U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

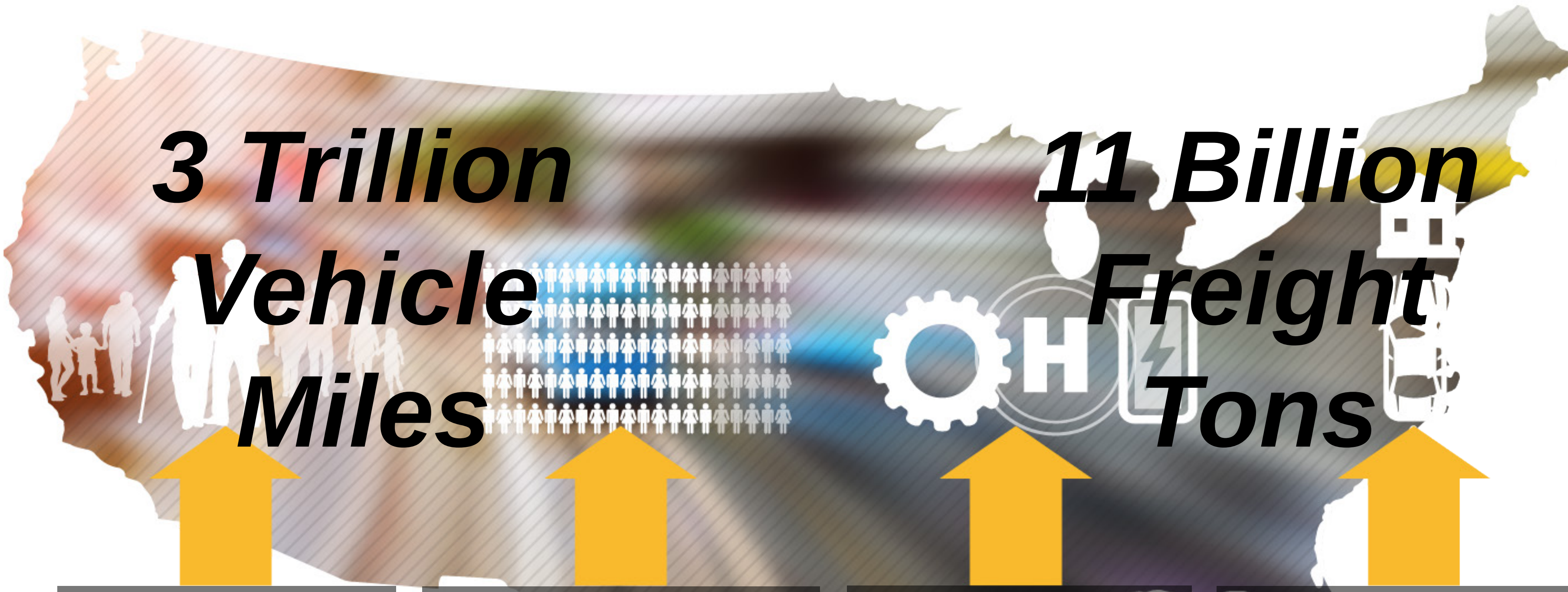
Mobility: Where are we going?

An update on Research from DOE

Michael R. Berube

Director, Vehicle Technologies Office

TRANSPORTATION IS FUNDAMENTAL TO OUR WAY OF LIFE



3 Trillion Vehicle Miles

11 Billion Freight Tons

The U.S. population is growing and aging

Population density is increasing—**75% of the population** lives in urban mega-regions

Technologies and fuel choices are expanding

Transportation costs are high—second only to housing expenses

EXPLORING POTENTIAL ENERGY IMPACTS

ENERGY EFFICIENT MOBILITY SYSTEMS

+ 200%

Empty miles
Easier Travel
Increased use by underserved populations

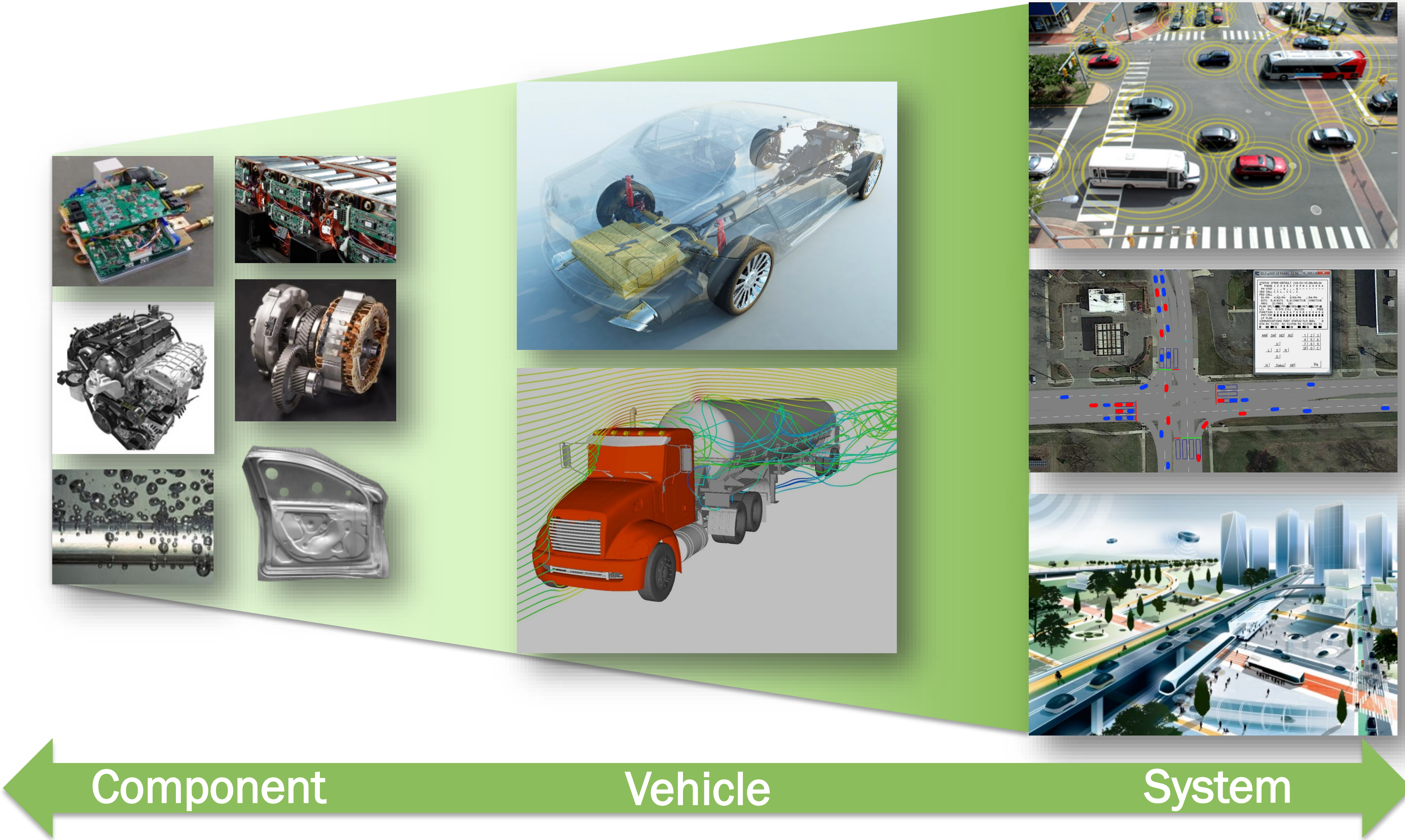
ENERGY USE

ENERGY USE

Vehicles right-sized
Less hunting for parking
Collision avoidance
Platooning

- 60%

CONDUCTING RESEARCH AT ALL LEVELS



CRITICAL NEED FOR

INTERAGENCY & INDUSTRY COORDINATION

To jointly advance the state-of-the-practice in safety, mobility, and energy efficiency in transportation

