50 Steps Toward Carbon-Free Transportation

Rethinking U.S. Transportation Policy to Fight Global Warming

FRONTIER GROUP | A New Way Forward

Written by

Tony Dutzik,
Frontier Group

Fall 2016

©2016, Frontier Group. Some rights reserved. This work is licensed under a Creative Commons Attribution Non-Commercial 4.0 International License. To view the terms of this license, visit www.creativecommons.org/licenses/by-nc/4.0/.

Frontier Group provides information and ideas to help citizens build a cleaner, healthier, fairer and more democratic America. We address issues that will define our nation's course in the 21st century – from fracking to solar energy, global warming to transportation, clean water to clean elections. Our experts and writers deliver timely research and analysis that is accessible to the public, applying insights gleaned from a variety of disciplines to arrive at new ideas for solving pressing problems. For more information about Frontier Group, please visit www.frontiergroup.org.

Acknowledgments

Frontier Group thanks the many people who contributed time, effort and expertise toward making this report a reality. We thank our partners at Environment America Research and Policy Center and the U.S. Public Interest Research Group (PIRG) for their support. Thanks to Susan Rakov, Alana Miller and Rachel Cross of Frontier Group, as well as Frontier Group intern Toby Armstrong for their research and editorial support. Thanks to all those who attended the January 2016 forum on transportation policy and climate change in Washington, D.C., which informed the recommendations in this report, as well as the following individuals who provided feedback or review: James Aloisi, former Massachusetts transportation secretary and principal at Trimount Consulting; Kevin DeGood, director of infrastructure policy at the Center for American Progress; Sharon Feigon, executive director of the Shared Use Mobility Center; Paul Lewis, Stanford Turner and Robert Puentes at the Eno Center for Transportation; Todd Litman, executive director of the Victoria Transport Policy Institute; John Olivieri, 21st century transportation campaign director with U.S. PIRG; Trip Pollard, senior attorney with the Southern Environmental Law Center; Eric Sundquist, managing director of the State Smart Transportation Initiative; Susan Shaheen, co-director of the Transportation Sustainability Research Center at the University of California, Berkeley; Will Toor and Mike Salisbury with the Southwest Energy Efficiency Project (SWEEP); and Aminah Zaghab, clean cars advocate with Environment America.

We offer our deep thanks to the William and Flora Hewlett Foundation for making this report possible.

The opinions expressed in this report are those of the authors and do not necessarily reflect the views of those who provided editorial review. Any factual errors are strictly the responsibility of the authors.

Table of Contents

Executive Summary > 1

Introduction > 13

A New Way Forward: The Path to a Climate-Friendly Transportation System > 15

Reality Check: How U.S. Transportation Policy Fails the Climate > 21

Building a Zero-Carbon Transportation System: 50 Steps > 53

Conclusion > 70

Appendix A. State Transportation Policy Indicators > > > 71

Appendix B. Carbon Dioxide Emissions from Transportation by State > 78

Notes > 80

Executive Summary

America and the world must reduce emissions of greenhouse gases immediately and dramatically if we are to prevent the worst impacts of global warming. If the world is to meet the promises of the Paris Climate Agreement, and limit global warming to no more than 2°C, the United States will have to virtually eliminate carbon pollution by mid-century.

America's transportation system has emerged as Climate Enemy #1, with cars, trucks and other vehicles now representing the nation's largest source of carbon pollution, and America producing more transportation carbon pollution per capita than any other major industrialized nation.

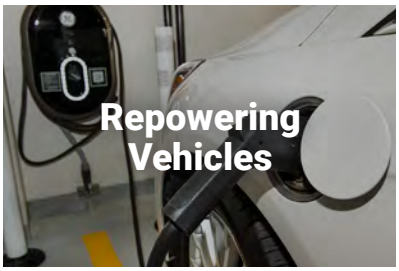
There is hope, however. New technologies and emerging social trends, from the resurgence of interest in walkable neighborhoods to advances in electric vehicles – create new opportunities to move the nation toward a zero-carbon transportation system, and to do it in ways that improve our health and well-being and support a vibrant economy.

To get there, America must reimagine our transportation policies and empower cities and states to implement effective solutions.

Current federal and state transportation policies in the United States often set us back in the fight against global warming. To move toward a carbon-free transportation system, America must adopt a bold new vision for transportation policy – with 50 common-sense policy reforms helping to chart a new way forward.

America has the tools to move toward a carbon-free transportation system.

America can eliminate carbon pollution from transportation in time to prevent the worst impacts of global warming. The *New Transportation Toolbox* is rich with promising approaches to cut carbon pollution:



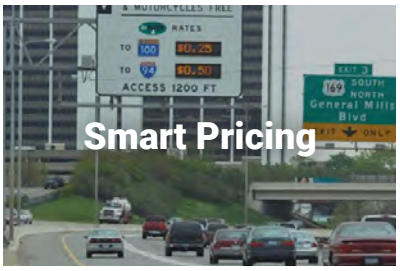
Efficient electric vehicles that can be powered by clean, renewable electricity are entering the marketplace faster than the hybrid cars of a decade ago and technology continues to improve, removing barriers to electric vehicle adoption.

American cities, especially their downtowns, are experiencing a renaissance, driven by a growing desire for walkable living.

An explosion of technology-enabled services – from carsharing to bikesharing to Lyft and Uber – has begun to revolutionize transportation in many cities. Services such as carsharing have already been shown to reduce vehicle ownership, driving and carbon pollution, and smart public policies can help to ensure that other shared mobility services deliver benefits as well.

Public transportation reduces vehicle travel (and greenhouse gas emissions) by about 10 percent in U.S. cities, and cities across the country are considering bold plans to expand access to high-quality transit.

Cities in the United States and around the world are reallocating space formerly devoted to cars to other public purposes, helping to fuel increased use of low-carbon modes of transportation.



Americans typically pay nothing to drive on most roads and enjoy the lowest gas taxes in the industrialized world, encouraging excessive driving and congestion. Cities around the world have shown that smart pricing policies can reduce congestion and encourage the use of low-carbon modes of travel.

Americans prefer walking to any other mode of transportation, according to a recent survey, and the number of people traveling by bicycle in many cities has grown dramatically in the last decade.

Advances in technology are enabling Americans to plan, schedule and pay for trips via low-carbon modes as easily as traveling by car.

In addition, **autonomous vehicles** can be deployed in ways that can support efforts to reduce greenhouse gas emissions – especially if they facilitate the use of shared mobility services, vehicle electrification and smart pricing, and if public policy limits any increases in vehicle travel resulting from automation.

A series of common-sense policy principles can guide America toward a zero-carbon transportation system. Current state and federal policies, however, fall far short of those principles.

Principle 1: Climate concerns should inform every transportation policy decision.

America cannot expect to make climate-smart transportation infrastructure and policy decisions without setting goals for reducing carbon pollution from transportation, evaluating progress toward those goals, prioritizing policies and projects that benefit the climate, and creating mechanisms for holding government accountable for progress.

The Reality:

- Climate change is rarely a factor in transportation decision-making. Only seven states have enforceable, economy-wide limits on carbon pollution, and, as of 2012, the vast majority of states and metropolitan planning organizations did not even consider greenhouse gas emissions in agency planning processes. States regularly make policy decisions – such as increasing highway speed limits – with little to no consideration of greenhouse gas impacts.
- Until recently, the federal government did not require that transportation projects be evaluated for their impacts on the climate. In 2016, the Obama administration moved to require states to include climate assessments in environmental reviews for federally funded transportation projects, and proposed that states adopt non-binding performance targets for transportation greenhouse gas emissions and track progress toward those targets.

Principle 2: Low-carbon transportation should be at the front of the line for public funding.

If the nation is to reduce carbon pollution from our transportation system, we need to invest accordingly.

The Reality:

- America spends vastly more on infrastructure for high-carbon modes of travel than low-carbon modes. Between 1956 and 2014, 79 percent of all government capital expenditures on transportation went toward highways, according to Congressional Budget Office data. Since 1995, subsidies for highways from general tax revenues have increased faster than subsidies for public transportation.

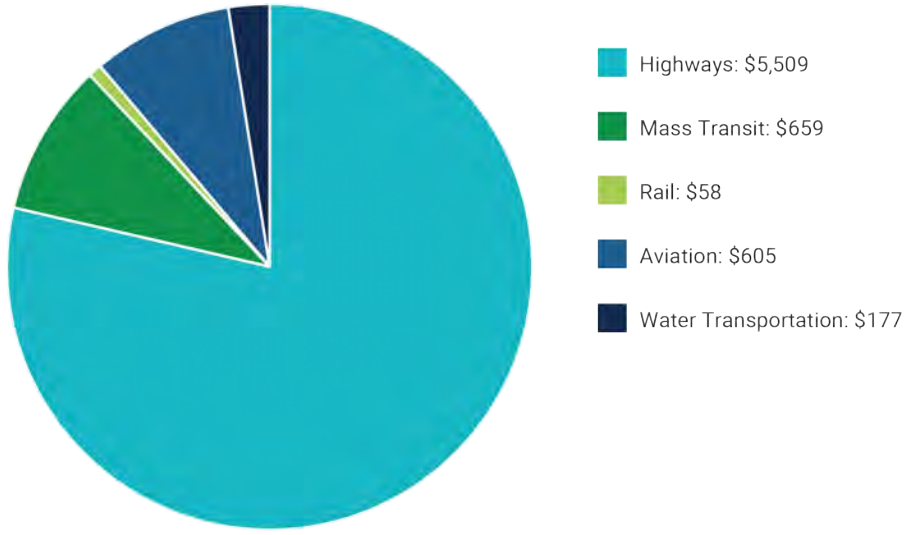
- Bureaucratic hurdles hamper low-carbon transportation investment. The federal funding match for new highway projects is generally higher, and the burden of evaluation lower, than major transit capital projects. Many state governments are barred from using gas tax revenues for purposes other than roads and bridges, with 24 states, home to more than 113 million people, spending the equivalent of less than a penny per person per day in state funds on public transportation.
- Low-cost strategies to improve transportation efficiency – such as transportation demand management programs and intelligent transportation systems – receive scant funding or attention.

Principle 3: People should be rewarded for making low-carbon transportation choices.

Americans will choose low-carbon transportation when it is more convenient, more comfortable and cheaper than high-carbon alternatives. Tax policies and market structure should reward decisions to use low-carbon modes of travel.

Figure ES-1. Government Capital Investment in Transportation Since 1956 (Billions 2014)

Source: Congressional Budget Office



The Reality:

- The tax code provides direct and indirect incentives that encourage driving. In most states, motor fuels are exempt from general state sales taxes, while the income tax exclusion for commuter parking subsidizes rush hour driving to the tune of more than $7 billion per year.
- U.S. gasoline taxes fail to compensate society even for the cost of maintaining and building highways, let alone impacts such as pollution, congestion and noise that driving inflicts on society. Incorporating such costs in the cost of gasoline would increase its cost by roughly $2.10 a gallon, according to researchers with Resources for the Future.

» Tax policies often limit the growth of innovative travel models. Carsharing faces excessive taxation in many cities, while bikesharing and other shared mobility modes are excluded from pre-tax commuter benefits programs.

Principle 4: Carbon-intensive vehicles and fuels should be phased out.

A transition to vehicles capable of running on zero-carbon sources of energy – such as electric vehicles – is a prerequisite for eliminating carbon pollution from transportation by mid-century.

The Reality:

» The Obama administration has made a commitment to reducing greenhouse gas emissions from cars and trucks through the adoption of landmark vehicle fuel economy and greenhouse gas emission standards. But current standards do not take full advantage of recent technological advances in energy efficiency and zero-emission vehicles to maximize reductions in carbon pollution.

» Federal policies have failed to tap the potential of lower-carbon fuels, with the federal Renewable Fuels Standard currently serving largely to encourage the use of corn ethanol, which has little to no greenhouse gas emissions benefit relative to gasoline.

Principle 5: Public policy should encourage climate-friendly communities.

Communities that are designed in ways that allow walking, biking, transit and shared mobility to serve as viable daily options create many opportunities for low- or zero-carbon transportation. Public policies – including policies at the federal and state level – can help support the creation of those communities.

The Reality:

» Public policies often hamstring the creation of climate-friendly communities. Federal housing and state economic development subsidies often privilege single-family housing, discourage mixed-use development, and support the migration of businesses and jobs from city centers to auto-centric suburbs.

- Many state and local governments retain policies that make the development of climate-friendly communities more difficult or impossible. Some states have shown the way forward by adopting policies to encourage compact forms of development or to lift barriers to new housing construction in high-demand markets, while some localities have begun to lift mandatory minimum parking requirements that add to the cost of new housing development and consume precious and limited urban space.

Principle 6: Public policy should foster innovation.

The past decade has brought tremendous innovation in information technology, shared mobility, and vehicle automation – much of it driven by private investment. By fostering and shaping innovation in ways that maximize potential climate benefits, cities and states can help lay the groundwork for a future transportation system that reduces carbon pollution.

The Reality:

- Key state and federal policies hamper innovation by failing to account for changing circumstances such as the emergence of shared mobility services or growing demand for urban living, or by locking officials into spending or policy practices more attuned to the needs of a previous generation.
- Recent years have seen state legislatures exercise veto power over local decisions to adopt low-carbon transportation technologies, while existing modal "silos" in state and federal transportation agencies limit agencies' ability to prioritize transportation projects that can reduce emissions.
- The quality and volume of transportation data collected by federal and state agencies is often poor, while transportation agencies have failed to make effective use of "big data" sources or streams of privately gathered data that can improve transportation planning and operation.

Federal and state governments should set goals for reducing carbon pollution from transportation consistent with the goals of the Paris Climate Agreement, and align transportation policies with the goal of eliminating carbon pollution from transportation by mid-century.

Specifically, state and federal governments should consider a series of 50 policy reforms that can help to pave the way for a zero-carbon transportation system. Specifically, policy-makers should:

- **Make addressing global warming a strategic goal** by setting and enforcing targets for greenhouse gas emission reductions from transportation and incorporating accurate assessments of climate impacts into every facet of transportation decision-making – from decisions on specific projects to the development of long-term transportation plans.
- **Stop doing harm,** by shifting public and private investment away from infrastructure that encourages carbon-intensive forms of travel and land use and toward low-carbon modes of travel.
- **Reform the transportation bureaucracy and policy framework** by revising criteria for allocating transportation funds; ensuring that state policies promote the use of low-carbon modes of travel; eliminating counterproductive "level of service" criteria from environmental and land-use reviews; and breaking up modal silos to allow for better transportation decision-making.
- **Get the most out of what we have** by maximizing the efficient use of existing infrastructure. States should be permitted and incentivized to use road pricing as a tool to reduce emissions and curb congestion, while transit agencies should be allowed to spend federal financial assistance to sustain or expand operations. Transportation demand management, intelligent transportation services, "complete streets" and active transportation strategies, and other "infrastructure-light" solutions should take center stage in addressing transportation challenges.
- **Level the playing field for shared mobility** by eliminating excessive taxation for carsharing; ensuring that shared mobility services with a positive impact on the climate are treated equitably in commuter benefits programs; and encouraging the substitution of shared mobility packages for mandated parking in new developments.
- **Harness the power of markets** by implementing carbon pricing, road pricing, distance-based insurance, and demand-responsive parking pricing where appropriate, and by considering new models of transportation service delivery and governance.
- **Speed the introduction of low-carbon vehicles** by strengthening and enforcing strong fuel economy and greenhouse gas emission standards, as well as state zero-emission vehicle standards; by continuing tax and other incentives for clean vehicles; and by taking advantage of synergies between efforts to clean up transportation and efforts to clean up the electric grid.

- **Speed the introduction of low-carbon fuels** by supporting a transition from fuel-specific mandates to a fuel-neutral low-carbon fuel standard, and by encouraging a broader transition to renewable energy.
- **Align transportation and land-use objectives** by targeting federal and state housing and economic subsidies to support low-carbon growth patterns; integrating land-use criteria into transportation project selection; removing state and local barriers to the creation of new housing in walkable, urban areas; and allowing transportation funds to be used to support transit-oriented development.
- **Support and guide innovation** by revising transportation policies and plans and the models that shape transportation decision-making; enabling and encouraging local innovation; adopting policies that maximize the sustainability benefits of new technologies; and supporting research and development into innovative, low-carbon transportation strategies.
- **Expand access** to new mobility solutions by ensuring that shared mobility services are available to all and encouraging early use of electric and other vehicles with the potential to provide emission-free travel in a wide range of communities.
- **Collect and share data** by devising and enforcing common standards for data collection and provision by public and private service providers; maximizing the provision of open data; enhancing data analysis capabilities; and protecting consumer privacy.
- **Reevaluate transportation governance** to ensure that America has institutions with the capability to envision strategies to move the nation toward zero-carbon transportation and empower people and businesses to make it happen.

50 Steps Toward Low-Carbon Transportation

Make addressing global warming a strategic goal.

1. Establish greenhouse gas performance measures for transportation and track progress.
2. Require greenhouse gas evaluations for transportation projects and plans and ensure that they are done appropriately.
3. Set and enforce greenhouse gas emissions limits consistent with climate science, applicable to the transportation sector.

Stop doing harm.

4. Shift public subsidies from highway capacity expansion to low-carbon transportation strategies.
5. Remove barriers to low-carbon transportation investments.
6. End the nexus between motor vehicle "user" revenue and investment in roads.

Reform the transportation bureaucracy and policy infrastructure.

7. Revisit transportation funding formulas.
8. Ensure that state laws and regulations treat users of low-carbon transportation equitably.
9. Eliminate highway level-of-service as a criterion in environmental and land-use reviews.
10. Break up modal silos in transportation agencies.

Get the most out of what we have.

11. Make demand management a central feature of transportation policy.
12. Remove limitations on use of federal funds for transit operations.
13. Remove the ban on tolling existing Interstate highways.
14. Encourage strategic development of intelligent transportation systems and connected vehicles.
15. Reallocate space to low-carbon modes.

Reward low-carbon travel decisions.

16. Eliminate the income tax exclusion for employer-provided or employer-paid commuter parking.
17. Eliminate state sales tax exemptions for motor fuels.
18. Ensure that fees charged for motor vehicle use meet or exceed the full societal costs imposed by driving.

19. Consider monetary incentives to encourage low-carbon travel behavior.
20. Support market reforms and that shift pricing from up-front to per-mile.

Level the playing field for shared mobility.

21. Eliminate excessive taxes on carsharing.
22. Expand access to commuter benefits to include shared mobility services that benefit the climate.
23. Encourage access to transit, active transportation and shared mobility as alternatives to parking.

Harness the power of markets.

24. Use market-based tools to manage transportation demand.
25. Consider new models of transportation service delivery and governance.

Speed the introduction of low-carbon vehicles.

26. Strengthen and enforce strong fuel economy/GHG standards.
27. Strengthen and enforce state zero-emission vehicle standards.
28. Continue financial incentives for clean vehicle adoption.
29. Encourage the large-scale, rapid build-out of charging infrastructure across the nation.
30. Develop and support markets for reuse of EV batteries for energy storage.
31. Foster regional and public-private collaborations to encourage adoption of electric vehicles.
32. Encourage integration of EVs into shared mobility fleets.

Speed the introduction of low-carbon fuels.

33. Replace the federal renewable fuel standard with a low-carbon fuel standard.
34. Expand renewable energy production.

Align transportation and land-use objectives to support climate-friendly communities.

35. Reform policies related to housing, economic development and the location of public facilities to support low-carbon communities.
36. Remove barriers to new housing in compact areas.
37. Integrate land-use criteria into transportation project selection.
38. Allow for the use of transportation funds to support integrated smart growth/transportation solutions, and encourage transit-oriented development.

Support and guide innovation.

39. Revisit existing policies, plans and models to reflect new technologies.
40. Reform procurement processes.
41. Remove roadblocks to local innovation.
42. Maximize the sustainability benefits of new technologies.
43. Provide research, development & deployment assistance for new low-carbon modes and services.

Serve everyone.

44. Encourage early adoption of electric vehicles among low-income users.
45. Employ shared mobility to address an array of transportation challenges.

Collect and share data.

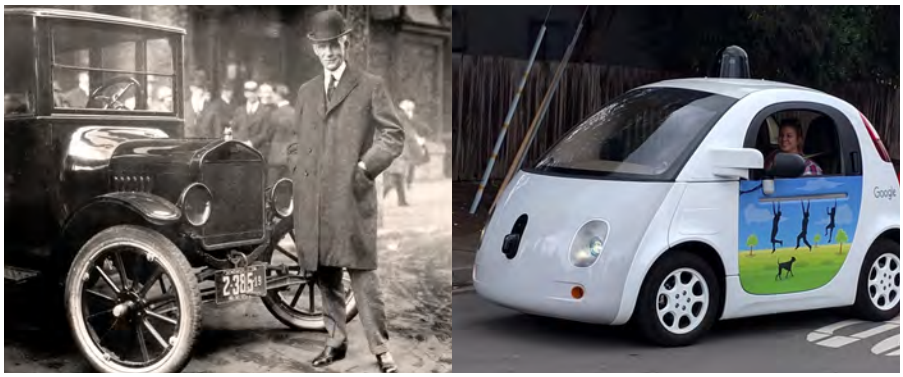
46. Devise and enforce common standards for data collection and sharing.
47. Maximize provision of open data.
48. Enhance federal and state data collection and analysis capabilities.
49. Draw clear lines around privacy.

Reform outdated institutional structures.

50. Create new, responsive transportation institutions for the 21st century.

Introduction

In 1908, Henry Ford introduced the Model T, cementing the dominance of the internal combustion engine in the emerging market for automobiles. In 1916, Congress adopted the Federal Aid Road Act, establishing the precedent of the federal government providing matching funds for state-directed highway improvements, provided that those highways remain free to the public.[1] That same year, New York City adopted the nation's first zoning code – separating commercial and residential land uses. In 1919, Oregon adopted the first state gas tax, which would come to be dedicated to highway construction and maintenance.



Henry Ford with Model T, 1921; Google car, 2016. Photo credits: Wikimedia, unknown, CC 0; Grendelkhan CC-BY-SA 4.0.

These technological and policy innovations created the framework that would govern American transportation and land use policy for the next century. Policies and technologies have evolved since then, but the basic assumptions, institutional structures, traditions and folkways – the genetic code – of U.S. transportation policy are little different than they were a century ago.

The early 20th century architects of those policies could not have imagined the results of their handiwork – both positive and negative – for the nation. And they certainly could not have envisioned that the decisions they made would one day contribute to the crisis of a warming planet.

Those visionaries also could not have imagined the cornucopia of advanced technologies – from smartphones to electric vehicles to robotics – that today provide us with new opportunities to address the critical social problems caused by our transportation system, including global warming.

America cannot expect to harness 21st century technologies and trends to address global warming within a policy framework developed to bring America out of the horse-and-buggy era. A new set of assumptions and priorities are needed to animate transportation policy in the 21st century – with the prevention of dangerous climate change a central and defining goal.

> *A new set of assumptions and priorities are needed to animate transportation policy in the 21st century.*

This report outlines a series of 50 immediate, practical steps by which state and federal policy-makers can begin to retool American transportation policy to respond to global warming. It also proposes a series of common-sense principles to guide climate-friendly transportation policy – and illustrates the

Today, we have the opportunity through our transportation policy and infrastructure decisions to shape the next century of American life.

many ways in which our current policies, which evolved to meet the very different challenges of a century ago, have become maladaptive in an era of climate change.

Many of the recommendations in this report are not new, having been championed by organizations of transportation professionals, leading transportation experts, and environmental, public health and community advocates for years. Many also promise to do much more than reduce carbon pollution – delivering benefits for our health, our economy, and the quality of life in our communities.

A century ago, advocates of a modern road network in the United States grappled – as we do today – with the limitations imposed by outdated policies and assumptions from another era.

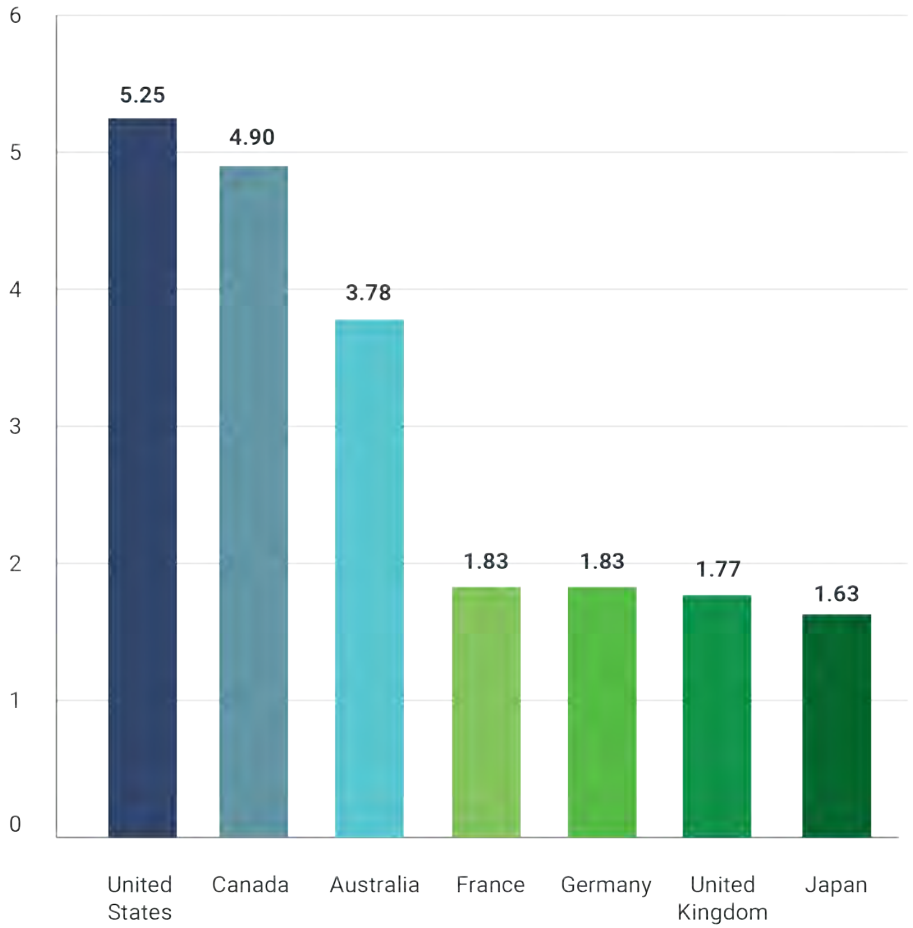
The planners, policy-makers and technologists of the early 20th century were bold in challenging established orthodoxies, adopting promising ideas from around the world, and proposing new ideas for public policy. Their efforts shaped America beyond their wildest imaginings.

