Surface Transportation Reauthorization and Climate Change: H.R. 2 and S. 2302

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SUMMARY

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Federal highway, public transportation, and intercity passenger rail programs are authorized through FY2020 under the Fixing America's Surface Transportation (FAST) Act (P.L. 114-94). During the 116th Congress, transportation bills including provisions related to climate change have moved forward in both the House and the Senate. In August 2019, the Senate Committee on Environment and Public Works reported the America's Transportation Infrastructure Act of 2019 (ATIA; S. 2302), which would reauthorize the highway infrastructure elements of surface transportation programs from FY2021 through FY2025. In July 2020, the House of Representatives passed the Investing in a New Vision for the Environment and Surface Transportation (INVEST) in America Act as part of the larger Moving Forward Act (H.R. 2). The INVEST in America Act would provide an extension of existing highway, public transportation, and intercity passenger rail programs for one year (FY2021) and a subsequent four-year reauthorization of modified programs (FY2022-FY2025). S. 2302 and H.R. 2 include both *mitigation* policies and programs that aim to reduce greenhouse gas (GHG) emissions from surface transportation and *adaptation* policies and programs that seek to make the surface transportation system more resilient and less vulnerable to the impacts of actual or expected future climate change.

Recent changes in the earth's climate and expected future changes are strongly related to the emission of GHGs from man-made sources. Transportation accounted for 28% of GHG emissions in the United States in 2018, the largest amount of any economic sector. These GHG emissions come mainly from highway travel, with passenger cars and light-duty trucks responsible for about 59% of the total, and heavy- and medium-duty trucks responsible for another 23%. GHG emissions from transportation peaked in 2005, but have risen over the past few years in part because of increased passenger travel and goods movement; emissions growth has been somewhat mitigated by improvements in vehicle fuel efficiency. Data are likely to show a continued increase of transportation emissions in 2019, but a drop in 2020 due to the disruptions related to the COVID-19 pandemic.

GHG emissions from surface transportation are largely a function of vehicle fuel efficiency, the carbon content of fuel used, and vehicle miles traveled (VMT). There are several current federal policies that address GHG emissions, but emissions reduction was not a primary goal when they were enacted. Moreover, many of these policies and programs are not typically addressed in surface transportation reauthorization legislation. For example, vehicle fuel efficiency standards were enacted mainly to address dependence on foreign oil and are typically undertaken in energy legislation.

Both S. 2302 and H.R. 2 include funding and policy changes that address GHG emissions primarily from a transportation infrastructure perspective. For instance, both bills include new programs aimed at reducing carbon pollution by funding infrastructure projects that would reduce highway vehicle travel. In the Senate bill this program would be authorized at $700 million per year and in the House bill at almost $2.1 billion per year. Both bills also include new programs to fund alternative fueling infrastructure, $200 million per year in the Senate bill and $350 million per year in the House bill. H.R. 2 would also authorize major increases in funding for public transportation and intercity passenger rail programs. For public transportation funding, for example, H.R. 2 would increase the authorized amount from $12.2 billion per year in the FAST Act to $21.4 billion per year.

Impacts from actual or expected future climate change are likely to include higher average temperatures, greater extremes of temperature, more precipitation overall with an increase in intensity and variation, and a rise in sea level. Existing surface transportation infrastructure may be vulnerable to a changing climate because it was constructed for sea level and weather extremes that are being or are likely to be exceeded in the future. Adaptation measures are actions taken to reduce the vulnerabilities and increase the resilience of the transportation system to these effects.

Currently, there is no dedicated surface transportation funding for adaptation and resilience projects, although existing program funding in many cases can be used to assess the potential impacts of climate change and to apply adaptation strategies. Both S. 2302 and H.R. 2 would create a new highway program for resilience projects. The Senate bill would authorize about $1 billion per year and the House bill would authorize almost $1.6 billion per year. Both bills would also require greater consideration of climate change in transportation planning.

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Introduction

Surface transportation is a major source of carbon dioxide (CO_2) in the atmosphere, one of the main greenhouse gases (GHGs) contributing to climate change. At the same time, the effects of climate change, such as extreme heat and sea level rise, pose a threat to highways, bridges, and public transportation infrastructure.

The authorization of federal highway, public transportation, and intercity passenger rail programs in the Fixing America's Surface Transportation (FAST) Act (P.L. 114-94) expires on September 30, 2020. Committees in both the House of Representatives and the Senate have taken reauthorization of surface transportation programs as an opportunity to propose policies and programs that address climate change.

In August 2019, the Senate Committee on Environment and Public Works unanimously reported the America's Transportation Infrastructure Act of 2019 (ATIA; S. 2302), which would reauthorize the highway infrastructure elements of surface transportation programs from FY2021 through FY2025. In July 2020, the House of Representatives passed the Investing in a New Vision for the Environment and Surface Transportation (INVEST) in America Act as part of the larger Moving Forward Act (H.R. 2). The INVEST in America Act would provide an extension of existing highway, public transportation, and intercity passenger rail programs for one year (FY2021) and a subsequent four-year reauthorization of modified programs (FY2022-FY2025).

