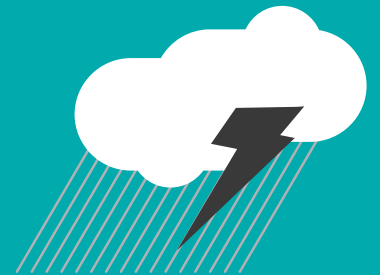
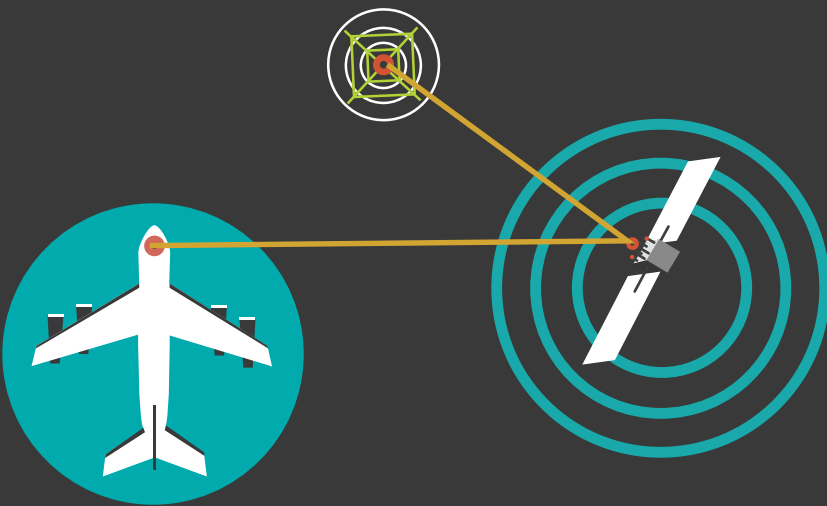
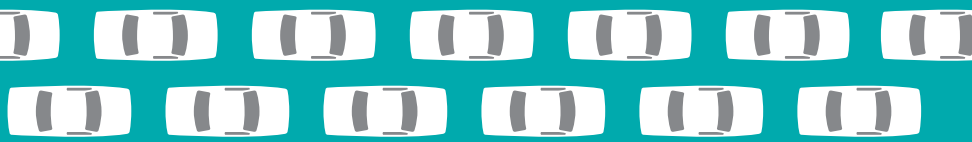
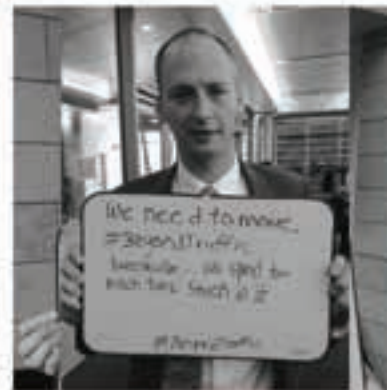
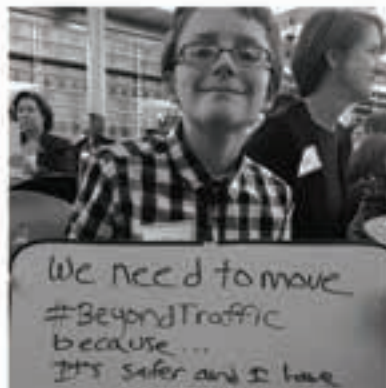




# Beyond Traffic 2045





## **DEDICATION**

**Thank you for participating in  
our stakeholder outreach events.  
We appreciate all you do for us.  
#BeyondTraffic.**

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# LETTER TO THE READER

We, as users of the transportation system, think little of the untold intricacies that converge so we can get to work, take children to their activities, or enjoy a cross country trip. There is hardware—the roads, runways, and railways. There is also software—the vehicles in which we move. There are the vehicle operators and fellow travelers with whom we share the highway, the sky, or the railroad tracks. There are the maps we use to chart our course. If any one of these elements fail, we may reach our destination but only after many hours have been lost. Increasingly, our ability to maximize our time correlates directly to transportation.

Transportation matters more than just as a way to get us places. Transportation, for good or ill, shapes places. Many road networks have been built upon foot-worn paths of our forbearers. Along these paths grew towns, and some of those towns grew into cities. As new forms of transportation grew—from the horse and buggy, to the bicycle, to the locomotive, to the automobile—it became necessary to smooth those paths and, more recently, pave them or lay rails upon them.

Places where we live and work also shape the transportation system. Clogged highways are not the product of poor design per se. Sometimes they choke with unanticipated traffic flows brought about by unforeseen zoning and land use decisions, regional population growth, or



deferred maintenance caused by inadequate budgets or perhaps misplaced priorities. Congestion is not limited to roads. A Midwestern farmer may have harvested several tons of grain to ship by rail only to find limited space on freight trains due to growing competition from commodities such as energy products. Even our commercial airspace is experiencing congestion around major hub airports. As we grow, and as our economy grows, the challenge of moving will become even more complicated. If we could anticipate today what will likely slow or stop our national progress, we could plan an effective response, engage in robust debate, and settle on a course of action. Unfortunately, we have too often misstated the problem as simply one of funding when it may be one of both resources and design.

In the enabling legislation that gave rise to the U.S. Department of Transportation, the Secretary of Transportation is vested with the responsibility to report on current and future conditions of our transportation system. This report is the U.S. Department of Transportation's most comprehensive assessment of national conditions in decades and is, in effect, a call to action. After years of chronic underinvestment and policy choices that sometimes work at cross-purposes with larger economic and social mobility goals, now is the time for a report like this to be read, understood, considered, and utilized to breathe new life into funding and policy discussions at the federal, state, and local levels.

Can we imagine a future in which traffic jams decline? Absolutely. Essentially, three strategies need to be employed—all of which demand increased funding and new, more adaptive policymaking at all levels of government. First, we clearly have to take better care of our legacy transportation systems. We cannot cross bridges that have fallen apart or connect commerce to ports in disrepair. Most obviously, the question of sufficient resources must be confronted squarely. Second, we must fund and prioritize new projects based on future projections, not arcane precepts of mobility. Living patterns are changing, as are transportation tastes. As is the nature of freight movement. Rather than plunge our heads in the sand, policymakers and practitioners should understand these trends and plan with them in mind. Third, we must use technologies and better design approaches that will allow us to maximize the use of our old and new transportation assets. Doing so may involve adapting for innovations in vehicle safety and automation, improving federal, state, and local coordination, and adopting best practices in the design of infrastructure.

These strategies are at variance with our current posture. The U.S. transportation system is still proceeding under a 20th century model in which our policies, practices, and programs are presumed to be sufficient, as are the resources devoted to them.

Over the past six years, the United States government has passed 32 short-term measures to keep its surface transportation system afloat. Funding uncertainty has undermined our ability to modernize our air traffic control system. Diffuse decision-making mechanisms at the state and local level have hampered our ability to address critical freight and trade corridors. And our programs and policies have not been reformed to tackle the challenges of tomorrow. The combination of these forces—inconsistent, unreliable funding, and static policies in an era of rapid change—has left our transportation infrastructure in an increasingly deteriorated and fragile state. It has left the United States on the precipice of losing its historical advantage in moving people and things faster, more safely, and more reliably than any other nation in the world.

Thankfully, on December 4, 2015, President Obama signed the first long-term surface transportation bill in a decade: the FAST Act. This Act required bipartisan cooperation on its contents and its “pay for.” The proposal made some achievements, but nothing on the order of what’s needed in light of the following pages. In terms of its “pay for,” the FAST Act largely used gimmicky offsets rather than dealing with the fundamental structural flaws inherent in the gas tax. Consequently, our system still lacks the galvanizing clarity of purpose and vision that can drive public support. If a robust and clear new vision for U.S. infrastructure can ever be developed in our time, the seed is planted in this report.

It is important to note that Beyond Traffic is not an action plan and is not intended to be. It is a survey of where we are and where current trends may take us if left unaddressed. The federal government alone cannot achieve resolution of all of the issues and concerns the future will bring; much decision making belongs to other stakeholders, including state and local governments and the private sector. Any comprehensive action plan would require consultation and coordinated execution by all of these participants.

Beyond Traffic is intended to start a long-overdue national conversation about what our country really needs and why we need it. To that end, a draft of the report was published in February 2015. In the subsequent 18 months it was downloaded more than 400,000 times. We asked you to provide us comments and you did. We received hundreds of comments via email and thousands more in the webinars and workshops we held to share our findings. We received comments from engineers, researchers, transportation planners, pilots, truck drivers, transit operators, safety advocates, and disability rights advocates, among others.

This final version reflects the prevailing themes of the comments we received, as well as the specific corrections some of you provided. In response to your concerns, we have added a new chapter to Beyond Traffic: How We Grow Opportunity for All.

This survey is not the first effort to capture current and future trends in transportation. Secretaries William Coleman, Sam Skinner, and Rodney Slater each published major reports in the past to contribute to the national dialogue. Each of these efforts has involved dedicated teams within the U.S. Department of Transportation, and Beyond Traffic is no

exception. Under Secretary of Policy Blair Anderson, Assistant Secretary Carlos Monje and our team in the Office of Policy, as well as the Volpe Center led by Anne Aylward, have built upon the work of their predecessors and these teams have remained deeply vested in overseeing the development of this product.

In perhaps the most definitive of these surveys, Secretary Coleman, in the 1977 study entitled “National Transportation: Trends and Choices (to the year 2000)” captured the sentiments that have guided our efforts in this work:

“National Transportation: Trends and Choices provides a starting point for that much needed public debate. It is an agenda of national transportation issues and alternative solutions that, from the perspective of the Department of Transportation, appear to have merit. It is not intended as a plan of action, although it encompasses programs and plans that already may have the force of law at various levels of Government. It is intended to be a prospectus of what is possible, practicable, and in the public service.”

I therefore ask that you, the reader, accept this document in the spirit in which it was prepared: as a basis upon which we can all build together.

## Anthony Foxx

### U.S. Secretary of Transportation

# INTRODUCTION

## Introduction: Summary in Brief

When the United States Department of Transportation was created, the Secretary of Transportation was charged by law to report on both the current and the anticipated future conditions of our nation's transportation system. Beyond Traffic 2045 is U.S. DOT's most comprehensive assessment of current and future conditions in decades—it is a call to action. After years of chronic underinvestment and policy choices that, in some cases, have actually worked at cross purposes with the broader economic and social goals held by most Americans, now is the time for a report like this one to be read, understood, considered—and used, to breathe new life into funding and policy discussions at all levels.

Importantly, Beyond Traffic doesn't prescribe a course of action. It doesn't advocate for specific or partisan solutions. And because we know that we can't predict the future with complete accuracy, Beyond Traffic doesn't contain the blueprints for solving all of the transportation challenges our nation faces. Instead, Beyond Traffic presents and analyzes the long-term and emerging trends that will shape our transportation system. By doing this, it provides a framework for the factual, rooted-in-reality discussions we will need to have about coming to grips with what our needs really are, and what our priorities will have to be.

Now is an exciting time to have this discussion. Our transportation system is on the cusp of a major transformation, akin to the introduction of the steam engine or the automobile. New technologies and business models—automated vehicles, electric cars, unmanned aerial systems, NextGen air-traffic operations, and mobility on demand, to name just a few—promise to dramatically improve the safety, efficiency, competitiveness, accessibility, and sustainability of our transportation system. To realize this transformation, we will need a corresponding transformation in our transportation policy.

- To promote the adoption of new technologies, we must create a governance system that enables and incentivizes innovation rather than stifles it: reducing regulatory barriers, promoting technology transfer and capacity building, and spurring basic research across all modes of transportation—even as safety remains our top priority.
- To encourage economic development, we will need to articulate policies that promote employment, economic growth, access and opportunity for all Americans, and our competitiveness on a global scale.



- To ensure a return on our transportation investments, we will need to evaluate them against what our needs truly are, and to choose projects that will deliver the most benefits, and the best value for money.
- To obtain the funding we will need, we must identify the best opportunities for public investment, public-private partnerships, and other financing mechanisms.

For the U.S. Department of Transportation, that transformation has already begun. In just the past year, we have made great strides in how we make investments and regulate technologies:

- We released the Federal Automated Vehicle Policy Statement, which lays the groundwork for the safe development, testing, and regulation of highly automated vehicles.
- We launched the Smart City Challenge, which inspired 78 cities to develop visions to transform urban mobility, and we committed \$40 million to help Columbus, Ohio, become the country's first city to fully integrate innovative technologies into their transportation network.
- We developed the Small Unmanned Aerial Systems Rule, providing national guidelines for the operation of non-recreational unmanned aircraft under 55 pounds, to enable the commercial application of drones by a wide range of industries.
- We launched a series of initiatives, like the Every Place Counts Challenge, to demonstrate how innovative transportation projects, learn from our long history, can revitalize communities and connect people to opportunity.

In short, our challenge is to build a transportation system that meets the needs of the future—not the past. We may not be able to predict the

future with certainty—but we are certain that if we fail to adapt, we will fall behind.

Our nation once had a transportation system that was the envy of the world. We built the Erie Canal, the Transcontinental Railroad, the Interstate Highway System, and set the world standard for aviation. These investments, each in their turn, opened up enormous opportunities for Americans: creating jobs and new sources of wealth, opening markets, and giving American businesses a significant advantage over economic competitors.

But *Beyond Traffic* reveals that over the next thirty years, our transportation system, which has powered our rise as a nation and enabled generations of economic growth, could become a drag on our economy and our way of life. Some warning signs are already all too clear. This year, for instance, the average American driver in a city or a suburb will spend an entire work week sitting in traffic. This year, trucks will lose \$28 billion in wasted time and fuel. This year, the companies that depend on our nation's transportation system—and the millions of workers who power those companies—will feel the effects.

And the effects are stark. Many of our major hub airports face severe congestion, which causes delays that have become chronic. Aging locks and dams are raising the costs of moving freight and fuel along our inland waterways. Ports need dredging and modernization if they are going to continue to compete, and to sustain jobs and regional economies. The transit systems that support millions of commuters throughout America face a \$100 billion maintenance backlog and are becoming increasingly unreliable.

Most troubling of all, and bucking a long historical trend of steady improvements, is an

increase in traffic fatalities, which rose a startling 7 percent in 2015. Preliminary estimates for the first half of 2016 are even more alarming—an increase of over 10 percent compared to the first half of 2015. Last year, 35,092 people were killed in traffic crashes. These people are all of us: your neighbor driving to work. Your niece walking to the park. Your brother biking home. Each day in America, nearly 100 people die from vehicle-related accidents. We should not accept even one.

These are problems we must fix. The good news is: these are problems we **can** fix. The future is a choice that is ours to make. But, of course, to shape the future we desire—a future where no one dies on our highways, flights and freight are not chronically delayed, and our efficient, clean, and accessible transportation system is again the envy of the world—we must start now. To truly move Beyond Traffic, we must begin making choices today.

Our analysis characterizes six major trends shaping transportation, and objectively identifies the critical policy choices we will need to make.

**First, how will we move?** How will we build a transportation system to accommodate a growing population and changing travel patterns?

- America's population will grow by 70 million by 2045.
- By 2050, emerging megaregions could absorb 75 percent of the U.S. population; rural populations are expected to continue declining.
- Population growth will be greatest in the South and West; existing infrastructure might not be able to accommodate it.
- It is possible that Americans, particularly

millennials, will continue—as a matter of preference—reducing trips by car in favor of more trips by transit and intercity passenger rail.

- By 2045, there will be nearly twice as many older Americans as now; they will need quality connections to medical care and related services.

Our basic policy for decades has been to expand capacity to meet demand by building new facilities. This in itself may not be enough in the face of a growing and changing population, increasing congestion, and deteriorating infrastructure conditions.

Key policy options to address how we will move include:

- Increase infrastructure capacity: build new roads, bridges, and other facilities; maintain existing facilities more effectively; use existing facilities more effectively by implementing better designs and technologies; or use some combination of these methods
- Reduce congestion through land use, telework and flex-time work schedules, smaller and automated vehicles, and pricing
- Promote public transit, biking, walking, and mobility on demand

**Second, how will we move things?** And reduce freight chokepoints that drive up the cost of doing business?

- By 2045, freight volume will increase by more than 40 percent.
- Online shopping is driving up demand for small package home delivery, which could soon substitute for many household shopping trips.

- Airline mergers and the consolidation of hubs may result in increased air traffic congestion.
- International trade balances, due in part to low U.S. energy costs, could shift from imports toward exports, but overall globalization will increase both, straining ports and border crossings.
- Strong domestic energy production may enable the U.S. to become a natural gas net exporter by 2020, but pipeline capacity may hamper growth and lead to greater movement of oil by rail.

Key policy options to address how we will move things include:

- Improve freight planning and coordination at national, regional and local levels
- Target policies and investments aimed at resolving freight congestion
- Encourage innovative strategies to address first- and last-mile freight issues

**Third, how will we adapt?** And make our infrastructure more resilient?

- Predicted rises in global temperatures and mean sea levels, and more frequent and intense storm events, could drastically affect highways, bridges, public transportation, coastal ports, and waterways.
- Federal fuel economy standards are slated to rise to the equivalent of 54.5 miles per gallon by 2025.
- Sales of hybrid and plug-in electric vehicles are growing rapidly and have the potential to greatly reduce transportation emissions.

Key policy options to address how we will adapt include:

- Reduce transportation emissions by improving fuel efficiency and increasing the use of alternative, cleaner fuels
- Align costs and incentives to encourage sustainable development patterns and research into new technologies that can aid in reducing greenhouse-gas emissions and energy use
- Design and build better infrastructure that is more resilient to events such as severe storms, rising sea levels, and flooding
- Avoid developments in vulnerable locations

**Fourth, how will we move better?** And knock down barriers to new technologies that promise to make travel safer, cheaper, and more convenient?

- Technological changes and innovation may transform vehicles, infrastructure, logistics, and the delivery of transportation services.
- New sources of travel data have the potential to improve travelers' experiences, support more efficient management of transportation systems, and inform thoughtful investment decisions.
- Automation and robotics will affect all modes of transportation, improving infrastructure maintenance and travel safety, and enabling the mainstream use of autonomous vehicles.

Key policy options to address how we will move better include:

- Address regulatory barriers to deployment of new technologies or procedures; develop infrastructure and standards to support emerging technologies

- Collect and manage data and transition to a data-driven investment system, while protecting individual privacy
- Support research on technological developments and deployment
- Maintain a paramount focus on safety

**Fifth, how will we grow opportunity for all?**

How will we create a transportation system that connects all Americans to the American dream?

- The top 10 percent of income-earning families now earn as much income as the remaining 90 percent.
- Middle- and low-income American households spend, on average, nearly 20 percent of their income on transportation and 40 percent on housing—higher shares than for wealthier Americans.
- Between 2000 and 2012, the number of poor people living in suburbs increased from 10 million to 16.5 million. Today, more poor people live in the suburbs than in the cities or rural areas.
- Sprawling urban development is increasing, as is economic segregation; economic opportunity and social mobility are decreasing.

Key policy options to address how we will grow opportunity for all include:

- Prioritize transportation investments in communities with the greatest needs, and ensure that local communities benefit from transportation investments
- Coordinate transportation and land-use policy, so that different kinds of decisions reinforce each other for community good
- Support affordable transportation services accessible to all Americans

**Finally, how will we align decisions and dollars?** And invest the trillions of dollars our transportation system needs in the smartest way possible?

- Public revenues to support transportation are not keeping up with the rising costs of maintenance and capacity expansion.
- Nearly two-thirds of our roads are rated in less than good condition; a quarter of our bridges need significant repair.
- Federal gasoline-tax revenues have failed to keep up with our transportation needs and could decline further as vehicle fuel efficiency improves, and inflation further erodes purchasing power.
- Insufficient highway and transit revenues and the absence of reliable federal funding for rail, marine highways, and ports have created a need for new financing mechanisms.

Key policy options to address how we will align decisions and dollars include:

- Ensure adequate revenues to address critical needs, through existing taxes, new excise taxes, user fees, tolls, congestion pricing, vehicle-miles-traveled fees, or other funding mechanisms
- Reduce spending to match revenues, and address the resulting consequences to the transportation system
- Prioritize investments based on performance outcomes
- Ensure clear roles of the public and private sectors: clarify authorities; seek changes in authority (e.g., greater federal role, the devolution of more functions to non-federal entities, privatization); improve investment coordination between sectors and levels of government

Beyond Traffic does not close the book on these questions. It opens the book wider, giving all of us more and better data with which to answer them.

Our hope is that Beyond Traffic provides Americans with a common basis of fact for a larger national discussion about the future of transportation. The trends shaping our transportation system will require changes in policy, new approaches to planning, and greater coordination between all levels of government, and between government and the private sector. These are, individually big challenges; in its totality, the task is daunting.

We can do it.

Let's get started on our transportation future.

# TRENDS

## What forces are challenging our nation's transportation system the most?

### How We Move

This section describes demographic, economic, geographic, and cultural trends affecting everyday travel. The focus is on the most common form of travel for most Americans: short-distance trips by surface transportation.

### How We Move Things

This section describes emerging challenges and opportunities in the freight sector. It discusses how changes in population, economy, and technology are affecting the movement of cargo and energy.

### How We Adapt

This section describes how the transportation system is contributing to, and may be impacted by, climate change. It discusses how the transportation sector is finding ways to limit greenhouse gas emissions, as well as the challenges of developing a resilient transportation system that can withstand the projected impacts of climate change, today and in the future.

### How We Move Better

In this section, discussion focuses on how technological advances, many of which have originated outside of the transportation sector and are now ready for implementation within it, are affecting and will affect our transportation system.

### How We Grow Opportunity for All

Our transportation system connects people to opportunity: jobs, schools, childcare, and medical services. However, our infrastructure all too often reinforces growing economic divisions in our society, dividing and neglecting low-income communities and enabling economic and racial segregation. This section examines the role transportation plays in creating and bridging social divides.

### How We Align Decisions and Dollars

This section explains the evolving role of government in planning, building, managing, and regulating the transportation system. It describes the financial challenges many governments are facing and discusses how the role of government and the way transportation is funded may change.

# HOW WE MOVE

## Introduction

Our transportation system connects us to our work, our homes, and our friends and families. We all have different needs and different values that we consider as we make transportation decisions—but we all value the connections that our transportation system provides.

As our population grows and changes, our needs and preferences will also change. In fact, we are already changing how we travel. Americans are walking, biking, and taking transit more than they did a decade ago. Many young Americans are choosing not to own cars—some do not even seek driver's licenses. We do more and more things online instead of in-person—teleworking, socializing, and shopping. These alternatives to vehicle travel are growing as traffic congestion continues to increase and vehicle travel becomes less reliable and convenient.

This chapter examines some of the most important demographics and trends in everyday personal travel that will shape our transportation network by 2045.

## Demographics: Increasing Population

Over the past 30 years the American population has increased 35 percent—from 239 million to 322 million. As our nation grows, so does our demand for travel. Today there are more people on the roads and in our airports and our rail stations than ever before.

## POPULATION INCREASE

2015: **320 million people**  
2045: **390 million people**

In 30 years our population is expected to grow by about

**70 million**

...that's more than the current populations of



Unfortunately, the capacity of our transportation system has not kept up with our requirements. Many roads and airports cannot accommodate the growing demand for travel, leading to record levels of congestion on our roads and frequent delays across our aviation system.

By 2045, our population is expected to increase by nearly 70 million people. That is a slower growth rate than previous decades, but it still means that we will add more than the current population of New York, Florida, and Texas combined. Our growing population will lead to increasing overall demand for travel even as rising congestion could make travel so inconvenient that many individuals will seek to travel less.

How will we accommodate 70 million more people and growing amounts of freight—with an aging transportation system that is already strained for capacity? Meeting the needs of the next generation of travelers requires us to make smart choices today.

## Changing Driving Habits

Over the past 50 years, as our suburbs have grown, we have depended more and more on cars. But our travel patterns are shifting and long-term growth in driving may be slowing. Between 2006 and 2013 per capita vehicle miles traveled, a measure of how much people drive, declined each year, causing economists to revise long-term traffic growth projections downward. In 2014 and 2015, traffic growth rebounded and total vehicle miles traveled reached record highs, yet on a per capita basis vehicle miles traveled remains below its 2005 peak.

Traffic congestion is severe, particularly in large urban areas, where population and economic growth is the greatest. By some calculations,

the average auto commuter in urban areas spends the equivalent of five vacation days each year delayed by traffic. In fact, high levels of congestion may be spurring some Americans to make different choices about where they live and how they get around.

Throughout the 1980s and 1990s, Americans spent more and more of their time in cars as commute lengths increased and traffic grew. Personal vehicle travel increased as a share of all travel; carpooling, transit, and walking all declined. Driving became more affordable as the cost of cars and gas fell relative to other costs and fuel economies improved. More Americans entered the workforce, especially women, and the boundaries of metropolitan areas expanded. The population of the suburbs increased and rural areas on the fringe of metropolitan areas became exurbs. Meanwhile, the population of cities stagnated. Commutes grew in distance and commuters spent more time in traffic.

By the mid-2000s, these trends began to change. Americans drove less on average in 2006 than in 2005, the first year per-capita driving had declined since the oil crises of the 1970s. The rate of women entering the workforce slowed and baby boomers began to pass their peak driving years. Gas prices increased to historic highs and entered a period of volatility. Then came the Great Recession. Unemployment doubled. Property values plummeted and housing construction ground to a halt. Economic uncertainty affected nearly everyone. Many Americans put off buying cars or homes, starting families, or beginning new careers. Driving rates declined and the use of other modes of transportation increased. Congestion, while still severe in many metropolitan areas, also declined from peak levels.



# BUMPER TO BUMPER



On average,  
we spend over

**42** HOURS

stuck in traffic  
each year



The annual cost of  
congestion in delays  
and lost fuel is

**\$160**

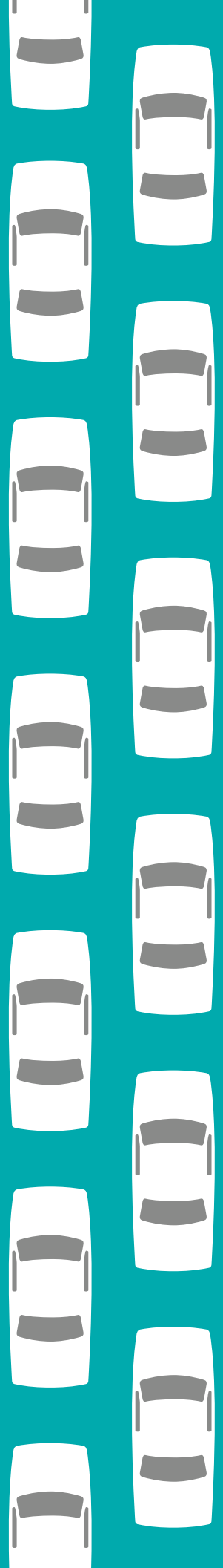
**BILLION**



The annual cost of  
**truck** congestion is

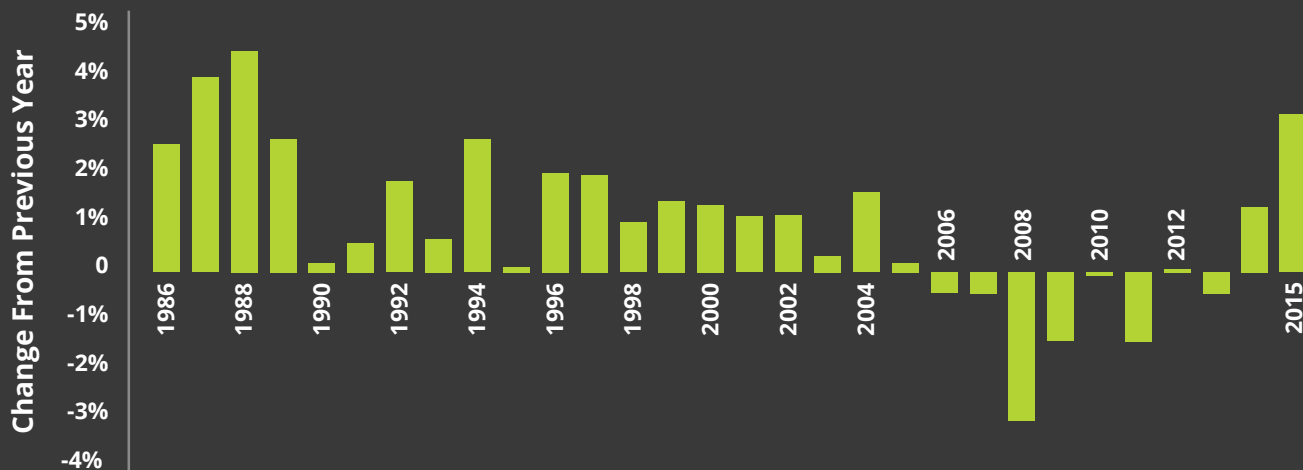
**\$28**

**BILLION**



# Annual Change in Vehicle Miles Traveled Per Capita

■ Annual % change in VMT



RAIL TRANSIT USE INCREASED BY 37 PERCENT AND THE NUMBER OF PEOPLE CYCLING TO WORK INCREASED BY 59 PERCENT OVER THE LAST DECADE.

Today unemployment rates are approaching pre-recession levels. People are working and once again buying houses and cars. Gas prices have returned to levels not seen in a decade and the overall amount of driving, as measured by vehicle miles traveled, has rebounded to peak levels. However, many experts now acknowledge that declining workforce participation, an aging and urbanizing population, increasing opportunities to telework, and changing attitudes toward commuting and a return to urban living may dampen long-term growth in driving.

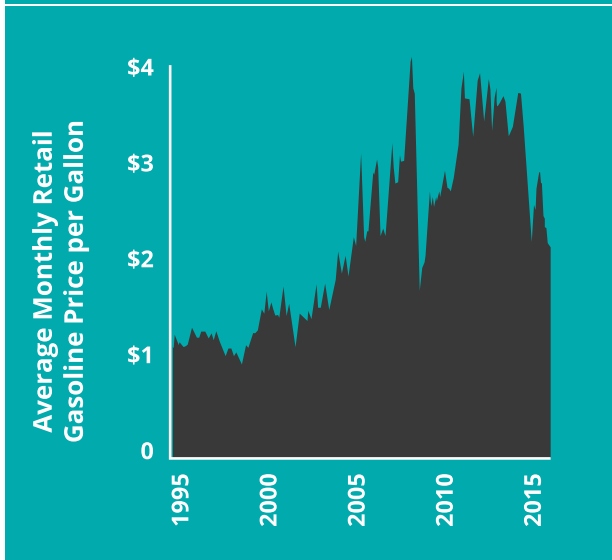
## Millennial Driving Patterns

While Americans on average are driving less than they did a decade ago, on a per capita basis, younger adults are driving much less. The travel behaviors of young adults matter. Today there are 83 million Americans aged 15 to 34, compared to 75 million Americans aged 51 to 69.

In 2009, Americans between the ages of 18 and 34 drove 21 percent fewer miles than those in that age group did in 2001. Fewer young adults are getting driver's licenses. Today nearly one in five young adults do not have a driver's license. The decline in licensure rates among young adults over the past decade has resulted in 3 million fewer drivers on the road than there would have been had licensure rates remained what they were ten years ago.

Younger adults are also more likely to take transit. According to surveys, adults under the

## U.S. Retail Gasoline Prices



age of 30 are more than twice as likely as their older counterparts to use transit.

Changes in household formation are affecting changing travel behavior in America, particularly among millennials. Americans are waiting longer to form families and have children. Household size is decreasing and the percent of Americans living alone is increasing. Today 35 million Americans live alone, an increase of nearly 70 percent over the past 30 years.

The Great Recession also hit young adults particularly hard. Many struggled to find a job and strike out on their own. Student debt burdens increased. Between 1990 and 2015, the proportion of Americans aged 18–34 living with their parents increased from 24 percent to 33 percent. These trends may have affected the ability of many young adults to afford a car, and delayed choices, such as having children or buying a home, which often led to increased driving.

Social trends are changing attitudes about travel, especially among young adults. From Uber to Zipcar to Skype, young adults are increasingly using technology to find new ways to travel or to avoid traveling. Surveys of millennials have shown that they are more likely to value access to their phone over access to a car and to shop or socialize online as alternatives to driving.

It remains unclear whether driving less is a matter of choice or a matter of economic necessity. It is conceivable that a significant portion of young adults have learned to manage without a car and will continue to drive less throughout their lives than previous generations. What is clear is that millennials are choosing where they live and how they get around based on their budget and their lifestyle.

If over the next 30 years, some portion of Americans continue to drive less it could mean less pollution and less congestion. It could also reduce gas tax revenues, making it difficult to maintain our roads and bridges. It might also mean that we have learned to live with an inadequate, congested transportation system by traveling less.

## Older Americans

Changes in the age of our population will have a lasting effect on how much we drive. Older

FHWA FORECASTS SHOW VEHICLE MILES TRAVELED (VMT) PER CAPITA REMAINING RELATIVELY STABLE AND OVERALL VMT INCREASING BY 23 TO 27 PERCENT OVER THE NEXT 30 YEARS.

BETWEEN 1990 AND 2015, THE PROPORTION OF AMERICANS AGED 18–34 LIVING WITH THEIR PARENTS INCREASED FROM 24 PERCENT TO 33 PERCENT.

Americans drive less on average than other Americans. On average, Americans over the age of 65 drive half the amount of Americans aged 25 to 64. That said, Americans are living longer and healthier lives and they are retiring later in life. Over the next 30 years, older Americans may work later in their lives and travel for work and leisure more often.

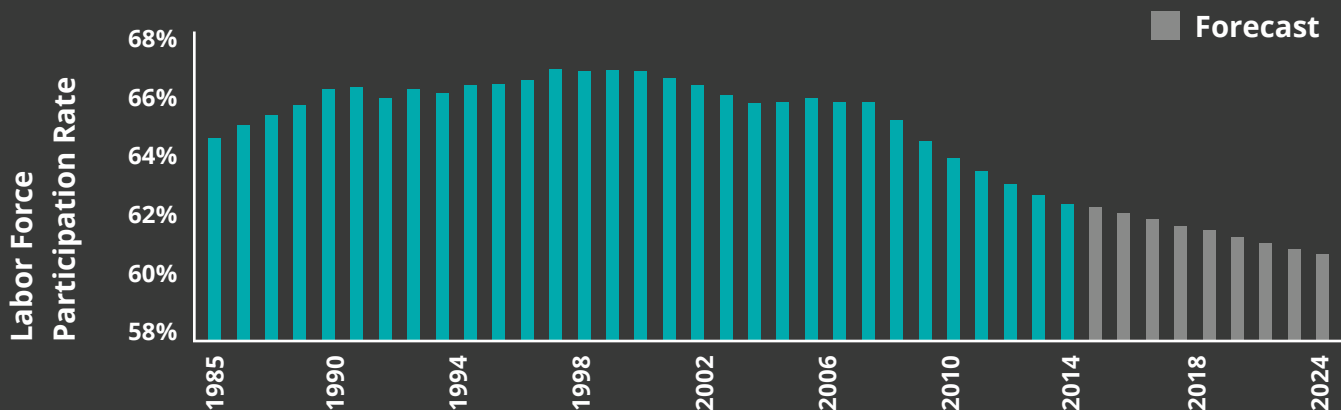
As the population as a whole ages, the proportion of Americans in the workforce is expected to shrink. Workforce participation, which peaked at 67 percent in 2000, is less than 63 percent today, and may decline to below 60 percent by 2045. While the population as a whole will grow by approximately 20 percent over the next 30 years, the workforce will grow by just 10 percent. Declining workforce participation may

slow growth in traffic, and rush hour traffic in particular.

By 2045, there will be an estimated 84 million Americans older than 65. That is nearly twice as many older Americans as there are today. Accommodating the travel needs of a growing population of older Americans could further strain transportation systems that are already facing multiple challenges. Public transit use by older Americans increased by approximately 40 percent over the past decade; even so, older adults use public transit for less than 3 percent of all trips.

Older Americans are more likely to have physical limitations, and, as they age, cognitive limitations that create challenges for driving, walking, and using traditional, fixed-route transit. In fact, older people who suffer from limitations related to health must often cease walking or using traditional public transit before they are forced to cease driving. Half of Americans over the age of 65 report having some form of disability, and one in three reported having trouble getting the transportation that they need.

## Labor Force Participation Rate



# OLDER AMERICANS — REDEFINING LONGEVITY

By 2045, the number of Americans over age 65 will increase by

77%



About **one-third of people over 65** have a disability that limits mobility. Their access to critical services will be more important than ever.

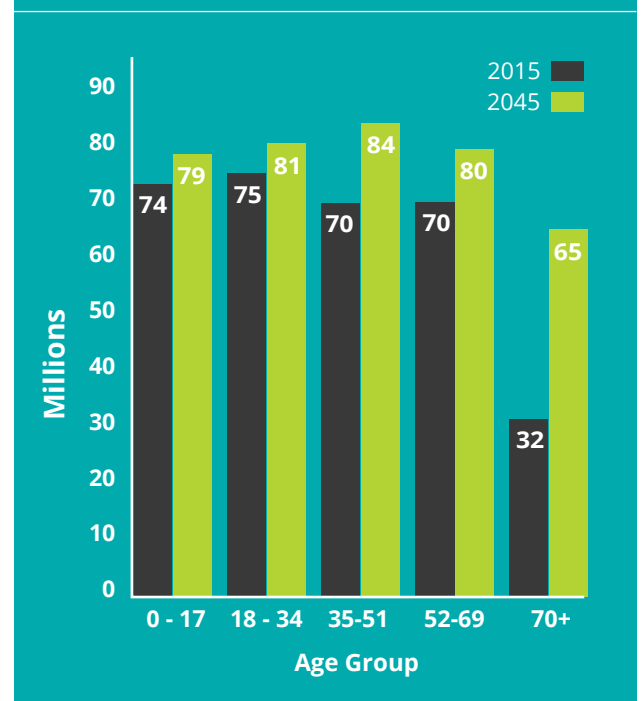
For Americans of all ages with disabilities—economic challenges, institutional barriers, and inaccessible services and infrastructure pose the greatest challenges to mobility. Difficulty affording a vehicle, inaccessible bus stops, or unreliable or infrequent transit service can make it difficult for people with disabilities to get and keep a good job or to get to important health and social services.

While public transit systems have made great strides in improving the accessibility of their buses and rail stations, infrequent off-peak service, poor reliability, inadequate pedestrian infrastructure, and a lack of appropriate assistance from drivers can pose barriers to greater public transit use by older Americans. Paratransit services—individualized door-to-door transportation services—offer a good option for some, but they are more than three times as expensive to provide as traditional, fixed-route transit services. As transit agencies have invested in paratransit to meet ADA requirements, many have also raised fares, restricted services, and set stricter rider eligibility guidelines.

How can we ensure that older Americans who may not be able to drive are still able to maintain their quality of life and connection to critical

services? Many older people have long depended on driving to maintain their lifestyles and may face serious mobility problems if and when they can no longer drive. Some rely on relatives and friends, but others face isolation and a reduced quality of life. Older Americans are unlikely to want to move from their homes to areas with better access to services. For people to be able

**Projected Additional Population by Age Group**



to age in their community and to maintain their connections to family, friends, and critical services, as with healthcare, they need access to a responsive and reliable transportation system designed to meet their needs.

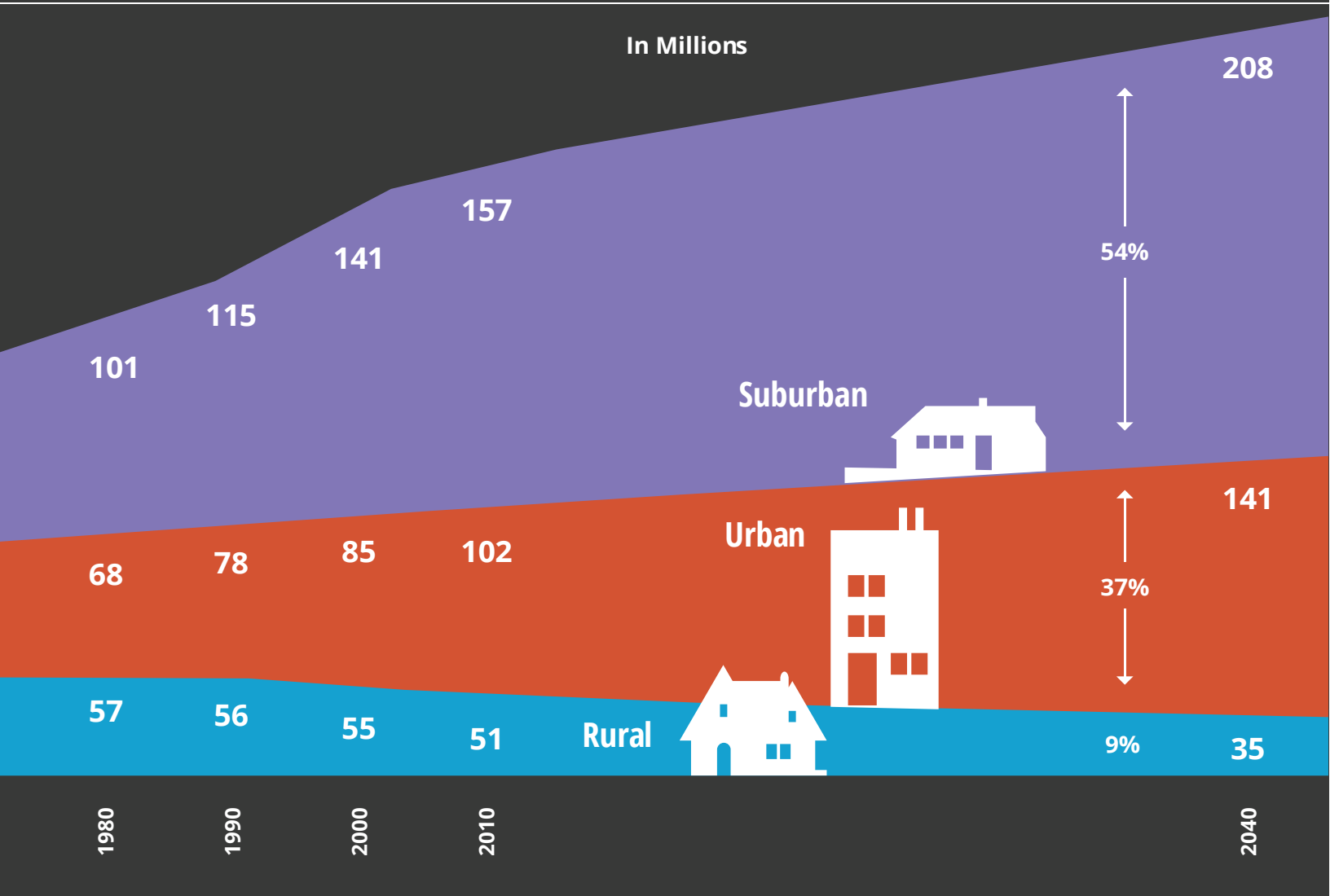
## Metropolitan Growth and Land Use

Our cities and suburbs are growing and the population in rural areas is declining. Over the past three decades our population has grown increasingly suburban. Today, approximately

half of all Americans live in the suburbs. Three-quarters of all population growth since 1980 has occurred in the suburbs. Jobs have also moved to the suburbs. In 2010, the number of jobs in metropolitan areas located more than 10 miles from downtown was nearly double the number of jobs located fewer than three miles from downtown.

With both population and employment moving to the suburbs, commuting is not simply about moving people from suburban homes to downtown jobs. Today, nearly four in ten of

## U.S. Population: Urban, Suburban, and Rural



## Jacksonville Expands Transportation Options

In recent years, the population of Jacksonville has grown at a rate nearly twice the national average, largely as the result of burgeoning employment opportunities in Northeast Florida. This growth has presented a major transportation challenge for Jacksonville. Traffic congestion is getting worse and convenient public transit alternatives to downtown jobs are in short supply. In order to help move the city's growing population, the Jacksonville Transportation Authority is using \$9.3 million in federal funding to implement a bus rapid transit (BRT) system. BRT systems use dedicated bus lanes to offer faster, more frequent, and more reliable trips to travelers. Jacksonville's BRT, known as the First Coast Flyer, will begin with six miles of routes and expand to a system of over 50 miles by 2019. First Coast Flyer is just one key element of Jacksonville's larger vision for transforming their transportation system. In addition to transit improvements, city leaders plan to invest \$100 million in new road work.

all commutes begin and end in the suburbs. Population and job growth in America's suburbs have serious implications for our transportation policy. Congestion may worsen as more Americans live in areas where transit service is less robust and where everyday trips to work, school, or a doctor's appointment, for example, are more likely to involve longer distances. Growing suburbanization also presents challenges for connecting older and low-income Americans to social services and jobs.

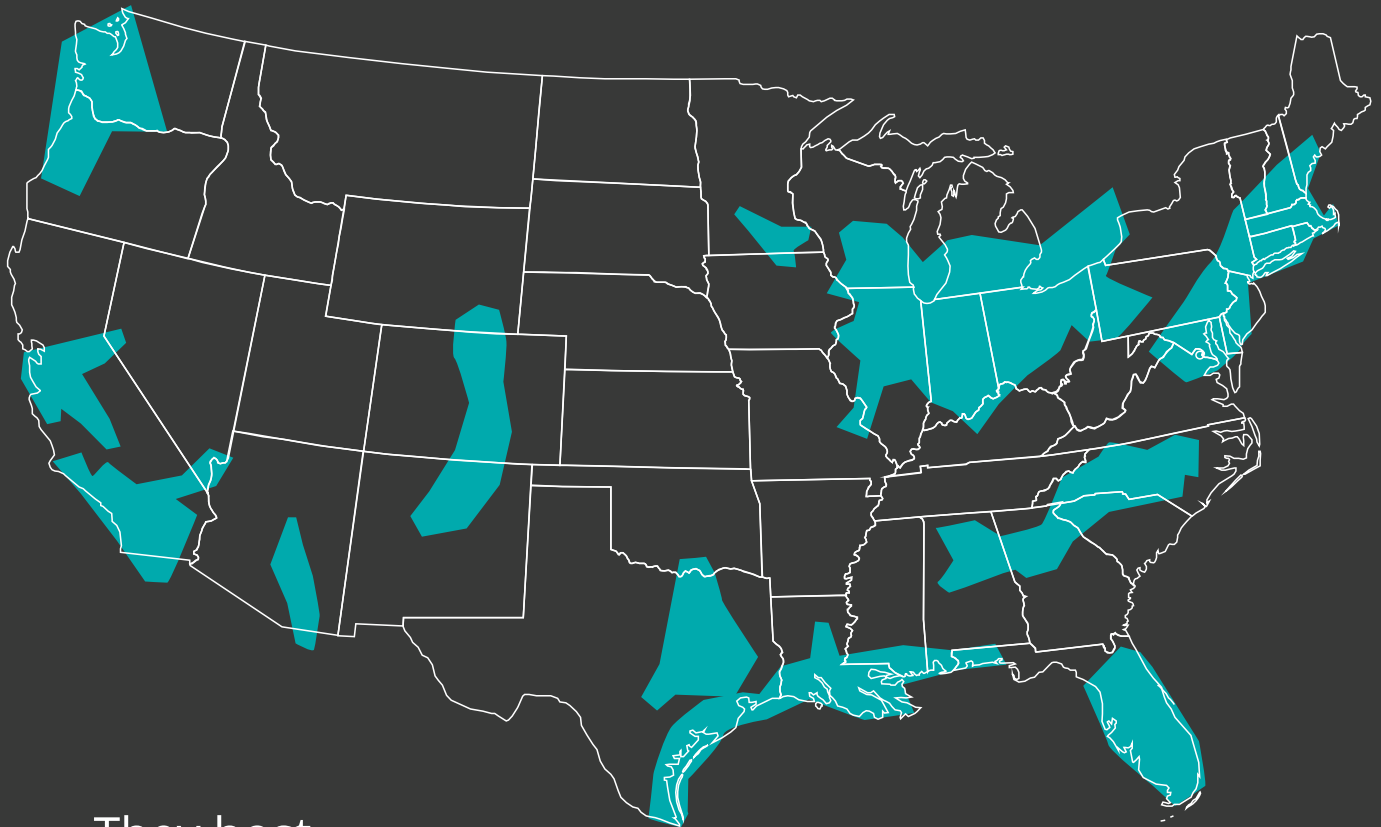
In recent years, the long-term trend of suburban growth has shown signs of shifting. The rate of suburban population growth peaked in the 1990s as exurbs grew on the fringes of metropolitan areas, leading to the incorporation of previously rural areas. In the 2000s, suburban population growth started to slow, while population growth in cities began to increase. Between 2010 and 2013, the annual population growth rate of large cities was double what it was the previous decade, outpacing growth in the suburbs. As cities became more desirable, housing prices in many of the wealthiest cities increased rapidly.

However, these population growth patterns may be reverting to pre-recession form. In 2014 and 2015 population growth in suburban counties outpaced growth in urban counties. Despite signs of change in settlement patterns, our population is likely to remain primarily suburban. On balance, Americans tend to move to areas with lower density, cheaper housing, and more jobs. Most of the fastest growing metropolitan regions in the country are in less dense regions in the South and West such as Dallas, Houston, Charlotte, Phoenix, Denver, and Orlando.

Population and economic growth in metropolitan areas is fostering the development of megaregions: networks of urban clusters connected not just by infrastructure but by economic and social relationships. Most of our nation's population growth, and an even larger share of job growth, over the next 30 years will take place in these regional clusters of cities. Residents of megaregions share mutual interests and depend on the same critical infrastructure—airports, ports, transit systems, and freight

# MEGAREGIONS AND SHIFTS IN POPULATION CENTERS

**11 megaregions** are linked by transportation, economics, and other factors.



They host

**75% of America's**

population and employment.

In 2014, 365,000 people moved to the South—up 25% from 2013—and moves to the West doubled.



corridors. However, these regions span counties and states which are often in competition with each other. The growth of megaregions will require greater regional collaboration and integration to ensure regions remain competitive in a global economy.

## Regional Differences

Population growth has been strongest in the South and the West. Between 1980 and 2010, the South and West added 68 million people, accounting for 83 percent of all population growth. Many of the metropolitan areas in these regions have experienced particularly high rates of population growth, resulting in rising demand for transportation system capacity and increasing levels of traffic congestion. At the same time, many counties in the Midwest and Northeast have been losing population.

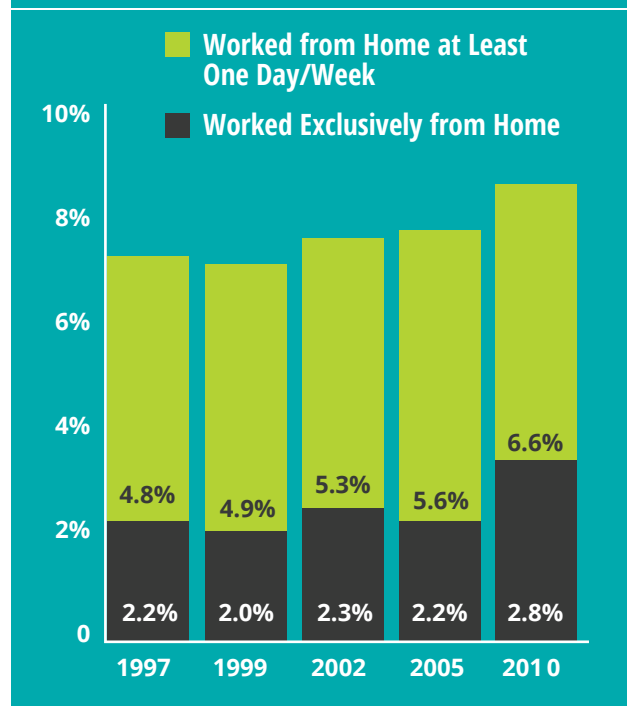
As the economy has shifted away from agriculture and manufacturing, rural counties in the Midwest and industrial counties in the Great Lakes region have shrunk. Between 1980 and 2010, more than 1,000 counties—nearly 40 percent of rural counties—experienced a net loss in population. As suburbs have expanded, rural populations have declined, birth rates in many rural areas have declined, and retirees and job seekers have moved to metropolitan areas. Although some rural areas, such as counties in recreational areas in the Rocky Mountains and along the Pacific Coast and areas near rapidly expanding metropolitan areas such as Atlanta, have experienced rapid growth.

Low-population density and slow or declining population growth in rural areas creates challenges for providing adequate transportation. The smaller tax base makes it difficult to fund the construction, maintenance, and operation of transportation systems. Rural economies are more likely to rely on freight

intensive industries, such as agriculture, mining, forestry, and manufacturing that can lead to higher infrastructure maintenance costs. Greater distances between locations, and, in some areas, rougher terrains, can contribute to higher transportation costs for households and businesses. Rural areas with declining population or economic growth face the threat of decreasing transportation services, such as the closure of regional airports or decreases in freight and intercity passenger rail service, such as Amtrak. As a result, rural households and businesses tend to have fewer transportation choices and are more likely to be sensitive to increases in transportation costs.

Transportation issues caused by slow or declining economic and population growth are not solely a rural problem. Even as urban areas gained population overall, some of the largest population losses over the past 30 years have

## Percentage of American Workers Who Work from Home



AS ONLINE SHOPPING CAPTURES A LARGE MARKET SHARE, IT WILL REDUCE TRAVEL ASSOCIATED WITH SHOPPING TRIPS, AND REDUCE THE NEED FOR PRIVATE VEHICLE OWNERSHIP, BUT IT MAY ALSO INCREASE TRUCK TRAFFIC IN URBAN AREAS AS GOODS ARE DELIVERED TO RESIDENCES.

occurred in metropolitan counties. A number of traditional manufacturing cities—in New York, Pennsylvania, Ohio, Indiana, and Michigan—lost population. Areas with shrinking populations face challenges maintaining existing infrastructure and preserving access to economic opportunities and social services.

## Innovations in How We Move

Advances in mobile and information technologies are allowing Americans to make different travel choices. The availability of global positioning systems (GPS) has made it easier for individuals and businesses to find the most efficient routes to their destination. Increasingly, the public has access to real-time traffic conditions and public transit schedule information, giving them more power to set and change travel schedules and routes. Innovations in the business world that use these technologies are also changing the way Americans access transportation, and the way they consume goods and services.

Travel preferences, flexible schedules, “hoteling” (unassigned office seating), teleworking, and improvements in communications technologies

are all changing how many Americans work and commute to work. Nearly one in ten American workers work from home at least one day per week. The number of Americans who work from home at least one day a week increased by 43 percent between 1997 and 2010. The fastest growing “mode” for commuting is, in fact, telecommuting.

Many employers now have much more flexibility in how their workers can commute and interact with their coworkers. Well over one-third of workers have the ability to set or change their arrival time at work—including nearly half of those in professional, managerial, and technical occupations. Increases in telecommuting and flexible work schedules could help to reduce congestion in large metropolitan areas by reducing travel demand at the busiest times of day.

**E-commerce may soon substitute for a significant portion of household shopping trips.** Currently, more than one in five trips taken by households is a shopping trip; online shopping has not yet significantly affected this pattern. In 2009, the average household reported purchasing three items per month online, and approximately 4 percent of retail sales were made online—but, by 2016, e-commerce sales accounted for 7.5 percent of all sales. The most common types of products purchased online were consumer electronics, books, and clothing. Online shopping continues to grow rapidly and its use is significantly more widespread among younger age cohorts. At current rates of growth, online purchases could account for 10 percent of retail in less than five years.

**New ways to access transportation are emerging that could reduce the degree to which Americans rely on personal vehicles.**

UBER, LAUNCHED IN 2010, IS VALUED AT ROUGHLY \$80 BILLION, AND OPERATES IN HUNDREDS OF CITIES WORLDWIDE. RIVAL RIDE-HAILING COMPANY, LYFT, HAS RECEIVED SIGNIFICANT INVESTMENT IN THE LAST YEAR, INCLUDING A NEW \$1 BILLION FUNDING ROUND, LED BY A \$500 MILLION INVESTMENT BY GENERAL MOTORS IN JANUARY 2016.

Car sharing is growing at a rapid rate. In 2015, there were 1.2 million members in 23 active car-sharing programs in the United States, marking a more than tenfold increase in membership over the past decade. For many urban households, car-sharing services make it more convenient to not own a private vehicle. For those households, car sharing makes using a car more affordable. Car sharing also reduces the incentive for households to own cars (either a second car, or any car at all). New sharing and ride-matching services now emerging allow individuals to share their personal vehicles with others and to match drivers with passengers.

In recent years, bike-share systems have emerged in some 65 cities, including New York, Chicago, San Francisco, Minneapolis, Boston, and Washington, D.C. Bike-share systems allow people to conveniently travel short distances as well as connect to other modes, particularly public transit. They also allow tourists to travel by

bike. Similar to car sharing, bike sharing provides a low-cost mobility service that addresses “first-mile” and “last-mile” needs.

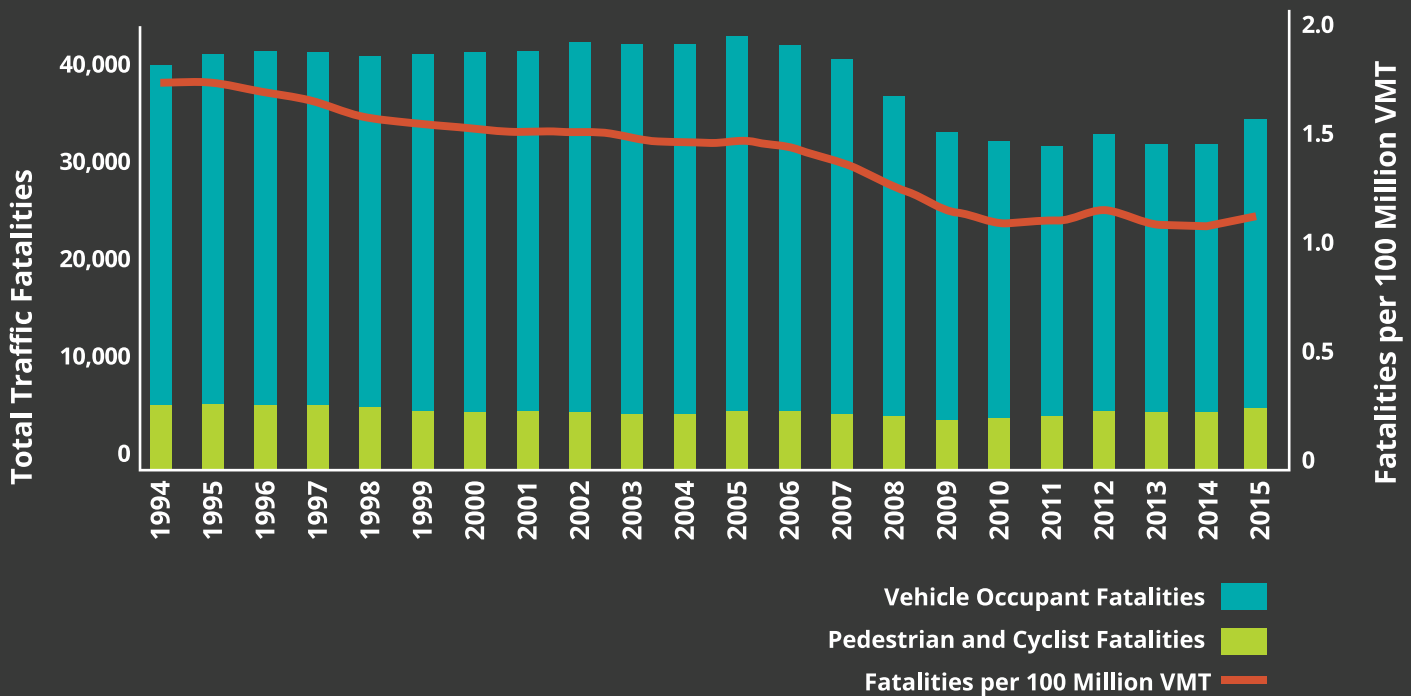
Ride-sourcing services, such as Lyft and Uber, are growing rapidly, both disrupting and augmenting traditional taxi service by using mobile apps to connect for-hire drivers to users. In response, traditional taxi companies are also adopting new technologies to make their service more reliable and convenient. Some cities have found that ride-sourcing services can help to supplement transit service by providing efficient, direct service for short trips and providing service during transit system off-hours.

These services may make it more likely that households decide to go car free. Despite a long-term trend toward increasing car ownership, recent years have shown a slight uptick in the portion of zero-vehicle households. Today more than 10 million households are vehicle free. Households that are vehicle free are much more likely to rely on transit and use car-sharing and ride-sharing services, such as Lyft, Uber, Car2Go, and ZipCar. They are also more likely to bike or walk for most trips.

