



| Transform Transportation

Strategies for a Healthier Future

Arizona PIRG

Education Fund

FRONTIER GROUP

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| Executive summary

AMERICA'S TRANSPORTATION SYSTEM is wrecking our health.

Traffic-related air pollution kills an estimated 58,000 Americans every year, and increases the risk of serious health conditions, including lung cancer, stroke, heart disease, asthma, and even dementia.¹ More than 38,000 people die in vehicle crashes in the U.S. every year and millions more are seriously injured.² Even our mental health and the health of our relationships are at risk – the time we spend driving, much less the time we spend stuck in stressful traffic, is time away from family, friends, exercise and leisure pursuits.

These health problems are a direct result of the way we've built our communities and our transportation system to be dependent on travel in fossil fuel-powered cars. Every year, Americans drive more than 3.2 trillion miles – nearly 10,000 miles per person and more miles per capita than people almost anywhere else in the world.³ Since 1990, the number of vehicle miles traveled by light-duty vehicles like cars and light-duty trucks has risen by more than 46 percent.⁴

There is a better way.

By rebuilding our transportation system to give more people the option to spend less time in a car, by expanding access to active means of travel such as walking and biking, and by adopting zero-emission electric cars and buses, we can make our transportation safer, healthier, cleaner and more efficient.

Transportation is a leading cause of air pollution that shortens lives and makes people sick.

In 2019, the transportation sector produced 55 percent of the nation's emissions of nitrogen oxides (NO_x) – a component of ozone smog – 16 percent of all emissions of volatile organic compounds (VOCs), and 2.7 percent of all emissions of primary particulate matter, often known as soot.⁵

This pollution causes or exacerbates a range of serious health conditions, including:

- **Cancer:** Diesel exhaust is classed as a potential cancer agent by the World Health Organization and the U.S. EPA.⁶ Exposure to diesel exhaust has been associated with higher rates of lung cancer and greater risk for bladder cancer.⁷ Particulate matter and nitrogen dioxide, emitted in vehicle exhaust, have both been associated with increased risk for lung cancer.⁸
- **Stroke:** Long-term exposure to particulate matter is associated with an up to 21 percent higher risk of stroke.⁹
- **Heart and lung disease:** Exposure to nitrogen dioxide, found in vehicle exhaust, has been linked to heart and lung diseases and premature death.¹⁰ Exposure to particulate matter can result in vascular damage and accelerated decline of lung function.¹¹
- **Asthma:** Exposure to vehicle exhaust causes and exacerbates childhood asthma, and recent research suggests it

also damages lung development even in non-asthmatic children, leading to increased risk of respiratory and cardiovascular diseases in later life.¹²

- **Dementia and cognitive decline** among the elderly: One study estimates that between 7 and 11 percent of dementia cases among individuals living within 50 meters of a major road are attributable to traffic exposure.¹³

The 45 million Americans who live in close proximity to busy roads or other traffic-related infrastructure are at increased risk from the health impacts of traffic-related pollution.¹⁴

- Studies have found increased prevalence of asthma in children living within 100 meters of a freeway.¹⁵ One study estimated that over 27,000 cases of childhood asthma in Los Angeles County were at least partly attributable to pollution associated with living close to a major road.¹⁶
- Living close to a major road increases the chances of suffering from an ischemic stroke by 42 percent and significantly increases the likelihood of dying as a result.¹⁷
- Higher levels of noise and air pollution are associated with increases in coronary heart disease (CHD) mortality. One study found that individuals exposed to the highest levels of noise pollution are 22 percent more likely to die as a result of CHD than those exposed to the lowest levels.¹⁸

American society's dependence on cars puts us at risk every time we take to the roads, whether or not we're in a car ourselves.

- Every year, approximately 38,000 Americans are killed in car crashes, making car crashes the leading cause of death for Americans between the ages of 1 and 54.¹⁹

- In 2018, nearly 6,300 pedestrians and more than 800 cyclists were killed in traffic-related accidents, with more pedestrian and cyclist fatalities on the roads in 2018 than in any year since 1990.²⁰

Driving even takes a toll on the health of drivers themselves. Excessive driving can lead to a range of health impacts, including:²¹

- **Chronic stress and poor mental health:** Commuters who travel to work by car experience substantially higher levels of stress, more negative moods and lower satisfaction with life than those who take active modes of transport.²²
- **Obesity and high blood pressure:** People with long car commutes are more likely to be obese and to have higher blood pressure. They are also less likely to do the recommended amount of physical activity, putting them at increased risk of diabetes, cardiovascular disease, osteoporosis, metabolic risk syndrome and certain kinds of cancer.²³

America's transportation system is the nation's number one source of greenhouse gas emissions and the largest single contributor to the climate crisis, which will harm public health for decades to come.

In 2018, transportation accounted for 28 percent of the nation's total greenhouse gas emissions – more than any other sector of the economy.²⁴ If emissions continue at their current level, the impacts on public health will be severe.²⁵

- **Extreme temperatures will kill more people.** As climate change makes extreme variations in temperature more common, deaths and hospitalizations from extreme heat and cold will rise.²⁶
- **Shifting weather patterns and high pollution will create high concentrations of ozone** in some areas, causing more premature deaths and hospitalizations due to respiratory illness.²⁷

- **Climate change will bring more disease**, as shifting temperatures lead to geographic shifts of disease-carrying insects like ticks and mosquitos.²⁸ Warmer weather will increase the prevalence of pathogens like *E. coli* and salmonella, which thrive in hot and humid conditions.²⁹

To address the health and environmental damage our transportation system causes, we need to completely transform the way we travel. And there are steps we can take right now, using proven policies and existing technology, that can help eliminate traffic-related pollution and move America’s transportation system towards a greener, healthier future:

Getting more people moving by foot, bike and transit can immediately reduce both global warming emissions and the toxic pollutants from our car-dependent transportation system. Walking and biking infrastructure has been shown to benefit communities in a variety of ways, including increased safety, improved health and happiness, and more freedom for older adults and people with mobility issues.

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 through infrastructure expansion and improvements.
- End subsidies that make driving artificially cheap to help make low-carbon transportation the easiest, cheapest, most convenient option.

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 harmful tailpipe emissions that cause cancer, asthma and other health problems.³⁰

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 pollution and would significantly improve the health of children who take school buses and the urban populations often served by buses.³¹

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, including 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.

| Introduction

IN MARCH 2020, the lives of millions of Americans changed in ways we never thought imaginable. The turmoil caused by the arrival of the coronavirus pandemic meant the abrupt suspension of business as usual. Our daily routines suddenly no longer included long, grueling commutes; freeways all over the country emptied, and city centers became eerily devoid of the noise, congestion and air pollution that many of us have come to accept as unavoidable facets of everyday life.³² Without realizing it, we had embarked on a transportation experiment on a previously inconceivable scale.

As lockdowns kicked in all over the country, a record decline in driving was accompanied by an increase in people walking, cycling and choosing other active modes of transportation.³³ Many of us discovered, with varying degrees of surprise, that our daily car commutes weren't actually necessary after all, and that even amid the stress and uncertainty of the pandemic there are more fulfilling ways of spending those hours than sitting in traffic. While gasoline sales plummeted, sales of bikes and e-bikes skyrocketed, and with fewer cars on the road, our neighborhoods became safer, cleaner and more agreeable places to be – especially in the many towns and cities that rededicated street space for pedestrians and cyclists to enable socially distanced individual mobility.

