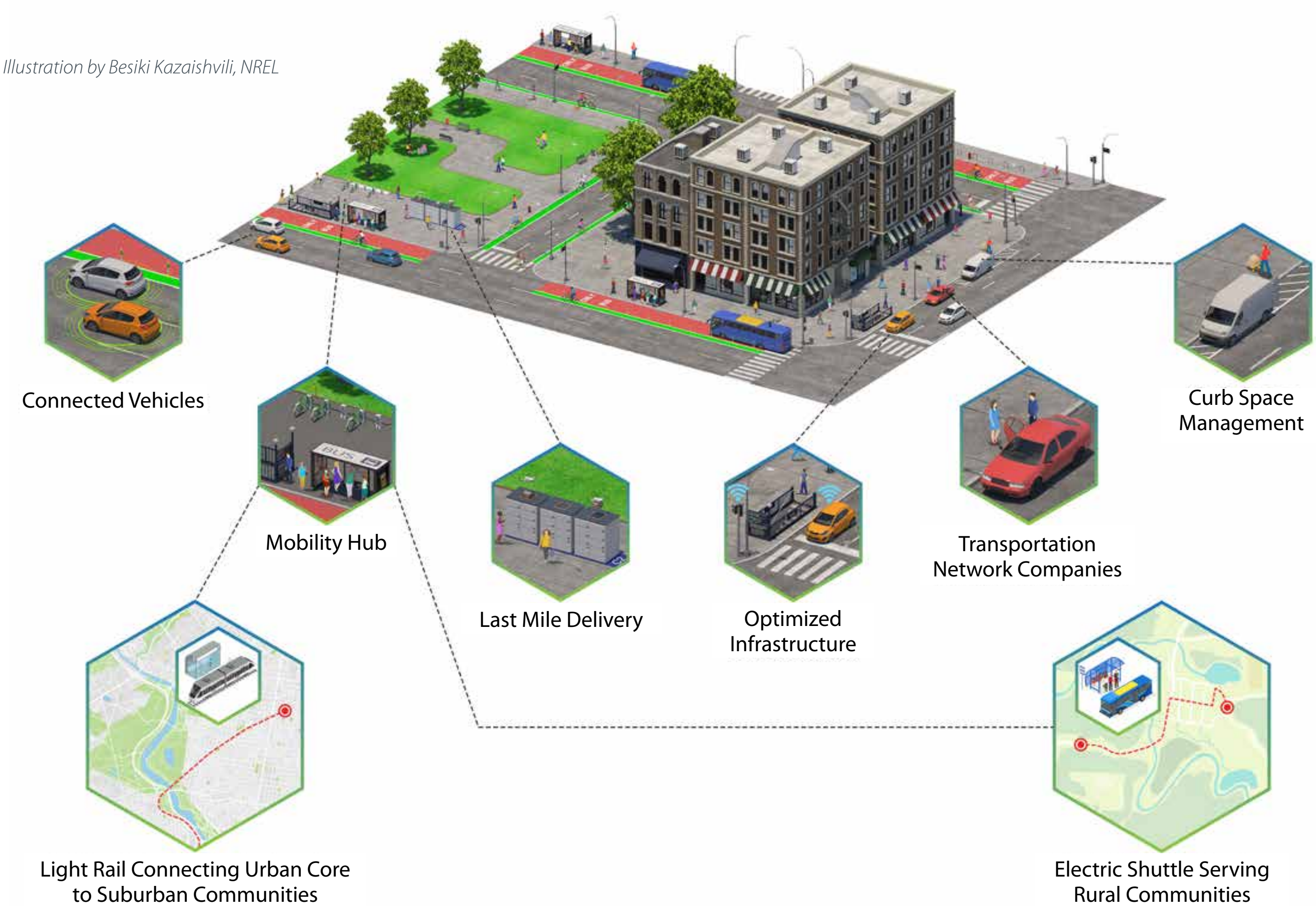
Advance Local Mobility Through Energy Efficient Mobility Systems Technologies

Everyone deserves reliable, affordable, and safe transportation to connect people to jobs, healthcare, education, and recreation. Our transportation systems are interconnected, multimodal networks working together to move people and goods. These systems are dynamic and are being reshaped by factors such as population trends, new technologies, shifting labor models, economic forces, and changing climate. Energy efficient mobility systems (EEMS) technologies can help transportation planners ensure changes in our transportation systems are equitable and sustainable by improving energy efficiency, travel time, and affordability, as well as overall access to mobility. Transportation planners and decision makers can use the following EEMS tools and strategies to advance local mobility.

