

FEBRUARY 24, 2020

CHICAGO METROPOLITAN AGENCY FOR PLANNING
(CMAP) FREIGHT COMMITTEE MEETING, CHICAGO, IL



ASSESSING THE E-COMMERCE EFFECT: PARCEL DELIVERY VS. HOUSEHOLD SHOPPING

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SMART MOBILITY CONSORTIUM

Who we are

The SMART Mobility Consortium is a multi-year, multi-laboratory collaborative dedicated to further understanding the energy implications and opportunities of advanced mobility solutions.

Argonne
NATIONAL LABORATORY

BERKELEY LAB

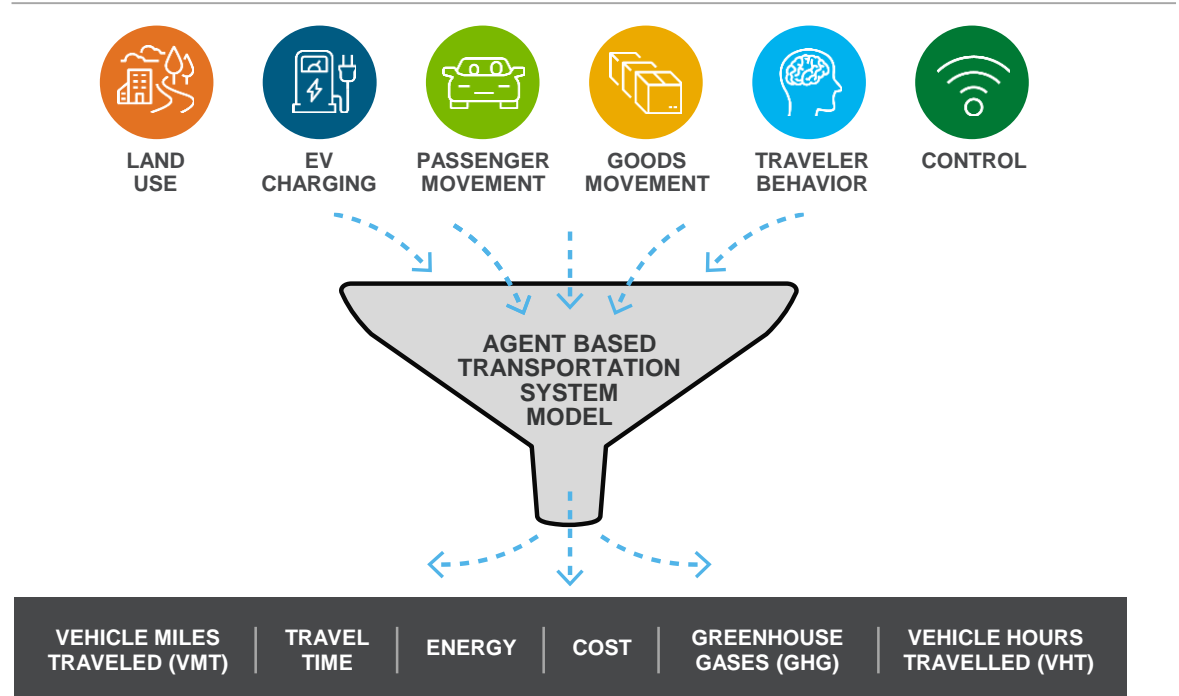
INL
Idaho National Laboratory

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

OAK RIDGE
National Laboratory

SMART MOBILITY MODELING WORKFLOW

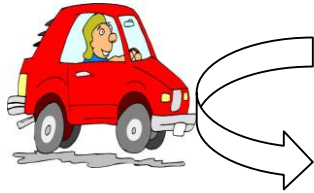
By creating a multi-fidelity end-to-end modeling workflow, SMART Mobility researchers advanced the state-of-the-art in transportation system modeling and simulation.



E-COMMERCE

Research question

As traditional shopping trips...



...are replaced by delivery trucks...



...what will be the net effect on regional Vehicle-Miles Traveled (VMT) and Energy Consumption?