Today, we have the opportunity through our transportation policy and infrastructure decisions to shape the next century of American life – and ensure the future health and prosperity of our country and the world. The stakes have never been higher. The need for bold thinking has never been greater. The time to act is now.

A New Way Forward: The Path to a Climate-Friendly Transportation System

Global warming poses a growing threat to the United States and the world. The wildfires, killer heat waves, massive floods and episodes of ecosystem destruction (such as the bleaching of the Great Barrier Reef) that affected regions around the globe in 2016 are illustrative of the "new normal" that awaits us, even if we stop polluting the atmosphere with greenhouse gases tomorrow. If the world continues to release carbon pollution at ever-growing rates, scientists warn that even more dangerous, large-scale disruptions to the climate will become inevitable.

Figure 1. Transportation Carbon Dioxide Emissions per Capita by Country (metric tons)[4]



In December 2015, the leaders of the world gathered in Paris to redouble their commitment to prevent the worst impacts of global warming. The ensuing Paris Climate Agreement committed the world's nations – including the United States – to preventing an increase in global average temperatures of 2°C or more above pre-industrial levels, with a further aspiration to holding temperature increases to 1.5°C or less.

Those commitments can only be fulfilled with significant and immediate reductions in greenhouse gas emissions by nations around the world. In the United States, preventing a global increase in temperatures of 2°C above pre-industrial levels will require emission reductions of at least 80 percent by 2050.[2]

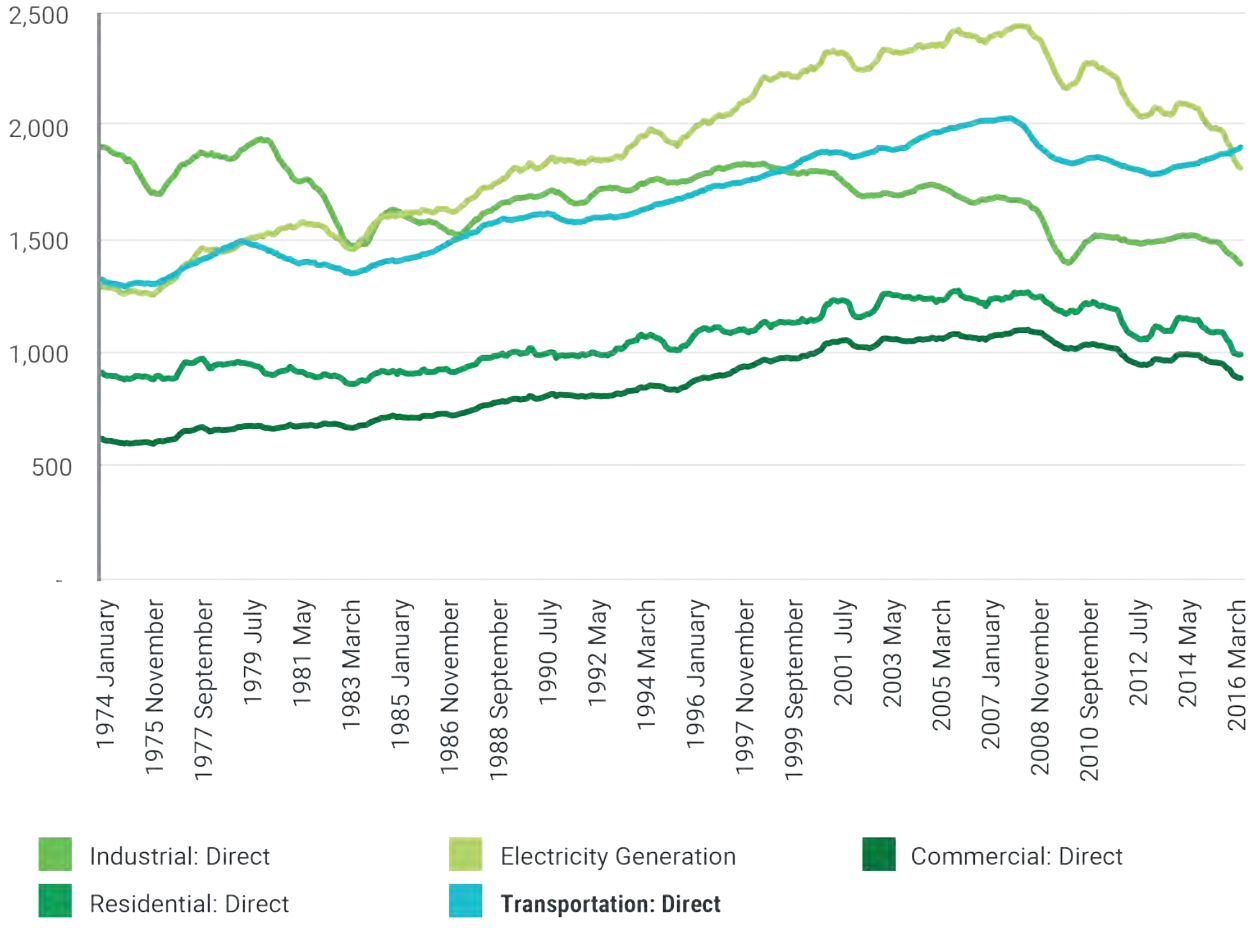
In the United States, Transportation Is Climate Enemy #1

America is the world's second-leading source of greenhouse gases, behind China. But when it comes to greenhouse gas pollution from transportation, the United States is in a class by itself.

America's transportation system produces more carbon pollution per capita than that of any major industrialized nation, and accounts for 4 percent of all greenhouse gas pollution worldwide.[3]

Moreover, in 2016, America's transportation system overtook electricity generation as the number one source of carbon dioxide in the United States, the result of increased vehicle travel and stagnating vehicle fuel economy.[5]

Figure 2. U.S. Carbon Dioxide Emissions from Fossil Fuel by Sector, Preceding 12 Months[6](Million Metric Tons)



"Direct"= emissions related to direct combustion of fossil fuels, excluding emissions related to electricity consumption.

The United States faces the unique challenge of transforming a transportation system that produces more carbon pollution than any other in the world to one that produces little or no carbon pollution – and doing it within the next 35 years.

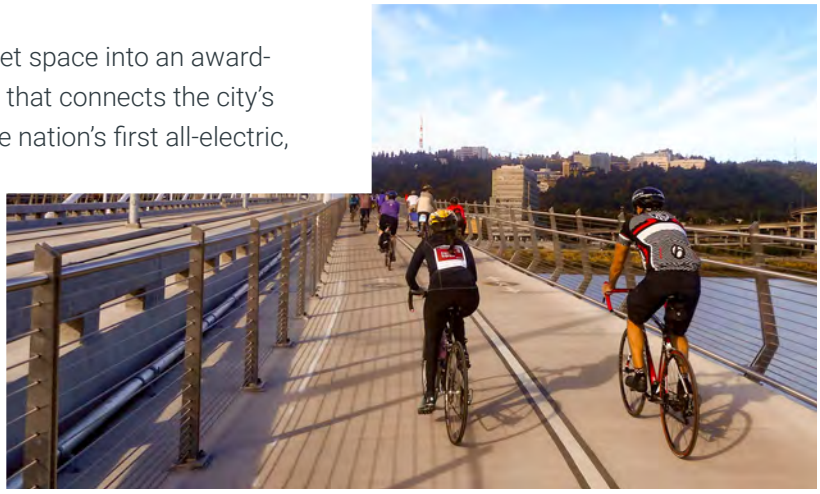
Can it be done?

Achieving a Zero-Carbon Transportation System

An array of proven measures and new and emerging technologies create the potential for America to transition to a zero-carbon transportation system.

The types of changes needed to bring a zero-carbon transportation future into being are already beginning to happen in small but promising ways in places around the country. Consider:

- In Pittsburgh, the transportation networking company Uber has launched the first publicly available "ridesourcing" service using autonomous vehicles, which some analysts believe can help accelerate deployment of shared, electric vehicles that reduce carbon pollution.
- In Colorado, local governments tapped into growing enthusiasm for electric vehicles (EVs) by launching an innovative group discount program for EVs that has put more than 300 electric cars and 80 electric bikes on the road since mid-2015.[7]
- In Portland, Oregon, city residents in 2015 welcomed the opening of the Tilikum Crossing Bridge – the largest car-free bridge in the United States, which carries pedestrians, cyclists, buses, streetcars and light rail vehicles over the Willamette River. In its first year, the bridge carried more than 615,000 bicycles as well as Portland's newest light rail line, the MAX Orange Line.[8]
- In Indianapolis, city leaders converted excess street space into an award-winning "cultural trail" for cyclists and pedestrians that connects the city's cultural districts. Indianapolis is also the site of the nation's first all-electric, station-based carsharing program: BlueIndy.
- Cities from Nashville to Los Angeles to Seattle have unveiled sweeping proposals for new investments in public transportation, hoping to reorient future development away from car-oriented sprawl, while other cities are restructuring bus networks and exploring new tools for connecting people to transit.



In Portland, Oregon, city residents in 2015 welcomed the opening of the Tilikum Crossing Bridge, which is used by pedestrians, people on bikes and the MAX light rail system. Photo credit: Wikimedia user Tedder, CC BY-SA 4.0

- Cities around the nation have adopted "Vision Zero" policies and plans aiming to reduce traffic deaths to zero – efforts that can make walking and cycling more attractive and viable ways for people to meet transportation needs.
- When electric automaker Tesla unveiled its new Model 3, more than 300,000 people made advance reservations to buy the $35,000 vehicle, which is expected to sport greater than 200-mile all-electric range, when it goes on sale in 2017.
- When the U.S. Department of Transportation (U.S. DOT) issued its "Smart City Challenge" – a competition for a $40 million grant for innovative strategies to use new technologies to address transportation challenges – 77 cities applied, a response the U.S. DOT labeled "overwhelming."[9]

All over the United States, in cities large and small, fresh thinking, new ideas and rapidly emerging technologies are creating a world of new possibility in transportation. Long associated with the worst of city life – congestion, pollution and noise – urban transportation is being reimagined in ways that can support the development of vibrant local economies, healthier people and a cleaner environment.

Urban transportation is being reimagined in ways that can support the development of vibrant local economies, healthier people and a cleaner environment.

Numerous academic, non-profit and government studies have shown that large-scale reductions in carbon pollution from transportation are technically possible in the next three decades, using a variety of strategies.[10] New technologies create additional opportunities, with studies suggesting that mass adoption of shared, autonomous and electric vehicles could slash greenhouse gas pollution from transportation by 90 percent or more – especially if accompanied by public policies that limit increases in driving and auto-intensive sprawl.[11]

Tapping the potential of new technologies and proven approaches to curb carbon pollution, however, will take a new vision for transportation policy, and leadership from federal, state and local leaders to make it a reality.

Envisioning a Zero-Carbon Transportation System

In May 2016, Frontier Group published ***A New Way Forward***, which explored a series of pathways by which American cities might eliminate greenhouse gas emissions from urban light-duty vehicles by mid-century.[12] The pathways incorporated unique mixes of new and old ideas, tailored for the needs of specific types of urban areas, showing that every type of city has a viable way forward in the effort to prevent dangerous global warming.

It also described a ***New Transportation Toolbox*** of strategies that – especially if combined in ways that maximize synergies among them – can help to create a zero-carbon transportation system. Among those strategies are:

Repowering Vehicles: Efficient electric vehicles that can be powered by clean, renewable electricity are entering the marketplace faster than the hybrid cars of a decade ago, and technology continues to improve, reducing costs and increasing travel range. Electric vehicles reduce carbon emissions even when using electricity from today's grid, and will deliver greater benefits in the years to come as America transitions to electricity provided by clean, renewable sources of energy.[13]

Urbanization and Smart Growth: American cities – especially their downtowns – are experiencing a renaissance, driven by a growing desire for walkable living. A future in which most new development takes place in urban and walkable neighborhoods could reduce transportation greenhouse gas emissions by 9 to 15 percent by mid-century, according to research by the Urban Land Institute.[14]

Shared Mobility: Over the last decade, an explosion of technology-enabled services – from carsharing to bikesharing to Lyft and Uber – has revolutionized transportation in many cities. Some of these "shared mobility" services have been shown to reduce vehicle ownership and driving, while the effects of others are just beginning to be studied.

Public Transportation: Transit ridership hit a modern high in 2014, the result of recent transit expansion projects and growing urban population and employment.[15] Current public transportation services reduce vehicle travel (and greenhouse gas emissions) by about 10 percent in U.S. cities, according to research conducted for the Transportation Research Board.[16]

Transit ridership hit a modern high in 2014, the result of recent transit expansion projects and growing urban population and employment.

Reallocating Space: The vast majority of street space in American cities is devoted to moving or storing cars, pushing people who walk, bike or take transit to the margins. Cities in the United States and around the world are reallocating space formerly devoted to cars to other public purposes, encouraging the use of low-carbon modes of transportation. U.S. cities with good bicycling infrastructure have nearly twice as many bike commuters as the national average.[17]

Smart Pricing: Americans typically pay nothing to drive on most roads and enjoy the lowest gas taxes in the industrialized world. Government subsidies for driving and parking, along with free access to roads and policies that encourage annual pricing for auto insurance and other costs of driving, create economic signals that encourage Americans to drive and put competing low-carbon transportation

Cities around the world have shown that smart pricing policies can reduce congestion and encourage the use of low-carbon modes of travel.

modes at an economic disadvantage. Cities around the world have shown that smart pricing policies can reduce congestion and encourage the use of low-carbon modes of travel.[18]

Walking and Biking: Americans prefer walking to any other mode of transportation, according to a recent survey, and the number of people traveling by bicycle in many cities has grown dramatically in the last decade.[19] The Institute for Transportation and Development Policy estimates that bicycling alone could curb global carbon dioxide emissions from transportation by 11 percent by 2050.[20]

Information Technology: Advances in technology are enabling Americans to plan, schedule and pay for trips via low-carbon modes as easily as traveling by car. Real-time transit information has already been shown to trigger modest increases in transit ridership.[21]

In addition, **autonomous vehicles** can be deployed in ways that reduce greenhouse gas emissions – especially if they facilitate the use of shared mobility services, vehicle electrification and smart pricing. Intelligent public policy can help to realize these benefits while preventing alternative scenarios that lead to marked increases in vehicle travel and pollution.

The smart application of tools from this New Transportation Toolbox can drive large-scale reductions in carbon pollution from transportation consistent with those the United States must achieve if it is to meet its goals under the Paris Climate Agreement.

Not every tool in the toolbox will be equally important everywhere. ***A New Way Forward*** describes several pathways by which a variety of cities – dense coastal cities, formerly industrial Midwestern cities, growing Western cities, and the sprawling cities of the Sun Belt – can combine the tools in unique ways to reduce pollution, improve the efficiency of the transportation system, and support economic, public health and societal equity goals.

Such a transformation is only likely to occur, however, with encouragement from federal and state policy. Today, however, federal and state transportation policies often work to hinder – not support – the emergence of a climate-friendly transportation system. To craft a new transportation policy capable of forwarding climate action in the 21st century, it is first necessary to understand how our current transportation policy framework impedes climate progress.

Reality Check: How U.S. Transportation Policy Fails the Climate

America has less than 35 years – just over a generation – to virtually eliminate greenhouse gas emissions, including from our transportation system. The infrastructure investments and public policy decisions we make today will shape that transition for decades to come.

America has less than 35 years to virtually eliminate greenhouse gas emissions.

The transformation to a zero-carbon transportation system will be technically complex – affecting hundreds of millions of vehicles, the cities and towns where hundreds of millions of Americans live, and the public policies adopted by thousands of units of government in all corners of the United States.

The principles to guide that transformation, however, are simple and common sense.

By realigning federal and state policy to follow those principles, America can take strong steps toward building a zero-carbon transportation system. But we have a long way to go. By nearly any measure, U.S. transportation policy currently makes progress toward a zero-carbon future *more difficult* – not easier.

Common Sense Principle 1: Climate Concerns Should Inform Every Transportation Policy Decision

The old management dictum states that you can't manage what you don't measure.

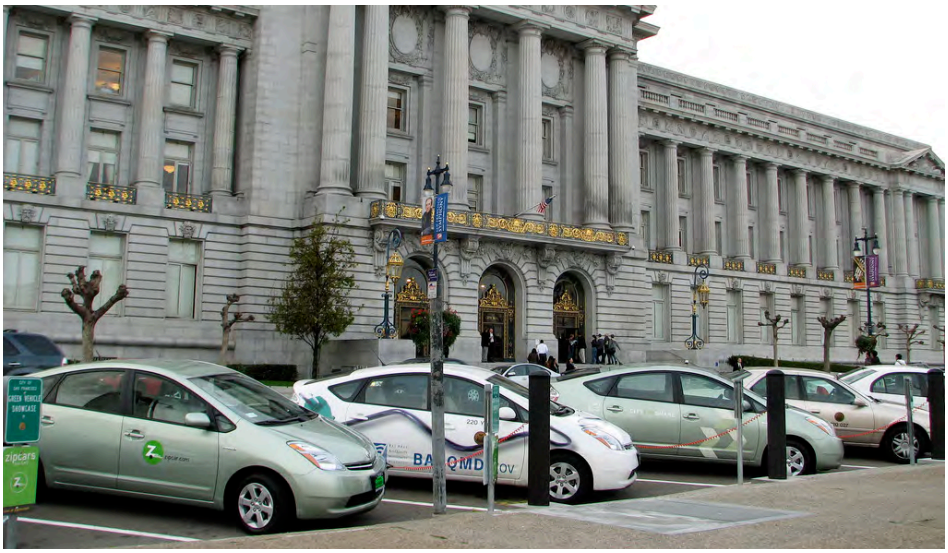
For decades, the United States has failed to measure the climate impacts of key transportation policy and infrastructure investment decisions, or to incorporate climate concerns into transportation decision-making. At the federal level, and in some states, that is now beginning to change. But to manage the transition, the United States will need to set emissions targets, regularly measure progress toward them, create mechanisms for accountability, and evaluate every major transportation decision, in part, by whether it aids in or hinders progress toward a zero-carbon transportation system.

The Reality: Climate Change Is Rarely a Factor in U.S. Transportation Decision-Making

Federal Laws Have Not Required Climate Analysis of Transportation Decisions

At the federal level, there are at least three major laws that could be used to bring climate concerns into transportation decision-making:

National Environmental Policy Act (NEPA): NEPA requires that agencies assess the effects of all "major Federal actions significantly affecting the quality of the human environment" – including federally funded transportation projects.[22] Until recently, the rules governing environmental assessments under the act allowed for, but did not require, the consideration of greenhouse gas emissions impacts of transportation projects.[23]



Seven states have adopted enforceable caps on carbon pollution, but only one – California – has incorporated transportation fuels into its carbon pricing system. Below, electric cars charge at stations outside San Francisco City Hall. Photo credit: Flickr user CalCars and edited by Flickr user Mariordo, CC BY-SA 2.0.

In August 2016, however, the Obama administration issued final guidance requiring federal agencies to consider greenhouse gas emissions in NEPA reviews.[24] The guidance will add a new layer of transparency and accountability to transportation decision-making with regard to the climate.

Incorporating greenhouse gas emission impacts into NEPA environmental assessments does not guarantee that those impacts will be estimated accurately or treated seriously. Identification of a significant environmental impact in a NEPA review does not necessarily compel governments to mitigate that impact. Past environmental impact statements have included only a cursory examination of the greenhouse gas impacts of major infrastructure projects.[25] And greenhouse gas evaluations that look solely at the short-term effects of a highway expansion at a local level can miss important effects – such as induced travel demand – that increase emissions at a regional scale and over a longer period of time.

Including robust, accurate and comprehensive greenhouse gas analysis of transportation projects as part of the NEPA review process could enable climate impacts to be understood by the public and decision-makers and factored into the debate over whether those projects should proceed.

Moving Ahead for Progress in the 21st Century (MAP-21) Performance Measures: MAP-21, the federal transportation law adopted in 2012, established performance monitoring, reporting and goal-setting requirements for a range of transportation outcomes, from safety to congestion relief. The performance targets required of states in the law are non-binding.

In 2016, the Obama administration requested comment on a proposal to require states to set greenhouse gas performance standards intended to guide transportation plans.[26] The proposed targets would put states on the record for specific greenhouse gas reduction commitments, and allow for evaluation of states' progress in meeting those targets over time.

Clean Air Act: The federal Clean Air Act empowers the federal government to take action to limit emissions of pollutants from motor vehicles that "may reasonably be anticipated to endanger public health or welfare."[27] The federal government has used this authority to set greenhouse gas standards for light-duty vehicles and heavy-duty trucks. (See page 42).

However, the Clean Air Act also provides a lever to compel states to develop transportation plans consistent with achieving or maintaining healthy air quality. States whose air quality falls short of national ambient air quality standards (NAAQS) are required to adopt state implementation plans that specify the steps states will take to reduce pollution to safe levels, or to maintain clean air in the event the standards have already been met.

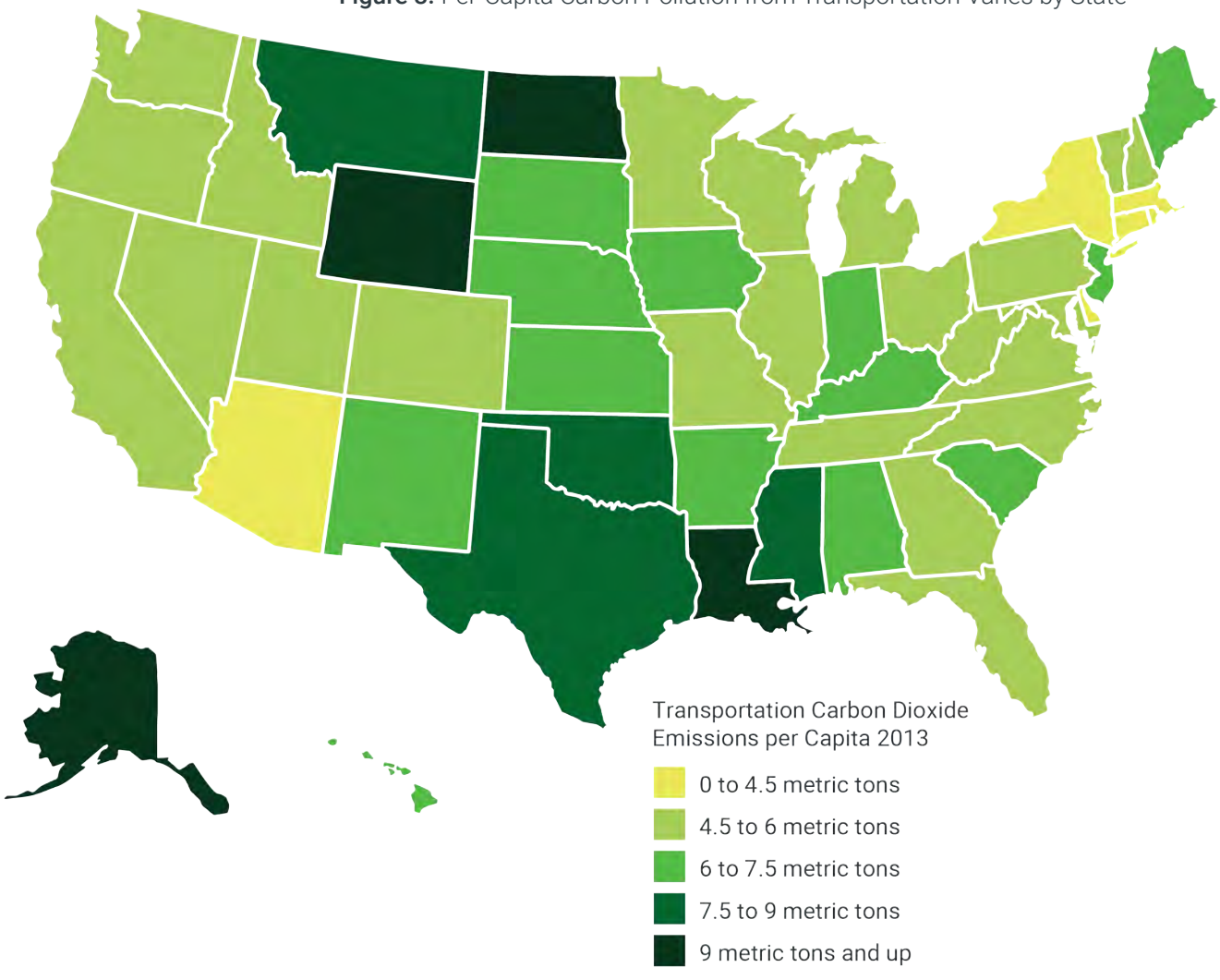
The act requires that transportation plans in areas that violate (or have previously violated) clean air standards be assessed for their conformity with clean air goals.[28] The conformity process is designed to ensure that federal money is not spent on transportation projects that will worsen air quality problems.[29] But, while greenhouse gases (GHGs) are regulated as pollutants under the Clean Air Act, no NAAQS for greenhouse gases have yet been established by the EPA, and no conformity process for greenhouse gases exists.