ACHIEVING GOALS

THROUGH FIVE EEMS ACTIVITY AREAS

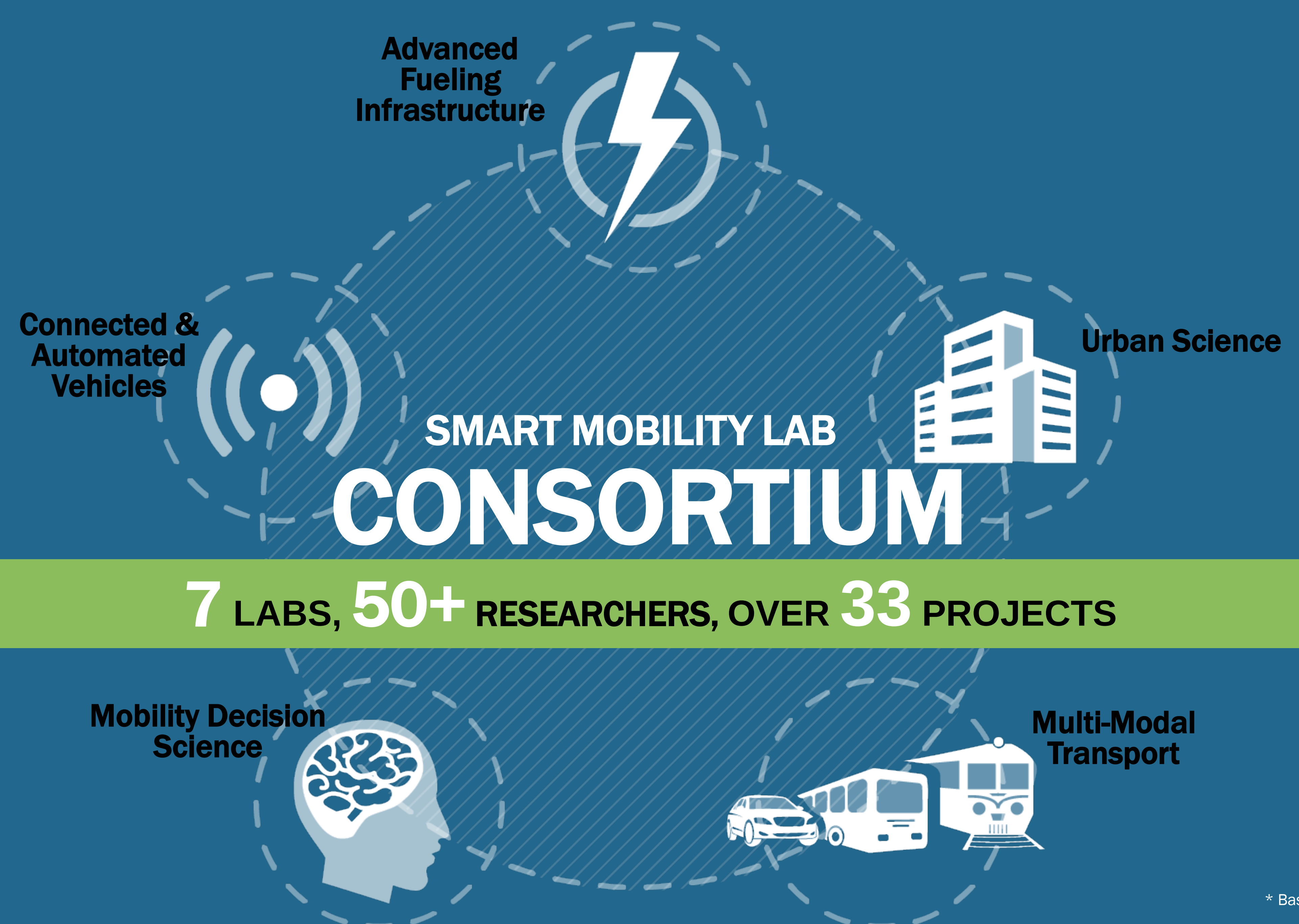
Advanced R&D Projects

Living Labs

Smart Mobility Lab Consortium

Core Evaluation & Simulation Tools

HPC4Mobility & Big Transportation Data Analytics


Advanced Fueling Infrastructure
Connected & Automated Vehicles
Urban Science
SMART MOBILITY LAB
CONSORTIUM
7 LABS, 50+ RESEARCHERS, OVER 33 PROJECTS
Mobility Decision Science
Multi-Modal Transport
* Bas

CORE EVALUATION & SIMULATION TOOLS

Building Integrated, Scalable Models
from vehicle to city level

Single Vehicle | **Corridor / Small Network** | **Entire Urban Area**

AUTONOMIE → RoadRunner → PTV VISSIM / Aimsun → POLARIS

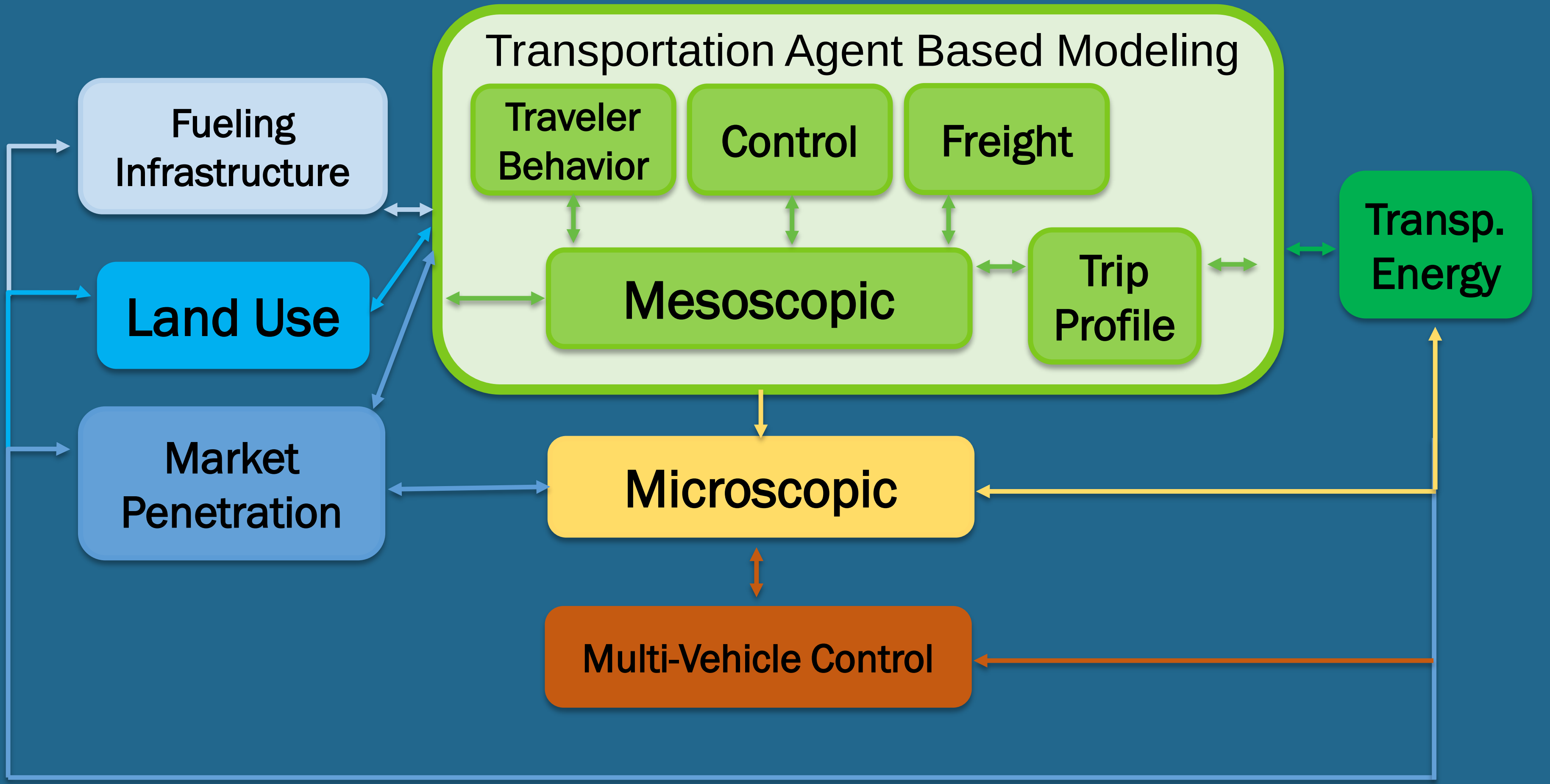
AUTONOMIE
- Vehicle energy consumption
- Powertrain and component performance requirements, cost and benefits
- Support NHTSA CAFÉ
- Large scale simulations
- Only commercial tool with vehicle level control
- Licensed to >250 companies

RoadRunner
- Only system simulation of multi-vehicle and their environment focused on advanced control enabled by V2V, V2I…
- Uses Autonomie powertrain models

PTV VISSIM / Aimsun
- Commercial Tools
- Microscopic traffic flow simulation
- Focus on detailed traffic flow, control

POLARIS
- Agent-based mesoscopic traffic flow simulation
- Focus on traveler behavior, transport modes, technologies
- Computationally efficient
- Integrated demand and traffic flow

CORE EVALUATION & SIMULATION



A CRITICAL RESEARCH NEED:

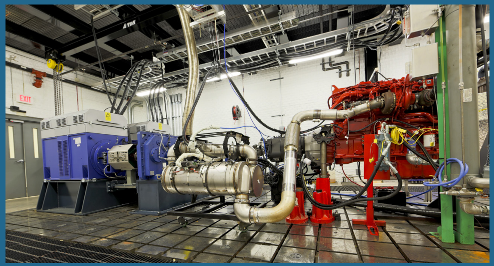
PROOF-OF-CONCEPT TESTING

FOR MODEL VALIDATION

Component/ Powertrain-Level

Vehicle-Level

Transportation System-Level



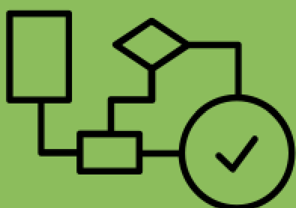
Engine/Powertrain Dyno Testing

Chassis Dyno Testing

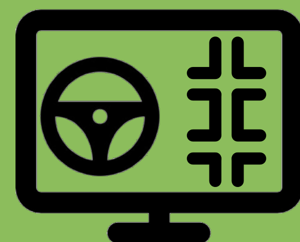
?