EEMS Program:
The U.S. Department of Energy's Vehicle Technologies Office EEMS Program supports the office's mission to improve transportation energy efficiency through low-cost, secure, and clean energy technologies by conducting and supporting early-stage research and development at the vehicle, traveler, and system levels. This leads to the creation of new knowledge, insights, tools, and technology solutions that increase mobility energy productivity, or the energy efficiency, affordability, and access provided by the transportation system for individuals and businesses. Learn more about the EEMS Program at energy.gov/eere/vehicles/energy-efficient-mobility-systems.

If you or your partners are interested in exploring the local deployment of any of these EEMS tools and technologies, contact your local Clean Cities and Communities coalition (cleancities.energy.gov/coalitions).

Illustration by Besiki Kazaishvili, NREL



Connected and Optimized Infrastructure

Connected and optimized infrastructure uses sensors, intelligent systems, and other technology to respond in real time to changes in traffic conditions, as well as provides dynamic data about roads, driver behavior, and infrastructure.

These technologies help safely coordinate vehicle and pedestrian movement, particularly during peak travel periods. Enhanced local signal control through connected infrastructure can increase safety and energy efficiency of traffic flow and reduce travel time.

Connected and Automated Vehicles

Connected vehicles can communicate with each other and connect with traffic signals, signs, and other road items. Automated vehicles can steer, accelerate, and brake with little to no human input. Connected and automated vehicle (CAV) technology could potentially improve traffic flow and safety, increase vehicle efficiency, and reduce transportation energy in certain applications. EEMS Program research shows even a modest market share of CAVs reduces congestion and energy consumption in situations such as vehicle merging at highway ramps.

One beneficial application of CAVs is truck platooning, a vehicle-to-vehicle communication strategy that uses sensors to virtually connect two or more trucks in a convoy. This allows vehicles to save fuel by accelerating and braking together and traveling at a closer distance. A study analyzed telematics data on 57,000 vehicles traveling 210 million miles and determined that 63% of U.S. interstate and highway miles may be platoonable.[1]

Three platooning trucks can **reduce fuel use 13%** and save **2.1 billion gallons** of fuel per year.

Curb Space Management

Curb space management is the process of optimizing, allocating, and managing access to curb space inventory for competing uses, including on-street parking, delivery, transit, and micromobility. Ineffective curb space management can lead to curb congestion, which extends into the roadway and impacts travel speed and vehicle flow, as well as impacting safety, reducing mobility, and increasing energy consumption. Curb management models can help optimize curb space for local priorities. EEMS's Curb Topology initiative documented real-world curb management issues and introduced a curbside value model to allocate space for competing purposes and improve mobility efficiency for all. Understanding external factors like curb use will be critical for optimizing energy supply chains, including power distribution for electric vehicles.

Shared Mobility

Shared mobility includes shuttles, buses, carpooling, and ride hailing, as well as programs where people pay to access a pool of cars, bikes, and scooters when needed. Shared mobility options can provide several benefits, including higher traffic network flows, lower energy consumption from travel, and lower travel costs. Shared micromobility (e-scooters, e-bikes, manual bikes, electric seated scooters/mopeds) is a viable replacement for many trip types, and high national adoption could save 805 million gallons of gasoline annually. Cities can support shared micromobility to gain transportation energy benefits.

Increased transit service can have significant impacts on energy use and greenhouse gas emissions in service areas. Optimizing transit to increase route frequencies can improve ridership up to 11% with moderate budget increases. Research shows transit and ride hailing can be complementary, and investment in both transit and first-mile last-mile subsidies can improve transit ridership by up to 15%.

Policymakers, transit agencies, and urban planners can use these insights to foster opportunities for mobility as a service, such as on-demand transit or public-private partnerships between transportation network companies (TNCs) and local transit agencies, while ensuring public transit services meet user needs and encourage mode shift.

Tool Spotlight

The SMART Mobility Laboratory Consortium created several modeling pathways to answer shared mobility questions. The Behavior, Energy, Autonomy, and Mobility (BEAM, beam.lbl.gov) framework uses land use, population, and activity data to simulate travel mode choice, ride-hailing market behavior, and parking behavior. When shared and automated vehicles are also electric, charging needs can be estimated by pairing BEAM with the Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite (afdc.energy.gov/evi-pro-lite), which provides a simple way to estimate electric vehicle (EV) charging needs and how it affects

[1] Lammert, M.P., Bugbee, B., Hou, Y., Mack, A. et al., "Exploring Telematics Big Data for Truck Platooning Opportunities," 2018, nrel.gov/docs/fy18osti/70869.pdf.

Glossary

Automated vehicle: A vehicle having one or more automated functions. SAE International defined six levels of vehicle automation: sae.org/standards/content/j3016_202104.

Connected vehicles: Vehicles that exchange information with other vehicles (V2V) or infrastructure (V2I).

Dedicated short-range communications (DSRC): Short- to medium-range wireless communication channels specifically designed for automotive use.