S. 2302 and H.R. 2 include both *mitigation* policies and programs that aim to reduce GHG emissions from surface transportation and *adaptation* policies and programs that aim to make the surface transportation system more resilient to the impacts of actual or expected future climate change and to reduce its vulnerability to the harmful effects of future climate change. This report begins with a discussion of transportation sector emissions and mitigation, and then moves to a discussion of climate change adaptation.

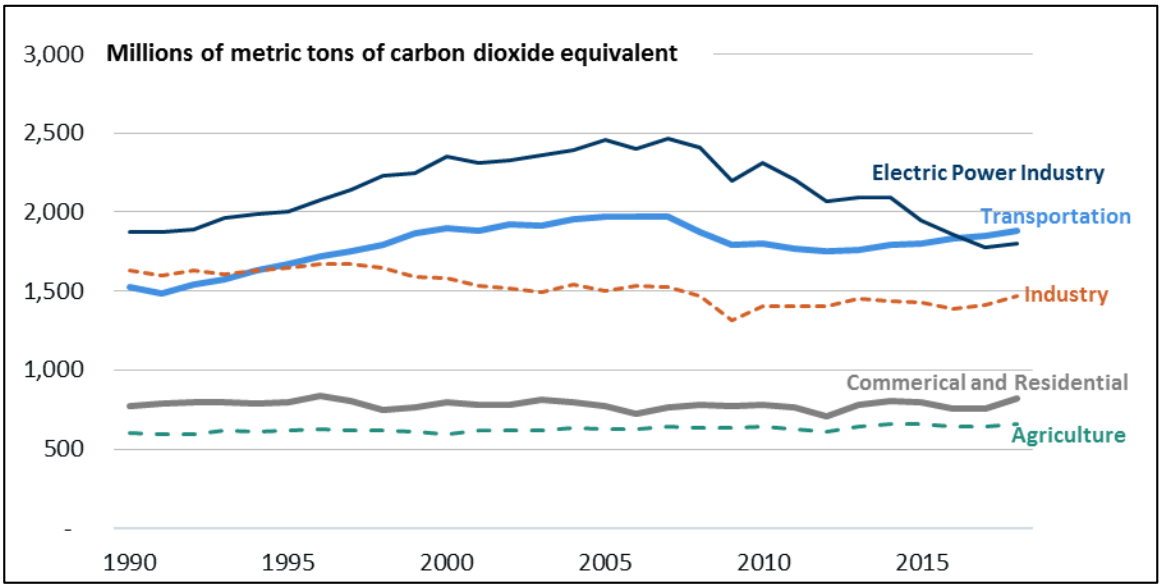
Transportation and GHG Emissions

The U.S. Environmental Protection Agency (EPA) estimates that since 2017, transportation has emitted more GHGs than any other sector of the U.S. economy. In 2018, transportation accounted for approximately 28% of the total (**Figure 1**).[1] Total GHG emissions from transportation were about 5% less in 2018 than in 2005, but have risen each year since a recent low in 2012, in part because of increased passenger travel and goods movement; the effects of greater vehicle mileage have been somewhat mitigated by improvements in fuel efficiency. Data are likely to show a continued increase of transportation emissions in 2019, but a drop in 2020 due to the disruptions related to the COVID-19 pandemic.

[1] If GHG emissions from the electric power industry are distributed to end-use sectors, emissions from the industrial sector were higher than those from transportation through 2018.

Figure 1. U.S. Greenhouse Gas Emissions by Economic Sector

1990-2018



Source: Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018*, table 2-10, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2018.

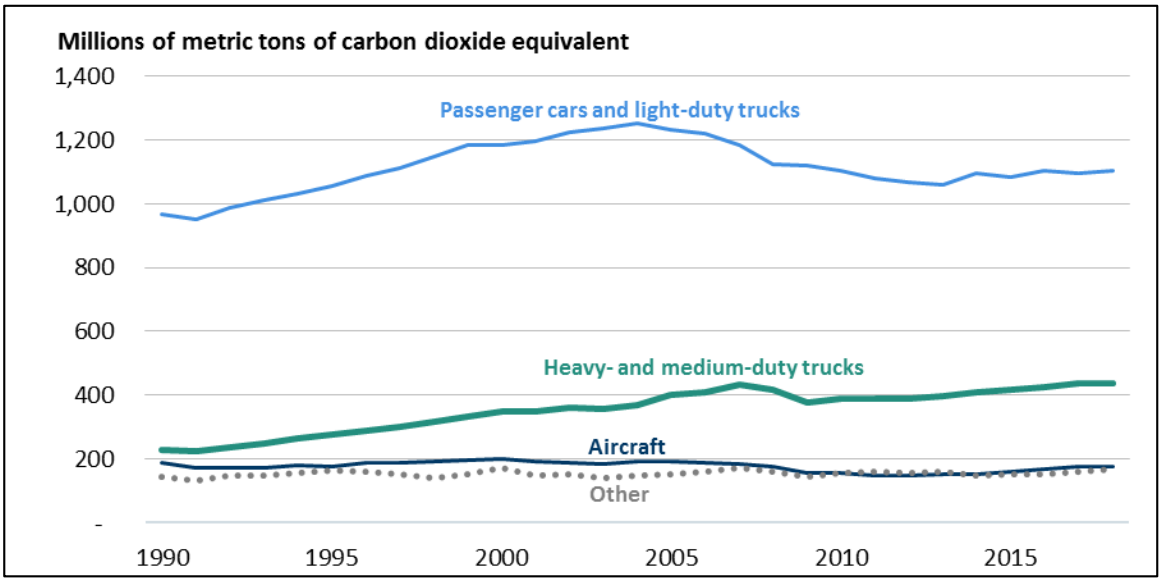
Passenger cars and light-duty trucks were responsible for about 59% of the transportation sector's GHG emissions in 2018, and heavy- and medium-duty trucks for another 23%. Since 2009, when the economy began to grow after the recession that began in 2007, GHG emissions from heavy- and medium-duty trucks have risen by almost 16%. Over that period, GHG emissions from passenger cars and light-duty trucks dropped by 1% (**Figure 2**).