DATA TO UNDERSTAND ENERGY IMPACTS -

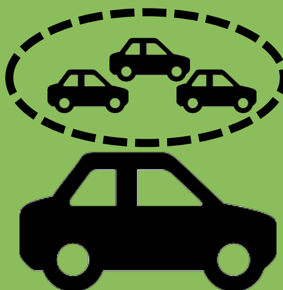
RESEARCH & DEVELOPMENT PROJECTS



Vehicle & Traffic Control Algorithms



CAV Vehicle & Transportation Simulation



CAV Vehicle-in-the-Loop Testing

Data Collection from CAV Deployments

Transportation System Optimization

DATA TO UNDERSTAND ENERGY IMPACTS - LIVING LABS PROJECTS

15 NEW Awards, $20M

SHARED MOBILITY ELECTRIFICATION
Seattle, Portland, NYC, Denver

ENERGY EFFICIENT FREIGHT LOGISTICS
NYC-Albany Corridor

ELECTRIC LAST MILE
Austin

- **First/Last Mile**
- **Real-World Platooning**
- **Optimized Transportation Hubs**
- **Data & Cities**

NEW OPPORTUNITIES FOR

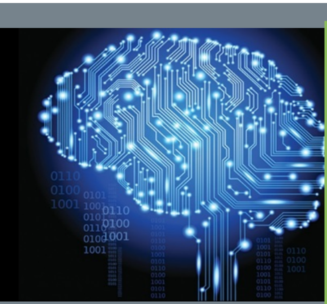
HPC4MOBILITY & BIG DATA ANALYTICS

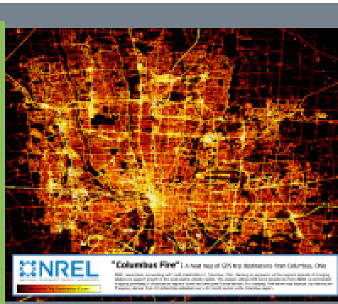
Over 5M in FY2019

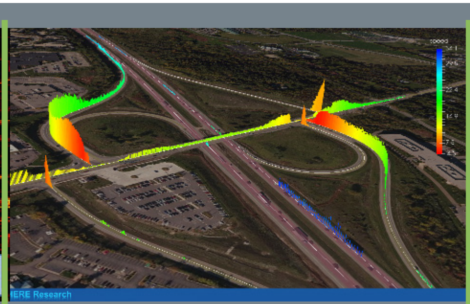
2005: Jaguar	2013: Titan	2018: Summit	2022: Frontier

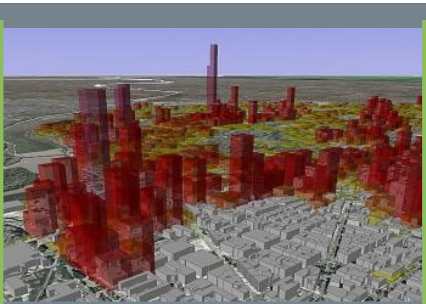
EXASCALE COMPUTING

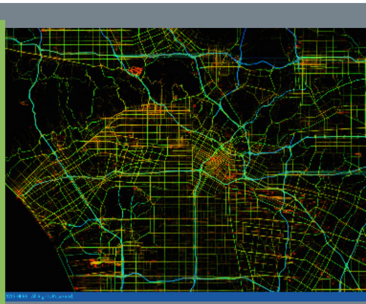
petaFLOP — **1,000x** — exaFLOP

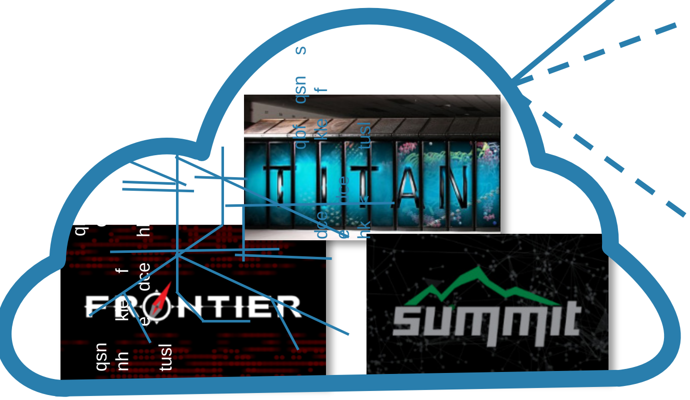










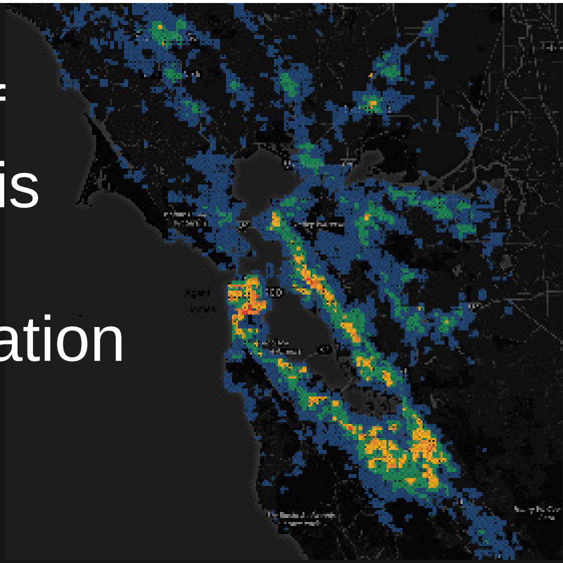


MOBILITY

Large-scale computing resources and big data can inform next generation transportation models

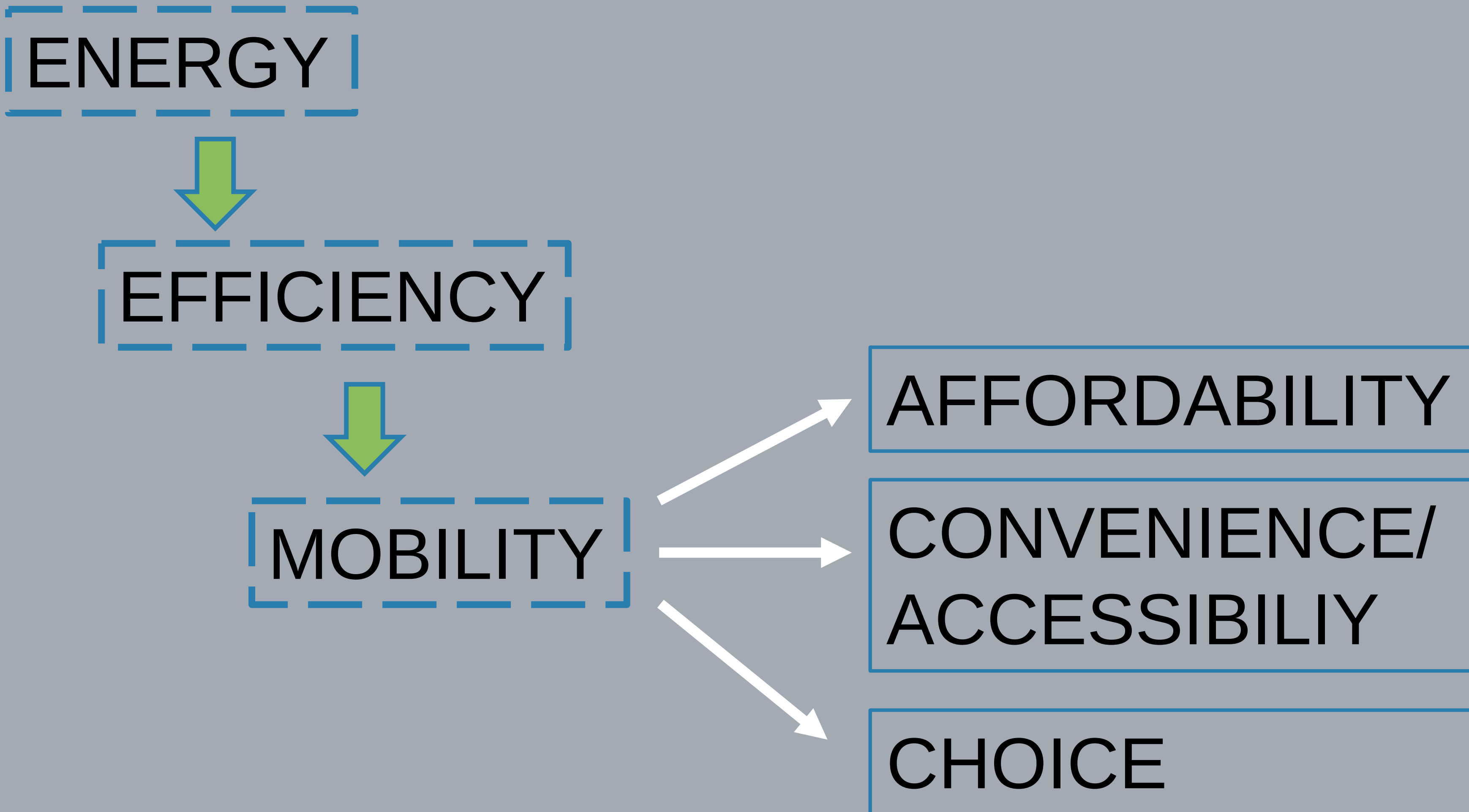
Can we predict and correct congestion before it occurs?

