NFSP

NATIONAL FREIGHT STRATEGIC PLAN

U.S. Department of Transportation

LETTER FROM THE SECRETARY

Every day the Nation's transportation network hauls more than 51 million tons of freight valued at nearly $52 billion via highways, railways, inland waterways, pipelines, and airports. Businesses in the United States depend on its world-class freight system to transport goods and materials across the country to and from the rest of the world and at a lower cost and greater reliability than businesses in other parts of the world. As freight demand continues to grow and shifting trends strain parts of the freight system, the Department seeks to lay out a strategic plan to maintain and improve the competitiveness of America's freight system.

As supply chains spread across the globe, poor or inadequate infrastructure at ports, border crossings, and along intermodal corridors limit America's ability to compete globally. Container traffic at the Nation's ports has increased by 25 percent in the past ten years and intermodal traffic has surpassed coal as the primary revenue generator for Class I railroads. Domestic fuel production has grown; making the U.S. a net energy exporter for the first time in more than 60 years. At the same time, e-commerce is increasing at double digit rates, affecting supply chains and increasing demand for deliveries in already congested urban areas.

Businesses, as well as State and local agencies, are working to meet these demands with ingenuity. Automation technologies, such as truck platooning and the automation of ports and warehouses, provide the potential for applications that could improve safety and lower costs across our network. Freight is also fertile ground for applications of wireless connectivity, machine learning, and artificial intelligence that can improve our ability to track freight movements and optimize supply chains. Emerging technologies such as Blockchain, delivery drones, hyperloop, and three-dimensional printing could transform our freight system.

Leadership is needed to meet the challenges posed by these trends. Steps must be taken to ensure that America's workforce is ready for the technology-driven jobs of the future. All levels of government need to streamline and reduce unnecessary regulations. Communities need assistance to adapt to changing freight demands and mitigate the potentially negative effects of increased freight movement on traffic, safety, and the environment. Finally, America needs to invest strategically in those parts of the freight system that have significance to the economy, to better support the Nation's economic competitiveness.

This National Freight Strategic Plan describes the steps that the U.S. Department of Transportation will take to address these challenges. It provides a vision for a national freight system that continues to drive economic growth and well-being, while maintaining and improving safety and efficiency. It lays out principles and goals to guide a strategic Federal role in freight. The Plan describes specific funding programs and initiatives to guide multimodal investments to address safety issues, reduce congestion, improve intermodal connectivity, and support rural communities and industries.

Thank you.

Elaine L. Chao

United States Secretary of Transportation

EXECUTIVE SUMMARY

The mission of the U.S. Department of Transportation (U.S. DOT) is to ensure our Nation has the safest, most efficient and modern transportation system in the world, that improves the quality of life for all American people and communities, from rural to urban, and increases the productivity and competitiveness of American workers and businesses.

Safe, reliable, and efficient transportation boosts exports, enhances commerce, and powers economic growth. Our robust national multimodal freight system supports our economy by lowering costs to businesses and consumers and boosting the competitiveness of American goods abroad. The safe and efficient movement of goods through our freight system is a top priority for the Department.

The Fixing America's Surface Transportation (FAST) Act establishes a national multimodal freight policy and requires the U.S. DOT to develop a National Freight Strategic Plan to implement the goals of this policy. This Plan defines the Department's vision and goals for the national multimodal freight system, assesses the conditions and performance of the freight system and barriers to freight system performance, and defines strategies to achieve its vision and goals. The Plan was developed through a multi-agency effort involving extensive consultation with freight stakeholders in both the public and private sectors.

The Department will use this Plan to guide national freight policy, programs, initiatives, and investments; inform State freight plans; identify freight data and research needs; and provide a framework for increased cross-sector, multijurisdictional, and multimodal coordination and partnerships. This Plan also defines a clear Federal role for leading efforts to improve the performance of the Nation's multimodal freight system.

VISION

The freight transportation system of the United States will strengthen our economic competitiveness with safe and reliable supply chains that efficiently and seamlessly connect producers, shippers, and consumers in domestic and foreign markets.

FEDERAL ROLE


Source: Adobe Stock

The Federal Government has an important role in supporting and overseeing our Nation's freight system. In today's global economy, the Nation relies on interstate and international commerce to support economic growth. It is the responsibility of the Federal Government to support the safe and efficient movement of these goods. The following principles guide U.S. DOT's strategic leadership to support safe, efficient, and reliable movement of goods.

1. **Modernize or eliminate unnecessary or duplicative regulations** that inhibit supply chain efficiency, reduce incentives to innovation, delay project delivery, or raise costs to shippers and consumers, while protecting safety and environmental outcomes.
2. **Improve cross-sector, multijurisdictional, and multimodal collaboration** to enhance intermodal connectivity and first- and last-mile connections, streamline interstate policies and regulations, and support multi-state investment.
3. **Provide targeted Federal resources and financial assistance** to support freight projects that provide significant benefits to the national economy.
4. **Invest in freight data, analytical tools, and research** to enhance the abilities of State, regional, and local agencies to evaluate and address freight issues.

STRATEGIC GOALS

This Plan supports the U.S. DOT's mission, strategic goals, and priorities. The strategic goals of our National Freight Policy are as follows:

SAFETY

Improve the safety, security, and resilience of the national freight system.

INFRASTRUCTURE

Modernize freight infrastructure and operations to grow the economy, increase competitiveness, and improve quality of life.

INNOVATION

Prepare for the future by supporting the development of data, technologies, and workforce capabilities that improve freight system performance.

GOAL	STRATEGIC OBJECTIVES
Safety *Improve the safety, security, and resilience of the national freight system.*	• Support the development and adoption of automation, connectivity, and other freight safety technologies • Modernize safety oversight and security procedures • Minimize the effects of fatigue and human error on freight safety • Reduce conflicts between passenger and freight traffic • Protect the freight system from natural and human-caused disasters and improve recovery speed
Infrastructure *Modernize freight infrastructure and operations to grow the economy, increase competitiveness, and improve quality of life.*	• Fund targeted investments in freight capacity • Improve consideration of freight in transportation planning • Prioritize projects that improve freight intermodal connectivity, and enhance freight flows on first- and last-mile connectors and at major trade gateways • Advance freight system management and operation practices • Improve job growth and economic competitiveness in rural and urban communities • Mitigate the impacts of freight movement on communities
Innovation *Prepare for the future by supporting the development of data, technologies, and workforce capabilities that improve freight system performance.*	• Support the development and adoption of automation and V2X • Support the safe deployment of UAS technology • Streamline regulations to improve governance, efficiency, and economic competitiveness • Improve freight data, modeling, and analysis tools and resources • Strengthen workforce professional capacity • Invest in freight research • Support regulatory frameworks that foster freight innovation.