The recent emergence of ride-sourcing businesses demonstrates a key challenge for governments. The sharing economy uses the Internet and mobile apps to allow individuals to monetize underutilized space, assets, and skills. The emerging sharing economy defies traditional

ON AN AVERAGE DAY IN AMERICA, 96 PEOPLE DIE IN MOTOR VEHICLE CRASHES AND NEARLY 6,700 ARE INJURED.

# Fatalities Resulting from Motor Vehicle Crashes



categories of “business” and “personal” and new business models are proliferating faster than the legal and regulatory arenas can adapt to them. Over the next 30 years, our legal and regulatory system may be increasingly challenged by emerging forms of business and travel that transcend traditional legal and planning concepts.

## Roadway Safety

Transportation safety is a critical societal issue and the U.S. DOT’s top priority. Among Americans aged 1 to 34, motor vehicle crashes are the leading cause of death. Americans spend more than 1 million days in the hospital each year as a result of crash injuries. In 2015, motor vehicle crashes resulted in 2.4 million injuries and 35,092 deaths, including 1,144 children under the age of 15. The 7.2 percent increase in traffic fatalities

between 2014 and 2015 represents the greatest percentage increase in nearly 50 years.

Among those killed, almost half were not wearing a seatbelt and nearly a third of fatalities involved an alcohol-impaired driver. Crash injuries resulted in Americans paying an estimated \$23 billion in medical costs and losing an estimated \$58 billion in lost work productivity.

Over the past decade, trends have shown an increasing number of Americans walking and bicycling for commuting and recreation. Over the same period, bicyclist and pedestrian injuries and fatalities have increased. In 2015, 818 cyclists were killed in traffic accidents, making up 2.3 percent of all crash fatalities. Pedestrian fatalities have increased over the past five years. In 2015, 5,376 pedestrians were killed in traffic accidents. Pedestrian and bicyclist fatalities increased from

13 percent of all traffic fatalities in 2005 to 18 percent in 2015.

Traffic safety continues to present a major challenge for our nation, and the precipitous increase in traffic fatalities in 2015 is deeply troubling. However, over the long-term safety has improved significantly across all transportation modes. Since 1990, the total number of transportation fatalities has decreased by 27 percent despite increasing passenger travel on all modes. Fatalities in commercial aviation have become exceedingly rare, and fatalities in rail and on waterborne transportation have steadily declined. These changes are the result of a wide range of factors, including improving vehicle technologies, safer infrastructure, increased enforcement, higher safety standards, slower traffic speeds, and changing demographics.

For example, seatbelt use has increased dramatically from a national level of about 14 percent in the early 1980s to 88 percent in 2015. It is estimated that seatbelt use alone saves more than 12,000 lives each year. Today, 49 states have adopted mandatory seatbelt-use laws. The introduction of airbags has also saved thousands of lives. The National Highway Traffic Safety Administration (NHTSA) estimates that since their introduction, frontal air bags have saved nearly 43,000 lives.

Vehicle safety technology has advanced beyond basic seatbelts and lighting, to high-tech safety features that can help drivers avoid crashes altogether. Thanks to continuing innovation, today's vehicles have contributed to significant long-term decreases in crash-related fatalities and injuries nationwide. In addition to frontal and side air bags that help to prevent injuries in crashes, a number of crash avoidance technologies are now featured in passenger cars

**BARRING MAJOR SOCIAL CHANGES, WE WILL REMAIN A LARGELY SUBURBAN POPULATION GIVEN THE CURRENT HOUSING SUPPLY AND INFRASTRUCTURE NETWORK IN SUBURBS.**

and trucks, including automated emergency braking systems, lane-departure and forward collision warning systems, and electronic stability control. In the future, connected and automated vehicle technologies could help drivers avoid a significant portion of the type of vehicle crashes that occur today.

Roadway safety is also improving thanks to innovations in roadway design and the introduction of a number of low-cost safety features to roadways. Roundabouts and other alternative intersection designs are improving safety and mobility at interchanges. Widespread use of rumble strips, reduced pavement edge drop-offs, and the application of high-friction surface treatments at critical locations are reducing the risk of crashes. Finally, the electronic collection of roadway and crash data is allowing decision makers to better understand the characteristics of high-crash locations and to systematically apply proven safety countermeasures to roadways.

## Policy Implications

Understanding how people might travel and where they might live in the future helps planners and policymakers decide what policies and investments may be needed to ensure the performance of our transportation system. The trends in population, geography, and mobility

## Attracting Millennials through Transportation

Across the country, cities are looking for ways to attract and retain young workers and promote local economic development. A survey conducted by the American Planning Association found that only 8 percent of millennials would prefer to live in an auto-dependent suburb. In Denver, city leaders have heard from both residents and business leaders that building a comprehensive bicycle network should be a top priority in order to attract and retain young people and the businesses that employ them. As a result, Denver's Downtown Area Plan outlines a specific strategy to build protected bike lanes to promote mobility and economic development.

reviewed in this chapter begin to demonstrate the challenges and opportunities that will face us in the coming years.

First and foremost, we will need to find ways to ensure that our already congested transportation system can accommodate the travel needs of nearly 70 million more people. To do this, we will either need more capacity to accommodate growing demand, or we will need strategies that result in more efficient use of existing capacity. Some strategies, like pricing, rely less on government investment; however, they may have other effects, such as creating "first" and "second" class transportation systems.

Changes in the composition of our population will counteract some, but not nearly all, of the increase in demand for transportation. As our population ages and workforce participation declines, per capita driving rates will likely stabilize or decrease. However, an increasing number of older Americans living in auto-dependent areas will face challenges accessing critical services.

We know that social and technological changes will affect how Americans travel, although we do not know exactly how. Millennials and future generations of Americans might drive

less than their parents throughout their lives. They might prefer cities to suburbs, phones to cars, and buying their groceries from online retailers instead of going to the supermarket. Initial indications seem to suggest that the overall effects of changes like these may be to slow growth in individual driving rates—even as population increases result in more travelers on all modes.

In 2045, most of us will probably still use personal vehicles to get to work and to go about our daily tasks. Our population will increasingly move toward large metropolitan areas. However, these metropolitan areas will not look like the cities of 100 or even 50 years ago. They will be much larger and much less dense, with new investments and developments being located outside the urban core where land is less expensive. Short of land-use plans that expressly curtail it, sprawl is likely to remain a dominant development pattern and, if we do not act, congestion will be much more widespread.

Some cities are becoming laboratories for new types of transportation, including ride-sharing and ride-sourcing services, enhanced cycling facilities, and an expanding set of public transit options. However, if cities cannot find ways to affordably accommodate increased population growth, suburbs will grow at a faster rate. We

may increasingly find ourselves in a world where some cities become the domain of the affluent, while those with less wealth must contend with congestion on metropolitan outskirts. As income inequality increases, and poverty becomes suburbanized, the provision of affordable housing and transportation options will become an increasingly important policy challenge.

As many metropolitan areas grow, rural populations and some economically challenged metropolitan areas are shrinking. These areas are likely to face challenges maintaining access for rural and economically disadvantaged populations as their tax bases decline. Governments at all levels will face challenges structuring programs to balance equity and fairness claims, while ensuring that scarce resources are allocated to areas that most need capacity.

There is a wide range of policies that could potentially reduce congestion and preserve quality, affordable, and accessible transportation options for all of us. These options include:

- Increasing investments in roadway capacity to address congestion in metropolitan areas.
- Restructuring federal surface transportation programs to allow for more targeted, demand-driven, mode-neutral investments.
- Expanding and/or improving the quality of public transit services by providing dedicated rights of way for transit buses.
- Strengthening the coordination of human service transportation services to meet the needs of older adults and people with disabilities.
- Continuing to improve the accessibility of public transit systems and pedestrian infrastructure.
- Subsidizing car ownership for the working poor.

- Promoting integrated transportation and land-use planning.
- Supporting services such as bike sharing, car sharing, and ride sourcing.
- Integrating land-use and transportation planning to support sustainable and efficient development patterns.
- Supporting design and planning choices that support alternatives to vehicle travel.
- Adopting congestion pricing.
- Lifting the federal restriction on the tolling of interstate highways.
- Encouraging companies to adopt telework policies.
- Supporting investments in transportation technologies and operational strategies that can reduce congestion.

These policy options are explored in further depth in the conclusion of this report.

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# HOW WE MOVE THINGS

## Introduction

Our freight system is a multimodal engine that we depend on to drive our economy. Trucks, trains, barges, and ports operate so efficiently at times most of us take it for granted. Yet, our coastal ports are modern wonders and critical gateways to a global economy. The twin ports of Long Beach and Los Angeles process hundreds of billions of dollars' worth of imports and exports each year. Imports arrive on giant container ships and are transferred to trucks and trains which take the cargo to intermodal transfer centers and, from there, to warehouses and stores across the country. Freight trains move enormous volumes of grain from farms in the Midwest and Great Plains to barges on the Mississippi, Missouri, and Ohio Rivers that are transferred to ships in ports along the Gulf Coast, eventually feeding markets abroad. As we dine in St. Louis on a fresh fillet of Sockeye Salmon caught off Alaska's Kenai Peninsula most of us don't give a passing thought to the wonders of our modern air freight system.

Our nation's ability to compete in global markets, and to meet the needs and expectations of consumers and industry depends on a robust multimodal freight transportation system. In an age of online shopping and next-day delivery, it can be easy to take for granted the policies, infrastructure, vehicles, trains and vessels, and workers that make all of this possible. But, today, our freight system is under serious strain. Our roads, railways, and some of the largest, busiest airports are becoming increasingly congested.

Many of our ports and inland waterways suffer from lack of dredging and aging facilities. Faced with these challenges, there are opportunities to improve the performance of our freight system.

Today, freight patterns are changing at a global and local scale. International trade is increasing, global manufacturing centers are shifting and trade routes are changing. Firms are driving down logistics costs through just-in-time shipping. Online shopping is increasing demand for home delivery of consumer products. Ports worldwide are becoming increasingly automated. Intermodal freight shipped in containers by ships, trains, and trucks is increasing rapidly. Surging domestic energy production is straining infrastructure in oil production regions. In the next 30 years, changes in freight demand, shipping, manufacturing, logistics, technology, and energy production are poised to transform the economics of transportation yet again.

This chapter addresses the trends that will shape the economics of transportation and freight movement through 2045.

## Population and Economic Growth

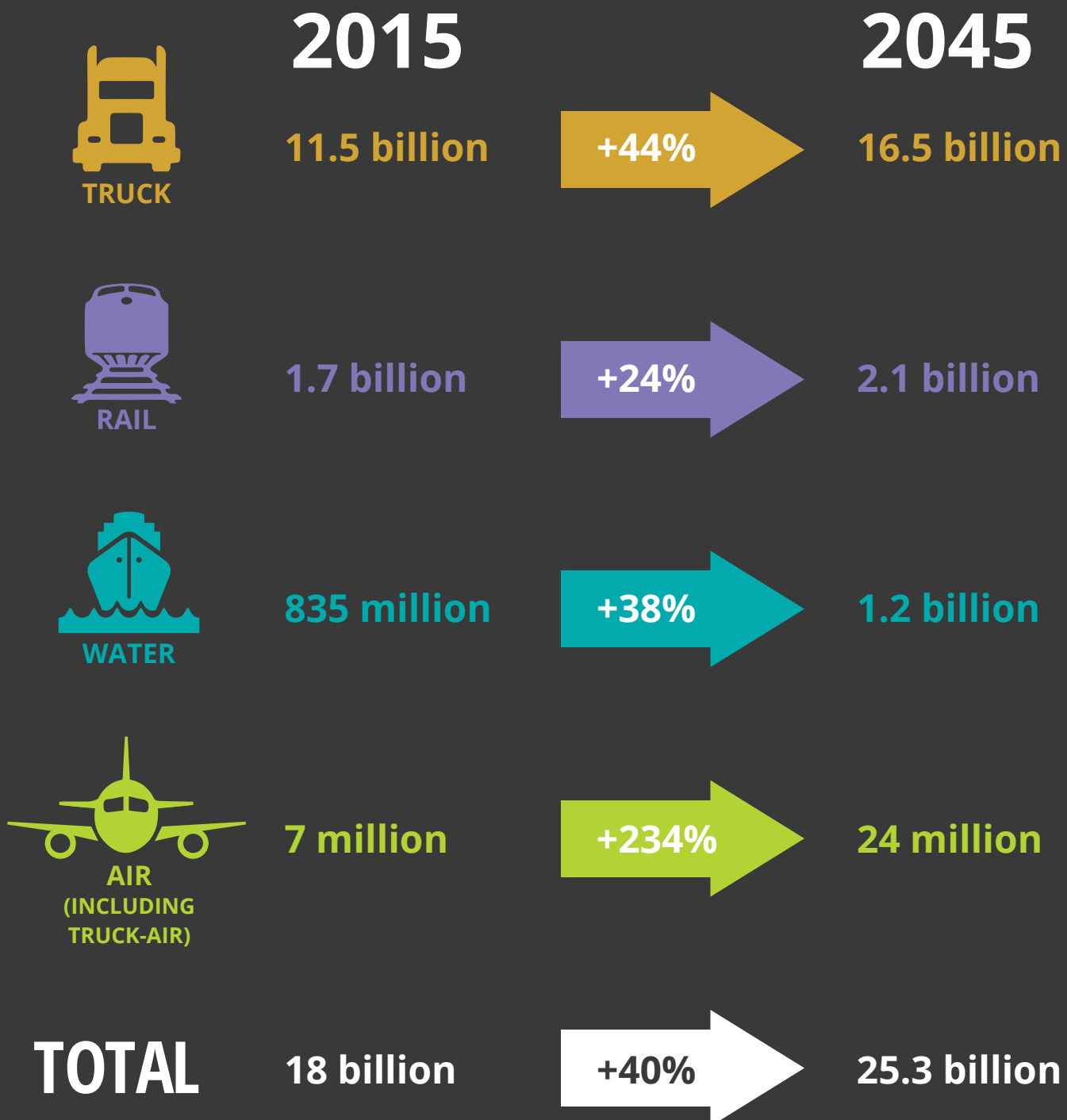
Our freight system moves approximately 63 tons of goods per American each year. As our population grows and our economy expands, demand for freight will grow as well, straining an already challenged system.

The economy is growing again. Despite the recent recession, the size of the American

# FREIGHT MOVEMENT IS

## MULTIMODAL

About **50 million** tons of freight move across our nation every day



## Moving Memphis Forward: A Local Freight Economy

Memphis is a major freight and logistics hub. Five major railways converge in the area and railroads have invested heavily in intermodal facilities there. Memphis is also home to the second-largest cargo airport in the world, Memphis International Airport, and the FedEx Global Operations Control Center. Memphis is also home to hundreds of trucking companies and services barge traffic on the Mississippi River. Nearly 30 percent of regional employment is concentrated in the transportation and warehousing sector. A key regional challenge to accommodate additional growth in freight will be to improve intermodal connectivity and to address freight bottlenecks, while ensuring that the potential negative impacts of increased freight transportation on local residents are avoided or mitigated.

economy has more than doubled over the past 30 years, growing at an average annual rate of approximately 2.6 percent. At the same time, businesses have become more efficient in their use of transportation. The American economy has benefited from the deregulation of the trucking and rail industries, which has led to increases in productivity and innovations in supply-chain logistics. Over the long term, transportation and logistics costs have declined as a percentage of gross domestic product (GDP). By some calculations, logistics and transportation costs have declined from 16 percent of GDP to 8 percent over the past 30 years. Logistics costs as a share of the American economy are some of the lowest in the world, comparing favorably to Europe and less than half those in China.

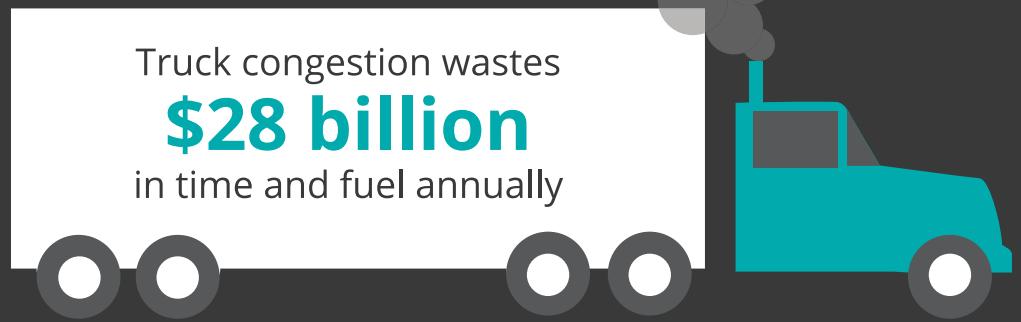
The American economy has become less freight-intensive as economic growth has outpaced the growth in freight activity. As we have shifted from a manufacturing economy towards a more service-oriented economy, and increased our production and consumption of higher-value, lower-weight products, such as pharmaceuticals and personal electronics, freight movements have declined in proportion to the total economy. Likewise, as our economy has

become increasingly dependent on foreign trade, the nature and location of freight movements has shifted. More goods produced by American factories and farms are now bound for export and manufactured goods are increasingly imported from overseas through our ports.

As our economy grows, and even by conservative estimates it is expected to nearly double in size over the next 30 years, freight movement will increase as well, albeit at a slower rate. Truck and rail freight movements are expected to increase by more than 40 percent. Air freight is expected to triple in response to demand for the rapid movement of high-value merchandise, while multimodal shipments will likely double. Overall, the volume of imports and exports transported by our freight system are expected to more than double in the next 30 years. This will have implications for ports, which handle 75 percent of America's international trade by volume, and for intermodal carriers that move imports and exports between ports of entry and inland locations.

# SYSTEM PERFORMANCE AND COST OF CONGESTION

By 2040, nearly **30,000** miles of our busiest highways will be clogged on a daily basis.



## Increasing Congestion and Deteriorating Infrastructure Conditions

Growth in overall freight demand will put increased pressure on freight bottlenecks throughout the country. In 2014, more than 10 million trucks moved more than 10 billion tons of freight across America's highways. These trucks are major contributors to congestion on 4,500 of the busiest highway miles in the nation.

Bottlenecks severely limit the performance and capacity of the highway system by delaying large numbers of truck freight shipments. Areas with the worst truck delays include major international trade gateways and hubs, such as Los Angeles, New York, and Chicago, and major distribution centers such as Atlanta, Charlotte, Dallas-Fort Worth, Denver, Columbus (Ohio), and Portland (Oregon). Border crossings are also bottlenecks. At two major Mexico border crossings, it takes trucks on average nearly an hour to enter the United States.

Freight systems across all modes face capacity constraints and rising maintenance costs. After decades of consolidation, rail companies face rising infrastructure costs to resolve bottlenecks

and to provide capacity to meet rising demand. Aging locks and dams are causing delays on inland waterways, and their maintenance costs are steadily increasing.

## Urban Freight Challenges

Our increasingly urbanized population poses challenges for "first mile" and "last mile" freight movements. Freight demand is expected to be concentrated in the large metropolitan areas where America's population is growing the fastest. Congestion in several metropolitan population centers is already severe and could become more extreme. Increasing freight demand in these densely populated areas will complicate first mile movement of goods out of ports and the last mile movement of goods from freight hubs to their final destinations, which is often the least efficient portion of the supply chain for many consumer goods.

Freight-related traffic can also result in delays and congested road conditions for passenger and emergency response vehicles. For example, highway-rail grade crossings can lead to lengthy delays. Traffic to and from ports and other major freight centers can increase traffic on local roads and affect neighboring communities through noise and air pollution. These issues may become

## Addressing the Chicago Region's Freight Rail Bottlenecks

Chicago is the busiest rail hub in the United States. Approximately one quarter of all U.S. rail traffic and nearly half of intermodal rail traffic passes through rail lines in or nearby Chicago. Six of the nation's seven largest freight rail carriers operate in the region. It is also a hub for intercity rail and home to the most heavily used commuter rail services outside of New York. Amtrak and regional commuter rail service share the same tracks as freight trains leading to conflict and delays as demand for passenger and freight rail transportation has grown. Increasing rail traffic has also created delays and safety risks for vehicular traffic and pedestrians where railways cross roadways.

**Today a train can traverse the country from the ports in Los Angeles to Chicago in as little as 48 hours, but the same train may spend 30 hours just to travel across the Chicago region.**

The Chicago Region Environmental and Transportation Efficiency Program (CREATE) is a \$3.8 billion cooperative project involving U.S. DOT, Illinois DOT, Chicago DOT, six major North American freight rail carriers, and two passenger carriers to resolve rail conflicts and increase rail capacity, speed, and reliability in the Chicago area. It involves the separation of freight and passenger trains at six key junctions and the elimination of 25 road/rail grade crossings by creating overpasses or underpasses at rail intersections. Fifty miles of new track will link yards and create a second east-west route across the city, building redundancy into the overburdened system. Established more than a decade ago, the program has completed close to half of a planned 70 projects throughout the region. So far the projects have helped to reduce the average time it takes to pass through the Chicago Rail Terminal from 48 hours to 32 hours.

more challenging as online shopping increases the portion of deliveries that are made directly to consumers' homes. The challenge of delivering freight to dense urban areas will grow in importance as urban populations and deliveries increase.

Freight and passenger traffic conflicts on our railways slows passenger travel and decreases the reliability of freight shipments. Amtrak and commuter trains frequently operate on privately owned and operated rail infrastructure and share tracks with freight trains. As the demand for both freight and passenger rail has grown in recent

years these systems have come into conflict more frequently. Rail-highway crossings are another area where conflict between passenger and freight modes can lead to safety hazards and delays. Coordinated investments and information sharing between public and private entities are required to resolve these conflicts and separate passenger and freight traffic where feasible.

## Rural Freight Transportation: A Critical Link

Many rural areas depend on a robust multimodal freight network to support their economy.

While the majority of freight in our country is delivered by trucks, railways are often essential for the affordable transport of heavy and bulky commodities such as lumber, wheat, coal, and heavy equipment. Inland waterways are also a critical feature of a robust rural freight transportation network. The first long distance system for moving goods and people, inland waterways remain an inexpensive alternative for moving commodities such as grain and iron ore. Ultimately, the role of freight in rural communities varies according to the primary economic sectors whether it is tourism, manufacturing, or agriculture. The nature of the agricultural product matters as well: heavy grains rely on barge and rail transport, while specialized or highly perishable fruits and vegetables may require air transport or overnight trucking to reach domestic and global markets.

Freight transport is critical to support rural industry as it transports the raw goods and products needed to support and promote growth in rural economies. Well-planned, multimodal freight systems provide opportunities for companies to locate and grow in rural regions due to efficient and reliable connections with major markets and ports. Intermodal facilities and logistics centers located in rural areas can benefit from lower costs than urban areas and may be strategically located at a key transfer point in a freight corridor.

Rural freight transportation also poses challenges to policymakers. For example, the restructuring of the rail industry has led to the abandonment of many branch lines, cutting off service to many rural areas, leading to grain elevator consolidation along mainline and increased truck travel on rural roads to get wheat from farms to grain elevators. Heavy truck traffic along freight corridors passing through rural areas can also raise road maintenance costs without bringing

direct economic benefits to the area. Such issues present challenges for rural regions, which have fewer resources and less flexibility to address such issues.

Increased demand for higher value goods is limiting the supply of transportation available for lower value bulk goods across all modes. The agriculture and natural-resource sectors tend to ship heavy products, such as grain and ore, in bulk, using barges, rail, and pipelines. These industries typically deal in high-weight, low-value commodity products, where transportation costs account for a higher proportion of the overall cost than is the case for manufactured goods. The relative efficiency of the American freight system helps these industries compete in export markets. For example, one dollar of final demand for agricultural products generally requires about 14 cents of transportation services, while manufactured goods and mining products require only between 8 and 9 cents. Higher freight costs for bulk goods could increase the prices that American consumers pay for goods, negatively impact local economies, particularly in rural areas, and reduce U.S. competitiveness when exporting these products abroad. In a

ASSUMING NO CHANGES IN NETWORK CAPACITY, INCREASES IN TRUCK AND PASSENGER VEHICLE TRAFFIC ARE FORECAST TO EXPAND AREAS OF RECURRING PEAK-PERIOD CONGESTION TO 37 PERCENT OF THE NATIONAL HIGHWAY SYSTEM IN 2040 COMPARED WITH 11 PERCENT IN 2007.



global economy, transportation costs can have a major impact on whether U.S. products are competitively priced.

## Safety Effects

The need to transport increasing amounts of freight to large urban areas could increase conflicts between freight and passenger traffic. Higher truck traffic and increasing movement of hazardous materials such as crude oil could raise safety risks; however, trends show impressive improvements in freight safety.

Freight transportation is involved in approximately 13 percent of all transportation fatalities. In 2015, 4,062 people were killed and more than 111,000 people were injured in crashes involving large trucks. Large trucks are less likely to be involved in crashes than passenger vehicles, but crashes involving trucks are more likely to be fatal.

In 2014, approximately 800 people died in rail, vessel, and pipeline accidents. While the amount of freight transportation activity has increased in recent decades, the number of fatalities has declined in nearly all modes.

The rail safety record is improving—accidents and derailments are down by nearly 50 percent over the past decade and fatalities are down by 13 percent. Accidents related to human error and track defects account for more than two-thirds of all train accidents, and trespassing and highway-rail grade crossing incidents account for approximately 95 percent of all rail-related fatalities. The implementation of positive train control should contribute to increasing safety in railroad operations.

Transportation of oil by rail has increased dramatically since 2008, when less than 1 percent

of oil was transported by rail. Today, more than 10 percent of all crude oil is now shipped by rail. Even so, crude oil still accounts for less than 2 percent of all car loads on major freight railroads.

While derailments in general have decreased, derailments of tank cars highlight rising safety and environmental risks associated with increasing transportation of oil by rail. As more oil has moved by rail, accidents involving oil spills have increased. In 2013, more than one million gallons of oil were spilled due to derailments, more than the total oil spilled as a result of rail accidents over the past 35 years.

To improve freight safety, railroads and trucking companies are also working closely with government and labor representatives to address operator fatigue issues, instill a culture of safety among operators and establish the use of performance-based risk management programs. In the long term, the introduction of connected vehicle technologies in trucks and automated vehicle technologies in both cars and trucks should lead to further improvements in safety as they come online.

## Environmental Impacts

Increasing freight activity in urban areas could also intensify the debate over land use and pollution. Without effective policies and regulations, growing freight movements will increase greenhouse gas emissions, and will affect human health in neighborhoods along freight corridors. Trucking, intermodal rail, waterborne transportation, and air cargo constitute large and growing sources of greenhouse gas emissions. Trucking accounts for about 9 percent of all highway miles traveled, but it is the source of 24 percent of all transportation-sector greenhouse gas emissions. Freight on other modes accounts for an additional 7

# THE U.S. ENERGY BOOM



The U.S. energy boom is placing unprecedented demand on our transportation system.

Crude oil production is

UP **74%**

since 2008

Rail carried

**493,146**

carloads of crude oil  
in 2013

**52X** the  
**9,500**

carloads of crude  
oil in 2008

percent of transportation sector greenhouse gas emissions.

Trucking is the single largest contributor to freight-related air pollution nationally. Compared to cars, heavy trucks emit large amounts of air pollutants—including hydrocarbons, particulate matter, and nitrogen oxides. While trucks have made great strides in reducing emissions, the average diesel-fueled heavy truck emits 50 percent more hydrocarbons per mile and 12 times as many nitrogen oxides per mile as the average passenger car. These emissions can impact human health, particularly in neighborhoods adjacent to heavily trafficked freight corridors.

Even as demand for freight movement increases, new vehicle emission standards, fuel sources, and energy-efficient intermodal transportation may lead to reductions in emissions of nitrogen oxide (NOx) and particulate matter. Substantial reductions in freight-related NOx emissions have been made since the U.S. Environmental Protection Agency required the use of ultralow

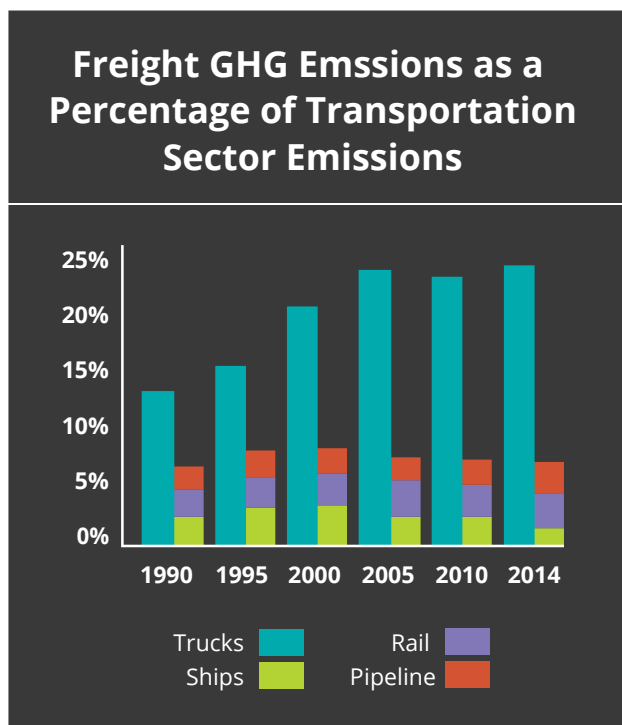
sulfur diesel fuel in heavy-duty trucks and other diesel-powered highway vehicles beginning in 2006. Truck-related NOx and PM-10 emissions are projected to decline by 56 and 66 percent, respectively, from 2012 to 2030.

In 2014, NHTSA and EPA established heavy-duty vehicle fuel efficiency standards that are expected to lead to 10–20 percent reductions in fuel consumption and greenhouse gas (GHG) emissions by 2018. Continued improvements in engine technologies, including the use of new fuels (such as natural gas or hydrogen) and vehicles built from lighter materials, should reduce fuel consumption and emissions from all forms of freight vehicles. Similarly, new standards for cleaner and more fuel-efficient trucks, trains, vessels, and aircraft may reduce the pollution associated with carrying more freight.

## Globalization

Over the past 30 years, international trade has increased at a much faster rate than overall economic growth. U.S. exports nearly doubled over the past decade. Total exports and imports of goods reached \$4 trillion in 2014, accounting for 23 percent of U.S. GDP.

In the next 30 years, it is likely that globalization will continue to expand the supply of imports domestically and demand for exports globally. With 95 percent of the world’s consumers outside



SINCE 1990, GREENHOUSE GAS EMISSIONS FROM TRUCKING HAVE INCREASED FIVE TIMES FASTER THAN EMISSIONS FROM PASSENGER TRAVEL.

the United States, and with a shrinking share of global GDP due to the projected economic rise of China, India, and other emerging markets, international trade will grow in importance and put increasing pressure on our ports, border crossings, airports, and intermodal facilities to efficiently move imports and exports to market.

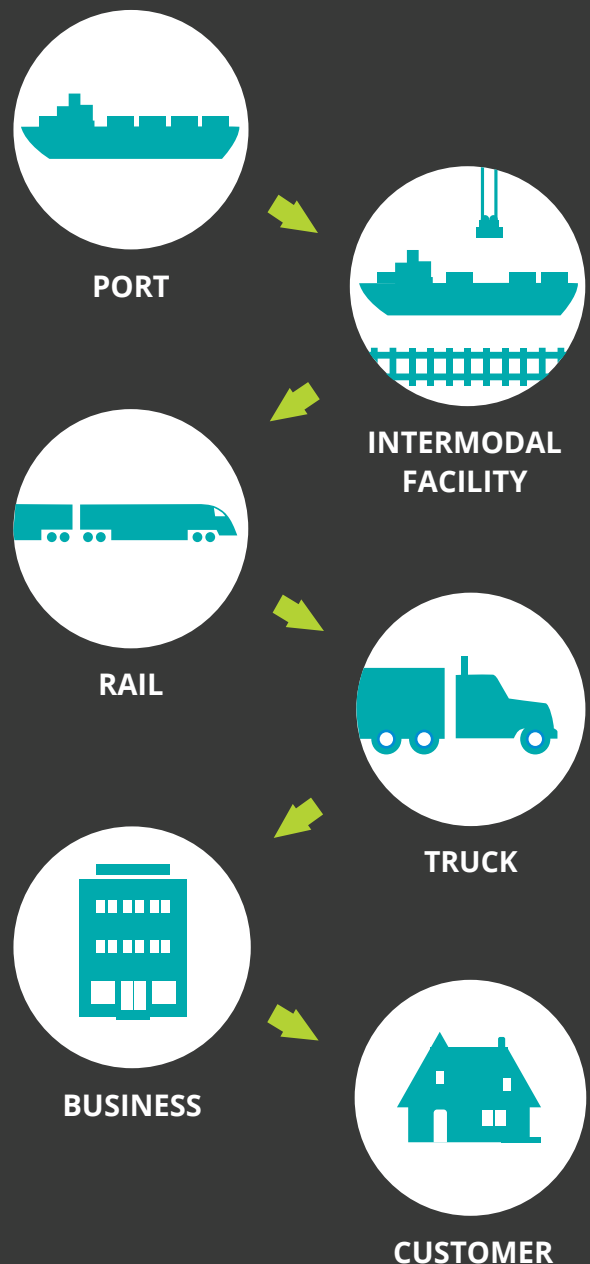
In addition to changes in the volume of international freight, the origin and destination of freight trips may undergo significant changes. Maritime trade will remain the leading form of international freight transportation; however, there will be changes in the dominant maritime trade routes.

The recent widening and deepening of the Panama Canal will enable larger ocean-going vessels, known as “post-Panamax” ships, to pass through the Canal. Of the cargo passing through the Canal, 64 percent originates in or is destined for the United States, so the widening is expected to increase container ship freight volume loaded and unloaded at Gulf and East Coast ports. Canal improvements may also increase traffic at West Coast ports by enabling more efficient commerce between those ports and the Caribbean, as well as Atlantic ports in South America. It will also become increasingly important for ports to address congestion and equipment shortage challenges generated by bigger, new-generation container ships that offload larger volumes of containers in relatively shorter amounts of time.

The melting polar ice cap is opening Arctic shipping lanes. The Northern Sea Route, a shipping lane across the rim of Siberia connecting the Atlantic to the Pacific, first became passable in 2007. In 2013, a Danish cargo ship became the first to use the Northwest Passage, the sea route running from Alaska through the Canadian Arctic Archipelago as an alternative to the traditional voyage through the Panama Canal.

# INTERMODAL FREIGHT

Intermodal freight, one of the **fastest growing sectors** of the freight market, involves the transportation of goods in containers using multiple modes of transportation.



# CONTAINER TRAFFIC AT U.S. PORTS

(by Value of Cargo)

**84%** of America's containerized freight flows through just ten ports. Container traffic at U.S. ports reached record highs in 2015 and is up by **28%** since 2009.

Ports are opportunity multipliers—economic engines, fueling good jobs not just on our coasts, but across the country.



While these seasonal routes are unlikely to rival the high-traffic Suez Canal and Panama Canal routes, they may provide a partial alternative to existing maritime routes. However, regular use of these new routes would require considerable investments in facilities to service and ensure safe passage of ships through these areas.

Increasing imports and exports could lead to greater congestion at container ports and border crossings, resulting in delayed shipments, increased transportation costs, and intensifying pollution. Today, intermodal shipments are concentrated in the top 10 to 12 deep-water ports with the requisite infrastructure. Eighty-five percent of America's imported and exported containerized freight flows through just 10 ports.

There are also international shipments that do not involve U.S. importers or exporters, or domestic supply and demand, but still influence volume and congestion on our freight network. These shipments, commonly referred to as in-transit shipments, travel from one country through the U.S. destined for another country without ever entering into U.S. commerce. Some foreign shippers use our nation's freight system of coastal ports, airports, pipelines, railways, and highways as a "land bridge." However, the Northern Sea Route, expansion of the Panama Canal, and the continued trends in congestion and bottlenecks may lead to a decrease in in-transit shipments through the U.S. in the future.

The concentration of intermodal shipments in these ports makes our international freight system vulnerable to disruption. If security incidents were to lead to heightened inspection requirements, they could further slow goods movement at ports of entry. Labor disputes and natural disasters also have the potential to impact operations at key ports and disrupt the national economy.

Port authorities are already investing billions to modernize their facilities and accommodate new-generation container ships by dredging harbors, raising bridges, and purchasing larger ship-to-shore cranes. Ports will need to continue to respond to increased demand for efficient intermodal freight movement with innovations that allow them to transfer cargo from ships to roads and rails more quickly. Finally, American ports may need to expand and become more efficient to compete with growing deep-water ports in neighboring and nearby countries.

## Freight Innovations

The freight industry is quietly going through a technological revolution as information and communications technologies are applied to optimize global supply chains. These technologies and business innovations are accelerating trends that have led to 30 years of declining logistics and transportation costs relative to GDP. Emerging supply-chain optimization practices are resulting in firms placing a premium on the reliability of transportation services.

Manufacturers and shippers are becoming better and better at using information technology to optimize performance. Today, the private sector uses new technologies to analyze demand and rapidly adjust supply chains. This is not a new practice, but enhanced data systems now provide manufacturers and distributors access to real-time information that allows them to adapt more quickly than ever before.

Private firms are also changing the way they package and ship products to make deliveries more efficient. Delivery consolidation through less-than-truckload deliveries combines multi-stop shipments into a single truck, and reduces the number of trucks on our highways.

Similarly, firms are now using mobile technology to connect truck drivers to last-mile freight orders that can fill excess truck capacity. By matching supply and demand, these companies have the potential to improve the efficiency of independent operators. These efficiency innovations may also help to reduce the impact of growing demand on the capacity of our freight transportation system.

Recent technological advances in data analysis systems, automatic vehicle and container identification systems, and satellite navigational systems will improve the efficiency of freight movement. These technologies will improve situational awareness, allowing real-time decentralized access to location and operational data. Understanding where a package is at any given time (even when it is in the air or on the road), and when it is due to arrive will allow for more efficient movement of freight across modes and through processing facilities.

Advances in information and communications technologies will improve data collection and analysis capabilities of logistics firms and freight planners, enabling faster and more accurate analysis of freight routes, travel times, and infrastructure capacity. They will also improve safety by automating and expediting inspection processes, and by allowing for improved monitoring of security information.

Fully and partially automated trucks, ships, and planes, and automatic freight-transfer facilities may eventually transform the freight industry. Autonomous vehicles will not suddenly appear on our roads, but automated features that promise to improve the safety and efficiency of freight movement are already being introduced. On trucks, these include sensor systems that combine adaptive speed control, automatic braking, lane-departure warning systems, and

vehicle-to-vehicle communications. By allowing sensors on one truck to communicate with sensors on another truck, partially automated trucks could soon travel more closely together to improve fuel efficiency, in a practice known as truck platooning or truck trains.

Automation is already affecting ports. At major container ports around the world, the process of transferring containers from ships to docks, trucks, and trains is becoming highly automated, reducing reliance on human operators. Major American container ports will need to invest in automation to compete.

Automation will change the nature of work in the freight industry. Advanced automation will increase productivity in the freight industry and change the skills needed to work in freight. Technologies that affect driving, vehicle maintenance, warehousing, and loading will alter professional development needs, and employment levels—and will affect the average income for transportation workers. Managing and maintaining automated ports and fleets will require advanced mechanical and data analysis jobs, which demand higher skills and higher pay than traditional freight work.

While some innovations in freight, such as automated driving, seem incredibly complex, some of the most transformative innovations are remarkably simple. The container—a large, standardized metal box used for cargo shipments—has become the essential unit of intermodal freight movement. Since its introduction as an alternative to conventional break-bulk cargo shipping in the 1960s, the container has influenced virtually all aspects of the freight transportation system, including the size of cargo ships, the design of container ships, the structure of freight railroads, and the scale of global trade.

The use of efficient, high-speed intermodal transfers in economically large units between ships, rail cars, truck chassis, and barges has led to profound changes in the transportation sector. By reducing handling time, labor costs, and packing costs, and also reducing damage and theft during transport, container transportation has facilitated economies of scale and improvements in handling speed and throughput, particularly for valuable non-bulk commodities. As a result of container use, intermodal freight movement has expanded dramatically since the 1980s, particularly for shipments over 2,000 miles.

The advent of containerization and the expansion of international trade has put a premium on seamless intermodal freight movements. The efficiency of our freight system now depends on fast and effective transfers of containers between modes. Intermodal facilities where cargo is stored, assembled, and transferred have become increasingly important for the efficient movement of freight. Many of the operational bottlenecks that cause delays and raise the costs of moving freight occur at or around intermodal transfer points, such as ports, rail facilities, and distribution centers.

Freight planners and policymakers will increasingly look to intermodal logistics hubs to improve the efficiency of transfers between multiple freight modes and reduce the negative impacts of freight on local communities.

Increased use of practices such as double-stacking of containers on railway cars will also increase the capacity and efficiency of the freight system.

## Workforce Challenges

The transportation industry employs nearly 5 million people and nearly a half million more jobs in transportation could be created over the next decade. These include a broad range of jobs such as truck and bus drivers, train operators, pilots, stevedores, mechanics, engineers, analysts, and planners. These are good jobs. A majority of the top transportation jobs pay above the median wage and many are union jobs with good benefits that don't require an advanced education. Yet changes to the transportation workforce and in the work of transportation itself present a growing challenge for the freight industry and transportation as a whole.

Several broad trends are affecting all aspects of this workforce. Nearly half of the transportation workforce could become eligible to retire in the next 10 years, resulting in the loss of valuable workers, skills, and institutional knowledge. For example, more than a third of transit workers and nearly a third of railroad workers are over 55 years old. Growing demand for transportation coupled with an expected wave of retirements will result in more than 4 million job openings for workers across the transportation sector over the next decade.

As a generation of transportation workers passes into retirement, transportation employers need to find ways to attract and retain a younger generation and more diverse cohort of workers in an evolving and competitive economy.

Currently, only one in five workers in the transportation industry are women. To ensure a

THE NUMBER OF INTERMODAL  
RAIL SHIPMENTS INCREASED  
FROM 2 MILLION IN 1980  
TO 13.5 MILLION IN 2014.



qualified transportation workforce in the coming decades the transportation industry as a whole will need to develop strategies to recruit and develop female employees. New technologies are also changing the nature of transportation work. The increasing use of information technology and computerized equipment necessitate new, more advanced skill sets, in many transportation industry jobs. These challenges are already making it difficult for many employers in the transportation industry to fill open positions and address gaps in skills.

## Increasing Domestic Energy Production

America is experiencing an energy renaissance. This current boom is a result of advances in technology that have opened up reserves of natural gas and shale oil previously unreachable at economically competitive rates. While shale oil has been extracted for over a century, new technologies and changes in global energy markets have made the recovery of shale oil, and gas production, significantly more profitable in recent years. As a result, domestic oil and gas production has increased rapidly, creating issues for the safe and efficient transportation of energy from production regions to refineries and consumer markets.

Over the past three years, domestic oil production has increased by nearly 60 percent. We now produce more than 280 million barrels of oil a month, the highest level in more than 30 years. Domestic shale gas production has increased from 2 trillion cubic feet in 2007 to 13 trillion cubic feet in 2014—enough natural gas to heat nearly 200 million homes each year. As a result of this boom, net imports of natural gas and oil have been falling since 2007. The Energy Information Administration has predicted that we will become a net exporter of natural gas

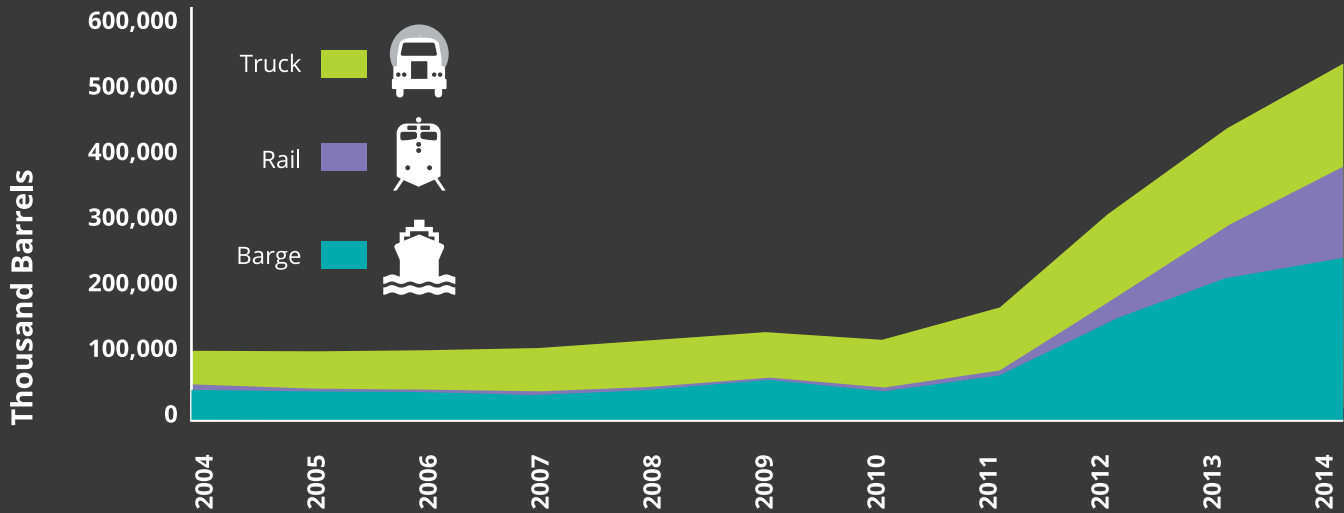
IN 2013, THE UNITED STATES SURPASSED SAUDI ARABIA TO BECOME THE LARGEST OIL-PRODUCING COUNTRY IN THE WORLD.

before 2017. That said, future developments, such as fluctuations in global fuel prices or the development of affordable alternative fuels could alter current oil and gas production trends.

High-value energy products already account for more than 30 percent of the domestic ton-miles of freight moved each year. Should U.S. energy production continue to grow, it will have profound implications for our transportation system. The natural gas and oil boom has created jobs in drilling, pipelines, and construction, and is attracting many new people to production regions. Simultaneously, these regions are transporting unprecedented levels of natural gas and oil to distribution centers around the country. As a result, demand for transportation in energy production regions has grown. Industrial traffic—heavy trucks, and drilling and other production equipment—is overwhelming many roads in states such as Pennsylvania, West Virginia, Ohio, and North Dakota.

The shifting geography of petroleum production is increasing safety risks and raising transportation and infrastructure maintenance costs. The current pipeline network, regulated by the U.S. DOT's Pipeline and Hazardous Materials Safety Administration, is oriented toward imports arriving at Gulf Coast refineries and does not connect the East and West Coasts to the newer domestic oil supplies.

# Domestic Crude Oil Refinery Deliveries by Non-Pipeline Mode



The domestic production boom will increase demand for infrastructure capacity to move oil and gas. Facilities will need to be reoriented to accommodate gas and oil supply and demand. Federal and state agencies will need to address new challenges related to human safety and risks to the natural environment resulting from the transportation of natural gas and petroleum. Lower fuel prices will lead the trucking, rail, and transit industries to increase the use of compressed natural gas (CNG) and liquid natural gas (LNG) as affordable alternatives to diesel.

## Policy Implications

Freight transportation is quietly undergoing a transformation. Our economy is becoming ever more globalized, with cargo increasingly moving across borders and between modes. This trend has increased the importance of international gateways and intermodal connections for facilitating the efficient movement of imports and exports. Innovations in supply-chain logistics

and information technologies are raising the expectations of consumers and firms for fast, reliable, flexible, and efficient delivery of goods and resources. Automation has the potential to revolutionize how ports, trains, vessels, and trucks operate. Domestic energy production has increased, leading to increased demand for infrastructure to safely and efficiently transport energy products to where they are needed.

As global economic competition increases and trade patterns change, we will need to decide how best to invest limited public resources in freight capacity. We will need to consider what infrastructure capacity is needed and where, and how to make the best use of existing capacity while considering the public benefits these investments offer. We will also need to consider what role government should play in ensuring that American workers have the skills and information needed to ensure the most efficient use of existing capacity and emerging technologies. Policymakers will also need to

work with the private sector when appropriate and mutually beneficial, to expand capacity and improving the efficient use of our freight infrastructure.

We will also need to consider how local policies, constraints, and investments may affect the performance of regional and national networks. Locally driven decisions about freight capacity can create regional competition that leads to inefficient national investments. The decision-making structure for critical freight networks varies from locale to locale, and the authority is often held by a mixture of public and private, state, local, and regional entities, which may represent one or many modes of freight movement. The Alameda Corridor, a 20-mile grade-separated rail corridor that runs directly to the Ports of Los Angeles and Long Beach to the rail mainlines near downtown Los Angeles, took nearly 20 years of coordinated efforts among public and private stakeholders across the region to become a reality. Completed in 2002, the project reduced travel times along the corridor from 4 hours to 30 minutes.

Many of the worst freight bottlenecks are located on the roads surrounding major urban areas and near coastal container ports and large intermodal terminals, where freight traffic and passenger traffic compete for capacity. As the population and economies of urban areas grow, demand for freight on already-congested access gateways to ports, road, rail, and aviation infrastructure is likely to increase. How can regions plan for increasing traffic and resolve conflicts that may arise between the transportation demands for freight, passengers, businesses, and local residents?

As we have seen with efforts to accommodate increasing domestic energy production, meeting the transportation needs of growing regional

economies is not without challenges and controversy. There are serious tradeoffs that need to be considered, especially when societal goals conflict. Policymakers have a significant role to play in assessing those tradeoffs to set policies and regulatory standards that effectively address issues of economic development, public safety, and environmental sustainability.

Public agencies will need to develop policies and regulations that address those risks and improve the resilience of our freight system. Policy options for improving the efficiency of our freight transportation system and mitigating the negative impacts of freight movements include:

- Establishing strategic freight funding programs that target freight bottlenecks.
- Encouraging private investment in freight infrastructure.
- Adopting policies that shift freight demand to safer, more environmentally sustainable modes.
- Using congestion pricing to manage demand.
- Investing in ports and intermodal facilities to make intermodal shipping more efficient.
- Incorporating freight planning into transportation planning and regional economic development decisions.
- Incentivizing the adoption of alternative-fuel and electric vehicles by freight companies.
- Supporting research into automation technologies.
- Investing in infrastructure to support the safe and efficient movement of energy supplies.

These policy options are explored in further depth in the conclusion of this report.

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# HOW WE ADAPT

## Introduction

Our climate is changing, producing harsher storms, rising sea levels, and higher average temperatures. In 2014, we experienced the warmest year on record. Droughts and floods have become more frequent, and more damaging. The scientific consensus is that these changes are largely the result of human activities that have emitted carbon dioxide and other heat-trapping gases into the atmosphere.

These changes have costs and consequences—for our economy, our public health, and our infrastructure. While it is difficult to definitively connect climate change to particular weather events, the trends are disturbing. Since 1980, the frequency of billion-dollar natural disasters has increased by approximately 5 percent per year, controlling for inflation. In 2012 alone, weather-related disasters in the United States were estimated to have cost more than \$120 billion. In 2014, at least \$2 billion in crops and 17,000 jobs were lost to the ongoing California drought—the worst drought in more than a century.

Our transportation facilities—our roads, bridges, tunnels, rails, airports, waterways, and ports—are uniquely vulnerable to damage caused by severe storms, rising sea levels, drought, and extremes of temperature. These vulnerabilities have become more pronounced as the frequency of these events increases. For example, in 2012, Hurricane Sandy caused \$700 million in damage to the rail infrastructure in four century-old tunnels under New York City, forcing repairs that

will disrupt service and severely inconvenience riders for years to come.

In 2014, transportation sources directly accounted for 26 percent of total U.S. greenhouse gas emissions. Next to the generation of electricity, which contributes 30 percent of greenhouse gases, the transportation sector is the second largest source in the United States. Industrial emissions related to the manufacture of transportation vehicles and the construction of infrastructure add to the total contribution of the transportation sector to emissions.

However, the transportation sector is making major strides: with new fuels, new vehicles, and new policies that can help to reduce emissions. New types of fuels that promise to dramatically reduce emissions for automobiles, trains, planes, and vessels are emerging, sales of plug-in electric and hybrid vehicles are increasing, and the fuel efficiency of new vehicles is improving. The federal government recently issued joint fuel economy and greenhouse gas emissions standards for cars and light trucks, and fuel economy standards were set for medium and heavy trucks for the first time ever. These regulations are expected to increase the fuel efficiency of vehicles by approximately 50 percent over the next decade.

New regulations, policies, incentives, and market forces to reduce emissions may all be needed, as will increased research and development of alternative fuels and vehicle types. Policymakers

and planners may also need to find ways to encourage less energy-intensive land-use patterns and transportation choices. The next generation of Americans could decide to make significantly different lifestyle choices than do current Americans—for reasons of cost or preference—that substantially reduce their environmental footprint. However, it is unlikely that just one measure—technological advances, market forces, or the altruism of future generations—will, by itself, solve the problem of climate change; we will have to combine multiple measures to make progress.

Introducing new policies might be difficult. But they may be necessary to blunt the expected long-term economic, social, and environmental consequences of climate change. This chapter will explore the effects of climate change on the transportation system and the efforts already underway to combat it.

## Impacts of Climate Change

Human activities contribute to climate change by adding carbon dioxide and other heat-trapping gases to the atmosphere. When we burn fuel—gasoline to power our car, oil to heat our home, coal to produce electricity—we produce carbon emissions. These emissions cause the surface temperature of the Earth to rise and increase the acidity of the oceans, changing the weather, threatening species, and jeopardizing crops.

Impacts from sea-level rise and storm surge, extreme weather events, higher temperatures and heat waves, precipitation changes, Arctic warming, and other climatic conditions are affecting the reliability and capacity of the U.S. transportation system in many ways. Sea-level rise, coupled with storm surge, will continue to increase the risk of major coastal impacts on transportation infrastructure, including both

temporary and permanent flooding of airports, ports and harbors, roads, rail lines, tunnels, and bridges.

Extreme weather events currently disrupt transportation networks in all areas of the country; projections indicate that such disruptions will increase. Each major weather event brings with it disruption and delay across our surface, air, and marine transportation systems. Transportation agencies can be forced to scramble and improvise in order to patch and repair after big storms, often with enormous financial and productivity losses, as well as tremendous inconvenience for the average commuter.

## Higher Temperatures

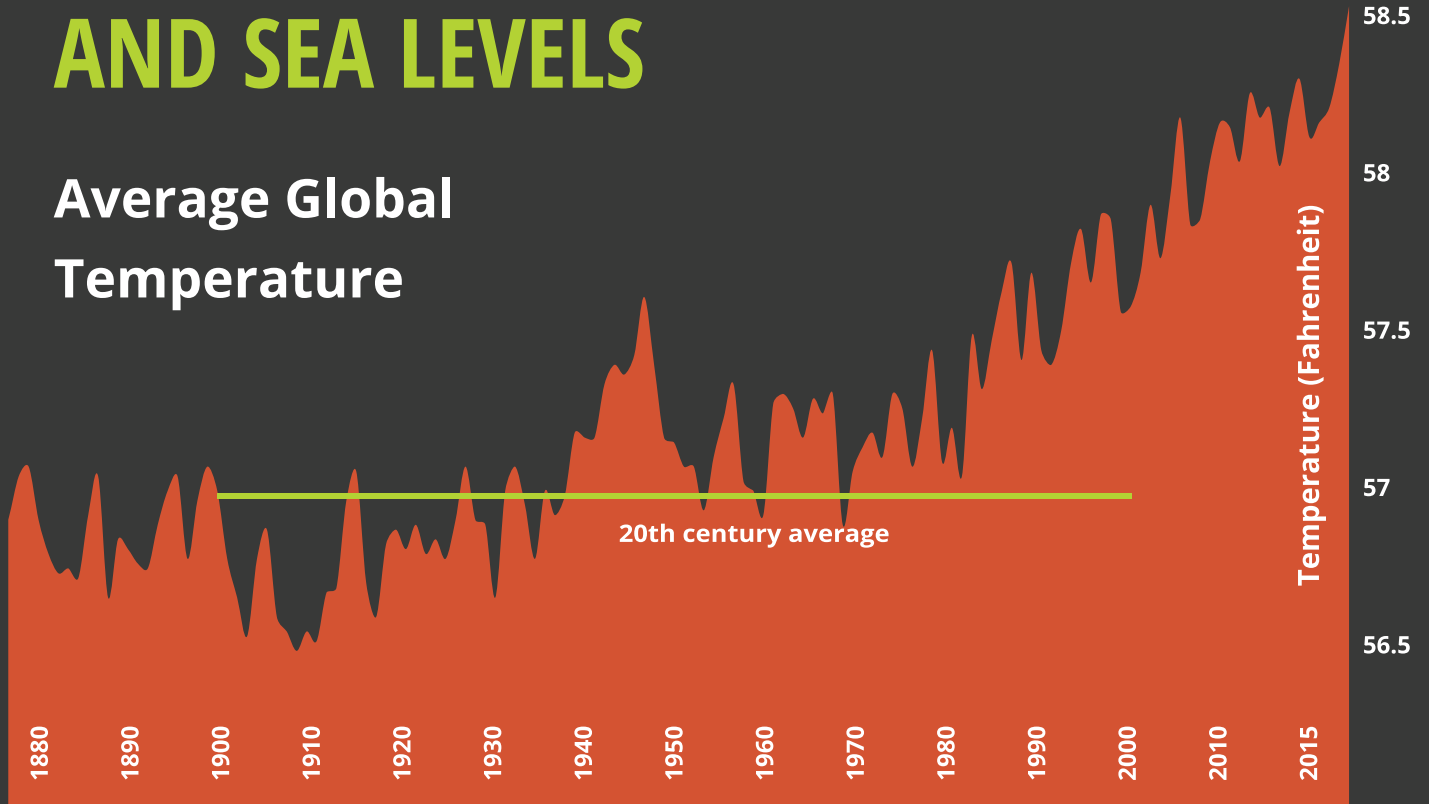
Earth's average temperature has risen by 1.3 to 1.9 degrees Fahrenheit (0.8 – 1 Celsius) since 1880. Much of this change has occurred in recent decades. By 2045, the United States will likely experience average temperatures that are 1–3 degrees Fahrenheit higher than today's averages. This may not sound like a significant increase, but the negative consequences of this change would be substantial and wide reaching. The frequency of heat waves will increase. Northern areas are expected to grow wetter, while southern and western areas are expected to become drier. Sea levels will rise due to the loss of glaciers and polar ice.