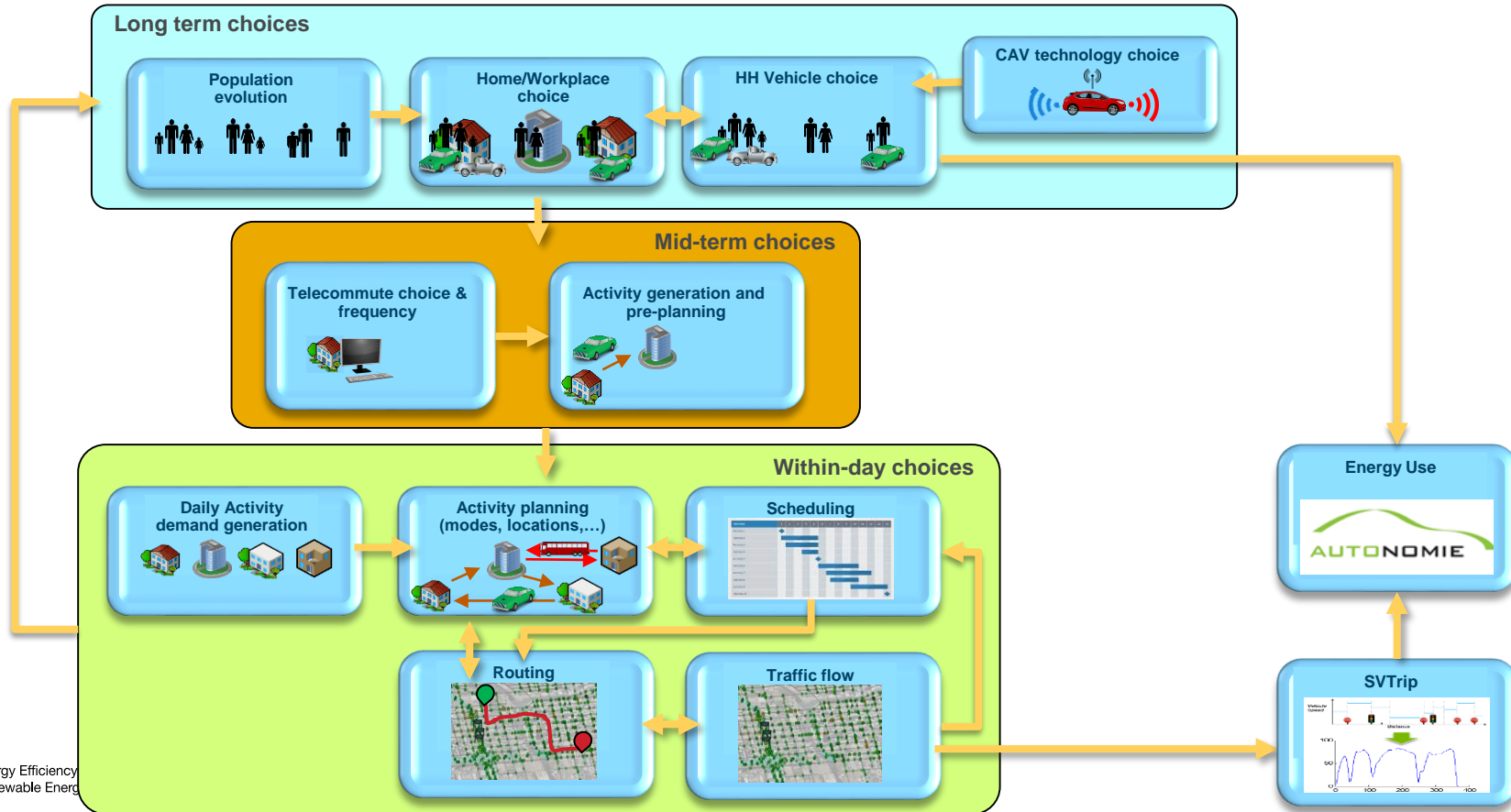
SCOPE

- Last-mile delivery
- Chicago Metropolitan Region



E-COMMERCE Approach

AGENT-BASED MODEL WITH ACTIVITY MODELING AND DYNAMIC TRAFFIC ASSIGNMENT



Methodology to Assess E-Commerce Impacts

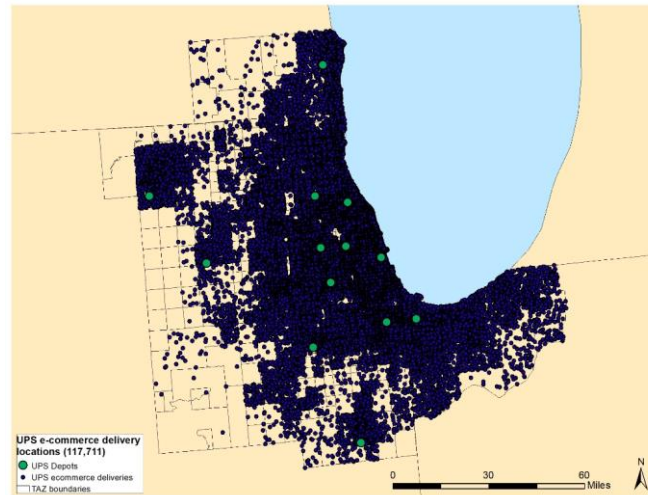
Step 1. Generate household delivery demand.

Step 2. Generate parcel delivery supply.