Almost all GHG emissions from the transportation sector are due to the release of CO_2 from the combustion of gasoline and diesel. Other GHGs, such as hydrofluorocarbons (HFCs), from air conditioning coolant, make up only about 3% of emissions from the sector.

GHG emissions from surface transportation are a function of vehicle fuel efficiency, the carbon content of fuel used, and vehicle miles traveled (VMT). VMT is a product of vehicle trips and trip distance, which themselves are related to a broader set of factors that include land use and the attractiveness of alternative transportation modes such as public transportation and bicycling. Places that are close together, such as homes and workplaces, will generate less travel, all else being equal. Greater use of alternative modes, similarly, will reduce the number of vehicle trips. For freight transportation, VMT is determined by the distance between where goods are produced, consumed, imported, and exported; the types of goods involved; and the speed and cost of different modes, such as trucking, rail, and water transportation.[2]

[2] Ralph Sims et al., "Chapter 8: Transport," in Ottmar Edenhofer et al. (eds.), Mitigation of Climate Change: Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 2014, at https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_full.pdf.

Figure 2. Greenhouse Gas Emissions from Transportation in the United States
1990-2018



Source: Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018*, table 2-13, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2018.

Note: "Other" includes buses, motorcycles, ships and boats, rail, pipelines, and lubricants.

Vehicle travel, and thus transportation GHG emissions per capita, are related to gross domestic product (GDP) per capita. Countries with lower GDP per capita, such as India and China, emit less GHG per capita from transportation than the United States. Nevertheless, there are major differences between countries with similar incomes. For example, the United States has about three times the transportation emissions per capita than Germany, Japan, and the United Kingdom (**Figure 3**).

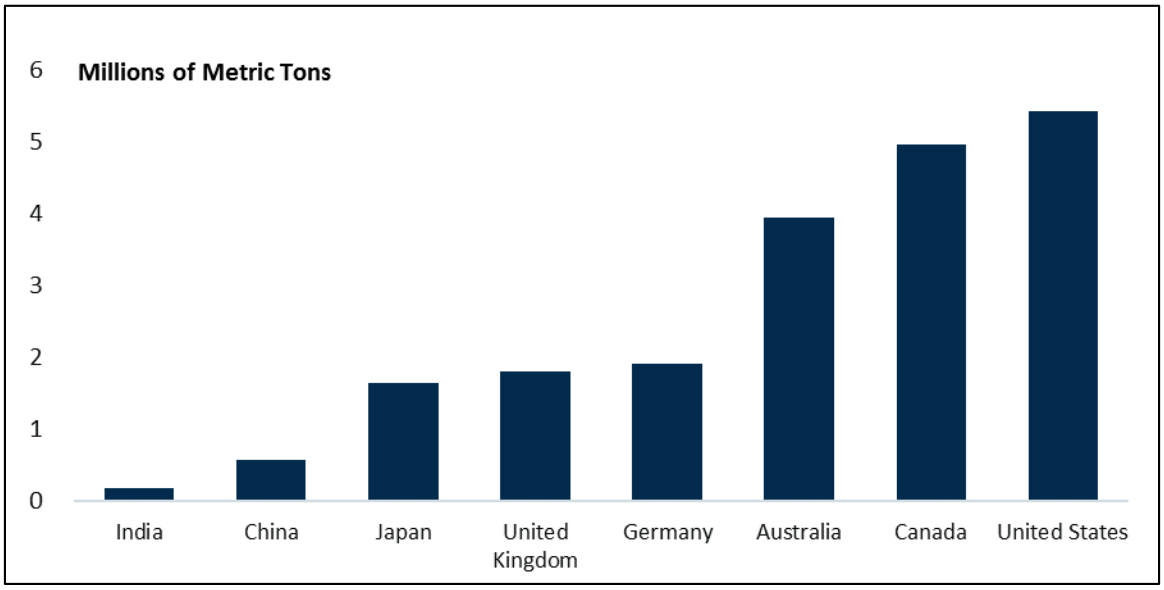
A prominent reason that GHG emissions per person from transportation are higher in the United States is the much greater amount of driving. For example, annual VMT per capita in the United States is about twice that in Great Britain.[3] Moreover, American cars and light trucks tend to be less fuel-efficient than those in other high-income countries. In 2013, for example, light-duty vehicles in the United States required, on average, 9 liters of gasoline equivalent to travel 100 kilometers, 80% more than in Japan, the country that had the most fuel-efficient fleet.[4]

[3] Federal Highway Administration, *Highway Statistics, 2018*, table VM-1; U.S. Census Bureau; Department for Transport, *Transport Statistics, Great Britain*, 2018; Office for National Statistics, *Overview of the UK Population: August 2019*.

