explosive growth in e-commerce has spurred dramatic demand for deliveries in urban areas.
- **Common-carrier parcel lockers** present a potential solution to the last-mile delivery challenges:
  - Provide a **secure, automated, self-service central hub** from which a consumer can receive packages from any carrier
  - **Create delivery density**, resulting in **reduced vehicle dwell time**
  - **Reduce failed delivery attempts** and the need for an additional trip
  - **Lower costs** for delivery firms
  - **Reduce delivery VMT, traffic congestion and emissions**



# RESEARCH QUESTIONS

- RQ1: How much would parcel lockers reduce **delivery times**?
- RQ2: How much would people **use parcel lockers**?
- RQ3: What would be **users' attitude** toward parcel lockers?

# LOCKER INSTALLATION

We installed a common-carrier parcel locker in a multi-story residential building in Seattle, WA.

- June 2020
- Mixed-use neighborhood
- 26-story building
- 133 units



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# DATA COLLECTION

## Field Data Collection



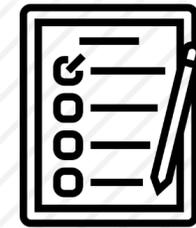
- Before (Jun 2020) and after (Feb 2021) locker
- Building entrance/exit and nearby parking spaces
- Commercial vehicle arrival and departure at the curb
- Courier's entry to and exit from the building

## Locker Usage Data



- 7 months (Jun-Dec 2020)
- Provided by the locker provider company
- Anonymous user & HH ID
- Package size
- Delivery and pickup timestamps
- Carrier

## Resident Survey



- Online survey (March 2021)
- Emails & flyers + raffle prize
- 60% response rate
- Online shopping behavior
- Socio-demographics
- Reported frequency of lost/missed packages
- Satisfaction



## RQ1: How much would parcel lockers reduce delivery times?

There has been no empirical analysis of impacts of parcel lockers on delivery times and traffic congestion.



We collected data before and after locker installation from the study building, as well as a similar nearby building as a control.

We applied a **causal inference method** and built regression models for **in-building time** and **vehicle dwell time** at the curb, to estimate the locker impacts.



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# RQ1: How much would parcel lockers reduce delivery times?

We found that the locker resulted in ...



in average **time spent in the building**



in delivery vehicles' **dwell time** at the curb

(Not statistically significant)

We controlled for the volume of packages carried in and out of the bldg, time of day, parking space type, and vehicle type.



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## RQ2: How much would people use parcel lockers?

We performed a descriptive analysis on the locker usage data, and found:

- A typical user received **one package every 5.5 days**.
- On average, users ordered **47% small, 38% medium**, and 13% large packages.
- **Time-to-pickup**: Mean = 12.5 hrs, Median = 4.2 hrs
- **84% of pickups happened within 24 hrs of delivery**. Time-to-pickups increased on weekends and during holidays.
- **Weekend deliveries** accounted for a small percentage (19%) of all deliveries.
- Package deliveries **almost doubled during Fall and Winter seasons**.
- The **peak delivery hour** for the building was **9-11 am**. This window widened moving into the busy holiday season.

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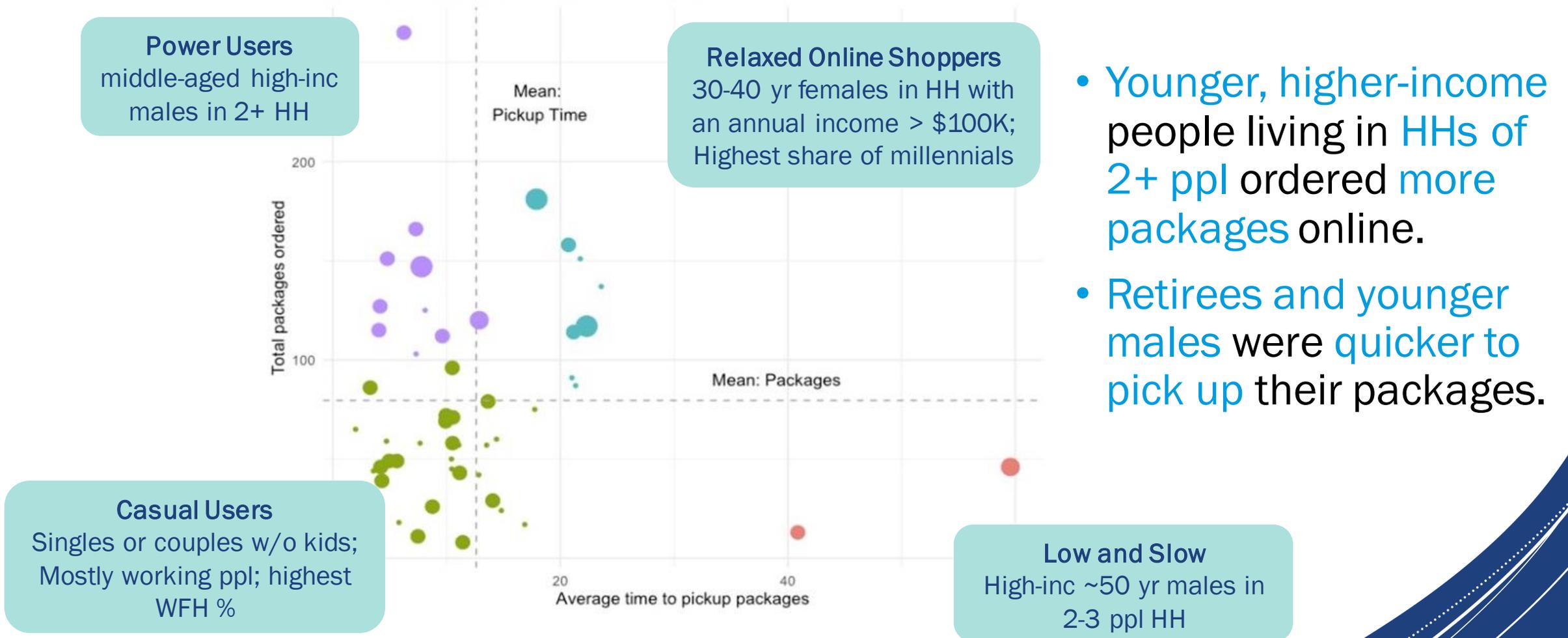
\*This research was carried out during COVID-19 pandemic, a period when residential areas saw dramatic spikes in package deliveries.



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## RQ2: How much would people use parcel lockers?

We clustered locker users based on the total number of packages ordered and average time-to-pickup.



- Younger, higher-income people living in HHs of 2+ ppl ordered more packages online.
- Retirees and younger males were quicker to pick up their packages.

## RQ3: What would be users' attitude toward parcel lockers?

- **96% of residents reported satisfaction with the locker, with much fewer missed or stolen deliveries.**



- Bldg managers reported **90% drop in the resident manager's workload.**

# SUMMARY

The results provided evidence that common carrier lockers are an efficient way of urban delivery and **can reduce commercial vehicle delivery time** and lower costs, while **improving package security and user satisfaction.**



# THANK YOU !

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