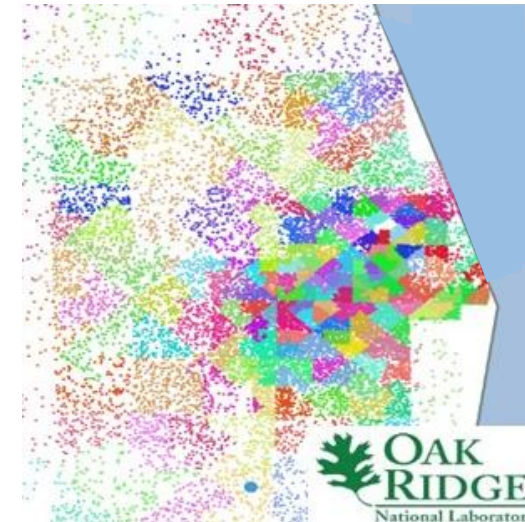
WholeTraveler
survey data



E-commerce Demand:
Household Behavioral Model



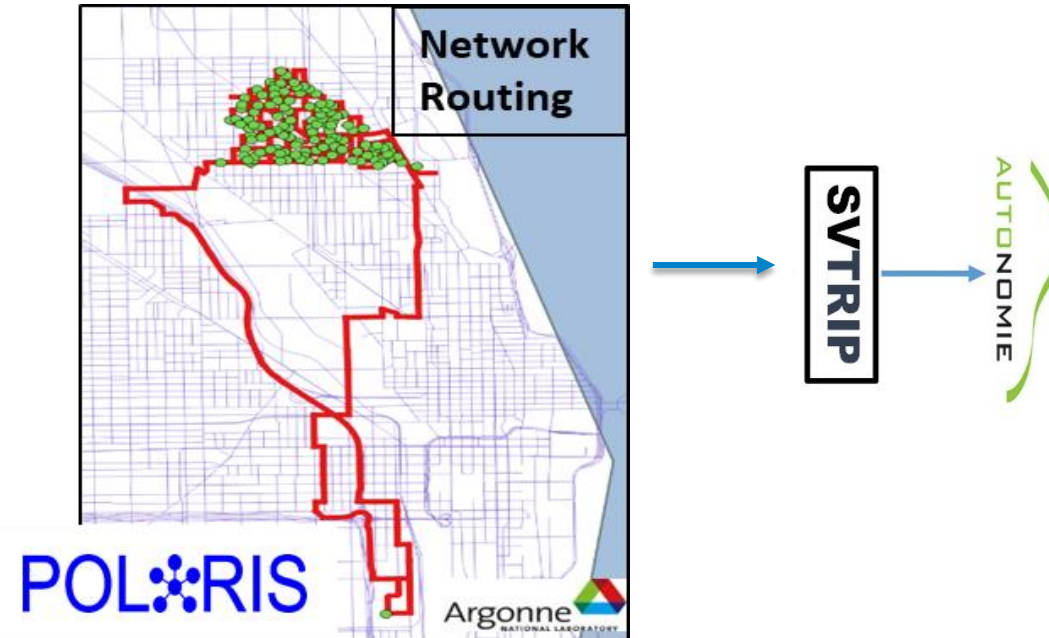
E-commerce Supply*:
Parcel Truck Stop
Sequence Model



Methodology to Assess E-Commerce Impacts

Step 3. Route delivery trucks in POLARIS.

Step 4. Compute vehicle-miles traveled (VMT) and energy use.



HOUSEHOLD E-COMMERCE DEMAND BEHAVIORAL MODEL

More e-commerce demand for households with:

- Higher incomes
- More children (busier parents)

Less e-commerce demand for households with:

- More vehicles
- Fewer adults
- Residence is walkable and/or relatively close to transit (high-density)

Binary Choice: Whether Participates in E-commerce or not		
Variables	Estimates	t-stat
Constant	-0.103	-1.64
# of HH Children	0.104	1.39
HH income less than 25k	-0.459	-2.33
HH income between 25k and 50k	-0.54	-3.37
HH income between 50k and 100k	-0.154	-1.41
HH income greater than 200k	0.355	3.32
Distance to nearest transit stop from home (in 100th of miles)	0.077	1.18
Ratio of Delivery to Retail Shopping		
<i>Parameters to the latent propensity</i>		
Constant	2.882	11.7
# of HH Adults	-0.146	-2.49
HH income greater than 200k	0.369	3.29
Walk Score (Range 0 to 10)	-0.057	-3
# of HH Vehicle	-0.18	-2.8
<i>Threshold Parameters</i>		
	-ve	
Theta 0	Infinity	Fixed
Theta 1	0	Fixed
Theta 2	1.576	11.86
Theta 3	2.162	15.74
Theta 4	2.738	19.23
Theta 5	3.482	22.34
	+ve	
Theta 6	Infinity	Fixed
Summary		
Number of Observations		971
Final Log-likelihood		-1362.45

Assumptions in Model Scenarios

Scenario	E-commerce Delivery Rate (Deliveries per week per household)	Vehicle & Powertrain Technology	Other Important Assumptions
Baseline	1	-	-
Short Term	3	Baseline, BAU (Business as usual), VTO Targets	Increased TNC Use
Long Term	5		2 scenarios: High TNC* Use & Low Private AV** Low TNC Use & High Private AV