The environmental impact of this accidental experiment was evident almost immediately. The smog that normally hangs over

our cities subsided, and by mid-April, at the height of lockdown, daily carbon dioxide emissions in the U.S. were down by around one-third.³⁴ Globally, emissions dropped an unprecedented 17 percent from 2019 levels, with almost half of that decrease attributable to the drop in road traffic alone.³⁵

As the economy gradually opened up and people began to get back in their cars, it became clear that emissions reductions on the scale seen during March and April were going to be short-lived.³⁶ Yet driving remains below its pre-COVID levels, and some analysts suggest that more Americans will continue to work from home long after the pandemic is over.³⁷

If our travel patterns could change so quickly and dramatically as a result of a pandemic, imagine what could happen if we made a deliberate effort to make it easier for Americans to live their lives without spending so much time in a car.

America's current transportation system has been designed, built and centered around the automobile. And it is a public health disaster. Traffic-related air pollution cuts short an estimated 58,000 American lives every year, and causes or exacerbates serious illnesses ranging from childhood asthma to lung cancer, strokes, heart disease and dementia. Excessive driving, and especially commuting, erodes our mental health, our relationships, and our quality of life – to say nothing of the thousands of people every year killed or injured in vehicle crashes.

The problems of our car-dependent transportation system are staring us in the face – and they have been for years. But the good news is, so are the solutions.

To make matters worse, many of us have no choice but to drive. In large parts of America, public transit simply isn't a viable alternative to personal vehicles. And where walking, cycling and other active modes of transport are an option, the auto-centric design of our streets can make these forms of transport unappealing at best, and at worst, lethal.

The problems of our car-dependent transportation system are staring us in the face – and they have been for years. But the good news is, so are the solutions.

Many of the clean transportation technologies that not so long ago seemed far off on the horizon are now tried and tested and well on their way to becoming mainstream. Zero-emission electric vehicles have proven themselves viable alterna-

tives to the internal combustion engine, and EV ownership is rising rapidly as more and more car manufacturers embrace the reality that the future of the automobile is electric. Cities and school districts that have added electric buses to their transit fleets have found them cheaper, cleaner and more efficient than their old, polluting diesel counterparts and every year brings new commitments from cities all over America to electrify their transit systems. Bike lanes, bike sharing, e-bikes and e-scooters are increasingly common sights in American cities. And it no longer seems so outlandish to imagine a near-future with streets designed for pedestrians and cyclists to coexist safely with cars, giving people the option to spend less time behind the wheel and more time traveling in ways more conducive to safeguarding our health, wellbeing and environment.

There has never been a more important time to fix a transportation system that too often makes us sick and unhappy. In this report, we lay out a vision for creating such a future – one based on zero-emission electric vehicles, expanded public transit, and increased access to active modes of travel like walking and cycling. These are the tools that should be front and center in the effort to free our roads from polluting fossil-fueled vehicles, in a reimagined approach to transportation that puts public health and the environment first.

Our car-dependent transportation system damages our health and wellbeing

THE CHRONIC CONGESTION of America's roadways is not simply an inconvenience, but a symptom of the failure of our nation's approach to transportation. Every year, Americans drive more than 3.2 trillion miles – nearly 10,000 miles per person and more miles per capita than people almost anywhere else in the world.³⁸ Among the 22 European countries for which the United Nations Economic Commission for Europe has recent data, no country had even 70 percent as much driving per person as the U.S.³⁹

All that driving places an increasingly heavy burden on our health, safety and wellbeing. America's car-dependent transportation system kills tens of thousands of people per year through crashes and exposure to air pollution, and hurts or sickens many more. Car dependence is also a major contributor to the global threat of climate change, which will pose threats to our health and our environment for generations to come.

Traffic-related air pollution harms people of all ages

Every year, approximately 107,000 Americans die as a result of air pollution.⁴⁰ Some studies have suggested that figure could be as high as 200,000.⁴¹ According to a recent study by the Massachusetts Institute of Technology, around 58,000 deaths each year are attributable to road transportation emissions specifically, making transportation

the largest single contributor to premature deaths from air pollution.⁴²

Exhaust from cars, trucks, buses and other diesel- and gasoline-powered vehicles contains dangerous pollutants that have been linked to health impacts including heart, vascular and lung conditions and cancer.⁴³ Diesel exhaust alone contains more than 40 toxic contaminants, including known or suspected carcinogens such as benzene, arsenic and formaldehyde.⁴⁴ It also contains fine particulates (referred to as PM_{2.5}) as well as volatile organic compounds (VOCs) and nitrogen oxides (NO_x) (which are both precursors of ground-level ozone), among other pollutants.⁴⁵



Pollutants found in exhaust from fossil-fuel-powered vehicles have been linked to a range of health impacts, including heart, vascular and lung conditions and cancer.

Photo: U.S. Environmental Protection Agency

Transportation is responsible for a large share of the health-threatening pollution that finds its way into America's air. In 2019, the transportation sector produced 55 percent of the nation's total nitrogen oxide (NO_x) emissions, with road traffic accounting for about a third of the national total. The transportation sector as a whole produced 44 percent of the nation's carbon monoxide emissions, with highway vehicles accounting for 26 percent of the nation's total. Transportation produced 2.7 percent of PM₁₀ and PM_{2.5} particulate matter emissions and 16 percent of all volatile organic compound emissions, with 8.9 percent of the national total coming from road traffic.⁴⁶

Traffic pollution causes or exacerbates a range of health problems, including asthma, impaired lung function, cardiovascular diseases and premature death.⁴⁷ Research has linked exposure to fine particulate matter and ground-level ozone to higher rates of mortality, concluding that exposure to these pollutants, even at levels below national standards, contributes to adverse health impacts.⁴⁸ Ultrafine particulate matter (< 0.1 micron in diameter) is especially dangerous since it can enter deep into lower airways, carrying heavy metals that are now linked to Alzheimer's disease, along with odorless, toxic chemicals such as polycyclic aromatic hydrocarbons (PAHs) that irritate the respiratory tract.⁴⁹ Ozone and PM_{2.5} from road transportation kill almost 60,000 Americans every year, making road transportation the largest single contributor to mortalities from these pollutants in the U.S.⁵⁰

Specific health impacts of traffic pollution include:

- **Cancer:** Diesel exhaust is classed as a potential cancer agent by the World Health Organization and the U.S. EPA, and at least 19 of the hydrocarbons it contains are

known to cause or suspected of causing cancer.⁵¹ VOCs, including benzene, acetaldehyde and 1,3-butadiene, have been linked to various types of cancer.⁵² In particular, exposure to diesel exhaust pollution has been associated with higher rates of lung cancer and greater risk for bladder cancer.⁵³ Particulate matter and nitrogen dioxide have both been associated with increased risk for lung cancer.⁵⁴ Exposure to nitrogen dioxide (NO₂) is also known to shorten the life expectancy of people with lung cancer.⁵⁵

- **Heart and lung disease:** Prolonged exposure to nitrogen dioxide has been linked to heart and lung diseases and premature death.⁵⁶ Exposure to particulate matter, too – even at relatively low levels – can result in vascular damage and accelerated decline of lung function.⁵⁷ PM_{2.5} poses a particular risk to elderly people, children and people with heart or respiratory conditions.⁵⁸
- **Respiratory problems:** Vehicle exhaust has been linked to a range of respiratory problems.⁵⁹ Particulate matter can cause inflammation in the respiratory system and long-term exposure to nitrogen dioxide can increase the risk of respiratory infections.⁶⁰ VOCs, too, can cause respiratory conditions. In sunlight, VOCs react with nitrogen oxides to form ground-level ozone, a major component of smog, which irritates the respiratory system, causing coughing and reduced lung capacity. NO_x itself can cause lung irritation and weaken the body's defenses against respiratory infections like pneumonia.⁶¹
- **Asthma:** Air pollution is extremely harmful to children's lungs, and numerous studies have shown that vehicle exhaust can cause and exacerbate childhood asthma.⁶² A 2010 study linked exposure to air pollution with altered

gene expression among asthmatic children and research in 2013 similarly suggested that diesel pollution increased children's susceptibility to asthma by turning off certain genes.⁶³ Exposure to NO₂ in early childhood has been shown to increase the likelihood of developing asthma.⁶⁴

