

# SMART MOBILITY OVERVIEW, KEY METRICS AND INSIGHTS SNEAK PEEK



February 14, 2023

# TODAY'S SPEAKERS



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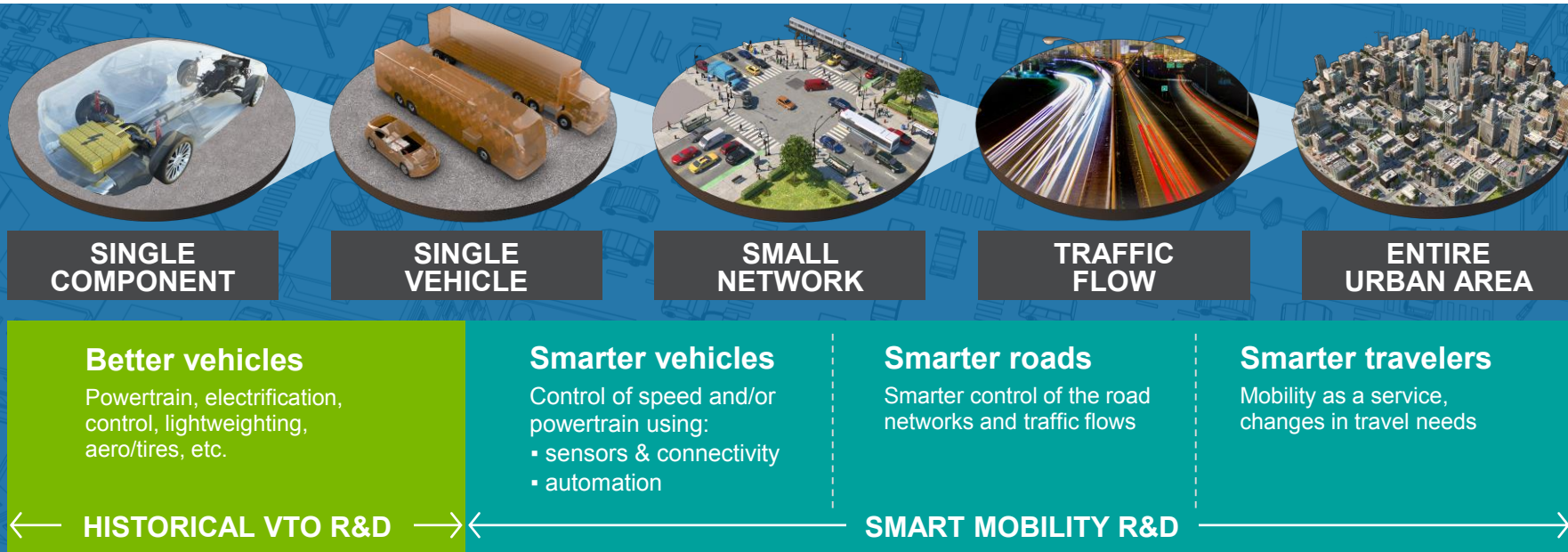
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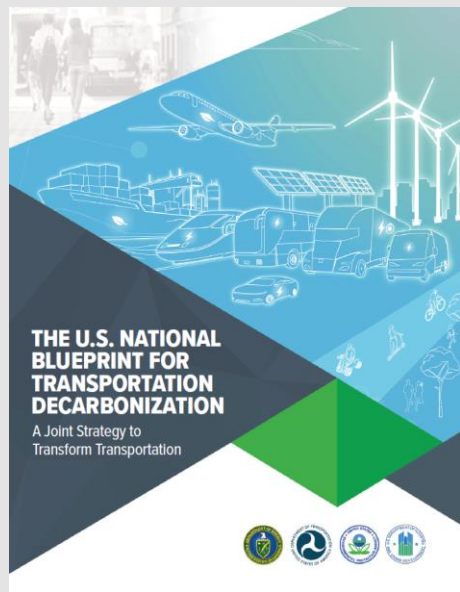
# SMART MOBILITY EXPANDS R&D BEYOND COMPONENT AND VEHICLE DESIGN

Impact of connectivity, automation, multi-modal travel,  
new modes, control... across wide range of metrics



# IMPROVING CONVENIENCE AND EFFICIENCY CRITICAL TO TRANSPORTATION DECARBONIZATION

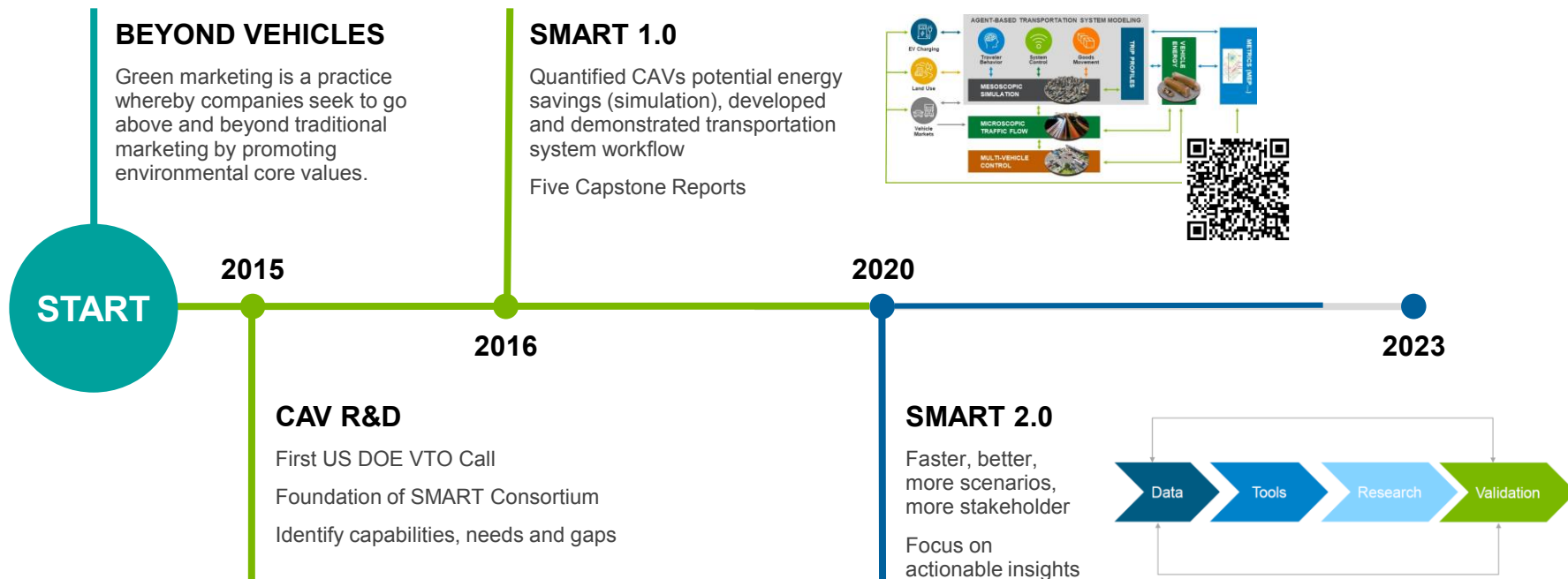
Land use combined with affordable, accessible, efficient  
and reliable mode at the center of SMART Mobility