[4] Global Fuel Economy Initiative, *LDV Fuel Economy and G20*, https://www.globalfueleconomy.org/data-and-research/publications/ldv-fuel-economy-and-g20.

Figure 3. CO_2 Emissions from Transportation per Capita, Selected Countries

2014



Source: Organisation for Economic Co-operation and Development (OECD), International Transport Forum, "Performance Indicators: Energy and Environment," https://www.itf-oecd.org/search/statistics-and-data.

Mitigating GHG Emissions from Surface Transportation

Economists generally agree that broad, market-based policies, such as a cap and trade system or carbon tax, are likely to be the most efficient way to reduce GHG emissions across all economic sectors.[5] A carbon tax would place a price on GHG emissions. A cap and trade system would place a cap on emissions and allow the market to determine the price of emissions.[6] Instead of an economy-wide system, however, most countries, including the United States, employ "an array of greenhouse gas mitigation policies that provide subsidies or restrictions typically aimed at specific technologies or sectors."[7] Many subsidies and restrictions have been specifically aimed at the transportation sector.[8]

Motor vehicle fuel taxes might be considered a crude form of carbon tax in surface transportation, and a factor in the amount of driving and the use of more fuel-efficient vehicles in other countries. In 2018, the average of U.S. state taxes weighted by fuel volume combined with the federal tax on a gallon of gasoline was 45 cents. The equivalent tax was $2.39 per gallon in Japan, $3.83 in the United Kingdom, and $4.36 in Italy.[9] Federal taxes on gasoline and diesel in

[5] Peter Howard and Derek Sylvan, *Expert Consensus on the Economics of Climate Change*, Institute for Policy Integrity, New York University School of Law, December 2015, p. 15, at https://www.edf.org/sites/default/files/expertconsensusreport.pdf.

[6] CRS Report R45472, *Market-Based Greenhouse Gas Emission Reduction Legislation: 108th through 116th Congresses*, by Jonathan L. Ramseur.

[7] Kenneth Gillingham and James H. Stock, "The Cost of Reducing Greenhouse Gas Emissions," *Journal of Economic Perspectives*, Vol. 32, No. 4, Fall 2018, pp. 53-72.

[8] David L. Greene and Stephen Plotkin, *Reducing Greenhouse Gases from U.S. Transportation*, Pew Center on Global Climate Change, January 2011.

[9] Federal Highway Administration, *Highway Statistics 2018*, table IN-1, at https://www.fhwa.dot.gov/

the United States have been collected largely to raise funds for infrastructure construction, not with the purpose of controlling GHG emissions.[10] They have sometimes been considered in surface transportation authorizing legislation.[11]

Several other current federal policies that address GHG emissions from transportation were not put in place for that purpose, and are not typically addressed in surface transportation reauthorization legislation. For example, vehicle fuel economy is regulated by the Corporate Average Fuel Economy (CAFE) standards administered by the National Highway Traffic Safety Administration (NHTSA) and, by extension, the GHG standards, administered by EPA. The CAFE standards were established in the 1970s under the authority of the Energy Policy and Conservation Act, as amended, primarily to reduce dependence on imported oil. The GHG standards were promulgated under the authority of the Clean Air Act, as amended. Neither of these standards is likely to be taken up in the surface transportation reauthorization.

Further, while recent surface transportation acts have encouraged the development and use of alternatively powered vehicles, the GHG emissions attributable to those vehicles over their service lives depend upon the power sources used to refine raw materials, manufacture vehicle components, and fuel the vehicles' engines or charge their batteries. These policies, along with tax incentives and grants for the domestic development and manufacture of alternative fueled vehicles, are typically dealt with in energy bills.[12]

Surface transportation programs do in some respects encourage the deployment of alternative fueled vehicles. For example, the Federal Transit Administration's program that provides funding for buses includes a discretionary set-aside for buses that are alternatively fueled. The original motivation for this was to meet air quality goals, but such policies may help reduce GHGs from surface transportation.

Policies aimed at reducing VMT have been enacted for several reasons, particularly congestion reduction and the attainment of ambient air pollution standards. The Congestion Mitigation and Air Quality Improvement (CMAQ) program, part of the Federal-Aid Highway Program, provides federal funding for projects that contribute to the attainment of ambient air pollution standards for ozone, carbon monoxide, and particulate matter. This typically involves projects that reduce pollutant emissions from passenger cars and trucks in ways that may contribute to lower GHG emissions. Other surface transportation programs that may contribute indirectly to the reduction of GHG emissions include the Transportation Alternatives Program, which funds projects such as bicycle and pedestrian infrastructure, and the federal public transportation program.

