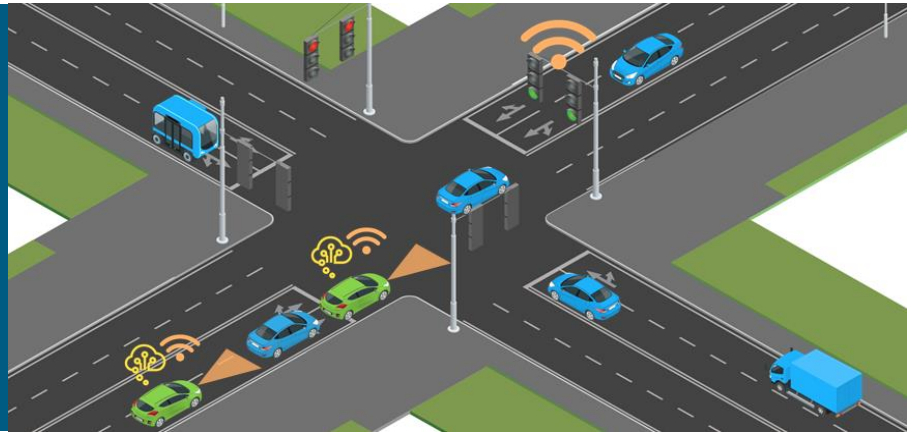
U.S. DEPARTMENT OF ENERGY
SMARTMOBILITY
Systems and Modeling for Accelerated Research in Transportation

SMART MOBILITY OVERVIEW, KEY METRICS AND INSIGHTS SNEAK PEEK



February 14, 2023

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Argonne NATIONAL LABORATORY
BERKELEY LAB
INL Idaho National Laboratory
NREL NATIONAL RENEWABLE ENERGY LABORATORY
OAK RIDGE National Laboratory
Pacific Northwest NATIONAL LABORATORY

TODAY'S SPEAKERS

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NREL

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

SINGLE COMPONENT

SINGLE VEHICLE

SMALL NETWORK

TRAFFIC FLOW

ENTIRE URBAN AREA

Better vehicles
Powertrain, electrification, control, lightweighting, aero/tires, etc.

Smarter vehicles
Control of speed and/or powertrain using:
- sensors & connectivity
- automation

Smarter roads
Smarter control of the road networks and traffic flows

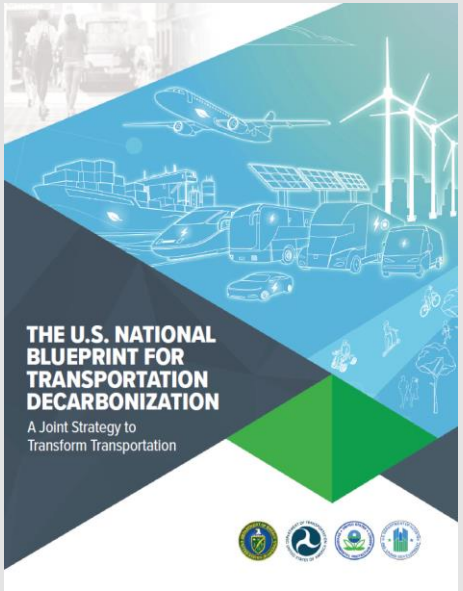
Smarter travelers
Mobility as a service, changes in travel needs

← HISTORICAL VTO R&D →

← SMART MOBILITY R&D →

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

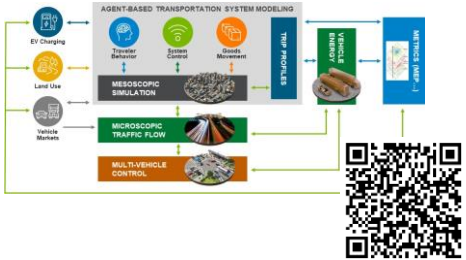
BEYOND VEHICLES

Green marketing is a practice whereby companies seek to go above and beyond traditional marketing by promoting environmental core values.

SMART 1.0

Quantified CAVs potential energy savings (simulation), developed and demonstrated transportation system workflow

