RSG — the science of insight

How Do Transport Impacts of Delivery Drones Compare to Other Delivery Modes?

18 September 2019

Delivery Context

Delivery of Small Items

DRIVE TO A STORE   **USE DELIVERY SERVICE**   **USE DELIVERY DRONE**

Delivery of Small Items

I'M HUNGRY!

I NEED MEDICINE!

What are my options?

DRIVE TO A STORE

USE DELIVERY SERVICE

USE DELIVERY DRONE

What are the CO_2 emissions associated with each?

CO$_2$ Emissions from Delivery of Small Items

DRONE DELIVERY OF SMALL ITEMS DIRECTLY TO CUSTOMERS

- How do the CO$_2$ emissions from these trips compare to customers going to stores to buy goods themselves?

- Or to on-demand delivery services like UberEats, Postmates, or DoorDash?

What can we expect?

The impact of drones on delivery emissions is only just beginning to be evaluated. Projects that have considered the emissions of passenger travel, delivery services, and drones provide some insight.

NOTABLE FINDINGS

- Energy and emissions efficiency for deliveries depends on
    - Hub locations
    - Vehicle type

- Consolidating deliveries yields energy saving and emissions benefits
    - One-off deliveries have the highest amounts of travel

- Flight is substantially more energy intensive than ground travel
    - But drones are much smaller than traditional ground vehicles

- Drones can travel "as the crow flies"
    - Ground vehicles must use less-direct road networks

Evaluating Delivery of Small Items

To evaluate the CO_2 emissions from the three different transport systems, vehicles were routed between homes and stores or the drone depot.

OVERALL METHOD

- Identify residential locations

- Central drone depot

- Identify retail locations

- Route drones

- Route vehicles

- Determine emissions

Case Study

Representing Delivery of Small Items
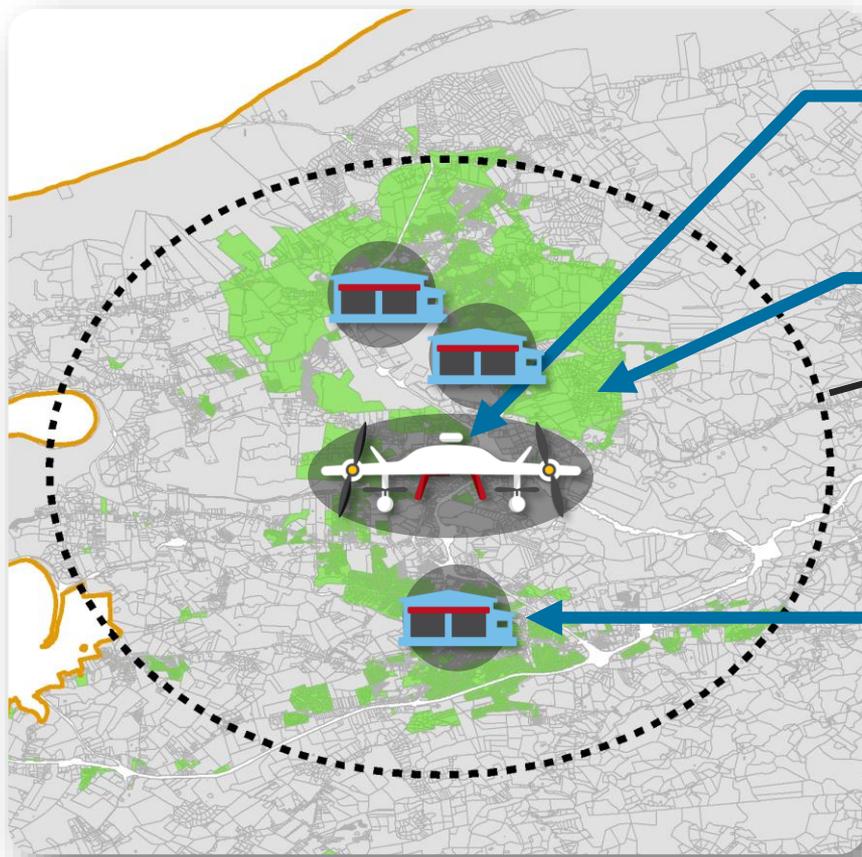
Drone Depot