Parallelization of simulation tools is challenging and requires optimization to achieve high performance.



HOW DO WE

EVALUTATE PROGRESS?

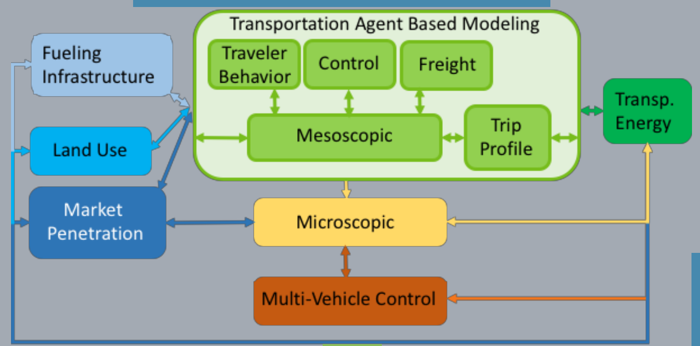


COORDINATED RESEARCH PLAN

Scenarios

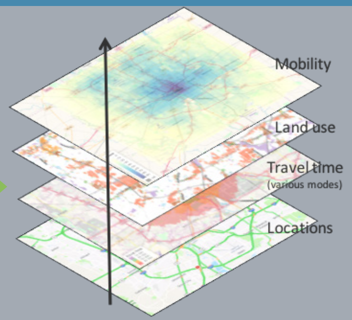
Combinations/values for parameters of interest

Workflow



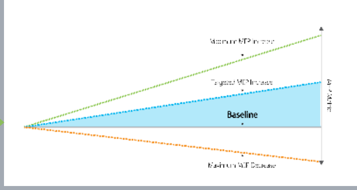
Existing SMART portfolio informs scenarios and develops analysis tools.

Metrics

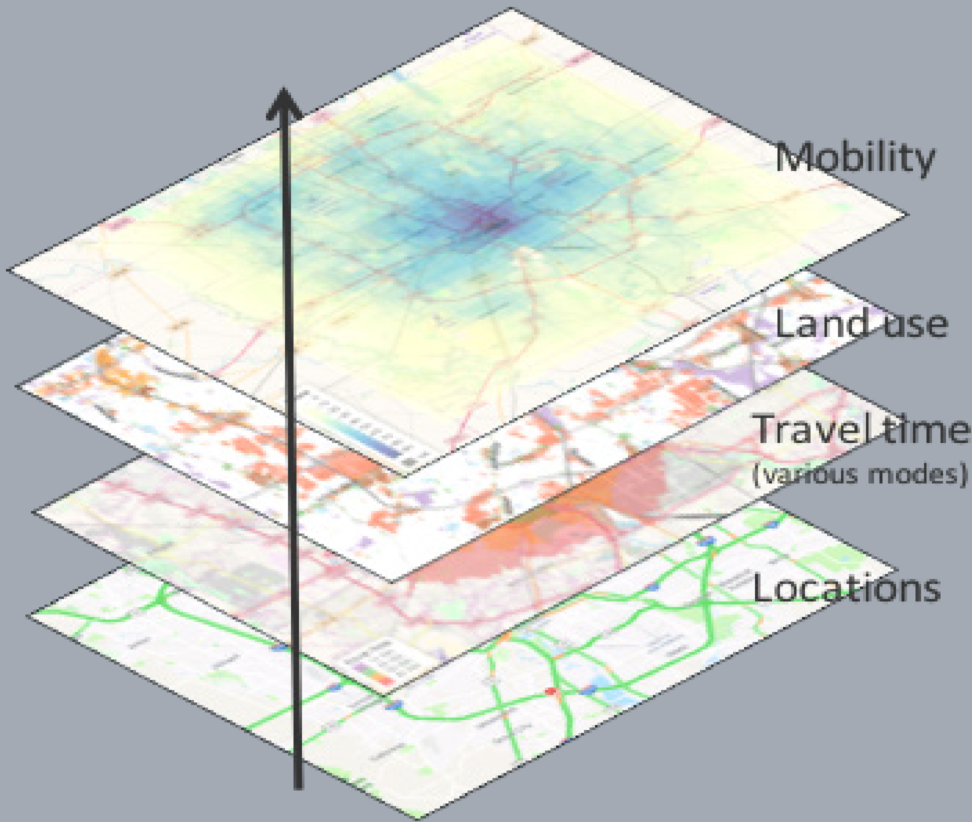


Common scenarios feed parameters into the workflow to calculate the impact on Mobility Energy Productivity and other metrics to generate insights.

Insights



MOBILITY ENERGY PRODUCTIVITY (MEP)



- **Quantify the number of opportunities** that people can reach within a certain travel time
- Opportunity is **weighted by the energy efficiency** and **frequency of trip**
- Opportunities could be further **weighted by the travel cost**

MOBILITY ENERGY PRODUCTIVITY (MEP)

Travel Time and Isochrone

- Third party isochrone APIs
- GPS trajectory data (TomTom, INRIX)
- Travel Demand Models

Land Use Data

- Metropolitan Planning Organizations

Energy Efficiency Measures

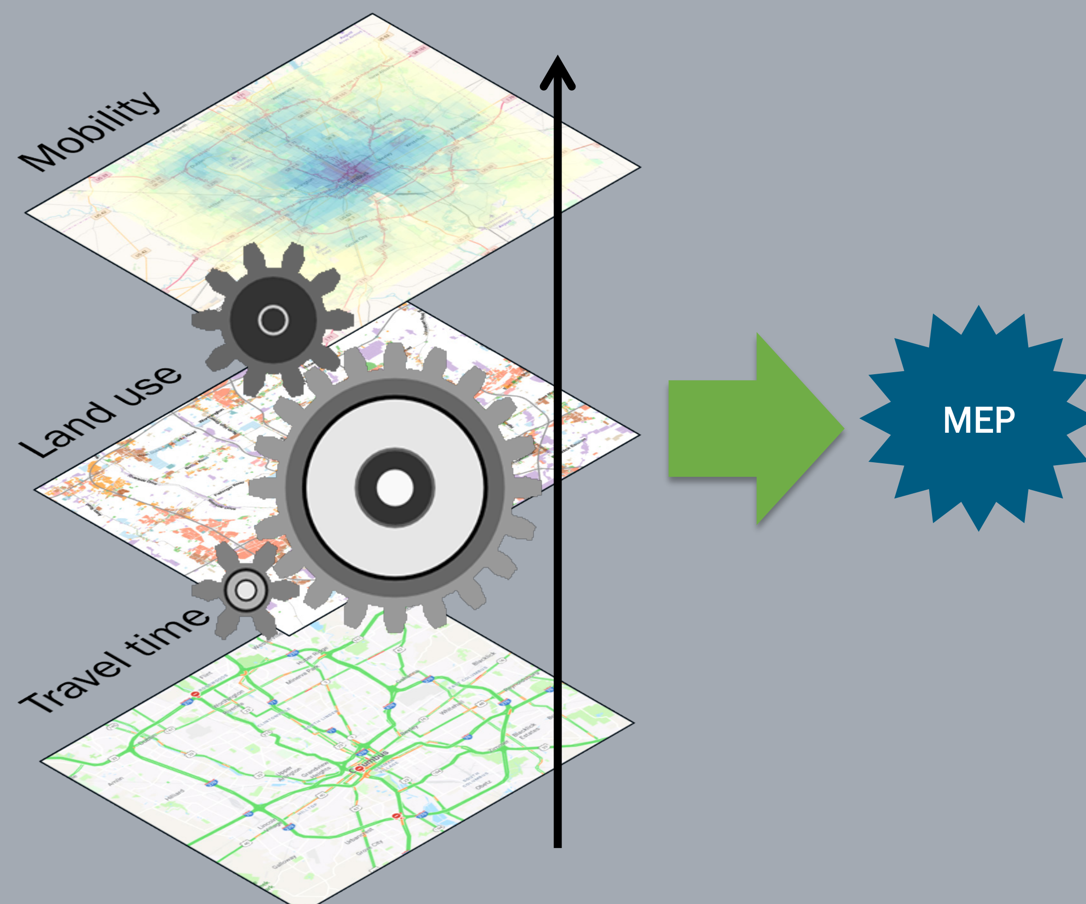
- Transportation Energy Data Book
- Other energy intensity studies

