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ADDRESSING TRANSPORTATION'S IMPACT

A Starter Guide to Reducing Transportation Greenhouse Gas Emissions

MOMENTUM

U.S. Department of Transportation, Office of the Secretary
www.transportation.gov/Momentum

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WHY CONSIDER CLIMATE CHANGE IN TRANSPORTATION DECISION-MAKING?

Transportation contributes to and is affected by climate change. Greenhouse gas (GHG) emissions from all modes of transportation contribute to climate change, just as sea level rise and extreme weather events resulting from climate change affect transportation, disrupting networks and degrading infrastructure.

Governments have an important role to play in achieving deep GHG emission reductions and building resilience to the impacts of climate change. This Toolkit explores the transportation sector's contributions to climate change and discusses options for governments to innovate with policies that reduce GHG emissions from transportation. Well-designed government policies can:

- Increase convenience by creating more livable communities;
- Improve efficiency by providing options to encourage shifting travel towards more efficient transport modes;
- Transition to cleaner transportation options by deploying zero emission vehicles, incentivizing sustainable fuels in hard-to-abate sectors, and improving efficiency for all vehicle types; and
- Promote the use of sustainable materials and construction practices, reducing emissions on a life-cycle basis.

The Building Resilient Infrastructure Toolkit in this series explores ways that governments can protect new and existing transportation infrastructure from the impacts of climate change while reducing transportation's GHG emissions.

What does the science tell us about climate change?

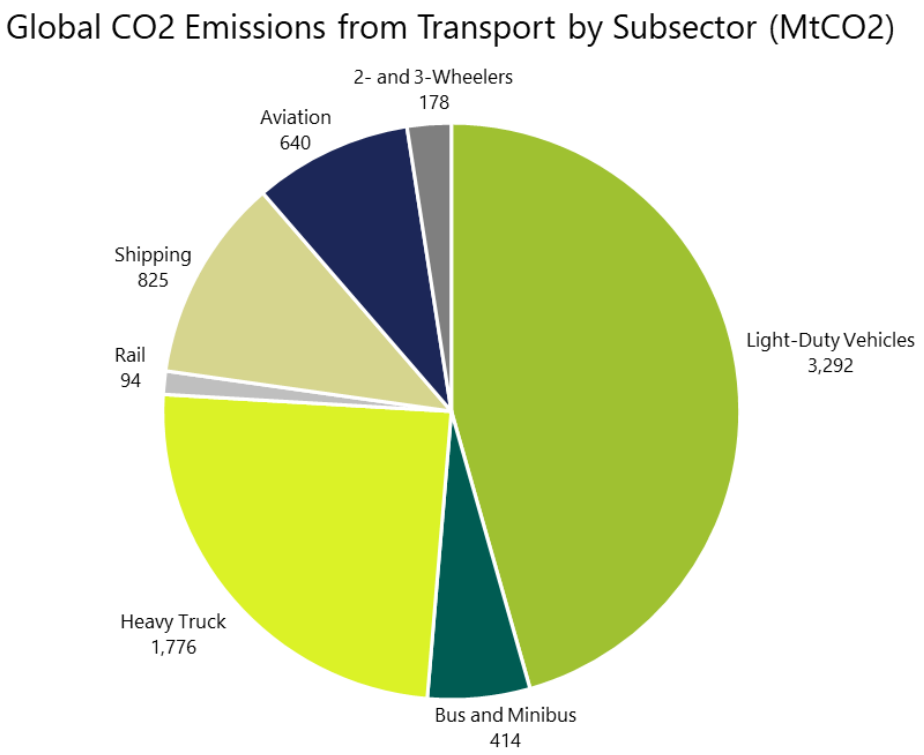
The world is facing a profound climate crisis. The scientific community has made clear that the scale and speed of necessary action is greater than previously understood. The Intergovernmental Panel on Climate Change (IPCC) has warned that significant and potentially dangerous shifts in climate and weather are possible even at 1.5 degrees Celsius (2.7 degrees Fahrenheit) of global warming beyond preindustrial levels.[1] At the 26th UN Climate Change Conference of the Parties (COP26), participating countries reaffirmed the Paris Agreement goal of limiting the increase in the global average temperature to well below 2 degrees Celsius above pre-industrial levels and pursuing efforts to limit it to 1.5 degrees Celsius. The Glasgow Climate Pact recognizes "that limiting global warming to 1.5 degrees Celsius requires rapid, deep and sustained reductions in global greenhouse gas emissions, including reducing global carbon dioxide (CO_2) emissions by 45 percent by 2030 relative to the 2010 level and to net zero around midcentury, as well as deep reductions in other greenhouse gases."[2]

Climate change is a threat to the global economy. The economic impacts and disruptions caused by climate change will be particularly acute for vulnerable populations. The World Bank estimates that the effects of climate change could push an additional 130 million people into poverty by 2030 and cause over 200 million people to migrate within their own countries by 2050.[3]