- Centrally located

Residential Locations

- Within 10 km of the depot
- Sampled from parcel data

Commercial Locations

- Reflect driving destinations

Drive to the Store
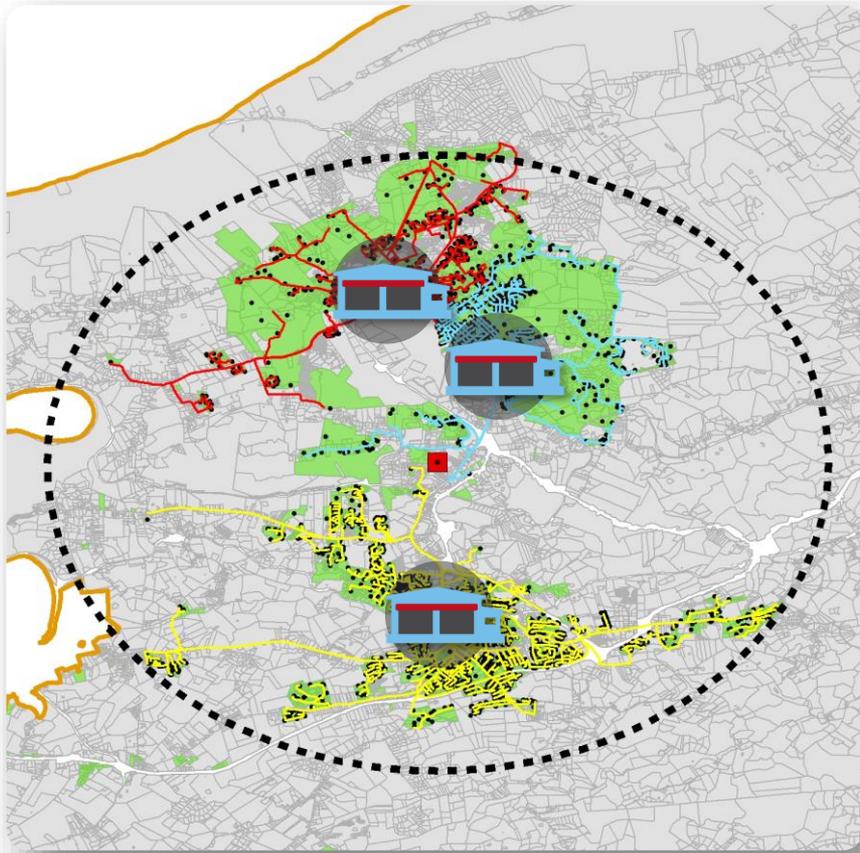
Driving to the Store

- Between homes and commercial locations

- Use real road network

  - Road classification hierarchy

  - Posted speeds

  - Associated emissions

Use Delivery Service
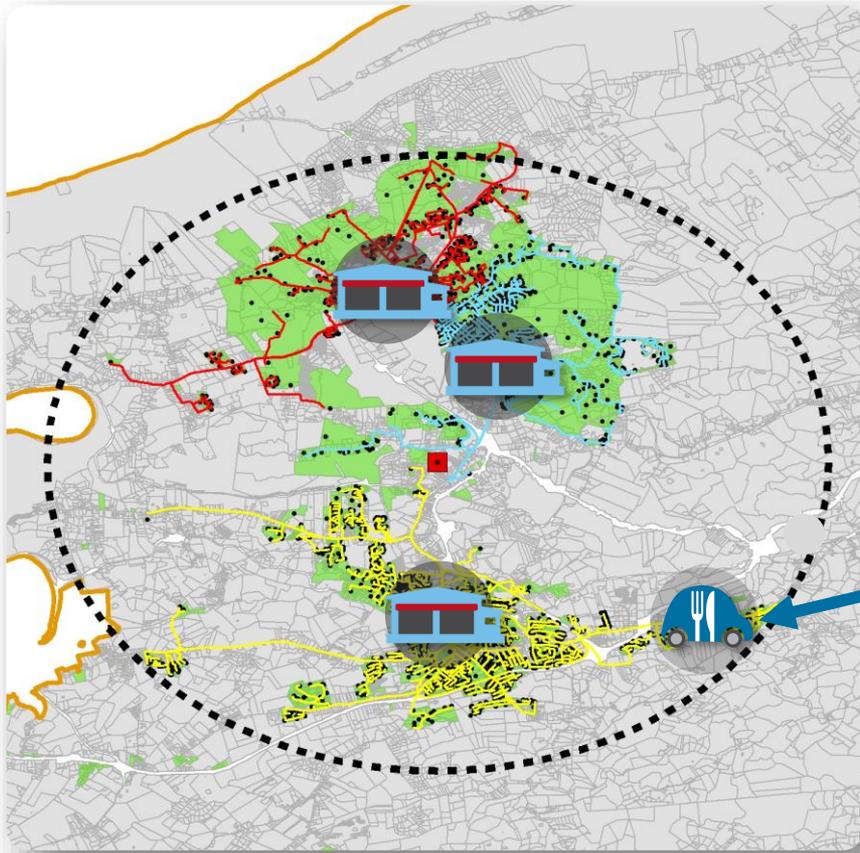
Delivery Driving

- Travel between starting point, store, and customers