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FIGURES

ACRONYMS

AAR	American Association of Railroads
AV	Automated Vehicle
BTS	Bureau of Transportation Statistics
BUILD	Better Utilizing Investments to Leverage Development grants
CRISI	Consolidated Rail Infrastructure and Safety Improvements grants
CREATE	Chicago Region Environmental and Transportation Efficiency program
CDL	Commercial Driver's License
CFS	Commodity Flow Survey
CBO	Congressional Budget Office
CBP	Customs and Border Protection
DOC	Department of Commerce
DOE	Department of Energy
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAC	Freight Advisory Committee
FAF4	Freight Analysis Framework
FAST	Fixing America's Surface Transportation Act
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
GAO	Government Accountability Office
GDP	Gross Domestic Product
HOV	High-Occupancy Vehicle
HPMS	Highway Performance Monitoring System
HSIP	Highway Safety Improvement Program
INFRA	Infrastructure for Rebuilding America grants
IoT	Internet of Things
IRI	International Roughness Index
ITS	Intelligent Transportation Systems
LNG	Liquefied Natural Gas
MPO	Metropolitan Planning Organization
MTO	Marine Terminal Operator
NBI	National Bridge Inventory
NDOT	Nebraska Department of Transportation

NEPA	National Environmental Policy Act
NFSP	National Freight Strategic Plan
NHFN	National Highway Freight Network
NHFP	National Highway Freight Program
NHPP	National Highway Performance Program
NHS	National Highway System
NMFN	National Multimodal Freight Network
NPMRDS	National Performance Monitoring Research Data Set
PHMSA	Pipeline and Hazardous Materials Safety Administration
PIDP	Port Infrastructure Development Program Grants
PTC	Positive Train Control
RFI	Request for Information
ROUTES	Rural Opportunities to Use Transportation for Economic Success
STB	Surface Transportation Board
STBGP	Surface Transportation Block Grant Program
STIP	State Transportation Improvement Program
Tcf	Trillion Cubic Feet
TEU	20-Foot Equivalent Units
TIP	Transportation Improvement Program
TPM	Transportation Performance Management
TTTR	Truck Travel Time Reliability
TxDOT	Texas Department of Transportation
UAS	Unmanned Aircraft Systems
USACE	United States. Army Corps of Engineers
USDA	United States Department of Agriculture
U.S. DOT	United States Department of Transportation
V2X	Vehicle-to-Everything
VIUS	Vehicle Inventory and Use Survey
VMT	Vehicle Miles Traveled

1 INTRODUCTION


Source: Adobe Stock

PURPOSE

The Nation's freight transportation system is a complex network made up of millions of miles of highways, railways, navigable waterways, and pipelines. The components of this network are linked through hundreds of ports, airports, and intermodal facilities. This system accommodates the movement of raw materials, intermediate, and finished products from across the entire spectrum of agricultural, manufacturing, natural resources, energy, retail, and other sectors of the United States' economy.

This Plan meets the requirements of Section 8001 of the Fixing America's Surface Transportation (FAST) Act (Pub. L. 114-94), which directs the U.S. Department of Transportation (U.S. DOT) to develop a National Freight Strategic Plan (NFSP or Plan). It establishes a national multimodal freight strategy to guide U.S. DOT freight policy and activities.
The U.S. DOT will use this Plan to:

- Inform infrastructure planning, coordinate investments, and support future freight efficiencies;
- Provide a framework for increased cross-sector, multijurisdictional, and multimodal coordination and partnerships; and
- Identify freight data needs to support improved decision-making.

BACKGROUND

The safe and efficient movement of freight is vital to the Nation's economic growth and to the creation of well-paying jobs for millions of Americans. In a competitive global market driven by rising consumer expectations for affordable goods and fast deliveries, an efficient, reliable freight system, helps to keep business operating and inventory costs low, ultimately reducing the costs of goods for consumers and allowing American businesses to compete in international markets.

Freight shipments are expected to increase by 22.4 percent over the next 20 years.[1] Investments in infrastructure capacity and operational improvements will be required to meet rising demand for freight. Yet, freight system performance can be hindered by regulatory, financial, and institutional barriers that raise the economic costs of freight movements. Such barriers can also make it difficult for transportation planners and policymakers to determine and allocate appropriate levels of public freight infrastructure investment. Large portions of the freight system are privately owned and operated, and public sector decision-makers may lack sufficient data on freight movements and costs. For this and other reasons, stakeholders and decision-makers often underestimate the national economic benefits of freight projects, making it difficult for freight projects to compete against other transportation investments for already limited funds. Finally, the scale and complexity of some freight projects requires coordination across multiple jurisdictions and funding sources, which can pose challenges.

To overcome these barriers and establish a more effective framework to guide the investment of billions of dollars in Federal funding, the Government Accountability Office (GAO) and others have suggested that the Federal Government develop a national freight strategy. In 2008, the GAO recommended that the Secretary of Transportation release a national freight strategy that defines the Federal role in freight transportation and to develop "a national strategy for freight transportation in order to improve freight mobility by more clearly defining the Federal role in the freight transportation network and to begin to align Federal expenditures with economically significant national public benefits."[2]

In section 8001 of the FAST Act, Congress requires the Under Secretary of Transportation for Policy to develop an NFSP that assesses the conditions and performance of the National Multimodal Freight Network (NMFN), forecasts freight volumes, and identifies trade gateways, freight corridors, and bottlenecks.

The FAST Act requires the NFSP to include the following elements:

- An assessment of the condition and performance of the NMFN;
- Forecasts of freight volumes for the succeeding 5-, 10-, and 20-year periods;
- An identification of major trade gateways and national freight corridors that connect major population centers, trade gateways, and other major freight generators;
- An identification of bottlenecks on the NMFN that create significant freight congestion;
- An assessment of statutory, regulatory, technological, institutional, financial, and other barriers to improved freight transportation performance, and a description of opportunities for overcoming the barriers;
- A process for addressing multistate projects and encouraging jurisdictions to collaborate;
- Strategies to improve freight intermodal connectivity;
- An identification of corridors providing access to energy exploration, development, installation, or production areas;
- An identification of corridors providing access to major areas for manufacturing, agriculture, or natural resources;
- An identification of best practices for improving the performance of the NMFN; and
- An identification of best practices to mitigate the impacts of freight movement on communities.

The FAST Act also requires each State to develop a comprehensive State Freight Plan to obligate National Highway Freight Program (NHFP) funding. The FAST Act established the NHFP to provide funding to the States for projects identified in State Freight Plans that contribute to the efficient movement of freight and are on the National Highway Freight Network (NHFN). As of 2020, all 50 States and the District of Columbia completed State Freight Plans and have developed infrastructure investment plans to improve freight flows across their jurisdictions. The completion of the initial set of State Freight Plans has provided valuable insight into how States view their freight transportation system, which is reflected in the NFSP. In turn, the NFSP will serve as a resource to States as they update their State Freight Plans.

The NFSP also incorporates inputs received from an extensive stakeholder outreach effort conducted to inform this document. The results of this effort are described in the following section.

STAKEHOLDER ENGAGEMENT

The U.S. DOT recognizes the importance of engaging with many different types of stakeholders to assist in developing a clear, national vision for freight transportation that is inclusive of public- and private-sector perspectives. These perspectives provide vital inputs to inform freight system operational challenges and opportunities to mitigate these challenges.

To develop this NFSP, the U.S. DOT consulted with stakeholder groups representing every mode of transportation; various shippers, carriers, and business groups that use and depend on the freight system; other Federal agencies; and, the general public. Stakeholders included representatives from ports, inland waterways, airports, air carriers, and railroad and trucking industries, as well as State DOT's, metropolitan planning organizations (MPOs), and academia. The U.S. DOT coordinated with Federal partners including the U.S. Department of Agriculture (USDA), the U.S. Army Corps of Engineers (USACE), the U.S. Department of Commerce (DOC), the Surface Transportation Board (STB), and the U.S. Department of Energy (DOE). Finally, the U.S. DOT received more than 80 comments through a formal Request for Information (RFI), issued in December 2019, which posed questions to the general public pertaining to a national freight policy. Themes and insights identified through this stakeholder engagement process directly informed the trends and challenges identified in this plan.

PLAN ORGANIZATION

This Plan is organized into seven chapters.