In short, until recently, the three main federal statutes that might be used to require assessment, disclosure and accountability for greenhouse gas emissions resulting from transportation infrastructure decisions all failed to do so. Pending improvements in the NEPA process – and the potential adoption of GHG performance measures under MAP-21 – create new opportunities to ensure that climate impacts are considered during the planning of transportation projects.

Until recently, the three main federal statutes that might be used to require assessment, disclosure and accountability for greenhouse gas emissions resulting from transportation infrastructure decisions all failed to do so.

One notable aspect of federal policy in which climate concerns have been given consideration is in the allocation of funds under the U.S. Department of Transportation's **discretionary capital grant programs**. Both the transit "New Starts" and "Small Starts" programs and the Transportation Investment Generating Economic Recovery (TIGER) grant program consider environmental sustainability – including measures related to the climate – in assessing the projects competing for federal funds.[30]

Figure 3. Per-Capita Carbon Pollution from Transportation Varies by State[31]



Few States Set Greenhouse Gas Limits or Require Projects to Be Evaluated for Climate Impacts

A few leading states have taken action to establish binding limits for greenhouse gas emission reductions across the entire economy, and several also require that climate impacts of transportation plans or projects be quantified in planning efforts. Only California, however, has begun to take the kind of bold steps needed to realign transportation policy with the need to address climate change.

States have several opportunities to set policies to measure and limit carbon pollution from transportation:

Enforceable caps on carbon pollution: Seven U.S. states – California, Connecticut, Hawaii, Maryland, Massachusetts, New Jersey and Rhode Island – have established binding, economy-wide targets for reducing greenhouse gas emissions.[32] Of those states, only one – California – has established an enforceable cap on carbon pollution from transportation fuels, which is incorporated within the state's multi-sector carbon cap-and-trade system. Under California's program, the carbon cap, which also covers the electric power sector and large industrial facilities, is reduced by 3 percent per year between 2015 and 2020.[33]

In 2016, Massachusetts' Supreme Judicial Court ruled that the state had failed to adopt regulations sufficient to ensure that the state's legally mandated emission reduction targets would be met.[34] The decision may result in the adoption of specific regulations for transportation emissions or the inclusion of transportation emissions within a carbon cap-and-trade program.

Many other states have non-binding greenhouse gas emission targets designed to guide policy action, but in many cases, the policy steps called for in those plans have not been implemented.[35] A 2012 report produced as part of the National Highway Cooperative Research Project (NHCRP) found that only six states and 12 metropolitan planning organizations (MPOs) of those surveyed had greenhouse gas emissions targets in place.[36]

Evaluation of transportation projects and policies for climate impacts: The effects of transportation investment decisions and policies on greenhouse gas emissions are often an afterthought – when they are considered at all – by state decision-makers.

Several states require that the greenhouse gas implications of transportation plans or projects be quantified and evaluated during the planning process.

New York, Washington, Massachusetts, California and Oregon, at minimum, require that major transportation projects and/or transportation plans include quantification and assessment of greenhouse gas emissions impacts.[37]

California, as a result of SB 375, passed in 2008, further requires the state's Air Resources Board to set regional targets for greenhouse gas emission reductions from passenger transportation and requires metropolitan planning organizations to produce "sustainable communities strategies" that incorporate transportation, land use and housing policies sufficient to meet the targets.[38]

The vast majority of states have not established binding greenhouse gas emission limits for transportation, nor do they provide clear and consistent guidance regarding how and when the greenhouse gas impacts of transportation projects and plans must be measured. Indeed, the 2012 NHCRP survey cited above found that only 10 percent of state DOTs and MPOs surveyed even ***considered*** greenhouse gas emissions in agency planning processes.

Climate considerations are also often missing from debates about transportation policy changes. In recent years, many states have increased the speed limits on their Interstate highways, especially in rural areas, a move that can lead to increased fuel consumption and greenhouse gas emissions. A 2013 study conducted by researchers at the Oak Ridge National Laboratory found that vehicle fuel economy drops by 12 percent on average when speeds increase from 50 to 60 miles per hour, a further 14 percent when speed increases to 70 miles per hour, and an additional 15 percent at 80 miles per hour.[39] In states like Pennsylvania, however, fuel consumption and emissions were not considered in decisions to raise speed limits.[40] When they have been considered, as was the case when the state of Michigan undertook a comprehensive evaluation of increasing speed limits, the effects on fuel consumption and emissions have been found to be significant.[41]

Highway expansion projects attract drivers and fuel sprawling development, usually leading to increased greenhouse gas emissions. Above, rush hour in Miami. Photo credit: Wikimedia user B137, CC BY-SA 4.0

The federally required addition of greenhouse gas analysis to the NEPA environmental review process, along with the potential adoption of greenhouse gas performance standards, will lead more states to consider the climate

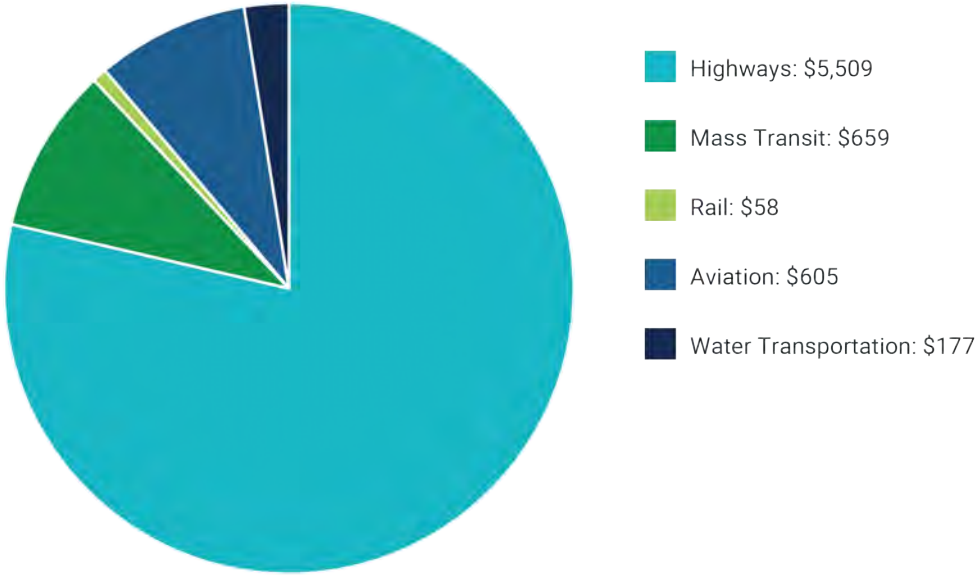
implications of transportation projects and plans. But states' refusal to take these steps to date, following a quarter-century of mounting evidence of the threat posed by global warming, suggests that continued vigilance will be needed to ensure that climate change is given appropriate weight in transportation decision-making.

Common Sense Principle 2: Low-Carbon Solutions Should Be at the Front of the Line for Transportation Funding

A worker who directed that her 401(k) be invested to achieve a specific set of goals would be shocked if the fund's manager turned around and invested it contrary to her wishes. Americans should be similarly shocked when the nation expresses a commitment to act on climate change even as government investment policies encourage the construction or expansion of high-carbon infrastructure.

Figure 4. Government Capital Investment in Transportation Since 1956 (Billions 2014)

Source: Congressional Budget Office



When it comes to transportation, the vast majority of public investment continues to flow toward highways – including expansion projects that fuel additional travel by high-carbon modes and exacerbate car-dependent forms of development. Budgets and investment policies are the surest and clearest statements of a society's values. Current transportation investment policies do not signal a commitment to a sustainable climate.

The Reality: America Spends Vastly More on Highways than on Low-Carbon Modes of Transport

Expanding highway capacity has long been understood to increase vehicle travel – and, by extension, greenhouse gas emissions – through the phenomenon of induced demand.

Investment in transportation infrastructure specifically geared toward bicyclists and pedestrians is minimal.

Adding new capacity to the highway network changes the behavior of people throughout a region. Wider highways lure people off transit and into cars, and draw people who had traveled earlier or later in the day to avoid traffic back to rush hour. Developers are attracted by new or widened highways to build new houses, stores and office parks farther away from already built-up areas. Walkable town centers see their commercial establishments flee to cheap land on the outskirts. Transit agencies struggle to retain customers and sustain the revenue needed to provide adequate, let alone high-quality service. And eventually, as sprawl spreads and transportation options dwindle, the highway becomes congested again, generating new calls for further expansion.

Research has shown that, all other things being equal, an increase in road capacity in an area will lead to a corresponding increase in vehicle travel.[42] When other greenhouse gas emissions impacts of highway expansion – including emissions generated in the construction of the highway and the emissions impact of traffic delays during construction – are taken into account, it is reasonable to assume that most highway capacity expansion projects will lead to a net increase in greenhouse gas emissions over time.[43]

By contrast, while investments in public transportation do not necessarily reduce highway traffic, they do support land use patterns that enable people to lead less car-intensive lifestyles and expand economic opportunities in urban areas, leading researchers to estimate that public transportation in the United States reduces vehicle travel and greenhouse gas emissions by approximately 10 percent.[44] Investments in bicycling and pedestrian infrastructure have received less study, but could be expected to substitute for some motorized travel as well.[45]

U.S. transportation investments since World War II have been dramatically skewed toward supporting high-carbon modes such as car, truck and air travel. Between 1956 and 2014, all levels of U.S. government spent a combined $5.5 trillion (2014$) on capital expenditures for highways, accounting for 79 percent of all government capital expenditure on transportation infrastructure during that time.[46] (See Figure 4.) Aviation accounted for an additional 9 percent of capital expenditures, nearly as much as was invested in public transportation nationwide.

This pattern of carbon-intensive investment continues today. In 2014, highways absorbed 68 percent of transportation capital expenditures by all levels of government, with aviation accounting for another 10 percent. Federal, state and

local governments currently spend approximately $200 billion per year – a little over 1 percent of U.S. gross domestic product – to operate, expand, maintain, administer and finance the nation's highways, roads and streets.[48]

Much of this money flows toward costly expansions of the highway network, as opposed to much-needed repairs. A 2014 report by Smart Growth America and Taxpayers for Common Sense found that, between 2009 and 2011, states spent $20.4 billion per year to build new roadways and add lanes to existing roads versus only $16.5 billion per year on repairs.[49]

Investment in transportation infrastructure specifically geared toward bicyclists and pedestrians is minimal. About 2 percent of federal transportation funds are dedicated to improvements in bicycling and pedestrian infrastructure, despite the fact that walking and biking account for about 12 percent of all trips made in the United States.[50] A 2016 study by Advocacy Advance estimated that states average just over $5 per capita annually in general fund spending on bicycling and pedestrian infrastructure.[51]

Advocates for highways sometimes argue that the bulk of road funding comes from highway users through gas taxes, and that roads "pay for themselves." This was never entirely true, and is less true today than ever, given slowing growth in gasoline consumption and the failure of governments to raise gas taxes to keep up with inflation.[52]

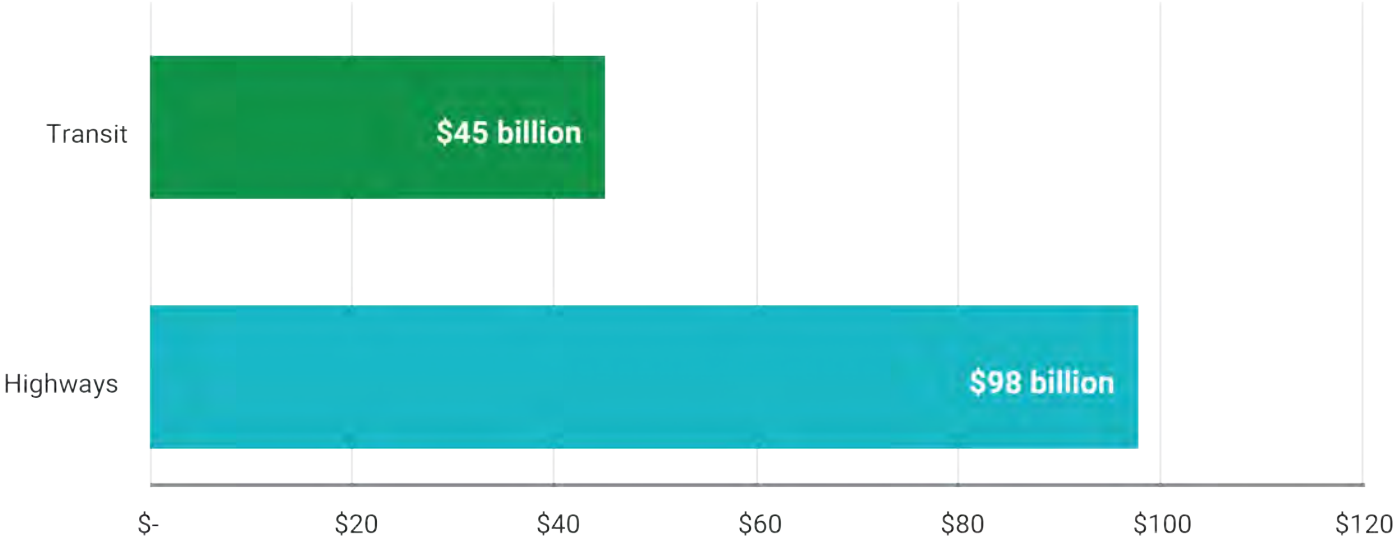
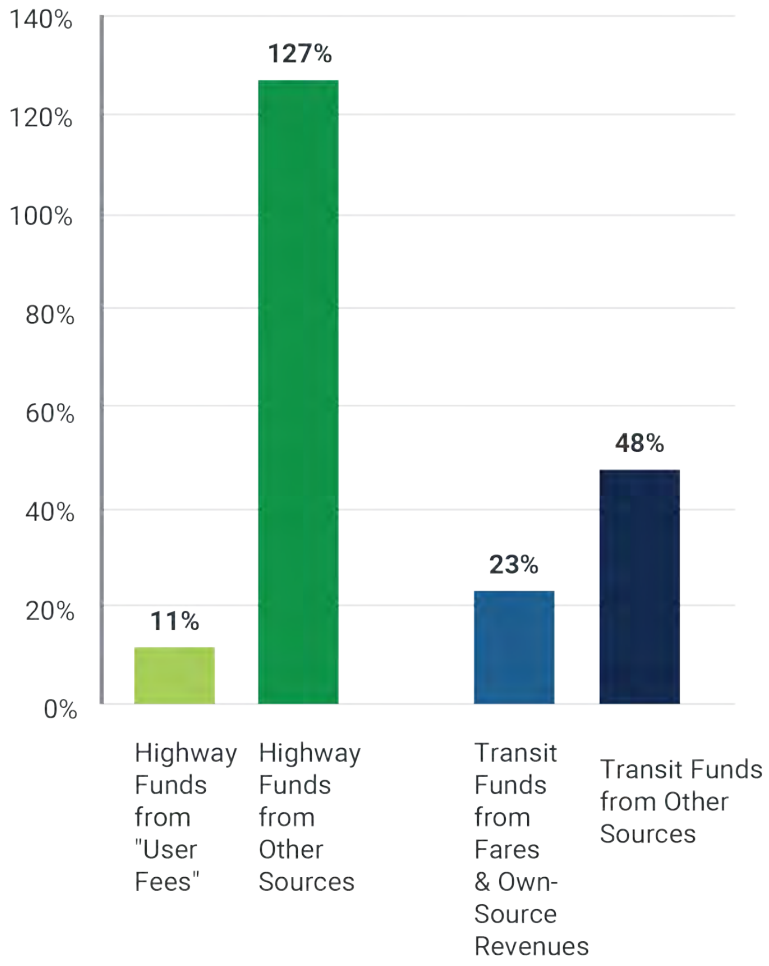


Figure 5. Non-User Funding for Highways and Public Transportation, All Levels of Government, 2014[53] (Billions)

Figure 6. Increase in User/Non-User Funds Used for Transportation: 1995 to 2012[56]



In 2014, non-user funds – much of them coming from income, property and sales taxes – provided $98 billion in funding for highways, compared with only $45 billion for public transportation.[53] (See Figure 5.) In other words, U.S. taxpayers provide more than twice the volume of subsidies to roads than they do to transit.

Since 1995, even as the dangers of global warming and the urgency of switching to low-carbon modes of transport have become more apparent, the balance of public subsidies has shifted ***even more dramatically*** toward highways and away from public transportation. According to data from the U.S. Department of Transportation, the amount of non-user revenue (or "supporting funds") for highways increased by 127 percent in inflation-adjusted terms between 1995 and 2012, compared with a 48 percent increase for public transportation.[55]

The Reality: Bureaucratic and Funding Hurdles Hamper Low-Carbon Transportation Investment

Many cities and some states are eager to change these patterns of investment – to dedicate a greater share of resources toward forms of transportation with broad community benefits and less impact on the climate. However, many local and state governments face institutional barriers that make investments in low-carbon infrastructure more difficult than highway expansion.

Federal matching programs privilege highway projects – States seeking to expand highways can often cover 80 percent of the cost with federal funding (90 percent for projects that are part of the Interstate Highway System) and face limited oversight from the U.S. Department of Transportation (DOT).[57] Decisions related to the expenditure of federal highway funds are primarily made by state DOTs and metropolitan planning organizations.

By contrast, most federally funded transit expansion projects require a much higher level of local financial support. The federal government's largest programs

for transit capital expansion – the New Starts and Small Starts programs – theoretically operate with the same 80 percent federal match as highway projects. But both programs rely on competitive grants, with local financial commitment an important criterion in determining which projects receive funding and which do not.[58] As a result, according to a 2012 Government Accountability Office report, federal funding for New Starts transit projects supplied only 45 percent of the project costs, rising to 67 percent for "Small Starts" projects.[59]

Governments looking to invest in transit may also tap into federal transit formula funds or funds that are "flexed" from highway programs. However, given competing demands for transportation investment, many states do not take advantage of these options. A 2012 Government Accountability Office study found that, between 2007 and 2011, states "flexed" only 10 percent of their available flexible transportation funding to transit, with four states – California, New York, New Jersey and Virginia – accounting for the majority of the transferred funds.[60]

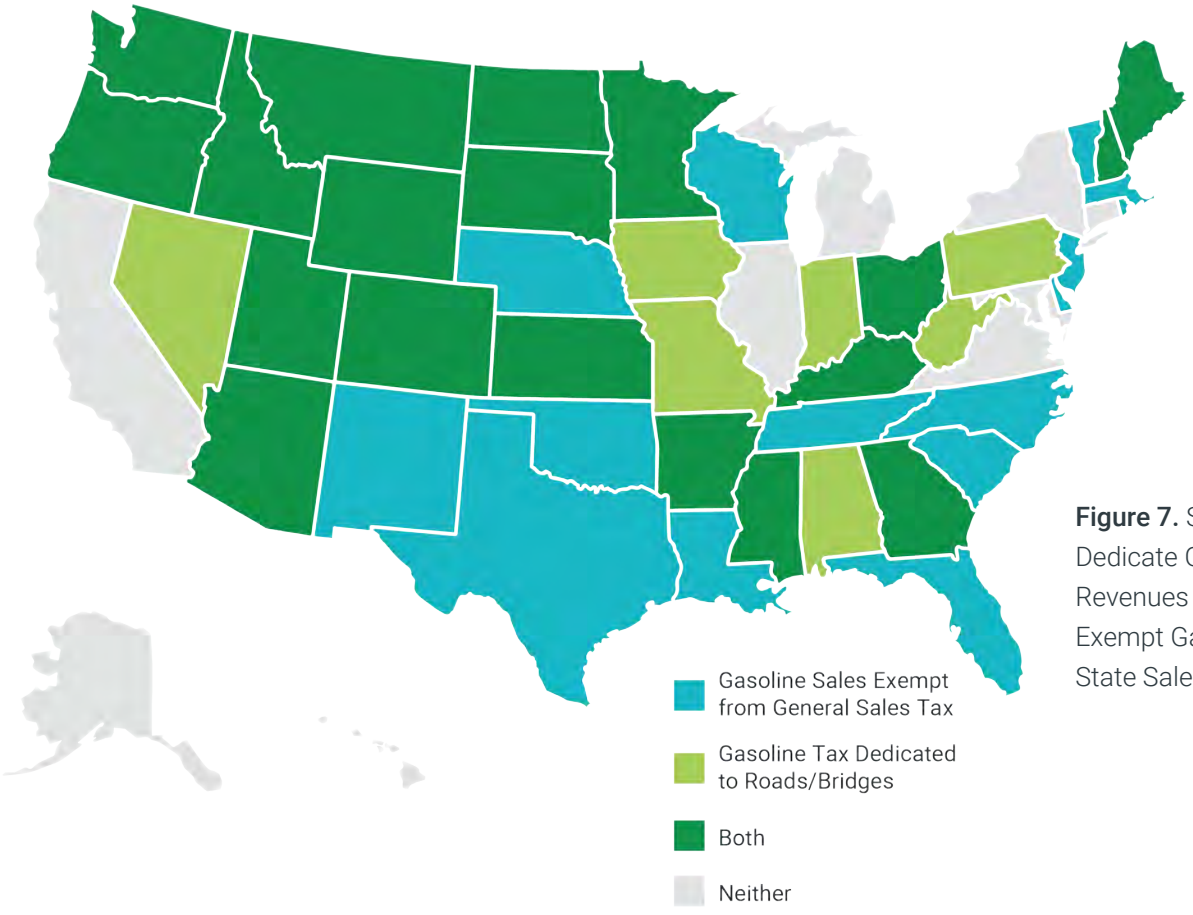


Figure 7. States that Dedicate Gas Tax Revenues to Roads, Exempt Gas from General State Sales Tax[61]

Requiring local governments and stakeholders to have "skin in the game" for transit projects – and to assemble a diverse package of financing as opposed to relying largely on federal largesse – is a good thing. So is comparing projects against one another on their merits. If these principles of cost-sharing and competition were applied to all major, federally funded transportation capital improvement projects – including highway projects – transportation funds would be spent more efficiently and on better projects, and all types of projects could be considered on a level playing field.

But for cities and states considering whether to spend limited local and state transportation dollars on highway or transit projects, the relative ease of obtaining federal funding for major highway improvements is an inducement to choose those projects over lower-carbon alternatives.

As of fiscal year 2014, 24 states spent the equivalent of less than a penny per person per day on state government support for public transportation.

State funding for low-carbon infrastructure is often limited or non-existent – If federal funding for low-carbon transportation infrastructure and services is lacking, one might expect state governments to fill the gap. However, institutional and legal barriers – along with political obstacles – often deter states from providing financial support for public transportation or other travel modes that support low-carbon lifestyles.

For example, 23 states have provisions in their state constitutions that bar the use of gas tax revenue for purposes other than roads and bridges; an additional three states have statutory provisions with similar effects.[62] Other states have specific provisions that direct most or all gas tax revenues either to roads and bridges or to transportation purposes generally.

Partially as a result, many states provide only token funding for public transportation – and sometimes no funding at all. As of fiscal year 2014, 24 states spent the equivalent of less than a penny per person per day on state government support for public transportation. These states house 113 million people and account for 42 percent of the nation's emissions of carbon dioxide from transportation.[63] If together they were a freestanding country, these 24 states would emit more greenhouse gas pollution from transportation than Japan, Germany, France and the United Kingdom – combined.[64]

Auto-centric policies limit investments in low-carbon infrastructure – Over the years, cities and states have adopted policies – often well-intentioned – that create barriers for investments in low-carbon transportation infrastructure and the addition of new development in already built-up areas, which is often more supportive of low-carbon transportation choices than building on the metropolitan fringe.

For example, many state environmental and planning laws require that new development or infrastructure be evaluated for its effects on automobile traffic congestion.[66] Level-of-service (LOS) standards, which grade roads on an A through F scale based on traffic flow, are commonly used as an indicator of congestion impacts. These metrics often put urban "infill" developments and facilities such as bus or bike lanes at a disadvantage, even if they reduce vehicle travel or greenhouse gas emissions over a broad area. Worse, they often require developers to mitigate traffic impacts by expanding roadway capacity – often making it more difficult for bicyclists or pedestrians to navigate an area safely.