Five Capstone Reports



START

2015

2016

2020

2023

CAV R&D

First US DOE VTO Call

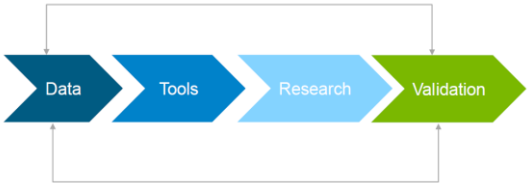
Foundation of SMART Consortium

Identify capabilities, needs and gaps

SMART 2.0

Faster, better, more scenarios, more stakeholder

Focus on actionable insights



CONSORTIUM FOCUSED ON ADDRESSING STAKEHOLDER QUESTIONS

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

R&D PARTNERS

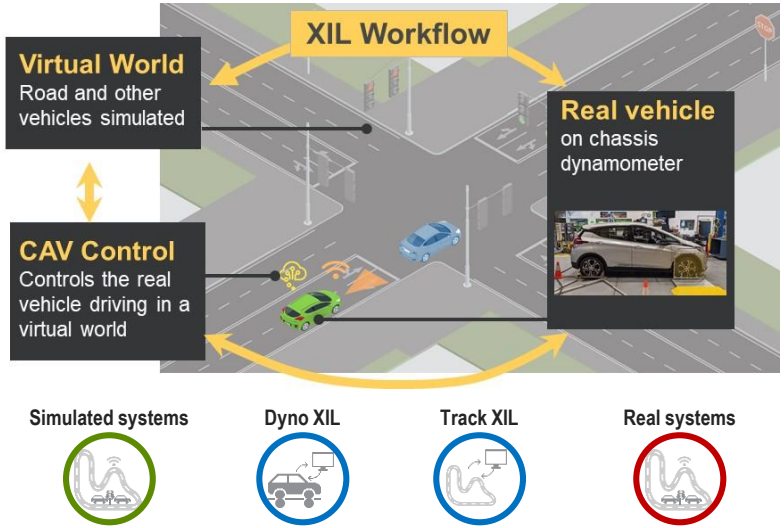
NATIONAL LABORATORIES

STAKEHOLDERS

PRIMARY APPROACHES FOR VEHICLE AND TRANSPORTATION SYSTEM IMPACT

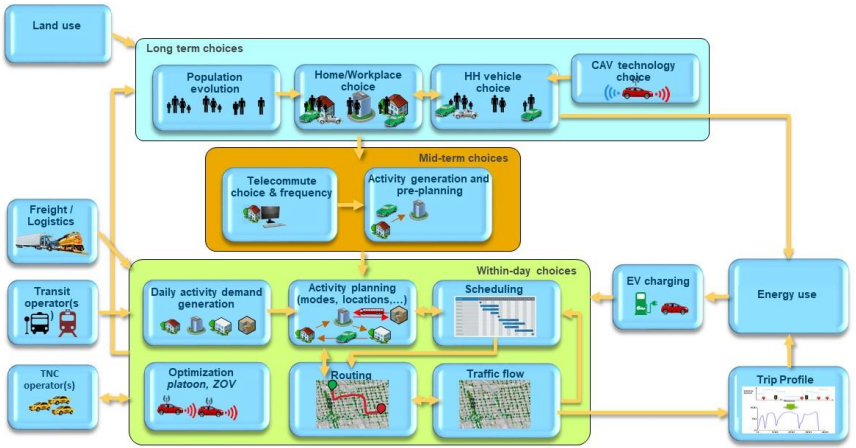
VEHICLE FOCUS

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



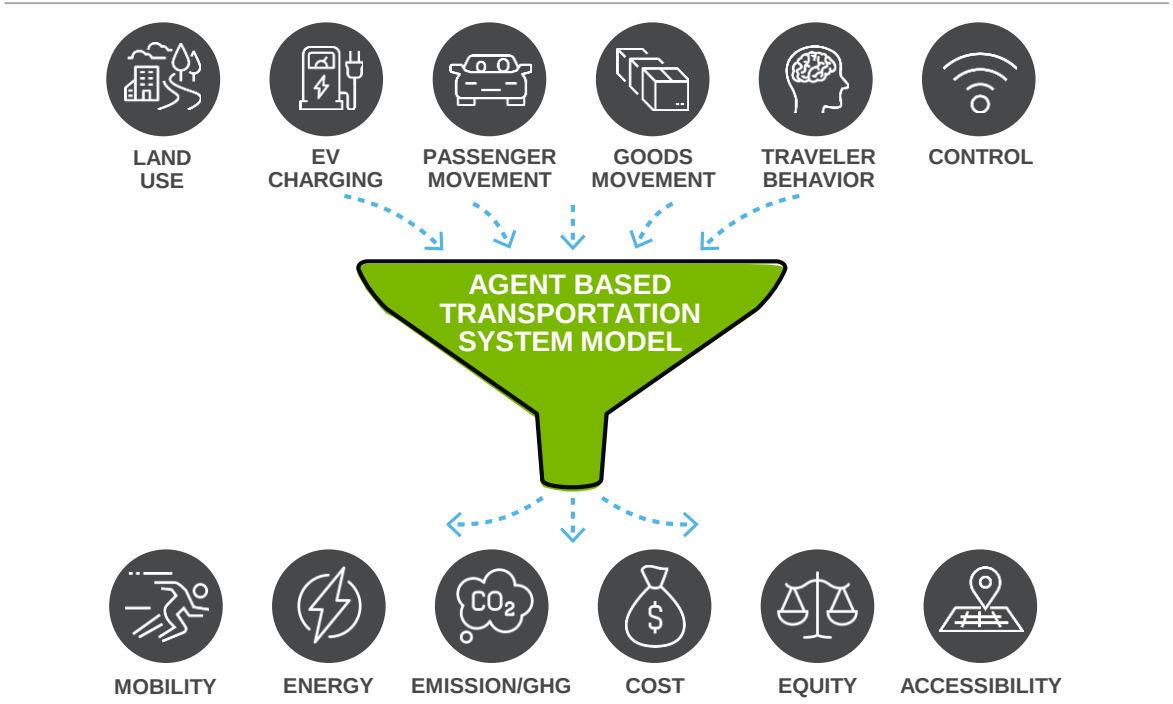
TRANSPORTATION SYSTEM FOCUS

