



REPORT

TRANSPORTATION REIMAGINED:

A ROADMAP FOR CLEAN AND MODERN TRANSPORTATION IN THE NORTHEAST AND MID-ATLANTIC REGION



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In addition to thanking our external reviewers, Jeremy Martin of the Union of Concerned Scientists and Gabe Pacyniak of the University of New Mexico Law School, the authors would like to acknowledge the invaluable contributions of a number of NRDC colleagues: Dale Bryk, Donna DeCostanzo, Amanda Eaken, Sasha Forbes, Stephanie Gidighi, Debbie Hammel, Mary Heglar, Kim Knowlton, Amanda Levin, Vijay Limaye, Jackson Morris, Yerina Mugica, Simon Mui, Carter Rubin, Khalil Shahyd, Jossie Steinberg, Jake Thompson, and Luke Tonachel.

About NRDC

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Cover image: © New York City DOT

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Executive Summary

Whether you travel by plane, ship, car, or public transit—or even by bicycle and on foot—you are making use of America’s vast transportation system. This marvel of American ingenuity moves people and goods from one end of the United States to the other. This indispensable system, however, also faces serious challenges, which are addressed along with potential solutions in the following report.

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Unfortunately, nearly all Americans have a transportation tale of woe. We’re often stalled in gridlock, creeping along congested roadways. Our buses, trains, and subways don’t always take us where we need to go when we need to get there, whether we live in Boston or Baltimore. We don’t have access to pedestrian walkways or bike paths for short trips around town, so we drive. Walkable, bikeable, and public transit-accessible communities often lack affordable housing. Too often we see severe decay and disrepair in our highways, roads, bridges, tunnels, ports, and terminals—the backbone of our transportation system. Too many communities lack equitable access to safe and affordable transportation options. Those very same communities often bear disproportionate burdens of pollution.

Given these problems, and others, it’s clear that our transportation system needs an extreme makeover. The American Society of Civil Engineers estimates that the nation’s deteriorating roads, bridges, and transit systems cost the U.S. economy \$147 billion in 2015 alone.¹ Climate change is amplifying natural disasters and extreme weather that threaten the safety and reliability of the transportation system. Further, the tailpipe pollution from our vehicles is not only bad for our health but exacerbates climate

change. In fact, transportation is now the largest source of climate-changing greenhouse gas emissions in the nation.² We simply cannot prevent future climate disasters without beginning to address this sector now.

In late 2017, a bipartisan coalition of governors in seven Northeast and Mid-Atlantic states and the mayor of Washington, D.C., agreed to develop a plan to revamp the region’s interconnected transportation system and tackle these problems.³ The states in this coalition are Connecticut, Delaware, Maryland, Massachusetts, New York, Rhode Island, and Vermont. These states are further exploring clean and modern transportation solutions as part of a broader collaboration with Maine, New Hampshire, New Jersey, Pennsylvania, and D.C. known as the Transportation and Climate Initiative (TCI).

This is not the first time these states have worked together on such a problem. For the last decade, these same states have partnered in the implementation of the Regional Greenhouse Gas Initiative (RGGI) to tackle greenhouse gas emissions in the power sector. In that time, they have cut in half emissions from the region’s power plants, while growing their state economies, creating jobs, and driving investment in clean energy.⁴

This report envisions a cleaner, more equitable, and more accessible transportation system for the region. We offer a number of solutions to reach these goals, including walkable and bikeable streets and improved access to public transit. We also recommend expanding electric vehicles (EVs) in commercial and government fleets as well as the general population—with the charging infrastructure to keep them going.

These strategies could yield substantial economic and social benefits. In 2016, drivers spent more than \$50 billion on motor gasoline in the 12 TCI jurisdictions that are the focus of this report.⁵ If we used more EVs, we would use less gas. That alone could save consumers billions of dollars at the pump. By spending less on imported fuels,

we could keep more transportation dollars within the local economy. Investments in clean transportation could also create tens of thousands of new jobs in fields such as science, technology, engineering, and math (STEM); public transit; and construction. A clean and modern transportation system would increase access to healthcare and opportunities for healthy living, improve road safety, and go a long way toward curbing the worst impacts of climate change. At the same time, it would improve the daily lives of residents across the region, as they commute to work, run errands, and visit loved ones.

In addition, a clean regional transportation system would improve public health and protect our environment. Today many of the densely populated metropolitan areas in the Northeast and Mid-Atlantic region, like New York City and Washington, have unsafe air quality. Cleaner transportation options would decrease harmful pollution, including fine particulate matter or “soot,” nitrogen oxides, and sulfur dioxide. These pollutants are linked to asthma and a host of other respiratory ailments. Reducing or eliminating fine particulate matter alone could save thousands of lives and prevent hundreds of thousands of lost workdays in the region each year.⁶

The report lays out specific benefits for urban, suburban, and rural communities from cleaning up, modernizing, and transforming transportation.

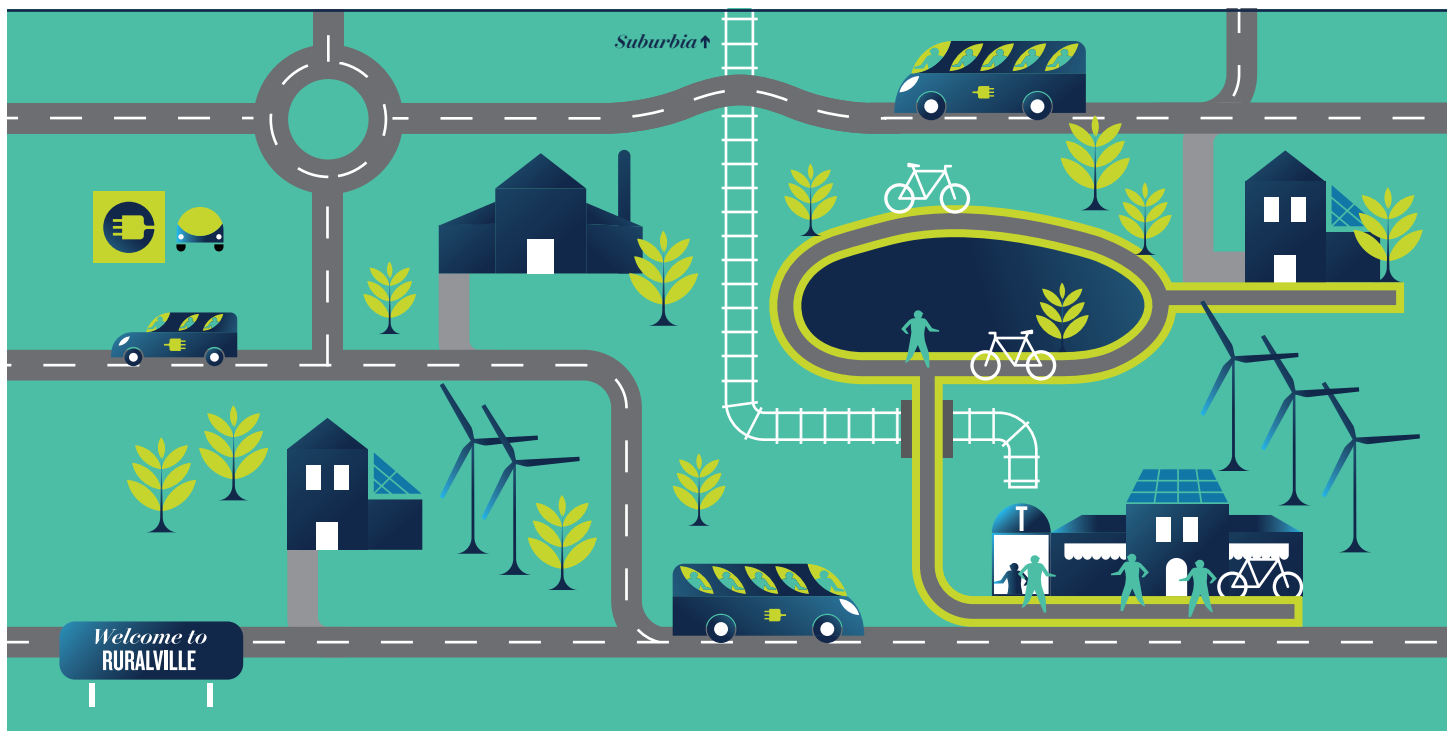
RURAL COMMUNITIES:

■ Expanded public transit and access to jobs.

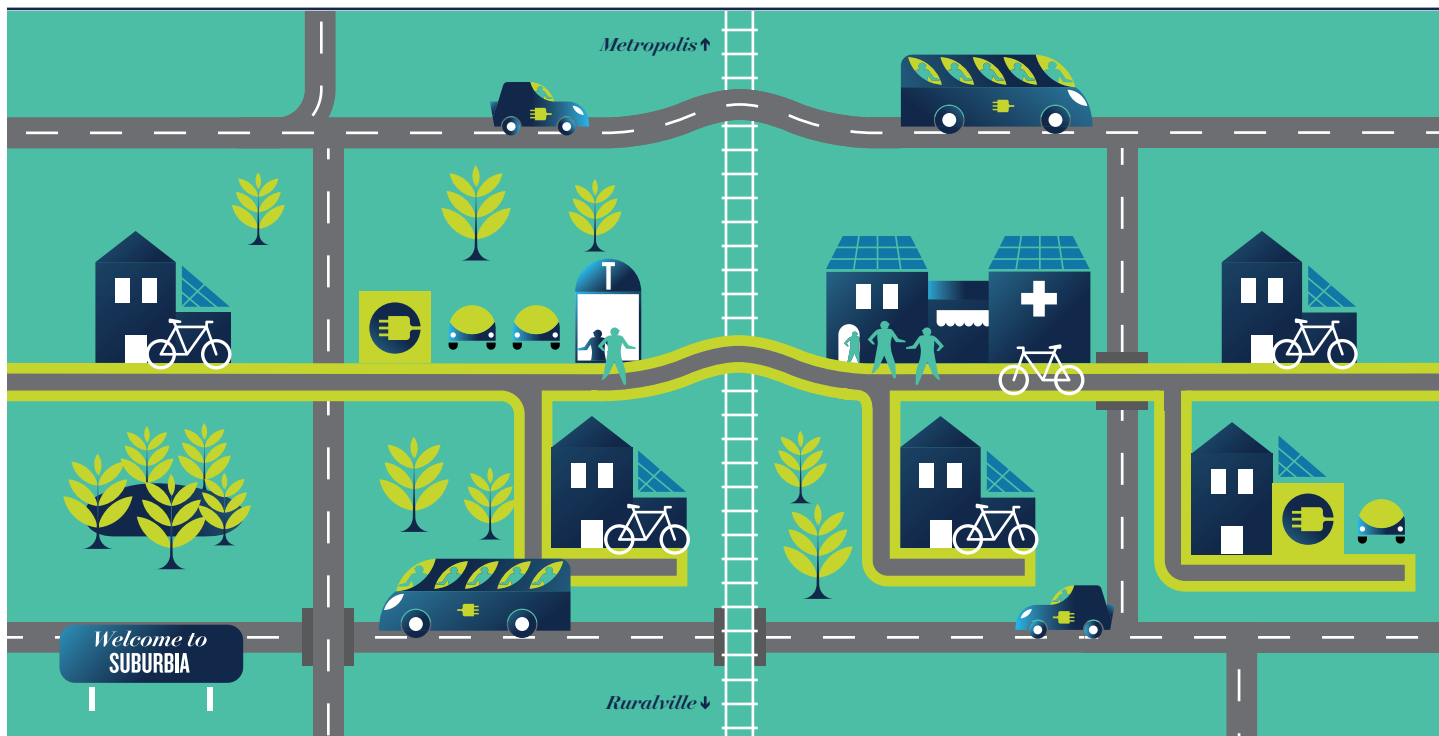
Convenient and affordable alternatives to driving are few and far between in most rural communities, creating a financial burden for many residents. On average, rural households spend 7 percent more of their budgets on transportation compared to urban households.⁷ And median income in rural households is lower—by 24 percent in 2015.⁸ Rural workers must travel on average 38 percent more miles than their urban counterparts, while rural low-income workers travel 59 percent more.⁹ Convenient, affordable, and accessible rural transit options could lower household expenses, increase employment, and reduce passenger vehicle miles traveled, while cutting air pollution and greenhouse gas emissions. These options include flexible route bus services and improved rapid transit connections between rural areas and job centers.

- **Mobility for older Americans.** A 2004 analysis found that 21 percent of Americans ages 65 and older do not or cannot drive, which limits their access to critical services and social opportunities.¹⁰ The analysis found that older non-drivers make 15 percent fewer trips to the doctor; 59 percent fewer shopping trips and visits to restaurants; and 65 percent fewer trips for social, family, and religious activities.¹¹ This is a particular issue in rural areas where 17 percent of residents are age 65 or older, five percent higher than in other areas.¹² Improved mobility options for older Americans can empower these

CONNECTING THE DOTS: MORE MOBILITY FROM FARM TO TOWN



CONNECTING THE DOTS: SMELLING THE ROSES IN WALKABLE, BIKEABLE, LIVABLE SUBURBS



citizens to retain their independence, decrease social isolation, and improve their health by connecting them with medical services. Options can include expanded public transit as well as paratransit services for people with disabilities.

- **Access to healthcare.** Improved bus and rail service in rural areas could also help other residents reach doctors' offices and other vital resources. Thirty-three percent of veterans enrolled in the Veterans Administration (VA) healthcare system, for example, live in rural areas, and improved rural transit options could help more of these veterans access VA facilities and services.¹³
- **Revitalizing rural America.** Improving rural transportation doesn't just mean buses and trains. Rural communities can also revitalize their economies and improve residents' quality of life by creating walkable and bikeable Main Streets.¹⁴ Modern EVs and expanded vehicle charging corridors can offer additional opportunities for cleaner and lower cost rural transportation.

SUBURBAN COMMUNITIES:

- **Affordable housing near transit.** Sustainable and equitable mixed-income housing sited near job centers and transit corridors can counteract rising rents and property values that increasingly force low- and middle-income residents to live farther away from their jobs and other economic opportunities. Such housing can also reduce residents' need to drive or own personal vehicles.¹⁵

- **Walkable, bikeable, and transit-friendly.** Suburban communities can become more walkable and bikeable, and provide access to public transit options into metro areas.¹⁶ Strategies to improve suburban commutes should also include linking pedestrian and bike paths to transit corridors, equipping buses with bike racks, and providing park-and-ride locations to link drivers to transit.
- **Expanding intercity rail.** The frequency of trains on commuter rail systems should be increased to provide the region's commuters with a true alternative to driving. This would also better accommodate the needs of residents, including many low-income and service industry workers who do not work 9-to-5 weekdays.¹⁷ Electrified commuter trains and other track and station improvements could also reduce emissions and improve system speeds and efficiency.¹⁸
- **Clean, electric vehicles.** EVs are a convenient, cleaner, and increasingly cost-saving option for suburban residents. Electric vehicles have a lower cost-per-mile than their gasoline-powered counterparts, potentially saving owners hundreds of dollars per year.¹⁹ They also require less maintenance, which equals even more savings. Though their upfront cost is currently higher, EV prices continue to fall. Furthermore, thanks to state and federal incentives, many models are already cost-competitive with comparable gasoline-fueled vehicles.²⁰ Improvements in EV battery efficiency and range as well as an expansion of charging infrastructure—powered by renewable energy—will keep suburban drivers moving.



URBAN COMMUNITIES:

- **Less time in traffic jams.** Today three of the top 10 most traffic congested urban areas in the U.S. are in the Northeast and Mid-Atlantic region: Boston, New York, and Washington, D.C.²¹ In 2017, drivers in Boston and Washington, D.C. were stuck in traffic for more than 60 hours, on average, while New York City motorists spent 91 hours battling traffic.²² More compact, multi-use development, walkable and bikeable neighborhoods, and improved public transportation can cut the amount of time residents spend behind the wheel in traffic—along with the harmful greenhouse gas emissions that come with it.
- **Revitalized neighborhoods.** Equitable transit-oriented development with a focus on providing affordable housing near public transportation can revitalize vacant and under-used parcels of land and breathe new life into neighborhoods, while preventing residential displacement from gentrification.²³
- **Electric buses and other clean vehicles.** Electric municipal public buses and other vehicle fleets can reduce soot and smog as well as greenhouse gas emissions. Electrifying New York City’s bus fleet, for example, would cut nearly half a million metric tons of carbon dioxide pollution per year.²⁴ Since electric motors are quieter and cleaner than combustion engines, replacing conventional vehicles with EVs can also reduce noise pollution and improve urban quality of life.

- **Addressing pollution hotspots.** Electrifying heavy trucks and other equipment at ports, airports, and truck depots can also reduce pollution in surrounding neighborhoods, which are often low-income communities and communities of color.²⁵ This also reduces fuel use and saves operators money.²⁶

NRDC encourages Northeast and Mid-Atlantic states—and their residents—to boldly chart the course toward a truly clean and modern transportation system. Achieving this vision will require a commitment to invest in modern technologies and infrastructure. We also need new policies and funding sources at regional, state, and local levels, and political leadership and public engagement.

But this is worth doing—and doing right. We can create a more efficient, equitable, and affordable clean transportation system. That system can, in turn, drive economic growth and help us live healthier, more productive lives to the benefit of our families and communities. Let’s get this show on the road.

Introduction

America's transportation systems are the veins that unite the country. These networks of roads, bridges, railways, ports, airports, waterways, and even bike paths and sidewalks keep Americans moving and connected. These systems include the interstate highways that take avocados from California to Massachusetts, as well as the public transit systems that take commuters to work every day. These complex systems don't just spring up organically—they require meticulous planning, funding, and technology. To maintain these interconnections, we must continue to invest in and upgrade our transportation systems as they age and new technology comes to the fore. The looming and intensifying threat of climate change further exacerbates the need to continuously improve our transportation infrastructure.

In that vein, in late 2017, a bipartisan coalition of seven Northeast and Mid-Atlantic states—Connecticut, Delaware, Maryland, Massachusetts, New York, Rhode Island, and Vermont—and Washington, D.C. announced a coordinated effort to develop a regional plan to modernize transportation.²⁷ This is not the first time these states have banded together to develop regional solutions. About a decade ago, these states established the Regional Greenhouse Gas Initiative (RGGI), a program that has helped cut greenhouse gas emissions from the region's power plants in half, while growing the states' economies, creating jobs, and providing funding for investments in clean energy efficiency and renewable energy.²⁸ While RGGI has helped tackle powerplant pollution, however, transportation emissions have remained high and are the largest contributor to greenhouse gas emissions in the Northeast and Mid-Atlantic states and, since 2016, the nation.²⁹

The scientific community has made it clear: if we want to avoid the worst impacts of climate change, we must limit global warming to 2 degrees Celsius or less.³⁰ The more than 190 countries that signed the 2015 Paris Climate Agreement have committed to taking actions toward that goal.³¹ As the world's second biggest emitter of greenhouse gases, and the biggest historical contributor, the United

States bears significant responsibility not only to take action, but to lead. To that end, in 2017, NRDC published a groundbreaking analysis, *America's Clean Energy Frontier: The Pathway to a Safer Climate Future*, that detailed the most effective pathways to cutting U.S. greenhouse gas emissions 80 percent by 2050—relying solely on existing technologies.³² Our analysis revealed the transportation sector as a key area for emissions reductions and efficiency, capable of delivering nearly a third of the emissions reductions we need to achieve by mid-century.³³

Revamping our transportation system allows us to address more than just climate change. It can also improve access to convenient and affordable transportation options, alleviate traffic congestion, improve equity, improve our air quality, and create jobs. As we work to cut emissions, we can make sure our transportation system is more resilient to a changing climate and more frequent extreme weather.

This report examines real-world transportation solutions, including deployment of cleaner, more efficient vehicles, better project and land use planning, smarter investments, and more equitable community design. We also explore the potential benefits of large-scale adoption and deployment of these strategies—from more jobs and lower costs to improved public health and access to opportunity.

