

# 1. INTRODUCTION

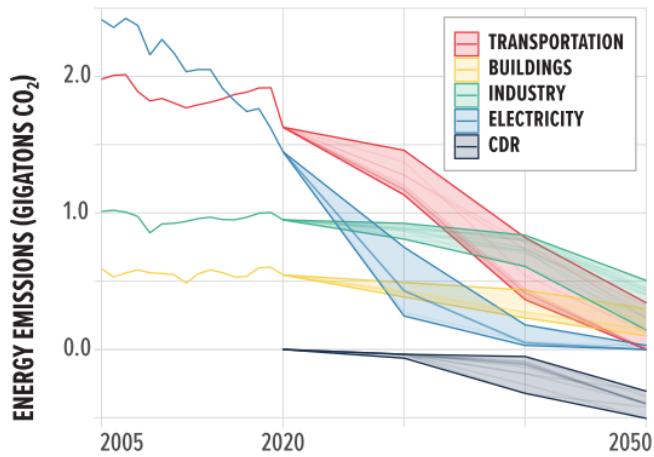
**"In the United States and around the world, we are already feeling the impacts of a changing climate. Here at home, in 2021 alone we have seen historic droughts and wildfires in the West, unprecedented storms and flooding in the Southeast, and record heatwaves across the country. We see the same devastating evidence around the world in places like the fire-ravaged Amazon, the sweltering urban center of Delhi, and the shrinking coastlines of island nations like Tuvalu. The science is clear: we are headed toward climate disaster unless we achieve net-zero global emissions by midcentury. We also know this crisis presents vast opportunities to build a better economy, create millions of good-paying jobs, clean our waters and air, and ensure all Americans can live healthier, safer, stronger lives."**

*The Long-Term Strategy of the United States, November 2021*

## A. CONTEXT & VISION

In November 2021, the Biden-Harris administration published *The Long-Term Strategy (LTS) of the United States*, a visionary climate strategy that outlines a plan to tackle the growing climate crisis by decarbonizing our national economy. The LTS established a goal of net-zero GHG emissions by no later than 2050 with an interim, near-term milestone of a 50–52% reduction from 2005 levels in economy-wide net GHGs by 2030. Addressing the climate crisis is critical for the long-term health and well-being of every resident of the United States and will require rapid, widespread, and major transformations of many complex systems that are closely intertwined with our economy and way of life. Achieving a net-zero-emissions economy by 2050 involves aggressive curbing of emissions from all sectors (see Figure 1), including transportation, which is now the largest source of U.S. GHGs—about a third of all domestic emissions. In the LTS, transportation emissions are projected to reduce by 80–100% by 2050.

The rising temperatures and increases in wildfires, droughts, and severe weather that are the direct



*Figure 1. The path to economy-wide decarbonization entails electricity emissions and emissions from transportation, buildings, and industry falling dramatically in all scenarios, with the greatest reductions coming from electricity, followed by transportation, and growth in non-land sink carbon dioxide removals (Source: LTS).*

impacts of climate change are already stressing the nation's transportation system. The results over the past few years are evident, for example, in the sections of California's Highway 1 that collapsed into the ocean

and forced officials to close the highway for more than a year and in the increased flooding in the New York City subway system. In Alaska, melting permafrost has buckled roads and bridges in areas that were previously frozen year-round. Flooding in the Gulf Coast halted rail service after Hurricane Harvey, and floods in Michigan shut down metropolitan highways for days. In Texas, a deadly ice storm led to several fatalities on I-35, while wildfires in California burned nearly 4,000 structures and mudslides in Colorado stranded more than 100 motorists overnight. Heat waves in the Pacific Northwest melted streetcar power cables in Portland. Deadly floods have occurred in eastern Kentucky, and hurricane winds knocked out power in all of Puerto Rico. Florida experienced its deadliest hurricane since the 1930s.