[1] IPCC, 2018. *Summary for Policymakers*, in *Global Warming of 1.5°C. An IPCC Special Report*. Available at: https://www.ipcc.ch/sr15/chapter/spm

[2] Glasgow Climate Pact. https://unfccc.int/sites/default/files/resource/cma3_auv_2_cover%2520decision.pdf

[3] The World Bank. October 26, 2021. World Bank Group COP26 Climate Briefs. https://www.worldbank.org/en/topic/climatechange/publication/world-bank-group-cop26-climate-briefs



(Source: International Energy Agency. Tracking Transport 2021. https://www.iea.org/reports/tracking-transport-2021)

Rising GHG emissions are causing an increase in average global temperatures and the frequency and severity of natural disasters, including storms, flooding, and wildfires.[4] This, in turn, poses many threats to transportation systems and users, including:

- Damage to roads, bridges, railways, ports, airports, and tunnels caused by flooding or extreme temperatures, disrupting travel and trade while driving maintenance and repair costs;
- Unsafe travel conditions during adverse weather events; and
- Increased congestion and travel delays due to weather events and failed or damaged infrastructure.

Emissions from the transport sector – including road, rail, air, and marine transportation – accounted for over 24 percent of global CO_2 emissions.

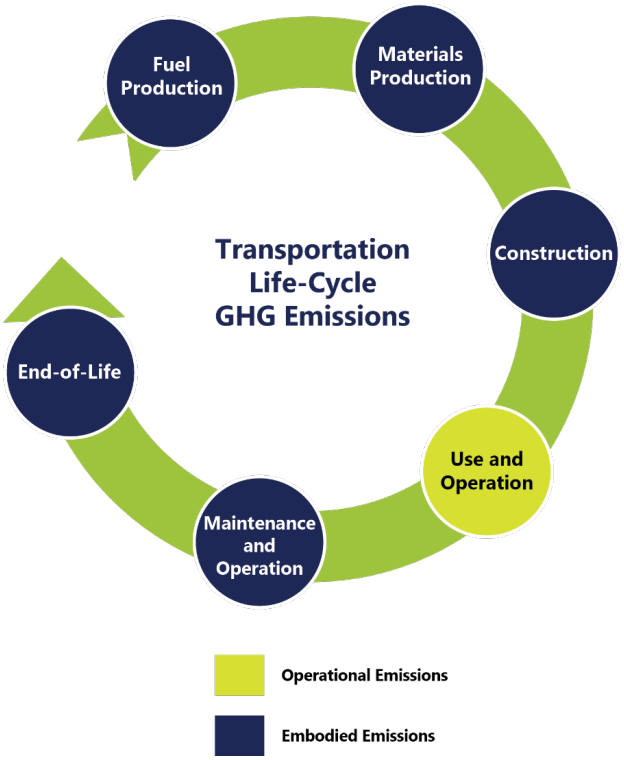
Without immediate action, transport GHG emissions are expected to continue to grow as global transportation demand increases over the coming decades. One set of projections forecasts that, absent significant policy shifts, total global emissions from transportation to increase from an estimated 8,400 megatons of CO2-equivalent emissions in 2020 to an estimated 11,700-12,700 megatons of CO_2-equivalent emissions in 2050.[1]

[4] IPCC, *Climate Change 2022 Summary for Policymakers: Impacts, Adaptation, and Vulnerability,* (H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama eds., 2022) at https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/

WHAT ARE SOURCES OF TRANSPORTATION RELATED GHG EMISSIONS?

The majority of GHGs emitted from transportation is CO_2 produced from burning of fossil fuels to operate cars, trucks, ships, airplanes, and other vehicles. Other GHGs emitted through the operation of transportation vehicles include methane (CH_4), nitrous oxide (N_2O) and hydrofluorocarbon (HFC) emitted during vehicle use. GHGs emitted through the operation of transport vehicles are known as operational emissions. In addition, there are also emissions associated with the production, refining, and distribution of fuels; the manufacture and disposal of vehicles, ships, trains and airplanes; the production and processing of construction materials (e.g., asphalt, concrete, steel); and the construction, maintenance, and disposal of transportation infrastructure. These are sometimes described as "embodied emissions," and they can be measured when the emissions associated with a product's development, production, transport and use are considered on a life-cycle basis. Some international bodies have developed tools for quantifying emissions on a life-cycle basis.[5] Transportation agencies can have a large influence over these emissions.

Reducing both operational and embodied emissions play an important role in reducing overall transportation-related GHG emissions.