Higher average temperatures will raise maintenance costs across all modes. High temperatures accelerate the deterioration of pavement on roads and runways, and cause failures of railroad tracks. Tires are more prone to blowouts in conditions of high heat, and transportation costs will increase as more refrigeration is needed for perishable items. Higher temperatures would significantly

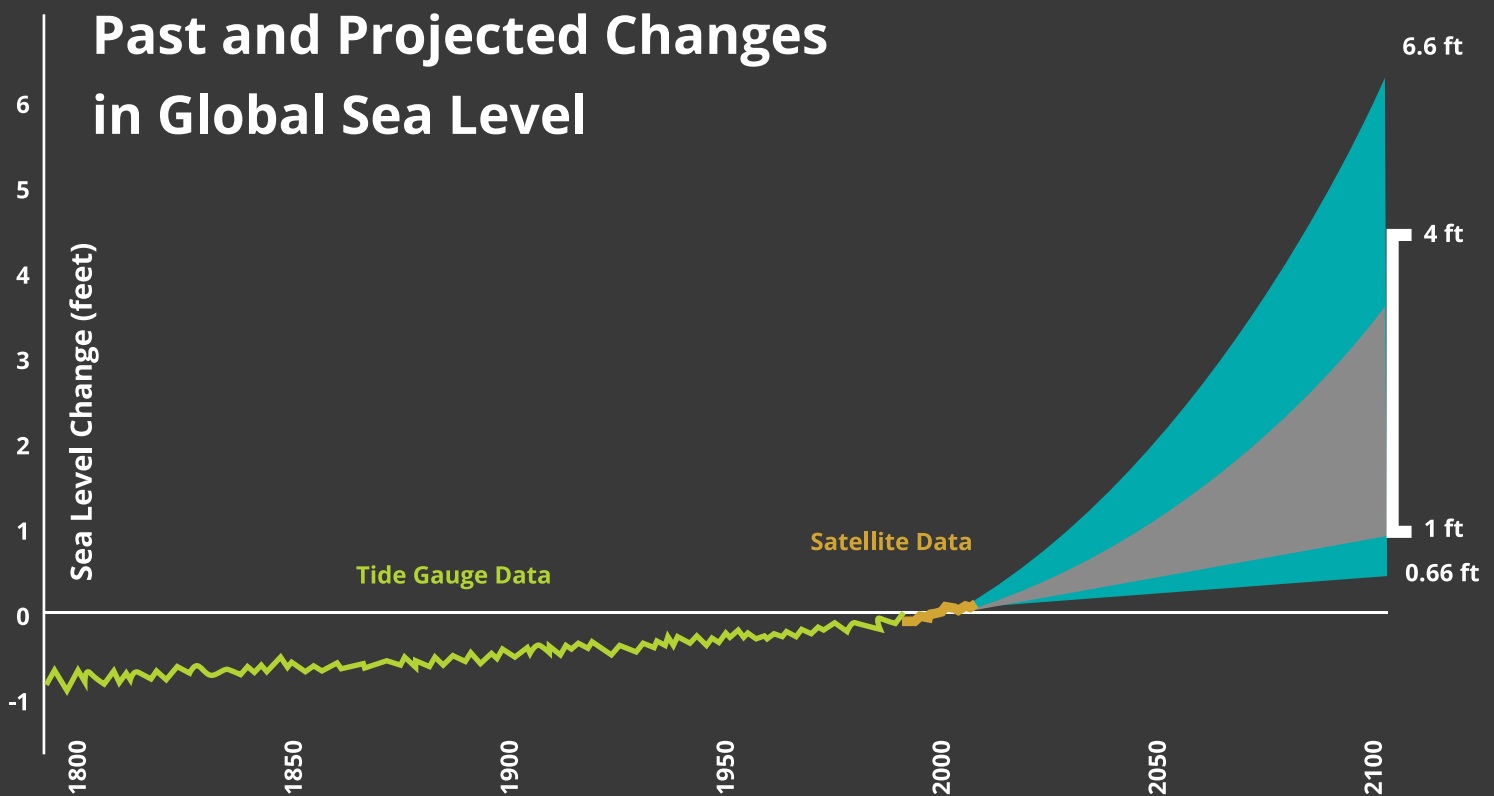


# GLOBAL TEMPERATURES AND SEA LEVELS

## Average Global Temperature



## Past and Projected Changes in Global Sea Level



increase the frequency of restrictions on aviation operations, particularly at high altitude airports. Extreme heat also impairs the operation of aircraft. In 2013, more than a dozen commercial flights from Phoenix were canceled due to extreme heat.

Extreme temperatures cause rail tracks to buckle, which could result in dangerous and costly derailments, and could increase the costs of rail maintenance, causing delays during extreme heat. Track buckling and other problems blamed on extreme heat caused more than \$77 million in damage to American railroads between 2010 and 2013. Extreme heat could also increase evaporation, lowering water levels in the Great Lakes and our nation's waterways, reducing navigability draft for vessels, and forcing them to carry less cargo, resulting in increased freight costs.

## Severe Weather and Sea-Level Rise

Climate change could make extreme weather, such as thunderstorms, tornadoes, and hurricanes, more frequent and more intense, increasing damage to infrastructure and reducing the reliability of our transportation system. Major storms have become more common across the globe since the early 1950s, including more intense winter storms that track northward and more damaging hurricanes and tropical storms. By 2045, projections indicate that global sea levels will rise another six inches to one foot over current levels. Sea-level rise, coupled with a higher frequency of severe weather, will make low-lying infrastructure increasingly vulnerable to flooding from storm surges, and may impede the clearance of vessels under bridges that were not designed for higher sea levels.

Much of our transportation infrastructure is only designed to withstand a 100-year storm—a storm of such severity that it only has a 1 percent chance of occurring annually. However, climate change is making such storms more likely and more intense. By 2045, storms that exceed current design standards will happen more frequently, leading to frequent weather-related outages and repairs. Flooding caused by rising sea levels and storms could force tunnels, subway stations, low-lying roads, rail lines, and marine cargo facilities to be relocated or even abandoned.

Governments may need to divert funds to relocating infrastructure and completing weather-related repairs—potentially affecting the public with closures, detours, and disruptions. Increasing the resiliency of our vulnerable infrastructure may result in higher infrastructure costs, but those costs will likely be less than costs of repair and recovery from severe weather events. Congress provided \$12.4 billion in transportation funding for recovery from Super Storm Sandy, significantly more than what transportation agencies in New York spend on all transportation capital improvements across the state in a given year.

Sixty thousand miles of coastal roads in America are exposed to flooding from heavy rain and storm surges. Low-lying road infrastructure is particularly vulnerable to storm surges. During Hurricane Katrina in 2005, a 27-foot storm surge occurred along the Bay St. Louis coast in Mississippi, washing out roads, bridges, railroad tracks—and entire neighborhoods.

Even relatively small sea-level changes will increase the vulnerability of infrastructure, particularly in areas that are unaccustomed to flooding from storm surges. For example, infrastructure in San Francisco and New York

City may be more susceptible to damage from storm surges than cities in the Gulf Coast, where hurricanes occur more frequently and infrastructure has been designed to be resilient to the impacts of these storms.

Bridges, because they often cross or are near bodies of water, are vulnerable to storm surges. Powerful waves stress super- and sub-structures, causing bridge spans to shift or even be unseated. Storm surges may also cause debris, vehicles, and buildings to collide with bridges and marine facilities.

Low-lying coastal and tidal-river airports are likely to suffer infrastructure damage from increasingly intense storms and sea-level rise, both of which can contribute to greater storm surge. Thirteen of the 47 largest airports in America are within reach of moderate-to-high storm surges, including all three major New York-area airports. Serving a region of 1.3 million people, Louis Armstrong International Airport in New Orleans is the lowest-lying airport in America, at 1.7 feet below sea level. Increased frequency of severe weather will also decrease the overall reliability of air travel as airline operations are disrupted and delays ripple throughout our entire aviation system.

Like airports, rail yards are often located in low-lying areas near water. The proximity of rail infrastructure and rolling stock to shorelines makes them vulnerable to damage during and

after intense storms. Hurricane Katrina caused nearly \$90 million in damage to rail assets throughout the affected area, and Amtrak service east of New Orleans into Florida remains suspended almost 10 years later. In Vermont in 2011, Tropical Storm Irene damaged more than 200 miles of rail and six rail bridges, with total damage of more than \$20 million.

Ports are also vulnerable to storm surges. Severe storms and storm surges can damage infrastructure, equipment, and goods temporarily stored at ports, and can disrupt fuel supplies; this threat is particularly acute in areas in the Gulf and along the East Coast, where intense storms will likely become more common by 2045. In fact, seven of the 10 largest ports (by freight tonnage) are located on the Gulf Coast.

Storms can also create movements in sediment and debris that reduce the navigability of shipping channels. The Mississippi River-Gulf Outlet was closed to commercial shipping after its depth fell to 22 feet—restricting access for large vessels—following Hurricane Katrina. A two-foot rise in sea level could force a change in shipping routes, and might prompt huge new investments in modifying infrastructure to allow for vessel clearance. As an example, the Bayonne Bridge, which connects New Jersey with Staten Island, is currently being modified to provide additional clearance for the largest container ships at an estimated cost of \$1 billion.

The likelihood of increased flooding and storm-related power outages may impact energy transported by pipeline. Pipelines are generally constructed inland such that coastal flooding will not likely impact safety or the environment. However, pipelines located offshore and around the Gulf Coast could be subject to great stresses, making failure more likely.

A TWO-FOOT RISE IN SEA LEVEL  
COULD SUBMERGE MORE THAN  
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The burden of weather-related damage is borne mostly in the immediate area of a storm, but the effects are felt widely, as shipping and personal travel alike are disrupted. Given the connected nature of freight movement, delays in affected areas can have wide-reaching effects. Substantial public money has been dedicated to cleaning up damage from recent major storms, and such costs are expected to rise as the effects of climate change become more pronounced. Creating 'resilient' infrastructure is increasingly important in order to allow our transportation system to withstand and recover from weather events.

## Reducing Transportation Emissions

The effects of climate change on our transportation infrastructure are being felt today. We know that carbon emissions are a major cause of climate change, and that transportation is a major contributor to carbon emissions through the burning of petroleum-based fuels. So how is the transportation sector reducing carbon emissions?

Almost all (95 percent) of the world's transportation energy comes from petroleum-based fuels, largely gasoline and diesel, which are a major source of greenhouse gas emissions. Globally, transportation accounts for approximately 14 percent of all greenhouse gas emissions. In the United States, where per capita levels of driving are higher than in other countries, transportation directly accounts for 27 percent of all such emissions.

In 2012, American automobiles accounted for 10 percent of all the oil consumed in the world, but their global share is falling over time as oil consumption and automobile use increases in emerging markets, such as China and India.

# AIRPORT SEA LEVELS

Rising Sea Levels Will Disrupt Transportation



SEA LEVEL IS PROJECTED TO RISE UP TO 4 FEET (2100)

SEA LEVEL IS PROJECTED TO RISE UP TO 1 FOOT (2045)

Sea level rise makes all of these airports vulnerable to storm surges like those experienced during Superstorm Sandy, which exceeded 7 feet.

## U.S. DOT Funding Builds Resiliency in the Wake of Superstorm Sandy

In the coming decades, climate change will result in more frequent severe weather. At the same time, sea-level rise is already increasing the vulnerability of low-lying infrastructure to flooding from storm surges. Superstorm Sandy, for example, produced massive flooding that forced transportation agencies to suspend more than 40 percent of all transit service in America, primarily in the New York-New Jersey region.

Since Superstorm Sandy, America has made great progress in rebuilding its damaged transportation assets, particularly transit systems. However, to help prepare for the continued impacts of climate change and the potential for stronger storms, the U.S. DOT recently awarded \$3.59 billion in grants to 40 transit projects in areas affected by Superstorm Sandy. These projects include resilience work such as sealing street-level vents and manholes; protecting underground pump rooms; and shielding underground facilities that deliver power throughout the subway system. While many of these projects will be invisible to riders, they will help the New York-New Jersey region withstand more frequent and severe storms. In the long term, these proactive projects will also save taxpayer dollars in repairs to transit services if and when another storm hits.

Although these disaster relief funds are concentrated in the Northeast, the wide-ranging impacts of Superstorm Sandy demonstrate the tremendous scale of the transportation investment needed nationwide. Beyond transit, severe flooding and storm damage also threaten highways, tunnels, rail lines, airports, and other critical assets across the nation. In order to improve the resilience of the transportation system, agencies must not only recover from the last storm, but also rebuild to withstand the next one.

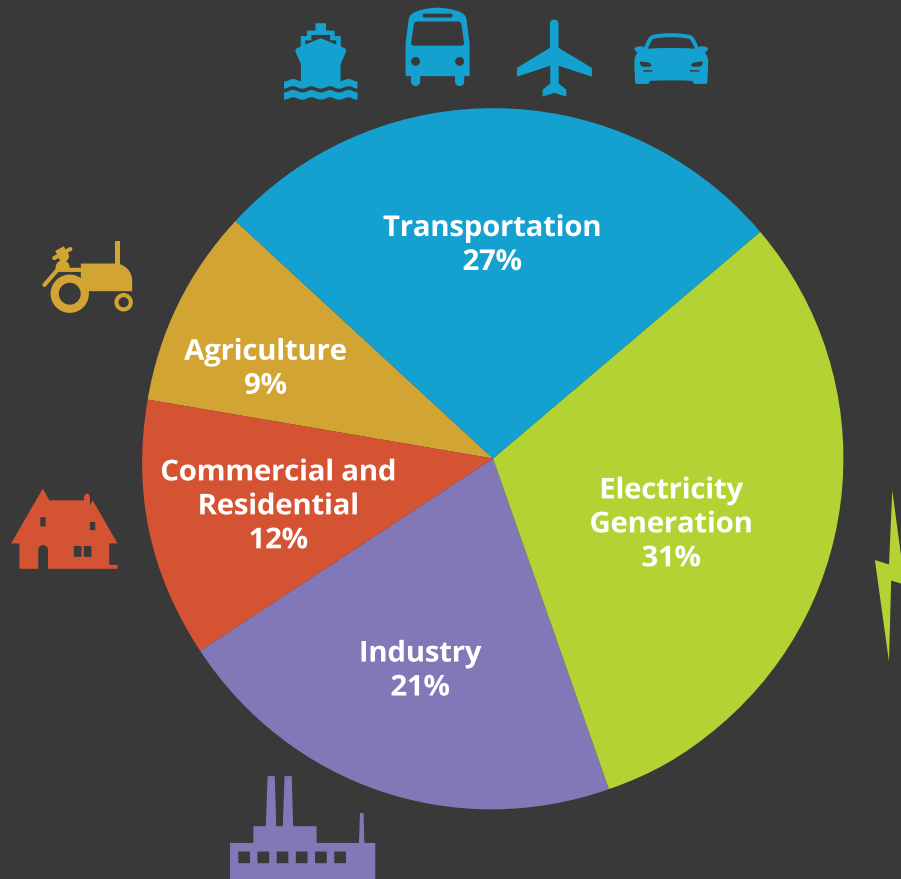
## Fuel Efficiency

Corporate Average Fuel Economy (CAFE) standards have had a significant positive impact on the fuel efficiency of light-duty vehicles. First enacted by Congress in 1975, CAFE standards reduce energy consumption by increasing the fuel economy of cars and light trucks. When first enacted, these standards raised the fuel economy of light-duty vehicles significantly, but the standards remained unchanged for nearly 25

years. The standards were updated in 2011 and they are now scheduled to rise from 32.7 miles per gallon in 2012 to the equivalent of 54.5 miles per gallon by 2025.

The automobile industry has already taken steps to meet the new CAFE standards earlier than required by the regulations. Approximately 28 percent of light-duty vehicles sold in 2013 met the most stringent greenhouse gas targets for 2016, accelerating efforts to reduce carbon

# U.S. Greenhouse Gas Emissions by Sector in 2014



emissions and the pace of climate change. Of course, these standards apply to new vehicles only, so the effect on the average emissions of all cars on the road is a function of the number of new cars on the road. At current rates of sales, turnover of the U.S. fleet would take approximately 14 years.

Heavy trucks account for 22 percent of transportation greenhouse gas emissions and diesel-related emissions have more than doubled over the past 30 years. This is more than three times the rate of increase for cars and light trucks. Increases in truck emissions outpaced increases in truck ton-miles, meaning that truck freight movement actually became less energy

efficient. This occurred despite improvements in engine efficiency, trailer aerodynamics, and truck tires. Operational factors, such as the growth in small, just-in-time shipments, and increasing congestion and idling, might explain some of the loss in efficiency.

Greenhouse gas and fuel efficiency standards were expanded to cover medium- and heavy-duty trucks in 2012. By 2018, new combination trucks will be required to achieve a 20-percent reduction in fuel consumption and greenhouse gas emissions. In August 2016, NHTSA and the EPA extended and tightened standards for medium- and heavy-duty trucks model years to the year 2027.

Transportation modes other than vehicles—including rail, aviation, pipeline, and maritime—make up the remaining 17 percent of transportation sector greenhouse gas emissions. Aviation activities accounted for 8 percent of domestic transportation-related greenhouse gas emissions.

Commercial airlines achieved efficiencies by improving the fuel economy of their fleet and increasing the number of passengers per flight. The FAA is working with industry to accelerate the development and commercial deployment of environmentally promising new aircraft and engine technologies. Improvements to the design of aircraft and aircraft engines will likely continue to improve their energy efficiency. When fully implemented, NextGen will allow planes to fly more direct routes, further improving efficiency and reducing emissions.

Other modes have also reduced emissions. Stricter regulatory requirements have been enacted for maritime emissions. Marine vessels and rail locomotives have adopted more energy efficient engines and designs. The energy efficiency of trains has increased by 50 percent since 1980 and will likely continue to increase as railroads put more efficient locomotives into service and make operational improvements.

Curbing emissions of methane is critical to our overall effort to address global climate change. Methane currently accounts for roughly 9 percent of domestic greenhouse gas emissions and has a global warming potential that is nearly 25 times greater than carbon dioxide. Methane is a primary component of natural gas and leaks in natural gas distribution pipelines are a significant source of methane emissions. These leaks are most likely to occur from damage and corrosion of older pipelines made from cast iron and unprotected steel. Currently, there are more

than 90,000 miles of gas distribution mains made from these materials. Improving the monitoring of methane emissions and replacing aging and leaking pipes is critical to reducing methane emissions from natural gas pipelines.

Over the next 30 years, higher regulatory standards are expected to spur continued improvements in fuel efficiency for cars and trucks. In recent years, high fuel prices have given individuals and private firms strong incentives to purchase vehicles with better fuel economy. But if gas prices decline in the coming decades, will regulatory standards need to be strengthened? Additional government policies or regulations could provide stronger incentives to accelerate the development and adoption of energy-efficient transportation.

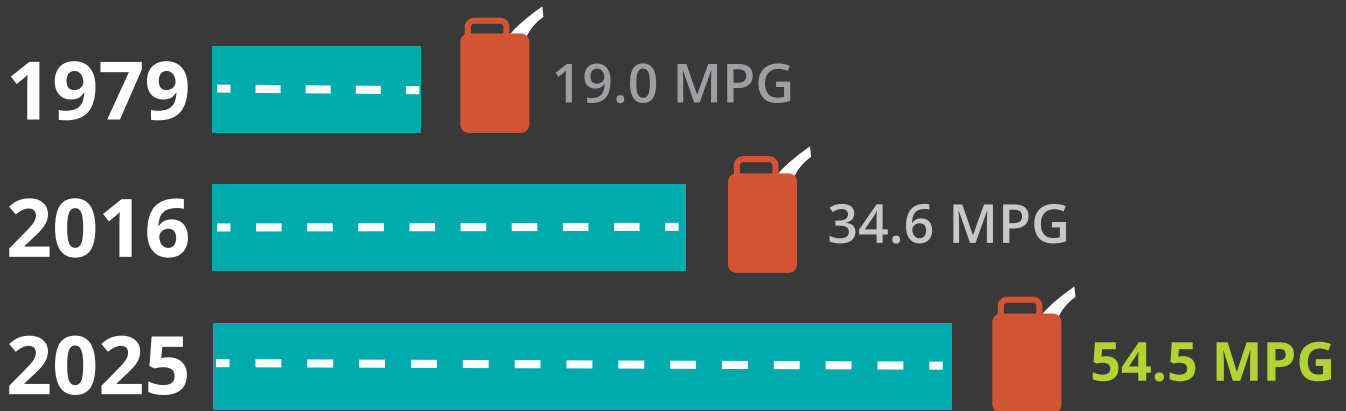
## Alternative Energy for Transportation

In recent years, a number of 'alternative' fuels, many of which emit fewer pollutants than do petroleum-based fuels, have emerged as economically competitive alternatives. These include biomass fuels, natural gas, and hydrogen. In addition, hybrid vehicles are increasingly popular, and plug-in electric vehicles are breaking into the commercial market.

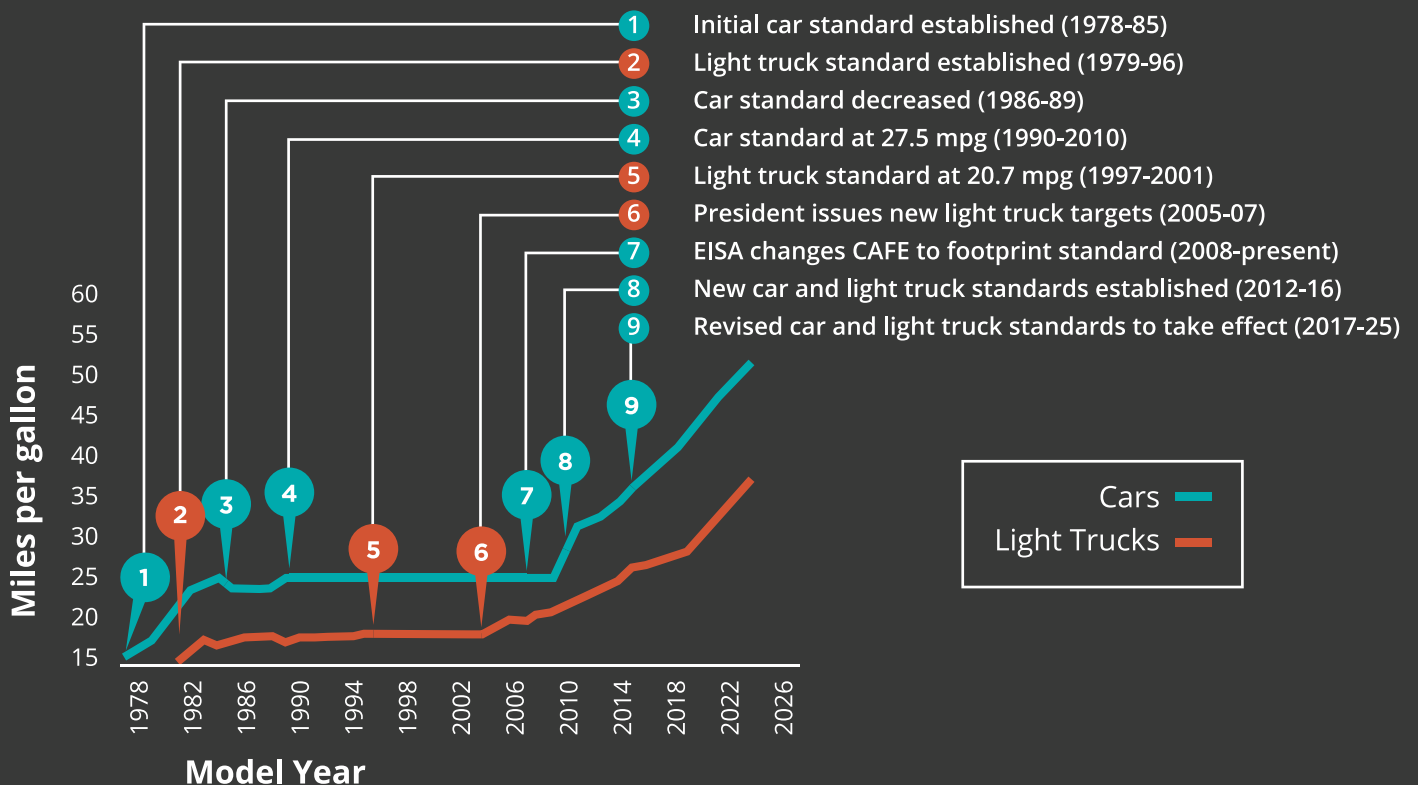
Advances in technology, volatile oil prices, public concern about climate change, and expanding recharging/refueling infrastructure have increased the market appeal of alternative fuel, hybrid electric, and all-electric vehicles. The use of alternative fuels in all modes is gradually increasing. Aggressive investment and innovation could reduce the use of conventional gas and diesel combustion engines to less than 10 percent of the passenger vehicle market by 2045.

# FUEL EFFICIENCY

New stronger fuel economy standards will double the efficiency of our cars and trucks. Corporate Average Fuel Economy Standards have saved 14 billion tons of CO<sub>2</sub> emissions since 1970.



## New Standards in Fuel Efficiency: Milestones





## Hybrid and Plug-In Electric Vehicles

Hybrid electric vehicles were successfully introduced into the passenger car market in the late 1990s. Hybrid vehicles use regenerative braking and an internal combustion engine to charge a battery. They are significantly more fuel efficient than are non-hybrid vehicles, and increasingly popular with the public. The fleet of hybrid electric vehicles in the United States is the largest in the world. Approximately 384,000 hybrid vehicles were sold in 2015; one in every 35 light-duty vehicles sold was a hybrid or plug-in electric vehicle.

Plug-in electric vehicles run on electricity stored in rechargeable battery packs. Currently, plug-in electric vehicles take 4 to 6 hours to recharge with a typical charger and their range between charges is limited by their battery storage capacity. Typically, electric cars can travel approximately 100 miles on 30-40 kilowatt hours of electricity, the equivalent of more than 100 miles per gallon. Some high-end commercial plug-in vehicles can travel as far as 300 miles on a single charge.

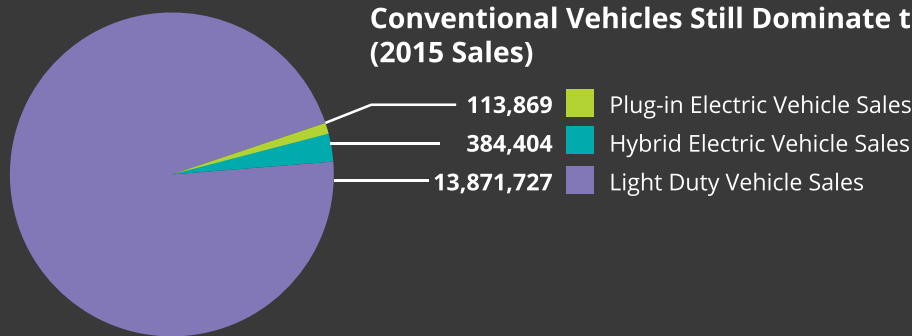
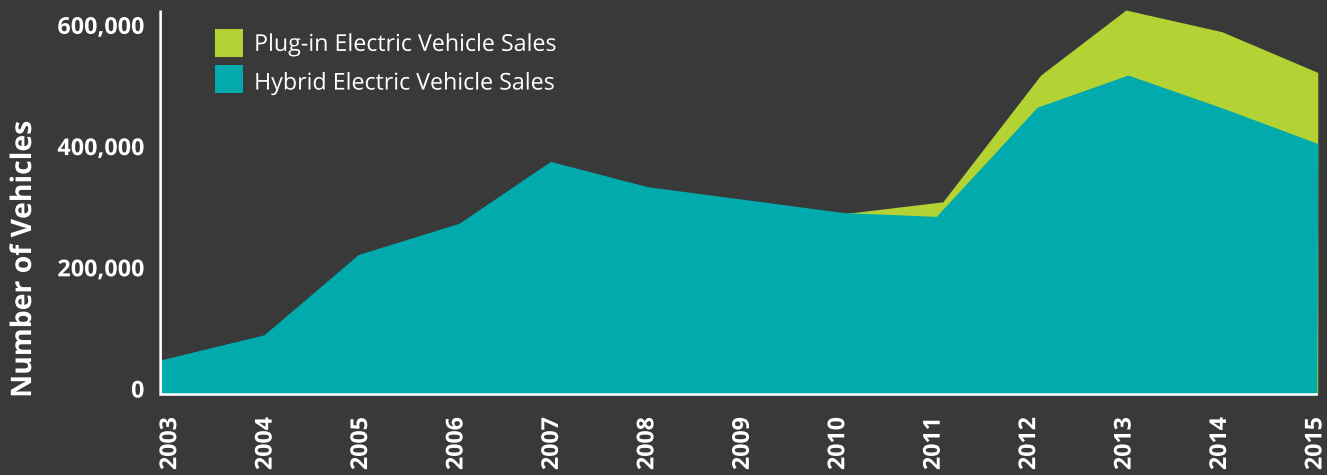
Due in part to their lower market share, electric and hybrid vehicles cost more to purchase than conventional fuel vehicles, although they can offer potential operational savings, since they do not require gasoline. Improvements in battery storage capacity, recharging time, and durability will almost certainly expand the market for electric vehicles. To be a widely viable transportation mode, however, plug-in electric vehicles require investments in recharging infrastructure, akin to our current network of gas stations. Transportation agencies at all levels of government are acting to accelerate the adoption of electric vehicles by supporting research, infrastructure, and fleet and consumer adoption.

CO<sub>2</sub> EMISSIONS FROM COMMERCIAL AIRCRAFT ROSE BY 3 PERCENT BETWEEN 1990 AND 2012, WHILE THE NUMBER OF U.S. CARRIER AIRCRAFT DEPARTURES INCREASED BY OVER 40 PERCENT OVER THE SAME PERIOD.

The number of electric vehicle charging stations has increased rapidly since the 2010 introduction of plug-in electric vehicles. Today, there are more than 16,000 electric vehicle charging stations in the United States. For overnight charging, electric vehicle owners, unless they are relying entirely on workplace charging, generally need to have ready access to an outlet (or 240-volt battery charger) and parking spot. In most areas of the country, this means access is limited to single family or townhomes rather than apartments or condos, although many state initiatives have begun to foster charging and parking solutions for multi-family housing.

Electric vehicle motors are more efficient than internal combustion engines and produce no emissions at the tailpipe, but the environmental benefits of electric vehicles depend, in part, on the source of their electricity. Although electric vehicles produce no tailpipe emissions, the electricity on which they run is produced by power plants, which vary considerably in their carbon intensity. According to the EPA, coal-fired plants are among the most carbon-intensive sources of electricity and are the source of 39 percent of the electricity generated in the United

# Hybrid and Plug-In Electric Vehicle Sales



States. In regions that depend on coal-fired plants for electricity, the use of electric vehicles may not result in significantly lower carbon emissions.

## Biofuels

Biofuels can be used to power every mode of transportation. Bioethanol can be produced from corn, sugar cane, sugar beets, and other cereals. Biodiesel can be manufactured from vegetable oils, animal fats, or recycled restaurant grease. Ethanol, the most popular biofuel, was blended into gasoline as early as the late 1970s. In 2014, about 13 billion gallons of ethanol were added

to the gasoline consumed in the United States, making up approximately 10 percent of all domestic gasoline consumed that year.

Producing ethanol and certain other biomass fuels requires the use of machinery, fertilizers, and land clearing, all of which can lead to increased carbon in the atmosphere. Depending on the feedstock and production process, some biofuels can emit even more greenhouse gas than some fossil fuels. Ethanol derived from food crops, such as corn, can lead to higher global food prices. Currently, biofuels require subsidies and other market interventions to compete economically with petroleum and natural

## **FHWA Establishes Electric Vehicle Charging Corridors**

In the past eight years the number of plug-in electric vehicle models has increased from 1 to more than 20, battery costs have decreased 70 percent, and we have increased the number of electric vehicle charging stations from less than 500 in 2008 to more than 16,000 today—a 40-fold increase.

In 2016, the Federal Highway Administration (FHWA) established a national network of “alternative fuel” corridors spanning 35 states plus the District of Columbia. Forty-eight interstates were established electric vehicle charging corridors, totaling almost 25,000 miles of electric vehicle routes in 35 states. To make it easier for drivers to identify and locate charging stations, states designated as “sign-ready” are authorized to use signs developed by FHWA that identify electric vehicle charging stations and other alternative fuels along the highways similar to existing signage that alerts drivers to gas stations, food, and lodging. In these corridors, drivers will be able to expect charging stations every 50 miles.

gas-based fuels. Today, most ethanol is derived from corn and cane sugar; however, research is underway on the conversion of non-food-based crops such as crop residue (e.g., corn stalks), switch grass, and algae that are believed to have greater potential to reduce greenhouse gas emissions.

## **Hydrogen**

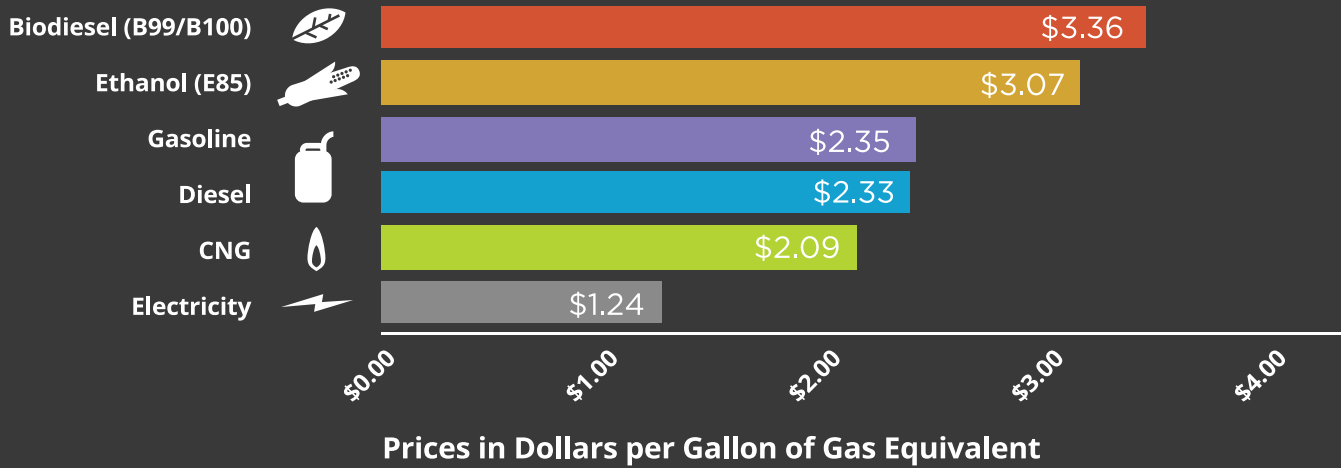
Hydrogen fuel-cell vehicles produce no tailpipe greenhouse gas emissions and are highly efficient. Unlike electric vehicles, they can be quickly refueled. Toyota recently announced that it will begin selling cars powered by hydrogen fuel cells in Japan. However, for hydrogen to become a viable fuel source for passenger and freight vehicles in the United States, it would require significant investments in production, distribution, and refueling infrastructure. Technical challenges for safely storing fuel and producing affordable fuel cells remain, and hydrogen, like biofuels, requires energy to produce. To encourage automakers to produce

vehicles and reduce statewide auto emissions, California has recently begun investing millions of dollars to establish hydrogen fuel cell stations throughout the state. As with biofuels, research is underway to overcome challenges to the economic viability of hydrogen-fueled vehicles, as well as to study uses of hydrogen in the marine industry.

## **Liquid and Compressed Natural Gas**

Liquid and compressed natural gas (CNG) are fossil fuels, but they burn cleaner than conventional gasoline or diesel due to their lower carbon content. The recent natural gas boom has reduced liquid natural gas (LNG) prices significantly, so that the price of LNG is now approximately half the price of diesel. As a result, natural gas vehicles have become an increasingly attractive alternative, particularly for centrally fueled fleets that operate within a limited area. Public transit agencies have already invested heavily in CNG vehicles and infrastructure. In

# Alternative Fuel Prices in October 2015



In addition, some private trucking and delivery firms have begun to invest in natural gas vehicle fleets. United Parcel Service now has more than 2,000 natural gas-powered delivery trucks in its fleet.

Other transportation modes and industries could also adopt compressed natural gas as a primary fuel, and may eventually do so. Locomotives that have been converted to natural gas are currently being tested by several U.S. railroads. However, converting any type of vehicle fleet to natural gas requires significant investment and is not without risk and complication, including the fact that existing fueling infrastructure is limited. Furthermore, similar to the production of biofuels, the extraction of natural gas can also

result in significant methane leakage (a major contributor to climate change) and cause water pollution.

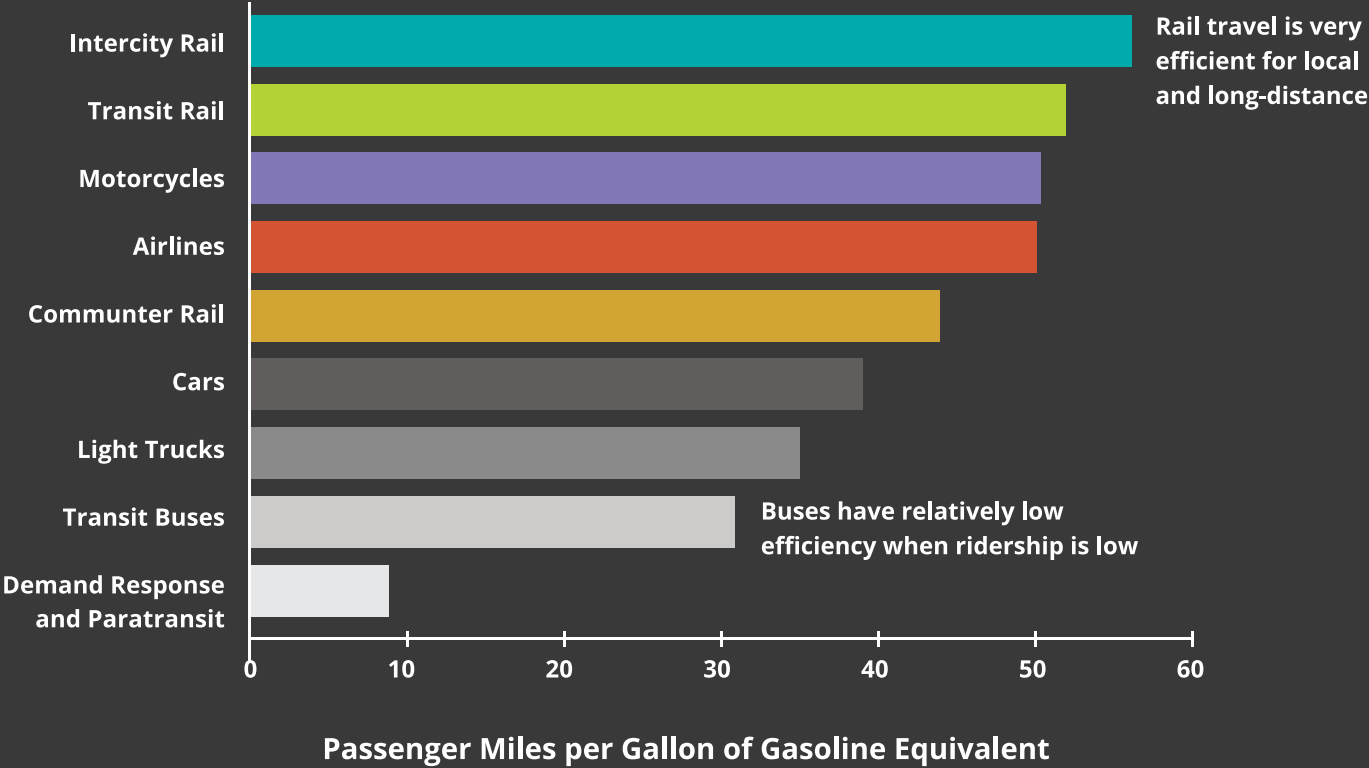
The use of natural gas for the propulsion of marine vessels is beginning, at least in part, as a result of strict international maritime regulations requiring the reduction of maritime emissions. At present, the American domestic maritime industry is building vessels that will be powered by LNG.

## Reducing Dependency on Cars

Over the past decade, many communities throughout America have adopted policies to encourage Americans to reduce carbon emissions by driving less. Although they are not viable options for every trip, walking and bicycling burn no fuel. Freight rail is significantly more efficient per ton-mile than truck haulage and other freight modes, and transit options are often more efficient per passenger mile than driving alone. In general, transit options become more efficient the more people they carry.

IN 2014, ONE IN FIVE TRANSIT BUSES USED COMPRESSED NATURAL GAS OR LIQUID NATURAL GAS.

# Fuel Economy by Mode



Increased use of these modes as an alternative to driving could lead to a reduction in carbon emissions levels.

Today, however, the use of alternative modes of transportation is often not a viable alternative for many trips. Limited facilities and services for alternative modes, and a legacy of auto-oriented planning and design in many cities, make shifting travel demand to more energy-efficient modes challenging. A lack of sidewalks and bike paths in many communities can make walking and cycling feel unsafe—even for short trips. While more Americans than ever live in metropolitan areas, only slightly more than half of all Americans have access to public transit. Intercity rail is a competitive alternative to flying or driving in only a few corridors.

Many Americans live in suburban areas and less dense cities where homes, jobs, schools, and services are spread out. Less dense settlement patterns can make it difficult to walk and cycle to destinations. It can also be more expensive to provide transit services in less dense communities. Major expansions of rail and public transit systems can cost billions of dollars. As transit services have expanded over the past decades to less dense cities such as Los Angeles and Atlanta, and into rural areas, transit, as a whole, has become less fuel efficient and more carbon intensive. Local zoning and development policies often encourage less dense development, raising the cost of transportation infrastructure and services, and discouraging the use of alternative modes.

Some communities have found ways to provide viable alternatives to driving by providing better bicycle lanes, wider sidewalks, and new public transit options. Others have found ways to coordinate land-use and transportation planning, adopting “smart growth” and sustainable development policies that support walking, cycling, and other less carbon-intensive transportation modes. Strategies that support mixed-use development and multiple transportation options and discourage sprawling development patterns can enable travelers to reduce trip lengths and frequencies, and select more carbon efficient means of travel.

Policies could be adopted to influence freight mode choices. Rail and water transportation are significantly less carbon intensive than transportation by truck. Policies that restrict transportation by truck or make it more expensive, or that increase subsidies to rail or maritime freight, could make these less carbon intensive modes more economically competitive. For example, it is estimated that major investments in rail capacity expansion could increase rail tonnage by 10 to 20 percent, potentially reducing carbon emissions by shifting freight from trucks.

## Policy Implications

Our climate is changing as a result of human activity, especially the consumption of fossil fuels. Scientists predict that some effects of climate change may be so profound as to be irreversible. The actions of policymakers today—in the transportation sector and other parts of society and the economy, particularly the production of energy and industrial production—will play a large role in determining the climate impacts of our future.

U.S. DOT'S 2014 CLIMATE ADAPTATION PLAN DESCRIBES THE ACTIONS U.S. DOT WILL TAKE TO ADDRESS POTENTIAL CLIMATE IMPACTS, INCLUDING INCORPORATING CLIMATE VARIABILITY AND CHANGE IMPACT CONSIDERATIONS IN ASSET MANAGEMENT SYSTEMS, AND ENSURING THAT TRANSPORTATION PLANS AND PROJECTS ADDRESS POTENTIAL CLIMATE IMPACTS IN ORDER TO PROTECT FEDERAL INVESTMENTS.

The transportation system uses vast amounts of petroleum, and vehicles and equipment of all types emit carbon-based pollution that is damaging our atmosphere. As much as it is a cause, our transportation system can also be a casualty of climate change. Reducing greenhouse gas emissions from transportation could help to avoid further effects of climate change. At the same time, we need to prepare for the major impacts climate change will have on our transportation system.

Governments at all levels are beginning to adopt policies to try to slow and adapt to climate change. They are incorporating climate change goals in their transportation plans and adopting strategies to make transportation systems more resilient to severe weather and sea-level rise. At the federal level, multiple agencies are investing

in research and developing guidance and policies to address climate change. Increasing federal fuel efficiency standards for cars and trucks is helping to reduce emissions in the transportation sector.

We know that vehicles are becoming more efficient, through a combination of technological improvements, regulation, fuel changes, and behavioral changes. Over the next three decades, higher fuel efficiency standards, changes in consumer behavior, and the adoption of alternative fuels in the U.S. transportation sector are expected to reduce overall greenhouse gas emissions by nearly 10 percent relative to current levels. In the United States, much more could be done to support fuel efficiency improvements, encourage the development and adoption of alternative fuels, and support shifting travel to more fuel-efficient modes. But real success in decreasing greenhouse gas emissions globally will require a concerted push of international diplomacy to address this global problem.

Policy options to reduce transportation sector greenhouse gas emissions include:

- Investing in alternative fuel research and infrastructure and the development of fuel efficient technologies.
- Subsidizing the purchase of electric and alternative-fuel vehicles.
- Pricing carbon emissions.
- Supporting pricing and operational strategies that reduce congestion on roadways.
- Increasing and extending fuel-efficiency standards across all modes.
- Supporting zoning and development policies that discourage sprawl.
- Encouraging companies to adopt telework policies.
- Investing in transit, rail, and maritime infrastructure to support mode shifts.

- Increasing international government-to-government engagement to pursue joint commitments to control greenhouse gas emissions.

It is becoming clear that climate change will have significant impacts on our current transportation infrastructure and on the ways we plan for our infrastructure of the future. Planners making decisions about infrastructure intended to last 50 or more years need to start planning for climate change today. This could require making difficult choices about how and where to invest resources to harden critical infrastructure and build system resilience to withstand severe weather events.

Policy options for adapting to climate change include:

- Integrating climate change considerations into asset management and transportation plans.
- Strengthening or abandoning infrastructure that is vulnerable to flooding.
- Setting higher standards for the resilience of yet-to-be constructed infrastructure.
- Adding redundant infrastructure to increase system resiliency.
- Promoting zoning, insurance, and disaster recovery policies that discourage development in vulnerable areas.

These policy options are explored in further depth in the conclusion of this report.

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# HOW WE MOVE BETTER

## Introduction

Over the next 30 years, advances in data collection, computing, navigation systems, communication and mobile technologies, and robotics have the potential to dramatically change the way we travel and deliver goods and services. Technologies emerging today promise to make our future transportation system safer, more reliable, more efficient, more environmentally sustainable, and more convenient. Many of the most transformative technology applications for transportation have been developed in other sectors and for other purposes. One magazine recently declared the smartphone the “most important transportation innovation of the decade.”

Governments have provided essential contributions through research, regulation, and policy to support the development of a number of technologies important to transportation, such as GPS, the Internet, and fuel-efficient vehicles, vessels, and aircraft. These inventions have boosted the American economy, creating jobs for American workers and improving our quality of life. Still, governments are often perceived as “behind the curve”—too slow to adopt promising technologies, and imposing unwarranted barriers on beneficial innovations.

As technology continues to advance, governments will need to anticipate, accommodate, and accelerate innovation. At the same time, as new technologies increase our reliance on ever more sophisticated and complex systems, governments will need to understand

and mitigate the risks associated with new technologies to ensure that our transportation system remains safe, secure, and accessible.

This section summarizes broad, crosscutting technological trends that are transforming transportation.

## Breakthroughs in Tracking and Navigation

GPS, initially developed for the military, is now used by transportation users, from drivers to cyclists to ocean-going cargo vessels, to access accurate location, timing, and navigation services. With the strong support of the federal government, positioning, navigation, and timing services have become widely available.

America’s GPS is no longer the only Global Navigation Satellite System (GNSS)—Russia’s GLOSNASS is operational and Europe’s Galileo soon may be. Nations such as China, Japan, and India are planning their own systems. Private systems combine other data sources, such as cell-tower locations and Wi-Fi signals, to provide location information. Future travelers will be able to access many of these systems from the same device, enabling speedier and more accurate location fixes, while providing some measure of redundancy. Today, GPS provides positioning, navigation, and timing information to all takers.

GPS is increasingly yielding benefits for transportation. For example, it allows drivers to choose routes based on prevailing traffic conditions, and allows public transit users to

know when the next bus or train is arriving. Fleet managers of freight companies, public transit systems, and school buses are able to track vehicles in real time, maximize vehicle utilization, and select efficient, reliable routes. Applied to aviation, GPS can help pilots navigate, and allow planes to fly more efficient routes more safely. In marine transportation, it improves the efficiency and security of ports by allowing for the identification and tracking of vessels and containers. Rail systems use GPS for asset management, tracking, and positive train control. For truck safety enforcement, GPS allows inspection sites to be mobile. In the future, GPS may play a large role in enabling the deployment of connected and automated vehicles and payment systems, which are discussed below.

## An Era of Big Data

Data collection and analysis will become cheap and widespread. The information that agencies and companies need to make transportation decisions has never been easier to acquire, understand, and use. The billions of machines networked together by the Internet are constantly generating data, much of which can be useful to all types of transportation agencies, as well as freight and logistics companies.

Emerging data sources and tools have the potential to improve how public agencies make investment and operational decisions, how standards are set and engage the public. For example, mobile applications can allow citizens to report potholes allowing local agencies to quickly respond to road maintenance needs. Sensors on transit, taxi, and truck fleets can monitor where vehicles drive, how fast they are being driven, and when maintenance is required. The same technologies can be applied to planes, trains, and vessels.

IN A “BIG DATA” WORLD, PUBLIC AGENCIES WILL NEED TO DEVELOP THEIR CAPACITY TO COLLECT, STORE, ANALYZE, AND REPORT DATA.

Among their many uses, GPS and smartphones enable automatic no-hands tracking, replacing the frequent written journal entries traditionally used by shippers and carriers. Data can be collected from commercial providers, or volunteers across all modes, even biking and walking. License plate scanners and wireless signal detection can collect the data needed to model traffic movement and demand at lower costs and higher volumes than traditional, manual methods. Today, many police forces use license plate scanners to search for stolen vehicles or vehicles that have failed to maintain license registration or insurance.

Data are increasingly easy to share and use, thanks to open-source software and open-data standards. For example, it is now commonplace to share transit schedule and route information, making it possible for software developers and researchers to work with transit agencies across the globe. Defining the public sector’s role in collecting, formatting, and sharing data will require input and support from stakeholders and potential beneficiaries.

New techniques for collecting and sharing real-time information are already being used to improve convenience and mobility for transit and vehicle travel. Real-time vehicle location data enables arrival time prediction apps for transit systems, which allow riders to time their arrival to a transit stop to when the bus or train will actually arrive. Apps using real-time traffic data

allow vehicle drivers to change their routes on the fly to avoid congestion or traffic crashes.

The increasingly widespread use of GPS and networked data collection devices also raises serious privacy concerns. Data security and privacy will continue to be concerns that may limit transportation applications. Freight companies, airlines—anyone who keeps information private to retain a competitive advantage—may be reluctant to release their data. Regulators, researchers, and other data users will need to establish agreements and systems to protect certain data. If agencies want to continue to use information collected from individual travelers, it will be critical to continue to remove characteristics from data that would allow for personal identification of individuals. Malicious thefts or inadvertent releases can erode public trust and make it difficult or impossible to use modern data science.

## Fast and Easy Payment

Payment will be easy, frequent, and inexpensive. Collecting user fees to fund transportation has often been a cumbersome process, whether it has involved public transit users converting change to tokens, or vehicle drivers stopping at booths to pay highway tolls. New payment and fee collection technologies are reducing queuing for collection, increasing the efficiency of collection, and allowing user fees to move toward reflecting true user costs.

These technologies can take many forms. Built-in and standardized hardware radio tags for vehicle tolls and swipe cards for transit riders have been implemented across the country, but require users to install dedicated hardware. Seamless payment that uses smartphone apps or license-plate readers are beginning to roll out, and are becoming popular with both users and

## THE WIDESPREAD ADOPTION OF TRAVELER INFORMATION SYSTEMS IS MAKING TRAVEL EASIER AND MORE CONVENIENT.

implementers. Public agencies are developing ways to ensure that low-income people, who are less likely to own a smartphone or have a bank account are able to benefit from these advances in payment technology.

New methods of payment will enable transportation agencies to develop more targeted user-fee-based revenue streams. It is now technically feasible for a transportation agency to charge individual road users for their use of infrastructure and their contributions to congestion, emissions, and wear and tear on roads by using GPS applications, smartphones, image-recognition software, and automated payment systems. In comparison, fuel taxes, sales taxes, and general-fund revenues are crude instruments, and physical toll infrastructure has significant costs of collection. To alleviate privacy concerns and incentivize voluntary citizen participation in more efficient and targeted automated payment systems, transportation agencies could use incentive-based programs, similar to auto insurance programs that offer discounts to drivers who use devices that track how safely they appear to drive.

## There's an App for That

The vast majority of Americans now have access to the Internet; 64 percent of all Americans, and 85 percent of Americans ages 18-29 now own a smartphone. Two-thirds of all smartphone owners use their phones to navigate while driving; one in four use their phone to get public

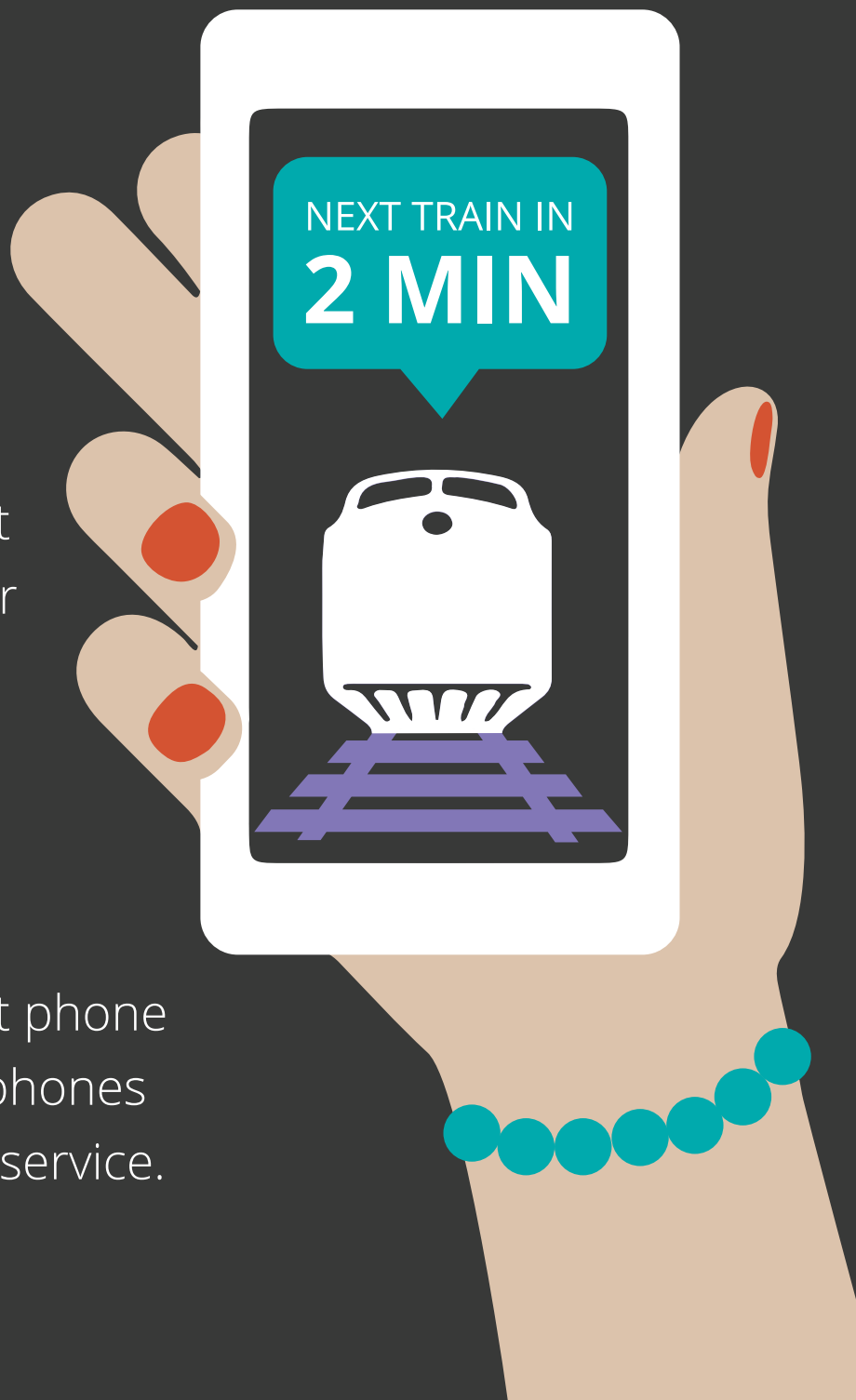
# REAL-TIME TRAVELERS

Mobile access to everything from **traffic data** to **transit schedules** informs our travel choices.

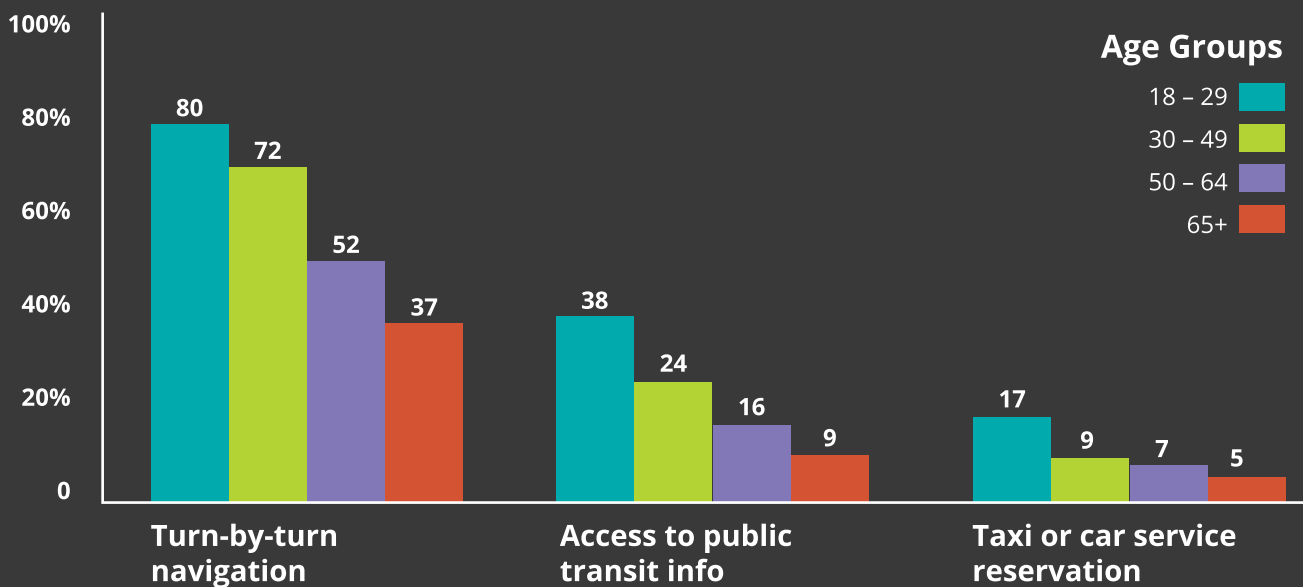
**68%** of American adults own a smart phone.

**67%** of smart phone owners use their phones' turn-by-turn navigation.

**28%** of smart phone users have used their phones to reserve a taxi or car service.



# Smartphone Use in Transportation by Age Group in 2014



transit information. Many vehicles are equipped with on-board computers and GPS navigation systems. These systems can be used to access detailed maps, real-time travel conditions, and up-to-the-minute service schedules that help travelers make decisions about how, when, and where to travel.

The relative openness of major smartphone platforms has allowed developers to release applications useful across all modes. A range of tasks—from obtaining walking directions to the nearest bus stop, to hailing taxis—is made easier due to the widespread adoption of smartphones. Mobile-phone apps are being used by public agencies to monitor air and vessel traffic and infrastructure conditions. Freight companies use mobile phones and tablets to log driver hours and monitor packages. Phone-based location data are used to collect and provide real-time information on traffic conditions. Smartphones are increasingly being used to make or certify payments for transportation services.

## Desktop Manufacturing

3D printing has the potential to disrupt traditional supply chains and counteract the growth of imports by reducing the need for large-scale manufacturing, transportation, and storage services. 3D printing is a groundbreaking technology that allows manufacturers to render three-dimensional objects from a digital file with great precision using a laser or an extruder to build an object layer by layer. Engineers have been using 3D printers for more than a decade, but 3D printers are now becoming more precise and more amenable to using a broader range of materials. Desktop 3D printers have been made commercially available and their costs are dropping, leading to more widespread consumer use. 3D printers could make it possible to manufacture customized products and parts more quickly and inexpensively.

Just as online shopping now makes it possible for companies to bypass traditional storefronts, 3D printing will allow for more localized production



and decentralized manufacturing. It may also lead to an increase in the delivery of raw materials for 3D manufacturing. In the service parts industry, 3D printing may result in decreasing shipments of finished parts. In health care, 3D printing is being used to manufacture customized hearing aids, braces, and even artificial limbs. The potential effects of 3D printing on certain industries—electronics, automobiles, and medicine—are great, but the future of such a novel technology is difficult to predict. Continued advances in 3D printing could impact freight transportation by shortening supply chains for high-value, urgent products, potentially reducing demand for air freight in particular.

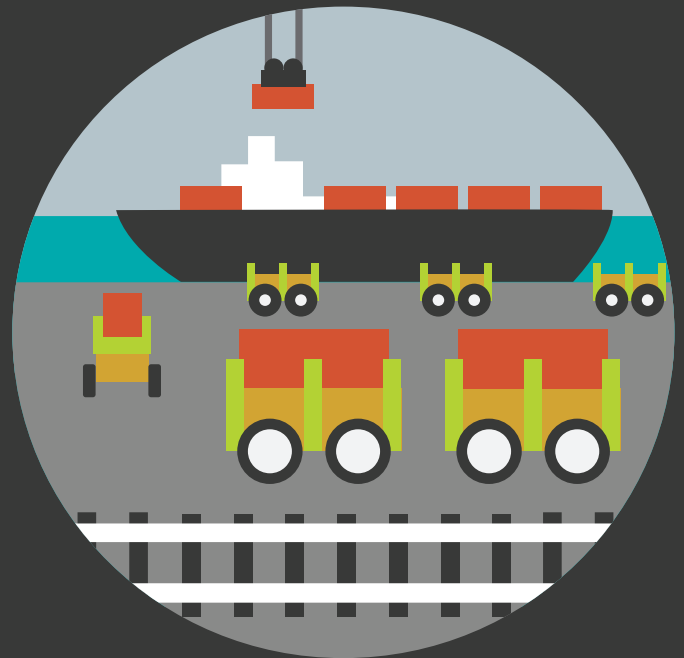
## Robotics and Automation

Robotics research is advancing across all transportation modes. Advances in robotics are useful in many broad applications. An algorithm that uses camera feeds to detect humans may have been developed to protect factory workers, but can be just as useful when applied to security cameras on a transit platform, or to the sensors on an automated vehicle. Billions of dollars in military, commercial, and academic research have brought about unmanned, commercially available aerial and ground vehicles and watercraft. Robotics and automation research is poised to change much of how transportation functions.