Without successfully decarbonizing the economy and fortifying the nation's infrastructure, impacts of climate change are projected to worsen and yield a substantial cost of *inaction*, potentially up to \$2 trillion annually or 10% of gross domestic product (GDP) by the end of the century [REF](#). The urgency is high, and the time to act is now. Transforming our transportation system, while challenging, is possible with a dedicated, coordinated effort. Doing so provides an unprecedented opportunity to tackle climate change, while improving quality of life; making mobility safer and more affordable; and creating vibrant, sustainable, healthy, resilient, and equitable communities.

In response to the urgency of the moment, the Department of Energy (DOE), the Department of Transportation (DOT), the Environmental Protection Agency (EPA), and the Department of Housing and Urban Development (HUD) are coordinating actions toward a decarbonized sustainable transportation future, starting with a memorandum of understanding (MOU) and this Blueprint. These agencies directly influence transportation decisions through policy, regulation, collaboration, and investments in innovation

## The urgency is high, and the time to act is now. Transforming our transportation system, while challenging, is possible with a dedicated, coordinated effort.

and RD&D of new technologies and infrastructure. **This Blueprint is the first comprehensive, whole-of-government approach to decarbonizing the transportation sector that aligns decision-making among agencies and identifies new and innovative opportunities for collaboration that are critical to achieving our shared vision of a future decarbonized transportation system.** The agencies provide guiding principles and strategies described here to shape future federal policies and actions direct the development and implementation of practical and effective pathways for all four agencies and our partners. This document will serve as a guide for other stakeholders, including other government agencies, local communities, the private sector, and philanthropic organizations, providing a united and consistent message on decarbonizing the transportation sector.

The Blueprint builds on and complements the LTS, which serves as a guidepost to determine the pathways for transportation, as part of a broader, U.S. economy-wide solution to the climate crisis. Following the Blueprint's release, the agencies will publish addenda detailing specific actions that each agency can take to enable and accelerate decarbonization across all transport modes and fuels. This Blueprint, and the addenda that will follow, are the beginning of a process that will continue to evolve over time. Consumer decisions, business actions, and evolving macroeconomic trends will shape the implementation of these strategies. To effectively address the climate crisis, we must be able to adjust course and act quickly to meet our goals through the decarbonization pathways outlined here.

## B. PLAN & STRATEGY

The emissions from transportation are the result of three interrelated factors, all of which must be addressed to achieve significant emissions reductions, while yielding significant co-benefits and advancing equity:

### 1. Transportation system design and land use –

Homes, workplaces, and services are often located far apart from one another. When people have limited transportation choices, or less accessible and efficient options, it can take them even more time to address their daily needs. The spatial mismatch between jobs, housing, and services is especially pronounced in disadvantaged communities.

### 2. Vehicle and engine efficiency –

While vehicle efficiency has improved greatly over the last several decades, further improvements are needed to meet decarbonization goals.

### 3. High-GHG fuels –

Petroleum provides nearly all energy used in transportation today. This reliance on petroleum is a major energy security concern and driver of transportation emissions.

**Decarbonizing the transportation sector will require strategies and actions that approach the problem from all angles.** Working with local partners to enhance land-use planning and coordinate public and private sector investments will tackle the problem at the root and make it possible for people to take fewer or shorter trips, or make it easier to walk and bike on those trips. This will both improve equity and provide better access to goods and services with less travel required for rural, suburban, and urban communities. Investments in passenger rail, public transportation, and active transportation infrastructure will give people the option to use more energy-efficient forms of transportation. And, thanks to significant strides in research and innovation, the technologies to decarbonize most

transportation systems are within sight and offer realistic and viable pathways to replace fossil fuels with sustainable solutions.

This Blueprint focuses on continued, coordinated RD&D and deployment efforts from multiple stakeholders to enable widespread and equitable deployment of solutions that are viable, affordable, and that have sufficient resources to scale. It also allows for the development of missing solutions via innovation and demonstration. We identify several enabling catalysts, such as policies that encourage increased convenience in our communities, transit and efficient mobility, vehicle



**Achieving meaningful reductions in emissions this decade is essential in reaching the near-term emissions reductions goals and enabling a pathway to reach net-zero emissions economy-wide by 2050.**

electrification, and availability of sustainable fuels. We can pair these actions with continued growth in research and technology deployment and coordination with the wide-ranging community to shape our transportation future. This will allow the United States to achieve our ambitious climate goals and improve lives.

