Destination: Zero Carbon

Three strategies to transform transportation in America

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Executive summary

In the U.S., transportation is climate enemy number one. America's transportation system produces more greenhouse gas emissions than any other sector of our economy and, on its own, is responsible for 4 percent of the world's greenhouse gas emissions – more than the entire economies of France and the United Kingdom combined.[1]

There is no solution to global warming that doesn't involve a sea change in how Americans get around and in how we power our cars and trucks. The good news: **A clean, efficient, and sustainable low-carbon transportation system is possible.** By phasing out fossil fuel vehicles, electrifying and improving our transit system, and getting more people walking and biking, the U.S. can take on today's greatest environmental challenge, while creating communities that are healthier, safer and more livable.

Transportation is the leading source of carbon pollution in the U.S., and light-duty vehicles – including cars, pickups and SUVs – are the biggest contributors to the problem. In 2017, light-duty vehicles accounted for one-sixth of America's greenhouse gas emissions, and nearly three-fifths of emissions from the transportation system.[2] That is equivalent to:

- Nearly all the carbon pollution from all the remaining U.S. coal-fired power plants.[3]
- More than the entire emissions of any country in the world except China, India, Russia and Japan.[4]

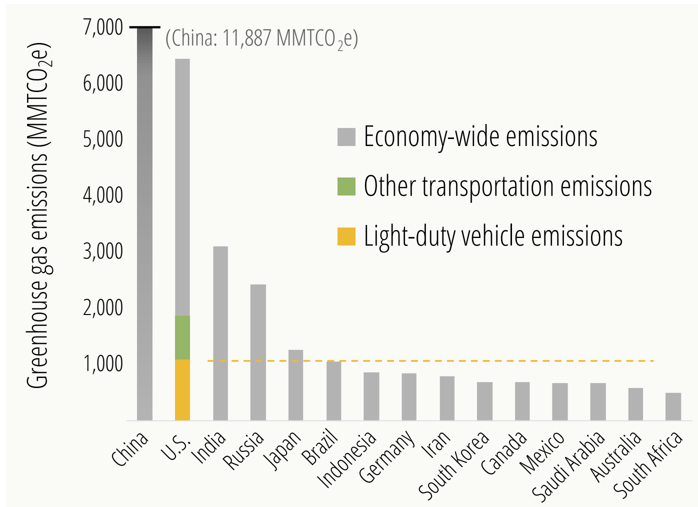

Figure ES-1. U.S. light-duty vehicles emit more greenhouse gas emissions than most entire countries[5]

High transportation emissions result in large part from Americans driving more than 3.2 trillion miles each year in inefficient, polluting vehicles.[6] Factors driving high emissions from light-duty vehicles include:

- **Oversized, inefficient vehicles that run on dirty fuels.** Typical U.S. vehicles are bigger, heavier and more powerful than those in most other countries, contributing to relatively high fuel use and carbon dioxide emissions per mile of travel.[7]
- **Subsidized driving.** Driving in the U.S. benefits from direct and indirect subsidies that lead to increased vehicle travel.[8]
- **Lack of transit access.** 45 percent of Americans lack access to public transit. And even in areas ostensibly

served by transit, many Americans live in places where transit is inaccessible, unreliable, infrequent or low quality.[9]

- **Dangerous walking and biking.** In 2018, nearly 6,300 pedestrians and more than 800 bicyclists were killed in traffic, increases of 3.4 percent and 6.3 percent, respectively, from 2017.[10] These deaths reflect infrastructure that is unsafe, and that can dissuade people from choosing to get around without a car.

- **Car-dependent land use patterns.** Many communities in the U.S. have attributes that make it hard to get around without a car, including low density and single-use zoning that separates homes and workplaces.[11] Research shows that Americans who live in low-density areas travel more often by driving, drive more miles, and tend to own more vehicles.[12]

To prevent the worst impacts of global warming, the U.S. must begin to rapidly decarbonize its transportation system. **Three goals, which are achievable with proven policies and existing technology, can help eliminate emissions from cars and light trucks and contribute to America's transition to a zero-carbon transportation future:**

➔ **PHASING OUT FOSSIL FUEL VEHICLES** can enable the U.S. vehicle fleet to operate with zero greenhouse gas emissions from driving or charging, if such a shift is accompanied by a transition to a grid powered by clean, renewable energy. Electric vehicles also benefit public health, as they do not emit tailpipe emissions like particulate matter and nitrogen oxides that cause cancer, asthma and other health problems.[13]

All new light-duty cars and trucks sold after 2035 should be electric vehicles. To achieve this goal, policymakers should:

- Set requirements to phase out fossil fuel-powered vehicles and adopt EV mandates.
- Make EVs cheaper to buy and own through tax credits and other incentives.
- Expand and improve EV charging infrastructure.

➔ **ELECTRIFYING AND IMPROVING TRANSIT** can create clean transit fleets for cities and schools, particularly if those fleets are powered by clean energy. Electric buses emit no tailpipe emissions and would improve the health of children who take school buses and the high-density populations often served by buses.[14]

U.S. transit agencies and school districts should replace all transit and school buses with clean electric buses by 2030. To achieve this goal, policymakers should:

- Adopt electric bus commitments at all levels of government, and at transit agencies and school districts.
- Provide transit agencies with financial and technical assistance to help them make the switch to electric buses while maintaining or increasing service.

➔ **GETTING MORE PEOPLE MOVING BY FOOT, BIKE AND TRANSIT** can immediately reduce emissions. Walking and biking infrastructure has been shown to benefit communities in a variety of ways, including increased safety, economic benefits for local businesses, improved health and happiness, and more freedom for older adults and people with mobility challenges.

The U.S. should at least double the number of people who travel by foot, bike or transit by 2030. To achieve this goal, policymakers should:

- Ensure that walking, biking and transit are safe, affordable, accessible and enjoyable.
- End subsidies that make driving artificially cheap to help make low-carbon transportation the easiest, cheapest, most convenient option.

These three goals – phasing out fossil fuel vehicles, electrifying transit, and getting more people traveling by foot, bike and transit – can help the U.S. create a zero-carbon transportation future in which vehicles are powered by clean, renewable energy, and in which more people get around without a car. By adopting goals to decarbonize transportation, policymakers can immediately begin reducing transportation emissions, while ensuring healthier, happier and safer communities for everyone.

Introduction

America's transportation system is so polluting and inefficient that it can be difficult to imagine what a clean, carbon-free transportation system in America might look like. Across the country, our highways are clogged each day with millions of vehicles producing carbon dioxide and other pollution. In many communities, getting to work or the grocery store without a car is close to impossible.

But a closer look reveals what could be the seeds of a different future.

Increasing numbers of Americans are ditching gasoline-powered vehicles for electric ones, with more than 360,000 electric vehicles sold in 2018.[15] Just a decade ago, electric cars were luxury curiosities for tech-savvy early adopters. Today, more than a dozen different models of EVs are on the market, ranging from low-cost sedans to ultra-high-performance sports cars and everything in between.[16]

At the same time, communities from Seattle to San Antonio are investing in transit systems that have helped increase ridership and reduce driving. And communities such as Seneca, South Carolina, are rolling out emission-free electric bus systems, bringing clean public transportation options to city streets.[17]

In many places across America, it's becoming easier and safer to travel without a car at all. Communities of all sizes have realized that citizens are happier, healthier, and safer when streets work better for people traveling by foot and bike. As of the end of 2018, nearly 1,500 communities across the country – primarily towns and small suburbs – had adopted "complete streets" policies to make streets safer and more accessible to people using a variety of travel modes.[18]

Yet, despite this notable progress, transportation remains the number one source of carbon pollution in the United States – and, with more people driving larger vehicles and fuel economy improvements stagnating, emissions are rising, not falling.

Achieving a zero-carbon transportation future will not be easy, but it can be done with the technology and know-how we have today. Plus, the same changes that enable a zero-carbon transportation system can also help create happier, healthier communities. Electric vehicles eliminate the street-level pollution that causes cancer, asthma and smog. Electric buses are whisper-quiet, providing riders and other city dwellers with relief from rumbling diesel engines. And by making our streets safer and more accessible for people who travel on foot or by bike, we can not only reduce the number of car trips and congestion, but also save lives.

The following pages present concrete steps that states and communities can take – right now – to get on a path to a zero-carbon transportation future. These are policies that have already been adopted successfully by communities around the country and the world. Taking these steps will help protect current and future generations from the potentially catastrophic impacts of climate change, while clearing our air and improving our quality of life.