*Transportation network company

**Autonomous vehicle

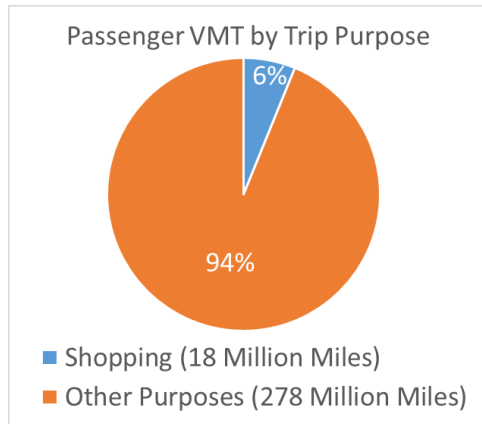
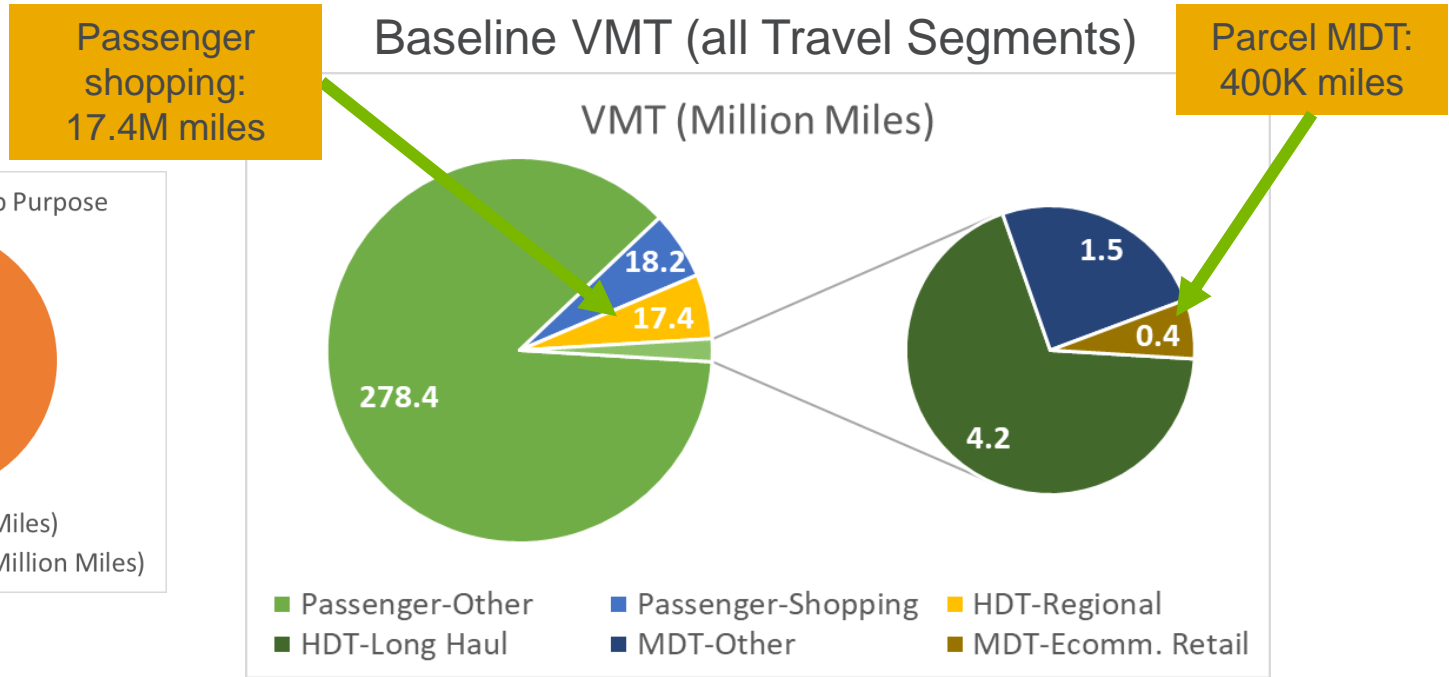
- Vehicle & Powertrain Technology: **Increasing levels of electrification** among passenger and commercial fleets
- Future growth in passenger and commercial trips due to **population growth** and **moderate commodity flow growth**

E-COMMERCE Results

Travel Segments in the E-commerce Analysis:

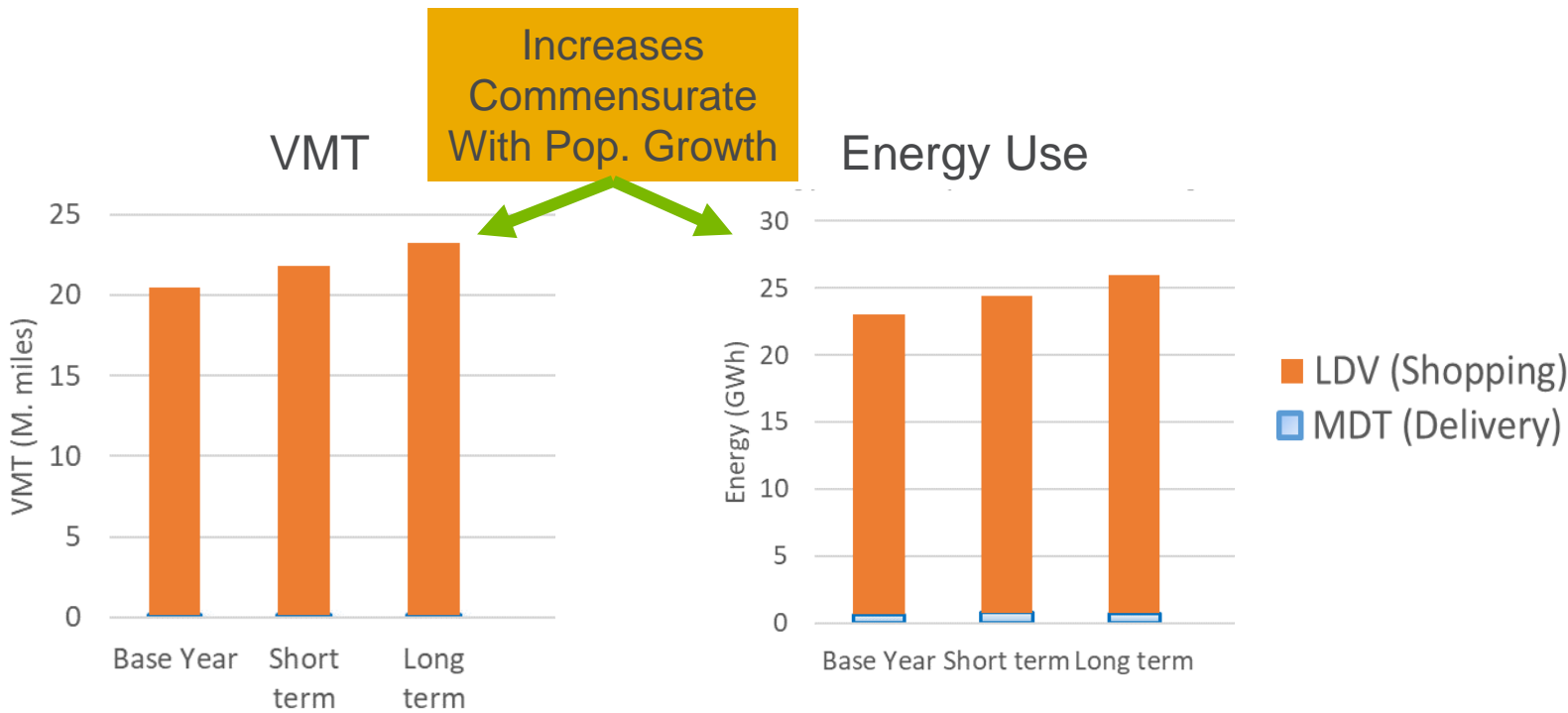
--Medium-Duty Parcel Delivery Trucks (MDT)

--Passenger Shopping Light-Duty Vehicles (LDV)



Slight Growth in VMT and Energy Use if E-commerce Rate Stays at

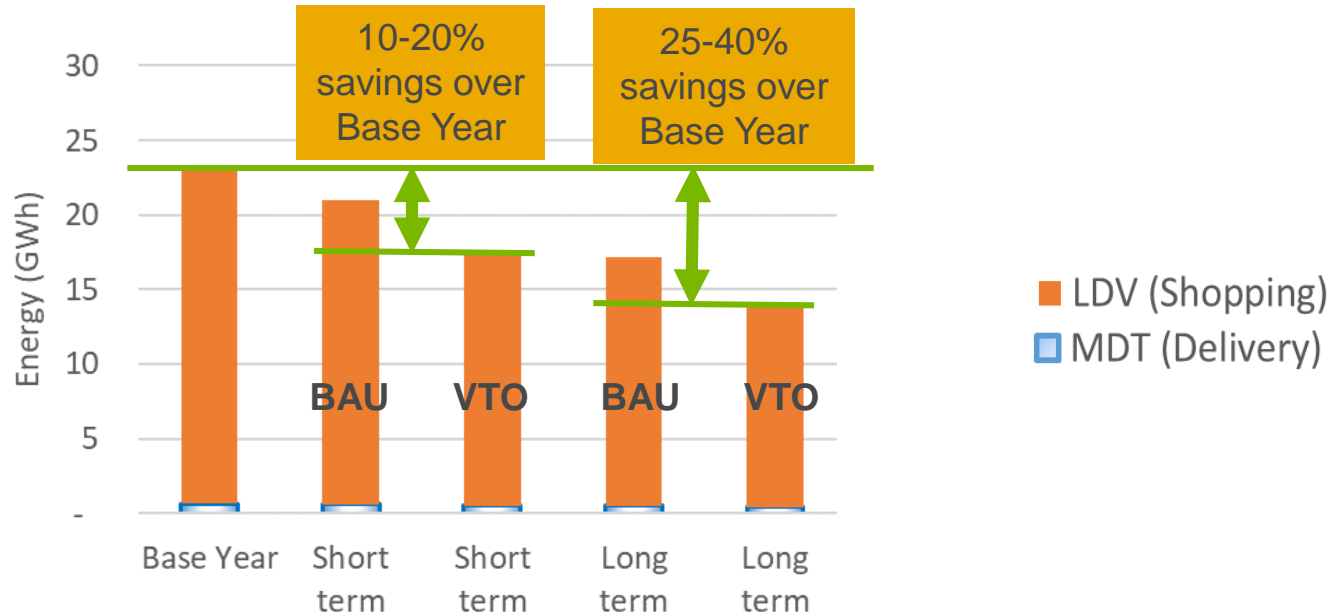
1 Delivery per Household per Week...