## SMART Mobility Consortium Focus

# SMART MOBILITY HAS ALREADY A LONG HISTORY

Unique set of system level expertise driven by stakeholders





# CONSORTIUM FOCUSED ON ADDRESSING STAKEHOLDER QUESTIONS

6 National Laboratories, 25+ R&D Partners, 50+ Stakeholders

## R&D PARTNERS



## NATIONAL LABORATORIES



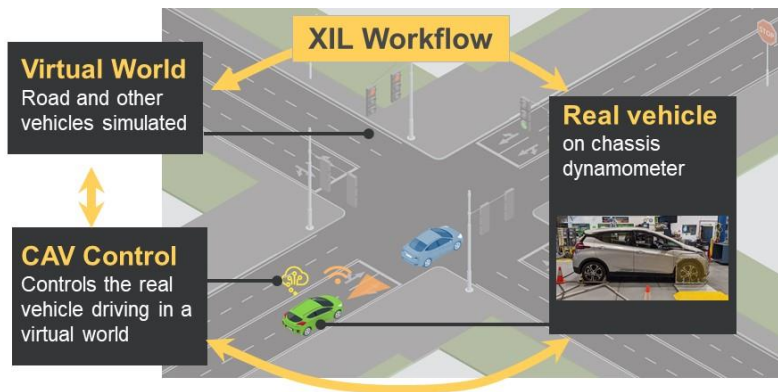
## STAKEHOLDERS



# PRIMARY APPROACHES FOR VEHICLE AND TRANSPORTATION SYSTEM IMPACT

## VEHICLE FOCUS

Develop and deploy energy-efficient vehicle and powertrain controls enabled by connectivity and automation



Simulated systems



Dyno XIL



Track XIL

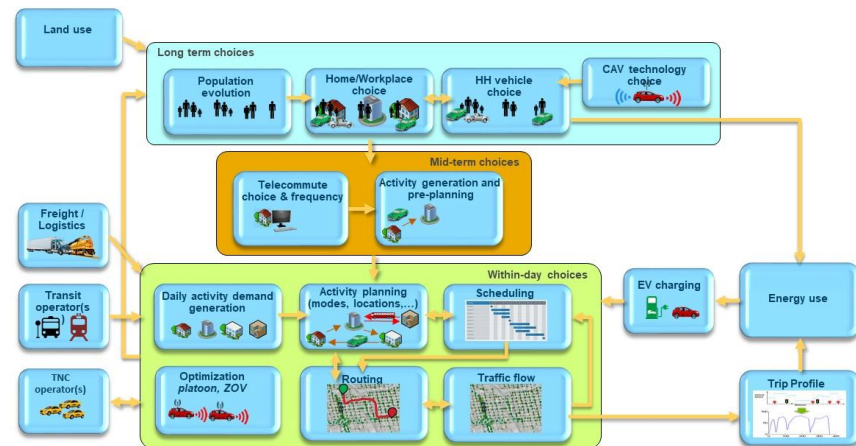


Real systems



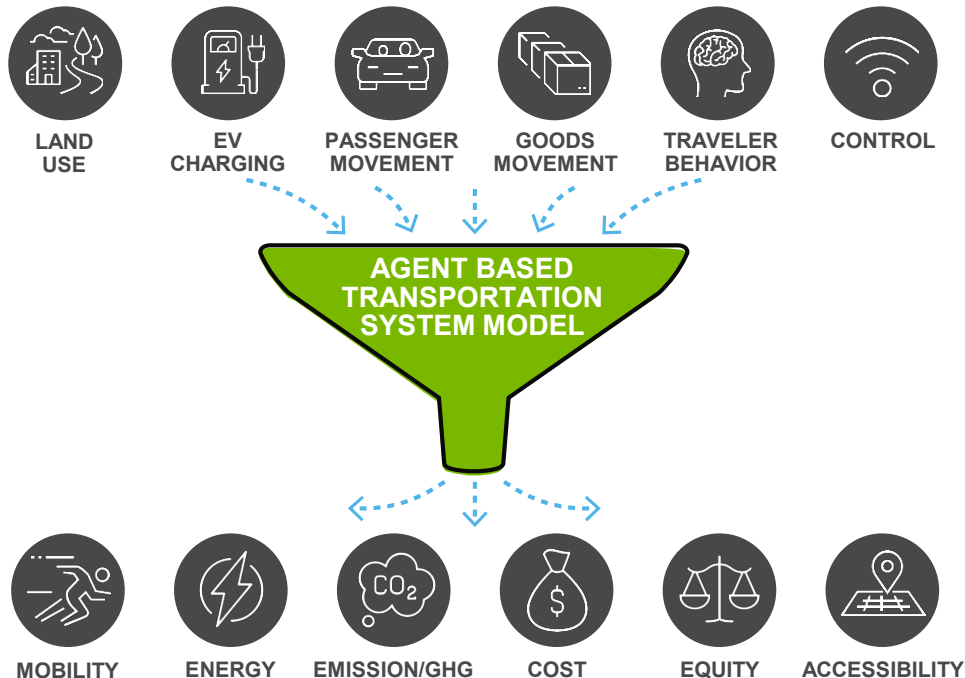
## TRANSPORTATION SYSTEM FOCUS

Agent-based transportation system simulation coupled with additional tools for land use, electric grid, energy, GHG, etc.



