CONVENIENT TRANSPORTATION:

An Action Plan for Energy and Emissions Innovation

December 2024

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EXECUTIVE SUMMARY

Our national transportation system is the backbone of America's economy and critical to supporting the daily needs of all system users. The transportation sector is also the largest source of greenhouse gas emissions in the United States. Emissions from the sector contribute to climate change, endangering lives across every income bracket in urban, suburban, and rural communities nationwide. Our past transportation and land use decisions promote a reliance on driving, long distances between destinations, and fewer mobility options. A reimagined transportation system that maximizes mobility choices and convenience can create benefits for individuals, the economy, and the climate.

The U.S. National Blueprint for Transportation Decarbonization ("Decarbonization Blueprint") serves as a holistic roadmap to achieve a future national transportation system that is clean, safe, secure, accessible, affordable, and equitable — while providing sustainable transportation options for all people and goods. The Blueprint is the product of a groundswell of local and private sector climate action and deep stakeholder engagement that led to a unique cross-agency partnership between the Department of Transportation (USDOT), the Department of Energy (DOE), the Department of Housing and Urban Development (HUD), and the Environmental Protection Agency (EPA). It concludes that the United States must decarbonize our transportation system by supporting transformative bottom-up and middle-out action. Together, we can build **Convenient, Efficient**, and **Clean** transportation options for all.

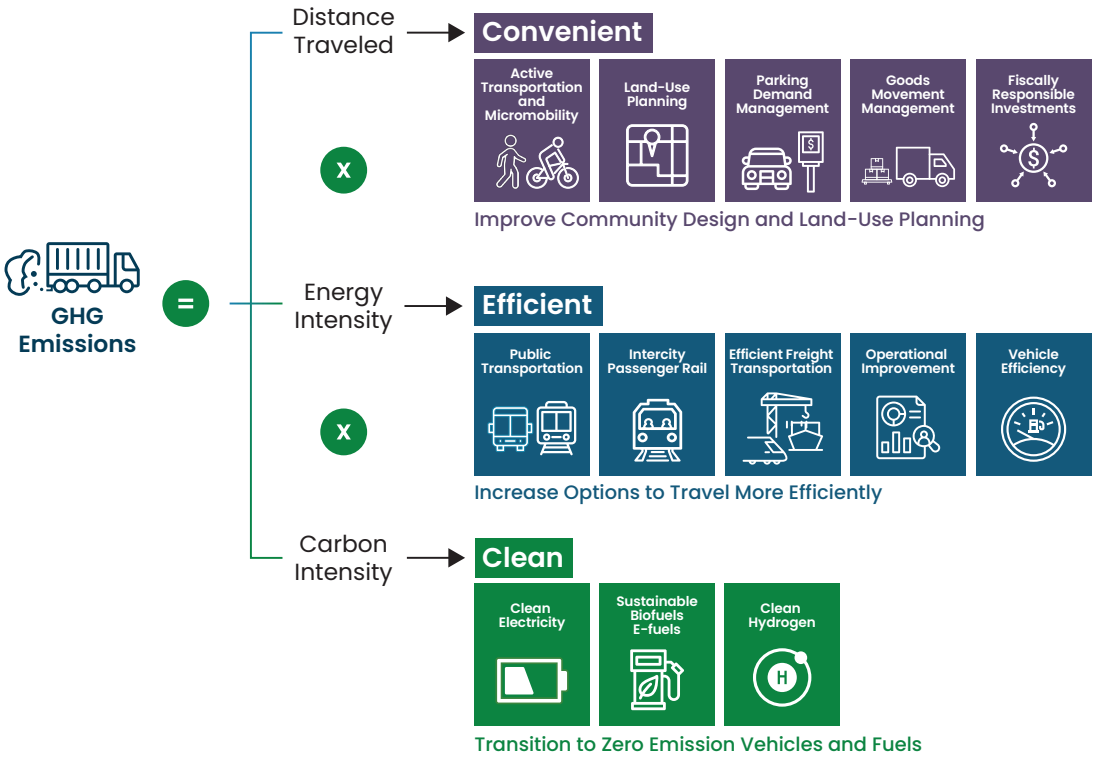

Figure 1: The Decarbonization Blueprint strategies of Convenient, Efficient, and Clean work to address the three main drivers of transportation emissions: distance traveled, energy intensity, and carbon intensity

CONVENIENT | Improve Community Design and Land-Use Planning

Active Transportation and Micromobility

- Infrastructure for walking, biking, rolling
- Shared and electric micromobility
- Incentives for active transportation

Land-Use Planning

- Transit-oriented development
- Zoning reform to enable compact, mixed-use development
- Coordinated planning across sectors and levels of government

Parking Demand Management

- Reduce parking requirements
- Repurpose curb space
- Financial incentives to encourage car-free trips
- Unbundle parking and housing costs

Goods Movement Management

- Warehouse and distribution center siting
- Last-mile delivery solutions
- Curb management

Fiscally Responsible Investments

- Prioritize maintenance
- Reconnect communities divided by highways
- Congestion pricing
- Convert fixed costs to variable costs to encourage more efficient choices

The **Convenience Transportation Action Plan** puts forth a bold vision, reinforced by resources and best practices, to catalyze locally-driven land use decisions that reduce distances between destinations, increase accessibility and affordability, and optimize the movement of people and goods—all vital pieces of a decarbonized transportation system. Current trends show that commutes are getting longer for everyday Americans and distances between destinations are expanding. We must build a more convenient and multimodal transportation system in order to meet our national climate action commitments, capitalize on innovation, and support fiscal responsibility in our transportation investments.

This **action plan** is a vision document and a point of reference for stakeholders at all levels of government and across sectors, for climate and transportation advocates, housing agencies and developers, innovators in goods movement management and active transportation modes, and researchers. This plan puts a broad array of transportation sub-sectors into conversation to reflect the local and private sector work already being done by all types of partners to transform our national transportation system.

This action plan focuses on decarbonization by increasing convenience through active transportation, land-use planning, parking demand management, fiscally responsible transportation infrastructure investments, and goods movement management. It complements the Efficiency Action Plan, which focuses on reducing the energy intensity of travel by supporting fuel efficiency and mode options, as well as a series of mode-based action plans that provide a deeper analysis of the potential to decarbonize travel and movement in **light-duty, medium-/heavy-duty, rail, aviation, maritime,** and **off-road** vehicles.

Local decision-makers are already championing convenient transportation nationwide—from the revitalization of rural downtowns, to new bike lanes and sidewalks, to closer coordination between housing and transportation agencies, to innovative freight delivery methods. To highlight the importance of a whole-of-nation approach, this plan includes case studies demonstrating state, regional, Tribal, territorial, local, private sector, and non-profit efforts and innovations. This plan is also accompanied by the Transportation Decarbonization Strategies Playbook and the July 2024 Transportation Decarbonization Symposium that convenes climate champions from all levels of government and private industry.

Additional Benefits: A convenient transportation system must, by definition, center equitable access to transportation options, including low-carbon modes. The benefits also extend far beyond decarbonization; secondary benefits of the strategies highlighted in this action plan include household budget savings, support for local economies, job creation, fiscal responsibility, roadway safety, accessibility, community vibrancy, air quality improvements, and better health outcomes.

Our Call to Action:

Carrying out the vision laid out in the Convenience Action Plan requires leaders from local governments, states, regions, Tribes, and territories, as well as the private and non-profit sectors, to take up the mantle, utilizing federal resources and intergovernmental coordination to create a better transportation system for all Americans. We look to those decision-makers to lead the way.

ACKNOWLEDGMENTS

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CONTENTS

EXECUTIVE SUMMARY i

ACKNOWLEDGMENTS iv

1. INTRODUCTION AND CONTEXT 1

2.1 A Vision for Transportation Decarbonization 1

2.2 Convenience Action Plan Purpose 3

2. ROLE OF CONVENIENCE IN REDUCING GHG EMISSIONS 8

2.1 Emissions Trends 8

2.2 Importance of the Convenience Strategy 11

3. CONVENIENCE STRATEGY ACTIONS 13

3.1 Active Transportation and Micromobility 13

Federal Actions and Initiatives 14

Opportunities 16

State, Local, and Industry Examples 18

Action Agenda 19

3.2 Land-Use Planning and Transportation System Design 20

Transit-Oriented Development (TOD) 20

Federal Actions and Initiatives 21

Opportunities 23

State, Local, and Industry Examples 23

Action Agenda 25

Zoning Reform 25

Federal Actions and Initiatives 26

Opportunities 27

State, Local, and Industry Examples 28

Action Agenda 29

Coordinated Transportation Planning 29

Federal Actions and Initiatives 30

Opportunities 31

State, Local, and Industry Examples 31

Action Agenda 32

CONTENTS (CONTINUED)

3.3 Parking Demand Management . . . 33
Federal Actions and Initiatives . . . 34
Opportunities . . . 35
State, Local, and Industry Examples . . . 36
Action Agenda . . . 37
3.4 Fiscally Responsible Transportation Investments . . . 37
Federal Actions and Initiatives . . . 39
Next Steps and Opportunities . . . 40
State, Local, and Industry Examples . . . 40
Action Agenda . . . 41
3.5 Goods Movement Management . . . 42
Federal Actions and Initiatives . . . 43
Next Steps and Opportunities . . . 43
State, Local, and Industry Examples . . . 44
Action Agenda . . . 46
3.6 Data, Tools, Research, and Technology . . . 46
Federal Actions and Initiatives . . . 48
Next Steps and Opportunities . . . 50
State, Local, and Industry Examples . . . 50
Action Agenda . . . 51
3.7 Cross-Cutting Strategies . . . 52
Federal Actions and Initiatives . . . 52
Next Steps and Opportunities . . . 52

4. CONCLUSION 53

APPENDIX: SUMMARY OF ACTIONS 55

ENDNOTES 58

1. INTRODUCTION AND CONTEXT

1.1 A Vision for Transportation Decarbonization

The transportation sector is the largest source of greenhouse gas (GHG) emissions in the United States, responsible for one-third[a] of all emissions.[1] These emissions contribute to global climate change, which is leading to rising temperatures, rising sea levels, and increasingly frequent and destructive extreme weather events that are disrupting and damaging critical infrastructure, human health, homes and businesses, and the vitality of our communities.[2] The effects of climate change impact all of us but disproportionately burden underserved communities.[3]

To address climate change and meet the climate goals defined under the Paris Agreement, the United States must eliminate nearly all GHG emissions economy-wide—including from the transportation sector—by 2050. This goal is consistent with Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad."

Our past transportation and land use decisions promote a reliance on driving, long distances between destinations, and fewer mobility options. A reimagined transportation system that maximizes mobility choices and convenience with destinations in close proximity can create benefits for individuals, the economy, and the climate. A convenient transportation system is a climate solution. Convenient transportation is also a win for transportation user safety, equitable access to mobility options, freedom of movement, economic development, and fiscal responsibility for our nationwide infrastructure system. A well-planned transition to a sustainable transportation future will result in more mobility choices; improved and affordable transportation services; better access to well-paying jobs, housing, services, and amenities; greater energy security; improved air quality and health; better quality of life and accessibility; and safer, more vibrant, resilient communities throughout the country.

In response to the urgency of the moment, the groundswell of local climate action, and feedback from stakeholders, the Department of Transportation (USDOT), the Department of Energy (DOE), the Department of Housing and Urban Development (HUD), and the Environmental Protection Agency (EPA) are coordinating actions to decarbonize transportation, as directed by a 2022 Secretary-level Memorandum of Understanding. In January 2023, these agencies published their unified vision in the U.S. National Blueprint for Transportation Decarbonization.

The Decarbonization Blueprint provides a framework for transitioning to a net-zero GHG transportation system through three interrelated strategies that tackle the *main drivers* of passenger and freight transportation GHG emissions: 1. Convenient *(distance traveled between destinations)*, 2. Efficient *(energy intensity of each mile traveled)*, and 3. Clean *(carbon intensity of the fuels)*.

a Transportation is the second largest source when indirect emissions from electricity end-use are allocated across sectors. The transportation sector is an end-use sector for electricity but currently represents a relatively low percentage of total electricity use.

- **Convenient:** An accessible[b] transportation system with reduced distances between destinations for people and goods; freedom to use public transit and safe, connected sidewalks, trails, and bike infrastructure; and thriving, vibrant, affordable communities.
- **Efficient:** Mobility options for people and goods, including transit, rail, and maritime travel, and reduced reliance on energy-intensive transport modes. The Efficiency strategy also involves improvements in the operation of transportation systems and the energy efficiency of vehicles.
- **Clean:** Deploying low- and no-emission vehicles, engines, and equipment alongside industry-wide electrification and investments in other clean fuel sources.

The systemic approaches of all three strategies in the Decarbonization Blueprint will help meet U.S. decarbonization goals and build a sustainable transportation sector. Thriving, vibrant communities are built upon a wide range of easy to access, affordable, and low-emission options for travel coupled with land use decisions that reduce the distances between destinations for people and goods. Through the 2021 Bipartisan Infrastructure Law (BIL), the 2022 Inflation Reduction Act (IRA), and the 2022 CHIPS and Science Act, Congress has provided unprecedented funding to reduce GHG emissions across the economy. With these resources, alongside preexisting federal transportation funding, the federal government can invest in decarbonizing the transportation sector.

This plan focuses on the Convenience strategy, while forthcoming companion action plans focus on the Efficiency strategy and the applications of all three strategies for each mode. For more information and to download these plans when available, see the Decarbonization Blueprint website.

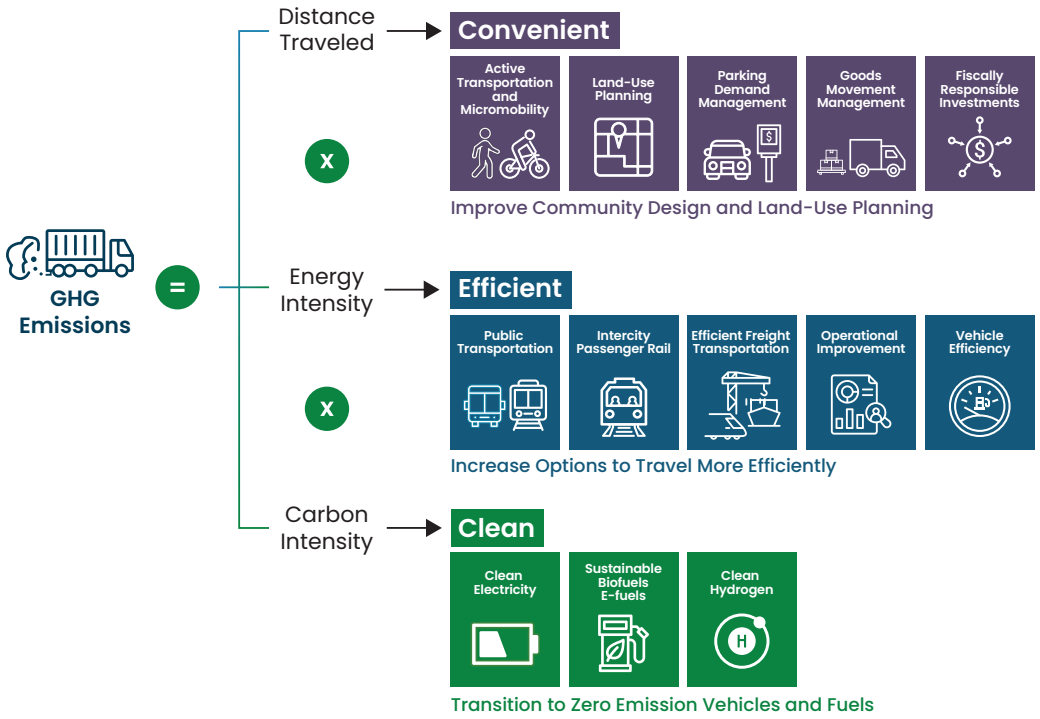


Figure 1: The Decarbonization Blueprint strategies of Convenient, Efficient, and Clean work to address the three main drivers of transportation emissions: distance traveled, energy intensity, and carbon intensity.

b In this context, "accessible" refers to the relative ease with which individuals can access their destinations. For additional context, see Merlin et al.

Finally, a note on scope: This action plan is broad but not exhaustive. The specific measures needed to make transportation more convenient in rural, suburban, and urban areas depend on the local context and the area's population density. This action plan also reflects the best available research to support decarbonization strategies. Because much of the existing research focuses on passenger transportation, additional research is needed on land use decarbonization for goods movement, particularly across supply chain and in rural contexts.

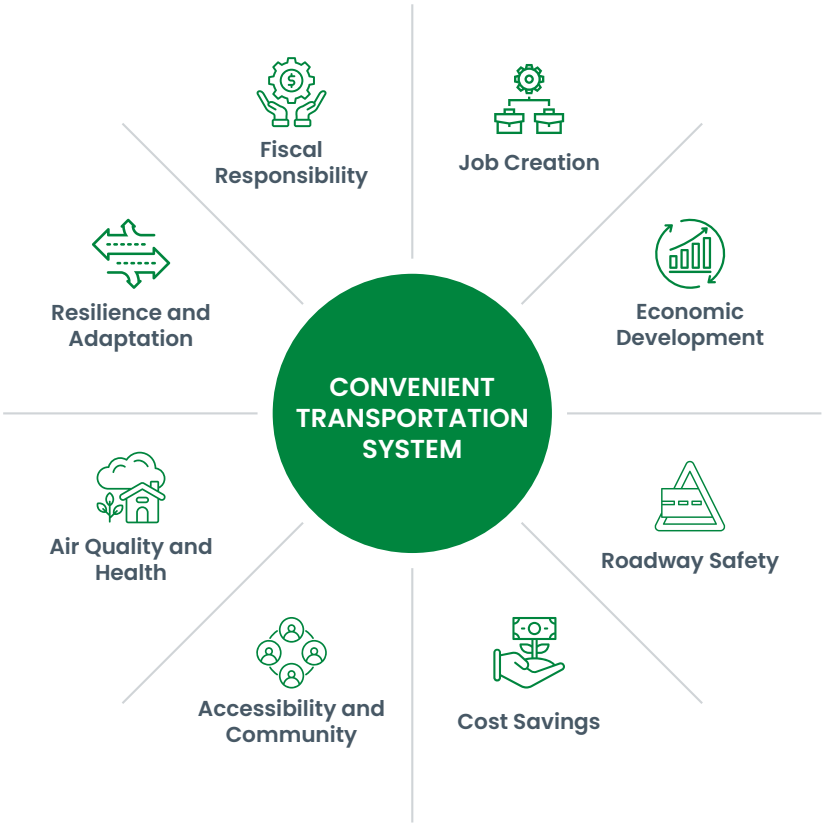
1.2 Convenience Action Plan Purpose

The purpose of this action plan is to identify actions under the **Convenience strategy** to realize the goal of decarbonizing the U.S. transportation sector by 2050. Emissions reductions from changes to land use and design are critical to meeting national climate goals. Because many of the strategies included in this action plan require system-wide changes to the built environment, action is necessary before 2030 in order to realize emissions reductions by 2050. For this reason, the plan focuses on actions that can be taken by 2030.

Increased convenience entails supporting community design and land-use planning to ensure that job centers, shopping, schools, entertainment, and essential services are strategically located near people's homes. The resulting reduction in travel distances and times can improve walkability and bikeability and enhance quality of life. Convenient transportation also means optimizing the movement of goods to reduce unnecessary miles traveled throughout the supply chain.

This plan focuses primarily on expanding the multimodal transportation capacity and accessibility of urban and suburban environments (described throughout as "urban"), where approximately 80 percent of the United States population live.[4] This plan also describes decarbonization opportunities and highlights corresponding climate leadership in rural areas. Examples of this may include policies and plans that revitalize downtown rural cores and support the convenient movement of goods.

Of the three strategies outlined in the Decarbonization Blueprint, Convenience strategies are uniquely influenced by local needs, opportunities, and context. Convenience solutions primarily lie within the jurisdiction of communities. Accordingly, this plan describes actions that can be taken by all levels of government, as well as in the private and nonprofit sectors, to improve convenience. This plan also provides examples of successful state, local, and private sector cases that proportionally represent the U.S. population.[5] This plan also describes how federal agencies can support actions taken by state and local governments.



There are numerous benefits of transportation system convenience alongside the benefits of GHG emissions reductions:

- **Fiscal Responsibility:** There are significant economy-wide long-term cost savings associated with convenience-focused transportation and land use policies, resulting from factors such as easier travel, reduced pollution, and economic stabilization of neighborhoods.[6] According to one estimate, a shift toward public and active transportation and denser urban development would save $13 trillion throughout the public and private sectors by 2050, due to reduced costs for manufacturing, maintaining, fueling, and operating vehicles and building and maintaining associated infrastructure.[7] Additional savings can be expected from reduced crashes and improved air quality.[8]
- **Job Creation:** Strategies such as investing in public transportation and road maintenance create more jobs per dollar spent than roadway capacity expansion projects, and lead to overall economic savings.[9] These jobs are also more likely to offer long-term, stable, and local employment in high-demand career fields.
- **Cost Savings and Housing Affordability:** The cost of transportation is a significant expense for many families, particularly for those in overburdened communities. Transportation is currently the second-largest household expense in the United States, with the average family spending more than $10,000 a year on transportation costs and comprising almost 20 percent of average annual household expenditures.[10] Shifting toward land use patterns that prioritize public transit and active transportation can reduce transportation costs by reducing the need for car ownership, maintenance, fuel, and parking costs. Convenience focused actions can help lower the combined cost of housing and transportation and also contribute to increased housing supply which can also lower housing costs.