(Still at 1 Delivery per Household per Week..)

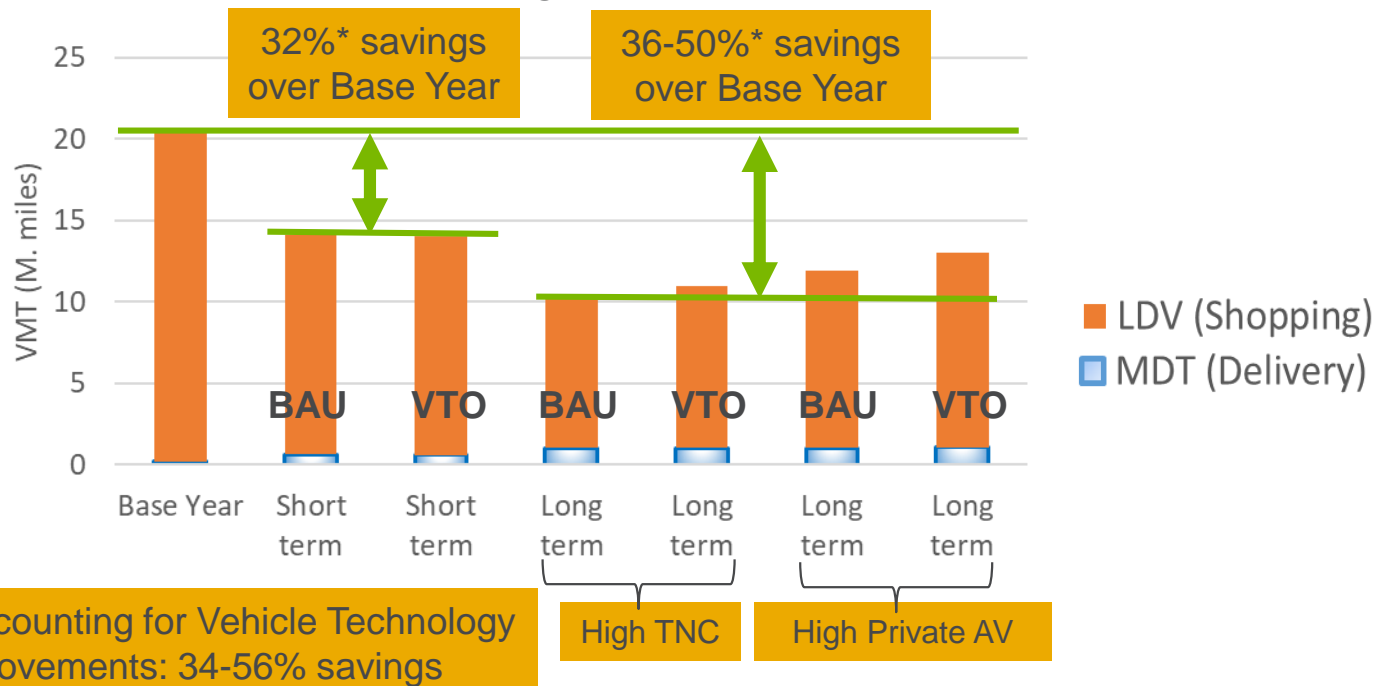
Vehicle Technology Improvements Can Greatly Reduce Energy Use