# LARGE NUMBER OF METRICS CONSIDERED SIMULTANEOUSLY

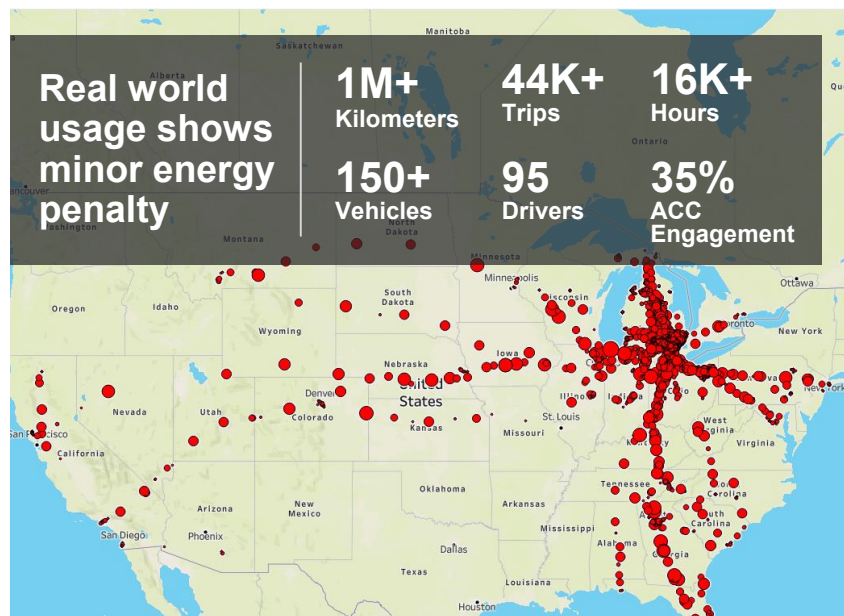
**Multi-fidelity end-to-end modeling workflow, provides unique insights by quantifying the impact of individual technologies and policies across the entire transportation system.**





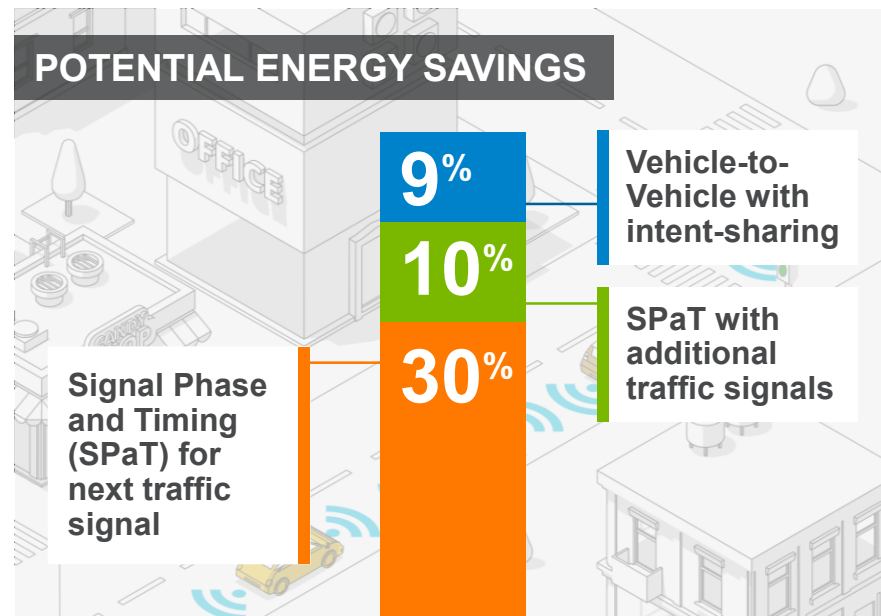
# CURRENT AUTOMATED DRIVING SYSTEMS ARE NOT FUEL EFFICIENT—BUT COULD BE

## TODAY



## TOMORROW

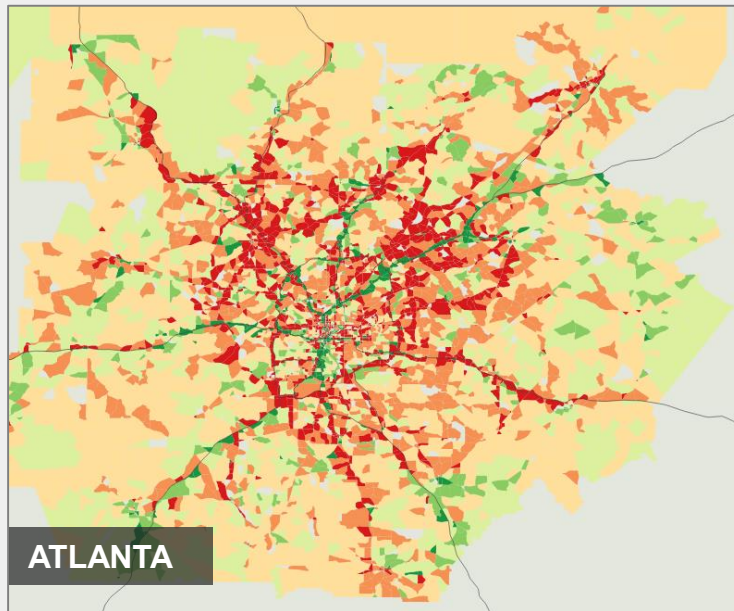
### POTENTIAL ENERGY SAVINGS



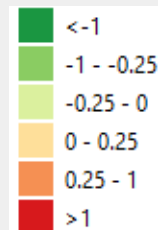
# LEVEL 4 AUTOMATED DRIVING MAY INCREASE GREENHOUSE GAS EMISSIONS



Level 4 automated highway driving encourages longer highway travel, so emissions increase, mostly along highways and in outlying areas. Mitigation strategies should focus on those spots