- **Strokes:** Higher levels of air pollution have been associated with a higher risk of stroke events. A 2015 meta-analysis of 20 epidemiological studies carried out over the previous decade identified exposure to particulate matter pollution, and especially PM_{2.5}, as a risk factor for stroke.⁶⁵ The study found that long-term exposure to PM air pollution is associated with an up to 21 percent increased risk of stroke.
- **Dementia and cognitive decline:** Particulate matter has been linked to dementia and cognitive decline among the elderly.⁶⁶ People living close to major roads are at higher risk for developing dementia (see below), thought to be due to increased exposure to NO₂ and PM_{2.5} as well as sleep fragmentation due to noise.⁶⁷

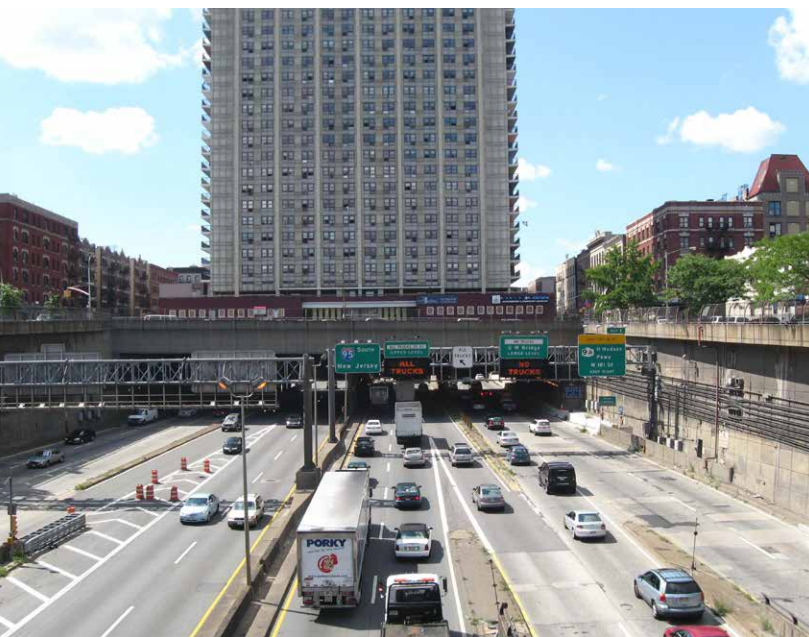
These impacts cause particular harm to vulnerable populations, including children, the elderly, and those with heart or lung conditions.⁶⁸ Children especially are at risk, as their respiratory systems are still developing and they inhale more air per pound of body weight than adults.⁶⁹ In addition, ethnic minorities and other marginalized groups often tend to bear the brunt of the air pollution in American cities. One study in California showed that African Americans and Latinos suffer disproportionately, being exposed to 40 percent more particulate matter than white Californians.⁷⁰ Low income households and those that don't own a car are exposed to 20 percent more pollution than the state average.⁷¹

Living near transportation infrastructure causes particular damage to health

Much of America's vast – and growing – network of roads traverses communities where people live and breathe. The EPA estimates that more than 45 million Americans live within 300 feet of a busy road, major transportation facility or other traffic-related infrastructure.⁷² Unsurprisingly, research shows that those of us who live in close proximity to roads are at a particularly high risk from the health impacts of traffic-related pollution.⁷³ A growing body of studies shows that long-term residential proximity to busy roads can reduce life expectancy and cause or exacerbate a range of diseases.⁷⁴

A number of studies have found an increased prevalence of **asthma** in children who live near busy roads.⁷⁵ A Dutch study of 1,498 children found that asthma and other chronic respiratory symptoms were significantly more prevalent in children who lived within 100 meters of a freeway.⁷⁶ A 2017 Rutgers University study of asthmatic children living near an industrial New Jersey seaport with heavy diesel truck traffic found that greater exposure to carbon soot coincided with markers for lung inflammation, and a UK study focusing on traffic within 150 meters of children's family homes found that the risk of respiratory problems markedly increased the closer children lived to a busy road.⁷⁷

Research published in 2012 estimated that over 27,000 cases of childhood asthma in Los Angeles County (8 percent of all cases) were at least partly attributable to pollution associated with residential location within 75 meters of a major road.⁷⁸ Another study from Southern California, published in 2006, found that risks for asthma increased more than twofold among those living within 75 meters of a major road. These



Apartments above a New York City freeway. A growing body of research shows that living close to busy roads can reduce life expectancy and cause or exacerbate a range of diseases. Photo: Jim Henderson via Wikimedia Commons

associations, the study concluded, were strongest among children with no parental history of asthma who had lived at the same address since early in life.⁷⁹

Not only does living near busy roads increase a child's likelihood of developing asthma and other respiratory diseases, it also damages lung development even in otherwise healthy, non-asthmatic children. A study published in *The Lancet* in 2007 found that children who lived within 500 meters of a freeway since age 10 had developed "pronounced deficits" in lung function by the age of 18, compared to children living a mile away or more, suggesting that exposure to traffic pollution is dangerous for all children, not just vulnerable subgroups.⁸⁰ Poor lung function in later life is known to be a major risk factor for respiratory and cardiovascular diseases.⁸¹

Living in close proximity to roads also has significant linkages to incidences of **strokes**. One study found that living within 100 meters of a major road increases the chances of suffering from an ischemic stroke by 42 percent.⁸² It also increases the likelihood of dying as a result: a 2013 study of 1,683 stroke patients observed that patients living 100 meters or less from busy roads had a 20 percent higher rate of poststroke mortality than those living more than 400 meters away.⁸³

Traffic-related noise and air pollution have also been linked to a range of **cardiovascular diseases**. A 2012 study of coronary heart disease (CHD) mortality among urban residents of Vancouver, Canada, for example, found that higher levels of noise and air pollution were associated with higher levels of CHD mortality. Individuals exposed to the most noise were 22 percent more likely to die as a result of CHD than those exposed to the least.⁸⁴

Strong links have also been found between traffic-related air pollutants and heart attacks. Research published in 2007 observed a "significant increase" in the odds of heart attacks associated with increasing exposure to traffic within 100 meters of patients' homes.⁸⁵ A 2002 study from the Netherlands found that living within 100 meters of a freeway or 50 meters of a major urban road was associated with increased incidence of death from heart attacks, among other cardiopulmonary conditions.⁸⁶

Living near roads can increase the risk of **cognitive decline** in older adults.⁸⁷ A 2012 study among community-dwelling seniors in Boston found that residential proximity to a major roadway was associated with "statistically significantly poorer performance" on cognitive tests of verbal learning and memory, psychomotor speed,

language and executive functioning, with participants who lived less than 100 meters from a major road performing worst.⁸⁸ A 2017 study of residents of Ontario, Canada, similarly found increased incidence of **dementia** among those who lived in close proximity to heavy traffic.⁸⁹ The study found that those most at risk were individuals who lived closest to the roads, who lived in major urban centers and who had never lived elsewhere.⁹⁰ The study concluded that among individuals with dementia who live within 50 meters of a major road, between 7 and 11 percent of cases are attributable to traffic exposure.⁹¹

Our dependence on cars has lethal consequences for road users

American society's dependence on cars puts us at risk every time we take to the roads, whether or not we're in a car ourselves. The current design of our roadways puts people who walk or bike in particular danger. Unsafe, car-oriented infrastructure discourages people from biking, walking or using public transit – further cementing car dependence and exacerbating the risks it poses to public health.