Travel Demand Data

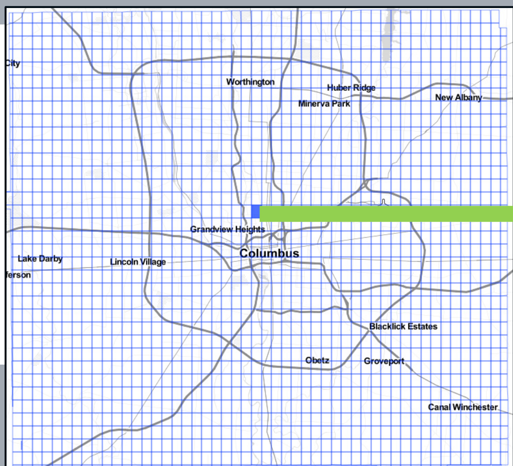
- National Household Travel Survey

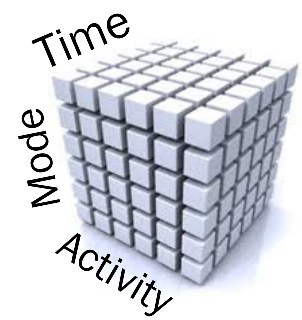
Cost Measures

- Capital costs, operational costs
- Value of time



Weighting Mechanism for MEP





	WORK	SHOP	GROCERY
DRIVING	804681	433	1952
TRANSIT	24628	8	109
BIKING	120292	40	676

Weighted by time

Weighted by modal energy intensity and cost

WORK	SHOP	GROCERY
105344	35	568

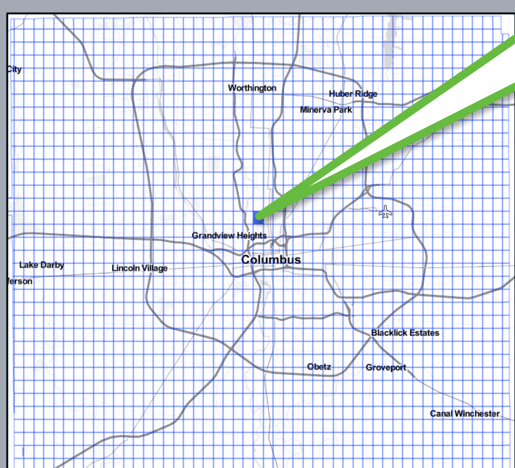
Weight by activity engagement frequency

MEP
68

FINAL
MOBILITY ENERGY PRODUCTIVITY
METRIC

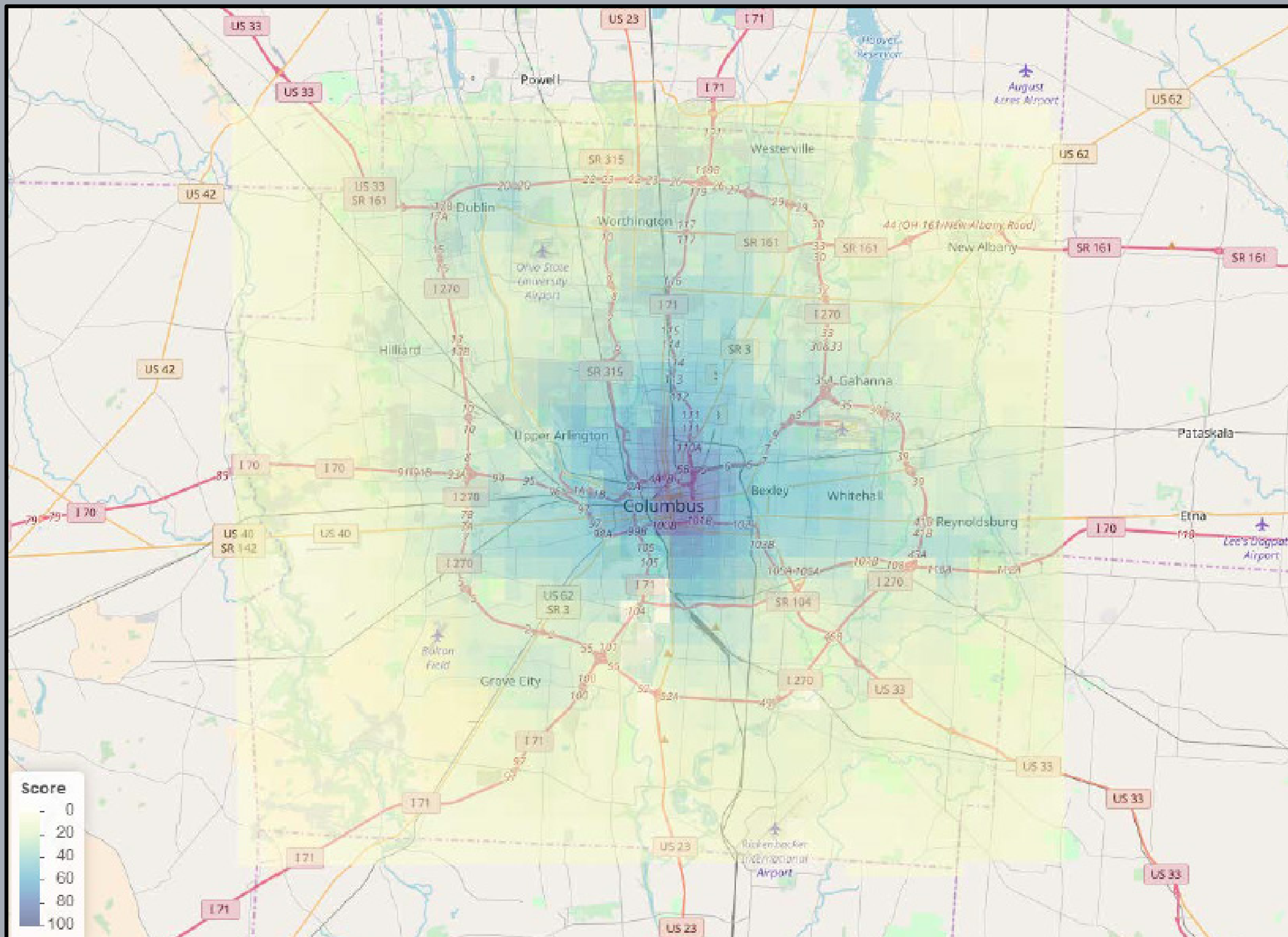
Final Energy Weighted Mobility Metric (0-100 score)