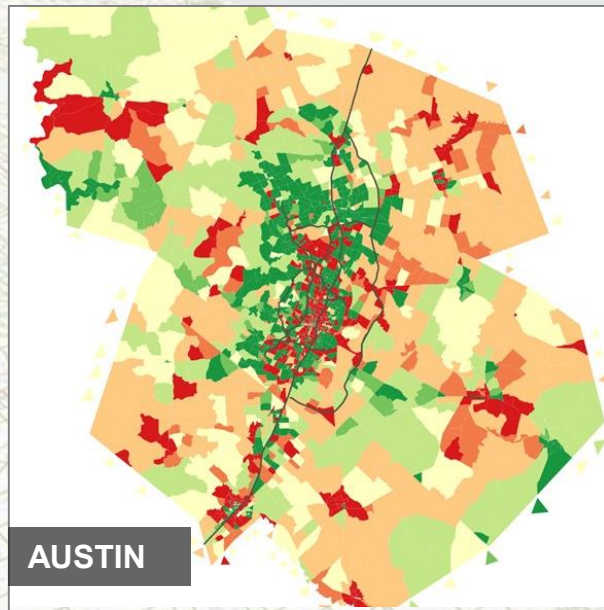
**Δ GHG  
emissions**  
(tonnes)



# CARBON PRICING CAN HELP MITIGATE LAND USE IMPACT OF LEVEL 4 AUTOMATED DRIVING

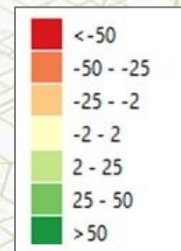


- Applied increased costs for carbon emissions over time coupled with EV ownership subsidies
- Carbon pricing reduces GHG from Level 4 automated driving by up to 25% when considering land use change
- Well designed policies counteract Value of Travel Time impacts



**$\Delta$  Level 4 Ref 2040  
vs. Base Ref 2020**

**$\Delta$  Population density per/km<sup>2</sup>**



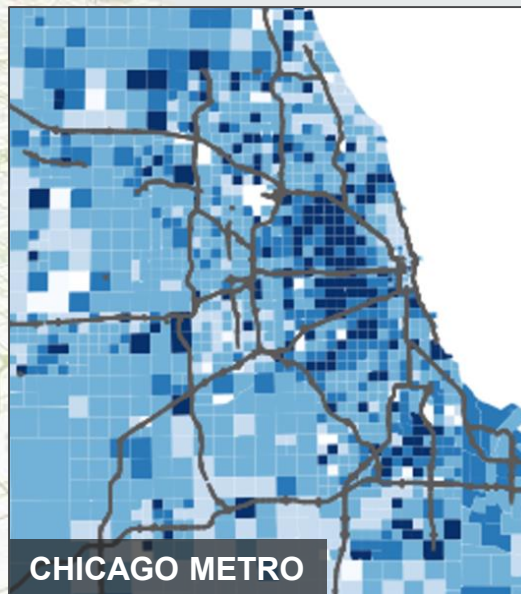
# ROAD PRICING COST INCREASES HIGHEST IN LOW INCOME AND EXURBAN AREAS



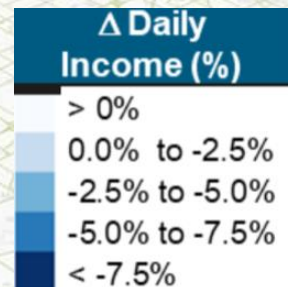
Delay based congestion pricing can increase network speed up to 11%

Total travel cost increases can reduce daily income by up to 7.5%

Agencies should explore ways to reinvest revenue from congestion pricing to reduce travel COST burden



$\Delta$  Daily Income

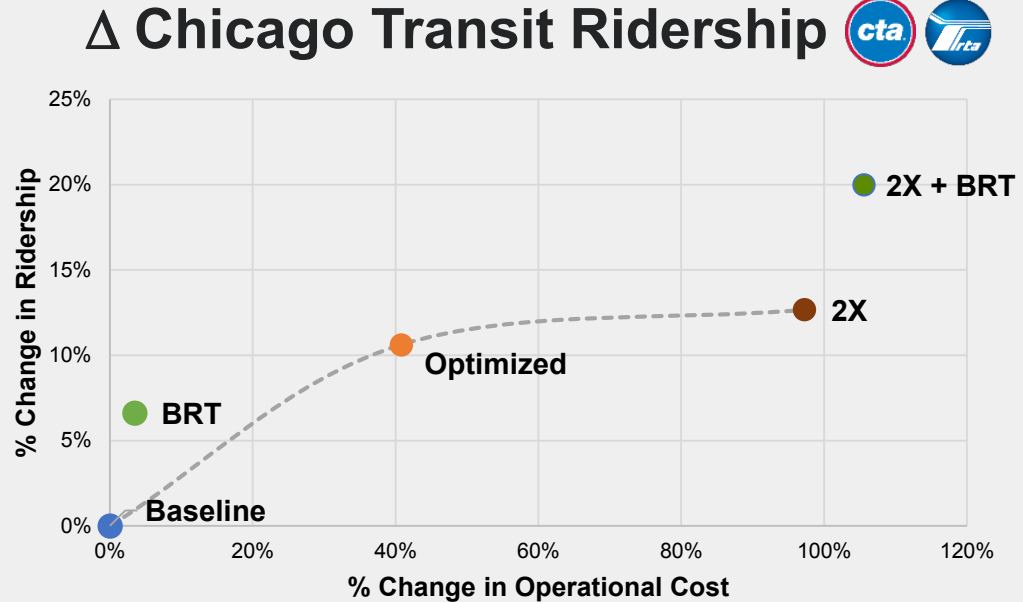




# TRANSIT OPTIMIZATION IMPROVES RIDERSHIP UP TO 11% AT MODERATE COST



- Increased bus frequencies or new Bus Rapid Transit (BRT) improves transit user experience (less waiting & travel times)
- Increased frequency more beneficial to Metra and Pace suburban buses than CTA
- New routes and BRT more beneficial to CTA