1. **Introduction:** Describes the purpose of the NFSP and the methodologies used to inform the Plan.
2. **The U.S. Freight System:** Describes the characteristics of the Nation's multimodal freight system.
3. **Freight Corridors:** Identifies the primary freight corridors for shippers in the sectors of agriculture, manufacturing, energy, and natural resources.
4. **Key Trends:** Describes the economic and technological trends driving changes in freight system uses.
5. **Challenges:** Discusses challenges affecting our freight system, including increasing safety risks and congestion, declining infrastructure conditions, and various barriers to advancing freight projects.
6. **Goals and Strategies:** Establishes strategies for achieving the U.S. DOT goals set forth in this Plan and highlights best practices.
7. **Conclusion**

2 THE U.S. FREIGHT SYSTEM


Source: Adobe Stock

America's freight system is a complex, interdependent, multimodal system of infrastructure and services owned and operated by a mix of public and private sector entities. The system comprises physical infrastructure or facilities, such as ports, waterways, airports, railroads, pipelines, roadways, and warehouses, as well as diverse carriers, shippers, and suppliers that use this infrastructure to transport goods. The freight system consists of approximately four million miles of highways and roads; 140,000 miles of rail lines; 25,000 miles of inland and coastal waterways; 2.8 million miles of pipelines; and more than 5,000 public airports.

Industry and consumers depend on the Nation's freight system to carry cargo of all types from raw materials to finished goods to waste products. In 2018, the U.S. transportation system moved a daily average of about 51 million tons of freight valued at nearly $52 billion.[3] A majority of this cargo crosses State lines and a significant portion is bound for markets abroad.

Each transportation mode has unique institutional arrangements with differing degrees of public involvement. Freight railroads and pipelines are almost entirely privately owned and operated. States and municipalities own and operate most roadway infrastructure, while private-sector firms provide truck delivery services. Similarly, the National Airspace System is operated by the Federal Government and airports are mostly publicly owned, while private-sector air carriers provide air cargo services. Privately owned ships and barges use publicly maintained waterways and both public and private port facilities. Each transportation mode is subject to varying degrees of safety, environmental, and economic regulation by all levels of government.

TABLE 1. SHIPMENT CHARACTERISTICS BY MODE OF TRANSPORTATION (2017)[4]

MODE CATEGORY	% OF TOTAL VALUE	% OF TOTAL TONS	% OF TOTAL TON-MILES	AVERAGE MILES PER SHIPMENT
Truck	73.0%	71.5%	41.6%	188
Rail	1.4%	9.3%	26.9%	554
Water	1.0%	4.5%	5.6%	225
Air (incl. truck and air)	2.8%	>0.1%	0.2%	1,437
Pipeline	2.8%	6.9%	NA	NA
Mail or courier	14.2%	0.3%	0.9%	890
Other multimodal	4.7%	6.6%	22.4%	1,127

TRUCKING

Trucks are involved in the movement of most goods, even those that travel on other modes for part of the journey. Trucks carry nearly 72 percent of all domestic freight by weight and 73 percent by value.[5] Trucks are the primary mode of choice for shipments that move under 750 miles.

Trucks operate on more than 4 million miles of public roads, including the 222,946 miles that comprise the National Highway System (NHS). Trucks carry all types of goods, ranging from high-value commodities, such as mixed freight and electronics, to bulk commodities such as gravel, grains, and gasoline. Long-haul freight truck traffic in the U.S. is concentrated on major routes connecting population centers, ports, border crossings, and other major hubs of activity. While commercial trucks accounted for approximately 9 percent of all highway vehicle-miles traveled (VMT) in 2018, they made up 15 percent of VMT on Interstates and 24 percent of VMT on rural Interstates.[6]

RAILROADS

The U.S. freight rail network consists of 140,000 rail miles operated by seven Class I railroads[7] with operating revenues of $433.2 million or more), 21 regional railroads, and 510 local railroads.[8] Class I railroads account for nearly 69 percent of the industry's mileage. Freight railroads are mostly privately owned and operate on infrastructure that is maintained and owned by themselves or another private railroad.

Rail is the primary mode used for shipments moved 750 to 2,000 miles.[9] Railroads carry a wide variety of bulk commodities including coal, chemicals, and agricultural products. Increasingly, rail is used to carry containerized intermodal freight as well. Approximately 15 percent of shipments by weight are carried by rail or involve some combination of modes including rail.[10]

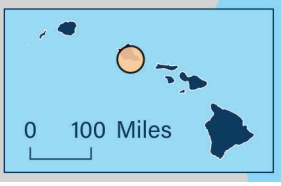

Source: Adobe Stock

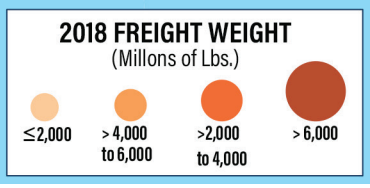
INLAND WATERWAYS AND GREAT LAKES

The inland waterway system comprises approximately 25,000 miles of active, navigable inland and coastal waterways.[11] These waterways include the upper and lower Mississippi River, Arkansas River, Illinois and Ohio Rivers, Tennessee River, and the Columbia River System. The Gulf, Atlantic, and Pacific Intracoastal Waterways as well as the Great Lakes and the St. Lawrence Seaway are also important components of our national maritime transportation system. These waterways are primarily managed by the U.S. Army Corps of Engineers (USACE), which is responsible for maintaining the locks and dredging the channels.

To mitigate landslide freight bottlenecks, MARAD has designated 25 Marine Highway routes.[12] Each all-water route is designated by the Secretary and offers relief to landside corridors suffering from traffic congestion, excessive air emissions, or other environmental challenges. They include the above-mentioned navigable waterways, as well as coastal waterways serving Alaska, Puerto Rico, Hawaii, and American Samoa.

The inland waterways system carries large volumes of bulk commodities (including coal, crude petroleum, and grain), and farm inputs, such as fertilizer, over long distances, and is of vital importance to numerous industries. Most inland waterways shipments (by freight volume) move through the Mississippi River System to the Gulf Coast. In 2018, 2,438 million tons of commodities moved on our Nation's Inland, Great Lakes, and Coastal Waterways.[13]





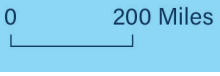


FIGURE 1. TOP AIR CARGO AIRPORTS BY WEIGHT OF CARGO (2018)[14]

AIR CARGO

In comparison with rail and water modes, air transport carries high-value products, such as electronics, precision instruments, pharmaceuticals, and medical equipment, as well as packages and letters, all of which require quick delivery. Air cargo includes cargo delivered by dedicated air freight traffic as well as cargo shipments carried in the baggage holds of passenger air craft. The top three U.S. airports for air cargo—Memphis, Anchorage, and Louisville—together handled nearly one-third of the total landed weight of all-cargo operations in 2017.[15] Memphis and Louisville are major hubs for FedEx and the United Parcel Service, respectively, and Anchorage is a major refueling stop for international trade with Asia (see Figure 1).


Source: Adobe Stock

PIPELINES

Pipelines are the dominant mode of transport for liquid and gaseous energy resources. American pipeline infrastructure includes more than 300,000 miles of natural gas transmission lines and 210,000 miles of pipelines for crude oil, refined oil products, and natural gas liquids. Pipelines transport raw materials from areas of production to refineries and chemical plants across the U.S. They also move the finished products to gasoline terminals, natural gas power plants, and other end users.

TRADE GATEWAYS

There are 467 ports of entry for international cargo in the United States, including airports, land border crossings, and seaports. In 2018, the top 25 ports of entry by value handled nearly two-thirds of the $3.89 trillion in total U.S.-international freight trade. These 25 ports of entry include five land border crossings, such as Laredo, Texas and Detroit, Michigan; 10 airports, such as John F. Kennedy International Airport and Chicago O'Hare; as well as 10 maritime ports, including the ports of Los Angeles and Long Beach and the Port of New York and New Jersey.

These ports can be characterized in different ways. Due to their extensive handling of bulk commodities, ports on the Gulf Coast handle large amounts of fuel and grain imports and exports, in addition to container traffic. The Ports of South Louisiana and Houston typically move more tonnage than any other U.S. ports. The top ports for containerized cargo volume are located primarily on the Pacific and Atlantic coasts. In 2018, the top 25 container ports handled 54 million 20-foot equivalent units (TEU).[16] The Ports of Los Angeles and Long Beach in California together handled 36 percent of all container traffic at U.S. water ports[17]

Land border crossings are the entry and exit points for trucks and trains moving commodities between the United States, Mexico, and Canada. The largest border crossings for freight traffic are in Laredo, Texas; Otay Mesa, California; Detroit and Port Huron, Michigan; and Buffalo, New York.