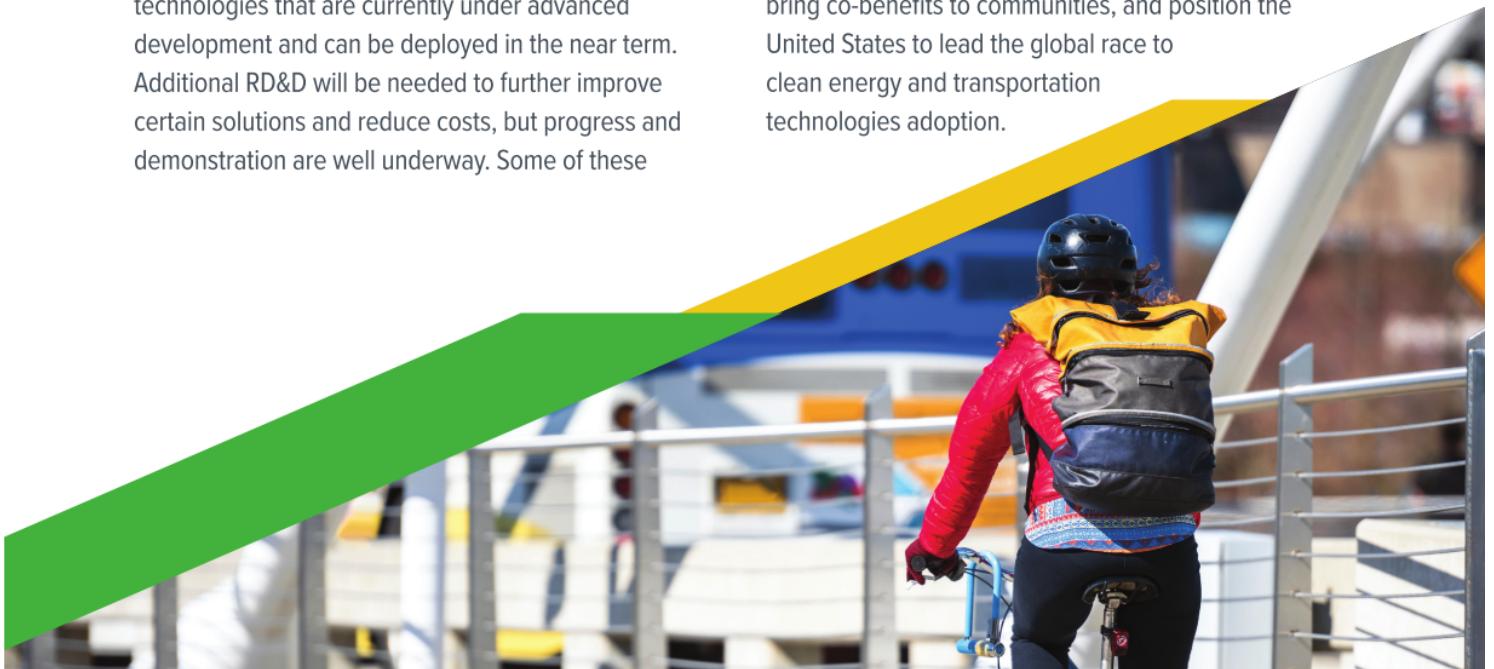
**We envision a future mobility system that is clean, safe, secure, accessible, affordable, and equitable, and provides decarbonized transportation options for people and goods.**

Achieving this vision will require actionable strategies that result in a major transformation of how people and goods move in the United States, including the modes of travel chosen and the fuels used. **This transformation is already underway, and consumers and businesses have started to adopt new clean technologies, but the trend needs to accelerate dramatically both in scale and scope. It is essential to make meaningful reductions in emissions this decade to reach near-term emissions reductions goals and enable a pathway to reach net-zero-emissions economy-wide by 2050.**

The strategies outlined in this Blueprint emphasize existing commercially available solutions or technologies that are currently under advanced development and can be deployed in the near term. Additional RD&D will be needed to further improve certain solutions and reduce costs, but progress and demonstration are well underway. Some of these

solutions will result in immediate emissions reductions while others will require a longer time to implement, with impacts that will be observed over the decades to come. We must act now to implement near-term and longer-term solutions that reduce GHG emissions from transportation.