# SUBSIDIZED RIDESHARE SERVICE INCREASES TRANSIT USE BY 12%



**Paid first-mile-to-last-mile (FMLM) boosts transit use from 4.5% to 5.0%, free FMLM to 5.6%**

**Free FMLM increases use of rideshare-to-transit by 76%**

**Largely used to reach commuter rail stations—increases catchment area up to 1.8 miles for those without autos**

**Potential to remove 100K auto-based commuter trips**

**CHICAGO METRO**



# WHAT IS MEP AND HOW IS IT CALCULATED?

**Mobility Energy Productivity (MEP)** quantifies **how well connected a place is**, and does so while **accounting for time, cost, and energy of modes** that provide mobility in that place

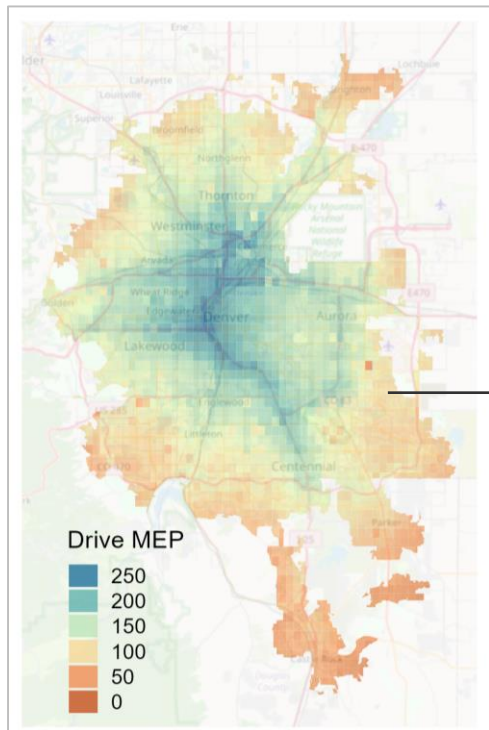
Quantify the number of **opportunities** that people can reach within a certain travel time threshold via different transportation modes

The opportunities measure is **weighted by the time, energy, and cost-efficiency** metrics of different transportation modes.

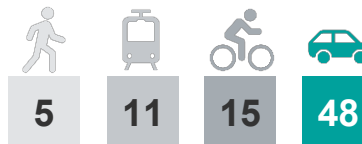
## EXAMPLE OF OPPORTUNITIES ACCESSIBLE BY BIKING



# UNPACKING THE MEP SCORE



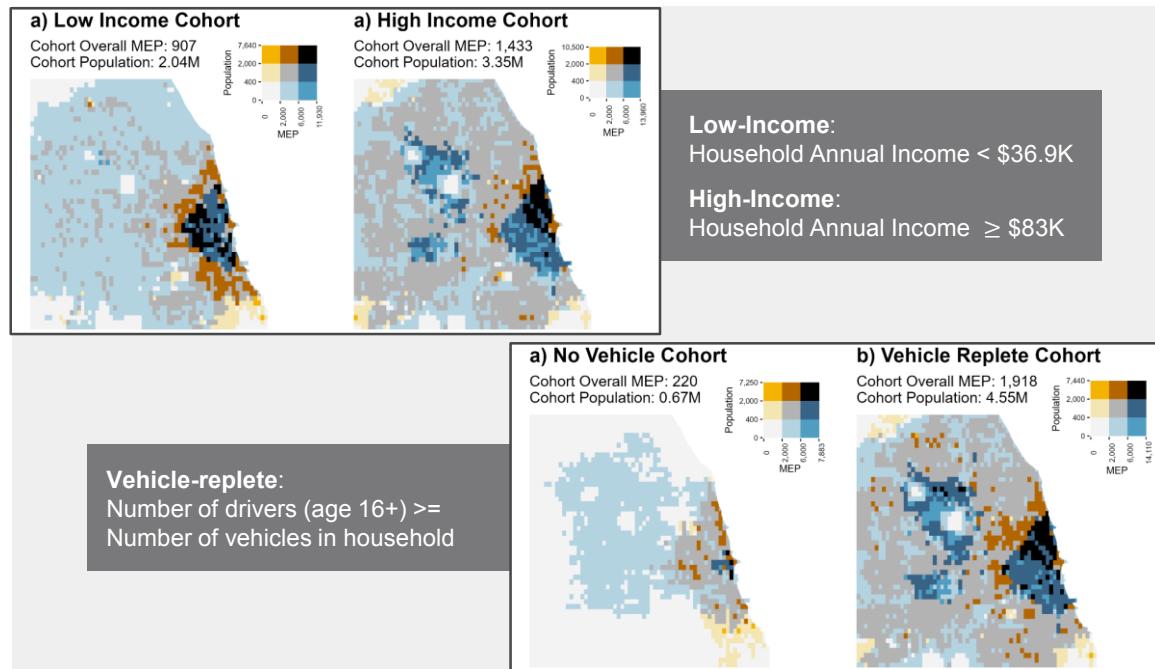
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# VEHICLE OWNERSHIP

Has an outsized impact on time, energy, and cost-efficient accessibility



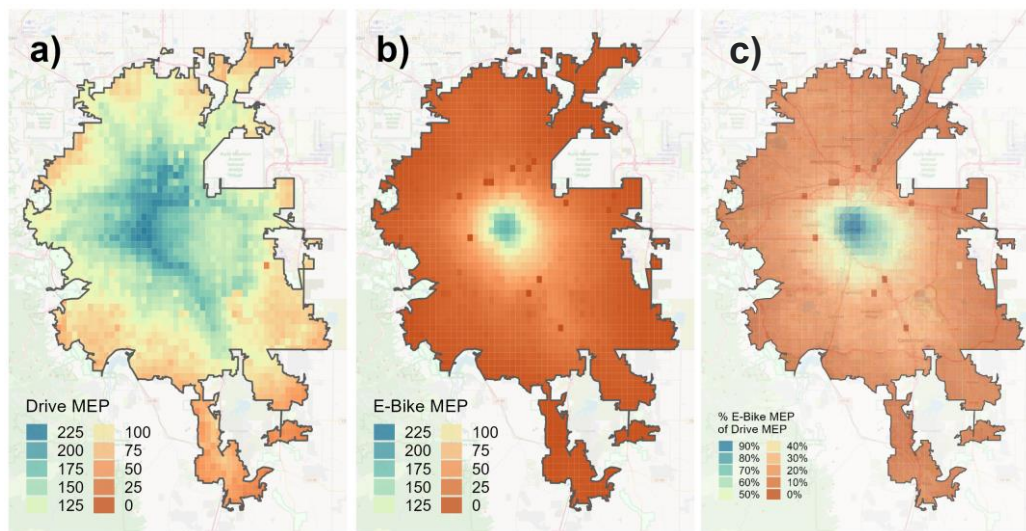
The spatial disparity in locations with high MEP scores vs. places of residence was stark for **vehicle-ownership based cohorts** compared to **income-based cohorts**.