Every year, approximately 38,000 Americans are killed in car crashes, making car crashes the leading cause of death for Americans between the ages of 1 and 54.⁹² In 2018, nearly 6,300 pedestrians and more than 800 cyclists were killed in traffic-related accidents – increases of 3.4 percent and 6.3 percent, respectively, from 2017.⁹³ In some urban areas, pedestrian fatalities account for up to 40 percent of all traffic-related deaths.⁹⁴ Between 2009 and 2018, pedestrian and cyclist deaths as a proportion of total traffic-related fatalities on America's roads rose by 6 percent, with more pedestrians and cyclists killed in 2018 than in any year since 1990.⁹⁵

Part of the reason for these high levels of fatalities among cyclists and pedestrians has to do with our unsafe infrastructure. 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.⁹⁶ 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.⁹⁷ For a pedestrian hit by a car moving at 42 mph, the risk of death is 50 percent.⁹⁸

Many roads also lack basic infrastructure that improves safety for walking and biking, like sidewalks and bike lanes.⁹⁹ A study of pedestrian crashes from the early 1990s found that, of the 2,885 incidents where such data was available, more than 80 percent took place on roads with no sidewalk.¹⁰⁰ Another study found that



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.

Photo: Oregon Department of Transportation

the risk of cycling on roads with physically separated bike lanes was about one ninth that of riding on roads with no bike lanes.¹⁰¹

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.”¹⁰²

Driving to work damages our health and makes us less happy with our lives

The public health danger from our dependence on cars doesn’t just come from pollution and road accidents. Driving also takes a toll on the health of drivers themselves – and Americans drive a lot.

Around 85 percent of Americans commute by car every day.¹⁰³ These commutes take a toll on us, physically and psychologically, leading to health problems ranging from headaches, backaches, digestive problems and concentration issues to a range of potentially extremely serious conditions.¹⁰⁴

- **Long car commutes can lead to chronic stress and poor mental health.**¹⁰⁵ A 2011 study of New York commuters found that those who travel to work by car experience “significantly higher” levels of stress and more negative moods than those who took active modes of transport.¹⁰⁶ A 2014 study by researchers in Canada found that people with longer commutes had lower satisfaction with life, and a 2011 study – also from Canada – found that traffic congestion and long commutes were associated with higher stress levels.¹⁰⁷ In the latter study, 36 percent of full-time workers with a commute of 45 minutes or more said that most days were “quite or extremely stressful,” compared to 23 percent of those with commutes of less than 15 minutes.¹⁰⁸

- **Longer commutes are linked to poor diet and lack of exercise.** A 2012 study of commuters in Texas found that individuals with longer commutes were less physically active, more likely to be obese, and had greater body mass index (BMI) and waist circumference and higher blood pressure.¹⁰⁹ A commute of 10 miles or more each way is associated with higher blood pressure, the study found, and participants who commuted more than 15 miles were more likely to be obese and less likely to do the recommended amount of physical activity, putting drivers at increased risk of diabetes, cardiovascular disease, osteoporosis, metabolic risk syndrome and certain kinds of cancer.¹¹⁰ Another study found that every hour sitting in a car was associated with a 6 percent increase in the odds of obesity.¹¹¹
- **Commuting is linked to poor sleep.** A study published in 2018 found that each additional hour of commute time means 15 minutes of sleep loss, and that individuals with longer commutes had greater variability in sleep duration and less stability of sleep rhythms than those with short commutes.¹¹² The 2012 Regus Work-Life Balance Index found that commutes of more than 45 minutes were associated with poor sleep quality and exhaustion.¹¹³ Sleep loss is in turn linked to a range of health problems, including diabetes and obesity.¹¹⁴
- **Commuting by car harms our relationships.**¹¹⁵ Studies have shown that people with longer commutes are less likely to spend time with family and friends, contributing to higher rates of stress and reduced life satisfaction.¹¹⁶ An analysis of commuting data from Sweden found that couples with longer commutes are 40 percent more likely to split up than those with shorter commutes.¹¹⁷ One study on the psychological costs of traffic conges-

tion even found a connection between extreme traffic and higher incidence of domestic violence, with a 9 percent increase in incidents of domestic abuse on days with extreme traffic.¹¹⁸

Transportation is the leading source of greenhouse gas emissions

In 2018, America's transportation sector emitted 1,882 million metric tons of greenhouse gases (MMT CO_2e), accounting for 28 percent of the nation's total greenhouse gas emissions – more than any other sector of the economy.¹¹⁹ U.S. transportation emissions now account for approximately 4 percent of total *global* greenhouse gas emissions.¹²⁰

By far the leading sources of U.S. transport emissions are light-duty vehicles like cars and light trucks. In 2017, these vehicles accounted for nearly three-fifths of transport emissions and one-sixth of America's total greenhouse gas emissions.¹²¹ In recent years, emissions from these kinds of vehicles have been on the rise. Between 2013 and 2017, the annual distance Americans drove in light-duty vehicles grew by 200 billion miles, and annual emissions from these vehicles rose by 36 million metric tons.¹²²

The typical American vehicle is heavy, inefficient and powered by fossil fuels. An analysis comparing the United States 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.¹²³ For every gallon of gas we put in our cars, we pump roughly 24 pounds of CO_2 and other harmful emissions into our atmosphere.¹²⁴

But the climate impacts of our automobile dependence don't just come from tailpipe emissions. The total carbon footprint of a



Around 85 percent of Americans commute to work by car. Research shows that all this driving takes a toll on our mental and physical health. Photo: prvideotv via Pixabay

vehicle also includes the emissions produced during its production, from the extraction of raw materials to the construction and assembly of its component parts and the extraction and shipping of fuels.¹²⁵ Quantifying the impacts of such a sprawling and complex process is difficult, but one recent estimate suggests that almost a quarter of a car's total lifetime carbon emissions are produced before it even hits the road.¹²⁶

The climate impacts of a car-dependent transportation system must also take into account the emissions associated with building and maintaining that system's infrastructure. A 2019 lifecycle analysis of a provincial road in Italy showed the building and maintenance of roadways, including raw materials, fuels, transportation and construction site set-up, are responsible for more than 47 percent of a road's total environmental impact, while the actual use of the road (i.e., environmental impacts from traffic, maintenance and so on) is responsible for the other 53 percent.¹²⁷

This transportation system is a major contributor to our changing climate, and if emissions continue at their current level, the impacts on public health will be severe.¹²⁸ Climate change influences human health and disease in a range of different ways, including intensifying existing threats to public health and creating the conditions for new ones to emerge.