In California, which enshrined level-of-service metrics in its flagship environmental law, the California Environmental Quality Act (CEQA), infill development projects were far more likely to be the target of CEQA lawsuits than projects on newly developed land, while transit projects were the most frequent target of litigation among public infrastructure projects, according to a study

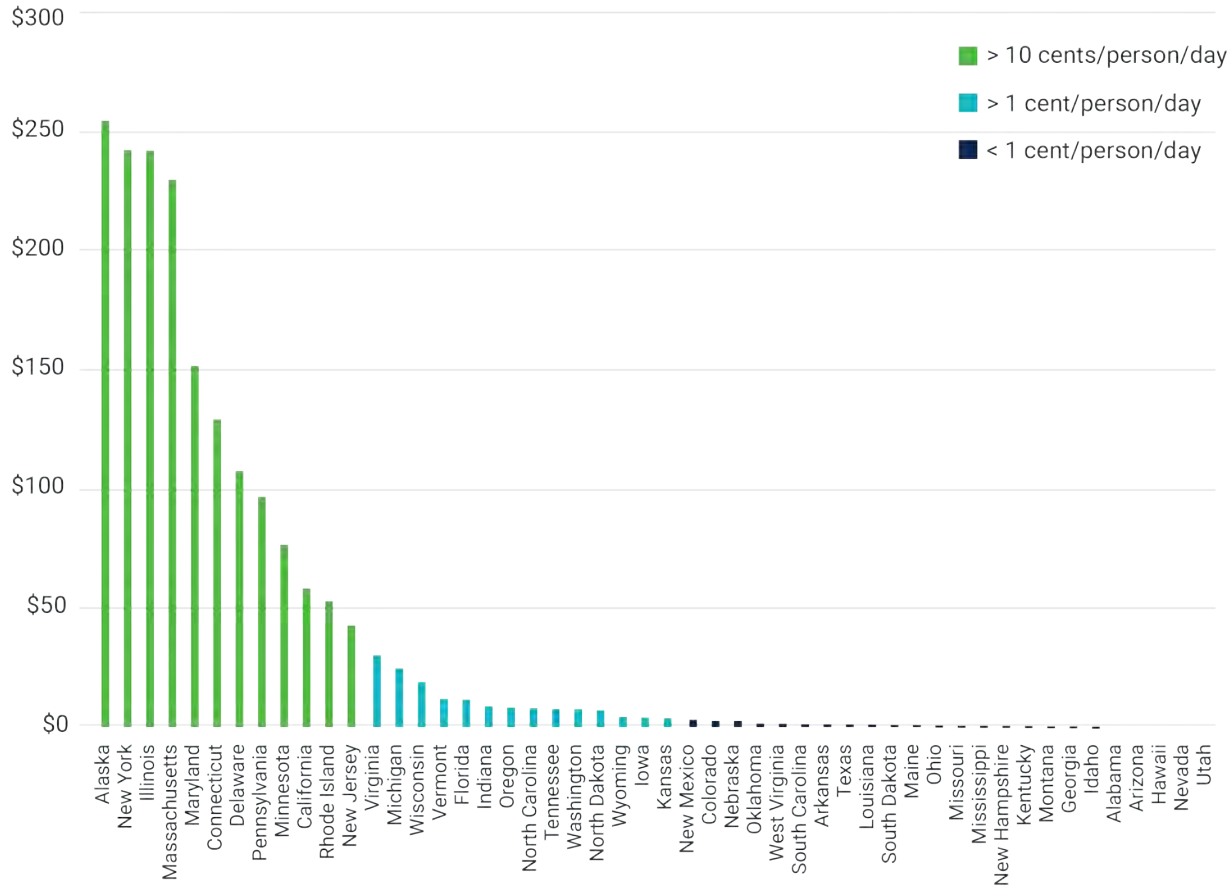
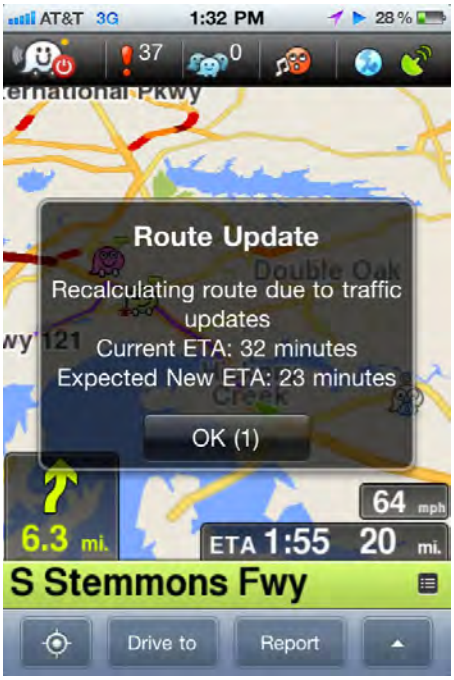


Figure 8. State Spending on Public Transportation per Capita[65] (FY 2014)

by the law firm of Holland & Knight.[67] California has since removed level-of-service from its evaluation of projects under CEQA, while the federal Department of Transportation has clarified that there are no federally imposed LOS requirements for federally funded highways.[68] Many state and local governments, however, continue to use these outmoded metrics.

Level-of-service is not the only measure that privileges the high-speed movement of vehicles over low-carbon transportation options or the development of walkable communities. In 2016, the U.S. Department of Transportation proposed national performance measures for congestion that focused on movement of vehicles, not people, a step that could drive states to deemphasize or devalue the needs of transit riders, pedestrians and people on bikes.[69]



Technology solutions – including smartphone apps like Waze (above) – can help to enable more efficient use of existing infrastructure. But public investment in technological solutions to traffic problems tends to lag well behind investments in infrastructure expansion. Photo credit: Flickr user Wesley Fryer, CC CC BY-SA 2.0.

The Reality: Programs to Reduce or Manage Travel Demand Are Poorly Funded

American transportation policy debates often focus on infrastructure – should we add more lanes of highway or more transit lines? But there is often comparatively little attention paid to, or money spent on, strategies that ensure that our existing infrastructure is used efficiently. Such strategies have the potential to significantly reduce greenhouse gas emissions.

These strategies have long been classified under the term "transportation demand management" (TDM). TDM strategies recognize that it can often be quicker, cheaper and more beneficial to address congestion and other transportation problems by reducing or shifting vehicle travel – through incentives to share rides, work from home, take transit or use active travel modes – than by adding new highway capacity.

High-quality, well-resourced TDM programs have shown impressive results in shifting travel habits. Arlington County, Virginia, for example, operates a comprehensive TDM program that partners with local businesses to provide an array of services – from real-time transit information screens in high-visibility locations to marketing campaigns directed toward residents, workers and visitors. As of 2011, the program helped shift more than 40,000 car trips per workday to higher occupancy modes of travel – reducing vehicle-miles traveled, congestion and pollution.[70] The program has a goal of reducing the share of trips taken by single-occupancy vehicles by 0.5 percent each year for the next 20 years. Many colleges and universities have created similar programs aimed toward students and staff.[71]

Technology solutions can also help to smooth traffic flow and manage demand, using electronic signboards, electronic tolling, automated traffic alerts, ramp metering and trip-planning tools that provide travelers with detailed, real-time information on alternatives to private vehicle travel. These "intelligent

transportation systems" have demonstrated the potential to deliver at least modest reductions in carbon emissions.[72]

TDM programs and technological solutions typically take a back seat to infrastructure expansion. While many cities and business districts have "transportation management associations" (TMAs) – private or public-private organizations charged with helping reduce or manage travel demand – these organizations often focus largely on commuting (which accounts for only 16 percent of all trips in the United States), not the overall travel needs of an area's residents, and usually operate with limited resources.[73] A 2014 survey of 51 TMAs found that more than half had annual budgets of between $100,000 and $500,000 per year.[74] Similarly, the Government Accountability Office (GAO) reported in 2012 that deployment of intelligent transportation systems had been "spotty" and their adoption by state and local governments had been "slow."[75]

Federal funding for transportation demand management – which accounts for two-thirds of all government TDM funding in the U.S. [76] – comes primarily through the Congestion Mitigation and Air Quality (CMAQ) program.[77] However, TDM efforts must compete with a myriad of other transportation programs in pursuit of these funds and receive only 4 percent of all funding allocated under the CMAQ program – approximately $40 million in 2014.[78] Intelligent transportation services, meanwhile, receive approximately 0.5 percent of federal surface transportation funding, despite cost-benefit ratios for these technologies that are vastly greater than highway expansions.[79]

State governments generally fail to prioritize TDM strategies, except during highway construction or other transportation system disruptions.[80] There are a few exceptions: Washington State, for example, has a long-running commute trip reduction program that provides technical assistance to employers to help them meet state targets for cutting vehicle trips to workplaces. The program is responsible for reducing approximately 33 million vehicle-miles of travel annually.[81]

The failure of state and federal governments to take full advantage of the potential for transportation demand management leaves a potentially large pool of low-cost carbon pollution reductions untapped. New modes of shared mobility that provide more ways for people to share vehicles and rides, coupled with improvements in information technology, create vast new opportunities for transportation demand management – if the people, resources and will exist to take advantage of them. Elevating the role of TDM as a strategy for addressing transportation problems can help to tap that potential.

The failure of state and federal governments to take full advantage of the potential for transportation demand management leaves a potentially large pool of low-cost carbon pollution reductions untapped.

Common Sense Principle 3: Public Policy Should Reward People for Making Low-Carbon Transportation Choices

At the very least, government policies should not penalize individuals or companies for making low-carbon transportation choices or reward those making high-carbon choices.

Americans will make low-carbon transportation choices when they are easier, more convenient, more comfortable and cheaper than higher-carbon alternatives. At the very least, government policies should not penalize individuals or companies for making low-carbon transportation choices or reward those making high-carbon choices. And market forces – which serve to balance supply and demand throughout the economy – should be employed appropriately to drive rational decisions by individuals, employers and governments.

Today, however, America's tax system fails to make drivers pay their fair share of the costs that driving imposes on the public – or even the cost of maintaining the roads on which they travel.[82] Key provisions of the tax code actually ***reward*** Americans for driving in some cases. Meanwhile, innovative modes of travel are often stifled by inequitable treatment under federal, state and local law.

Market forces, which might be employed to drive the adoption of economically efficient strategies to cut carbon pollution, are largely absent from the management of the transportation network. America's approach to transportation policy has been derided by some observers as "asphalt socialism,"[83] with free travel on most highways and free parking on many streets fueling excessive demand and shortages (in the form of congestion) that some have likened to Soviet bread lines.[84]

The result is a system that rewards and encourages people to use high-carbon modes of transportation – undercutting the nation's efforts to reduce global warming pollution.

The Reality: American Drivers Do Not Pay the Full Costs of Driving

The "polluter pays" principle is a cornerstone of environmental law – asserting that it is the responsibility of those who pollute the environment to pay for restoring the damage. The "user pays" principle has long been enshrined (in theory, if not in practice) as a cornerstone of the U.S. system of transportation finance – asserting that those who benefit from the use of transportation infrastructure should be responsible for its costs.

Both principles lead to one conclusion: to assure fairness and to deliver societally optimal results, those who engage in transportation activities that inflict damage on roads, pollute the environment, contribute to congestion, or impose other impacts on society should be held responsible for paying for the damage. Failing

to do so, in effect, subsidizes destructive practices and encourages them to continue.

One of the enduring myths of U.S. transportation policy is that drivers pay for the cost of the roads they use through gas taxes. In reality, however, general taxpayers contribute nearly as much to the construction and maintenance of the nation's road network as do drivers through so-called "user fees." In 2014, taxes on general taxpayers supplied $98 billion in highway funding, nearly as much as was supplied through fees such as gas taxes on highway users ($106 billion).[85]

One of the enduring myths of U.S. transportation policy is that drivers pay for the cost of the roads they use through gas taxes.

But driving does more than damage roads – it also damages human health, the environment and community quality of life. A 2007 study by researchers with Resources for the Future estimated that these and other "external costs" of driving was equivalent to approximately $2.10 per gallon of fuel consumed.[86]

Countries around the world have acknowledged the costs that driving imposes on society by setting high levels of taxation for motor fuels. According to a 2014 report by the Federal Highway Administration, the average gas tax rate in

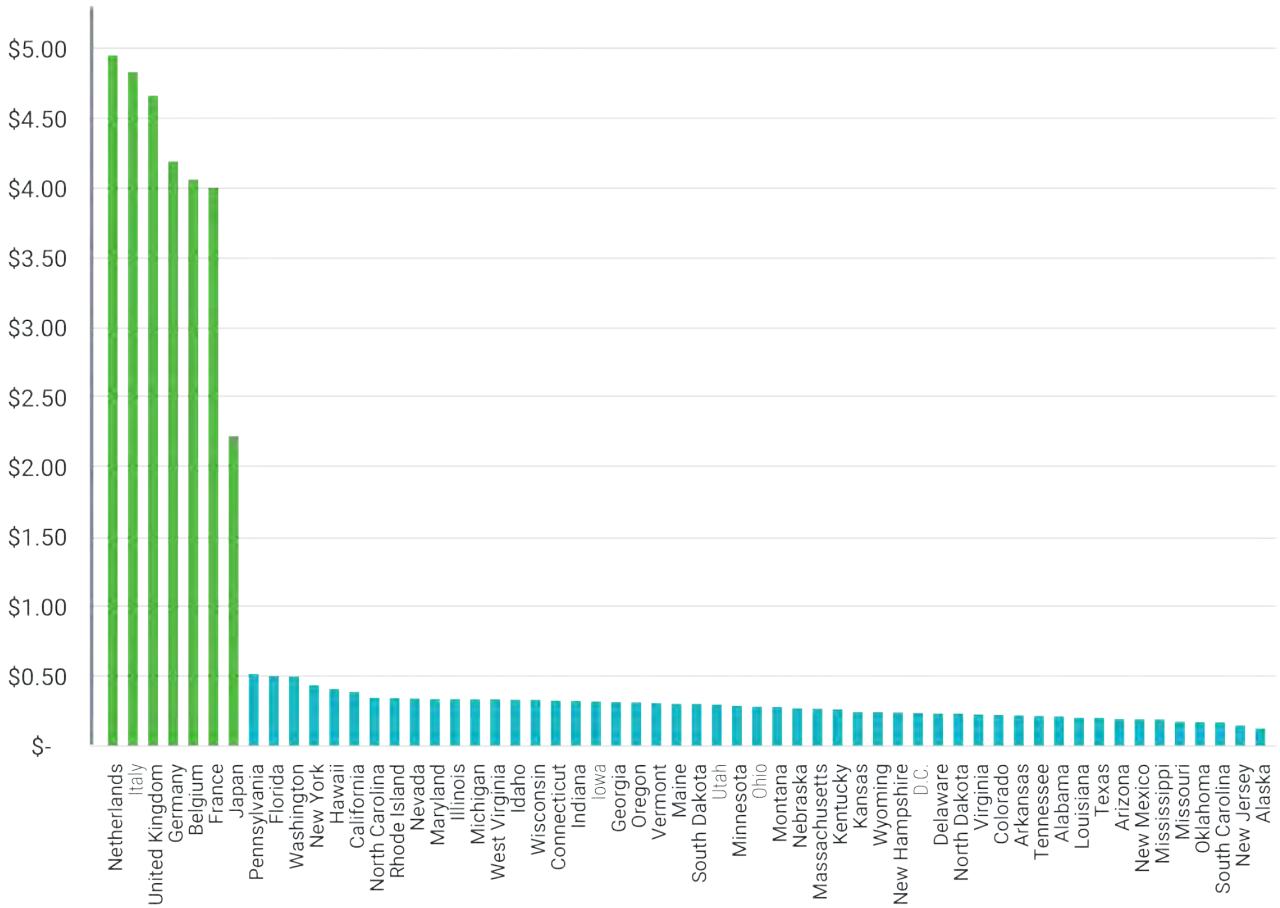


Figure 9. International and Domestic Gas Tax Rates, Compared[89] (Gasoline Tax Per Gallon)

the United States was 42 cents a gallon, compared with more than $4 a gallon in Germany and the United Kingdom.[87] In these countries, high gasoline taxes are seen as ways to recoup some of the societal costs imposed by driving, not as ways to raise revenues to pay for highway maintenance and construction.[88] Undertaking a similar shift in the purpose of fuel taxes in the United States – or augmenting gas taxes with carbon taxes or other similar fees – would ensure that any increases in taxation do not end up supporting highway expansions that lead to further driving and sprawl.

The Reality: Tax Incentives Provide Rewards for Driving

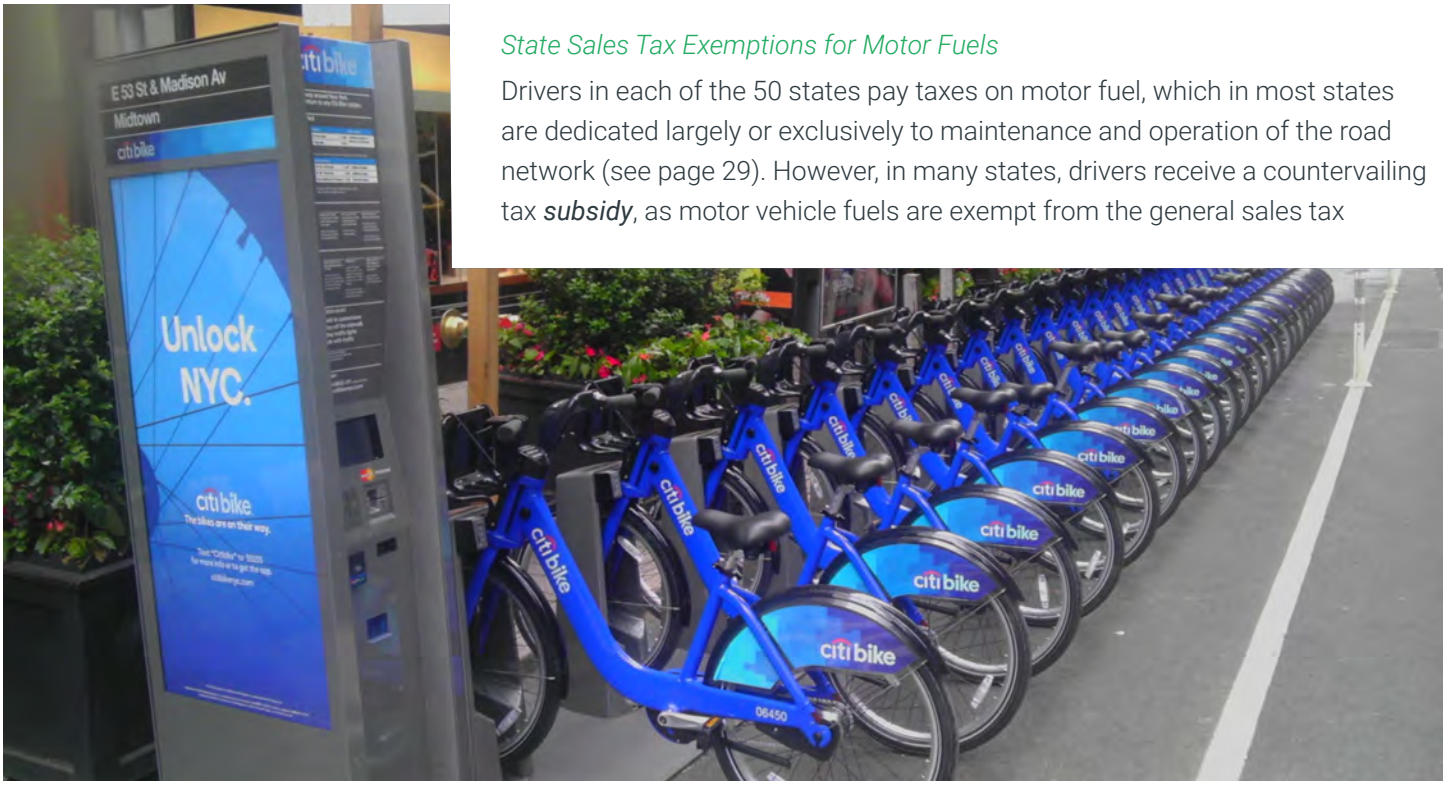
Governments often use the tax code to encourage societally beneficial behaviors or discourage damaging ones. The U.S. Treasury Department has identified more than 160 "tax expenditures" in the federal income tax code – provisions of the tax code designed, among other things, to incentivize basic scientific research, support adoption of clean energy technologies, and encourage home ownership through the home interest mortgage deduction.[90]

Tax expenditures function much like government spending – both represent the targeting of resources (taxpayer funds or tax money otherwise owed that is not collected) to specific purposes. State and federal governments provide tax expenditures that exclusively benefit motorists, transferring resources from general taxpayers to those engaged in a polluting activity.

State Sales Tax Exemptions for Motor Fuels

Drivers in each of the 50 states pay taxes on motor fuel, which in most states are dedicated largely or exclusively to maintenance and operation of the road network (see page 29). However, in many states, drivers receive a countervailing tax ***subsidy***, as motor vehicle fuels are exempt from the general sales tax

Policies such as the federal income tax exclusion for transit commuter benefits have failed to incorporate newer travel options like bikesharing. Below, bikesharing station in NYC. Photo credit: Wikimedia user Jim.henderson, CC0.



assessed on the majority of items that consumers buy. In the most extreme cases, when gasoline prices are high, the value of the sales tax exemption can exceed the value of the gas tax itself. A 2015 analysis estimated that, at then-prevailing gas prices, the value of the sales tax exemption for gasoline exceeded $9 billion annually.[91]

Commuter Parking Subsidy

The value of parking provided by employers for the use of their workers is exempt from taxation under federal and state law, within certain limits. A 2014 TransitCenter/Frontier Group report estimated the value of this tax expenditure at greater than $7 billion.[92] The commuter parking subsidy likely has an outsized impact on greenhouse gas emissions from vehicles, as it is most valuable in large cities with downtowns where parking is expensive. These cities also tend to experience severe congestion, meaning that the tax provision encourages people to drive in the most congested cities at the most congested times of day.

The Reality: Tax Policies Limit Growth of Innovative Travel Modes

Over the past decade, an array of new "shared mobility" services have emerged in the United States – from carsharing to bikesharing to "ridesourcing" services provided by transportation network companies such as Lyft and Uber. These new modes have often been born into regulatory uncertainty, with rules and policies designed to govern traditional business models suddenly proving ill-equipped to meet the new demands and opportunities presented by new market entrants.

Some shared mobility services – including carsharing and bikesharing – have been shown to reduce greenhouse gas emissions, in part by encouraging people using those services to sell or forgo the purchase of a personal car.[93] In order for these services to survive in the marketplace and expand to serve more Americans, they must be treated equitably under the tax code. Unfortunately, current tax policies make it more costly for some of these services to operate.

Here are two examples:

Taxation of Carsharing

Local and state governments often find it politically easier to raise revenue by taxing tourists and other visitors than by taxing residents. Over the years, this has led many governments to impose taxes on services visitors tend to use more frequently than locals, including hotels, restaurant meals and car rental.

In many states, however, tax policies applied to traditional car rentals have also been applied to carsharing, significantly increasing the cost of short-term vehicle rentals to local residents. More than 40 states tax rental cars, while 15 states

In many states, tax policies applied to traditional car rentals have also been applied to carsharing, significantly increasing the cost of short-term vehicle rentals to local residents.

empower local governments to assess their own rental car taxes.[94] A 2016 study by researchers at DePaul University found that eight of the 12 largest U.S. cities impose taxes of 15 percent or more on short-term carsharing rentals – a rate far higher than local general sales taxes and higher than taxes assessed on competing services such as Lyft and Uber. For the shortest reservations, those of one hour, nine of the top 40 U.S. cities impose taxes at rates exceeding 30 percent.[95] These high tax rates likely discourage many potential users of carsharing services – especially one-way carsharing services, whose users pay the same rental tax in some cities for a short, cross-town hop as a tourist might pay for an extended rental.

Exclusion of Shared Mobility Modes from Commuter Benefits

As discussed above, federal and state governments allow employers to provide workplace parking to their employers tax-free, within certain limits. A similar provision of the tax code enables employers to provide tax-free public transportation passes or benefits to their employees, as well as a smaller benefit available for commuter bicycle use.[96]

The commuter tax exclusion is not available for shared mobility modes such as carpooling, carsharing and bikesharing.

The commuter tax exclusion, however, is not available for shared mobility modes such as carpooling, carsharing and bikesharing.[97] As a result, employees using these services must pay tax on the income used to pay for their commutes, while people driving to work receive valuable workplace parking tax-free. This arrangement inherently subsidizes personal private vehicle ownership and use, encouraging people to drive to work.

The Reality: Lack of Effective Markets Encourages High-Carbon Travel

Market-based mechanisms can help to ensure that the transportation system is used efficiently, while minimizing the costs of transportation system use on society and the environment.

The market for surface transportation in the United States is anything but efficient. The limited supply of roadway capacity on heavily traveled routes at peak periods is rationed not through the use of pricing, but through congestion, which is environmentally burdensome, not to mention aggravating to those forced to endure it. Meanwhile, the price charged for driving – which, in the United States, is theoretically wrapped into the price of motor fuel through the gasoline tax – comes nowhere close to paying for transportation infrastructure (see page 36), let alone offsetting the costs to society of driving.

Effective markets can also help to ensure that those who make choices that reduce congestion or pollution see the benefits of those decisions in their pocketbooks.