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



LARGE NUMBER OF METRICS CONSIDERED SIMULTANEOUSLY

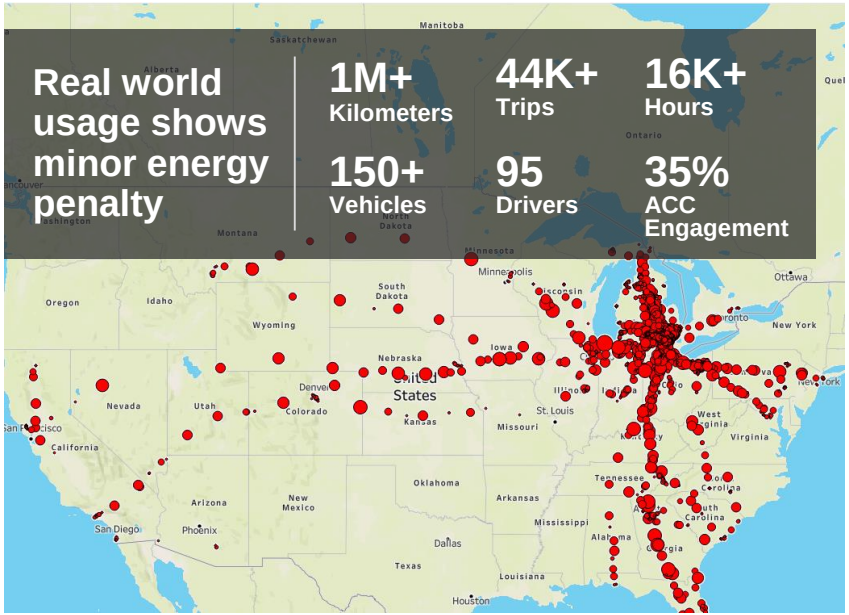
Multi-fidelity end-to-end modeling workflow, provides unique insights by quantifying the impact of individual technologies and policies across the entire transportation system.



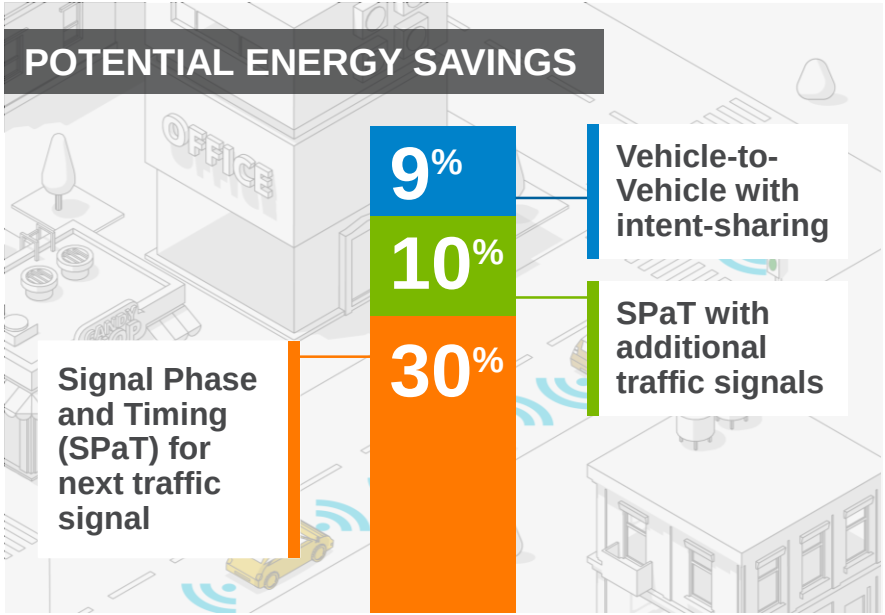
CURRENT AUTOMATED DRIVING SYSTEMS ARE NOT FUEL EFFICIENT—BUT COULD BE

U.S. DEPARTMENT OF ENERGY SMARTMOBILITY Systems and Modeling for Accelerated Research in Transportation

TODAY

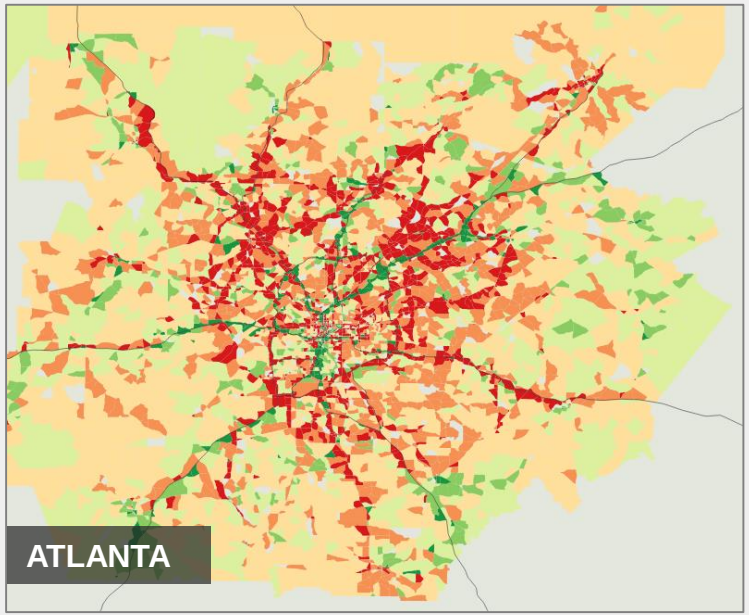


TOMORROW



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

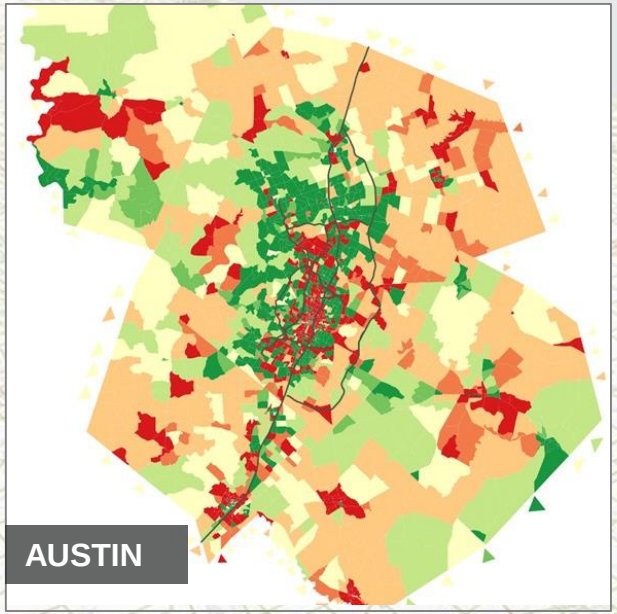


Δ GHG emissions
(tonnes)