Energy Use: Improved Technologies



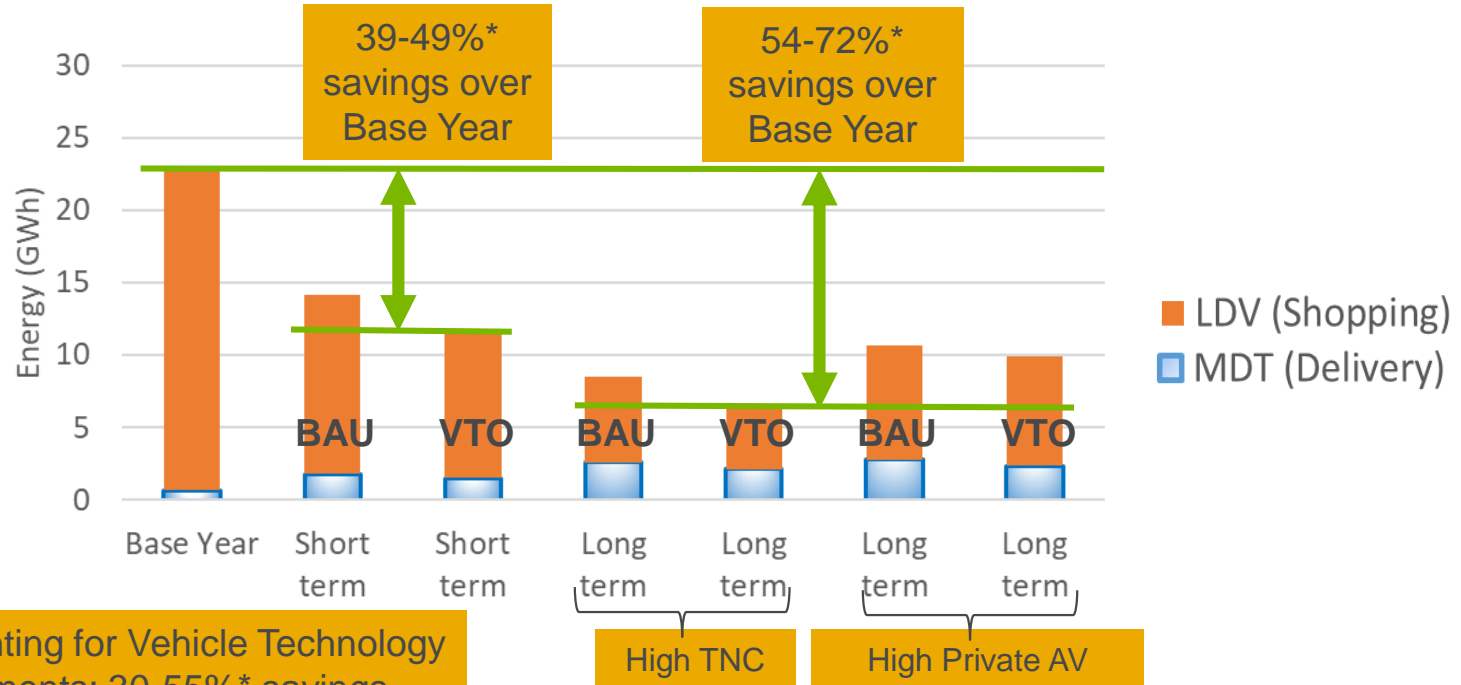
In a World with Increasing E-commerce, Parcel MDT VMT Grows by about 300-500%, but Total Last-Mile Retail VMT Decreases Significantly...

VMT: Improved Technologies + More E-commerce



Energy Use Also Declines Significantly as E-commerce Increases...

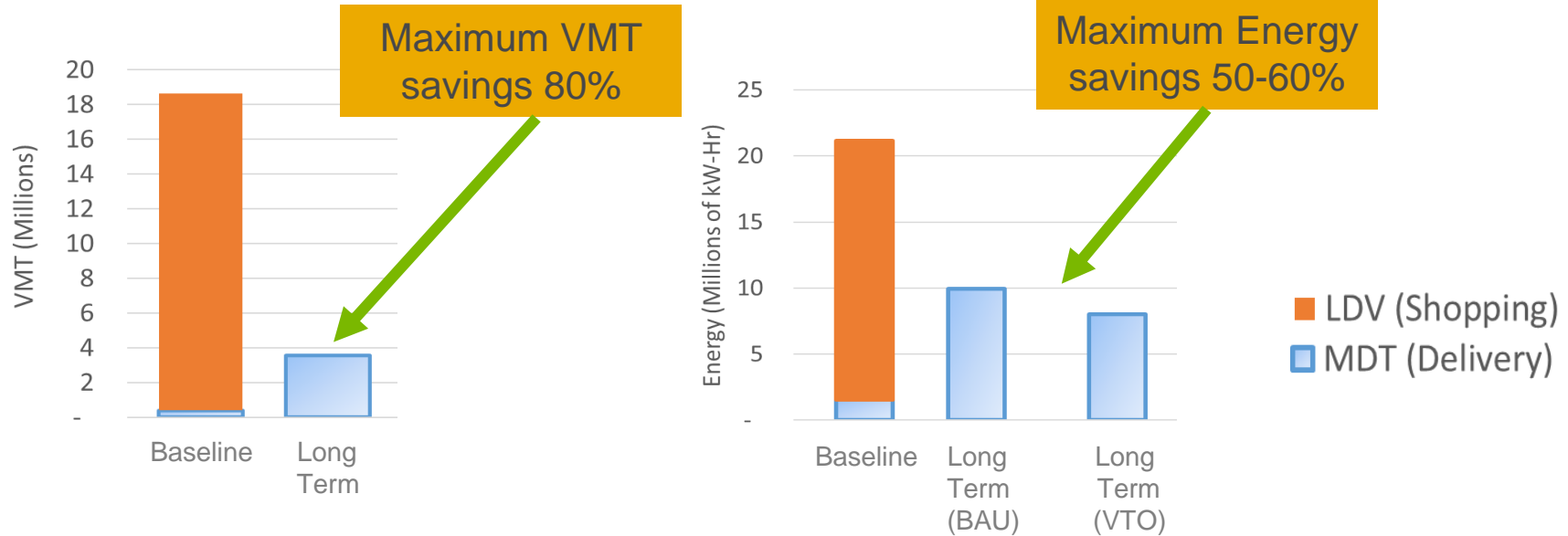
Energy Use: Improved Technologies + More E-commerce