- **Fewest emissions:**
  delivery drivers start at the store

- **Most emissions:**
  delivery drivers start at the distant periphery

  – Added emissions for this scenario provides upper bound

Use Drone Delivery
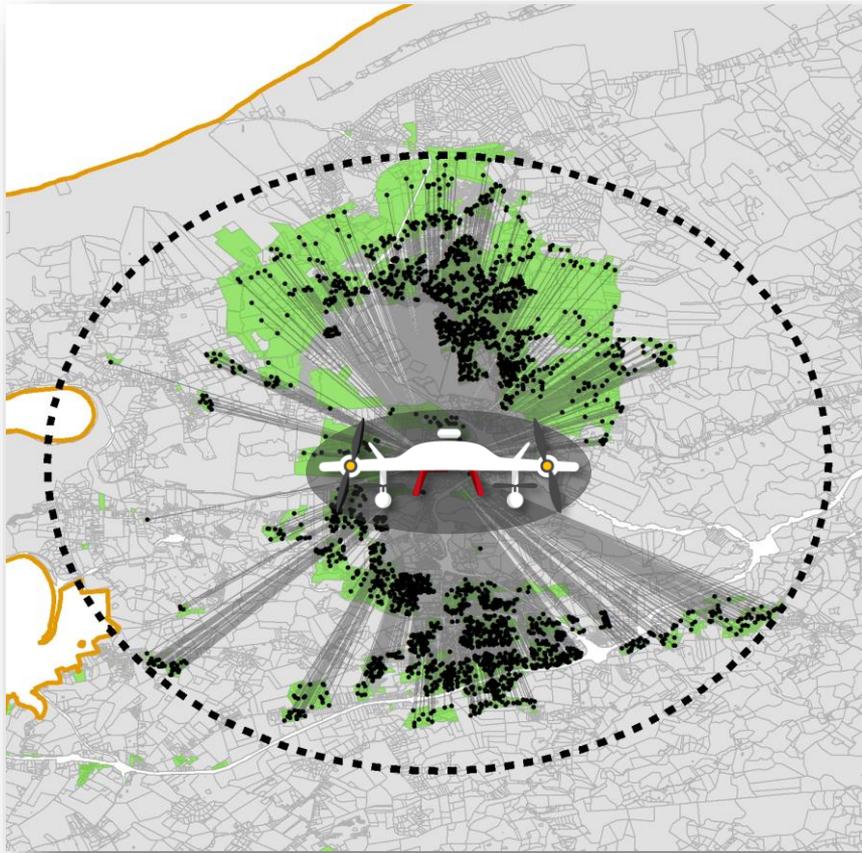
Drone Delivery

- Between homes and drone depot

- Fly direct out and back

Range of CO$_2$ Emissions for Each Delivery Method
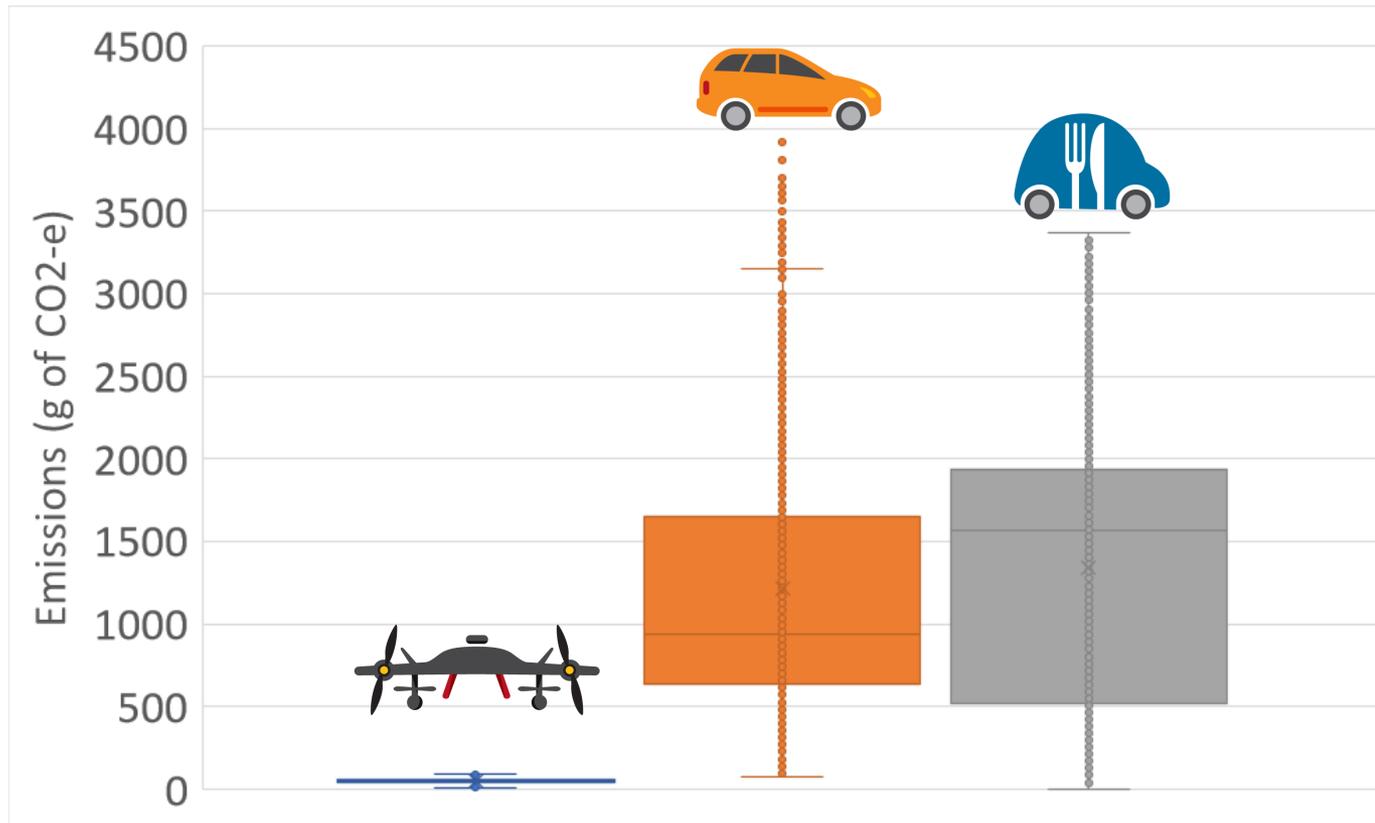
Results

DRONE DELIVERY GENERATES FAR FEWER GRAMS OF CO_2 EMISSIONS

- Drone delivery
  - averages 7 mi (11.3 km) round trip
  - generates approximately 50 grams of CO_2 emissions per trip

- Passenger driving
  - averages 3.8 mi (6.1 km) round trip
  - generates approximately 26 times more CO_2 emissions

- Delivery driving
  - averages 4.0 mi (6.4 km) per trip, large range
  - generates approximately 28 times more CO_2 emissions

CO$_2$ Emissions for Driving Delivery Depends on Driver Location

Average store to customer drive

Additional driving required to get to store. The additional amount could be anywhere in this range.