We specifically focus on 11 states—Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont—and Washington, D.C. Collectively, we refer to this grouping as the “Northeast and Mid-Atlantic region.” Only eight of these jurisdictions have thus far joined the effort to develop a regional clean transportation plan. However, all 12 are members of the Transportation and Climate Initiative (TCI), which has focused on clean transportation solutions more broadly since 2010.³⁴

With planning, vision, and political leadership, the region can address climate change and create a truly 21st-century transportation system. In so doing, it can lead the nation and the world.

WHAT IS THE TRANSPORTATION SYSTEM?

Transportation system: the networks used to transport people and goods to their destinations, including: (1) infrastructure modes (roads, bridges, rail lines, ports, bike paths); (2) vehicles (cars, trucks, buses, trains); and (3) operations (technology, funding, planning).



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A Vision for 21st-Century Transportation



In the 21st century, the Northeast and Mid-Atlantic region could become virtually free of tailpipe pollution. Clean and modern trains and buses could provide fast, reliable, and convenient transportation. With community planning and sustainable, mixed-income development, more people could afford to live closer to their jobs. That way, they could walk or bike to their destinations, resulting in decreased traffic congestion and air pollution. The vehicles that remain on the road could be quieter, cleaner electric cars and trucks.

Our streets could become shared spaces for pedestrians and cyclists, as well as efficient trains, buses, and other clean vehicles. Road segments could be repurposed into public gathering and play areas, creating community open spaces that attract shops and cafes. Across the region, residents would have access to an interconnected, multipurpose transportation network that is clean, modern, and affordable.

It may seem idealistic, but it is not unrealistic. We can achieve all of this with existing technologies and planning. Many pieces of the vision are already starting to roll out in communities today.

Still, if you ask almost any resident in the Northeast and Mid-Atlantic if the transportation system needs improvement, they will likely answer with a resounding yes. In 2017, Massachusetts held a series of public workshops on the future of the transportation system. They found that more than 80 percent of participants believed

that the current system was not in good condition and that elected officials should make improving it a higher priority.³⁵

Major roads and bridges and many of our public transit systems were built and designed a half century ago—or longer—when transportation system demands and technology options were far different. Many of those road building projects have left legacies of displaced and divided communities, lowering property values and creating barriers to economic and transportation opportunities, particularly in low-income communities and communities of color.³⁶ Attempts to solve congestion with new roads or expanded highways have simply attracted more drivers, further ensnaring traffic.³⁷ Transit riders must contend with crowded trains and buses that are often delayed. And many residents cannot access public transportation at all due to limited routes and schedules, handicap accessibility, lack of affordability, and underinvestment. Poor road conditions delay the delivery of goods to market, costing the U.S. economy billions of dollars each year.³⁸ Trucks spew toxic plumes of black smoke into our air, putting us at risk of severe respiratory complications. Many roads are not safe for pedestrians and cyclists as they battle cars, trucks, and buses.³⁹

With political leadership, strong investments, and input from diverse stakeholders and communities, we can create a 21st-century transportation system that better meets our needs. This report draws inspiration from initiatives around the country to chart the course toward that vision.



MODERNIZING TRANSPORTATION EQUITABLY

In addition to reducing greenhouse gas emissions, a 21st-century transportation system must improve access to convenient and affordable transportation solutions and address legacies of underinvestment and inequality. A modern transportation system should serve all ages, races, ethnicities, genders, family types, incomes, and abilities across urban, suburban, and rural communities. The planning process should be open and inclusive, with space for diverse voices. Policymakers and planners should be intentional about including communities with inequitable access to affordable transportation, that have been disadvantaged by past transportation decisions, or that bear disproportionate burdens of pollution in these conversations.

The U.S. Department of Transportation's 2017 *Beyond Traffic* study provides guidance on how policymakers and communities can address transportation equity and provide economic opportunity for all.⁴⁰ Its recommendations

include, for example, recognizing how our current transportation system has caused or perpetuated inequities; ensuring underserved communities are engaged in transportation planning; creating affordable transit-oriented housing; and ensuring people can walk and bike safely and have access to public transportation, including in low-income and rural areas.

As part of a coalition, NRDC has also developed a set of *Shared Mobility Principles for Livable Cities*,⁴¹ many of which are applicable to rural and suburban areas as well (see Appendix A). These principles recognize the need for stakeholder engagement, an equitable approach, and prioritizing access to transportation and the mobility of people across different modes, not just personal vehicles.

These principles and ideas should be incorporated into discussions around modernizing the Northeast and Mid-Atlantic region's transportation, and are further embodied in the strategies and case studies discussed below.

The Building Blocks for Modern Transportation



Cities and towns around the world are deploying innovative transportation solutions to create more efficient, convenient, and sustainable transportation systems. Below, we profile some of the most promising and effective solutions already taking root in the Northeast and Mid-Atlantic and other areas.

I. PEDESTRIAN- AND BIKE-FRIENDLY STREETS

Reducing passenger vehicle miles traveled is key to reducing greenhouse gas emissions in line with our climate goals.⁴² Policies and planning efforts should encourage walkable and bikeable development. The benefits aren't just environmental. For trips under one mile, which account for 28 percent of U.S. car trips,⁴³ biking and walking are often cheaper and more efficient modes of transportation. Higher density development that supports walking and biking can also reduce travel stress and improve health.⁴⁴ More foot and bike traffic can attract and support local retail shops and restaurants.⁴⁵ Bike paths and pedestrian walkways can create healthy and fun ways to get around and see a city or town from a new perspective. Visionary planning and development and well-maintained sidewalks, streets, protected bike lanes, and open spaces can all encourage and enhance safety for pedestrians and cyclists.⁴⁶ Policymakers should ensure access to these opportunities across communities.

Rethinking Rural Main Street: Waterloo, NY

Waterloo, New York (population 4,936),⁴⁷ redeveloped its central Main Street as part of a multiyear, community-wide planning process that emphasized smart growth. The project sought to protect open space and contribute to the health and well-being of the community and spur economic development.⁴⁸ To incentivize and support safe walking and biking, Waterloo reduced its Main Street from four driving lanes down to two, reducing motor vehicle traffic, and added bike lanes.⁴⁹ The town also connected its new bike



lanes on Main Street to existing bike trails along the nearby Cayuga-Seneca Canal. The town earned a “2017 Great Streets Award” from the American Planning Association.⁵⁰

Creating a Bike-Friendly City: Washington, D.C.

In 2005, Washington, D.C. adopted a “Bicycle Master Plan,” prioritizing the installation of bike lanes and parking, education, and improved enforcement of traffic and safety laws.⁵¹ The plan built on earlier bike-friendly efforts, including the city’s 2002 decision to equip all public buses with bike racks.⁵² In developing the Bicycle Master Plan, D.C. solicited input at public workshops attended by more than 150 citizens, through surveys distributed in person and online, and through the release of a draft plan for public review.⁵³ All told, D.C. received and considered more than 1,000 citizen comments.⁵⁴

In 2010, D.C. expanded bike lanes in key city corridors and launched its Capital Bikeshare program, now used by both commuters and tourists.⁵⁵ The program currently includes more than 4,300 bikes and 500 parking stations,⁵⁶ and has provided more than 20 million bike rides since its inception.⁵⁷ Capital Bikeshare has reduced vehicle miles traveled by almost 10 million miles a year⁵⁸ and climate-warming carbon dioxide emissions by more than 28 million pounds to date.⁵⁹ D.C. is now experimenting with “dockless” bike sharing—GPS-equipped bikes that can be picked up and dropped off across the city.⁶⁰ The D.C. bikeshare program has also formed partnerships with local nonprofits and banks to ensure that residents can access this program regardless of their income.⁶¹

Washington, D.C.’s bike-friendly policies and initiatives have helped nearly triple the number of bike commuters over the last decade, and given the city the second highest percentage of bike commuters in the nation, behind only Portland, Oregon.⁶² An estimated 17,000 D.C. residents commuted by bicycle in 2016.⁶³

Other cities are also leading in this area. New York City has the largest network of bike lanes in North America, with more than 1,000 miles of bike routes.⁶⁴ And smaller cities like Cambridge, Massachusetts, are incentivizing bike ridership as well. Cambridge has developed a master plan for cycling, installed bike-friendly infrastructure, including protected bike lanes, and adopted an ordinance to ensure new developments include high-quality bicycle parking.⁶⁵

Prioritizing Walking and Biking in the Suburbs: Arlington County, VA

Arlington County, Virginia, is one of the D.C. region's many suburbs. Decision-makers in this county have shown that suburban communities can be walkable and bikeable. For example, Arlington has widened its sidewalks and provided pedestrians with safer crossing options, including clearly defined crosswalks as well as median islands and sidewalk extensions that shorten road crossing distances for pedestrians.⁶⁶ The county has also installed well-marked and protected bike lanes along many of its roads.⁶⁷

In 2009, the county was the first in the United States to install automated sensors along trails and bike paths to monitor bicycle and pedestrian traffic.⁶⁸ These sensors help decision-makers understand how people use biking and walking infrastructure so they can identify areas and priorities for improvement. For example, the sensors show that while rainy days reduce bike ridership, many people continue to use bike paths during cold weather. This finding prompted officials to prioritize winter trail maintenance so people don't revert to personal vehicles during the winter months.⁶⁹ Arlington's snow removal plans treat heavily used trails with the same priority as major streets.⁷⁰ Its sensors also capture peak trail use times, which allows maintenance crews to schedule work around the busiest times.⁷¹

Arlington has also engaged in community education. For example, the county's "Car-Free-Diet" program encourages residents to walk, bike, or use public transportation instead of driving. Its "Safe Routes to Schools" program helps elementary and middle school students map out routes for walking and biking to school.⁷²

In 2015, 99 percent of Arlington's residential streets had sidewalks, an increase of 26 percent from 1997, while traffic on 7 of its 9 busiest roads had declined between 5 and 23 percent since 1996.⁷³ Arlington's robust bike and pedestrian infrastructure also get significant traffic. Major trails can see half a million bicycle trips per year and many sidewalks are used by more than 3,000 pedestrians per day.⁷⁴ Combined, walking and biking account for more than 16 percent of trips in the area.⁷⁵ A September 2017 survey of Arlington residents found that 89 percent of respondents would like to bike even more often, with 62 percent saying that adding more protected bike lanes would help them do so.⁷⁶ Arlington's many efforts have earned the county designations as a "silver" level bicycle-friendly community

from the League of American Bicyclists⁷⁷ and a "gold" level community from the Walk Friendly Communities program.⁷⁸

2. EQUITABLE TRANSIT-ORIENTED DEVELOPMENT

Locating housing near transit hubs can further reduce emissions and vehicle miles traveled by increasing access to public transportation. Transit-Oriented Development (TOD) is a community planning and development strategy that creates compact, walkable, mixed-use communities within a half mile of high-frequency transit options. TOD can, however, increase property values and rents, which can lead to gentrification and displacement.⁷⁹ Equitable TOD (eTOD), on the other hand, prioritizes the needs of lower- and mixed-income communities, who are often more reliant on public transit,⁸⁰ and can include zoning ordinances that mandate affordable housing. The eTOD approach can also focus on revitalizing vacant or under-used parcels of land to breathe new life in neighborhoods.

Healthy Living Near Transit: South Bronx, NY

The Bronx is the northernmost borough of New York City. The county is majority people of color, and has the highest poverty rate in the city. In 2016, average household income was roughly \$38,000 with a poverty rate of 28 percent, based on U.S. Census Bureau classifications, compared to less than 19 percent citywide.⁸¹ In New York's 15th Congressional District, which includes the South Bronx as well as western parts of the borough, median household income is even lower—under \$30,000—the lowest of any Congressional district nationwide.⁸²

In 2006, New York City began working with developers to transform a vacant railroad yard in the South Bronx into an affordable and sustainable mixed-income community.⁸³ The site, known in the Bronx as "The Hub," is located near a busy commercial area and various public transit options including at least five bus lines and a subway station served by two major train lines. Redevelopment of the site was supported and informed by community input, including the area's local community board, which developers engaged early in and throughout the process.⁸⁴ Community members expressed preferences for affordable housing, including some for-sale units, as well as building designs to promote sustainable and healthy living, to help combat high obesity and asthma rates.⁸⁵

The final Via Verde development includes 151 rental units reserved for low-income households earning 40 to 60 percent of the area's median income (AMI), and 71 middle-income co-op units that can be purchased by buyers with household income of 70 to 100 percent of AMI.⁸⁶ Purchased co-op units can later be resold to other similarly qualified buyers.⁸⁷ Via Verde's for-sale units sold out within seven months of its opening, and rental units were leased immediately.⁸⁸



The building is energy efficient, which reduces energy bills. In fact, Via Verde uses 30 percent less energy than it would have if it had merely met the building codes.⁸⁹ The development's focus on energy efficiency and its other sustainable designs earned it a gold certification (the second highest level) under the Leadership in Energy and Environmental Design (LEED) program.⁹⁰

Via Verde also includes rooftop fruit and vegetable gardens that supplement the lack of healthy food in the neighborhood. There is also a health clinic and pharmacy located within the building.⁹¹

From Parking Lot to Housing: North Philadelphia, PA

Paseo Verde is a mixed-use commercial and residential development in North Philadelphia that is adjacent to a regional commuter rail station as well as bus lines and a subway station.⁹² The development was built on a previously fenced-in, rundown city-owned parking lot.⁹³ It includes 120 rental units that provide affordable housing for low-income families, commuters to downtown Philadelphia, and students attending nearby Temple University.⁹⁴ Fifty-three of the building's housing units are rented at lower, subsidized rates to households with incomes between 20 and 60 percent of AMI.⁹⁵ The remaining 67 units are rented at market rates.⁹⁶

Construction of Paseo Verde was completed in August 2013, and within one year of opening, 90 percent of the building's commercial and residential spaces were occupied.⁹⁷ By 2015, 100 percent of these spaces were occupied.⁹⁸

Commercial tenants include the building's developer, as well as a nonprofit healthcare provider, dental office, and pharmacy.⁹⁹

Paseo Verde has earned a platinum certification (the highest designation) under the LEED for Homes program, in recognition of the building's rooftop gardens, solar panels, energy efficient appliances, green spaces, and permeable pavement and other green features to manage stormwater. Paseo Verde has also earned a platinum certification under the LEED for Neighborhood Development program, recognizing its walkable access to transit as well as food, banking, healthcare, and education.¹⁰⁰ To incentivize use of sustainable transportation, the building includes more bike storage spaces than parking, keeps residents informed about surrounding transit options, and hosts an on-site car-sharing service.¹⁰¹

Affordable Housing in Small Towns: Old Saybrook, CT

In 2009, Old Saybrook, Connecticut (population 10,132)¹⁰² adopted a new land use policy to provide more affordable housing in the community, including for older residents, young people, veterans, and formerly homeless residents.¹⁰³ The "incentive housing zone" policy enables housing development in certain areas that were previously zoned for commercial use only, and includes a streamlined permitting process that allows property owners in designated incentive housing zones to create higher density developments. The town's first incentive housing zone has resulted in 100 new units of affordable housing,¹⁰⁴ which are defined as units that are rented or sold to persons

earning 80 percent or less of AMI at prices that enable them to spend 30 percent or less of their annual income on housing.¹⁰⁵

Under the town's policy, at least 20 percent of housing units developed in a designated incentive housing zone must be affordable.¹⁰⁶ These zones and their associated developments must have reasonable access to public transportation.¹⁰⁷ As part of an application to build housing in the zone, a developer must demonstrate that the proposed construction will be compatible with the town's natural limits of topography, soil conditions, and wetlands, as well as its historical patterns of development.¹⁰⁸ Old Saybrook also requires developers to set aside land for parks or recreation centers. Combined, these requirements help ensure the town's goals of creating vibrant, mixed-use commercial and residential districts that are walkable; transit-accessible; and connect residents to jobs, services, and recreation.¹⁰⁹

3. BETTER PUBLIC TRANSPORTATION

Improved public transportation can go a long way toward tackling climate change, while easing travel for day-to-day life. Convenient, reliable, and affordable public transportation reduces the need to own a personal vehicle, eliminating a major budget line for many households. Fewer cars means a major dent in overall vehicle miles traveled, and cuts the stress of driving in bumper-to-bumper traffic. Public transportation is also more efficient, saves fuel and fuel costs, and reduces tailpipe pollution. Because lower-income residents are more likely to rely on public transit, improving and investing in transit systems can also increase equity.¹¹⁰ There are many ways to improve public transportation systems, including investing in system upgrades and service extensions to improve access and reliability, better integration between different transit modes such as buses and trains, and deploying cleaner and more efficient hybrid and electric vehicle technologies.

Improving City Bus Service: Seattle, WA

In 2014, Seattle voters approved new funding for the City's bus service to increase its reliability and frequency. In 2016, voters approved further investments to expand the region's public transit systems.¹¹¹ The city has created transit-only corridors, which restrict private vehicles from certain streets during the morning and afternoon rush hours. This improves bus speed and efficiency by cutting down on traffic jams and making it easier for buses to make stops.¹¹² Seattle has also created designated traffic lanes that enable buses to jump ahead of other vehicles at stop lights.¹¹³

These improvements have helped Seattle increase bus ridership while many U.S. cities have seen ridership decline.¹¹⁴ In 2015, about one in five Seattle workers rode the bus to work.¹¹⁵ Over the last 9 years, the city's



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bus ridership has grown by 8 percent.¹¹⁶ Residents are increasingly choosing to ride the bus in Seattle rather than driving. Since 2010, as the city's bus ridership has grown, the number of commuters driving personal vehicles downtown has declined by 10 percent, even as Seattle's population has grown by 15 percent over the same time period.¹¹⁷ Because riding public transit is more efficient than driving a personal vehicle, Seattle's buses displace four times more greenhouse gas emissions than they emit, while reducing traffic congestion and the number of cars on the road.¹¹⁸

Connecting the Suburbs with Regional Rail: Massachusetts and Rhode Island

The Boston-based nonprofit TransitMatters has outlined a detailed vision to improve the current suburban commuter rail system that connects Boston to other Massachusetts communities and Providence, Rhode Island.¹¹⁹ Boston's commuter rail system is designed primarily to accommodate the traditional 9-to-5 weekday workday and service during other times is infrequent.¹²⁰ TransitMatters envisions a more frequent, reliable, and expanded intercity rail system in the Greater Boston area.¹²¹ This system would also improve rail access for lower-income residents who often work nontraditional hours.¹²²

TransitMatters recommends more frequent service and free transfers to local buses and subways. They propose raised train station platforms to enable quicker and more accessible, step-free boarding, and strategically investing in rail infrastructure, such as targeted track upgrades, to relieve system bottlenecks.¹²³ Their plan also includes switching to all-electric trains, which accelerate faster than diesel locomotives. TransitMatters estimates that step-free boarding and electric trains could cut travel times by 40 percent.¹²⁴ An efficient and accessible regional rail system would create an alternative to driving on congested roads and reduce emissions.¹²⁵



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Providing First- and Last-Mile Solutions

People are less likely to use public transit when distances to or from bus stops or train stations are too far or too unsafe. The “first- and last-mile connection” refers to the facilities, infrastructure, and services that allow people to get from their front door to their final destination via transit without a personal vehicle.¹²⁶ A lack of first- and last-mile connections is especially acute in rural and suburban areas where routes are often less dense as well as underserved urban neighborhoods. Expanded transit routes can address these issues, but it is not always feasible or affordable.