Accordingly, this Blueprint's vision will guide and inform agencies' policy and decision-making across a wide range of activities, including regulatory standard development, infrastructure investments, grants and technical assistance, research and innovation, evaluation, and deployment. This Blueprint can also serve to guide other decision-makers, including federal, regional, state, local, and Tribal governments; the private sector, academia, and community-based organizations; and non-profit, grassroots, and philanthropic organizations toward decarbonized transportation solutions. Our vision for a transformed transportation sector not only minimizes GHG and pollutant emissions but also ensures improvements towards a safe, affordable, and equitable system that provides better access to clean transportation options for all communities. Transportation systems must support resilience to the impacts of climate change, create new domestic jobs and economic opportunities, bring co-benefits to communities, and position the United States to lead the global race to clean energy and transportation technologies adoption.



## ENVIRONMENTAL JUSTICE AND EQUITY

The benefits and costs of transportation systems in the United States have historically been unequally distributed. American transportation systems have disproportionately impacted underserved or overburdened communities [REF](#), [REF](#). Low- and medium-income and minority households tend to have less access to personal vehicles and fewer transportation options that connect them to housing, employment centers and other services and amenities. Historical underfunding of public transportation has deprioritized or neglected enhancements in public transportation quality in the communities that need it most, leading to longer travel times and constrained mobility options. These communities are often underfunded in other infrastructure areas, including sidewalks, bike lanes, and EV chargers, further constraining residents' transportation options.

Communities that are overburdened and historically underserved are also exposed to a disproportionate amount of air pollution and environmental hazards, including the release of toxic pollutants from petroleum refineries and petrochemical facilities, which exacerbates existing health and economic inequities. Additionally, **the financial burden of transportation as a percentage of income is almost three-times higher for households in the bottom income quintile compared to the top quintile** [REF](#).

These disproportionate impacts are reinforced by a long history of federal, state, and local policies that have shaped our transportation system. In many cities and towns, exclusionary practices such as redlining and other discriminatory housing policies led to racially segregated neighborhoods, with areas with predominantly minority populations tending to suffer from chronic underinvestment. While investments in amenities were disproportionately directed to wealthier areas, highways were in many cases intentionally routed through existing neighborhoods, damaging the character and economies of those communities, and affecting the wellbeing of residents due to long-lasting effects from worsened air quality, increased heat and noise pollution, and physical barriers to opportunity and mobility.

In some places, housing policies and land-use decisions have reinforced the transportation barriers.<sup>4</sup> For example, disjointed housing and transportation policies over the past decades have impeded access to safe and reliable transportation options and hindered travel to critical destinations—including work, schools, grocery stores, and health care facilities—leading to increased transportation and housing cost burdens.<sup>5</sup> Further, many communities' land-use codes or development processes have failed to provide sufficient affordable housing, thereby excluding low-income and moderate-income residents. In many instances, these communities can lift exclusionary barriers, invest more in affordable housing, and link those investments to enhancements in public transportation and a viable mix of travel options.<sup>6</sup> Additionally, communities of color have often been passed over for infrastructure wealth-creation opportunities such as jobs, careers, and the use of minority-owned contractors.

The federal government is committed to the Justice40 initiative, which establishes the goal that at least 40% of the benefits of certain federal investments flow to disadvantaged communities [REF](#). As investments in cleaner transportation solutions increase, it will be important to ensure that disadvantaged communities reap the benefit of those investments, including jobs and business opportunities. It will be necessary to balance community priorities as potential federal investments are considered. Strategies should avoid resident displacement and address the need for quality affordable housing near transit or other affordable and convenient transportation options. Federal investments in the clean energy economy can lead to decreased consumer costs, increased access to clean transportation, improved public health, new business and workforce opportunities, and enhanced community resiliency [REF](#). Meaningful public involvement is critical to realize these goals, including early and proactive discussions with communities to develop plans and programs. Decarbonizing the transportation sector while addressing equity will be key to ensuring our future transportation infrastructure results in better outcomes for everyone, particularly residents of disadvantaged communities.