- <-1
- -1 - -0.25
- -0.25 - 0
- 0 - 0.25
- 0.25 - 1
- >1

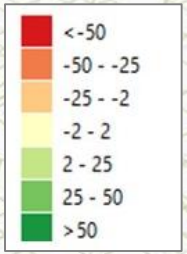
CARBON PRICING CAN HELP MITIGATE LAND USE IMPACT OF LEVEL 4 AUTOMATED DRIVING

- 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



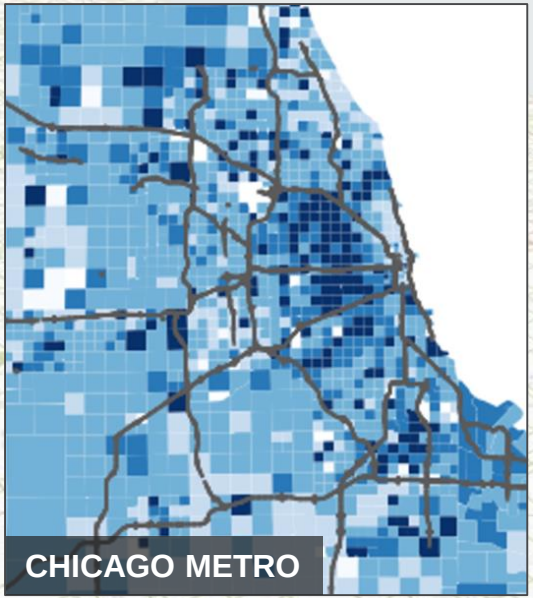
Δ Level 4 Ref 2040 vs. Base Ref 2020

Δ Population density per/km^2

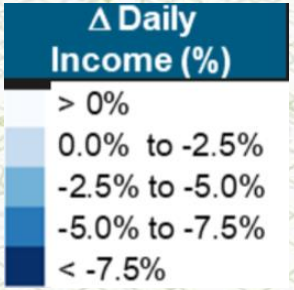


ROAD PRICING COST INCREASES HIGHEST IN LOW INCOME AND EXURBAN AREAS

- 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

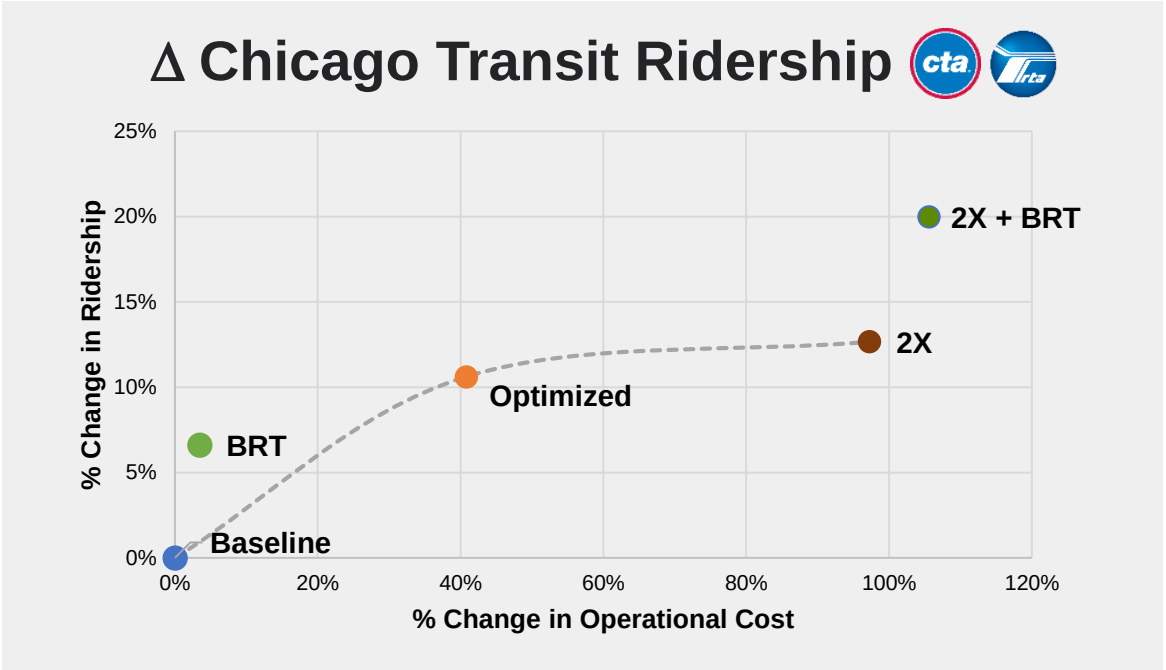


Δ Daily Income

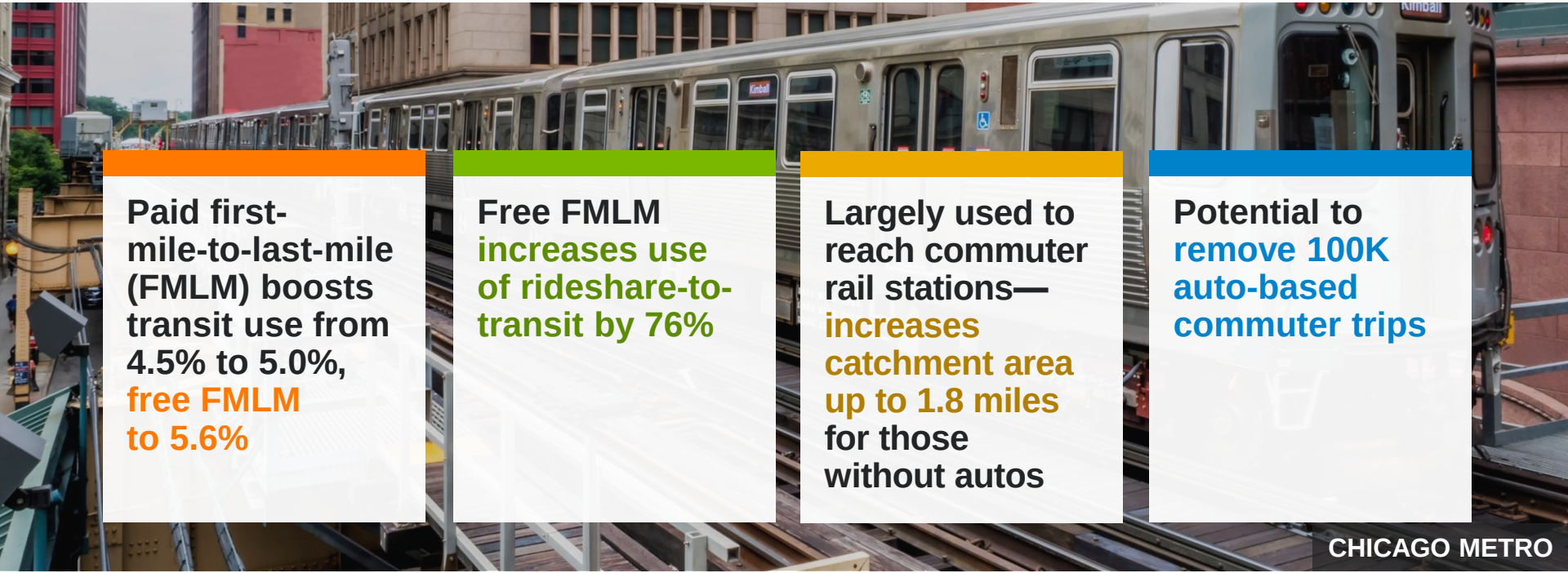