There are a variety of ways to improve first- and last-mile connections. Policymakers could link safe and convenient pedestrian and bike paths to transit corridors, install bike racks on transit buses, or adopt bike-sharing programs, which have been shown to increase bus and rail use.¹²⁷ Park-and-ride locations near bus and rail stations can also encourage rural and suburban commuters to take public transit. In the Washington, D.C., and Baltimore metro areas, there are more than 400 park-and-ride lots with more than 160,000 parking spaces. Two thirds of these parking lots have bus or rail service available.¹²⁸

Ride-hailing services could potentially contribute to first- and last-mile solutions by connecting riders with existing transit hubs. Public transit agencies in areas like suburban Summit, New Jersey, and Southeastern Pennsylvania have begun piloting programs with the ride-hailing services Lyft and Uber that give free or discounted rides to and from train stations in attempts to create a more comprehensive transportation system.¹²⁹ It is important to ensure that ride-hailing services do not displace transit ridership, however, as this could result in more vehicles on the road, increasing both traffic congestion and emissions.¹³⁰

Flexible Rural Bus Routes and Rapid Transit: Northwest Connecticut and Montgomery County, MD

The Northwestern Connecticut Transit District’s CandyStriper bus helps close the first- and last-mile gap in rural Connecticut. The bus runs along defined routes

between the towns of Torrington, Winsted, and Litchfield. Buses will, however, deviate up to three-quarters of a mile off their normal routes on request.¹³¹ The Transit District also offers a curb-to-curb “dial-a-ride” service for passengers with disabilities that serves 17 towns.¹³²

Montgomery County, Maryland, located just north of Washington, D.C., is developing a Bus Rapid Transit (BRT) line that will connect a park-and-ride lot in the rural-suburban community of Burtonsville to a transit hub in the more populous urban center of Silver Spring. There, riders can access additional bus, subway, and train connections to the D.C. metro area.¹³³ To improve bus speeds and reliability, the BRT line will incorporate high-capacity buses and traffic signals that prioritize bus passage, such as by extending green lights or shortening red ones.¹³⁴ The new bus line will also include stops in several suburban areas and serve a corridor that is 65 percent people of color and where 30 percent of households earn an annual income of less than \$30,000.^{135 136}

4. CLEAN, EFFICIENT, AND ELECTRIC VEHICLES

Enhanced fuel efficiency will further cut greenhouse gas emissions and other air pollutants. This includes the transition to electric vehicles (EVs). Switching to EVs and other clean vehicle technologies, combined with a broader transition to clean energy, can significantly cut greenhouse gas emissions and get us closer to our climate goals. The environmental impact of an EV depends on the mix of power plants that provide its electricity. However, on average, the carbon footprint of EVs in the United States is already much lower than any conventional gasoline-fueled car on the market, releasing as many emissions as a car that gets 80 miles per gallon.¹³⁷ In New England, which has a relatively low-carbon power grid, driving an EV is equivalent to driving a gasoline-fueled car that gets more than 100 miles per gallon.¹³⁸ These benefits will grow as we continue to expand renewable energy on the power grid, enabling EVs to charge on increasingly clean energy. NRDC’s 2017 report, *America’s Clean Energy Frontier*, recommended that, by 2050, 60 percent of all miles traveled by passenger vehicles should be powered by clean



electricity to avoid the worst impacts of climate change.¹³⁹

Many states in the region have adopted ambitious targets for adoption of EVs and other clean vehicles. Collectively, Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Rhode Island, and Vermont aim to achieve close to 2.4 million “zero-emission vehicles,” or ZEVs, on their roads by 2025.¹⁴⁰ The term ZEV refers to EVs, hydrogen fuel cell vehicles,¹⁴¹ and plug-in hybrid EVs, which combine a conventional gasoline or diesel-fueled engine with an EV battery and motor.¹⁴²

But there is still a long way to go. In 2017, these states had fewer than 90,000 ZEVs on the road.¹⁴³ In that same year, though, ZEV sales nearly tripled compared to 2016—from less than 9,966 sold in 2016 to more than 27,085 sold in 2017.¹⁴⁴ California, which is the nation’s leader in ZEVs, saw sales of nearly 100,000 such vehicles in 2017, showing that still higher rates of adoption are possible.¹⁴⁵

To meet their EV and climate goals, Northeast and Mid-Atlantic states and local communities can adopt policies

and programs that incentivize EV use and make them more accessible. States can also work with utilities and other partners to expand EV charging infrastructure. Several electric utilities in the region have proposed programs that would invest hundreds of millions of dollars to expand vehicle charging options in residential, public, business, and low-income areas.¹⁴⁶

Ensuring Equitable Access

EVs require less maintenance and have a lower and more stable cost-per-mile, compared to fluctuations in gas prices—all of which adds up to long-term cost savings.¹⁴⁷ The introduction of lower-cost EV models is making these vehicles even more accessible for more people. At the same time, the upfront purchase cost for a new EV, as well as the lack of access to EV charging infrastructure, remains a barrier for many low- and middle-income consumers. States should ensure that the EV revolution does not bypass the households or neighborhoods disproportionately impacted by air quality problems.

To address upfront costs, California offers larger rebates for low- and moderate-income consumers on the purchase of personal ZEVs.¹⁴⁸ The state is piloting a program that provides these state rebates upfront, rather than as end-of-year tax credits.¹⁴⁹ California also offers grants to support EV car-sharing programs and install charging stations in low-income and pollution-burdened neighborhoods in Los Angeles, Sacramento, and the San Francisco Bay Area.¹⁵⁰

Massachusetts’ Department of Energy Resources is developing a pilot program to help low-income families purchase electric vehicles.¹⁵¹ Electric utilities and policymakers in Massachusetts, Rhode Island, and Maryland are also developing plans to deploy EV charging stations in low-income and pollution-burdened, frontline communities.¹⁵²

Electric Transit and School Buses

The conversation about EVs must include public transit, especially municipal bus fleets. Electric buses have already been deployed at scale in other parts of the world. The Chinese city of Shenzhen deploys 16,359 electric buses. That’s more buses, of any type, than the transit agencies of America’s ten largest cities had—combined—in 2016.¹⁵³ In July 2017, the LA Metro set an ambitious goal of converting to an all zero-emissions public bus fleet by 2030.¹⁵⁴

Electric buses are also being deployed in the Northeast and Mid-Atlantic. In 2017, the Federal Transit Administration provided \$55 million to help fund low- and zero-emission buses in 39 states. That included new electric buses in Connecticut, Delaware, Massachusetts, New Jersey, New York, Pennsylvania, and Vermont.¹⁵⁵ In 2018, New York City’s transit authority initiated a three-year pilot program. It ordered 10 electric buses, with plans to purchase 60 more after evaluating the performance of buses used in

the pilot phase.¹⁵⁶ The city aims to have a fully electric bus fleet by 2040,¹⁵⁷ which could eliminate nearly half a million metric tons of carbon pollution per year.¹⁵⁸ In April 2018, Washington, D.C. added 14 electric buses to its fleet.¹⁵⁹ The Worcester Regional Transit Authority in central Massachusetts has operated six electric buses since 2014.¹⁶⁰ Rhode Island plans to lease three electric buses for its transit fleet starting in fall 2018 and to purchase up to 20 such buses beginning in 2021.¹⁶¹ While the initial upfront cost is more expensive than diesel buses, electric buses pay back over time due to their lower fuel and maintenance costs.¹⁶²

School buses can also be electrified. School districts and bus service providers in California, Minnesota, Massachusetts, and New York have started piloting electric school buses.¹⁶³ Early results from one California district show that its electric school buses are saving more than 80 percent on fuel costs compared to diesel models.¹⁶⁴ State funding to deploy up to 60 new clean school buses in rural California areas, including roughly 40 electric buses, is further expected to reduce greenhouse gas emissions by 10,000 metric tons.¹⁶⁵ Electric school buses also help reduce children's exposure to harmful vehicle exhaust.¹⁶⁶

Electrifying Government and Commercial Fleets

Cities and states can also lead by example by switching municipal and state vehicles to EVs. And a wide range of government vehicles are ripe for electrification. New York City has begun deploying municipal EVs, including ambulances, with a target, announced in 2015, of integrating 2,000 EVs into the city's fleet by 2025.¹⁶⁷ Vermont aims to ensure at least 25 percent of its light-duty state fleet vehicles are ZEVs by 2025.¹⁶⁸

Electrification can also clean up the sanitation sector. For example, all of the stops required along a garbage route can reduce fuel efficiency for conventional trucks, but it can actually help recharge the batteries for electric models.¹⁶⁹ In November 2017, the City of Palo Alto, California, rolled out one of the first electric garbage trucks in North America.¹⁷⁰ This side-loading garbage truck has zero tailpipe emissions, a range of 65 to 75 miles, and a charge time of 2.5 hours. It's also far quieter, which residents greatly appreciate, especially for late-night routes.¹⁷¹ Los Angeles, Sacramento, and Chicago are also deploying electric garbage trucks.¹⁷²

Large companies, including Frito-Lay, FedEx, and UPS are experimenting with electric delivery trucks.¹⁷³ The short delivery routes make them ideal for electrification because shorter-range vehicles do not require as many batteries, which lowers the vehicles' weight and cost.¹⁷⁴ In February 2018, UPS announced plans to deploy 50 new electric delivery trucks across the country.¹⁷⁵ UPS already has 300 EVs in the United States and Europe, and is converting its entire central London fleet of 170 trucks to EVs.¹⁷⁶



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Cleaner Ports, Airports, and Truck Depots

Ports, airports, and truck depots typically have heavy diesel vehicle and equipment use and are significant sources of pollution. The surrounding neighborhoods are often low-income and bear disproportionate health impacts.¹⁷⁷ Truck drivers and other workers are also frequently exposed to these elevated pollution levels.¹⁷⁸ Electrifying these vehicles and equipment can reduce emissions, improve air quality, and improve health for these vulnerable populations. It also reduces fuel use, which can lower operating costs.

California's Port of Long Beach, the second busiest port in the country, is building infrastructure to support electric tractors and cranes.¹⁷⁹ Georgia's Port of Savannah has made similar efforts and is already saving around 6 million gallons of diesel fuel a year, a cost savings of nearly \$10 million.¹⁸⁰

Some of the nation's busiest airports, including Logan (Boston), O'Hare (Chicago), and Hartsfield-Jackson (Atlanta), already use or are developing electric equipment to support their ground operations.¹⁸¹ These efforts can have a major impact on fuel consumption and emissions. O'Hare and Hartsfield-Jackson, for example, are estimated to save 1.4 million and 250,000 gallons of diesel, respectively, each year.¹⁸² This reduces greenhouse gases and soot emissions and improves local air quality.

The New England Produce Center in Chelsea, Massachusetts, is the hub for virtually all produce deliveries in and out of New England. In 2009, a grant from the U.S. Environmental Protection Agency (EPA) enabled its truck owners to replace 90 diesel-powered transportation refrigeration units with new electric models.¹⁸³ This effort is expected to save roughly a quarter of a million gallons of diesel fuel per year, avoid almost 900 tons of annual carbon dioxide emissions, and reduce harmful air pollution in the surrounding community.¹⁸⁴

Other Clean Vehicle Technologies

A wide range of other vehicle types can also be electrified, including heavy-duty, long-haul trucks, with electric models—and associated charging infrastructure—increasingly being announced and developed.¹⁸⁵ Other cleaner vehicle technologies are also available or on the horizon. Transit systems in California and Massachusetts, for example, have started piloting hydrogen fuel cell-powered buses.¹⁸⁶

Sustainably grown biofuels may also contribute to reducing greenhouse gas emissions from medium and heavy-duty trucks in cases where electric options are unavailable. To ensure biofuels provide climate benefits, however, it is necessary to independently verify that their use will lead to deep carbon reductions, by assessing the environmental impacts of all stages of the fuels' production and use. California has adopted a Low Carbon Fuel Standard that requires progressive improvements in the carbon intensity of fuels sold in the state and assesses the lifecycle carbon pollution of fuels.¹⁸⁷ Well-designed, third-party sustainability certification systems, such as the Roundtable on Sustainable Biomaterials,¹⁸⁸ are also critical to ensure that biofuels do not cause other harms to food security, land, water, air, wildlife, ecosystems, or local communities. Using such systems can help ensure that biofuels production provides both environmental and socioeconomic benefits.¹⁸⁹

Biofuels have potential uses beyond just vehicles on the ground; they can also power airplanes. In 2017, NRDC published our fourth *Aviation Biofuel Scorecard*, designed to encourage airlines to adopt truly sustainable biofuels to reduce their climate footprint.¹⁹⁰

5. SMART TRANSPORTATION SYSTEMS AND DESIGNS

In December 2015, the U.S. Department of Transportation (USDOT) issued its Smart City Challenge to mid-sized cities. Cities all over the country were encouraged to propose strategies to create an integrated, smart transportation system using new technologies and data.¹⁹¹ Seventy-eight cities shared their ideas for smart transportation systems that could close first- and last-mile gaps, optimize traffic flow, and reduce pollution.¹⁹² The submissions showed a strong preference for new and emerging technologies like sensors, cameras, data analytics, and mobile phone applications.

Building a Smart City: Columbus, OH

Columbus, Ohio, won the Smart Cities Challenge, earning a \$40 million USDOT grant to build its smart transportation system.¹⁹³ Columbus plans to introduce sensors to manage and coordinate the region's 1,250 traffic signals and optimize traffic flow based on real-time data. This will



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allow the city to cut travel times and reduce traffic jams, prioritize emergency vehicles, and increase pedestrian safety.¹⁹⁴ Smartphone apps will help residents plan trips and coordinate travel across modes, including public transit and bike-sharing.¹⁹⁵ Columbus will also install EV charging infrastructure and is developing plans to pilot autonomous EVs.¹⁹⁶ Under a complementary \$10 million private grant, the city will simultaneously work to reduce greenhouse gas emissions.¹⁹⁷ Ultimately, these measures will improve access to jobs, stimulate the economy, and improve the efficiency and sustainability of transportation.

Creating Mobility Hubs: Los Angeles, CA

Like many other transit systems, Los Angeles has experienced a decline in transit ridership in recent years.¹⁹⁸ In an effort to reverse that trend, Los Angeles will develop transit access points with frequent transit service, or “mobility hubs,” across the city.¹⁹⁹ According to the General Manager of the city's Department of Transportation, “[w]e envision mobility hubs as places near light rail stations where people can access a variety of choices from EV car sharing to bike sharing to buses. To refocus this project on people, we worked to understand needs that go well beyond transportation—a shady place to sit, games for kids to play while they wait, USB ports, real-time arrival information, a spot to get a cold drink.”²⁰⁰

Smart Transit Systems: Singapore

Singapore is deploying new technologies and smart systems to streamline its transit system and decrease reliance on personal vehicles. They have deployed wearable devices to pay train and bus fares and sensors to monitor traffic, air quality, and public safety.²⁰¹ The city uses sensors to monitor the number of people waiting at bus stops. They use that data to determine the need for more buses.²⁰² The city also uses data to predict commuter behaviors and forecast crowding.²⁰³ In addition, Singapore has piloted an innovative bus stop design with Wi-Fi and other services to enhance the commuter experience.²⁰⁴

Economic and Employment Benefits

Cheaper options, increased accessibility, improved economy

LOWER TRANSPORTATION COSTS

Transportation expenses account for around one-sixth of American families' expenditures, second only to housing.²⁰⁵ Expenses are even higher in rural areas, where workers travel 38 percent more miles than their urban counterparts, and where lower income rural workers travel 59 percent more miles.²⁰⁶ Rural households have lower incomes than urban ones—24 percent lower on average, in 2015.²⁰⁷ But they spend 7 percent more of their household budgets on transportation.²⁰⁸ More affordable alternatives to driving and a shift to EVs can reduce these costs.

Although small amounts of oil are produced in New York and Pennsylvania, the vast majority of gas and diesel used

in the Northeast and Mid-Atlantic must be imported from other states or countries—either as refined gasoline or diesel fuels or as crude oil that is later refined in region.²⁰⁹ Thus, nearly every gallon of gasoline and diesel—even those that are processed by local refineries—represents dollars leaving the region. In 2016, drivers in the Northeast and Mid-Atlantic region spent more than \$50 billion on motor gasoline alone.²¹⁰ Moving forward, each one percent decrease in motor gasoline consumption is projected to save the region \$600 to 700 million per year.²¹¹ Incrementally reducing gasoline consumption by one percent in 2018, two percent in 2019, and so on could produce cumulative regional savings of more than \$100 billion by 2035, as shown in the figures below.²¹²

FIGURE 1. HISTORICAL AND PROJECTED REGIONAL MOTOR GASOLINE EXPENDITURES IN TRANSPORTATION UNDER BUSINESS AS USUAL AND WITH INCREMENTAL REDUCTIONS IN CONSUMPTION OF ONE PERCENT PER YEAR FROM 2018 TO 2035²¹³

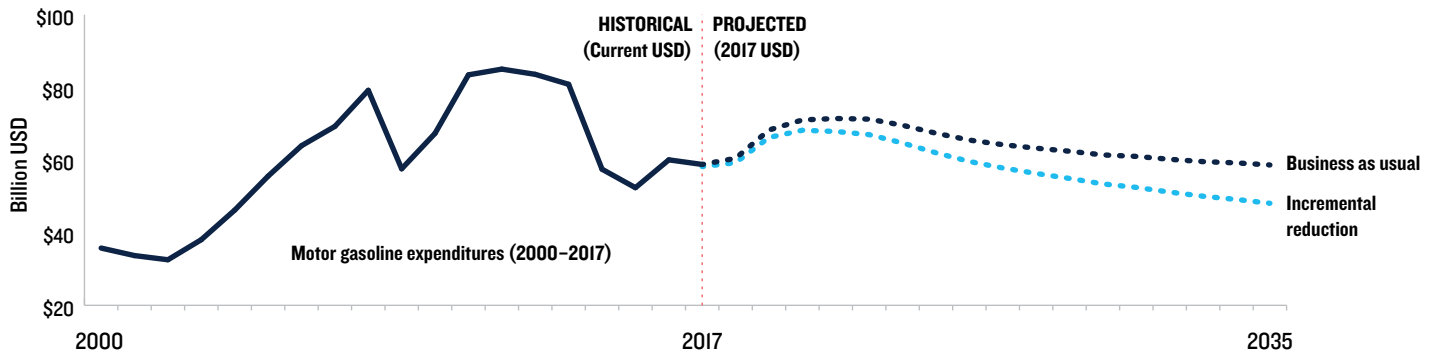
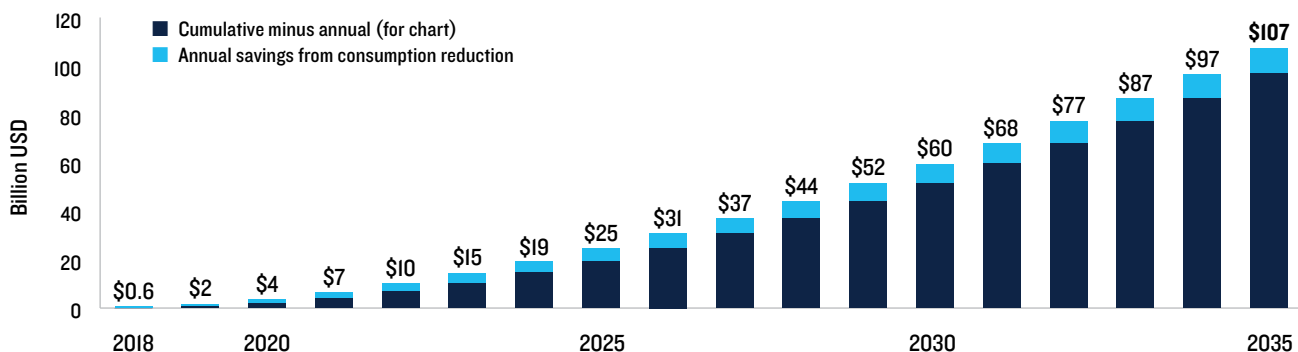


FIGURE 2. PROJECTED CUMULATIVE REGIONAL SAVINGS FROM INCREMENTALLY REDUCING MOTOR GASOLINE CONSUMPTION IN TRANSPORTATION BY ONE PERCENT PER YEAR FROM 2018 TO 2035 (IN BILLION 2017 USD)²¹⁴



Congestion costs the region tens of billions of dollars due to lost productivity, increased fuel consumption, and negative health effects.