Free Roads and Free Parking

Access to the vast majority of U.S. roads and highways is free – despite the costs imposed by use of the roadways in the form of congestion, environmental damage, and road damage. As of 2015, there were 3,296 miles of tolled highways on the Interstate system and 2,260 miles on non-Interstate highways, an increase of 17 percent and 23 percent, respectively, since 2005.[98] Some of the increase is attributable to the creation of tolled "express lanes" adjacent to existing free highways. However, tolled highways still make up a minority of the nation's 65,000 miles of Interstates and freeways.[99] Failing to charge for highway use at periods of peak demand leads to overconsumption of limited highway space, resulting in congestion that wastes energy and often leads to calls for further highway expansion.

Free and subsidized parking – provided by many municipalities on streets or in off-street lots – also encourages overconsumption (leading to wasted fuel and increased emissions from vehicles "cruising" for parking) and represents a public subsidy to vehicle owners and users. In congested urban areas where parking is scarce, failure to price or regulate (e.g., through the issuance of residential parking permits that ration access to public parking spaces) can lead to negative results. In Boston, for example, some households legally park as many as 11 vehicles on city streets – for free – even as other residents drive endlessly to find a place to park, carsharing services find it difficult to expand their services, and parking concerns limit the expansion of safe infrastructure for cyclists and pedestrians. An analysis by the ***Boston Globe*** in 2015 found that 500 Boston housing units possessed five or more free residential parking permits.[100]

Use-based pricing of the road network – through mechanisms such as dynamic congestion pricing or cordon tolls – has the potential to reduce greenhouse gas emissions by encouraging the use of low-carbon modes of travel and by reducing congestion. The potential benefits are magnified if such pricing is paired with pricing measures that specifically address carbon pollution, such as gasoline taxes or carbon fees. The appropriate pricing of parking spaces, the elimination of municipally subsidized parking, and ending the implicit subsidy provided to vehicle owners as a result of minimum parking requirements for new development can also help to reduce vehicle travel and encourage the use of low-carbon modes.

Use-based pricing of the road network – through mechanisms such as dynamic congestion pricing or cordon tolls – has the potential to reduce greenhouse gas emissions.

Upfront versus Mileage-Based Charges

Many of the costs of car ownership are incurred in upfront, lump sum payments that vary little depending on the distance driven. The cost of storing, insuring and registering vehicles tends not to change – or to change very little – based on mileage, creating an economic incentive for vehicle owners to "get their money's

worth" by using their vehicle for most of their transportation needs. Shifting lump-sum charges such as insurance and registration to per-mile charges can enable drivers to more accurately realize the cost of every additional mile of travel and lead to reductions in vehicle-miles traveled.

In recent years, insurers have begun to offer "pay-as-you-drive" insurance products that reward vehicle owners for reducing their driving (or, in the case of some systems that monitor driving behavior, for driving more safely). In some cases, however, state insurance regulations can make offering pay-as-you-drive insurance difficult.[101] And few states have taken affirmative steps – such as the tax credit for insurers offering pay-as-you-drive policies adopted by Oregon – to encourage the shift to mileage-based charges.[102]

In early 2016, Tesla announced its upcoming Model 3, which will boast a 200-plus mile electric range at a cost competitive with conventional vehicles. More than 300,000 people pre-ordered the vehicle. Photo credit: Flickr user Steve Jurvetson, CC BY 2.0.

Common Sense Principle 4: Carbon-Intensive Vehicles and Fuels Should Be Phased Out

Eliminating carbon pollution from our transportation system will require all of our vehicles to operate on zero-carbon fuels by mid-century. Phasing out carbon-intensive vehicles and fuels – by promoting improvements in vehicle fuel economy, shifting to vehicles that can operate on zero-carbon fuels, and reducing the carbon content of fuels over their entire life-cycle – is essential for achieving a zero-carbon transportation system.

It is also the area of transportation policy in which the United States has arguably had the most success in reducing its carbon footprint. Since 1975, the federal government has enforced corporate average fuel economy (CAFE) standards for light-duty vehicles that have driven reductions in per-mile gasoline consumption and greenhouse gas emissions. Since 2009, the federal government, following the lead of 14 states, has implemented greenhouse gas emission standards designed to reduce emissions of pollutants that cause global warming. Similar standards for heavy-duty vehicles are estimated to save an additional 1.25 billion metric tons of greenhouse gas pollution over their lifetimes.[103]

The light-duty vehicle emission standards adopted for cars sold in model years 2012 to 2025 are projected to reduce greenhouse gas emissions by 6 billion metric tons over the lifetime of the vehicles – an amount greater than that produced by the entire U.S. economy in a single year.[104] However, the second phase of these standards, to be in effect from 2022 to 2025, is currently undergoing a midterm evaluation. The current standards can be met with existing technologies alone, while emerging technologies create the potential to achieve

far greater emission reductions over time. The midterm evaluation creates a unique opportunity to strengthen the standards in order to reduce carbon pollution from the vehicle fleet for years to come.

The Reality: The Potential for Low-Carbon Vehicles Has Not Been Met

Fuel economy and electric vehicle technologies are advancing rapidly – making it possible to consider faster and more aggressive timelines for transition to low-carbon transportation than appeared feasible just a few years ago.

Production of battery packs for electric vehicles has doubled each year since 2010, helping to drive an 8 percent annual reduction in prices for electric vehicle batteries during that time.[105] Electric vehicles haven't just been getting cheaper, but they've also been getting better, with at least five auto manufacturers suggesting that they will have vehicles with 200-plus miles of electric range on the road within the next several years.[106]

Combined with federal financial incentives and policy supports such as the Zero-Emission Vehicle program (adopted by California and a number of other states), advances in electric vehicles are fueling increasing enthusiasm among consumers. Sales of plug-in vehicles during the first half of 2016 ran well ahead of sales the year before, despite lower gas prices.[107] And when, in early 2016, Tesla announced its upcoming Model 3, which will boast a 200-plus mile electric range at a cost competitive with conventional vehicle, more than 370,000 people placed pre-orders for the vehicle, in what some analysts have termed the "iPhone moment" for electric vehicles.[108]

Electric vehicles aren't the only types of vehicles to benefit from technological advances. The recent draft technical assessment of federal light-duty fuel economy and greenhouse gas emission standards estimated that the costs of achieving the standards will be 5 to 16 percent lower than originally projected in 2012.[109] The assessment further found that the 2025 emission targets could be met with only minimal use of hybrid and fully electric vehicles.

Embracing the growing potential of electric vehicles creates the opportunity to clean up the light-duty vehicle fleet faster than had previously been thought possible. Nations around the world have recently begun to consider a once-unthinkable step: the near-term phase-out of internal combustion cars and light trucks. Norway and the Netherlands have both considered measures to encourage or require all new cars to run on electricity by 2025.[110] Meanwhile, in the United States, eight states on the East and West coasts have joined together in a compact to encourage the sale of zero-emission vehicles, with the goal of putting 3.3 million such vehicles on the road by 2025.[111]

Nations around the world have recently begun to consider a once-unthinkable step: the near-term phase-out of internal combustion cars and light trucks.

With recent advances in electric vehicles, it is possible to envision faster progress toward the ultimate goal: ensuring that all new vehicles be capable of traveling carbon-free by the mid-2030s, enabling a full transition to zero-emission vehicles by 2050. Efforts such as the Obama administration's recently announced inter-agency, public-private collaboration to support electric vehicles can help to achieve that goal.[112] Further strengthening of federal greenhouse gas emission standards for vehicles, and increased adoption and enforcement of state zero-emission vehicle programs, can also help hasten the deployment of a fully decarbonized fleet.

America's record on decarbonizing vehicle fuels has been far more mixed than its record in improving vehicle fuel economy.

The Reality: Progress to Reduce the Climate Impact of Transportation Fuels Has Been Slow

America's record on decarbonizing vehicle fuels has been far more mixed than its record in improving vehicle fuel economy. The federal Renewable Fuels Standard (RFS) was adopted in 2005 and revised in 2007 and calls for the incorporation of increasing volumes of biofuels into the American motor fuel supply. The RFS was intended to spur a gradual ramp-up of production of advanced and cellulosic biofuels with low life-cycle greenhouse gas emissions, even as it continued to support the expanded use of ethanol derived from corn, which delivers limited (and not universally acknowledged) climate benefits.[113] However, development of advanced and cellulosic ethanol has occurred more slowly than envisioned in the RFS – for 2017, the EPA has proposed a cellulosic ethanol requirement of 312 million gallons and an advanced biofuel requirement of 4 billion gallons, compared with 5.5 billion gallons and 9 billion gallons, respectively, in the RFS.[114]

California adopted a more expansive program to encourage climate-friendly fuels, the Low-Carbon Fuel Standard (LCFS). Unlike the federal RFS, California's program is intended to deliver overall reductions in the carbon intensity of the fuel supply, targeting a 10 percent reduction by 2020. The LCFS incorporates a wider variety of fuel pathways as potential compliance options, and uses market-based cap-and-trade mechanisms to encourage reductions in fuel carbon content. As of 2015, the carbon intensity of California's fuel supply had declined by 2 percent.[115] Northeastern and Mid-Atlantic states have considered following California's lead by adopting a similar standard.[116]

Among the fuels incentivized by the LCFS are electricity and hydrogen. Both fuels produce no tailpipe emissions of carbon dioxide, and can be produced in ways that produce few lifecycle greenhouse gas emissions through the use of renewable energy – including electricity generated from the sun and the wind. A collection of federal and state policies – from tax breaks for solar and wind power to state renewable energy standards, which set minimum thresholds for the integration of renewable energy into the electricity supply – have succeeded

in more than tripling America's production of wind energy and increasing production of utility-scale solar energy more than 30-fold since 2008.[117]

A series of studies have suggested that the United States could obtain the vast majority, if not all, of its electricity from renewable sources.[118] But while wind and solar energy are expanding dramatically and falling in price, the future of key policy supports that have helped to fuel the renewable energy boom is in question.

A series of studies have suggested that the United States could obtain the vast majority, if not all, of its electricity from renewable sources.

- State renewable energy standards, which set a floor for the amount of renewable energy in a state's energy supply, have helped to drive 60 percent of America's renewable energy growth since 2000.[119] While current state renewable energy targets will double between 2015 and 2030, much of that growth will take place in a few states that have adopted strong targets (such as California), with only limited growth beyond 2020 in several regions of the country.[120]
- The federal renewable energy production tax credit (which mainly benefits wind generation) and investment tax credit (which mainly benefits solar power) have been important drivers of renewable energy growth. Both are scheduled to expire within the next seven years, with the PTC phasing out beginning at the end of 2016, with full elimination by the end of 2019,[121] and the ITC ending in 2023.[122]
- Policies designed to provide fair compensation for individuals installing distributed renewable energy generation, especially solar power, have been under attack in several states, with states such as Nevada adopting policies to make it more costly for individual homeowners or business owners to adopt solar energy. Future utility policy decisions could either encourage further growth in local renewable energy generation or discourage it.
- The Clean Power Plan, adopted by the Obama administration in 2015 and intended to reduce carbon pollution from power plants by 32 percent relative to 2005 levels by 2030, was stayed by the Supreme Court in early 2016 and must overcome several legal hurdles before it is fully implemented.[123] The plan is forecast to accelerate the adoption of renewable energy in regions across the country.[124]

Ensuring consistent and meaningful policy support for renewable energy can guarantee that, at whatever point the transportation fleet comes to be powered by electricity and/or hydrogen, the ultimate source of that energy is clean and renewable.

Common Sense Principle 5: Public Policy Should Support the Development of Climate-Friendly Communities

Communities that are designed in ways that allow walking, biking, transit and shared mobility to serve as viable daily options create many opportunities to encourage low-carbon transportation. They also provide a range of other benefits to public health, local economies, and quality of life. Policies such as planning and zoning rules, tax codes, and even policies related to health, education and trade can shape communities in profound ways – either supporting low-carbon lifestyles or encouraging car dependence.

Communities that are designed in ways that allow walking, biking, transit and shared mobility to serve as viable daily options create many opportunities for decarbonizing transportation. Above, buses and bikes mingle at the Portland Transit Mall in Portland, Oregon. Photo credit: Wikimedia user Steve Morgan, CC BY-SA 3.0.

Local governments around the country bear the primary responsibility for community planning and the design and enforcement of land-use laws. However, current federal and state practices exert strong influence on local land-use decisions.

The Reality: Public Policies Hamstring Creation of Climate-Friendly Communities

Much as public policy makes it easier to build high-carbon transportation systems such as highways than low-carbon options such as transit or bike infrastructure, so too do tax, planning and budget policies often make it more difficult to build communities in which low-carbon transportation is a viable option.

State planning, land-use and environmental review laws can have perverse effects that make low-carbon development more difficult. As noted above, policies intended to prevent reductions in highway level of service (see page 33) have often been used to limit the exact kinds of infill development that can expand access to walkable, bikeable communities where destinations are closer to one another.

Academics and other experts have identified numerous federal and state policies that deliberately or unwittingly contribute to auto-dependent forms of development:

- **Subsidies for single-family housing:** Federal housing programs and tax subsidies have long encouraged car-dependent sprawl-style development. A 2013 report by Smart Growth America estimated that the federal government alone spent $450 billion per year on grants, low-interest loans, loan guarantees and tax expenditures on real estate, geared largely toward single-family homeowners. For example, 90 percent of Federal Housing Administration support for housing flowed to single-family homeowners.[125]

- **Bias against mixed-use developments in multi-family projects:** Even the small share of federal subsidies and loan guarantees aimed at multi-family housing fails to meet its potential for supporting smart growth. Developments that mix residential and commercial uses tend to improve walkability, reduce vehicle-miles traveled, and curb transportation greenhouse gas emissions.[126] Federal loans and loan guarantees, however, often exclude mixed-use developments by imposing low and arbitrary caps on the share of floor space or income from commercial uses in multi-family projects. Because of these policies, traditional forms of city and town-center development – such as low-rise, multi-story residential buildings with ground-floor retail or office use – are difficult to finance with federal support or, in many cases, in private markets.[127]

- **Economic development subsidies:** Economic development subsidies offered by states have also, over time, encouraged relocation of business and industry outside of urban cores and into sprawling, auto-dependent areas. A series of analyses of economic development subsidies by the organization Good Jobs First has noted that tools such as tax-increment financing and enterprise zones – which were originally intended in many cases to revitalize urban areas and town centers – have increasingly come to be used to support suburban sprawl.[128] For example, in Ohio, 164 small- and medium-sized firms relocated within the Cleveland and Cincinnati metropolitan areas through subsidy programs, with the vast majority of the moves being outward toward the metropolitan periphery.[129] In many cases, the moves relocated jobs out of reach of transit networks used by low-income people and others to access employment and economic opportunity.

- **Location of government facilities:** State and federal policies and investment decisions can also encourage sprawl by placing government facilities such as schools, courts and offices in locations that can only be conveniently reached by automobile. The U.S. General Services Administration, which manages federal facilities, has come under fire for relocating major government facilities from established downtowns to outlying areas, often in contravention of the desires of local government and local land-use plans.[130]

State and federal policies and investment decisions can also encourage sprawl by placing government facilities such as schools, courts and offices in locations that can only be conveniently reached by automobile.

- **Barriers to new housing in compact areas:** Fast-growing cities across the United States have experienced dramatic increases in housing prices, due in part to imbalances between supply and demand. In many cases, the supply of new housing – especially in the compact city neighborhoods and suburbs with high-quality transit access that are most in demand – is constrained by outdated planning and zoning policies. The result has been displacement of lower-income residents amid fierce competition for urban space, as well as the creation of new incentives for sprawl. In 2016, the Obama administration issued a "housing development toolkit" recommending steps state and local governments can take to meet urban housing demand.[131]
- **Parking requirements:** A further barrier to compact development identified by the Obama administration is off-street parking requirements applied by local governments to new developments. By requiring developers to build parking – regardless of actual demand – these policies drive up the cost of new housing and commercial development in urban areas and consume urban space that could be put to higher and better use. While parking requirements are generally applied by local governments, state governments can encourage or require local governments to change their policies. In 2015, for example, the state of California moved to override local parking requirements for residential developments near transit stations that meet affordable housing thresholds.[132]

In recent years, both the federal government and several states have launched efforts intended to help communities forward transit-oriented developments with the capability of reducing vehicle travel.

On the positive side, in recent years, both the federal government and several states have launched efforts intended to help communities forward transit-oriented developments with the capability of reducing vehicle travel. Further efforts will be needed, however, to transform federal and state policies that influence land-use from enabling car-dependent sprawl to supporting forms of development that enable multiple, low-carbon travel choices.

Common Sense Principle 6: Public Policy Should Foster Low-Carbon Transportation Innovation

Cities around the world have shown that combining proven tools such as smart land use, effective public transportation, protected spaces for walking and biking, and tax policies that discourage excessive driving can lead to the creation of pleasant cities whose transportation systems produce a fraction of the carbon pollution of U.S. cities. But technological and social innovation are constantly creating new opportunities to decarbonize transportation. Federal and state policies should foster innovation and transportation carbon emissions.

The Reality: Key State and Federal Policies Hamper Innovation

Despite recent efforts by the federal government to spark innovation through programs such as the Smart City Challenge, and efforts by state governments to open the doors to innovative technologies such as autonomous vehicles and new services such as carsharing and ridesourcing, transportation policy continues to be constrained by assumptions and policy structures created a half-century to a century ago.

Public Policy Often Fails to Account for New and Emerging Modes of Transportation

In many cities and states, the emergence of ridesourcing services such as Lyft and Uber created fundamental uncertainty regarding whether those services should be regulated as taxis, treated like voluntary ridesharing arrangements, or be thought of as a new category of service. It is but one of a growing number of examples of how new technologies or services can fit awkwardly into long-standing regulatory structures.

Should private bus shuttles or "microtransit" providers be able to use public bus stops and, if so, under what conditions? Are ridesourcing platforms or their drivers ultimately responsible for complying with laws such as the Americans with Disabilities Act? When is a car used to transport passengers or shared with other users a "personal vehicle" for insurance purposes and when is it a "commercial vehicle?" These are just a few of the questions that have emerged along with the growth of new mobility services and arrangements.

The advent of autonomous vehicles will require revisions to state motor vehicle policies. Above, a self-driving Uber travels the streets of Pittsburgh. Photo credit: Flickr user Foo Conner, CC BY 2.0.

The arrival of autonomous vehicles will bring up even more questions. State motor vehicle laws, for example, assume the existence of a vehicle "driver" or "operator," with Texas motor vehicle regulations, for example, defining the operator as "a person who drives or has physical control of a vehicle."[133] In an autonomous vehicle, in which a computer may have actual moment-to-moment control of a vehicle, the application of state motor vehicle codes is unclear. Applying existing legal standards of care, meanwhile, to autonomous vehicles could limit the potential benefits of practices such as "platooning," in which vehicles travel closely together for the purposes of reducing drag, increasing fuel economy and reducing greenhouse gas emissions.[134]

Thus far, local, state and federal officials have moved slowly in adapting existing public policies to the new transportation realities of the 21st century, leaving many new service operators in regulatory limbo. Failure to clarify and adapt public policies to new needs can lead either to innovative services being squelched by inappropriate regulations – leading to missed opportunities to reduce vehicle ownership and greenhouse gas emissions – or to those services operating free from appropriate regulatory constraints, putting public health and safety at risk.

The emergence of new models of mobility demands a thorough review of motor vehicle, traffic and land use regulations that have accumulated over the course of more than a century. Policy-makers in much of the country have yet to even begin that process of reevaluation. A 2015 survey by the National League of Cities found that only 6 percent of city or metropolitan transportation plans referenced potential changes resulting from driverless cars, while only 3 percent addressed transportation network companies such as Uber and Lyft.[135]

Outdated Policies Often Constrain Response to Changing Conditions

Public policies adopted decades or generations ago often constrain policy-makers' response to changing conditions and innovative technologies.

Policies such as constitutional or statutory limitations on the use of gas tax revenue (see page 32) and predetermined splits of funding among specific modes or specific regions limit the ability of decision-makers to apply funds to new solutions or to respond to changing transportation needs and opportunities.

Similarly, the federal ban on tolling existing Interstate highways (outside of a limited number of pilot programs) has the potential to limit states' ability to use tools such as road pricing that have proven effective worldwide at reducing traffic, raising funds for transportation and other purposes, and encouraging shifts to more sustainable modes of travel.

Local governments are best equipped to develop and test new solutions to transportation problems.

States Often Clamp Down on Local Innovation

When it comes to innovation, local governments are best equipped to develop and test new solutions to transportation problems. In recent years, however, some state governments have gone well beyond their proper role to stand in the way of local governments pursuing innovative strategies for low-carbon transportation. In North Carolina and Tennessee, state lawmakers overturned the judgment of local officials and the results of established transportation planning and funding processes to bar or constrain the construction of new bus rapid transit and light rail systems.[136] Other states have considered similar measures, while North Carolina's Legislature considered a ban on "road diets" that are often part of changes made to make streets safer for pedestrians and cyclists.[137] In

other states, state highway officials have been accused of heavy-handed tactics to force metropolitan and local governments to approve highway projects that run counter to local desires for more balanced transportation options.[138]

State tax policies can also leave local governments with limited options for pursuing investments in public transportation and other sustainable modes. As noted above, many states spend little to nothing to support public transportation, making local funding a central piece of many transportation expansion plans. Cities across the United States, and especially in the West, have used voter-approved local option taxes (usually sales taxes) to fund major transit improvements. However, in 16 states, there are no provisions for local option taxation, removing a critical tool from cities and regions pursuing transit projects.[139]

State tax policies can leave local governments with limited options for pursuing investments in public transportation and other sustainable modes.

Bureaucratic Silos Stifle Innovation

Many state departments of transportation evolved from state highway departments, adding, over time, divisions related to transit, rail and other modes. Historically, in most states, transportation planning conforms to modal divisions rather than being driven by an overall strategy for improving the efficiency and effectiveness of the entire transportation network. At a time when more Americans are becoming multimodal, and when information technology makes it more possible than ever to plan and execute trips using multiple modes, the persistence of modal silos in transportation agencies represents a missed opportunity that limits innovation.

Multimodal competitive grant programs such as the federal TIGER program, multimodal project selection processes such as those adopted in states like Virginia,[140] and bureaucratic reforms that reorganize transportation agencies by function[141] (e.g., safety, freight movement) rather than mode can facilitate the creation of transportation solutions that are more cost-effective for the public and take advantage of the opportunities for innovation presented by linking modes together efficiently.

Traditional public sector procurement processes can also limit the potential for innovation. Requests for proposals may be overly restrictive and limited to tools and strategies used in the past. Entrepreneurs with innovative ideas may have no way to reach potential customers in public agencies in the absence of a formal procurement process. The ability to do quick, small-scale pilot projects may also be limited by cumbersome rules. Transportation agencies may be limited in their ability to partner with other government agencies or with private-sector actors to address mutual challenges.

The Reality: Data Collection and Availability Fails to Support Innovation

Existing public sources of transportation data are inadequate to understand the rapid changes taking place in transportation and to support innovation that moves the nation toward a zero-carbon transportation system.

Unlike several other industrialized countries that conduct annual or continuous travel surveys, the U.S. National Household Travel Survey – the sole detailed national survey of transportation behaviors – takes place only irregularly. The last edition was conducted in 2008 and released in 2009, at a time when the mobile Internet revolution was in its infancy and key transportation services such as Uber did not exist. (A new edition of the survey is being conducted in 2016.)

Governments need to assert their prerogative to obtain data needed to plan and operate the transportation system.

At the same time, vast new reservoirs of data on the daily transportation behaviors of Americans – from cell phone records, crowdsourced data sets, social media, fitness trackers such as Strava and Fitbit, and other sources – create the potential to understand transportation as never before, unlocking potential new strategies for supporting sustainability. While a few agencies have begun to take advantage of new sources of data, public agencies are not guaranteed access to many of these sources, and the level of detail of the data raise privacy concerns.

Governments need to assert their prerogative to obtain data needed to plan and operate the transportation system, and provide access to open data that can fuel innovative strategies, solutions and business models for decarbonizing transportation, even as they safeguard privacy.

Building a Zero-Carbon Transportation System: 50 Steps

Federal and state transportation policy in the United States is not currently up to the task of building an affordable, efficient, safe and equitable transportation system that is also compatible with a stable climate. In fact, many current state and federal policies serve to ***impede*** effective climate action.

Eliminating carbon pollution from transportation requires not just the adoption of new forward-looking policies, but also the elimination of policies – some of which date back as much as a century and many of which receive little public attention – that make decarbonization of the transportation system more difficult.

Any program for transportation policy reform that hopes to address the climate challenge must be able to change over time. As technologies evolve, conditions shift, and short-term milestones toward decarbonization are met, priorities for policy action will change – new opportunities for action will arise and formerly critical policies will become less important. In addition, transportation carbon emissions are influenced by a vast array of public policies adopted by thousands of local governments and dozens of state and federal agencies. No single document can possibly list all of the specific policy changes that can make a meaningful contribution to decarbonization.

In the short run, the top priority for leaders in government, business, and non-profit and community organizations concerned with climate change must be to articulate and build public support for a clear set of principles to guide future policy. In this report, we have proposed the following principles:

1. Climate concerns should inform every transportation policy decision.
2. Low-carbon transportation solutions should be at the front of the line for public funding.
3. Public policy should reward people who make low-carbon transportation choices.
4. Carbon-intensive vehicles and fuels should be phased out.
5. Public policy should support the development of climate-friendly communities.
6. Public policy should foster low-carbon transportation innovation.