The busiest land port of entry is Laredo, Texas. In 2018, Laredo was the point of entry for $228 billion of freight primarily by truck and train. The most significant commodities passing through Laredo by value were vehicles ($57 billion), computer-related machinery ($48 billion), and electrical machinery ($34 billion).

TABLE 2. TOP TRADE GATEWAYS BY VALUE IN 2018

(BILLIONS OF CURRENT DOLLARS)[18]

TRADE GATEWAY	TYPE	EXPORTS	IMPORTS	TOTAL
Laredo, TX	Land	99.7	128.3	228.0
Los Angeles, CA	Water	35.5	187.0	222.5
New York, NY	Water	45.3	166.4	211.6
JFK Intl Airport, NY	Air	92.4	100.0	192.4
Long Beach, CA	Water	34.1	150.1	184.2
Chicago, IL	Air	51.2	125.4	176.6
Houston, TX	Water	88.7	68.6	157.3
Detroit, MI	Land	75.2	58.8	134.0
Los Angeles Intl Airport, CA	Air	57.3	62.3	119.6
Savannah, GA	Water	27.1	74.7	101.8

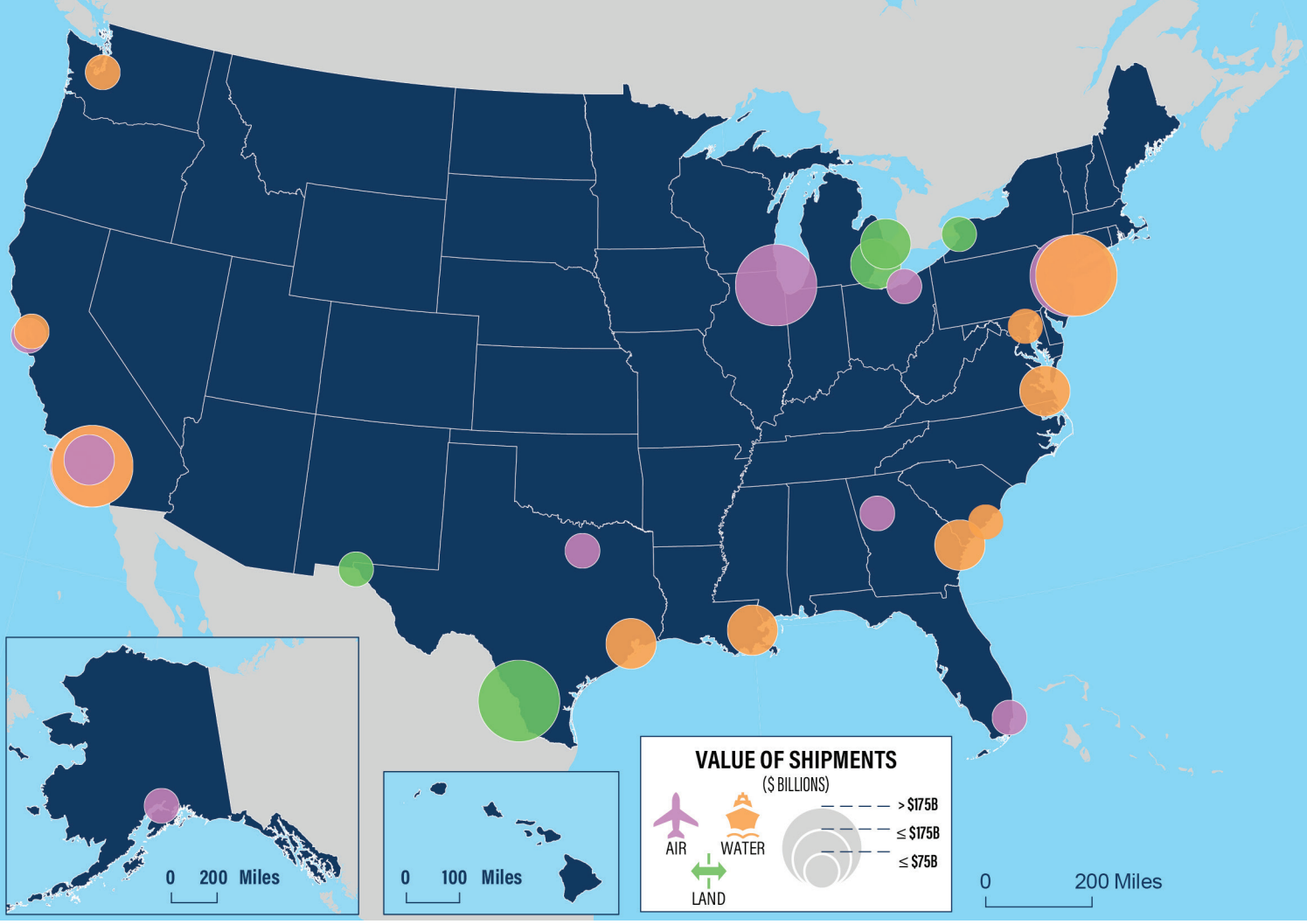


FIGURE 2. TOP 25 INTERNATIONAL TRADE GATEWAYS BY VALUE OF SHIPMENTS (2018)

INTERMODAL FREIGHT

Intermodal freight refers to a cargo that transfers from one transportation mode to another as the shipment moves from origin to destination. Most intermodal freight moves in large standardized shipping containers that are easy to transfer among ships, trains, and trucks. As international trade has increased, the amount of intermodal, or containerized, freight has increased as well. At some high-volume ports, on-dock rail transfer facilities place containers directly on trains, thereby reducing the number of truck and rail drayage trips.

Rail intermodal volumes have increased by 52 percent since 2000 and make up an increasing share of rail freight.[19]

Intermodal freight often moves on trucks for a portion of the trip. Highway intermodal connectors are roads that provide the "last-mile" connection between major port, rail, airport, and intermodal freight facilities and the NHS. These important components of the transportation system can affect the timely and reliable delivery of goods. There are 941 designated NHS connectors, spanning more than 2,500 miles of roads and connecting freight intermodal facilities to the Nation's highway network.[20]

National Multimodal Freight Network (NMFN)

The FAST Act requires the Department to establish an NMFN in the United States that identifies significant transportation assets for freight movement. The NMFN has four statutory goals: (1) to assist States in strategically directing resources toward improved system performance for the efficient movement of freight; (2) to inform freight transportation planning; (3) to assist in the prioritization of Federal investment; and (4) to assess and support Federal investments to achieve the National Multimodal Freight Policy goals and the NHFP goals as outlined in the FAST Act.

The FAST Act established a two-stage process for designating the NMFN. The Department (U.S. DOT) was required to establish an Interim NMFN within 180 days of the passage of the FAST Act that included the network components outlined by Congress. These components included the following:

- The National Highway Freight Network, as established under 23 U.S.C. 167—approximately 51,029 highway miles
- The freight rail systems of the Class I railroads—approximately 104,296 miles
- Public Ports with total foreign and domestic trade of more than 2 million short tons—113 ports
- The inland and intracoastal waterways of the United States, the Great Lakes, St. Lawrence Seaway, coastal, and open-ocean waterways—approximately 25,000 miles
- The top 50 airports with highest annual landed weight
- Other strategic freight assets—the Department defined these to include:
  - Approximately 9,000 miles of Class II and Class III railroads
  - Three ports designated as commercially strategic by the Department of Defense
  - Six additional airports

The Department published the Interim NMFN on June 6, 2016 and subsequently opened two comments periods: from June 6, 2016 through September 6, 2016 and from October 25, 2017 through February 22, 2018. The Department received 126 comments combined between the two public comment periods. Commenters provided feedback on a wide range of topics related to the NMFN, but two areas stood out. First, commenters overwhelmingly supported increasing the highway component of the NMFN and many suggested including the entire NHS. Second, commenters wanted clarity on the purpose of the NMFN and the relevance of having routes/facilities on the network.