We can achieve these savings through more efficient gasoline- or diesel-fueled vehicles, fewer cars on the road, and a major shift toward EVs. The estimated fuel savings from driving a new EV versus a new gasoline-powered vehicle vary depending on electricity rates, but range from more than \$500 per year in Boston to more than \$1,000 a year in New York City.²¹⁵ Powering vehicles with homegrown wind and solar electricity will also keep more of our transportation dollars in the region, boosting local economies.

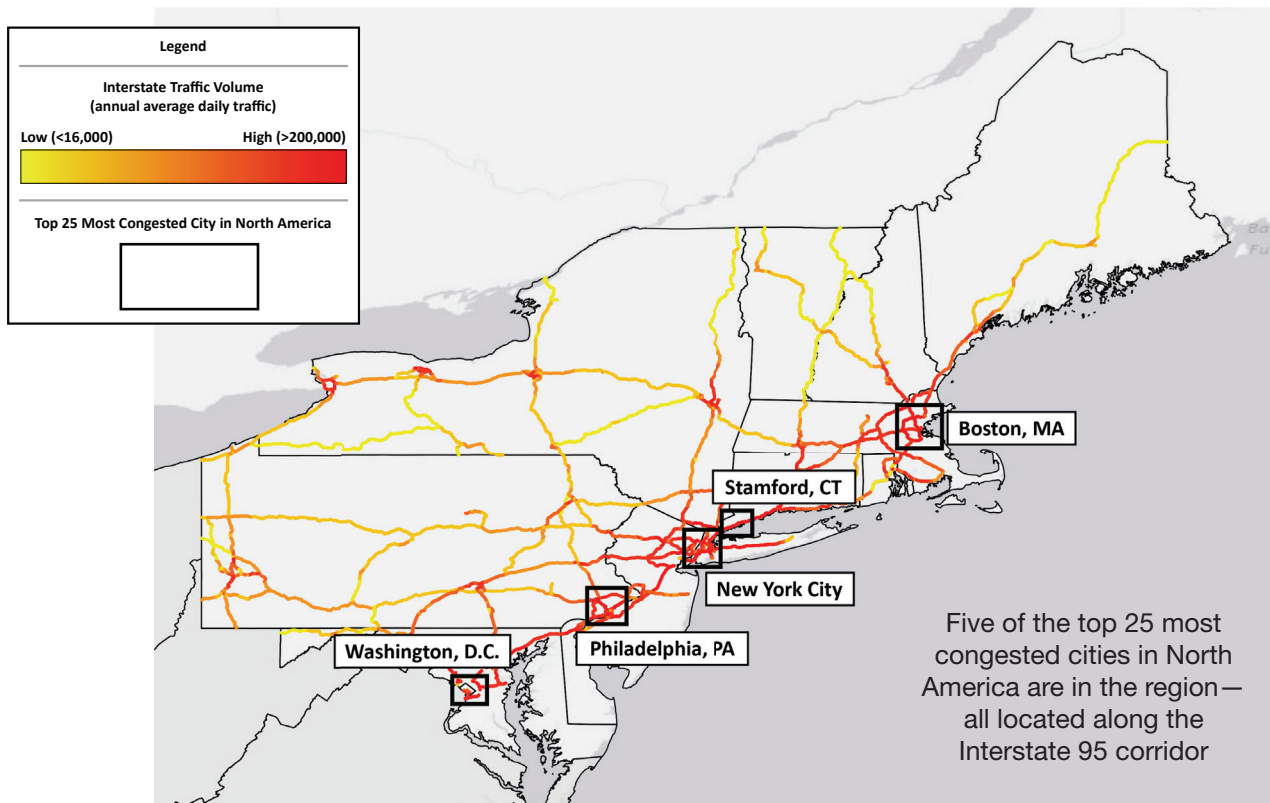
As mentioned earlier, although EV costs continue to fall, their upfront cost is currently higher. This includes both the vehicle purchase price and associated charging equipment. State and federal incentives, such as vehicle purchase price and charging infrastructure rebates, are key for broader EV adoption as newer, lower-cost technologies continue to develop. With lower upfront costs, households of all income levels can realize significant financial benefits from EV ownership.

LESS TRAFFIC CONGESTION

The Northeast and Mid-Atlantic region is notorious for its transportation gridlock. In fact, the region is home to six of the ten most congested road corridors in the United States.²¹⁶ Regional traffic patterns are not changing significantly, but certain urban areas are experiencing rapid growth in vehicle miles traveled. Maryland and Massachusetts, for instance, have each seen annual urban vehicle miles traveled increase by around 15 percent since 2007.²¹⁷

The Northeast and Mid-Atlantic region is also home to three of the top ten most congested urban areas in the United States: Boston, New York, and Washington, D.C.²¹⁸ And five of the region's cities—including the previous three plus Stamford, Connecticut, and Philadelphia—are among the 25 most congested cities in North America.²¹⁹ In these five cities, people spend an average of 74 hours per year in traffic congestion.²²⁰ In New York City, it's 91 hours per year.²²¹ All of that results in annual economic losses of more than \$50 billion.²²²

FIGURE 3. FIVE OF THE TOP 25 MOST CONGESTED CITIES IN NORTH AMERICA ARE IN THE REGION²²³





If we could reduce traffic congestion to increase the average speed of all trips in the region by just one mile per hour, we would save nearly \$19 billion per year in time savings, reduced fuel use, lower pollution impacts, and lower costs of doing business.²²⁴

Taken together, the strategies discussed above can help reduce the number of cars on the road and increase efficient road use, helping to alleviate traffic congestion. Other strategies and ideas could also help: for example, congestion pricing, which applies roadway fees during peak travel hours, discourages driving during these peak traffic hours. This policy has helped reduce traffic congestion by at least 25 percent in European cities such as London²²⁵ and Stockholm.²²⁶ While no American city thus far has implemented such a policy, a recently proposed congestion fee in New York City was projected to reduce traffic by 13 to 14 percent and generate more than \$1 billion in revenue per year, which would be invested in public transit.²²⁷ California has had a “parking cash out” law since 1992 that requires employers to offer employees the option of a cash allowance in lieu of their subsidized workplace parking spot. This policy has encouraged employees to carpool, take transit, and walk or bike to work.²²⁸ In the future, autonomous vehicles that can communicate with each other and with infrastructure may eventually eliminate traffic induced by human error. However, these technologies are still being tested and developed.

JOB GROWTH AND EMPLOYMENT OPPORTUNITIES

A Georgetown Climate Center study found that clean transportation policies and investment strategies could create 125,000 new jobs, increase personal disposable income by \$14.4 billion, and add \$17.7 billion to the Northeast and Mid-Atlantic economy by 2030. At the same time, the region would reduce carbon pollution from transportation by 40 percent.²²⁹ Meanwhile, Standard & Poor’s estimates that every \$1.3 billion invested in transportation infrastructure could create 29,000 construction jobs and additional jobs related to infrastructure industries.²³⁰ Research has shown that investments in public transit create 30 percent more jobs per dollar spent than investments in new roads and bridges.²³¹ For example, investments in public transit under the 2009 federal stimulus bill produced 70 percent more job-hours per dollar than highway projects.²³² A modern transportation system will also require computer programmers to oversee its design, maintenance, security, and safety.²³³

Health and Environmental Benefits

Cleaner vehicles, cleaner air, healthier people

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IMPROVED SAFETY

Nationally, pedestrian deaths have increased, even as total traffic fatalities have dropped, and pedestrian traffic deaths as a percentage of total traffic deaths is at its highest level in more than three decades.²³⁴ More than 4,500 people died in vehicle collisions in the Northeast and Mid-Atlantic region in 2016.²³⁵ The regional total included 970 pedestrian deaths, an 18 percent increase in the number of pedestrian fatalities from 2011. In addition, 115 cyclists were killed by motor vehicles on the region's roadways.²³⁶ On an average per-mile basis, fatalities from vehicle collisions occurred twice as frequently on rural roadways as on urban ones.²³⁷

Our streets should be safe for all who use them, and a modern transportation system would prevent many roadway deaths and injuries. Traveling by bus, subway, and trains is significantly safer than traveling by car. Overall, these trips result in less than a tenth of the traffic casualties per mile traveled compared to automobiles.²³⁸

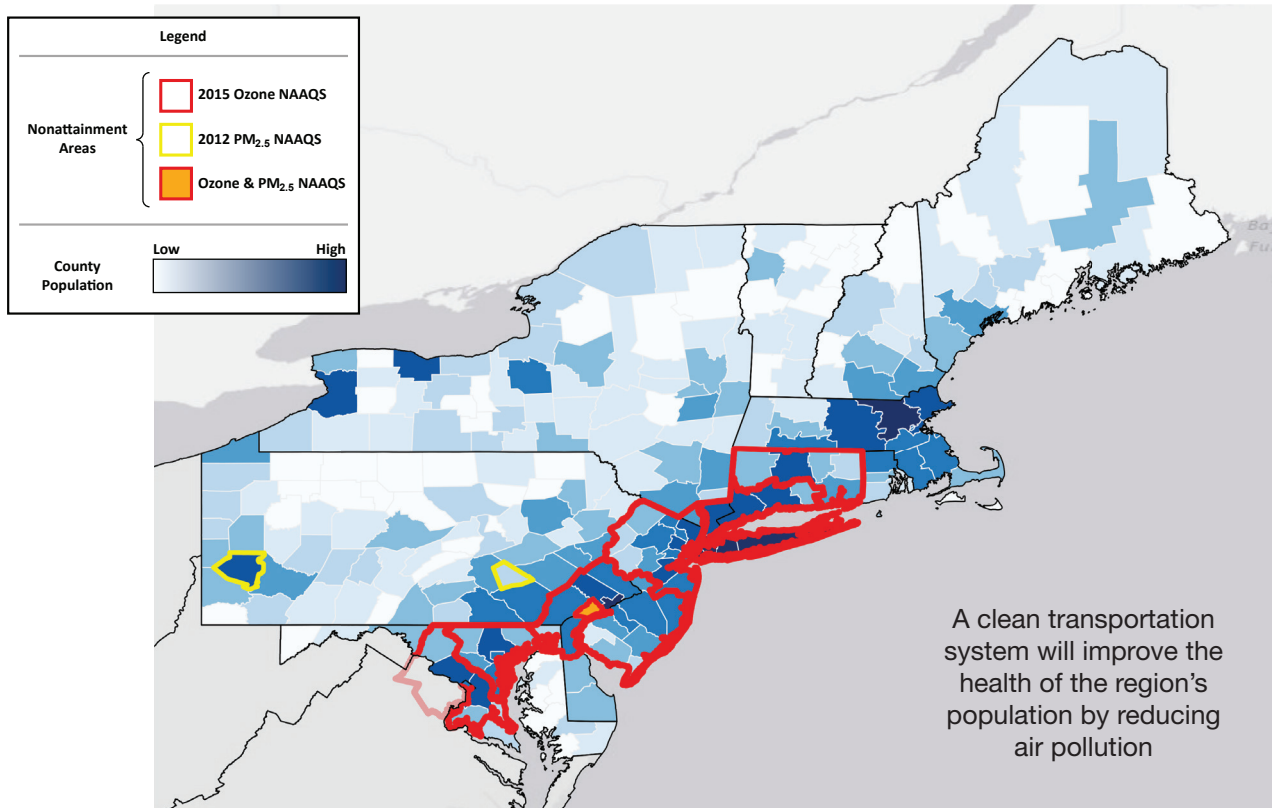
Communities with higher public transit ridership also have lower rates of fatalities across transportation modes—walking, biking, driving, and transit-riding.²³⁹

Protected sidewalks and bike paths can promote access to public transit while making streets safer for pedestrians and cyclists. Smart transportation control systems, communication technologies, and sensors can also help identify and communicate potential hazards, like stalled cars and infrastructure problems, before they become catastrophes.

REDUCED AIR POLLUTION

Emissions from conventional vehicles are responsible for premature mortality and numerous respiratory and cardiovascular diseases. These pollutants include directly-emitted fine particulate matter (PM_{2.5}), commonly referred to as soot, as well as nitrogen oxides (NOx) and sulfur dioxide (SO₂). NOx and SO₂ are both precursors to the formation of further harmful particulate matter.

FIGURE 4. AREAS DESIGNATED BY EPA AS IN NONATTAINMENT UNDER 2015 OZONE AND 2012 PM_{2.5} NAAQS²⁴⁰



They also contribute to acid rain, and NO_x is a primary component in the formation of harmful ground-level ozone pollution, also known as smog.

In the Northeast and Mid-Atlantic region, almost 60 percent of the population—around 37 million people—live in areas that do not meet the National Ambient Air Quality Standards (NAAQS) for PM_{2.5}, ozone pollution, or both.²⁴¹ Across the region, many areas with the highest population densities, and that have the most vehicles on the road, correspond with these unsafe air quality areas. Residents of these areas are at higher risk of asthma attacks and other adverse health effects.

Table 1 shows adverse annual health effects as a result of PM_{2.5} emissions—both directly emitted PM_{2.5} and NO_x and SO₂ precursors—from on-road vehicles in the region. Reducing these emissions by just one percent could save dozens of lives and prevent thousands of respiratory symptoms each year, while saving the region hundreds of millions of dollars.²⁴² Eventually eliminating PM_{2.5} emissions from vehicles could save thousands of lives, save tens of billions of dollars in avoided health costs, and prevent hundreds of thousands of lost workdays each year.²⁴³

A SAFER CLIMATE

NRDC's report on *America's Clean Energy Frontier* makes it clear that to ensure a safer climate, we need a cleaner transportation system.²⁴⁴ The strategies in this report will help reduce greenhouse gas emissions. More compact and better land use planning will reduce vehicle miles traveled and their associated emissions. If residents use public transportation when their destinations are too far to walk or bike, they can significantly reduce climate pollution. On average, heavy rail transit such as subways produce 76 percent fewer greenhouse gases per passenger mile than the average single-occupancy vehicle.²⁴⁵ Light rail systems and bus transit produce 62 percent and 33 percent less, respectively.²⁴⁶ Electrifying these public transit systems could produce still greater climate benefits.

Our climate is already changing, and powerful storms and rising sea levels pose severe threats to our transportation infrastructure. In 2012, for example, Superstorm Sandy caused extensive damage when water poured into New York City's subway system, the country's busiest.²⁴⁷ All told, Sandy caused more than \$70 billion in damage on the East Coast.²⁴⁸ In 2011, Hurricane Irene destroyed or damaged more than 2,400 roads, 800 homes and businesses, 300 bridges, and half a dozen railroad lines in Vermont.²⁴⁹

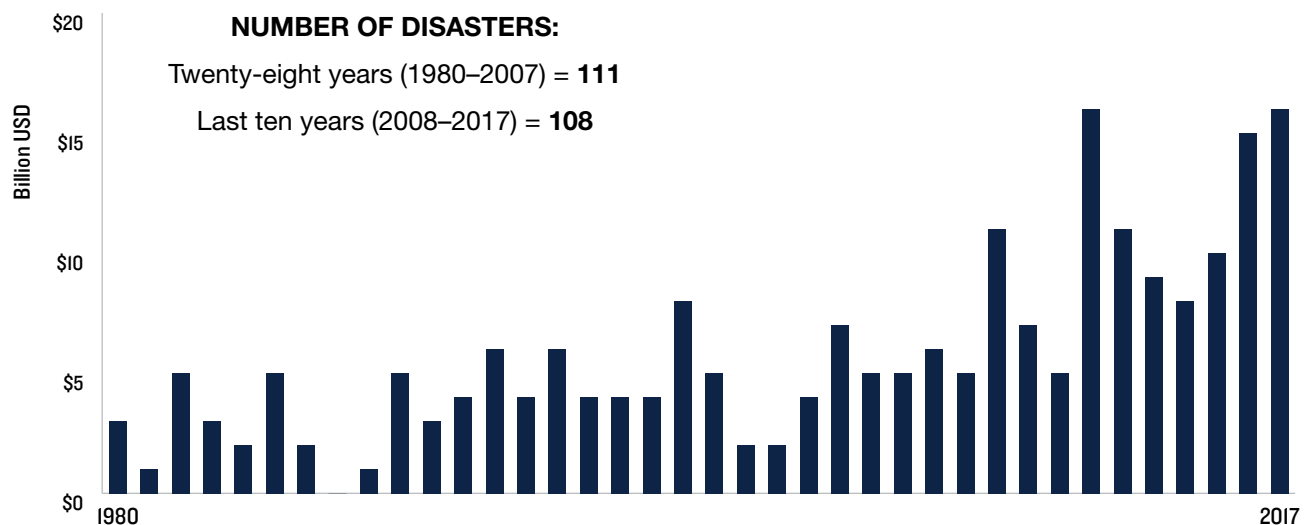
And hurricanes are not the only threat. Over the past few decades, the number of natural disasters, including severe storms, flooding, fires, and other events, to cause more than \$1 billion dollars in damage has increased, as shown in the

figure below. As climate change worsens, the frequency and intensity of severe storms will only get worse, leading to even more disasters.²⁵⁰

TABLE I. HEALTH IMPACTS OF PM_{2.5}-RELATED EMISSIONS FROM ON-ROAD VEHICLES IN THE REGION IN 2014²⁵¹

Health Effects	PM _{2.5} Precursors		Directly Emitted PM _{2.5}	Total
	NO _x	SO ₂		
Premature mortality (adults)	550-1200	12-27	1,000-2,300	1,600-3,600
Non-fatal heart attacks	56-520	1-10	110-990	170-1,500
Respiratory ER visits	300	6	600	910
Cardiovascular hospital admissions	130	3	240	370
Respiratory hospital admissions	120	3	240	360
Acute bronchitis	800	20	1,500	2,400
Work loss days	74,000	1,700	140,000	220,000
Lower respiratory symptoms	9,800	250	20,000	30,000
Upper respiratory symptoms	15,000	360	29,000	44,000
Minor restricted activity days	420,000	9,900	850,000	1,300,000
Asthma exacerbation	17,000	420	34,000	51,000

FIGURE 5. NUMBER OF BILLION-DOLLAR NATURAL DISASTERS IN THE UNITED STATES FROM 1980-2017²⁵²



The frequency of severe natural disasters has increased since 1980.



Given these risks, we should avoid development in areas that are particularly vulnerable to flooding and coastal damage. Existing infrastructure in these areas needs to be strengthened or relocated. New roads should have permeable surfaces to allow for sufficient stormwater drainage. New bridges should be built with stronger materials and enhanced expansion joints to sustain more severe temperature changes. Transit systems should also incorporate redundant infrastructure in case of power outages or network problems. Proactive planning now can avoid billions of dollars in future climate-related damages and ensure a safe, efficient, and dependable transportation system for the future.²⁵³

ACCESS TO HEALTHCARE AND HEALTHY FOOD

Accessible transportation can also help ensure access to healthy food and healthcare. Currently, more than 12 million people in the region do not live near a supermarket (see Figure 6).²⁵⁴ Access to healthy food is a particular problem in many low-income urban neighborhoods, as local grocery stores have closed or moved to the suburbs.²⁵⁵ The lack of first- and last-mile connections to public transit can exacerbate these problems by leaving residents with limited options to access healthy food elsewhere.²⁵⁶

Around a quarter of the region's population also lives in areas with shortages of primary care health services for residents (see Figure 7).²⁵⁷ As recognized by the Federal Transit Administration, limited access to transportation can make it particularly challenging for residents to access health screenings and to obtain treatment.²⁵⁸ For example, diabetic patients without access to a car may struggle to reach their regular dialysis treatments, and cancer patients may struggle to keep their chemotherapy schedules.