68



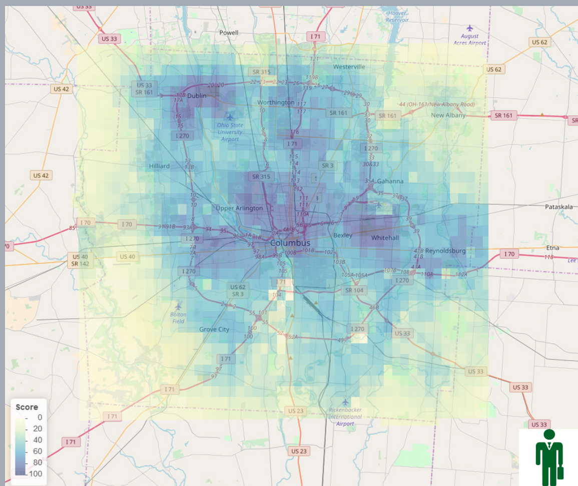
MOBILITY ENERGY PRODUCTIVITY

COLUMBUS, OHIO

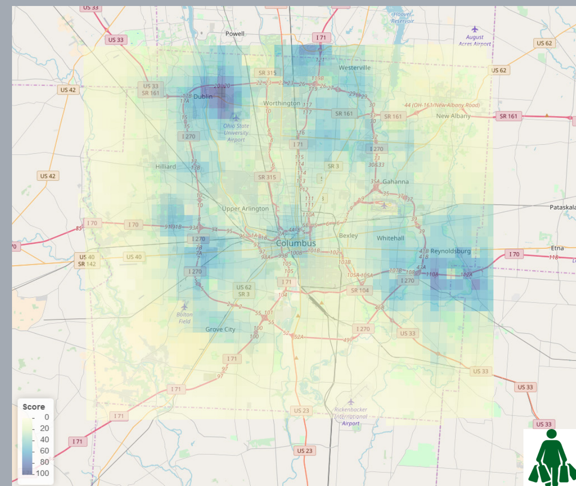


MOBILITY ENERGY PRODUCTIVITY

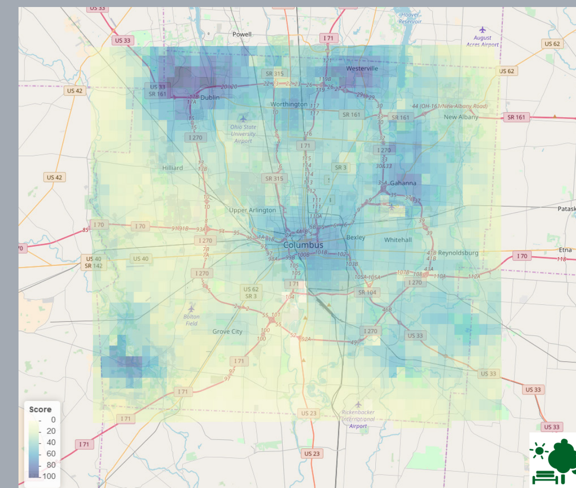
BY ACTIVITY



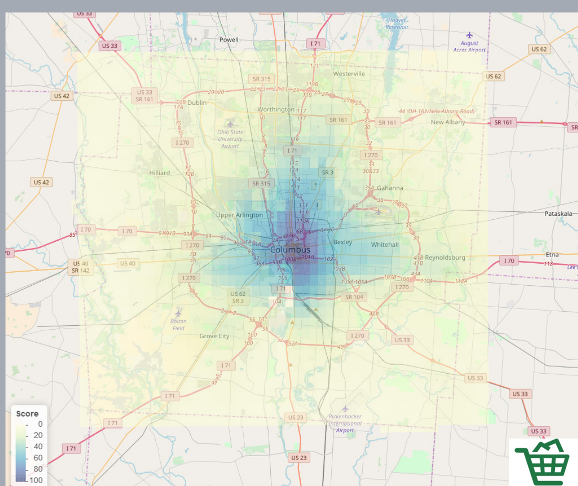
WORK



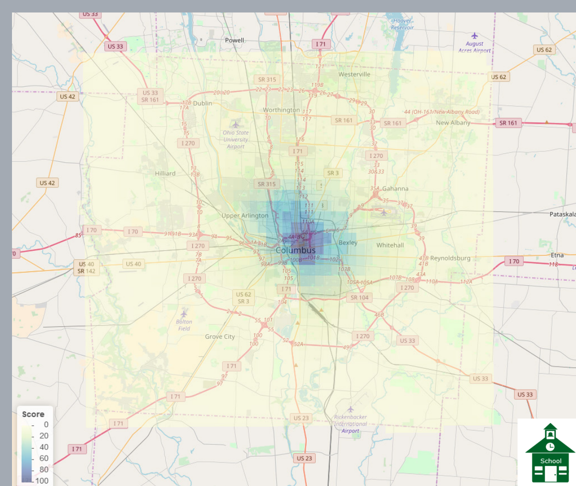
SHOPPING



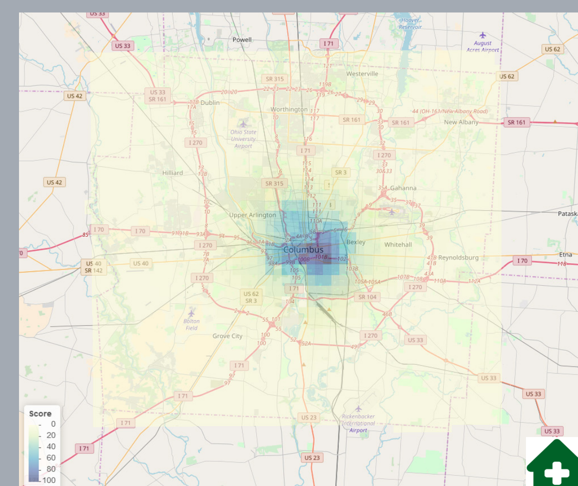
PARK



GROCERY



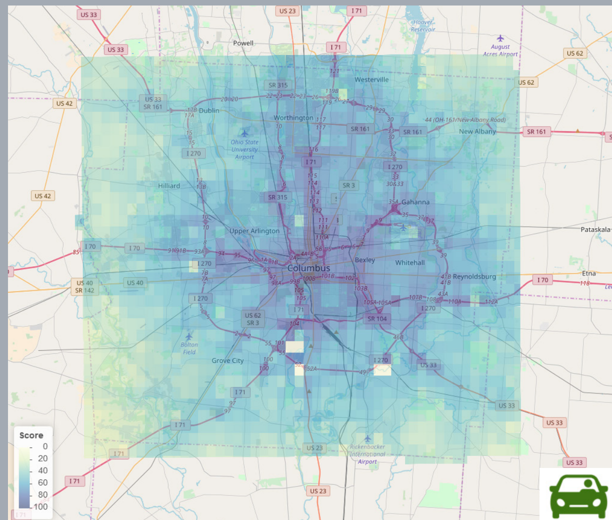
SCHOOL



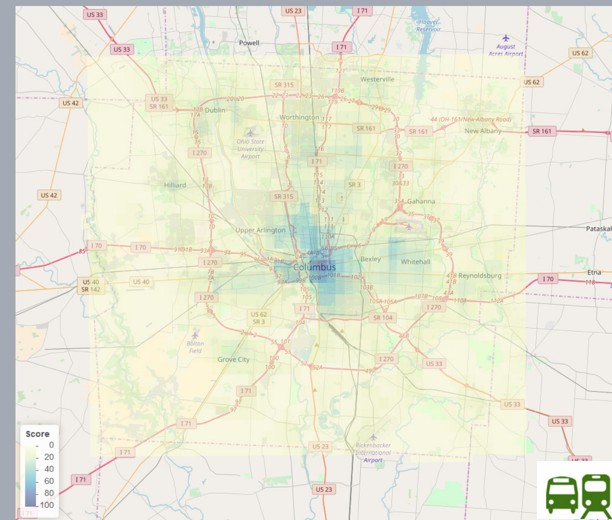
MEDICAL

MOBILITY ENERGY PRODUCTIVITY

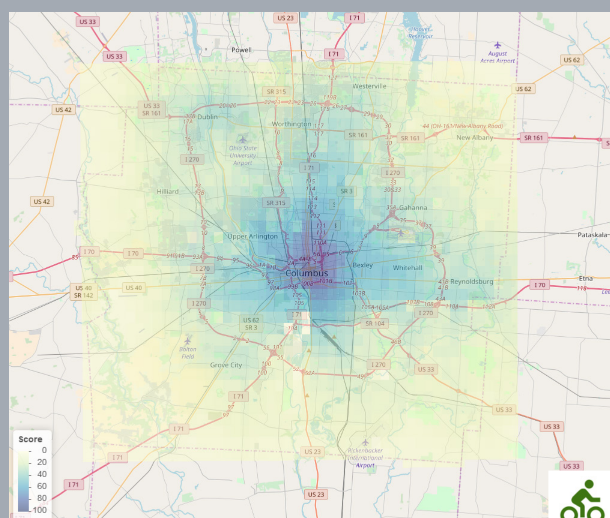
BY MODE (NOT ENERGY WEIGHTED)