- **Economic Development:** Adding active transportation infrastructure like bike lanes, trails, and sidewalks encourages downtown revitalization and increased local spending. Cyclists and pedestrians spend more at businesses than drivers, and they frequent local businesses at a higher rate. Safe active transportation, transit-oriented development, and other features of a convenient transportation system support the foot traffic that enables local businesses to thrive.[11]
- **Roadway Safety:** Designing communities with pedestrians, transit riders, bicyclists, and other micromobility users in mind can reduce the incidence of collisions, injuries, and fatalities on shared roadways. Safer streets and connected trails can, in turn, encourage further shifts toward active transportation.[12,13]
- **Accessibility and Community:** Mobility options increase access to job opportunities, education, and everyday destinations for those who cannot or do not drive, especially older adults, people with disabilities, youth, and people living in lower-income communities. For seniors, transportation is the most common reason for not leaving the home, limiting access to basic services.[14] In contrast, both active and public transportation are linked to decreased loneliness, increased access to family and friends, and greater levels of socialization.[15,16] Opportunities to walk and bike and co-location of housing and destinations create a stronger sense of place, which encourages community cohesion, trusting neighbors, and participation in civic life.[17]
- **Air Quality and Health:** Reducing the number of emissions-emitting vehicles on the road, especially in densely populated areas, decreases air pollutants that are harmful to human health. The particle emissions from tires and brakes are another major source of pollution associated with driving in both electric and internal combustion engine vehicles.[18] Pollution from tailpipe and non-tailpipe emissions contribute to health inequities for communities[19]—especially communities of color, which are disproportionately located near major roadways and create runoff pollution to nearby waterways.[20,21] Further, poor indoor air quality inside cars can negatively impact passengers and drivers.[22]
- **Resilience and Adaptation:** Compact and infill development in areas less vulnerable to extreme weather and natural disasters and designing such projects to be more resilient protects people and property. Adaptation strategies that support community density, like preservation of open green space, using greenways or other trails to mitigate flooding or heat impacts,[23,24,25] or using multimodal hubs as evacuation points or heating/cooling centers for vulnerable populations help communities be more resilient to extreme events like floods, while supporting long-term climate adaptation and bringing other environmental, health, equity, and economic benefits.[26]

Holistic transportation sector decarbonization is possible only if we dramatically improve the accessibility of goods, services, and destinations and reduce the need for energy-intensive travel. Investing in strategies to create more compact, walkable, transit-accessible communities increases access to multimodal transportation, reducing the distance of driving trips or even eliminating the need to drive for many trips. With convenient options to reach destinations by public transit or active transportation, many households may be able to reduce their reliance on driving and limit associated expenses.

Zoning, land use, and transportation decisions made by federal, regional, state, local, and Tribal governments have shaped our current transportation landscape. Car dependence, traffic, congestion, and vehicle emissions are accepted as norms, as are their associated emissions. In many places, housing policies and zoning codes encourage and subsidize spread-out, inefficient development. This creates transportation barriers for underserved communities, increasing their transportation and housing cost burdens and hindering access to critical services, opportunities, and destinations. These decisions also often cause disproportionate environmental and health impacts on low-income, minority, and underserved communities and deprive them of investments in affordable, low-carbon transportation options. Increasing convenience by implementing system-level design solutions that prioritize access and proximity to destinations not only plays a vital role in reducing GHG emissions from transportation but can also address these historical inequities by enhancing quality of life and public health for residents while meeting mobility and accessibility needs by expanding transportation options.

A convenient transportation system must serve people of all income levels and physical abilities. It should be safe, appealing, and accessible to all, including those with limited options due to factors such as age, ability, or work and school schedules. Affordability and access, particularly for low-income communities, are critical elements of a convenient transportation system.

This action plan focuses on the following strategies:

1. **Active Transportation and Micromobility:** Infrastructure that supports walking, biking, rolling,[c] and electric micromobility such as e-bikes and e-scooters (together referred to as "active transportation") can lead to greater utilization of these low- and no-emission modes. Strategies to enhance active transportation use include investments in on-road and off-road infrastructure for walking and biking; safe, accessible, and convenient connections to transit services; shared micromobility; and low-emission last-mile delivery services.
2. **Land-Use Planning and Transportation System Design:** Improving the design of communities and transportation systems starts with deliberate land-use planning. Land use strategies to improve convenience and reduce emissions include transit-oriented development (TOD), rural main street and downtown revitalization, suburban retrofits, compact and mixed-use development, zoning reform, and coordinated transportation planning across sectors and jurisdictions.

c As used above, "rolling" indicates the variety of devices individuals may use as part of active mobility/transportation. The term includes manual or power wheelchairs, walkers, strollers, scooters, roller-skates/blades, and other non-vehicular methods of transportation with wheels.

3. **Parking Demand Management:** Managing parking, especially when combined with encouraging convenient alternatives to driving, can reduce the number of trips that can only be taken via personal vehicles and can free up space to build more housing and commercial buildings. Parking management strategies include financial incentives to choose more efficient modes of travel, zoning reforms to reduce burdensome and costly parking requirements, and management of curb space.
4. **Fiscally Responsible Transportation Investments:** Prioritizing improvement or rehabilitation of existing transportation assets and investment in communities over highway and roadway capacity expansion projects leads to more fiscally responsible use of public dollars, supports mobility freedom, and reduces personal vehicle dependency, while improving equity and quality of life.
5. **Goods Movement Management:** Careful land-use planning can promote movement of goods throughout the supply chain while reducing associated emissions. Strategic warehouse siting, curb management, cargo micromobility, and off-peak delivery strategies can reduce delays and distances traveled for goods movement.
6. **Data, Tools, Research, and Technology:** Data, tools, research, and technology support our understanding of the GHG emissions impacts of land use and transportation investments and can help scientists, policymakers, and individuals evaluate the impacts of new and emerging technologies.

2. ROLE OF CONVENIENCE IN REDUCING GHG EMISSIONS

2.1 Emissions Trends

In 2017, the transportation sector surpassed the electric power sector to become the largest direct source of U.S. GHG emissions,[d] representing 33 percent of U.S. GHG emissions in 2022. Transportation-related emissions increased 21 percent[e] between 1990 and 2019, largely due to increased vehicle miles travelled (VMT) (see Figure 2).[27] One factor leading to increased VMT is land use patterns that increase the distance that people and goods must travel to reach their destinations. Between 1990 and 2022, the average vehicle trip length rose from 8.8 to 11.5 miles.[28] Land use decisions can also make it unsafe and inconvenient to walk or take transit, therefore requiring more and longer vehicle trips to accomplish daily tasks.

Projections by the Federal Highway Administration (FHWA) and the 2023 Annual Energy Outlook (AEO) reference case published by the U.S. Energy Information Administration show this trend continuing, with passenger and freight VMT increasing through at least 2050. The FHWA forecast projects an annual average 0.6 percent increase in VMT for all vehicle types from 2019 to 2049—an approximately 20 percent increase over the 30-year period.[29] The AEO reference case projects light-duty vehicle (LDV) GHG emissions falling through the early 2040s, as a result of fuel economy improvements and increased deployment of electric vehicles (EVs), before increasing again through 2050 due to increased travel demand (see Figure 3). The AEO's VMT projection is slightly higher than the FHWA projection, estimating that U.S. passenger VMT will grow by 23 percent between 2022 and 2050.[30]

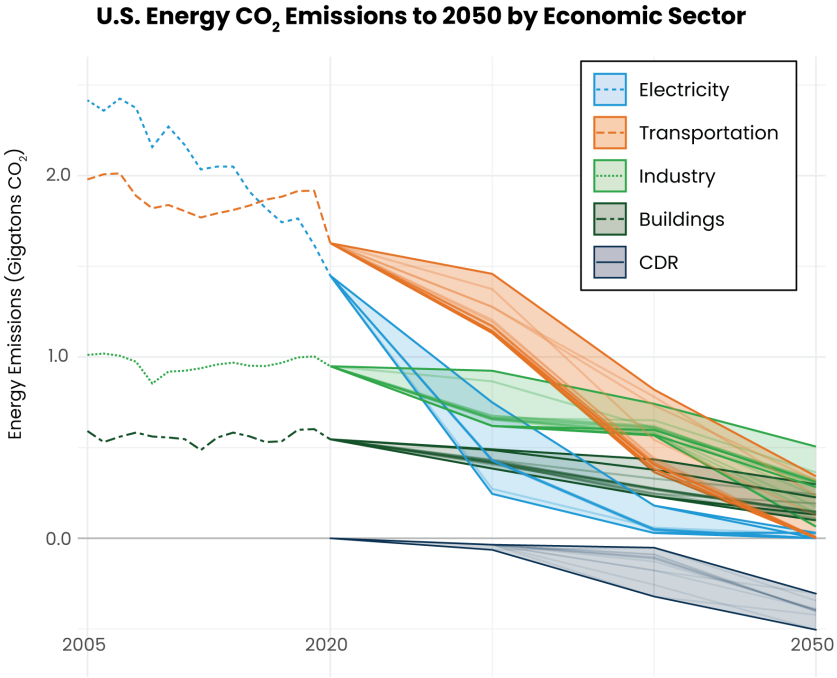


Figure 2: U.S. Energy CO_2 Emissions to 2050 by Economic Sector. Electricity CO_2 emissions and direct CO_2 emissions from the transportation, buildings, and industry fall dramatically in all scenarios, with the greatest reductions coming from electricity, followed by transportation, and non-land sink carbon dioxide removals (CDR) increase. Notes: Historical data are from EIA Monthly Energy Reviews, projections include data from all LTS scenarios using both GCAM and OP-NEMS, projections are shown in ten-year time steps. Source: The Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050.

d "Direct emissions" refers to emissions generated by the use phase of transportation vehicles and systems.

e This statistic includes emissions from transportation-related fossil fuel combustion, non-energy use (e.g., lubricants) sources, and hydrofluorocarbons from vehicle air conditioners and refrigerated trucks—as well as indirect emissions from electricity use.

EVs alone are not enough to meet national emissions reduction targets. Given these projected trends of increased demand for passenger and freight vehicle travel, transportation emissions are expected to decline only slightly even with an increased uptake of EVs and more robust fuel economy standards. Therefore, to meet U.S. emissions reduction goals, we must reduce VMT relative to the projections. This is possible through changing land use patterns to reduce distances between destinations, reducing the number of trips needed for daily life, and making options like public transit and active transportation more attractive.

While nationwide VMT is closely tied to economic conditions and gas prices, Table 1 illustrates the variation in on-road (passenger and freight) VMT per capita change between 2005 and 2019 across the states with the highest and lowest per capita VMT change. Between 2005, when per capita VMT peaked nationwide, and 2019, per capita VMT increased in some states and significantly decreased in others. This demonstrates that significant changes in VMT are possible, dependent on behavioral changes, concerted policy effort, and funding prioritization.

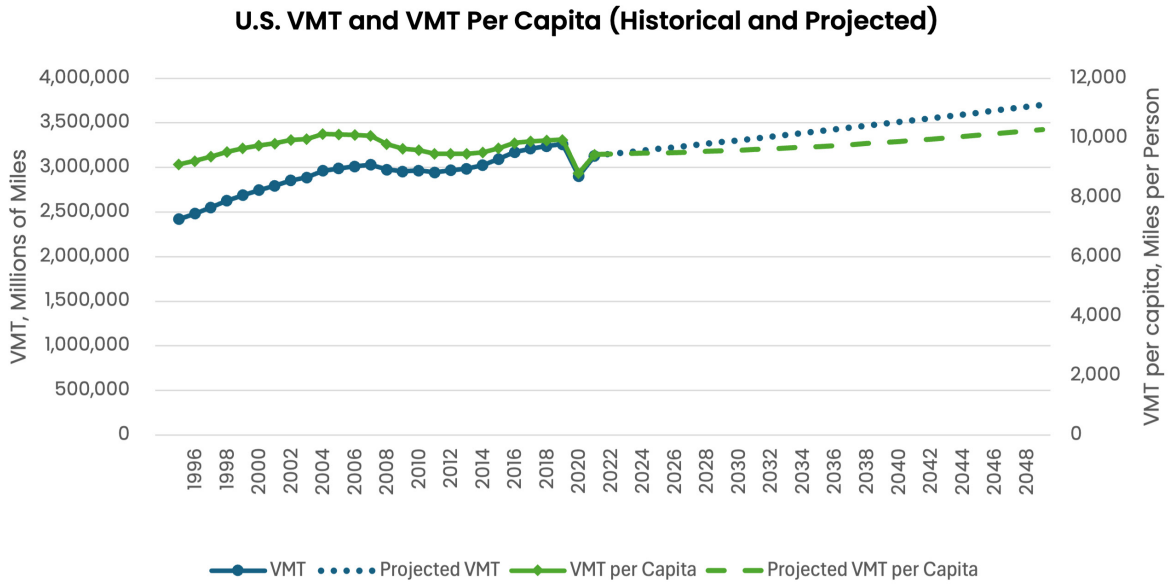


Figure 3: VMT and VMT per capita in the United States, historical 1995-2021 and projections 2022-2049. Sources: BTS and Census Bureau. Projections created using FHWA VMT Forecast[31] and Census Bureau population projection.[32]

Table 1: VMT per capita change for selected states (five highest and five lowest states not including U.S. territories). On-road vehicle miles include LDVs, motorcycles, trucks, and buses. Sources: BTS and Census Bureau.

State	VMT per Capita 2005	VMT per Capita 2019	Percentage Change in VMT per Capita from 2005 to 2019
Louisiana	9,828	11,048	12.4%
Alabama	13,055	14,630	12.1%
North Dakota	11,717	12,894	10.0%
Nevada	8,542	9,348	9.4%
Massachusetts	8,661	9,415	8.7%
Rhode Island	7,772	7,156	-7.9%
Colorado	10,355	9,487	-8.4%
New York	7,188	6,373	-11.3%
Oregon	9,765	8,490	-13.1%
Oklahoma	13,250	11,283	-14.8%
United States (national average)	10,117	9,937	-1.8%

Strategies like investing in active transportation and land-use planning to reduce distances between destinations can put all states on the path towards reducing VMT and contributing to a more sustainable and decarbonized transportation future.

2.2 Importance of the Convenience Strategy

The projected growth in U.S. passenger VMT and freight ton-miles travelled represents a significant challenge to achieving decarbonization. All three strategies outlined in the Decarbonization Blueprint—increasing convenience, improving efficiency, and transitioning to clean options—are key to meeting our decarbonization goals and building a sustainable transportation system. To meet national emission reduction goals, the United States needs a rapid and widespread transition to clean options, such as zero-emission vehicles (ZEV), improved fuel economy and shifts to more efficient modes, and increased convenience to reduce overall travel demand.

Focusing entirely on vehicle electrification without investing in strategies to improve the convenience and efficiency of the transportation system could continue a trend of increased driving and goods movement that undermine the GHG emissions reduction benefits of improved fuel economy and electrification.[33,34,35] The United States will not be able to decarbonize the transportation sector by midcentury without providing viable options for vehicle travel. Moreover, improving convenience leads to benefits to safety, affordability, health, quality of life, and community vibrancy.

Numerous studies show that reducing travel demand and encouraging destinations in close proximity can lead to significant transportation sector decarbonization.[36,37]

Figure 4 shows how reducing VMT by 10 percent below current levels (solid lines), consistent with policy scenarios that focus on mixed-use development and public transportation investment, reduces emissions more rapidly than electrification alone, resulting in significantly lower cumulative emissions over time. Conversion to electric vehicles will not be effective alone, with 20 percent business-as-usual VMT growth (dashed lines) leading to significantly higher GHG emissions, even in scenarios with rapid EV adoption and decarbonization of the electric grid.

Similarly, another recent study found that electrification plus zoning changes and increased transportation options could cut total U.S. transportation sector emissions in urban and suburban areas by an average of nearly 80 percent by 2050, while creating significant cost savings in the private and public sectors. This is compared to around a 40 percent decrease from electrification or a 70 percent reduction from zoning changes in GHG emissions from baseline levels from either strategy alone.[38] Researchers have found that enacting state-level land use reform to encourage compact development can reduce annual U.S. pollution by 70 million tons of carbon dioxide equivalent in 2033 — the equivalent of nearly eight billion gallons of gasoline.[39] State-level analyses in Minnesota, California, and Hawaii demonstrate that while EV adoption is a cornerstone of emission reductions, more action is needed to meet state climate goals.[40]

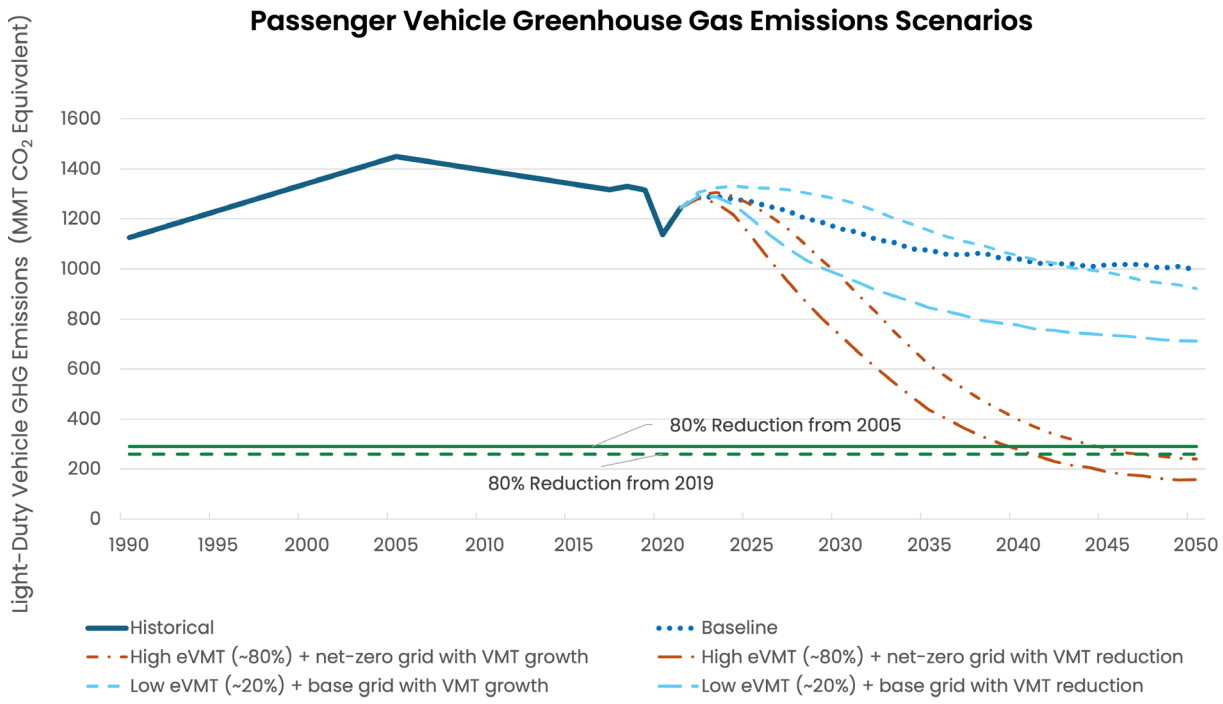


Figure 4: Passenger Vehicle Greenhouse Gas Emissions Scenarios. Light-duty VMT change has a major impact on GHG emissions in the transportation sector.[41] The red lines show an optimistic scenario in which EVs are rapidly adopted and account for 80 percent of LDV VMT by 2050. It also assumes a zero-emissions electricity grid by 2035. The light blue lines show a scenario with 20 percent electric LDV VMT by 2050, consistent with the Department of Energy's reference, or baseline, scenario.[f] (Source: Hoehne et al. 2023 in Nature Communications, DOI: 10.1038/s41467-023-42483-0)

In addition to reducing tailpipe emissions, reducing VMT and encouraging mode shift also reduces life-cycle emissions. Less reliance on driving reduces the need for roadway construction and maintenance, resulting in lower emissions from pavement production and construction vehicles. This can also reduce upstream emissions from the extraction and production of fuels, as well as the manufacturing and maintenance of vehicles. Further, reducing distances traveled and encouraging shifts to more efficient vehicles and modes alleviates the demands on the electric grid necessary to power EVs while making travel more convenient.

f Notes: Scenarios modeled using TEMPO (https://www.nrel.gov/transportation/tempo-model.html). GHG emisions are for passenger LDVs including private auto, Mobility as a Service, and motorcycles. Each trajectory shows mean emissions across scenarios extracted from 2,000 simulations exploring decarbonization pathways. Scenario VMT change and electric VMT (eVMT) are calculated as mean trend from 2040-2050 across at least 12 simulations each. EV well-to-wheels (WTW) emissions consider bounding electricity generation scenarios of a base grid (-46 percent in 2050) and net-zero by 2035 grid. Baseline is aligned with Annual Energy Outlook 2019 Reference and assumes low EV adoption and ~20 percent VMT growth by 2050. Historical emissions (derived from EPA-420-F-23-016) and Baseline emissions assume a well-to-tank factor of 1.18 fossil fuels.

3. CONVENIENCE STRATEGY ACTIONS

This section describes key **Convenience** strategies to reduce GHG emissions from the transportation sector. For each strategy, this action plan discusses existing federal programs that support a more convenient transportation system; future-looking opportunities that all levels of government, the private sector, and the nonprofit sector can take to reduce GHG emissions; and relevant examples from states, cities, Tribes, and industry. In achieving a convenient transportation system, local governments and communities will play the central role of developing and implementing the unique set of strategies that work for their community's needs.

3.1 Active Transportation and Micromobility

Walking, biking, and rolling are collectively referred to as "active transportation." Active transportation options are zero- or near-zero emission forms of transportation that can also improve mental and physical health and reduce roadway congestion. USDOT's Strategic Plan for 2022-2026 set a national mode shift target to increase the percentage of person trips by transit and active transportation modes from 4 percent to 6 percent of 2020 levels.[42]

Compact, mixed-use, and walkable land use strategies support modal shift to active transportation, while investments in active transportation infrastructure can make it easier for people to choose low-emission options for everyday trips, improving safety for all road users. When active transportation infrastructure is safe, accessible, and inviting, more people will choose to walk and bike when they travel to work, school, shops and services, and other destinations.[43]

Residents of low-density areas, especially in more rural settings, are less likely to have access to safe infrastructure to walk, yet rural residents may rely on walking as well.[44] Despite limited access to safe active transportation infrastructure, 30 percent of rural residents report walking to their destinations with some frequency, compared to 38 percent of suburban residents and 48 percent of urban residents.[45] Rural residents are also less likely to have a variety of modes to choose from,[46] a disadvantage that is compounded by the higher rates of disability and decreased access to medical services experienced by rural communities.[47] This lack of infrastructure causes higher rates of death and injury, especially in Tribal communities.[48] Rural communities can expand recreational trail networks and connect them with other active transportation infrastructure, like sidewalks and bike lanes, to give them a dual purpose of recreation and transportation.

According to the 2017 National Household Travel Survey, 52 percent of trips were 3 miles or less, with 73 percent of these taken by car. Of the nearly 30 percent of trips under 1 mile, more than 60 percent were taken by car. Encouraging active transportation could significantly decrease the number of these short trips taken by cars, resulting in fewer emissions.[49] If each person in a city of 50,000 walked or biked rather than driving for one mile per day, car travel would decrease by more than 12.5 million miles annually.[50]

Investment in active transportation infrastructure can enhance access to jobs and economic opportunity while reducing transportation cost burdens, since walking and biking are extremely low-cost transportation modes. This is especially true for historically low-income and underserved communities that often lack safe active transportation options. Investment in safe infrastructure also promotes the perception and reality of safety, and safe and comfortable walking and biking infrastructure reduces the

likelihood of fatalities and serious injuries from collisions. This positively reinforces the choice to use low-emission modes.[51] Better active transportation infrastructure, including on-road and off-road facilities, can also enhance connectivity to transit services, allowing for safer and faster first-mile and last-mile travel options that do not require driving a personal vehicle.