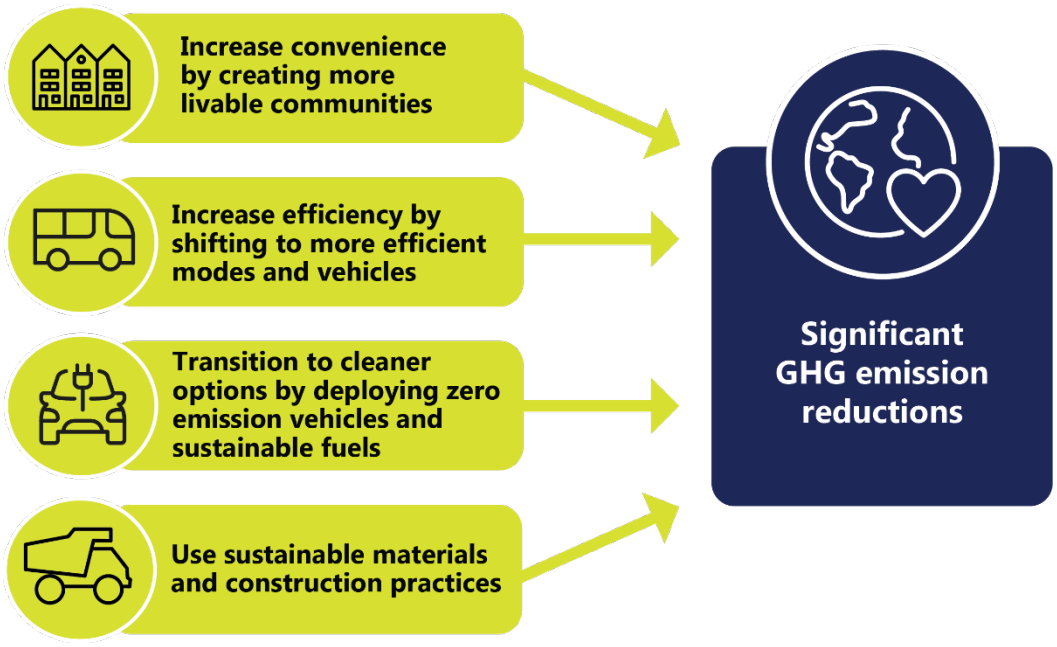
[5] See, e.g., ICAO (International Civil Aviation Organization). 2021. "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels." ICAO, Montreal. https://www.icao.int/environmental-protection/CORSIA/Documents/ICAO%20document%2006%20-%20Default%20Life%20Cycle%20Emissions%20-%20March%202021.pdf

WHAT ARE EFFECTIVE STRATEGIES TO REDUCE TRANSPORTATION-RELATED GHG EMISSIONS?

A broad set of policies and actions is needed to achieve a sustainable, low-carbon transportation system. Strategies to deliver better, more efficient transportation systems while driving down GHG emissions include:

- Use integrated land use and transportation planning to **locate people's work close to their homes, schools, medical and other community services** to reduce commuting times and distances.
- Use integrated transportation planning to **promote efficient modes like transit and rail** to connect communities to each other and to larger urban cores.
- **Provide incentives for encouraging transition to cleaner options**, including zero-emission vehicles, sustainable fuels, and improved efficiency for all vehicle types, including cars, trucks, agricultural and construction equipment, aircraft, trains, and ships.
- Adopt policies that **encourage the use of more sustainable materials and construction practices.**

When applied collectively, these multifaceted strategies can enable countries to achieve deep GHG emission reductions, encouraging more efficient forms of vehicle use, supporting a greater reliance on active and public transportation, accelerating the adoption of low- or zero-emission vehicle technologies and fuels, and building transportation infrastructure sustainably.



HOW CAN INTEGRATED LAND USE AND TRANSPORTATION PLANNING SUPPORT SUSTAINABLE TRANSPORTATION?

Communities benefit when decisions about transportation and land use are made at the same time. Deciding to build houses, schools, grocery stores, employment centers, and transit stations close to one another—while providing a well-connected street network and facilities for walking or biking—provides more transportation choices and convenient access to daily activities.

Compact and transit-oriented developments:

- Enhance integration of multimodal transportation infrastructure and facilities;
- Expand opportunities for economic development and revitalization;
- Reduce consumption of open land and rural landscapes;
- Allow people to make shorter trips, fewer trips, or walk or bike to where they need to go;
- Decrease the overall cost of moving people, goods, and services; and
- Can reduce infrastructure and operating costs for new roads, water and sewers, schools, and services.

Integrated land use and transit-oriented development primarily occurs when regional or local governments encourage it through land use planning, zoning laws, and changes to building codes, among other things.

Malaysia Mass Rapid Transit (MRT) in Kuala Lumpur

For more information:

- Federal Transit Administration Transit-Oriented Development webpage and resources
- Federal Highway Administration Transportation and Livability webpage and resources
- U.S. Environmental Protection Agency Smart Growth webpage

WHAT ACTIONS CAN GOVERNMENT AGENCIES TAKE TO SHIFT TRAVEL AND GOODS MOVEMENT TO MORE EFFICIENT MODES AND VEHICLES?

Shifting travel demand to more efficient and lower GHG-emitting modes is another pillar of developing a sustainable, low-carbon transportation system. In a well-planned transportation system, various alternative modes of transportation come together to form a connected system of options that support mobility, access, and energy efficiency.

When replacing motor vehicle trips, active transportation, micromobility, and public transportation can help to curb climate change impacts and improve access and mobility for underserved communities.