GHG Mitigation Provisions in H.R. 2 and S. 2302[13]

Both H.R. 2 and S. 2302 would authorize funding for new programs that aim to reduce or mitigate GHG emissions from surface transportation (**Table 1**). H.R. 2 also would authorize large increases in funding for public transportation and intercity passenger rail that may contribute to a

policyinformation/statistics/2018/in1.cfm.

[10] Prior to this, federal taxes on gasoline and diesel were typically used for general purposes. CRS Report RL30304, *The Federal Excise Tax on Motor Fuels and the Highway Trust Fund: Current Law and Legislative History*, by Sean Lowry.

[11] Motor fuels tax provisions in past surface transportation bills have been reported by the House Ways and Means Committee and the Senate Finance Committee.

[12] CRS Report R42566, *Alternative Fuel and Advanced Vehicle Technology Incentives: A Summary of Federal Programs*, by Lynn J. Cunningham et al.

[13] Although they are not wholly equivalent terms, the bills appear to use the terms "carbon," "carbon dioxide," and "greenhouse gas emissions" interchangeably. This report employs the terms as they are used in the respective bill texts.

reduction in GHGs. In the Senate, public transportation programs are under the jurisdiction of the Banking, Housing, and Urban Affairs Committee and intercity passenger rail programs are under the jurisdiction of the Commerce, Science, and Transportation Committee. Neither committee has acted on reauthorization legislation.

The bills would authorize both formula programs, with funds distributed to the states according to a formula laid out in law, and discretionary programs, for which U.S. Department of Transportation agencies determine grant awards according to evaluation criteria in law. Not all programs that may influence GHG emissions are detailed here. For example, both bills would reauthorize the CMAQ program that seeks to reduce air pollutants from surface transportation. However, the comparisons below do include detail on other policy changes that appear to be directly related to reducing GHG emissions.

Table 1. Proposed New Funding Programs Related to Reducing GHG Emissions

Program	Average Annual Authorization (millions of dollars)
America's Transportation Infrastructure Act (S. 2302)	
Carbon Reduction Incentive Program	700
Formula	*600*
Discretionary	*100*
Alternative Fueling Infrastructure Program	200
Port Emissions Reduction Program	74
Congestion Relief Program	40
INVEST in America Act (H.R. 2)	
Carbon Pollution Reduction Program	2,085
Alternative Fueling Infrastructure Program	350
Community Climate Innovation Program	250
Active Transportation Connectivity Program	63
Gridlock Reduction Program	63

Source: H.R. 2 (as passed by the House of Representatives on July 1, 2020) and S. 2302 (as reported by the Senate Committee on Environment and Public Works on August 1, 2019).

Notes: Average annual authorizations are based on five years (FY2021-FY2025) for S. 2302 and four years (FY2022-FY2025) for H.R. 2.

Highway Programs for GHG Reduction Projects

- S. 2302 (§1403) would establish formula and discretionary grant Carbon Reduction Incentive programs to support projects and planning that reduce on-road mobile sources of CO_2 emissions. Eligible projects might include ridesharing programs, truck stop electrification, and incident management programs. Funding would average $600 million annually for the formula program and $100 million annually for the discretionary program. The Senate bill would also establish a discretionary grant program to support projects that would

reduce GHG and air pollutant emissions at ports by reducing truck idling (§1402). Funding would average $74 million annually.

- H.R. 2 (§1213) would establish a formula program, the Carbon Pollution Reduction (CPR) Program, to fund surface transportation projects that reduce GHG emissions to meet new, state-established GHG emission performance goals established at 23 U.S.C. §150. High-performing states would be allowed to transfer funds from the CPR Program to the more flexible Surface Transportation Program (STP). Low-performing states would be required to transfer 10% of their STP funds to the CPR Program. Funding for this program would average $2.1 billion per year. H.R. 2 (§1304) would also establish a discretionary Community Climate Innovation Grant Program to fund surface transportation projects that reduce GHG emissions. Funding would be $250 million per year.

Highway Programs Related to Alternative Fueling

- S. 2302 (§1401) would establish a discretionary grant program to support the construction and operation of alternative fueling infrastructure (electric, hydrogen, and natural gas) along designated alternative fuel corridors. Funding would average $200 million annually.
- H.R. 2 (§1303) would establish a discretionary program for alternative fueling infrastructure in designated corridors, including electric, hydrogen, natural gas, and propane. Funding would be $350 million per year.

Highway Programs for Highway Congestion Reduction

- S. 2302 (§1404) would establish a discretionary grant program for highway congestion reduction projects that may indirectly reduce transportation emissions. Funding would average $40 million annually.
- H.R. 2 (§1306) would establish a discretionary Gridlock Grant Reduction Program, with at least half of the funds set aside for projects that address freight congestion. For freight-related projects the reduction of GHG emissions is an evaluation factor. Funding would be $250 million for FY2022 only.