Extreme temperatures will kill more people. Many cities have seen sharp increases in fatality rates during heat waves in recent years, including from heat stroke and related problems, as well as cardiovascular, respiratory and cerebrovascular diseases.¹²⁹ Extreme heat also brings a rise in hospital admissions for cardiovascular, kidney and respiratory disorders.¹³⁰ As the frequency and intensity of extreme temperatures increase in the coming decades as a result of climate change, these numbers will rise.¹³¹

Climate change will create high concentrations of ground-level ozone and air pollution. Ozone will increase in some areas and decrease in others, as the climate crisis will affect the weather patterns in different regions differently. Exposure to ozone is linked to premature deaths and hospitalizations due to various respiratory illnesses.¹³² Estimates suggest that, by 2050, climate change could lead to as many as 4,300 additional premature deaths every year in the U.S. from the health effects of ozone and particulate matter pollution.¹³³

Climate change will bring more severe natural disasters. Larger floods, wildfires and winter storms can result in death and injury and cause major damage to infrastructure. Droughts can devastate water quality and have negative impacts on respiratory health, as can wildfires.¹³⁴ Wildfire smoke contains particulate matter, carbon monoxide, nitrogen oxides and VOCs and can significantly damage air quality.¹³⁵

Climate change will bring more disease. Shifting temperatures will also lead to geographic shifts of disease-carrying insects like ticks and mosquitos.¹³⁶ Changes in air and water temperatures and other climatic conditions can affect the transmission of the pathogens that cause diarrheal diseases, such as salmonellosis and campylobacteriosis.¹³⁷ Warmer weather will increase the prevalence of pathogens like *E. coli* and salmonella, which thrive in hot and humid conditions, and warming seas will see an increase in bacteria in seafood. Climate change may even bring about new diseases.¹³⁸

* * *

According to the EPA's 2019 Automotive Trends report, new vehicles are at a historic low in terms of the grams per mile of CO₂ they produce and a historic high in terms of fuel efficiency.¹³⁹ Since 2004, new vehicles' CO₂ emissions have decreased 23 percent and fuel economy has increased 30 percent.¹⁴⁰ And yet, over this period, there has been no corresponding reduction in total greenhouse gas emissions from transportation.¹⁴¹ Instead, over the last decade, emissions from the transportation sector have been on the rise.¹⁴²

This is largely because we're driving more. In other words, making our vehicles cleaner and more energy efficient – while important – isn't enough to address our transportation system's role in accelerating climate change. To mitigate our impact on the climate, and to alleviate the many other health impacts of a transport system centered around fossil-fuel-powered vehicles, we need to completely overhaul the way we travel.

We can transform America's transportation system

TRANSFORMING OUR transportation system into one that is safe, healthy and environmentally friendly is a huge and complicated endeavor. But there are several steps we can take right now, using tools and technologies already available, that can do the bulk of the heavy lifting. Three goals, which are achievable with proven policies and existing technology, can help eliminate pollution from cars and light trucks and move America's transportation system towards a greener, healthier future:

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

By rebuilding our transportation system to give people the option to spend less time in a car and more time traveling by healthy means such as walking and biking, and by adopting clean vehicle technologies that do not produce the dangerous emissions of fossil-fuel-powered vehicles, we can reduce the health and environmental impacts of our car-dependent transportation system and build healthier, safer, better connected communities.

Give more people the option to travel by foot, bike and transit

In 2017, more than four in five trips taken by Americans were made by car, pickup truck, SUV or van.¹⁴³ Shifting some of these trips to transit, walking and cycling is an important way to reduce air pollution and greenhouse gas emissions from transportation, even if all vehicles are eventually powered by electricity from renewable sources.

Shifting modes of travel can make an immediate impact on air pollution and health, even as the nation transitions its automobile fleet to electric vehicles, builds its infrastructure for charging them, and transitions to an electricity system powered by 100 percent clean energy. Shifting from driving to transit, cycling and walking creates an opportunity to address the many other impacts of widespread automobile dependence, including dangerous and congested streets. Improved walking and transit infrastructure can bring vital accessibility improvements for older adults and people with mobility issues.¹⁴⁴

Making it easier for people to travel without a car brings valuable benefits for our health and the health of our communities. Research shows that communities with more walking and biking see more

user enjoyment, better health, improved economic activity, stronger communities resulting from positive interactions between neighbors, and more neighborhood security.¹⁴⁵ A 2014 study from the UK found that commuters who stopped driving and started walking or cycling to work experienced higher levels of wellbeing, with the likelihood of feeling constantly under strain or unable to concentrate at least 13 percent higher when commuting by car.¹⁴⁶ Walking and cycling can also provide the proven health benefits that come from increased physical activity:

- Research published in *The American Journal of Preventive Medicine* in 2013 found that people who walk to work are 17 percent less likely to have high blood pressure than those who drive, and people who commute by bike are around half as likely to have diabetes as those who drive. The study also found that cycling, walking and using public transit were all associated with lower risk of obesity than driving.¹⁴⁷ A 2012 study showed that an hour of walking each day can even help override the effects of a genetic predisposition to obesity.¹⁴⁸
- A recent study from the UK found that commuters who walked, cycled or took public transit at least part of the way to work were 11 percent less likely to develop cardiovascular disease and 30 percent less likely to die from it than people who commuted solely by car.¹⁴⁹
- Research published in the *British Medical Journal* in 2017 found that, compared to those who drive or take public transit, cycle commuters were 41 percent less likely to die prematurely, 46 percent less likely to develop heart disease and 52 percent less likely to die from it, and 45 percent less likely to develop cancer and 40 percent less likely to die from it. The same study found that those who walk

to work have a 27 percent lower risk of developing cardiovascular disease and a 36 percent lower risk of dying from it.¹⁵⁰

Reducing driving will also reduce car crashes, which take an enormous toll, both economically and in terms of lost lives. There were more than 36,000 people killed in crashes in 2018.¹⁵¹ 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.¹⁵²

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 the beginning of the kind of transformative change that is needed if the United States is going to end its damaging dependence on the automobile. 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 on foot, bike or public transit, America can improve public health, reduce emissions, enhance communities, and substantially ease the task of moving to a zero-emissions transportation 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.¹⁵³ 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.¹⁵⁴ 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. Studies have found that people who walk or bike to work are happier with their commutes.¹⁵⁵ If the U.S. were to double walking and biking mileage, Americans would burn an extra 2.7 trillion calories in 2030.¹⁵⁶

GETTING THERE

To double the number of people who travel by foot, bike and transit, the U.S. must make these forms of travel the cheapest, easiest, most comfortable and safest options available.¹⁵⁷ That will mean undertaking a variety of initiatives, including providing better infrastructure and changes to transportation finance.

While policies for encouraging increased transit use and active forms of transport are varied, they can also reinforce each other and make the path forward far easier. For example, the design changes that make cycling safer also typically make walking more pleasant.¹⁵⁸ Because around 90 percent of transit trips are accompanied with walking trips for a part 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.¹⁵⁹ And policies that reduce subsidies to driving can make all forms of non-auto transportation more attractive, particularly if paired with increased funding for those modes.