# E-BIKES IMPROVE EFFICIENT ACCESS

Provide at least half the access that driving does for 9% of Denver's Population

Taking the energy, cost, and speed tradeoffs of e-bikes and cars into account, it was found that **personal e-bikes can provide access that is comparable to cars** in some areas (~9% of the cities population or 4% of its area) in Denver



\*Preliminary results

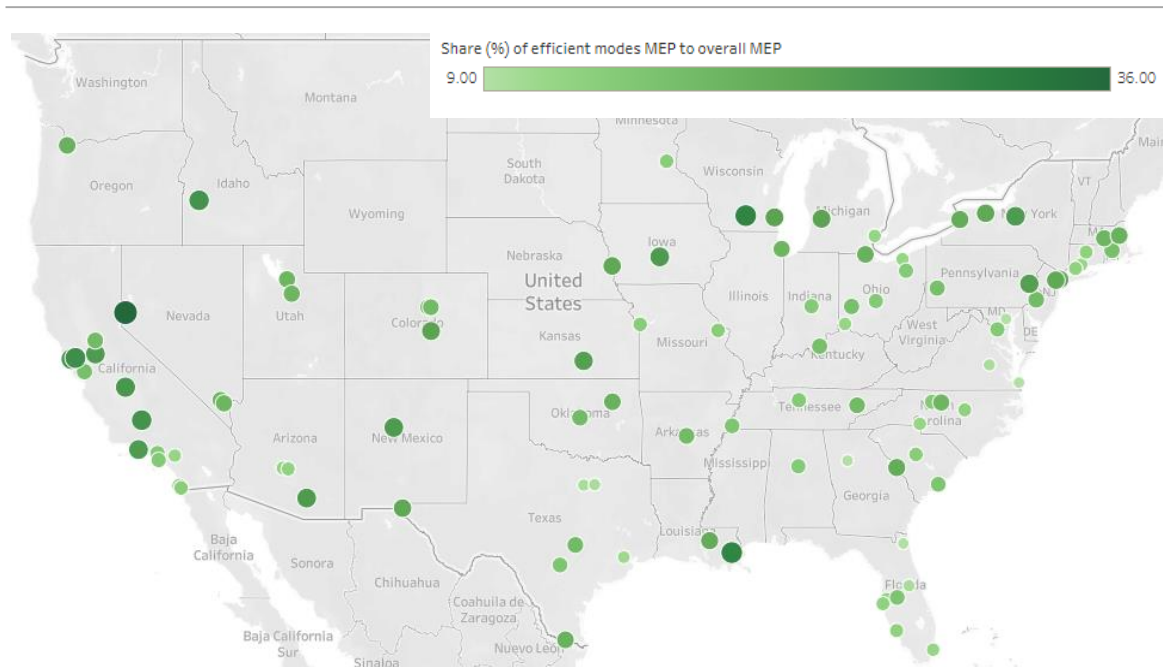
# MEP SCORES HELP QUANTIFY AVAILABILITY OF DRIVING ALTERNATIVES IN U.S. CITIES

## MEP Scores Analyzed for ~ 100 U.S. Cities



Of the 10 highest-scoring cities in the ACEEE scorecard's transportation chapter, 7 earned at least 20% of their total MEP score through the contributions of efficient modes.

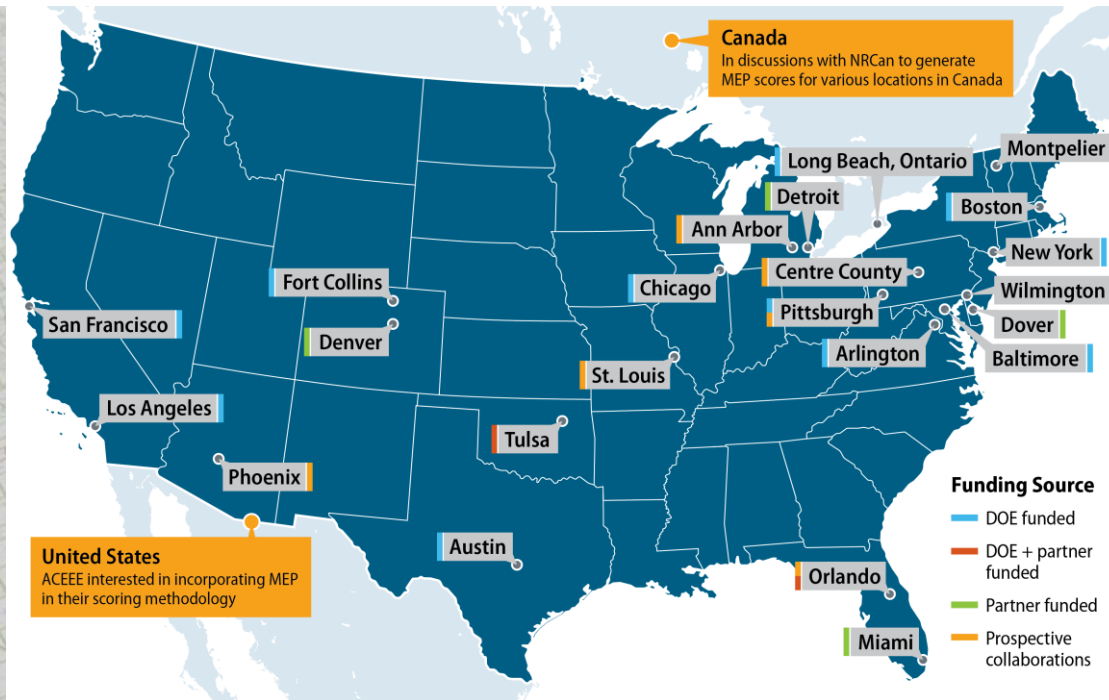
The top 4 scorers for transit funding also had an exceptionally high mean MEP efficient-mode ratio of 25%.