Non-Motorized Programs

- S. 2302 (§1109(a)) would increase the annual amount of Surface Transportation Program Block Grant Program funds set aside for the Transportation Alternatives Program from an average of $844 million per year under the FAST Act to an annual average of $1.249 billion. S. 2302 (§1208) would also require the use of some state planning and research and metropolitan planning funding for the development of "safe and accessible options for multiple travel modes for people of all ages and abilities."
- H.R. 2 (§1309) would establish a discretionary Active Transportation Connectivity Grant Program for projects related to walking and bicycling. Funding would be $250 million for FY2024 only. H.R. 2 would also increase funding of the Transportation Alternatives Program, a set-aside of Surface Transportation Block Grant Program (STBG) funding. Funding for FY2020 is $850 million. Funding under H.R. 2 would average $1.5 billion per year.

Freight Programs

- S. 2302 would allow for funding for highway and freight programs—both the existing Nationally Significant Freight and Highway Projects Program (known as the INFRA Grants Program) (§1110) and National Highway Freight Program (§1114)—to be used for water transportation projects, such as locks, dams, and marine highways, if a project is expected to reduce on-road mobile source emissions. A diesel engine emissions reduction program, administered by the Department of Energy, would be reauthorized (§1408).
- H.R. 2 (§1301) would change eligibility of the INFRA Grants Program to include major public transportation and intercity passenger rail projects. Section 1212 would modify the goals of the National Highway Freight Program to specifically include reducing GHG emissions.

Other Highway Programs

- H.R. 2 (§1302) would establish a discretionary program for community transportation investment grants. These grants would be for projects to improve surface transportation safety, asset condition, accessibility, and environmental quality. GHG emissions reductions would be one evaluation factor. Funding would be $600 million per year.

Public Transportation and Intercity Passenger Rail Program

- H.R. 2 would authorize major increases in funding for public transportation and intercity passenger rail programs and make other changes that could be considered climate change mitigation provisions, assuming that the funding leads to a rise in ridership that replaces trips made by private vehicles. Section 2101 would authorize an increase in public transportation funding from $12.2 billion per year to $21.4 billion per year. Section 2201 would create a discretionary grant program for transit agencies that increase bus frequency or succeed in increasing ridership. As is traditionally the case, H.R. 2 would authorize about 80% of the funding for the public transportation programs from the mass transit account of the Highway Trust Fund and the other 20% from the general fund.
- H.R. 2 would increase dedicated funding for the purchase of low- and no-emission buses and related infrastructure from $55 million per year to about $430 million per year.
- H.R. 2 would also authorize major increases in intercity passenger rail funding, including a large increase for Amtrak. In FY2020, intercity passenger rail programs were authorized at $2.2 billion from the general fund. H.R. 2 would authorize $11.9 billion per year on average from the general fund.

Other Provisions

- S. 2302 (§1510) would establish a federal interagency working group to develop a strategy to transition the vehicle fleets of federal agencies to hybrid-electric vehicles, plug-in electric drive vehicles, and alternative fueled vehicles.
- H.R. 2 would add GHG reduction to the list of national performance goals (§1403) and add specific references to GHG reduction throughout the federal highway and public transportation programs. H.R. 2 (§1201) would also place new requirements on the use of National Highway Performance Program funds

for building new capacity for single-occupant vehicles. These requirements would include demonstrating progress toward state of good repair on National Highway System roads in the state and a comparative economic analysis of alternatives such as operational and public transportation improvements.

- H.R. 2 (§1403) would require the Secretary of Transportation to establish measures of transportation access for use in statewide and metropolitan planning processes. States and metropolitan planning organizations would be required to assess how transportation projects planned would affect the overall level of transportation system access.

Adaptation to Climate Change in Surface Transportation

Impacts from actual or expected future climate change are likely to include higher average temperatures, greater extremes of temperature, more precipitation overall with an increase in precipitation intensity and greater variation, and a rise in sea level. While the consequences of some of these changes may depend to some extent on other human activities, such as urban development patterns, they are likely to include more frequent periods of extreme heat; fewer days below freezing; more coastal, riverine, and flash flooding; and more droughts and wildfires. Intense precipitation could lead to more mudslides, particularly following droughts and wildfires.[14]

Existing surface transportation infrastructure can be vulnerable to climate change because it was constructed for sea level and weather extremes that are being or are likely to be exceeded in the future. If the effects of climate change become more pronounced, as studies anticipate, the impacts of extreme weather on surface transportation infrastructure and operations are likely to increase in magnitude, duration, and frequency. For example, an increase in the number of very hot days may cause more damage to bridges because of greater thermal expansion of bridge joints. More intense precipitation and flooding could result in more road washouts, bridge scour, and roadside mudslides. Not all the effects of climate change will be negative for transportation infrastructure. For example, a warmer climate could reduce road pavement deterioration in some places due to less freezing, snow, and ice.[15]

The effects of climate change on surface transportation, both in terms of the infrastructure and its operation (**Table 2**), will vary according to the type of climate event, the type of transportation asset, and its location. A rise in sea level and storm surge, for example, would most likely affect transportation systems along the Atlantic and Gulf Coasts, particularly in specific places that are susceptible to land subsidence, erosion, and the loss of wetlands. Higher average temperatures may reduce travel disruption due to snow and ice, but may also cause more freeze-thaw cycles that damage infrastructure in northern states. In Alaska, warming is shortening the ice road season and thawing permafrost. The loss of permafrost could lead to road and bridge damage through foundation settlement, slope instability, and shoreline damage.