Eliminating carbon pollution from transportation requires not just the adoption of new forward-looking policies, but also the elimination of policies that make decarbonization of the transportation system more difficult.

In the pages that follow, we propose 50 concrete federal and state policy steps that can move America toward a carbon-free transportation system. We do not address local policy systematically in this document, as there are many leading cities around the world and cutting-edge organizations implementing innovative low-carbon transportation solutions, whose efforts can serve as models for effective local policy action.[142] There are, however, limits to what cities can accomplish on their own. Effective state and federal policy will be essential if the nation is to fulfill its commitment to the world to help forestall climate catastrophe.

(Policy recommendations are not listed by order of importance.)

Transportation policies have often neglected the needs of those who do not drive. States like California are revising these policies, ensuring, for example, that vehicle replacement programs designed to get polluting cars off the road allow financial incentives to be used for transit passes or carsharing services, as well as cars. Above, a bus travels the streets of Los Angeles. Photo credit: Wikimedia user Nikhil Kulkarni, CC BY-SA 2.0.

Make Addressing Global Warming a Strategic Goal

Eliminating greenhouse gas pollution from transportation is only likely to occur if it becomes a guiding goal of transportation policy. Specific steps federal and state governments can take include the following:

1. **Establish greenhouse gas performance measures for transportation and track progress.** Federal law already includes several mechanisms that can be used to align climate and transportation goals. For example, the Obama administration is considering adopting a performance measure for greenhouse gases under federal transportation law.

To be effective, the performance standards should be:

- Universal: Applied to all states and metropolitan planning organizations.
- Specific: With numerical goals for carbon pollution per capita from transportation.
- Life-Cycle Based: Including emissions not only from the vehicle itself but also from "upstream" emissions related to the extraction, transportation, and conversion of the energy used in the vehicle.[143]

2. **Require greenhouse gas evaluations for transportation projects and plans and ensure that they are done appropriately.** The recent guidance issued by the Obama administration requiring inclusion of greenhouse gas impacts in NEPA environmental reviews is another important step toward transparency and accountability in transportation decision-making. Federal and state officials should ensure that environmental reviews under NEPA are transparent in their methodology and assumptions, comprehensive in their scope, accurate in their assumptions and, to the extent possible, consistent across jurisdictions.

3. **Set and enforce greenhouse gas emissions limits consistent with climate science, applicable to the transportation sector.** Seven states have adopted enforceable greenhouse gas emission reduction targets. To date, however, only California has included transportation fuels in its greenhouse gas cap-and-trade program and many state greenhouse gas reduction plans – whether enforceable or advisory in nature – lack consistent implementation and follow-through in the transportation sector. To guide emission reduction efforts, additional states should adopt economy-wide and transportation-specific greenhouse gas emission reduction targets and establish the legal frameworks necessary to ensure those targets are met.

Stop Doing Harm

U.S. transportation policy is still focused largely on the expansion and maintenance of the highway network – an objective that runs counter to climate imperatives.

U.S. transportation policy is still focused largely on the expansion and maintenance of the highway network – an objective that runs counter to climate imperatives.

An important, basic and necessary step for the United States will be to eliminate policies that give preference to the construction of high-carbon infrastructure. Specifically, federal and state governments should:

4. **Shift public subsidies from highway capacity expansion to low-carbon transportation strategies**. Federal and state transportation funding formulas should be revised to target funds toward low-carbon transportation infrastructure and transportation demand management.

5. **Remove barriers to low-carbon transportation investments.** All transportation infrastructure expansion projects – highways and transit – should be evaluated according to common criteria that include climate impacts. Several states – most notably Virginia – have moved toward merit-based systems for evaluating and prioritizing transportation system

investments, with the federal TIGER program taking a similar multimodal approach. Transportation projects scored through such programs should be evaluated on a life-cycle basis, with costs of maintenance, operations and repair, as well as life-cycle environmental and community impacts, considered at the time of approval.

Funds raised through gas taxes can often be spent for far better purposes than funding road expansion projects.

6. **End the nexus between motor vehicle "user" revenue and investment in roads.** America's "user fee" based system of highway finance was an ingenious response to the transportation challenge of the early 20th century: building enough good roads to sustain a modern economy. The system, however, has outlived its usefulness. Funds raised through gas taxes can often be spent for far better purposes than funding road expansion projects – many of which deliver little to no return on investment. Most major industrialized economies deposit revenue from gas taxes into the general fund, then use general fund revenue to fund high-value transportation infrastructure projects, with no direct nexus between the two. Ending the nexus between gas taxes and road spending – such as by repealing state laws that dedicate gas tax revenue toward roads – can ensure that transportation investments better track with real needs. They can also ensure that any increase in revenue that results from taxes or tolls used to manage congestion are not then spent on highway expansions that set America back in the fight against climate change.

Reform the Transportation Bureaucracy and Policy Infrastructure

Transportation bureaucracies can inhibit innovation and make it difficult to undertake the type of nimble policy responses that will be needed to harness the power of new low-carbon technologies and practices. Among the reforms that must be made to transportation bureaucracies and the policy infrastructure are the following:

7. **Revisit transportation funding formulas.** Federal and state governments often allocate transportation funds based on modal or geographic formulas that have little to do with need or with the potential of a project to assist in the achievement of overall transportation goals, such as reducing greenhouse gas emissions. States and the federal government should move toward competitive, merit-based systems for allocating transportation funds in which greenhouse gas emission reductions are a criterion for evaluation and accountability for decision-making is clear.

8. **Ensure that state laws and regulations treat users of low-carbon transportation equitably.** State government operations and programs often discriminate against non-drivers. From the location of state offices to the scheduling of public hearings, the needs of those who use low-carbon modes of travel are often ignored in key decisions. State governments should direct agencies to include the needs of non-drivers in governance decisions, and to avoid program designs that indirectly incentivize car ownership and driving. For example, California's 2014 Charge Ahead initiative, like many previous "cash for clunkers" type programs, bought back inefficient vehicles in exchange for a voucher to help finance the purchase of an electric vehicle. Unlike previous programs, however, the program also allowed the voucher to be used for the purchase of transit passes or carsharing services – providing an opportunity for some Californians to go car-free.[144]

9. **Eliminate highway level-of-service as a criterion in environmental and land-use reviews**. Infill developments and expansions of sustainable transportation infrastructure should not be delayed or denied solely because of their impact on automobile traffic. California has begun to replace level-of-service standards with metrics based on reducing vehicle-miles traveled. Other states should follow.

10. **Break up modal silos in transportation agencies.** Modal silos in transportation agencies can deter the development of creative multi-modal strategies to solve transportation problems. State and federal governments should encourage performance-based planning efforts that foster collaboration across modal divisions and eliminate modal silos where possible.

Get the Most Out of What We Have

Infrastructure is expensive to build and maintain. Historical inequities between investments in highways and more sustainable modes (such as intercity rail, rail transit and bus rapid transit) – coupled with growing demand for these options in many parts of the country – argue for increased investment in low-carbon transportation infrastructure. But there are many ways in which existing infrastructure and systems can be used more efficiently, reducing carbon pollution and conserving public resources.

There are many ways in which existing infrastructure and systems can be used more efficiently, reducing carbon pollution and conserving public resources.

11. **Make demand management a central feature of transportation policy.** TDM strategies have proven effective in encouraging more efficient travel habits – saving workers, employers and the public money, while reducing greenhouse gas emissions. States and metropolitan areas should be required to

evaluate demand management strategies as alternatives to transportation infrastructure expansion. For example, the state of Washington requires that regional transportation plans be "based on a least-cost planning methodology that identifies the most cost-effective facilities, services, and programs."[145] Funding for transportation demand management programs should be increased, goals for vehicle travel reductions established and compliance evaluated, mandatory targets (such as commute-trip reduction goals or VMT targets) considered, and the scope of TDM programs expanded to include non-commute trips. TDM programs and transportation agencies should also be encouraged to use the full palette of tools employed by leading efforts in the United States and around the world – including emerging tools such as gamification, communications strategies targeted to people at particular stages of life, and "deliberate disruptions" such as tactical urbanism and open-streets events – all of which can encourage people to experiment with new transportation choices and adopt long-term behavioral changes.

12. **Remove limitations on use of federal funds for transit operations.** Current policies that channel federal transit spending toward capital investments limit the flexibility of transit agencies to use funds to get the most out of existing equipment by increasing service where appropriate.

13. **Remove the Interstate tolling ban.** The federal government has gradually relaxed previous limits on tolling of Interstate highways, but currently the only way to toll an existing Interstate highway is through a pilot program. The federal government should shift from a policy of discouraging tolling to one of actively encouraging and rewarding states that experiment with regional road pricing and other systems that use market forces to get the most out of existing infrastructure.

14. **Encourage strategic development of intelligent transportation systems and connected vehicles.** Technology can be used to encourage the efficient flow of people and goods through and between our cities. Advances in communications technology create the possibility for connected vehicles, which have the potential to reduce greenhouse gas emissions by encouraging energy-efficient driving habits, reducing congestion, and facilitating vehicle platooning, among other means. Policy-makers have an important role in encouraging connected vehicles by providing funding for infrastructure and communications technology and helping to develop standards for vehicle manufacturers. Policy-makers must also ensure that the spread of connected vehicle technology does not erode other public policy objectives, such as the preservation of consumer privacy.

Technology can be used to encourage the efficient flow of people and goods through and between our cities.

15. **Reallocate space to low-carbon modes.** Bicycling, walking and transit can often move more people more efficiently in a smaller space than general travel lanes occupied by single-occupant vehicles. States should lift limitations or hurdles to the conversion of street space to dedicated transit or bicycle lanes, and adopt and enforce "complete streets" policies that ensure that the needs of bicyclists, pedestrians and transit riders are accommodated in the design of transportation infrastructure.

Reward Low-Carbon Travel Decisions

Governments can begin to tip the scales in favor of low-carbon transportation options by removing tax breaks for driving, ensuring that the cost of high-carbon modes of travel reflects their full environmental and social costs, and finding novel ways to reward individuals and companies for making climate-smart choices.

Individuals will choose low-carbon transportation options when they are cheaper, more convenient and more reliable than higher-carbon alternatives." Above, a protected bike lane in Cambridge, Mass.
Photo credit: Adam Coppola

16. **Eliminate the income tax exclusion for employer-provided or employer-paid commuter parking**. The federal income tax exclusion for commuter parking has no compelling transportation policy rationale, encouraging people to drive to work alone at the most congested times of day. The exclusion should be repealed.

17. **Eliminate state sales tax exemptions for motor fuels.** Many states exempt gasoline from state sales taxes that fund general government operations at the same time they assess gasoline taxes spent largely for the benefit of drivers. Eliminating exemptions from state sales taxes for motor fuels will eliminate the perverse situation by which burning fossil fuels is given favorable tax treatment relative to the purchase of other goods and services.

18. **Ensure that fees charged for motor vehicle use meet or exceed the full societal costs imposed by driving.** Charges and fees related to vehicle use should be gradually increased over time to reflect the societal costs of driving. State and federal governments have many options for how to achieve this goal: increases in the gasoline tax, VMT fees, carbon taxes, tolls and/or congestion prices. Ideally, the mix and level of fees chosen should be

tied as closely as possible to the costs imposed by the specific activity being undertaken, with due consideration given to administrative and compliance costs and to policies that can mitigate any equity concerns.

Strategic use of monetary incentives can be used to encourage people to try new forms of low-carbon mobility or to change their travel habits.

19. **Consider monetary incentives to encourage low-carbon travel behavior.** Strategic use of monetary incentives can be used to encourage people to try new forms of low-carbon mobility or to change their travel habits. Vehicle replacement programs, incentives for the purchase of low-carbon vehicles, "feebate" programs that set differential vehicle registration fees based on vehicle carbon emissions, and tax credits for the use of transit or installation of electric vehicle infrastructure are among the potential incentives that can be used to nudge individuals toward lower-carbon transportation choices – and can potentially be funded either through the elimination of subsidies to driving or the redirecting funds currently allocated to highway system expansion.

20. **Support market reforms and that shift vehicle pricing from up-front to per-mile.** The high upfront cost of vehicle ownership tends to lock car owners into car-centered travel patterns. Regulatory barriers to reforms such as pay-per-mile auto insurance should be lifted, while state and federal governments should play an active role in the creation of "mobility-as-a-service" systems that enable individuals to purchase a package of mobility services (e.g. carsharing, ridesourcing and transit) that substitutes for the need to own a private vehicle and ties the cost of transportation more closely to patterns of use.

Level the Playing Field for Shared Mobility

Shared mobility has the potential to replace the need for private vehicle ownership among many consumers, with benefits ranging from reduced demand for parking to reduced vehicle travel. State and federal governments should take steps to encourage shared mobility services in situations where they deliver climate benefits. A good first step is to eliminate or reform policies that put shared mobility services at a disadvantage.

21. **Eliminate excessive taxes on carsharing.** Rental car tax policies were not designed for today's short-term carsharing market, yet many such taxes are applied to carsharing, increasing costs for customers and reducing access to the service. Cities and states should exempt short-term rentals from car rental taxes or develop appropriate tax regimes specific to carsharing to ensure that the market thrives.

22. **Expand access to commuter benefits to include shared mobility services that benefit the climate**. The federal income tax exclusion for commuter transit fails to include a number of emerging modes of travel that can provide alternatives to traveling to work in a privately owned vehicle. To the extent that federal and state governments continue to allow income tax exclusions for commuter parking and public transportation, they should also consider extending similar treatment to one-way carsharing, bikesharing, and other shared mobility services that deliver demonstrated climate benefits.

23. **Encourage access to transit, active transportation and shared mobility as alternatives to parking.** Laws or policies that require or encourage the provision of parking should be revised to provide shared mobility-based alternatives. For example, the city of San Francisco has entered into agreements with at least one developer to allow for the provision of free passes for transit and access to ridesourcing as an alternative to on-site parking.[146] State governments should encourage local governments to experiment with these and other solutions to reduce the amount of urban space that is dedicated to the storage of motor vehicles, while both state and federal governments should encourage similar arrangements for their own facilities.

Harness the Power of Markets

The power of market forces is woefully underutilized in urban transportation. The United States provides lavishly subsidized, free urban highways that contribute to environmental pollution and congestion, only to then turn around and provide subsidized public transportation intended to "take cars off the road." The use of market forces – from carbon cap-and-trade to congestion pricing – can ensure that individuals and businesses receive price signals consistent with the nation's overall climate goals, and can unlock new sources of innovation and revenue to improve low-carbon transportation.

Congestion pricing has been shown around the world to reduce congestion, increase the use of transit and low-carbon modes of travel in cities where it has been implemented, and reduce greenhouse gas emissions. Below, congestion pricing in London. Photo credit: Wikimedia user Nevilley, CC BY-SA 3.0.

State and federal governments should experiment with market-based tools such as comprehensive congestion pricing.

24. **Use market-based tools to manage transportation demand.** Congestion pricing has been shown around the world to reduce congestion, increase the use of transit and low-carbon modes of travel in cities where it has been implemented, and reduce greenhouse gas emissions.[147] Other market-based mechanisms – from carbon cap-and-trade systems to dynamically priced parking – have the potential to encourage sustainable transportation choices while simultaneously addressing the nation's most pressing transportation challenges. Not every market-based solution is appropriate in every situation – American urban land-use patterns, for example, differ from those of other nations that have implemented congestion pricing – and not all tools that are designed to reduce congestion will also reduce carbon pollution. Still, state and federal governments should experiment with market-based tools such as comprehensive congestion pricing and, if demonstrated to be effective, support the expansion of the model to other metropolitan areas.

25. **Consider new models of transportation service delivery and governance.** The emergence of transportation network companies such as Lyft and Uber has shown the potential for technological platforms to aggregate transportation demand and match it with services supplied by a wide array of private individuals. However, it has also raised concerns about centralization of power in the hands of companies that own and operate the platforms. Policy-makers at the local, metropolitan and state level must develop effective models of governance that balance the benefits of aggregation with the need to protect the public interest. Several models are possible: ownership of platforms by government or independent agencies, by publicly owned or regulated utilities, or by private entities under reasonable regulation by government. Cities and states should also encourage the expansion of shared mobility platforms to include transit-like services and to foster seamless integration with traditional transit.

Speed the Introduction of Low-Carbon Vehicles

Any transition to a zero-carbon transportation system will require adoption of vehicles that are capable of running on zero-carbon sources of energy. The United States has several policy mechanisms that have proven effective in spurring innovation in low-carbon vehicles and expanding access to zero-carbon technologies. Building on those models can enable the United States to hasten the transition to a zero-carbon transportation fleet.

26. **Strengthen and enforce strong fuel economy/GHG standards**. Technological advances in both electric vehicles and the energy efficiency

of conventional vehicles create opportunities for further strengthening of standards, including reforms to the existing system of loopholes and credits that threatens to reduce the system's effectiveness in driving fuel economy improvements. As part of the federal government's mid-term review of the program, federal agencies should set higher goals and tighten enforcement, while also laying the groundwork for further improvements in the years to come.

27. **Strengthen and enforce state zero-emission vehicle standards.** California's zero-emission vehicle program, first adopted in 1990 and subsequently adopted by nine other states, has played an important role in driving technological innovation in electric and other advanced vehicles. California and other states should enforce and strengthen the ZEV program in order to continue to drive technological innovation, while other states should consider adopting the program, and states that have adopted it should continue to work collaboratively on practical measures to speed EV adoption.

28. **Continue financial incentives for clean vehicle adoption.** Existing state and federal tax credits for electric vehicles have played an important role in getting the market for those vehicles off the ground. While the cost of electric vehicles is declining and their range is increasing, continued financial support for electric vehicles and infrastructure – in the form of tax incentives and rebates – will be needed to ensure further growth in the market and the achievement of economies of scale.

Existing state and federal tax credits for electric vehicles have played an important role in getting the market for those vehicles off the ground.

29. **Encourage the large-scale, rapid build-out of charging infrastructure across the nation.** State and federal transportation funds should be allocated to fast charging infrastructure along highway corridors, while state governments should adopt policies encouraging utility investment in charging at workplaces and multifamily housing and supporting the installation of electric vehicle charging in new homes.

30. **Develop and support markets for reuse of EV batteries for energy storage.** Electric vehicles and their batteries can help to support the transition to a cleaner electric grid by providing a source of electricity storage for an increasingly renewable grid. Electric vehicles can also supply power directly to the grid through vehicle-to-grid technology. Delaware, for example, has created a program to ensure that electric vehicle owners receive fair compensation for electricity discharged back to the grid.[148] Other states should consider the role EV batteries can play in meeting emerging energy storage needs and work to establish markets by which consumers or dealers can efficiently capture the value in second-life batteries.

31. **Foster regional and public-private collaborations to encourage adoption of electric vehicles.** The Obama administration's cross-agency, public-private electric vehicle collaborative and the multi-state zero-emission vehicle task force established by the governors of eight states in 2013 are examples of the types of collaborations needed to address and resolve the multiple issues involved in transitioning from a fossil fuel-based transportation system to one powered by electricity.[149] State and federal officials should continue to build on these collaborations and expand them to other areas where policy coordination is important (e.g., low-carbon freight transport).

Electric vehicles may be able to support the growth of renewable energy by directly serving as a form of energy storage for renewably generated electricity, or through systems to employ used EV batteries for energy storage. Above, an electric car charges in New York. Photo credit: Flickr user Metropolitan Transportation Authority of the State of New York.

32. **Encourage integration of EVs into shared mobility fleets.** The transition to electric vehicles and the emergence of shared mobility systems have the potential to be mutually reinforcing. States should investigate policy options for encouraging the adoption of electric vehicles by shared mobility fleets.

Speed the Introduction of Low-Carbon Fuels

Transitioning to low-carbon fuels is a key element of eliminating transportation's contribution to global warming.

33. **Replace the federal renewable fuel standard with a low-carbon fuel standard.** The federal Renewable Fuel Standard has thus far failed in its mission to replace oil with low-carbon fuels and to facilitate the growth of advanced biofuels with minimal impacts on the environment and the climate. The development of sustainable biofuels remains important – especially given the present lack of low-carbon fuel options for long-distance forms of transportation such as air travel and shipping. However, the current RFS largely functions to maintain the production of corn-based ethanol, which has little to no net greenhouse gas benefit and brings with it other environmental concerns. A better approach is the low-carbon fuel standard adopted by California, which sets targets for lifecycle GHG emission reductions from transportation fuels. The LCFS has the benefits of being explicitly targeted at reducing carbon pollution and incorporating all fuels,

helping to drive not only the adoption of sustainable biofuels, but also the use of electricity and oil-based fuels from sources with lower carbon emissions. States should consider adopting LCFS policies as well.

34. **Expand renewable energy production.** The transition to a zero-carbon transportation system will require the transition of the electric grid to zero-carbon sources reliant on renewable energy. To facilitate the eventual decarbonization of transportation, the United States should adopt mandatory renewable electricity standards and other policies designed to move the nation toward 100 percent renewable energy by mid-century.

Align Transportation and Land-Use Objectives to Support Climate-Friendly Communities

Land-use policies often lead to the creation of communities where individual auto ownership is a near-requirement for daily life. Most land-use policies are developed and enforced at the local level, but state and federal governments have a critical role to play in setting the overall framework for land-use policy and allocating public resources.

The transition to a zero-carbon transportation system will require the transition of the electric grid to zero-carbon sources reliant on renewable energy.

35. **Reform policies related to housing, economic development and the location of public facilities to support low-carbon communities.** Federal housing programs should not preference single-family development over multi-family or mixed use development, while state economic development subsidies should not support the relocation of jobs and industry from walkable urban locations to areas only accessible by car. Public facilities – both federal facilities and facilities such as schools that are supported by state funding programs – should be located in areas accessible by a variety of modes of travel, including walking, biking and, where applicable, public transportation.

36. **Remove barriers to new housing in compact areas.** The land use decisions made by local governments have broad impacts on housing affordability and economic conditions at the regional, state and even national scale. State governments should encourage or require local governments to revise policies that make the construction of affordable housing in urban areas difficult or impossible, including zoning restrictions and minimum parking requirements for new developments.

37. **Integrate land-use criteria into transportation project selection**. Federal and state funds should not be invested in highway projects that accelerate sprawl and increase transportation carbon emissions. Similarly, federal and

state transit investment dollars should be focused on projects that support existing communities, infill developments, or smart growth developments.

38. **Allow for the use of transportation funds to support integrated smart growth/transportation solutions, and encourage transit-oriented development**. In recent years, the federal government has taken a few steps to recognize the connection between transportation and land use. The 2015 FAST Act opened transit-oriented development projects up for federal credit assistance through the Transportation Infrastructure Finance and Innovation Act (TIFIA) program.[150] The FAST Act also continued the federal government's modest program to support transit-oriented development planning. U.S. Transportation Secretary Anthony Foxx has also publicly acknowledged the scars highway construction has inflicted on urban communities in announcing the Every Place Counts Design Challenge, which catalyzed conversations intended to help heal the divisions.[151] State and federal policy-makers should work to provide technical assistance, financing and regulatory support to support transit-oriented development and empower communities to implement effective land-use practices.

Support and Guide Innovation

Transportation technology is advancing quickly. Transportation policy reforms at the federal and state level can help to foster further innovation and ensure that private-sector innovation aligns with sustainability goals.

Transportation policy reforms at the federal and state level can help to foster further innovation and ensure that private-sector innovation aligns with sustainability goals.

39. **Revisit existing policies, plans and models to reflect new technologies.** Federal and state authorities must revisit existing policies and motor vehicle laws to accommodate autonomous and connected vehicles and to clarify questions regarding liability for autonomous and semi-autonomous driving modes. In addition, transportation models shape policy and investment decisions in critical ways, including project evaluation, cost-benefit analysis, and long-range planning. Few transportation models currently incorporate the effects of new shared mobility modes such as carsharing and ridesourcing, and the advent of autonomous vehicles raises foundational questions about the assumptions used in transportation modeling. These models also often fail to accurately incorporate the effects of induced demand. State and federal officials must work to update the assumptions used in transportation modeling, acknowledging the great uncertainty about the future impacts of new technologies and services. Transportation planners may need to shift their approach to rely more on scenario planning, given the rising uncertainty.

40. **Reform procurement processes.** Federal, state and local rules regarding public procurement should be reformed to allow greater flexibility in the pursuit of short-term pilot projects, facilitate partnerships across public sector agencies, allow for unsolicited proposals, and allow greater flexibility in the solutions considered to specific transportation problems.

41. **Remove barriers to local innovation.** States should refrain from interference with local government efforts to experiment with and demonstrate the feasibility of different approaches to decarbonizing transportation. Similarly, federal funding formulas should be reoriented to provide direct financial support to local governments pursuing innovative low-carbon transportation strategies.

42. **Maximize the sustainability benefits of new technologies.** Autonomous and connected vehicles create the potential to achieve system efficiencies that can make significant contributions to sustainability goals. Vehicle platooning, "ecodriving" (the use of energy efficient driving cycles), "rightsizing" (the use of vehicles sized optimally for the specific trip being undertaken), automated speed limit enforcement, congestion mitigation, optimized routing and incident control are among the possibilities created by automated and connected vehicles that can contribute to large-scale reductions in energy use.[152] As government and the private sector design standards, technology and infrastructure for automated and connected vehicles, they should adopt protocols, regulatory requirements or incentives to ensure that these technologies are used to maximize energy savings and greenhouse gas emissions.