The advent of automated ground vehicles can change the way transportation agencies perform operations and maintenance, and deploy fleets and utility vehicles. Many tasks associated with construction, and road operations and maintenance, can be performed by either automated vehicles or remotely operated vehicles. Automated

# ROBOTICS

Advances in robotics are changing transportation operations and will impact the **future transportation workforce.**



Robots will perform vital transportation functions, such as critical infrastructure inspection.

climbing robots for aviation radio towers, autonomous railroad track measurers, and fully autonomous pipeline inspection gauges are all under development, with some already available commercially.

Automation will have a potentially transformative impact across all transportation modes, increasing productivity, improving safety, and enhancing the capacity of existing infrastructure. It will also have a profound impact on the transportation workforce, changing the skills required to manage, operate, and maintain transportation vehicles and systems. The applications and effects of automation and other technological advances on the transportation system are described in greater detail below.

## Modal Advances

### AVIATION

The Next Generation Air Transportation System (NextGen) is beginning to modernize air traffic control nationwide. The Federal Aviation Administration (FAA) controls and regulates the national airspace system. NextGen is an upgrade from the earlier ground-based radar navigation system to satellite-based navigation technology that is expected to make aviation safer and more efficient. Although NextGen is a long-term and complex undertaking, we are already witnessing significant benefits from it—giving pilots and controllers more flexibility at certain airports, reducing wake-based separation standards at others, and reducing congestion in some busy metro areas.

Many of these gains will be enabled by new technologies, policies, and procedures, such as systems to coordinate information exchange, and GPS-based aircraft surveillance and

communications to improve safety. The use of GPS-based systems will greatly improve the precision of air traffic control operations. Aircraft will be routed to more direct and more efficient paths between origins and destinations and will be able to fly more closely spaced, reducing congestion and delays caused by congestion, and improving efficiency. Onboard digital communications equipment will improve communications between the cockpit and air traffic control and allow for enhanced information accessibility. Improved air navigation procedures are already being rolled out which allow aircraft to use less fuel, saving airlines and consumers money and reducing emissions.

Even as FAA finishes installing the foundational infrastructure necessary to enable digital communications and optimized routing that are yielding tangible benefits to air travelers, challenges remain to complete the roll out of NextGen. A key challenge is coordinating among numerous stakeholders from manufacturers to airports, to commercial carriers and international partners. Many of the major technological element of NextGen require airlines to make voluntary investments in equipment. Cooperation among stakeholders is needed to set standards, develop technologies, and make the investments necessary to achieve promised benefits. Past budget uncertainty has affected FAA's ability to implement NextGen leading to delays and raising questions from industry partners. Finally, cybersecurity issues also present an ongoing technical challenge that FAA has sought to address by integrating cybersecurity risk management activities throughout its NextGen research, development, and deployment activities.

Commercial space transportation will become available to the public. Wealthy individuals have

been able to purchase seats on the Russian Soyuz for many years, but flights are infrequent, cost millions of dollars, and require months of training.

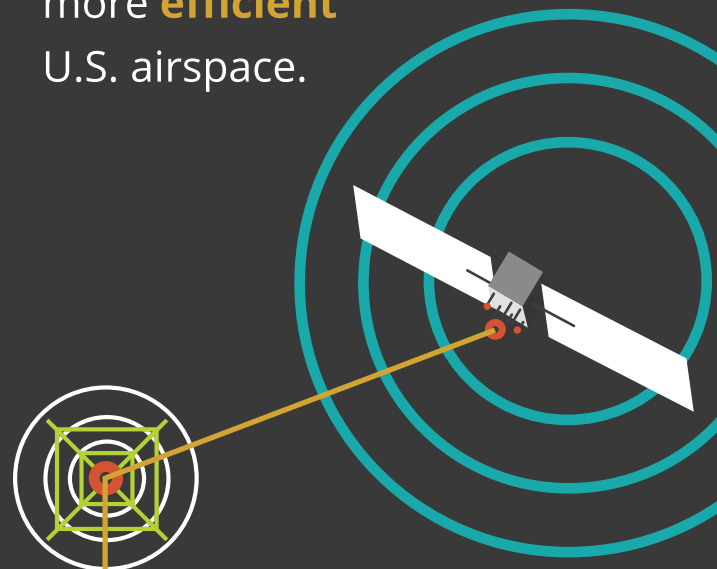
New vendors are competing to provide lower cost and more routine private space flight, eventually turning this once novel mode of transportation into a reality for more people. Established vendors will provide cost-effective transportation for critical government or private-sector assets, such as satellites. Additionally, space tourism is seen as highly likely at some point in the near future, and nearly a thousand tickets have already been purchased. Communities across the country are already competing to host this emerging market and have invested public funds in infrastructure to support spaceport development.

Initial uses will be suborbital tourism flights, where tourists experience the sights and sensations of space for a few minutes. The appeal of a two-hour suborbital flight from the East Coast to Asia continues to draw interest and research funds, but may take decades to become economically feasible. Success in the suborbital market is expected to translate eventually into longer orbital flights and visits to space stations.

Widespread commercial use of unmanned aircraft systems (UAS) is imminent. The burgeoning commercial drone industry is projected to generate more than \$82 billion for the U.S. economy and, by 2025, could support as many as 100,000 new jobs. On June 21, 2016 the Obama administration announced rules to govern non-recreational uses of UAS under 55 pounds. The rules seek to ensure the safety, security, and privacy of the American public, while permitting the responsible commercial, scientific, public, and educational use of UAS.

## NEXTGEN

GPS and new technologies are leading to a **safer**, more **efficient** U.S. airspace.

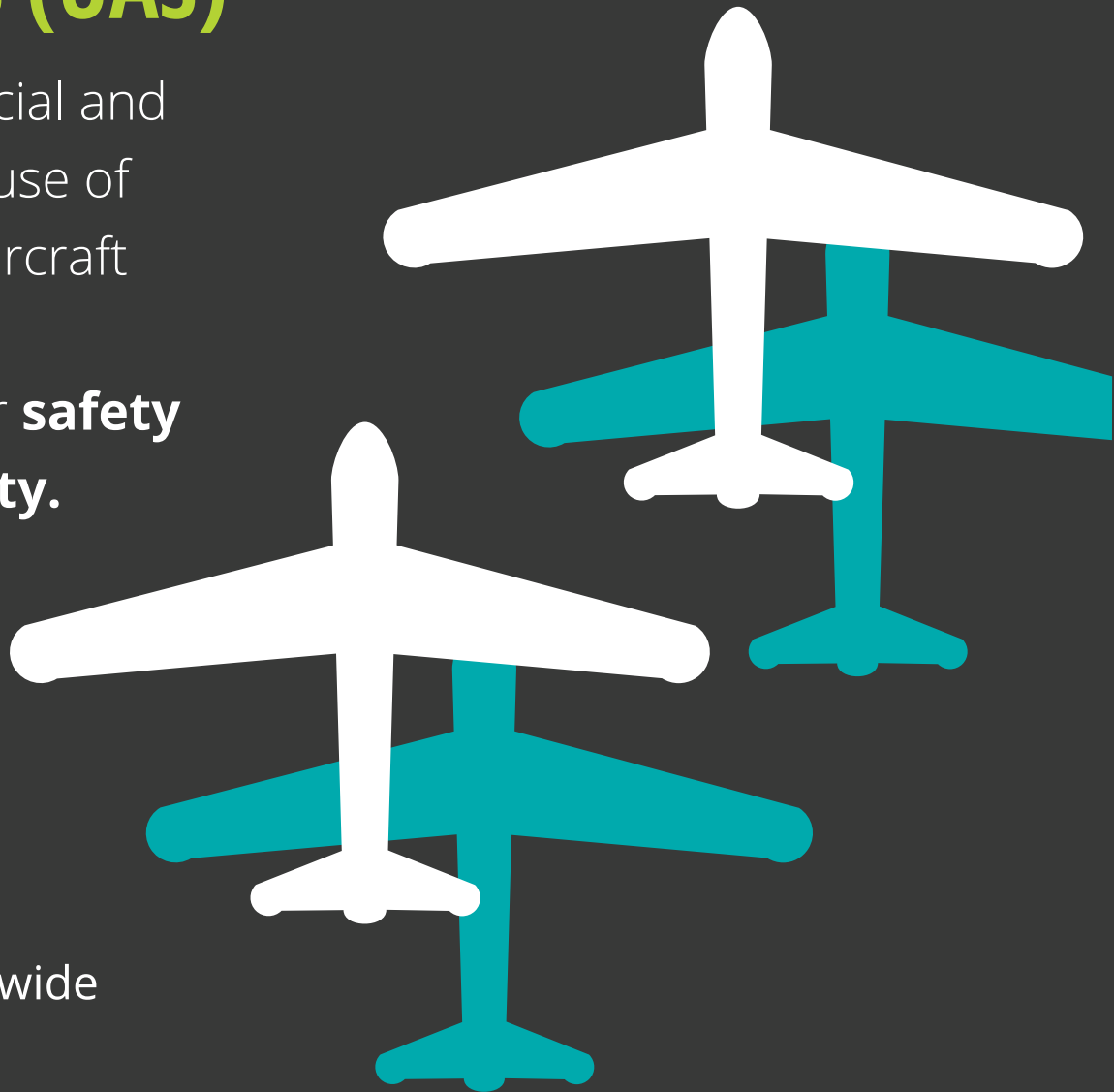


By **2020**, second-by-second updates will pinpoint the aircraft location and speed of **30,000** commercial flights daily.



# UNMANNED AIRCRAFT SYSTEMS (UAS)

The commercial and recreational use of unmanned aircraft requires high standards for **safety** and **reliability**.



Annual worldwide spending on unmanned aircraft is expected to **double** to

**\$ 11.5**  
**BILLION**

over the next decade.



2016



2026

This new technology has already helped government, the research community, and industry carry out their work more efficiently and safely. Today, unmanned aircraft are used for a variety of applications in areas like environmental monitoring and scientific research, precision agriculture and crop maintenance, safe infrastructure inspection, firefighting, search and rescue operations, and education. UAS will enable high-impact research, create new jobs and industries, save lives, and provide scientific, economic, and social benefits that public and private entities are only beginning to explore.

Many of the early missions for civilian UAS are for such purposes as remote sensing and surveillance. Unmanned aircraft have already been deployed by international emergency response teams in mudslides, wildfires, hurricanes, structural collapses, nuclear accidents, and tsunamis. In the U.S., government efforts to monitor wildlife and endangered and invasive plant and animal species, protect sensitive ecosystems, inspect and repair infrastructure, map and predict extreme weather events, and manage and monitor the environment have all seen improvement with the use of unmanned aircraft systems. Larger vehicles capable of carrying heavier payloads will enable more uses, such as spraying farm fields, surveying lands and infrastructure, and providing radio coverage to broad areas as an alternative to satellites.

Google, Amazon, and DHL have been evaluating delivery of packages by unmanned aircraft for several years. Remotely piloted drone deliveries could soon be used to provide high-value and urgent cargo to remote and hard-to-reach locations. For example, the ability to use unmanned aircraft deliveries could be used to deliver medical supplies to remote areas after a natural disaster has already been demonstrated.

Delivery by unmanned aircraft in dense urban environments presents significantly greater security, safety, and privacy risks, and will likely take longer to develop.

## MARINE TRANSPORTATION

Marine automation is increasing efficiency and decreasing crew size. A large vessel that would have employed a crew of 25 only a decade ago may be possible to operate with a much smaller crew over the next few decades. While this reduces the costs of shipping freight and grants vessel operators more flexibility, it could also mean that a ship's crew has less ability to quickly respond to incidents such as spills, groundings, and piracy. Ships could be piloted remotely with a small crew of technicians onboard in case of mechanical failure.

While full automation is still decades away, the signs of the future are on the horizon. In the summer of 2014, the U.S. Coast Guard introduced a pilot project to deploy virtual aids to navigation as opposed to physical sea buoys. Virtual aids to navigation will help to lay the foundation for the remotely-operated ships of the future. Likewise, research and development efforts are focused on examining barge operations on inland waterways.

The labor required to load and unload vessels has been decreasing since motorized equipment became available at ports. With the advent of containerization, even more cargo transfer functions have been automated from the cranes unloading the ships to the use of automated vehicles to maneuver containers around the port. These trends continue to enhance the efficiency of cargo handling operations and are leading to changes in the skillsets required of the port workforce. Increasingly, automated ports will require less manual labor, but will

demand a highly trained, tech-savvy workforce to run and maintain the automated machinery. Technological advances also reduce the cost of shipping and increase flexibility, while enabling the needed capacity expansion to handle larger vessel sizes.

## RAIL TRANSPORTATION

Positive train control (PTC) refers to critical national transportation infrastructure consisting of advanced interoperable technologies, which, when fully and properly configured can prevent collisions, derailments, and other safety incidents. PTC systems use digital radio communications, GPS services, and other technologies to send and receive a continuous, real-time stream of information about the location, direction and speed of trains in real time. In this way, PTC helps dispatchers and train crews safely and efficiently manage train movements.

Deployment of PTC on critical portions of the nation's rail transportation network is mandated by federal law. Meeting this mandate requires the installation of equipment and technology on 60,000 miles of Class I freight railroad rights-of-way, and an additional 8,400 miles of track for intercity passenger and commuter railroads. Railroads implementing PTC must equip over 22,500 locomotives, install over 48,000 radios, and modify 23,000 signals and switches. They also must secure sufficient radio frequency spectrum and install 22,000 wireless communications towers. These final two items are subject to Federal Communications Commission approval, in addition to the normal regulatory oversight by the Federal Railroad Administration. Implementation of interoperable PTC systems at this scale is unprecedented and has been slow due to the enormous complexity of the task. Railroads continue to make

incremental progress toward implementation to meet the recently extended deadline mandated by federal law of December 31, 2018.

New technologies are emerging to monitor the health of tracks and identify locations on the rail network that require attention to prevent derailments. These technologies will be mounted to trains in operational service so that measurements are made continuously and automatically. New sensors are also being installed by the side of strategically located tracks to monitor the health of every rail car that passes. These devices automatically analyze trends in performance so that cars needing attention can be taken out of service for maintenance before their condition deteriorates below a safe limit.

Advances in high-speed rail technologies could increase the speed and convenience of passenger travel. In addition to high-speed locomotives expected to emerge in the United States over the coming decades, magnetic levitation (maglev) trains—which utilize magnetic forces to lift, guide, and propel trains—are a budding technology (although more prominent in some international systems). In congested travel corridors, high-speed rail could compete for airline traffic, alleviating aviation

IN 2008, THE PORT OF PITTSBURGH WAS GRANTED A PATENT FOR "SMARTLOCK," A NEW INTEGRATION OF TECHNOLOGIES THAT ALLOWS TOWBOATS AND THEIR TOWS TO PASS SAFELY THROUGH LOCKS IN ZERO VISIBILITY.

congestion and boosting regional economies. The investment required to make high-speed rail corridors a reality, even if only in our most densely populated areas, is on the order of tens of billions of dollars. Public high-speed rail investments have moved forward in California, as have investments to improve the speed of trains along the North East Corridor, but sufficient public support has not been forthcoming elsewhere.

In recent years, interest in Hyperloop, or pneumatic tube transportation systems, and related technologies has grown. Hyperloop systems use vacuum tubes to reduce air resistance and transport goods and passengers over magnetic tracks at high speeds. The technology is still in early phases of conceptual development, though it could one day rival high-speed rail as a mode of high-speed surface travel. Yet there are numerable technical and practical questions that must be answered before Hyperloop travel becomes a realistic transport option. To name just one of the many challenges facing this technology, Hyperloop systems must travel in straight lines and would require significant right of way. This could make construction of a Hyperloop system near and through populated areas prohibitively expensive.

## **MOTOR VEHICLES**

Three distinct but related streams of technological change and development are occurring simultaneously: in-vehicle crash avoidance systems that provide warnings and/or limited automated control of safety functions; connected vehicle technologies—vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications that support various crash avoidance applications; and self-driving vehicles.

V2V technologies will soon be deployed that allow nearby vehicles to exchange data on their positions and use these data to warn drivers of potential collisions or to support automated safety technologies to prevent collisions. While many new models of automobiles currently use on-board sensors for collision warning systems, such as forward crash warnings, V2V technologies are capable of warning drivers of potential collisions that are not visible to sensors, such as a stopped vehicle blocked from view, or a moving vehicle at a blind intersection.

V2I communications will allow infrastructure, such as traffic signals, to communicate with vehicles. V2I systems could be used to send information to vehicles that allow the vehicles to warn drivers about weather conditions, traffic, upcoming work zones, and even potholes. V2I communications could also create a variety of operational benefits, such as enabling wireless roadside inspections and helping truckers to identify parking spots.

V2I technologies could also allow for coordinated signal timing and improved parking information systems that could improve traffic flows in urban areas. Data from connected vehicle technology could provide traffic management centers with detailed, real-time information on traffic flow, speeds, and other vehicle conditions, and allow more rapid response to traffic incidents. This real-time information could be used to increase the efficiency of urban and regional transportation systems. Adaptive traffic signal control could adjust signal timing to respond to congestion or other traffic conditions. Transit agencies could apply real-time information and connected vehicle technology to allow for real-time monitoring and control of transit vehicles leading to quicker, more reliable service for riders.

The application of connected vehicle technologies presents significant technical and policy challenges to public agencies and private partners. These include continuing to develop the standards and architecture for wireless systems, having enough equipped vehicles and roadside units to fully realize benefits, and deploying the systems needed to enable V2I communications. Deployment of V2I systems could require substantial investments to install and maintain roadside equipment, and to upgrade traffic management systems. However, given its tremendous potential, the federal government is supporting the deployment of connected vehicle-to-vehicle and vehicle-to-infrastructure technology.

## AUTOMATED VEHICLES

The automation of motor vehicles will revolutionize ground transportation. We are at the beginning of a period of dramatic change in the capabilities of, and expectations for, the vehicles we drive. The development of advanced automated vehicle safety technologies, including fully self-driving vehicles, may prove to be the greatest personal transportation revolution since the popularization of the personal automobile nearly a century ago.

Fully automated vehicles use GPS extensive mapping data, wireless communications, and sensor systems, including cameras, lasers, and radar, to “see” and to navigate through their environment. Partial automation of driving functions, such as lane guidance, active cruise control, and automatic braking are already available in luxury vehicles, and are becoming more widespread. With hundreds of millions of private and public dollars invested in

researching and developing automation features, these technologies will become increasingly common in the near future.

Many expect a tiered roll out of vehicles as driving functions are increasingly automated over the next decade. Automated driving on limited-access highways could be an option on luxury vehicles in several years. Fully automated, self-driving vehicles could be commercially available within the next decade.

Automated vehicles have the potential to transform our transportation system. Unresolved issues, such as cost considerations and the impact on emissions remain, but automated vehicles may create many benefits, including:

- Significantly reducing crashes, thereby improving safety, travel time reliability, and congestion associated with crashes.
- Enabling real-time route planning, thus improving travel time and reliability.
- Increasing the ability of existing infrastructure to accommodate more vehicles due to synchronized traffic flows.
- Improving transportation access to the young, older adults, and people with disabilities.
- Reducing costs associated with delivering freight.
- Freeing up time traditionally spent driving for more productive or recreational activities.

Research shows that human error and choice is partly or totally to blame for 94 percent of all crashes. Unsafe driving behavior—including distracted driving, speeding, reckless driving, and driving under the influence of drugs and alcohol—is a common cause of, and contributor to, fatalities and serious injuries. Distracted



driving remains a critical concern as the flow of information to the driver from in-vehicle systems and portable electronic devices is expected to increase. This information must be managed to ensure safety.

In 2015, 35,092 people died in traffic crashes; 2.4 million people were injured. Ultimately, automation features in vehicles could prevent many of the crashes that are caused by unsafe driving, potentially saving tens of thousands of lives each year. Preventing significant numbers of crashes, in addition to relieving the enormous emotional toll on families, will also greatly reduce the related societal costs—lives lost, hospital stays, days of work missed, and property damage—that total hundreds of billions of dollars each year.

Eliminating a significant portion of motor vehicle crashes would also reduce congestion. Currently, traffic incidents account for about one-third of all delays related to traffic congestion. Congestion caused by motor vehicle crashes also leads to wasted fuel and increased pollution. The ability to anticipate braking and acceleration in other vehicles will not only reduce crashes—it will also lead to additional fuel savings and reduced vehicle maintenance.

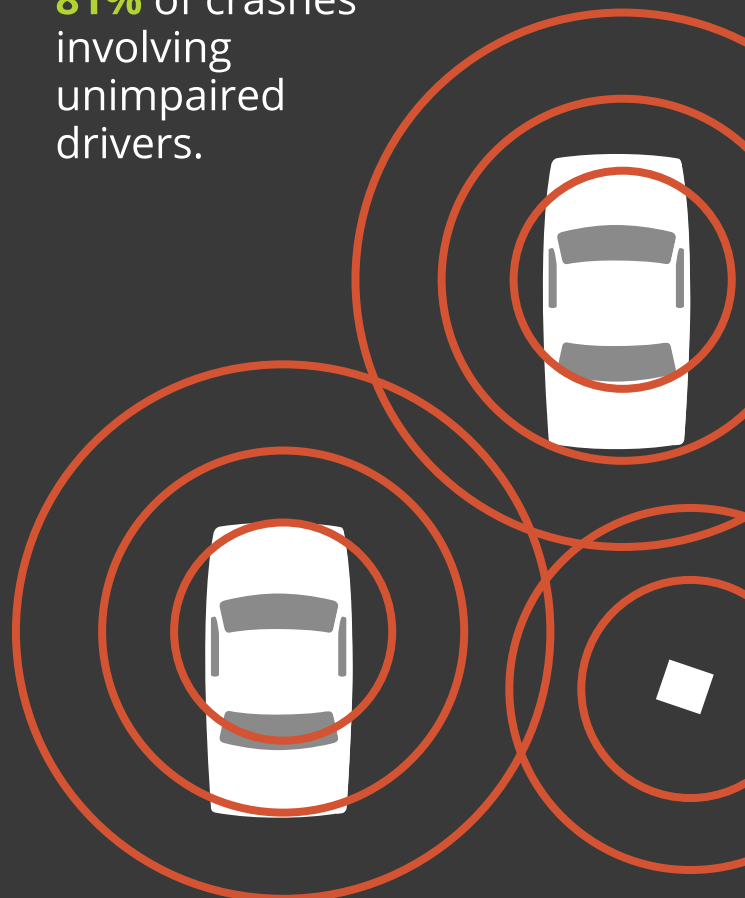
Automated, connected vehicles might also be able to drive more closely together, potentially reducing congestion and decreasing travel times. By some estimates, a partially automated fleet of vehicles could increase freeway capacity by 10–25 percent, while estimates for the capacity increases for a fully automated automobile fleet range as high as a 5-fold increase. In urban areas, automation will increase parking capacity: self-parking cars can park more closely together. Congestion could be further reduced as cars spend less

# CONNECTED VEHICLES

Vehicles that communicate are the latest innovation in a long line of successful safety advances.

The motor vehicle fatality rate has dropped by **80%** over the past 50 years.

Connected vehicles and new crash avoidance technology could potentially address **81%** of crashes involving unimpaired drivers.



time searching for parking spaces. Parking apps, including truck parking apps, are already being deployed, and have already begun to reduce emissions and improve efficiency.

Highly automated vehicles could change the way many people access mobility, increasing the use of on-demand car services, both personal and pooled, and reducing the need for personal vehicle ownership. Automated vehicles could also lower the operating costs and improve the safety and reliability of buses and paratransit services. On-demand services providing connectivity and last-mile services could work in conjunction with rail and other transit services, making traditional line-haul services more efficient. Automated vehicles providing last-mile services could also provide paratransit services for those with disabilities, and significantly lower the cost to transit agencies of operating paratransit. The ability to encourage carpooling by matching riders with similar trips could allow for low-cost use of automated vehicles, making it affordable for all.

Perhaps one of the greatest benefits of automated vehicles from a user perspective is time. The average American driver spends almost an hour each day driving. Automated driving could free up much of this time.

By making driving more accessible and convenient, automated driving may increase the number of “drivers,” as well as the total number of miles driven. Automated vehicles could also make driving more accessible to people with disabilities, the young, and older adults. Currently, slightly more than two-thirds of the population is licensed to drive. Between 5 and 10 million people do not drive due to disabilities. Automated vehicles may also change where people live and the distances they are willing to travel. This could lead to increased settlement of

## EMERGING TECHNOLOGIES PROMISE A CONTINUUM OF VEHICLE AUTOMATION, FROM VEHICLES WITH NO ACTIVE CONTROL SYSTEMS TO SELF-DRIVING CARS.

exurban areas and reductions in agricultural land and open space. Increased volumes of traffic could also increase the maintenance needs of infrastructure and offset efficiency gains, leading to increased emissions.

The impacts of automated vehicles will not be unique to passenger travel. Fully and partially automated trucks and vehicles at transfer facilities may transform the freight industry. Already, automated vehicles are being implemented in a variety of freight contexts—including transferring containers at shipping ports as well as harvesting corn and other crops. Partial automation, using radar and V2V communication would allow for truck platooning, leading to greater fuel efficiency without compromising on safety. In recent

THE INSURANCE INSTITUTE FOR HIGHWAY SAFETY HAS ESTIMATED THAT IF ALL VEHICLES HAD FORWARD COLLISION AND LANE DEPARTURE WARNING, BLIND SPOT ASSIST, AND ADAPTIVE HEADLIGHTS ABOUT 1 IN 3 FATAL CRASHES AND 1 IN 5 INJURY CRASHES COULD BE PREVENTED.

tests, a two-truck platoon led to 10 percent fuel savings for the rear truck and 4.5 percent fuel savings for the lead truck. Low-speed, small-scale autonomous vehicles offer a potential last-mile solution for freight delivery in urban areas.

Automated vehicles could change workforce needs in the freight industry. Partial automation could allow for remote operation of trucks and transfer facility vehicles, reducing the need for traditional, in-cab drivers. Advanced automation will increase productivity across the freight industry and shift the skillsets needed to work in the industry from manual labor to the more technical skills required for managing and maintaining automated fleets.

Despite the technical feasibility and potential benefits, there are a number of challenges to address to encourage widespread adoption of automated vehicles, including:

- High vehicle costs
- Public safety
- Privacy concerns
- Unresolved regulatory and legal liability issues
- Security issues

Automated car features tend to be costly, at least initially, and will likely be first introduced to a luxury market. For example, Tesla recently released a software update that allowed their Model S cars to steer within a lane, change lanes using the turn signal, adjust vehicle speed, and parallel park on command. Widespread availability of automated vehicles may be delayed until costs come down. The operation of fleets of automated vehicles using car sharing and pooled ridesharing models, similar to Zipcar or Lyft, could drive down the costs of accessing automated vehicles.

Public agencies will also need to determine how to regulate automated vehicles to ensure their safety. New performance standards will be needed to ensure that highly automated systems operate safely and securely in a wide variety of road environments and conditions. Questions abound: How will automated vehicles be licensed? What will be the responsibilities of owners and operators of automated vehicles? How will liability be determined if an automated vehicle is in a crash? Will automated vehicles be vulnerable to cyber-attack due to their reliance on information systems and connectivity, or could they even be used as weapons? Finally, there is the question of how to manage data generated by automated vehicles. Drivers may have privacy concerns regarding the generation, ownership, and sharing of vehicle travel data.

Recognizing the great potential benefits of highly automated vehicles, the federal government recently released a Federal Automated Vehicle Policy which sets out an ambitious approach to accelerate the deployment of such technologies. The remarkable speed with which increasingly complex, highly automated vehicles are evolving challenges the government to take new approaches that ensure these technologies are safely introduced, provide safety benefits today, and achieve their full safety potential in the future. The policy is intended to speed the delivery of an initial regulatory framework and provide guidance to states and manufacturers on the safe design, development, testing, and deployment of highly automated vehicles.

The policy outlines best practices for the safe pre-deployment design, development, and testing of highly automated vehicles prior to commercial sale or operation on public roads. In recent years, a growing number of states have passed legislation allowing for the testing and operation of automated vehicles on their roads.

## Visions of an Automated Future

In recent years, a number of private companies and individuals have described their visions of how highly automated vehicles could transform transportation in the near future.

Jon Zimmer, the co-founder of Lyft, sees fleets of self-driving vehicles providing on-demand transportation services in cities throughout the country within five years. Lyft believes that private car ownership among city dwellers will become obsolete within a decade. This transformation, they claim, will lead to a new era of city planning and land use, allowing cities to reclaim land dedicated to roads and parking for bike lanes and public plazas.

In his Master Plan for Tesla, Elon Musk envisions Tesla producing electric, self-driving, cars, trucks and buses that are 10 times safer than manually driven vehicles. He sees Tesla operating a fleet of on-demand self-driving vehicles, including accessible, automated shuttles in major cities. He believes personal ownership of automobiles will continue and that owners will make money by renting out their vehicles to others when they are not personally using them.

Robin Chase, the co-founder of Zipcar, describes two possible futures: an undesirable future, where personal automated vehicle use and “zombie cars,” (cars driving around with no one in them) lead to increased congestion and emissions, millions of unemployed drivers, and deteriorating infrastructure; or, a desirable future, where car sharing and ridesharing models drive down costs, reduce congestion, and allow urban parking spaces to be repurposed as affordable housing, green space, and grocery stores. To achieve the desirable future, Chase suggests that regulators act proactively to promote shared-vehicle use, reduce incentives for “zombie cars, provide alternative incomes for unemployed drivers, and ensure that automated vehicles are electric.

The policy provides guidance to states on their responsibilities concerning vehicle licensing and registration, traffic laws and enforcement, and motor vehicle insurance and liability regimes. The Policy also identifies the need for additional regulatory tools along with new expertise and research to allow NHTSA to more quickly address safety challenges and speed the responsible deployment of lifesaving technology.

Widespread adoption of automated vehicles would have a transformative effect on nearly all aspects of transportation. Entire business models and professions would be created, transformed, or eliminated as robotic taxis and driverless freight become possible. The broader effects on society are subject to debate, with uncertainty surrounding whether automated vehicles will curtail or enable sprawling land use patterns.

Many of these questions will not be answered until fully automated vehicles are commercially available and popular enough to prompt widespread adoption.

## **TECHNOLOGY, SAFETY, AND SECURITY**

While many emerging technologies could have major safety and security benefits when applied to transportation, in some cases they could also create new vulnerabilities. The safe operation of NextGen, positive train control, and intelligent transportation systems all depend on secure, reliable digital communication infrastructure and systems. Attacking a conventional train signal system requires actually being there in person—but, in theory, a transportation control system that is connected to the Internet can be attacked from anywhere in the world. One teenager in Poland, for example, hacked into a tram system, causing multiple derailments. Frequent hacks into highway dynamic message signs are a more benign demonstration of the vulnerability of electronic systems. Preventing these attacks will be a major challenge for transportation agencies and service providers.

There are also risks to a future where transportation services depend too heavily on access to GPS-reliant applications for operations. Disruptions to service can be created by weather events, demand overload, jamming and spoofing by hackers, and excess system demand. The government agencies responsible for GPS and the transportation firms and agencies that depend on those systems are considering ways to mitigate the risks of service disruptions. This may require making decisions on how best to maintain legacy navigation systems and capabilities, and/or building targeted backup systems.

Increasing automation of vehicles, vessels, trains, and aircraft can also result in diminishing ability and awareness among operators to respond to incidents when they occur. We have already seen several high profile incidents where overreliance on automation features has led to safety failures, such as the crash of Asiana Airlines Flight 214 at San Francisco International Airport. Greater information flows from on-board or independent systems can also create distractions that increase the risk of operator error. Finally, the increasing complexity of automated and interconnected systems may make it more difficult for those responsible for the safety and security of these systems to detect defects or vulnerabilities in advance of potentially harmful events.

While the net benefit of new technologies should lead to a safer, more efficient, and secure transportation system, significant effort and resources will be required to address the vulnerabilities raised by reliance on increasingly complex and interdependent systems. Ensuring the resilience, safety, and security of these systems will require a holistic consideration of issues across the transportation enterprise, from systems engineering, to risk management by system administrators, to training and certification of system operators. Greater cooperation between national governments will also be essential in combating breaches of security in transportation-related systems.

## **POLICY IMPLICATIONS**

Continued success will require sustained public and private investment in transportation research and development activities. The federal government can play a key role in supporting and promoting innovation, and in keeping America on the forefront of new technologies. Federal funding invested in transportation

research has declined to 0.01 percent of GDP, down from a high of 0.07 percent in 1971. Such research has led to breakthroughs in automotive and aviation safety, such as connected vehicle technology and NextGen. It has also been instrumental in the advancement of alternative fuels technologies, the development of charging stations for electric vehicles, improved roadway designs and traffic controls that have saved countless lives, and more durable pavements that reduce the need for expensive reconstruction and repair of roads, bridges, and runways. By sponsoring research, the federal government allows us to understand and plan for the challenges facing us and to train the next generation of transportation professionals to help meet those challenges. Federally supported research can also help to ensure that the public and policymakers are kept fully informed of the potential benefits and risks of new technologies.

Transportation innovation may be restricted by the traditionally slow pace of legislation and rulemaking. Rapidly evolving technology will demand government flexibility: regulations may be necessary, but to advance and encourage innovation, not prevent it. Government must also ensure the primacy of safety as new technologies are implemented. As innovations are developed, we will face new challenges in confronting the idea of what should, and should not, be regulated.

Public agencies assume many roles in their relationships with transportation technologies: from researchers to regulators, from users to developers. This requires a talented workforce, but attracting and keeping such a workforce presents major challenges. The evolving role of transportation agencies means that they must hire staff with expertise in entirely new disciplines. This requires recruiting and training for specific skills, or at least ensuring that

contracts are written for these precise skills. It could be difficult for public agencies to develop these capabilities, since transportation agencies are not the only employers in the labor market, and wage competition for the best-qualified workers is already fierce, especially for in-demand skill sets, such as software engineering.

- At the international level, the U.S. government will need to ensure that foreign governments do not erect regulations or product standards that set unfair barriers to trade for U.S. technology. Further, because of the competitive nature of international business, if the U.S. government seeks to maintain global leadership in developing these technologies and retain the employment opportunities associated with them, regulations and policies need to be structured in a way that facilitates industry growth.

Policy decisions will undoubtedly shape the extent to which technology and data are continually incorporated into our already complex transportation systems. Decision makers may consider a variety of policy options, including:

- A regulatory framework that encourages innovation, rather than hinders it, and places a top priority on ensuring the safety of the overall transportation system.
- Fostering proactive engagement with those in technology-related industries to help the public sector anticipate future technology enhancements.
- Incentivizing a skilled transportation workforce that is increasingly competent in the fields of science, technology, engineering, and mathematics.

- Requiring that privacy and cybersecurity concerns are adequately addressed in the consideration and adoption of new technologies.

These policy options are explored in further depth in the conclusion of this report.

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# HOW WE GROW ECONOMIC OPPORTUNITY FOR ALL

## Introduction

Transportation not only connects us to the larger world but also shapes the corner of the world we inherit. Transportation is all too often thought of only as a means to an end—a method to get people or goods from one place to another. The system itself has been designed with this primary function in mind but not in every case with regard to the impacts of the infrastructure on the nation’s communities.

Like other institutions in America, the development of the transportation system is colored by the same socioeconomic prejudices that defined us in the past. As a result, our transportation system is failing to meet the needs of all communities. All too often, infrastructure cuts through communities imposing obstructions and inconveniences, rather than connecting people to opportunities. Because of the legacy of infrastructure designed for those wealthy enough to own an automobile and fortunate enough to be able-bodied, too many Americans are shut out from opportunities. When a car breaks down and a family can’t replace it, when a loved one develops a disability and can no longer get around how they used to, or when walking or biking to school involves navigating a six-lane road with no sidewalks or bike lanes, opportunities—the

opportunity to work, to participate in one’s community, to go to school, to live in good health—are lost.

Infrastructure designed to serve the needs of some can limit the physical and economic mobility of others. When infrastructure is built without regard to place or community, urban highways sever a city, runway expansion displaces a neighborhood, crosswalks, bus stops and railroad crossings become an afterthought. For instance, an interstate overpass constructed with the intention of decreasing congestion could in turn lead to residents having to walk underneath a dark and dangerous underpass to get to the closest bus stop or the local job that was previously an open pathway. When communities lack a voice in the transportation planning process and infrastructure is designed with solely mobility in mind, a child’s neighborhood is divided by transportation infrastructure in a manner that segregates one area from another, personal connections are cut, local businesses lose their customers, opportunity is lost.

These issues are not philosophical. Our transportation community must acknowledge its historical role in furthering opportunity gaps, and, as these gaps continue to grow, embrace its role in closing them.

## The Widening Gap

Our economy is recovering from a long recession. In 2016, the unemployment rate dipped below 5 percent for the first time since early 2008 and median household income grew by more than 5 percent between 2014 and 2015.

Despite this good news, the recovery has been uneven, its benefits have been distributed unequally, and financial security remains a major concern for many American families. The top 10 percent of income earning families now earn as much income as the remaining 90 percent combined. By this measure, income inequality—the wealth gap between American families—has reached its highest level since the 1920s. Adjusting for inflation, the income of the average American is at nearly the same level as it was 30 years ago.

As income inequality grows, so too does the number of Americans living in poverty. Today, more than 46 million Americans live below the official poverty threshold, an increase of 15 million since 2000. More than one in five children in America live in poverty.

Increasingly, low-income Americans are living in suburban areas, where they face higher transportation costs and longer commutes. Between 2000 and 2012, the number of poor people living in suburbs increased from 10 million to 16.5 million. In some of largest metropolitan areas in our country more than 3 in 4 individuals living in poverty live in the suburbs. Yet even as the number of people living in poverty in the suburbs has grown, high levels of poverty stubbornly persist in many urban neighborhoods, where gentrification is the exception to the rule. As a result, people with low incomes often face difficult tradeoffs, forgoing access to transit and jobs to escape crime, access

to more affordable housing, or getting their kids into better schools in the suburbs.

Our transportation system and policies play an important role in providing access to economic opportunity and improving the quality of life of all Americans. Infrastructure design can connect communities, contributing to job creation, or it can create barriers, forcing job creators to invest somewhere else.

Varying levels of government are compelled to examine whether infrastructure has indeed caused these pockets of disparity or whether they are merely correlated. In a time of rising economic inequality, the transportation sector must simultaneously recognize its legacy and work anew to knit a new, more inclusive fabric.

Income inequality is not just an issue of fairness or a cause for compassion, it affects us all, regardless of where we work or where we live. When such a large proportion of the American people are struggling to get into and stay in the middle class, the impacts are far-reaching. There is a link between high income inequality and slower overall economic growth. We know it can also lead to higher rates of crime, social unrest, and political instability. Inequality means fewer people can afford a good education, the car they need to get to an interview, or the childcare they need so that they can work. For too many, the American Dream is growing out of reach.

Other than housing expenses, the cost of transportation is the largest cost to American families. The failure to keep up with the demands of a growing population and basic system maintenance and repairs forces individuals and families to spend more time and more money getting from place to place. At the same time, middle class wages are stagnating, and the

number of Americans living in poverty is growing. When planned and designed the right way, investments in transportation can help to restore and revitalize underserved and disconnected communities by spurring development and creating local job and housing opportunities. Affordable, reliable, and convenient transportation options—in cities, suburbs, and rural areas—are critical to the millions of people who are trying to take advantage of the opportunities our nation affords.

## A Legacy of Disenfranchisement and Underinvestment

After James Robertson’s car died, he faced a dilemma. His home was in the city of Detroit and the factory he worked at was 23 miles away in the suburb of Rochester Hills. His \$10.55/hour wage was better than working for the minimum wage but it was not enough for him to be able to afford to replace his car. After a 90-minute bus ride from his home, Mr. Robertson would still have to walk 7 more miles to get to work. The entire morning commute would take 4 ½ hours. Getting home would be worse. After he finished his shift at 10 p.m., he would have to repeat his 7-mile walk to the bus stop to catch the last bus to Detroit at 1 a.m. Upon return, the bus would make its final stop at the city line, leaving Mr. Robertson a 5-mile walk home. He would arrive home at 4 a.m. Mr. Robertson made this commute for five days a week for years, including in the middle of winter.

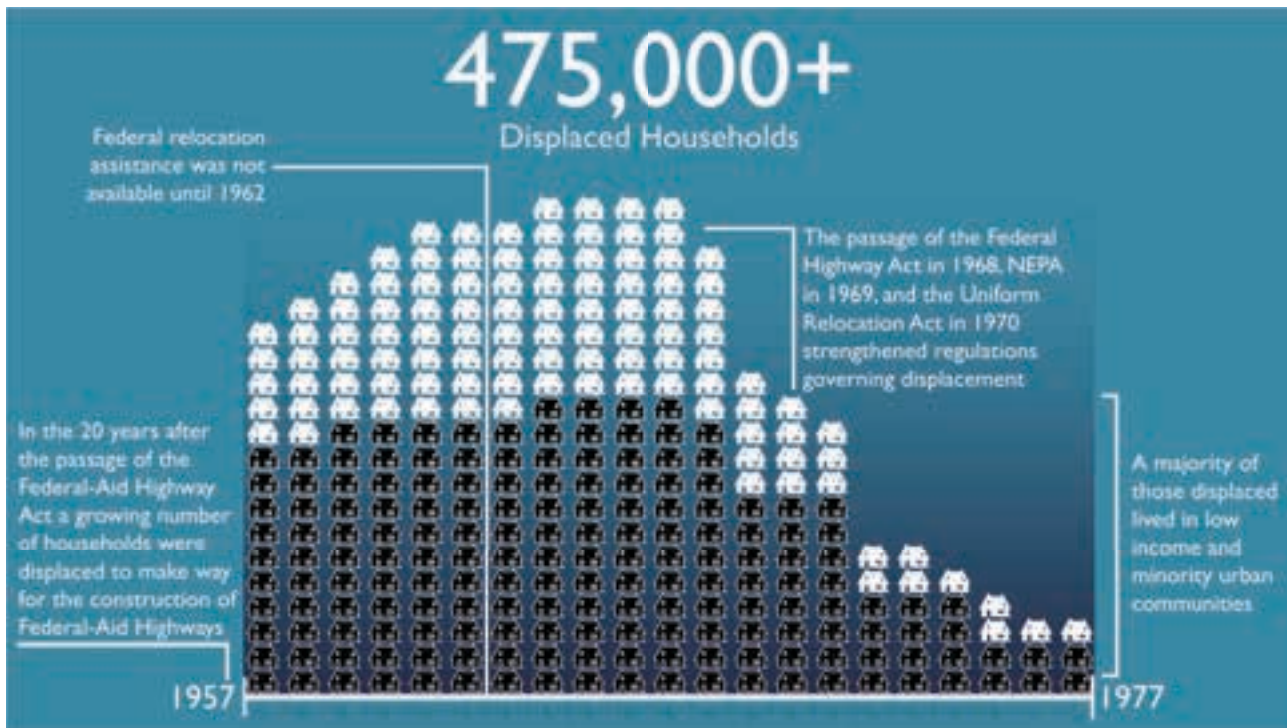
What makes Mr. Robertson’s story exceptional is the remarkable faith, determination, and endurance he showed to make this his regular commute. Unfortunately, the dilemma he faced is all too common. Cutbacks in transit service have limited the transportation options available to low-income workers like Mr. Robertson,

while jobs that are geographically spread outside of the main city’s business district and the decline of factory jobs have meant that many workers must travel farther to reach employment opportunities. Transit service is often not coordinated across municipalities and bus service may stop at the city line. Suburban transit services are frequently inadequate and infrequent, especially for those who work late in the evening or early in the morning.

These issues have their roots in the ways we have built infrastructure and planned our communities—which in turn have been shaped by our society’s attitudes about where we live and how we get around. Over time, the way we have built our infrastructure—the routes we have chosen and the types of infrastructure we have prioritized—have shaped our country and our communities in ways that deeply affect our everyday lives and our relationships with one another.

The construction of the interstate highway system, in Detroit and nearly every other major city in our nation, indelibly affected our society. In many cases, interstate routes were chosen based on areas where land costs were the lowest or where political resistance was weakest. In practice, this meant that urban interstates cut through low-income and minority communities more often than not. Done in coordination with urban renewal initiatives the construction of urban interstates was often used as a means to remove low-income housing, seen as slums or urban blight, to make way for new development. In fact, many of the communities destroyed by urban renewal and the construction of urban highways were once densely populated, vibrant, affordable, and accessible neighborhoods.

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That the builders of highways failed to see or chose to ignore this fact was in some cases a matter of sheer racial prejudice, but more often it appears to have been the result of a focus on improving the mobility of cars to get from point a to point b and the failure to consider the points in between. Highway route choices were made without significant local input and without consideration for the impact of those highways on urban neighborhoods, which not only displaced more than a million individuals and businesses, but also reduced local land values, and erected lasting physical barriers that continue to divide neighborhoods today disconnecting them from opportunities. The interstate highway system promoted the development of suburban communities, which in many cases actively excluded people of color, facilitating white flight, reinforcing and increasing

de facto racial segregation, and undermining the tax base of many urban communities and the ridership and profitability of regional transit systems.

For all the mobility and safety benefits that the urban interstates provided, their construction is also an object lesson in what can happen

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## Seattle: A City Divided

Low-income and minority Americans suffered disproportionately from the destruction and division of neighborhoods that accompanied the construction of the urban interstates and urban renewal policies of the 1950s and 1960s. In Seattle, the construction of the I-5 Interstate through Seattle divided the city in half, destroyed thousands of homes, and divided neighborhoods—such as the blue collar neighborhood of Cascade. Residents opposing the highway at the time of its construction in the early 1960s argued for decking the highway and investing in transit to preserve neighborhood connectivity and support affordable transportation options. These debates continue today.

when we fail to consider the needs of local communities and prioritize the mobility of cars over all other values. Despite legislation and policy changes aimed at ensuring a comprehensive planning process and protecting underserved populations, many low-income and minority communities continue to live within the physical barriers that have made their communities less desirable for attracting jobs, neighborhood services, and a range of other stabilizing forces. Many also suffer from a legacy of underinvestment in affordable transportation options and barriers in the housing market.

A number of factors continue to contribute to the marginalization of underserved communities from the transportation decision-making process, including a lack of political representation of underserved communities; a lack of diversity among transportation officials; inadequate public outreach and engagement in the planning process; and the systemic bias of traditional transportation policies and institutional structures. Policies that allow disproportionate investments in highways and political processes that lead to the underrepresentation of the interests of low-income communities have fostered increasing dispersion of populations

and jobs, and reduced the efficiency and quality of service of affordable transportation services in low-income urban communities. Political processes influencing regional transportation decision making often favor suburbs and wealthier communities over urban and rural communities and low-income residents. For example, MPO boards, which are typically made up of elected officials and representatives from transportation agencies, are often structured in a way that overrepresent suburban interests. Urban populations are often underrepresented and rural and unincorporated areas may not be represented at all. The MPO that represents the planning area of greater Milwaukee, one of the most racially segregated regions of the country, is made up of 21 representatives of whom only three represent the county of Milwaukee, where the city of Milwaukee is located. In recent years, the state of Wisconsin has shifted funding for transit projects to major highway expansion projects and faced lawsuits for failing to adequately address environmental justice issues.

In 2006, a Brookings Institute study found that only 12 percent of the members of MPO boards were minorities while the population

## Engaging Underserved Communities in Transportation Planning

Planning agencies seeking to enhance public input from underserved communities have employed a variety of methods including:

- Establishing civic advisory committees made up of local residents;
- Employing interpreters and posting key planning documents in multiple languages and in accessible formats;
- Working closely with neighborhood community groups and disability advocacy groups to promote awareness and engagement;
- Employing digital and mobile technologies to better communicate transportation projects and create remote engagement opportunities outside of traditional public meetings and hearings; and
- Ensuring that minorities and transit-dependent individuals are appointed to leadership positions in transportation agencies.

of minorities in those metropolitan areas was 39 percent. Increasing participation of minority and low-income communities in MPOs and state department of transportation planning process is particularly important because they are the primary entities responsible for deciding how surface transportation funding is spent. State DOT's, which control the majority of transportation funding, can face similar issues of underrepresentation and lack of diversity among those responsible for investment decisions.

Federal regulations require that state DOTs and MPOs "seek out and consider the needs of those traditionally underserved by existing transportation systems" on federally funded projects. However, individuals from underserved groups often face linguistic, economic, and physical barriers that limit their engagement in public meetings and discourse, and they may be unaware of transportation proposals that could dramatically change their lives.

As congestion grows, Americans are increasingly using transit and showing more interest in

living in transit-rich neighborhoods. More and more Americans believe in the value that transit services have in attracting amenities, shortening commutes, and improving the quality of life of a neighborhood. This increased interest is contributing to development patterns where wealthier residents are moving into transit-rich neighborhoods, driving up rents, and displacing minority and low-income residents into less desirable areas with longer commutes and less access to social services. Gentrification can also drive down transit ridership as car-owning residents replace transit-dependent residents. One study of 42 neighborhoods found that in more than 70 percent of those neighborhoods automobile ownership actually increased after a rail transit station was built there. The positive impacts of transportation improvements should be felt by everyone. Transportation facilities should be built of, by, and for the communities served by them.

Low-income neighborhoods have more than double the fatality rate from traffic collisions as high-income neighborhoods. The reason can be



## **Affordable Transportation for Affordable Neighborhoods**

Many local and regional agencies have found ways to address this issue by developing comprehensive transit-oriented approaches to housing and transportation planning. As the Seattle region expands its rail transit system and housing costs rise across the region, King County is seeking to create a region where all households have an equitable opportunity to be connected to community by investing in affordable housing development near current and planned transit stations. By bonding against hotel tax revenues, the county plans to finance \$87 million in projects that will create at least 700 units of affordable workforce housing in walkable, economically diverse neighborhoods over the next five years.

traced, at least in part, to the lack of the basic infrastructure that wealthier communities often take for granted. American Housing Survey data show that many Americans lack adequate infrastructure to walk or bike safely in their neighborhoods. Overall, only 55 percent of households are in neighborhoods with adequate sidewalks and less than 15 percent have access to bike lanes. But these aggregate data mask severe disparities. For example, 89 percent of high-income neighborhoods have sidewalks while only 49 percent of low-income neighborhoods do. These disadvantaged areas also have less street lighting and fewer crosswalks. These disparities have major safety implications. For instance, Miami-Dade County's low-income census tracts recorded 16.5 pedestrian deaths per 100,000 people, compared with a rate of 8.9 for the rest of Miami-Dade.

New transportation services such as bike-share systems and ride sourcing are at risk of repeating patterns of economic and racial inequities in transportation. For example, even though low-income workers are more likely to bike or walk to work, studies have shown that bike-share stations are disproportionately located in wealthier, less-diverse neighborhoods.

## **A Lack of Affordable Transportation Options**

Access to affordable transportation choices is critical to the quality of life of all Americans. Middle- and low-income American households spend, on average, nearly 20 percent of their income on transportation and 41 percent on housing. Limited access to affordable housing near employment centers—or to affordable and reliable transportation options to and from employment centers—creates the high burden of transportation costs for many families.

For example, owning a car is expensive, costing, on average, more than \$6,000 per year. And if the car is old, and requires more maintenance and repair, that cost can go up. Households with annual incomes of less than \$25,000 are seven times less likely to have a car than those with higher incomes. There are also racial disparities in access to vehicles; 19 percent of African American households and 11 percent of Hispanic households live without a car, compared to approximately 6 percent of white, non-Hispanic households. A recent study found that good drivers in predominantly African American neighborhoods pay, on average, 70 percent more for their car insurance than good drivers living in

## Preventing Tragedies by Design

In 2010, Raquel Nelson's four-year-old son was struck and killed by an impaired driver when her son escaped from her grasp as she tried to cross the street from the bus stop by her apartment in suburban Atlanta. Compounding this tragedy were charges of homicide against Ms. Nelson for recklessly "jaywalking." The bus stop was located across the street from her apartment, but using the closest crosswalk would have required her to walk more than a half mile out of her way. Homicide charges against Ms. Nelson were eventually dropped, but her tragic story is revealing. Our roadway design, especially in growing suburban communities, is often unsafe for pedestrians.

neighborhoods where the residents are mostly white.

Transit can be an affordable option, and in fact, access to transit may be a determining factor guiding the housing choices of many low-income households in urban areas. But people who depend on transit still face long commutes and limited access to job opportunities. A study by the Brookings Institution found that the typical metropolitan resident can reach only about 30 percent of jobs in their metropolitan area via transit in 90 minutes or less. In the suburbs, where the majority of Americans live, transit service is even less likely to provide adequate access to employment opportunities. The same study revealed that working-age residents in low-income suburban neighborhoods can reach only 4 percent of metropolitan jobs within a 45-minute commute. Furthermore, low-income jobs disproportionately require workers to work nights or weekends, times during which public transit routes run much less frequently or not at all.

Job accessibility has become even more difficult as employers have increasingly moved away from central business districts to suburban locations. A recent study found that in a majority

of our largest metropolitan areas fewer jobs were within reach of a typical commute than there were 10 years ago. During this period, the number of jobs in proximity to minority and low-income residents fell much more steeply than for white and middle class residents. As the share of workplaces in downtown areas has declined, it has become more challenging to connect workers to workplaces through transit.

Higher housing and transportation costs in many metropolitan areas have forced families to choose between more expensive housing closer to job centers or more affordable housing with longer commutes. It is rare to find affordable housing near job centers. At best, this is a choice between a greater drain on resources, or longer travel times. Lack of affordable transportation puts jobs, health or child care services, or an education out of reach. And, for many low-income Americans, whether they are elderly and on a fixed income, or have a disability, there is no choice.

## Access to Opportunity in Rural and Tribal Communities

Eight million Americans in poor households live in rural areas and some of the highest rates of poverty in our country are concentrated

## Growing Suburban Poverty and the Challenge of Access

A growing number of poor families live in the suburbs. Many of these families face enormous transportation issues in accessing employment opportunities and critical services. To simply apply for a job across town in Atlanta, Lauren Scott, had to undertake an epic trip. After a day-care bus picked her daughter up from the homeless shelter, Ms. Scott began her trip to an industrial site that would have been 27 minutes away by car. Ms. Scott's trip, however, involved 69 stops on a bus, a 9-minute train ride, an additional 49 stops on another bus, and a quarter mile walk. Her entire trip took two hours.

Ms. Scott's journey for economic opportunity exemplifies the region's challenge of the impoverished. Over time, metropolitan areas of the Deep South have instituted policies and altered real estate development that in turn has pushed the poor out of urban centers and thus further away from jobs. People with lower incomes have become more reliant on public transit which is of weak quality. A recent study found that in the nation's largest metropolitan areas, 15 of the weakest 20 systems, with respect to system coverage and job access, were in the South – including Atlanta where Lauren Scott lives.

in rural areas such as the Mississippi Delta, Appalachia, in Texas along the Mexican border, and on American Indian lands. Low-population densities and limited transportation options can make it difficult for low-income and unemployed individuals in rural areas to reach economic opportunities and essential services. Declining populations and tax revenues in some rural counties can make it difficult for local governments to maintain existing roads and bridges or preserve air and rail passenger services.

While many in metropolitan areas face challenges using transit to reliably and conveniently access opportunities, in rural areas, few individuals have access to any transit at all. Only 11 percent of households in rural areas report having access to transit services, compared to 64 percent of households in metropolitan areas. Where rural transit services

are provided, they can help to maintain the independence of senior citizens, meet the healthcare, childcare, and educational needs of families, and help low-income households get ahead by providing a reliable and affordable means of getting to work.

Transportation investments can be a critical factor in whether a rural community thrives or declines. For example, while rural communities often rely on highways to access jobs, connect goods to markets, and attract tourism, when highways bypass small town centers, they can shift the economic activity in ways that are detrimental for some communities. One way to foster investment and economic development in rural areas is to ensure that rural communities have a voice in the transportation planning process and that street connectivity, bicycle and pedestrian facilities, and intercity bus and rail connections are considered when planning

# AMERICAN HOUSEHOLD SPENDING ON TRANSPORTATION

Middle- and low-income American households spend, on average, nearly **20 percent** of their income on transportation and **40 percent** on housing.

## Household Expenditures as Percentage of Household Income

Other - 4%

Clothing - 4%

Entertainment - 6%

Healthcare - 10%

Food - 16%

**Transportation - 20%**

**Housing - 41%**



## The Revitalization of MacArthur Park

MacArthur Park, Los Angeles, is home to a majority Central American and Mexican immigrant community, many of whom have below-average incomes and rely heavily on public transit. When Los Angeles Metro proposed a major development around the MacArthur Park metro station, local community-based organizations and City Council members worked to ensure that the project included a significant affordable housing component, supported neighborhood small businesses, and provided public space for street vendors and cultural festivals. The project ultimately included more than 90 affordable housing units and the neighboring park was transformed from a passive recreational space to an active public space filled with street vendors, informal soccer fields, and cultural celebrations. The participation of community-based organizations in an inclusive planning process helped to ensure that the project revitalized the neighborhood while benefiting the low-income Latino immigrant community living there.

transportation investments in rural areas as well as urban areas. For example, Washington State has invested federal transit funds in a public-private partnership to enhance intercity bus service that connects small towns and rural areas to regional centers and major cities.

Tribal areas, in particular, are home to some of the most underdeveloped and unsafe road networks in the United States. More than 5 million American Indians and Alaskan Indians live in the United States and over half live in rural areas or small towns. The majority of the 140,000 miles of public roadways owned and maintained by the Bureau of Indian Affairs or Indian tribes are unpaved. Approximately 24 percent of the more than 6,000 bridges are classified as deficient. American Indians face the highest rates of pedestrian injury and death per capita of any racial or ethnic group. Motor-vehicle-related death rates for American Indians/Alaska Natives are more than twice that of the general population.

The unemployment rate of those living on Indian reservations is nearly 20 percent. Approximately 23 percent of American Indian families live in households below the poverty line.

## Accessibility Challenges

People with disabilities face transportation challenges due to a lack of accessible transportation facilities and services and economic challenges that limit incomes. People with disabilities are more likely to be unemployed and live in poverty and face difficulties accessing affordable transportation options that meet their needs. According to a national survey, nearly 20 percent of people with disabilities say that inadequate transportation is a problem. The more severe the disability of the respondent was, the more serious were the reported transportation problems—more than one-third of people with severe disabilities say that inadequate transportation is a major problem.

Despite significant progress over the past decades, many transportation facilities are still not in compliance with Americans with Disabilities Act (ADA) rules regarding access. Nearly a third of transit stations are not yet ADA compliant and sidewalks throughout the country fail to meet ADA standards. Poorly designed or maintained facilities, such as unplowed sidewalks or misplaced curb cuts, can also limit the mobility of people with disabilities and increase safety risks.