Facilitating Mode Shift Towards More Efficient Modes

Active Transportation: Active transportation is any human-powered mode of mobility, such as biking and walking. Active transportation directly replaces motor vehicle miles traveled, so these modes are effective at conserving fuel, reducing vehicle emissions, bridging the first- and last-mile gap, and improving individual and public health.

Micromobility: Micromobility refers to any small, low-speed, human- or electric-powered transportation device, including bicycles, scooters, electric-assist bicycles (e-bikes), electric scooters (e-scooters), and other small, lightweight, wheeled conveyances. These devices offer new ways to help people meet their transportation needs for short trips. E-bikes and e-scooters can help many people overcome barriers that would otherwise prevent them from taking active forms of transportation.

Public Transportation: Public transportation includes buses, urban and regional rail systems, aerial tramways, and ferries, among other modes. Although public transportation produces GHG emissions, public transportation emissions are lower on a per-passenger mile basis due to higher occupancy rates and lower energy consumption. These methods of transit can also be electrified more easily than other modes, creating a pathway to zero emissions.

The use of transportation demand management (TDM) strategies in conjunction with compact and transit-oriented development can further enable communities to reduce transportation-related GHG emissions. TDM is the application of strategies and policies to dynamically manage demand, including reducing travel demand or redistributing the demand to alternate modes or routes.

Active transportation and micromobility strategies to promote the use of more efficient transportation modes include:

- Accommodating all roadway users with comprehensive street design measures such as "complete streets," including sidewalks, bicycle lanes, and share-the-road signs that provide safe and convenient travel for all users of the roadway;
- Separating motor-vehicle traffic from non-motorized traffic with physical barriers, such as the construction of bicycle boulevards;
- Constructing a connected network of multi-use trails; and
- Providing shared bicycle and scooter fleets near transit stops and stations, in well-traveled areas, or public parking corrals.

Public transportation strategies to promote the use of more efficient transportation modes include:

- Providing high-frequency, reliable transit services;
- Improving local access connections to transit stations to enable travelers to easily move from one mode to another;
- Providing incentives for using transit, such as reduced transit fares, and/or disincentives for driving, such as congestion pricing, tolls, and charging for parking; and
- Improving safety and accessibility at public transportation stations and stops.

Fuel Efficiency Improvements

The average fuel consumption of new Internal Combustion Engine (ICE) vehicles has improved significantly in recent years due to governments imposing more stringent emission regulations. In addition to establishing new or increasingly stringent vehicle emission standards, governments can support fuel efficiency improvements by creating incentives to retire older vehicles for more fuel-efficient vehicles. Achieving efficiency improvements is particularly important for the aviation and shipping sectors, given strong projected growth in these sectors and the long implementation timescales for new, low-emission propulsion technologies. Governments can work collaboratively with industry to encourage the development and deployment of lower-emission vehicles (including heavy trucks, buses, railcars, shipping vessels, and aircraft).

For more information:

- Federal Highway Administration Guidebook for Measuring Multimodal Network Connectivity
- Federal Highway Administration Bicycle Network Planning & Facility Design Approaches in the Netherlands and the United States
- Federal Highway Administration Delivering Safe, Comfortable, and Connected Pedestrian and Bicycle Networks: A Review of International Practices
- Federal Highway Administration Complete Streets website
- Federal Highway Administration Active Transportation and Demand management webpage and resources
- Federal Highway Administration Shared Micromobility and Equity Primer

Examples:

Micromobility in Mexico City

Mexico City established EcoBici in 2010 to make bicycles available to individuals for shared use on a short-term basis. The program, which was initially launched with 85 stations, has grown into the largest bikeshare system in Latin America. Since its inception, over 350,000 users have taken a combined 76.9 million trips. EcoBici is current expanding its program to 687 bike stations in 32 neighborhoods to connect with more transport services throughout Mexico City.[6]

Mexico City EcoBici (Source: © Ralf Roletschek/ roletschek.at)

[6] Gobierno de la Ciudad de Mexico. https://www.ecobici.cdmx.gob.mx/

Bicycling Infrastructure in Bogota, Colombia

Over the past decades, Colombian cities have increasingly promoted urban cycling as a solution to congestion and a sustainable development goal. Bogotá has become one of the leading cities for urban cycling in South America. A once neglected and "invisible" mode, Bogotá's pro-bicycling policy has mainstreamed bicycle use. Between 2015 and 2021, the City's bicycle infrastructure expanded by 33 percent, from 443 km to 590 km[7], and the City's 2020-2024 Strategic Plan includes a goal to further expand bicycle infrastructure by 830 km and increase the number of cycling trips by 50 percent.[8] In addition, the City established cycling as a priority mode of transportation for future planning efforts.