43. **Provide research, development & deployment assistance for new low-carbon modes and services.** The federal government, as well as the states, can help to create the next round of transportation innovation by providing seed funding for innovative programs through competitive grant programs like the U.S. DOT Smart City Challenge. The federal government can also continue and accelerate investment in basic research into electric and other zero-emission vehicles, renewable energy, energy storage, and autonomous and connected vehicle technologies, all of which are potential building blocks of a zero-carbon transportation system.

Autonomous and connected vehicles create the potential to achieve system efficiencies that can make significant contributions to sustainability goals.

Serve Everyone

To be truly effective, a zero-carbon transportation system must serve everyone. Access to shared mobility services and electric vehicles cannot be limited to "early adopters" but must become ubiquitous throughout society and geared toward serving a variety of transportation needs.

44. **Encourage early adoption of electric vehicles among low-income users.** California's "Charge Ahead" initiative established differential rebate levels for electric vehicles by income level. Enabling low-income households to access electric vehicles enables their spread both by serving as an example of their viability within the community and by surfacing specific challenges related to EV adoption, charging and use that may be unique to low-income communities.

Shared mobility services may provide low-cost methods to improve access to social services while improving the efficiency and bottom line of service providers.

45. **Employ shared mobility to address an array of transportation challenges.** Transportation is a key, if often overlooked, element in the provision of social services, from education to health care. Shared mobility services may provide low-cost methods to improve access to social services while improving the efficiency and bottom line of service providers. Columbus' successful application to the U.S. DOT's Smart City Challenge, for example, includes an effort to use shared mobility and information technology to help patients reach health care appointments.[153] The Massachusetts Bay Transportation Authority (MBTA) recently launched a partnership with Lyft and Uber to expand access to on-demand transportation services for users of the MBTA's paratransit service for the disabled.[154] Government agencies that provide or purchase transportation should be empowered to consider shared mobility services as alternatives, while governments and transit agencies should be encouraged – and provided with access to funding to support – shared mobility provision in low-income neighborhoods or in areas where first- or last-mile gaps affect the ability of riders to use transit services.

Collect and Share Data

Data represents the most valuable currency in the emerging transportation system of the 21st century. Understanding how travel decisions are made, how vehicles interact with one another in transportation networks, and how transportation and energy systems intersect will shape long-range policy decisions as well as the day-to-day operations of the transportation network. Meanwhile, the emergence of transportation platforms such as Lyft and Uber, the expansion of open road tolling and connected vehicles, and other advances in technology will result in tremendous volumes of personal data being exchanged,

as well as the potential for the formation of monopolies or oligopolies that limit competition in the transportation marketplace and fail to serve public needs.

46. **Devise and enforce common standards for data collection and sharing.** Federal and state governments should work with a variety of stakeholders to develop common standards for transportation data sharing and dissemination, applicable to recipients of federal funds.

47. **Maximize provision of open data.** Transportation agencies should operate under the presumption that data collected related to the operation of the transportation system will be open and made available to the public, with few exceptions, such as data that compromises personal privacy. Data should be made available through common sharing platforms and standardized, as much as possible, among various modes of transportation.

48. **Enhance federal and state data collection and analysis capabilities.** Current federal and state data collection activities – including highway traffic counts and household travel surveys – use 20th century technology and practices to assess the operations of a rapidly evolving 21st century transportation system. State and federal officials should enhance and expand collection of data related to the use of the transportation system (including privacy-protected "big data"), make it available to researchers, and revise existing data analysis and reporting practices to accommodate it.

49. **Draw clear lines around privacy.** State and federal governments should take steps to develop and enforce standards around data privacy in transportation.

State and federal governments should take steps to develop and enforce standards around data privacy in transportation.

Reform Outdated Institutional Structures

A cross-cutting concern is whether the United States has the right institutional structures to adapt to a 21st century transportation system. For example, most U.S. metro regions do not have a regional governance body with the resources or the mandate to develop or institute a regional program of road pricing or a regional shared vehicle platform. Many states lack a "chief innovation officer" or "chief data officer" focused on issues central to the development of 21st century government generally, and transportation specifically.

50. **Create new, responsive transportation institutions for the 21st century.** States and the federal government should identify emerging institutional reform needs and be proactive in creating the governmental structures that can effectively manage the transition to a zero-carbon transportation system.

Conclusion

New technologies and emerging social trends hold out the possibility of a different future – one in which all Americans have access to convenient and affordable low- and zero-carbon transportation.

Over the course of the last century, the United States has built an intricate system of public policies that have had the effect of requiring most Americans to own and use a fossil fuel-powered car for most of their daily transportation. Those policies have helped to create a transportation system that is an important contributor to climate change at a global scale – one that we must change if the nation is to prevent the worst impacts of global warming.

Today, new technologies and emerging social trends hold out the possibility of a different future – one in which all Americans have access to convenient and affordable low- and zero-carbon transportation.

Technological advances alone, however, are not enough to guarantee that we will achieve that vision – especially if outmoded public policies from an earlier era continue to limit innovation and make it harder, rather than easier, for individuals, businesses and local governments to make climate-friendly transportation decisions.

The 50 policy actions recommended in this report represent necessary first steps toward reforming the transportation policy system of the 20th century and retooling our approach to transportation to meet the needs of the 21st century.

A zero-carbon transportation system is within our reach by mid-century – if we lay the groundwork for it now by reforming transportation policy.

Appendix A. State Transportation Policy Indicators

	AL	AK	AZ	AR	CA	CO	CT	DC	DE
Constitutional/ statutory restriction on gas tax	X		X	X		X			
Zero-emission vehicle program					X		X		
Complete streets policy					X	X	X	X	X
Exempts motor fuels from general state sales taxes			X	X		X		X	X
Legally enforceable GHG limits					X		X		
Dedicated funding for biking and walking					X	X			X
Gas tax rate ranking by state (1=highest)	41	51	44	39	6	38	16	34	35
Transit spending per capita (2014)	$0.00	$254.71	0	$1.20	$58.23	$2.61	$129.31	$770.82	$107.52
Transit spending per capita rank (2014, 1=highest)	47	2	47	34	11	29	7	1	8
Highway Spending per capita (2014)	$472.65	$1,590.39	$359.95	$683.49	$373.40	$487.66	$539.76	$594.66	$1,395.06
Highway spending per capita rank (2014- 1 is high)	35	1	46	13	45	32	26	19	2

	FL	GA	HI	ID	IL	IN	IA	KS	KY
Constitutional/ statutory restriction on gas tax		X		X		X	X	X	X
Zero-emission vehicle program									
Complete streets policy	X	X	X		X	X			
Exempts motor fuels from general state sales taxes	X	X		X				X	X
Legally enforceable GHG limits			X						
Dedicated funding for biking and walking							X		
Gas tax rate ranking by state (1=highest)	2	19	5	14	11	17	18	31	30
Transit spending per capita (2014)	$11.55	$0.33	0	$0.19	$242.09	$8.78	$4.09	$3.79	$0.42
Transit spending per capita rank (2014, 1=highest)	18	45	47	46	4	19	26	27	43
Highway Spending per capita (2014)	$435.63	$274.44	$281.74	$501.00	$491.15	$397.71	$654.73	$596.36	$669.54
Highway spending per capita rank (2014- 1 is high)	41	51	49	30	31	42	15	18	14

	LA	ME	MD	MA	MI	MN	MS	MO	MT
Constitutional/ statutory restriction on gas tax		X				X	X	X	X
Zero-emission vehicle program		X	X	X					
Complete streets policy	X	X	X	X	X	X	X	X	
Exempts motor fuels from general state sales taxes	X	X		X		X	X		X
Legally enforceable GHG limits			X	X					
Dedicated funding for biking and walking	X	X	X	X	X	X			
Gas tax rate ranking by state (1=highest)	42	22	10	29	12	25	46	47	27
Transit spending per capita (2014)	$1.07	$0.86	$151.71	$229.92	$24.74	$76.61	$0.53	$0.56	$0.37
Transit spending per capita rank (2014, 1=highest)	36	38	6	5	15	10	41	40	44
Highway Spending per capita (2014)	$383.20	$530.92	$468.96	$435.69	$345.37	$552.83	$472.13	$565.91	$752.81
Highway spending per capita rank (2014- 1 is high)	44	27	37	40	47	24	36	22	9

	NE	NV	NH	NJ	NM	NY	NC	ND	OH
Constitutional/ statutory restriction on gas tax		X	X					X	X
Zero-emission vehicle program				X		X			
Complete streets policy				X		X	X		
Exempts motor fuels from general state sales taxes	X		X	X	X		X	X	X
Legally enforceable GHG limits				X					
Dedicated funding for biking and walking		X		X			X		X
Gas tax rate ranking by state (1=highest)	28	9	33	50	45	4	7	35	26
Transit spending per capita (2014)	$2.59	0	$0.51	$42.70	$3.19	$242.38	$7.98	$7.05	$0.63
Transit spending per capita rank (2014, 1=highest)	30	47	42	13	28	3	21	24	39
Highway Spending per capita (2014)	$832.05	$278.89	$545.98	$840.73	$487.59	$578.36	$448.20	$1,216.14	$445.10
Highway spending per capita rank (2014-1 is high)	7	50	25	6	33	20	38	3	39

	OK	OR	PA	RI	SC	SD	TN	TX	UT
Constitutional/ statutory restriction on gas tax		X	X			X			X
Zero-emission vehicle program		X		X					
Complete streets policy		X	X	X	X		X	X	X
Exempts motor fuels from general state sales taxes	X	X		X	X	X	X	X	X
Legally enforceable GHG limits				X					
Dedicated funding for biking and walking		X					X		
Gas tax rate ranking by state (1=highest)	48	20	1	8	49	23	40	43	24
Transit spending per capita (2014)	$1.48	$8.23	$96.75	$52.90	$1.24	$0.90	$7.62	$1.13	0
Transit spending per capita rank (2014, 1=highest)	31	20	9	12	33	37	22	35	47
Highway Spending per capita (2014)	$520.40	$565.82	$641.60	$485.37	$390.68	$769.51	$305.88	$742.56	$510.45
Highway spending per capita rank (2014-1 is high)	28	23	17	34	43	8	48	10	29

	VT	VA	WA	WV	WI	WY
Constitutional/ statutory restriction on gas tax			X	X		X
Zero-emission vehicle program	X					
Complete streets policy	X	X	X	X		
Exempts motor fuels from general state sales taxes	X		X		X	X
Legally enforceable GHG limits						
Dedicated funding for biking and walking	X		X		X	
Gas tax rate ranking by state (1=highest)	21	37	3	13	15	32
Transit spending per capita (2014)	$11.87	$30.19	$7.50	$1.45	$18.97	$4.32
Transit spending per capita rank (2014, 1=highest)	17	14	23	32	16	25
Highway Spending per capita (2014)	$848.37	$642.82	$688.58	$709.39	$577.45	$1,018.55
Highway spending per capita rank (2014-1 is high)	5	16	12	11	21	4

Sources:

Constitutional/statutory restriction on gas tax: National Conference of State Legislatures and AASHTO Center for Excellence in Project Finance, *Transportation Governance and Finance: A 50-State Review of State Legislatures and Departments of Transportation,* "Figure 5. State Uses of Fuel Tax Revenues," 2011; **Zero-emission vehicle program:** Alliance of Automobile Manufacturers, *ZEV States,* accessed 20 September 2016, archived at web.archive.org/web/20161004172128/http://www.zevfacts.com/zev-states.html; **Complete streets policy:** Smart Growth America, *Inventory of All Complete Street Policies,* September 2016, archived at web.archive.org/web/20161004175054/https://smartgrowthamerica.org/program/national-complete-streets-coalition/policy-development/policy-atlas/; **Data for gas tax ranking by state and exempt motor fuels from general state sales tax:** American Petroleum Institute, *July 2016 State Motor Fuel Taxes by State,* August 2016, available at www.api.org/oil-and-natural-gas/consumer-information/motor-fuel-taxes; **Dedicated funding for biking and walking:** Advocacy Advance, *BEST PRACTICES: States with Dedicated Sources of Funding,* accessed 20 September 2016, archived at web.archive.org/web/20161004172724/http://www.advocacyadvance.org/statefunding/dedicated; **Transit spending per capita (2014):** American Association of State Highway and Transportation Officials, *Survey of State Funding for Public Transportation: Final Report 2016- FY 2014 Data,* Table 1-6, April 2016; **Total highway spending (2014):** Federal Highway Administration, U.S. Department of Transportation, *Highway Statistics 2014,* "Table SF-2. State Disbursements for Highways 2014," December 2015, available at www.fhwa.dot.gov/policyinformation/statistics/2014/sf2.cfm. In calculating highway spending per capita, we used total disbursements from 2014 and population data from 2013; **State population:** U.S. Census, "Table 1. Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2014", available at www.census.gov/popest/data/state/totals/2014/.

Appendix B. Carbon Dioxide Emissions from Transportation by State

State	Transportation CO_2, 2013 (million metric tons)	Transportation share of state CO_2 emissions, 2013	Transportation CO_2 emissions per capita, 2013 (metric tons)	Transportation CO_2 emissions per capita rank (2013-1 is high)
Alabama	30.3	25%	6.3	17
Alaska	12.0	33%	16.3	1
Arizona	29.8	32%	4.5	45
Arkansas	18.0	26%	6.1	21
California	190.7	54%	5.0	35
Colorado	26.3	29%	5.0	34
Connecticut	14.4	42%	4.0	48
D.C.	1.0	33%	1.5	51
Delaware	3.9	30%	4.2	47
Florida	95.8	44%	4.9	36
Georgia	53.5	40%	5.4	29
Hawaii	9.6	53%	6.8	11
Idaho	8.8	52%	5.5	28
Illinois	61.6	27%	4.8	38
Indiana	40.9	20%	6.2	19
Iowa	19.6	25%	6.3	15
Kansas	18.8	26%	6.5	13
Kentucky	28.9	21%	6.6	12
Louisiana	44.4	23%	9.6	4
Maine	8.4	53%	6.3	16
Maryland	27.0	47%	4.5	44
Massachusetts	29.1	45%	4.3	46
Michigan	46.7	29%	4.7	41
Minnesota	28.7	32%	5.3	30
Mississippi	24.1	40%	8.1	5
Missouri	35.4	27%	5.9	23
Montana	7.8	24%	7.7	7
Nebraska	13.0	25%	7.0	10
Nevada	13.6	38%	4.9	37

New Hampshire	6.3	45%	4.8	39
New Jersey	55.8	53%	6.3	18
New Mexico	13.3	25%	6.4	14
New York	66.2	41%	3.4	50
North Carolina	46.7	38%	4.7	40
North Dakota	9.2	16%	12.7	3
Ohio	59.9	26%	5.2	31
Oklahoma	29.8	29%	7.7	6
Oregon	20.0	53%	5.1	33
Pennsylvania	58.6	24%	4.6	43
Rhode Island	3.7	37%	3.5	49
South Carolina	29.5	43%	6.2	20
South Dakota	6.2	41%	7.3	9
Tennessee	38.9	40%	6.0	22
Texas	201.8	31%	7.6	8
Utah	16.5	25%	5.7	27
Vermont	3.2	53%	5.1	32
Virginia	47.8	46%	5.8	24
Washington	39.8	55%	5.7	26
West Virginia	10.7	12%	5.8	25
Wisconsin	26.7	27%	4.6	42
Wyoming	7.6	11%	13.0	2

Sources:

U.S. Energy Information Administration, *State Carbon Dioxide Emissions,* "Transportation Emissions by State (1980-2013)", 26 October 2015; U.S. Census, "Table 1. Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2014", available at www.census.gov/popest/data/state/totals/2014/.

Notes

1 Richard F. Weingroff, "Federal Aid Road Act of 1916: Building the Foundation," *Public Roads,* Summer 1996, archived at web.archive.org/web/20160910094829/http://www.fhwa.dot.gov/publications/publicroads/96summer/p96su2.cfm.

2 The "80 percent or more by 2050" target has long been used as a guideline for necessary reductions from industrial countries like the United States to prevent dangerous global warming. (See, for example, The White House, *Fact Sheet: U.S. Reports its 2025 Emissions Target to the UNFCCC,* 31 March 2015, accessed at www.whitehouse.gov/the-press-office/2015/03/31/fact-sheet-us-reports-its-2025-emissions-target-unfccc, 26 April 2016.) Deeper and faster reductions in emissions may be needed to achieve the targets of the Paris Climate Agreement.

3 Per capita emissions: Based on data from World Energy Council, *Energy Efficiency Indicators,* accessed 2 February 2016, archived at web.archive.org/web/20160201204437/https://www.wec-indicators.enerdata.eu/transport-co2-intensity.htm; 4 percent: U.S. emissions: U.S. Environmental Protection Agency, *Greenhouse Gas Inventory Data Explorer* www3.epa.gov/climatechange/ghgemissions/inventoryexplorer/#allsectors/allgas/econsect/all, accessed 27 April 2016; global GHG emissions: David Victor, Dadi Zhou, et al., "Introductory Chapter," in *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* 2014, archived at web.archive.org/web/20160201203321/https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter1.pdf.

4 Based on data from World Energy Council, *Energy Efficiency Indicators,* accessed 2 February 2016, archived at web.archive.org/web/20160201204437/https://www.wec-indicators.enerdata.eu/transport-co2-intensity.html.

5 U.S. Energy Information Administration, *Monthly Energy Review September 2016,* 27 September 2016.

6 Ibid.

7 Mike Salisbury and Will Toor, Southwest Energy Efficiency Project, *Evaluation of Colorado Electric Vehicle Group Purchase Programs,* February 2016; Boulder County, *Benefits Boulder County,* accessed 10 September 2016, archived at web.archive.org/web/20160910124123/http://www.bouldercounty.org/env/sustainability/pages/ev.aspx/

8 TriMet, *Bike Barometer: Portland Tilikum Crossing,* accessed at portland-tilikum-crossing.visio-tools.com/, 10 September 2016.

9 U.S. Department of Transportation, *Overwhelming Response by Cities Across the Country to U.S. Department of Transportation Smart City Challenge,* 8 February 2016, archived at web.archive.org/web/20161007153201/https://www.transportation.gov/briefing-room/overwhelming-response-cities-across-country-us-department-transportation-smart-city.

10 See, for example: Michael A. Replogle and Lewis M. Fulton, Institute for Transportation and Development Policy, *A Global High Shift Scenario: Impacts and Potential for More Public Transport, Walking and Cycling with Lower Car Use,* September 2014, archived at web.archive.org/web/20160201215853/https://www.itdp.org/wp-content/uploads/2014/09/A-Global-High-Shift-Scenario_WEB.pdf; U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Transportation Energy Futures,* March 2013, archived at web.archive.org/web/20160201215635/http://www.nrel.gov/docs/fy13osti/56269.pdf; Rocky Mountain Institute, *Reinventing Fire: Projected Decline in U.S. Transportation Sector Fuel Use,* 2010-2050, accessed 1 February 2016, archived at web.archive.org/web/20160201220034/http://www.rmi.org/RFGraph-Projected_decline_in_US_transportation_sector_fuel_use; James Williams, et al., *Pathways to Deep Decarbonization in the United States,* prepared for Sustainable Development Solutions Network and the Institute for Sustainable Development and International Relations, 2014, archived at web.archive.org/web/20160201220351/http://unsdsn.org/wp-content/uploads/2014/09/US-Deep-Decarbonization-Report.pdf; Gabe Pacyniak, et al., Georgetown Climate Center, *Reducing Greenhouse Gas Emissions from Transportation: Opportunities in the Northeast and Mid-Atlantic,* November 2015.

11 See, for example: Jeffery B. Greenblatt and Samveg Saxena, "Autonomous Taxis Could Greatly Reduce Greenhouse Gas Emissions of U.S. Light-duty Vehicles," *Nature Climate Change,* 5: 860-863, 2015, DOI: 10.1038/nclimate2685; International Transport Forum, Corporate Partnership Board, *Shared Mobility: Innovation for Liveable Cities,* 2016.

12 Tony Dutzik and Alana Miller, Frontier Group, *A New Way Forward: Envisioning a Transportation System without Climate Pollution,* May 2016, available at www.frontiergroup.org/reports/fg/new-way-forward.

13 Current: Rachael Nealer, David Reichmuth and Don Anair, Union of Concerned Scientists, *Cleaner Cars from Cradle to Grave: How Electric Cars Beat Gasoline Cars on Lifetime Global Warming Emissions,* November 2015.

14 Urban Land Institute, *Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions,* July 2009.

15 American Public Transportation Association, *Record 10.8 Billion Trips Taken on U.S. Public Transportation in 2014* (news release), 9 March 2015.

16 Frank Gallivan et al., Transportation Research Board of the National Academies, *Quantifying Transit's Impact on GHG Emissions and Energy Use – The Land Use Component,* 2015.

17 The League of American Bicyclists, *Where We Ride: An Analysis of Bicycling in American Cities,* October 2014.

18 Ed Pike, International Council on Clean Transportation, *Congestion Charging: Challenges and Opportunities,* April 2010.

19 National Association of Realtors, Portland State University, *Community & Transportation Preferences Survey,* 23 July 2015, archived at web.archive.org/web/20160202174726/http://www.realtor.org/sites/default/files/reports/2015/nar-psu-2015-poll-report.

20 Jacob Mason, Lew Fulton and Zane McDonald, Institute for Transportation & Development Policy and University of California, Davis, *A Global High Shift Cycling Scenario: The Potential for Dramatically Increasing Bicycle and E-bike Use in Cities Around the World, with Estimated Energy, CO_2, and Cost Impacts,* 12 November 2015.

21 Candace Brakewood, Sean Barbeau, and Kari Watkins, "An Experiment Evaluating the Impacts of Real-Time Transit Information on Bus Riders in Tampa, Florida," *Transportation Research Part A: Policy and Practice,* Vol. 69: 409-422, November 2014; Candace Brakewood, Sean Barbeau, and Kari Watkins, "The Impact of Real-Time Information on Bus Ridership in New York City," *Transportation Research Part C: Emerging Technologies,* Vol. 53: 59-65, April 2015.

22 42 U.S.C. § 4332(2)(C)

23 40 U.S.C. § 1508.8

24 Council on Environmental Quality, *CEQ Releases Final Guidance on Greenhouse Gases and Climate Change,* accessed 11 September 2016, archived at web.archive.org/web/20160912000823/https://www.whitehouse.gov/administration/eop/ceq/initiatives/nepa/ghg-guidance.

25 See Amy L. Stein, "Climate Change under NEPA: Avoiding Cursory Consideration of Greenhouse Gases," *University of Colorado Law Review,* 81:473-544.

26 81 FR 23805

27 42 U.S.C. § 7521(a)(1)

28 U.S. Department of Transportation, Federal Highway Administration, *Air Quality: Transportation Conformity,* accessed 11 September 2016, archived at web.archive.org/web/20160912002223/http://www.fhwa.dot.gov/environment/air_quality/conformity/.

29 James E. McCarthy, Congressional Research Service, *Transportation Conformity Under the Clean Air Act,* 21 May 2015.

30 81 FR 9935; 78 FR 1992.

31 Carbon dioxide emissions: U.S. Energy Information Administration, *State Carbon Dioxide Emissions,* "Transportation Emissions by State (1980-2013)", 26 October 2015; population: U.S. Census, "Table 1. Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2014", available at www.census.gov/popest/data/state/totals/2014/.

32 Elizabeth Ridlington and Jeff Inglis, Frontier Group, Travis Madsen, Environment America Research & Policy Center, *Path to the Paris Climate Conference: American Progress in Cutting Carbon Pollution Could Pave the Way for Global Action,* Summer 2015

33 California Air Resources Board, *Overview of ARB Emissions Trading Program,* 9 February 2015.

34 Massachusetts Supreme Judicial Court, *Isabel Kain & Others vs. Department of Environmental Protection.*

35 For a database of state climate action plans, see Center for Climate Strategies, *State and Local Climate Blackboard,* accessed at www.climatestrategies.us/policy_tracker/state/index, 12 September 2016,

36 Tiffany Batac, Guido Schattanek and Michael D. Meyer, NCHRP 08-36, Task 107, *Synthesis of State DOT and MPO Planning and Analysis Strategies to Reduce Greenhouse Gas Emissions,* October 2012.

37 Federal Highway Administration, *Climate Mitigation: Questions & Answers,* updated January 2016, archived at web.archive.org/web/20160912135919/https://www.fhwa.dot.gov/environment/climate_change/mitigation/q_and_a/; Oregon: Oregon Department of Transportation, *Oregon Sustainable Transportation Initiative,* accessed 12 September 2016, archived at web.archive.org/web/20160912140825/https://www.oregon.gov/ODOT/TD/OSTI/Pages/Scenarios.aspx.

38 California Air Resources Board, *Sustainable Communities,* accessed 12 September 2016, archived at web.archive.org/web/20160912141106/https://www.arb.ca.gov/cc/sb375/sb375.htm.

39 John F. Thomas, Brian H. West and Shean P. Huff, "ORNL Researchers Quantify the Effect of Increasing Highway Speed on Vehicle Fuel Economy," *Green Car Congress,* 18 January 2013, archived at web.archive.org/web/20161004141246/http://www.greencarcongress.com/2013/01/thomas-20130117.html.