Improvements in bicycle and pedestrian infrastructure also enable greater use of electric micromobility options, which can lead to emissions reductions when they replace trips made in personal vehicles. The North American Bikeshare Association (NABSA) reports that 37 percent of shared micromobility trips replaced a trip in a personal vehicle, taxi, or ridehail vehicle.[52] Recent modeling in the Los Angeles area found that expansion of shared electric bicycles and electric-assist bicycles could reduce citywide vehicle miles travelled by about 5 percent, annual GHG emissions by about 316,000 tons of CO_2 equivalent compared to internal combustion engine vehicles, and annual electricity demand by about 187 gigawatts compared to light-duty EVs.[53] Similarly, a National Renewable Energy Laboratory (NREL) study of travel patterns of e-bike owners in six locations across Colorado found that e-bikes replaced cars in approximately 34 percent of e-bike trips, with the majority of the trips used for commuting or other essential purposes.[54]

Last-mile delivery services also rely on active transportation infrastructure. For more information on last-mile delivery opportunities, see Section 3.5: Goods Movement Management.

FEDERAL ACTIONS AND INITIATIVES

Safe Streets and Roads for All (SS4A) Grant Program. This USDOT competitive grant program was established by the Bipartisan Infrastructure Law (BIL) and provides $5 billion over five years to support regional, Tribal, and local initiatives to prevent roadway deaths and serious injuries. In Fiscal Years 22 and 23, this program provided $1.7 billion in Federal funding

to over 1,000 communities, in all 50 States and Puerto Rico. Those who do not have a choice in their transportation mode should not have to compromise on safety. In this way, SS4A supports USDOT's National Roadway Safety Strategy and the goal of zero roadway deaths.

Active Transportation Infrastructure Investment Program (ATIIP). This FHWA program was established by BIL to support planning and active transportation implementation at the network scale, rather than on a project-by-project basis. ATIIP provides awards to plan, design, and construct networks of safe and connected active transportation facilities that connect destinations within a community or metropolitan region, or active transportation "spines" that connect communities, metropolitan regions, or states. In 2023, FHWA received $45 million in annual appropriations for ATIIP. State, regional, Tribal, and local governments are all eligible to apply for both planning and design grants and construction grants. Improvements in active transportation networks under ATIIP will expand and improve active transportation and promote it as a low-emissions transportation option.

Surface Transportation Block Grant (STBG) Program Transportation Alternatives Set-Aside. FHWA sets aside 10 percent of national STBG funds for a variety of smaller-scale transportation projects such as pedestrian and bicycle facilities, recreational trails, safe routes to school projects, and vulnerable road user safety assessments.

Set-aside funds are available through states to regional governments, metropolitan planning organizations, transit agencies, natural resource or public land agencies, schools, Tribal governments, and nonprofit entities. Annual funding is approximately $1.4 billion for Fiscal Years 2022 through 2026.

Community Development Block Grant (CDBG) Program. HUD's CDBG Program provides annual grants on a formula basis to states, cities, and counties. The program's flexibility empowers people and communities to design and implement strategies tailored to their own needs and priorities, and the types of activities selected by grantees may vary depending on their needs each year. In FY 2023, $304 million of CDBG funds was used for 1,794 street improvement activities, $110 million was used to fund 951 sidewalk improvements, and $5.8 million was used for transportation services (182 activities).

Roadway safety commitments. In 2022, USDOT released the National Roadway Safety Strategy, a comprehensive approach to reducing serious injuries and deaths on our nation's roadways, working toward an ambitious long-term goal of reaching zero roadway fatalities. One such example is FHWA's Zero Deaths and Safe System Program, which prioritizes safe mobility for all people to eliminate fatalities on the transportation system. The program focuses on designing and managing road infrastructure to minimize the risk of crashes, reducing danger to vulnerable road users to make active transportation a more attractive mode choice.

Rural active transportation projects. The USDOT Rural Surface Transportation Grant Program supports projects to improve and expand surface transportation infrastructure in rural areas to increase connectivity, improve the safety and reliability of the movement of people and freight, and generate regional economic growth.

Local Match Waiver for Complete Streets. The Federal Transit Administration (FTA), in coordination with FHWA, approved a waiver of the non-federal match for the Metropolitan Planning Program and the State Planning and Research Program for activities promoting complete streets—that is streets where all mobility types are encouraged. The waiver encourages infrastructure such as sidewalks, bicycle lanes, bus lanes, public transportation stops, crossing opportunities, median islands, accessible pedestrian signals, curb extensions, modified vehicle travel lanes, streetscape, and landscape treatments. This supports the construction of active transportation street facilities.

Complete Streets Initiatives. FHWA has a number of programs designed to encourage construction of complete streets. Because transportation infrastructure has disproportionately been built around single occupancy vehicles, FHWA's tools focus on creating human-scaled and protective infrastructure. In addition to information about funding complete streets, the site includes technical resources for planning and analyzing complete streets and for implementing complete streets improvements.

Complete Streets AI Initiative. This initiative aims to develop decision-support tools using data science approaches like artificial intelligence, computer vision, and machine learning that state, local, and Tribal transportation agencies can use to design and implement complete streets. Funding will be awarded to small businesses to develop the capacity to use novel approaches to data and analytical methods and develop tools for deploying complete streets. The resulting tools will aim to increase access and opportunity to use active and public transportation, while also improving freight and delivery routes.

Community-Port Collaboration Toolkit. EPA developed this toolkit to foster partnerships between ports and near-port communities to address community needs and environmental

justice concerns. This funding has recently supported community planning for active transportation projects.

Open-source tools. NREL has developed and deployed open-source tools to quantify the benefits of active mobility. States, counties, and cities are using the Open Platform for Agile Trip Heuristics (OpenPATH) and Mobility Energy Productivity (MEP) tools to model, predict, and understand how active transportation will shape and benefit their communities so that they can plan better to meet demand.

Other technical assistance resources to encourage active transportation include:

- USDOT provides technical resources for active transportation planning design and implementation, including guidance on procurement, pilot funding, project development assistance, and direct assistance in preparing federal grant applications.
- FHWA's Strategic Agenda for Pedestrian and Bicycle Transportation, which was completed in 2016, is being updated to chart a new roadmap of activities that support active transportation initiatives for the next five years (2024-2028). FHWA has also compiled a number of resources on achieving multimodal networks and connectivity, project design and implementation, and funding resources. These are available on FHWA's Bicycle and Pedestrian Program webpage.
- The Joint Office of Energy and Transportation whitepaper, Community Charging: Emerging Multifamily, Curbside, and Multimodal Practices, explores the landscape of existing EV charger installation for denser housing types and urban settings and includes information on micromobility charging and mobility hubs.
- EPA's Smart Growth website hosts resources to help local governments and community leaders. For example, the Smart Location Database contains metrics to evaluate the relative transportation emissions associated with specific sites.
- EPA's Green Infrastructure website includes resources to help communities design and build streets that incorporate trees, plants, and other green infrastructure techniques to make active transportation more pleasant while also increasing health benefits.
- EPA's Travel Efficiency Assessment Method (TEAM) provides a framework to estimate the potential future emission reductions. This method has been used to focus on the relationship between transportation and GHG emissions.

OPPORTUNITIES

Implement vulnerable road user research plan recommendations. FHWA recently published a research plan that identifies specific gaps in active transportation planning research: improving safety, promoting equity, building multimodal networks, and encouraging more trips via active modes. Ongoing support of these research needs can support analysis of and insight into active transportation planning to make active transportation safer and more effective in the future.

Expand funding eligibilities for micromobility projects. To strengthen first/last mile connections to transit, the definition of "associated transit improvement" per 49 USC 5302(2) could be expanded beyond public transit and related facilities to include wider eligibilities for shared use micromobility projects. Grant programs could expand eligibility for electric micromobility charging infrastructure to include operational subsidies.

Continued investment in programs that support active transportation and micromobility. Many federal programs supporting active transportation are oversubscribed. For example, the Safe Streets for All Program received approximately $2.5 billion in requests for $580 million available in FY 2023.

Create a per-mile reimbursement rate for biking mileage with the Internal Revenue Service (IRS). The IRS sets a reimbursement rate for vehicle use by federal employees, and many other companies use this rate for their employees. The IRS could consider setting a similar rate for reimbursement for bicycle use business and non-commuting purposes. Employers could also consider expanding pre-tax benefits for employees to get to work via transit, biking, and shared micromobility.

Leverage the metropolitan and statewide planning process to close gaps in active transportation networks. State DOTs and Metropolitan Planning Organizations can leverage state and metropolitan planning processes to prioritize projects that address gaps in active transportation networks within and between communities, including on-road and off-road facilities. Agencies can encourage the development of infrastructure and initiatives that enhance active transportation options. This focus on closing gaps in active transportation networks improves active transportation network connectivity and accessibility.

Consider active transportation and transit-oriented development guidelines. Many state and local zoning codes and street design guidelines take a car-focused approach to land use, often disincentivizing access to destinations by other, less polluting means. For example, zoning regulations often prioritize businesses that face parking lots instead of sidewalks, or drive-through curb cuts which interrupt and endanger pedestrian travel. Rethinking the built environment to represent the diversity and vulnerability of road users, such as through pedestrian-oriented overlay districts near transit stations, interconnected trail systems, and active transportation design elements, can encourage lower-emission modes of travel.

Establish e-bike incentive programs. As of February 2024, more than 160 state and local governments offered e-bike rebate or incentive programs. These programs are generally successful at shifting behavior towards more active transportation trips and reducing emissions.[55,56] Federal, state, or local governments could offer rebates, tax credits, or other incentives to make micromobility devices more affordable and encourage them as an alternative for shorter trips that would otherwise be made by car.

Develop functional classification systems to support context-sensitive planning. Several states have developed additional or alternative road classification systems for planning and engineering. Instead of focusing primarily on road size, many of these classification systems account for a road's function and context. FHWA's classification system includes context-sensitive solutions, especially for secondary roads, and could also provide additional flexibility to allow for different uses of the rights of way. This may make it easier to integrate sidewalks, bike lanes, housing, and related carbon-reducing infrastructure into transportation planning. The American Association of State Highway and Transportation Officials' bicycle and pedestrian facility design guides include guidance for "flexible and performance-based" roadways that incorporate function and context as key determinants of design. Similarly, major street and transportation design guides, including National Association of City Transportation Officials' (NACTO's) Urban Street Design Guide and the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), encourage local decision-makers to leverage their knowledge of local context to promote walkability and traffic calming.

Include natural infrastructure. There are many benefits associated with including green and natural spaces near transit and in compact neighborhoods, such as a reduction in the "heat island effect" where lack of vegetation can cause higher local temperatures.[57] Beyond the mental health advantages associated with smart community design, people are motivated to walk and bike where there is a dedicated, well-maintained place for them to do so. Designing safe green transit corridors that reflect a sense of place can motivate usage and increase uptake of active transportation modes.[58]

Assess and improve vehicle blind zone risk. Trucks pose an outsized risk to cyclists and pedestrians because the physical design of some trucks creates blind zones that hide active transportation users, especially smaller children.[59] Car buyers and fleet managers can consider how blind spots in larger vehicles can increase the risk their vehicle poses to active transportation users. By assessing blind zone risks as part of vehicle purchase decisions, public and private fleets can improve active transportation safety and accessibility.

STATE, LOCAL, AND INDUSTRY EXAMPLES

Bay Mills Indian Community, MI: Spirit Stone Trail. Federal, state, Tribal, and local stakeholders collaborated to improve active transportation facilities along the Spirit Stone Trail, which passes through Bay Mills Indian Community land. Providing a safe walking and bicycling route improves connectivity within and around the Bay Mills Indian Community. The trail improvements encourage active transportation commutes. The trail also led to additional development in the area, with plans to build a health center and residential properties that will utilize the trail connections.

Basalt, CO: Rural bikeshare program. As a collaborative effort between the City of Aspen, City of Basalt, Eagle County, and WE-cycle (a non-profit organization), the Movimiento en Bici bikeshare and outreach program was launched in Basalt. The program provides Spanish-language bicycle lessons and conducts outreach to Latinx communities to participate in the bikeshare program as a means to support equitable bikeshare services. As one of the main transportation challenges in Basalt was first and last mile connections, the program ensured

strategic placement of bikeshare stations near transit stops, residential areas, and commercial centers to foster participation while reducing the need for vehicles for first and last mile connections.

Public-private partnerships for shared micromobility programs. Partnerships between local governments and private sector operators are essential for a sustainable and equitable shared micromobility program. Several cities across the United States have successfully operated long-standing shared mobility programs through public-private partnerships such as Bluebikes in Boston, Capital Bikeshare in Washington D.C., Citi Bike in NYC/Jersey City/Hoboken, and Divvy in Chicago/Evanston.[60]

Texas: Statewide Trail Network Development. The Texas Department of Transportation (TxDOT) developed a conceptual statewide bicycle tourism trails network that is over 8,000 miles long. To help identify priority areas for trail development, TxDOT developed a GIS-based tool that scores segments of the bicycle network based on key priorities, such as coordination with development projects.

ACTION AGENDA

The following represent a selection of the most promising opportunities for reducing emissions through investments in active transportation. The table below summarizes these actions and associated lead sectors.

Private Sector	• Support public-private partnership bike share programs. • Incentivize employees to bike and walk to work.
Tribal, State, Local, and Regional Governments	• Leverage metropolitan and statewide planning processes to close gaps in active transportation networks.
Federal Government	• Create a per-mile reimbursement rate for biking mileage with the Internal Revenue Service. • Develop functional classification systems to support context-sensitive planning.

3.2 Land-Use Planning and Transportation System Design

Compact cities, town centers, and rural main streets and downtowns can opt to significantly reduce transportation sector GHG emissions if they have a mix of commercial, residential, and civic uses. As a result, people and goods will be able to reach their destinations more easily because the distance between where people live, work, and play is shorter. By establishing systems such as regular public transit service, connected active transportation, and streamlined goods movement, communities can promote this diversity of land use. This allows people to spend less time in traffic and save money on gas, car maintenance, and parking, while reducing the GHG emissions associated with their movement and the movement of goods through supply chains. A study of three high-growth U.S. metropolitan areas found that local zoning reforms to accommodate housing growth along public transportation corridors and on underused urban land closer to downtowns would reduce the need to travel by car by up to 13 percent and GHG emissions by up to 14 percent.[61]

Sprawling development leads to significant fiscal and economic costs in the long term. Many of those costs are borne by the individual, disproportionally impacting low-income residents.[62] Sprawling development patterns mean that many essential services are accessible only by car or long, inconvenient transit trips. This contributes to more and longer driving trips and more carbon-intensive travel,[63] significantly increasing GHG emissions. In the United States, lower carbon emissions associated with higher population densities in urban cores is offset by the higher-than-average emissions of low-density, suburban areas.[64] Households near multiple activity centers (e.g., downtowns, major suburban employment centers, and main streets) typically travel 14,500 fewer miles per year than counterparts further from activity centers.[65]

Reducing distances can also make supply chain more convenient, from manufacturing to delivery. For more information, See Section 3.5: Goods Movement Management.

Areas that are reliant on driving as the primary mode of travel can pose significant burdens to those who cannot drive, including children and older individuals. A reliance on driving also limits options for people who cannot afford a vehicle. According to the National Household Travel Survey, households making less than roughly $25,000 per year are eight times less likely to own cars than households making more than $25,000. Shifting toward land use patterns that prioritize public transit and active transportation would improve equity, increase job access, and promote economic development.[66,67] Remaining car trips would also get shorter, as living in more compact and accessible areas can cut annual costs by $920-$1,200 and reduce CO_2 emissions equivalent to burning as much as 1,500 gallons of gas.[68] In addition, compact, walkable, mixed-use communities with reliable transit service benefit older individuals who can no longer drive and want to age in place.

Transit-Oriented Development (TOD)

Supporting mixed-use development, including affordable housing, near transit can reduce trip distances and make public transportation more convenient. Homes in walkable and transit-accessible areas are extremely desirable, and insufficient supply generally leads to higher prices for these homes.[69] Increasing the amount of development near transit enables lower housing costs and makes more convenient transit service available for residents of all incomes.[70]

Pairing transit-oriented development with a diverse mix of housing and infill development can also help avoid displacement of existing residents and allow them to reap the benefits of economic development and increased job access near their homes.[71] TOD can also make accessing common destinations and public services like grocery

stores and libraries easier. In a suburban context, co-development of increased housing density and transit stations with active transportation infrastructure offers a way for commuters to reach their destinations without needing to rely on personal vehicles. In rural town centers, TOD could involve constructing housing adjacent to intercity rail or intercity bus terminals. Research has shown that TOD alone can reduce GHG emissions by as much as 31 percent, with even higher reductions achieved through integration of TOD and other strategies to support public transit ridership.[72] Value capture, one of these TOD integration techniques, can recover a portion of the land value and related economic activity created by transportation facilities. Revenue generated can support community goals such as additional transportation access projects, equitable housing, and public services.

Location efficiency is the siting of housing and commercial development in proximity to transit and other amenities. Past suburban and exurban development resulted in families moving further and further from downtowns and urban centers to find affordable housing. In doing so, they often incurred higher transportation costs associated with the location of that housing. Several tools are available to measure location affordability, or the combined cost of transportation and housing, including USDOT and HUD's Location Affordability Index, the Center for Neighborhood Technology's Housing and Transportation Affordability Index, and EPA's Smart Location Database.

FEDERAL ACTIONS AND INITIATIVES

USDOT TOD Policy. USDOT released a Policy Statement on TOD that encourages TOD projects to consider public benefit provisions such as anti-displacement strategies and increased supply of affordable housing. The policy statement provides project developers with guidance on strategies to ensure equitable housing practices for TOD, and compliance could be used in the future as a condition for certain discretionary funding programs.

Financing programs. USDOT's Transportation Infrastructure Finance and Innovation Act (TIFIA) and Railroad Rehabilitation and Improvement Financing (RRIF) programs provide low-interest financing for surface transportation projects. The 2015 FAST Act expanded both programs to include TOD projects, and BIL made minor expansions to those authorities.

Innovative Finance Grants. The USDOT Build America Bureau's Innovative Finance and Asset Concession Grant Program makes $100 million available over five years to assist public entities in facilitating and evaluating public-private partnerships and exploring innovative financing and delivery opportunities for TIFIA eligible projects, including TOD projects.

Section 108 Loan Guarantee Program. For recipients of Community Development Block Grant funding, HUD supports leveraging grant funds for economic development, housing, public facilities, and infrastructure. Because Section 108 is so flexible, as are its repayment terms, the program can be an ideal source of funding for TOD projects and related development efforts, either on its own or in combination with other economic development financing.

Pilot Program for TOD Planning. This FTA program supports the expansion of more conveniently located and affordable housing near transit. The program provided approximately $17.6 million in competitive grants for FY 2023 and has a total of $68 million available from FY 2022 through FY 2026. The program provides an opportunity to receive a 100 percent federal share for applications that have a substantial focus on increasing affordable housing.

Choice Neighborhoods Program. This HUD program helps communities transform neighborhoods by revitalizing severely distressed public or assisted housing and catalyzing critical improvements in the neighborhood, including vacant property, housing, businesses, services, and schools, through public and private funding. Communities can receive funding for transformative planning, enabling both public and private reinvestment in amenities and assets that are important to residents.

Joint Development Guidance. FTA offers information to guide the use of FTA funds for development that integrally relates to public transportation. Under the guidance, local transit agencies can use land that was purchased with FTA funds to support TOD through joint development partnerships or transit joint development. With FTA approval, local transit agencies can improve property through incorporation of private investment, including commercial or residential development, if the transit agency can demonstrate that the development supports transit.[73]

TOD Infrastructure Finance Guide. In collaboration with four transit agencies, EPA developed a set of case studies that describe how a range of public and private financing models can be combined to support the essential infrastructure improvements that are often needed to accommodate TOD.

FTA Interim Asset Disposition Guidance. FTA may authorize the transfer of land and land improvements, such as buildings, to a local governmental authority, non-profit organization, or other third-party entity if, among other factors, it will be used for TOD and includes affordable housing. To be eligible, the property must be a necessary component of a proposed TOD project that will increase ridership, at least 40 percent of the housing units in the TOD must be affordable housing, and the property must remain in use for these purposes for at least 30 years after the date the asset is transferred.

Commercial to residential conversions. Actions include establishing dedicated funding, allowing existing funding to be used towards conversions, and releasing the Commercial to Residential Federal Resources Guidebook. Conversion of these properties could further support the development of new housing near existing density and transit networks. The Exploring Office to Residential Conversions Grant Program also provides funding for residential conversion activities.

Technical assistance to communities. Technical assistance, such as through FHWA's National Highway Institute's Integrating Transportation and Land Use course, can help transit agencies and local governments implement TOD projects. The course focuses on augmenting the resources available to communities and providing expertise in navigating grant programs to integrate transit and development.

OPPORTUNITIES

Encourage increasing affordable, quality housing supply near transit by leveraging existing programs and funding. Many existing programs include opportunities to incentivize additional housing supply near transit to encourage more equitable development patterns, especially through locating affordable and/or mixed-income housing near transit. For example, FTA includes land use and affordable housing as considerations in both the land use and economic development statutory evaluation criteria in the Capital Investment Grants program.

Capture increased land value. Transit infrastructure improvements can lead to higher local land values and increased development. Private land and property owners are often able to benefit from infrastructure investment in this way, and municipalities may be able to capture some of this value for residents through public-private partnerships, tax increment financing districts, or other local measures. In this way, some of the costs associated with public infrastructure to spur economic development could be recouped or reinvested into active and public transit infrastructure.