<sup>4</sup> Ewing, Reid, Rolf Pendall, and Don Chen. "Measuring sprawl and its transportation impacts." *Transportation research record* 1831 (2003): 175-183.

Howell, Amanda, et al. "Transportation impacts of affordable housing." *Journal of Transport and Land Use* 11.1 (2018): 103-118.

<sup>5</sup> Rothstein, R. (2018). *The color of law*. Liveright Publishing Corporation.

<sup>6</sup> Van Wee, Bert. "Land use and transport: research and policy challenges." *Journal of transport geography* 10.4 (2002): 259-271; Litman, Todd. "Evaluating transportation land use impacts." (2008).

Achieving a net-zero economy by 2050 will require major transformations across all sectors and effective integration between them. The *Inventory of U.S. Greenhouse Gas Emissions and Sinks*, which EPA publishes annually, provides detailed accounting of GHG emissions across the U.S. economy.<sup>REF</sup> The sources of GHG emissions for 2019 are shown in Figure 2, along with additional detail for the transportation sector.<sup>7</sup> This Blueprint focuses on reducing emissions from the use phase of the transportation sector (the blue slice in Figure 2). Analyses throughout this Blueprint will use 2019 as a baseline, as impacts due to the COVID-19 pandemic complicate the use of later data.

## 2019 U.S. GHG EMISSIONS

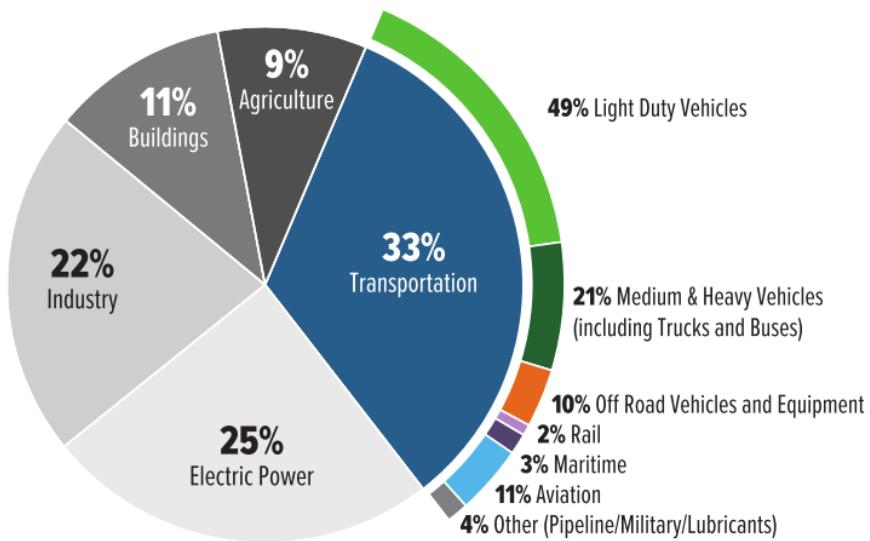
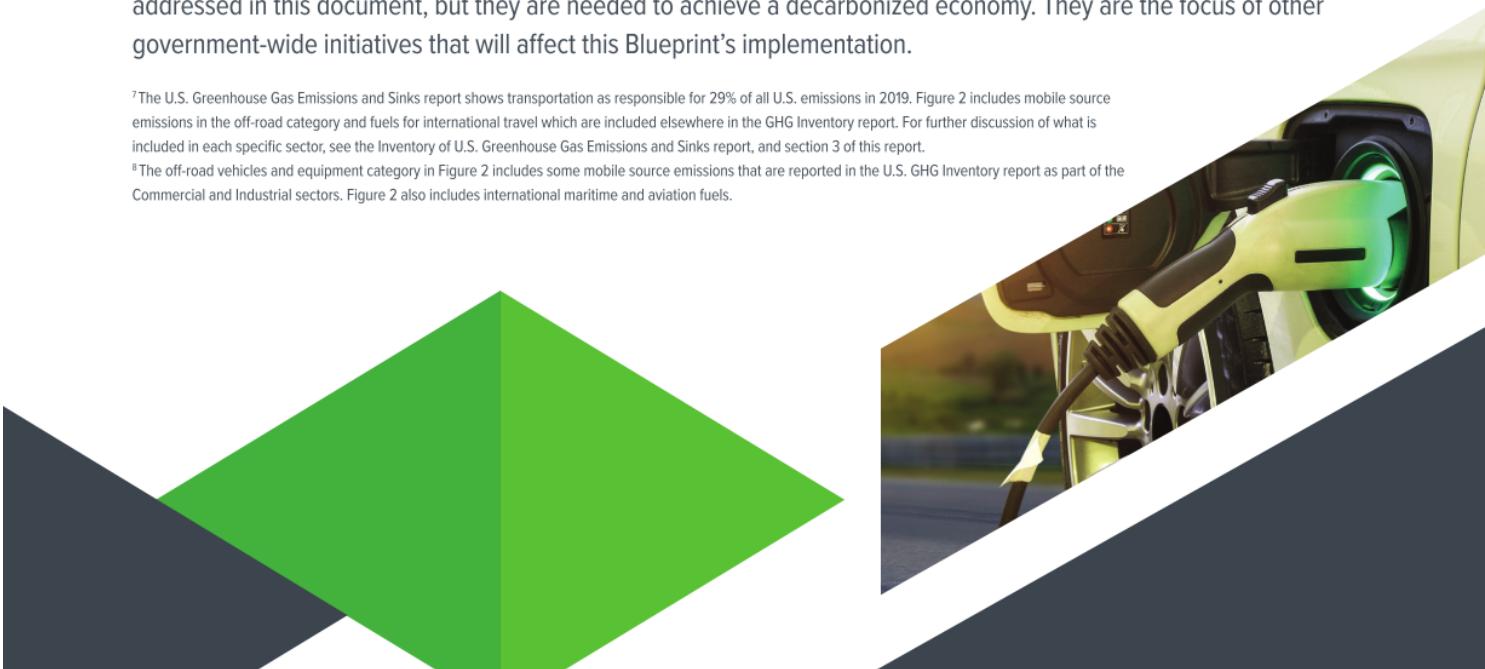