40 Laura Legere, "As Speed Limits Rise on Pa. Highways, Fuel Economy Falls," *Pittsburgh Post-Gazette PowerSource* blog, 10 May 2016.

41 Peter Savolainen, et al., *Evaluating the Impacts of Speed Limit Policy Alternatives: Final Report,* prepared for the Michigan Department of Transportation, 21 July 2014.

42 See Gilles Duranton and Matthew Turner, *The Fundamental Law of Road Congestion: Evidence from U.S. Cities,* 8 September 2009; Todd Litman, Victoria Transport Policy Institute, *Generated Traffic and Induced Travel: Implications for Transport Planning,* 11 May 2016; Susan Handy and Marlon G. Boarnet, *Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions* (policy brief), prepared for California Air Resources Board, 30 September 2014.

43 Clark Williams-Derry, Sightline Institute, *Increases in Greenhouse Gas Emissions from Highway Widening Projects,* October 2007.

44 Frank Gallivan, et al., *Quantifying Transit's Impact on GHG Emissions and Energy Use – The Land Use Component,* Transit Cooperative Research Program Report 176, 2015.

45 Susan Handy and Marlon G. Boarnet, *Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions* (policy brief), prepared for California Air Resources Board, 30 September 2014.

46 Congressional Budget Office, *Public Spending on Transportation and Water Infrastructure, 1956 to 2014*, supplemental data, 2 March 2015.

47 Ibid.

48 Expenditures: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2014,* Table HF-10, March 2016; GDP: U.S. Bureau of Economic Analysis, *Current Dollar and "Real" GDP* (Excel file), accessed at www.bea.gov/national/xls/gdplev.xls, 12 September 2016.

49 Smart Growth America and Taxpayers for Common Sense, *Repair Priorities 2014: Transportation Spending Priorities to Save Taxpayer Dollars and Improve Roads,* March 2014.

50 2 percent: Alliance for Biking and Walking, *Bicycling & Walking in the United States: 2016 Benchmarking Report,* 2016; 12 percent: U.S. Department of Transportation and Pedestrian and Bicycle Information Center, *The National Bicycling and Walking Study: 15-Year Status Report,* May 2010.

51 Alliance for Biking and Walking, *Bicycling & Walking in the United States: 2016 Benchmarking Report,* 2016.

52 See Tony Dutzik and Gideon Weissman, Frontier Group, Phineas Baxandall, U.S. PIRG Education Fund, *Who Pays for Roads? How the "Users Pay" Myth Gets in the Way of Solving America's Transportation Problems,* Spring 2015.

53 $98 billion: Sum of revenue used for highways from property taxes and assessments, general fund appropriations and other taxes and fees from U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2014,* Table HF-10, March 2016; $45 billion including all transit revenues except fares and "other directly generated funds" from U.S. Department of Transportation, Federal Transit Administration, *National Transit Database for 2014,* tables 1 and 7, accessed at www.transit.dot.gov/ntd/ntd-data, 12 September 2016.

54 Ibid.

55 U.S. Department of Transportation, *Government Transportation Financial Statistics 2014,* August 2014, Table 10B. "Other sources" includes all revenue sources identified as "supporting revenue," plus, in the case of transit, funding from the Mass Transit Account of the Highway Trust Fund and state gasoline taxes used for transit and designated as "own-source revenues" by U.S. DOT. "User fees" for highways includes own-source revenues deposited in the Highway Account of the Highway Trust Fund and all state and local own-source revenues. "Fares and own-source revenues" for transit includes all own-source revenues except revenues dedicated to transit from gas taxes and tolls.

56 Ibid.

57 Robert S. Kirk, Congressional Research Service, *Federal-Aid Highway Program (FAHP): In-Brief,* 14 January 2016.

58 U.S. Department of Transportation, Federal Transit Administration, *Annual Report on Funding Recommendations: Fiscal Year 2017 Capital Investment Grant Program,* 2016.

59 U.S. Government Accountability Office, *Public Transit: Funding for New Starts and Small Starts Projects,* October 2004 through June 2012, November 2012.

60 U.S. Government Accountability Office, *Flexible Funding Continues to Play a Role in Supporting State and Local Transportation Priorities,* 15 November 2012.

61 Gasoline tax dedication: National Conference of State Legislatures and AASHTO Center for Excellence in Project Finance, *Transportation Governance and Finance: A 50-State Review of State Legislatures and Departments of Transportation,* Figure 5, 2011 May; Sales tax exemption: American Petroleum Institute, *July 2016 State Motor Fuel Taxes by State,* August 2016, available at: www.api.org/oil-and-natural-gas/consumer-information/motor-fuel-taxes.

62 Jamie Rall, et al., National Conference of State Legislatures and AASHTO Center for Excellence in Project Finance, *Transportation Governance and Finance: A 50-State Review of State Legislatures and Departments of Transportation,* May 2011. In some cases, the text of these provisions can and has been interpreted to allow for some expenditure of state funds for public transportation or other purposes.

63 American Association of State Highway and Transportation Officials, *Final Report 2016 – FY 2014 Data: Public Transportation: Survey of State Funding,* April 2016. Population data: U.S. Census Bureau. State carbon dioxide emissions from transportation: U.S. Energy Information Administration, *State Carbon Dioxide Emissions with Data for 2013,* 26 October 2015.

64 State carbon dioxide pollution from transportation: U.S. Energy Information Administration, *State Carbon Dioxide Emissions with Data for 2013,* 26 October 2015, accessed at www.eia.gov/environment/emissions/state/; international emissions: Organization for Economic Cooperation and Development, *OECD.Stat: Greenhouse Gas Emissions, Table A13, Transport,* accessed at stats.oecd.org/Index.aspx?DataSetCode=AIR_GHG#, 12 September 2016. Japan, Germany, France and the United Kingdom emitted 619 million metric tons, carbon dioxide-equivalent, of greenhouse gases in 2014. These four nations house more than 330 million people – more than the population of the entire United States.

65 American Association of State Highway and Transportation Officials, *Final Report 2016 – FY 2014 Data: Public Transportation: Survey of State Funding,* April 2016.

66 Michelle DeRobertis, et al., "Changing the Paradigm of Traffic Impact Studies: How Typical Traffic Studies Inhibit Sustainable Transportation," *ITE Journal,* May 2014.

67 Jennifer Hernandez, David Friedman and Stephanie DeHerrera, Holland & Knight, *In the Name of the Environment: How Litigation Abuse Under the California Environmental Quality Act Undermines California's Environmental, Social Equity and Economic Priorities – and Proposed Reforms to Protect the Environment from CEQA Litigation Abuse,* August 2015.

68 Angie Schmitt, "The Feds Want to Reform the Cult of Level of Service," *Streetsblog USA,* 28 January 2016.

69 Stephen Lee Davis, Transportation for America, *Ten Things to Know About U.S. DOT's New Proposal for Measuring Traffic Congestion,* 20 April 2016, archived at web.archive.org/web/20161004142350/http://t4america.org/2016/04/20/nine-things-to-know-about-usdots-new-proposal-for-measuring-traffic-congestion/.

70 Arlington County (Virginia) Commuter Services, *Transportation Demand Management Strategic Plan Update: Fiscal Years 2014 to 2031,* 2012.

71 For more details on college TDM efforts, see Will Toor and Spenser W. Havlick, *Transportation & Sustainable Campus Communities: Issues, Examples, Solutions,* Island Press, 2014; Tom Van Heeke and Elise Sullivan, Frontier Group, Phineas Baxandall, U.S. PIRG Education Fund, *A New Course: How Innovative University Programs Are Reducing Driving on Campus and Creating New Models for Transportation Policy,* February 2014.

72 Matthew J. Barth, Guoyuan Wu and Kanok Boriboonsomsin, "Intelligent Transportation Systems and Greenhouse Gas Reductions," *Current Sustainable/Renewable Energy Reports,* 2(3): 90-97, September 2015, doi: 10.1007/s40518-015-0032-y.

73 "16 percent": American Association of State Highway and Transportation Officials, *Commuting in America 2013: Brief 2: The Role of Commuting in Overall Travel,* 2013.

74 Philip L. Winters, Center for Urban Transportation Research, 2014 *TMA Survey – Final Results,* accessed 12 September 2016, archived at web.archive.org/web/20160912155933/http://www.bestworkplaces.org/wp-content/uploads/2015/07/TMA-Survey-2014-Final-Results-4-7-15-compressed.pdf.

75 U.S. Government Accountability Office, *Intelligent Transportation Systems: Improved DOT Communication and Collaboration Could Enhance the Use of Technology to Manage Congestion,* March 2012.

76 U.S. Department of Transportation, Federal Highway Administration, I*ntegrating Demand Management into the Transportation Planning Process: A Desk Reference,* August 2012, Chapter 11.

77 Steven Higashide, TransitCenter, "How Federal Policy Holds Back Local TDM Innovation and How it Can Help," *The Connnection* blog, 24 July 2015; U.S. Department of Transportation, Federal Highway Administration, *Air Quality: Congestion Mitigation and Air Quality Improvement (CMAQ) Program,* accessed 12 September 2016, archived at web.archive.org/web/20160912161307/http://www.fhwa.dot.gov/environment/air_quality/cmaq/.

78 Based on data from U.S. Department of Transportation, *CMAQ Public Access System,* accessed at fhwaapps.fhwa.dot.gov/cmaq_pub/, 27 September 2016. Includes only spending labeled "Transportation Demand Management." The CMAQ program also supports programs such as ridesharing and transit improvements that are sometimes supported by Transportation Management Associations and other agencies concerned with TDM strategies.

79 Stephen J. Ezell and Robert D. Atkinson, Information Technology & Innovation Foundation, *From Concrete to Chips: Bringing the Surface Transportation Reauthorization into the Digital Age,* May 2015.

80 National Cooperative Highway Research Program, *Research Reports Digest 348: State Department of Transportation Role in the Implementation of Transportation Demand Management Programs,* July 2010.

81 Washington State Commute Trip Reduction Board, *2015 Report to the Legislature,* 2015.

82 See note 52.

83 Joe Cortright, "House Republicans' Asphalt Socialism," *The American Conservative,* 17 November 2015.

84 Stephen Crim, "Highway Congestion, America's Soviet Bread Line Problem, Needs a Price," *Mobility Lab,* 7 April 2016.

85 U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2014,* Table HF-10, March 2016. Note: highway user fees contributed an additional $27 billion used for non-highway purposes (public transportation or general government purposes), while governments generated an additional $48 billion in proceeds for highways from bond issues and the use of investment proceeds and other unspecified revenues.

86 Ian W. H. Parry, Margaret Walls and Winston Harrington, Resources for the Future, *Automobile Externalities and Policies,* revised January 2007.

87 U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2014,* Table IN-1, August 2015.

88 Eno Center for Transportation, *The Life and Death of the Highway Trust Fund,* December 2014.

89 See note 87; American Petroleum Institute, *July 2016 State Motor Fuel Taxes by State,* August 2016, available at: www.api.org/oil-and-natural-gas/consumer-information/motor-fuel-taxes.

90 U.S. Congress, Joint Committee on Taxation, Tax Expenditures, *Estimates of Federal Tax Expenditures for Fiscal Years 2015-2019,* 7 December 2015.

91 See note 52.

92 TransitCenter and Frontier Group, *Subsidizing Congestion: The Multibillion-Dollar Tax Subsidy That's Making Your Commute Worse,* November 2014.

93 Impacts of bikesharing and carsharing on vehicle ownership, use and/or greenhouse gas emissions: Elliot Martin, Susan Shaheen, and Jeffrey Lidicker, Transportation Sustainability Research Center, University of California Berkeley, "Impact of Carsharing on Household Vehicle Holdings: Results from North American Shared-Use Vehicle Survey," *Transportation Research Record*, No 2143: pp 150-158, doi: 10.3141/2143-19, 2010; Susan A. Shaheen, et al., Mineta Transportation Institute, *Public Bikesharing in North America During a Period of Rapid Expansion: Understanding Business Models, Industry Trends and User Impacts,* October 2014; Elliot Fishman et al., "Bike Share's Impact On Car Use: Evidence From The United States, Great Britain, and Australia," *Transportation Research Part D: Transport and Environment,* 31 (2014): 13-20, doi:10.1016/j.trd.2014.05.013, August 2014; Elliott Martin and Susan Shaheen, Transportation Sustainability Research Center, University of California, Berkeley, *Impacts of Car2Go on Vehicle Ownership, Modal Shift, Vehicle-Miles Traveled and Greenhouse Gas Emissions: An Analysis of Five North American Cities* (working paper), July 2016.

94 National Conference of State Legislatures, *Rental Car Taxes,* 18 March 2015, accessed at www.ncsl.org/research/fiscal-policy/rental-car-taxes.aspx.

95 Joseph P. Schwieterman and Heather Spray, Chaddick Institute for Metropolitan Development at DePaul University, *When Sharing Is Taxing: Comparing the Tax Burden on Carsharing Services in Major U.S. Cities,* 21 July 2016.

96 Internal Revenue Service, *Publication 15-B (2016): Employer's Guide to Fringe Benefits,* 2016.

97 Bikesharing: Internal Revenue Service, Letter from Lynne Camillo to unknown recipients regarding eligibility of bike-sharing expenses for commuter benefits, 26 July 2013, archived at web.archive.org/web/20160912194647/https://www.irs.gov/pub/irs-wd/13-0032.pdf; for further discussion of treatment of shared mobility in commuter benefits rules, see: Jordan M. Berry and Paul L. Caron, "Tax Regulation, Transportation Innovation and the Sharing Economy," *University of Chicago Law Review,* 82:69-84, 2015.

98 Federal Highway Administration, *Toll Facilities in the United States,* January 2016, archived at hweb.archive.org/web/20160912194958/https://www.fhwa.dot.gov/policyinformation/tollpage/.

99 Federal Highway Administration, *Highway Statistics 2014,* Table HM-220, 1 October 2014.

100 Todd Wallack, "Unlimited Permits Strain Boston's Parking System," *Boston Globe*, 20 January 2015.

101 Jason E. Bordoff and Pascal J. Noel, The Hamilton Project at the Brookings Institution, *Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity,* July 2008.

[102] Oregon Department of Consumer & Business Services, *Pay As You Go Auto Insurance: Available in Oregon?,* June 2013, archived at web.archive.org/web/20161004145351/https://www.oregon.gov/DCBS/Insurance/gethelp/Documents/guides/4845-30_pay-as-you-go-insurance.pdf.

[103] U.S. Environmental Protection Agency, *EPA and NHTSA Propose Standards to Reduce Greenhouse Gas Emissions and Improve Fuel Efficiency of Medium- and Heavy-Duty Vehicles for Model Year 2018 and Beyond,* June 2015; U.S. Environmental Protection Agency, *EPA and NHTSA Adopt First-Ever Program to Reduce Greenhouse Gas Emissions and Improve Fuel Efficiency of Medium- and Heavy-Duty Vehicles,* August 2011.

[104] U.S. Environmental Protection Agency, *EPA and NHTSA Set Standards to Reduce Greenhouse Gases and Improve Fuel Economy for Model Years 2017-2025 Cars and Light Trucks,* August 2012.

[105] Peter Faguy, U.S. Department of Energy, *Overview of the DOE Advanced Battery R&D Program* (Powerpoint presentation), 8 June 2015; Bjorn Nykvist and Mans Nilsson, "Rapidly Falling Costs of Battery Packs for Electric Vehicles," *Nature Climate Change,* 5: 329-332, 2015, DOI: doi:10.1038/nclimate2564.

[106] Jeff Cobb, "Five Pending 200-Mile Range EVs That Won't Break the Bank," *HybridCars.com,* 25 May 2016, archived at web.archive.org/web/20161007154916/http://www.hybridcars.com/five-pending-200-mile-range-evs-that-wont-break-the-bank/.

[107] Sales: Inside EVs, *Monthly Plug-In Sales Scorecard,* accessed 12 September 2016, archived at web.archive.org/web/20160912200841/http://insideevs.com/monthly-plug-in-sales-scorecard/.

[108] 370,000 preorders: Noah Joseph, "Tesla Model 3 Pre-Orders Whittled Down to 373,000," *AutoBlog,* 19 May 2016, archived at web.archive.org/web/20160912200604/http://www.autoblog.com/2016/05/19/tesla-model-3-pre-orders-lower-report/.

[109] Based on comparison of costs of compliance for the EPA GHG standards between 2012 initial model rule and 2016 mid-term assessment. Source: U.S. Environmental Protection Agency, California Air Resources Board and National Highway Traffic Safety Administration, *Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025,* July 2016 ES-9.

[110] Steve Hanley, "Netherlands on Verge of Banning New Gasoline Cars by 2025," *CleanTechnica,* 16 August 2016; Craig Morris, "Norway Will Not Ban Gas & Diesel Car Sales," CleanTechnica, 9 June 2016.

[111] ZEV Program Implementation Task Force, *Multi-State ZEV Action Plan,* May 2014.

[112] The White House, *Fact Sheet: Obama Administration Announces Federal and Private Sector Actions to Accelerate Electric Vehicle Adoption in the United States,* 21 July 2016, archived at web.archive.org/web/20160912201753/https://www.whitehouse.gov/the-press-office/2016/07/21/fact-sheet-obama-administration-announces-federal-and-private-sector.

[113] Corn ethanol is required to meet a 20 percent life-cycle greenhouse emission reduction to qualify under the Renewable Fuel Standard, but the extent of life-cycle emission reductions depends greatly on the assumptions used to calculate them.

[114] U.S. Environmental Protection Agency, *Proposed Renewable Fuel Standards for 2017 and the Biomass-Based Diesel Volume for 2018,* accessed 12 September 2016, archived at web.archive.org/web/20160912202043/https://www.epa.gov/renewable-fuel-standard-program/proposed-renewable-fuel-standards-2017-and-biomass-based-diesel; U.S. Environmental Protection Agency, *Program Overview for Renewable Fuel Standard Program,* accessed 12 September 2016, archived at web.archive.org/web/20160912202153/https://www.epa.gov/renewable-fuel-standard-program/program-overview-renewable-fuel-standard-program.

[115] California Air Resources Board, *Low Carbon Fuel Standard: Data Dashboard,* accessed 12 September 2016, archived at web.archive.org/web/20160912202337/https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm

[116] *Northeast and Mid-Atlantic Low-Carbon Fuel Standard Memorandum of Understanding,* 30 December 2009.

[117] Based on data from U.S. Energy Information Administration, *Electricity Data Browser,* accessed at www.eia.gov/electricity/data/browser/, 12 September 2016.

118 See, for example: Alexander MacDonald et al., "Future Cost-Competitive Electricity Systems and Their Impact on U.S. CO_2 Emissions," *Nature Climate Change,* DOI: 10.1038/nclimate2921, 25 January 2016; Mark Jacobson et al., "100% Clean and Renewable Wind, Water, and Sunlight (WWS) All-sector Energy Roadmaps for the 50 United States," *Energy & Environmental Science 2015* 8:2093, DOI: 10.1039/C5EE01283J, 27 May 2015; Sven Teske et al., *Energy [R]evolution: A Sustainable World Energy Outlook 2015,* Greenpeace International, Global Wind Energy Council, Solar PowerEurope, September 2015; James H. Williams et al., Energy and Environmental Economics, *Pathways to Deep Decarbonization in the United States,* 16 November 2015; Cory Budischak, "Cost-minimized Combinations of Wind Power, Solar Power and Electrochemical Storage, Powering the Grid up to 99.9% of the Time," *Journal of Power Sources,* 225: 60-74, 1 March 2013; M.M. Hand et al., National Renewable Energy Laboratory, *Renewable Electricity Futures Study,* December 2012; WWF, *The Energy Report – 100% Renewable Energy by 2050,* 2011.

119 Galen Barbose, Lawrence Berkeley National Laboratory, *U.S. Renewables Portfolio Standards 2016 Annual Progress Report,* April 2016.

120 Ibid.

121 U.S. Department of Energy, *Renewable Energy Production Tax Credit,* accessed 12 September 2016, archived at web.archive.org/web/20160912203719/http://energy.gov/savings/renewable-electricity-production-tax-credit-ptc.

122 Solar Energy Industries Association, *Solar Investment Tax Credit (ITC),* accessed 12 September 2016, archived at web.archive.org/web/20160912203822/http://www.seia.org/policy/finance-tax/solar-investment-tax-credit.

123 "32 percent": U.S. Environmental Protection Agency, *Fact Sheet: Overview of the Clean Power Plan,* accessed 4 October 2016, archived at web.archive.org/web/20161004145519/https://www.epa.gov/cleanpowerplan/fact-sheet-overview-clean-power-plan.

124 U.S. Energy Information Administration, *Today in Energy: Clean Power Plan Accelerates the Growth of Renewable Generation throughout United States,* 17 June 2016, archived at web.archive.org/web/20161004145742/https://www.eia.gov/todayinenergy/detail.php?id=26712.

125 Smart Growth America, *Federal Involvement in Real Estate: A Call for Examination,* January 2013.

126 Steven Spears, et al., *Impacts of Land-Use Mix on Passenger Vehicle Use and Greenhouse Gas Emissions, prepared for California Air Resources Board,* 30 September 2014.

127 Regional Plan Association, *The Unintended Consequences of Housing Finance,* January 2016.

128 Greg LeRoy, "Subsidizing Sprawl," *Reimagine,* accessed 12 September 2016, archived at https://web.archive.org/web/20160912204328/http://www.reimaginerpe.org/node/27.

129 Greg LeRoy and Leigh McIlvane, Good Jobs First, *Paid to Sprawl: Subsidized Job Flight from Cleveland and Cincinnati,* July 2011.

130 N. J. Slabbert, "What a Giant, Dysfunctional Federal Agency is Doing to America," *Governing,* 1 September 2016.

131 The White House, *Housing Development Toolkit,* September 2016.

132 Ibid.

133 7 Tex. Trans. 541.001 (1)

134 Scott Le Vine, et al., *Vehicle Automation, Legal Standards of Care, and Freeway Capacity* (working paper), 21 June 2016.

135 National League of Cities, *City of the Future: Technology and Mobility,* 2015

136 Colin Campbell, "NC Senate Budget Jeopardizes Durham-Chapel Hill Light Rail," *News & Observer,* 3 June 2016; Michael Kranish, "A City's Immovable Roadblock," *Boston Globe,* 10 October 2015.

137 Angie Schmitt, "Advocates Prevail Over Road Diet Ban in North Carolina," *Streetsblog USA,* 22 September 2015.

138 See, for example: Nok-Noi Ricker, "Planners Claim State Forced them to Approve I-395 Connector Project," *Bangor Daily News,* 26 March 2016.

139 Kail Padgitt, Tax Foundation, *State and Local-Option General Sales Tax Rates,* 19 August 2010.

140 Eric Sundquist, State Smart Transportation Initiative, *Virginia Adopts Multimodal, Competitive Project Scoring Process,* 22 June 2015.

141 See, for example, Beth Osborne, The Century Foundation, *New Principles for Our Transportation Program,* 11 May 2016.

142 For example: C40 Cities, ICLEI USA – Local Governments for Sustainability, the National Association of City Transportation Officers, and others.

143 See additional comments in Center for Neighborhood Technology, Natural Resources Defense Council and United States Public Interest Research Group, *Treatment of Greenhouse Gases in the Federal Highway Administration Proposed Rule for National Performance Management Measures, Docket No. FHWA-2013-0054,* 8 August 2016, accessed at www.nrdc.org.

144 Charge Ahead California, *New California Law Speeds Transition to Electric Vehicles,* accessed 12 September 2016, archived at https://web.archive.org/web/20160912210529/http://chargeahead.org/2014/09/new-california-law-speeds-transition-to-electric-vehicles/.

145 Kathy Lindquist and Michel Wendt, Washington State Department of Transportation, *Least-Cost Planning in Transportation: Synthesis,* 12 April 2012.

146 Michael Cabanatuan, "Parkmerced Plans to Subsidize Residents' Use of Uber, Muni, BART," *SFGate,* 18 May 2016.

147 Ed Pike, International Council on Clean Transportation, *Congestion Charging: Challenges and Opportunities,* April 2010.

148 26 DE Code Section 1014g

149 See Multi-State ZEV Task Force, www.zevstates.us/.

150 Federal Highway Administration, *FAST Act: Transportation Infrastructure Finance and Innovation Act*, accessed 12 September 2016, archived at web.archive.org/web/20160912213014/https://www.fhwa.dot.gov/fastact/factsheets/tifiafs.cfm.

151 U.S. Department of Transportation, *U.S. Transportation Secretary Foxx Announces Four Winning Cities of the Every Place Counts Design Challenge* (press release), 27 June 2016.

152 Zia Wadud et al., *Help or Hindrance? The Travel, Energy and Carbon Impacts of Highly Automated Vehicles,* Transportation Research Part A: Policy and Practice, 86:1-18, April 2016, www.sciencedirect.com/science/article/pii/S0965856415002694.

153 See City of Columbus, Ohio, *#SmartColumbus: Application,* accessed at www.columbus.gov/smartcolumbus/application/, 4 October 2016.

154 Luz Lazo, "Uber, Lyft Partner with Transportation Authority to Offer Paratransit Customers Service in Boston," *Washington Post,* 16 September 2016.