TRANSIT OPTIMIZATION IMPROVES RIDERSHIP UP TO 11% AT MODERATE COST

- 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?

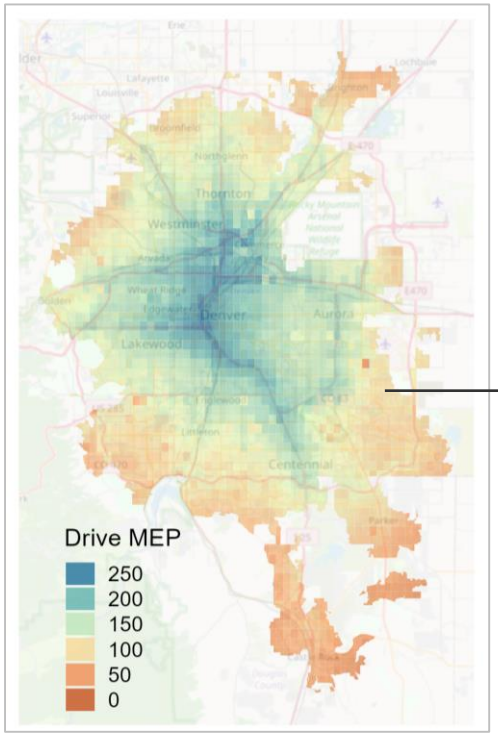
Mobility Energy Productivity (MEP) quantifies how well connected a place is, and does so while accounting for time, cost, and energy of modes that provide mobility in that place

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



79

5 11 15 48

16

12

10

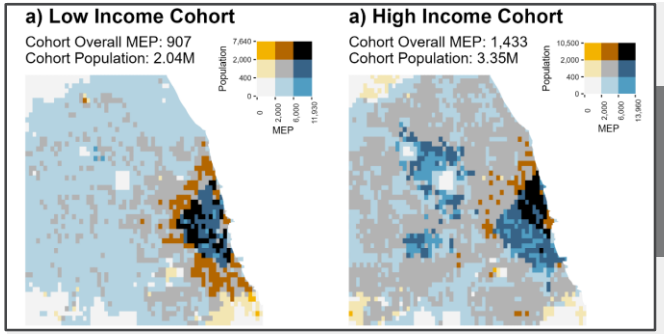
4

3

3

VEHICLE OWNERSHIP

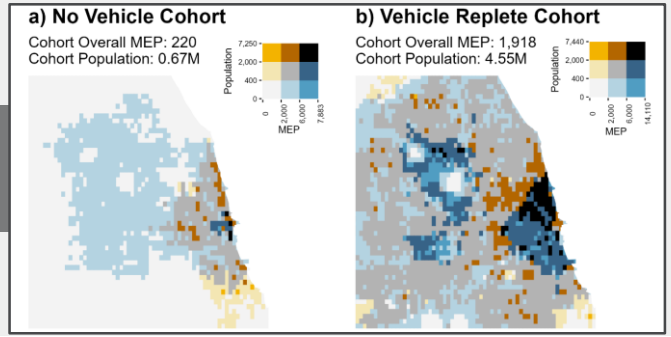
Has an outsized impact on time, energy, and cost-efficient accessibility