A 2004 analysis of national transportation data found that 21 percent of Americans ages 65 and older do not (or cannot) drive, which often limits their access to healthcare.²⁵⁹ The analysis found that older nondrivers make 15 percent fewer trips to the doctor and 59 percent fewer shopping trips and visits to restaurants. They also made 65 percent fewer trips for social, family, and religious

activities.²⁶⁰ This is especially acute in rural areas, where populations are older on average, and where there are often fewer alternatives to driving.²⁶¹ Moreover, the percentage of rural residents age 65 and older is growing nationally and across much of the Northeast and Mid-Atlantic region.²⁶² Thirty-three percent of veterans enrolled in the VA healthcare system also live in rural areas, and lack of transportation access can affect their abilities to access healthcare services.²⁶³

A modern transportation system can help millions of people in the region gain improved access to healthier food choices and medical care.

Expanded public transportation, combined with solutions to close the first- and last-mile connection gap, can increase access to healthcare and healthy food. Expanded mobility options for older Americans can empower these citizens to retain their independence, decrease social isolation, and provide safer and more reliable transportation to receive medical care. Improved public transit services for people with disabilities can also significantly reduce the unemployment rate for disabled residents.²⁶⁴

HEALTHIER ECOLOGY

Roads, highways, and corresponding land-use development can damage ecosystems. Roads can cause habitat fragmentation. Paved, impervious surfaces can exacerbate flooding. Pollutants from vehicles can contaminate soil and waterways.²⁶⁵ As we rethink the ways we move, we must remain cognizant of these possible pitfalls, as well as the current and past environmental impacts of the transportation system. A modern transportation system should preserve biological diversity, improve stormwater management, and create land and water spaces that are cleaner and safer for both recreational and commercial activities.

FIGURE 6. AREAS WITH LOW ACCESS TO FOOD²⁶⁶

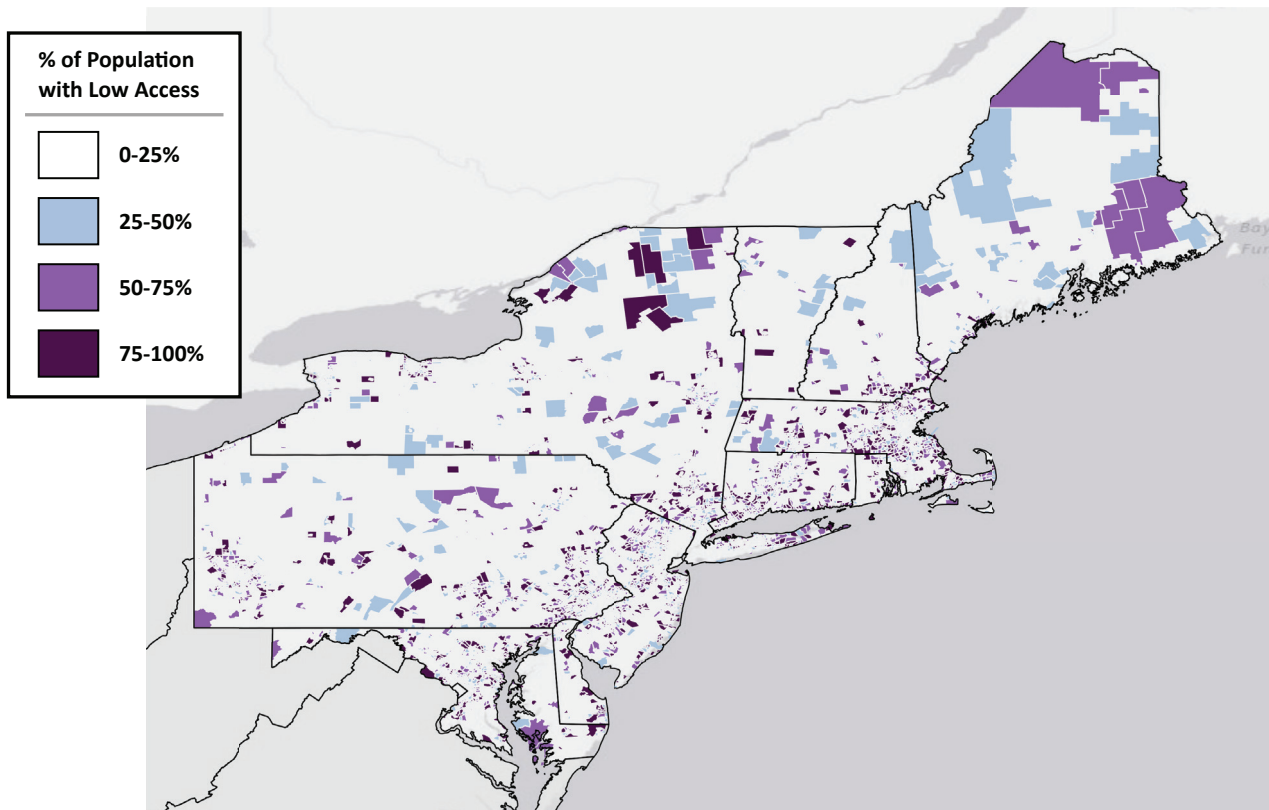
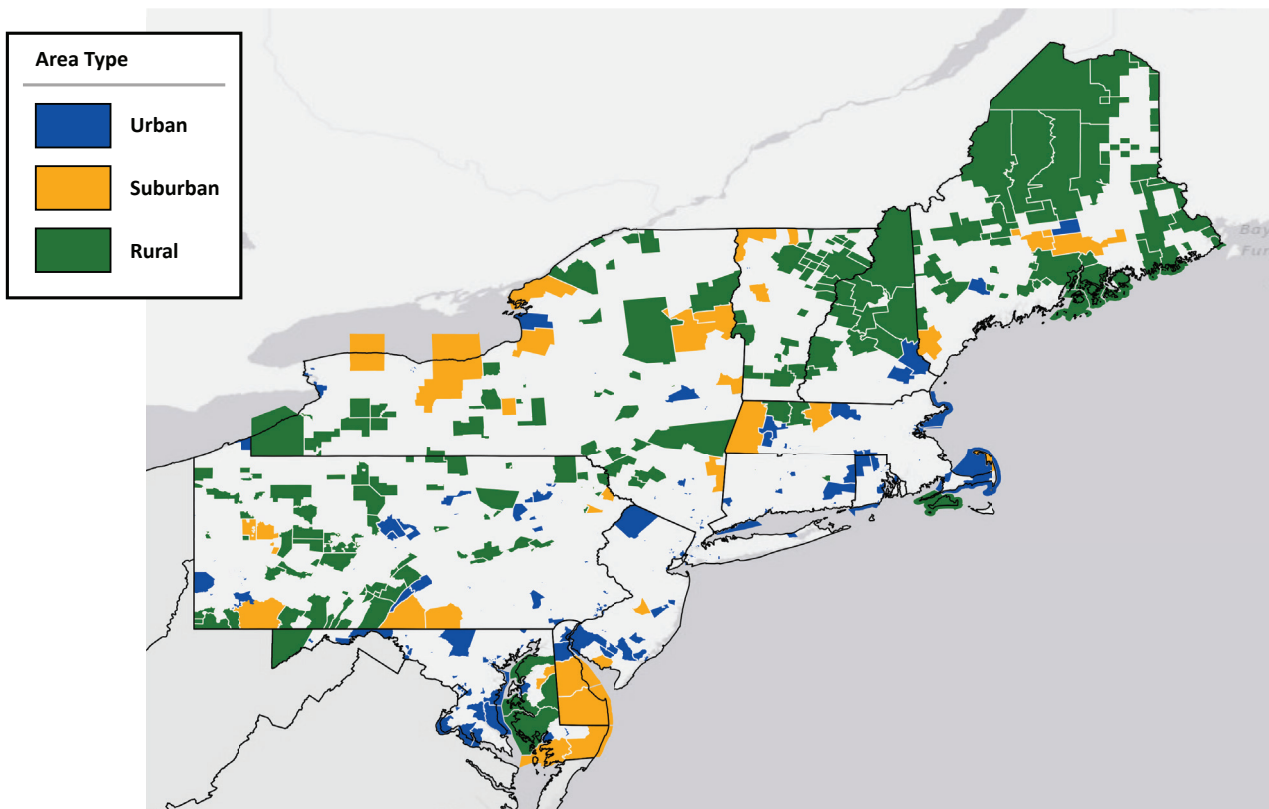


FIGURE 7. MEDICALLY UNDERSERVED AREAS²⁶⁷



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The Northeast and Mid-Atlantic region needs a 21st-century transportation system, which if done right, can make the region a beacon to the rest of the country and the world. But this will require strong commitments from regional, state, and local leaders. The region must invest in modern transportation systems, upgrade its infrastructure and technologies, and develop policy frameworks that encourage continuous improvement and innovation. Businesses, government agencies, community organizations, residents, and others must be included in the discussion. And special attention must be given to historically underserved, overburdened communities.

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We encourage policymakers, residents, and businesses to think boldly. While the scale of our transportation challenges is large, the potential benefits of clean and modern transportation are enormous and well worth the effort. With planning, vision, and commitment, we can create a clean, efficient, reliable, resilient, and equitable transportation system for the 21st century.

The tools are available. The need is obvious. It is time to act.

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- 261 *Ibid.* at 5 and 7. Todd Litman, *Public Transportation's Impact on Rural and Small Towns: A Vital Mobility Link*, *supra* note 7, at 6-7.
- 262 Todd Litman, *Public Transportation's Impact on Rural and Small Towns: A Vital Mobility Link*, *supra* note 7, at 6-7.
- 263 *Ibid.* at 11.
- 264 Council of State Governments, *Providing transportation, technology and other employment supports to people with disabilities* (January 2017), knowledgecenter.csg.org/kc/system/files/CR_providing_transportation.pdf.
- 265 *See, e.g.*, Jean-Paul Rodrigue, "Chapter 8: Transport, Energy, And Environment," *The Geography of Transport Systems* (2017), transportgeography.org/?page_id=5711.
- 266 NRDC and M.J. Bradley & Associates analysis in *Transportation Reimagined* (2018) of USDA data on food access and U.S. Census Bureau 2010 census tracts. Figure is as of 2015. "Low access" means located further than 1 mile from the nearest supermarket in urban areas and 10 miles from the nearest supermarket in rural areas based on a USDA definition. *See* Appendix B, Explanation #14.
- 267 NRDC and M.J. Bradley & Associates analysis in *Transportation Reimagined* (2018) of HRSA-designated MUAs and U.S. Census Bureau 2010 census tracts. *See* Appendix B, Explanation #15.

Appendix A: Shared Mobility Principles

Our streets are a finite, scarce, and valuable *shared* resource. Yet today, our country’s streets are too often built around a single mode of transportation—motor vehicles. This approach does not sufficiently account for the public’s diverse mobility needs or for cleaner, healthier, and more efficient modes of transportation, such as walking, biking, and improved public transit. The rapid emergence of new transportation technologies and services, such as ride-hailing and autonomous vehicles, will have a profound impact on livelihoods, congestion, and land use in our communities. Doubling down on the pollution and inequitable access of the status quo isn’t an option.

As a part of a coalition, NRDC developed the following set of *Shared Mobility Principles for Livable Cities* to inform a vision for a better transportation system, with a focus on producing better environmental and social outcomes.¹ While geared primarily toward urban areas, many of these principles also apply to rural and suburban areas and the ways we collectively develop and share our transportation resources.

SHARED MOBILITY PRINCIPLES FOR LIVABLE CITIES

- 1. We plan our cities and their mobility together.** The way our cities are built determines mobility needs and how they can be met. Development, urban design and public spaces, building and zoning regulations, parking requirements, and other land use policies shall incentivize compact, accessible, livable, and sustainable cities.
- 2. We prioritize people over vehicles.** The mobility of people and not vehicles shall be in the center of transportation planning and decision-making. Cities shall prioritize walking, cycling, public transport and other efficient shared mobility, as well as their interconnectivity. Cities shall discourage the use of cars, single-passenger taxis, and other oversized vehicles transporting one person.
- 3. We support the shared and efficient use of vehicles, lanes, curbs, and land.** Transportation and land use planning and policies should minimize the street and parking space used per person and maximize the use of each vehicle. We discourage overbuilding and oversized vehicles and infrastructure, as well as the oversupply of parking.
- 4. We engage with stakeholders.** Residents, workers, businesses, and other stakeholders may feel direct impacts on their lives, their investments and their economic livelihoods by the unfolding transition to shared, zero-emission, and ultimately autonomous vehicles. We commit to actively engage these groups in the decision-making process and support them as we move through this transition.
- 5. We promote equity.** Physical, digital, and financial access to shared transport services are valuable public goods and need thoughtful design to ensure use is possible and affordable by all ages, genders, incomes, and abilities.
- 6. We lead the transition towards a zero-emission future and renewable energy.** Public transportation and shared-use fleets will accelerate the transition to zero-emission vehicles. Electric vehicles shall ultimately be powered by renewable energy to maximize climate and air quality benefits.
- 7. We support fair user fees across all modes.** Every vehicle and mode should pay their fair share for road use, congestion, pollution, and use of curb space. The fair share shall take the operating, maintenance and social costs into account.

¹ Shared Mobility Principles for Livable Cities, “RELEASE: Shared Mobility Principles for Livable Cities Launched by Consortium of Transport Experts,” October 17, 2017, www.sharedmobilityprinciples.org/release-shared-mobility-principles-for-livable-cities-launched-by-consortium-of-transport-experts. The coalition that developed these principles includes C40 Cities Climate Leadership Group, ICLEI – Local Governments for Sustainability, Institute for Transportation and Development Policy, Natural Resources Defense Council, Partnership on Sustainable Low Carbon Transport, Rocky Mountain Institute, Shared-Use Mobility Center, Transportation for America, and WRI Ross Center for Sustainable Cities.

- 8. We aim for public benefits via open data.** The data infrastructure underpinning shared transport services must enable interoperability, competition and innovation, while ensuring privacy, security, and accountability.
- 9. We work towards integration and seamless connectivity.** All transportation services should be integrated and thoughtfully planned across operators, geographies, and complementary modes. Seamless trips should be facilitated via physical connections, interoperable payments, and combined information. Every opportunity should be taken to enhance connectivity of people and vehicles to wireless networks.
- 10. We support that autonomous vehicles (AVs) in dense urban areas should be operated only in shared fleets.** Due to the transformational potential of autonomous vehicle technology, it is critical that all AVs are part of shared fleets, well-regulated, and zero emission. Shared fleets can provide more affordable access to all, maximize public safety and emissions benefits, ensure that maintenance and software upgrades are managed by professionals, and actualize the promise of reductions in vehicles, parking, and congestion, in line with broader policy trends to reduce the use of personal cars in dense urban areas.

Appendix B: Technical Assumptions and Methodologies

Summary Report

This appendix describes the sources, assumptions, and methodologies behind the statistics, charts, tables, and maps in NRDC’s 2018 report *Transportation Reimagined: A Roadmap for Clean and Modern Transportation in the Northeast and Mid-Atlantic Region*, which were produced by NRDC and M.J. Bradley & Associates (MJB&A).

EXPLANATION #1:

STATEMENT (EXECUTIVE SUMMARY, PAGE 4): **“In fact, transportation is now the largest source of climate-changing greenhouse gas emissions in the nation.”**

STATEMENT (PAGE 8): **“While RGGI has helped tackle powerplant pollution, however, transportation emissions have remained high and are the largest contributor to greenhouse gas emissions in the Northeast and Mid-Atlantic states and, since 2016, the nation.”**

The U.S. Energy Information Administration (EIA) reports energy-related carbon dioxide emissions by state and sector.¹ As shown in Table B-1, the region’s transportation sector accounted for more than 39 percent of energy-related CO₂ emissions in 2015, the most recent year for which EIA state-level emissions data are available. Electric power, the region’s second highest contributor, accounted for less than 25 percent of emissions. Nationwide, the transportation sector is also now responsible for the largest share of U.S. greenhouse gas emissions overall at 28.5 percent of the total, edging out the electric power industry’s 28.4 percent, according to the U.S. Environmental Protection Agency’s (EPA) national-level emissions data in 2016, the most recent year available.²

TABLE B-1: ENERGY-RELATED CO₂ EMISSIONS BY SECTOR BY STATE IN 2015 IN MILLION METRIC TONS

Analysis of EIA data³

STATE	COMMERCIAL	ELECTRIC POWER	RESIDENTIAL	INDUSTRIAL	TRANSPORTATION	TOTAL
CT	4.3	7.4	7.7	1.9	15.1	36.5
DC	1.0	0.0	0.8	0.0	1.1	3.0
DE	0.9	3.3	1.0	3.8	4.4	13.4
MA	7.6	11.3	13.5	3.5	29.7	65.6
MD	5.3	16.7	6.5	2.5	28.5	59.5
ME	1.8	1.6	3.0	1.7	8.8	16.8
NH	1.5	3.5	2.7	0.8	6.7	15.1
NJ	10.7	17.9	15.5	9.6	58.1	111.9
NY	22.8	29.2	35.2	9.7	71.4	168.3
PA	11.5	87.9	20.7	53.6	59.5	233.2
RI	1.0	2.8	2.4	0.6	4.1	10.9
VT	1.0	0.0	1.4	0.4	3.3	6.1
TOTAL	69.5	181.5	110.3	88.1	290.8	740.2
% OF TOTAL	9.4%	24.5%	14.9%	11.9%	39.3%	100.0%

¹ U.S. Energy Information Administration, “Table 3. 2015 State energy-related carbon dioxide emissions by sector,” *Energy-Related Carbon Dioxide Emissions by State, 2000-2015* (January 22, 2018), www.eia.gov/environment/emissions/state/analysis/pdf/table3.pdf.

² U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016* (April 12, 2018), www.epa.gov/sites/production/files/2018-01/documents/2018_complete_report.pdf, at ES-24.

³ See U.S. Energy Information Administration, “Table 3. 2015 State energy-related carbon dioxide emissions by sector,” *supra* note 1.

EXPLANATION #2:

STATEMENT (PAGE 16): **“The Chinese city of Shenzhen deploys 16,359 electric buses. That’s more buses, of any type, than the transit agencies of America’s ten largest cities had—combined—in 2016.”**

The city of Shenzhen reportedly had a fleet of 16,359 all-electric buses by the end of 2017.⁴ We compared this figure to Federal Transit Administration (FTA) figures on the total number of buses (of any type) reported by the transit agencies in the ten largest U.S. cities in 2016, the most recent data year available.⁵ We determined the ten largest U.S. cities in 2016 by using U.S. Census Bureau population estimates.⁶ As shown in Table B-2 below, the FTA reported a combined total of 16,296 buses of any type in the ten largest U.S. cities’ transit fleets, which is less than the number of electric buses in Shenzhen in 2017.

TABLE B-2: NUMBER OF BUSES IN THE 10 LARGEST U.S. CITIES’ TRANSPORTATION FLEETS IN 2016

Analysis of FTA and U.S. Census Bureau data⁷

TOTAL BUSES OF ALL TRANSIT AGENCIES WITHIN SELECTED CITIES							
RANK	CITY	BUS	ARTICULATED BUS	OVER-THE-ROAD BUS	DOUBLE DECKER BUS	SCHOOL BUS	TOTAL
1	New York	3,847	871	1,017	0	0	5,735
2	Los Angeles	2,363	461	0	0	0	2,824
3	Chicago	1,565	304	0	0	0	1,869
4	Houston	787	70	578	0	0	1,435
5	Phoenix	746	101	0	0	0	847
6	Philadelphia	1,231	185	0	0	0	1,416
7	San Antonio	515	19	0	0	0	534
8	San Diego	473	86	25	0	0	584
9	Dallas	547	0	0	0	0	547
10	San Jose	436	69	0	0	0	505
	TOTAL	12,510	2,166	1,620	0	0	16,296

EXPLANATION #3:

STATEMENT (PAGE 19): **“Although small amounts of oil are produced in New York and Pennsylvania, the vast majority of gas and diesel used in the Northeast and Mid-Atlantic must be imported from other states or countries—either as refined gasoline or diesel fuels or as crude oil that is later refined in region.”**

We compared total crude oil produced to total petroleum consumed by the transportation sector by state using data from the EIA’s State Energy Data System (SEDS) for 2015, the most recent year of state production data available.⁸ New York and Pennsylvania, the only two states in the region with oil production, produced 41.6 trillion btu of crude oil in 2015. In contrast, the region’s transportation sector consumed 4,173.4 trillion btu of petroleum, as shown in Table B-3. In other words, on a btu basis, the amount of crude oil produced in the region in 2015 was less than one percent of the transportation sector’s petroleum demand. Because other sectors also use petroleum, the region’s comparatively small crude oil production amounts do not necessarily help offset the region’s transportation sector fuel demands.