Indonesia's National Visions for Non-Motorized Transport

The Ministry of Public Works and Housing in Indonesia has partnered with the Institute for Transport and Development Policy (ITDP) Indonesia and the United Nations Environment Programme (UNEP) Share the Road initiative to develop the National Vision of Non-Motorized Transport Infrastructure. The document is a practical guide for city governments in planning and prioritizing the needs of pedestrians and cyclists. The strategy aims to "create a safe, comfortable, inclusive, and comprehensive walking and cycling space which supports public transport usage."

Pedestrian and Bicyclist in Jakarta, Indonesia
(Source: Institute for Transportation and Development Policy)

[7] Cycling Infrastructure in Cities: Bogotá's Ambitious Bicycle Network Expansion. https://www.transformative-mobility.org/news/cycling-infrastructure-in-cities-bogot%C3%A1s-ambitious-bicycle-network-expansion

[8] Bogota District Development Plan 2020-2024. https://bogota.gov.co/yo-participo/plan-desarrollo-claudia-lopez-2020-2024/

New Bus Rapid Transit System in West Africa

Dakar, Senegal is developing a Bus Rapid Transit (BRT) system as part of a comprehensive plan to restructure the capital city's transport network by 2025. The planned 18.3 km BRT system will run from Guediawaye to downtown Dakar along fully dedicated bus lanes. The project, which is being financed by the Senegalese Government, the World Bank, and others, includes three major passenger terminals, 20 stations, and 121 battery-powered buses. The new BRT system is expected to substantially improve travel conditions for people traveling to Dakar each day and support Senegal economic growth.[9]

Dakar Bus Rapid Transit system, Dakar, Senegal (Source: meridiam.com)

[9] https://projects.worldbank.org/en/projects-operations/project-detail/P156186

WHAT ACTIONS CAN GOVERNMENT AGENCIES TAKE TO PROMOTE A TRANSITION TO CLEANER VEHICLES?

Even with reduced demand for motorized travel, cars will continue to play an important role in the global transportation system. In addition, demand for passenger and cargo air travel and shipping activities worldwide is expected to continue to grow. As a result, transitioning to zero-emission vehicles and sustainable fuels is vital to reduce GHG emissions from the transport system. Governments have an important role to play in facilitate the increased use of alternative fueled vehicles.

Electrification

Electrification has an important to role to play in reducing emissions in the transport sector. The global electric car fleet — while still a small fraction of the total automobile market — has grown rapidly over recent years.[10] Similarly, other motor vehicles, including buses and two- and three-wheelers, are also experiencing an increase in electrification. While all-electric vehicles produce zero operational GHG emissions, there may be embodied emissions associated with producing the electricity that powers the vehicles. The amount of GHG emissions associated with generating the electricity to power an electric vehicle varies widely based on how the power is generated. For example, coal or natural gas emit GHGs, whereas renewable energy sources do not. As a result, the source of the local electricity generation mix is an important factor in determining whether electrification provides a meaningful strategy to reduce GHG emissions in a given location.

In addition to electric vehicles, governments are investing in electric port infrastructure to reduce emissions from port activities. This can include equipment for providing onshore power for vessels while docked and electric cargo handling equipment.

The continued electrification of the transport sector requires strong policy support from government agencies. Strategies to support vehicle electrification include:

- Providing financial incentives for electric vehicle purchases;
- Supporting the development and deployment of interconnected electric vehicle (EV) charging networks; and
- Supporting electric grid development and the decarbonization of electricity.

Electric Vehicle Charging Stations

[10] International Energy Agency. Global EV Outlook 2021. Available at https://www.iea.org/reports/global-ev-outlook-2021/trends-and-developments-in-electric-vehicle-markets

Alternative Fuels

While electrification is a viable strategy for road and rail transport, the increased use of sustainably produced alternative fuels offers significant climate mitigation opportunities for hard-to-abate sectors, such as maritime and aviation. Sustainable aviation fuels (SAF) — aviation fuels produced from renewable and waste feedstock — have the same performance and safety as conventional jet fuels and can be used in today's infrastructure, engines, and aircraft without modification. While SAF emits similar quantities of CO_2 as conventional aviation fuel when combusted, SAF provides emissions reduction benefits on a life-cycle basis. The total emissions reduction benefits vary based on the feedstock and production pathway used to create the SAF. Similar methods can be applied to reduce the life-cycle emissions of maritime fuels.

While there is a great deal of interest in using SAF, the availability of SAF is limited, and currently, the costs of producing SAF are much higher than the cost of petroleum. Expanding SAF supply, increasing its end use, and reducing the cost of SAF will require addressing key challenges and risks across the supply chain. SAF supply chains encompass an extremely complicated system of systems, including feedstock production, collection, and distribution to SAF production facilities; conversion of feedstock to fuel; and transport, storage, and delivery of the finished fuel to the infrastructure required to fuel aircraft.

Governments have an important role in supporting critical activities that expand the SAF feedstock and conversion technology portfolio and drive down cost of production across the supply chain. Governments can support the development and use of SAFs by funding research and demonstration projects, implementing policy frameworks that reduce risk to industry and provide incentives for production, and providing financial support for new infrastructure and commercialization.