Transportation is climate enemy number one

In the United States, transportation is climate enemy number one, responsible for more greenhouse gas emissions than any other sector of the economy. In 2017, the transportation sector emitted 1,866 million metric tons of greenhouse gases ($MMTCO_2e$), accounting for 29 percent of total greenhouse gas emissions.[19] In fact, U.S. transportation emissions now account for approximately 4 percent of total *global* greenhouse gas emissions.[20]

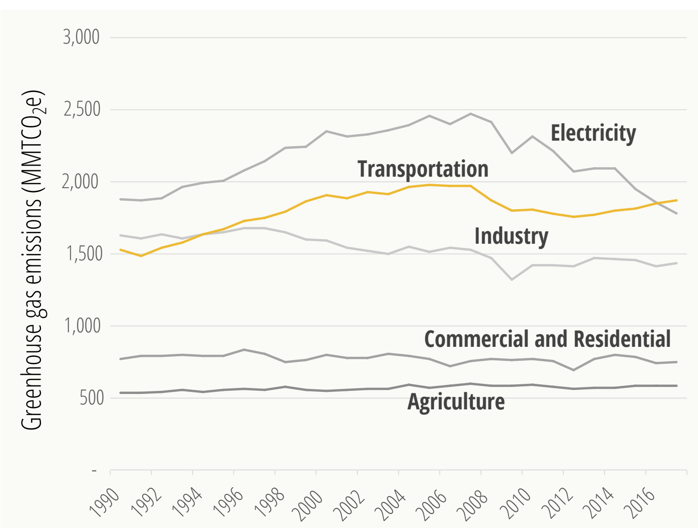

Figure 1. Transportation is now the leading source of greenhouse gas emissions in the U.S.[21]

Cars and light trucks are the leading source of U.S. transportation emissions. In 2017, light-duty vehicles accounted for one-sixth of America's total greenhouse gas emissions, and nearly three fifths of transportation emissions.[22] Other major sources of transportation emissions include medium- and heavy-duty trucks (such as large pickups, semi-trailer trucks, and garbage trucks), air travel, trains and buses.[23]

In 2017, light-duty vehicles emitted 1,098 million metric tons of greenhouse gases, equivalent to:

- 17 percent of total U.S. greenhouse gas emissions.
- 91 percent of emissions from all U.S. coal-fired power plants.[24]
- An amount greater than the entire emissions of any country in the world except China, India, Russia and Japan.[25] For context, the economy-wide emissions of Brazil, the country with the world's sixth highest greenhouse gas emissions, were 1,050 $MMTCO_2e$ in 2016.
- An amount greater than emissions produced by the entire countries of France and the United Kingdom combined.[26]

In recent years, emissions from light-duty vehicles have increased. From 2013 to 2017, the annual distance Americans drove in light-duty vehicles increased by 200 billion miles, and annual greenhouse gas emissions from light-duty vehicles rose by 36 million metric tons.[27]

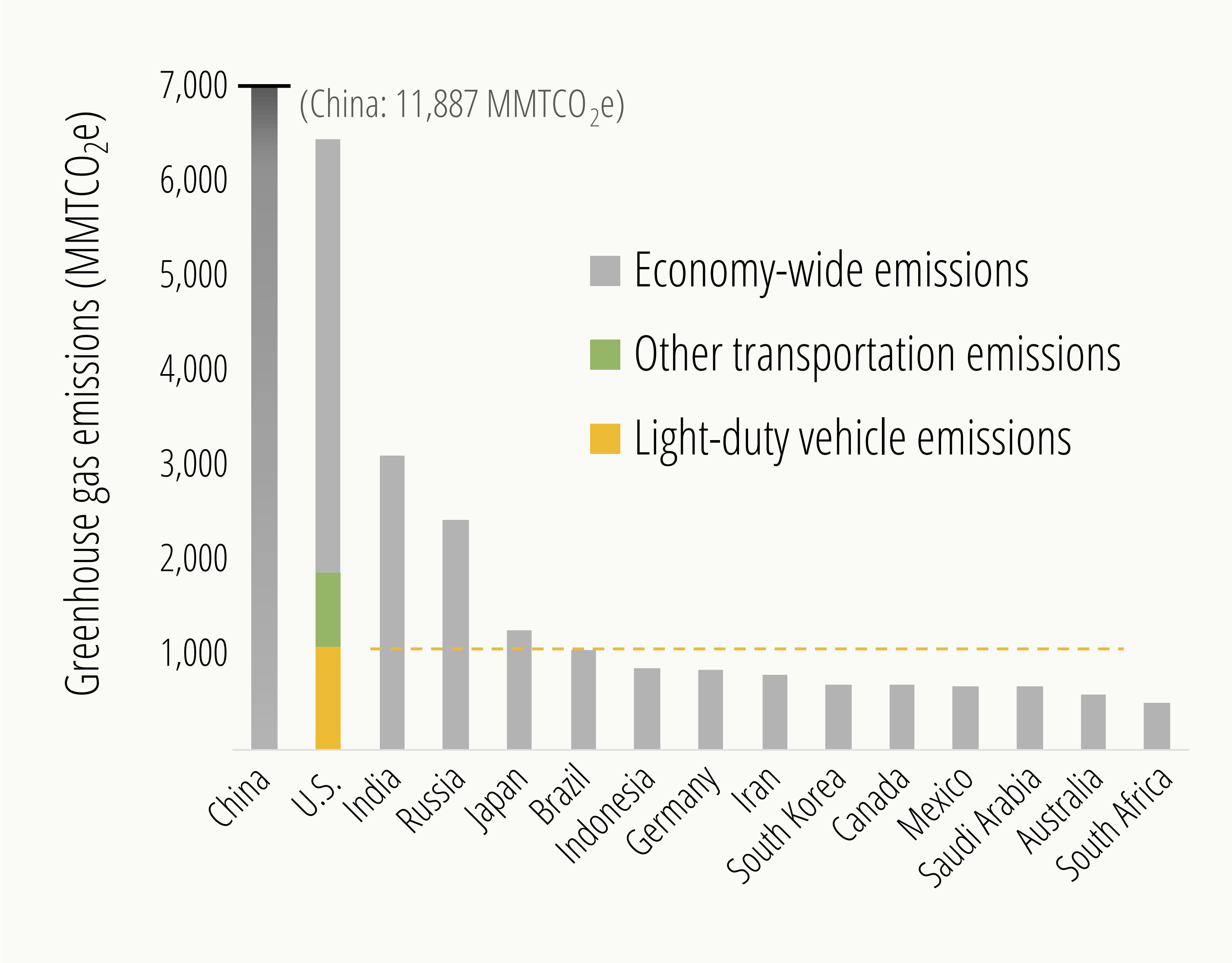

Figure 2. U.S. light-duty vehicle greenhouse gas emissions are higher than most entire countries[28]

Transportation emissions vary by state

Total and per-capita transportation emissions vary by state. States with large urban areas, especially those with good transit, tend to have lower per-capita transportation emissions, while rural states and states dominated by suburban development or extractive industries tend to have higher per-capita emissions.

Total emissions by state

Three U.S. states have total transportation emissions of more than 100 million metric tons of carbon dioxide: Texas, California and Florida.[29]

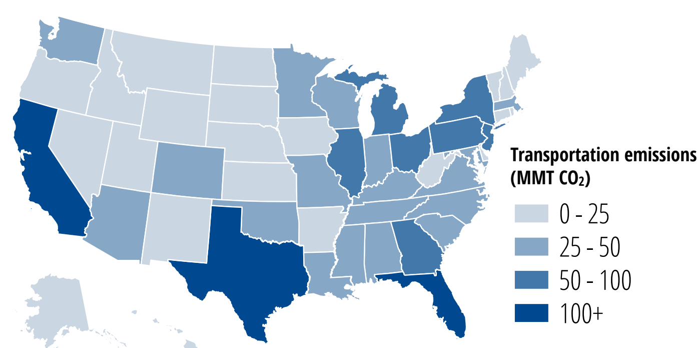

Figure 3. Transportation emissions by state[31]

Texas, with the country's second-highest population along with high per-capita transportation emissions, is the leading emitter of CO_2 from transportation in the U.S. In 2016, Texas' transportation sector emitted 226 million metric tons of CO_2, more than the economy-wide emissions of countries such as Vietnam, Argentina and the Netherlands.[30]

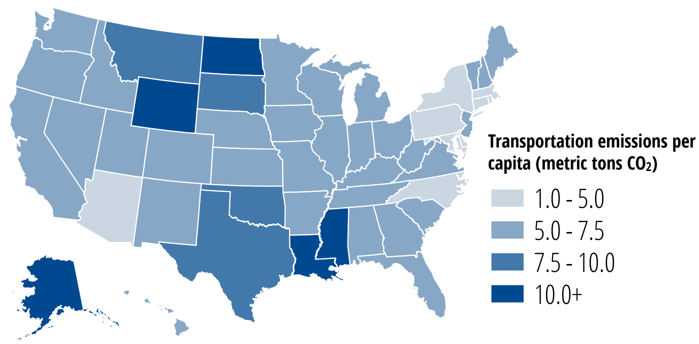

Figure 4. Per capita transportation emissions by state[33]

Per capita emissions by state

In five U.S. states in 2016, per capita transportation emissions were more than 10 metric tons: Alaska, Wyoming, North Dakota, Louisiana and Mississippi. In Alaska, per capita transportation emissions in were 16.2 metric tons of CO_2.[32] The states with the lowest 2016 transportation emissions per capita were Rhode Island, New York, Connecticut, Maryland and Massachusetts. In Rhode Island, per capita transportation emissions were 3.7 metric tons of CO_2.