Based on this feedback, U.S. DOT has recognized the need for the national freight strategy to inform the designation of the NMFN and provide a purpose for the identification of facilities, routes, and infrastructure. Following the release of the NFSP, the Department intends to designate the final NMFN, incorporating comments received from stakeholders on the Interim NFMN.

3 FREIGHT CORRIDORS


Source: Adobe Stock

Our Nation's economy depends on an efficient freight system to move commodities to markets at home and abroad. These commodities include bulk and break-bulk goods, such as gravel, coal, lumber, and steel, as well as consumer goods packed in containers. They also include energy products such as oil and natural gas, predominantly moved via pipeline, as well as agricultural commodities, such as grains, feed, fruit, and livestock. In addition to domestically produced goods bound for domestic consumption, imported and exported goods make up 18 percent of all commodities shipped in the United States by weight and are transported through our Nation's sea ports and border crossings.

This section provides an overview of how major commodities move through the Nation's freight system and identifies primary freight corridors for shippers in the following sectors, as required by the FAST Act.

Agriculture **Energy** **Natural resource** **Manufacturing**

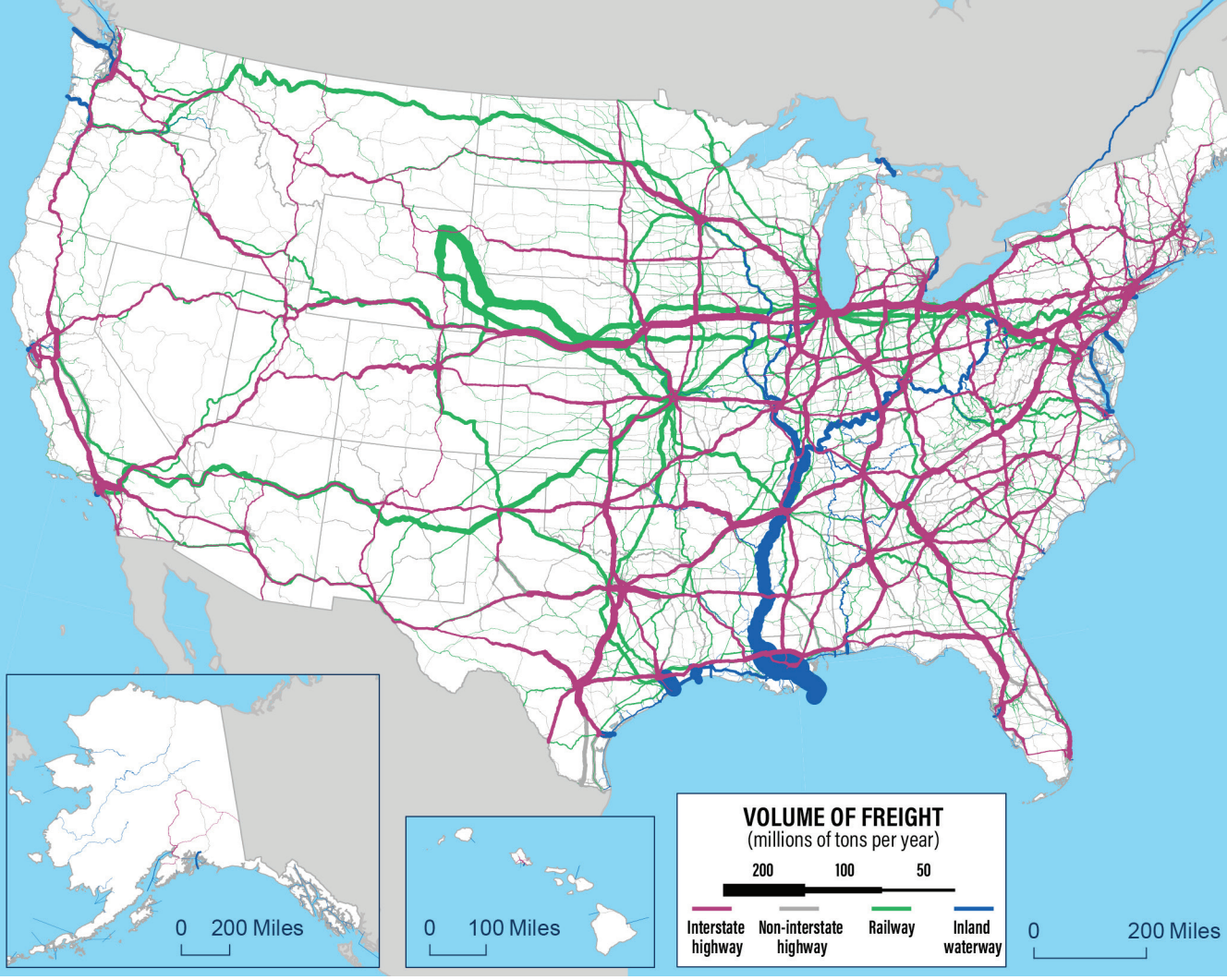
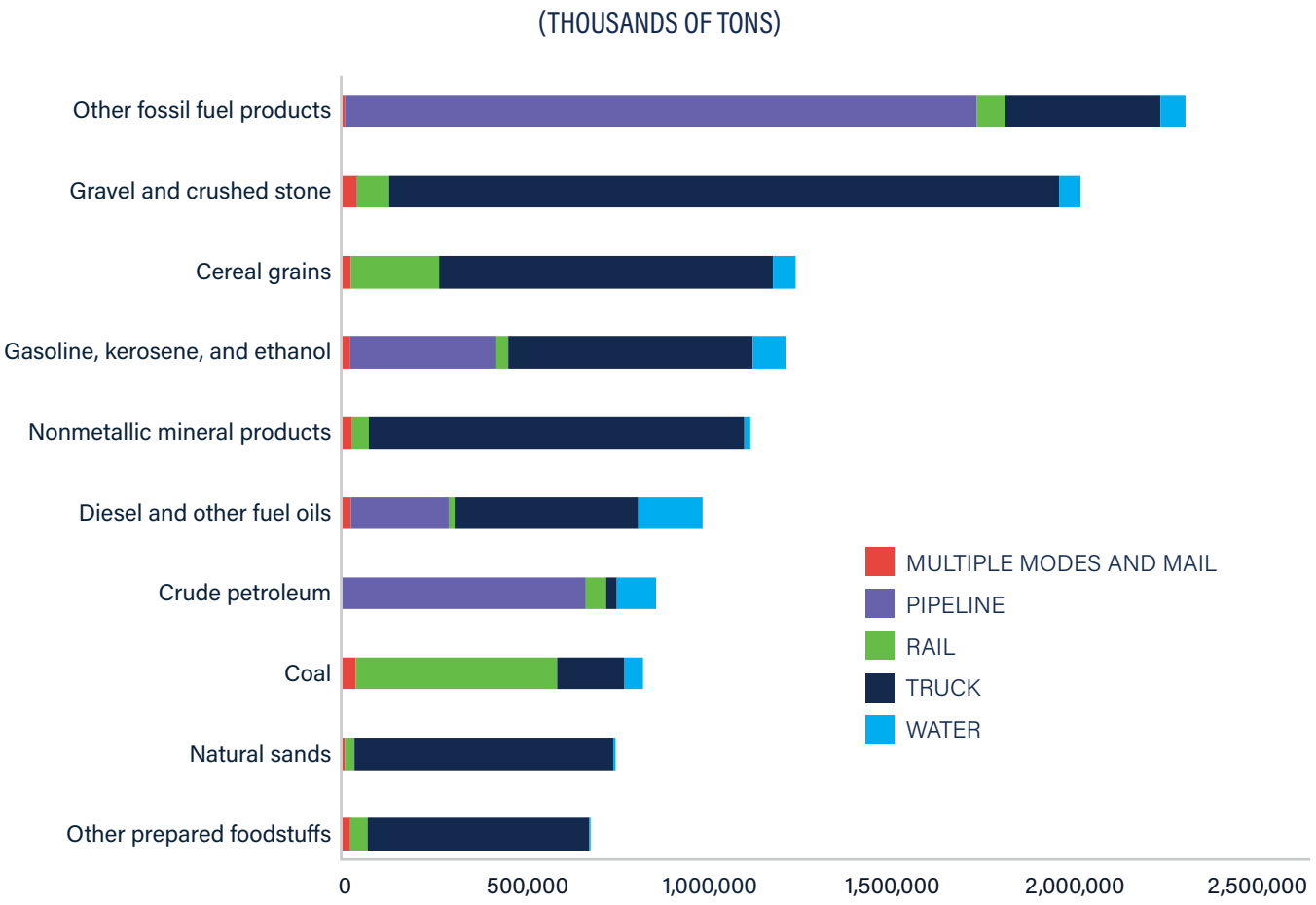