For more information:

- U.S. Department of Transportation Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure
- Federal Highway Administration and Oregon Department of Transportation Alternative Fuel Toolkit
- Federal Transit Administration Transit Bus Electrification Tool
- U.S. Department of Energy, U.S. Department of Transportation, U.S. Department of Agriculture, U.S. Environmental Protection Agency Sustainable Aviation Fuel Grand Challenge Roadmap
- Federal Aviation Administration Sustainability webpage and Aviation Climate Action Plan
- ICAO Sustainable Aviation Fuels Guide
- Federal Railroad Administration Future of Rail Workshop Proceedings
- Maritime Administration Port Electrification Report
- National Renewable Energy Laboratory Adoption of Biofuels for the Marine Shipping Industry: A Long-Term Price and Scalability Assessment

Example:

Antelope Valley Transit Authority, California

In January 2022, Antelope Valley Transit Authority (AVTA) in California became the first all-electric transit agency in North America. Since AVTA placed its first electric bus into service in 2014, the agency has replaced all of its aging diesel buses with a 100 percent battery-electric bus fleet. AVTA uses high-power inductive chargers to help power the zero-emission buses. These chargers allow the electric buses to charge wirelessly simply by driving the vehicles over charging pads embedded into the ground. When not in service, the electric buses charge their batteries at an AVTA bus yard via hard-wired conductive charging stations. AVTA has started the process of building a solar field coupled with battery storage that will enable AVTA to charge their battery-electric bus fleet with 100 percent solar energy, further reducing the agency's carbon footprint.

Zero emissions electric bus (Source: AVTA)

WHAT ACTIONS CAN GOVERNMENT AGENCIES TAKE TO PROMOTE THE USE OF SUSTAINABLE MATERIALS AND CONSTRUCTION PRACTICES?

Building transportation infrastructure uses a large amount of energy and produces GHG emissions. There are embodied emissions from extracting, processing, and transporting the necessary materials (e.g., aggregate, asphalt, concrete, steel), and operational emissions produced from the use of construction equipment to grade, lay road base and pavement, and build bridges and rail lines. Achieving reductions in the embodied and operational emissions from building, modifying, maintaining, and disposing of transportation infrastructure is integral to reducing GHG emissions from the transport sector.

Transportation agencies can conduct a life-cycle assessment (LCA) to assess embodied emissions of transportation infrastructure over its life-cycle, from raw material production to end of life. An LCA can give a more complete picture of the environmental impacts of a transportation project and help to identify where the most significant improvements can be made while identifying potential trade-offs. An increasing number of industries are creating LCA-based environmental product declarations (EPD) to attest to the environmental performance of products. An EPD is a transparent, verified report used to communicate the environmental impact (e.g., resource use, energy, emissions) associated with the manufacture or production of construction materials, such as asphalt, cement, asphalt mixtures, concrete mixtures, or steel reinforcement. EPDs allow for meaningful comparisons of the environmental performance of materials and can be used to inform green procurement practices.

The sustainability of pavement materials and construction practices has changed significantly over the last several decades. New technologies have been developed that offer the potential for significant improvements in pavement quality and construction efficiency while decreasing environmental impacts. These construction practices, in concert with appropriate pavement structural designs that use appropriate materials (e.g., recycled materials, co-products, waste materials), can provide significant improvements to the overall sustainability of a pavement system.

In addition to using sustainable materials and practices to reduce emissions from the construction process, transportation agencies can also offset emissions through climate uses of the transportation rights-of-way (ROW). Such uses include siting renewable energy resources, such as solar panels or wind turbines, in the highway ROW, installing photovoltaic noise barriers (the combination of noise barrier systems and photovoltaic systems), and planting native vegetation to sequester carbon.

For more information:

- Federal Highway Administration Infrastructure Voluntary Evaluation Sustainability Tool (INVEST)
- Federal Highway Administration Sustainable Pavements Program
- Federal Highway Administration Infrastructure Carbon Estimator
- Federal Transit Administration Transit Greenhouse Gas Emissions Estimator
- Federal Highway Administration Highway Renewable Energy: Photovoltaic Noise Barriers
- PIARC Green Paving Solutions and Sustainable Pavement Materials
- Federal Highway Administration Sustainable Rest Area Design and Operations
- Federal Highway Administration Highway Renewable Energy: Photovoltaic Noise Barriers

Examples:

City of Portland, Oregon Low-Carbon Concrete Initiative

The City of Portland's 2016 Sustainable Supply Chain Analysis identified construction services as the top spend category contributing to the City's supply chain GHG emissions. Within construction services, concrete is one of the most GHG-intensive materials typically used on City construction projects. As a result, in 2019, after gathering both internal and external stakeholder input, the City established its Low-Carbon Concrete Initiative to reduce the overall carbon intensity of the concrete mixes used on City projects. From 2019 to early 2022, the Initiative involved: 1) establishing a product-specific Environmental Product Declaration (EPD) requirement for concrete mixes used on City projects; 2) conducting pilot tests of lower-embodied carbon concrete mixes; and 3) defining concrete "embodied carbon thresholds" for concrete mixes.