[14] Transportation Research Board, *Strategic Issues Facing Transportation, Volume 2: Climate Change, Extreme Weather Events, and the Highway System: Practitioner's Guide and Research Report*, NCHRP Report 750, 2014.

[15] Transportation Research Board, *Potential Impacts of Climate Change on U.S. Transportation*, Special Report 290, 2008.

Table 2. Climate Change and Examples of the Effects on Surface Transportation

Potential Climate Change	Example of Effects on Operations	Example of Effects on Infrastructure
Increase in very hot days	More potential buckling of public transportation rail (slow orders)	Greater thermal expansion of bridge joints
Decrease in very cold days	Reduced travel disruption due to snow and ice	Decreased damage to roads and bridges from road salt
Increases in Arctic temperatures	Shorter season for ice roads	More subsidence of road beds due to thawing of permafrost
Sea level rise and storm surge	More interruption of services in coastal areas due to flooding of roads, bridges, and rail lines	Greater damage to coastal roads, bridges, and rail lines
Increase in extreme precipitation events	Increase in weather-related delays	Increase in road washouts, landslides, bridge scour
Increase in droughts and wildfires	More disruption due to poor visibility and rerouting	Fire destruction of roads, bridges, and rail infrastructure
Change in seasonal precipitation and flooding patterns	More interruption of services due to flooding of roads, bridges, and rail lines	Increase in road washouts, landslides, bridge scour
Increases in hurricane intensity	More frequent and more extensive emergency evacuations	Destruction of roads and bridges

Source: CRS, based on Transportation Research Board, *Potential Impacts of Climate Change on U.S. Transportation*, Special Report 290, 2008, Annex 3-1.

"Adaptation" is action to reduce the vulnerabilities and increase the resilience of the transportation system to the effects of climate change.[16] Adaptation and resilience options for surface transportation systems include structural and nature-based engineering and policy-based activities. For example, highway bridges can be engineered structurally to withstand the threats of higher wind and water. Nature-based engineering may involve reducing climate vulnerabilities through activities such as wetland restoration, construction of artificial reefs, and beach restoration. Policy-based activities include changing maintenance practices, such as more frequent cleaning of drains, and improving operations plans for weather emergencies.[17]

Currently, there is no dedicated surface transportation funding for adaptation and resilience projects. The Federal Highway Administration (FHWA) has stated that federal-aid highway funds can be used to assess the potential impacts of climate change and to apply adaptation strategies.[18] Likewise, federal transit funding administered by the Federal Transit Administration (FTA) can be used for adaptation projects. Both FHWA's and FTA's Emergency Relief programs, which

[16] There is no consensus on the definitions of "adaptation" and "resilience." FHWA defines adaptation as "adjustment in natural or human systems in anticipation of or response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative effects" and resilience as "the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions." See Federal Highway Administration, "Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events," FHWA Order 5520, at https://www.fhwa.dot.gov/legsregs/directives/orders/5520.cfm.

[17] Federal Highway Administration, *Vulnerability Assessment and Adaptation Framework, 3rd Edition*, FHWA-HEP-18-020, 2017, https://www.fhwa.dot.gov/environment/sustainability/resilience/adaptation_framework/.

[18] Federal Highway Administration, "Eligibility of Activities to Adapt to Climate Change and Extreme Weather Events Under the Federal-Aid and Federal Lands Highway Program," Memorandum, September 24, 2012, at https://www.fhwa.dot.gov/federalaid/120924.cfm.

provide funds for rebuilding after natural disasters, also allow some spending on resiliency features.[19] Moreover, several aspects of federal law, regulation, and policy require state and local agencies that manage surface transportation assets to consider the effects of climate change. FHWA, in cooperation with state departments of transportation, has sponsored vulnerability assessments and conducted research into making surface transportation more resilient to climate change.[20] FTA has conducted similar research in cooperation with transit agencies.[21]

Adaptation and Resilience Provisions in S. 2302 and H.R. 2

Both H.R. 2 and S. 2302 would create new programs dedicated to highway infrastructure adaptation and resilience (**Table 3**). H.R. 2 does not include similar dedicated programs for public transportation or intercity passenger rail infrastructure.

Table 3. Proposed New Funding Programs for Infrastructure Adaptation and Resilience

Program	Average Annual Authorization (millions of dollars)
America's Transportation Infrastructure Act (S. 2302)	
PROTECT Grant Program	986
Formula	*786*
Discretionary	*200*
Disaster Relief Mobilization Pilot Program	1
INVEST in America Act (H.R. 2)	
Predisaster Mitigation Program	1,563

Source: H.R. 2 (as passed by the House of Representatives on July 1, 2020) and S. 2302 (as reported by the Senate Committee on Environment and Public Works on August 1, 2019).

Notes: Average annual authorizations are based on five years (FY2021-FY2025) for S. 2302 and four years (FY2022-FY2025) for H.R. 2.