FIGURE 3. FREIGHT FLOWS BY HIGHWAY, RAILROAD, AND WATERWAY (2017)[21]

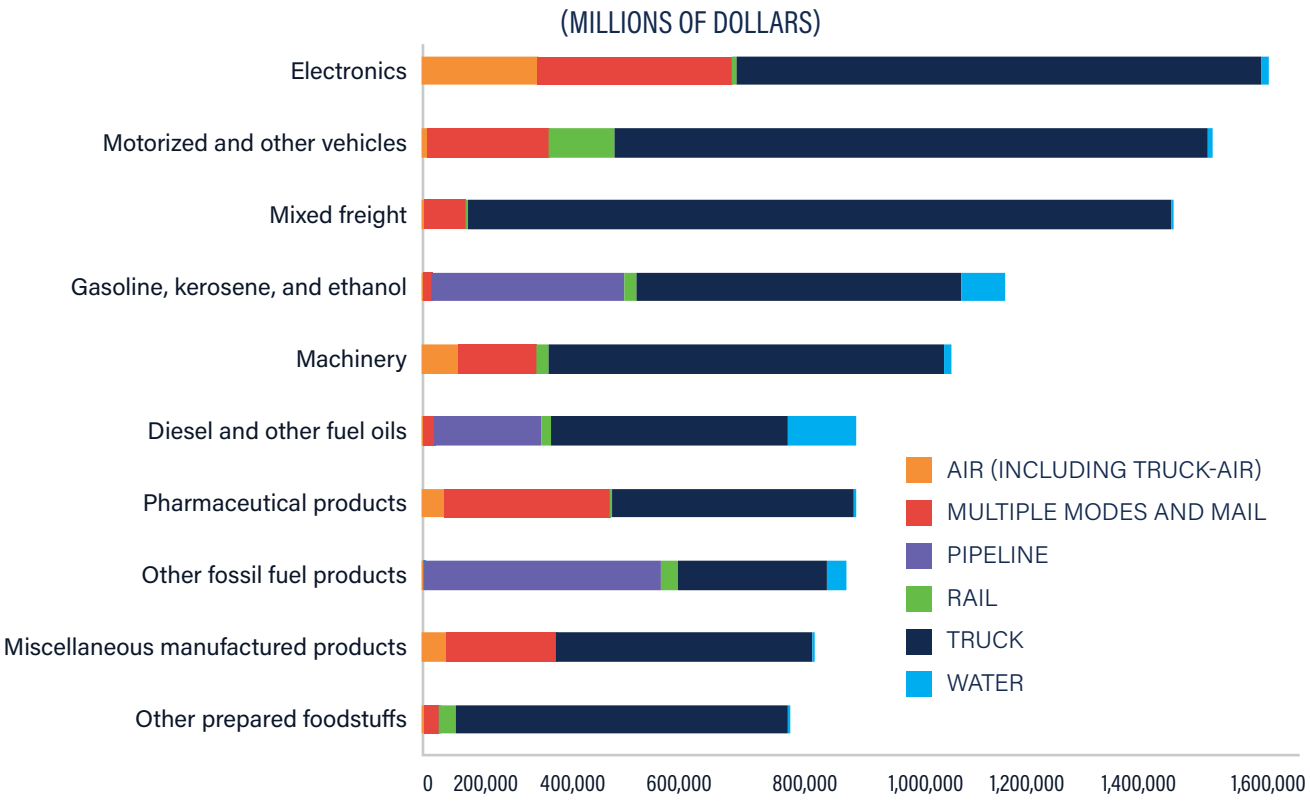
The leading commodities by weight are bulk goods, including fossil fuel products such as natural gas, coke, and asphalt; gravel; gasoline; cereal grains; and crude petroleum (see Figure 4). These commodities account for 68.0 percent of total tonnage, but only 25.8 percent of the value of goods moved in 2018. The leading commodities by value are high value-per-ton goods, such as electronics, motorized vehicles, mixed freight (largely food)[22], gasoline, and machinery. These commodities accounted for 36.8 percent of total tonnage, but 57.9 percent of total value of goods moved that year.[23]

FIGURE 4. FREIGHT SHIPMENTS OF TOP 10 COMMODITIES BY WEIGHT (2018)[24]



Shippers choose from various modes depending on their availability, speed, and reliability, as well as the weight and value of the commodity and the length of the shipment. Trucks carry all types of goods, ranging from high-value commodities, such as mixed freight and electronics, to bulk commodities, such as gravel, grains, and gasoline. In comparison, rail and water modes primarily move bulk products while air (including truck-air transport) moves high-value items, such as electronics and pharmaceuticals. Modes are often used in combination, depending on cost, commodity, distance, size, weight, and time requirements, although trucks provide first- and last-mile connections for most multimodal shipments.

FIGURE 5. FREIGHT SHIPMENTS OF TOP 10 COMMODITIES BY VALUE[25]



Modal shares of freight also vary by distance. Trucks carry the largest shares by value, tons, and ton-miles for shipments moved less than 750 miles, while rail is the dominant mode by tons and ton-miles for shipments moved 750 to more than 2,000 miles. Air, multiple modes, and mail (including intermodal container shipments), and other/unknown modes accounted for 51.2 percent of the value of shipments moved more than 2,000 miles (Figure 6).

The NFSP relies on the 4th generation Freight Analysis Framework (FAF4) for freight volume forecasts for 2020 through 2045 (see Table 3). The Federal Highway Administration (FHWA) and the Bureau of Transportation Statistics (BTS) developed forecasts of freight volumes by commodity type and mode for FAF4 in 2016. FAF4 is a critical dataset for freight planning because it integrates data from a variety of sources to create a comprehensive picture of freight movement among States and major metropolitan areas by all modes of transportation. The FAF4 forecasts use the macroeconomic assumptions on the short- and long-term trends of the U.S. economy at the time of the FAF4 forecasts development (January 2016) as the basis for inter-regional domestic and international freight flows tonnage and value forecasts. These assumptions about the national economy form the basis of national-level forecasts of output, consumption, and trade, by industry for the various FAF regions, which are ultimately applied to the FAF4 base-year database (2012) to drive the FAF4 forecasts.

In the case of energy and agricultural commodities, more recent Federal agency forecasts are cited to supplement FAF4 forecasts. Severe macroeconomic disruptions, such as effects of COVID-19, can have significant near-term and long-term effects on freight demand and demonstrate the uncertainty associated with any forecast that relies on economic assumptions that may be subject to dramatic changes as a result of historic events.