Low Carbon Concrete Construction, Portland, Oregon (Source: Portland.gov)

Thailand: Highway Rehabilitation for Sustainable Environment Development for National Highway Route No. 1: Tak-Kampangphet

The National Highway Route No. 1: Tak-Kampangphet is the major highway toward the northern region of Thailand. The roadway experienced a number of block cracks, particularly in the heavy truck lane. The Department of Highways sought a rehabilitation design to address the problem areas that would also improve the homogeneity, uniformity, and structural integrity of the pavement. The Department proposed a 600 mm thick layer of recycled base overlaid by a 100 mm thick layer of hot-mix asphalt. The existing subbase and the underlying selected materials layers were recycled and remixed in place with dry cement powder to form the lower recycling base (300 mm). A pavement evaluation conducted two years after construction found only minor rutting and no sign of any other pavement distress such as cracking, demonstrating the exceptional in-service performance that can be achieved using recycled materials.

Recycled Materials in Pavements, Thailand (Source: World Road Association (PIARC))

Highway Renewable Energy in Oregon

In December 2008, the Oregon Department of Transportation installed the first large-scale solar highway project in the U.S. The Oregon DOT's 104-kW ground-mounted solar array, consisting of 594 solar panels, is situated at the interchange of Interstate 5 and Interstate 205 south of Portland, Oregon. The solar array offsets over one-third of the energy needed for freeway lighting at the site.[11]

Solar Highway in Oregon (Source: Oregon DOT)

[11] Federal Highway Administration. Renewable Energy in Highway Right-of-Way. https://www.fhwa.dot.gov/real_estate/right-of-way/corridor_management/alternative_uses.cfm

PUTTING STRATEGIES INTO ACTION

The scale of the climate crisis requires immediate action across all of levels of government and society to reduce transportation-related GHG emissions. Governments must take a leadership role in mobilizing meaningful action by implementing policy interventions and financing measures that prioritize and facilitate low-carbon transportation solutions. Building upon this foundation, governments will need to work with stakeholders to achieve emission reductions:

- **Local Governments:** Local governments play an important role in implementing efficient land use patterns; investing in low-carbon transportation infrastructure, such as bike lines and bus systems; and making green procurement decisions.
- **The Private Sector:** Private sector partners are key players in developing and deploying technologies that drive the decarbonization of the transportation sector. These can include developing fuel-efficient vehicles and alternative fuels and providing new modes of transport, such as bike and scooter sharing.
- **The Public:** Governments must actively engage with the public to design transportation systems that are responsive to and reflective of the needs of local communities. Governments also need to adopt incentives and other policies—grounded in solid data on emissions—that build support and demand for harvesting emission reduction opportunities through low- and zero-emitting, climate-resilient transportation technologies and approaches. The first key step is to measure emissions – "what you measure, you manage."

Spotlight: Strategies in Action

The City of Buenos Aires is pioneering bold climate action in Argentina. Through its latest Climate Action Plan, Buenos Aires aims to achieve a 50 percent reduction in emissions by 2030 and carbon neutrality by 2050. The transportation sector is a key focus in the plan, with 6 of 19 actions directly targeted toward reducing transportation-based emissions. These actions are focused on both reducing automobile trips and transitioning to cleaner fuels. Example actions include:

- **Meeting Streets**: In recent years, Buenos Aires has been transforming itself into a polycentric city where people can carry out their daily tasks and leisure activities within their neighborhoods without traveling long distances. "Meeting Streets" is a project that consists of the transformation of one street in each of the City's 48 neighborhoods into pedestrian and recreational spaces. The selection of

Buenos Aires Climate Action Plan 2050 (Source: buenosaires.gob.ar)

locations is carried out through a participatory process with neighbors, neighborhood organizations, merchant associations, and local institutions.

- **Pedestrian Priority**: The City of Buenos Aires has been developing pedestrian priority areas in particularly dense locations. Pedestrian priority areas seek to consolidate neighborhood centers to reduce the need to commute and to prioritize non-motorized travel modes. Within these areas, the City takes action to reduce vehicular lanes, level crossroads, widen sidewalks, and introduce vegetation. The City plans to increase the number of pedestrian areas in the short-term.
- **Low-Emission Public Transport**: Buenos Aires has 9,700 buses that transport an average of 4.5 million passengers per day. In partnership with the National State, neighboring jurisdictions, and the private sector, the City is taking action towards technological changes to achieve emission-free public transportation. In 2019, the City launched a pilot test of new electric and 100 percent biodiesel bus technologies to evaluate the technical feasibility of new mobility technologies and their operational, economic, and environmental viability. Next steps outlined in the City's Climate Plan include coordination with private companies on the implementation and migration of chosen technologies, and collaboration with electric power distribution companies on the design of charging stations.
- **Efficient Urban Logistics**: Growth in e-commerce and demand for rapid delivery have caused an increase in the number and frequency of use of delivery systems, resulting in greater congestion and emissions. The City of Buenos Aires has teamed up with the private e-commerce and urban logistics sectors to implement efficiency plans for their shipments. In 2018, the City carried out a pilot test of the use of electric vehicles in conjunction with a logistics company. The objective was to analyze the technical, operational, economic, and environmental performance of this technology in real operating conditions to understand its potential for large-scale implementation. The City also plans to:
    - Develop the necessary infrastructure to increase the number of ordered loading and unloading spaces, both for cars and motorcycles, along with their proper signage;
    - Foster the use of bicycles, motorcycles, and electric tricycles for the distribution of "last mile" shipments; and
    - Implement nighttime loading and unloading.