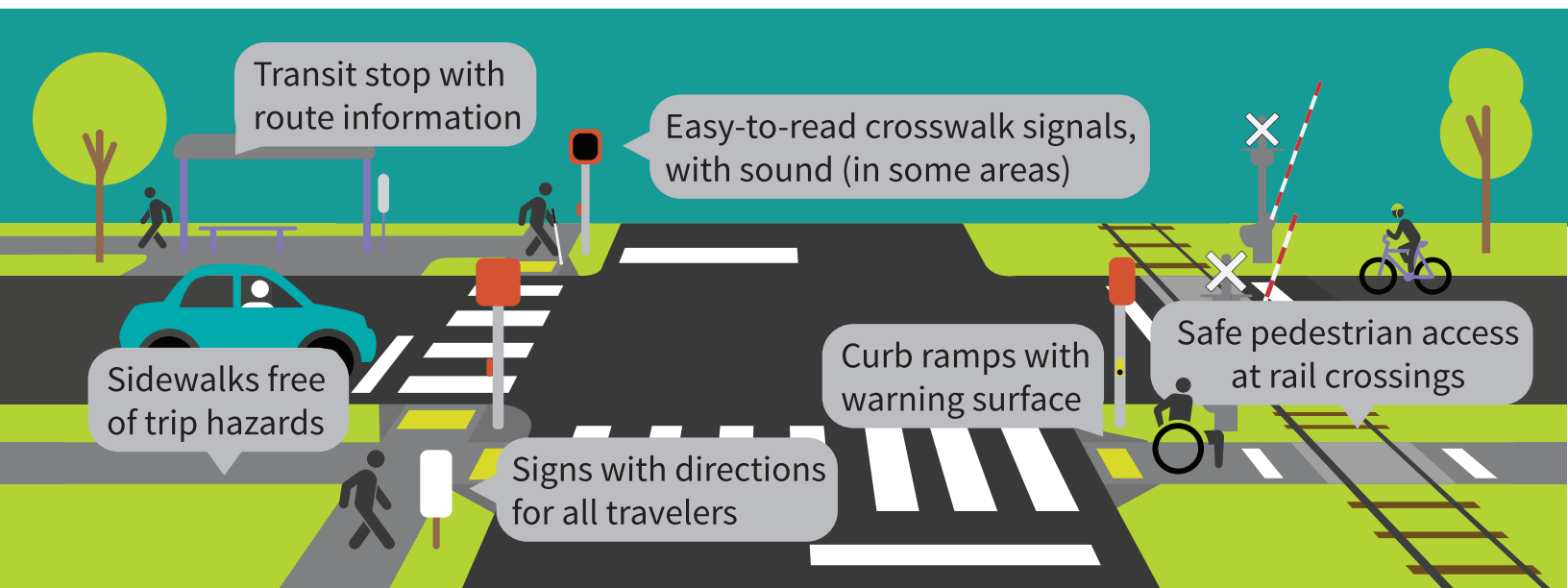
Lack of access to transportation makes it difficult for many to get to work, to obtain necessary medical services, or to participate fully with their communities—to shop, socialize, or participate in recreational or spiritual activities. As a result, many people with disabilities suffer economic challenges or experience social isolation due to the lack of safe, reliable, accessible transportation services and infrastructure.

## Growing Economic Segregation and Declining Social Mobility

As the middle class shrinks, so do middle class and mixed-income neighborhoods. A growing

number of families now live in neighborhoods that are either very poor or very rich. Rising economic segregation means that an increasing number of poor households are located in distressed neighborhoods where they face challenges such as failing schools, high rates of crime, and inadequate access to services and jobs that make it harder for individuals and families to escape poverty. The pattern of growing concentration of poverty holds true for suburbs as well as cities. Suburban neighborhoods with poverty rates of 20 percent or higher are home to approximately 38 percent of poor residents and 53 percent of poor African American residents living in the suburbs. The concentration of poor households in distressed neighborhoods has reduced access to economic opportunity and stunted social mobility. Recent economic research has shown that children that grow up in areas with greater segregation, both by race and by income, are less likely than other children to earn more money than their parents did.

As economic segregation and sprawling urban development goes up, economic opportunity and social mobility goes down. This is why transportation choices can make or break



## Safety Implications

While the number of people that die in motor vehicle crashes has declined in recent years—25 percent over the last decade—the declines are not seen among all segments of the population. For people 25 years old and older with less than a high school diploma, fatality rates have only increased over time. A number of contributing factors play into this, including the prevalence of older cars with fewer safety features, fewer trauma centers in poor and rural areas, and high pedestrian rates among poor communities.

When crashes occur in rural areas, the critical timing of emergency response can mean the difference between life and death. Lack of technology in rural areas can also contribute as advanced crash notification may not be as readily available, cell phone service may be less reliable, and communication to additional emergency response may be difficult. Lack of sidewalks and prominent lighting along roadways can present dangerous situations for pedestrians and bicyclists.

a family struggling to survive. Proximity to job centers is correlated with their likelihood of employment and the length of their job searches when unemployed. Researchers at Harvard University have also found that children showed less upward mobility if they grew up in neighborhoods where residents had longer commutes. They found that residents of sprawling cities with high levels of race and income segregation had less social mobility than their peers. A similar study found that residents of more sprawling metropolitan areas faced higher transportation costs, had higher obesity rates, and experienced less social mobility. These studies suggest that sprawling development patterns support racial and income segregation and reduce access to opportunities for low-income families to get ahead.

The development of sprawling American metropolitan areas with dispersed suburban populations is inextricably linked with the development of our transportation infrastructure. Massive investments in urban highways and beltways coupled with

underinvestment in transit services have allowed regions to simply bypass poorer areas. For many living in our metropolitan areas, the low-income neighborhoods where a large portion of the region's population live, is just a place they drive by on the way to work. The highways have been in many ways, designed just for this very purpose.

As the range of costs of sprawl and auto-dependency become apparent—time lost in congestion, soaring rates of obesity, rising costs of maintaining existing infrastructure, and increasing inequality—societal attitudes are again changing. More and more people want to live in walkable, livable communities—integrated areas rich in amenities and transportation choices. Regions experiencing this change in attitudes are now faced with the challenge of improving the livability of cities while ensuring the affordability of traditional low-income and minority communities—so that those that suffered from decades of underinvestment and neglect aren't now pushed aside by rising costs of living.

This represents a new challenge for many planners, but it should not be overstated. For all the attention it gets, incidence of actual gentrification where a low-income neighborhood becomes significantly wealthier remain a relatively rare phenomenon. Many cities are still struggling to find ways to make urban neighborhoods attractive, desirable places to live and work. Yet as society's attitudes about where we live and how we get around slowly change, planners, policymakers, and entrepreneurs are finding ways to adapt and develop our infrastructure to support the more integrated, equitable, affordable, and accessible communities that many desire.

## Policy Implications

Transportation investments can help to close the opportunity gap by creating jobs, catalyzing economic development, saving individuals money and time, and improving access to economic and educational opportunities. Yet transportation policy is often an overlooked instrument to address issues of income inequality and poverty. Previous generations of poverty reduction strategies often focused on changing the conditions within distressed areas by renovating buildings, delivering services, or organizing residents to work collectively. However, increasingly, scholars and practitioners are recognizing that many services and opportunities that are needed for distressed communities are located outside their neighborhoods, necessitating better ways to connect residents to those services. For example, few Americans today work in the same neighborhoods where they live. When these issues are not considered in the transportation planning process, it is often the poorest and most disadvantaged that suffer the consequences.

As income inequality and economic segregation grows, connecting all Americans to economic opportunity will require a departure from business as usual. Creating a more just and equitable transportation system means considering equity issues in a wide range of transportation policies, from roadway design that accommodates diverse users to coordinated planning decisions that prioritize housing and transportation needs of underserved communities, to innovative approaches that leverage technology to better understand and meet the transportation needs of the working poor.

As trends continue to show the majority of population and employment growth occurring in suburbs, traditional transit investments are becoming an increasingly inadequate solution to connect low-income residents to quality housing and employment opportunities. For people who rely on public transportation, commuting to and from the suburbs can be costly and time consuming. For many poor families and individuals, access to an automobile for personal use could vastly increase their access to job and educational opportunities, their choice of neighborhoods to live in, and, ultimately, the likelihood that they or their children might escape poverty. Policies that reduce barriers to credit, subsidize membership in car-share services, or change welfare eligibility requirements regarding car ownership could improve access to automobiles for low-income residents. These policies are not without controversy, as some argue that they would contribute to increased congestion and pollution; however, they may be relatively inexpensive compared to investments in transit and more effective in reaching jobs and low-income residents increasingly located beyond the range of convenient transit services.



## Building Ladders of Opportunity

Together, we can address the opportunity gap and build a stronger and more connected nation, a healthier economy, and more vibrant communities. The U.S. DOT is leading the way through its Ladders of Opportunity initiatives. These include:

- U.S. DOT's Local Hire Initiative—A pilot program to allow recipients of federal highway and transit grants to give hiring preference to local residents, low-income workers, and veterans.
- Cross-Modal Connectivity Research—The U.S. DOT is using transportation research dollars to make data on job connectivity and environmental justice available to the public.
- Ladders of Opportunity Bus and Bus Facilities Grant Program—A \$100 million program to ensure that federal grants for transit help to connect Americans with mobility disadvantages to jobs.
- Improving Coordination and Participation in the Planning Process—Through research, guidance, and technical assistance, the U.S. DOT is taking steps to ensure that the transportation planning process considers the needs and voices of disadvantaged populations and economically distressed communities.
- LadderSTEP—The Transportation Empowerment Pilot has provided targeted technical assistance to seven cities to build Ladders of Opportunity.
- Every Place Counts Design Challenge—The Challenge calls on local officials to reimagine existing transportation projects to empower communities to reconnect people and neighborhoods to opportunity.

Emerging technologies may also help public agencies better meet mobility needs. Today, many of the most innovative models that leverage technology to serve urban transportation needs, such as ride sourcing, car sharing, and bike sharing, bypass low-income and minority communities. Yet it may be possible to utilize these and other emerging transportation technologies to better serve these communities. Boston, for example, is using social media outreach tools to engage low-income communities in the transportation planning process. In San Francisco, BART is partnering with ride-sourcing companies to provide first-mile and last-mile connections to connect underserved neighborhoods to job opportunities. Researchers are also looking at ways to make better use of

big data to better understand transportation needs and improve the design, operation, and coordination of transportation and social services.

Increased transportation investment can help create jobs for low- and middle-income workers. In metropolitan areas that have historically underinvested in transit, investments in rail and bus services that connect low-income neighborhoods to job centers can greatly improve the prospects for residents of those communities while supporting economic development. Investments may include expanding the transit system to afford greater access or increasing the reliability, quality, and frequency of service to shorten travel times and

make getting to work and other services more convenient and accessible. To support increased transit investments, policy makers could reduce funding siloes that lead to more than 80 percent of state and federal surface transportation funding being dedicated to highways. In addition, lawmakers could build upon pilot efforts to blend federal funds between housing and transportation elements that currently segregate funds. To ensure that transportation investments are made equitably across regions, MPOs could subject their transportation plans to rigorous equity analysis and seek to measure the impact of transportation capital programs on access to economic opportunity.

It should go without saying that transportation projects should benefit the residents that live nearby. But often the majority of transportation benefits go to those just passing through. To ensure that transportation investments benefit the neighborhoods in which they are built, more should be done to ensure that those investments provide access to employment opportunities for local residents. This includes planning transportation projects to connect residents to job centers. It also means ensuring that local residents are given a fair shot at the construction jobs created by transportation investments.

Improved coordination of transportation, housing, and land-use policies can help to address declining access to economic opportunity for low-income workers. Investments in transit can be made in coordination with policies that encourage the maintenance and development of affordable housing and the location of job centers along new and enhanced transit corridors. Public-private partnerships in support of transit-oriented development could help to increase the amount of affordable housing with access to transit. Federal transportation funding policies could be

established that disincentivize investments in highway capacity expansion that contribute to greater job sprawl and economic segregation. By addressing rising inequality and promoting equal opportunity, transportation policies can restore the economic health of disadvantaged communities and increasing the quality of life and social mobility of individuals and families, they can also strengthen national economic growth to the benefit of all Americans.

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# HOW WE ALIGN DECISIONS AND DOLLARS

## Introduction

When a bridge collapses, highway traffic stalls, or a tragedy occurs on a major transit line, Americans wonder not only what went wrong but whom to hold responsible. When a major road project takes years to build or the funding for a new project falls apart, Americans lack a clear line of accountability. Every level of government depends on others to ensure the effectiveness of the entire system.

The transportation decisions we need to make—to plan, fund, and build infrastructure, to safely operate our national airspace system, and to make our trains and buses run—have become increasingly complex. These decisions often require coordination across multiple government agencies and with the private sector, and this coordination often takes a lot of time. For example, building a new airport runway can easily take more than a decade: such a project requires planning and public meetings, billions of dollars of funding, financing from an array of sources at every level of government, an extensive environmental review, and permits from multiple federal and state agencies.

In the future, as metropolitan populations grow, and our economy expands and technology changes, it is likely that transportation decisionmaking will only become more complex and infrastructure will grow more costly. To respond to these trends—to make it possible

for projects to be carried out despite increasing complexity—governments will need to become smarter and more innovative. They will need to adopt strategies and technologies that allow them to improve coordination, streamline processes, increase efficiency and accountability, and make the best possible use of time and money. The future calls for more resourceful, responsive, and adaptive governance that can meet emerging challenges, and that can build and sustain a transportation system that meets the needs of current and future generations.

Planning a surface transportation project can be a complex and time-consuming process; major projects can easily take more than a decade to move from conception to completion. For instance, federally funded transportation projects must be identified through a federally certified state or regional transportation planning process. If a project might have a significant impact on the environment then it must go through an environmental review process. The environmental review process allows transportation officials to make project decisions that balance engineering and transportation needs with social, economic, and natural environmental factors. During the process, a wide range of partners, including the public, businesses, interest groups, and agencies at all levels of government provide input into project and environmental decisions. It can take major projects three years or more to go through the environmental review process.

# TRANSPORTATION INVESTMENT

Improving the condition and performance of the surface transportation system will cost **\$120 billion** annually for highways and bridges between **2015 and 2020.**



Current annual spending at all levels of government—federal, state and local—is just **\$88.3 BILLION.**



**\$43** BILLION annually for public transportation is needed.



Meanwhile, annual capital spending is just **\$17.1** BILLION.

This chapter describes how the transportation system is financed and governed, and concludes with policy options to address finance and governance considerations going forward. What role do we expect the various levels of government to play in ensuring the performance of our transportation system? How do we fund those different governmental agencies to perform those roles? How can we optimize transportation decision making to reduce inefficiency and overlapping authorities while still meeting varied local, regional, and national transportation needs? What role should the private sector play? These questions are often subject to fierce debates that we do not intend to resolve here. Instead, this chapter lays out in broad terms some of the trends underlying those debates and seeks to identify possibilities for change in the future.

## The Evolving Role of Government

The federal government and state and local governments and authorities each have distinct and evolving roles to play in supporting our transportation system. Federal involvement in transportation has evolved to address a core set of concerns. First, federal transportation programs allow for coordination across jurisdictions at a national scale to ensure consistent standards, interconnectivity of facilities, and sufficient investment in nationally beneficial infrastructure. Second, the federal government is uniquely positioned to raise funds and to spread the financial burden of supporting costly and critical transportation services. Finally, the federal government can promote national objectives, such as national security, environmental sustainability, economic expansion, and social welfare and equity.

Of course, as the history of transportation governance demonstrates, there are limits to federal power and effectiveness. Battles over limited resources, whether between southern and northern states, or urban and rural areas, have often divided Congress and limited federal support for initiatives that provided distinctly regional benefits. This holds true across all modes of transportation. The first transcontinental railroad was delayed as Congress debated whether the route should pass through free or slave states; today, part of the debate over federal transit and intercity rail funding is over their limited regional applications. In fact, some federal transportation programs allocate resources to areas with less demand that are less able to pay for the full value of a particular service, in order to ensure that those areas maintain access to transit, rail, or aviation services.

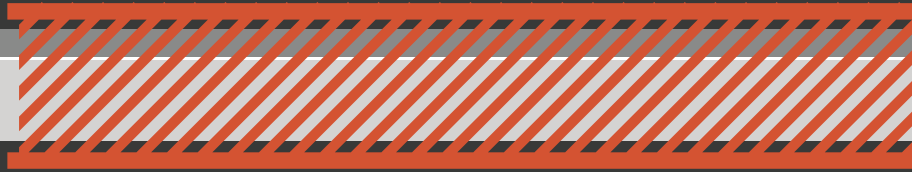
As the transportation system has grown and become more complex, the federal role has changed as well. Federal support for transportation modes has created constituents with a distinct interest in preserving federal support, even while some have promoted more devolution of authority to state and local levels. In addition to these challenges, governments at all levels face challenges coordinating across modes and jurisdictions, generating sufficient revenues to maintain performance, and efficiently allocating resources.

The federal role varies greatly by the type of transportation it supports. Highways are funded by a mix of federal, state, and local funds, but the federal government owns and maintains only a small portion of our nation's roads, and most decisions about where and how to invest in transportation are made by state and regional governments. Transit agencies are mostly local and regional organizations funded through a

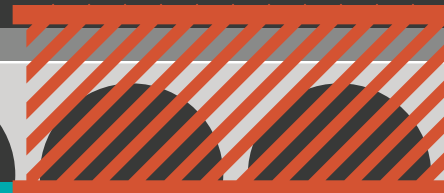
# STATE OF REPAIR

To compete in the global economy, the U.S. needs a world-class transportation system. Some of our most critical transportation infrastructure is crumbling.

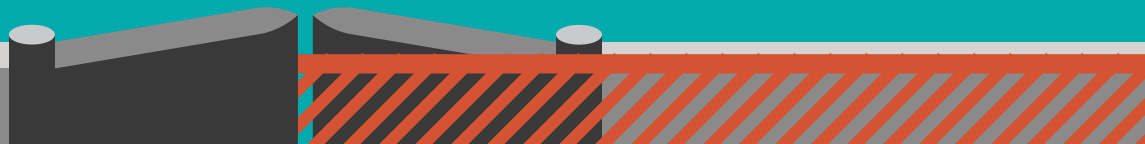
**58%** of U.S. roads are in less than good condition



**23%** of U.S. bridges need significant repair or can't handle today's traffic



**50%** of U.S. locks and chambers are more than 50 years old





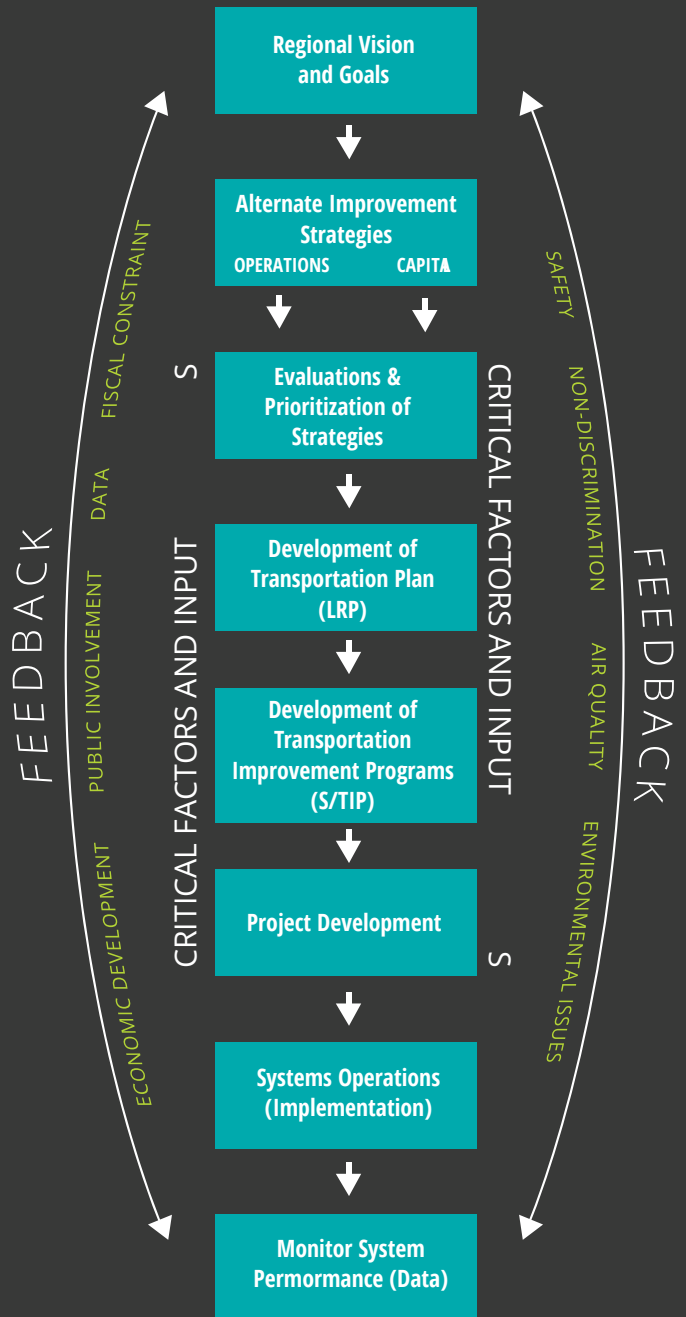
mix of fare box revenues and government subsidies. Railroads, on the other hand, are privately owned and operated, with the notable exception of Amtrak. Our air traffic control system is operated by the federal government, while airports are typically locally run authorities.

## Coordinating Decisions

Decentralization of decision making can help to ensure investment in projects that local residents value. In the 1960s and 1970s, some local citizens and city governments protested against a highway planning process that was largely controlled by state highway engineers. At its peak in 1960s, federally funded construction of highways demolished tens of thousands of housing units each year, the majority in low-income and minority communities. The highway revolts demonstrate how centralized decisionmaking can lead to decisions that disregard local concerns and cause harm to local communities.

Today, federally mandated planning and environmental review processes are designed to ensure that community stakeholders have a voice in the transportation decisionmaking process. However, these same processes are often blamed for slowing or preventing the delivery of needed transportation projects and driving up transportation costs. It can take more than a decade to complete the planning and environmental review process for an infrastructure project such as a new runway, as such projects require comprehensive study and coordination across multiple jurisdictions and public agencies.

# OVERVIEW OF THE TRANSPORTATION PLANNING PROCESS



## Obstacles to Metropolitan Planning: The Challenge of Coordination Across Boundaries

The challenges of interagency coordination are especially pronounced in Florida, where a large number of county-based MPOs, transit operators, airports, seaports, and toll authorities share responsibility for the transportation network. This governance structure means that groups of agencies make joint decisions for regions that might be better served by a single regional planning entity. In light of this fact, 22 of the state's 26 MPOs have entered into formal partnerships to coordinate regional transportation planning activities. In the Tampa Bay Area, seven regional planning organizations have formed the West Central Florida MPO Chairs Coordinating Committee (CCC) to collaboratively address the region's transportation needs. While alliances like these exist to reconcile local goals and streamline collaborative decisionmaking, interagency coordination often adds a costly and time-consuming layer to the transportation planning process. When not done effectively, this approach can result in project delays, poor public involvement, inefficient investments, and a confused decision-making process.

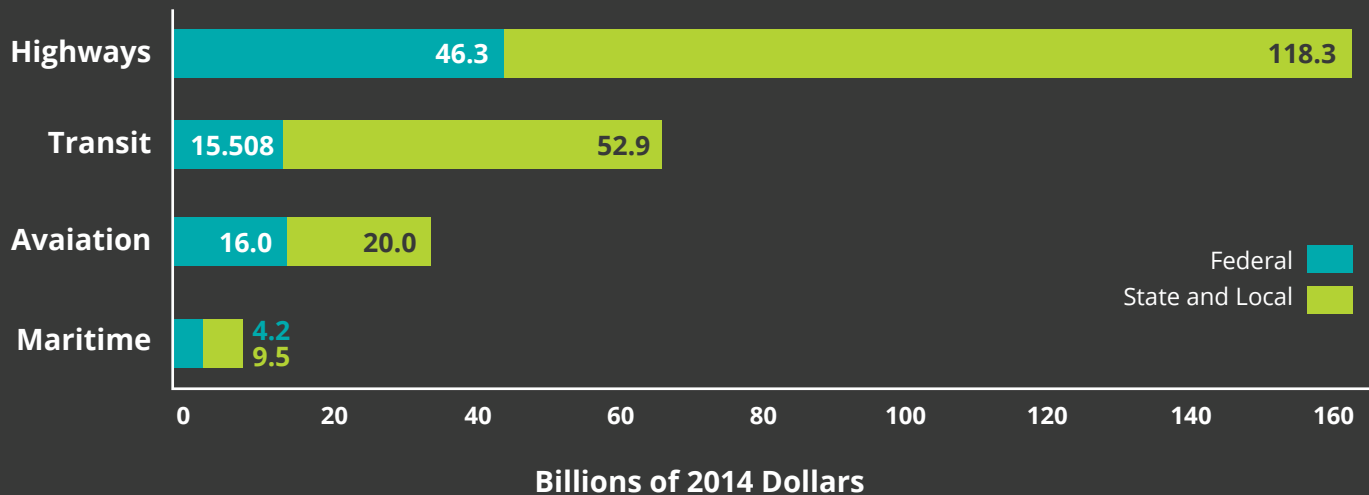
As local responsibility over transportation decisionmaking has increased, and the number of local governments and independent authorities has grown, the coordination of transportation programs has become increasingly difficult. The federal government provides funding for transportation and sets policies and goals that serve to guide investments of federal funding, but it does not take a direct role in land-use decisions. Instead a large number of organizations share authority over surface transportation and land-use decisions, including state agencies, municipal governments, metropolitan planning organizations (MPOs), port authorities, transit operators, the business community, and others, all of which have various ownership, operations, and planning authorities that affect the transportation network.

This multilayered decision-making process can pose challenges for efficient network development and require time-consuming interagency coordination. As metropolitan areas

continue to expand and responsibilities for planning, financing, permitting, constructing, and operating infrastructure become more and more fragmented, it has become increasingly difficult to reconcile local goals while ensuring transportation investments are efficient at a regional level. The necessary process of developing a consensus among numerous transportation agencies, local governments, and community stakeholder groups with varying objectives often leads to delays and inefficiencies in delivering projects.

For example, roads that are part of the Interstate Highway System are subject to certain standards and are usually maintained by a state DOT. County or city streets are designed, operated, and maintained by counties or local municipalities. Transit systems are often built, operated, and maintained by a separate entity. In metropolitan areas, the MPO is responsible for actively seeking the participation of all relevant agencies and stakeholders in the planning

# Total Federal, State and Local Transportation Funding



process; similarly, the state DOT is typically responsible for activities outside metropolitan areas.

Increasingly, metropolitan areas are the locus for the vast majority of our nation’s economic and population growth. MPOs are responsible for planning transportation investments in these areas and to do so they must coordinate with state DOTs as well as local transit operators, development agencies, local governments, environmental resource agencies, tribal governments, ports, airports, and railways within their boundaries. But addressing issues like air pollution and traffic congestion often requires coordinating across jurisdictions to achieve regional transportation planning solutions. As metropolitan areas grow in size and population, traditional jurisdictional boundaries are becoming blurred. This increases the impetus for regional cooperation across planning agencies to address issues that do not stop at state, city, or county lines.

## Funding Scarcity

Since the mid-1990s, inflation has eroded the purchasing power of federal transportation funds by nearly 40 percent and the balances of most dedicated transportation trust funds have declined as outlays have exceeded revenues. Federal fuel taxes per gallon have not been increased since 1993. Similarly, per capita vehicle miles traveled (VMT) decreased between 2005

FOLLOWING THE EXPIRATION OF A MULTI-YEAR FUNDING BILL IN 2007 FOR THE FAA’S LONG-TERM AUTHORIZATION, THE FAA WAS FUNDED BY 23 SHORT-TERM EXTENSIONS BEFORE CONGRESS PASSED A MULTI-YEAR AUTHORIZATION IN 2012.

and 2014. Fuel economy standards have also increased over this same period; the average fuel economy of a passenger vehicle increased by 12 percent leading to reductions in fuel use and reduced fuel tax revenues.

Today, funding constraints motivate many major transportation decisions across all modes. As public revenues have become increasingly scarce relative to the costs of maintaining, operating, and expanding infrastructure assets, public agencies have had to find ways to do more with less and, in some cases, scale back services. Often funding scarcity constrains options in ways that are ultimately detrimental and inefficient; for example, forcing public agencies to defer maintenance such that the lifecycle costs associated with repairs increase.

The growing scarcity of federal funding has led some state and local governments to seek to generate additional revenues to pay for a greater share of infrastructure across all modes. In aviation, passenger facility fees, first authorized by Congress in 1990, now contribute to more than 30 percent of airport capital investment. Following the recession of 2007, state and local governments faced sharply declining revenues and spending cutbacks. Governments at all levels had to make difficult tradeoffs and find ways to do more with less. Adjusted for inflation, federal, state, and local spending on surface transportation fell by \$29 billion, or 12 percent, between 2002 and 2012.

One major exception to the trend in declining surface transportation spending was the American Recovery and Reinvestment Act of 2009 (ARRA). Passed in direct response to the economic crisis, ARRA included \$27.5 billion in federal funding for highways, \$8.4 billion for transit, \$9.3 billion for passenger rail, and \$1.5 billion in multimodal infrastructure grants.

Some states, such as California, Maryland, Massachusetts, Vermont, and Wyoming have raised state gas taxes and more than 30 states have passed transportation-related fiscal initiatives in recent years. In California, regional and local governments now provide 49 percent of all transportation funding, while the federal government provides less than a quarter. County-level sales taxes in California generate nearly \$4 billion annually for transportation.

However, nearly half of all states have chosen not to raise their gas tax over the past decade. Other states have found alternative ways to fund transportation spending by, for example, dedicating a portion of the state sales tax to transportation or raising vehicle registration fees. States have increasingly used debt to fund transportation projects. States' use of debt to fund highway projects tripled over the past decade.

At all levels of government, user fees have declined as a portion of surface transportation revenues. In 2000, user charges accounted for more than 95 percent of all federal highway revenues. By 2010, less than half of all federal highway revenues were derived from user charges as a result of the use of General Funds to cover Highway Trust Fund (HTF) shortfalls. Stimulus spending on transportation projects following the Great Recession was drawn from the General Fund. Lower-than-expected federal fuel tax revenues have also led Congress to supplement the Highway Trust Fund with transfers from the General Fund and other revenue sources. The portion of state highway revenues derived from user charges also declined—from 74 percent in 2000 to 56 percent in 2010.

Public transit system revenues are also covering a lesser share of operating costs than was

previously the case. In 2014, public transit systems recovered 36 percent of operating expenditures from system-generated revenues, down from 45 percent in 2000.

Airport and Airway Trust Fund excise tax revenues have fluctuated since 2000. A number of factors, such as external events and general economic conditions, contributed to this fluctuation in revenues because they affect the number of tickets purchased, the fares paid by passengers, the amount of fuel purchased, and the value of air cargo shipped. For example, revenues declined early in the decade because of a series of largely unforeseen events, including the September 11, 2001, terrorist attacks, which reduced the demand for air travel, resulting in a steep decline in airline industry revenue. Similarly, during the recent recession, Trust Fund revenues declined from \$12 billion in fiscal year 2008 to \$10.9 billion in fiscal year 2009, in part because of the decline in domestic passenger traffic during that period. Trust fund tax revenues reached \$12.5 billion in fiscal year 2012 and \$13.5 billion in fiscal year 2014. In recent years, FAA budget resources received from General Fund revenues have averaged about 28 percent annually.

## Declining Trust Funds

Over the past decade, Congress has struggled to pass timely long-term transportation authorizations. The last five-year transportation act—the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)—was passed in 2005 after a two-year delay. Moving Ahead for Progress in the 21st Century (MAP-21), passed in 2012, authorized spending for just two years and was passed after nearly a three-year delay. On December 4, 2015, President Obama signed the Fixing America’s Surface Transportation Act (FAST Act) into law,

U.S. DOT IS BOLSTERING EFFORTS TO DEVELOP STANDARDIZED PERFORMANCE MEASURES FOR SURFACE TRANSPORTATION THAT REFLECT FEDERAL GOALS. IN SOME AREAS, ACHIEVEMENT OF PERFORMANCE TARGETS WILL BE TIED TO A SMALL PORTION OF FEDERAL FUNDING FOR STATES.

after 36 short-term extensions, marking the first long-term transportation bill passed by Congress in 10 years.

Uncertainty about federal funding leads to delays in planning and constructing transportation projects and can raise the cost of issuing debt. The critical issue facing Congress in recent years, given unprecedented declines in gas tax revenues as fuel economy has improved and per capita driving has decreased, has been identifying sufficient revenues to fund a long-term surface transportation program without enacting dramatic cuts to spending. Since 2001, Congress has authorized greater federal spending on highways and transit than the HTF has accrued in receipts from highway excise taxes and outlays from the HTF have generally exceeded revenues on an annual basis.

Rather than raise fuel tax rates or reduce outlays, Congress has supplemented federal transportation funding on an ad-hoc basis. Between 2007 and 2014, Congress has transferred more than \$60 billion from the Treasury’s General Fund to the Highway Trust

Fund. MAP-21 was funded through transfers from the General Fund and from the Leaking Underground Storage Tank Trust Fund. To offset the cost of these transfers, Congress has enacted provisions unrelated to transportation. For example, in the last extension of MAP-21, Congress offset transfers to keep the HTF solvent through May 2015 and by allowing companies to reduce the amount they contribute to pension funds and extending customs service fees for one year, from 2023 to 2024. The FAST ACT, passed in December 2015, provides the Highway Trust Fund an additional \$70 billion in transfers from the General Fund over the next five years to make up for federal gas tax shortfalls. By 2020, when the FAST Act authorization comes to an end, federal gas tax shortfalls will have grown to \$24 billion annually, or the equivalent of a 12-cent per gallon tax increase.

The Inland Waterways Trust Fund (IWTF) supports the construction and rehabilitation of capital projects on U.S. inland waterways. Approximately \$80 million annually is generated for the IWTF from a fuel tax on vessels using inland waterways. The balance of the IWTF has declined over the past from around \$400 million in 2001 to slightly more than \$100 million today largely due to greater than expected costs to construct the Olmsted Locks and Dam on the Ohio River. To support new construction and major rehabilitation of our inland waterways, Congress increased the per gallon tax on barge fuel from 20 cents to 29 cents in 2015.

The expiration in 2007 of the FAA's long-term authorization was followed by 23 short-term extensions before Congress passed a multi-year authorization in 2012. An authorization lapse in 2011 led to a two-week partial shutdown of the FAA in 2011 that required the FAA to stop construction projects and then restart them. The Airport and Airway Trust Fund lost an estimated

\$400 million in revenues from the lapse in authority. Operating under a long series of short-term extensions complicated agency operations and made it difficult for FAA to carry out long-term planning and strategic development of future technologies and innovation. In 2016, Congress again extended FAA authorization for almost a full year, through the end of September 2017.

## Policy Trends and Options

Governments can address the challenge of funding scarcity through a range of approaches, including better allocation of limited resources, more efficient delivery of projects, and increased revenues. Many governments are deploying these approaches in combination through use of innovative financing. Recently Vermont and Maryland have increased sales taxes on gasoline to raise transportation revenues. The Commonwealth of Virginia, for example, has both raised taxes to fund transportation and embarked on an ambitious program of public-private partnerships which use private financing to incentivize the accelerated delivery and efficient management of transportation projects.

## Focusing the Federal Role

Experienced observers from think tanks representing views from across the political spectrum have called for the establishment of a more focused, goal-driven, mode-neutral, and performance-based federal transportation program. Some have argued that federal transportation spending could be brought more closely in line with federal transportation revenues by limiting the federal role to focus on funding those projects of national and regional significance that increase national economic competitiveness as demonstrated through rigorous benefit-cost analysis. Nonprofit policy think tanks have proposed consolidated,

## TIFIA Loan Helps Extend Transit Service in Los Angeles

In response to declining transportation revenues, many transportation agencies are using innovative finance mechanisms to fund much needed transportation infrastructure. The Los Angeles County Metropolitan Transportation Authority (LACMTA), for example, recently received \$2.1 billion in federal support to help build the 9.4-mile Westside Purple Line Extension project from downtown Los Angeles to Beverly Hills, the University of California, Los Angeles, and the Westwood Veterans Affairs Hospital. LACMTA will receive \$1.25 billion in construction grant funds from FTA's Capital Investment Grant program and \$856 million from the U.S. DOT's TIFIA federal credit program. LACMTA will repay the TIFIA loan with revenues from a voter-approved retail sales tax. As transportation projects struggle to get off the ground nationwide, innovative funding mechanisms will remain a popular strategy for investing in beneficial projects that help communities such as the Los Angeles plan for a livable, sustainable future.

competitive, non-modal federal funding programs that set performance standards and incentivize improved performance. Some transportation policy experts have proposed directing funding to improve the conditions of existing infrastructure first and foremost, while financing new capacity projects through federally subsidized bonds and loans, and non-federal revenue sources.

Geographic equity concerns increase the challenge of allocating federal funding on the basis of performance, or to focus funding programs on areas with the most need. Geographic equity is considered by many to be essential for gaining national support for federal transportation programs, but the goal of equitably distributing funding across states or regions often conflicts with the goal of providing funding where it will have the greatest impact on transportation system performance. These concerns extend across every mode. With surface transportation, the concern is that sufficient federal gas tax revenues are distributed to small and rural states. In aviation, federal

funding is provided to ensure the availability of air services for small and rural areas. Federal funding for Amtrak is provided to subsidize service on national routes that incur large operating losses. In transit, projects are often funded to extend service to new areas with less ridership rather than invest in improvements in service quality where ridership is high. These same tensions concerning the geographic equity of transportation investments exist at all scales, within states, regions and cities.

## Performance Management

Transportation agencies in all modes and at all levels are increasingly using performance measures and data to inform decisions and increase accountability. State and local agencies utilize these practices to demonstrate to the public that they are good stewards of taxpayer dollars and that transportation infrastructure is a worthwhile investment.

A study by the Pew Center and the Rockefeller Foundation found that over the past 30 years

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## Virginia's I-495 Express Lanes P3

A few states, such as Virginia and Florida, have used P3s to successfully deliver a number of major projects. For example, the I-495 Express Lanes added dynamically tolled express lanes to a 14-mile stretch of the Capital Beltway in Virginia through a public-private partnership. An innovative design proposed by the private sector minimized property takings and drove down project costs. The \$2 billion project, which involves an 85-year concession to a private entity to design, build, finance, operate, and maintain the express lanes, was ultimately financed using \$589 million in private activity bonds, \$348 million in private equity, a \$589 million federal TIFIA loan, and \$409 million grant from the Commonwealth of Virginia. The financing will be repaid with income from toll revenues.

public agencies have developed increasingly sophisticated measures to guide asset management and safety decisions. However, few state agencies have found effective ways to accurately measure how transportation investments can affect outcomes in critical goal areas such as economic development and environmental sustainability. The Pew Center report identified 13 states including Washington, California, Virginia, Minnesota, and Missouri that are leading the way on the use of performance measures to guide decisions across a range of goals. Washington State, for example, has used performance measures to demonstrate to voters and the state legislature how a 5 cent per gallon increase in the state gas tax funded projects to improve safety, mitigate congestion, reduce emissions, and support economic development.

At the federal level, most transportation funding is currently allocated on the basis of formulas that are not directly tied to performance, such as population or lane miles. Under the FAST Act approximately 92 percent of federal highway funding and

80 percent of transit funding is distributed by formula to state DOTs, which are responsible for investment decisions. Few federal transportation programs use performance-based criteria to award funding.

MAP-21 marked a significant step toward making federal surface transportation programs more performance-based. MAP-21 defined seven national goal areas and performance planning and reporting requirements for a number of surface transportation programs. MAP-21 established the National Highway Performance Program which defines measures for states to use to assess and report pavement and bridge condition. It requires that safety performance measures be established for carrying out the Highway Safety Improvement Program and that traffic congestion and emissions measures be established for the Congestion Mitigation and Air Quality Improvement Program. The FAST Act continues these requirements.

As established by MAP-21 and continued under the FAST Act, states and MPOs are required to develop a number of performance-based plans including: Metropolitan Transportation Plan, Statewide Transportation Plan, Asset

Management Plan, Strategic Highway Safety Plan, CMAQ Performance Plan, and State Freight Plan. Several federal highway programs now have performance-based rules that require funding set-asides if performance in a particular goal area falls below established standards. MAP-21 also authorized NHTSA to establish national performance measures for motor vehicle safety, which must be reported on annually in state highway safety plans.

Several prominent examples of competitive, multimodal, discretionary federal transportation programs have been used to support innovative, multimodal investments that meet federal goals. The Transportation Investment Generating Economic Recovery or TIGER, Program, is a competitive grant program that was initiated as part of ARRA in 2009. TIGER grants fund planning and capital projects across different surface transportation modes. TIGER was originally funded for \$1.5 billion, and it has subsequently been renewed seven times. Since its establishment in 2009, the TIGER grant program has provided a combined \$5.1 billion to 421 projects in all 50 states, the District of Columbia, Puerto Rico, Guam, the Virgin Islands, and tribal communities. These federal funds leverage money from private sector partners, states, local governments, metropolitan planning organizations, and transit agencies. The 2016 TIGER program alone is leveraging nearly \$500 million in federal investment to support \$1.74 billion in overall transportation investments. In total, the Department has received more than 7,300 applications requesting more than \$143 billion for transportation projects across the country. Criteria for grant awards included stipulations from Congress that awards be equitably distributed across the country and balance the needs of urban and rural communities.

## Innovative Finance

Facing limits on transportation revenues, states are increasingly turning to tax-exempt bond markets and innovative funding mechanisms to finance transportation infrastructure. State and local municipal bond issuances for highways have tripled since 2000, as states have sought to take advantage of low interest rates on bonds to advance urgent transportation projects.

Beyond the municipal bond market, innovative financing for infrastructure investment is becoming increasingly important as public budgets continue to tighten at all levels of government. Through programs such as the Transportation Infrastructure Finance and Innovation Act (TIFIA), the Railroad Rehabilitation and Improvement Financing Program (RRIF), and tax-exempt qualified private activity bonds (PABs), U.S. DOT plays a particularly important role in supporting innovative finance for projects across the country. Interest in these programs has increased in recent years. These funding tools apply to transportation projects across modes. Highway, transit, railroad, intermodal freight, and port access projects are all eligible for federal credit assistance through the TIFIA program. Any form of transportation project receiving federal assistance is eligible for PABS. Freight rail projects and intermodal facilities are eligible for assistance under the RRIF Program.

The TIFIA program provides federal credit assistance in the form of direct loans, loan guarantees, and standby lines of credit to partially finance transportation surface transportation projects at low interest rates. The FAST Act authorizes \$275 million to \$300 million annually for the TIFIA program, which can be leveraged to provide as much as \$3 billion in credit assistance. Loans are repaid by revenues generated by revenues generated by

## Building Communities: The Economic Benefits of Transportation Projects

Transportation plays a major role in promoting economic growth, livability, and opportunity in communities across America. Transportation projects create new jobs, expand the gross regional product, increase property values and tax bases, and improve the overall quality of life. Transportation supports economic growth through short-term stimulus impacts and longer-term impacts on economic productivity. In assessing the economic development impacts of transportation, economists at University of Minnesota's Center for Transportation Studies have demonstrated that careful investments and well-designed transportation projects can yield substantial economic benefits that greatly exceed overall project costs.

Consider, for example, the case of East St. Louis, Illinois an industrial suburb. For decades, the city's economic and demographic situation has been bleak; the city lost more than two-thirds of its population between 1950 and 2010 as a result of deindustrialization and economic decline. Despite these challenges, in the early 2000s planners and citizens were able to capitalize on the eastward expansion of the St. Louis light rail system—MetroLink—to enact a transportation vision that promised a brighter future for the area. The construction of a MetroLink station in the Emerson Park neighborhood helped link low-income residents with job opportunities in the Greater St. Louis area and spurred a series of transit-oriented affordable housing projects for local residents. The rail station also helped persuade lenders to finance mortgages and began to attract developers, retailers, and employers to the area. More than 10 years later, the station is still spurring economic development, including a recently opened \$22 million mixed-use apartment complex.

the projects—through tolls, for example—or committed to the project by sponsor agencies.

Interest in TIFIA has grown in recent years. The rate and structure of TIFIA loans are attractive to many states seeking alternative ways to finance major transportation projects. The FAST Act creates the National Surface Transportation and Innovative Finance Bureau to serve as a one-stop shop for state and local governments to receive federal funding, financing, or technical assistance.

The RRIF program is authorized to provide direct loans and loan guarantees up to \$35 billion to finance development of railroad infrastructure. Up to \$7 billion is reserved for projects benefiting freight railroads other than Class I carriers. Direct loans can fund up to 100 percent of a railroad project with repayment periods of up to 35 years and interest rates equal to the cost of borrowing. Under the FAST Act, RRIF loans can now also be used to finance commercial and residential development near passenger rail stations.

Some state and local governments have entered into public-private partnerships (P3s) to finance, construct, and operate transportation infrastructure. The goal of P3s is to deliver projects more efficiently by expanding the role of the private sector. Because P3s typically take more resources to evaluate and procure than conventional projects, and private financing costs are often higher than the costs of public financing, P3s are only appropriate for complex, high-risk projects. Consequently, P3 investments account for only a small portion of overall transportation investments. Between 2007 and 2013, \$22.7 billion of public and private funds was invested in P3s, about 2 percent of overall capital investment in the nation's highways during that same period.

P3s can provide an alternative source of financing that can accelerate projects and save taxpayers money when used appropriately under the right circumstances. However, P3s should not be considered as a source of funding for transportation infrastructure, but rather as a form of financing which will be repaid by public users. In a P3, the private firms invest equity upfront to help pay for the design and construction costs of the project, but, over the long run, they seek competitive rates of return on those investments. Those returns are typically paid through tolls on the constructed facility or by annual payments from the public partner.

P3s face a number of challenges, including estimating the value of delivering a project through a P3, estimating the lifecycle costs of a project, and the expected project revenues, and estimating the value of transferring risk to the private sector. Another significant obstacle is the patchwork of legal environments and procurement practices that differ across states, raising transaction costs for investors. In addition, state and local governments are very familiar

with traditional municipal bond financing of infrastructure projects, which thus becomes the default approach, even on projects for which there are opportunities for long-term net savings through well-designed P3s. Some P3s have also been criticized for providing overly generous terms or subsidies to private, for-profit firms. Policymakers may also lack the political will either to implement enabling legislation or to increase revenue streams through tolling and other approaches.

### Alternative Revenues

Federal and state governments are increasingly turning to alternatives to the gas tax for funding transportation infrastructure. Gas tax receipts are declining as cars and trucks become more fuel efficient and growth in highway travel slows. In the face of political challenges to raising fuel taxes and declining prospects for future revenues, state and local governments have sought alternative revenue sources to finance transportation.

At the state level, states such as Massachusetts, Maryland, New Hampshire, and Wyoming have raised state gas taxes in recent years. Some states, such as Pennsylvania and Virginia, have transitioned from a traditional gas tax levied as a flat amount per gallon to a sales tax at the wholesale level. Others have dedicated a portion of the state sales tax to transportation funding or

OPEN SKIES AGREEMENTS  
ARE ESTIMATED TO HAVE  
LOWERED TICKET COSTS AND  
INCREASED DEMAND FOR  
INTERNATIONAL FLIGHTS.

have raised license, registration, and excise fees on vehicles. A number of states have turned to tolling and priced express lanes, in particular, to deliver projects that expand roadway capacity while managing congestion.

Local governments have also demonstrated success raising taxes for transportation, often in exchange for a dedicated program of projects. For example, local options for sales taxes have been used to fund the expansion of transit systems in Los Angeles, Denver, and Seattle. In Portland, Oregon, the city used a variety of funding sources, including special assessments on local businesses and tax increment financing, which captured property tax revenues generated by increasing property values, to help finance a 15-mile streetcar network.

## Value Capture

Some localities have experimented with more innovative forms of revenue, such as value capture and transportation utility fees. Value capture strategies can include a variety of mechanisms to capture a portion of the value generated by increases in land value near transportation improvements. Value capture can take the form of improvement districts where property owners and businesses agree to pay annual fees to fund a transportation improvement. Tax increment financing districts are another form of value capture where a portion of future property taxes resulting from increased property values is used to pay for infrastructure. Transportation utility fees are charged to residents and businesses on the basis of the type of business or residency and the number of trips they are estimated to generate.

## Mileage Fees

Vehicle-miles-traveled (VMT) fees are charged to drivers based on the miles they drive. Devices

can be installed in vehicles to securely collect mileage data, data can be collected by satellite, or drivers can self-report usage. VMT fees have been piloted by Oregon and in 12 cities as part of a federally funded national evaluation. VMT fees are increasingly considered as a long-term solution to transportation revenue needs.

The advantage of VMT fees is that they are a more direct user fee. Revenues will not erode as vehicles become more efficient. If used in conjunction with a global positioning system (GPS), rates could be varied based on the geographic location of the vehicle or the time of travel. Such widespread congestion pricing could result in savings from reduced delays and fuel consumption equaling more than \$20 billion annually. However, implementing VMT taxes is far more technically challenging than collecting gas taxes. There are also privacy concerns to consider as citizens may fear that the government could use GPS data to track their whereabouts. One way to protect the privacy of citizens would be to restrict government's access to data about where people are traveling by using independent private services to scramble the data and manage billing.

## Tolling

Many state and local governments have also begun implementing tolling strategies to raise revenue for transportation infrastructure. Not only can tolling be used to generate revenues to fund the construction of new highway capacity and to maintain existing capacity, it can also be used to manage congestion on a facility. Dynamic tolling, in which toll rates change based on the time of day or level of congestion, is particularly well suited to this role.

Tolling has also increased as a strategy to fund highways, bridges, and tunnels. Since 1992, tolls

as a portion of state and local highway revenues have increased from 6 to 9 percent. Tolling is a more direct user fee than the gas tax, but it is more costly to collect than the gas tax. However, with the advent of electronic toll collection and mobile payment technologies, tolling has become more cost-effective and convenient. Tolling has increasingly been used to fund the construction and maintenance of price-managed lanes—or dedicated toll and high-occupancy vehicle (HOV) lanes.

Federal law currently restricts the use of tolls on interstate system routes. However, beginning with the enactment of the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991 and through succeeding federal surface transportation authorization acts, several exceptions to restrictions on tolling have been provided. Tolling can be used on new facilities and on bridges and tunnels that are reconstructed or replaced. These include special pilot programs that were established to allow tolling on a limited number of interstate segments for the purpose of funding reconstruction and rehabilitation of the interstate. However, none of these pilots have been implemented to date.

## International Cooperation

Over the past 30 years, the global economy has become increasingly integrated. More global travel and trade has made international government cooperation more important than ever. Issues requiring international cooperation include setting safety and security standards for international travel, pursuing standards harmonization for transportation industry products, seeking greater regulatory cooperation, facilitating market access and promoting international trade, and addressing global environmental issues.

For example, Open Skies civil aviation agreements— an international service agreement between two or more nations, designed to loosen rules and regulations of international aviation—especially for commercial aviation— led to international travel and economic growth, by reducing government involvement in commercial airline decisions about routes, capacity, and pricing. The U.S. has pursued Open Skies agreements with international partners since 1992 and there are now more than 100 agreements in place covering 70 percent of international departures. By opening up international aviation, Open Skies agreements improve flexibility for airline operations, boost local economies, and strengthen and expand economic and cultural links with foreign countries.

In our globalized economy, international cooperation is needed to ensure compatibility and consistency as technological advances are adopted in aviation and marine transportation, vehicle safety and fuel efficiency, and international transportation systems. International research collaboration can promote innovation to address the common transportation problems faced by countries and individuals.

International cooperation is critical to addressing global environmental issues. For example, to address air pollution and emissions, the U.S. and other countries have worked cooperatively to establish marine fuel quality and engine emissions standards for international shipping. The United States is also working with the United Nations International Civil Aviation Organization to find ways to address aircraft emissions caused by international air travel through coordinated action and cooperative research and the development of new technologies.

## Policy Implications

Transportation agencies at all levels and across all modes face serious financial challenges that limit their ability to maintain our existing transportation system, let alone invest in the transportation system of tomorrow. While the American public believes in the importance of transportation, they are unable to agree on how to pay for it. Some are not convinced that governments will make efficient use of new revenues. Others want to be assured that tax dollars and other investments are distributed to the region where they live, or to the mode that they use.

The last 20 years have been marked by a shift from transportation system expansion to system preservation. The federal gasoline tax was last raised in 1993, just a couple of years after the last major segments of the interstate highway system were completed. Today, the bulk of transportation funding goes to preserving and enhancing existing facilities. For example, one of the most costly transportation projects currently underway is the \$2.3-billion reconstruction of a 21-mile stretch of Interstate 4 through Orlando, which will preserve the existing corridor while adding additional lanes of traffic to accommodate a growing metropolis.

Some of the largest projects are to replace structurally deficient bridges. Replacement of the Tappan Zee Bridge in New York will cost an estimated \$3.9 billion, while the replacement of the San Francisco Bay Bridge cost \$6.4 billion. The bulk of ARRA transportation funding went to projects to repair and rehabilitate existing systems rather than expand capacity. In this era of scarcity, visionary capacity building projects, like the development of high-speed rail corridors, face intense scrutiny and skepticism.

As resources have become increasingly constrained, governments are being forced to make hard choices about whether to maintain services on roads and facilities that are less economically important. The use of enhanced data on the location and conditions of infrastructure and the location and characteristics of safety incidents have become increasingly important to public agency decision makers to guide resources to where they can be used most effectively to preserve the system and to demonstrate to the public that their tax dollars are put to good use. Asset management data help transportation agencies make investments that minimize lifecycle costs. Public agencies are using safety data to assess risks and guide the implementation of countermeasures.

Even as public agencies increasingly rely on data to support decisions, they can also use those data and the growing number of sophisticated digital communications tools to educate and engage the public in the decision-making process so that more voices are heard. Performance measures can help agencies communicate to the public the needs and potential benefits of transportation investments and strategies. Social media can be leveraged, not just to alert system users of potential delays or hazards, but to engage the public in planning and visioning processes, or even to crowdsource data collection and tactical problem-solving activities.

Increasingly, governments are looking for ways to transfer risks and responsibilities for managing transportation systems to the private sector. However, the private sector tends to be interested in assets from which it can generate a competitive rate of return. Governments are also developing strategies to leverage revenues through finance to bring private and public funding to the table to fund projects in the public interest. In the absence of robust federal

support, local governments have increasingly sought ways to develop their own revenues to fund transportation projects that directly benefit those localities. But, ultimately, the performance of America's transportation system depends on planning and making decisions at a regional and national level that benefit the performance of the network as a whole. And, it is the federal government's responsibility to ensure the sustained performance of this interconnected multimodal, national transportation system.

Over the next 30 years the nation will need to embrace reforms to improve the effectiveness of transportation governance. A wealth of policy options exist that can improve transportation governance and finance, including:

- Developing measurable national transportation objectives that tie performance to incentives or consequences for recipients of federal funding.
- Incentivizing coordination across jurisdictions, and the development of local revenues.
- Strengthening planning and project development at the regional level.
- Improving data collection and analysis capabilities to enable transportation programs to become more performance-based.
- Quantifying the economic benefits and lifecycle costs of projects to aid in maintenance and investment decisions.
- Developing revenue vehicles that can provide sustainable, predictable revenue streams that support efficient, long-term planning decisions for both capital expenditures and operating expenses.

- Facilitating access to credit assistance for transportation projects and establishing policies that level the playing field for states and municipalities seeking to deliver transportation infrastructure through public-private partnerships.
- Reforming the project delivery process by improving coordination and streamlining permitting and oversight.
- Using pricing and market-based solutions when appropriate to efficiently manage demand and to reduce regulatory burdens on travelers and industry.

These policy options are explored in further depth in the conclusion of this report.

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# SYSTEM IMPLICATIONS

How will trends affect the different components of the transportation system? We must examine implications for each mode.

This part of the report explores how the trends we have just presented will affect the transportation system's modal components.

Each "modal" section, in addition to describing the implications of the major trends, discusses trends in safety and physical infrastructure conditions, or state of good repair.

The modal sections are as follows:

- Highways
- Pedestrians and Cyclists
- Public Transit
- Aviation
- Intercity Rail
- Maritime
- Pipelines

The modal sections are preceded by a discussion of travel demand.

# WHY DO PEOPLE TRAVEL

To understand trends in transportation demand, we must understand why people travel. The most common reasons are to commute to and from work, to travel to school and religious services, to shop, to go on vacation and visit friends and relatives, and to travel for business purposes. Personal travel makes up about three quarters of all highway travel. Freight movement, public-vehicle travel, and utility-services travel make up the remaining quarter of travel on roads.

People travel much more today than they did 30 years ago. Over the past 30 years total VMT nearly doubled; VMT per capita increased by approximately 40 percent. Today there are 93 million more registered vehicles and 58 million more licensed drivers on our roads than there were 30 years ago. Indeed, travel by all modes has been increasing. Both passenger rail and public transit travel have increased by more than a third. The largest increase is in commercial aviation, where passenger miles traveled has more than doubled. However, as described in the How We Move section, the trend in growth in per capita travel may be slowing.

## Commuting

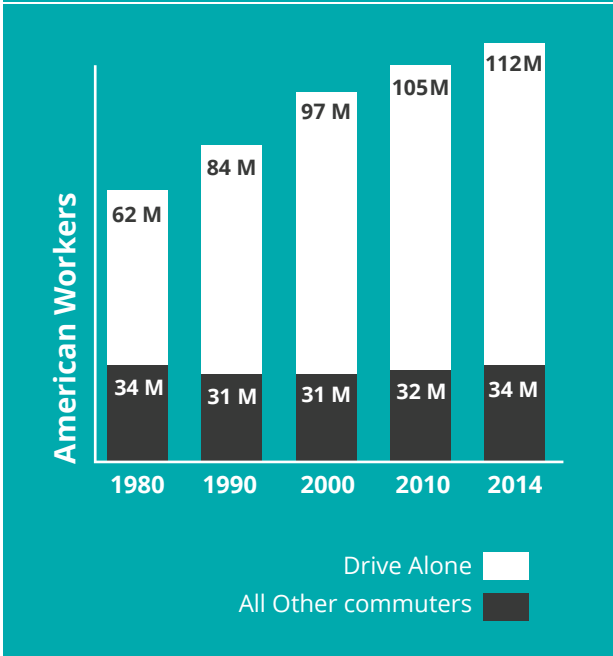
Commuting is one of the most common reasons for travel. Over the past 30 years, average commuting distances have increased and commuting speeds have declined, leading Americans to spend more time commuting. More and more Americans traveled to work in a car alone and traffic increased in many major metropolitan areas.

Travel for commuting constitutes nearly 40 percent of all public transit passenger miles traveled, and 28 percent of all vehicle miles traveled. Workers travel significantly more than non-workers. Workers as a group average about twice the level of overall travel and almost three times the level of auto travel compared to retirees.

People are much more likely to travel alone when they are commuting than when they are traveling to run errands and for social and recreational purposes. Although rush hour traffic includes a significant portion of people traveling for non-work purposes, commuting times tend to coincide with peak travel times, between 7 and 9 a.m. and again between 4 and 6 p.m. According to the most recently published National Household Travel Survey data, average commute distances increased significantly between 1983 and 2001, from 8.5 miles to 12.1 miles per trip, before declining slightly to 11.8 miles in 2009. Likewise, the average time we spend commuting has increased, from 18 minutes per trip in 1983 to 24 minutes in 2009. Finally, since 1990 the average speed of commuting has declined in all metropolitan areas as traffic has increased.

Nearly all of the growth in commuting traffic can be attributed to growth in commutes by private vehicle. Census data on commuting show that between 1980 and 2014, the proportion of workers driving alone to work increased from 64 percent to 76 percent. During the same period, carpooling decreased from 20 percent of all trips to 10 percent and public transit's share

## Number of Americans who Drive to Work Alone



of commuters decreased from 6 percent to 5 percent.

Between 2003 and 2013, the long-term trend of increasing travel by personal vehicle slowed. While the share of those carpooling continued to decline, the share of other modes, such as transit, walking, cycling, and telecommuting increased slightly. Rapid growth in the share of automobile commuting appears to be ending, and the use of public transit and other modes is rebounding. However, these recent changes have had a relatively minor impact on overall commuting patterns. Today more than three in four Americans commute by driving alone.

Looking ahead to the next 30 years, the most influential factors affecting commuter travel are likely to be two trends highlighted earlier: the size of the workforce and the growth in flexible schedules and teleworking. The portion of Americans in the workforce is expected to decline as the population ages, moderating growth in the

number of commuters. The continued growth in teleworking and the use of flexible schedules will also serve to moderate demand for commuting, particularly at peak travel times. These changes may combine to slow growth in congestion in metropolitan areas.

## Non-Work Travel

While commuting is an important component of personal travel, nearly half the population does not work, and a majority of travel is for non-work purposes. Non-work trips include trips for shopping, personal errands, and social and recreational travel. They account for 81 percent of all passenger miles traveled and 54 percent of all vehicle miles traveled.

Non-work trips tend to be shorter than work trips and are more likely to be undertaken with others. For non-work trips, particularly social and recreational travel and travel to school and religious services, individuals are less likely to use a private vehicle or take transit, and much more likely to walk. Non-work travel also tends to be undertaken throughout the day, and on weekends as well as weekdays.