Low-Income:
Household Annual Income < $36.9K

High-Income:
Household Annual Income ≥ $83K

Vehicle-replete:
Number of drivers (age 16+) >=
Number of vehicles in household

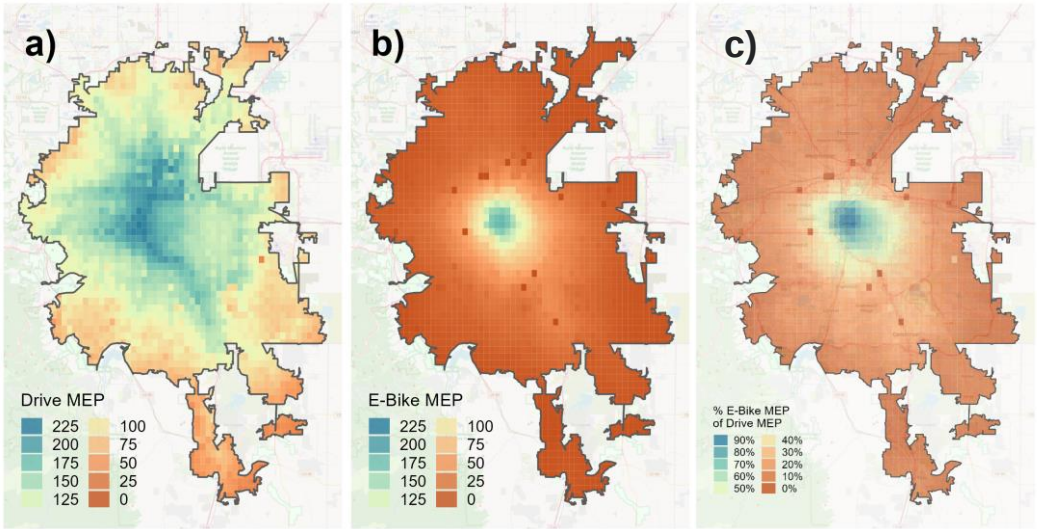


The spatial disparity in locations with high MEP scores vs. places of residence was stark for vehicle-ownership based cohorts compared income-based cohorts.