Polluting vehicles, subsidized driving, and trillions of miles traveled: Why U.S. transportation emissions are so high

Every year, Americans drive more than 3.2 trillion miles in all vehicles, or nearly 10,000 miles per person.[34] Americans drive more miles per capita than people almost anywhere else in the world. Among the 22 European countries for which the United Nations Economic Commission for Europe had recent data, no country had even 70 percent as much driving per person as the U.S.[35]

This high level of driving, much of it done in heavy, inefficient vehicles powered by oil, contributes to America's high carbon emissions from light-duty vehicles.

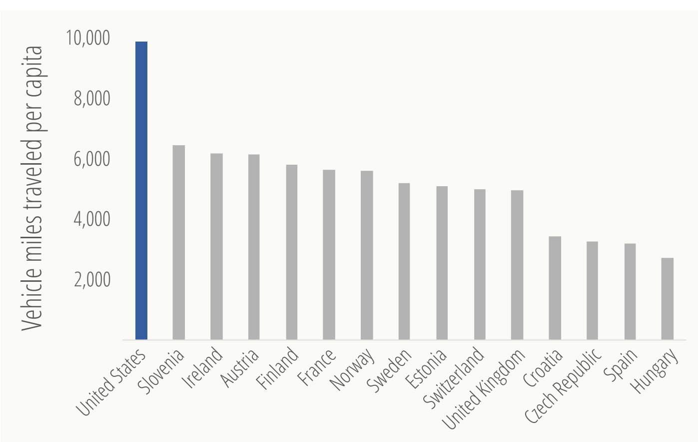

Figure 5. Americans drive many more miles per person than residents of European countries[36]

Vehicles are inefficient and run on dirty fuels

The typical American vehicle is heavy, inefficient and powered by dirty fossil fuels, meaning that each mile driven imposes a heavy burden on the climate. An analysis comparing the U.S. with seven countries plus the European Union found that the average U.S. passenger vehicle emits more CO_2 and consumes more fuel per mile than the average vehicle in all but three countries, and is bigger, heavier, and has a more powerful engine than the average vehicle in any other country.[37] For example, the average U.S. passenger vehicle has 200 horsepower, compared to 125 horsepower for vehicles in the E.U., and weighs 1.8 tons, compared to 1.5 tons in the E.U.[38]

The inefficiency of vehicles is in part the result of the auto industry's focus, particularly throughout the 1990s, on increasing vehicle size and power rather that increasing fuel economy.[39] Per mile, the average vehicle sold today burns more than 80 percent as much gas per mile as the average vehicle sold in 1990 – despite tremendous improvements in engine and vehicle technology – while the average weight of vehicles has increased by almost 20 percent.[40]

Vehicle trends since 1975 demonstrate the relationship between power, weight and emissions, and the importance of efficiency standards. Vehicle per-mile CO_2 emissions dropped sharply after the nation's first Corporate

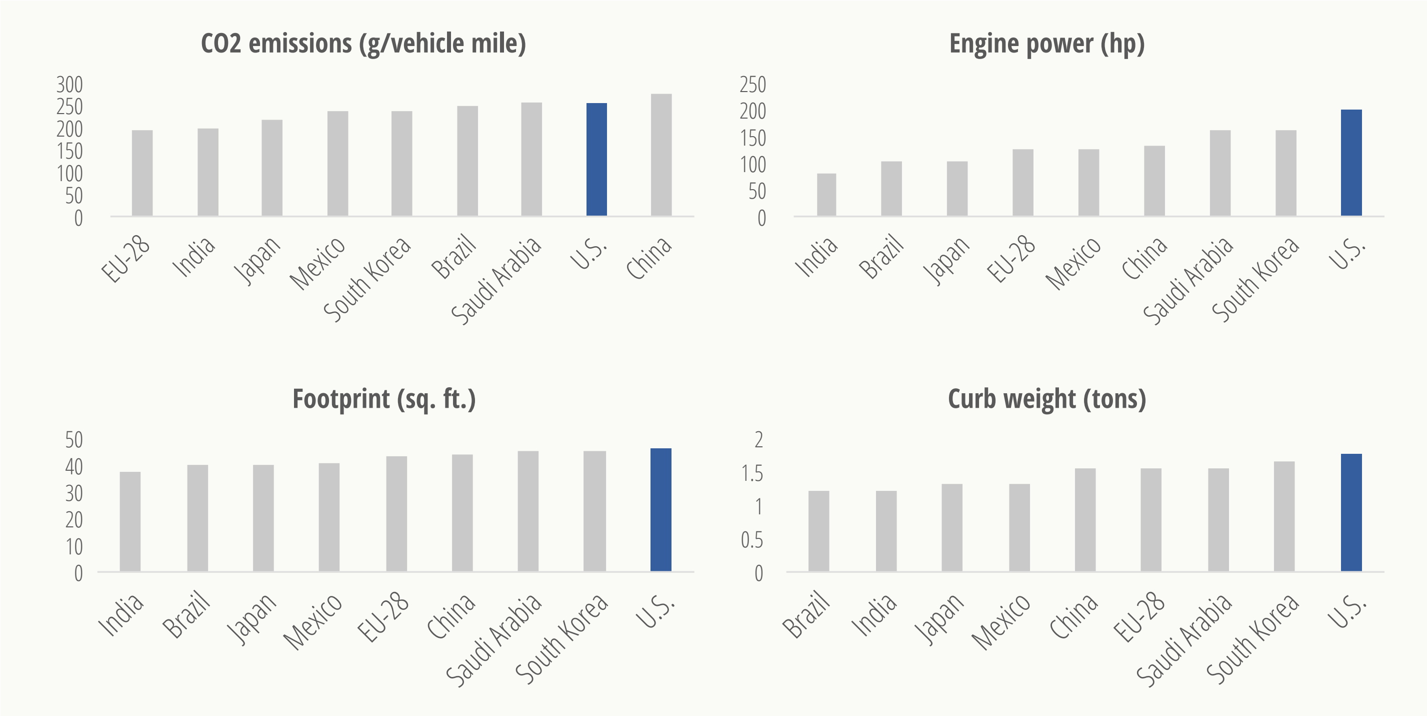

Figure 6. U.S. passenger cars tend to be bigger, heavier and worse for the climate than those in other countries[42]

Average Fuel Economy (CAFE) standards were passed in 1975.[41] When those standards were weakened, emissions rose while vehicles became heavier and more powerful. In recent years, strengthened standards have once again helped reduce vehicle per-mile CO_2 emissions.

The design of our communities breeds car dependence

Many American communities are physically laid out in ways that require car trips for basic, everyday travel. In particular, many communities are low density – and if destinations are far apart, it's more difficult to get around without a car. While rural areas have always been spread out, since World War II, America has been intentionally designing suburban communities in ways that virtually require the use of a car to conduct nearly every daily task, a decision that has helped fuel the rise in the number of miles Americans drive.

The Intergovernmental Panel on Climate Change, the foremost scientific authority on global warming, writes, "[i]n low-density developments with extensive road infrastructure, [light-duty vehicles] will likely dominate modal choice for most types of trips."[43] This is both because it is difficult or unpleasant to walk or bike in sprawling neighborhoods, and because low-density areas are harder to serve with transit.