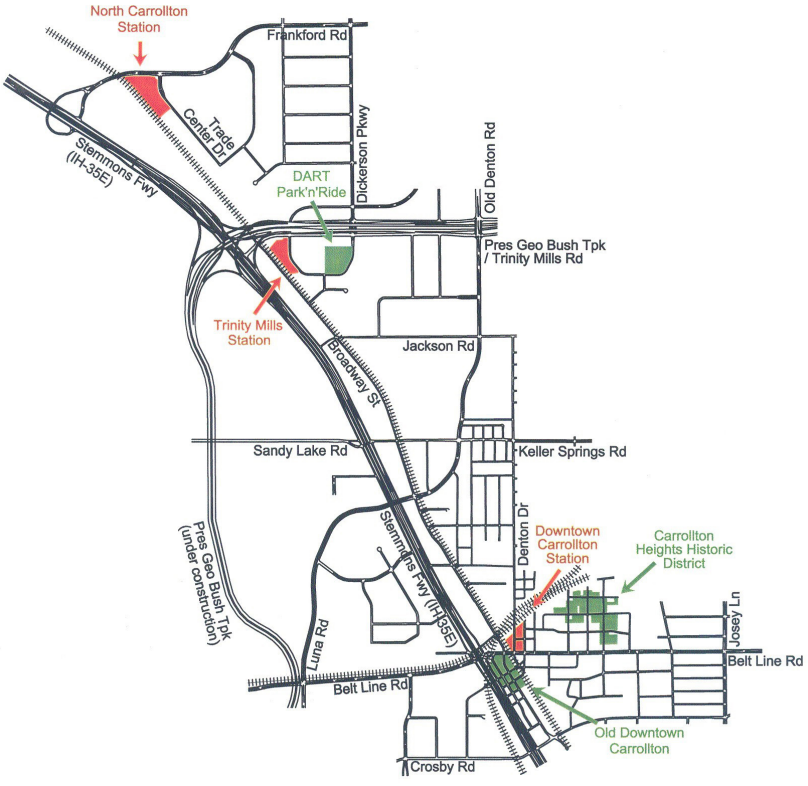
Assess barriers to additional land assemblage in transit-proximate locations. Identify barriers to making use of funding and financing programs for additional property acquisition for the purposes of joint development. Barriers to property acquisition and vacant land assemblage are major hurdles to building affordable housing and other community-serving developments in transit-proximate locations.

STATE, LOCAL, AND INDUSTRY EXAMPLES

Massachusetts: Multi-family zoning near transit. The Commonwealth of Massachusetts requires a minimum amount of multi-family zoning near Massachusetts Bay Transit Authority (MBTA) stops. These multi-family zoning districts must be within a half-mile of a transit stop and have a set minimum density. The requirements apply to all

cities and towns in the state with rapid transit or commuter rail stations, as well as those that are adjacent to these communities—a total of 177.

Carrollton, TX: **Master Planned TOD.** The largest TOD project in the world is currently under development just outside of Dallas, TX, at Trinity Mills Station in the City of Carrollton. Taking advantage of the existing DART Green Line station with service into the Dallas-Fort Worth Metro area, this project will develop 25 acres for mixed-use development with active transportation infrastructure, including miles of pedestrian trails, and commuter rail access. The self-described "urban village" also places a focus on third spaces—that is, places for individuals and families to gather and socialize outside of work and the home.



TOD developments in Carrollton, Texas, creating dense, mixed-use communities in suburban areas with access to nearby cities of Dallas, Fort Worth, and Denton. Source: City of Carrollton

Atlanta, GA: TOD policy implementation. Since the adoption of its TOD affordable housing policy in 2010, the Metropolitan Atlanta Rapid Transit Authority (MARTA) has engaged partners in fulfilling its commitment. In 2020, Invest Atlanta, the city's development authority, along with Enterprise Community Loan Fund and the Low-Income Investment Fund, created a $15 million TOD Fund focused on the acquisition and development of affordable housing near transit. In 2021, MARTA announced the creation of a $100 million private fund to support the preservation of affordable housing within a half mile of transit stations. In 2023, MARTA secured $1.75 million in funding from the USDOT to stand up a transit and TOD accelerator. MARTA has begun awarding contracts to developers for TOD at three sites as of early 2024, including at Bankhead, Kensington, and Indian Creek.

Indianapolis, IN: TOD overlay. As part of its 2021 zoning code revision, Indianapolis created a TOD overlay zone that promotes compact, mixed-use development around bus rapid transit stops and improves streetscapes to make walking and biking safer and easier.[74]

Arlington County, VA: Rosslyn-Ballston Corridor. Arlington County implemented transit-oriented policies to increase development density along transit lines. Despite population growth at 1 percent per year, VMT has not increased, equating to a 20-30 percent VMT reduction per person from 1980 to 2005. Transit and active transportation modes of travel account for 47 percent of commutes, compared to a regional average of 29 percent. 12 percent of households in Arlington County do not own a car, compared to a regional average of 4 percent.

ACTION AGENDA

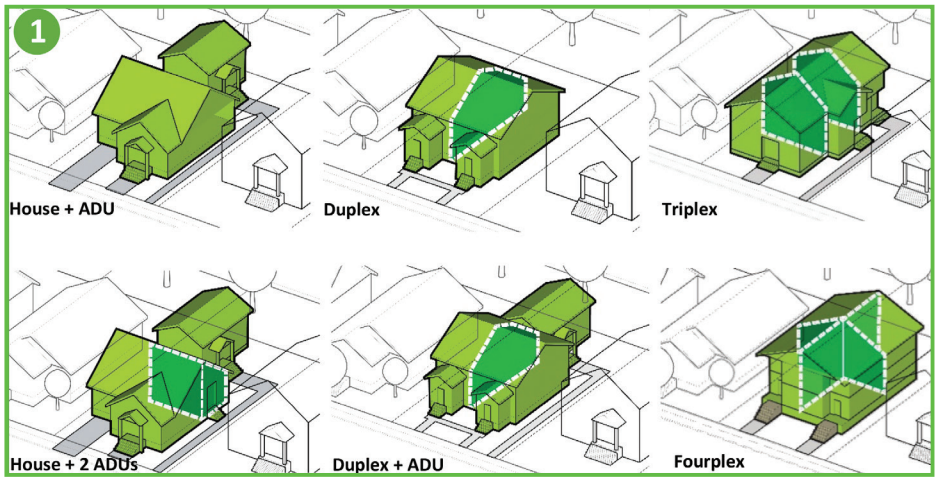
The following represent a selection of the most promising opportunities for reducing emissions through transit-oriented development. The table below summarizes these actions and associated lead sectors.

Private Sector	• Support public-private partnerships for transit and rail that increase land value for local business and development.
State, Local, and Regional Governments	• Leverage USDOT financing programs (TIFIA and RRIF) to fund new development near transit.
Federal Government	• Provide robust technical assistance for federal financing programs (TIFIA and RRIF) to enable housing and affordable housing development.

Zoning Reform

Conventional land use codes, regulations, and policies—especially since the 1950s—have led to land-use patterns that increase transportation-related GHG emissions. This has left many individuals entirely reliant on vehicles to make trips from home. Zoning codes often require strict separation of uses (e.g., residential and commercial districts) and single-family housing on lots of a required minimum size. This encourages sprawling development with longer distances between homes and destinations. These provisions have resulted in car-dependent communities with limited choice of transportation mode or residence type. In addition, high housing costs and limited housing supply in areas close to jobs and transit can lead to displacement, with people moving farther away to find affordable housing, leading to a feedback loop of longer commutes and more trips made by car.[75] In some exurban and rural settings, job growth is occurring in areas with little existing housing or transportation services, leading to more travel time and higher costs to access these jobs. Updating land use codes, regulations, and policies to increase housing supply and encourage compact, mixed-use, and mixed-income development with convenient access to active transportation and public transit can reverse this trend. Resulting communities would be more inclusive of diverse income levels, supported by convenient transportation options, and more affordable when considering the combined cost of transportation and housing.

Zoning reform can help create more shared public spaces for community members, in places such as rural town centers and suburban public squares. These reforms can support options for living, working, and playing with full mobility freedom and without depending on car



Housing options for infill development. Source: City of Portland, Oregon Bureau of Planning and Sustainability

ownership or use. In rural or suburban contexts, this can mean supporting active transportation and enabling additional transportation decarbonization strategies like intercity bus and rail connectivity. These changes also promote economic development, safety, and community vibrancy.[76,77]

Zoning is often a local responsibility. However, the federal government and state governments can support local governments as they consider policies that encourage housing production, TOD, and walkable communities. In suburban areas, this would mean easier access to shops and services as a wider variety of uses is woven into existing development. Communities can also support the preservation of existing affordable housing to help current residents stay in their transit-accessible neighborhoods in the face of new development pressures.[78] All of these policies could help reduce distances between destinations by making it easier for people to live and work in locations with more transportation choices, including lower carbon-intensity modes —thereby reducing GHG emissions.[79] Land use reform that supports density can lead to the protection of natural, undeveloped land, since growth is focused within a smaller area. Conserving land that would otherwise be developed can have carbon sequestration benefits, further supporting decarbonization goals.[80]

Promoting density where transit access already exists helps individuals reach destinations without the need for a personal vehicle. Density is a major factor in creating high-quality public transportation as riders can reach more destinations in less time, resulting in higher ridership and revenue. An increase in the frequency of service and number of routes can continue to improve ridership, creating positive feedback effects. Protecting and redeveloping small urban cores, main streets, rural downtowns, and other pockets of relatively higher density jointly promotes economic development and decarbonization.[81] For more details on strategies to encourage mode shift to transit, see the Efficiency Action Plan.

FEDERAL ACTIONS AND INITIATIVES

Pathways to Removing Obstacles to Housing (PRO Housing) Grants. HUD provides funding to communities that seek to remove barriers to affordable housing, increase housing production, and lower housing costs for families. Potential barriers addressed through this program include restrictive regulatory, zoning, or land use policies, as well as outdated procedures or permitting processes. Following a competitive grant process for $85 million in allocated funds, HUD will offer the program a second time with $100 million in funding.

FTA Capital Investment Grants Program. This program includes economic development, which examines local plans and policies, as an evaluation criterion. Research shows that transit access is a major factor in economic development at the local and regional levels,[82] and FTA considers the extent to which a proposed project is likely to induce additional, transit-supportive development based on the policies and plans surrounding the development.

Land Use Reforms and Off-Site Construction Research Grant. HUD is providing communities with up to $3 million to assess the potential for off-site construction methods that increase housing supply, lower the cost of construction, or reduce housing expenses. These off-site construction methods include manufactured housing, modular homes, and prefabricated structural components. The program also funds a study on the impacts of local zoning and other land use regulations that could increase the supply of quality, affordable housing. The increased housing density is more conducive to high-quality public transit and active transportation networks, which in turn leads to a reduction of VMT.

Rural downtown revitalization funding. HUD supports rural downtown revitalization on Tribal lands and Alaska Native villages through the Indian Community Development Block Grant Program. Rural communities may receive funding

from their state through HUD's Community Development Block Grant State Program.

National Zoning Atlas. HUD's Office of Policy Development and Research awarded $350,000 to support Cornell University's development of the National Zoning Atlas. This first-of-its-kind program will create a standardized, nationwide database of zoning to allow municipalities and local officials to learn from and share with their peers and will promote research into trends and best practices.

Land use guidance. HUD's policy guidance on Pro-Housing Land Use and Zoning Reforms summarizes the impacts of restrictive land use policies and highlights reforms that state and local governments can adopt to increase the supply of housing. The Housing Supply Action Plan describes legislative and administrative actions that would help close America's housing supply shortfall in five years, starting with the creation and preservation of more affordable housing units. This plan encourages USDOT to continue including language in discretionary grant programs to promote locally driven land use reform, density, rural main street revitalization, and TOD. The U.S. Department of Agriculture supports rural downtown revitalization through technical assistance and a funding navigator website.

Essential Fixes for Zoning Codes. EPA convened a group of national land use and zoning experts to develop a guide for communities seeking to update their codes, ordinances, and policies. Through a yearlong process, the group helped produce a guide to both small and larger changes that advance better environmental, housing, economic, and public health outcomes.

Green building certifications. Many HUD programs have minimum energy standards or requirements in the form of green building certifications. For grantees and contractors receiving funding from HUD, these green building certifications encourage active and public transportation along with compact urban design. For example, projects under the Enterprise Green Communities Program must include transit access for any new, urban construction projects — with higher scores given to projects which prioritize transportation connectivity.

OPPORTUNITIES

Further emphasize local land use factors in discretionary grant scoring. Federal agencies can consider the effects of proposed projects on land use. This could mean prioritizing locally-sensitive designs that promote compact development, active transportation, and public transit. Municipalities can increase their scores in many affordability and equity-focused federal grant programs by enacting policies for housing abundance.[83] For example, USDOT includes housing as an element for consideration in a number of discretionary grant programs, such as the Reconnecting Communities and Neighborhoods (RCN) Grant Program.

Encourage mixed-use building types and districts. Expanding building typologies to allow live-work units and smaller mixed-use buildings (e.g., above-shop flats) can create spaces for more small businesses and economic development. These efforts also lower transportation costs, better use existing infrastructure, and lower emissions per capita by putting employment, commerce, and essential services near housing.

Adopt form-based zoning. In many municipalities, development is constrained by zoning laws that specifically prohibit mixed-use and mixed-density areas. Instead of focusing on the use of a structure, a form-based zoning code focuses on its physical attributes, providing flexibility for the type of structure while preserving a certain character through compliance with consistent height and massing requirements.[84] Adopting this type of zoning code can reduce VMT by increasing density and bringing jobs and services closer to housing, while making these developments more resilient to changing market conditions and demand for different uses in the buildings.

Diversify housing options near transit. States and localities can modify building codes and land use regulations to allow a diversity of housing. This can include building types between single-family homes and high-density apartment buildings, often called "missing middle" housing, such as duplexes, townhouses, live-work units, co-housing, small apartment buildings (4-8 units), and co-ops.[85] These kinds of structures can be an especially good fit for low-density urban areas as they can be "infilled" to add density without significantly changing the neighborhood's character.[86] One especially flexible type of middle housing is the accessory dwelling unit—an independent, secondary structure nearby or attached to a single-family home.[87] This increased density can, in turn, create more transit-friendly communities and reduce distances traveled.

STATE, LOCAL, AND INDUSTRY EXAMPLES

Statewide zoning reforms. Several states, including California, Maine, Oregon, Washington, and Vermont, have passed laws requiring local governments to allow more housing types in existing neighborhoods.[g] To date, such efforts have been focused on adjusting land use regulations to allow missing middle housing, such as accessory dwelling units, duplexes, and townhomes. These types of housing are often not allowed through local zoning, but many states have chosen to increase available housing through statewide action.

Montana: Increased Land Use Flexibility. Montana recently passed several laws intended to reform zoning statewide, with a focus on giving landowners the right to use their land in a wider variety of ways. In addition to allowing ADUs, residential uses will be permitted by-right in some previously commercial zones, thereby allowing more mixed-use development. Similarly, duplexes will be allowed anywhere single-family zoning is currently in effect. Local governments will also be required to consider how they will meet future housing needs through local-level land use reform.

Portland, OR: Residential Infill Project: Portland became the largest U.S. city to end single-family zoning in 2021 with its "Residential Infill Project" and associated zoning reforms. The zoning reforms allow new forms of housing on residential parcels previously zoned for a single-family detached house. The new rules also permit new types of housing, and set new, more flexible rules for how residential buildings can be configured and how large they can be. The overall purpose of the project is to provide more density, allowing more housing without expanding Portland's existing urban footprint.

California: Streamlined Housing Approvals. Under California Senate Bill 35, every eight years, state and regional officials perform a Regional Housing Needs Assessment (RHNA) to determine the appropriate housing minimums to ensure housing affordability for current and potential residents of California's cities. Recently passed "builder's remedy" legislation makes it easier to construct new housing when cities do not meet these targets by allowing builders to pursue a streamlined approval process, especially through the construction of mixed-income and infill development.[88]

g These include SB 9 (CA), LD 2003 (ME), SB 323 (MT), SB 245 (MT), HB 2011 (OR), and S. 100 (VT).

ACTION AGENDA

The following represent a selection of the most promising opportunities for reducing emissions through zoning reform. The table below summarizes these actions and associated lead sectors.

Private Sector	• Support public-private partnerships for rural downtown revitalization, suburban retrofits, and other walkable areas to enable foot traffic for local business.
Tribal, State, Local, and Regional Governments	• Modify state and local land use regulations to support diversified housing options.
Federal Government	• Consider local land use factors and smart growth planning in discretionary grants with local government lead applicants.

Coordinated Transportation Planning

Achieving a convenient transportation system requires planning that is coordinated across multiple levels of government, governing jurisdictions, and program areas. Much of urban development is interrelated; transportation system performance depends heavily on land use decisions, and transportation investments affect land use outcomes. Thus, coordination between transportation planning agencies (including transit agencies), land-use planning entities, natural resource and recreation agencies, and housing agencies and across state, territorial, regional, Tribal, and local governments can foster outcomes that reduce GHG emissions.

BIL includes several changes to the planning process that provide new opportunities to align investments in transportation and housing.[89] These include provisions for metropolitan planning organizations to consider projects that promote consistency between transportation improvements and state and local housing patterns, increase consultation with housing officials and opportunities for comment by affordable housing organizations, and integrate housing, transportation, and economic development strategies through housing coordination. Transportation planning should also be coordinated across different transportation agencies in a region, including the state and territorial DOTs, MPOs or regional planning agencies, rural transportation planning organizations, Tribal transportation planning agencies, and local transit agencies. This can help ensure that multimodal trips between different modes or transit systems are easy, accessible, convenient, and affordable for riders.

Community members gathered for a planning exercise. Source: NACTO and Chicago Department of Transportation

FEDERAL ACTIONS AND INITIATIVES

Equitable Transportation Community (ETC) Explorer. USDOT's ETC Explorer is an interactive web application that uses Census data to explore the cumulative burden communities experience as a result of underinvestment in transportation. It includes metrics of transportation insecurity, climate and disaster risk burden, environmental burden, health vulnerability, and social vulnerability. This application can be used to support equitable transportation planning processes to ensure decisions are serving communities that could benefit most from access to low-cost and public transit modes.

FTA support for planning activities. FTA is increasing federal support for planning activities that help communities with lower population densities or lower average access to public transportation. Eligible recipients submitting grant applications to the Metropolitan Planning Program (MPP) and the State Planning and Research Program (SPRP) can request an increased federal share up to 100 percent.

Thriving Communities Network (TCN). The Thriving Communities Network helps federal agencies coordinate strategy, collaborate across initiatives, and target deployment of a full range of federal place-based technical assistance and capacity-building resources to urban, rural, and Tribal communities experiencing a history of economic distress and systemic disinvestment. More than 10 federal agencies are participating in the program by offering technical assistance to support equitable and accessible development and smart infrastructure investments. For example, the Thriving Communities Program at USDOT (TCP) provides place-based technical assistance to communities to plan and transform infrastructure and community development projects. Similarly, HUD's Thriving Communities Technical Assistance Program (TCTA) helps local governments ensure housing needs are considered as part of their larger infrastructure investment plans. EPA and DOE are supporting Environmental Justice Thriving Communities Technical Assistance Centers (TCTACs) across the country to help communities with environmental justice concerns access federal funding.

OPPORTUNITIES

Support community decision-making in rural areas. Rural areas often lack a regional planning body to plan transportation, in contrast to the MPOs mandated for urbanized areas. As a result, for rural areas, the state DOT often plans and funds rural transportation with only limited input from local communities. Some states have Rural Transportation Planning Organizations (RTPOs) to encourage meaningful cooperation with rural residents and respond to rural-specific concerns. This practice, if employed more broadly, could allow rural residents to advocate for better community design, more vibrant rural downtowns and corridors, better active transportation infrastructure, and increased transit and shared mobility options.

Encourage coordination between long-range transportation and housing plans. USDOT requires states and MPOs to develop long-range transportation plans and Transportation Improvement Plans. Many states and Councils of Governments require regionally coordinated housing plans. HUD requires development of Consolidated Plans to guide long-term housing planning and investments. Encouraging coordination between these plans to identify overlapping priorities that address both transportation and housing needs—including mixed-use development, co-location, and projected climate impacts in the region—can lead to more effective uses of funding and better integration of transportation networks and housing.

Institutionalize coordination between USDOT and HUD. USDOT and HUD have strengthened their partnership through the Decarbonization Blueprint, Reconnecting Communities and Neighborhoods Grant Program, and the Thriving Communities Technical Assistance Program. Institutionalizing coordination between USDOT and HUD would build on existing collaboration, strengthen ties, and ensure that the integration of housing and transportation policies, along with the associated GHG benefits, will continue. Potential steps include creating a coordinating council, exchanging staff detailees, or creating a Joint Office to mirror the success of the Joint Office of Energy and Transportation established under BIL. Such actions would align resources and expertise to enable changes in land-use planning and transportation systems design, and they would help support local decision-making by aligning USDOT and HUD requirements, technical assistance, and resources.

STATE, LOCAL, AND INDUSTRY EXAMPLES

Traverse City, MI: Holistic planning. The Traverse City Grand Vision is a citizen-led initiative for the future of land use, transportation, economic development, and environmental stewardship in northwest Michigan. As part of the Grand Vision, the city highlights two key factors in linking affordable housing and transportation: (1) housing developers must consider location and accessibility in siting affordable housing, including from the perspective of future residents, and (2) housing and transit advocates must be at the table together to ensure that affordable housing is built in areas where reliable public transportation is provided.

Boise, ID: Communities in Motion. The Community Planning Association of Southwest Idaho, serving as the regional MPO for the City of Boise and greater Treasure Valley, updated its long-range plan, called Communities in Motion 2050, in 2022 to include greater coordination with affordable housing development. The Community Planning Association of Southwest Idaho expanded its advisory groups to include housing representatives to inform the long-range plan, harnessing connections with United Way and others. Communities in Motion 2050 includes a vision that sites new housing near planned transit routes as well as a goal to "promote development patterns and a transportation system that provide for affordable housing and transportation options for all residents."

Arizona Gila River Indian Community, AZ: Gila River Transit: A joint effort between the FTA, Arizona DOT, and the Gila River Indian Community,

the Gila River Transit system serves the Gila River Indian Community to address connectivity needs and improve access to destinations. The transit service provides a safe, accessible method to travel within and around the community, reducing the use of personal vehicles while fostering place and community-based development.

Chicago, IL: Net-zero emissions tools. The Chicago Metropolitan Agency for Planning, Commonwealth Edison, and the Respiratory Health Association will be working with the Argonne and Oak Ridge National Laboratories to refine tools and analyses to help reach net-zero transportation emissions by 2050. These improved tools will help the Greater Chicago region better understand opportunities and challenges for implementing low-emission transportation technologies, such as passenger and freight travel electrification and energy-efficient mobility options. The partnership will also help guide land use and planning approaches, including TOD and smart growth.

Vermont: Central Vermont Region Location Affordability Model. Central Vermont Regional Planning Commission (CVRPC) developed a housing and transportation affordability model for the Central Vermont Region to advocate for the importance of location as a factor in housing and transportation costs. The results were included in CVRPC's 2016 Housing Element update.

ACTION AGENDA

The following represent a selection of the most promising opportunities for reducing emissions through coordinated transportation planning. The table below summarizes these actions and associated lead sectors.