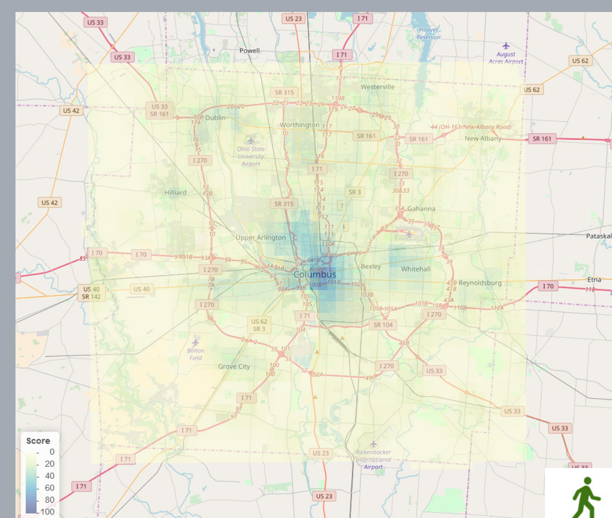
DRIVING



TRANSIT



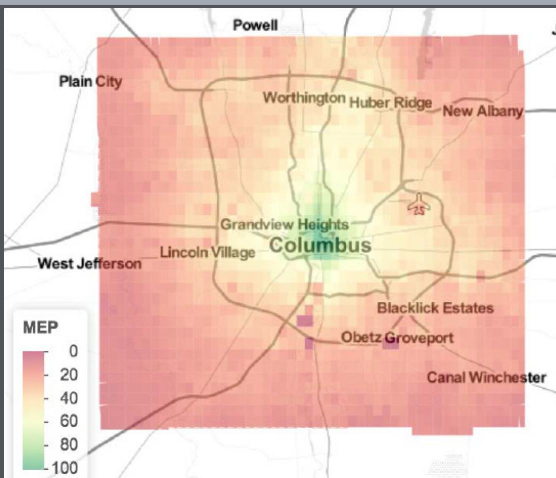
BIKING



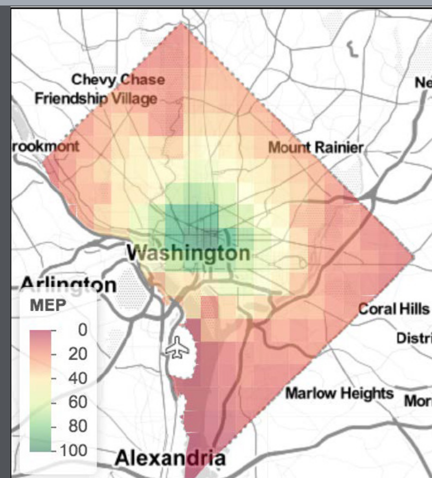
WALKING

APPLYING METRICS

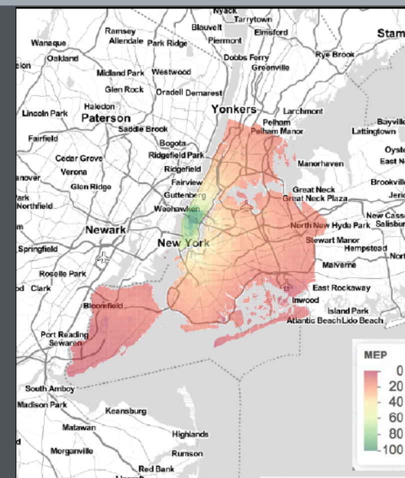
MOBILITY ENERGY PRODUCTIVITY (MEP)



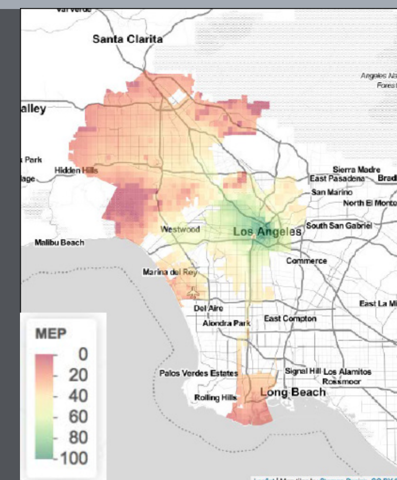
COLUMBUS



WASHINGTON D.C



NEW YORK CITY



LOS ANGELES

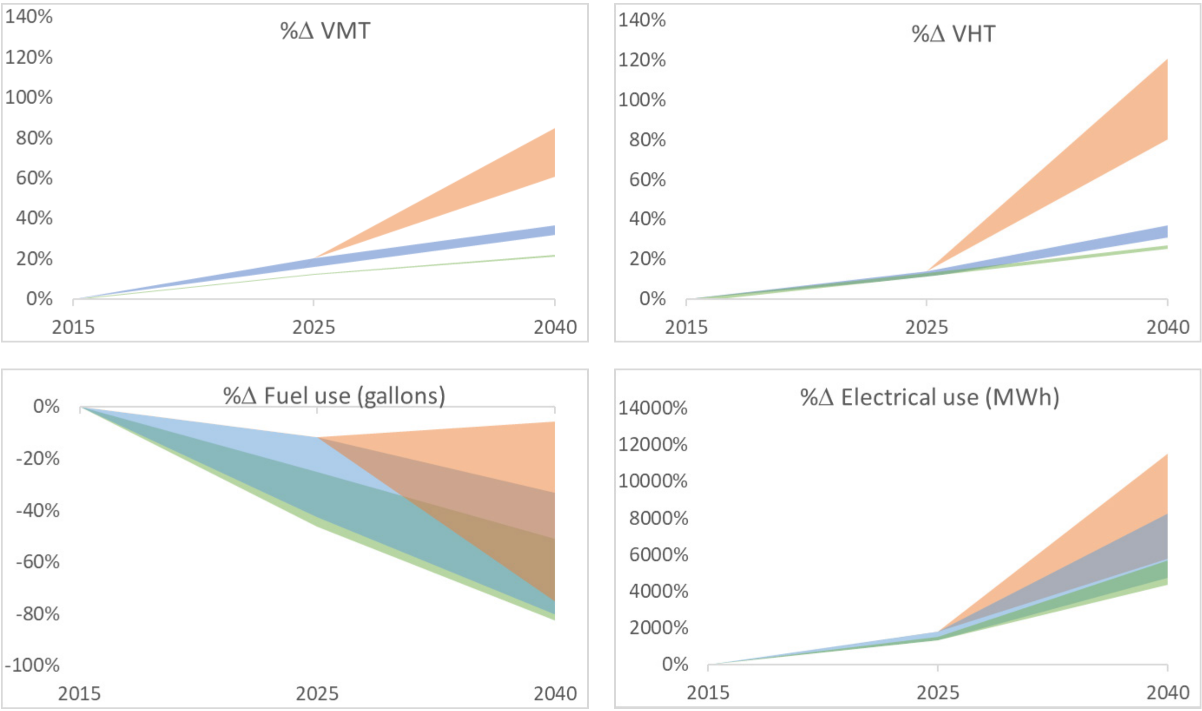
ENERGY EFFICIENT MOBILITY SYSTEMS

RESULTS & INSIGHTS

Smart Mobility Lab Consortium

ACCOMPLISHMENT:
IMPACT OF CAV TECHNOLOGIES

Range in Performance Metrics over All Scenarios by Year



POLARIS

Regional study of Bloomington, IL

Base Case

L4 Automation Case

L5 Automation Case

Best case for each scenario is high-tech powertrain case, 600W CAV accessory load, low CAV penetration, charge for ZOVs.

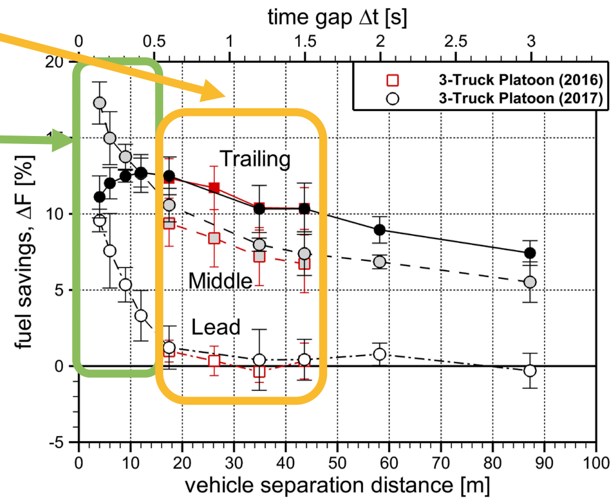
Worst case for each scenario is low-tech powertrain case, 2500W CAV accessory load, high CAV penetration, no charge for ZOVs.

ACCOMPLISHMENT:

TRUCK PLATOONING TESTING

Previous limit of understanding

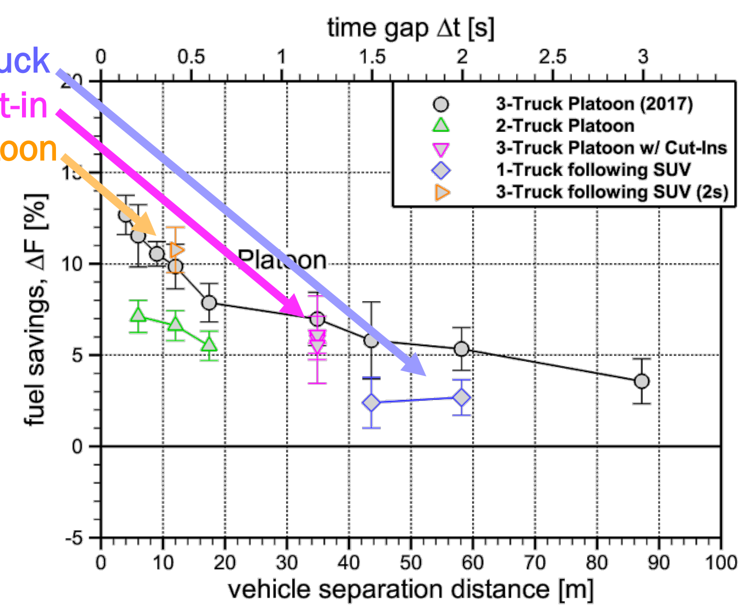
New knowledge of effects at close separation