For the roughly two-thirds of Americans who live in low-density areas, it is not only harder to get around without a car, car trips also tend to be longer.[44] According to a study by the State Smart Transportation Initiative, a decrease in density of 10 people per square mile corresponds with an increase in vehicle travel per person of almost 400 miles.[45]

Transit is often of poor quality or expensive … where it exists at all

Many Americans lack options to get around without a car. Nearly half (45 percent) of Americans lack access to any public transit.[46]

Even in areas ostensibly served by transit, transit can be infrequent, hard to access or low quality. According to a survey by the TransitCenter, frequency of service is the top concern of bus riders (and the study notes that the top concern of train riders, crowding, can be ameliorated by frequency improvements).[47] Distance from transit stops also reduces ridership. A 2001 study found that bus transit use sharply declines for households more than more than 0.15 miles from bus stops.[48] Another study found that in San Jose, "each additional five minutes in perceived walking time to transit decreases transit ridership frequency by 5 percent for nondrivers and by 25 percent for drivers."[49]

When transit service is unavailable or low quality, the result is more driving. The previously cited TransitCenter survey found that users who are dissatisfied with transit quality use it less, and that "[o]verwhelmingly, survey respondents who abandon or substantially scale back their transit use replace those trips with increased private car use."[50]

Overpriced transit can also deter riders. The Victoria Transport Policy Institute conducted a research review concluding that, for every 1 percent increase in transit fares, transit ridership decreases by between 0.2 and 0.5 percent in the short run (less than a year), and by 0.6 to 0.9 percent over the long run (more than five years).[51] A 2018 Congressional Research Service report found that average fares have risen faster than inflation in recent years.[52] From 2004 to 2014, the average inflation-adjusted U.S. price of bus fare increased 15 percent; commuter rail 22 percent; subway 1 percent; and light rail and streetcar 26 percent.[53] (By contrast, the federal gasoline tax has not been increased since 1993, resulting in a more than 40 percent reduction in the amount of federal taxes drivers pay per gallon, when adjusted for inflation.)[54]

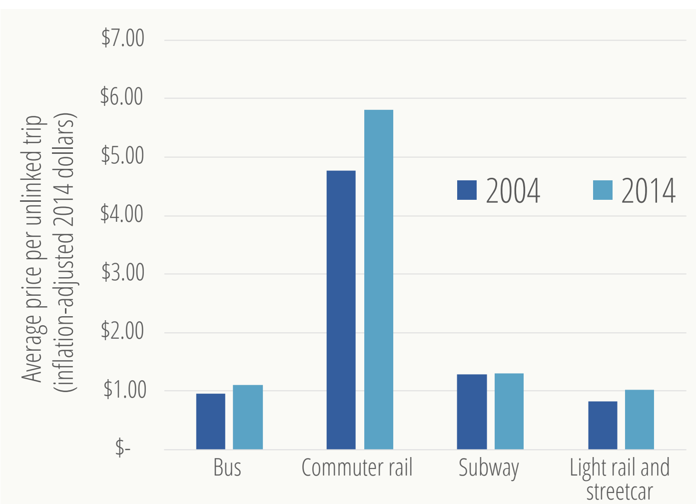

Figure 7. All transit modes saw trip prices increase from 2004 to 2014[55]

Walking and biking are often difficult or unsafe

In much of America, walking and biking can be dangerous. In 2018, nearly 6,300 pedestrians and more than 800 bicyclists were killed in traffic, increases of 3.4 percent and 6.3 percent, respectively, from 2017.[56] Per mile, the U.S. fatality rate for bicyclists is five times higher than in cycling-heavy countries the Netherlands and Denmark.[57]

Walking and biking deaths are often the result of infrastructure that is unsafe. Unsurprisingly, when people perceive that an activity – like walking or biking – is likely to put their safety at risk, they will be less likely to do it. According to a research review by Active Living Research, "[s]afety concerns, both real and perceived, are a major deterrent to active travel."[58]

High fatality and injury rates for pedestrians and bicyclists are in part the result of road and community design that prioritizes vehicle throughput and speed. For example, nearly all states use a design metric called "level of service," which uses vehicle delay as the measure of a road's performance.[59] Use of this measure can lead to fast, wide streets that put vehicles first, and increase danger for pedestrians. The risk of death for a pedestrian hit by a car more than doubles, from 10 percent to 25 percent, if the speed of the car increases from just 23 mph to 32 mph.[60] For a pedestrian hit by a car moving at 42 mph, the risk of death is 50 percent.[61]

Many roads also lack basic infrastructure that improves safety for walking and biking, like sidewalks and bike lanes.[62] A study of pedestrian crashes from the early 1990s found that, for the 2,885 incidents where such data was available, more than 80 percent took place on roads with no sidewalk.[63] Another study found that the risk of biking on roads with physically separated bike lanes (cycle tracks) was about one ninth that of riding on roads with no bike lanes.[64]

Roads without infrastructure for walking and biking make it less safe and more difficult to get around without a car. This area of Shady Cove, Oregon, was later the focus of an improvement project to add sidewalks and bike lanes. Credit: Oregon Department of Transportation

Driving is heavily subsidized

Many Americans perceive that they pay the full cost of driving through the taxes on gasoline, vehicle registration fees and other fees on driving. In reality, these taxes and fees do not even cover the cost of building and maintaining roads.

Local streets and roads have always been largely paid for by local taxpayers, often through property taxes. And since 2008, outlays by the Highway Trust Fund (HTF) have exceeded revenue from federal fuel taxes and other sources, while the HTF received nearly $115 billion in general fund transfers from 2008 to 2018.[65] This is due in part to low fuel taxes: In a comparison of 61 countries, *Bloomberg* found that a gallon of gas is cheaper in the U.S. than in all but 12 other countries, largely due to differences in taxation and subsidies. [66]

New road capacity increases transportation emissions

In 2014, the latest year for which data is available, federal, state and local governments spent $26 billion to expand the nation's already-massive roadway network.[72] By creating more infrastructure designed to make driving faster and easier, spending on new road capacity increases driving, and also often makes other forms of transportation more difficult.

Research shows that building more road capacity leads to more driving. More road capacity can encourage travelers to take more and longer car trips, and can lead to more dispersed development that creates long-term increases in driving.[73] The phenomenon of "induced travel," sometimes referred to as "induced demand," is so predictable that it has been called the "Fundamental Law of Road Congestion."[74] This not only means that new roadways quickly fill with new traffic – undercutting the very purpose for which most expansion projects were undertaken – but also that new road capacity generates more pollution.

In addition to creating more traffic, many roadway expansions also make it harder to get around via low-carbon transportation modes. Highway expansions can sever street connections that make walking and biking convenient, create "dead zones" alongside highways where street life is unpleasant or dangerous, and create noise and pollution that worsens life outside of a car.

In contrast, experience shows that by choosing to end car-centric infrastructure investments, communities can both avoid the negative impacts of more road capacity and also rejuvenate efforts to improve conditions for walking, biking and transit. A 2019 study by Frontier Group and U.S. PIRG Education Fund described a number of such examples. In neighborhood of Tampa Heights in Tampa, Florida, for example, the cancellation of a highway expansion project coincided with new neighborhood projects to encourage walking and biking.[75]

There are also ways in which governments directly subsidize driving. Each year, for example, the U.S. government spends more than $7 billion to encourage people to drive to work through the federal income tax exclusion for employer-provided and employer-paid commuter parking.[67] Other examples of subsidies for driving include free on-street parking, subsidized municipal parking, and subsidies for the fossil fuel industry that contribute to artificially low fuel prices.[68]

The subsidies provided to driving appear even higher when considering the massive costs that driving imposes on the rest of society, including environmental problems, health problems, congestion and the economic and societal damage wrought by vehicle crashes. In 2010, the last year for which data is available, the economic costs of car crashes, including lost lives, injuries and property damage, amounted to $242 billion.[69] One study from 2007 found that the unpriced, external costs of driving (including costs to other drivers in the form of congestion and crash damage) are approximately $2.28 per gallon of gasoline.[70]

Research shows that this heavy subsidization is an important factor underlying high levels of driving in the U.S. A 2011 study comparing U.S. and German residents found that, after controlling for factors like land use and access to transit, Americans are still more likely to drive.[71] The reason why, the study suggested, is that U.S. subsidies encourage and incentivize driving even in places where walking, biking or transit are available.

The path to zero-carbon transportation

Transportation is now the leading source of greenhouse gas emissions in the United States. Science tells us that the United States must aim to virtually eliminate carbon pollution by 2050 if we are to prevent the worst impacts of global warming.[76]

There is no comprehensive solution to global warming that doesn't involve significant changes in how Americans get around and in the vehicles and fuels we use.

Decarbonizing our transportation system is a huge and complicated endeavor. But the good news is that there are several important steps we can take right now – using technologies and tools that already exist – that can do the lion's share of the work in moving toward a zero-carbon transportation system.

Three goals, which are achievable with proven policies and existing technology, can help eliminate emissions from cars and light trucks and contribute to America's transition to a zero-carbon transportation future:

- Ensuring that all personal vehicles sold after 2035 are electric.
- Electrifying all transit and school buses by 2030.
- Doubling the number of people who travel by walking, biking and public transit by 2035.

By achieving these goals, the U.S. can lay the groundwork for a zero-carbon transportation system – even as we build communities that are healthier, safer, better connected and happier.

Phase out fossil fuel vehicles

A zero-carbon transportation system requires that the U.S. eliminate emissions from light-duty vehicles. To do so, the U.S. must end the use of fossil fuel-powered vehicles. That means reducing our dependence on motorized transportation where possible, and shifting our remaining travel to highly efficient vehicles powered by electricity.