Private Sector	• Participate in public engagement processes for land use and transportation long-range plans to support better integration and maximized value capture through increased transit-oriented development, transit, and active transportation options.
Tribal, State, Local, and Regional Governments	• Support community decision-making in rural areas by expanding capacity to better enable planning for rural downtown revitalization, rural transit, and active transportation.
Federal Government	• Institutionalize coordination between USDOT and HUD through development of a joint program office.

3.3 Parking Demand Management

Context-insensitive parking planning increases distances between destinations to make room for parked cars. The allocation of space for parking limits access to active transportation, public transit, and housing development while increasing flood risk, degrading water quality, and generating urban heat loads. Parking spaces, parking demand, and curb congestion increase traffic congestion, energy use, and GHG emissions.[90] Parking demand management can reduce the amount of space devoted to parking and lead to fewer trips made in single-occupancy vehicles. This strategy is especially effective when paired with affordable transit options and accessible and safe bicycle and pedestrian infrastructure.

Information on the availability of off-street parking reduces searching for parking and the associated vehicle travel and emissions, particularly in commercial areas. Information about off-street parking availability reduced emissions by almost 40 percent in commercial neighborhoods in one scenario, though impacts were more modest in the residential and mixed-use areas.[91]

Many zoning codes have a mandatory minimum number of parking spaces. Removing or reducing required minimums for new development is an effective way to encourage development of transit-oriented housing by lowering development costs and making room for more housing on a given lot.[92] Removing parking minimums also gives control to business owners and developers to set the number of parking spaces that make sense for their type of establishment and context. A community can increase flexibility for developers and residents by reducing minimums, allowing residents to use land in ways that may be more valuable to a development. Accessible parking spaces must still be provided where required. Reducing or removing parking minimums also has the benefit of increasing density, providing more land for residential and commercial development, and supporting active

Source: NACTO and Los Angeles DOT

transportation network access, as less area is devoted to vehicle accommodation and buildings are more contiguous and accessible.

Repurposing some curb space for uses other than parking can allow communities to meet a variety of needs, providing benefits for all people, including those who cannot or do not drive. In recent years, curb space use has expanded and diversified beyond parking. During the COVID-19 pandemic, businesses reclaimed parking spaces to install outdoor dining areas, a trend that has since remained popular.[93] Parking spaces in denser environments can be repurposed to host curb furniture and amenities (like benches or street trees) that support street access and make sidewalks safer and more appealing to active transportation users and people with disabilities. Many communities also incorporate green infrastructure, such as rain gardens or other vegetation, along the curb, which separates people on the sidewalk from traffic and provides aesthetic, environmental, and health benefits. Curb space can also be modified to support charging infrastructure for EVs and electric micromobility, and thoughtful planning and permitting can improve charging access for multifamily housing without creating hazards for cyclists and pedestrians.[94]

Parking demand management strategies also include financial incentives such as parking cash-out, tax-free transit, and vanpool benefits. FHWA studies show that providing a cash-out incentive to reward travelers for finding alternatives to driving alone can be very effective in reducing single-occupancy trips and reducing emissions, often at no cost to employers.[95]

For modeling and simulation tools available to support parking demand management, refer to Section 3.6: Data, Tools, Research, and Technology.

FEDERAL ACTIONS AND INITIATIVES

Curb management technical assistance. DOE's Pacific Northwest National Laboratory (PNNL) developed a city-scale dynamic curb use simulation tool and an open-source curb management platform. With the ability to simulate different prices, numbers of spaces, allowed parking duration, times of sale or reservation, and curb space uses, the tool allows users to model strategies to reduce curbside congestion and increase the efficacy of existing spaces. The FHWA Curbside Inventory Report outlines effective strategies and case studies for curbside management. This report was developed to serve as a guide on how to improve curbside management for practitioners. The Institute of Transportation Engineers' Curbside Management Resources can also help cities plan their curb use.

Strengthening Mobility and Revolutionizing Transportation (SMART) Grants Program. This USDOT grant program has funded several projects focused on improving curbside management, including zero-emissions delivery zones. The SMART Grants Program leverages technology to solve transportation infrastructure challenges, so it is especially well-suited for projects that seek innovative methodologies for curb and parking space usage. In its inaugural year, FY 2022, the program awarded nine curb management projects. With support through this program, the City of Portland and Miami-Dade County are both piloting digitally-enabled e-cargo bike delivery zones. The program is also supporting the development of digital curb inventories from San Francisco to Minneapolis to Buffalo, and the deployment of a digital commercial vehicle permit system in Seattle.

Employee benefits. Bikeshare memberships can be offered as an employee benefit. For example, a number of federal agencies, including USDOT, DOE, and the Office of Personnel Management, offer membership to Capital Bikeshare for federal employees located in the National Capital Region.[96] Employees may both enroll in bikeshare benefits and their agency's transit subsidy program.

Clean Cities and Communities Coalition transportation demand management (TDM) strategies. Many Clean Cities and Communities

Coalitions, in partnership with DOE, leverage TDM as part of their overall strategies to reduce local VMT. A number of coalitions hosted by MPOs have supported TDM projects in their regions.

Parking Spaces/Community Places. This EPA publication describes flexible parking management policies and strategies that can help communities balance parking with other development-related goals.

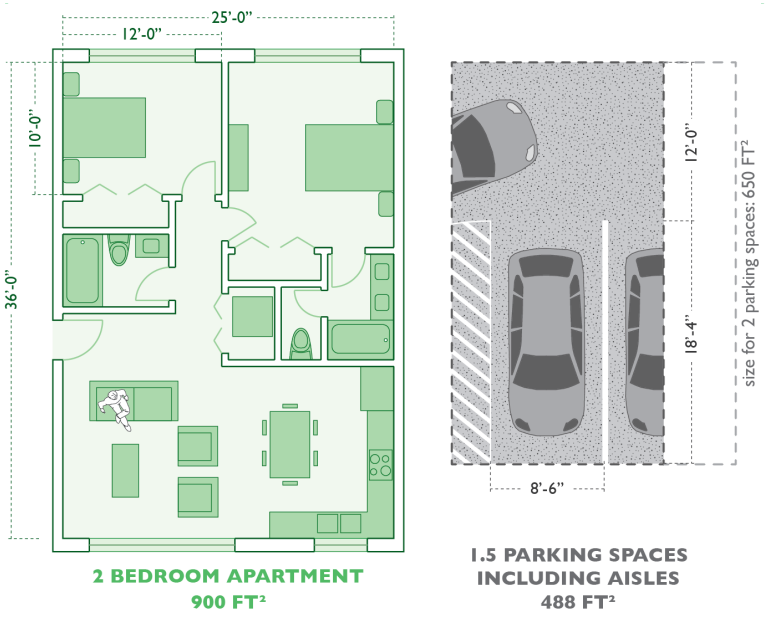
OPPORTUNITIES

Programming and funding for curbside management. To encourage state and local agencies to implement better curbside management strategies, USDOT could designate funding for curbside management planning and implementation and include provisions in existing programs to support curbside management.

Reform parking and transportation policies for large employers. The federal government can lead other large employers by example to encourage employers to subsidize and encourage alternatives to driving alone, such as:

- **Parking cash-out for employees.** Instead of offering free parking to employees, a parking "cash out" program would offer employees the equivalent value of maintaining the parking space. Unused parking could then be sold, leased, or developed—often at a profit to the business.
- **Increased transit and bicycle commuting benefits for employees.** Employers could consider expanding pre-tax benefits for employees to get to work via transit, biking, and shared micromobility.
- **Standards for bike parking and access.** Employers could set standards for bike parking, electric bike charging, and access so that employees who bike to work can be guaranteed infrastructure to securely store their bikes and access associated amenities such as showers and lockers. These steps have shown to increase the rate of bike commuting.[97]

Unbundle parking and housing costs. Communities can implement strategies to decouple the cost of housing from the cost of parking, which can lead to lower housing construction costs and less space devoted to parking. For example, communities could consider reducing or eliminating the minimum number of parking spaces required for new developments, giving developers the option to construct the number of parking spaces that makes sense for their particular context and location. Communities could also set parking maximums to discourage building excess parking, and instead encourage developers to manage travel demand by including transit passes and bikeshare memberships as building amenities. Multifamily building operators could remove parking from the rent cost and instead offer a



Comparing space requirements of living spaces and parking spaces

Source: https://www.sightline.org/2013/07/23/infographic-living-space-v-parking-space/

paid parking space as a separate option, making their units more competitive to renters without a vehicle and allowing operators to price parking at market rates. Under such a policy, people who buy condos or rent apartments could decide whether they want to buy parking, rather than having parking costs automatically bundled into the cost of housing. Cities can also promote or require this decoupling in order to better align vacant spots and parking demand while increasing affordable housing.

STATE, LOCAL, AND INDUSTRY EXAMPLES

SpotHero: Parking reservations. SpotHero is a private sector innovation that reduces the need for additional on-street parking by allowing drivers to locate parking lots or garages near their destinations to reserve a parking spot. Being sure of parking spot availability reduces the extra time and miles spent driving around in search of parking, eliminates the perception of parking scarcity, and matches underutilized spots with paying drivers. As a result, drivers can more accurately predict the most convenient mode of travel, choosing another mode or time of departure as needed.

Baltimore, MD: Demand-Responsive Parking Pricing. The Parking Authority of Baltimore City used demand for parking spaces to determine the hourly parking meter rate on blocks in six areas of the city. Meter rates are adjusted using data collected every six months with the goal of maintaining one or two empty parking spaces per block, benefiting businesses and reducing traffic congestion and emissions.

Pittsburgh, PA: Smart Loading Zones. The City of Pittsburgh and Pittsburgh Parking Authority have implemented Smart Loading Zones as a way to manage curb space to increase delivery efficiency and decrease congestion and emissions. License plate reading technology is used to analyze curbside activity and automate payment for the duration a vehicle is parked at a curb. The smart zones decrease emissions from unnecessary idling and circling, reduce parking-related congestion, improve pedestrian and cyclist safety, and make better use of existing parking spaces in business districts.

Buffalo, NY: Elimination of Parking Minimums. Buffalo, NY, became. the first major U.S. city to abolish parking requirements in 2017 when it formally adopted its Unified Development Ordinance (UDO) "Green Code," which included the elimination of off-street parking minimums. The elimination of off-street parking minimums helps to promote citywide development, density, and the use of alternative transportation modes. Research on this new policy has shown a decrease in off-street parking, relative to the previous standard, in almost half of new developments, indicating that developers expect a better return on investment with less space devoted to parking and potentially leading to a stronger real estate market.[98]

Houston, TX: Houston-Galveston Area Council Commute Solutions. Funded by the Texas Department of Transportation and FHWA, Commute Solutions provides a range of tools and resources for employers, commuters, colleges and universities, and property managers in the Houston-Galveston Area. Through the program, organizations can access customized travel demand management and telework plans, along with services like commuter surveys, zip code mapping, and technical assistance. Additionally, Commute Solutions offers direct support for commuters, including ride-matching for carpools, connections to vanpools, transit and bike maps, route assistance, and educational support for telework and compressed work weeks. Commute Solutions also features a commute calculator that illustrates individual emissions impacts and costs associated with different commuting modes, empowering users to make informed choices for a more convenient and efficient commute.

ACTION AGENDA

The following represent a selection of the most promising opportunities for reducing emissions through parking demand management. The table below summarizes these actions and associated lead sectors.

Private Sector	• Maintain bike parking and bike access at employment centers. • Provide parking cash-out for employees who bike or walk and do not require parking space.
Local and Regional Governments	• Reduce or eliminate mandatory minimum numbers of parking spaces for new housing development.
Federal and State Governments	• Provide programming and funding for curbside management.

3.4 Fiscally Responsible Transportation Investments

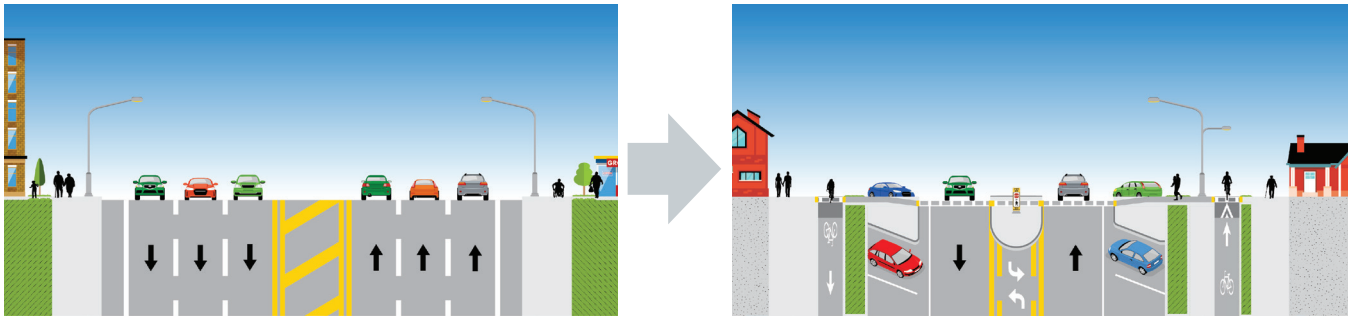
Prioritizing fixing and modernizing existing assets, rather than expanding road infrastructure (e.g., widening highways), enables a more convenient and fiscally responsible transportation system. Increasing roadway capacity does not meet long-term local travel demand or land use needs but does lead to net increases in overall emissions, and increased overall maintenance and operation costs.[99,100,101] Prioritizing maintenance over continual expansion enables sustainable transportation system investments and good governance, and it helps keep increases to traffic at a minimum by providing more options for travel. Further, increased highway infrastructure can make it inconvenient to access destinations by walking, biking, and public transit both due to sprawl induced by highway expansion and because highways can create unsafe or obstructed conditions for sidewalks, bike lanes, and transit routes. Fiscally responsible transportation infrastructure investing can reduce congestion without increasing traffic.

Retrofitting highways can reconnect communities, create space for transit or active transportation infrastructure, stimulate economic development, and support sustainable transportation system investments. For example, a post-project evaluation of a highway removal project in Rochester, New York, found that while the project cost $22 million, it generated $229 million in economic development. The project also increased walking by 50 percent and biking by 60 percent.[102] Research has shown that public and active transportation infrastructure projects produced more jobs per dollar compared to road infrastructure projects.[103,104] Active transportation projects can also spur economic development and generate revenue to cover the minimal maintenance costs of the active transportation infrastructure.[105] Walkable, dense, urban metropolitan areas are associated with higher economic activity, with the largest 35 urban metros in the U.S. accounting for 19.1 percent of U.S. GDP despite only making up 1.2 percent of U.S. land and 6.8 percent of the total U.S. population.[106] In areas with train crossings, retrofitting roads with grade separations can prevent lengthy detours and vehicle idling when trains are passing, while improving safety for both drivers and pedestrians.[107]

Fixing existing transportation assets has positive safety and convenience impacts for rural areas, where many bridges are in poor condition. Unsafe bridges require drivers to make detours and add unnecessary miles to vehicle trips. According to the National Bridge Inventory, average detour miles for rural travelers is nearly twice as much as detours by urban travelers.[108] It is also estimated that 46 percent of freight truck miles travelled occurs in rural areas.[109] Fixing bridges in rural areas to prevent unnecessary detours can lead to a significant reduction in miles traveled for both passengers and goods and reduce local air pollution in near-highway communities.

Congestion pricing and parking pricing, which is led by state and local entitites, can also support fiscal responsibility while reducing on-road congestion and encouraging lower carbon intensity modes of travel that take up less road space. Pricing allows local communities and states to recapture some of the value associated with road maintenance and construction. As an example at the federal level, the heavy motor use tax generates revenue that goes towards maintaining federal highway infrastructure. Also, DOE analysis found that congestion pricing, combined with transit deployment and off-hours delivery policies, can provide a 14 percent improvement in system level efficiency, compared to the deployment of clean vehicles alone.[110] A system-wide, delay-based congestion charge reduced total travel time by 14.2 percent and energy use by 5.1 percent. Long-term, vehicle traffic entering the pricing area was reduced by 18 percent, traffic congestion was reduced by 30 percent, bus travel increased by 33 percent, and 10 percent of trips were shifted to transit, cycling, and walking.[111, 112] For more details on mode choice, see the Efficiency Action Plan.

Transportation can be "repriced" in an equitable manner by converting fixed costs to variable costs. This saves travelers money while encouraging more efficient travel choices. State and local entities may also consider that fixed transportation costs such as insurance premiums, vehicle taxes, and registration fees can be converted to variable costs by charging them on a per mile basis. Employer-provided parking converted to cash payouts similarly rewards travelers for more efficient choices. An FHWA study found that bundling six different repricing strategies could reduce vehicle miles traveled by 32 percent and save low-income drivers $460 per year.[113]



Source: U.S. Department of Transportation

FEDERAL ACTIONS AND INITIATIVES

Reconnecting Communities and Neighborhoods (RCN) Grant Program. USDOT's RCN Grant Program places emphasis on addressing equity and environmental justice, particularly through anti-displacement strategies, including zoning reform. Nearly $2 billion in funding is available through grants for capital construction, community planning, and regional partnerships. The RCN Program also houses the Neighborhood Access and Equity Grant Program, which targets transportation infrastructure that divides or burdens low-income and underserved communities, to provide funding for removing, retrofitting, or mitigating existing facilities. Additionally, this program encourages applicants to propose projects that address regional challenges holistically, which can include land use, zoning, and transportation issues, instead of focusing on a single site. For example, a regional project can include expanding transit and trail networks, facilitating transit-oriented development, addressing transit gaps, and other strategies that can increase access to jobs, housing, and transportation in a region.

State of Good Repair Grants Program. This FTA grant program provides funding to transit agencies for capital projects to maintain their assets in a state of good repair. The funds can be used to replace, rebuild, maintain, and rehabilitate assets to ensure existing transit systems are working at their full operational capacity.

Congestion Mitigation and Air Quality (CMAQ) Improvement Program. CMAQ provides funding for a wide range of projects and programs that aim to reduce congestion and improve air quality. CMAQ funding can be used towards improvements to existing transit systems, such as replacing or retrofitting transit vehicles and operations assistance. Other eligible projects include TDM, active transportation infrastructure, and intermodal freight facilities.

Federal-State Partnership for Intercity Passenger Rail Grant Program. This Federal Railroad Administration (FRA) program funds capital projects that reduce state of good repair backlog and/or improve performance of intercity passenger rail service, including high-speed rail services. Funds can also be used for expanding or establishing new intercity or high-speed passenger rail services.

Congestion Relief Program. This FHWA program, established under BIL, provides competitive grant funding for programs that reduce congestion through pricing roadway use and parking, as well as other methods of decreasing congestion. Pricing roadway use and parking can encourage the use of other modes of travel that pollute less and take up less road space, while recapturing some of the value associated with maintenance and construction required for road use.

Asset management and investment prioritization. FTA's Transit Asset Management rule (49 CFR 625) requires public transit providers that

receive federal funding to develop Transit Asset Management Plans, while 23 CFR 515 requires state DOTs (as well as Washington, D.C. and Puerto Rico) to develop Transportation Asset Management Plans. These plans involve assessing the conditions of capital assets, identifying risks, and informing decision-making to maintain a state of good repair. These plans can serve as a framework to prioritize investments towards existing, critical assets.

NEXT STEPS AND OPPORTUNITIES

Strengthen requirements to consider alternatives to capacity expansion. Current federal regulations (23 CFR 450.322) require MPOs in large metropolitan areas to address congestion through a range of strategies. This requirement could be expanded to spur MPOs to consider alternative congestion management strategies.

Develop local congestion pricing initiatives. Title 23 of the U.S. Code includes a general prohibition on the imposition of tolls on federal-aid highways. Currently, there are few exceptions and limited tolling pilot programs.[114] Expanding exceptions would allow flexibility for state and local governments to design and deploy innovative pricing strategies to reduce congestion and encourage the use of public transportation. Such strategies could also raise revenue for transportation investments, including new and expanded transit service on tolled corridors. Congestion pricing can also take into account the higher costs in terms of congestion and emissions produced by freight movement and can encourage more efficient operations by incentivizing consolidated truckloads and off-hour deliveries.

Provide more guidance and research on demand elasticity. BIL Section 11205 requires USDOT to produce guidance to support more accurate travel demand modelling and to develop a web-based tool to enable states and MPOs to evaluate highway and public transportation investments.[115] It is critical to ensure that travel demand models are accurate, transparent, and easy to use. They must also consider the historical accuracy of projections when selecting transportation projects. Travel demand models should be capable of performing comprehensive analysis that includes factors such as induced vehicle travel, redistributed growth, regional effects, and long-term impacts of projects; this helps compare between build and no-build scenarios more effectively. This will help to support a selection process that maximizes benefits to communities and supply chains in the long-term and prevents overestimation of the benefits of highway expansion projects.[116]

STATE, LOCAL, AND INDUSTRY EXAMPLES

Colorado: GHG Reduction Planning. SB 260, the Colorado Greenhouse Gas Pollution Reduction Planning Rule, established emission reduction goals for Colorado DOT (CDOT) and MPOs in the state and requires CDOT and MPOs to develop a plan to meet the goals. CDOT and MPOs must also be able to demonstrate that proposed investments or projects will contribute to meeting these emission reduction goals. If not, the agency must add more mitigation measures, which can restrict the manner in which they use state funds. These requirements incentivize agencies to consider alternatives to expanding highway capacity and to re-evaluate the emissions impact of their decisions. For example, SB 260 has been credited with giving the City of Denver flexibility to achieve traffic reduction by allocating funds towards bus rapid transit projects, instead of the continued expansion of I-25.[117] It is expected that SB 260 will reduce Colorado's total VMT by 6-9 percent in 2030.[118]

California: Induced Demand Calculator. The National Center for Sustainable Transportation (NCST) developed the California Induced Travel Calculator, which allows users to estimate induced VMT from highway capacity expansion projects. Induced VMT is often not accurately predicted when evaluating transportation projects, so this calculator offers a simple way to estimate induced VMT for a more

complete understanding of the impacts on travel demand. This helps to accurately analyze whether the congestion benefits of a project might be outweighed by the potential induced VMT in order to select projects that will have high decarbonization potential. The tool is best suited to urban and suburban contexts as the application of the calculator in rural projects found that the tool overestimated rural VMT growth.[119] This further demonstrates the need to research demand elasticity.

Lee County, Florida: Bridges Variable Pricing. Lee County, Florida, which includes the Fort Myers and Cape Coral metropolitan areas, has used variable bridge tolls to manage congestion since 1998. The objectives of the program are to provide travelers with an incentive to travel during non-peak periods, lower out-of-pocket transportation costs, and encourage the use of electronic tolling. Tolls are charged at three bridge points: a midpoint plaza, Cape Coral Plaza, and Sanibel Island Plaza. The tolling program includes significant discounts for traveling during off-peak hours and using electronic transponders.