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

Ensuring that active transportation options and public transit are safe, affordable, accessible and enjoyable is key to increasing the number of people who travel without a car.¹⁶⁰ Places that have invested in improved infrastructure and better service have seen subsequent improvements in safety and increased transit 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 cycling, ranging from road design, to speed limits, to infrastructure elements like sidewalks and bus and bike lanes.¹⁶¹ Many of these elements fall under the concept of “complete streets,” which, as described by the 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.”¹⁶² By the end of 2018, nearly 1,500 communities across the U.S. – primarily towns and small suburbs – had adopted “complete streets” policies.¹⁶³

Cities that have implemented complete streets policies typically see more walking and biking, and less driving.¹⁶⁴ Good bicycle infrastructure, including separated bike lanes, is associated with both greater cyclist safety and higher rates of cycling.¹⁶⁵ 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.¹⁶⁶

Complete streets also increase safety. A study published in the *American Journal of Public Health* found that protected bike lanes can reduce injury risk by almost 90 percent.¹⁶⁷ 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.¹⁶⁸ 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 bicy-

cling appear to be an effective route to improving the safety of people walking and bicycling.”¹⁶⁹

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.¹⁷⁰

Expand and improve transit

Cities and transit agencies need to maintain, expand and improve public transit service. There are many ways to do this, including



By designing streets to serve pedestrians, bicyclists and transit – including by adding infrastructure like this separated bike lane in Vancouver – cities can encourage low-carbon transportation and make streets safer for everyone. Photo: Paul Krueger via Flickr, CC BY 2.0

adding routes, building better platforms and transit stations, allocating dedicated bus lanes and reducing the cost of riding. Improving frequency, reducing passenger crowding, and ensuring safety and reliability are all important ways to improve rider satisfaction.¹⁷¹ With local transit systems facing serious revenue crises due to the sharp drop-off in ridership during the coronavirus pandemic, enabling cities to undertake these improvements will require significant – and immediate – investment of federal funds.¹⁷²

Experience shows that this investment is worthwhile. 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.¹⁷³ 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.¹⁷⁴

In Seattle, for example, ridership levels have increased since 2014, when voters approved the Seattle Transportation Benefit District Proposition 1 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.¹⁷⁵ 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 route with an average of a trip every 10 minutes in each direction) from 25 percent to 67 percent.¹⁷⁶

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.¹⁷⁷

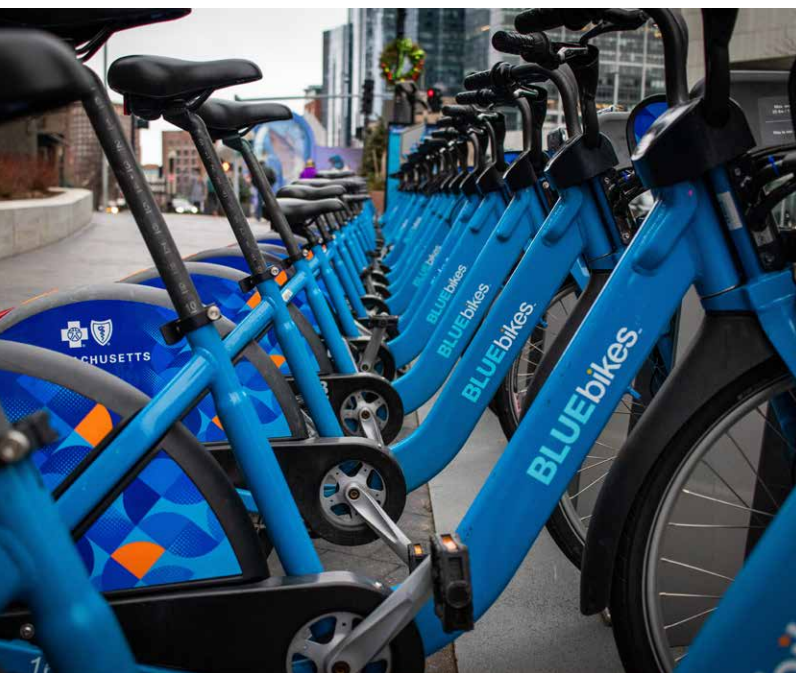
Maintaining, improving and expanding public transit should begin with ensuring maintenance of existing systems. Among other things, this will require increasing funding to the Federal Transit Administration’s “State of Good Repair” program to address the current \$98 billion backlog in needed transit repairs, while also investing more in other funding mechanisms to allow for the expansion and construction of new public transit.¹⁷⁸ Grants or loan assistance programs, such as competitive programs like Better Utilizing Investments to Leverage Development (BUILD) grants and Capital Investment Grants, are another opportunity to fund more low-carbon transportation options.

Allocation of federal grant money for transit projects can be expedited by easing federal red tape for small-scale transit projects with clear environmental benefits. Federal funding programs that are currently limited to capital expenditures could be expanded to also support operating expenses, encouraging transit agencies to increase service on already-existing bus and rail lines. Funding programs should include requirements that hold states accountable for setting and meeting goals that reduce per capita miles driven, and the allocation of federal funding should favor direct financial support to local governments pursuing innovative land-use and demand management transportation programs. In addition, increased federal funding – for example through the Passenger Rail Improvement, Modernization and Expansion (PRIME) federal grant program – should be allocated for railway improvement and expansion, including for the electrification of rail lines across the country.

Covering transit operating costs for every American city costs money. Estimates vary as to the precise amount. The Urban Institute recently estimated that \$16.7 billion in annual operating support would be sufficient to ensure that every urban area with 100,000 residents or more is able to provide high-quality public transit service, and Transit Center has called for \$20 billion in operating assistance as part of an overall increase in federal transit spending to \$50 billion a year.¹⁷⁹

Incentivize strategies for vehicle sharing and micromobility

Cities, employers and college campuses should pursue policies that encourage forms of shared micromobility, such as car-, bike- and scooter-sharing, which give people short-term access to transportation on an 'as-needed' basis.¹⁸⁰ Such programs have been proven to help people lead lifestyles that don't require owning a car, or that require owning fewer cars.



Programs that promote forms of shared micromobility, like bike-sharing, have been proven to help people reduce their reliance on cars. Photo: Aaron Doucett via Unsplash

Studies have shown that roundtrip car-sharing, for example, reduces the number of vehicles on the road, as well as VMT, greenhouse gas emissions and individual transportation costs.¹⁸¹ Research published in 2015 on members of car-sharing company Zipcar found that 40 percent of users of the company's Zipcar for Business package either sold or opted not to buy a vehicle due to shared vehicle access through their employers.¹⁸² Another study similarly found that 30 percent of users of the now defunct San Francisco service City Car-Share relinquished one or more of their own personal vehicles, and two-thirds decided to postpone buying another vehicle after using the service for two years.¹⁸³ A 2011 study of roundtrip carsharing programs in the U.S. and Canada found that a quarter of the study participants sold a vehicle and another quarter put off buying a new vehicle as a result of carsharing.¹⁸⁴ The latter study found that one carsharing vehicle replaced between nine and 13 vehicles among carsharing members. With this came an up to 43 percent decline in household annual VMT and an up to 41 percent reduction in annual household greenhouse gas emissions.¹⁸⁵

End subsidies that make driving artificially cheap

All efforts to increase the number of people who switch to transit and active modes of travel will be made easier by ending subsidies that make driving artificially cheap. Every 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.¹⁸⁶ 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.¹⁸⁷ This heavy subsidization is an important factor underlying

ing high levels of driving in the U.S. A 2011 study comparing U.S. and German residents found that Americans are more likely to drive since U.S. subsidies encourage and incentivize driving even in places where walking, biking or transit are available.¹⁸⁸

Policies that raise the cost of accessing roadways or parking make the financial cost of driving come closer to reflecting 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.¹⁸⁹

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 per-mile cost of driving.

If reduced cost leads to more driving, that additional driving could offset some of the climate benefits of cleaner and more efficient vehicles.¹⁹⁰

Electrifying public transportation

Enabling more Americans to shift from driving to public transit is a crucial step toward reducing emissions from the transportation sector. But while riding the bus or train has substantial environmental benefits compared to relying on private vehicles, most of America's buses and trains are still powered by polluting fossil fuels, such as diesel. Although buses emit far less pollution per passenger than personal vehicles per mile of travel, they emit significant quantities of both global warming emissions and air pollutants that pose a threat to public health.¹⁹¹ By electrifying public transit – including the nation's school buses – public transportation can eventually be powered with clean, renewable energy, creating a transit system that would emit no pollution either from charging or driving.