⁴ Lu Lu, Lulu Xue and Weimin Zhou, “How Did Shenzhen, China Build World’s Largest Electric Bus Fleet?” World Resources Institute, April 4, 2018, www.wri.org/blog/2018/04/how-did-shenzhen-china-build-world-s-largest-electric-bus-fleet.

⁵ Federal Transit Administration, “2016 Vehicles,” 2016 National Transit Database (October 2017), www.transit.dot.gov/sites/fta.dot.gov/files/Vehicles_0.xlsx.

⁶ U.S. Census Bureau, “Annual Estimates of the Resident Population for Incorporated Places of 50,000 or More, Ranked by July 1, 2017 Population: April 1, 2010 to July 1, 2017 - United States -- Places of 50,000+ Population,” American Fact Finder (May 2018), factfinder.census.gov/bkmk/table/1.0/en/PEP/2017/PEPANRSIP.US12A.

⁷ See *ibid.* Federal Transit Administration, “2016 Vehicles,” *supra* note 5.

⁸ U.S. Energy Information Administration, “Table P5A. Primary Energy Production Estimates, Fossil Fuels and Nuclear Energy, in Trillion Btu, Ranked by State, 2015,” *State Energy Data System (SEDS): 1960-2015 (complete)* (June 30, 2017), www.eia.gov/state/seds/sep_prod/xls/P5A.xlsx. U.S. Energy Information Administration, “Table C8. Transportation Sector Energy Consumption Estimates, 2015 (Trillion Btu),” *State Energy Data System (SEDS): 1960-2015 (complete)* (June 30, 2017), www.eia.gov/state/seds/data.php?infile=/state/seds/sep_sum/html/sum_btu_tra.html&sid=US.

TABLE B-3: 2015 OIL PRODUCTION AND CONSUMPTION BY THE TRANSPORTATION SECTOR BY STATE

From EIA data

STATE	CRUDE OIL PRODUCTION (TRILLION BTU) ⁹	PETROLEUM PRODUCTS CONSUMED BY TRANSPORTATION SECTOR (TRILLION BTU) ¹⁰
CT	-	220.5
DC	-	15.4
DE	-	64.7
MA	-	431.5
MD	-	415.7
ME	-	127.8
NH	-	99.8
NJ	-	841.7
NY	1.6	1,013.2
PA	40.0	836.2
RI	-	58.0
VT	-	48.9
TOTAL	41.6	4,173.4

EXPLANATION #4:

STATEMENT (EXECUTIVE SUMMARY, PAGE 4): **“In 2016, drivers spent more than \$50 billion on motor gasoline in the 12 TCI jurisdictions that are the focus of this report.”**

STATEMENT (PAGE 19): **“In 2016, drivers in the Northeast and Mid-Atlantic region spent more than \$50 billion on motor gasoline alone.”**

Table B-4 shows the EIA’s SEDS data for the region’s total motor gasoline expenditures in the transportation sector—which totaled more than \$52 billion—in 2016, the most recent data year available.¹¹

TABLE B-4: 2016 MOTOR GASOLINE EXPENDITURES IN TRANSPORTATION BY STATE

From EIA data¹³

STATE	EXPENDITURES (BILLION USD)
CT	\$3.264
DC	\$0.265
DE	\$1.036
MA	\$5.950
MD	\$5.856
ME	\$1.735
NH	\$1.505
NJ	\$8.658
NY	\$11.821
PA	\$10.805
RI	\$0.803
VT	\$0.678
TOTAL	\$52.377

9 U.S. Energy Information Administration, “Table P5A. Primary Energy Production Estimates, Fossil Fuels and Nuclear Energy, in Trillion Btu, Ranked by State, 2015,” *supra* note 8.

10 U.S. Energy Information Administration, “Table C8. Transportation Sector Energy Consumption Estimates, 2015 (Trillion Btu),” *supra* note 8.

11 U.S. Energy Information Administration, “Table F3: Motor gasoline consumption, price, and expenditure estimates, 2016,” *State Energy Data System (SEDS): 2016 (updates by energy source)*, (February 2, 2018), www.eia.gov/state/seds/sep_fuel/html/pdf/fuel_mg.pdf.

12 *Ibid.*

EXPLANATION #5:

STATEMENT (PAGE I9): “Moving forward, each one percent decrease in motor gasoline consumption is projected to save the region \$600 to 700 million per year. Incrementally reducing gasoline consumption by one percent in 2018, two percent in 2019, and so on, could produce cumulative regional savings of more than \$100 billion by 2035.”

WITH ACCOMPANYING FIGURES (PAGE I9):

FIGURE 1. HISTORICAL AND PROJECTED REGIONAL MOTOR GASOLINE EXPENDITURES IN TRANSPORTATION UNDER BUSINESS AS USUAL AND WITH INCREMENTAL REDUCTIONS IN CONSUMPTION OF ONE PERCENT PER YEAR FROM 2018 TO 2035

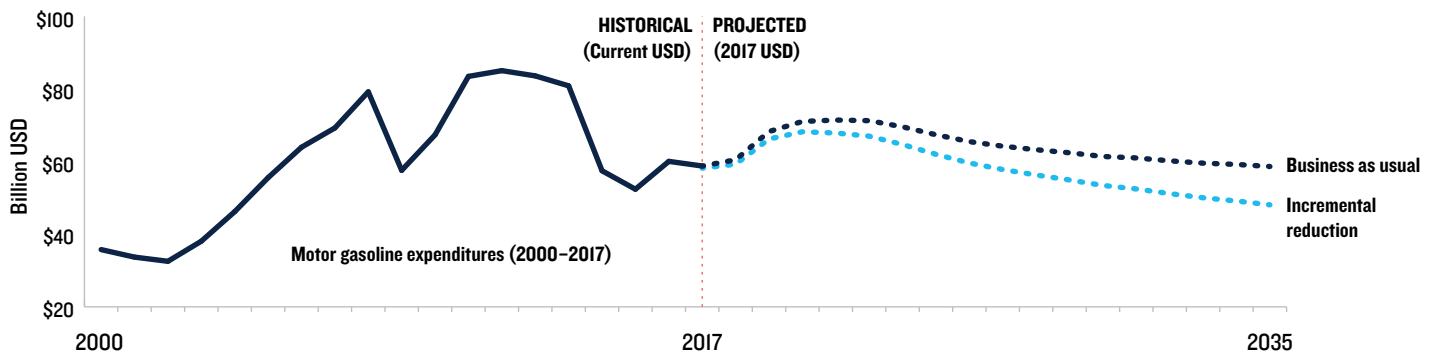
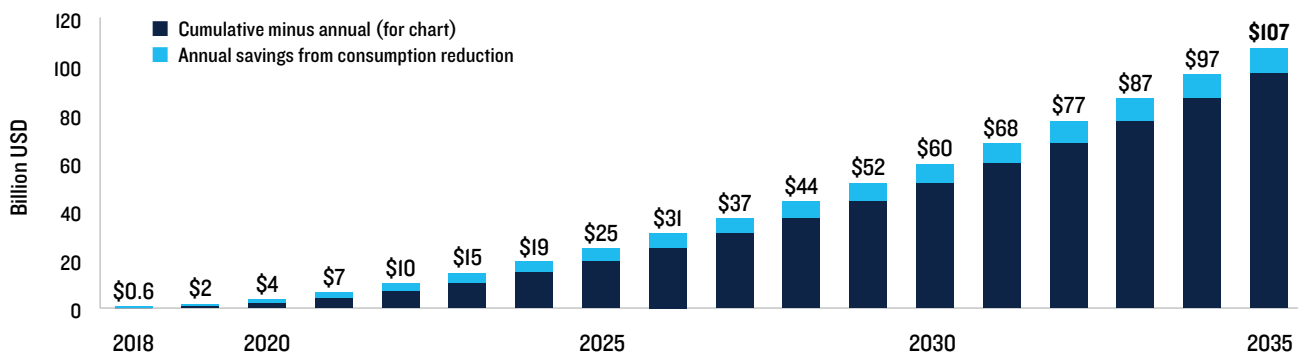


FIGURE 2. PROJECTED CUMULATIVE REGIONAL SAVINGS FROM INCREMENTALLY REDUCING MOTOR GASOLINE CONSUMPTION IN TRANSPORTATION BY ONE PERCENT PER YEAR FROM 2018 TO 2035 (IN BILLION 2017 USD)



Using the EIA’s SEDS database, we calculated total historical motor gasoline consumption and expenditures in the transportation sector from 2000 to 2016 within the 11 Northeast and Mid-Atlantic states and Washington, D.C., the jurisdictions that are the focus of this report.¹³ Next, we created business-as-usual (BAU) projections of motor gasoline consumption and expenditures in transportation in the region from 2017 to 2035. To do so, we used the EIA’s *Annual Energy Outlook (AEO) 2018* reference case projections of transportation motor gasoline energy consumption and prices for the EIA regions corresponding to the geographic focus of this report (i.e. the EIA’s New England, Mid-Atlantic, and

¹³ U.S. Energy Information Administration, “All consumption estimates in Btu,” *State Energy Data System (SEDS): 2016 (updates by energy source)* (June 1, 2018), www.eia.gov/state/seds/sep_update/use_all_btu_update.csv. U.S. Energy Information Administration, “All prices and expenditures estimates: Expenditures,” *State Energy Data System (SEDS): 2016 (updates by energy source)* (June 1, 2018), www.eia.gov/state/seds/sep_update/ex_all_update.csv.

South Atlantic regions).¹⁴ We combined SEDS’s most recent (2016 data year) motor gasoline energy consumption and expenditures data with the applicable AEO 2018 regional projections to develop state-specific projections. We then summed these state-specific energy consumption and expenditures projections to produce a BAU scenario for the region.

From the regional BAU projections, we calculated the potential cost savings of (a) each one percent reduction in motor gasoline consumption below BAU in years 2018 to 2035, and of (b) incrementally growing the rate of motor gasoline consumption reductions in transportation by one percent per year (i.e., starting with a one percent reduction below BAU in 2018, followed by two percent in 2019, and so on, finally reaching 18 percent in 2035). Table B-5 below shows selected years’ results from our analyses, while the figures shown above and in the report visually represent the results of the second analysis (incremental reduction). To calculate cost savings, we multiplied AEO 2018’s projections of motor gasoline prices in future years by the gallons of fuel saved in those years in our analyses.

As shown in Table B-5, each one percent reduction in motor gasoline consumption below BAU results in annual savings of between \$586 million and \$683 million. Similar savings were also calculated for the years not shown in the table. We summarize the results of this analysis in the report as showing annual cost savings of approximately \$600 million to \$700 million per year. Table B-5 also shows that the cumulative savings from 2018 to 2035 in our second analysis are more than \$107 billion, which we summarize in the report as more than \$100 billion.

TABLE B-5: PROJECTED FUEL CONSUMPTION AND EXPENDITURES AND SAVINGS FROM REDUCED CONSUMPTION IN THE REGION

Analysis of EIA data¹⁵

		2018	2020	2025	2030	2035
BAU projections	Gallons of motor gasoline (billion)	23.65	23.05	19.93	17.66	16.27
	\$/gallon	\$2.49	\$2.96	\$3.38	\$3.48	\$3.60
	Cost (billion 2017 USD)	\$58.78	\$68.26	\$67.38	\$61.40	\$58.64
	Approximate MMT CO ₂	188.8	184.0	159.1	141.0	129.9
(a) Estimated savings from 1% consumption reduction from BAU	Annual savings (billion 2017 USD)	\$0.588	\$0.683	\$0.674	\$0.614	\$0.586
	Cumulative savings (year to date in billion 2017 USD)	\$0.588	\$1.875	\$5.382	\$8.550	\$11.536
(b) Estimated savings from incrementally reducing consumption by an additional 1% per year	Annual savings (billion 2017 USD)	\$0.588	\$2.05	\$5.39	\$7.98	\$10.56
	Cumulative savings (year to date in billion 2017 USD)	\$0.588	\$3.85	\$24.79	\$59.54	\$107.26

EXPLANATION #6:

STATEMENT (PAGE 20): “Maryland and Massachusetts, for instance, have each seen annual urban vehicle miles traveled increase by around 15 percent since 2007.”

The Federal Highway Administration (FHWA) reports state-specific vehicle-miles traveled (VMT) per year by urban and rural road types.¹⁶ We calculated the percent changes in VMT over a 10-year period (both overall and by road type) using FHWA data for 2007 and 2016, the most recent data year available. Table B-6 below shows the results for states in the region. Maryland and Massachusetts saw increases in urban VMT of 15.6 percent and 14.7 percent, respectively, between 2007 and 2016.

¹⁴ U.S. Energy Information Administration, “Energy Consumption by Sector and Source, Case: Reference Case,” *Annual Energy Outlook 2018* (February 6, 2018), www.eia.gov/outlooks/aeo/data/browser/#/?id=2-AEO2018&cases=ref2018&sourcekey=0.

¹⁵ See U.S. Energy Information Administration, “All consumption estimates in Btu,” *supra* note 13. U.S. Energy Information Administration, “All prices and expenditures estimates: Expenditures,” *supra* note 13. U.S. Energy Information Administration, “Energy Consumption by Sector and Source, Case: Reference Case” (New England, Middle Atlantic, and South Atlantic regions), *supra* note 14.

¹⁶ Federal Highway Administration, “Vehicle-miles of travel, by functional system, 1980-2016,” *Highway Statistics 2016* (September 2017), www.fhwa.dot.gov/policyinformation/statistics/2016/xls/vm202.xls.

TABLE B-6: 2007-2016 VMT CHANGES BY STATE

Analysis of FHWA (2017) data¹⁷

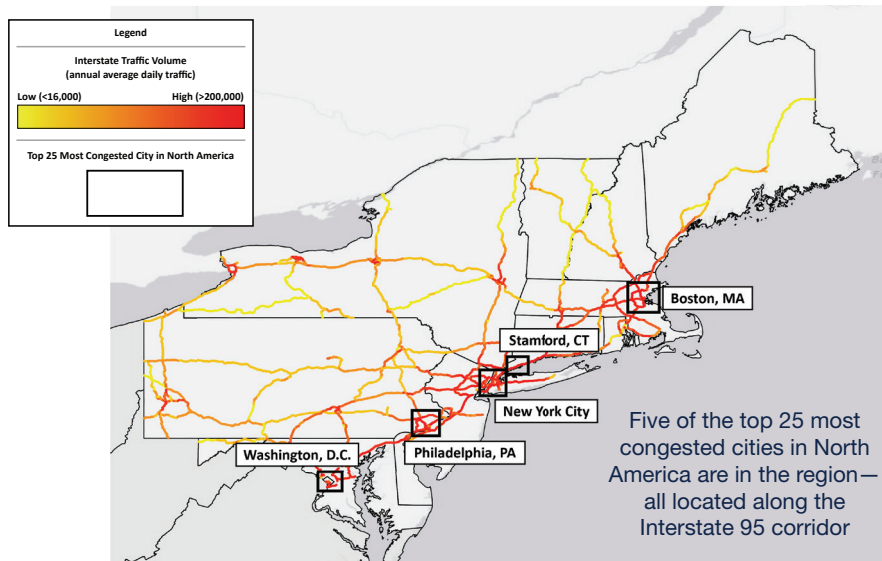
STATE	URBAN	RURAL	TOTAL
Connecticut	1.5%	-20.9%	-1.3%
Delaware	7.5%	6.8%	7.3%
District of Columbia	0.4%	0.0%	0.4%
Maine	15.1%	-7.6%	-1.3%
Maryland	15.6%	-26.9%	4.7%
Massachusetts	14.7%	-17.3%	12.3%
New Hampshire	8.2%	-9.5%	0.4%
New Jersey	4.2%	-28.4%	1.2%
New York	-4.9%	-26.1%	-10.1%
Pennsylvania	-3.8%	-12.0%	-6.7%
Rhode Island	-8.9%	-2.1%	-8.2%
Vermont	8.6%	-8.4%	-4.1%
TOTAL	2.8%	-17.6%	-2.2%

EXPLANATION #7:

STATEMENT (PAGE 20): “In these five cities [Boston, New York, Philadelphia, Stamford, and Washington, D.C.], people spend an average of 74 hours per year in traffic congestion. . . . All of that results in annual economic losses of more than \$50 billion.”

WITH ACCOMPANYING FIGURE (PAGE 20):

FIGURE 3. FIVE OF THE TOP 25 MOST CONGESTED CITIES IN NORTH AMERICA ARE IN THE REGION



17 See *ibid.*

As noted in the report, three of these five cities (Boston, New York, and Washington, D.C.) were among the top 10 most congested cities in the United States in 2017, and all five cities were among the top 25 most congested cities in North America that year, according to INRIX Research’s *Global Traffic Scorecard*.¹⁸ INRIX defines traffic congestion as travel speeds below 65 percent of free-flow (uncongested) road speeds.¹⁹ To determine the most congested cities, INRIX used a proprietary algorithm, real-time traffic flow information, and anonymous, real-time vehicle GPS data.²⁰ The INRIX report ranks cities by congestion, reports the average number of hours that drivers in each city spent in congestion, and lists city-specific losses or congestion costs per driver and across all city drivers.²¹ INRIX calculated and defined these congestion costs as costs to drivers from lost time and higher fuel use, social costs of higher emissions, and indirect costs to consumers due to businesses passing on their congestion costs in the form of higher priced goods and services.²²

We calculated a weighted average of the time drivers spent in congestion across these cities using INRIX data for congestion costs per driver, congestion costs to all drivers, and average number of hours spent in congestion per driver in the region’s five most congested cities (Boston, New York, Philadelphia, Stamford, and Washington, D.C.) in 2017. Table B-7 below shows the INRIX data we used and our resulting estimate of 74.4 hours in congestion per driver per year. We also calculated the total cost of congestion in these five cities in 2017 at \$50.4 billion using the INRIX data.

For the map shown above and in the report, we used GIS software to identify and project all interstates in the region. To convey relative traffic volumes within the region, we displayed roadways based on the annual average daily traffic (AADT) of each interstate segment, using FHWA data for 2015.²³ We further highlighted the five most congested cities in the region in 2017 according to the INRIX data.

TABLE B-7: COST OF CONGESTION IN THE FIVE MOST CONGESTED CITIES IN THE REGION IN 2017

Analysis of INRIX Research data

SOURCE:	INRIX ²⁴	INRIX ²⁵	MJB&A CALC.	INRIX ²⁶	MJB&A CALC.
City	Cost per driver	Total cost (billions)	Approximate # drivers	Hours in congestion per driver	Total hours (millions)
New York	\$2,982	\$33.7	11,301,140	91	1,028.4
Washington, DC	\$2,060	\$6.1	2,961,165	63	186.6
Boston	\$2,086	\$5.7	2,732,502	60	164.0
Stamford	\$1,588	\$2.8	1,763,224	41	72.3
Philadelphia	\$1,427	\$2.1	1,471,619	37	54.4
Across five most congested cities	-	\$50.4	20,229,651	74.4*	1,505.6

* Value calculated by MJB&A

18 INRIX Research, *INRIX Global Traffic Scorecard* (2018), inrix.com/scorecard/, at 14 and 19.

19 Ibid. at 4.

20 Ibid. at 4.

21 Ibid. at 19.

22 Ibid. at 6.

23 Federal Highway Administration, “HPMS Public Release of Geospatial Data in Shapefile Format” (2016), www.fhwa.dot.gov/policyinformation/hpms/shapefiles.cfm. From the Highway Performance Management System (HPMS) webpage, we downloaded HPMS shapefiles for states in the region for year 2015.