Effect of SUV leading single truck

Effect of SUV cut-in

SUV leading 3-truck platoon

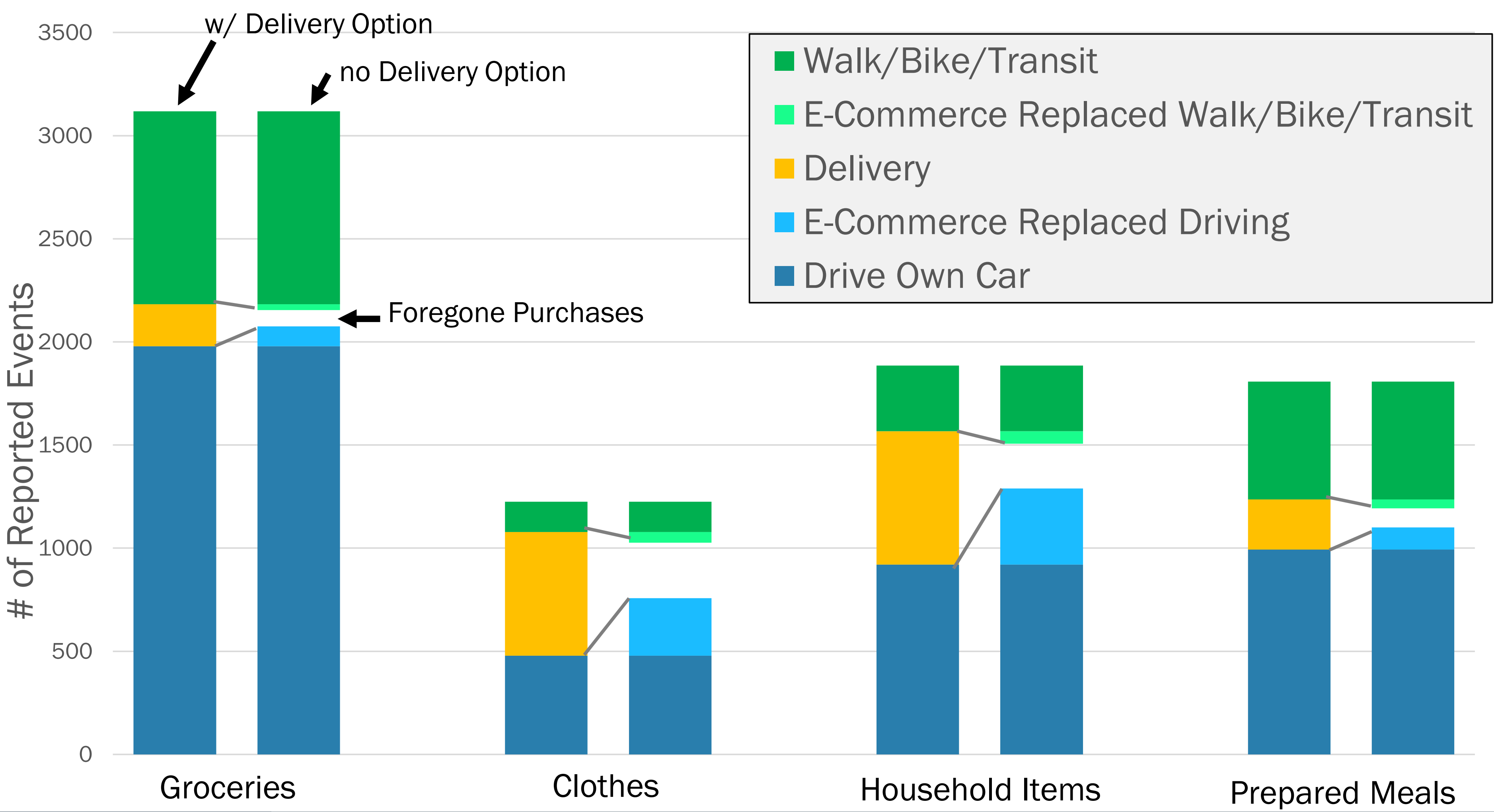


Multiple Test Scenarios: Variation in speed, separation distance, traffic cut-in, etc.

ACCOMPLISHMENT:

EFFECT OF E-COMMERCE

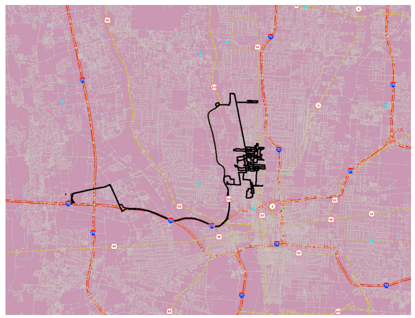
(Based on WholeTraveler Survey of SF Bay Region)



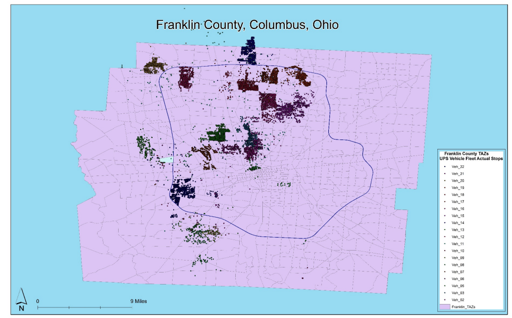
ACCOMPLISHMENT:

FREIGHT TOUR-BASED MODELING

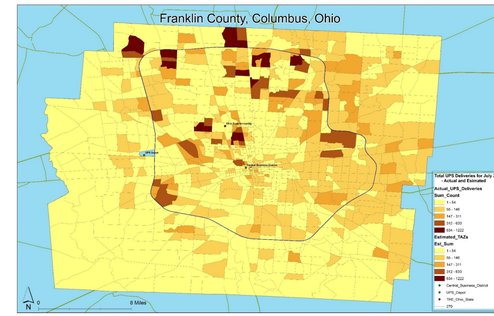
Real-world freight delivery data used to create Freight Delivery Demand Model for Columbus, OH



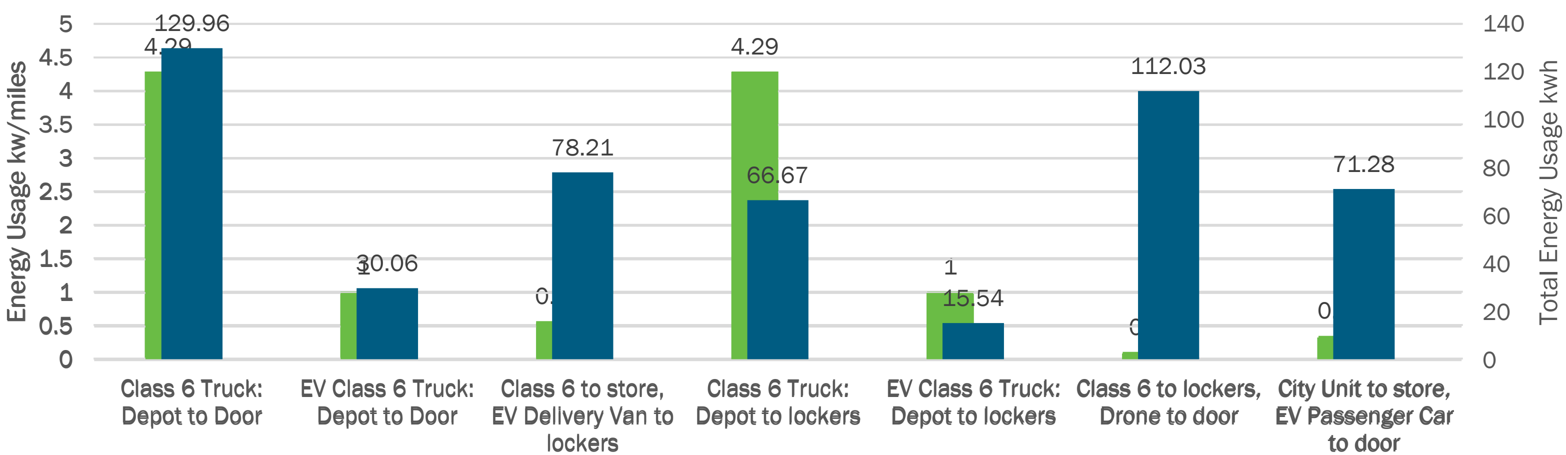
UPS-provided GPS Tour Route Data



Franklin County, OH UPS delivery Data



Freight Delivery Demand Estimation Model



Model applied to specific case-studies to determine energy consumption of different delivery modes

VEHICLE TECHNOLOGIES OFFICE

OUR VISION

more mobility choices,

more efficient,

when & where it is needed,

more affordable

MOBILITY ENERGY PRODUCTIVITY

Thank You

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Energy.gov/vehicles