GLOSSARY

Adaptation: In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.

Carbon Dioxide (CO_2): A naturally occurring gas, CO_2 is also a by-product of burning fossil fuels (e.g., oil, gas, coal), of burning biomass, of land-use changes and of industrial processes (e.g., cement production). It is the principal anthropogenic GHG that affects the Earth's radiative balance.

Climate: The average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

Climate Change: A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent human-caused changes in the composition of the atmosphere or in land use.

Climate Variability: Variations in the mean state and other statistics (e.g., standard deviations, the occurrence of extremes) of the climate on all spatial and temporal scales beyond that of individual weather events.

Embodied Emissions: Emissions associated with the production, refining, and distribution of fuels; the manufacture and disposal of vehicles, ships, trains, and airplanes; the acquisition and processing of construction materials (e.g., asphalt, concrete, steel); and the construction, maintenance, and disposal of transportation infrastructure.

Extreme Weather Event: An event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense.

Fossil Fuels: Carbon-based fuels from fossil hydrocarbon deposits, including coal, oil, and natural gas.

Global Warming: The estimated increase in global mean surface temperature averaged over a 30-year period, or the 30-year period centered on a particular year or decade, expressed relative to pre-industrial levels unless otherwise specified. For 30-year periods that span past and future years, the current multi-decadal warming trend is assumed to continue.

Greenhouse Gas (GHG): Gaseous constituents of the atmosphere that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself and by clouds. This property causes the greenhouse effect. Water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary GHGs in the Earth's atmosphere.

Life-Cycle Assessment (LCA) Emissions: The total life-cycle emission value for a given fuel or material is the sum of the Core LCA emission and the Induced Land Use Change (ILUC) emission. In the case of fuels, the Core LCA emissions include the emissions associated with feedstock development and/or feedstock cultivation, feedstock harvesting, collection and recovery, direct land use change, feedstock processing and extraction, feedstock transportation to processing and fuel production facilities, feedstock to fuel conversion processes, fuel transportation and distribution, and fuel combustion. ILUC emissions occur when fuel/feedstock production on land displaces crops or livestock for which the land was previously used, and those uses move to other lands, resulting in emissions due to the conversion of natural vegetation (forest, other natural land), soil organic carbon, oxidation of peatlands, and sequestered biomass.[12]

Mitigation: A human intervention to reduce emissions or enhance the sinks of GHGs.

Operational Emissions: GHGs emitted through the operation of transport vehicles (e.g., cars, trucks, ships, airplanes, other vehicles).

Resilience: The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning, and transformation.

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

[12] See Life Cycle Emissions of Sustainable Aviation Fuels (icao.int) and CORSIA Sustainability Criteria.

SELF-ASSESSMENT QUESTIONS

Take some time to think through how transportation in your country contributes to climate change through GHG emissions, and how your government is working to reduce GHG emissions. Consider the following questions:

- **According to your country's most recent GHG Inventory submitted to the United Nations Framework Convention on Climate Change (UNFCCC), what are the emissions of your transportation sector?**
  - How is your government analyzing, documenting, and communicating the transportation sector's contributions to climate change in your country?
  - What transportation modes emit the most GHG emissions in your country?
- **What are your country's climate priorities across the transportation sector and for each sector?**
- **What are your country's established emission reduction targets for the transportation sector?**
- **What strategies is your government implementing to reduce transportation-related GHG emissions, both operational and embodied?**
  - How is your government measuring the success of these strategies?
- **What strategies are local governments in your country implementing to reduce transportation-related GHG emissions on a local level?**
  - How is your government promoting the adoption of successful local GHG-reduction strategies?
- **How are private companies in your country reducing transportation-related GHG emissions?**
  - How is your government promoting or incentivizing the adoption of GHG emission reduction strategies in the private sector?
- **What are strategies that your country is interested in implementing or learning more about to reduce transportation-related GHG emissions?**
- **What challenges is your government experiencing in implementing strategies that reduce transportation-related GHG emissions?**
  - How does your government plan to address those challenges?
- **What questions do you have about reducing transportation-related GHG emissions in your country?**

For more information about reducing transportation-related GHG emissions, or to learn more about partnering with Momentum, please contact us at momentum@dot.gov.