## Long-Distance Travel

The vast majority of trips we take are for relatively short distances. Less than 5 percent of all trips people take are more than 30 miles in length. However, these trips account for approximately a third of passenger vehicle miles traveled. Most long-distance trips are to visit friends and family, and for vacation. Another common reason is business travel. Like all trips over one mile, the dominant mode for long distance travel is a personal vehicle. Personal vehicle travel accounts for 9 out of 10 trips of 100 miles or more. Another 6 percent are made by air travel. The remaining 4 percent are made by bus and train.

## Tourism and the U.S. Economy

Increasing travel and tourism can increase employment and strengthen economies in urban, suburban, and rural regions throughout the United States. According to the Department of Commerce, spending by international visitors in 2013 totaled more than \$180.7 billion, up nearly \$1.3 billion per month from 2012. The travel and tourism industry now accounts for 26 percent of all American services exports, making tourism the top service that the United States exports, and nearly 8 percent of overall exports. The National Travel and Tourism Strategy, proposed by President Obama and adopted in 2012, identified ways to significantly increase travel and tourism in and to the United States and set a goal of annually welcoming 100 million international visitors to the United States by 2021. U.S. DOT is working hard with other federal agencies to help accomplish that goal. The United States requires world class infrastructure to attract and facilitate domestic and international tourism, and maintain its leadership position as a top global travel destination.

For trips between 100 and 500 miles, express buses, trains, and airlines all compete for customers. Altogether, between 2010 and 2012 the number of operations by discount intercity bus carriers nearly doubled. Today, the motor coach industry carries more than 600 million passengers a year in the United States, nearly as many as U.S. airlines and twenty times as many as Amtrak. While traditional scheduled motor coach providers, such as Greyhound, have operated for almost 100 years, today, discount intercity bus services—which first emerged in the mid-2000s—are expanding rapidly. As a result, traditional providers have remodeled their business approach to compete with discount carriers. This entry of new carriers is spurring competition that also leads to more convenient services. Intercity bus carriers compete for travelers by providing low fares, convenient online ticketing services and amenities such as power outlets and uninterrupted Wi-Fi service.

Average intercity bus fares are significantly lower than those for passenger train and airlines for

the same city pair, and the costs are generally lower than driving.

The rapidly increasing intercity bus market has also led to increased safety risks as new low-cost carriers have entered the market. Strengthening federal and state regulations and increased oversight and enforcement can help to ensure that intercity bus services are safe and accessible.

## International Travel and Tourism

More than half of all international trips, and virtually all trips taken outside of North America, are taken by plane. U.S. citizens made more than 73 million international trips in 2015. About 55 percent of all international trips were to Mexico or Canada, and more than 85 percent of those trips were made by surface transportation.

International tourism is growing rapidly—the number of international visitors to the United States has grown by 60 percent over the past decade. International tourists spent \$221 billion

in 2014, accounting for nearly 10 percent of all U.S. exports. While the United States set records for international visitation in recent years, the global travel market has become increasingly competitive. Other countries actively market themselves, and new destinations are aggressively competing for market share. Transportation policy can play a critical role in attracting tourists by facilitating tourist arrivals in our airports, ports, and border crossings and enabling access to safe multimodal travel throughout the country. By engaging with international partners to reduce trade barriers, transportation policy can support safe and affordable international air travel for both U.S. citizens and international visitors.

## Freight

Our freight transportation system is made up of multiple interconnected modes and networks that fit together to transport an immense variety of goods and services.

The fastest growing rail freight sector is intermodal traffic—or the movement of a wide range of products in containers and trailers. More than 10 percent of freight is now transported on multiple modes. For example, imported merchandise arrives in container ships to coastal ports such as Los Angeles/Long Beach, where it is transferred to trains and trucks to be transported to inland distribution centers across the country.

Trucking is the primary mode of travel for most freight and is the dominant mode for distances under 750 miles. Commercial trucking accounts for about 9 percent of all highway vehicle miles traveled. Trucks are the dominant mode for freight because the extensive public road network allows for point-to-point delivery.

Rail and marine transportation are more commonly used for long-distance hauls of bulk goods and raw materials. Freight rail traffic has nearly doubled since the industry was deregulated in the early 1980s.

The transportation of agricultural products and other goods by barge remains a viable alternative to road and rail transportation in many parts of our country. Millions of tons of bulk commodities are transported throughout the Ohio River Basin, along the Mississippi River and the Great Lakes, and on the Columbia and Snake Rivers on the West Coast. However, over the past 30 years ton-mileage of domestic marine transportation has declined considerably, as trucks have taken a larger share of domestic freight, and the economy has shifted toward services and away from agricultural production.

Air freight carries only a small portion of overall freight tonnage, but it is the mode of choice for carrying high value cargo over long distances. The most important cargo airports, by landed weight, are Memphis and Louisville, which are the global hubs for FedEx and UPS, respectively, as well as Anchorage, which is a gateway for trade with Asia. However, many other airports also accommodate significant levels of air cargo, such as Miami International, Los Angeles International, Chicago O'Hare, and the New York City-area airports.

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# HIGHWAYS AND MOTOR VEHICLES

Our nation's robust highway system connects Americans from across the country. Safe, high-functioning roadways, bridges, and tunnels support freedom of movement and enable access to goods, services, and markets that are essential to the way of life of all Americans. Yet today our highway system is facing many challenges, from aging infrastructure and increased congestion to reduced fuel tax revenues, which threaten to lower our quality of life and reduce our economic competitiveness.

As we look to the future it is clear that the demographic, economic, technological, environmental, and cultural trends highlighted in this report will have a major impact on highway performance over the next 30 years. Critical trends affecting highways include:

- Population and economic growth will lead to increased motor vehicle travel, particularly in metropolitan areas, leading to increasing congestion.
- Many aging highways and deficient bridges will require reconstruction and replacement demanding more funds to maintain our roadway infrastructure in a state of good repair.
- Higher fuel efficiency standards will lead to lower fuel consumption driving down fuel tax revenues and forcing policymakers to consider alternative sources of funding for transportation.

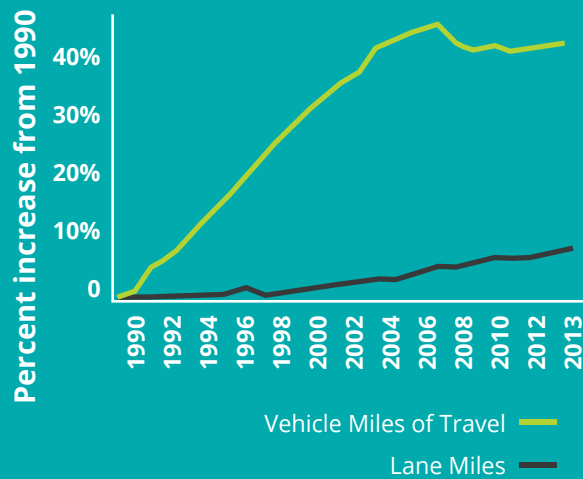
- Advances in automation of vehicles will lead to continued improvements in safety and enhance the productivity of our transportation system while creating new challenges for planners, regulators, and policymakers.
- Continued safety advances will result in thousands of lives saved.

## History

The modern era of public road planning and construction begins with the bicycle. In the 1890s, groups like the League of American Wheelmen, with 150,000 members at its peak, and the National League for Good Roads, started the Good Roads Movement to lobby for public investment in roads. But it was not until 1916 that the Federal Aid Road Act was established to improve rural post roads, marking the beginning of federal aid to states for modern road construction. The Federal-Aid Highway Act of 1921 extended funding to interstate highways for urban motorists. In 1932, the Hoover administration enacted a penny-per-gallon fuel tax—the first federal gas tax—to address the growing federal budget deficit. The federal gas tax continued to support general federal revenues until the Federal-Aid Highway Act of 1956.

The Federal-Aid Highway Act of 1944 was the first to call for an extensive national system of interstate highways, but the interstate system

## Percent Increase in VMT and Lane Miles



was not federally funded until President Eisenhower signed the landmark Federal-Aid Highway Act in 1956. The Act created the Highway Trust Fund to cover the expenses of the federal-aid highway program and dedicated federal fuel tax receipts to it. With more than 41,000 miles of interstates constructed, the system was proclaimed essentially complete in 1992.

The vast majority of our roadway system is made up of state and local roads that are not part of the interstate highway system. In total, there are more than 4 million miles of public roads. More than three quarters of these roads are owned by local governments.

The construction and expansion of highways slowed following the substantive completion of the interstate system in 1992. Construction of new roads and bridges slowed in part due to technical and fiscal challenges of expanding capacity in the built-up metropolitan areas where capacity is most needed. Higher planning, environmental, and engineering standards

increased the cost and time it takes to build roadway capacity, while fuel efficiency gains reduced fuel tax revenue and inflation eroded the purchasing power of transportation dollars. As highway expansion slowed, vehicle travel continued to increase, leading to increasing congestion. Today, highways across the country suffer from high levels of congestion, particularly in metropolitan areas, even as the growth of vehicle travel has slowed.

## Increasing Congestion

We all know the frustrating experience of sitting in traffic. Unfortunately, for many of us traffic is part of our daily lives. We spend long hours stuck in traffic, or we go out of our way to avoid traffic by going to work at odd hours, leaving early for appointments, or by taking roundabout routes to avoid areas of chronic congestion. By some estimates, the average American spends 42 hours in traffic each year, the equivalent of five days of vacation. Congestion also holds back our economy; all told, highway congestion in metropolitan areas costs our economy an estimated \$160 billion each year in wasted time and fuel and an average commuter more than \$960.

Congestion will likely increase in the coming years as the population and economic growth are increasingly concentrated in already congested metropolitan areas. Highway congestion has a

INTERSTATE HIGHWAYS MAKE UP ONLY ABOUT 1 PERCENT OF ROADWAY MILES IN THE UNITED STATES BUT THEY CARRY MORE THAN 17 PERCENT OF ALL TRAFFIC.

## The Costs of Freight Bottlenecks

The long and often vulnerable supply chains of high-value, time-sensitive commodities are particularly susceptible to congestion. Congestion results in enormous costs to shippers, carriers, and the economy. For example, Nike spends an additional \$4 million per week to carry an extra 7 to 14 days of inventory to compensate for shipping delays. One day of delay requires a container transportation provider to use an additional 1,300 containers and chassis, which adds \$4 million in costs per year. A week-long disruption to container movements through the Ports of Los Angeles and Long Beach could cost the national economy between \$65 million and \$150 million per day. Freight bottlenecks on highways throughout the United States cause more than 243 million hours of delay to truckers annually, a loss of about \$6.5 billion per year.

negative impact on all aspects of our lives that require travel and the movement of goods. As the population in metropolitan areas grows over the next 30 years, the increases in vehicle travel, albeit at slower rates than the past 30 years, can be expected to further exacerbate congestion resulting in added costs for road users.

FHWA projects vehicle travel to grow at an average annual rate ranging from 0.58 to 0.86 percent over the long-term—as fast as or slightly faster than the rate of population growth. At these rates, the traffic on our roadways would increase to between 19 and 29 percent by 2045. Since most population growth will be located in metropolitan areas, growth in vehicle travel will likely disproportionately affect fast growing metropolitan areas.

Congestion not only inconveniences commuters it also hurts our economy by raising the costs of delivering goods. Trucking is the primary freight mode and many key truck routes on the National Highway System are expected to experience significant increases in truck volume over the next 30 years. Congestion along truck corridors decreases the reliability of truck deliveries affecting the industry's ability to respond to

customer requirements and raising the costs of goods. Over the past 30 years, deregulation and other factors have increased the productivity and lowered the cost of freight transportation. However, failure to invest in strategies to address congestion could increase the cost of moving all goods in the years ahead.

## Aging Highways and Bridges

It is becoming more costly to maintain high-quality driving conditions on America's roadways—many of which were constructed in the 1950s and 1960s with engineering lifespans of 25 to 50 years. While certain states or regions face more severe pavement quality issues than do other states, state of good repair is an issue across the nation, particularly on urban and rural roads off of the NHS. Poor conditions on roads and bridges

THE AVERAGE AMOUNT OF TIME  
THAT AMERICAN AUTO COMMUTERS  
LOST DUE TO CONGESTION DELAYS  
HAS NEARLY TRIPLED SINCE 1982.

## ONE QUARTER OF THE BRIDGES IN OUR TRANSPORTATION SYSTEM ARE EITHER STRUCTURALLY DEFICIENT OR FUNCTIONALLY OBSOLETE.

threaten to increase vehicle operating costs, produce time delays, and increase the frequency of crashes.

Bridge conditions are improving, but significant investments are needed to address continued maintenance backlogs on our nation's bridges. Of the 611,845 public road bridges, 58,791 were classified as structurally deficient in 2015, and another 84,124 were classified as functionally obsolete. In other words, nearly one quarter of the bridges in our transportation system are not meeting today's standards. A bridge classified as structurally deficient or functionally obsolete is not unsafe, but may require the posting of a vehicle weight or height restriction.

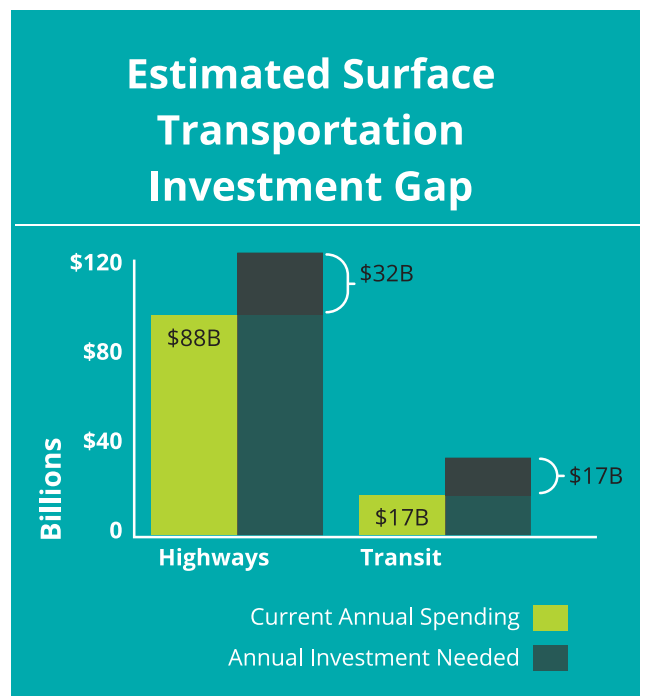
Over the past decades, governments have prioritized bridge maintenance and have made the investments necessary to improve the conditions of bridges. Since 1990, the number of bridges classified as structurally deficient or functionally obsolete have been gradually falling. However, fixing and replacing bridges can be costly. In recent years more than 15 percent of state capital spending on highways has gone to bridge rehabilitation and replacement.

### Declining Revenues

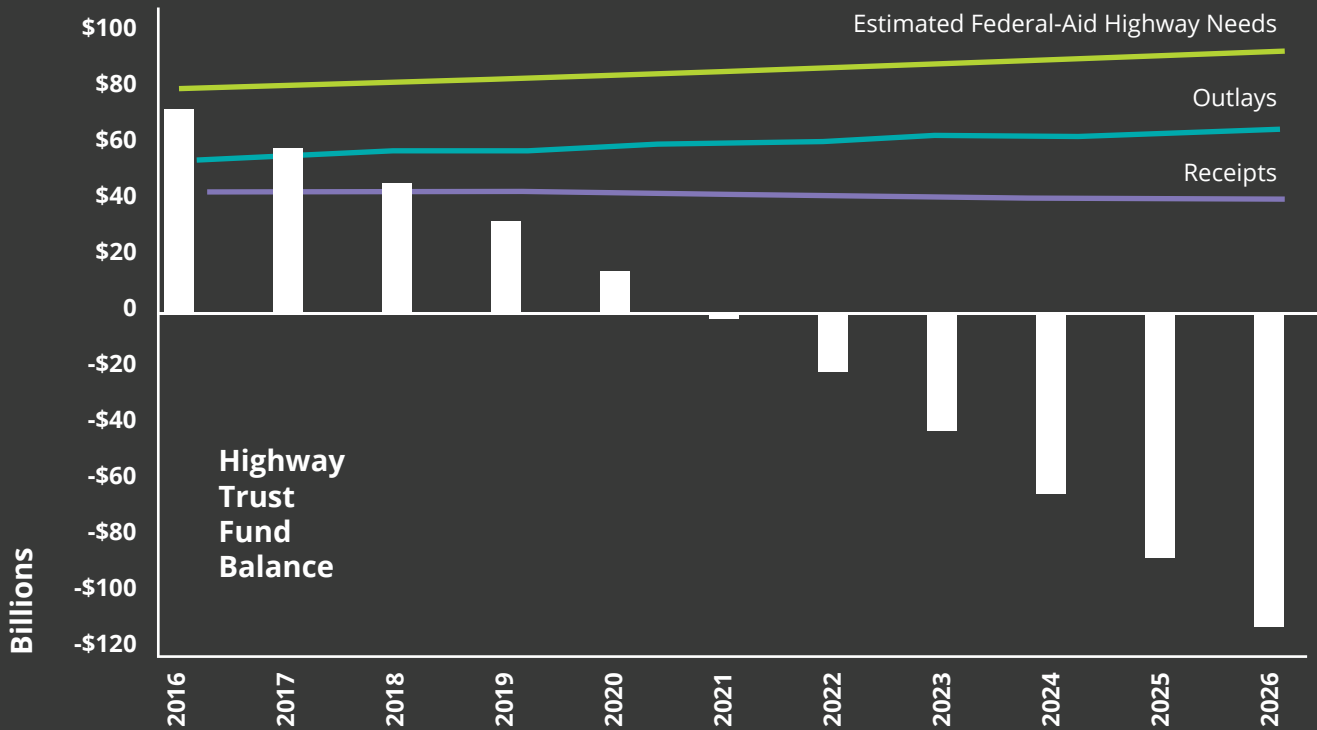
The erosion of fuel tax revenues has made it close to impossible for many states and regions

to maintain a state of good repair and an acceptable level of service on our roadways. The federal gas tax has not been increased since 1993 and inflation has reduced the purchasing power of gas tax revenues. Increasing fuel efficiency and reduced vehicle travel have compounded this problem as inflation-adjusted federal gas tax revenue fell by \$15 billion, or 31 percent, from 2002 to 2012. Over the same period, state gas tax revenues decreased by \$10 billion, or 19 percent, adjusting for inflation. Consequently, in 2010, user charges accounted for just \$93 billion out of a total \$205 billion in all highway revenue, as governments have increasingly resorted to alternative revenue sources to fund highway expenditures.

The Congressional Budget Office (CBO) estimates that, to prevent future shortfalls and preserve current levels of spending without transferring additional funds, lawmakers would either need to reduce federal highway obligations by approximately 25 to 30 percent or raise the gas tax by about 10 to 15 cents per gallon. CBO has further determined that simply maintaining current levels of federal highway spending would



# Projected Highway Trust Fund Balance



THE AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO) RECENTLY ESTIMATED THE CAPITAL INVESTMENTS NEEDED FROM ALL LEVELS OF GOVERNMENT TO MAINTAIN THE PERFORMANCE OF OUR TRANSPORTATION SYSTEM. EVEN THEIR MOST CONSERVATIVE ESTIMATES SHOW AN ANNUAL INVESTMENT GAP OF TENS OF BILLIONS OF DOLLARS.

require a minimum of \$11-12 billion more per year. FHWA has estimated that at least \$24 billion in additional capital spending would be required from all levels of government to improve highway system performance.

In the coming years, higher fuel standards will increase our energy independence, reduce air pollution, and lower costs for consumers, but they will also reduce fuel tax revenues. The CBO has estimated that the higher fuel efficiency standards already in place will reduce fuel tax revenues by 21 percent by 2040. Breakthroughs in renewable fuels, electric vehicles, or automation could lead to further decreases in fuel tax revenues over the next 30 years. Looking to the future, innovations in highway financing and highway revenue sources could help to address revenue shortfalls. Finding new revenue sources that are not tied to fuel

## County Governments Use Federal Funding to Rebuild Roads in Rural Mississippi

In one rural part of Mississippi, three counties—Claiborne, Franklin and Jefferson counties—struggle to maintain high-quality roadways. Many roads are deteriorating faster than county governments can repair them, and 60 area bridges have been rated as deficient.

In recognition of this challenge, the U.S. DOT recently awarded \$17.8 million in TIGER grant funding to support the Three-County Roadway Improvements Program, also known as TRI-Mississippi. Through TRI-Mississippi, the three county governments are undertaking a series of improvements that will modernize 41 miles of roads and 18 substandard bridges. Across the nation, projects like TRI-Mississippi are making American lives easier by connecting them with employers, schools, and services. While the need for infrastructure investment is great, projects like these demonstrate that local governments have the power to ensure that their communities have access to reliable transportation options.

consumption such as taxes on vehicle miles traveled, vehicle registration fees, or sales taxes could help to alleviate the downward pressure on revenues caused by declining fuel consumption. Expanding the use of tolling and congestion pricing could help to reduce congestion while generating revenues that could be used to finance the construction of new roadways and bridges or maintain existing facilities. Public-private partnerships, where the private sector finances the construction of new capacity, could be used to accelerate the timeline of some transportation projects and shift a greater share of the risks of delivering transportation projects to the private sector.

## Automated and Connected Vehicles

New technologies will have significant implications for the operations and use of roadways and motor vehicles, including changes to how we drive, how we choose where and

whether or not to drive, and how we pay for using roadways. There is a significant opportunity for new technology to expand capacity and efficiency of our roads and other transportation systems, and to also expand the travel options available to us, while also allowing transportation agencies to collect user fees that accurately reflect the cost of the service provided while ensuring the privacy of individuals. Automation, connected vehicles, and advancing automotive technologies offer some of the most potentially transformative changes, enhancing safety through obstacle detection systems, and potentially expanding capacity on roads by enabling vehicles to travel more closely together. Continued introduction of automation features to vehicles will lead to improvements in safety and could enhance the capacity of our roadways. While the technical feasibility of these features is becoming increasingly apparent, the timeline for the mainstream adoption of automated features and the impact of these features on safety, highway capacity, and travel and settlement

## **Distracted Driving: A Serious Safety Concern**

Distracted driving is a dangerous epidemic on America's roadways. In 2012 alone, 3,328 people were killed in distracted driving crashes. Distracted driving involves all types of distractions from adjusting the radio to reading a map, but the use of text messaging is by far the most alarming source of distraction. At highway speeds a car can travel the length of a football field in the time it takes to read a text message. Texting while driving makes it 23 times more likely a driver could end up in a crash and causes an estimated 1,600,000 accidents per year. Yet, more than half of young adult drivers claim it is easy to text and drive. As the use of mobile devices increases in our society there is a real concern that this problem may only get worse.

patterns remains unclear. The advance of these potentially transformative technologies makes it difficult for transportation planners to plan for long-term transportation system needs.

## **Improving Safety**

Safety on America's highways has dramatically improved over the past several decades. Cars and roadways have become safer, seatbelt use has increased, and alcohol-impaired driving rates have declined. Over the past decade, the number of people killed in crashes on American highways has declined by 25 percent.

Despite these improvements, motor vehicle crashes remain among the leading causes of death for Americans under the age of 64. In 2014, 32,675 individuals lost their lives in motor vehicle crashes. Of those, nearly one-third were killed in a crash involving an alcohol-impaired driver. Nearly half of those killed were not wearing a seatbelt.

Demographic trends, technological advances, and improvements to traffic safety enforcement, education, and engineering are likely to lead to continued safety improvements in the next 30 years. As our population grows more urban,

more driving will likely take place on safer roads at slower speeds. Stronger restrictions on youth driving and an overall aging of our population may contribute to reduced incidents of reckless driving. Continued education and enforcement efforts will be needed in the future as issues such as distracted driving threaten the safety of our roadways.

Advances in automation and connected vehicle technology will likely contribute to sustained improvements in safety. Safety features such as airbags, antilock braking systems, electronic stability control, rearview and blind spot cameras, lane departure warnings, and adaptive cruise control have all made vehicles much safer.

## **Policy Implications**

Personal motor vehicles will continue to be a predominant mode of travel, despite shifting demographics and economic climates, but the rate of growth in vehicle miles traveled will increase at a lower rate than that experienced over the last 30 years. Over the next 30 years, several policy options will be critical to how highways are utilized, paid for, and maintained:

## Vehicle Safety Recalls

The National Highway Traffic Safety Administration has the authority to issue vehicle safety standards and to require manufacturers to recall vehicles that have safety-related defects or do not meet federal safety standards. In 2014, more than 60 million vehicles were recalled, double the previous annual record of 30 million.

Manufacturers voluntarily initiate many of these recalls, while others are either influenced by NHTSA investigations or ordered by NHTSA via the courts. If a safety defect is discovered, the manufacturer must notify NHTSA, as well as vehicle or equipment owners, dealers, and distributors. The manufacturer is then required to remedy the problem at no charge to the owner. NHTSA is responsible for monitoring the manufacturer's corrective action. Consumers, however, are not required to fix their vehicle regardless of the severity of a safety defect and the recall completion rate has been estimated at around 75 percent. This means that unsafe vehicles remain on the road and may be resold. Furthermore, NHTSA does not have the authority to notify potential used car buyers of a defect. One potential solution would be to ban the sale and rental of unfixed, recalled vehicles or to increase the authority to levy civil penalties against automakers who fail to act quickly on vehicle recalls.

- Identifying sustainable funding mechanisms to offset the decreasing purchasing power of motor fuel taxes, and increasing federal credit assistance and private financing options for roadway improvements.
- Utilizing technology to create seamless intermodal travel routes, schedules, payment systems, and traveler information.
- Improving access to current and emerging shared transportation modes (bike share, car share, transit, etc.) through public education, affordability, and infrastructure investment.
- Prioritizing investments in key transportation corridors to provide reliable freight and passenger movement.
- Ensuring that states and law enforcement agencies take steps to address distracted driving.

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# TRANSIT

Public transit in America is experiencing a resurgence. Public transit ridership is the highest it has been in more than 50 years. Over the past two decades public transit ridership has increased by nearly 25 percent, outpacing the rate of national population growth and VMT growth over the same period. Cities and counties across the country are expanding transit services—whether in traditional transit cities in the Northeast, such as New York City and Boston, or in the once exclusively autocentric cities of Los Angeles and Phoenix. Over the past decade, new rail transit systems have opened. Demand-response transit services, services that dispatch cars, vans, or small buses to respond to reservation requests by riders are expanding rapidly as well. Rural areas are even getting into the act; today more than three-quarters of all counties in America have some level of rural transit service.

Nationwide, public transit accounts for less than 5 percent of all trips to and from work, and approximately 2 percent of all trips; however, it performs a number of critical functions, including alleviating congestion and pollution in large metropolitan areas and providing a critical transportation option to those who cannot or choose not to drive. By one estimate, if public transit services in the 15 largest metropolitan areas in America were eliminated and their riders shifted to private vehicle travel, it would result in a 24 percent increase in traffic congestion.

Many of the trends highlighted in this document, such as growing urban populations or the emergence of ride-sourcing services, could have

a major impact on public transit over the next 30 years. These trends include:

- Growing populations in metropolitan areas and changing attitudes toward travel will likely increase demand for public transit services.
- Declining fuel tax revenues could constrain federal support for the expansion and maintenance of aging public transit systems leading to increasing maintenance backlogs and higher transit fares.
- Enhanced information and communications technologies are improving the convenience of transit and the efficiency and responsiveness of public transit services.
- Emerging vehicle technologies are providing opportunities for continued improvements to the safety and fuel efficiency of new public transit vehicles.
- Climate change will increase the vulnerability of some public transit systems, particularly those in low-lying areas, to flooding.

## History

In the 19th century, public transit was a popular and transformative innovation. As public transit modes developed from horse- and cable-drawn trolley systems to suburban rail services and, eventually, modern subways and motorized buses, workers and residents used them to seek respite from overcrowded city centers, pushing the boundaries of urban development outwards. Transit systems were privately owned, profit-driven operations often established to support

## Who Uses Transit?

Public transit is as popular as it has been in 50 years. Transit use is growing across all age groups and ethnicities and in regions across the country. But- who are transit users?

Not surprisingly, transit users are more likely to live in areas with convenient and reliable transit systems. Transit users also tend to be regular riders; trips to work and school account for approximately 70 percent of all trips. Those who earn less than \$50,000 per year are more likely to be regular transit riders than those who earn between \$50,000 and \$150,000 per year. Transit ridership is also higher among those who make more than \$150,000 per year. Approximately 30 percent of transit riders come from households that do not own a car. Finally, those under the age of 30 are more than twice as likely as those over the age of 30 to use transit.

real estate ventures in the areas they would serve.

The advent of the automobile, the creation of the modern freeway system, and the suburbanization of America's population changed all of this. Public transit ridership peaked in 1946, and then declined rapidly. By 1963, ridership had dropped to one-third of its peak level. Local government agencies took over public transit systems, which were no longer profitable for private operators. When the Urban Mass Transportation Act of 1964 established the agency now known as the Federal Transit Administration (FTA), the federal government began to provide assistance to those local agencies. Despite the federal role in transit, ridership flagged through the 1990s, as Americans spent more and more of their time in cars.

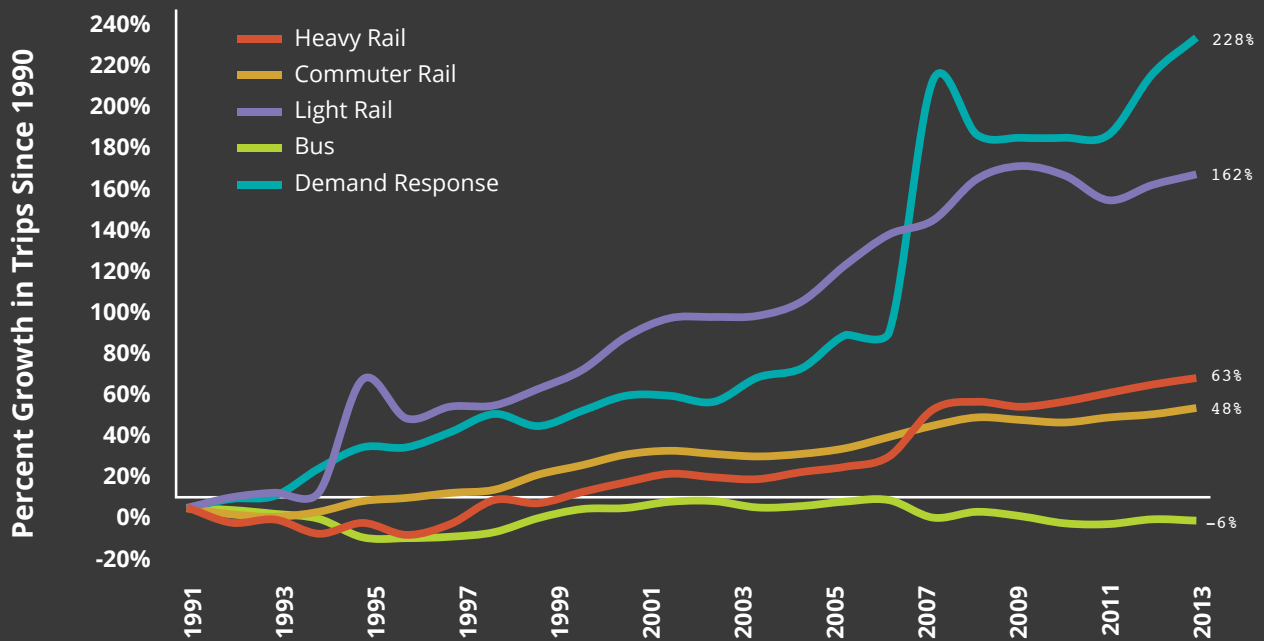
## Increasing Ridership and Service

In the 1990s, after decades of public investments to improve and expand public transit services,

ridership started to grow again. Over the past two decades, public transit ridership, led by increased rail transit system use, has grown by more than 20 percent, or approximately the same pace as metropolitan area population growth. Increasing populations in urban areas and expansions in public transit service have helped to spur increasing ridership. The fastest growing cities for sheer numbers of transit rides over the last 20 years include traditional transit-oriented cities like New York, Washington, D.C., Boston, Philadelphia, and Chicago as well as fast-growing cities with expanding transit systems such as Seattle, Miami, Las Vegas, Denver, and San Diego.

Many public transit agencies have substantially expanded service; since 1995, public transit vehicle revenue service hours, a measure of public transit service, have increased by 46 percent. Over that same time period, commuter rail service has increased by nearly 50 percent, while the amount of light rail service has more than doubled and on-demand paratransit services have tripled.

# Growth in Ridership by Transit Mode



Transit agencies are also investing in new buses, bus shelters, and fare systems to make bus services more accessible and convenient. While the use of traditional transit bus services has declined in recent decades, the use of on-demand services, van service, and other innovative on-the-road transit services have increased rapidly. Bus rapid transit (BRT) systems, where buses typically have priority right of way and operate at faster speeds, have been established in cities such as Boston, Cleveland, Miami, Eugene, Las Vegas, Los Angeles, Pittsburgh, and Seattle.

Population growth in urban areas, increasing congestion on roadways, and changing attitudes toward travel are factors that are likely to contribute to continued gains in transit ridership over the next 30 years. Increased interest in the development of compact, mixed-use development near transit facilities, or transit-oriented development, may also help to increase transit ridership and conserve land in

metropolitan areas. California, for example, is embarking on an ambitious program to build affordable housing near transit as part of an effort to reduce greenhouse gas pollution from auto emissions.

Significant progress has also been achieved in increasing the accessibility of transit stations to Americans with disabilities. Over the past 20 years, transit agencies have made major capital investments to make nearly all of America's busiest public transit stations Americans with Disabilities Act (ADA)-accessible. Today, nearly all public transit buses and two-thirds of public transit stations are ADA-accessible.

## Rising Costs of Service

While ridership has increased over the past two decades, aging vehicles and infrastructure are increasing the costs of maintaining our public transit systems in a state of good repair. As

## Improving Transit Safety

The passenger fatality rate on public transit is approximately one-twentieth the rate of private motor vehicles, and the rate of transit fatalities has been more or less constant since 2004. Excluding suicides, the fatality rate for transit passengers is very low: one death for each 250 million passenger miles traveled. Despite this impressive record, transit safety could still be improved—safety gains have been far slower than those seen in other modes, and several high-profile rail transit safety incidents led to the extension of federal safety oversight to transit in 2012.

a whole, public transit systems in our nation face a repair backlog totaling more than \$100 billion. At current levels of investment this backlog is expected to grow to \$141 billion by 2030. Addressing this investment backlog would require public transit agencies to increase their current spending on system preservation from approximately \$10 billion to \$18 billion annually.

As ridership grows, higher levels of investment will be needed to maintain the current level of service. To support the growth rate in ridership we've seen over the past 15 years at the same level of service, public transit agencies would need to invest an estimated \$7 billion annually in system expansion. To effectively maintain the conditions and level of service on our current public transit systems, the vast majority of these investments would need to be made in large urbanized areas with heavy transit use like New York, San Francisco, and Chicago, where they are most needed.

Generating funding sufficient to meet the growing needs of our public transit system will mean that governments will have to find ways to increase revenues to support transit. Increasing ridership can help increase the revenues from fares, but fares cover only about 24 percent of the approximately \$66 billion spent annually to provide public transit services in America.

Beyond fare collection, the remainder of transit funding comes from various federal, state, local, and private sources. Federal, state, and local fuel taxes provide approximately \$10 billion in funding, while states and locals use sales and fuel tax revenues, General Funds, and other sources of dedicated tax revenues to pay for the difference.

Barring increased funding to address system preservation needs, public transit costs are likely to grow in the coming decades as systems continue to expand and age. Public transit operating costs are likely to increase as new transit services expand to less densely populated cities and an aging population drives demand for paratransit services. Meeting these needs will require innovative strategies to operate more efficiently and generate revenues to support targeted investments.

## Technologies Transforming Public Transit

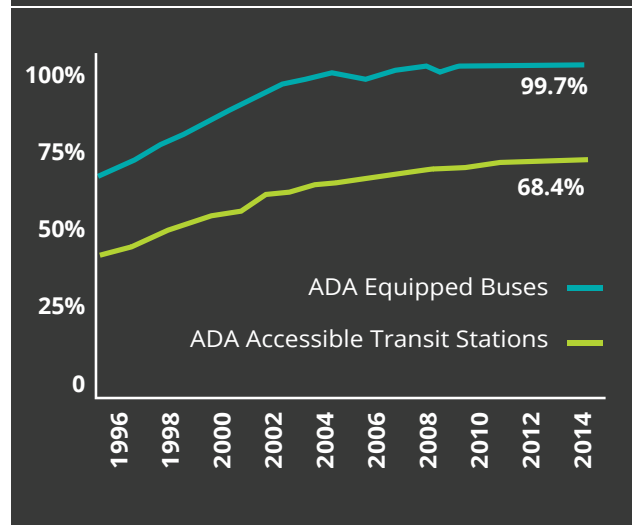
Improving information and communication technologies are increasing the convenience of transit by providing real-time schedule information and simple, seamless fare payment. The same technologies are making data on public transit increasingly easy to access and use, allowing public transit agencies to improve

operations. Information on trips by time of day, for example, can allow public transit agencies to model the impacts of different detours, lane closures, or route changes for bus services.

As data capabilities increase in the coming years, improved traffic and demand data could allow for more dynamic, demand-responsive scheduling and dispatching of buses potentially replacing some late night or mid-day fixed-route services. Using sensors and mobile technologies, public transit systems could also be used as probes to collect information on traffic and roadway conditions for local and regional transportation agencies.

In addition to data and mobile technologies, automation and connected vehicle technologies promise to improve the safety, efficiency, and convenience of public transit activities. For example, signal systems at intersections can be connected to transit system information to allow for signal prioritization to ensure that buses stay on schedule and maintain headways. PTC, which uses digital and radio communications and GPS systems to allow dispatchers to remotely manage trains, and CBTC, which uses two-way communications between intelligent trains and wayside computers to determine train location and speed, have the potential to improve the efficiency of public transit costs and improve

## Transit Accessibility for Americans with Disabilities

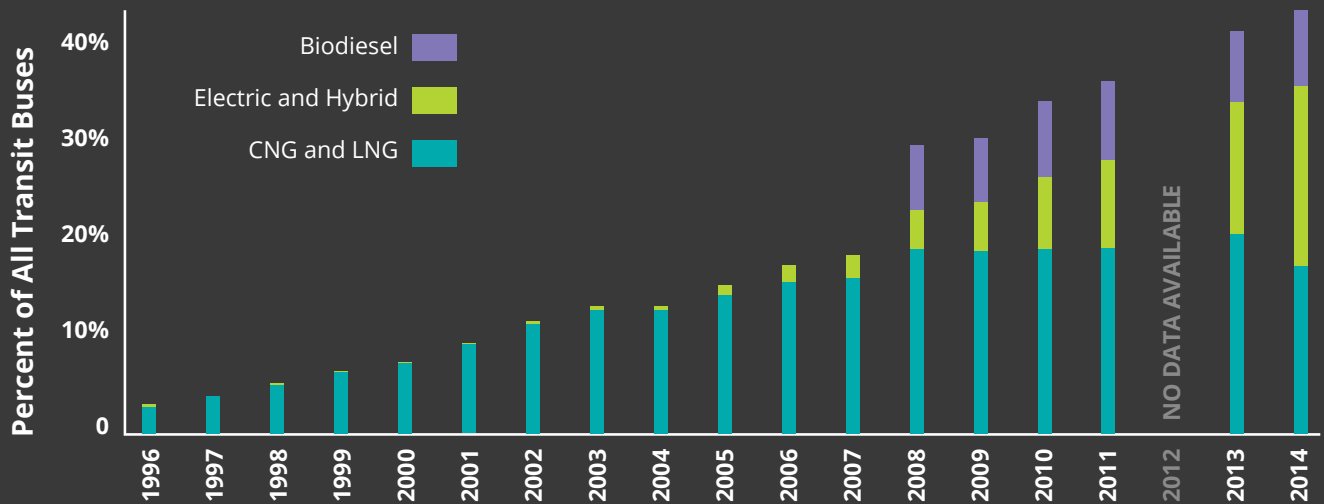


safety on transit rail systems. New urban transit systems constructed in the next 30 years will be able to take advantage of PTC and other automation technologies. Driverless vehicles, meanwhile, will improve the productivity of bus transit and potentially allow for the expansion of bus routes.

Over the past decade public transit agencies have demonstrated that they are well positioned to take advantage of advances in fuel cell technologies, electric vehicle engines, and other vehicle energy technologies to reduce emissions and save on fuel costs. The percentage of buses using compressed or LNG or biodiesel in our nation's public transit fleet increased from 7 percent in 2000 to 25 percent in 2014. An additional 17 percent of transit buses run on electric or hybrid-electric engines. As domestic production of natural gas expands, public transit agencies are likely to convert their buses to run on more efficient liquefied natural gas rather than diesel fuel or gasoline.

PUBLIC TRANSIT SYSTEMS IN OUR NATION FACE AN ESTIMATED \$86 BILLION BACKLOG IN PRESERVATION INVESTMENTS, A BACKLOG THAT IS EXPECTED TO GROW TO \$141 BILLION BY 2030.

# Alternative Power Use by Transit Bus Fleets



## Adapting to Climate Change

Many of our busiest public transit systems, including those in the New York-Newark metropolitan area, which account for more than 40 percent of daily transit ridership nationwide, serve coastal metropolitan areas that are highly vulnerable to sea-level rise and frequent storm surges. Transit assets, such as subway or bus tunnels, rail yards, tracks, and control signals are often located underground and in low-lying areas and are especially vulnerable to flooding. To prepare for the effects of climate change, public transit agencies with at-risk assets will need to assess the resiliency of their assets to climate change hazards, such as heat waves and flooding, and develop adaptation strategies, such as retrofitting existing assets to prevent water incursion and siting new facilities outside of expanded flood plains.

## Conclusion

In the next 30 years, public transit may take on a larger overall share of commuting and local non-work travel. However, many factors influence an individual's choice of travel mode, including availability, cost, and convenience. Expanding public transit would help promote mode-shift, but the benefits of these investments must be weighed with the costs, since expanding and maintaining rail transit infrastructure requires high initial investments and long-term financial commitment to reasonable levels of service and proper maintenance. Policy options to preserve and expand public transit's vital role include:

- Investing in the reconstruction and rehabilitation of existing public transit services that are in critical need of repair.
- Decreasing total travel-time and increasing the reliability and frequency of public transit services.

- Investing in bus rapid transit services by converting existing general-purpose travel lanes into connected regional networks of dedicated bus-only right of way to greatly improve safety, access, travel speeds, frequency, and reliability.
- Identifying sustainable funding mechanisms to offset the decreasing purchase power of fuel taxes.
- Increasing use of performance measurements to direct funds for state of good repair.
- Promoting the use of common technologies and platforms to make public transit payments more seamless and convenient.

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# PEDESTRIANS AND CYCLISTS

Walking, running, and cycling offer an appealing, active, and affordable travel alternative for many Americans. Together, cycling, running, and walking make up a substantial proportion of local trips that people take for non-work purposes, particularly in urban areas. Together, they account for approximately one-half of all trips taken under one mile and more than 10 percent of all trips of any length. Over the next three decades, trends that will affect walking and cycling include:

- Cycling and pedestrian activities will continue to grow in popularity as metropolitan areas grow in population, lifestyle preferences change, and infrastructure is adapted to accommodate their use.
- Cities and towns across the country will increasingly invest in pedestrian and bicycle friendly infrastructure to accommodate greater demand for these modes.
- As people bicycle and walk more frequently, pedestrian and bicyclist safety will become an increasingly pressing issue for policymakers, particularly in urban areas.

## Rising Popularity of Walking and Cycling

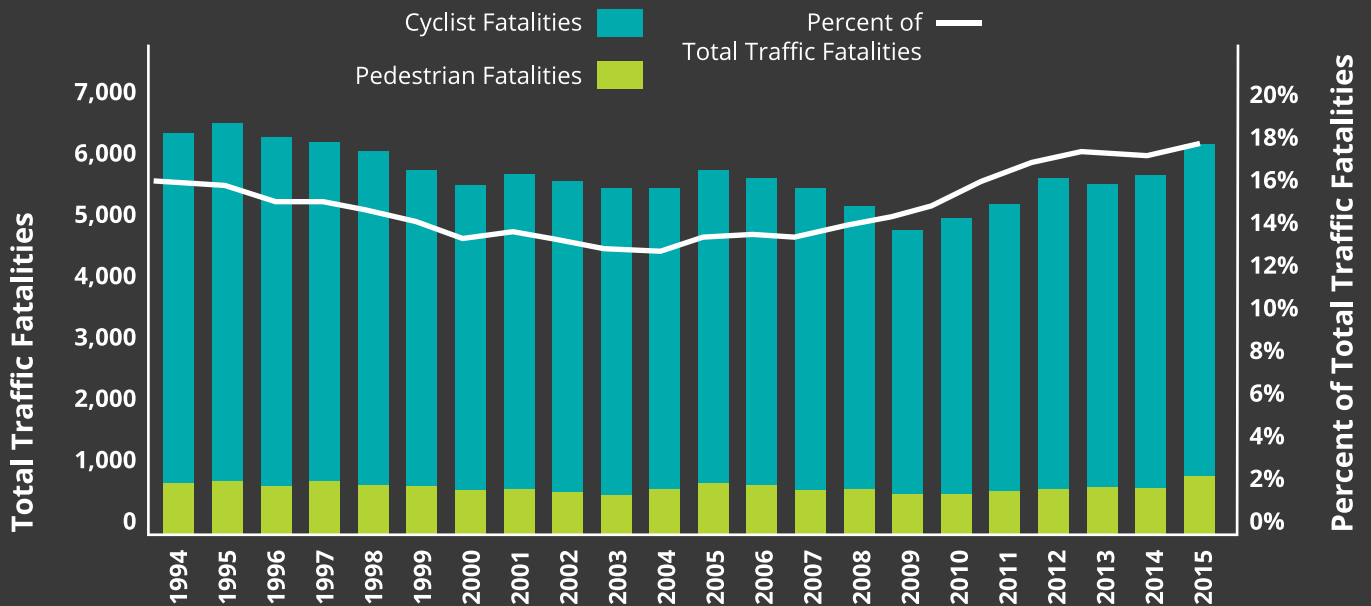
Since the 1960s, as our population has grown more suburban and automobile-oriented, cycling and walking have declined in popularity. In 1969, nearly half of all K-8th grade students walked or

biked to school; today only 13 percent of children walk or bike to school. In 1980, 5.6 percent of Americans walked to work; in 2012, only 2.8 percent of Americans walked to work. However, there is evidence to suggest that Americans have been walking and bicycling more in recent years. For example, national travel survey data show that since 1995, walking has increased from 5 percent of all trips to more than 10 percent of all trips, mainly as a result of increases in walking for social and recreational purposes. While less than 1 percent of Americans bike to work on a regular basis, the number of regular cycling commuters has nearly doubled over the past decade.

In those cities that are densest—that have robust transit systems, high student populations, or where significant investments have been made in walking and biking facilities—walking to work or bicycling are more common. More than 10 percent of commuters walk to work in four American cities—Boston, Washington, D.C., New York, and San Francisco. Portland, Oregon had the highest share of cycling commuters: 6.1 percent.

OVER THE NEXT 30 YEARS,  
AMERICAN CITIES HAVE  
PLANNED TENS OF THOUSANDS  
OF NEW BIKE FACILITIES.

# Pedestrian and Cyclist Traffic Fatalities



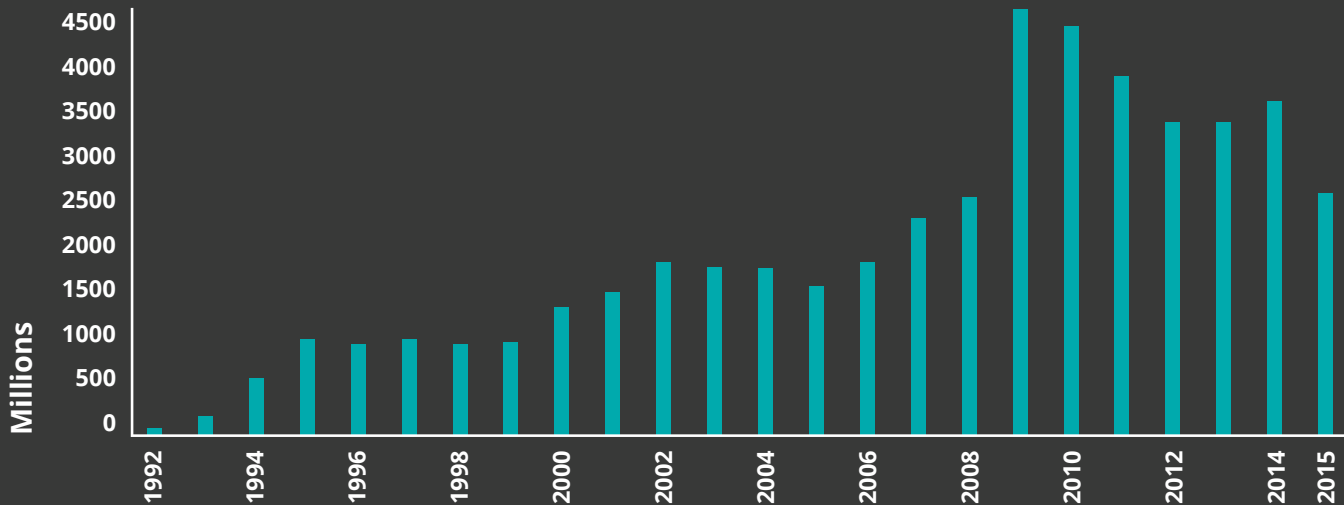
## Increasing Investments in Pedestrian- and Bike-Friendly Infrastructure

Legacy infrastructure designed to accommodate heavy automobile traffic complicates travel by walking or bicycling. Over the last decade, many cities have made a commitment to change this, adopting complete streets policies to ensure roads are designed for all users, including public transit vehicles, walkers, and cyclists. Techniques used to accommodate walking and bicycling include “road diets,” pedestrian and bicycling walk signals, and separated bicycle lanes. Cities throughout the country are expanding their bike lane networks. This is not only happening in large metropolises like New York City, San Francisco, and Chicago, but bike lanes are in the planning or construction phases in Louisville, KY; Raleigh, NC; the Buckhead neighborhood of Atlanta; Ferndale, MI; Rutland,

VT; and Elyria, OH. Several American cities have also introduced a new infrastructure element: bicycle-sharing programs that put bicycles on the street for short-term rental. In cities in which such programs have been implemented, these systems have increased the use of bicycles, particularly as a way to make connections to public transit.

Federal funding for pedestrian and bicycle improvements increased significantly beginning in 1991. Federal funding peaked in 2009 as a result of the federal stimulus programs, but overall spending levels remain more than double what they were a decade ago. In 2015, federal transportation programs provided \$834 million in funding for pedestrian and bicycle facilities and programs. This amounted to approximately 2 percent of total federal transportation funding.

# Federal-Aid Highway Program Funding for Pedestrian and Bicycle Facilities and Programs



## Safety Trends

Safety for cyclists and walkers has improved significantly since 1990. The number of pedestrian and cyclist fatalities declined from 9,035 in 1980 to 5,478 in 2013—a 39 percent reduction. Nevertheless, safety for the most vulnerable users of our transportation systems remains a problem, and we have not had the same success in reducing pedestrian and bicyclist fatalities that we have had in reducing highway fatalities. In fact, the overall number of deaths among pedestrians and bicyclists has increased since 2009.

## Policy Implications

The following policy options can help build upon recent advances to ensure continued growth and improved safety in cycling and walking over the next 30 years:

- Incentivizing improved pedestrian and bicycle infrastructure and mixed-use development in and around multimodal transit hubs to promote car-free travel;
- Designing and retrofitting of roads to allow for safe, harmonious passage of vehicles, bicycles, and pedestrians, including individuals who use assisted mobility devices;
- Educating drivers, bicyclists, and pedestrians on their legal responsibilities and sound practices to safely share public streets; and,
- Promoting policies that advance safe and independent mobility for people with disabilities and older adults.

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## Rising Popularity of Walking and Cycling

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# AVIATION

Our air transportation system connects friends and families across the country, supports national and international business travel, and enables the fast delivery of time-sensitive goods. A well-functioning aviation system is critical to ensuring our economic growth and way of life. Making up a significant component of this system, U.S. commercial airlines operate, on average, over 29,000 domestic and international flights every day carrying approximately of 2 million passengers and 21,000 tons of cargo. Another crucial component of our aviation system is general aviation, whose airports form an extensive network and make important economic contributions to society, providing access when scheduled service is either not available or inconvenient.

Over the next 30 years, advancing technology and increasing demand for air travel will present challenges and opportunities that will demand flexible and innovative responses from government and industry. Trends that are expected to impact aviation in the coming years include:

- Growing demand for air passenger and cargo traffic will increase air congestion and impact service, particularly at busy metropolitan airports.
- The maintenance backlog on our aging air traffic control facilities and equipment will increase.
- NextGen technologies will gradually be implemented across our aviation system leading to safety improvements, reduced delays, and increased fuel efficiency.

- The commercial use of unmanned aircraft systems and space travel will grow as technical, regulatory, and operational challenges are gradually overcome.

## History

The American civil aviation system began as a government-run air mail system in the early 1900s. As air travel became safer, faster, and more convenient its popularity grew and by the 1950s air travel became the mode of choice for long distance travel. From the passage of the Air Commerce Act in 1926, the federal government has taken steps to foster air commerce and ensure the safety of the air transportation system. After World War II air traffic control became a federal responsibility at most airports. In 1958, the Federal Aviation Agency (FAA) was established, and has been known as the Federal Aviation Administration since 1967, when it became part of the newly established Department of Transportation (DOT). The Airline Deregulation Act of 1978 created a highly competitive airline industry, which in turn increased FAA workload exponentially. Since its establishment, the FAA has worked to modernize the air traffic control system, and enhance safety and security throughout the system.

## Growing Demand for Air Travel

Air travel has grown steadily since the end of the Great Recession and is expected to continue to grow in the coming years as economic and population growth and an increasingly globalized economy drive demand for domestic

## General Aviation

Most air travelers pass through our 389 primary airports. However, there are more than 19,000 airports, heliports, seaplane bases, and other landing facilities in America, the majority of which are used primarily for general aviation. General aviation airports provide a variety of specialized functions, such as access to remote communities, emergency medical services, firefighting, law enforcement and border control, flight training, freight and business transportation, agricultural services, and recreational aviation.

and international air travel. The total number of people flying on U.S. airlines is expected to increase by approximately 50 percent over the next two decades, while international air travel to and from the United States will more than double. This could lead to increased workloads for air traffic controllers and potentially increase congestion at certain busy airports.

Flight delays and congestion cost the economy more than \$20 billion each year. In 2014, only 76 percent of domestic flights by U.S. air carriers arrived on time. While many flight delays are due to weather, high airport terminal volumes are a factor in approximately 20 percent of all flight delays. Some of the busiest airports in the country including the three major New York-area airports—Kennedy, La Guardia, and Newark—as well as San Francisco International, Philadelphia, Atlanta, and Chicago O'Hare, suffer from high levels of delays which can cause delays throughout the national aviation system. In 2010, a GAO review of FAA data found that 80 percent of all departure delays can be traced back to those seven airports.

## A Dynamic Aviation Industry

Since the turn of the century the commercial air carrier industry has suffered several major shocks that have led to volatile demand for air travel including the terrorist attacks of

September 11, 2001, rising fuel costs, and a severe global recession. In response, airlines have adjusted their business models to lower operating costs, eliminated unprofitable routes, and grounded older, less fuel-efficient planes. Starting in 2010, the passenger and cargo airline industries have posted net profits. While the average cost of a roundtrip ticket in inflation-adjusted dollars has dropped 15 percent over the last 20 years, many airlines have found ways to generate additional revenue by charging for services, such as bag fees, that had been previously included in the price of a ticket and by increasing the number of paying passengers on each flight. Load factor—the percentage of seats carrying passengers—increased from 69 percent in the 1990s to 83 percent today.

To save costs and increase revenues many airlines are gradually shifting to larger jets that carry more passengers per flight. Industry consolidation and streamlining is also leading to reductions in the number of flights that service smaller, less profitable airports. This has reduced access in smaller communities where it may no longer be economically viable to provide service with larger aircraft. Between 2007 and 2012, 24 small airports lost network carrier services.

## Modernizing Our Nation's Air Traffic System

To make the best use of emerging technology to meet the needs of the flying public, FAA has committed to major investments in NextGen. NextGen is a wide-ranging transformation of the air transportation system, including air traffic management technologies and procedures; airport infrastructure improvements; and environmental, safety, and security-related enhancements. NextGen technologies use satellite navigation to allow planes to fly more direct routes closer together, saving fuel and reducing delays.

The overall vision of this system includes the use of digital communication, satellite surveillance, improved navigation technologies, and more advanced safety systems to increase the capacity of the National Airspace System and the predictability of flights. New digital technologies will improve flight and weather information and enhance communications among pilots and air traffic controllers. FAA estimates that over the next 15 years NextGen could result in more than \$130 billion in social benefits from avoided delays and cancellations, reduced flight times, and other benefits.

Significant financial investment from the aviation industry and the public is required to achieve the benefits of NextGen. FAA's total investment in NextGen is projected to be \$14 billion from 2013 to 2030 in addition to the costs necessary to continue to operate and maintain existing systems and infrastructure.

Many NextGen benefits require large numbers of aircraft with the necessary avionics to be equipped in order to accrue the maximum amount of benefit. Some commercial aircraft are already equipped with the building blocks for certain NextGen capabilities but retrofitting

previously unequipped aircraft could prove costly to operators. FAA estimates that over the next 15 years, \$15 billion in expenditures is required from aircraft operators to equip their aircraft with NextGen avionics.

The Airport and Airway Trust Fund (AATF) provides the primary source of funding for FAA and receives revenues principally from a variety of excise taxes paid by users of the national airspace system. In the last five fiscal years, approximately 60 percent of FAA funding was dedicated to operating our air traffic control system and safety programs. About 20 percent of funding was for the Airport Improvement Program (AIP), which provides grants to airports for projects that generally enhance capacity, safety, or environmental concerns, such as runway construction and rehabilitation, airfield lighting, and airplane noise mitigation. Remaining FAA funds are used for modernization and maintenance of air traffic facilities and equipment, and research, engineering, and development of new air traffic technologies such as NextGen.

Constrained budgets have resulted in deferral of maintenance of today's air traffic control system infrastructure over the last several years, placing at risk reliability in operations and resilience in emergency situations. Some types of critical air traffic control facilities are many decades old, though replacing and/or consolidating them requires substantial investment. Under the current budget environment, FAA's maintenance backlog is expected to continue growing.

Running a complex enterprise operating 24 hours a day while undertaking as large and sophisticated an infrastructure project as modernizing the entire national airspace system presents governance challenges, especially in the face of conflicting priorities within

## Commercial Space Transportation

Commercial space transportation and the services it enables, such as weather forecasts, emergency and disaster response, and credit card payments, accounted for more than \$208 billion in economic activity in 2009. Today, commercial space transportation is used for launching satellites into orbit, as well as delivering cargo to and from the International Space Station and conducting science and technology demonstrations. There is also increasing momentum behind space tourism—space travel flights for the general public.

constrained budgets. FAA has improved program management focus and increased collaboration with industry—resulting in improved safety, program performance, and aligned prioritization with industry on which NextGen capabilities to deploy together over the next few years—but continues to seek opportunities for further improvements.