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



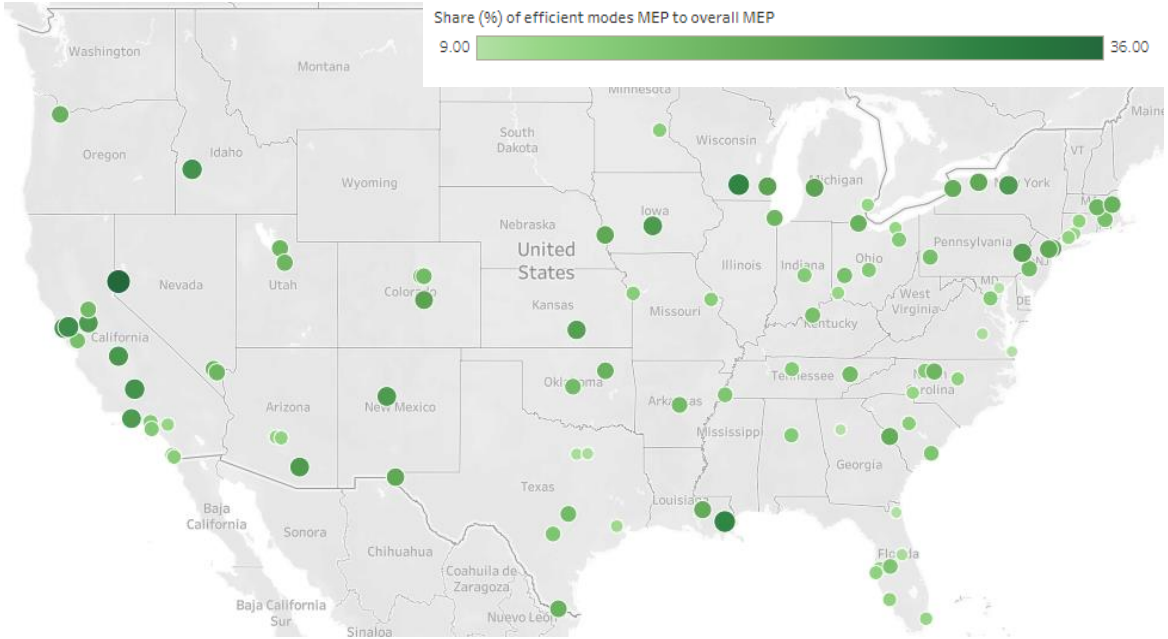
*Preliminary results

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

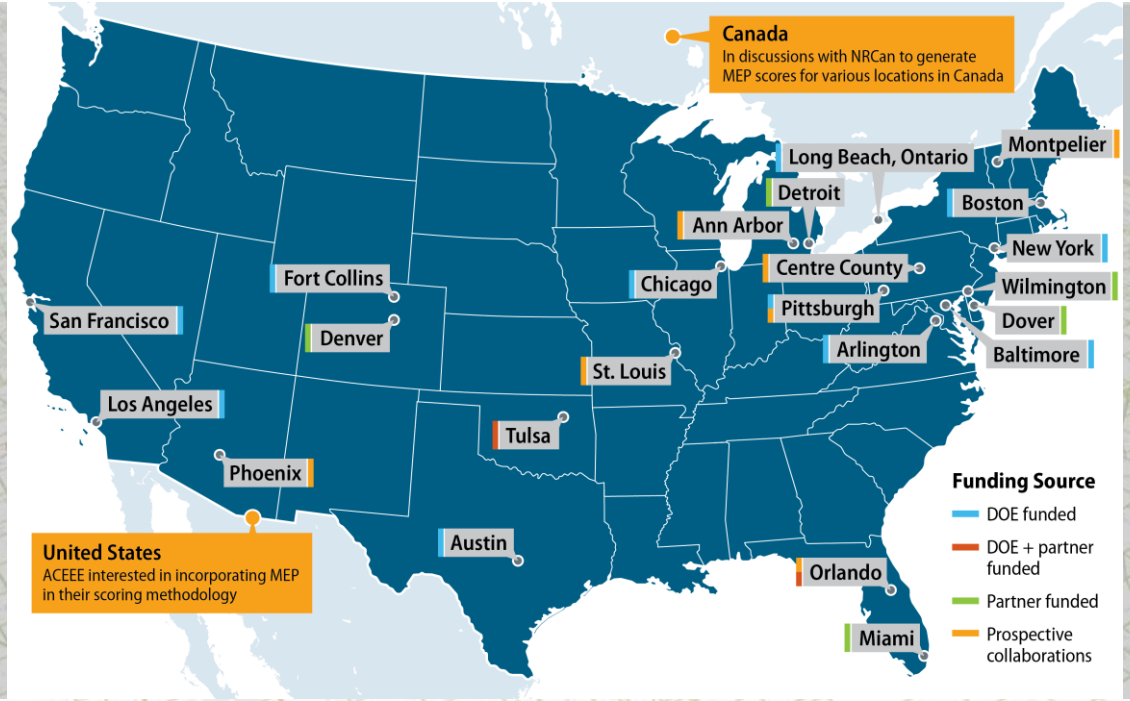
MEP Scores Analyzed for ~ 100 U.S. Cities

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
***In**dividual **ex**perienced **u**tility-based **s**ynthesis*

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

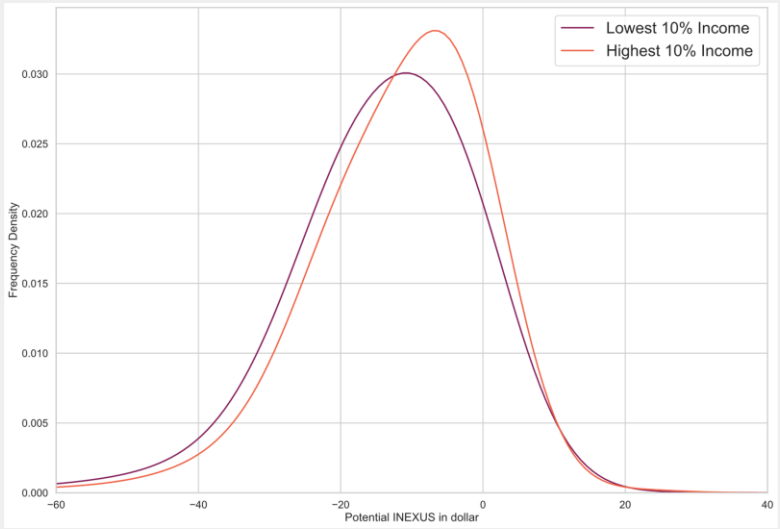
- High-resolution agent-based modeling frameworks are powerful tools for exploring alternative transportation system policy, design, and technology deployment scenarios.
- Gaining multi-faceted insights from these scenario outcomes requires a range of innovative ways of processing the results, including 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.

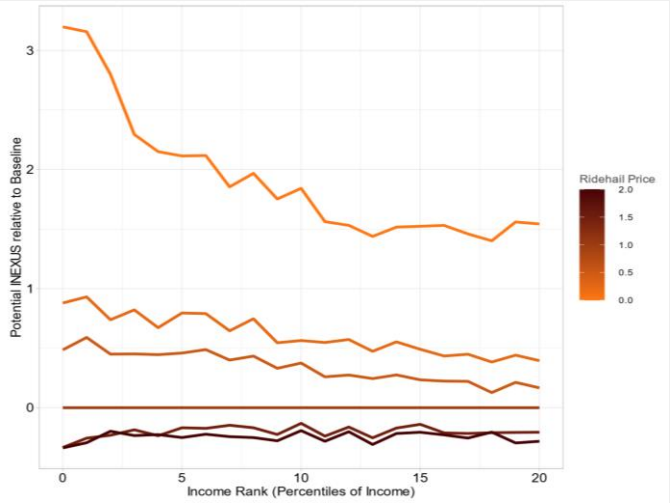
Distribution of Potential INEXUS values for mandatory trips in the baseline scenario across income groups