Electric vehicles have key benefits that can help achieve a zero-carbon transportation future. They can be powered by clean energy, they are efficient, and they work well as small, light vehicles that can reduce energy use. Even when considering manufacturing and charging using today's electric grid, EVs still emit far less global warming pollution than gasoline-powered vehicles over their lifetimes.[77]

While there are environmental costs to manufacturing EVs, an electric vehicle powered by wind turbines or solar power emits no pollution related to driving or charging.[78] A detailed study by the Electric Power Research Institute and the Natural Resources Defense Council concluded that "electrification is an essential strategy for achieving deep GHG emission reductions in the transportation sector."[79] That study found that, under a scenario in which electricity powers 53 percent of personal vehicle miles traveled, transportation emissions would be reduced by 52 percent to 60 percent, depending on the share of the grid powered by low- or zero-emission energy sources.[80] As penetration of electric vehicles and clean energy increases, so do the climate benefits.

Electric cars are more than three times as efficient as cars powered by fossil fuels, which means that replacing the current fleet of vehicles with electric ones will lead to a large reduction in overall energy use, easing the task of repowering America with clean energy sources like wind and solar power.[81] Gas-powered vehicles waste large amounts of energy; they lose about 60 percent of the energy they consume just to engine heat loss.[82] EVs, on the other hand, waste little thermal energy, waste almost no energy from idling, and can recover energy using regenerative braking.[83] As a result, EVs are able to convert about 60 percent of electrical energy to power at the wheels, while gasoline-powered vehicles are only able to convert about 20 percent of the energy stored in gasoline.[84] In large part because of their efficiency, even today's EVs powered by a largely fossil fuel grid are reducing emissions and cleaning the air. The U.S. Department of Energy's Argonne National Laboratory found that, through 2017, U.S. plug-in electric vehicles had offset 2.6 million metric tons of carbon dioxide emissions, even after accounting for emissions from generating the electricity to charge the vehicles.[85]

Battery technology is also flexible and well-suited for small, efficient vehicles ranging from scooters to "neighborhood electric vehicles," or NEVs, which are golf-cart sized vehicles with low top speeds.[86] Compared to full-size vehicles, NEVs have smaller batteries and use less energy to charge and manufacture.[87] Lighter weights and slower speeds may also reduce risks to pedestrians and bicyclists on residential streets, helping encourage those other forms of low carbon transportation.[88]

This electric vehicle charging station is powered by solar panels installed on a parking canopy. Because electric vehicles can be powered by clean energy sources including wind and solar power, they can enable a transition to a zero-carbon transportation future. Credit: Dennis Schroeder, National Renewable Energy Laboratory

The goal

All new light-duty cars and trucks sold after 2035 should be electric vehicles.

By phasing out sales of fossil fuel vehicles by 2035, the U.S. can help create a clean, emission-free transportation system. Specifically, achieving this goal would:

- Help ensure that, by 2050, almost all cars on American roads produce zero emissions. The average age of light-duty vehicles on the road is 11.8 years.[89] If every car sold by 2035 is an electric vehicle, by 2050 the vast majority of cars on the road will be electric, with only a small number of aging conventional vehicles left on the road, barring proposals to ban or accelerate the retirement of fossil fuel vehicles.
- Eliminate the vast majority of carbon emissions from personal vehicles by 2050. Replacing the vehicle fleet alone will not eliminate all transportation emissions, because EVs need to be charged from the electric grid. But an entirely electric fleet paired with a zero-emission grid would mean zero emissions from charging or driving.
- Improve air quality and public health. Replacing gasoline vehicles with electric ones would eliminate the harmful street-level emissions currently produced by internal combustion engines, including particulate matter (very fine particles that can be harmful when inhaled) and nitrogen oxides (which contribute to smog and ground-level ozone). A 2019 study found that electrification of passenger vehicles would lead to modest improvements in air quality with the current grid and would achieve dramatic air quality improvements when EVs are powered by clean, renewable energy sources.[90]

Getting there

Getting to 100 percent EV sales by 2035 can be achieved with existing technology and proven policy pathways. Today's EVs have long enough range to serve the vast majority of the trips most Americans take. A 2016 study found that the 2013 Nissan Leaf, with a range far below most EVs on the market today, could "replace 87% of vehicles driven on a given day without recharging."[91]

Americans are already adopting EVs in large numbers: More than 360,000 electric vehicles were sold in 2018 alone, accounting for more than 2 percent of all vehicle sales.[92] Eliminating sales of fossil fuel vehicles by 2035, however, will require a rapid transformation of the vehicle market, with the share of vehicle sales accounted for by EVs needing to expand 50-fold in just 15 years.[93]

While such growth is large, it is within the realm of current trends. From 2017 to 2018, EV sales grew by more than 80 percent.[94] An annual sales growth rate of 25.5 percent would see EVs overtake conventional vehicle sales by 2032, and account for 100 percent of vehicle sales by 2035, if the total number of vehicles sold remains the same as today.[95]

The hundreds of thousands of electric vehicles on the road today are there in large part thanks to policy support from cities, states and the federal government. Accomplishing the growth necessary to achieve 100 percent EV sales will require building on those policies in the years ahead.

Set goals to phase out conventional vehicles and require increased sales of EVs

Sales goals and requirements for electric vehicles can drive car companies to sell zero-emission vehicles, contribute to continued advances in technology, and create certainty in the market for electric vehicles that can unleash investment in public chargers and other supporting infrastructure.

State policies to require EV sales have already helped put hundreds of thousands on the road. The Zero-Emission Vehicle (ZEV) program, a California state regulation that has been adopted by 10 other states, requires that automakers sell a set percentage of electric cars and trucks.[96] In 2017, the California Air Resources Board found that the program had helped result "in over 215,000 ZEVs and [plug-in hybrid electric vehicles (PHEVs)] being placed in California over the last five years and an expansion from 25 models offered today to over 70 unique ZEV and PHEV models expected in the next five years."[97]

Achieving 100 percent EV sales will also likely require action at the federal level. Indeed, while a transition to all-electric vehicles by 2035 would enable the U.S. to achieve a zero- or near-zero carbon transportation system by 2050, some elected officials and political candidates have proposed more ambitious plans for a complete shift to zero-emission light-duty vehicle sales by 2030.[98] If successful, such plans would help the U.S. achieve even more rapid reductions in greenhouse gas emissions.

A federal EV goal would align with other efforts from the international community. Policymakers in eight countries have already set goals to completely phase out fossil fuel vehicles, although most have not been accompanied by binding legislation.[99]

Reduce financial hurdles to EV adoption

As the result of low fuel and maintenance costs, EVs are typically cheaper to own than conventional vehicles over the vehicle's lifetime.[100] In the face of higher upfront costs and the usual uncertainty surrounding new technologies, however, financial incentives are an important tool for increasing EV sales. [101]

Financial incentives are proven tools to increase adoption of electric vehicles.[102] To date, the Federal Plug-In Electric Drive Vehicle Credit has been perhaps the most important program in the United States for boosting sales of electric vehicles. A 2016 study by the Institute of Transportation Studies at University of California-Davis attributed 30 percent of all plug-in electric vehicle sales to the tax credit.[103] The tax credit was found to be particularly important for sales of lower-cost EVs, buyers of which tend to be price sensitive.[104]

Perhaps the strongest evidence that tax credits are important for electric vehicle sales has been the effect of their removal. In Georgia, sales of electric vehicles dropped precipitously following the removal of the state's EV rebate program.[105]

Programs that bring down the already-low cost of owning an electric vehicle can also be important tools to encourage EV purchases. Such programs include those that reduce the cost of charging an EV, or that give EV owners opportunities to sell EV batteries into a secondary market where they can be reused for grid storage or other purposes.

Incentives can be more effective when paired with consumer education, including through initiatives that help car dealerships effectively promote and sell EVs. In Columbus, Ohio, the Electrified Dealer program provides benefits to car dealerships that pass a certification program. To pass, dealerships must meet criteria including keeping EVs in inventory for test drives, installing charging stations on-site, training sales staff and offering educational materials.[106] Within the first five months of the program, 13 dealerships were certified, carrying a total of 16 models of EVs and plug-in hybrid electric vehicles.[107]

Expand and improve the EV charging network

For electric vehicles to become mainstream, they need to be easy to charge. But today, in many parts of the country, EV chargers can be both hard to find and hard to use. One 2019 survey found that a majority of consumers considering an EV purchase believed there were too few charging stations around their home and work areas, suggesting that lack of a ubiquitous charging network presents a barrier to widescale adoption.[108]

States have already demonstrated effective policies to boost the number of charging stations. In Connecticut, the EVConnecticut Electric Vehicle Charging Station Incentive Program has provided $1.1 million to partially fund 336 charging outlets at 214 locations, for both the public and private sector.[109] A similar program in New Jersey has used funding from the Volkswagen "Dieselgate" settlement to award charging station grants through the state's "It Pay$ to Plug In" program.[110] And on the West Coast, California, Oregon and Washington, along with British Columbia, have collaborated on the "West Coast Electric Highway," which the project describes as "an extensive network of electric vehicle (EV) DC fast charging stations located every 25 to 50 miles along Interstate 5, Highway 99, and other major roadways."[111]