Across the country, cities and school districts are considering a shift from diesel to electric buses. By eliminating diesel exhaust emissions, particulate pollution and pollutants that contribute to the formation of ground-level ozone, electric buses improve the air quality in our communities.¹⁹² Replacing diesel buses with electric ones would bring major public health benefits to the densely populated areas that transit buses often serve. 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 2050.¹⁹³

They also produce significantly lower greenhouse gas emissions than their fossil-fuel-powered counterparts. Replacing all of the country's diesel-powered transit buses with

electric ones could eliminate more than 2 million tons of greenhouse gas emissions each year, and replacing all school buses with electric models could avoid an average of 5.3 million tons of emissions each year.¹⁹⁴ Benefits would continue to increase as America transitions to clean, renewable energy.¹⁹⁵

A 2018 study by the Union of Concerned Scientists found that electric buses produce significantly lower greenhouse gas emissions than diesel, diesel hybrid and natural gas-powered buses over their entire life cycle, including the process of generating the electricity that powers them, and that there are benefits across the country, even in places where the electric grid is carbon intensive.¹⁹⁶ Buses charged on California's clean electric grid, for example, had 70 percent lower life-cycle emissions than diesel or natural gas buses, but the study found that electric buses consistently produce lower emissions than both diesel and natural gas-powered buses in every area of the country.¹⁹⁷ Over its entire life cycle, an electric bus charged with the national electricity mix produces less than half of the carbon dioxide-equivalent (CO₂e) emissions per mile as are produced by natural gas or diesel-hybrid buses.¹⁹⁸

By switching to electric buses, transit agencies and school districts can help individual towns and cities reduce their contribution to global warming. For example:

- If the Chicago Transit Authority were to replace its entire diesel fleet with electric buses it would avert nearly 55,000 tons of greenhouse gas emissions each year, equivalent to taking more than 10,000 cars off the roads.
- The transit agency serving Philadelphia, the Southeastern Pennsylvania Transportation Authority, could avert 22,000 tons of greenhouse gas emissions every year, akin to taking more than 4,000 cars off the roads.

- Replacing Denver's diesel buses would avert nearly 47,000 tons of greenhouse gas emissions each year, equivalent to taking more than 9,000 cars off the road.¹⁹⁹

Electric buses provide other benefits, too. They are quiet, and can help bring down noise levels in urban environments. Traffic-related noise pollution has been associated with adverse health effects including strokes and cardiovascular disease, as well as cardiovascular and all-cause mortality.²⁰⁰ They also have lower operational costs, and can provide cities and school districts with long-term financial savings.²⁰¹

Electric buses are a relatively new technology, and over the last two decades the cities and school districts pioneering this technology, in collaboration with electric bus manufacturers, have worked to overcome the inevitable challenges and hurdles that come with such technology.²⁰² The technology has improved exponentially, but there are a number of things policymakers can do to further minimize operational difficulties. These include providing grant programs and subsidies for agencies to go electric, and financing programs whereby states 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 immediate monetary savings. In addition, public officials and utilities should provide discounted off-peak charging rates, limit excessive demand charges, and experiment with policies and practices that allow battery-electric buses to be used for energy storage.²⁰³ With proper policy support, electrification need not come at the expense of service. Both should be prioritized.

The switch to electric buses needs to be in the context of a broader shift toward the electrification of other forms of transit –

including rail. Rail is already one of the most environmentally friendly modes of travel and the most energy-efficient means of motorized passenger transport.²⁰⁴ However, while the sector produces lower emissions than other forms of transport, diesel-powered locomotives still emit soot, VOCs, nitrogen oxides and other dangerous pollutants found in diesel exhaust.²⁰⁵ Switching to electric trains would reduce this pollution – which is especially important since many rail lines pass through urban areas. Electric trains even now emit up to 35 percent less carbon per passenger mile than their diesel counterparts, and when powered by renewable energy can provide carbon-free transit.²⁰⁶

Connecting major cities with electric high-speed electric rail will reduce the need for short-distance air travel, reducing carbon emissions from the aviation sector. Research suggests that high-speed rail lines can reduce aviation transport on the same routes by up to 80 percent.²⁰⁷ According to the International Energy Agency, a new high-speed line can produce “almost immediate” net CO₂ benefits by reducing air and car journeys.²⁰⁸ Electric engines are also 35 percent cheaper to operate than diesel and transport freight five times more efficiently than trucks.²⁰⁹ Per ton-mile, they also cause only about one-eighth as many fatalities as truck freight.²¹⁰ In addition, as residents and businesses cluster around rail transit hubs, the expansion of high-speed rail will promote more walkable, transit-oriented development.²¹¹

THE GOAL

U.S. transit agencies and school districts should replace all transit and school buses with clean electric buses by 2030, while also electrifying other transit services.

By electrifying all transit and school buses, America can ensure that public transit, which is already cleaner and more efficient than



Electric buses reduce greenhouse gas emissions and bring important public health benefits both to the densely populated areas that transit buses often serve, and to young people who ride school buses.

Photo: SounderBruce via Flickr, CC BY-SA 2.0

personal vehicles, contributes to a healthy, zero-emissions transportation system. Specifically, accomplishing this goal would:

- 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 urban populations often served by buses.²¹²
- 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.²¹³ As America expands public transit, these emissions benefits will grow.

GETTING THERE

Achieving 100 percent electric buses by 2030, and electrifying other forms of transit, 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. By the end of 2018, 13 percent of transit agencies had either already deployed or ordered an electric bus.²¹⁴

Nevertheless, American electric bus adoption is still in its early stages. As of November 2020, only around 650 of the more than 65,000 transit buses currently in use in the U.S. were electric – a significant jump from previous years, yet still accounting for just 1 percent of all transit buses.²¹⁵ 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.²¹⁶

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.²¹⁷ Transit agencies and school districts 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.²¹⁸ Transit agencies and school districts typically have central depots where buses can charge.²¹⁹ And there are major cost savings to be made by adopting electric buses, which can be much cheaper to fuel and maintain than fossil fuel-powered buses.²²⁰

Electric buses are also ready for widescale adoption. They have already been deployed successfully in communities around the U.S., and there are now more than 500,000 buses on the road worldwide, mostly in China.²²¹

Other forms of electric transit – including electric trains, trams and trolleybuses – have been in existence for more than a century and can also encourage the shift away from fossil fuel-powered transportation.

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.²²² The average age of full-size buses in service was 7.6 years in 2017.²²³

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 the Chicago Transit Authority (CTA) – have plans to transition to all-electric bus fleets.²²⁴ The LA Metro plans to transition to an all-electric fleet by 2030, and has begun procuring and testing electric buses.²²⁵ The agency deployed its first 60-foot electric bus in July 2020.²²⁶ The MTA, which operates the nation's largest bus fleet and buys approximately one out of every 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.²²⁷ By moving to all-electric fleets, the MTA, LA Metro, and the CTA would move the entire U.S. fleet toward electrification and could prompt other transit systems to make similar commitments.

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 2040.²²⁸ The California policy sets different timelines for large and small transit agencies, allowing smaller agencies to make a somewhat slower transition.²²⁹

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.²³⁰

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.²³¹ In FY2019, all 38 projects that received program funding were for bus electrification, in 38 different states.²³² 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.²³³

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 state's funding goals and actual project funding.²³⁴ 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.²³⁵ Virginia's Department of Environmental Quality will begin accepting applications in the spring of 2021.²³⁶

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."²³⁷ 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."²³⁸

In addition to providing financial support, 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.²³⁹ Government assistance can help with a wide variety of technical challenges and questions. States can ensure that cities and 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.

Electric vehicles

A healthy, 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 vehicles powered by electricity.