24 INRIX Research, *INRIX Global Traffic Scorecard*, *supra* note 18, at 19.

25 Ibid. at 19.

26 Ibid. at 19.

EXPLANATION #8:

STATEMENT (PAGE 21): “If we could reduce traffic congestion to increase the average speed of all trips in the region by just one mile per hour, we would save nearly \$19 billion per year in time savings, reduced fuel use, lower pollution impacts, and lower costs of doing business.”

We calculated state-specific costs per driver per hour spent in congestion using the formula below, which combines data from INRIX’s *Global Traffic Scorecard* and FHWA’s 2017 *National Household Travel Survey* (NHTS). As shown in the formula, we used INRIX’s estimates of the economic value of time and of congestion multipliers (the value people place on avoiding congestion) by trip type (commuting, business-related, or other)²⁷ and NHTS data on trip types and vehicle occupancy by trip type by state.²⁸

Cost per driver per hour in congestion (by state): $\Sigma[(\text{trip type \% from NHTS}) \times (\text{vehicle occupancy of trip type from NHTS}) \times (\text{hourly value of trip type from INRIX}) \times (\text{INRIX congestion multiplier of trip type from INRIX})]$

We next used total VMT and total time spent in vehicles reported under the NHTS by state²⁹ to estimate the average travel speed for each state in the region:

Average travel speed (by state): $(\text{total VMT from NHTS}) / (\text{total time spent in vehicle from NHTS})$

We used average travel speed and FHWA data on total state VMT in 2016 (the most recent data available)³⁰ to estimate the total number of hours that drivers in each state spent in vehicles. We then increased the calculated state average speeds by one mile per hour to calculate a new estimate of time spent in vehicles if average travel speeds could be increased by this amount. We calculated the hours that would be saved with these increased travel speeds as follows:

Hours saved with 1 mph increase: $(\text{total VMT of state from FHWA}) / (\text{calculated average speed}) - (\text{total VMT of state from FHWA}) / (\text{calculated average speed} + 1 \text{ mph})$

To determine the potential state-specific and total regional cost savings from increasing travel speeds, we multiplied the time savings by the value of time previously calculated as follows:

Economic savings: $(\text{calculated hours saved}) \times (\text{calculated cost per hour in congestion})$

As shown in Table B-8 below, which provides condensed data from our analysis, we estimate regional savings of \$18,561 million, or approximately \$19 billion, if average trip speeds were increased by 1 mph. The specific form of savings mentioned in the report—time, reduced fuel use, fewer emissions, and lower costs of doing business—are per INRIX’s definition of the economic costs of congestion.³¹

27 Ibid. at 7.

28 Federal Highway Administration, “2017 Data,” *2017 National Household Travel Survey* (March 2018), nhts.ornl.gov/assets/2016/download/Csv.zip (60 MB).

29 Ibid.

30 Federal Highway Administration, “Vehicle-miles of travel, by functional system, 1980-2016,” *supra* note 16.

31 INRIX Research, *INRIX Global Traffic Scorecard*, *supra* note 18, at 6-7.

TABLE B-8: POTENTIAL REGIONAL SAVINGS FROM REDUCING CONGESTION (CALCULATED AS A 1 MPH INCREASE IN AVERAGE TRAVEL SPEEDS)

Analysis of INRIX Research and FHWA data

SOURCE:	NHTS ³²			INRIX/NHTS ³³	NHTS ³⁴	FHWA ³⁵	MJ&BA CALC.		
	TRIP TYPE			APPROXIMATE COST/HOUR	AVERAGE SPEED (MPH)	TOTAL VMT (MILLIONS)	SAVINGS FROM 1 MPH INCREASE		
STATE	WORK	BUSINESS	OTHER				TIME SAVINGS (MILLION HRS)	DOLLAR SAVINGS (MILLIONS USD)	
CT	17.0%	2.6%	80.4%	\$34.99	27.6	31,639	40.1	\$1,405.1	
DC	24.2%	2.8%	73.0%	\$31.86	17.9	3,622	10.7	\$340.5	
DE	14.2%	2.6%	83.2%	\$32.35	31.8	10,178	9.8	\$316.2	
MA	22.3%	3.2%	74.5%	\$32.86	26.1	61,825	87.6	\$2,881.4	
MD	20.0%	3.0%	77.0%	\$33.22	33.5	59,137	51.1	\$1,698.7	
ME	18.5%	3.2%	78.2%	\$34.07	33.0	14,838	13.2	\$451.6	
NH	18.8%	3.5%	77.7%	\$33.24	28.6	13,513	15.9	\$528.9	
NJ	22.4%	2.0%	75.6%	\$32.87	37.0	77,093	54.8	\$1,802.7	
NY	18.8%	2.3%	78.9%	\$33.22	29.3	122,930	138.2	\$4,593.0	
PA	19.5%	3.2%	77.2%	\$32.92	28.5	101,362	120.3	\$3,961.9	
RI	19.7%	4.4%	75.9%	\$30.28	25.6	7,927	11.6	\$353.1	
VT	19.9%	3.3%	76.8%	\$30.40	30.9	7,382	7.5	\$227.8	
TOTAL: \$18,561.0 MILLION									

³² See Federal Highway Administration, “2017 Data,” *supra* note 28.

³³ See *ibid.* INRIX Research, *INRIX Global Traffic Scorecard*, *supra* note 18.

³⁴ See Federal Highway Administration, “2017 Data,” *supra* note 28.

³⁵ Federal Highway Administration, “Vehicle-miles of travel, by functional system, 1980-2016,” *supra* note 16.

EXPLANATION #9:

STATEMENT (PAGE 22): “More than 4,500 people died in vehicle collisions in the Northeast and Mid-Atlantic region in 2016. . . . On an average per-mile basis, fatalities from vehicle collisions occurred twice as frequently on rural roadways as on urban ones.”

Using FHWA data, we calculated total traffic fatalities in 2016 in the region both as a whole (4,557) and by road type, as shown in the table below.³⁶ We next calculated the frequency of fatalities per VMT using FHWA data on total VMT on urban and rural roads in 2016, and then compared the frequency of fatal traffic accidents on rural versus urban roadways. Regionally, 2.26 times more fatalities per VMT occurred on rural roads than on urban roads in 2016, as shown in Table B-9 below.

TABLE B-9: ROADWAY FATALITIES AND FATALITIES PER VMT BY STATE IN 2016

Analysis of FHWA data

SOURCE:	FHWA ³⁷				FHWA ³⁸		MJ&BA CALC.		MJ&BA CALC.
	FATALITIES BY ROAD TYPE				VMT (BILLIONS)		FATALITIES PER BILLION VMT		RURAL:URBAN FATALITY RATIO
STATE	RURAL	URBAN	UNKNOWN*	TOTAL	RURAL	URBAN	(A) RURAL	(B) URBAN	(A) / (B)
CT	37	251	5	293	3.2	28.5	11.71	8.81	1.33
DC	0	26	1	27	0.0	3.6	N/A	7.18	N/A
DE	69	50	0	119	3.0	7.2	23.00	6.97	3.30
MA	17	372	0	389	3.5	58.3	4.87	6.38	0.76
MD	106	393	6	505	10.7	48.5	9.93	8.11	1.23
ME	130	28	3	161	10.0	4.8	12.97	5.81	2.23
NH	75	61	0	136	5.4	8.2	14.00	7.48	1.87
NJ	85	512	4	601	4.9	72.1	17.18	7.10	2.42
NY	456	569	0	1,025	25.0	98.0	18.26	5.81	3.14
PA	647	528	13	1,188	34.4	67.0	18.83	7.88	2.39
RI	10	41	0	51	0.9	7.0	11.05	5.84	1.89
VT	52	10	0	62	5.3	2.1	9.90	4.69	2.11
REGION	1,684	2,841	32	4,557	106.1	405.3	15.87	7.01	2.26

* Fatalities that occurred on unknown road types are not included in the calculations of Urban and Rural Fatalities per VMT or the Rural:Urban Fatality Ratios.

36 Federal Highway Administration, “12.4.5. Persons fatally injured in motor vehicle crashes, by Functional system,” *Highway Statistics 2016* (October 2017), www.fhwa.dot.gov/policyinformation/statistics/2016/xls/fi20.xls.

37 Ibid.

38 Ibid.

EXPLANATION #10:

STATEMENT (PAGE 22): “The regional total included 970 pedestrian deaths, an 18 percent increase in the number of pedestrian fatalities from 2011. In addition, 115 cyclists were killed by motor vehicles on the region’s roadways.”

We calculated total pedestrian and cyclist fatalities in 2011 and 2016 by state and across the region using data from the National Highway Traffic Safety Administration (NHTSA). We then compared the annual totals to determine the percentage change between the two years. The results are shown below in Table B-10.

TABLE B-10: PEDESTRIAN AND CYCLIST FATALITIES (BY STATE)

Analysis of NHTSA data

STATE	PEDESTRIAN FATALITIES			CYCLIST FATALITIES		
	2011 ³⁹	2016 ⁴⁰	% CHANGE	2011 ⁴¹	2016 ⁴²	% CHANGE
CT	26	54	108%	8	5	-38%
DE	18	27	50%	0	2	N/A
DC	8	8	0%	1	1	0%
MA	58	80	38%	0	4	N/A
MD	102	104	2%	5	16	220%
ME	10	17	70%	5	10	100%
NH	5	17	240%	4	2	-50%
NJ	142	162	14%	17	18	6%
NY	287	304	6%	57	38	-33%
PA	147	169	15%	11	16	45%
RI	14	14	0%	0	2	N/A
VT	3	14	367%	0	1	N/A
REGION	820	970	18.3%	108	115	6%

39 National Highway Traffic Safety Administration, *Traffic Safety Facts, 2011 Data: Pedestrians* (August 2013), crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/811748

40 National Highway Traffic Safety Administration, *Traffic Safety Facts, 2016 Data: Pedestrians* (March 2018), crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812493.

41 National Highway Traffic Safety Administration, *Traffic Safety Facts, 2011 Data: Bicyclists and Other Cyclists* (April 2013), crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/811743.

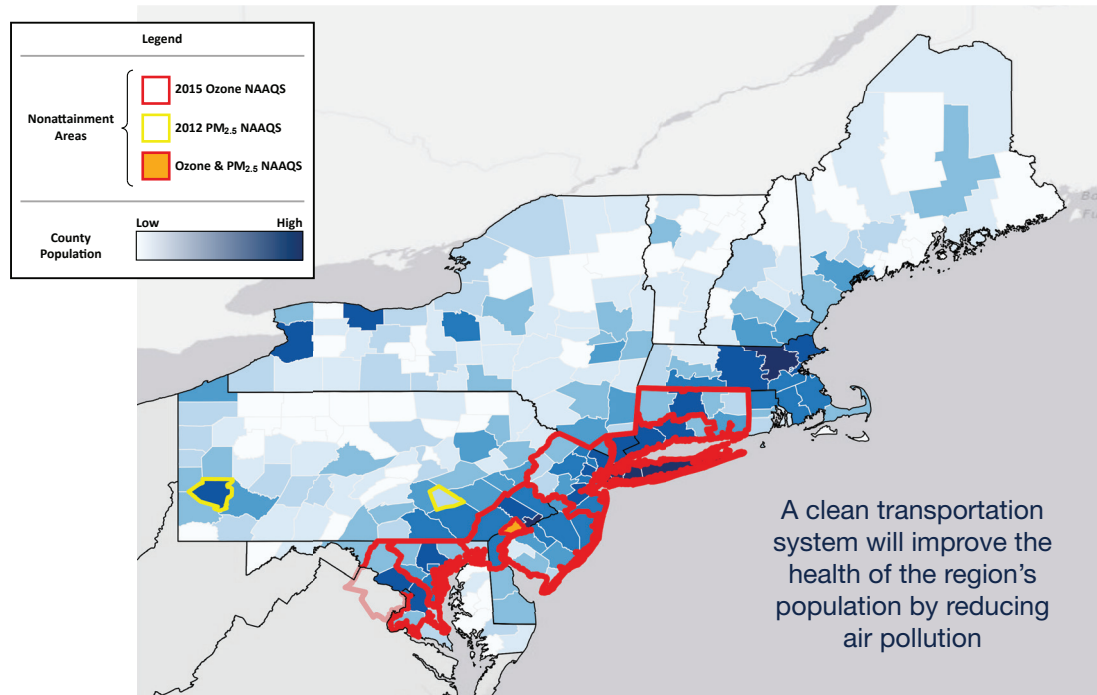
42 National Highway Traffic Safety Administration, *Traffic Safety Facts, 2016 Data: Bicyclists and Other Cyclists* (May 2018), crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812507.

EXPLANATION #II:

STATEMENT (PAGE 23): “In the Northeast and Mid-Atlantic region, almost 60 percent of the population—around 37 million people—live in areas that do not meet the National Ambient Air Quality Standards (NAAQS) for PM_{2.5}, ozone pollution, or both.”

WITH ACCOMPANYING FIGURE (PAGE 23):

FIGURE 4. AREAS DESIGNATED BY EPA AS IN NONATTAINMENT UNDER 2015 OZONE AND 2012 PM_{2.5} NAAQS



We calculated the total number of people living in counties in the region that are in nonattainment areas. To do so, we used the EPA’s nonattainment area designations under the 2015 ozone NAAQS (as issued in June 2018)⁴³ and the 2012 PM_{2.5} NAAQS (as updated in April 2015),⁴⁴ combined with U.S. Census Bureau estimates of population by county in 2017.⁴⁵ 64.2 million people lived in the Northeast and Mid-Atlantic region in 2017, according to the census estimates.⁴⁶ As shown in Table B-11 below, in 2017, 37.5 million people, or approximately 58.4 percent of the regional population, lived in areas the EPA has designated as nonattainment for the ozone and/or PM_{2.5} NAAQS.

For the map in the report and above, we combined the EPA’s county ozone and PM_{2.5} nonattainment designations with the U.S. Census Bureau’s 2017 population estimates by county. We used GIS software to project the information and shaded counties based on their population magnitude.

43 U.S. Environmental Protection Agency, *2016 and Early-Certified 2017 Ozone Design Values used in Final Designations* (April 30, 2018), www.epa.gov/sites/production/files/2018-05/ozone_dv_tables_final_04-30-18.xlsx. U.S. Environmental Protection Agency, *Additional Air Quality Designations for the 2015 Ozone National Ambient Air Quality Standards Fact Sheet — Final Area Designations for the National Ambient Air Quality Standards for Ozone Established in 2015*, 83 Fed. Reg. 25776 (June 4, 2018), www.govinfo.gov/content/pkg/FR-2018-06-04/pdf/2018-11838.pdf. The 2015 ozone NAAQS designations will take effect on August 3, 2018.

44 U.S. Environmental Protection Agency, *2012 Annual Fine Particle (PM_{2.5}) Designations* (May 2017), epa.maps.arcgis.com/apps/MapJournal/index.html?appid=a76e14f777de49baa5d32f5544c8e20b&webmap=fc297672dd074e4ab5b208aeb21fa52. U.S. Environmental Protection Agency, *Additional Air Quality Designations and Technical Amendment To Correct Inadvertent Error in Air Quality Designations for the 2012 Primary Annual Fine Particle (PM_{2.5}) National Ambient Air Quality Standards (NAAQS)*, 80 Fed. Reg. 18535 (April 7, 2015), www.gpo.gov/fdsys/pkg/FR-2015-04-07/pdf/2015-07948.pdf.

45 U.S. Census Bureau, “Population, Population Change, and Estimated Components of Population Change: April 1, 2010 to July 1, 2017,” *County Population Totals and Components of Change: 2010-2017* (2018), www2.census.gov/programs-surveys/popest/datasets/2010-2017/counties/totals/co-est2017-alldata.csv.

46 Ibid.

TABLE B-11: POPULATION IN DESIGNATED NONATTAINMENT AREAS BY STATE

Analysis of EPA and U.S. Census Bureau data⁴⁷

STATE NAME	2015 OZONE ONLY	2012 PM _{2.5} ONLY	BOTH	TOTAL
Connecticut	3,588,184	0	0	3,588,184
Delaware	559,793	0	0	559,793
District of Columbia	693,972	0	0	693,972
Maryland	5,335,941	0	0	5,335,941
New Jersey	9,005,644	0	0	9,005,644
New York	12,794,277	0	0	12,794,277
Pennsylvania	3,554,572	1,362,802	564,696	5,482,070
TOTAL	35,532,383	1,362,802	564,696	37,459,881

EXPLANATION #12:

STATEMENT (EXECUTIVE SUMMARY, PAGE 5): **“Reducing or eliminating fine particulate matter alone could save thousands of lives and prevent hundreds of thousands of lost workdays in the region each year.”**

STATEMENT (PAGE 23): **“Reducing these emissions by just one percent could save dozens of lives and prevent thousands of respiratory symptoms each year, while saving the region hundreds of millions of dollars. Eventually eliminating PM_{2.5} emissions from vehicles could save thousands of lives, save tens of billions of dollars in avoided health costs, and prevent hundreds of thousands of lost workdays each year.”**

WITH ACCOMPANYING TABLE (PAGE 24):

TABLE I. HEALTH IMPACTS OF PM_{2.5}-RELATED EMISSIONS FROM ON-ROAD VEHICLES IN THE REGION IN 2014

HEALTH EFFECTS	PM _{2.5} PRECURSORS		DIRECTLY EMITTED PM _{2.5}	TOTAL
	NO _x	SO ₂		
Premature mortality (adults)	550-1,200	12-27	1,000-2,300	1,600-3,600
Non-fatal heart attacks	56-520	1-10	110-990	170-1,500
Respiratory ER visits	300	6	600	910
Cardiovascular hospital admissions	130	3	240	370
Respiratory hospital admissions	120	3	240	360
Acute bronchitis	800	20	1,500	2,400
Work loss days	74,000	1,700	140,000	220,000
Lower respiratory symptoms	9,800	250	20,000	30,000
Upper respiratory symptoms	15,000	360	29,000	44,000
Minor restricted activity days	420,000	9,900	850,000	1,300,000
Asthma exacerbation	17,000	420	34,000	51,000

We determined state-specific PM_{2.5} precursor (NO_x and SO₂) emissions and directly emitted PM_{2.5} (condensable and filterable) from on-road vehicles in the region using the EPA’s 2014 National Emissions Inventory (NEI) data, the most recent data year available.⁴⁸ We then calculated the health and financial impacts of these emissions using national benefits-

⁴⁷ Ibid. U.S. Environmental Protection Agency, *2016 and Early-Certified 2017 Ozone Design Values used in Final Designations*, supra note 43. U.S. Environmental Protection Agency, *2012 Annual Fine Particle (PM_{2.5}) Designations*, supra note 44.

⁴⁸ U.S. Environmental Protection Agency, “Sector Summaries - Criteria and Hazardous Air Pollutants by 60 EIS emission sectors,” *2014 National Emissions Inventory (NEI) Data* (2018), www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data. From the NEI webpage, we queried data for NO_x, SO₂, and PM_{2.5} primary emissions from on-road mobile sources in all states in the region.

and incidence-per-ton factors (for analysis year 2016) of avoided health effects (mortality and morbidity) as developed by EPA and described in a 2018 Technical Support Document (TSD).⁴⁹ These factors correspond with nationwide effects that result from direct PM_{2.5} emissions and PM_{2.5} precursor emissions and are often used to estimate health and economic effects in lieu of more comprehensive regional air modeling scenario analysis.