ACTION AGENDA

The following represent a selection of the most promising opportunities for reducing emissions through fiscally responsible infrastructure investments. The table below summarizes these actions and associated lead sectors.

Research	• Study the impact of public transit, active transportation, and highway expansion projects on travel demand by mode and emissions impacts.
Local and Regional Governments	• Pilot congestion pricing programs in high congestion areas with robust public transit options.
Federal Government	• Strengthen requirements to consider alternatives to capacity expansion through federal planning rule and environmental guidance.

3.5 Goods Movement Management

Land-use planning and design can have significant implications for freight and goods movement, particularly on the number of miles traveled throughout the supply chain. Approximately 73 percent of freight shipments in the United States are carried by truck.[120] While other modes can offer comparative advantages for shipping certain types of goods and certain types of trips, the American economy will continue to rely on trucks for the foreseeable future, with trucking demand predicted to increase by 35 percent by 2040.[121] Increasing the capacity of more efficient freight modes is covered in the Efficiency Action Plan.

The location of warehouses and distribution centers has a significant impact on VMT for goods movement. Incorporating goods movement into land-use planning can reduce emissions by supporting strategic siting. Communities living near warehouses are disproportionately exposed to air pollution, due to the higher volumes of freight trucks. The total number of trucks on the road or truck miles can also be abated through advanced planning and logistics strategies, such as eliminating deadhead mileage. Most freight and goods movement is carried out by the private sector, which has strong incentives to reduce unnecessary travel and delays that contribute to higher operating costs and higher emissions.

Population centers are responsible for the majority of freight demand, as both consumers and producers are concentrated there. At the regional level, major freight distribution centers have increasingly located on the urban periphery as the cost of land has increased in the urban core. Maintaining industrial and commercial sites in locations closer to customers would reduce VMT.[122] However, it is important that freight operators in these locations take measures to mitigate air pollution impacts, such as switching to zero-emission vehicles and optimizing deliveries so that fewer trips are needed.

Curb management is an increasingly important task that can contribute to VMT reductions from freight in urban, suburban, and downtown rural core contexts. Curb space has historically been dedicated to accommodating freight vehicles for parking and loading. Although goods movement still relies predominantly on medium- and heavy-duty vehicles, it has diversified to include food delivery couriers, e-bikes, and other micromobility modes for last mile deliveries. These services, as well as passenger ridehail and shared micromobility services, have increased demand for curb space and highlighted the need for improved curbside management to accommodate all types and modes of freight and passenger vehicles. Curbside demand management, including dedicated freight/commercial zones, can help reduce the amount of time freight vehicles search for adequate parking to make deliveries.[123] Designated freight parking can also increase roadway safety by preventing trucks from double parking and unloading illegally in the street, where they may pose a hazard for people walking and biking.

Additionally, extending delivery hours in commercial areas to allow off-peak deliveries can ease freight congestion, reduce truck idling, and lead to faster deliveries. By allowing off-peak deliveries, freight trucks will be more likely to find parking close to the delivery point and avoid idling while waiting for a facility to open.[124] Accommodating micromobility devices for delivering goods curbside and providing charging infrastructure is another way to reduce curb congestion. For any curbside management strategies, enforcement will be a key component to ensure effective implementation.

Delivery lockers or conveniently located access point locations may also reduce curb congestion and respond to an increase in demand for deliveries. Firms can use delivery lockers to consolidate shipments for multiple households, reducing delivery costs and trips. At the same time, customers can pick up their package at

their convenience at a secure location close to their home or other easily accessible locations. Delivery lockers as a decarbonization strategy is highly context-dependent.[125] For suburban and rural areas where the distance to the lockers may be greater, VMT of the households to reach the lockers must be considered to properly evaluate the emission reduction potential of this strategy.

FEDERAL ACTIONS AND INITIATIVES

Funding zero emissions delivery research. USDOT supports two University Transportation Centers focused on advancing research and innovation related to freight and goods movement: the Freight Mobility Research Institute at Florida Atlantic University and the Center for Freight Transportation for Efficient & Resilient Supply Chain at the University of Tennessee, Knoxville. The Joint Office of Energy and Transportation also awarded funding to the Los Angeles Cleantech Incubator to develop innovative, community-centered, zero-emission delivery strategies. This project aims to also develop a Zero Emission Delivery Business and Policy Model Platform that can be adapted by communities across the country for wider adoption of lower-emission freight strategies.

Office of Multimodal Freight Infrastructure and Policy. USDOT established the Office of Multimodal Freight Infrastructure and Policy in 2023 to oversee national multimodal freight policy and programs and to support state and local freight mobility and supply chain management efforts. The office leads research on how to improve multimodal freight mobility, facilitates engagement between the private and public sectors on freight issues, and supports state, regional, and local governments in building freight and supply chain expertise.

Technical assistance. FHWA developed a Primer for Improved Urban Freight Mobility and Delivery for public and private entities seeking to improve freight movement in urban areas. The Primer provides best practices in freight operations, logistics, and technology for a comprehensive approach to urban freight planning. FHWA is updating the Freight and Land Use Handbook, which was originally published in 2012. The Handbook provides guidance for state, regional, and local governments to better coordinate land use and freight planning efforts including best practices, case studies, tools, and resources. The update is expected to be complete in 2025.

Unmanned Aerial System (UAS) for goods movement. The Federal Aviation Administration (FAA) has developed regulations and guidance for using UAS to transport goods. To explore feasibility of integrating UAS into the national airspace, FAA developed the Unmanned Aircraft System (UAS) Integration Pilot Program (IPP) and the BEYOND program to test and evaluate projects related to UAS integration. Several of the funded projects focused on using UAS for goods movement, which may have the potential to reduce VMT.

NEXT STEPS AND OPPORTUNITIES

Provide funding, resources, and technical assistance to support strategic warehouse and distribution center siting. Federal agencies could fund strategic warehouse and distribution center planning and siting, as well as emissions analysis. Agencies could develop resources and provide technical assistance to help public and private stakeholders coordinate for strategic siting of warehouses and distribution centers that optimize both operations and convenient transportation. Local government could develop special permits for warehouse and distribution facilities based on criteria related to impacts on emissions, such as trip generation, congestion impacts, and proximity to access roads.[126]

Promote efforts to reduce freight-related emissions through planning. States are required to develop State Freight Plans in order to obligate National Highway Freight Program formula funding. States could coordinate the development of their State Freight Plans with their Carbon Reduction Strategies prepared pursuant 23 U.S.C. 175. States that are required to develop state implementation plans to attain or maintain national ambient air quality standards could coordinate the development of those plans with the State Freight Plans. This would encourage alignment across all of these plans toward reducing emissions of GHGs and other pollutants. For example, Freight Plans could specifically address the emissions-related impacts of increased last mile deliveries.

Implement green loading zones and micromobility freight delivery. State and local governments could establish green loading zones or zero emissions delivery zones to incentivize the adoption of cargo e-bike and light- to medium-duty EV deliveries. Local governments could also better accommodate micromobility freight delivery by adding bike lanes or bike parking in urban and downtown rural corridor contexts.

Encourage adoption of designated delivery lockers and access point locations. E-commerce has led to a shift in shipment patterns, making last mile deliveries more complex due to an increase in residential deliveries. Residential areas may not be designed for frequent freight vehicle trips. With the growing frequency of curbside deliveries, the designation of delivery locker locations or other access points for pickups offers a potential solution for last-mile deliveries, particularly for dense, urban areas.

STATE, LOCAL, AND INDUSTRY EXAMPLES

FedEx: Network 2.0. In 2023, FedEx announced a new long-term strategy called Network 2.0 to consolidate and streamline their operations. This effort will include consolidating collection points and removing redundant routes to improve operations, which is expected to result in fewer miles travelled for both drop-offs and deliveries.

New York, NY: LockerNYC. The New York City Department of Transportation announced LockerNYC, a pilot program to install delivery lockers throughout the city. The effort is aimed at providing secure package deliveries while reducing last-mile emissions. The pilot program will be available across multiple private delivery carriers who are interested in participating.

Delivery lockers can provide a centralized location to receive or send packages.

Washington State: 2022 Freight System Plan. Washington has experienced a 60 percent growth in transportation emissions from 2010 to 2018. To address the growth, the state plans to implement and support a multimodal freight system to increase efficiency, meet economic demands, and reduce impacts on the environment. The State Freight System Plan emphasizes the increasing demand for distribution centers outside urban centers and air cargo facilities, and the potential of micro-distribution centers to respond to demand.

New Jersey: 2023 Statewide Freight Plan. The New Jersey Statewide Freight Plan includes supporting additive and distributed manufacturing such as 3D-printing location networks—alongside changes in warehouse and factory siting and modal shift. The plan aims to promote distributed manufacturing, leading to small factories in many local markets instead of large plants in limited locations. If realized at scale, this plan has the ability to reduce total freight miles traveled, leading to reduced emissions.

University of Washington: Urban Freight Lab. The Urban Freight Lab is a research lab dedicated to a wide array of topics related to urban freight. The Lab engages with the academic, private, and public sectors to gain a comprehensive perspective on research topics. In addition to research publications and development of tools and guidance, the Lab also supports implementation of projects to test ideas and theories.

San Francisco, CA: E-Bike Delivery Pilot. With funding from DOE's Vehicle Technologies Office, the San Francisco Environment Department carried out a pilot program in collaboration with app-based food delivery companies to shift deliveries from vehicles to e-bikes. The pilot will gather data to better understand impacts on delivery efficiency, safety, worker income, congestion, and emissions.

Dublin, OH: Curbside Management Efforts. The City of Dublin is partnering with Automotus, a curb management company, to collect data on downtown curb activity. The data will be used to inform curb management policies that improve traffic flow, reduce emissions, and better accommodate bicyclists and pedestrians.

Florida: Regional Rural Transportation Plan. Florida DOT's Regional Rural Transportation Plan directs transportation planning organizations to consider connectivity of freight systems between urban and rural areas. Other considerations include first and last mile links and impacts from current and future land use. Ensuring that freight planning occurs in coordination with urban and rural areas will allow for better integrated freight systems.

ACTION AGENDA

The following represent a selection of the most promising opportunities for reducing emissions through goods movement management. The table below summarizes these actions and associated lead sectors.

Private Sector	• Pilot alternative delivery programs such as delivery lockers, access point locations, and off-peak delivery. • Consider convenient land use in distribution in warehousing and manufacturing center siting.
Tribal, Local, and Regional Governments	• Implement green loading zones or zero-emission delivery zones. • Pursue zoning and land-use policies to incentivize location-efficient development for freight warehousing and distribution facilities.
State Governments	• Promote efforts to reduce freight-related emissions through planning aligned with the federal Zero Emission Freight Strategy and National Multimodal Freight Network.

3.6 Data, Tools, Research, and Technology

Data, tools, research, and technology play a critical supporting role in creating convenient transportation systems. Together, they can help us understand the GHG emissions impacts of land use and transportation investments and evaluate how new and emerging technologies can reduce trip distances and associated GHG emissions.

Further, transportation modeling tools can guide transportation and land use decisions by allowing decision-makers to predict potential impacts of decisions on emissions and make informed decisions. These resources enable users to input transportation and other relevant factors to help guide planning processes, transportation investments, and policy decisions. Analytical tools can quantify projected impacts from transportation and land use decisions, including emissions and energy use, which can help decision-makers maximize both decarbonization potential and accessibility of low-carbon transportation options.

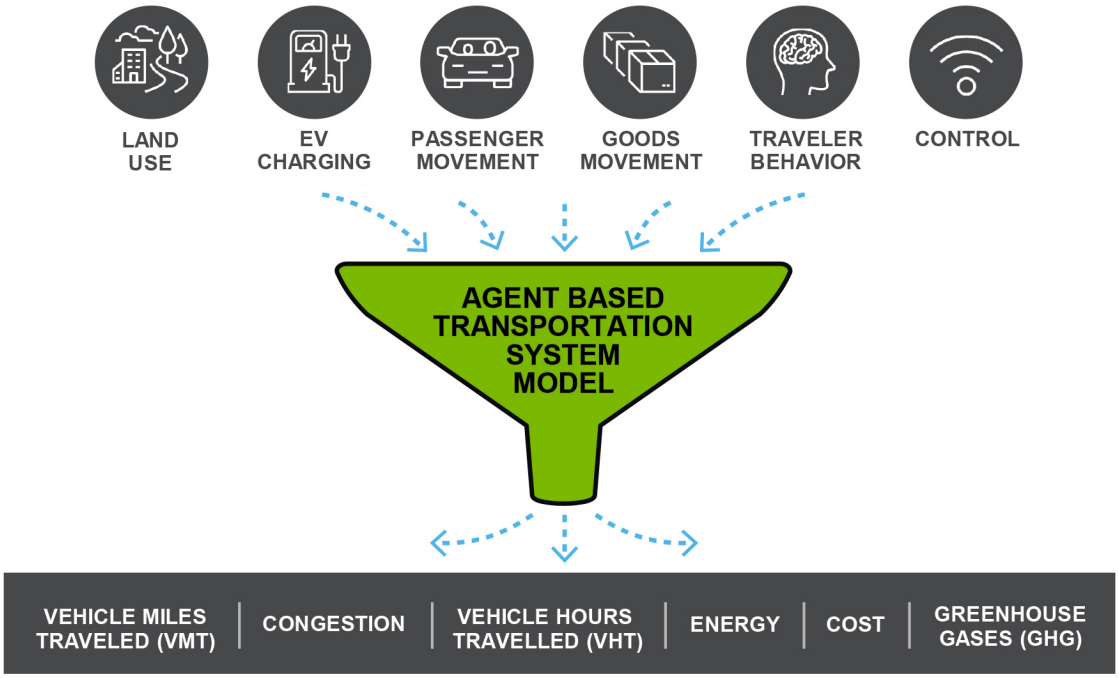
Research and technology advancements can be leveraged to support decarbonization goals. Emerging trends in digitalization and connectivity can be utilized for digital tools that aggregate information to directly support a more convenient transportation system. When deployed strategically, other technological advances, including integrated systems-of-systems across modes, data science, artificial intelligence, system architecture, and. digital infrastructure could be leveraged to encourage shorter trips and increase the opportunity and incentives for people to walk, bike, and take transit. Examples of multi-modal technology transfer applications that could significantly contribute to increasing convenience include:

- Mode-agnostic mobility wallets, which can support multimodal trips to get people where they need to go without the need to own or operate a car, through seamless trip planning and payment capabilities.
- Open loop payment systems, which allow transit payment through tap-and-pay debit/credit card technology and smart phones, reducing the need for fare vending machines and improving ease of access to transit.

- Dynamic use of curb space enabled by open data standards for freight deliveries, passenger pick-up and drop-off, transit, and parking.
- Micro-charging stations for e-bikes and e-scooters to improve usability and reliability. This can be paired with other EV charging infrastructure.
- Adaptable smart infrastructure to facilitate on-demand conversion of right-of-way for pedestrians and cyclists and after-school play zones. This may include streets and lanes that can be modified to accommodate active transportation modes and other shared street uses depending on the time of day and traffic patterns through adaptive, smart signaling.

Further research and analysis can help us better understand the potential for emerging trends to contribute to GHG reduction strategies for land use and transportation. For example, e-commerce, telework, and automation are emerging areas that could, under some conditions, contribute to decarbonization pathways, but additional research is needed to understand the GHG emissions consequences of these mobility trends.

- **E-commerce:** Research and results are mixed on e-commerce as a component of transportation decarbonization. A DOE study found that on-demand delivery and changes in e-commerce patterns can reduce overall demand for light-duty vehicles and lower energy consumption. At the same time, increasing access to technology boosted the demand for online purchases of goods and accelerated the move towards on-demand delivery (ODD) of prepared meals and groceries. In this analysis e-commerce generated an increase in parcel truck delivery trips, so the net effect of e-commerce is a reduction in VMT and fuel consumption due to shopping trip reductions. In contrast, ODD operations could lead to a significant increase in operational VMT. Although substitutionary trips come from exchanging a percentage of driving activities for ODD operations, a significant source of emissions from delivery operations is empty miles, while the driver is repositioning or idling. The varied results from existing research demonstrate the need for further research to understand the GHG impacts associated with e-commerce trends.
- **Telework:** DOE analysis shows that telework has not led to the decarbonization benefits expected from eliminating commutes. When 60 percent of all work events are through telecommuting (similar to levels observed during the COVID-19 lockdown), transportation energy consumption is reduced, but in the long run, there is a shift in where people live and work. People move away from urban core and central business district areas and rural populations increase. A recent survey of small- and mid-sized businesses found that the average distance households live from their employer has been consistently increasing since the onset of the COVID-19 pandemic, from 10 miles prior to March 2020 to over 25 miles as of December 2023. The increase was larger for workers with higher salaries, and for employees that were hired after March 2020.[127] It is not clear how much of this increase is due to employees moving their home location further from urban areas where employers are concentrated, or to employees applying for fully remote jobs at companies based further away from where they live. And while commuting is significantly reduced, there is an increase in discretionary travel, such as dining out, running errands, shopping, and social activities.
- **Vehicle Automation:** Automated driving systems are still developing and their impacts on convenience in the long term are highly uncertain. Depending on vehicle platform, business models, and use cases, there is the potential for changes to land use if the technology were adopted at a broad scale. The exact impacts of these strategies



are difficult to determine and are contingent on how they are implemented and whether they are complemented by other decarbonization strategies. For example, e-commerce deliveries could be conducted with ZEV, including e-bikes in urban areas and downtown rural cores, to lead to emissions reductions. Further research and demonstration programs are needed.

FEDERAL ACTIONS AND INITIATIVES

Investments in research and technology transfer. USDOT's Climate Change Center advances research and technology at USDOT and through partners to substantially reduce transportation-related GHG emissions and pollution while building more resilient and sustainable transportation systems to benefit and protect communities. The University Transportation Centers Program provides grant funding to advance technology and innovation in transportation research while providing educational opportunities and fostering knowledge transfers, including several national transportation research centers focused on climate and environmental research. USDOT's Advanced Research Projects Agency – Infrastructure (ARPA-I) funds high-risk, high-reward next-generation technologies to build a future where our transportation systems are safe, secure, efficient, and resilient while achieving net-zero emissions and increasing equity and access for all. The USDOT Technology Transfer Program has a vision to advance the economic, transportation, and national security interests of the nation through partnerships with diverse innovators to accelerate the commercialization and deployment of beneficial transportation technologies.

Tools and resources for estimating emissions. FHWA's Congestion Mitigation and Air Quality Emissions Calculator Toolkit consists of a series of tools that public and private stakeholders can use to estimate emissions from their projects. Tools are available for a wide range of project types. FTA's Transit Greenhouse Gas Emissions Estimator allows users to estimate the partial life-cycle emissions of a transit project from the construction, operation, and maintenance phases. FHWA's Infrastructure Carbon Estimator

provides estimates of life-cycle emissions from the construction and maintenance of transportation infrastructure, which can be used to inform planning and design processes as well as project prioritization. DOE's Argonne National Laboratory developed the Greenhouse gases, Regulated Emissions, and Energy use in Technologies (R&D GREET) model, which can conduct life cycle analyses of transportation and energy systems to estimate environmental and emission impacts. EPA's Travel Efficiency Assessment Method (TEAM) provides a framework for transportation planners to estimate potential future emission reductions of strategies aimed at reducing travel activity. EPA's Smart Location Calculator estimates the efficiency of a workplace location relative to where people live. FHWA's Energy Emissions Reduction and Policy Analysis Tool (EERPAT) analyzes various GHG reduction scenarios from the transportation sector at the state level.

Simulation and modeling tools. DOE's NREL has developed several tools that allow users to estimate and evaluate the impacts of transportation and land use decisions on emissions and energy use to support data-driven decision-making and maximize the potential for equity-focused emissions reductions. Open Platform for Agile Trip Heuristics (OpenPATH) is NREL's open-source application that allows communities and their residents to track their mode of transportation and measure the associated emissions and energy use. OpenPATH generates a comprehensive travel diary, including walking and bicycling/micromobility along with interactions with other travel modes. Transportation Energy & Mobility Pathway Options Model (TEMPO) is a comprehensive travel demand model that can develop long-term scenarios to evaluate energy use, emissions, and impact on energy supply/systems at a national scale. The Mobility Energy Productivity (MEP) metric evaluates the ability of a transportation system to connect individuals to goods, services, employment opportunities, and others while accounting for time, cost, and energy. MEP includes Level of Traffic Stress (LTS) as an additional quantitative parameter impacting walking, biking, and micromobility access.

POLARIS Transportation System Simulation Tool. DOE's Argonne National Laboratory developed this a high-fidelity, high-performance, agent-based simulation platform for modeling regional-scale and larger transportation systems. POLARIS can be used to simultaneously model all aspects of travel decisions through a network-demand model. POLARIS can be coupled with UrbanSim, a land use model, so that transportation technology or policy changes in POLARIS affect land use over time in UrbanSim and vice-versa. This tool can be used to understand the impacts of transportation decisions on congestion, accessibility, cost, emissions, energy, and environmental justice, which can help inform land-use planning.

Behavior, Energy, Autonomy, and Mobility Comprehensive Regional Evaluator (BEAM CORE). DOE's Lawrence Berkeley National Laboratory (LBNL), in collaboration with researchers from DOE's NREL, developed this open-source, integrative modeling tool that can capture and analyze a wide set of transportation system components. The tool produces various metrics, such as aggregate vehicle and person miles traveled, congestion, energy consumption, and accessibility, for insight into the interconnected impacts between transportation and policy decisions. Through integration with UrbanSim, BEAM CORE can analyze how transportation policies and changes impact land use. The model can also examine how land use decisions impact transportation. The Application and Collaboration Tool (ACT) online dashboard allows stakeholders to visually compare results from different assumptions and scenarios generated using the BEAM CORE system.

Location Affordability Index (LAI). HUD and DOT created the LAI in 2015 to increase public access to data about transportation, housing, and land use. The LAI provides a combined

index of household transportation and housing expenditures, taking into account proximity to transit, car ownership, access to amenities and services, and other factors.

VisionEval. FHWA developed this scenario planning tool to evaluate and compare the impacts of multiple scenarios under different assumptions and inputs. The tool allows for a comprehensive analysis that can inform decision making.

NEXT STEPS AND OPPORTUNITIES

Support research and technology transfer activities. It is important to ensure that new and emerging trends in transportation, such as connectivity, digitization, automation, and other advancements, are deployed in ways that support and do not counteract decarbonization goals. Research and technology transfer efforts can help ensure that these trends are deployed in ways that maximize emissions reduction potential and minimize other risks.