# PARTNERS/LICENSEES/COLLABORATORS





# INNOVATIVE METRICS CAN PROVIDE MEANINGFUL NEW INSIGHTS

## Agent-based modeling

### INEXUS Suite of Metrics

*Individual experienced  
utility-based synthesis*

#### Potential INEXUS

Captures the full utility of modal options available to the individual

#### Realized INEXUS

Measures the utility experienced by the agent for the mode they actually chose

#### Social INEXUS

Measures the utility experienced by and the externalities associated with the agent for the mode chosen

- High-resolution agent-based modeling frameworks are powerful tools for exploring alternative transportation system policy, design, and technology deployment scenarios.
- Gaining multi-faceted insights from these scenario outcomes requires a range of innovative ways of processing the results, including development of informative metrics.
- We demonstrate an example of this using a sensitivity analysis in the BEAM CORE integrated agent-based modeling framework:
  - price of ride-hailing is varied from 0% to 800% of the baseline.
  - This makes a flexible backup option more or less affordable and accessible.

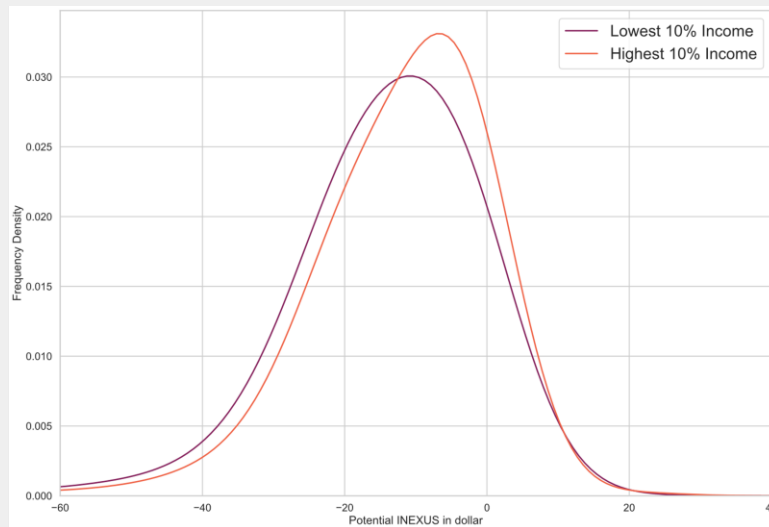


# POTENTIAL INEXUS

## Can highlight inequities in the baseline transportation system

- A multitude of factors (residence location, mode availability, budget constraints, vehicle ownership, etc.) contribute to systematic inequities in the current transportation system.
- Potential INEXUS for mandatory trips for highest income travelers is 16% higher than for lowest income travelers.

Distribution of Potential INEXUS values for mandatory trips in the baseline scenario across income groups

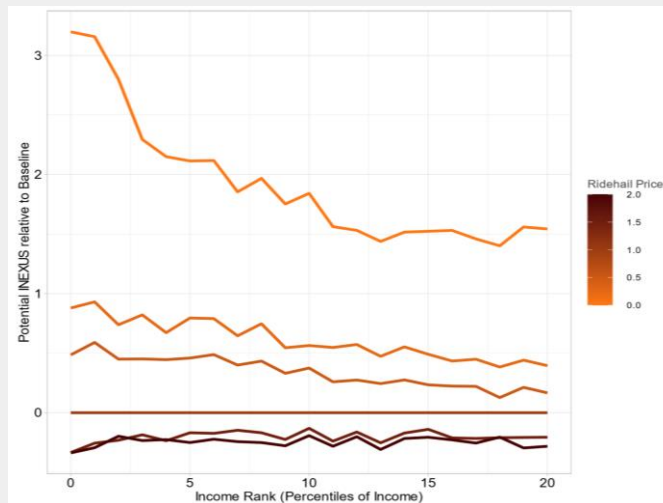


# AFFORDABLE BACKUP MODAL OPTIONS DISPROPORTIONATELY BENEFIT LOWEST INCOME SUBPOPULATION



Moving from baseline price to no-cost ridehail results in a 44% improvement in the median Potential INEXUS for the lowest income group compared to a 13% improvement for the highest income group.

Distribution of Potential INEXUS across ridehail price scenarios by the income of travelers