FIGURE 6. VALUE OF FREIGHT BY MODE AND DISTANCE[26]

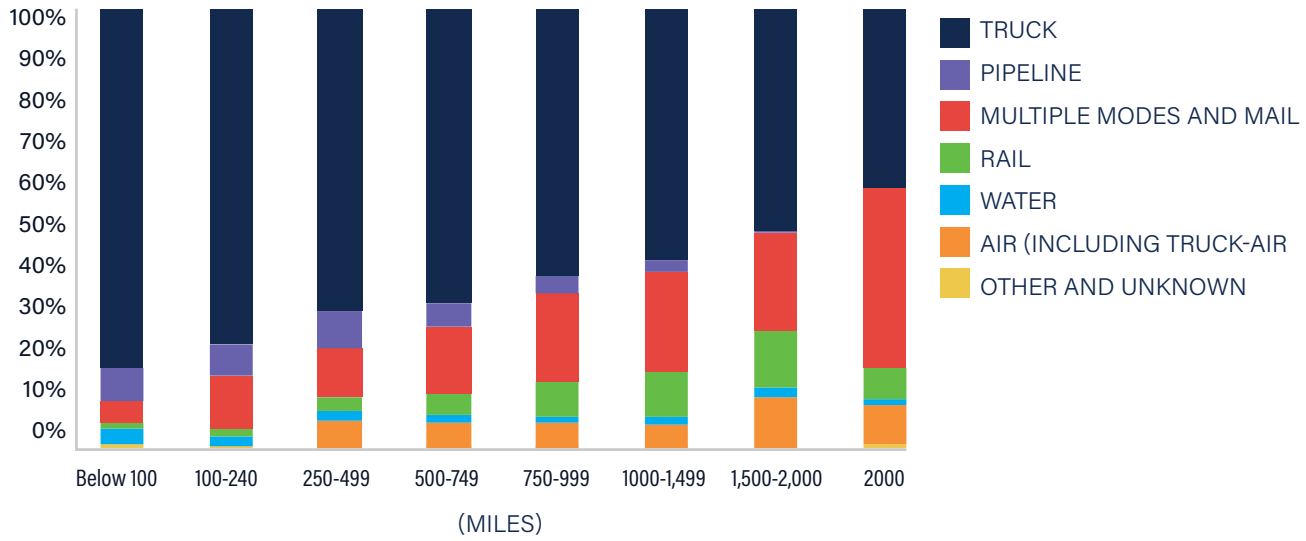


TABLE 3. FORECASTED GOODS MOVEMENT BY MODE[27]

(THOUSANDS OF TONS)

OVERALL	2020	2025	2030	2035	2040	2045
Truck	12,417,523	13,132,935	3,840,459	4,572,969	15,474,235	16,414,977
Rail	1,795,948	1,866,043	1,939,856	2,021,716	2,135,560	2,250,033
Water	780,553	819,228	839,389	864,383	903,684	942,244
Air (include truck-air)	9,703	11,887	14,300	17,397	22,129	26,211
Multiple modes/mail	478,272	522,850	572,596	630,243	711,698	799,761
Pipeline	3,976,704	4,266,485	4,419,310	4,554,760	4,637,816	4,766,228
Other and unknown	32,402	32,019	29,824	29,900	30,568	31,688

AGRICULTURE

In 2017, agricultural products represented almost a third of all goods moving across all modes in the U.S. by ton-miles. American farmers rely on the Nation's multimodal transportation system to get their goods to the market. While transportation costs for agricultural goods typically make up only 3-4 percent of total costs, these costs can be higher for goods shipped overseas. Efficient, reliable, and cost-effective transportation can make a significant difference to the quality, cost, and competitiveness of U.S. agricultural goods.

Source: Adobe Stock

Agricultural products move predominantly by truck, especially for shorter domestic trips. However, agriculture is also a major user of inland waterways and railroads. Barges on inland waterways transported more than 70 million short tons of farm products in 2019.[28] U.S. railroads moved another 1.6 million carloads (approximately 157 million short tons).[29]

Agricultural goods bound for export rely on inland waterways, rail, and ports for their transportation. Agricultural producers in

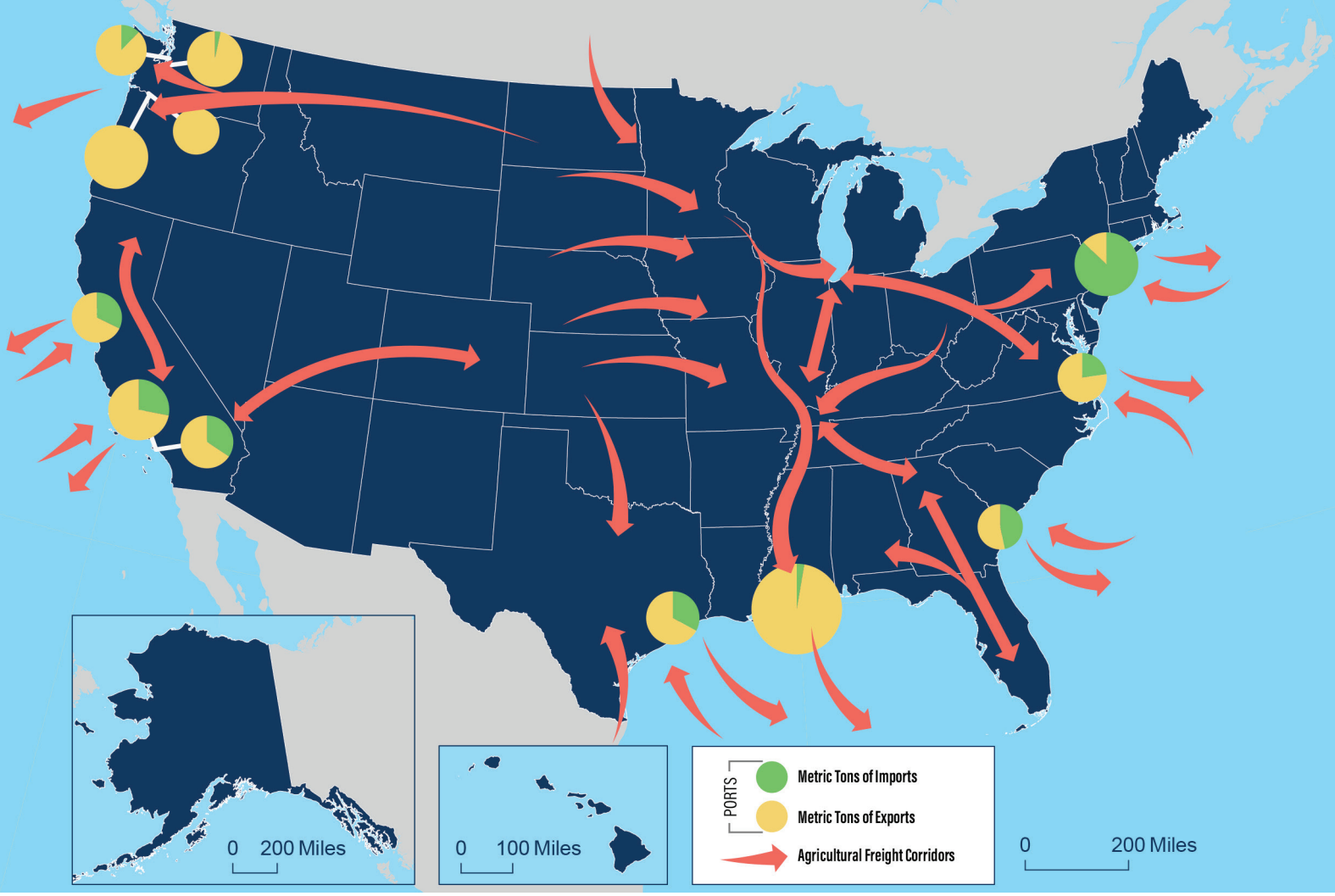


FIGURE 7. MAP OF AGRICULTURAL TRADE FLOWS

the heartland region rely on the Mississippi River System to move grain, such as corn, soybeans, and wheat, to southern Louisiana for export. The New Orleans port region handles approximately 47 percent of the more than 150 million metric tons of exported agricultural goods handled by U.S. ports annually.[30]

Agricultural goods also make up the majority of commodity flows on the Columbia River system, which is a key corridor for shipping wheat.