To calculate estimated health and economic impact levels, we multiplied emissions levels by the applicable impact factors from the TSD (e.g., 24,191 tons of direct PM_{2.5} emissions could result in 34,000 asthma attacks (24,191 x 1.4) nationwide). For some health effects, namely premature mortality and non-fatal heart attacks, we show ranges of values in Table 1 in the report (reproduced above), which reflect low to high incidence-per-ton factors across multiple studies, as defined in tables 29 and 30 of the TSD.

The tables below show the emissions and TSD factors we used to generate the estimated dollar savings and health effects mentioned in the report. For economic impacts, we further adjusted economic values to 2017 dollars using the U.S. Bureau of Labor Statistics (BLS) Consumer Price Index (CPI) factors.⁵⁰

Based on the data in the tables below, we calculate that if all PM_{2.5} precursors and directly emitted PM_{2.5} from on-road vehicles in the region were eliminated, the total economic savings (using the high estimate of economic effects from the TSD) would be nearly \$35 billion per year:

$$[(613,832 \text{ tons NO}_x \times \$19,000/\text{ton}) + (5,222 \text{ tons SO}_2 \times \$48,000/\text{ton}) + (24,191 \text{ tons PM}_{2.5} \times \$900,000/\text{ton})] \times [1.034 \text{ (2015-2017 CPI-U adjustment factor from BLS)}] = \$34.84 \text{ billion}$$

We similarly calculate that a one percent reduction in PM_{2.5} precursors and directly emitted PM_{2.5} from the region's on-road vehicles (i.e., reductions in NO_x, SO₂, and PM_{2.5} emissions of roughly 6,140, 52, and 242 tons, respectively) would result in approximately 36 fewer deaths (using the high estimate value from the TSD), 1,276 fewer incidences of respiratory issues (acute bronchitis, lower/upper respiratory symptoms, and asthma exacerbation), and economic benefits of \$154 million to \$348 million per year.

TABLE B-12: DIRECT PM_{2.5} AND PM_{2.5} PRECURSOR EMISSIONS IN THE REGION IN 2014

From EPA NEI data⁵¹

STATE	PRECURSORS		DIRECT
	NO _x (TONS)	SO ₂ (TONS)	PM _{2.5} (TONS)
CT	30,676	286	1,019
DC	4,384	51	211
DE	12,066	93	358
MA	44,729	555	1,726
MD	73,232	537	2,744
ME	23,094	152	843
NH	16,292	134	596
NJ	71,433	725	2,735
NY	143,495	1,486	6,807
PA	174,231	1,041	6,321
RI	12,581	81	517
VT	7,619	81	316
TOTAL	613,832	5,222	24,191

49 U.S. Environmental Protection Agency, *Technical Support Document: Estimating the Benefit per Ton of Reducing PM_{2.5} Precursors from 17 Sectors* (February 2018), www.epa.gov/sites/production/files/2018-02/documents/sourceapportionmentbpttsd_2018.pdf.

50 U.S. Bureau of Labor Statistics, *Historical CPI-U* (April 2018), www.bls.gov/cpi/tables/supplemental-files/historical-cpi-u-201804.pdf.

51 U.S. Environmental Protection Agency, "Sector Summaries - Criteria and Hazardous Air Pollutants by 60 EIS emission sectors," *supra* note 48. From the NEI webpage, we queried data for NO_x, SO₂, and PM_{2.5} primary emissions from on-road mobile sources in all states in the region.

**TABLE B-13: NATIONWIDE ECONOMIC EFFECTS OF PM_{2.5} AND PM_{2.5} PRECURSOR EMISSIONS
(2015 DOLLARS PER TON, USING 2016 ANALYSIS YEAR AND 3% DISCOUNT RATE)**

From EPA TSD Table 29 data⁵²

	NO _x	SO ₂	PM _{2.5}
Low Estimate (Krewski et al. 2009)	\$8,300	\$21,000	\$400,000
High Estimate (Lepeule et al. 2012)	\$19,000	\$48,000	\$900,000

**TABLE B-14: NATIONWIDE HEALTH EFFECTS OF PM_{2.5} AND PM_{2.5} PRECURSOR EMISSIONS
(INCIDENCES PER TON, USING 2016 ANALYSIS YEAR)**

From EPA TSD Table 30 data⁵³

INCIDENCE-PER-TON (NATIONWIDE)	NO _x	SO ₂	PM _{2.5}
Mortality			
Low (Krewski et al. 2009)	0.000890	0.002300	0.043000
High (Lepeule et al. 2012)	0.002000	0.005200	0.097000
Morbidity			
Respiratory ER visits	0.000490	0.001200	0.025000
Acute bronchitis	0.001300	0.003800	0.064000
Lower respiratory symptoms	0.016000	0.048000	0.810000
Upper respiratory symptoms	0.024000	0.069000	1.200000
Minor restricted activity days	0.690000	1.900000	35.000000
Work loss days	0.120000	0.330000	5.900000
Asthma exacerbation	0.028000	0.081000	1.400000
Cardiovascular hospital admissions	0.000210	0.000500	0.010000
Respiratory hospital admissions	0.000200	0.000480	0.009800
Non-fatal heart attacks (low)	0.000091	0.000220	0.004500
Non-fatal heart attacks (high)	0.000840	0.002000	0.041000

⁵² U.S. Environmental Protection Agency, *Technical Support Document: Estimating the Benefit per Ton of Reducing PM_{2.5} Precursors from 17 Sectors*, supra note 49, at 44.

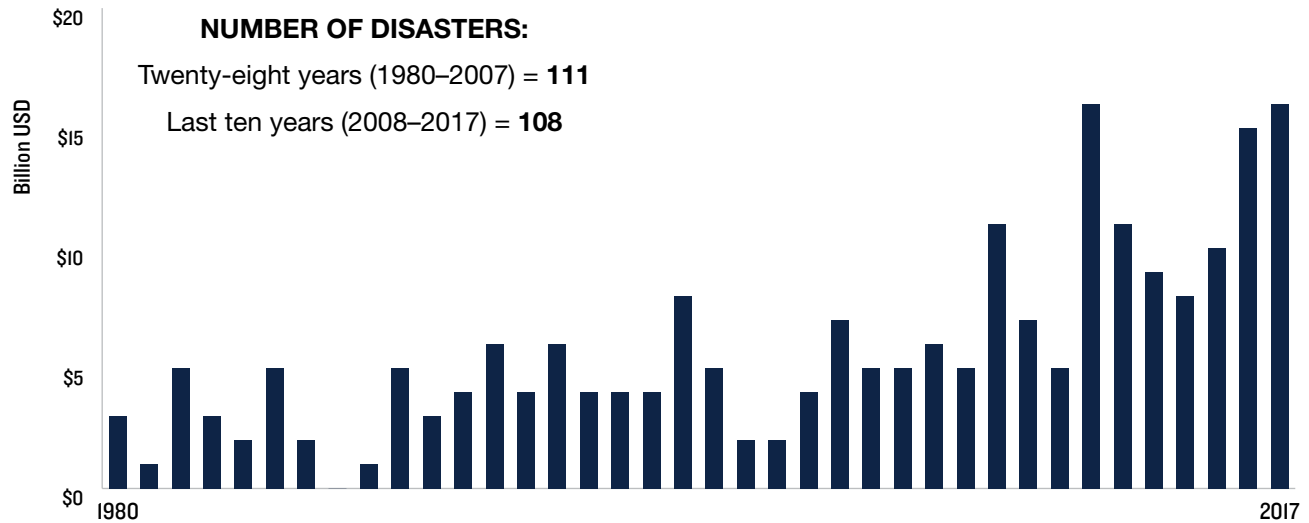
⁵³ Ibid. at 44.

EXPLANATION #13:

STATEMENT (PAGE 24): “Over the past few decades, the number of natural disasters, including severe storms, flooding, fires, and other events, to cause more than \$1 billion dollars in damage has increased, as shown in the figure below.”

WITH ACCOMPANYING FIGURE (PAGE 24):

FIGURE 5. NUMBER OF BILLION-DOLLAR NATURAL DISASTERS IN THE UNITED STATES FROM 1980-2017



The frequency of severe natural disasters has increased since 1980.

The National Oceanic and Atmospheric Administration (NOAA) reports the number of weather and climate disasters in the United States since 1980 that have caused total damages of at least \$1 billion each.⁵⁴ The chart plots these data through 2017 (the last year of complete data available) and shows that the number of billion-dollar disasters per year has grown over time. For purposes of this chart, we have adjusted the disaster damages to 2017 dollars using BLS CPI factors,⁵⁵ consistent with how we report other dollar values from our analyses in the report.

54 National Oceanic and Atmospheric Administration, *Weather and Climate Billion-Dollar Disasters to affect the U.S. from 1980-2017 (CPI-Adjusted)* (2018), www.ncdc.noaa.gov/billions/events-US-1980-2017.csv.

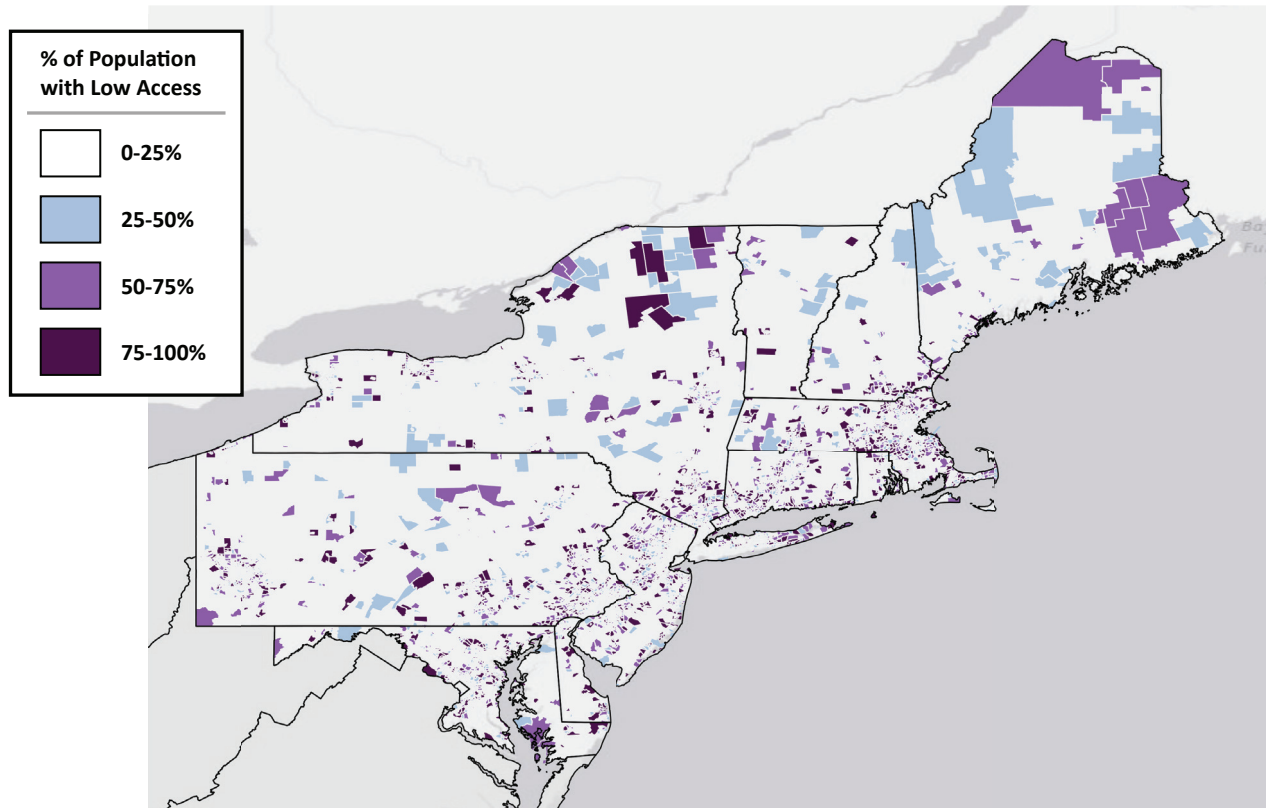
55 U.S. Bureau of Labor Statistics, *Historical CPI-U*, *supra* note 50.

EXPLANATION #14:

STATEMENT (PAGE 25): “Currently, more than 12 million people in the region do not live near a supermarket (see Figure 6).”

WITH ACCOMPANYING FIGURE (PAGE 26):

FIGURE 6. AREAS WITH LOW ACCESS TO FOOD



We determined the number of urban and rural residents by state in the region who do not live in “close proximity” to a supermarket—defined as within one mile of a supermarket in urban areas and within 10 miles of a supermarket in rural areas⁵⁶—using USDA’s *Food Access Research Database* data for 2015, the most recent data year available.⁵⁷ More than 12.3 million of the region’s residents do not live in close proximity to a supermarket, as shown in Table B-15 below.

For the map of areas with low access to food shown in the report and above, we combined the USDA’s 2015 food access data with the U.S. Census Bureau’s 2010 census tracts⁵⁸ and projected them spatially using GIS software. Tracts are shaded according to the applicable percentages of the local population (shown in the map legend) that do not live in close proximity to a supermarket, as defined by the USDA. For purposes of this analysis, we relied on the U.S. Census Bureau’s 2010 census data, the most recent year the required spatial data are available. (We have used more recent census estimates in areas of the report that did not require spatial analysis.)

56 U.S. Department of Agriculture, *Food Access Research Atlas Documentation* (January 3, 2014), www.ers.usda.gov/webdocs/DataFiles/80591/documentation.pdf?v=41642. USDA uses three measures of “low-access census tracts” in its *Food Access Research Atlas*. We selected the middle measure for our analysis, which defines low-access as greater than 1 mile from a supermarket in an urban area, or greater than 10 miles from a supermarket in a rural area.

57 U.S. Department of Agriculture, *Food Access Research Atlas Data Download 2015* (May 18, 2017), www.ers.usda.gov/webdocs/DataFiles/80591/DataDownload2015.xlsx?v=42873.

58 U.S. Census Bureau, 2010 Demographic Profile Shapefiles (2012), www2.census.gov/geo/tiger/TIGER2010DPL/Tract_2010Census_DPL.zip.

TABLE B-15: ESTIMATED NUMBER OF URBAN AND RURAL RESIDENTS WITH LOW ACCESS TO FOOD IN 2015

Analysis of USDA and U.S. Census Bureau data⁵⁹

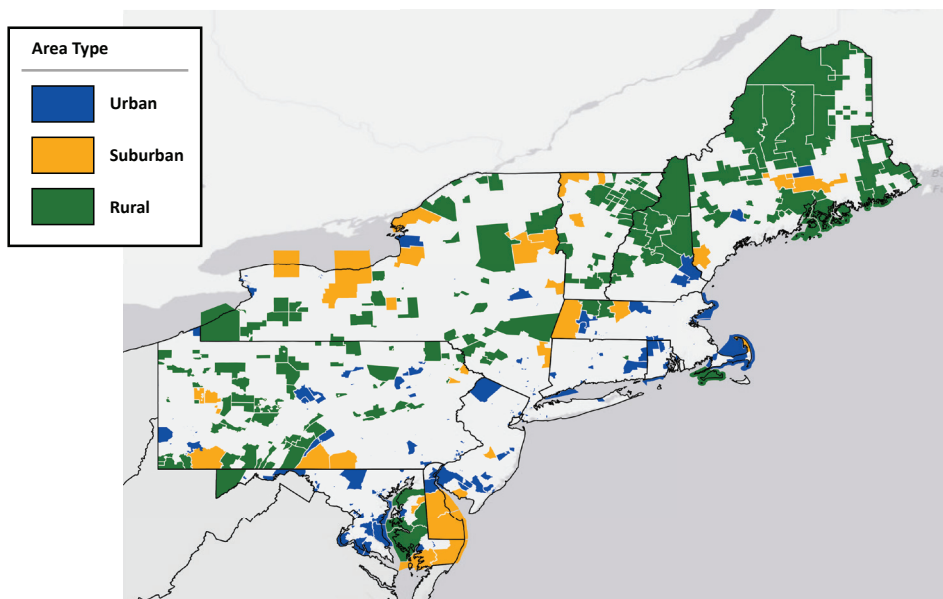
STATE	LOW ACCESS (TOTAL)		TOTAL
	URBAN	RURAL	
CT	1,065,111	129	1,065,240
DE	228,397	0	228,397
DC	12,749	0	12,749
ME	150,801	34,107	184,908
MD	1,292,172	7,875	1,300,047
MA	1,830,605	7,165	1,837,769
NH	372,504	5,959	378,463
NJ	2,082,142	2,352	2,084,495
NY	2,162,141	87,575	2,249,716
PA	2,635,029	47,865	2,682,895
RI	249,288	1,051	250,339
VT	64,222	14,325	78,547
TOTAL	12,145,162	208,403	12,353,565

EXPLANATION #15:

STATEMENT (PAGE 25): “Around a quarter of the region’s population also lives in areas with shortages of primary care health services for residents (see Figure 7).”

WITH ACCOMPANYING FIGURE (PAGE 26):

FIGURE 7. MEDICALLY UNDERSERVED AREAS



59 See *ibid.* U.S. Department of Agriculture, *Food Access Research Atlas Data Download 2015*, *supra* note 56.

The U.S. Department of Health and Human Services' Health Resources and Services Administration (HRSA) designates medically underserved areas (MUAs), areas with a shortage of primary care health services for residents.⁶⁰ To be designated as a MUA, an area must score 62 or less out of 100 on the Index of Medical Underservice (IMU), which is calculated based on the (1) population to provider ratio; (2) percent of the population below the federal poverty level; (3) percent of the population over age 65; and (4) infant mortality rate in the area.⁶¹ More information is available on the HRSA website: bhw.hrsa.gov/shortage-designation/muap.

To determine the number of people living in MUAs in the region, we used GIS software to project the 2010 census tracts from the U.S. Census Bureau⁶² and HRSA data on MUA designations, current as of April 2018.⁶³ We ran a spatial analysis in the software to determine the population within the boundaries of MUAs, based on census tract data. To estimate the population for MUAs that did not span an entire census tract, we applied the population density of the underlying tract to the area of the tract within the MUA. Table B-16 displays relevant information from this analysis and show that roughly 26 percent of residents in the region are in a MUA. Urban and non-urban populations, as shown in Table B-16, are defined by census tract classifications. As with the food access analysis above, we relied on the U.S. Census Bureau's 2010 census data, which is the most recent year the required spatial data are available.

For the map of MUAs in the report and above, we combined HRSA's MUA designations with the 2010 census tracts and projected them spatially using GIS software. We labeled individual MUAs as rural or urban according to census tract classifications. We labeled MUAs that spanned both urban and rural census tracts as "suburban."

TABLE B-16: ESTIMATED NUMBER OF URBAN AND NON-URBAN RESIDENTS LIVING IN MUAS IN THE REGION

Analysis of HRSA and U.S. Census Bureau data⁶⁴

	URBAN	NON-URBAN	TOTAL
Number of MUAs	363	213	576
MUA Population	12,591,512	3,549,360	16,140,872
Total Population	51,746,903	10,843,546	62,590,449
% TOTAL IN MUAS	24%	33%	26%

60 Health Resources and Services Administration, "Medically Underserved Areas and Populations (MUA/Ps)" (October 2016), bhw.hrsa.gov/shortage-designation/muap.

61 Ibid.

62 U.S. Census Bureau, 2010 Demographic Profile Shapefiles, *supra* note 58.

63 Health Resources and Services Administration, *Medically Underserved Areas/Populations (MUA/P): Parent Boundaries - SHP* (2018), datawarehouse.hrsa.gov/DataDownload/DD_Files/MUA_SHP.zip (123 MB).

64 See *ibid.* U.S. Census Bureau, 2010 Demographic Profile Shapefiles, *supra* note 58.



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