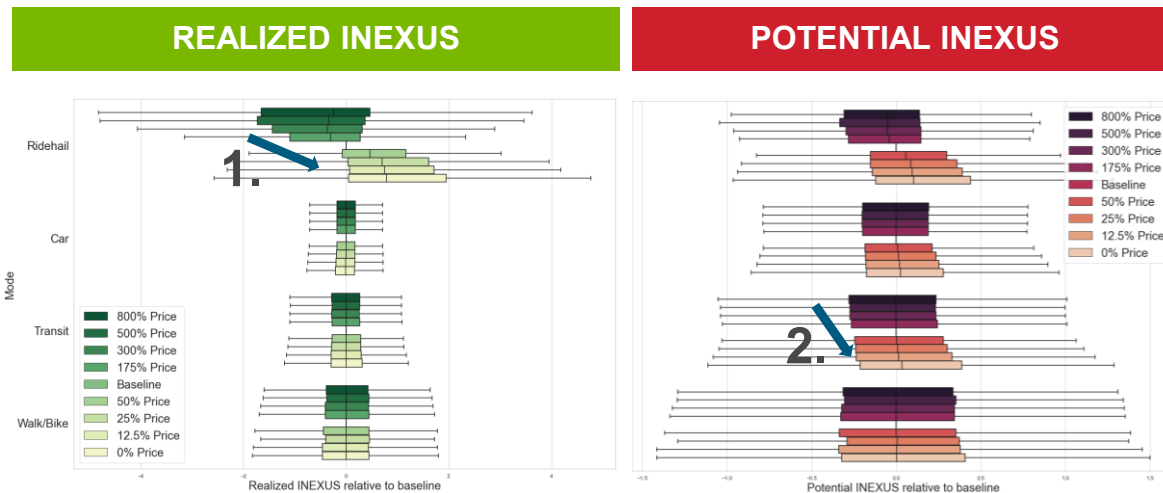


# INEXUS CAN CAPTURE A RANGE OF POTENTIAL BENEFITS FROM A SYSTEM CHANGE EVEN WITHOUT BEHAVIOR CHANGE



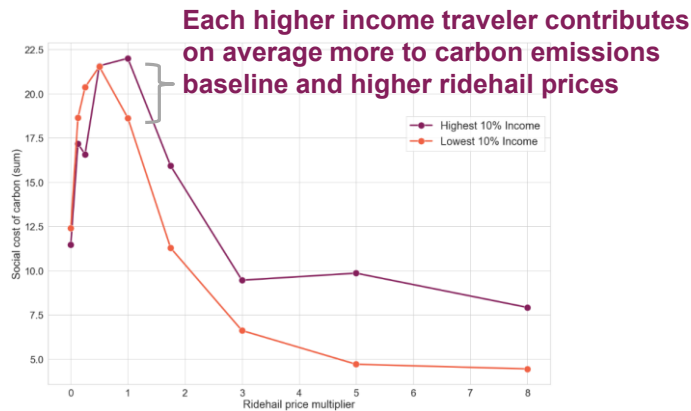
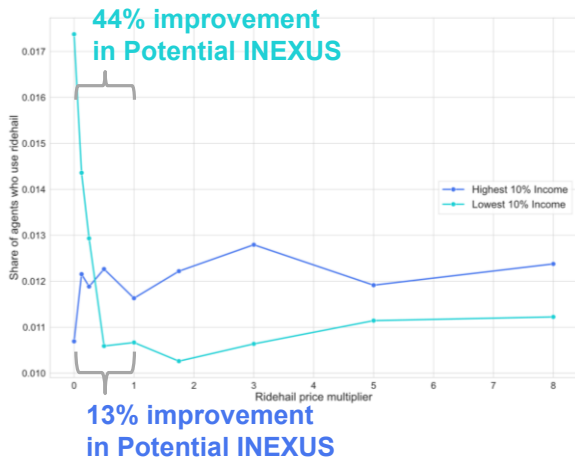
**1. Freeride direct benefit:**  
travelers that use ridehail in both the baseline and the lower ridehail price scenario receive benefits without any induced behavior change

**2. Backup option indirect benefit:**  
some travelers that don't reoptimize are still better off because they have a more appealing backup option available



Realized and Potential INEXUS for travelers who **do not change** their mode from the baseline

# SOCIAL INEXUS CAN REVEAL DIFFERENCES IN THE SHARE OF CARBON EMISSIONS ACROSS SUBPOPULATIONS

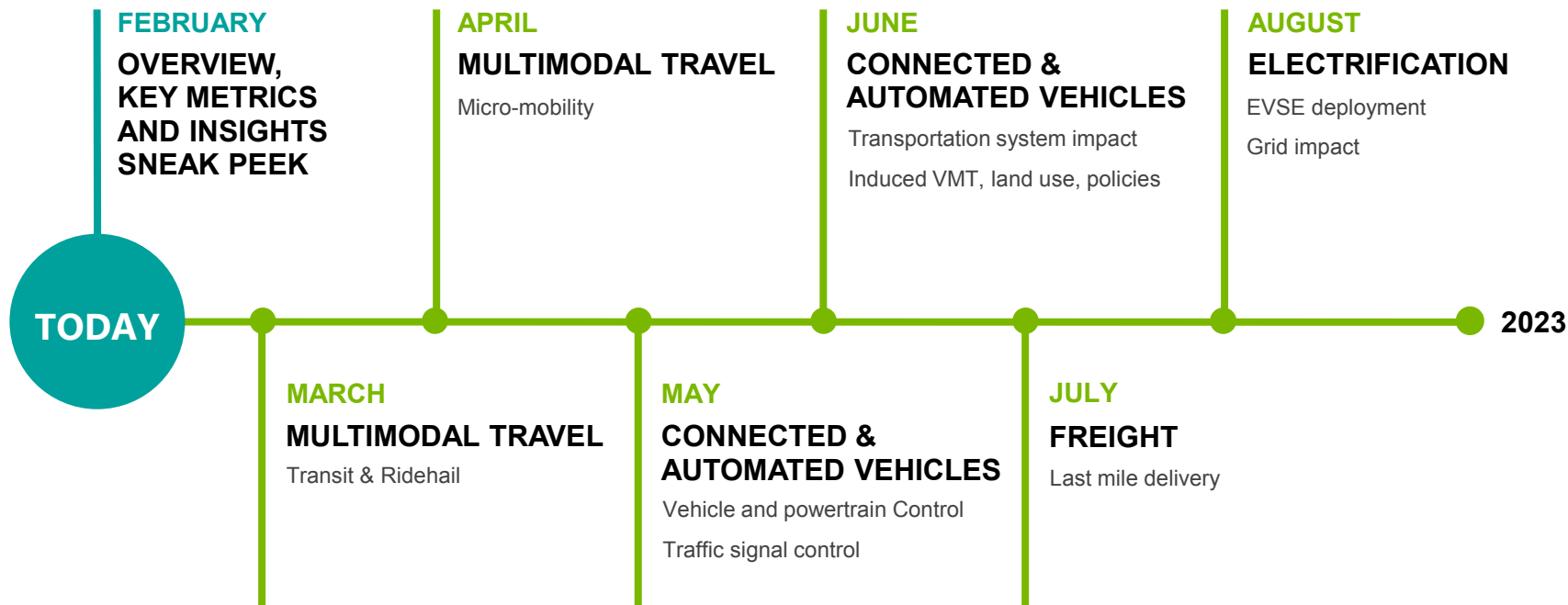


Improving equity and environmental outcomes can often be difficult to achieve simultaneously, but tools like these can help understand the mechanisms underlying these tradeoffs

At lower ridehail prices, more low-income households switch to ridehail, resulting in a 44% improvement in their accessibility and experience.

This improvement in accessibility comes with a trade-off → lower income traveler more similar to their higher income counterparts in terms of carbon emissions contributions

# UPCOMING WEBINARS







U.S. DEPARTMENT OF ENERGY

# SMARTMOBILITY

Systems and Modeling for Accelerated Research in Transportation

General questions, comments, please contact  
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