After accounting for Vehicle Technology Improvements: 30-55%* savings

A corner case*: E-commerce deliveries replace ALL household shopping trips...

*from an earlier version of the model



→ overall trend: efficient e-commerce system saves last-mile VMT & energy
 → room to improve truck efficiency



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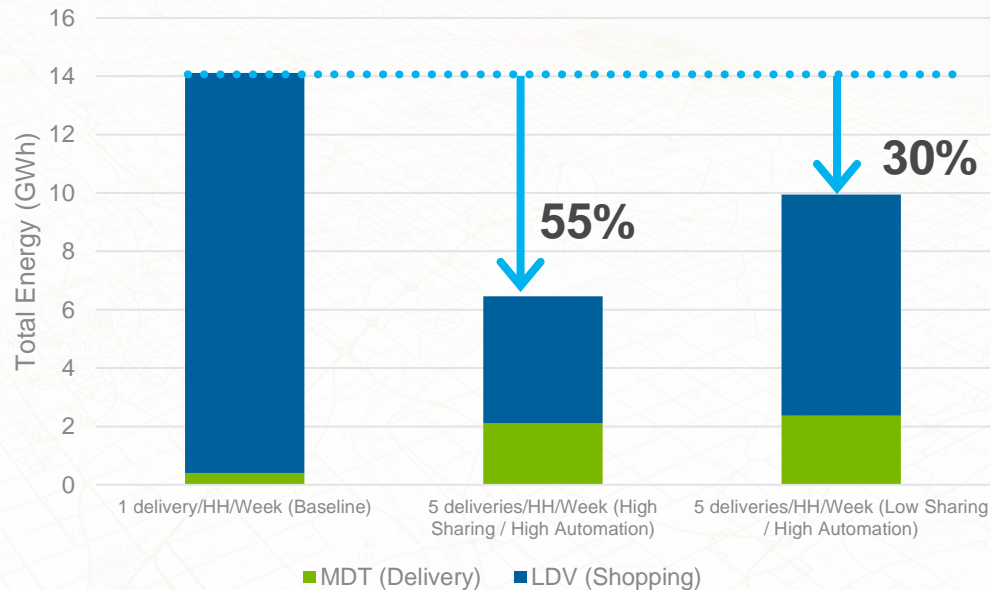
SUMMARY

HOME DELIVERIES CAN DECREASE TRANSPORTATION ENERGY USE

Energy savings from e-commerce and vehicle technologies



CHICAGO



INCREASE IN E-COMMERCE LOWERS OVERALL SYSTEM VMT AND ENERGY

Fewer shopping trips, more deliveries make the difference



CHICAGO

SHOPPING TRIP = 7 to 8 miles



DELIVERY TRIP

1 ADDED STOP = 0.4 mile



For more information:

Citywide Impacts of E-Commerce: Does Parcel Delivery Travel Outweigh Household Shopping Travel Reductions?

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ABSTRACT

E-commerce has facilitated online ordering of goods by households in recent years. This technological advancement has disrupted shopping related transportation. While the National Household Travel Survey (NHTS [1]) finds that household shopping frequency has declined in the last 10-20 years, deliveries by parcel delivery trucks and vans [2] have increased. However, the net effect of these phenomena on overall trip making, vehicle-miles traveled (VMT) and fuel consumption has not been quantified. From a regional planning perspective, understanding the net effect is important for informing city policies—for example, in regards to land use and transportation planning.

The objective of this research is to address this gap. In this study, the net regional impact of e-commerce on transportation and fuel consumption is evaluated.

1 Introduction and Background

Generally speaking, city planning and policy measures aim to promote economic health, mobility, energy efficiency, and other desirable urban traits that enhance quality of life for residents. Access to shopping and low levels of congestion typically are considered desirable features in a metropolitan area.

In recent years, however, travel by motorized vehicles has grown to such levels that congestion is a top concern in many cities. At the same time, accessibility to shopping has been enhanced in a new way with the emergence of e-commerce, which has grown from less than 1% of US retail purchasing in 2000 to about 10% in 2018 [5]. Traffic by parcel delivery trucks, which transport deliveries from fulfillment centers and other e-commerce distribution points to homes and businesses, has grown

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