## Integrating Unmanned Aircraft Systems (UAS)

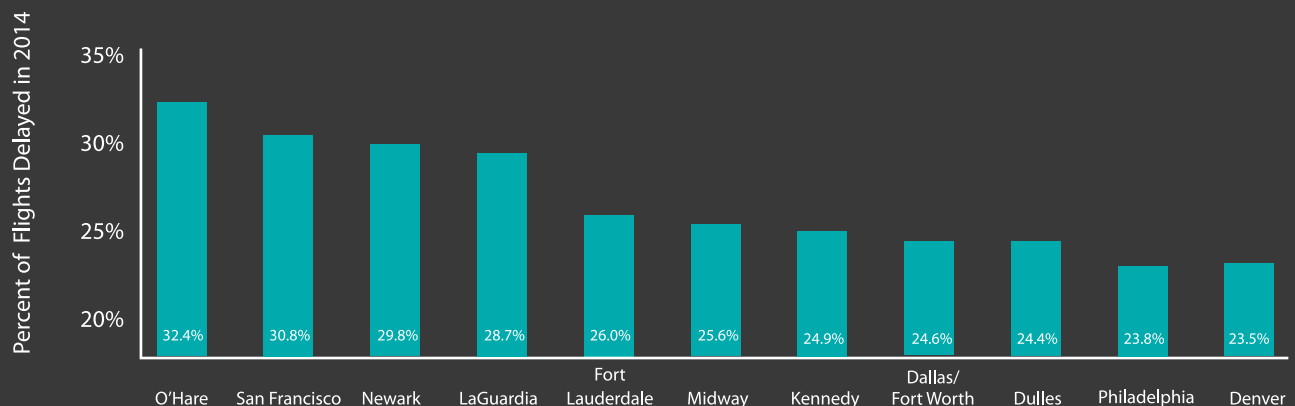
In recent years private sector interest in UAS has increased at a rapid rate. The private sector sees the potential for a wide range of uses of

UAS from crop dusting and land surveying to humanitarian disaster response and filmmaking. A recent U.S. DOT report commissioned by the United States Air Force estimated that between public and commercial uses, the total number of UAS vehicles in operation will reach 250,000 by the year 2035.

FAA first allowed the use of UAS in the national airspace system in 1990. Most UAS that are allowed to operate today are used for security, research, and environmental monitoring purposes. UAS operations over major urban areas, where there tend to be high densities

## 10 Worst Airports for Delays

(Percent of Flights Delayed in 2014)





# Aviation Accidents



of manned aircraft, is limited and approved on a case-by-case basis. Existing restrictions on the use of UAS have been based around concerns about the safety and intent of use of these vehicles. New regulations targeted at the phased integration of UAS are in development. FAA has already issued rules that define some requirements for operating a private UAS safely, within sight of the operator. Future rules will be targeted at allowing a wider scope of operations for smaller UAS, and enabling flights over people.

Beginning in 2013, six test sites around the country began conducting UAS research. In order to safely integrate UAS into the national airspace system, several technical and procedural hurdles will have to be overcome (e.g., making sure UAS can detect and avoid other aircraft and maintain communication with pilots). FAA is pursuing a

phased integration of UAS. This gradual process is intended to ensure safety and manage risk to the National Airspace System.

A full regulatory framework agreement on certification and technology standards, and procedures to collect and analyze safety data are still challenges that need to be met in order to ensure that UAS operate effectively and safely.

## Safety Trends

Over the last 50 years, taking a flight in a commercial aircraft has become the safest possible means of travel. Aviation accident rates have declined dramatically since the 1960s. Today, commercial aviation accidents with fatalities are exceedingly rare—some 99.997 percent of air traffic operations occur without

safety or compliance incidents. On average, a person could fly every single day for 50,000 years and still not be involved in a fatal crash. In 2015, U.S. commercial carriers flew nearly 900 million passenger miles without a single air carrier fatality. Globally, there were four accidents resulting in passenger fatalities, and accident rates for scheduled commercial flight fell to about one major accident for every 3.1 million flights. However, acts of suspected terrorism and suicide resulted in the deaths of 374 passengers and crew on two flights, highlighting security and mental health challenges.

Advancements in safety are the result of improving technologies, better training, effective regulation, and the use of a risk-based approach to safety management. The aviation system and regulators systematically analyze and learn from safety incidents. Sophisticated aircraft systems and modern air traffic control technologies also improve the situational awareness of pilots and air traffic controllers. Today, the FAA increasingly uses tools and techniques for data recording, collection, reporting, and analysis that allow for early identification, assessment and mitigation of safety risks. These tools and techniques provide FAA with access to an abundance of safety data, allowing them to make smarter, data-driven, risk-based decisions and, with industry and global partners, to identify emerging hazards and predict the associated safety risks before they become accidents.

This data-driven approach helps FAA improve safety and informs the agency's policies, standards, and training programs. Due to the extremely low rate of casualties in air travel, it is becoming necessary to employ data and analysis more effectively in order to prevent crashes before they occur, rather than analyzing accidents that have already happened. The future will require us to move away from the

forensics toward a more predictive safety-analysis approach. Safety challenges for aviation in the future are likely to be focused on the introduction of new technology and the safe entry of new types of aircraft into the system (e.g., space launches, UAS), and the maintenance of high levels of safety around increasingly congested hub airports.

## Policy Implications

Aviation has changed much in the past 30 years and will undoubtedly continue to evolve over the next 30 years as new technologies are introduced and the population and economy grow. Policy options that will influence the future course of the aviation system include:

- Ensuring that sufficient revenue is available to support the operating and capital needs of our National Airspace System.
- Balancing the system's multiple and sometimes conflicting needs for modernization, maintenance, access, efficiency, capacity, environmental sustainability, and services.
- Enabling the safe integration of commercial space flights and unmanned aircraft systems into the NAS while minimizing risk to other users of the system.
- Shifting to a more collaborative, data-informed and risk-based safety management approach to proactively address emerging safety risks.
- Improving surface access to airports for passengers and freight.

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# INTERCITY RAIL

Our intercity passenger and freight rail networks are a vital component of America's vast intermodal transportation network. The intercity passenger rail system operated by Amtrak carries millions of passengers each year to destinations across the country. Freight rail is a \$70 billion industry connecting U.S. consumers to agricultural, economic, logistics, and manufacturing centers.

Trends that will impact the performance of our passenger and freight rail system over the next 30 years include:

- Demand for speedy and reliable passenger rail service in growing megaregions will continue to increase.
- Ridership growth will result in continuing improvements to Amtrak's financial performance, but, absent sustainable federal funding, Amtrak will continue to face challenges meeting the costs of providing national passenger rail service.
- Increasing freight rail demand will increase pressure to address freight chokepoints and resolve passenger-freight conflicts.
- Continued emphasis on rail safety will lead to sustained safety improvements.

## Intercity Passenger Rail

Amtrak operates our intercity passenger rail system. Amtrak was created by the 1970 Rail Passenger Service Act in order to assure the continuation of passenger train service given financial turmoil in the private rail industry

at the time. Amtrak operates as a national public-private corporation, operating a national rail network of more than 21,000 route miles serving more than 500 destinations in 46 states, the District of Columbia, and three Canadian provinces.

## Rising Passenger Rail Ridership

Our intercity passenger rail system carries more than 30 million passengers each year. Millions more passengers ride commuter trains over tracks that are often shared with Amtrak and freight trains. Although Amtrak trips comprise less than 1 percent of all domestic intercity trips, Amtrak's ridership has grown in recent years. Annual ridership has increased by more than 50 percent since 1993, with total passenger trips reaching 30.8 million in fiscal year 2014. Increasing popularity among young adults and improvements in service such as e-ticketing and improving broadband access are helping to drive demand.

Passenger rail service is an attractive alternative for intercity travel, particularly for trips between 100 and 500 miles. Well over 85 percent of all passenger trips on Amtrak are for journeys less than 250 miles, while less than 5 percent of trips are for journeys more than 400 miles. Amtrak ridership is especially strong in growing megaregions such as the Northeast Corridor, the Chicago Hub area, and the West Coast. More than one out of every three Amtrak passengers travels along the Northeast Corridor between Washington, D.C., New York, and Boston.

## High-Speed Intercity Rail

FRA's High-Speed Intercity Rail Program has provided \$10 billion in grant funding to states along critical rail corridors. Several projects are currently underway, including nearly \$1 billion in investments to upgrade the Northeast Corridor, \$3.9 billion to lay the groundwork for high-speed rail in California, and \$1.9 billion for track upgrades in the Midwest. With the exception of high-speed rail in California, these projects have largely focused on upgrading existing track and vehicles to improve speeds and reduce delays.

Amtrak-owned infrastructure also supports critical commuter rail services particularly in the Northeast Corridor. An average of more than 847,000 people every weekday depend on commuter rail services that use Amtrak-owned infrastructure and shared operations. In addition, states provide intercity passenger rail corridor services across the country through operating contracts with Amtrak. These state-supported routes carry nearly half of all of Amtrak's passengers. This arrangement is part of a shift in the passenger rail service industry away from centralized Amtrak-operated services toward more services funded, managed, and overseen by states and localities. While this shift is only just beginning, it could ultimately result in the creation of intercity operators other than Amtrak.

In the next 30 years, the American population will grow by 23 percent, increasing demand for personal travel across all modes, including rail. As the American population grows and the population and economy become increasingly centered in major metropolitan areas, passenger rail could become a more attractive option for many travelers. Increasing highway and airport congestion could also make passenger rail a more competitive alternative. Other social and cultural changes, such as changing attitudes toward driving, especially among young adults, may also influence future ridership. In the future,

higher-speed rail service in dense population corridors could increase travel options for intercity travelers and help to relieve growth in congestion on highways and at busy airports in major metropolitan areas.

## Funding Passenger Rail to Address Growing Demand

Unlike highways, transit, and aviation, passenger rail lacks a source of predictable, dedicated funding. Revenues from passenger rail tickets are Amtrak's primary source of funding. In fiscal year 2014, Amtrak earned a record setting \$2.2 billion in ticket revenues, of which more than half were generated on the Northeast Corridor. On top of its annual revenues, Amtrak receives approximately \$1.5 billion in federal appropriations each year. In 2014, Congress provided more than \$1 billion in grants for capital expenses and debt service and \$340 million in grants for operating costs.

Ticket sales for popular routes, such as the Northeast Corridor, produce an operating surplus for Amtrak that defrays, but does not fully cover, the operating costs of long-distance routes. Although Amtrak's 15 long-distance lines comprise only a small percentage of all intercity trips by rail, they offer the only intercity transportation alternatives in many areas.

## Intermodal Container Traffic

Intermodal container traffic is one of the fastest growing segments of the freight rail industry and currently accounts for 11 percent of rail freight. The use of intermodal transfers in large containers has greatly improved the efficiency of freight rail by reducing handling time and labor costs for non-bulk commodities. Although the growth in container transportation has affected freight movement by all modes, the productivity of freight railroads has improved dramatically due to the growth in intermodal freight and the development of practices such as double-stack rail transport.

Five percent of Amtrak riders travel to or from communities that are underserved by intercity bus and airline operators.

Highways, transit, aviation, inland waterways, ports, and harbors all benefit from dedicated trust funds. Rail is unique in that it lacks a committed source of federal revenue. As a result, passenger rail capital investments have generally failed to keep up with the needs of existing fleets and infrastructure, leading to a backlog of state of good repair and other basic infrastructure needs. There is currently a multibillion dollar backlog of projects required to maintain a state of good repair on our nation's rails, as well as a significant deficit in the capital funding available for maintaining assets and adding capacity for anticipated increases in demand. The Northeast Corridor alone requires investments of nearly \$1.5 billion per year over 15 years to bring the corridor into a state of good repair and maintain it in that condition. To achieve high-speed rail service along the corridor and address maintenance backlogs, Amtrak's Master Plan for the Northeast Corridor calls for nearly \$151 billion in investments, including \$15 billion for the construction of new trans-Hudson River tunnels and a new Penn Station in New York City.

## Freight Rail

America's freight rail system consists of over 140,000 route miles connecting consumers to agricultural, economic, manufacturing, and population centers. An indispensable aspect of our freight infrastructure, railroads move roughly 39 percent of all intercity freight ton-miles in America each year. Rail is the predominant mode of transportation for heavy bulk commodities like coal, grain, and minerals and for high valued cargo, such as intermodal traffic, traveling between 750 and 2000 miles. Freight rail is a \$70 billion industry comprising over 560 regional and short-line freight railroads, including seven "Class 1" railroads that represent the bulk of the industry's rail mileage, revenues, and workforce.

## Meeting Freight Rail Demand

After the Staggers Rail Act partially deregulated rail freight in 1980, shipping rates for all railroads declined by more than 30 percent, and rail freight traffic has nearly doubled. Railroads have generated record revenues by growing traffic and concentrating on highly trafficked railroad lines. The number of privately operated rail miles has declined by more than 40 percent and the workforce has fallen by more than half.

## Short-Line Railroads

While Class 1 railroads generate over 95 percent of all freight rail revenues in America, they own and maintain less than 70 percent of America's rail miles. Most of the remaining rail miles are owned by small and medium railroad companies, including short-line railroads that serve a small number of towns and industries. Many short-line railroads lack the capital to make the investments necessary to maintain a state of good repair. With limited annual revenues, these rail operators may struggle to meet current and future freight demand.

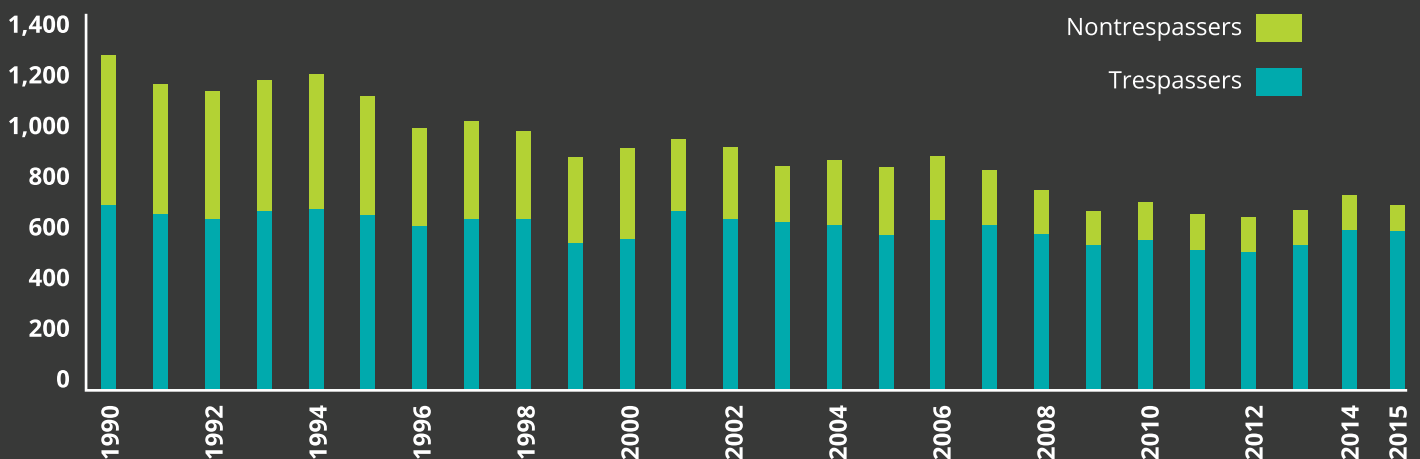
The volume of goods moved by rail has increased steadily since 1980, and is projected to increase by 24 percent through 2045. With increases in passenger traffic and freight demand, track congestion may increase, especially in higher-traffic passenger corridors. Growing congestion may reduce the reliability of the railway network for both freight and passenger movements.

Meeting this growing demand will require substantial investments led by the private rail industry in rail capacity. Unlike most other modes of transportation, rail operates on infrastructure that is built and maintained as private infrastructure. As such, private railroads

invest a high percentage of their revenues to maintain and add capacity to their system, including more than \$25 billion in both 2013 and 2014. Since 1980, freight railroads have spent \$550 billion on these investments.

To meet burgeoning freight demand, effective investments in U.S. transportation infrastructure must be made and innovative transportation solutions must be considered. One way to do this is to form public-private partnerships where private companies and governments cooperate to maintain, improve, and expand transportation infrastructure. Rail transportation investments provided by public-private partnerships are

## Rail Fatalities





## Marine Governance

Most port facilities are owned by state and local government or the private sector. The Maritime Administration (MARAD) is responsible for improving port facilities; expanding the use of the nation's waterways; promoting the development of the United States merchant marine; and ensuring that the United States maintains adequate shipbuilding and repair services, and effective intermodal connections to marine transportation systems. Several other agencies also have considerable responsibility for elements of the marine transportation system. The U.S. Army Corps of Engineers is responsible for deepening and maintaining navigation channels. The U.S. Coast Guard is responsible for maritime security, law enforcement, and the maintenance of aids to navigation. Customs and Border Protection is responsible for clearing goods into and out of the United States.

an effective way to meet future transportation challenges while at the same time providing significant public benefits such as reductions in road congestion, highway fatalities, fuel consumption and greenhouse gases, logistics costs, and public infrastructure maintenance costs. Public-private partnerships may also help to resolve freight chokepoints, particularly where freight and passenger traffic operate on the same track.

As new rail projects emerge and private participation increases, federal regulatory agencies, such as the Surface Transportation Board, the regulatory agency that authorizes rail construction, abandonments, and other transactions, may face increasing demands for timely decisions and oversight.

## Improving Rail Safety

Rail transportation is safe and getting safer. Train accident rates, already low, have steadily declined since the 1990s. Fatal accidents involving employees have been cut in half since the early 1990s. The vast majority of fatal train accidents—96 percent—are related

to trespassing or highway-rail grade crossing incidents. Trespassing fatalities have remained high over the same period and now account for 60 percent of all train-related fatalities. Continued focus on safety by Amtrak and Class 1 railroads, the adoption of safety management systems, fostering of a safety culture at rail agencies, and the research, development and implementation of new safety technologies and practices will continue to drive safety improvements in the future.

## Policy Implications

Increasingly, interconnected communities and megaregions drive a need for strong intercity transportation connections for both people and goods. Passenger and freight rail services compete for limited capacity in some markets, although there are policy options available that can help to align incentives and achieve a more collaborative working environment:

- Encourage public-private partnerships and new models for the shared use of privately owned freight rail lines that identify incentives to encourage more efficient passenger and freight movements.

## The St. Lawrence Seaway

The St. Lawrence Seaway is a binational waterway directly serving an eight-state, two-province region. The Seaway moves, on average, 40 million metric tons of cargo annually between North American and international markets of virtually every type of bulk, breakbulk, and general cargo, including iron ore for the U.S. steel industry, limestone for construction and steel industries, coal for power generation and steel production, grain exports from U.S. farms, and finished steel and heavy lift products for industry. Maritime commerce on the Seaway system impacts 227,000 U.S. and Canadian jobs, \$35 billion in transportation-related business revenue, \$14 billion in personal income, and \$5 billion in federal, state, provincial, and Great Lakes taxes each year.

- Focus federal investment in research, development, and technology to accelerate safety technology while creating a regulatory structure that incentivizes advanced safety technology.
- Explore new models of public-private partnerships that more clearly identifies public and private benefits of projects to enable the inclusion of a broader spectrum of public and private sector participants.

Current public funding levels are not able to meet the coming transportation demand or fully fund the replacement of legacy infrastructure; however, steps can be taken to leverage current funding and spur more investment:

- Continue investment in high-performance passenger and freight rail, through track and vehicle upgrades, particularly on shared-use corridors and those for which cost-effective improvements will make passenger train travel both price and time competitive with the automobile and aviation markets.
- Provide a predictable, dedicated funding source for rail projects that allows for current projects to advance, while spurring the development of a pipeline of new projects and encouraging private participation by reducing uncertainty.

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# MARINE

America's rivers and waterways formed the nation's first freight corridors. In the early nineteenth century, substantial public, private and state resources were invested in canals and ports, which functioned as engines of economic development in the pre-railroad era. Even as railroads and highways spread across the nation, today's marine transportation system, made up of inland waterways and ports, coastal routes, and deep water ports, is still the foundation of our robust international and domestic trade and will remain so for the foreseeable future.

Looking to the future, several critical trends will have a major impact on the performance of the critical marine links in our transportation system, including:

- Increasing imports and exports and containerized freight will lead to greater congestion at America's coastal and inland ports.
- Investments in ports, harbors, and waterways will be essential to meet the demand of increased global trade and competition.
- Automation will improve the productivity and efficiency of marine transportation and ports.

## Increasing Global Trade and Intermodal Freight

In 2014, total exports and imports of goods reached a value of \$4 trillion, or approximately 23 percent of U.S. gross domestic product. In

the next 30 years, it is reasonable to expect that the volume of imports and exports transported by sea will continue to grow, with dramatic implications for America's ports and transportation system.

Deepwater ports on every coast handle more than 70 percent of our nation's imports and exports by weight and are a vital link in our globalized economy. Ports along the Gulf Coast, such as South Louisiana, Houston, New Orleans, and Beaumont, Texas handle much of the petroleum, gas, steel, coal, and grain entering and leaving the United States. Three ports, Los Angeles, Long Beach, and New York/New Jersey handle 48 percent of all foreign containerized trade entering and exiting the United States. In fact, 10 ports account for 83 percent of our nation's containerized international trade. This concentration provides an opportunity for America to focus its resources on expanding the capacity of our most important ports. But, it also makes our entire freight system vulnerable to disruption or delay due to natural disasters or security incidents.

At the same time, container ships will continue to expand their capacity, potentially leading to increases in containerized freight movement. If not adequately accommodated and planned for, this increase in throughput could lead to delayed shipments, congestion at intermodal transfer points, increased transportation costs, intensifying pollution, and other negative consequences.

## Port Infrastructure: The Port of Seattle Prepares for the Future

Our nation's economy depends on the efficiency of port facilities to keep goods moving in and out of the country. However, growth in international trade and the expanding capacity of container ships will lead to greater congestion at America's seaports and intermodal facilities. American port authorities are taking steps to prepare for expected increases in demand. For example, the Port of Seattle, which recently formed a Seaport Alliance with the Port of Tacoma, just received a \$20 million TIGER grant from the U.S. DOT to make strategic investments that will help Seattle maintain its competitiveness with American and Canadian ports.

Seattle/Tacoma is a key stop on the trade corridor between East Asia and the United States. Although the port handles roughly 5,000 containers per day, its facilities are in need of repair. In light of this fact, the port plans to use the TIGER grant funding to strengthen an aging dock and extend a dock crane rail. These improvements will increase the port's capacity and allow it to accommodate two post-Panamax vessels at the same time. The port will also use the TIGER grant to construct a new truck ramp with more direct access to the port's intermodal yard. Together, these investments will improve safety conditions, speed up the intermodal transfer of goods, and relieve highway congestion in and around the port.

Over the past 30 years, U.S.-international trade has increased at a much faster rate than our nation's overall economic growth, as measured in annual GDP growth. In the next 30 years, increasing imports and exports will lead to greater congestion at America's coastal ports. Because international trade and GDP are thoroughly linked, modern and efficient ports are essential to our international trade and to the health of our overall economy.

## Modernizing Ports and Inland Waterways

To support the continued competitiveness of American goods in a global economy it is essential that we maintain and modernize our ports and repair our aging inland waterway infrastructure. Significant inland waterways include the Great Lakes and St. Lawrence

Seaway; the Ohio River Basin; the Mississippi River System; the Columbia River; and the Gulf Coast Coastal Waterways. Our nation's largest inland ports like Duluth, Pittsburgh, St. Louis, and Huntington handle tens of millions of tons of grain, steel, cars, and coal.

American port authorities are already investing billions of dollars to modernize their facilities and accommodate increasingly larger ships. Raising bridges, dredging harbors, widening channels, and purchasing bigger ship-to-shore cranes are key steps to preparing for expected increases in demand and ensuring safe and efficient intermodal freight movement into the future. Ports do not stand alone. Port authorities and their partners are also participating in many efficiency-improving road and rail projects to eliminate freight bottlenecks and facilitate the

movement of freight from ports to distribution centers. Although our ports are becoming increasingly busy, opportunities for innovation may be able to improve our port infrastructure even as the international economy places greater strains on the marine component of our transportation system.

Port infrastructure itself has not historically received federal funding assistance. However, with ports struggling to keep pace with increasing demand, TIGER Discretionary Grants have provided nearly \$500 million for port projects. In light of the increasing need for port infrastructure to keep pace with demand, MARAD's Strong Ports Program is also helping ports modernize their infrastructure by providing planning expertise and assistance to U.S. port authorities. However, this program does not yet include a dedicated funding vehicle.

The Harbor Maintenance Trust Fund (HMTF) funds the federal government's surveying and dredging projects, as well as the maintenance of breakwaters, the operation of locks, and the Saint Lawrence Seaway Development Corporation. Over the past decade, the U.S. Army Corps of Engineers (USACE) has spent an average of \$1.5 to \$2 billion on navigation projects each year. These federal navigation projects are funded by a combination of user-fee-supported trust funds and appropriations from the General Fund. Costs for deep-draft improvements are typically shared with local port authorities. Public port authorities spend more than \$1 billion annually on dredging and infrastructure improvement.

The HMTF draws its funding from an ad valorem tax (duty on imported items) on inbound shipments. In response to the increasing value of imports, HMTF revenues have grown to a current total of nearly \$2 billion annually. Over the past decade, these receipts have outpaced spending

from the HMTF, leaving the HMTF with a surplus balance of \$8.5 billion. Spending can only be authorized by Congress and, in recent years, Congress has preferred to preserve the surplus in order to count it toward the deficit reduction figure, although the latest spending authorization bill includes scheduled increases in spending over the next decade.

The Inland Waterways Trust Fund (IWTF) funds capital projects to improve inland waterways. This fund generates approximately \$80 million each year from a fuel tax on vessels using inland waterways. The balance of the IWTF declined from \$400 million in 2001 to slightly more than \$100 million today, largely due to the cost of building the Olmsted Locks and Dam project on the Ohio River in Illinois. This fund will get a boost in revenues of approximately \$26 million with the enactment of the Achieving a Better Life Experience Act (ABLE Act) of 2014 which will raise barge fuel taxes.

USACE reports a backlog of over 500 active inland navigation projects, with an estimated completion cost of about \$38 billion. Movement of freight on our inland rivers and waterways is hampered by an aging, antiquated system of locks and dams which have exceeded their design service lives and are too frequently out of service. Approximately half of the navigation locks on inland waterways are over 50 years of age and require frequent repair. Targeted, performance-based investments are needed to repair and reconstruct this aging inland waterway infrastructure.

## Automating Ports and Ships

Automation technologies are having major impacts at foreign ports and may spread to American ports. With the advent of standardized containerization, cargo transfer functions have

become increasingly automated. At major container ports around the world, the process of transferring containers from ships to docks, trucks, or rail is becoming highly automated, reducing reliance on human operators. If this trend continues, the human role in cargo handling could be greatly altered and reduced, thereby reducing the cost of shipping, providing the needed capacity to handle increased vessel sizes, and changing the nature of work in the marine transportation sector.

At sea, automation is also increasing efficiency allowing vessels to operate with fewer crew members than ever before. This trend has the potential to reduce the costs of freight, but may also create new risks as larger ships are crewed by fewer mariners. Managing and maintaining these new vessels will, in some cases, require advanced mechanical and data analysis jobs that demand higher skills and offer higher pay than traditional freight work, but may also displace the traditional mariner workforce.

## Policy Implications

Our ports, rivers, waterways, and coastal routes remain a critical piece of our intricate transportation network, and continued investment is essential to keep up with increased globalization and technology advancements. These are some of the policy options available to bolster our maritime industry:

- Develop a nationwide strategy to improve capacity at U.S. ports, where appropriate, with emphasis on those ports that are or will be able to accommodate larger container ships;
- Invest in America's port and related infrastructure, where this would be highly effective in reducing the congestion and environmental impacts of trucks on our nation's roadways;

- Consolidate the roles and responsibilities of the many agencies with jurisdiction over port facilities, which will streamline goods movement, and increase safety and security;
- Address performance of our port and related infrastructure as an integral component of our nation's freight transportation system and;
- Encourage automation in ports and on ships that increase efficiency and create jobs for highly skilled workers.

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# PIPELINES

More than 2.6 million miles of pipelines transport natural gas, oil, and other hazardous liquids across the United States every day. Each year pipelines carry oil, gas, and other products valued at more than a trillion dollars from production fields to refineries, processing plants, and ports and, eventually to consumers. Our natural gas distribution mains and service pipelines bring natural gas to more than 70 million homes and businesses. In 2012, this system moved approximately 1.5 billion tons of products, about 8 percent of all freight shipments by volume.

- Rising domestic production of oil and natural gas will strain existing pipeline capacity.
- Highest risk pipeline infrastructure will raise safety and environmental risks if not repaired, rehabilitated, or replaced.

## Rising Domestic Energy Production

America is experiencing an energy boom. American oil production has increased by more than 50 percent over just the past three years. In fact, the United States now produces more crude oil than any other country in the world. At the same time, America is consuming natural gas at historic highs, primarily for electric power and industrial uses. Some 24 trillion cubic feet of natural gas were used by residential, commercial, power, and industrial consumers in 2014.

These trends are likely to continue, although sharply dropping oil prices may curtail growth in domestic fossil fuel production in the near term. Over the long term, the Energy Information

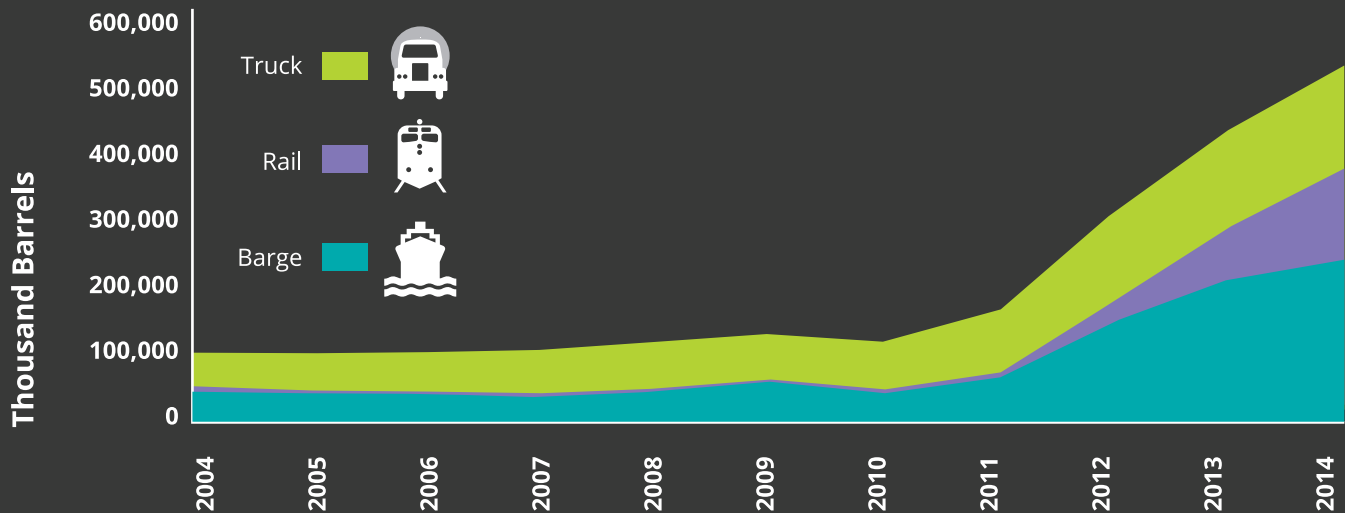
Administration (EIA) expects natural gas production to continue to grow and that energy production will expand rapidly in regions of the country with shale energy resources. This growth will likely outpace domestic energy consumption, even as the demand for natural gas increases. As a result of growing production and increasing global demand, the United States could become a net exporter of natural gas.

America's fossil fuel boom will continue to increase demand for the processing facilities, storage fields, and transmission lines necessary to move oil and gas safely and efficiently. Approximately 74 percent of domestic crude oil—more than 2 billion barrels per year—are shipped by pipeline.

## Who Operates Pipelines?

America's pipelines are operated by approximately 3,000 companies that vary in size and type, including both small local gas utilities and large multinational corporations. Four industry segments are directly involved in transporting materials by pipelines: hazardous liquid pipeline operators; gas transmission pipeline operators; LNG facilities, which store gas; and gas distribution utilities, which distribute natural gas to residential customers and smaller commercial users.

## Domestic Crude Oil Refinery Deliveries by Non-Pipeline Mode



America's current pipeline network, which was primarily designed to transport crude oil to refineries in the Gulf Coast, has limited connections from the East and West Coasts to the shale formations that are accelerating America's energy production. This has resulted in limited pipeline capacity in many regions, placing extra demand on other modes, such as rail and maritime. However, pipeline construction may replace the use of other modes to move oil, gas, and hazardous liquids.

As production of domestic natural gas and crude oil has surged in recent years, the oil and gas industry has had to invest in infrastructure to reorient our nation's existing network of pipelines. In 2013, private companies invested \$6.6 billion in crude oil pipelines and \$3 billion in natural gas liquid pipelines. These companies will continue to create new infrastructure to expand capacity and accommodate rapidly shifting production patterns, increasing demand for government oversight of pipeline construction.

Although pipeline construction may increase, much of the new demand for energy movement will be absorbed by our existing pipeline infrastructure.

### Improving the Safety of Pipelines

Pipeline incidents resulting in death, major injury, and hazardous liquid spills have gradually declined over the past 20 years, even as shipments of hazardous materials by pipeline have increased. Much of this improvement is attributable to advances in pipeline materials, corrosion protection methods, and construction technologies and standards over time. However, many of our nation's existing pipelines were designed using materials that would not meet safety standards if they were built today. Older cast and wrought-iron pipelines, for example, represent 2.5 percent of gas distribution mains and account for 10.5 percent of gas main incidents. Pipelines that were constructed before

requirements to install a protective coating on the outside of the pipe are also of concern. This aging infrastructure raises the risk of safety incidents.

In recent years, the pipeline industry, the U.S. DOT, and state governments have focused on the repair, rehabilitation, and replacement of the highest-risk pipeline infrastructure. As a result, the amount of cast and wrought-iron pipeline in use has declined significantly. Currently, 38 states have accelerated pipe replacement programs. Sixteen states have completely eliminated cast or wrought iron natural gas distribution lines within their borders, including Alaska, Arizona, Hawaii, Idaho, Montana, North Carolina, North Dakota, New Mexico, Nevada, Oklahoma, Oregon, South Carolina, Utah, Vermont, Wisconsin, and Wyoming.

While overall incidents have declined, major pipeline accidents over the last five years have done extensive damage to the environment, increasing public concern. The Deepwater Horizon oil spill in 2010, while not a pipeline incident, still raised public awareness of the potential environmental consequences and operational risks of petroleum production and transport. Minor leaks in gas transmission lines are a source of methane emissions. Methane is about 40 times as powerful a greenhouse gas as carbon dioxide. The EPA has estimated that 1 to 2 percent of all natural gas moved through pipelines is lost through leaks, accidents, maintenance, or operations. Finally, while major incidents have not occurred in the United States, pipelines may be vulnerable to vandalism, theft, and conventional and cyber-terrorism, and must be protected. The pipeline industry is taking steps to ensure that these complex control systems are secure and resilient to cyber attack or natural disasters.

THE EPA HAS ESTIMATED THAT 1 TO 2 PERCENT OF ALL NATURAL GAS MOVED THROUGH PIPELINES IS LOST THROUGH LEAKS, ACCIDENTS, MAINTENANCE, OR OPERATIONS.

Emerging technologies also promise to improve the safe and efficient operation of America's pipelines. Fully autonomous pipeline inspection "pigs," for example, have recently become widely available. These devices travel inside of pipelines and detect corrosion, cracks, and other problems. New "smart pig" technology promises to improve the accuracy of these devices and alternative methods of detecting trouble spots are on the horizon, as are data analytics innovations that can conduct continuous and automatic analysis of pipelines.

These cost-effective monitoring systems will reduce pipeline leaks and help pipeline companies cut costs. Additionally, automated technologies for valve operation, communications, and actuators may help the pipeline industry improve safety by shortening pipeline isolations and response time.

## Policy Implications

As the production of oil and gas and other commodities extracted far from ports and inland waterways increases, there will be increased need to upgrade and expand our pipeline network. Among the policy options to sustain, maintain, and develop new pipeline infrastructure include:

- Working with public and private partners at all levels, and building on efforts to date, to coordinate comprehensive inventories of the national pipeline infrastructure.
- Utilizing performance metrics to identify emerging safety trends and structure oversight to drive pipeline companies toward pipeline integrity assurance.
- Removing impediments and providing incentives for repair, replacement, and rehabilitation of the nation's higher risk pipelines, including promotion of creative rate recovery mechanisms.
- Addressing new challenges resulting from the changing demands of the energy boom.

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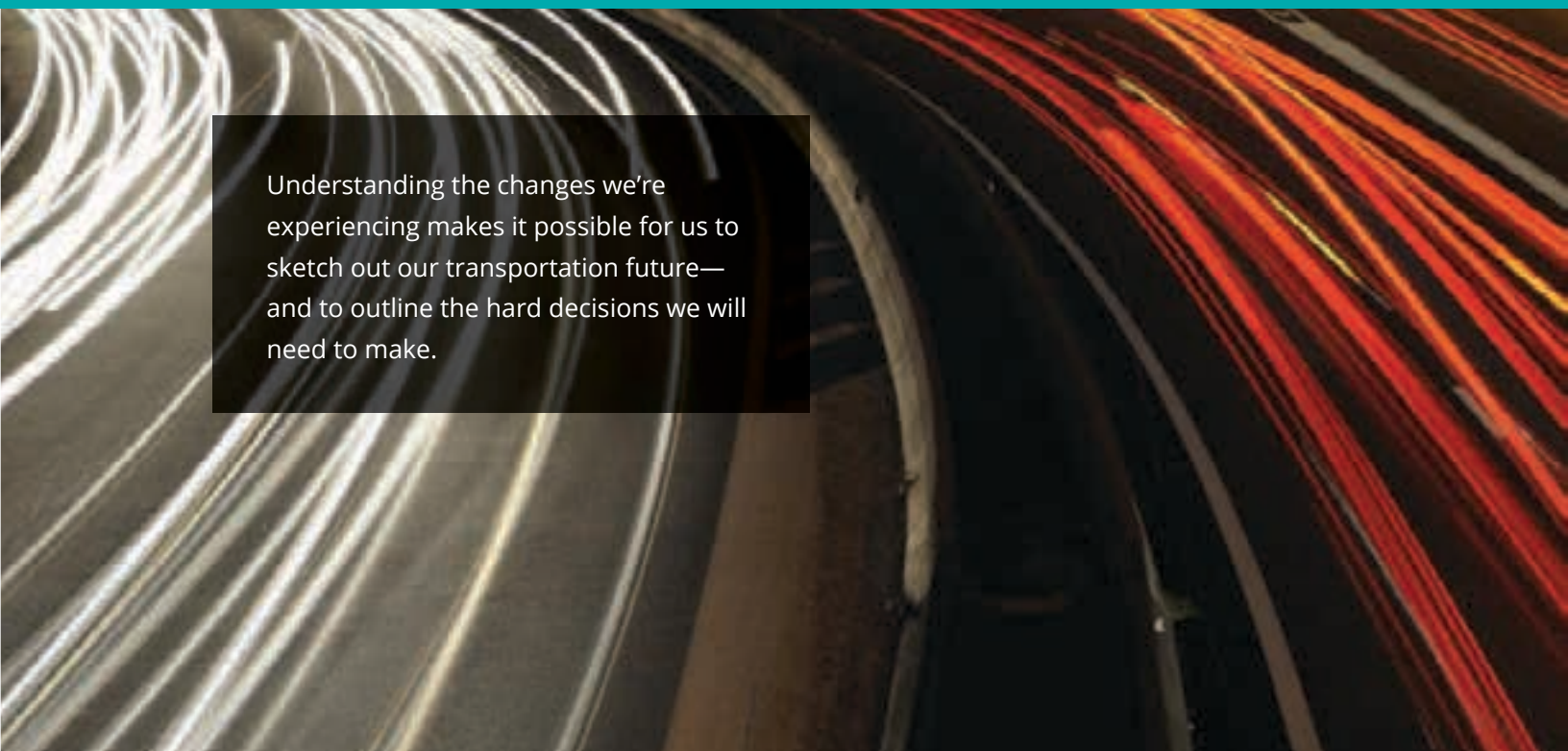
## **Figure. Domestic Crude Oil Refinery Deliveries by Non-Pipeline Mode**

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# SHAPING OUR FUTURE:

Choices in Changing Times

WHAT DO ALL THE CHANGES WE'RE SEEING MEAN FOR OUR TRANSPORTATION POLICIES? WHAT SHOULD WE DO ABOUT THEM?



Understanding the changes we're experiencing makes it possible for us to sketch out our transportation future—and to outline the hard decisions we will need to make.

# SCENARIO 2045: FROM GRIDLOCK TO DEADLOCK?

## Purpose

We have used our trend analysis as a guide to construct a snapshot of a possible future: one in which we have failed to make the choices we need to make to address the challenges our transportation system faces. Different policies, technological breakthroughs, economic crises, or other developments could yield different outcomes. We certainly hope so. Nevertheless, this future scenario provides a starting point for discussing the tough choices ahead.

## Summary

In the Gridlock to Deadlock scenario, transportation policies at all levels of government continue essentially unchanged. Instead of proactively addressing our challenges through

changes in policy, we do nothing, and the trends identified in our report—a growing population, increasing inequality, climate change, etc.—are left to shape the performance of our nation’s transportation system.

Just going about one’s daily travel routine is increasingly challenging. Highway congestion increases in major metropolitan areas and air travel delays become more frequent. Transit services become increasingly expensive and intercity rail services are reduced, pushing more traffic onto already overcrowded roadways. Shipping of goods becomes increasingly unreliable and American exports become less competitive as the costs of transporting freight go up. The effects of climate change raise the costs of maintaining infrastructure and increase the

### Atlanta Regional Commission, Plan 2040

In the years 2010 through 2040, the 20-county Atlanta region is projected to add 2.6 million residents for a total population of nearly 7.9 million. This forecasted growth rate represents an average annual growth of 87,825 people. This rate is significant enough to place a heavy burden on regional infrastructure, which is already strained by the robust growth experienced over the past 60 years. The projected net effect of not taking action through to the year 2040 will result in daily average congestion speed nearly 10 miles per hour slower (27.5 mph to 18.8 mph) and a distinct rise in annual congestion costs—that is, wasted time and fuel used in traffic—per capita (\$874 to \$2,945).

frequency of travel disruption. Our regulatory system can't keep up with technological change—and potentially transformative transportation and safety technologies are held back. Governments fail to make the investments necessary to preserve our infrastructure and patchwork state policies increase the costs of interstate commerce. In the absence of any new thinking, and a willingness to make hard decisions, the performance and condition of the entire transportation system decreases overall, acting as a drag on the economy, constraining its growth. If this sounds familiar, it's because many of these trends are already affecting our transportation system. And they may only get worse if we fail to act.

## From Gridlock to Deadlock: How We Move

Petroleum prices remain relatively stable in large part due to strong domestic production, so the vehicle fleet is still largely powered by gasoline and diesel. Fluctuations in oil prices continue to cause occasional price shocks. However, without significant market or policy incentives in place to encourage major technological breakthroughs in alternative fuels or battery capacity, there are none, with the exception of some niche applications. The low price of fuel encourages Americans to increase their driving.

Congestion increases significantly in major metropolitan areas. Although congestion is viewed as a major inconvenience, especially when combined with the deterioration of roads and bridges, suburbs continue to grow. Housing prices in the city centers of high-growth metropolitan areas increase precipitously, becoming unaffordable to most Americans; suburban growth is fueled by land and housing that is less expensive. To adapt to congestion,

many companies have generous telework policies and flexible schedules. However, there is a growing divide between Americans who are able to take advantage of these flexibilities and those who are not.

Transit use remains strong in large cities with heavy-rail systems; transit system construction stalls in Sunbelt cities, with the construction of few new light rail, streetcar, or bus rapid transit lines. Ridership increases nationally, but transit still accounts for less than one in 10 commutes. Transit services become increasingly expensive to provide: the population grows older and more suburban, infrastructure and fleet-replacement costs mount, and transit agencies face legacy retirement and health-care costs for their employees. Fares increase, disrepair becomes more widespread, and the quality of service, particularly in poorer neighborhoods, declines. Intercity passenger rail increasingly provides efficient services in many markets, including the heavily used Northeast Corridor, throughout California and in the Chicago region. Some services, including long-distance routes, continue to rely on a public operating subsidy to provide critical national connections between regional networks. While revenues may not be gained annually in these markets, these routes provide mobility options for communities—including across rural landscapes.

Passenger air travel increases and remains affordable, but air traffic delays become more frequent. Airports with high volumes of international travelers find ways to generate revenues through user fees or retail receipts. Regional airports, on the other hand, face reduced services, and many rural airports depend on federal subsidies. Airport infrastructure and air traffic control, particularly at the largest, busiest airports, are not able to keep up with the growth in passenger demand.



## **PlaNYC: A Stronger, More Resilient New York**

According to the City of New York's PlaNYC, the New York City Panel on Climate Change (NPCC) predicts that, by the 2050s, the city may see as much as 30 inches of sea-level rise and twice the number of residents (up to 800,000) living in the 100-year-floodplain. To make the transportation system more resilient, the city is seeking to protect critical elements of the system from damage, maintain system operations during extreme events, and put in place backup transportation options in case of system interruption. The city has already raised traffic control signals above flood elevation in vulnerable areas, nearly completed road reconstruction and drainage infrastructure along roads in some vulnerable and impacted areas, and has begun to plan with a variety of city agencies to identify critical transportation network elements and improve transportation responses to major events through regular resiliency planning exercises.

### **From Gridlock to Deadlock: How We Move Things**

Freight traffic increases as the population grows. Trucking carries an increasing portion of freight, but increasing congestion, combined with unreliable infrastructure, reduces service reliability. More hazardous materials are transported by truck, thereby increasing safety risks.

Traffic at a few large container ports increases rapidly, as does intermodal traffic. Other ports struggle to compete despite significant subsidies from states and metropolitan areas that are trying to generate local economic activity. Intermodal traffic increases rail revenues, but capacity constraints limit the amount of freight that can be shifted to rail. Domestic maritime freight declines as locks and dams critical to internal waterways fall into disrepair or fail. Increasing shipping costs reduce the competitiveness of American businesses abroad. Air freight triples and the economy at air freight hubs thrives.

### **From Gridlock to Deadlock: How We Adapt**

The negative impacts of climate change are felt broadly. The increasing frequency and intensity of severe weather events cause major disruptions to travel and the closure of critical transportation facilities to become more commonplace. Critical airports and ports are shut down by major storm-surge events with increasing frequency. The costs of disaster recovery increase significantly.

Passenger and freight traffic gradually shifts to less vulnerable areas. Great sums are expended on improving the resiliency of such facilities—but only on a case-by-case basis, and usually after major damage has already been sustained. Such spending rarely improves the economic competitiveness of areas now perceived as unreliable, and is derided. National climate-change regulations have not been introduced.

## From Gridlock to Deadlock: How We Move Better

Vehicle automation has progressed incrementally, but because a comprehensive regulatory framework was never established for them, fully automated vehicles are not permitted on public roadways. Only a patchwork of local, regional, and commercial standards and applications exists, yielding a number of technological and operational incompatibilities. A few high-profile safety incidents result in further limitations on automation features. Meanwhile, automated vehicles are commonplace in other developed countries. Fortunately, driving continues to become safer, although only because improved vehicle safety technologies contribute to declines in fatalities and serious injuries resulting from crashes.

Unmanned aircraft systems (UAS) are widespread, but regulations generally restrict them to public-sector functions, such as law enforcement and recreational use. In the absence of a comprehensive policy and regulatory approach to UAS, commercial applications remain severely limited. America is no longer a leader in the transportation technology industry. American jobs in the transportation sector decline as most innovation in the sector is driven by countries with conducive regulatory environments and ample research budgets.

## From Gridlock to Deadlock: How Grow Economic Opportunity

Housing and transportation costs consume an increasingly large portion of household budgets. White collar workers telework whenever possible or move to rapidly gentrifying cities and inner suburbs where the commutes are still bearable. Urban housing prices in economically

### **Knoxville, Tennessee**

Adopted in 2013, the Knoxville Regional Planning Organization Long Range Mobility Plan 2040 identified the need to leverage and invest in technologies in transportation. It identified strategies to coordinate local investments in intelligent transportation systems by transit providers to improve service and efficiency.

thriving cities become unaffordable to the average worker as suburban living increasingly unattractive. Commutes grow in length and time for low- and middle-income workers as they seek affordable housing in distant exurbs. Many individuals give up looking for work in the formal economy—with such lengthy commutes, it's hardly worth it. Private vanpools and black-market jitneys become an increasingly common form of transportation for low-income suburban workers beyond the reach of convenient public transit. As inequality grows, economic segregation and suburban poverty increase and many Americans struggle to meet their daily needs for shelter and mobility. In failing suburbs with declining tax revenues, traffic safety enforcement is seen merely as a method of forcefully extracting revenues from low-income and minority residents. Incidents of social unrest become more prevalent.

## From Gridlock to Deadlock: How We Align Decisions and Dollars

The federal fuel tax has not been increased, and no alternative funding source has been identified for the Highway Trust Fund. As a result,

## Charlotte 2030 Transit Corridor System Plan

On November 15, 2006, the Metropolitan Transit Commission (MTC) adopted the 2030 Transit Corridor System Plan. This updated, long-range plan consists of multiple rapid transit improvements in five corridors, a series of Center City improvements, and bus service and facility improvements throughout the region. The implementation plan for the 2030 Transit Corridor System Plan includes the North and Northeast Corridors seeing early implementation followed by the streetcar project. Once complete, the 2030 Transit Corridor System Plan will consist of 25 miles of commuter rail, 21 miles of light rail, 16 miles of streetcar, 14 miles of bus rapid transit, and an expanded network of buses and other transit services. efficiency.

revenues do not keep pace with needs—in fact, they have continued to decline, as the average fuel economy of cars and trucks has increased. The Highway Trust Fund is maintained through transfers from the General Fund and short-term budget fixes (as political conditions permit), but its purchasing power continues to decrease. Multi-year surface transportation authorizations are no longer the norm; transportation spending is instead authorized mainly through short-term bills and extensions. Political deadlocks sometimes result in withholding of federal funding, creating economic uncertainty.

This short-term focus leads to delays in roadway and transit projects, especially large projects. It is increasingly difficult to plan for major capital projects requiring the certainty of more than one year of funding. Some needed projects are canceled; others never make it off the drawing board. The construction workforce in particular is affected, with short-term contract employment becoming more and more common. This creates a “skills gap” in the construction industry, and much institutional knowledge is lost, and never regained, as employment in construction becomes less attractive. Lack of experience and expertise hinders the industry’s uptake of new construction technologies that might otherwise

have yielded improved performance at lower costs.

Changes in the aviation industry and increasing pressure on the federal budget create increasing funding instability and budget uncertainties for FAA, delaying the adoption of NextGen and delaying the integration of UAS and commercial space transportation into the national airspace.

Transportation revenues are patchwork and increasingly decentralized. Some states have turned to tolling and public and private debt financing to fund major transportation projects. Other states have placed tolls on major facilities. Some states develop alternative sources of transportation revenues, including mileage-based fees. Other states raise vehicle registration fees, increase sales taxes, and revert to using General Funds rather than dedicated transportation revenues. Overall, a patchwork system of financing and an unequal quality of service between states exerts a drag on interstate commerce. Drivers become accustomed to paying tolls and fees.

Some states manage to maintain their roads and bridges in good condition. Overall, however, many states with stagnant populations struggle

to maintain critical transportation facilities as their tax base declines and maintenance costs increase. Due to aging and physical deterioration, select major facilities and infrastructure experience weight restrictions or emergency repairs with greater frequency; this leads to congestion on existing alternate routes. Drivers, especially truck drivers, are used to being rerouted frequently due to closed facilities and other emergency restrictions, such as weight limitations applied to bridges while critical repairs are conducted. Travel times generally increase, and become less reliable. Freight shipments are often delayed.

## **From Gridlock to Deadlock: Conclusion**

In general, public cynicism about transportation increases. Vehicle manufacturers advertise their products' strong suspensions and entertainment capabilities. The quality of the transportation workforce declines as the industry is considered a backwater, while nations such as China showcase the latest technologies and operational enhancements. Political and business leaders speak of "managing the decline," and openly predict not just gridlock in the transportation system, but complete economic gridlock as well.

# A BETTER PATH

To avoid going from Gridlock to Deadlock, we will need to make choices in a number of major areas. The list of choices we present is not exhaustive, but follows from this report's analysis, and is meant to illustrate the range of options that can be considered. Our task is to understand how to prepare our policies, and our institutions, to lead us to the best possible future. To set our path, we will first elaborate a set of principles to guide us in making sound transportation policy decisions. Policies should:

1. Recognize the perilous forces that threaten our transportation system and address those forces honestly, transparently, and in a fact-based manner framed by data and analysis.
2. Develop new mechanisms to adapt to changing circumstances and advancing technologies with speed and flexibility.
3. Reevaluate and simplify the roles of various levels of government and engage the private sector to foster collaborative solutions and partnerships to achieve common goals.
4. Assure adequate resources to preserve, sustain, and build transportation assets and support options for funding and/or financing new investments in 21st century assets.
5. Advance balanced and sustainable economic growth without exacerbating income inequality or social division.
6. Support technological innovation, while ensuring the preeminence of safety, security, and privacy.

Although we do not include an evaluation of policy options in this document, we suggest that the reader evaluate the options presented by considering if they are consistent with these simple principles and by remembering this—if we make no policy choices, we've seen what will happen. But, this all can be avoided if we are willing to think differently and creatively about the challenges we face, and make the difficult choices we must confront.

## How We Move

How will we make it possible for Americans to get around in 2045? Our basic policy for decades has been to expand capacity to meet demand by building new facilities. This in itself may not be enough in the face of a growing and changing population, increasing congestion, and other factors (such as deteriorating facility conditions).

Most Americans expect transportation choices—and the access to opportunity those choices bring—that are probably unmatched in history or anywhere else in the world today. Nonetheless, we face obstacles in how to maintain and improve those options as our circumstances change. How can we continue to make possible the mobility that we want and need? The policies we ultimately choose can also be used to achieve broader social goals. Our transportation system does not have to be a force that exacerbates social divisions and income inequality—it can be connective tissue that provides opportunities for us all.

## Key Policy Options:

- **Increase infrastructure capacity: build new roads, bridges, and other facilities; maintain existing facilities more effectively; use existing facilities more effectively by implementing better designs and technologies; or use some combination of these methods.**
- **Reduce congestion through land use, telework, and flex-time work schedules, smaller, automated vehicles, and pricing.**
- **Promote public transit, biking, and walking.**

**Increasing infrastructure capacity.** The traditional response to addressing congestion has been to increase the supply of roads, rail, and other infrastructure. Particularly in fast-growing and highly congested corridors, new capacity is needed just to meet existing demand, much less accommodate projected growth. Design and construction of new facilities can respond to the needs and preferences of current and future generations. For instance, younger people living in cities may prefer to ride public transit in greater numbers than their parents did. On the other hand, new capacity can be very costly to build, and even more costly to maintain over its lifetime. There may be physical limits to the construction of new facilities in areas that are already fully built up. Non-financial costs (e.g., time and environmental effects) may add up. And, in the long term, new facilities could encourage development patterns that may actually induce even more congestion.

But increasing capacity doesn't just have to mean building new facilities. Our existing transportation system can in many cases be

used more efficiently, increasing capacity without pouring concrete. Better designs, such as "Complete Streets," could make it possible to handle travel growth in several different modes of transportation without breaking any new ground. In some cases, reducing highway capacity in urban centers can simultaneously reduce the maintenance burden, restore community connections, and create more developable land. And implementing advanced technologies, across every type of transportation, can also increase capacity—NextGen airplane-navigation aids, for instance, can enable planes to land every two minutes, rather than every four minutes. Incorporating modern designs and technologies can yield safety benefits, too, not just increased capacity.

Capacity may also be increased by providing up-to-date information to the traveling public, allowing people to choose the least congested, most efficient route or mode available. We can also manage and maintain our system more effectively. Better data and decision making about which facilities are most critical to the smooth operation of the whole network will make it possible to precisely target scarce construction and maintenance dollars. This kind of prioritization can increase capacity by keeping roads open and trains running, reducing the time that vital pieces of our transportation system are out of commission due to their condition. Improved construction and maintenance practices—including new materials, and even innovations in the contracting process (such as incentive payments for early project completion)—also have the potential to reduce delays and closures.

**Reducing congestion.** Matching supply and demand works both ways: in addition to increasing transportation capacity to meet the demand for travel, another policy option is to

## Portland, Oregon

Many local communities are forecasting future population growth and developing strategies to address it. For example, by adopting Resolution 36918, Portland's City Council agreed to use the Portland Plan to guide decision making. To this end, the City Council set a host of improvement benchmarks to be met by the year 2035. To measure the progress of their 12 Portland Plan Measures of Success, Portland strives to ensure that:

- 70 percent of Portlanders take active transportation, transit, or carpool to work, or work from home.
- 80 percent of Portlanders live in walkable, complete neighborhoods.
- Carbon emission levels are 50 percent below 1990 levels.

To get there, the city is pursuing an aggressive Transportation System Plan that meets state and regional planning requirements and addresses local transportation needs. It includes:

- Policies that guide the maintenance, development, and implementation of Portland's transportation system.
- A list of projects and a financial plan that will accommodate 20 years of population and employment growth.
- Thorough examination of Master Street Plans and modal plans.
- Strategies and regulations for implementation, including street classification maps.

consider how travel demand could be leveled, or even reduced, to meet the existing capacity of the system. This may mean considering how to address demand throughout a single day or within a region, to reduce the occurrence of congestion during peak periods, or in areas that suffer chronic high congestion.

One mechanism for accomplishing this is to use tolls that vary in cost throughout the day, depending on the extent of congestion. This creates an incentive for those with schedule flexibility to travel at off-peak periods. The same concept can be applied to all transportation modes to spread out demand and reduce congestion.

Congestion can also be managed through land-use policies that help to reduce commuting

distance. Mixed-use developments, where homes are near jobs, mean that commutes are shorter, and often make it possible for people to walk or bike to work. In general, development patterns that promote denser land use rather than sprawl help to reduce total commuter travel demand.

Employers can be an important partner in managing congestion through travel demand, if they are able to facilitate flex-time schedules and teleworking. This reduces the need for commuters to be traveling during peak times. Employers may also provide benefits and amenities that encourage employees to use public transit, or to bike or walk to work.

Congestion can also be lessened by reducing the actual amount of roadway needed by drivers. This can take several forms. First, smaller

## Kansas City—Mid-Area Regional Council—Transportation Outlook 2040

In the future, an aging population, continued decline in the proportion of families with children, and changing settlement preferences could increase the demand for more walkable, transit-friendly development. While developing Transportation Outlook 2040, the Mid-Area Regional Council created two growth scenarios that showed alternate ways of accommodating the region's expected overall growth. The baseline scenario shows how the region would look if past development trends were extended into the future. An adaptive scenario shows how the region might look if local governments continue a trend toward adopting sustainable growth patterns so that sustainable growth is carried out at a regional scale. Strategies and regulations for implementation, including street classification maps.

vehicles require less space for parking. Second, an increase in ride sharing would increase the number of passengers per car, reducing the number of cars on the road. Third, just as with airplanes, better technologies, leading to full automation, could make it possible for vehicles to follow one another more closely without compromising safety.

Some efforts to enhance mobility by reducing congestion may align with policies to achieve social goals, such as improving access to jobs and opportunities, and reducing income inequality. These can include new capacity investments that are planned so as to connect disadvantaged communities to jobs. On the other hand, some such policies may not enhance quality of life or opportunities, and some congestion mitigation policies may even be at odds with such goals. For instance, a pricing policy—e.g., increasing commuter costs during peak times—may reduce congestion, but for some individuals who lack work-hour flexibility (particularly low-income people), such costs also create barriers to accessing centers of employment during working hours. Policymakers should consider how to mitigate these kinds of conflicts. As one example, the money collected from congestion fees could be rebated to all commuters.

Finally, freight congestion can affect passenger transportation, as trucks jostle with cars on freeways and freight and passenger trains share our nation's rails. New policies or investments may be needed to address these kinds of conflicts: facilities dedicated to commercial use, for instance, or, drawing on automation technology, more advanced techniques for different kinds of vehicles to safely and efficiently share the same infrastructure.

Promoting transit, biking, and walking. Encouraging Americans to take transit and to bike and walk not only enhances mobility but can provide other benefits as well—improved health, greater flexibility, and a reduction in travel costs, energy use, and emissions—all while reducing congestion on our roadways.

## How We Move Things

*How can we keep our freight engine running?*

Our multimodal freight system was once the envy of the world, but today it is increasingly inadequate to meet the needs of a growing and changing population and economy. Congestion on highways and at airports, chokepoints on our rail system, aging locks and dams on our inland rivers and waterways, delays at border crossings,



and inefficient intermodal connections at our port facilities are resulting in lost productivity, increased pollution, and higher transportation costs. Ultimately, these costs fall on American workers and consumers.