Figure 2. Total 2019 U.S. GHG emissions with transportation and mobile sources breakdown. Data derived from the EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks <sup>REF</sup>.<sup>8</sup> This Blueprint uses 2019 as a baseline since impacts due to COVID-19 complicate the use of later data.

Transportation is closely interconnected with other sectors of the economy. For example, EVs rely on electricity generation and will have different implications for manufacturing relative to manufacturing of internal combustion engine vehicles. Specific strategies to reduce full life-cycle emissions associated with transportation activities are not addressed in this document, but they are needed to achieve a decarbonized economy. They are the focus of other government-wide initiatives that will affect this Blueprint's implementation.

<sup>7</sup>The U.S. Greenhouse Gas Emissions and Sinks report shows transportation as responsible for 29% of all U.S. emissions in 2019. Figure 2 includes mobile source emissions in the off-road category and fuels for international travel which are included elsewhere in the GHG Inventory report. For further discussion of what is included in each specific sector, see the Inventory of U.S. Greenhouse Gas Emissions and Sinks report, and section 3 of this report.

<sup>8</sup>The off-road vehicles and equipment category in Figure 2 includes some mobile source emissions that are reported in the U.S. GHG Inventory report as part of the Commercial and Industrial sectors. Figure 2 also includes international maritime and aviation fuels.