States and cities can also ensure that new homes and buildings are constructed with EV charging equipment installed, or with the necessary wiring to accommodate future installation of EV charging equipment. For example, the city of Atlanta passed an ordinance requiring that all new homes and parking structures be ready to accommodate EV charging equipment.[112]

Policies can also help make charging an electric vehicle as easy as filling up a gas-powered one, something that today is often not the case. A 2019 report by Environment America Research & Policy Center and Frontier Group found that, in California, the day-to-day experience of EV drivers seeking to charge up their vehicles "has a long way to go to match the ease and convenience of refueling a gasoline-powered car – especially when it comes to public charging."[113] The report found that many stations are not open 24 hours a day, are incompatible with different car types, or require a membership to use.[114]

The convenience and comfort of owning an EV can be improved by setting basic standards for charging stations. In Europe, for example, countries including Norway and the Netherlands have worked to ensure a high level of interoperability.[115] In the Netherlands, EV drivers can use any public charging station in the country with a fob or key card from any network, as the system is entirely interoperable.[116]

Electrify public transportation

Enabling more Americans to shift from driving to public transit is a critical step to reducing transportation emissions. So, too, is converting public transportation from polluting fossil fuels to electricity.

By electrifying all modes of transit, public transportation can eventually be powered with clean, renewable energy. Such a system would emit no pollution from charging and driving. The IPCC notes, for example, that electrified rail transit powered by clean energy can enable transportation that is "deeply decarbonized."[117]

Among transit modes, buses are the biggest source of global warming pollution.[118] While buses emit far less pollution per passenger than personal vehicles per mile of travel, they emit significant quantities of both global warming pollution and air pollutants that pose an immediate threat to public health.[119] Transit and school buses emit approximately 17 million metric tons of greenhouse gas emissions each year.[120]

Electrifying buses would bring important public health benefits to both the densely populated areas that transit buses often serve, and to young people who ride school buses. The diesel exhaust that buses emit can cause respiratory diseases and worsen existing conditions like asthma and is internationally recognized as a cancer-causing agent.[121] A 2019 study attributed more than 9,000 U.S. deaths in 2015 to particulate matter and ozone pollution from on-road diesel vehicles.[122] Replacing diesel buses with electric ones would reduce this pollution. For example, the state of California estimated that, under a state law that requires bus electrification, cumulative nitrogen oxide and particulate matter emissions would be reduced by 7,000 tons and 40 tons, respectively, from 2020 to 2050.[123]

Electric buses provide other benefits, too. They are quiet, and can help bring down noise levels in urban environments. They also have lower operational costs, and can provide cities and school districts with long-term financial savings.[124]

Electric buses reduce greenhouse gas emissions and bring important public health benefits to both the densely populated areas that transit buses often serve, as well as to young people who ride school buses. Credit: Wikimedia user Steve Morgan (CC BY-SA 4.0)

The goal

U.S. transit agencies and school districts should replace all transit and school buses with clean electric buses by 2030.

By electrifying all transit and school buses, America can ensure that public transit, which is already cleaner and more efficient than personal vehicles, contributes to a zero-carbon transportation system. Specifically, accomplishing this goal would:

- Eliminate the approximately 17 million metric tons of greenhouse gas emissions that transit and school buses currently emit each year if buses are charged using clean, renewable energy.[125] As America expands public transit, these emissions benefits will grow.
- Improve air quality and public health. Electrifying buses would eliminate harmful street-level emissions from diesel combustion in buses, including particulate matter and nitrogen oxides. This would benefit the health of anyone who would otherwise be exposed to bus exhaust, including the 25 million children who ride school buses each day, and the high-density populations often served by buses.[126]

Getting there

Achieving 100 percent electric buses by 2030 can be achieved using technology that is available today and with which transit agencies are gaining increasing levels of experience. To make the switch, however, policymakers must help agencies access the know-how and financial resources they need to adopt electric buses.

Transit agencies and governments around the country have already begun to explore a future of electric buses. As of the end of 2018, 13 percent of transit agencies had either already deployed or ordered an electric bus.[127]

Nevertheless, American electric bus adoption is still in its early stages. As of the end of 2018, just 528 of the more than 65,000 transit buses currently in use in the U.S. were electric – a jump of 29 percent over 2017, yet still accounting for less than 1 percent of all transit buses.[128] Among the 480,000 school buses currently in use, data on the number of electric buses is not available, although as of July 2019 the Lion Electric Company had deployed more than 200 electric school buses in North America.[129]

Fortunately, buses provide a key opportunity for rapid electrification. Most buses on the road are owned and operated by transit agencies and school districts that can make wholesale commitments to shifting their fleets. Transit agencies also have important reasons to adopt electric buses. Buses often drive in stop-and-go traffic, where diesel engines waste energy and electric buses can use regenerative braking.[130] Transit agencies typically have central depots where buses can charge.[131] Transit agencies can also save money by adopting electric buses, which can be much cheaper to fuel and maintain than fossil fuel-powered buses.[132]

Electric buses are also ready for widescale adoption. They have already been deployed successfully in communities around the United States, and there are now more than 420,000 buses on the road worldwide, most in China.[133]

Adopt electric bus commitments

By adopting commitments to transition their fleets, transit agencies, school districts, cities and states can put America on the path to a fully electrified bus system. By doing so quickly, transit agencies and school districts could electrify their entire bus fleets by 2030 with only minimal premature retirements of fossil fuel-powered buses. According to the Federal Transit Administration (FTA), the minimum useful life of buses ranges from five years for medium-size, light-duty buses to 12 years for large, heavy-duty transit buses.[134] The average age of full-size buses in service was 7.6 years in 2017.[135]

Transit agencies, cities and states have already begun making commitments for fully electrified fleets. The three largest bus transit systems in the country – New York City's Metropolitan Transportation Authority (MTA), the Los Angeles County Metropolitan Transportation Authority (LA Metro) and Chicago Transit Authority (CTA) – have plans to transition to all-electric bus fleets.[136] The LA Metro plans to transition to an all-electric fleet by 2030, and has begun procuring and testing electric buses.[137] The MTA, which operates the nation's largest bus fleet and buys approximately one out of 10 buses sold in North America each year, plans to transition its entire fleet by 2040 and to add 1,800 electric buses to its fleet within 10 years.[138] By moving to all-electric fleets, the MTA, LA Metro, and CTA would move the entire U.S. fleet toward electrification, and could prompt other transit systems to make similar commitments.

And in the state of California, the California Air Resources Board has adopted a policy that will require 100 percent of new buses purchased by transit agencies to be electric by 2029, and has set a statewide goal of a fully electrified bus fleet by 2040.[139] The California policy sets different timelines for large and small transit agencies, allowing smaller agencies to make a somewhat slower transition.[140]

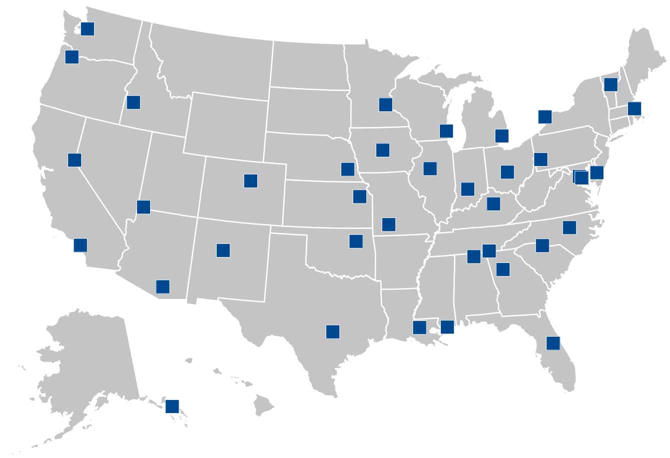

Figure 8. In FY2019 the Federal Transit Administration's Low or No Emission Vehicle program provided electric bus funding for agencies in 38 states[145]

Provide financial and technical assistance

The work of electrifying bus fleets operated by America's more than 1,000 bus transit agencies and 14,000 school districts can be helped considerably by assistance from the federal and state levels.[141]

Financial assistance programs have been important in getting the first generation of electric buses on the road. While electric buses tend to save money over vehicle lifetimes, they are more expensive to purchase, and going electric creates additional costs, including charging infrastructure.