Much more can be done to address the issues facing our nation's freight system. Improved coordination between the public and private sectors could guide more efficient and innovative freight investments and operations. A national freight strategy that engages freight stakeholders across all modes and regions could identify actions to address major freight issues affecting national goals. Increased financing and funding, including public funding, for targeted freight projects could be used to alleviate bottlenecks. Greater attention to international gateways could speed freight flows across borders. Finally, streamlining regulations on freight movements could lower the costs of freight.

**Improving freight planning.** With the globalization of our economy and the growth of intermodal container shipping, the efficient functioning of our freight system increasingly depends on reliable and seamless freight movements across borders and modes to meet just-in-time expectations. Even so, there is little coordination among the myriad public agencies and private companies that own and operate our freight system to improve the efficiency of freight system operations and investments. As a result, public and private resources are often used inefficiently, and important safety, environmental, and infrastructure issues go unaddressed. Our country lacks a coordinated national freight strategy that could help to focus attention and investments on issues that would allow for the achievement of national goals. Strategies to improve our freight system could include leadership in improving freight data and planning processes, streamlined regulations,

## Key Policy Options:

- **Improve freight planning and coordination at national, regional and local levels.**
- **Target policies and investments aimed at resolving freight congestion.**
- **Encourage innovative strategies to address first and last-mile freight issues.**

and targeted investments to address freight bottlenecks.

The federal government could create incentives—and provide guidance and technical assistance to state and local agencies—to integrate freight issues into policies and planning processes. Public agencies could also develop institutions and policies that allow for the coordination of freight investments across state lines, such as the I-95 Corridor Coalition. Federally funded competitive grant programs could be established to incentivize innovative state, regional, and local solutions to freight issues. States, metropolitan planning organizations, and local governments could work more closely with private partners in the freight industry to resolve first- and last-mile freight issues. Strategies could include developing strategically located distribution centers, intermodal centers, and “freight villages” to facilitate efficient movement of goods into and out of urban areas. For example, distribution centers on the edges of urban areas could be used to encourage the consolidation of deliveries into dense commercial and residential areas, making possible the use of smaller, quieter and more energy-efficient trucks. Strategies to address truck parking along freight corridors and in urban areas can improve safety and help to

## Charlotte, North Carolina

Challenging terrain and deteriorating facilities present obstacles to moving freight. With \$364 billion in goods shipped from sites within North Carolina and \$337 billion in goods shipped to sites in the state each year, the quality of the transportation system is increasingly important as a site selection criterion for companies looking to relocate or expand. Specifically, highway accessibility remains their number-one site selection factor. Eighty-six percent of goods shipped from sites within North Carolina are carried by truck, which illustrates that well-maintained roads without traffic bottlenecks are essential to a vibrant economy.

The strength of the logistics and shipping industries in the state's central region will be marginalized unless the needed maintenance and traffic flow improvements are made in this increasingly congested portion of the state. The call to invest in solutions includes enhancing access to inland ports—including improving highway connections and seeking economically competitive rail service to inland ports in and around Charlotte—and strengthening highway connectivity from mountains to coast in an effort to improve U.S. 74 to interstate standards from Asheville to Charlotte and from Charlotte to Wilmington to improve freight movements and in-state access to the Port of Wilmington. Without new investments to expand industrial rail access, freight movements throughout the region may become less efficient and less reliable. Growth in agribusiness will become flat, commercial warehouses will continue to move away, and businesses attracted to the quality of life unique to the region will ultimately decide to locate elsewhere. Which would mean fewer jobs available for local residents.

relieve local congestion. Regions and states could also work with the freight industry to encourage off-hours delivery schedules that reduce truck-related congestion. Finally, intelligent transportation system (ITS) technologies that provide real-time parking or traffic information, enable automated toll collection, and help to speed the resolution of traffic incidents can be applied to facilitate freight movements.

**Addressing freight bottlenecks.** Roadways and rail lines, particularly in metropolitan areas that are home to ports and intermodal transfer centers, are becoming increasingly congested. Policies to alleviate freight bottlenecks could

include targeted capacity investments, or planning strategies and policies that influence the timing or location of freight movements to avoid congestion. Capital investments in the modernization of facilities or in new capacity can help improve reliability while also improving efficiency. For instance, older bridges or railways that restrict the total weight carried by trucks and trains could be modernized to allow for more efficient routing of freight, thereby improving travel times and reducing emissions harmful to the environment. Investments to reduce at-grade rail crossings could also improve the efficiency of freight movements and the safety of travel.

Projects to increase freight capacity and modernize freight facilities could be undertaken in conjunction with private partners that would benefit from such improvements. To spur private investment in freight infrastructure, federal financing programs, such as RRIF and TIFIA, could be expanded. Tax credits for freight infrastructure investments could also be used to reduce the private sector tax burden and incentivize the creation of new capacity.

The FAST Act established the Nationally Significant Freight and Highway Projects program to provide \$800 million to \$1 billion annually in competitive grants, known as FASTLANE grants, to nationally and regionally significant freight and highway projects. There remains no dedicated federal revenue source to support surface transportation freight movements; however, there are a number of potential revenue sources that could be dedicated to support a strengthened national freight system. A portion of federal fuel taxes could be dedicated to freight issues; however, fuel-tax revenues have failed to keep up with inflation and may not represent a sustainable source of revenues. Alternatively, federal freight-related taxes based on freight waybills or freight ton-miles, or taxes on imported or exported goods, could be used to raise revenue to address freight bottleneck issues. Where federal funding mechanisms do exist to support the maintenance and infrastructure of inland waterway assets and the dredging of harbors, funding for capital projects could be more focused on the most economically beneficial improvements. Finally, pricing strategies such as dynamic tolling could also improve the reliability of high-value freight shipments along congested freight corridors.

**Streamlining regulations.** Competition among shippers within and between modes can help

ensure that shipping costs stay low and therefore do not act as drag on the economy. Regulations that inhibit competitiveness and drive up costs could be eliminated or streamlined. Regulatory agencies can work to standardize regulations across jurisdictions and to simplify, reduce, or eliminate paperwork and paperwork submission processes. However, many regulatory reforms that could lower freight costs, such as raising weight limits or allowing combination trucks on national highways have tradeoffs in terms of safety, security, infrastructure condition, and environmental impacts that would need to be considered.

## How We Adapt

**How do we ensure that our transportation system can weather the years to come?** To be responsible stewards of our transportation system, we must work to reduce its impact on the environment; to keep America moving, we must adapt to the anticipated effects of climate change. We have achieved large successes in cleaning our air, land, and water relative to trends evident 30 to 40 years ago, but these were highly focused efforts; today, our challenge is to consider more broadly how we can reduce, mitigate, or eliminate the negative effects of transportation projects and operations.

Our transportation system presents challenges—but it can also be part of a solution that allows our entire economy to adapt to a changing environment. We cannot always expect exactly when or how a Hurricane Katrina or Superstorm Sandy will strike, but we can work to minimize the disruptions caused by such events from the moment we begin thinking about any kind of transportation project. To accomplish this holistic goal, we need a strong, resilient infrastructure, backed up by thoughtful policies.

**Reducing emissions** means meeting our transportation demand in a less “carbon-intensive” manner. This may mean, for instance, moving more freight by rail or water, or moving more people by public transit or in electric vehicles, assuming the electricity is supplied by a renewable or low-carbon source. Vehicle emissions are expected to decline significantly due to rising fuel-economy standards for light- and heavy-duty cars and trucks. Standards are set for all vehicle model years through 2025; new policies could accelerate fuel efficiency gains for the years to follow. The potential health benefits that could result from lower emissions are also significant.

Technological advances such as carbon capture and sequestration—technologies that can capture up to 90 percent of the CO<sub>2</sub> emissions produced from the use of fossil fuels in electricity generation and industrial processes—may

## Iowa—Adapting to Increased Flooding

Iowa DOT and local universities used global climate models and the state’s hydrological model to project future flood frequencies and identify bridge and roadway vulnerabilities in two river basins. Iowa plans to integrate the information into its real-time warning system to protect the traveling public. The results of the pilot may also influence guidelines for the design of bridges and culverts on Iowa’s primary highways.

also significantly reduce the greenhouse gas emissions being released into the atmosphere.

### Key Policy Options:

- **Reduce transportation emissions by improving fuel efficiency and increasing the use of alternative, cleaner fuels.**
- **Align costs and incentives to encourage development patterns, and research into new technologies, that can aid in reducing greenhouse-gas emissions and energy use.**
- **Design and build better infrastructure that is more resilient to anticipated climate-change effects, such as severe storms, rising sea-levels, and flooding.**
- **Avoid developments in vulnerable locations.**

**Aligning costs and incentives.** Changes in land use that reduce the total demand for transportation—such as promoting mixed-use developments, enabling convenient bicycling and walking options, and other measures that reduce the travel required for commutes and other trips—can lead to reduced energy use. Thoughtful policies could effectively reduce demand or make low-emissions alternatives more attractive. Such policies could use financial incentives to encourage cleaner types of transportation. Other strategies, such as promoting ride sharing, could also help to reduce overall transportation demand.

Policies may change the relative costs of different modes. For instance, increasing the cost of carbon could make shipping goods by truck more expensive relative to shipping by barge. Such a scenario would also increase the total cost of travel for all modes that rely on fossil fuels. However, this kind of policy is likely to stimulate

research into new technologies that can reduce emissions and energy use, and it may prompt shippers, carriers, vehicle manufacturers, and others to seek innovative ways to reduce their costs.

Any revenues resulting from new policies could be rebated back to individuals in order to reduce overall costs, or could be used to finance resilient, energy-efficient transportation facilities. Without an alignment of costs and incentives, the marketplace—both individuals and the private sector as a whole—is less likely to choose to pursue courses of action that support a responsible future. In the absence of coordinated policy, if we fail to create a more resilient infrastructure, the effects of climate change—ranging from higher temperatures to sea-level rise—will mean higher costs, greater disruption, and more damage to vulnerable communities.

#### **Designing and building better infrastructure.**

In addition to reducing contributions to climate change-causing emissions, transportation policies can shape how resilient we are to the effects of climate change, both disruptive individual events (that may occur with greater frequency over time) and gradual, long-term changes to our atmosphere, land and seas. Infrastructure can be designed and built to be less vulnerable to heat or storm events, and design standards can be used to promote resilience through the choice of adopting building standards, using stronger building materials or building in locations that are less exposed to flooding, heat, and other impacts. While such policies may require greater initial investments, they may substantially reduce long-term overall costs. Ongoing research into materials and technologies that enhance resilience could also advance the state of the practice.

**Avoiding vulnerable developments.** Policies can also be used to shape where investments are made, and to reduce the overall costs to our nation for new developments in vulnerable areas. For instance, laws can require the purchase of private insurance in flood-prone areas, or use zoning and land-use policies to limit new developments in vulnerable locations. Funding could be made available for improving the resilience of critical infrastructure—or funding could be withheld for investments that are likely to be short-lived due to the effect of climate change.

## **How We Move Better**

How can we make the best use of rapid technological advances? New technologies have the potential to radically improve our entire transportation enterprise. However, our regulatory, permitting, and oversight tools are all products of a previous era—and many of them have been very slow or difficult to adapt to technological innovations. Government also must balance its dual role: promoting technologies, but ensuring that they are safe for widespread adoption.

Whether we, as a society, are positioned to take advantage of these opportunities will depend on the choices we make. Will we speed or hinder the emergence and adoption of new technologies? Will we invest public funding in research? And how will we develop the future transportation workforce? For decades, when “transportation” primarily meant “road-building,” we needed civil engineers who were versed in construction and materials technologies. In a time of smartphones, autonomous aircraft, and “big data,” what kinds of professions and technical skills will we need for the system of tomorrow?

**Addressing regulatory barriers.** As new technologies emerge, we will need to build upon

the principles of flexibility and innovation to help ensure that our policies lead rather than follow, change, and enable us to maximize the positive benefits of technological improvements and the informative value of “big data.” Regulations will need to be balanced to ensure public safety and security while enabling commercial development of technologies with widespread social benefits. In every mode, our capacity to improve safety and efficiency has never been better—or more fraught with policy ramifications that can substantially affect our privacy, our footprint on the planet, and our ability to foster shared prosperity.

With many new technologies, such as NextGen and connected vehicles, a critical mass of people must adopt it for there to be any benefit. This is often a chicken-and-egg problem: electric cars, for instance, are only viable with a network of charging stations—but charging stations are only viable once there is sufficient use of electric cars. Once a new technology is sufficiently adopted, substantial network benefits may accrue—so that

## **Potholepalooza: Crowdsourcing Urban Road Maintenance**

In spring 2015, the Washington, D.C. Department of Transportation, with the help of the Waze app, declared a “war on potholes.” The “Potholepalooza” campaign asked users to submit information about potholes via Waze. In just a month Potholepalooza campaign, the city received 10,000 pothole reports through Waze—more than three times the normal citizen reporting rate. The voluntary reporting of 650,000 Waze users in the D.C.-area proved an effective and efficient way of identifying potholes. By the end of the year, D.C. DOT had filled 16,500 potholes, many of those were identified by citizens with the help of Waze.

### **Key Policy Options:**

- **Address regulatory barriers to deployment of new technology or procedures; develop infrastructure and standards to support emerging technologies.**
- **Collect and manage data and transition to a data-driven investment system, while protecting individual privacy.**
- **Support research on technological developments and deployment.**
- **Maintain a paramount focus on safety.**

even those who haven’t adopted the technology can be better off. For example, the availability of automobiles equipped with collision-avoidance warning systems helps us all, not just those who buy such vehicles. To make these outcomes possible, government agencies will need to find ways to overcome barriers to adopting new technologies with clear societal benefits, while enacting policies that set mandatory technology standards or incentivize adoption of such technologies. In some cases, where the barriers are largely economic, government support to those with limited resources may help to ensure that a critical mass of users adopt such technologies.

Public agencies need to be prepared to support and regulate rapidly emerging technologies. For example, in recent years public agencies at all levels and across all modes have had to develop policies, laws, and regulations to deal with the safety effects of distracted driving caused by the use of mobile technologies. At the federal level, the FAA is currently faced with the challenge of developing regulatory policies to manage the use of UAS, which have commercial potential but also present great safety, security, and environmental concerns that will need to be fully addressed before their potential can be realized.

As cars increasingly become computers on wheels, NHTSA must develop a regulatory approach that allows performance failures in electronic control systems to be identified. Detecting a bug in software code requires a very different approach and skill set than determining whether there is a mechanical defect in a braking system. As connected and automated vehicles are deployed, public agencies will need to consider investing in infrastructure that supports their use, while addressing workforce capacity issues and developing policies to manage data and mitigate privacy concerns.

Overall, our institutions themselves may need to evolve. Government agencies historically have not changed at the speed of technology. If they cannot adapt quickly enough to technological developments in the marketplace, we will need to reassess our institutions so they do not become barriers to innovation, or deter would-be innovators from pursuing their work.

**Collecting and managing data.** For all the promise of new technologies, we will need to find ways to manage their use to preserve our safety, security and privacy. As collection of data from cell phones, payment systems and remote sensors becomes increasingly inexpensive and

widespread, governments may need to set standards and regulations to ensure that our personal information is protected. This is an entirely new area, changing by the day.

**Supporting research.** As technology advances in other sectors, increased investments in transportation research will likely be needed to identify and deploy transportation applications and to effectively manage the effects of technological change on the transportation system. Such research goes beyond the direct study of technology to examining a much broader set of related issues: for instance, the legal and jurisdictional implications of new technologies. Increased research investment could be ensured by increasing public research spending or private sector research could be encouraged through partnerships, tax credits, and subsidies. Increased research investments could boost efforts to commercialize leading-edge technologies, increasing the competitiveness of U.S. firms.

**Maintaining safety as the top priority.** As we become more reliant on increasingly sophisticated technological systems, we will need to find ways to preserve the functioning of transportation systems when these systems are disrupted. This will require retaining redundant systems and maintaining piloting, driving, and navigation skills, even as GPS-based navigation systems and automated functions become more prevalent. We will also need to develop systems that can identify, diagnose, and anticipate breakdowns in complex technological systems. Finally, we will need to develop standards that protect such systems from malicious attacks that could disrupt services, sowing chaos and confusion.

## How Do We Grow Opportunity for All?

Transportation is about more than getting people from place to place. Transportation investments help to shape communities. Depending on how they are planned and implemented, transportation projects and service can divide, displace, or disperse people or they can help to create connected, attractive, and prosperous communities. Increasingly, policymakers are recognizing that transportation policies and investments can play a critical role in closing the opportunity gap by creating jobs, catalyzing economic development, saving individuals money and time, and improving access to economic and educational opportunities. By addressing rising inequality and promoting equal opportunity, transportation policies can restore the economic health of disadvantaged communities and by increasing the quality of life and social mobility of individuals and families, they can also strengthen national economic growth for the benefit of all Americans.

To begin to address these issues, Secretary Foxx has called on transportation decision makers at all levels of government to adopt four fundamental principles for inclusive design:

### Key Policy Options:

- **Prioritize transportation investments in communities with the greatest needs and ensure local communities benefit from transportation investments.**
- **Coordinate transportation and land-use policy.**
- **Support affordable transportation services accessible to all.**

1. Transportation connects people to opportunity and can invigorate opportunity within communities. To the greatest extent possible, we should support transportation projects that do both.
2. While we cannot change the past, we can ensure that current and future transportation projects connect and strengthen communities, including areas that have, in the past, been on the wrong side of transportation decisions.
3. Transportation facilities should be built by, for, and with the communities impacted by them. Development of transportation facilities should meaningfully reflect and incorporate the input of all the people and communities they touch.
4. Prioritize transportation investments in communities with the greatest needs and ensure local communities benefit from transportation investments.

Many low-income and minority communities in both urban and rural America suffer from a legacy of underinvestment and disenfranchisement. Creating a more just and equitable transportation system may require prioritizing policies and projects that help to meet the housing and transportation needs of underserved communities. Equity impacts should be a critical consideration in assessing the impacts of transportation programs, policies, and investments. As innovative technologies and business models are integrated into the transportation system and provide new ways of accessing transportation services, policymakers should look for ways to ensure the benefits of those technologies are accessible to underserved populations. Emerging technologies may also help public agencies better meet mobility needs. Increased transportation investment can help create jobs for low- and middle-income workers.



In metropolitan areas that have historically underinvested in transit, investments in rail and bus services that connect low-income neighborhoods to job centers can greatly improve the prospects for residents of those communities while supporting economic development. Investments may include expanding the transit system to afford greater access or increasing the reliability, quality, and frequency of service to shorten travel times and make getting to work and other services more convenient and accessible. To support increased transit investments, policy makers could reduce funding siloes that lead to more than 80 percent of state and federal surface transportation funding being dedicated to highways. In addition, lawmakers could build upon pilot efforts to blend federal funds between housing and transportation elements that currently segregate funds. To ensure that transportation investments are made equitably across regions, MPOs could subject their transportation plans to rigorous equity analysis and seek to measure the impact of transportation capital programs on access to economic opportunity.

It should go without saying that transportation projects should benefit the residents that live nearby. But often the majority of transportation benefits go to those just passing through. To ensure that transportation investments benefit the neighborhoods in which they are built, more should be done to ensure that those investments provide access to employment opportunities for local residents. This includes planning transportation projects to connect residents to job centers. It also means ensuring the local residents are given a fair shot at the construction jobs created by transportation investments.

**Coordinate transportation and land-use policy.** Improved coordination of transportation, housing, and land-use policies can help

to address declining access to economic opportunity for low-income workers. Investments in transit can be made in coordination with policies that encourage the maintenance and development of affordable housing and the location of job centers along new and enhanced transit corridors. Public-private partnerships in support of transit-oriented development could help to increase the amount of affordable housing with access to transit. Federal transportation funding policies could be established that disincentivize investments in highway capacity expansion that contribute to greater job sprawl and economic segregation.

Support affordable transportation services accessible to all. Transportation agencies can support affordable transportation services by prioritizing accessibility over mobility and making investments that create safe, affordable options for travelers. These include investments that:

- Improve transit services and improve the accessibility of those services.
- Make places more walkable and bikeable.
- Repair and mitigate the effects of infrastructure that reduces connectivity of neighborhoods.
- Reduce barriers to automobile access through policies that improve access to credit, subsidize membership in car share services, or change welfare eligibility requirements regarding car ownership could improve access to automobiles for low-income residents.

## How We Align Decisions and Dollars

**How will we ensure that we have the institutions and funding we need to accomplish our goals?** Our institutional structure is piecemeal; it has been built up over

many decades, even centuries, in response to case-by-case situations. Even the U.S. Department of Transportation, which was established nearly half a century ago, is in some ways a collection of agencies that were created at different times, for different reasons, with separate sources of funding. In the past, our solution to each problem may have been to add a new layer or institution of governance; now, we have a collection of stovepipes that do not always work together. The solution is not to add yet more stovepipes—we need to reimagine the way we fund and govern our system.

In times of both crisis and opportunity throughout our history, both our federal, state, and local governments and our robust private sector have found ways to support critical transportation infrastructure that has spurred the growth of our nation. The public and private sectors have worked together to raise the funds needed to construct and maintain critical infrastructure, and to coordinate investments that ensure that standards are met, and regional and national benefits are achieved. Visionary leadership has played an essential role in the planning and construction of infrastructure in every mode from the Erie Canal and the Transcontinental Railroad to our national air traffic control system and interstate highways. These investments have connected population centers to our frontiers, opened new markets, and created economic opportunities for all Americans. Today, however, we confront institutional structures that often hamper, rather than facilitate, the sophisticated decision making and funding mechanisms we need to tackle our toughest transportation challenges.

**Ensuring adequate revenues.** The overall funding challenge is stark: how will we fund the maintenance, expansion and modernization of our transportation system? This is not just a

## Key Policy Options:

- **Ensure adequate revenues to address critical needs, through existing taxes, new excise taxes, user fees, tolls, congestion pricing, VMT fees, or other funding mechanisms.**
- **Reduce spending to match revenues.**
- **Prioritize investments based on performance outcomes.**
- **Ensure clear roles of the public and private sectors: clarify authorities (greater federal role, the devolution of more functions to non-federal entities, privatization); improve investment coordination between states, MPOs, and private investors.**

question about how much money is needed—it is also a question about what kind of transportation system we want, who should be responsible for what, and how we ensure that we make the best use of limited public resources.

Revenues can be derived from a variety of sources, including mechanisms already in place (such as state and federal gasoline taxes), excise taxes, user fees (such as vehicle-registration fees), tolls, congestion-pricing programs, and vehicle-miles-traveled fees. If we want our nation to continue to support a world-class transportation system that can meet the needs of a growing population and a growing economy, we will need to raise funding levels to support the necessary public investment, and we will need policies that spur private investment. In recent years, many of the revenues paid by users that support public funding of our transportation

## Utah's Unified Transportation Plan: 2011-2040

Future revenue increases are needed to maintain, preserve, and expand our state and local road and transit systems. Utah's Unified Transportation Plan cannot be implemented by using only the future revenue stream from existing funding sources. The legislature, local communities, and the public will decide how to raise this revenue. The following specific strategies were assumed but will likely vary at the discretion of Utah's state and local elected officials:

- Increase statewide fuel tax or equivalent
- Increase statewide vehicle registration fee
- Add local-option taxes (varies by MPO and county)

system, such as the federal gasoline tax, have proven insufficient to meet the challenge of maintaining and modernizing our current system. For example, over the past decade, lawmakers have transferred more than \$65 billion of General Funds into the Highway Trust Fund to keep it solvent.

As gasoline-powered vehicles become even more fuel-efficient, electric and alternative-fuel vehicles become more popular, and the cost of building and maintaining infrastructure continues to rise, the purchasing power of the gas tax will keep declining. We may need to revisit the fundamental assumptions that underpin how our surface transportation infrastructure is funded. The Congressional Budget Office estimates that we will face a \$167 billion budget shortfall over the next decade if we choose to maintain current spending levels without addressing revenues. This is unsustainable.

In recent years, a number of proposals have come forward to raise revenues to support federal surface transportation programs. The CBO estimates that a fuel tax increase of 10 to 15 cents per gallon would restore its purchasing power to roughly its 1993 level, after adjusting for inflation, and would be sufficient to

accommodate current levels of spending over the next decade. Fuel taxes could also be pegged to inflation, so that future increases in the costs of building and maintaining infrastructure trigger automatic adjustments to tax rates. New sources of funding could also be derived from alternative user fees, such as mileage-based user fees or federal vehicle registration taxes. Finally, user-based revenues could be further augmented, or replaced, by more broad-based revenue streams, such as a dedicated national sales tax, carbon tax, or income tax.

There are also revenue challenges associated with the rail, marine, and aviation sectors. In some ways, these are even more difficult, given the complicated mix of public and private revenue streams. One priority should be to ensure that revenues are aligned as much as possible with the policies and goals associated with each mode: funding should support priorities.

**Reducing expenditures.** Alternatively, we could decide that it is infeasible or undesirable to raise revenues for surface transportation and instead cut federal funding of transportation so that it is in line with dedicated revenues. This would require an approximate 30 percent cut

in current federal funding levels. Cuts could be made in a variety of ways. Currently, the federal government pays for 80 percent of most capital projects. State matching requirements could be increased so that states assume more of the burden of funding capital projects. Eligibility of projects for federal funding could be narrowed. Federal funding for transit and transportation alternatives from gas tax revenues, which account for approximately 17 percent of Highway Trust Fund revenues, could be eliminated in favor of road projects. Federal funding could be prioritized for critical maintenance, reconstruction, and replacement of existing roads, bridges and transit infrastructure, while federal support for capacity expansion projects could be limited to financing and tax subsidies.

**Prioritizing investments to emphasize performance.** Transportation programs and funding sources could be more closely tied to performance metrics, so that a greater portion of federal funding is dedicated to investments that demonstrably support national objectives. Federal requirements could be strengthened to ensure that lower levels of government use planning processes that fully consider the economic costs and benefits of transportation projects, and collect data on completed projects that allows them to assess whether the stated goals of a particular project are actually being met.

**Ensuring clear roles.** Proper governance is about much more than the question of doing more or less: it should be about doing things better. Transportation programs and institutions could be reformed to increase their efficiency and effectiveness. This could result in better decisions, lower costs, and faster delivery of infrastructure projects.

Traditionally, most federal surface transportation funding is distributed to states through formulas set by Congress and based on factors such as road miles, road usage, and state population. One way to reform federal transportation programs would be to revisit who has authority over how federal transportation dollars are spent. Currently, only a small portion of federal funding is allocated at the discretion of the U.S. DOT; most transportation investment decisions are made by states and metropolitan planning organizations. A greater portion of federal funding could be dedicated to competitive grant and financing programs with criteria tied to national objectives.

Or, the federal government could be given less control over federal funding; investment decisions could be transferred to states, or to other governance structures, including new institutions, perhaps organized around emerging megaregions. Federal requirements tied to federal funding—such as environmental and labor standards—could be reduced or eliminated in favor of standards established by other bodies. Federal transportation funding could be allocated in block grants, reducing limitations on the use of funding to support particular programmatic objectives such as safety or air quality. Alternatively, increased funding flexibility could be granted as a reward for states that demonstrate good governance and planning practices.

Policies could be adopted that support increased private sector participation in the transportation sector with the goal of speeding the delivery of projects and improving the efficiency of operations and maintenance. More states could adopt policies that support the use of private financing to deliver transportation projects and the federal government could support tax policies that encourage greater private

investment in infrastructure. Management of transportation systems and facilities, such as the air traffic control system or public toll roads, could be privatized or restructured to operate more like a business, potentially generating near-term revenues and creating long-term cost savings for government agencies. Regulatory bodies could find ways to reduce barriers of entry and encourage competition among private firms seeking to provide transportation services in all modes.

current and future conditions will require greater coordination between levels of government and between government and the private sector. We will make our choices one stitch at a time, in state capitals, city halls, corporate boardrooms, and union halls. All of them, put together, reflect where we will go.

**The future is always a choice.**

## Conclusion

Our transportation network is the tie that literally binds our nation together. It sows the seeds of economic opportunity and national prosperity one row at a time, and links those rows to each other—neighbor to neighbor, town to town, state to state, all into one nation. It is the finest transportation system the world has ever known. But it is aging and increasingly incapable of bearing the load our future demands.

It is perhaps the greatest testament to our forebears and their dedication to us that we enjoy this system in relative complacency. They built the transcontinental railroad. They built the Panama Canal. They built a national highway system. They carved an inland waterway of locks and dams. They established the world's first—and still the most robust—air traffic control system. They broke the sound barrier and put men on the moon. It is because they envisioned a better future and endured sacrifices to achieve it that we are even in a position to choose which future we want now.

But there is a difference between having choices and making choices. By knowing more about trends impacting upon our transportation system over the long term, we hope to make clear that

# BEYOND TRAFFIC 2045: MEGAREGION FORUMS

## Introduction

In September and October of 2015, we held a series of discussions on the themes of Beyond Traffic: Trends and Choices 2045 in 11 cities across the country. The goal of Beyond Traffic is to start a conversation. We wanted to hear from regional transportation stakeholders about what the trends identified in Beyond Traffic meant for their region. Participants ranged from elected officials to students. They included transportation planners, bicycle advocates, freight carriers, port operators, business owners, and community leaders.

Each city we visited represented a hub of an emerging megaregion. As described in Beyond Traffic, megaregions are networks of urban clusters connected by economic and social relationships. These megaregions will grow in importance as engines of economic growth as our nation's population in metropolitan regions grows. Residents and businesses in these megaregions often depend on the same critical infrastructure—airports, ports, rail

“MILLENNIALS, BABY BOOMERS, AND THE REST CANNOT AND SHOULD NOT BE PIGEONHOLED INTO SPECIFIC NEEDS OR WANTS—IT COMES DOWN TO OPTIONS. I AM A MILLENNIAL LIVING IN AN INNER-RING SUBURB...I DRIVE TO WORK, BUT VALUE MY COMMUTE OF LESS THAN 10 MINUTES. OUTSIDE OF WORK, I USE TRAILS, I BIKE, I WALK, AND VALUE THOSE OPPORTUNITIES. THEY'VE REALLY INFLUENCED MY CHOICE OF WHERE I LIVE, AND WHERE I WILL BE IN THE FUTURE.” – FORUM PARTICIPANT

lines, and freight corridors. Yet the planning and operation of our transportation system is rarely coordinated across these regions. As regional entities become increasingly interdependent and transportation issues grow in geographic scale, transportation stakeholders within megaregions will need to work together to remain competitive in the global economy.

To plan and operate the transportation system of the future, we need to build collaborative relationships and institutions that reflect the growing interdependence of megaregions. That's why we brought transportation stakeholders together in the following cities, each representing a different megaregion:

- Sacramento, Northern California, September 18, 2015
- Phoenix, Sun Corridor, September 21, 2015
- Long Beach, So-Cal, September 28, 2015
- Austin, Texas Triangle, September 30, 2015
- Orlando, Florida, October 2, 2015
- Seattle, Cascadia, October 6, 2015
- Boston, Northeast Corridor, October 14, 2015
- New Orleans, Gulf Coast, October 16, 2015
- Indianapolis, Great Lakes, October 21, 2015
- Charleston, Piedmont-Atlantic, October 23, 2015
- Denver, Front Range, October 27, 2015



“I BROUGHT MY 9 YEAR OLD DAUGHTER TO WORK AND WE WANTED TO GO TO LUNCH. WE HAD TO SNAKE THROUGH SOME SHRUBS TO GET TO A SIDEWALK, WHICH ENDED BEFORE THE NEXT ONE BEGAN. I HELD HER HAND AS WE CROSSED AN EIGHT-LANE ROAD TO GET TO THE RESTAURANT. AT LUNCH SHE ASKED WHY THE WALK WASN'T EASIER. “HOW DO PEOPLE DO THIS EACH DAY?”

- *LOIS BOLLENBACK,*  
*ROUNDTABLE PARTICIPANT*

# NORTHERN CALIFORNIA (SACRAMENTO, CA)



Sacramento hosted the first of the 11 regional forums on Beyond Traffic at California State University, Sacramento. The town hall style event brought together citizens, elected officials, metropolitan planners, transportation industry partners, business owners, and community leaders from across Northern California to provide input.

Panel discussants included:

- Kevin Johnson, mayor of Sacramento
- Kome Ajise, chief deputy director, Caltrans
- Steve Heminger, executive director, Metropolitan Transportation Commission
- Michael McKeever, CEO, Sacramento Area Council of Governments
- Karen E. Philbrick, director, Mineta Transportation Institute
- Victor Mendez, deputy secretary of Transportation, U.S. DOT

## Northern California Megaregion

Stretching more than 100 miles from the foothills of the Sierra Nevada Mountains across the state to San Francisco Bay, Northern California is one of the most important and economically dynamic megaregions in the country. The cities of Oakland, Reno, Sacramento, San Jose, and San Francisco serve as the region's principal hubs. Home to a diverse array of companies and industries, the region has experienced rapid expansion propelled by the growth of the technology sector. By 2050, the population of Northern California is expected to increase by over 50 percent.

## Discussion

Much of the roundtable discussions focused on ways to better coordinate regional governance, and identify new, longer-term funding mechanisms to support investments and expansion of the area's transportation infrastructure. There is a need for more consistent land-use policies among cities, counties, and special-use districts across the state, and transportation agencies need to do more to coordinate transportation and land use policy and streamline project delivery to address congestion.



To address the transportation issues, Northern California faces planning needs to take place at the scale of the megaregion.

Participants emphasized the importance of adopting and integrating emerging technologies to improve the operation and management of our transit systems, roads, airports, and ports. Transportation organizations and institutions need to develop stronger relationships with industry partners and build capacity to leverage big data and integrate technology to improve performance.

### Top Issues Discussed:

1. Technology Integration
2. Regional Coordination
3. Reducing Sprawl and Auto-Dependence
4. Mobility on Demand
5. Automation

ARTIFICIAL BOUNDARIES AND SILOS ARE THE ENEMY OF SMART THINKING AND SMART ACTING. IF WE ARE TO SUCCEED IN GROWING, INCREASE THE QUALITY OF LIFE, AND UPHOLD VALUES FOR OUR VESTED INTERESTS, WE ARE GOING TO HAVE TO START WORKING TOGETHER ACROSS THE MEGAREGION."

*MIKE MCKEEVER, CEO, SACRAMENTO AREA COUNCIL OF GOVERNMENTS*

# ARIZONA SUN CORRIDOR (PHOENIX, AZ)



On September 21, 2015, leaders from across Arizona met in Phoenix to discuss the challenges and opportunities raised in *Beyond Traffic*, to listen to key regional experts and leaders discuss their outlooks and strategies for the Sun Corridor. Phoenix Mayor, Greg Stanton, hosted the forum, which featured Deputy Transportation Secretary Victor Mendez and more than 130 participants from a wide range of transportation- and planning-related fields. Planning and management staff from the cities of Phoenix, Glendale, Sedona, and Tucson were joined by Maricopa, Pinal, and Pima county officials. Regional leaders from the transportation industry, public utilities, and civil engineering firms, and professors and students from Arizona State University all attended.

## Sun Corridor Megaregion

Lying in the American Southwest, the Sun Corridor is predicted to be the fastest growing megaregion of the United States. The Sun Corridor comprises only 2 percent of the United States' current population, but it is one of the fastest growing regions of the country; the population is expected to double by 2045. The Sun Corridor includes the cities of Phoenix and Tucson and has strong cross-border linkages to cities like Nogales, Mexico. The region has a robust and balanced economy with concentrations in advanced manufacturing, semiconductor production, as well as a fast-growing aerospace and defense industry.

## Discussion

A common theme of the discussions at the forum was the desire to expand the capacity of the transportation system to keep pace with rapid regional population growth. Mayor Greg Stanton stressed the need to address congestion and provide transportation choice to residents of the region. Other participants agreed that increased transportation funding and streamlined project delivery processes would be needed to accelerate the planning and construction of new infrastructure projects.

Another common discussion topic was the issue of supporting the region's aging population. Regional planners stressed that the needs of the regions aging population must be considered in any long-term transportation plan.

## Top Issues Discussed:

1. Streamlining Project Planning and Delivery
2. Automation
3. Improving Access for Older Americans
4. Funding Needs
5. Improving Rail and Transit Services

SENIORS WANT ACCESS TO THE INFRASTRUCTURE, BUT DON'T WANT TO DRIVE. THEY ARE INTERESTED IN MASS TRANSIT. THEY HAVE THIS IN COMMON WITH OUR YOUTH.

*MAYOR SHARON WOLCOTT,  
SURPRISE, ARIZONA*

# SOUTHERN CALIFORNIA (LONG BEACH, CA)

On September 28th, 2015, U.S. Maritime Administrator Paul “Chip” Jaenichen and Long Beach Vice Mayor Suja Lowenthal hosted a regional Beyond Traffic forum at the Long Beach Convention Center. The meeting featured California state senators and assembly members, city and county officials, directors of the California and Nevada Departments of Transportation, as well as representatives from industry, nonprofit organizations, port facilities, universities, councils of government, and various transit agencies.

## Southern California Megaregion

The Southern California megaregion extends east from the Los Angeles metropolitan area to Las Vegas, Nevada, and south across the Mexican border into Tijuana. Anchored by the principal cities of Los Angeles, San Diego, Anaheim, Long Beach, and Las Vegas, this megaregion serves as a global gateway and is closely tied to logistics and freight industries. It is home to some of the largest ports in the nation, and the population is expected to increase by over 61 percent to 39 million by 2050. With more than 25 percent of its bridges rated structurally deficient or functionally obsolete and 34 percent of its roads in poor condition, the region will need to make critical infrastructure investment decisions so that they are able to accommodate increasing demand for passenger and freight travel.



## Discussion

Given the forum’s location at Long Beach, many participants were concerned about issues affecting ports and neighboring communities. They saw a need for policies and infrastructure designed to facilitate safe and efficient intermodal freight movement across the region. They also discussed the environmental and health implications of ports and associated freight traffic for neighboring communities and identifies strategies for mitigating those impacts. Many participants at the forum expressed concerns about workforce issues. Participants described challenges training and recruiting qualified employees. They saw difficulties in

attracting talent to the transportation industry as a critical challenge affecting the ability of the industry to prepare for the future.

Participants also identified an emerging challenge in ensuring the safety of walking and cycling and promoting their use. Many participants saw the improvement of bicycle and pedestrian facilities as a critical element of enhancing mobility choices and intermodal connectivity for residents of the region. Participants discussed policy and funding strategies to encourage the development of interconnected, multimodal infrastructure that improve transportation choices for all.

## Top Issues Discussed

- Workforce Challenges
- Promoting Safe, Active Transportation
- Funding Infrastructure
- Intermodal Connectivity

WE'VE BUILT OUR CITIES TO ENCOURAGE OBESITY, DIABETES, AND TRAFFIC FATALITIES. THIS IS BASED ON DESIGNS THAT PRIVILEGE FAST-MOVING AUTO-TRAFFIC OVER WALKING AND CYCLING. THANKFULLY, THIS MINDSET IS CHANGING. I WANT MORE COMMUNITIES IN THE SOUTHERN CALIFORNIA MEGAREGION TO HAVE CHOICES, WHICH ALLEVIATE POLLUTION, AND MAKE OUR WHOLE REGION HEALTHIER.

*MEGHAN SAHLI-WELLS, COUNCIL MEMBER, CULVER CITY*

# TEXAS TRIANGLE (AUSTIN, TX)

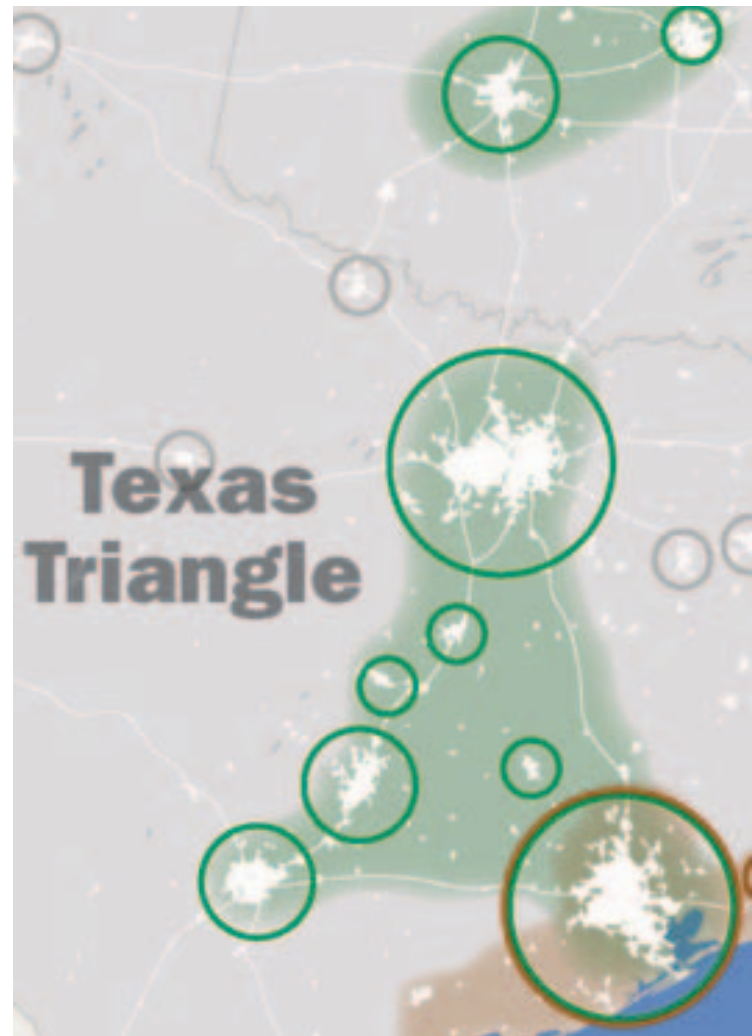
This megaregion forum was hosted by Austin Mayor Steve Adler at the Asian American Resource Center in Austin, Texas. The mayor was joined by U.S. Transportation Under Secretary Peter Rogoff, Tom Lambert, president and CEO of the Metropolitan Transit Authority of Harris County, and Christopher Evelia, executive director of the Waco Metropolitan Planning Organization. The event brought together citizens, academics, public safety officials, and industry partners from across the state of Texas to discuss the Beyond Traffic framework in greater detail and make regional suggestions for the final version.

## The Texas Triangle

Three interstate highways, I-35, I-45, and I-10 serve to delineate the boundaries of the Texas Triangle, and connect the cities of Houston, Austin, San Antonio, and Dallas-Ft. Worth. By 2050, approximately 35 million people, or nearly 70 percent of the population of Texas, will live in the four metropolitan areas that comprise the Texas Triangle. If these expected growth patterns hold, the metropolitan areas of Houston, Austin, San Antonio, and Dallas-Ft. Worth will face significant consumption pressure on land, water, and other natural resources that will need to be addressed in a collaborative approach.

## Discussion

A significant part of the discussion focused



on emerging transportation technologies and the effect they are having and will have on regional transportation. Topics such as telework, automated vehicles, the use of big data, and technology access were highly discussed, with diverging viewpoints often emerging. Big data and issues of data ownership and governance were hotly debated, with participants asking

questions like: who should own transportation data and how much data should be shared? Participants also raised questions on transformative potential and difficult regulatory challenges presented by emerging technologies such as unmanned aircraft and automated vehicles.

Participants also discussed the deteriorating conditions of infrastructure in the region. Rapid exurban population growth in Central Texas has resulted in increasing traffic volumes on roads designed for much lower volumes. As a result, pavement conditions are deteriorating more rapidly than expected and safety is being compromised. These problems can be exacerbated by extreme weather, which can cause even more damage.

A number of participants noted that rapid population growth and sprawling development patterns have contributed to congestion and reduced access to opportunity for those without access to a vehicle. They suggested that more focus needs to be placed on managing demand, providing transportation choices, and improving affordable access to jobs and opportunities. As the population ages and the travel preferences of younger residents change there will need to be greater emphasis on transit and land-use planning to meet the changing demand.

## Top Issues Discussed

- Automation
- Big Data
- Congestion
- Access to Opportunity
- Streamlining Project Planning and Delivery

A LOT OF THE CHANGES WE SEE TODAY ARE GOING TO BE AFFECTED BY TECHNOLOGY. I BELIEVE TECHNOLOGY IS GOING TO BE THE MAJOR GAME CHANGER IN TRANSPORTATION.

*DOUGLAS ATHAS, MAYOR OF GARLAND, TEXAS*

# FLORIDA (ORLANDO, FL)



Leaders from across Florida joined with Federal Highway Administrator Gregory Nadeau, and Orlando Mayor Buddy Dyer for this Beyond Traffic Megaregion Forum. Participants met on October 2nd, 2015, at the Dr. Phillips Center for the Performing Arts in Orlando, Florida to discuss freight, transit, bike and pedestrian safety, and technology issues. Panel discussants included Tampa Mayor Bob Buckhorn, Boca Raton Mayor Susan Haynie, Palm Beach Mayor William Capote, and Miami-Dade Transit Director Alice Bravo. Also present were researchers and academics from several of the region's major universities, as well as port officials, civic leaders, and industry leaders.

## The Florida Megaregion

The Florida megaregion is one of the fastest growing in the country. It is also one of the most diverse. Miami, Orlando, Tampa, and Jacksonville anchor this megaregion, which is expected to grow by 80 percent from 2010-2050, with most of that growth occurring in or around the state's major urban centers. Much of the region's development is in areas vulnerable to rising sea levels and storms.

## Discussion

Florida is home to many older Americans and a significant portion of the discussion focused on how to improve access for older residents. Participants discussed ways to ensure that older residents can preserve their mobility and independence even after they can no longer drive.

Another focal point of discussion was the need to expand modal options for travelers. Several

ORLANDO HAS EMBRACED ELECTRIC CARS AND THE TRANSIT HERE CONSIST OF GREEN FLEETS. AS WE MOVE FORWARD, GREEN TECHNOLOGIES SHOULD BE AT THE FOREFRONT OF THE CONVERSATION.

BUDDY DYER, ORLANDO MAYOR



participants noted the potential for expanding rail passenger services between the region's major cities. Others noted that Florida has a high rate of pedestrian fatalities and that more needs to be done to ensure the safety of pedestrians and bicyclists. Still others suggested that land-use patterns would need to change to make cities more walkable and transit more desirable.

Many participants suggested that innovative technologies could provide transportation solutions for the region. They suggested that increasing transportation data could make driving and transit more convenient while helping transportation agencies better understand travel patterns and infrastructure conditions. Another area of intense interest was the use of electric vehicles. Participants discussed strategies for accelerating the development and adoption of affordable electric vehicles to reduce fuel costs and combat climate change.

# CASCADIA (SEATTLE, WA)

## Cascadia Megaregion

Cascadia links the cities of Seattle, Washington, Portland, Oregon, and Vancouver, British Columbia into a connected corridor stretching along the Pacific Ocean. On October 6th, 2015, U.S. Transportation Secretary Anthony Foxx and Seattle Mayor Ed Murray hosted the sixth of the 11 nationwide regional forums on Beyond Traffic at Seattle City Hall. Panel discussants also included Marilyn Strickland, mayor of Tacoma and Lynn Peterson, secretary of the Washington State Department of Transportation.

The Cascadia megaregion, also commonly referred to as the Pacific Northwest, is projected to grow 41 percent by 2050. Most of the expected population growth will be concentrated in the Portland–Seattle–Vancouver urban corridor, which serves as the primary transportation and logistical hub for the region. Each of these cities maintains large ports and freight operations, which played a central role in the development of the region. Featuring a diversified economy of high-tech industries, aerospace firms, mining operations, and agriculture, as well as creative clusters in film, music, and green building, the region has experienced rapid development and job growth over the past decade.

## Discussion

Much of this forum focused on how to better plan and incorporate the expected increases in freight traffic while managing congestion and



reducing sprawl. In general, participants told us about the need to examine the freight system holistically because the movement of freight involves all modes of transportation. Land use, workforce issues, safety, and existing congestion were all recognized as factors that need to be incorporated into any regional freight plan moving forward. There was the sentiment that freight was underrepresented when compared to other transportation-related issues.

The need to enhance public awareness around the importance of freight, especially around the last mile, was an especially important topic for these participants. Accompanying the region's recent population growth has been an increase in highway congestion, which an increase in freight traffic will only further impact. Participants noted a variety of solutions, including designated freight corridors, promoting modal shifts, and congestion pricing, but much of this conversation was tied into reducing sprawl.

## Top Issues Discussed:

1. Freight planning and connectivity
2. Regional Equity and Coordination
3. Reducing Sprawl and Promoting Density
4. Congestion and Growth
5. Highway Congestion
6. Promoting Safe Active Transportation

PEOPLE DON'T USUALLY SEE THE IMPORTANCE OF PRIORITIZING FREIGHT—THEY DON'T SEE THE IMPACT. SEATTLE IS TRYING TO GET PEOPLES' ATTENTION BY TELLING THE STORY OF HOW YOUR BASKET OF FISH AND CHIPS GETS TO YOUR TABLE AT A RESTAURANT—WHAT ALL WAS INVOLVED IN THE PROCESS.

*ROUNDTABLE PARTICIPANT*

# NORTHEAST (BOSTON, MA)



The Northeast is perhaps the country's most complex megaregion. Hugging the Atlantic seaboard, it includes the principal cities of Boston, New York, Philadelphia, Baltimore, and Washington D.C. On October 14th, 2015, U.S. Transportation Under Secretary Peter Rogoff and Boston Mayor Martin J. Walsh hosted this forum at Boston University.

#### Panel discussants also included:

- Kathy Sheehan, mayor of Albany, NY
- James Redeker, Connecticut Department of Transportation commissioner
- Richard Dimino, CEO, A Better City

- Chris Osgood, chief of Streets-City of Boston
- Barry Seymour, executive director, Delaware Valley Regional Planning Commission.

## Northeast Megaregion

The Northeast megaregion encompasses the District of Columbia, as well as 11 states. The major cities of Boston, New York City, Philadelphia, Baltimore, and Washington, D.C., and their respective metropolitan areas are home to the majority of the megaregion's estimated 52 million residents. Connected by an array of rail and road networks, the region is home to some of the country's largest corporations and media conglomerates.

## Discussion

One of the primary needs identified in this megaregion forum was greater regional coordination. While this region does not have to deal with the intense population growth found in other areas, it will still experience growth from immigration. Given its high number of jurisdictions, we heard from participants the need for stakeholders to cooperate across their respective boundaries, and ensure that planning "didn't just stop at the next line." Enhancing communication between the various parties was considered a critical first step to engendering cooperation. One participant suggested, "There should be incentive for states to work together, to talk to each other." Another stated that to enhance cooperation they would need a

megaregion planning framework or a long-range plan for improved coordination among planning groups.

The Northeast has very little room to build new rights of way and must make better use of existing infrastructure by squeezing additional capacity out of existing modes. It was recognized that there is a need to balance maintaining aging infrastructure and infrastructure expansion.

## Top Issues Discussed:

1. Regional Coordination
2. Reducing Distance between Job and Residence
3. Promoting Safe Active Transportation
4. Improving Access for Older & Disabled
5. State of Repair
6. Construction and Maintenance Costs

THE CHALLENGE BETWEEN  
MAINTENANCE AND EXPANSION  
IS REAL BUT WE CAN'T WALK AND  
CHEW GUM AT THE SAME TIME.

*BARRY SEYMOUR, DVRPC*

# GULF COAST (NEW ORLEANS, LA)



With a multitude of significant ports, as well as a growing population, the Gulf Coast megaregion will play an important role in shaping the economic future of the United States. On October 16, 2015, participants met at the Regional Transit Authority Headquarters in New Orleans, Louisiana to discuss issues pertinent to this megaregion.

## Panel discussants included:

- Andy Kopplin, New Orleans deputy mayor
- Kip Holden, mayor, Baton Rouge
- Larry L. "Butch" Brown, mayor, Natchez, MS
- Sherri H. LeBas, secretary of the Louisiana Department of Transportation

## Gulf Coast Megaregion

Traversing a network of counties and parishes across Texas, Louisiana, Mississippi, Alabama, and Florida, the Gulf Coast megaregion is expected to grow 76 percent from 2010-2050. Its largest city, Houston, Texas, is rapidly growing,

and now considered the fourth largest city in the United States. Other major urban centers include the cities of New Orleans and Baton Rouge, Louisiana, Corpus Christi, Texas, and Mobile, Alabama. The regional economy is highly specialized in the energy, agribusiness, petrochemical, logistics, and transportation industries.

## Discussion

The Gulf Coast region is experiencing a rapidly growing population, with increasing freight volume and demographic shifts in rural and urban areas. Their transportation system is facing more frequent extreme weather events, particularly hurricanes. Participants indicated that freight bottlenecks are a critical threat that pose a danger to the regional economy, especially given the expected increases in freight traffic over the next 30 years.

Other participants noted that there is a need to better collaborate across city, parish/county and state lines, and recognize that smaller ports may be an effective way to distribute future demand. It was recognized that, "Collaborative efforts are a necessity in today's transportation environment."

Many of the employment opportunities prevalent throughout the megaregion require specialized labor and skill sets, which is likely why many

of the participants cited workforce issues more frequently than any other topic during roundtable discussions and presentations. As one participant noted, “Workforce is important; you need the right people to make the system work.” We heard that the region needs to do more to improve the identification of employment opportunities—and then link residents with the skills/tools necessary to obtain those jobs.

THE MISSISSIPPI RIVER SEPARATES  
TWO STATES, BUT IT SHOULD NOT  
SEPARATE COMMUNITIES.

*BUTCH BROWN, MAYOR, NATCHEZ, MS*

## Top Issues Discussed:

1. Workforce Issues
2. Improved Freight Planning
3. Expected Growth in Freight
4. Intercity Rail
5. Intermodal Connectivity

# GREAT LAKES (INDIANAPOLIS, IN)

Beyond Traffic Megaregion Forum participants met on October 21, 2015, at the University of Indianapolis to examine transportation trends and potential policy considerations for their megaregion spanning from Minneapolis, Minnesota to Rochester, New York, and stretching south to St. Louis, Missouri.

## Panel discussants included:

- Peter Rogoff, U.S. Transportation under-secretary
- Greg Ballard, mayor of Indianapolis
- Grace Gallucci, executive director, Northeast Ohio Areawide Coordinating Agency
- Sean Northup, executive director, Indianapolis Metropolitan Planning Organization
- Brandye Hendrickson, Indiana Department of Transportation commissioner

## Great Lakes Megaregion

Unlike other megaregions connected by a single corridor, the Great Lakes region is dispersed across the Midwest in a “hub and spoke” network with many of its major cities situated near its namesake geography. While projected to be one of the slowest growing megaregions in terms of population growth, the region still has a diverse economic base. Much of the United States’ transportation infrastructure passes through the region, and it features some of the country’s busiest airports, and is considered a major freight rail hub.



## Discussion

Due to its location in the center of the country, the Great Lakes megaregion sits at the heart of the country’s transportation network. As a result, we heard from many residents about the need to improve intermodal connectivity, enhance safety and reduce congestion, especially in terms of passenger and freight conflicts. There was the sentiment that developing affordable transportation options would help to shift the conversation beyond traffic. Increasing rail capacity and improving intercity rail were also topics that received a great deal of attention, both during the panel and at the various roundtables.

There was mixed sentiment when the topic shifted to workforce issues. There were concerns expressed about the possibility of eliminated jobs brought by the advent of automated freight, but at the same time it was noted that “CDL



requirements are becoming more stringent, truck drivers are aging out, and the talent pool is shrinking.” Participants also commented on the difficulty with identifying and retaining qualified drivers. It was agreed that moving forward the impact of automation on the workforce will need to be examined more closely.

## Top Issues Discussed:

1. Workforce Issues
2. Streamlining
3. Passenger/Freight Conflicts (Safety)
4. Intermodal Connectivity
5. Increase Rail Capacity/Demand

DON'T SHY AWAY FROM  
BEING BOLD. WE FACE MANY  
TRANSPORTATION CHALLENGES  
THAT CAN'T BE FIXED BY “DOING  
WHAT WE’VE ALWAYS DONE.

*LORI MISER, HNTB*

# PIEDMONT ATLANTIC (CHARLESTON, SC)



## Introduction

The Piedmont Atlantic megaregion forum was held on October 23, 2015, at the Charleston Gaillard Center. The event occurred just weeks after significant flooding devastated parts of the state, damaging large swaths of the state.

### Panel discussants included:

- Anthony Foxx, U.S. Transportation secretary
- Joseph P. Riley, mayor of Charleston
- Kasim Reed, mayor of Atlanta
- Steve Benjamin, mayor of Columbia
- Nick Tennyson, secretary of the North Carolina Department of Transportation

## Piedmont Megaregion

Spread across a wide swath of southern states, the Piedmont Atlantic megaregion draws its name from the Piedmont plateau, an area

characterized by gentle rolling hills and low-lying coastal regions. The region serves as a gateway to a diverse variety of freight and passenger traffic, with Hartsfield–Jackson Atlanta International Airport, currently one of the busiest airports in the world, a number of large ports on the Atlantic coast, and a network of major interstates crossing the region.

## Discussion

Coming only weeks after severe flooding struck the region, we heard a lot about the importance of creating more durable infrastructure and resilient transportation systems. Many of the roundtable discussions focused on finding ways to undertake this in a cost-effective manner. Some shared suggestions from their localities about cost-effective upgrades, including undertakings such as paving road shoulders and utilizing stronger, more resilient road-striping techniques.

These discussions around hardening infrastructure often coincided with conversations about the current state of repair of the region's infrastructure. Participants noted the backlog of projects necessitating repair, and how current projects, including bridge infrastructure were underfunded. It was noted that identifying new sources of long-term revenue would be important to ensure timely rehabilitation of these important assets, especially infrastructure

that was multi-jurisdictional. With the expected expansion of the region's ports, many suggested that this issue will only grow in importance.

## Top Issues Discussed:

1. Harden Infrastructure
2. State of Repair
3. Increase Gas Tax
4. Passenger/Freight Conflicts
5. Expanding Transit Service

MEETING MINIMUM STANDARDS  
WILL MAKE THE CUT, BUT WHEN  
INFRASTRUCTURE IS DESIGNED FOR  
A LONGER LIFE SPAN THERE WILL BE  
LESS MAINTENANCE AND RECOVERY  
OF CONSTRUCTION COSTS.

*- PARTICIPANT*

# FRONT RANGE (DENVER, CO)



## Introduction

On October 27th, at the Mile High United Way's CoBank Leadership Center in Denver, Colorado, the final megaregion forum was held. Secretary Anthony Foxx, remarked that Colorado was an appropriate place to conclude their tour because, "The state epitomizes the proactivity required for a large increase in population."

### Panel discussants included:

- Anthony Foxx, U.S. Transportation secretary
- Michael Hancock, mayor of Denver

- John Hickenlooper, governor of Colorado
- Kelly Brough, CEO and president of the Denver Metro Chamber of Commerce
- Bob Yaro, co-chair of America 2050

## Megaregion Description

The Front Range megaregion is anchored by the city of Denver, but includes the rapidly growing cities of Albuquerque, Santa Fe, and Colorado Springs. This region is expected to see a population increase of 87 percent, growing from a current population of 4.7 million to more than 5.4 million. The region derives its name from the Front Range, which is a stretch of the southern Rocky Mountains.

## Discussion

A points of emphasis during the panel and the subsequent roundtable discussion was the long history of cooperation and regional planning within the state of Colorado. Participants noted that the ability to solve very complex issues with collaboration from lots of different communities was something unique about the Denver area. Innovative solutions was a strength of the region that was cited by Secretary Foxx. He noted that the city of Denver has embraced innovation—both in practice and in planning—with projects like the Eagle P3 transit and development project, funded by public and private sources.

Another program that received additional praise was FasTracks. The FasTracks Program is a multibillion dollar comprehensive transit expansion plan to build 122 miles of new commuter rail and light rail, 18 miles of bus rapid transit, 21,000 new parking spaces at light rail and bus stations, and enhance connections across the eight-county district. In April 2016, the program will connect the Denver International Airport to Denver Union Station. Governor Hickenlooper noted, "FasTracks is a great start but we don't have the same system in Fort Collins and Colorado Springs. We need to find ways to partner with the federal government."

## Top Issues Discussed:

1. Regional Coordination
2. Public Sector
3. Long-Term Funding
4. Workforce

THE REINVENTION OF DENVER UNION STATION IS AN EXCELLENT EXAMPLE OF MULTI-AGENCY COOPERATION, VISIONARY DESIGN, AND PLACE-MAKING. IT WENT FROM A PRIMARILY WALK-THOUGH SPACE TO A VIBRANT CENTERPIECE OF A NEW/OLD NEIGHBORHOOD.

*TIM HARRIS*





**U.S. Department  
of Transportation**