A shift to electric vehicles won't meaningfully reduce the threat of death or injury from traffic crashes, or other threats to health and safety that stem from the act of driving itself. However, because electric vehicles are efficient and can be powered by clean energy, electrification can reduce energy use, greenhouse gas emissions and emissions of many of the toxic pollutants of fossil-fuel-powered vehicles into the atmosphere.²⁴⁰

A study published in 2020 by Environmental Defence and the Ontario Public Health Association projected that replacing all cars and SUVs in the Greater Toronto area with electric vehicles would avoid 313 deaths from air pollution in Toronto every year. If all buses were replaced with electric buses as well, that figure increases to 456.²⁴¹ A study from China estimates that if just 27 percent of private cars and a slightly larger percentage of commercial vehicles were electric, the reduction in annual concentrations of fine particulate matter, nitrogen dioxide and summer concentrations of ozone in the air by 2030 could avoid almost 17,500 deaths across China every year.²⁴²

While there are environmental costs to manufacturing EVs, an electric vehicle powered by wind turbines or solar power

emits no pollution from fossil fuel combustion.²⁴³ 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."²⁴⁴ 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.²⁴⁵ As penetration of electric vehicles and clean energy increases, so do the climate benefits.

Electric cars are more than three times as energy 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 and greenhouse gas emissions.²⁴⁶ Gas-powered vehicles waste large amounts of energy; they lose about 60 percent of the energy they consume just to engine heat loss.²⁴⁷ EVs, on the other hand, waste little thermal energy, waste almost no energy from idling, and can recover energy using regenerative braking.²⁴⁸ As a result, EVs are able to convert more than 77 percent of electrical energy to power at the wheels, while gasoline-powered vehicles are only able to convert between 12 and 30 percent of the energy stored in gasoline.²⁴⁹ 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.²⁵⁰

Since electric vehicles are significantly quieter than internal combustion engines and their exhaust systems, switching to electric vehicles will also reduce noise pollution.



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. Photo: Dennis Schroeder, National Renewable Energy Laboratory

A growing body of research links noise pollution to a wide range of serious health impacts.²⁵¹ These include increased risk for cardiovascular disease and atrial fibrillation – which can increase the risk of heart failure and stroke – elevated stress levels, and impaired mental health.²⁵²

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.²⁵³ Compared to full-size vehicles, NEVs have smaller batteries and use less energy to charge and manufacture.²⁵⁴ 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.²⁵⁵

THE GOAL

All new light-duty cars and trucks sold after 2035 should be electric vehicles and all new medium and heavy-duty trucks sold by 2040 should be electric.

By phasing out sales of fossil fuel vehicles by 2035, including federal, state and municipal fleets, as well as private and business fleets (such as delivery trucks and ride hailing fleets that have high VMT), 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 11.9 years.²⁵⁶ 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 fossil fuel vehicles left on the road, barring proposals to ban or accelerate the retirement of such vehicles.

- Improve air quality and public health. Replacing gasoline vehicles with electric ones would reduce the harmful street-level emissions currently produced by internal combustion engines, including eliminating the particulate matter and nitrogen oxides released in vehicle exhaust. A 2019 study found that electrification of passenger vehicles would lead to modest improvements in air quality with the current grid and dramatic air quality improvements when EVs are powered by clean, renewable energy sources.²⁵⁷
- 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 fuel-related emissions from charging or driving.

GETTING THERE

Getting to 100 percent EV sales by 2035 can be achieved with existing technology and proven policy pathways. Today's EVs have a great 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."²⁵⁸

Americans are already adopting EVs in large numbers: nearly 330,000 electric vehicles were sold in 2019 alone, accounting for more than 2 percent of all vehicle sales.²⁵⁹ To date, a total of more than 1 million battery-powered and plug-in hybrid EVs have been sold cumulatively across the U.S.²⁶⁰ 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.²⁶¹

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 that 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.²⁶² 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."²⁶³ In September 2020, California Governor Gavin Newsom issued an executive order requiring 100 percent of in-state sales of new passenger cars and trucks be zero-emission by 2035.²⁶⁴

Achieving 100 percent EV sales nationally will also likely require action at the federal level. Indeed, while a transition to all-electric

tric 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 2030.²⁶⁵ If successful, such plans would help the U.S. achieve even more rapid reductions in greenhouse gas emissions and pollution.

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.²⁶⁶

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.²⁶⁷ 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.²⁶⁸

Financial incentives are proven tools to increase adoption of electric vehicles.²⁶⁹ 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.²⁷⁰ The tax credit was found to be particularly important for sales of lower-cost EVs, buyers of which tend to be price sensitive.²⁷¹

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.²⁷²

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. Similarly, used EV programs such as California's Clean Vehicle Rebate Project (CVRP) can help make EVs more accessible for low income residents. Rebates should be available at point of purchase.²⁷³

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.²⁷⁴ 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.²⁷⁵

Just as it is crucial to subsidize electric car ownership, encouraging people to switch from gasoline-powered vehicles to cleaner modes of transport can also be facilitated by subsidizing other electric modes of personal transport. The rise of the e-bike, for example, provides such an opportunity. In 2018, e-bike sales in the U.S. were up 79 percent over 2017 levels, prompting some industry experts to suggest that America could be on the brink of an "e-bike revolution."²⁷⁶ Those predictions appear to have been confirmed since.

During the coronavirus pandemic e-bike use has skyrocketed, with some manufacturers reporting sales three times those

of 2019.²⁷⁷ Given that almost 60 percent of vehicle trips in the U.S. are less than six miles, many of those trips can easily be done on e-bikes.²⁷⁸ In a 2018 survey, e-bike owners reported that more than 75 percent of their e-bike trips would have otherwise been made by car.²⁷⁹ However, for many people, the high cost of e-bikes is an obstacle to e-bike ownership.²⁸⁰ Currently neither the federal government nor any states provide any kind of tax credit for purchasing an e-bike. Where e-bike buying incentive programs have been put in place, however, research shows that they are successful in encouraging people to buy and use them.²⁸¹ To get people out of their cars, e-bikes should be included in clean vehicle incentive programs.

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.²⁸²

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.²⁸³ 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.²⁸⁴ 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.”²⁸⁵

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.²⁸⁶

Policies can also help make charging an electric vehicle as quick and 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.”²⁸⁷ 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.²⁸⁸ Moreover, instead of accepting payments through a commonly accepted method such as cash, credit or debit, some charging stations require users to take out a subscription while others allow users to pay for individual charges with a credit card. The fact that many of these services are incompatible with one another represents a further inconvenience for users.²⁸⁹

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.²⁹⁰ 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.²⁹¹ In addition to setting these kinds of common standards, cities should take a strategic approach to locating publicly available chargers, including shopping centers, workplaces, apartment buildings and other locations where people leave their cars for extended periods of time. Utility rate structure reform, such as limiting excessive demand charges, and time of use pricing, such as discounted off-peak charging rates, will incentivize EV adoption.

| Conclusion

AMERICA'S CAR-DEPENDENT transportation system is a public health disaster. Our cars and trucks put our lives and health on the line every day – from crashes on the roads to pollution in the air we breathe. We need to transform transportation to give Americans new freedom to travel in ways that are clean, convenient and beneficial to our health and our communities.

The technologies of a clean transportation future are already here. The pathways to that future are increasingly self-evident. What's needed now in order to achieve the sweeping changes necessary to protect our health, wellbeing and environment is a fundamental shift in thinking at the policy level regarding transportation infrastructure, land use, clean energy, pricing and more, as part of a new approach to transportation that puts public health and the environment first.

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