The Federal Transit Administration's Low or No Emission Vehicle Program, for example, has funded dozens of electric bus projects around the country. Since 2016, the program has provided nearly $280 million in funding primarily for electric buses and related infrastructure.[142] In FY2019, all 38 projects that received program funding were for bus electrification, in 38 different states.[143] In 2010, funding from the program helped the City of Seneca, South Carolina, develop the first scalable model of an all-electric bus transit system in the U.S. With funding help from the program, along with a mix of state and local funding, in 2014 Seneca became the first city in the world to launch an all-electric municipal bus fleet.[144]

The Volkswagen Environmental Mitigation Trust, formed with nearly $3 billion as part of VW's settlement over emission violations, has served as another important funding source for bus electrification. A study by the U.S. PIRG Education Fund in 2019 found that 30 states have prioritized electric bus projects with the funding, based on a review of each states' funding goals and actual project funding.[146] In Virginia in 2019, for example, Governor Ralph Northam announced an initiative to use $20 million from the Volkswagen Environmental Mitigation Trust to reimburse school districts for spending on electric school buses and charging infrastructure.[147]

Also in Virginia, the electric utility Dominion Energy has announced a novel approach that it claims will help the state achieve 100 percent electric school buses by 2030. The program will, according to the utility, "offset the additional costs of an electric school bus, including charging infrastructure, above the standard cost for a diesel bus."[148] Dominion expects that a network of electric school buses will help the utility deploy renewable energy resources, by using bus batteries "to store and inject energy onto the grid during periods of high demand when the buses are not needed for transport."[149]

In addition to providing direct financial support, public officials and utilities can create financing programs in which they front the initial investment for electric buses and allow cities and school districts to pay back on utility bills as they save on fuel and maintenance costs. These "pay as you save" financing programs can help agencies overcome the higher upfront costs of electric buses and deliver monetary savings immediately.[150] Utilities can also redesign electricity rates to reduce vehicle charging costs, limit excessive demand charges, and experiment with policies and practices that allow battery-electric buses to be used for energy storage.

The federal and state governments can also play a role in providing technical assistance. In a report by the World Resources Institute, lack of technical knowledge was identified as a key barrier to city and transit agency adoption of electric buses.[151] Government assistance can help with a wide variety of technical challenges and questions. States can ensure that cities or transit agencies understand the benefits of and opportunities for deploying electric buses. They can help states plan charging networks, route adjustments, and vehicle procurement. And once cities have an electric fleet running, states can ensure cities have the tools they need they need to manage charging, collect data, and optimize operations.

Get more people traveling by foot, bike and transit

In 2017, more than four in five trips taken by Americans were taken by car, pickup truck, SUV or van.[152] Shifting some of these trips to transit, walking and biking is an important way to reduce transportation emissions, even if all vehicles are eventually powered by electricity from renewable sources.

For one thing, shifting modes of travel can make an impact right away, even as the nation transitions its automobile fleet to electric cars, builds out its infrastructure for charging them, and transitions to an electricity system powered by 100 percent clean energy. In addition, expanding transportation options can reduce the total energy demand of the transportation system, making it easier to power the system with renewable energy. Finally, shifting from driving to transit, biking and walking can address the many other impacts of widespread automobile dependence, including dangerous and congested streets.

Trips taken by foot or bike require no energy from the grid, while trips by transit also generally reduce transportation energy use. A 2008 study estimated that the annual energy saved by the U.S. transit system is, after accounting for the fuel savings from reduced congestion, equivalent to 4.2 billion gallons of gasoline.[153]

Making it easier for people to travel without a car also brings other valuable benefits. A study by the Victoria Transport Policy Institute found that communities with improved walking and biking see more user enjoyment, better health, improved economic activity, better communities resulting from positive interactions between neighbors, and more neighborhood security.[154] Improved walking and transit infrastructure can bring important improvements for people with mobility issues, and for older adults.[155]

Reducing driving will also reduce car crashes, which take an enormous toll, both economically and in terms of lost lives. There were more than 37,000 people killed in crashes in 2017.[156] And in 2010, the last year for which data is available, the total economic impact of car crashes including lost lives, injuries and property damage amounted to $242 billion.[157]

The goal

The U.S. should at least double the number of people who travel by foot, bike or transit by 2030.

Doubling the number of people who travel by foot or bike or on transit by 2030 is just the beginning of the kind of transformative change that will be needed if the United States is going to eliminate carbon pollution from our transportation system. It is, however, an ambitious mid-term goal – one that can drive emission reductions in the short term and push the nation to build more sustainable communities with more transportation options in the long run.

By doubling the number of people who travel primarily by low-carbon modes of travel – namely, walking, biking and transit – America can reduce emissions, improve communities, and substantially ease the task of moving to a zero-carbon transit system. Specifically, achieving this goal would:

- Increase walking, biking and transit travel by more than 100 billion miles, assuming that the current distance traveled by these modes were to double.[158] If this increase were to be matched by a parallel decrease in miles traveled by car, vehicle carbon dioxide emissions would be reduced by approximately 32 million metric tons.[159] While this does not take into account potential increases in emissions from new transit routes, a rapid transition to electric buses would reduce the greenhouse gas impacts of those additional trips.
- Reduce overall transportation energy use, making the task of repowering the transportation system with clean energy far easier.
- Benefit public health and wellbeing, and improve neighborhoods. Studies have found that people who walk or bike to work are happier with their commutes.[160] If the U.S. were to double walking and biking mileage, Americans would burn an extra 2.7 trillion calories in 2030.[161]

Getting there

To double the number of people who travel by foot, bike and transit, the U.S. must make low-carbon means of travel the cheapest, easiest, most comfortable and safest options available.[162] That will mean undertaking a variety of initiatives, including providing better infrastructure and changes to transportation finance.

While the policies for encouraging low-carbon transportation are varied, they can also reinforce each other and make the path forward far easier. For example, the design changes that make biking safer also typically make walking nicer.[163] Because around 90 percent of transit trips are accompanied with walking trips for a portion of the journey, improved walking conditions make transit more accessible; similarly, increased transit ridership will mean more people walking to and from rail and bus stops.[164] And policies that reduce subsidies to driving can make all forms of low-carbon transportation more attractive in comparison, particularly if paired with increased funding for those modes.

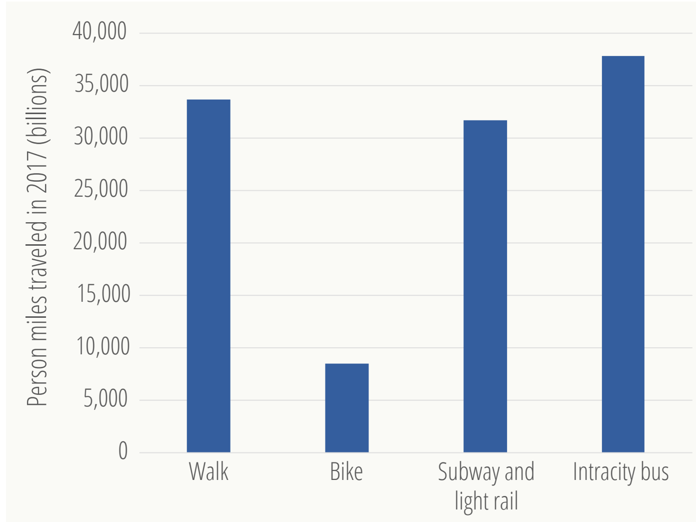

Figure 9. Americans traveled more than 100 billion miles by foot, bike and transit in 2017[165]

Ensure that walking, biking and transit are safe, affordable, accessible and enjoyable

Making sure that low-carbon transportation options are safe, affordable, accessible and enjoyable is key to increasing the number of people who travel without a car.[166] Places that have invested in improved infrastructure and better service have seen subsequent improvements in safety and increased ridership. Two approaches in particular – adopting "complete streets" principles, and investing in transit improvements – can get more people traveling by foot, bike and transit.