Definitional Issues

- S. 2302 (§1103) would add definitions to Title 23 of the *U.S. Code*, including "resilience" and "natural infrastructure." Resilience would be defined as "a project with the ability to anticipate, prepare for, or adapt to conditions or withstand, respond to, or recover rapidly from [weather and natural disaster] disruptions." Natural infrastructure would be defined as infrastructure that "uses, restores, or emulates natural ecological processes."
- H.R. 2 (§1103) would add definitions to 23 U.S.C. §101(a) including "adaptation," "climate change," "evacuation route," "greenhouse gas," "natural

[19] CRS Report R45298, *Emergency Relief for Disaster-Damaged Roads and Public Transportation Systems*, by Robert S. Kirk and William J. Mallett.

[20] Federal Highway Administration, "Resilience Pilots," at https://www.fhwa.dot.gov/environment/sustainability/resilience/pilots/.

[21] Federal Transit Administration, *Transit and Climate Change Adaptation: Synthesis of FTA-Funded Pilot Projects*, August 2014.

infrastructure," "protective feature," "repeatedly damaged facility," and "resilience." It also would add "assessing resilience" to the definition of "construction."

Highway Programs for Adaptation and Resilience Funding

- S. 2302 (§1407) would establish a grant program, the PROTECT Grant Program, to support adaptation and resilience projects, such as constructing more resilient infrastructure, natural infrastructure, and a more resilient transportation system, including improved evacuation routes and access to routes to important facilities, such as hospitals. Funding would average $986 million annually, with $786 million distributed to the states by formula and $200 million distributed competitively. Discretionary grants would be awarded for planning, resilience, community resilience and evacuation routes, and at-risk coastal infrastructure. The program would also be intended encourage the development of resilience improvement plans. Section 1505 would also create a disaster relief mobilization pilot program to help communities "develop disaster preparedness and disaster response plans that include the use of bicycles."
- S. 2302 would make certain "protective features" designed to mitigate the risk of recurring damage from extreme weather events, flooding, or other natural disasters eligible expenses under the federal highway program. The federal government would pay up to 100% of the cost of projects such as raising roadway grades, stabilizing slopes, and adding bridge scour protection; for most other types of highway construction, the states would be required to pay at least 10% or 20% of the cost. The Senate bill would make natural infrastructure, added in the definitions section, eligible for federal highway funding. S. 2302 would also add resilience as an additional consideration for funding in the INFRA Grants Program.
- S. 2302 (§1105) would add to the purposes of the National Highway Performance Program (NHPP) "to provide support for measures to increase the resiliency of Federal-aid highways and bridges on and off the National Highway System to mitigate the impacts of sea level rise, extreme weather events, flooding, or other natural disasters." The Senate bill would allow up to 15% of the annual apportionment of NHPP funding to be used for resilience features for a highway or bridge that is not part of the National Highway System. Anew discretionary highway bridge funding program (§1119) would include resilience and benefits to nonvehicle users and public transportation as evaluation factors.
- H.R. 2 (§1202) would establish a Predisaster Mitigation Program to enhance the resilience of the transportation system, including strengthening infrastructure and improving evacuation routes. Funding distributed by formula would average $1.6 billion per year. H.R. 2 also would add resilience to the goals and eligibilities of programs throughout the surface transportation program.
- H.R. 2 (§1201) would add to the purpose of the National Highway Performance Program (23 U.S.C. §119) "to increase the resilience of Federal-aid highways and bridges." It would make "Projects on or off the National Highway System to enhance resilience of a transportation facility, including protective features," eligible for funding from the program.

Highway Emergency Relief Program

- S. 2302 (§1523) would add wildfire and sea level rise to the definition of natural disaster in the Highway Emergency Relief program, and explicitly make economically justifiable resilience features eligible for funding as part of repair and reconstruction projects.
- H.R. 2 (§1203) would make changes to the Emergency Relief Program to provide specific authority for betterments "including protective features to increase the resilience of the facility." This section would also authorize funding from the general fund for a Predisaster Hazard Mitigation Pilot program. Funds from the pilot program would be for cost-effective resilience projects.

Planning Provisions

- S. 2302 (§1405) would add adaptation strategies to the required contents of the National Freight Strategic Plan and state freight plans.
- H.R. 2 (§§1201, 1401, and 1402) would make changes to state and metropolitan planning requirements to include an analysis of the effects of climate change, such as specific references to resilience and conducting a vulnerability assessment.

Research

- S. 2302 (§3003) would create a Data Integration Pilot Program that would "provide research and develop models that integrate, in near-real-time, data from multiple sources." In so doing, the Secretary of Transportation would be required to "address the safety, resiliency, and vulnerability of the transportation system to disasters." Section 3005 would add to the requirements of an infrastructure needs report the inclusion of resilience needs (23 U.S.C. §503(b)(8)(A)).
- H.R. 2 (§1621) would require a climate-resilient infrastructure study to be conducted by the Transportation Research Board (TRB). H.R. 2 (§1303) would also require a TRB study on developing a national electric vehicle charging network.

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