## LIFE-CYCLE EMISSIONS AND EMBODIED CARBON

This Blueprint focuses on the direct transportation emissions from the use phase of transportation vehicles and systems, but our vision considers full life-cycle emissions reductions and recognizes that the transportation sector also induces additional GHG emissions from the production and end-of-life phases. These include GHG emissions from fuel production and processing; vehicle manufacturing and disposal; and construction, maintenance, and disposal of transportation infrastructure. Transportation systems contribute to climate pollution at a variety of points and full life-cycle transportation GHG emissions need to be considered and addressed. The carbon emissions from the full life-cycle of a product or service—often referred to as “embodied carbon”—are significant, although they are not included in the 33% of economy-wide emissions attributed to the transportation sector in Figure 2. Decarbonizing those sectors of our economy is the focus of other government-wide initiatives that complement this Blueprint. In particular, many transportation decarbonization solutions rely on electricity directly or indirectly (such as the production of hydrogen or certain sustainable fuels). Achieving

100% clean electricity by 2035, largely through new solar and wind energy development, will be a critical co-strategy to support transportation decarbonization [REF](#).

For example, according to America’s Cement Manufacturers, over the next five years, spending from the BIL alone will result in the use of 18.63 million metric tons (MMT) of cement for roads and bridges, 5.78 MMT for airports, 2.99 MMT for ports and waterways, and 0.31 MMT for rail and transit. About 0.5-0.6 tons of carbon dioxide (CO<sub>2</sub>) is emitted per ton of cement produced, so cement used in projects funded by the BIL will result in about 15.2 MMT of CO<sub>2</sub> emissions [REF](#) [REF](#). This is equivalent to the emissions from about 3.3 million gasoline-powered vehicles driving for a year. Reaching the goal of net-zero GHG emissions by 2050 requires addressing the GHG emissions associated with the production and end-of-life phases of fuels, vehicles, and transportation infrastructure and systems, both directly through procuring lower-carbon materials and indirectly by employing more sustainable construction practices, including leveraging digitalization and e-construction.

This Blueprint provides a comprehensive, system-level perspective covering the entire transportation sector across all passenger and freight travel modes and fuels, and lays out a three-pronged strategy for a transition to a sustainable transportation future, all centered around providing better options to **increase convenience, improve efficiency, and transition to clean options:**

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**1**

### INCREASE CONVENIENCE

by supporting community design and land-use planning at the local or regional level that ensure that job centers, shopping, schools, entertainment, and essential services are strategically located near where people live to reduce commute burdens, improve walkability and bikeability, and improve quality of life...

*...Because every hour we don't spend sitting in traffic is an hour we can spend focused on the things and the people we love, all while reducing GHG emissions.*

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**2**

### IMPROVE EFFICIENCY

by expanding affordable, accessible, efficient, and reliable options like public transportation and rail, and improving the efficiency of all vehicles...

*...Because everyone deserves efficient transportation options that will allow them to move around affordably and safely, and because consuming less energy as we move saves money, strengthens our national security, and reduces GHG emissions.*

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**3**

### TRANSITION TO CLEAN OPTIONS

by deploying zero-emission vehicles and fuels for cars, commercial trucks, transit, boats, airplanes, and more...

*...Because no one should be exposed to air pollution in their community or on their ride to school or work and eliminating GHG emissions from transportation is imperative to tackle the climate crisis.*



**Coordination of effort across all three of these areas will be necessary to achieve our long-term goals.**

**It is essential to implement design solutions that increase convenience, provide better access to clean modes of travel, and support demand management policies that make it easier and more convenient to choose more efficient travel options.**

These solutions, which may take time to implement, will provide critical co-benefits such as improved safety and quality of life, and while they are not sufficient to reach our net-zero goals, they are essential to offsetting expected increase in travel demand driven by population and economic growth. It will also be important to improve system and vehicle efficiency, while supporting greater use of more efficient travel modes such as rail and transit. Absent solutions to increase convenience and improve efficiency, we will see the undesirable outcomes of travel amplified—more and longer trips needed to support day-to-day activities; long hours spent sitting in traffic on the daily commute; and higher expenses for gasoline, vehicle maintenance, and other costs.



A transition to clean options that involves the rapid and widespread deployment of clean vehicle and fuel technologies is critical to achieving deep emissions reductions by mid-century. Agency-led efforts are crucial to tying these strategies to necessary policies and partnerships and to further incentivize innovation where it is most needed to accelerate the pace of deployment. Collaboratively focusing on solutions ranging from system-level design integrations to investments in new technologies will allow all Americans to benefit from improved mobility options in the equitable and decarbonized transportation sector of the future.