Drone: A remotely controlled or automated device, such as an aerial or ground vehicle or more generally, a robot.

Eco-approach and departure at signalized intersections: A system using wireless data communications sent from a roadside equipment unit to connect vehicles to encourage "green" approaches to and departures from signalized intersections.

Mobility as a service (MaaS): Means of transportation provided to travelers who pay through a single point of payment (per trip, per month).

Traffic signal coordination: Control of traffic signal timing to allow a "wave" of vehicles to pass through a string of green lights. This can increase traffic capacity, reduce collisions, and reduce unnecessary stopping.

Transportation network company (TNC): A company that uses an online platform to allow paying passengers to engage drivers who use their private, non-commercial vehicles to drive the passengers. Also called "car sharing" or "ridesourcing."

Transportation as a system: A way of looking at the transportation system holistically to consider opportunities for greater efficiency and mobility and to inform current R&D work.

Vehicle-to-infrastructure (V2I): Connectivity allowing wireless exchange of safety and operational data between vehicles and roadway infrastructure.

Vehicle-to-vehicle (V2V): Communication technology that allows communication of data between vehicles, e.g., via DSRC.

charging load profile. Through system modeling and simulation, EEMS researchers found that 420,000 personal and ride-hailing EVs in San Francisco and 7,770 fast-charging plugs could be necessary to meet demand (a nine-fold increase).

Transportation Demand Management

Transportation demand management (TDM) is the use of strategies to encourage traveler actions that can improve transportation system efficiency. TDM can include appropriate pricing of parking and tolls, incentives, or gamification to encourage travelers to use modes other than single occupancy vehicles (such as public transit, bicycle, or carpool), use of bicycle and pedestrian infrastructure, and promotion of telecommuting or hybrid work schedules. TDM can help alleviate traffic congestion, improve air quality, and save commuters money by cutting fuel consumption. For example, the EEMS SMART Mobility Consortium found that flexible work schedules could reduce peak-period commuter trips by 20%, and a high telecommuting scenario in Atlanta would reduce overall travel hours by 11% and emissions by 7%.

E-Commerce and Last-Mile Delivery

High e-commerce penetration is projected to increase its associated vehicle miles traveled (VMT) by up to 40% and its greenhouse gas emissions by 50%, but

Mobility Energy Productivity (MEP):

A comprehensive metric that quantifies a transportation system's ability to connect individuals to goods, services, employment, and activities while accounting for energy, time, and affordability of transportation. Learn more about MEP (nrel.gov/transportation/mobility-energy-productivity-metric.html).

Electrification of shared mobility is a win-win to increase MEP. Seattle, Washington, led an effort including other metropolitan regions, TNCs, and Clean Cities and Communities coalitions to analyze the business case for smart, shared, and sustainable mobility services. This yielded an EV Shared Mobility Playbook (evsharedmobility.org) that summarizes key findings and best practices for organizations considering pilot programs for electrification in shared mobility.

Proving the operational and financial effectiveness of medium- and heavy-duty EVs for freight applications is key to increasing adoption. Learn how Clean Fuels Ohio (energy.gov/sites/default/files/2021-06/ti118_stein_2021_o_5-14_635pm_KS_ML.pdf) is implementing medium- and heavy-duty EVs in delivery and transit applications, while analyzing data to inform future projects.

city planners and fleet operators can work together to implement vehicle technologies and decarbonization measures to mitigate those impacts. Similarly, on-demand deliveries are responsible for even higher levels of VMT than e-commerce, but fostering bike deliveries could reduce those VMT by up to 60%.

Additionally, off-hour deliveries direct to consumers could help reduce truck VMT by up to 35% if at least 20% of households participate, and a mix of delivery approaches—drones and trucks—could be considered to optimize efficiency depending on prevailing wind patterns.

Tool Spotlight

Researchers used the WholeTraveler Transportation Behavior Study (transportation.lbl.gov/mobility-decision-science) survey of San Francisco Bay residents to understand characteristics of likely adopters of transportation technologies as well as shopping patterns. The study suggests that delivery replaces household shopping by vehicle approximately 50% of the time.

SMART Mobility Consortium

The Systems and Modeling for Accelerated Research in Transportation (SMART) Mobility Consortium, an effort led by the U.S. Department of Energy and multiple national laboratories, delivered new data, analysis, and modeling tools, and created new knowledge to support smarter mobility systems.

Many of the insights in this brochure came from the SMART Mobility Consortium. Find webinar recordings and capstone reports at **energy.gov/eere/vehicles/articles/eems-smart-mobility-capstone-reports-and-webinar-series**

Learn more from SMART Mobility Capstone reports summarizing the Consortium's research methods, results, and insights. Findings were also highlighted in a monthly webinar series. ■

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