Create "complete streets" that work for everyone

There are a wide variety of design and policy factors that affect the safety and quality of walking and biking, ranging from road design, to speed limits, to infrastructure elements like sidewalks and bus and bike lanes.[167] Many of these disparate elements fall under the concept of "complete streets," which, as described by U.S. Department of Transportation, are "streets designed and operated to enable safe use and support mobility for all users," including "people of all ages and abilities, regardless of whether they are travelling as drivers, pedestrians, bicyclists, or public transportation riders."[168] As of the end of 2018, nearly 1,500 communities across the country – primarily towns and small suburbs – had adopted "complete streets" policies.[169]

By designing streets to serve pedestrians, bicyclists and transit – including by adding infrastructure like this bike lane and floating bus stop in Seattle – cities can encourage low-carbon transportation and make streets safer for everyone. Credit: Adam Coppola Photography via Flickr (public domain)

Cities that have implemented complete streets policies typically see more walking and biking, and less driving.[170] Good bicycle infrastructure, including separated bike lanes, is associated with both greater bicyclist safety and higher rates of bicycling.[171] Research has found that, for U.S. cities with over 250,000 people, each additional mile of bike lane per square mile increases the share of people who bike by about 1 percent.[172]

Complete streets also increase safety, which itself is a valuable benefit, even as it helps get more people walking and biking. A study published in the American Journal of Public Health found that protected bike lanes can reduce injury risk by almost 90 percent.[173] Another study assessed impacts of adding complete street elements – including a raised median, redesigned intersections and sidewalks – to a suburban four-lane road in New Jersey. The study found that after the changes were implemented, pedestrian "exposure risk" – the time it takes pedestrians to cross a street, where they are exposed to oncoming traffic – dropped by 28 percent.[174] As more people use the roads for walking and biking, safety likely increases further: A study in the journal *Injury Prevention* determined that there is "safety in numbers" for pedestrians and bicyclists, and that "[p]olicies that increase the numbers of people walking and bicycling appear to be an effective route to improving the safety of people walking and bicycling."[175]

Complete streets policies can be particularly effective when tied to a broader strategy to improve safety, including so-called "vision zero" strategies to eliminate all traffic fatalities. "Vision zero" strategies include not just complete streets and other improvements to the built environment, but also engagement with public health officials, law enforcement, and community members, the collection and application of data on traffic deaths, and a focus on safe speed limits.[176]

Expand and improve transit

There are many ways to make transit service better. Cities and transit agencies can add routes, build better platforms and transit stations, dedicate lanes to buses, reduce the cost of riding, and more. Improving frequency, reducing crowding, and ensuring safety and reliability are all important ways to improve rider satisfaction.[177]

While every region is different, the evidence is clear that when transit service is expanded or improved, more people ride. A TransitCenter analysis of the National Transit Database found that in 2018, transit ridership increased in seven of the 35 regions with the highest transit usage.[178] Of those seven regions, six –

Seattle, Houston, Austin, San Antonio, Las Vegas and Pittsburgh – had either substantially increased transit service since 2013, or had recently reoriented their transit networks to meet growing demand.[179]

In Seattle, for example, ridership levels have increased since 2014, when voters approved the Seattle Transportation Benefit District Proposition 1 (STBD) to generate about $50 million each year to invest in the city's transit system. The initiative has added nearly 7,000 weekly bus trips to the city. It has provided every public high school student with free, unlimited transit passes.[180] Perhaps most importantly, the initiative has given more people access to high-frequency transit service, increasing the percentage of households that live within a 10 minute walk of "10-minute service" (a line with an average of a trip every 10 minutes in each direction) from 25 percent to 67 percent.[181]

As service has expanded and improved, Seattle has seen an increase in transit use, as well as other low-carbon modes, and a decrease in driving. From 2010 to 2017, the percentage of commuters getting to downtown Seattle via transit grew from 42 percent to 48 percent, while the share of trips in single-occupancy vehicles fell from 35 percent to 25 percent.[182]

In San Antonio, Texas, transit ridership has gone up thanks to investments in increased service and improved bus stops. Credit: VIA Metropolitan Transit

End subsidies that make driving artificially cheap

All efforts to increase the number of people who travel via low-carbon transportation modes will be made easier by ending subsidies that make driving artificially cheap. (See "Driving is heavily subsidized," on page 12, for more on these subsidies.)

Policies that raise the cost of accessing roadways or parking make driving come closer to paying its true costs and increase the attractiveness of walking, biking and transit. Increasing the gas tax or imposing carbon fees or taxes can help to ensure that the price people pay for driving corresponds to the damage it inflicts on the environment, society and our infrastructure.

One example is congestion pricing, which refers to tolling methods that take a market-based approach to managing congestion, often with tolls that vary by time of day or traffic level. Particularly when paired with expanded transit service, congestion pricing has proven to be an effective policy for increasing transit ridership.[183]

Low-carbon transportation can likely be further encouraged with more fundamental changes to the U.S. system of transportation finance. To date, taxes on drivers have been seen primarily as a way to raise money for transportation. But they can fill a more important purpose by being used to recoup some of the costs drivers impose on society and improve the efficiency of the transportation system. Congestion pricing, parking pricing, pollution-based charges and similar charges can encourage transportation choices that deliver the greatest benefits to or impose the least costs on society – even if every penny of revenue from those fees is returned to taxpayers or used for purposes other than transportation.

Such changes will likely become more important with increased adoption of efficient electric vehicles, which could significantly reduce the cost of driving. If reduced cost leads to more driving, that additional driving could offset some of the climate benefits of vehicle efficiency improvements.[184]

Conclusion

To avoid the worst impacts of climate change, America must decarbonize our transportation system. Three goals that can help us get there are electrifying personal vehicles, electrifying buses, and doubling the number of Americans who walk, bike or take transit to work.

Achieving these goals will do much more than help us take on the climate crisis. It will bring us happier commutes; cleaner air in our communities; and better health from walking and biking.

To put America on a path to a zero-carbon transportation system, policymakers should work to achieve the following goals:

Phase out fossil fuel vehicles. *Specifically, all new light-duty cars and trucks sold after 2035 should be electric vehicles.* To get there, policymakers should:

- Set goals to phase out conventional vehicles and require increased sales of EVs.
- Reduce financial hurdles to EV adoption.
- Expand and improve the EV charging network.

Electrify public transportation. *Specifically, U.S. transit agencies and school districts should replace all transit and school buses with clean electric buses by 2030.* To get there, policymakers should:

- Adopt electric bus commitments at transit agencies, school districts, and at all levels of government.
- Provide financial and technical assistance to help transit agencies adopt electric buses.

Get more people traveling by foot, bike and transit. *Specifically, America should at least double the number of people who travel by these low-carbon modes by 2030.* To get there, policymakers should:

- Ensure that walking, biking and transit are safe, affordable, accessible and enjoyable, including by:
  - Building “complete streets” that the serve the needs of everyone.
  - Expanding and improving public transit.
- End subsidies that make driving artificially cheap.

As policymakers implement the recommendations throughout this report, they must also ensure the rapid development of clean, renewable energy. Electric vehicles will only be truly clean if powered by emission-free energy sources such as wind and solar power.

Appendix

TABLE A-1: 2016 TRANSPORTATION EMISSIONS AND PER CAPITA TRANSPORTATION EMISSIONS BY STATE[185]

State	Total transportation emissions		Transportation emissions per capita	
	MMT CO_2	National rank	Metric tons CO_2	National rank
Alabama	34.9	18	7.2	13
Alaska	12.0	39	16.2	1
Arizona	33.3	19	4.8	44
Arkansas	19.5	31	6.5	23
California	214.2	2	5.5	30
Colorado	28.4	27	5.1	37
Connecticut	15.4	34	4.3	48
Delaware	4.6	48	4.9	42
Florida	104.1	3	5.0	39
Georgia	54.4	9	5.3	34
Hawaii	10.3	41	7.2	12
Idaho	10.8	40	6.4	25
Illinois	68.9	5	5.4	33
Indiana	43.7	16	6.6	21
Iowa	21.5	29	6.9	14
Kansas	18.8	32	6.5	24
Kentucky	32.5	22	7.3	10
Louisiana	47.6	14	10.2	4
Maine	9.0	42	6.7	16
Maryland	27.8	28	4.6	47
Massachusetts	31.9	23	4.7	46
Michigan	50.5	10	5.1	38

State	Total transportation emissions		Transportation emissions per capita	
	MMT CO_2	National rank	Metric tons CO_2	National rank
Minnesota	31.6	24	5.7	28
Mississippi	30.1	25	10.1	5
Missouri	38.3	17	6.3	26
Montana	7.9	44	7.6	9
Nebraska	14.0	37	7.3	11
Nevada	15.1	35	5.2	35
New Hampshire	6.8	47	5.0	40
New Jersey	58.5	8	6.6	22
New Mexico	14.3	36	6.8	15
New York	75.8	4	3.9	49
North Carolina	49.4	11	4.9	43
North Dakota	8.4	43	11.1	3
Ohio	63.5	6	5.5	31
Oklahoma	32.8	20	8.4	6
Oregon	20.6	30	5.0	41
Pennsylvania	61.1	7	4.8	45
Rhode Island	3.9	49	3.7	50
South Carolina	32.8	21	6.6	20
South Dakota	6.9	46	8.0	8
Tennessee	44.0	15	6.6	19
Texas	226.1	1	8.1	7
Utah	17.8	33	5.9	27
Vermont	3.4	50	5.4	32
Virginia	47.8	13	5.7	29
Washington	48.9	12	6.7	18
West Virginia	12.3	38	6.7	17
Wisconsin	29.7	26	5.1	36
Wyoming	7.9	45	13.4	2

Notes

1 U.S. transportation emissions (for 2017): U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2017*, 11 April 2019, available at https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks; countrywide emissions excluding land-use change and forestry (for 2016): Climate Watch, *Data Explorer*, accessed on 6 January 2020 at https://www.climatewatchdata.org/data-explorer/historical-emissions.

2 U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2017*, 11 April 2019, available at https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks.

3 See note 2, table 2-11.

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