Provide technical assistance on use of resources for modeling VMT and GHG emissions. Federal agencies can encourage decarbonization-focused policies and decision-making by providing training and educational resources for both public and private stakeholders to understand and effectively use these tools. Currently, there are a number of VMT and GHG emission models, all with varying levels of detail and ease of use. USDOT could strategize around how to leverage the tools and models available and develop guidance for stakeholders to quantify emissions and VMT through a range of scenarios and strategies using the model best suited for their needs and priorities. This would enable stakeholders to prioritize decisions and projects based on the emission reduction potential.

Support further modelling efforts. DOE has recently started a new project, National Impacts of Community-Level Strategies to Decarbonize and Improve Convenience of Mobility, to improve mobility convenience to advance decarbonization. To do this, the project must extend high-fidelity, regional scale modeling to the national scale and explore how differing local strategies and investments can contribute to meeting national decarbonization objectives.

Integrate transportation system models with building and power sector models. It is important to understand how strategies in the action plans affect carbon emissions in other sectors. USDOT can coordinate with other federal agencies to identify opportunities to jointly pursue decarbonization strategies related to land use and transportation and de-silo modelling processes.

Incorporate recommendations and research from technical stakeholders. The Mobile Sources Technical Review Subcommittee (MSTRS) provides the EPA with independent advice, counsel, and recommendations related to mobile source air pollution and fuels. In 2021, MSTRS developed the Future of Mobility Report[128] with recommendations for EPA to better study mobility trends and leverage those trends to further decarbonization efforts across transportation. The MSTRS recommendations will heavily influence EPA's work for years to come. EPA will also continue to evaluate how and where to include data for emerging trends in agency models, such as the Motor Vehicle Emissions Simulator (MOVES) model.

STATE, LOCAL, AND INDUSTRY EXAMPLES

RMI's E-Bike Environment and Economics Impact Assessment Calculator for Cities. This tool can estimate the potential emissions and VMT reductions from shifting to e-bikes and e-bike incentive programs at the local level. This tool can

be used to support e-bike initiatives and provides a user-friendly method to quantify the benefits.

Minnesota: Rural Transit App. Minnesota DOT launched a pilot to add multimodal trip planning to TransitApp, a popular mobile application for route and trip planning. The enhanced functionality for rural use aims to provide seamless trip planning for rural residents, through digital ticketing and payment services and information on travel/route options. This pilot will be used to better understand rural ridership and to inform future public transit investments.

ACTION AGENDA

The following represent a selection of the most promising opportunities for reducing emissions through research. The table below summarizes these actions and associated lead sectors.

Private Sector	• Support research and technology transfer and commercialization activities to advance the role of new and emerging technologies to meet decarbonization goals.
Academia	• Support demand management modelling efforts.
Public Sector	• Provide technical assistance on use of resources for modeling VMT and GHG emissions.

3.7 Cross-Cutting Strategies

The Convenience strategy requires a whole-of-government approach to transportation decarbonization. The greatest possible emissions reductions from land use and system design will be realized by stacking actions together. At the same time, convenient transportation primarily lies in the jurisdiction of local decision-makers, and success depends on best practices developed at that level. This action plan seeks to acknowledge and lift up that local work and recognize the whole-of-nation orientation needed to achieve transformative change. Much of a convenient national transportation system hinges on intersectional and system-wide collaboration. While these decisions are often made at the local level, there is a role for federal agencies to support local governments in their efforts to make travel more convenient in urban, suburban, and rural contexts. Accordingly, these cross-cutting strategies are critical to the paradigm shift towards an accessible and decarbonized transportation system.

FEDERAL ACTIONS AND INITIATIVES

Carbon Reduction Program (CRP). This FHWA formula program provides funding to states for projects that reduce transportation emissions from on-road highway sources. This can include a wide range of projects, including micromobility and active transportation programs.

Every Day Counts (EDC) initiative. FHWA's EDC initiative deploys proven but underutilized innovations that make transportation adaptable, sustainable, equitable, and safer for all. In the seventh round of the program, FHWA funded the integration of GHG assessment and reduction targets into transportation planning. This not only includes tailpipe emissions but may also include life-cycle emissions associated with vehicle manufacturing, associated infrastructure, disposal, and other sources.

Coordination. This action plan itself, as both a follow-on document to the interagency U.S. National Blueprint for Transportation Decarbonization and as a product of dozens of stakeholder engagement calls and deep research into local action, is a product of whole-of-government and cross-silo coordination. Implementing the vision of a convenient, nationwide transportation sector continues to require deep coordination led by decision-makers at all levels of government.

NEXT STEPS AND OPPORTUNITIES

GHG Reduction Dashboard. USDOT could establish annualized emissions reduction targets to meet 2030 and 2050 transportation sector climate goals. USDOT could coordinate with DOE and EPA on projections for emissions reductions to identify gaps between sectoral reductions and climate goals on an annual basis and release those findings on a publicly available dashboard.

4. CONCLUSION

The U.S. National Blueprint for Transportation Decarbonization is the product of a unique cross-agency partnership unprecedented in its size and charter. The Department of Transportation, Department of Energy, Department of Housing and Urban Development, and the Environmental Protection Agency jointly undertook the project of developing the Blueprint and the strategy-specific and mode-specific action plans that followed. The goals of these plans are two-fold: align four federal government agencies towards the shared goal of transportation decarbonization, across jurisdictions and areas of expertise, and produce a national vision of the work to be done across all jurisdictions to meet our national climate action commitments.

The Blueprint outlines three central strategies for transportation decarbonization by 2050: transforming the national transportation system into one that is **convenient, efficient,** and **clean.** These three strategies must work in synergy to maximize the transportation system's decarbonization potential. Decarbonizing our transportation system will require addressing the growth in vehicle miles traveled, supporting low carbon intensity modes and mobility choice, and adopting zero-emission fuels. At its core, the **Convenience** strategy puts forth a vision, resources, and best practices for stakeholders to utilize in creating a transportation system that puts people first. This plan aims to make travel easier by reducing commuter burden, improving the quality of transportation, and improving the attractiveness and ease of use of multiple modes, including active modes. Reducing the distances between destinations through more thoughtful land-use planning is an important strategy to make travel more convenient for people and goods. Specific objectives within the Convenience strategy vary by a location's population density. Carrying out these actions yields multiple co-benefits alongside the Efficiency and Clean strategies, including cost savings, economic growth, air quality and health improvements, and greater accessibility and community opportunities.

Many of the actions included in this Convenience plan are in the purview of state, local, and Tribal governments and the private sector. Federal agencies can provide support to all levels of government and the private sector by providing funding and providing the data and tools necessary for them to track their progress toward the general objectives of the Convenience plan. The table below summarizes the actions outlined in this document and key metrics that can be used to evaluate progress. While some of these metrics can be aggregated to track progress at the national level, others are more appropriate for local communities to consider.

Actions	Key Metrics
• Enhance safe and accessible active transportation infrastructure. • Provide incentives to encourage active transportation.	• Active transportation trip share. • Miles of bike lanes and shared use paths. • Number of bikeshare and E-scooter Systems. • Active transportation incentives (e-bike rebates, tax incentives, etc.) and number of programs funded. • Pedestrian injury and fatality rates.

Actions	Key Metrics
• Encourage TOD projects. • Support zoning reform that increases convenience. • Improve coordination between transportation and housing planning.	• Number of TOD projects funded. • Percentage of residents living near transit services. • Number of jobs accessible without a car. • Guidance resources, events, and funding available for zoning reforms that increase convenience (increased density, allowing mixed-used developments, etc.). • USDOT-HUD joint activities and programs.
• Encourage curbside management practices that support convenience. • Reduce the amount of required parking constructed. • Provide incentives for using lower emission transportation modes for commuting.	• Increase the number of resources and funding for curbside management projects. • Increase funding allocated for active transportation and transit commuter benefits for employees. • Guidance resources to support ordinances that address over-supply of parking (eliminating parking minimums, parking pricing schemes, etc.).
• Promote or incentivize exploring other alternative strategies before highway capacity expansion. • Improve or retrofit existing infrastructure to support active or public transportation.	• Guidance, resources, and technical assistance to encourage consideration of induced demand for projects. • Increase the number of projects implementing congestion pricing. • Increase the percentage of transit systems in state of good repair. • Increase the percentage of the nation's highways and bridges that are in a state of good repair.
• Encourage freight and goods movement planning and practices that reduce emissions. • Continue to support innovative strategies for addressing emissions from goods movement.	• Increase the number of state freight plans that consider emission reduction strategies. • Increase the amount of resources and funding available for innovative goods movement.
• Continue to support research and technology transfer activities. • Provide guidance on how to effectively use data, models, and tools for modeling VMT and GHG emissions.	• Increase the number of research and technology transfer events and opportunities. • Guidance resources, webinars, and trainings developed.

The Blueprint was produced not only in recognition of the imperative to decarbonize the Nation's highest-emitting sector, but also to support implementation of the once-in-a-generation Bipartisan Infrastructure Law. As of March 2024, roughly $300 billion in transportation infrastructure funding has been announced, with approximately 40,000 projects across 4,500 communities in all 50 states, Washington, D.C., U.S. territories, and Tribal lands. All across the country, funding has hit the streets and shovels are in the ground. This landmark effort to revitalize the nation's infrastructure has hit its stride. Now local, regional, Tribal, and state decision-makers, as well as the private and non-profit sectors, are taking up the charge. This document is intended to support these actors in the implementation of strategies that create a decarbonized national transportation system.

APPENDIX: SUMMARY OF ACTIONS

The table below summarizes the key actions contained in this Convenience Action Plan. These actions include continuing to implement and expand the federal government actions and initiatives currently underway, as well as realizing opportunities across all levels of government and the private sector. The table also includes key metrics to track and measure progress towards these goals.

Topic Area	Action	Lead	Key Metrics
Active Transportation	Support public-private partnership bike share programs.	Private sector	• Increase the percentage of active transportation trip share. • Increase the number of miles of bike lanes and shared use paths. • Increase the number of bikeshare and E-scooter Systems. • Increase the amount allocated for active ctive transportation incentives (e-bike rebates, tax incentives etc.) and programs funded. • Reduce the pedestrian injury and fatality rates.
	Incentivize employees to bike and walk to work.	Private sector	
	Leverage the metropolitan and statewide planning process to close gaps in active transportation networks.	State and local	
	Create a per-mile reimbursement rate for biking mileage with the Internal Revenue Service.	Federal (IRS)	
	Develop functional classification systems to support context-sensitive planning.	Federal (USDOT)	
Transit Oriented Development	Support public-private partnerships for transit and rail that increase land value for local business and development.	Private sector	• Increase the number of TOD projects funded. • Increase the percentage of residents living near transit services.
	Leverage USDOT financing programs (TIFIA and RRIF) to fund new development near transit.	State and local	
	Provide robust technical assistance for federal financing programs (TIFIA and RRIF) to enable housing and affordable housing development.	Federal (USDOT)	
Zoning Reform	Support public-private partnerships for rural downtown revitalization, suburban retrofits, and other walkable areas to enable foot traffic for local business.	Private sector	• Increase the number of jobs accessible without a car. • Increase the availability of guidance resources, events, and funding available for zoning reforms that increase convenience (increased density, allowing mixed-used developments, etc.).
	Modify state and local land use regulations to support diversified housing options near transit.	Tribal, state, and local	
	Consider local land use factors and smart growth planning in discretionary grants with local government lead applicants.	Federal (USDOT, DOE, EPA, HUD)	

Topic Area	Action	Lead	Key Metrics
Coordinated Transportation Planning	Participate in public engagement processes for land use and transportation long-range plans to support better integration and maximized value capture through increased transit-oriented development, transit, and active transportation options.	Private sector	• Increase the number and extent of USDOT-HUD joint activities and programs.
	Support community decision-making in rural areas by expanding capacity to better enable planning for rural downtown revitalization, rural transit, and active transportation.	Tribal, state, and local	
	Institutionalize coordination between USDOT and HUD through development of a joint program office.	Federal (USDOT, HUD)	
Parking Demand Management	Maintain bike parking and bike access at employment centers.	Private sector	• Increase the resources and funding for curbside management projects. • Increase the amount allocated for commuter benefits for employees. • Increase the availability of guidance resources to support ordinances that address over-supply of parking (eliminating parking minimums, parking pricing schemes, etc.).
	Provide parking cash-out for employees who bike or walk and do not require parking space.	Private sector	
	Reduce or eliminate mandatory minimum numbers of parking spaces for new housing development.	Tribal, state, and local	
	Provide programming and funding for curbside management.	Federal (USDOT)	
Fiscally Responsible Infrastructure Investments	Provide more guidance and research on the impact of public transit, active transportation, and highway expansion projects on travel demand by mode and emissions impacts.	Research	• Increase the availability of guidance, resources, and technical assistance to encourage consideration of induced demand for projects. • Increase the number of projects implementing congestion pricing. • Increase the percentage of transit systems in state of good repair. • Increase the percentage of national highways and bridges in a state of good repair.
	Pilot congestion pricing programs in high congestion areas with robust public transit options.	State and local	
	Strengthen requirements to consider alternatives to capacity expansion through federal planning rule and environmental guidance.	Federal (USDOT)	

Topic Area	Action	Lead	Key Metrics
Goods Movement Management	Pilot alternative delivery programs, like delivery lockers, access point locations, and off-peak delivery.	Private sector	• Increase the number of state freight plans that consider emission reduction strategies. • Increase the availability of resources and funding for innovative goods movement.
	Consider convenient land use in distribution center siting and warehousing.	Private sector	
	Implement green loading zones or zero emissions delivery zones.	Tribal, state, and local	
	Pursue zoning and land-use policies that enable convenient siting of distribution and warehousing.	Tribal, state, and local	
	Promote efforts to reduce freight-related emissions through planning aligned with the federal Zero Emission Freight Strategy and National Multimodal Freight Network.	Tribal, state, and local	
Data, Tools, Research, and Technology	Support research and technology transfer and commercialization activities to advance the role of new and emerging technologies to meet decarbonization goals.	Private sector	• Increase the number of research and technology transfer events and opportunities. • Increase the availability of guidance resources, webinars, trainings, etc., developed.
	Support demand management modelling efforts.	Academia	
	Provide technical assistance on use of resources for modeling VMT and GHG emissions.¬……	Federal (DOE)	

ENDNOTES

1 US EPA Office of Transportation and Air Quality. U.S. Transportation Sector Greenhouse Gas Emissions 1990-2022.EPA 430-R-24-004, US EPA, April 2024, https://www.epa.gov/system/files/documents/2024-04/us-ghg-inventory-2024-main-text_04-18-2024.pdf.

2 Reidmiller, D.R. et al. "Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II", 2017, doi: 10.7930/NCA4.2018.

3 Jay, Alexa K., et al. "Overview: Understanding Risks, Impacts, and Responses." Fifth National Climate Assessment, edited by A.R. Crimmins et al., U.S. Global Change Research Program, 2023, https://doi.org/10.7930/NCA5.2023.CH1.

4 U.S. Census Bureau. *Redefining Urban Areas Following the 2020 Census*. 22 Dec. 2022, https://www.census.gov/newsroom/blogs/random-samplings/2022/12/redefining-urban-areas-following-2020-census.html.

5 Auld, Joshua, et al. Multi-Regional Analysis of Near-Term Smart Mobility Scenarios Using the POLARIS Modeling Workflow. 102nd Annual Meeting of the Transportation Research Board, Washington, D.C.

6 US EPA. Attracting Infill Development in Distressed Communities: 30 Strategies. 13 May 2015, https://www.epa.gov/smartgrowth/attracting-infill-development-distressed-communities-30-strategies

7 Fulton, Lewis, and D. Taylor Reich. Compact Cities Electrified: United States. Institute for Transportation & Development Policy and UC Davis Institute of Transportation Studies, Jan 2024, https://www.itdp.org/wp-content/uploads/2024/01/CCities_USA_Brief-for-Policymakers_Download.pdf

8 Dutzik, Tony, et al. Who Pays for Roads? U.S. PIRG Education Fund, Spring 2015, https://pirg.org/wp-content/uploads/2015/05/Who-Pays-for-Roads-vUS_1.pdf.

9 Smart Growth America. Recent Lessons from the Stimulus: Transportation Funding and Job Creation. Feb 2011, https://smartgrowthamerica.org/wp-content/uploads/2016/08/lessons-from-the-stimulus.pdf

10 U.S. Department of Transportation, Bureau of Transportation Statistics. "Household Spending on Transportation: Average Household Spending". https://data.bts.gov/stories/s/Transportation-Economic-Trends-Transportation-Spen/ida7-k95k/.

11 Liu, Jenny H., and Shi Wei. Understanding Economic and Business Impacts of Street Improvements for Bicycle and Pedestrian Mobility – A Multicity Multiapproach Exploration. NITC-RR-1031/1161, Transportation Research and Education Center (TREC), 2020.

12 Brown, Barbara B., et al. "A Complete Street Intervention Promote Walking to Transit, Non-Transit Walking, and Bicycling: A Quasi-Experimental Demonstration of Increased Use." Journal of Physical Activity & Health, vol. 13, no. 11, Nov. 2016, pp. 1210–19. PubMed Central, https://doi.org/10.1123/jpah.2016-0066.

13 Raifman, Matthew, et al. "Mortality Implications of Increased Active Mobility for a Proposed Regional Transportation Emission Cap-and-Invest Program." Journal of Urban Health : Bulletin of the New York Academy of Medicine, vol. 98, no. 3, June 2021, pp. 315–27. PubMed Central, https://doi.org/10.1007/s11524-020-00510-1

14 American Public Transportation Association. Aging Americans: Stranded Without Options. 2004. Internet Archive, http://archive.org/details/aging_stranded.

15 Williams, Andrew James, et al. Final Report on Loneliness and Transport Systematic Review. University of St Andrews School of Medicine, June 2021.

16 Victoria Transport Policy Institute. "Community Cohesion as a Transport Planning Objective". 6 October 2023. https://www.vtpi.org/cohesion.pdf.

17 U.S. EPA. "Our Built and Natural Environments: A Technical Review of the Interactions Among Land Use, Transportation, and Environmental Quality, Second Edition." June 2013. https://www.epa.gov/sites/default/files/2014-03/documents/our-built-and-natural-environments.pdf

18 Grigoratos, Theodoros, and Giorgio Martini. "Brake Wear Particle Emissions: A Review." Environmental Science and Pollution Research International, vol. 22, no. 4, 2015, pp. 2491–504. PubMed Central, https://doi.org/10.1007/s11356-014-3696-8.

19 Wang, Xiaoliang, et al. "Evidence of Non-Tailpipe Emission Contributions to PM2.5 and PM10 near Southern California Highways." Environmental Pollution, vol. 317, Jan. 2023, p. 120691. ScienceDirect, https://doi.org/10.1016/j.envpol.2022.120691.

20 US EPA Office of Transportation and Air Quality. Near Roadway Air Pollution and Health: Frequently Asked Questions. FAQ, EPA-420-F-14-044, US EPA, Aug. 2014, https://www.epa.gov/sites/default/files/2015-11/documents/420f14044_0.pdf.

21 Jbaily, Abdulrahman, et al. "Air Pollution Exposure Disparities across US Population and Income Groups." Nature, vol. 601, no. 7892, Jan. 2022, pp. 228–33. www.nature.com, https://doi.org/10.1038/s41586-021-04190-y.

22 Zulauf, Nicole, et al. "Indoor Air Pollution in Cars: An Update on Novel Insights." International Journal of Environmental Research and Public Health, vol. 16, no. 13, July 2019, p. 2441. PubMed Central, https://doi.org/10.3390/ijerph16132441.

23 Davis, Sarah, et al. Trails and Resilience: Review of the Role of Trails in Climate Resilience and Emergency Response. Cambridge, MA, FHWA-HEP-23-01, Volpe Center, Feb. 2023. Zotero, https://www.fhwa.dot.gov/environment/recreational_trails/publications/fhwahep23017.pdf.

24 Ciabotti, Jeffrey, et al. Trails as Resilient Infrastructure. FHWA-HEP-24-007, Cambridge Systematics, Toole Design Group LLC, and AECOM, Nov. 2023, https://www.fhwa.dot.gov/environment/recreational_trails/publications/trails-resilient-infrastructure-guidebook.pdf.

25 US EPA. Green Infrastructure for Climate Resiliency. 1 Oct. 2015, https://www.epa.gov/green-infrastructure/green-infrastructure-climate-resiliency.

26 US EPA. Smart Growth Fixes for Climate Adaptation and Resilience. 2017. https://www.epa.gov/smartgrowth/smart-growth-fixes-climate-adaptation-and-resilience

27 US EPA Office of Transportation and Air Quality. U.S. Transportation Sector Greenhouse Gas Emissions 1990-2022.EPA 430-R-24-004, US EPA, April 2024, https://www.epa.gov/system/files/documents/2024-04/us-ghg-inventory-2024-main-text_04-18-2024.pdf.

28 Bricka, S., et al. Table 2-9. Summary of Travel Trends: 2022 National Household Travel Survey. FHWA-HPL-24-009, Federal Highway Administration, 2022, https://nhts.ornl.gov/assets/2022/pub/2022_NHTS_Summary_Travel_Trends.pdf

29 FHWA Office of Highway Policy Information. Spring 2023 VMT Forecast Summary. USDOT FHWA, Spring 2023, https://www.fhwa.dot.gov/Policyinformation/tables/vmt/2023_vmt_forecast_sum.pdf.

30 U.S. Energy Information Administration. 2023 Annual Energy Outlook Narrative. AEO2023, US EIA, 16 Mar. 2023, https://www.eia.gov/outlooks/aeo/pdf/AEO2023_Narrative.pdf.

31 FHWA Office of Highway Policy Information. Spring 2023 VMT Forecast Summary. USDOT FHWA, Spring 2023, https://www.fhwa.dot.gov/Policyinformation/tables/vmt/2023_vmt_forecast_sum.pdf.

32 US Census Bureau. 2023 National Population Projections Tables: Main Series. https://www.census.gov/data/tables/2023/demo/popproj/2023-summary-tables.html.

33 Milovanoff, A., Posen, I. D. & MacLean, H. L. Electrification of light-duty vehicle fleet alone will not meet mitigation targets. *Nat Clim Chang* 10, 1102–1107 (2020).

34 Girod, B., van Vuuren, D. P. & Deetman, S. Global travel within the 2C climate target. Energy Policy 45, 152–166 (2012).