CO2 Emissions (g)

0   500   1000   1500   2000   2500
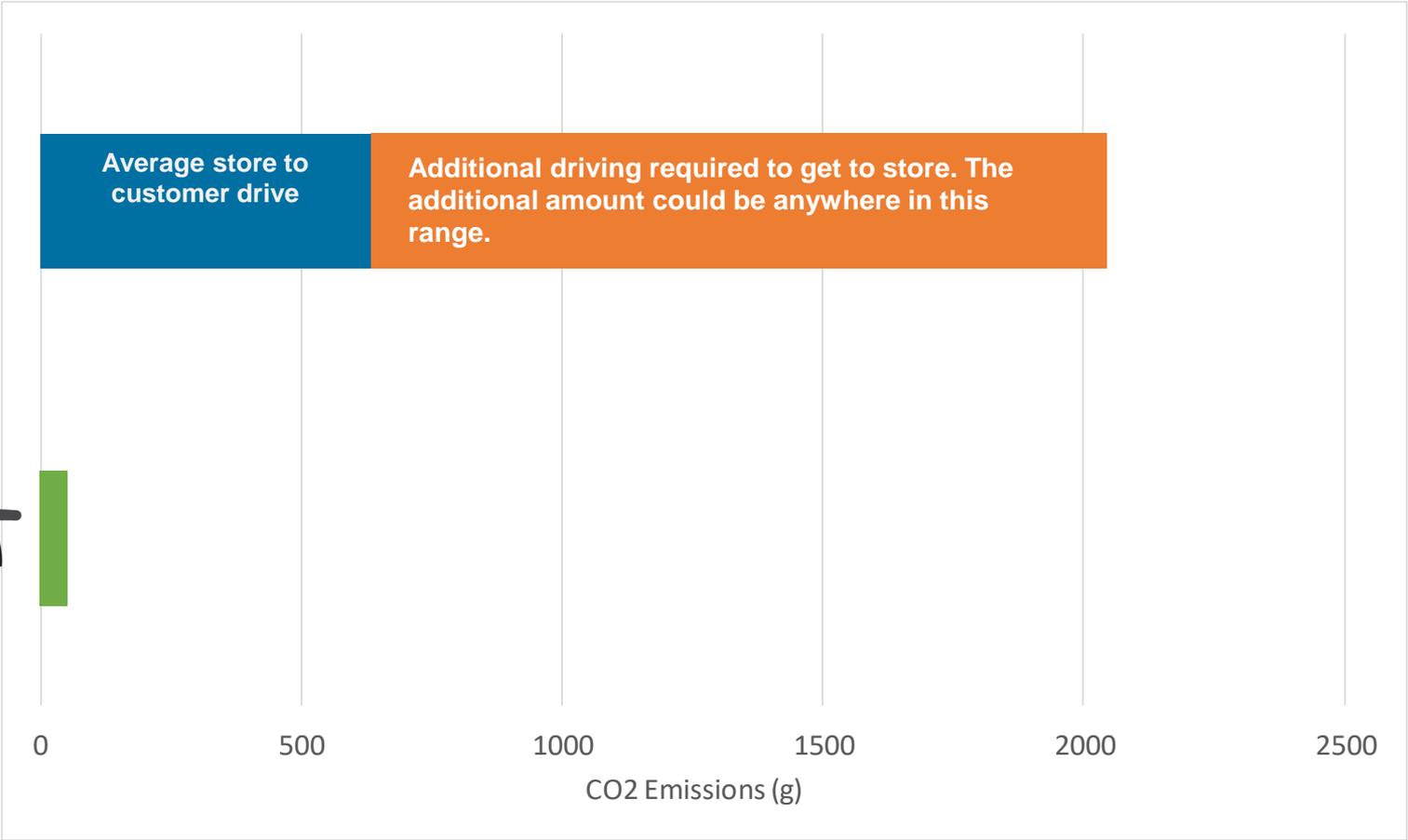
Summary

What does this mean?

This work is ground-breaking, illustrating the relative impacts of drones in comparison to personal shopping or on-demand delivery services. The design of delivery drones yield meaningful savings in CO_2 emissions.

NOTABLE FINDINGS

- Delivery drones are incredibly efficient.

- Straight-line route helps, but energy efficiency drives the results.

- The number of retail destinations and drone depots will affect the results.

- The starting location of the driver for on-demand driving delivery services significantly impacts the total emissions for that system.

Contacts

www.rsginc.com

ERICA WYGONIK, PhD, PE
DIRECTOR

Erica.Wygonik@rsginc.com
802.359.5585

ANNE GOODCHILD, PhD
PROFESSOR

avgoodchild@gmail.com
206.491.1883