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

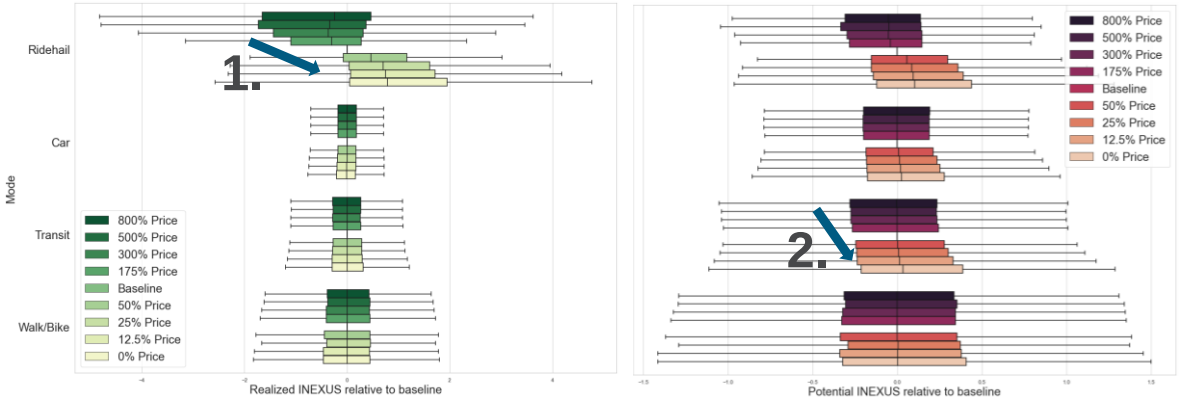


INEXUS CAN CAPTURE A RANGE OF POTENTIAL BENEFITS FROM A SYSTEM CHANGE EVEN WITHOUT BEHAVIOR CHANGE

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

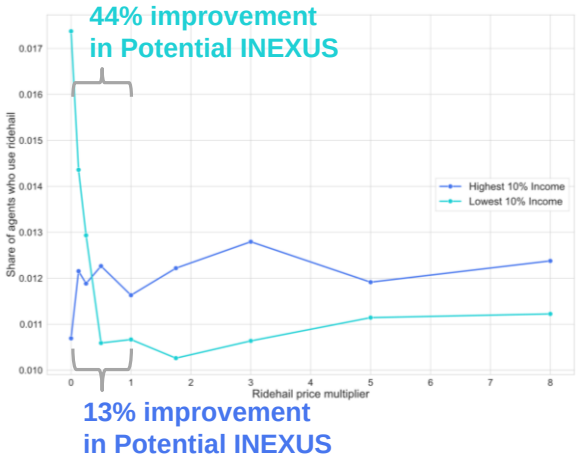
2. **Backup option indirect benefit:** some travelers that don't reoptimize are still better off because they have a more appealing backup option available

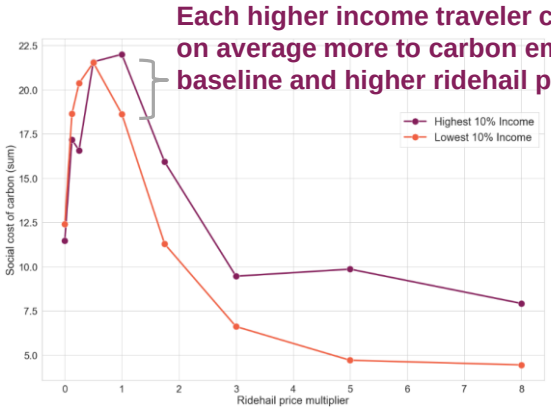
REALIZED INEXUS | **POTENTIAL INEXUS**



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



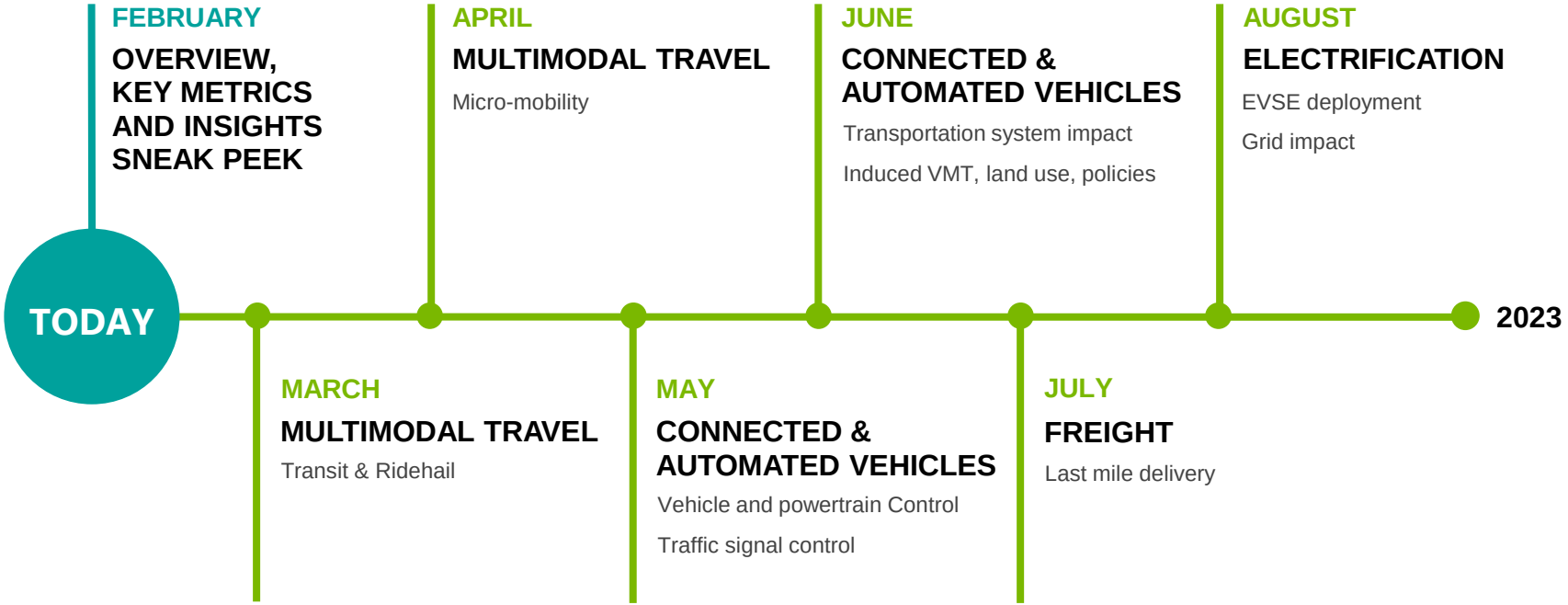


Improving equity and environmental outcomes can often be difficult to achieve simultaneously, but tools like these can help understand the mechanisms underlying these tradeoffs

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



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General questions, comments, please contact
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