35 McCahill, Chris. "The amount we drive could make or break clean energy plans." State Smart Transportation Initiative, September 2021, https://ssti.us/2021/09/13/the-amount-we-drive-could-make-or-break-clean-energy-plans/. T4A-Climate-3-EVs-are-not-enough.pdf (t4america.org)

36 Alarfaj, Abdullah F., W. Michael Griffin, and Constantine Samaras. "Decarbonizing US passenger vehicle transport under electrification and automation uncertainty has a travel budget." Environmental Research Letters 15.9 (2020): 0940c2.

37 Feijoo, F., Iyer, G., Binsted, M. & Edmonds, J. US energy system transitions under cumulative emissions budgets. Clim Change 162, 1947–1963 (2020).

38 Fulton, Lewis, and D. Taylor Reich. Compact Cities Electrified: United States. Institute for Transportation & Development Policy and UC Davis Institute of Transportation Studies, Jan. 2024, https://www.itdp.org/wp-content/uploads/2024/01/CCities_USA_Brief-for-Policymakers_Download.pdf.

39 Korn, Jacob, et al. "Why State Land Use Reform Should Be a Priority Climate Lever for America." RMI, 16 Feb. 2024, https://rmi.org/why-state-land-use-reform-should-be-a-priority-climate-lever-for-america/.

40 Bureau of Transportation Statistics, New and Used Passenger Car and Light Truck Sales and Leases, 2023. https://www.bts.gov/content/new-and-used-passenger-car-sales-and-leases-thousands-vehicles

41 Hoehne, Christopher, et al. "Exploring Decarbonization Pathways for USA Passenger and Freight Mobility." Nature Communications, vol. 14, no. 1, Oct. 2023, p. 6913, https://doi.org/10.1038/s41467-023-42483-0.

42 USDOT FY 2022-26 Strategic Plan. U.S. Department of Transportation, https://www.transportation.gov/sites/dot.gov/files/2022-04/US_DOT_FY2022-26_Strategic_Plan.pdf.

43 Raifman, Matthew, et al. "Mortality Implications of Increased Active Mobility for a Proposed Regional Transportation Emission Cap-and-Invest Program." Journal of Urban Health : Bulletin of the New York Academy of Medicine, vol. 98, no. 3, June 2021, pp. 315–27. PubMed Central, https://doi.org/10.1007/s11524-020-00510-1.

44 Thakkar, Anushka, et al. An Active Roadmap: Best Practices in Rural Mobility. Smart Growth America and National Complete Streets Coalition, July 2023, https://smartgrowthamerica.org/wp-content/uploads/2023/07/SGA-Rural-Transportation-Field-Scan_Final_7.27.pdf.

45 Binette, Joanne. *2018 Home and Community Preferences Survey: A National Survey of Adults Age 18-Plus: A Look at Rural Communities*. AARP Research, 21 May 2019. https://doi.org/10.26419/res.00231.010.

46 Wang, Weijing, et al. "Rural–Nonrural Divide in Car Access and Unmet Travel Need in the United States." Transportation, Sept. 2023. Springer Link, https://doi.org/10.1007/s11116-023-10429-6.

47 US Census Bureau. "The South Had Highest Disability Rate Among Regions in 2021." Census.Gov, https://www.census.gov/library/stories/2023/06/disability-rates-higher-in-rural-areas-than-urban-areas.html. Accessed 6 May 2024.

48 Quick, Kathryn, and Guillermo Narváez. Understanding Roadway Safety in American Indian Reservations: Perceptions and Management of Risk by Community, Tribal Governments, and Other Safety Leaders. Report, Center for Transportation Studies, University of Minnesota, Oct. 2018. conservancy.umn.edu, http://conservancy.umn.edu/handle/11299/200728.

49 Faghih-Imani, Ahmadreza, et al. "Hail a Cab or Ride a Bike? A Travel Time Comparison of Taxi and Bicycle-Sharing Systems in New York City." Transportation Research Part A: Policy and Practice, vol. 101, July 2017, pp. 11–21. ScienceDirect, https://doi.org/10.1016/j.tra.2017.05.006.

50 Borray, Luis, et al. Creating Walkable and Bikeable Communities. DU206SF-14-Q-0007, U.S. Department of Housing and Urban Development Office of Policy Development and Research, Dec. 2016.

51 Boutros, Anthony, et al. "Integrating Equity into Transportation: An Overview of USDOT Efforts." Public Roads, no. Equity in Transportation, Spring 2023, https://highways.dot.gov/public-roads/spring-2023.

52 North American Bikeshare and Scootershare Association. 4th Annual Shared Micromobility State of the Industry Report. https://nabsa.net/about/industry/.

53 Lee, Dong-Yeon, et al. Chapter 10: Household Transportation Electrification. National Renewable Energy Laboratory and Los Angeles Department of Public Works, Nov. 2023.

54 Akcicek, Cemal, et al. Freewheeling: What Six Locations, 61,000 Trips, and 242,000 Miles in Colorado Reveal About How E-Bikes Improve Mobility Options. NREL/TP-5400-86388, National Renewable Energy Laboratory, 1 June 2023, https://doi.org/10.2172/1987488.

55 Jones, Luke R., et al. "Consumer Purchase Response to E-Bike Incentives: Results from a Nationwide Stated Preference Study." Transportation Research Part D: Transport and Environment, vol. 129, Apr. 2024, p. 104114. ScienceDirect, https://doi.org/10.1016/j.trd.2024.104114.

56 McQueen, Michael, et al. "The E-Bike Potential: Estimating Regional e-Bike Impacts on Greenhouse Gas Emissions." Transportation Research Part D: Transport and Environment, vol. 87, Oct. 2020, p. 102482, https://doi.org/10.1016/j.trd.2020.102482.

57 Coseo, Paul, and Larissa Larsen. "Cooling the Heat Island in Compact Urban Environments: The Effectiveness of Chicago's Green Alley Program." Procedia Engineering, vol. 118, Dec. 2015, pp. 691–710, https://doi.org/10.1016/j.proeng.2015.08.504.

58 Ngo, Victor Douglas, et al. "Effects of New Urban Greenways on Transportation Energy Use and Greenhouse Gas Emissions: A Longitudinal Study from Vancouver, Canada." Transportation Research Part D: Transport and Environment, vol. 62, July 2018, pp. 715–25, https://doi.org/10.1016/j.trd.2018.04.013.

59 Brodeur, Alyssa, et al. Boston Blind Zone Safety Initiative: Current Fleet Analysis, Market Scan, and Proposed Direct Vision Rating Framework. DOT-VNTSC-BOS-23-01, 1 Aug. 2023. ROSA P, https://rosap.ntl.bts.gov/view/dot/68730.

60 National Association of City Transportation Officials. *2022 Shared Micromobility in the U.S. and Canada Report*. National Association of City Transportation Officials, 2023, https://nacto.org/publication/shared-micromobility-in-2022/.

61 Holland, Ben, et al. *Urban Land Use Reform: The Missing Key to Climate Action Strategies for Lowering Emissions, Increasing Housing Supply, and Conserving Land*. RMI, Cities, 2023. https://rmi.org/insight/urban-land-use-reform/.

62 Axelrad, Tina. *Measuring & Coping with the Costs of Sprawl: A Summary of the National Literature on Costs of Sprawl*. https://cpb-us-w2.wpmucdn.com/sites.wustl.edu/dist/a/3075/files/2021/12/axelrad.pdf. Rocky Mountain Land Use Institute Eighth Annual Conference.

63 Tomer, Adie, et al. "We Can't Beat the Climate Crisis without Rethinking Land Use." Brookings, 12 May 2021, https://www.brookings.edu/articles/we-cant-beat-the-climate-crisis-without-rethinking-land-use/.

64 Jones, Christopher, and Daniel M. Kammen. "Spatial Distribution of U.S. Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density." Environmental Science and Technology, vol. 48, no. 2, Jan. 2014, pp. 895–902, https://doi.org/10.1021/es4034364.

65 Tomer, Adi, and Caroline George. "Building for Proximity: The Role of Activity Centers in Reducing Total Miles Traveled." Brookings, 29 June 2023, https://www.brookings.edu/articles/building-for-proximity-the-role-of-activity-centers-in-reducing-total-miles-traveled/.

66 Chatman, Daniel G., and Robert B. Noland. "Transit Service, Physical Agglomeration and Productivity in US Metropolitan Areas." Urban Studies, vol. 51, no. 5, Apr. 2014, pp. 917–37, https://doi.org/10.1177/0042098013494426.

67 Pokharel, Ramesh, et al. "How Does Transportation Facilitate Regional Economic Development? A Heuristic Mapping of the Literature." Transportation Research Interdisciplinary Perspectives, vol. 19, May 2023, p. 100817, https://doi.org/10.1016/j.trip.2023.100817.

68 Tomer, Adie, and Caroline George. "Building for Proximity: The Role of Activity Centers in Reducing Total Miles Traveled." Brookings, 29 June 2023, https://www.brookings.edu/articles/building-for-proximity-the-role-of-activity-centers-in-reducing-total-miles-traveled/.

69 Rodriguez, Michael A., and Christopher B. Leinberger. Foot Traffic Ahead. Smart Growth America and Places Platform, Jan. 2023, https://smartgrowthamerica.org/wp-content/uploads/2023/01/Foot-Traffic-Ahead-2023.pdf.

70 Glaeser, Edward. "Reforming Land Use Regulations." Brookings, 24 Apr. 2017, https://www.brookings.edu/articles/reforming-land-use-regulations/.

71 Institute for Transportation and Development Policy. TOD Standard, 3rd Edition. 2017, https://itdpdotorg.wpengine.com/wp-content/uploads/2017/06/TOD_printable.pdf.

72 ICF. Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity. California Air Pollution Control Officers Association (CAPCOA), Dec. 2021.

73 Zimmerman, Mariia V., et al. Coordination of Public Transit Services and Investments with Affordable Housing Policies. Transportation Research Board, 2022, p. 26542, https://doi.org/10.17226/26542.

74 Forman, Ben, Matt Norris, and Lian Plass. Reshaping the City: Zoning for a More Equitable, Resilient, and Sustainable Future. Washington, DC: Urban Land Institute, 2023, https://knowledge.uli.org/en/reports/research-reports/2023/reshaping-the-city-zoning-for-a-more-equitable-resilient-and-sustainable-future. ULI, Reshaping the City.

75 Boarnet, Marlon G., et al. Displacement and Commuting in the San Francisco Bay Area and Beyond: An Analysis of the Relationship Between the Housing Crisis, Displacement, and Long Commutes. METRANS Transportation Center, 2021, https://rosap.ntl.bts.gov/view/dot/67409

76 Steuteville, Robert. "The State of the Art of Suburban Retrofit." *Public Square: A CNU Journal*, 21 Jan. 2021, https://www.cnu.org/publicsquare/2021/01/21/state-art-suburban-retrofit.

77 U.S. Department of Agriculture. *Downtown Revitalization*. https://www.nal.usda.gov/rural-development-communities/downtown-revitalization. Accessed 18 Apr. 2024.

78 National Housing Conference. "Affordable Rental Housing Preservation: Policies and Funding Strategies." https://nhc.org/policy-guide/affordable-rental-housing-preservation-the-basics/affordable-rental-housing-preservation-policies-and-funding-strategies/ Accessed 4 April 2024.

79 Gately, Conor, and Tim Reardon. "The Impacts of Land Use and Pricing in Reducing Vehicle Miles Traveled and Transport Emissions in Massachusetts." MAPC, 22 Jan. 2021, https://www.mapc.org/resource-library/vehicle-miles-traveled-emissions/.

80 Vaughn, Richard M., et al. "The Influence of Subdivision Design and Conservation of Open Space on Carbon Storage and Sequestration." Landscape and Urban Planning, vol. 131, Nov. 2014, pp. 64–73, https://doi.org/10.1016/j.landurbplan.2014.08.001.

81 Love, Hanna, and Mike Powe. "Why Main Streets Are a Key Driver of Equitable Economic Recovery in Rural America." Brookings, 1 Dec. 2020, https://www.brookings.edu/articles/why-main-streets-are-a-key-driver-of-equitable-economic-recovery-in-rural-america/.

82 Barkley, Brett. "The Role of Equitable Transit-Oriented Development in Promoting Economic Opportunity." Federal Reserve Bank Philadelphia, Fall 2017, https://www.philadelphiafed.org/community-development/the-role-of-equitable-transit-oriented-development-in-promoting-economic-opportunity.

83 Freemark, Yonah. "Achieving Housing Abundance Near Transit." Terner Center, https://ternercenter.berkeley.edu/research-and-policy/housing-abudance-near-transit/.

84 Chicago Metropolitan Agency for Planning. Form-Based Codes: A Step-by-Step Guide for Communities. Nov. 2013, https://formbasedcodes.org/wp-content/uploads/2013/11/CMAP-GuideforCommunities.pdf.

85 "What Is Missing Middle Housing?" Missing Middle Housing, https://missingmiddlehousing.com/about/. Accessed 29 Mar. 2024.

86 Municipal Research and Services Center. *Missing Middle Housing*. https://mrsc.org/explore-topics/housing-homelessness/housing/middle-housing. Accessed 28 Mar. 2024.

87 American Planning Association. *Accessory Dwelling Units*. https://www.planning.org/knowledgebase/accessorydwellings/. Accessed 28 Mar. 2024.

88 State of California. SB-423 *Land Use: Streamlined Housing Approvals: Multifamily Housing Developments*. 11 Oct. 2023, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202320240SB423.

89 BIL Section 11201(d), 23 USC 134.

90 Institute for Transportation and Development Policy. "To Tackle Climate Change, Cities Need to Rethink Parking." Transport Matters, 20 Sept. 2022, https://itdp.org/2022/09/20/to-tackle-climate-change-cities-need-to-rethink-parking/.

91 Jaller, Miguel. Curbside Management Is Critical for Minimizing Emissions and Congestion. Policy Brief, 10.7922/G27W69H5, National Center for Sustainable Transportation, Aug. 2021, https://escholarship.org/uc/item/7q69b37f.

92 Weinberger, Rachel. "Death by a Thousand Curb-Cuts: Evidence on the Effect of Minimum Parking Requirements on the Choice to Drive." *Transport Policy*, vol. 20, Mar. 2012, pp. 93–102. ScienceDirect, https://doi.org/10.1016/j.tranpol.2011.08.002.

93 Mandhan, Sneha, and Kelly Gregg. "Managing the Curb – Public Space and Use of Curbside Cafes during the Coronavirus Pandemic." *Cities (London, England)*, vol. 132, Oct. 2022, p. 104070. PubMed Central, https://doi.org/10.1016/j.cities.2022.104070.

94 Epstein, Alexander, et al. *Community Charging: Emerging Multifamily, Curbside, and Multimodal Practices.* Joint Office of Energy and Transportation, Feb. 2024, https://driveelectric.gov/files/community-emobility-charging.pdf.

95 Abou-Zeid, Gabriella, et al. *An Assessment of the Expected Impacts of City-Level Parking CashOut and Commuter Benefits Ordinances*. FHWA-HOP-23-023, Federal Highway Administration, 28 Mar. 2023, https://ops.fhwa.dot.gov/publications/fhwahop23023/fhwahop23023.pdf.

96 U.S. Office of Personnel Management. *OPM, DOT and GSA Announce Federal Partnership With Capital Bikeshare Program*. 4 Oct. 2020, https://www.opm.gov/news/releases/2010/10/opm-dot-and-gsa-announce-federal-partnership-with-capital-bikeshare-program/.

97 Mobility Lab. *Want Your Employees to Stay Healthier? Invest in Showers and Bike Parking*. https://mobilitylab.org/research/bike/want-your-employees-to-stay-healthier-invest-in-showers-and-bike-parking/. Accessed 28 Mar. 2024.

98 Hess, Daniel Baldwin, and Jeffrey Rehler. "Minus Minimums: Development Response to the Removal of Minimum Parking Requirements in Buffalo (NY)." Journal of the American Planning Association, vol. 87, no. 3, July 2021, pp. 396–408. Taylor and Francis+NEJM, https://doi.org/10.1080/01944363.2020.1864225.

99 Georgetown Climate Center. *Issue Brief: Estimating the Greenhouse Gas Impact of Federal Infrastructure Investments in the IIJA*. 16 Dec. 2021, https://www.georgetownclimate.org/articles/federal-infrastructure-investment-analysis.html.

100 Speck, Jeff. *Walkable City: How Downtown Can Save America, One Step at a Time*. New York, Farrar, Straus and Giroux, 2012; Handy, Susan and M.G. Boarnet. "*Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions*." 30 September 2014, California Environmental Protection Agency Air Resources Board.

101 Georgetown Climate Center. Issue Brief: Estimating the Greenhouse Gas Impact of Federal Infrastructure Investments in the IIJA. 16 Dec. 2021, https://www.georgetownclimate.org/articles/federal-infrastructure-investment-analysis.html.

102 Kathleen McCormick. "Deconstruction Ahead: How Urban Highway Removal Is Changing Our Cities." Land Lines Magazine, no. April 2020, https://www.lincolninst.edu/publications/articles/2020-03-deconstruction-ahead-urban-highway-removal-changing-cities.

103 Smart Growth America. What We Learned from the Stimulus. 5 Jan. 2010, https://smartgrowthamerica.org/wp-content/uploads/2016/08/010510_whatwelearned_stimulus.pdf.

104 Peltier, Heidi. *Pedestrian and Bicycle Infrastructure: A National Study of Employment Impacts*. Political Economy Research Institute; University of Massachusetts, Amherst, June 2011.

105 WeConservePA. *Economic Benefits of Trails*. https://library.weconservepa.org/guides/97-Economic-Benefits-of-Trails/. Accessed 27 Mar. 2024.

106 Rodriguez, Michael A., and Christopher B. Leinberger. Foot Traffic Ahead. Smart Growth America and Places Platform, Jan. 2023, https://smartgrowthamerica.org/wp-content/uploads/2023/01/Foot-Traffic-Ahead-2023.pdf.

107 Federal Highway Administration. "Blocked Highway-Railway Grade Crossings." FHWA Highway Safety Improvement Program, https://highways.dot.gov/safety/hsip/xings/highway-railway-grade-crossing-action-plan-and-project-prioritization-8.

108 Bureau of Transportation Statistics. *Rural Transportation Statistics*. 16 Aug. 2022, https://www.bts.gov/rural.

109 Bureau of Transportation Statistics. Rural Transportation Statistics. 16 Aug. 2022, https://www.bts.gov/rural.

110 Auld, Joshua, et al. *Large-Scale Evaluation of Mobility, Technology and Demand Scenarios in the Chicago Region Using POLARIS.* Submitted for presentation at the 2024 World Symposium of Transportation and Land User Research, and publication in the Journal of Transport and Land Use. 2024.

111 Transport for London. *Congestion Charge Marks 20 Years of Keeping London Moving Sustainably*. 17 Feb. 2023, https://tfl.gov.uk/info-for/media/press-releases/2023/february/congestion-charge-marks-20-years-of-keeping-london-moving-sustainably.

112 Bhatt, Kiran, et al. *Lessons Learned from International Experience in Congestion Pricing*. FHWA-HOP-08-047, 1 Aug. 2008. ROSA P, https://rosap.ntl.bts.gov/view/dot/16555.

113 Viggiano, Cecilia et al. "State-Level Transportation Repricing for Carbon Reduction and Equity Toolkit." Transportation Research Board Annual Meeting Poster, January 2024.

114 FHWA Center for Innovative Finance Support. *Federal Tolling Programs*. https://www.fhwa.dot.gov/ipd/tolling_and_pricing/tolling_pricing/federal_tolling_programs.aspx.

115 Infrastructure Investment and Jobs Act, Section 11205

116 UC Davis Institute of Transportation Studies. *We Can, and Should, Account for the Consequences of Expanding Highways*. 31 Mar. 2021, https://its.ucdavis.edu/blog-post/we-can-and-should-account-for-the-consequences-of-expanding-highways/.

117 Brasuell, James. "Colorado's 'Greenhouse Gas Planning Standard' Changes the Transportation Equation." *TransitCenter*, 3 Feb. 2023, https://transitcenter.org/colorados-greenhouse-gas-planning-standard-changes-the-transportation-equation/.

118 Frommer, Matt. "Colorado Updates Transportation Plans to Comply with New Climate Rules - *Southwest Energy Efficiency Project*." Southwest Energy Efficiency Project, 3 Nov. 2022, https://www.swenergy.org/colorado-transportation-greenhouse-gas-reduction/.

119 Damkowitch, Jim. *Rural Counties Task Force: Rural Induced Demand Study*. https://www.nctc.ca.gov/documents/Reports/RCTF/Rural-Induced-Demand-presentation-Nov-8-2023.pdf. Rural Induced Demand Project Advisory Committee.

120 U.S. Department of Transportation. *National Freight Strategic Plan*. Sept. 2020, https://www.transportation.gov/freight/NFSP.

121 U.S. Department of Transportation. National Freight Strategic Plan. Sept. 2020, https://www.transportation.gov/freight/NFSP.

122 Holguín-Veras, José, et al. *Effective Decision-Making Methods for Freight-Efficient Land Use*. National Cooperative Highway Research Program (NCHRP); Transportation Research Board, Mar. 2020, https://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_998Document.pdf.

123 Dalla Chiara, Giacomo, and Anne Goodchild. "Do Commercial Vehicles Cruise for Parking? Empirical Evidence from Seattle." *Transport Policy*, vol. 97, Oct. 2020, pp. 26–36. ScienceDirect, https://doi.org/10.1016/j.tranpol.2020.06.013.

124 Sahin, Olcay, and Monique Stinson. Off-Hours Delivery: Simulated Systemwide Results for the Chicago Region. https://www.metrans.org/assets/upload/sahin_stinson-0.pdf. METRANS International Urban Freight Conference.

125 Zuniga, Natalia and Kyungsoo Jeong. *SMART Webinar Series #6: Freight*. https://www.energy.gov/sites/default/files/2023-07/Smart_Mobility_Insights_%236_-_Freight_-_FINAL.pdf.

126 AIA New York. Delivering the Goods: NYC Urban Freight in the Age of E-Commerce. AIANY Freight and Logistics Working Group, 2022, https://www.aiany.org/wp-content/uploads/2022/11/AIANY-Delivering-the-Goods-NYC-Urban-Freight-Nov-2022.pdf.

127 Akan, Mert, et al. "Americans Now Live Farther From Their Employers." Gusto, 3 Mar. 2024, https://gusto.com/company-news/americans-now-live-farther-from-their-employers.

128 EPA Mobile Sources Technical Review Subcommittee. The Future of Mobility: A Report by the EPA Mobile Sources Technical Review Subcommittee. US EPA, Oct. 2021.

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