TABLE 4. USDA AGRICULTURAL COMMODITY PRODUCTION PROJECTIONS[31]

(MILLIONS OF BUSHELS)

COMMODITY/YEAR	2019/20	2029/30	% CHANGE
Barley	1,143	1,256	9.9%
Corn	79,361	91,577	15.4%
Oats	859	886	3.1%
Sorghum	1,857	1,597	-14.0%
Soybeans	17,473	20,179	15.5%
Wheat	12,770	12,407	-2.8%
Total	114,549	129,063	12.7%

Rail carries approximately 30 percent of all ton-miles of agricultural products. Some products rely on rail more than others. For example, 72 percent of wheat and 56 percent of barley is moved to domestic and export markets by rail.[32] In 2018, movements of grain and grain-related products accounted for approximately 12 percent of the revenue of Class I railroads. Most grain traveling by rail originates in the grain-producing States of the Midwest, while more than half of all shipments terminate in the States of Washington, Texas, Illinois, and California. Many of these shipments are destined for ports on the West Coast and the Gulf Coast. Chicago functions as a transfer point for rail, as agricultural goods are often shipped to Chicago and then transferred for shipment to another destination.

The USDA publishes 10-year projections for agricultural production on an annual basis. The most recent USDA projections for key grain products are summarized in Table 4. Forecasted freight volumes by mode for agricultural commodities according to FAF4 are shown in Table 5.

TABLE 5. FORECASTED AGRICULTURE GOODS MOVEMENT BY MODE[33]

(THOUSANDS OF TONS)

AGRICULTURE	2020	2025	2030	2035	2040	2045
Truck	2,817,157	3,018,495	3,242,591	3,452,430	3,721,402	3,997,312
Rail	353,756	381,522	414,353	444,915	486,157	526,952
Water	59,712	66,135	73,061	78,955	88,329	97,086
Air (include truck-air)	1,045	1,242	1,441	1,672	1,985	2,306
Multiple modes/mail	101,892	114,734	127,936	141,551	161,039	180,754
Other and unknown	215	284	361	462	619	735

ENERGY

Over the past decade, domestic fuel production has increased significantly with advances in technology and extraction techniques. The growth of energy production in new regions and the Nation's shift to net fuel product exports has placed new demands on the freight transportation system and spurred investments in pipeline capacity.

Source: Adobe Stock

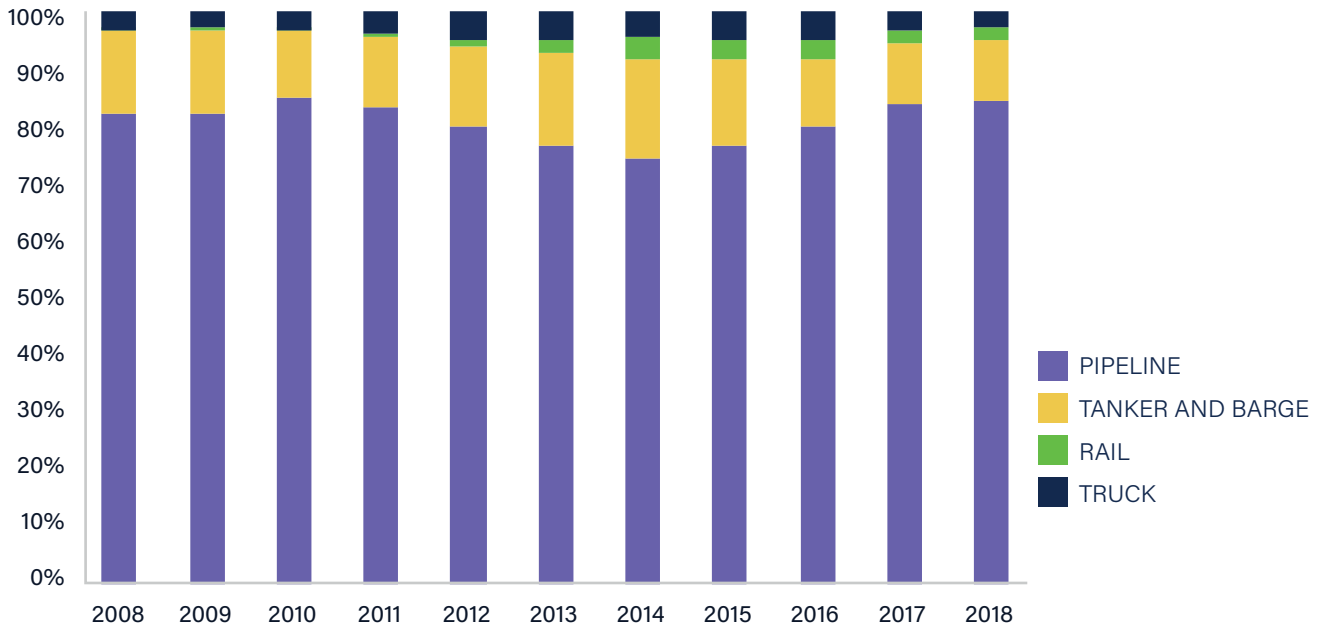
CRUDE OIL

Pipelines are the dominant mode of transport for liquid and gaseous energy resources. Where pipelines are not available as a transport option, oil producers may also rely on rail, trucks, barges, and tankers. Pipelines have a strong safety record in transporting energy products while railroads and trucking have much more flexibility in pickup and delivery options. Nearly all retail gasoline and diesel fuel makes the final leg of its journey to retail stations by truck. Waterborne movement of liquids offers economical transportation between locations on inland and coastal waterways and many coastal ports play a key role in ensuring the efficient movement of oil imports and exports.

With rising production, energy corridors have changed significantly. Historically, oil was imported into ports along the U.S. Gulf Coast and flowed North. Today, these flows have reversed, with oil now being transported from Canada and North Dakota toward the Great Lakes and on to Oklahoma and Texas.34 Figure 9 shows how crude oil flows have changed with the dramatic growth in domestic oil production. Flows have increased from the Bakken oil field in North Dakota and Montana and from other parts of the Rockies, as well as from Canada, moving through the Midwest to storage hubs in Oklahoma and refineries and export hubs in the Gulf Coast region. Refineries in the Northeastern U.S. continue to rely on imported oil due to a lack of pipeline connectivity to domestically produced crude oil.

As oil production surged in the early 2010s in areas such as the Bakken formation with limited pipeline capacity in 2012, shipments of crude oil by rail increased dramatically. Shipments of crude oil by rail increased through 2015 then decreased as the energy industry constructed new pipelines and reconfigured existing pipelines to accommodate changing commodity flows. A number of pipeline projects completed between 2014 and 2018 were designed to move crude oil from the Rockies, which includes the Bakken formation, to Cushing, Oklahoma, a key crude oil storage hub.35 The largest pipeline buildout took place in the U.S. Gulf Coast region (which includes the Permian Basin in west Texas and New Mexico), and was responsible for 70 percent of the growth in U.S. crude oil production between 2010 and 2018. As a result, the percentage of domestic crude oil transported by pipelines to domestic refineries increased from 74 percent in 2014 to 84 percent in 2018 (see Figure 8).

FIGURE 8. PERCENTAGE OF DOMESTIC CRUDE OIL MOVED BY PIPELINE, TANKER AND BARGE, AND RAIL TO U.S. REFINERIES[36]



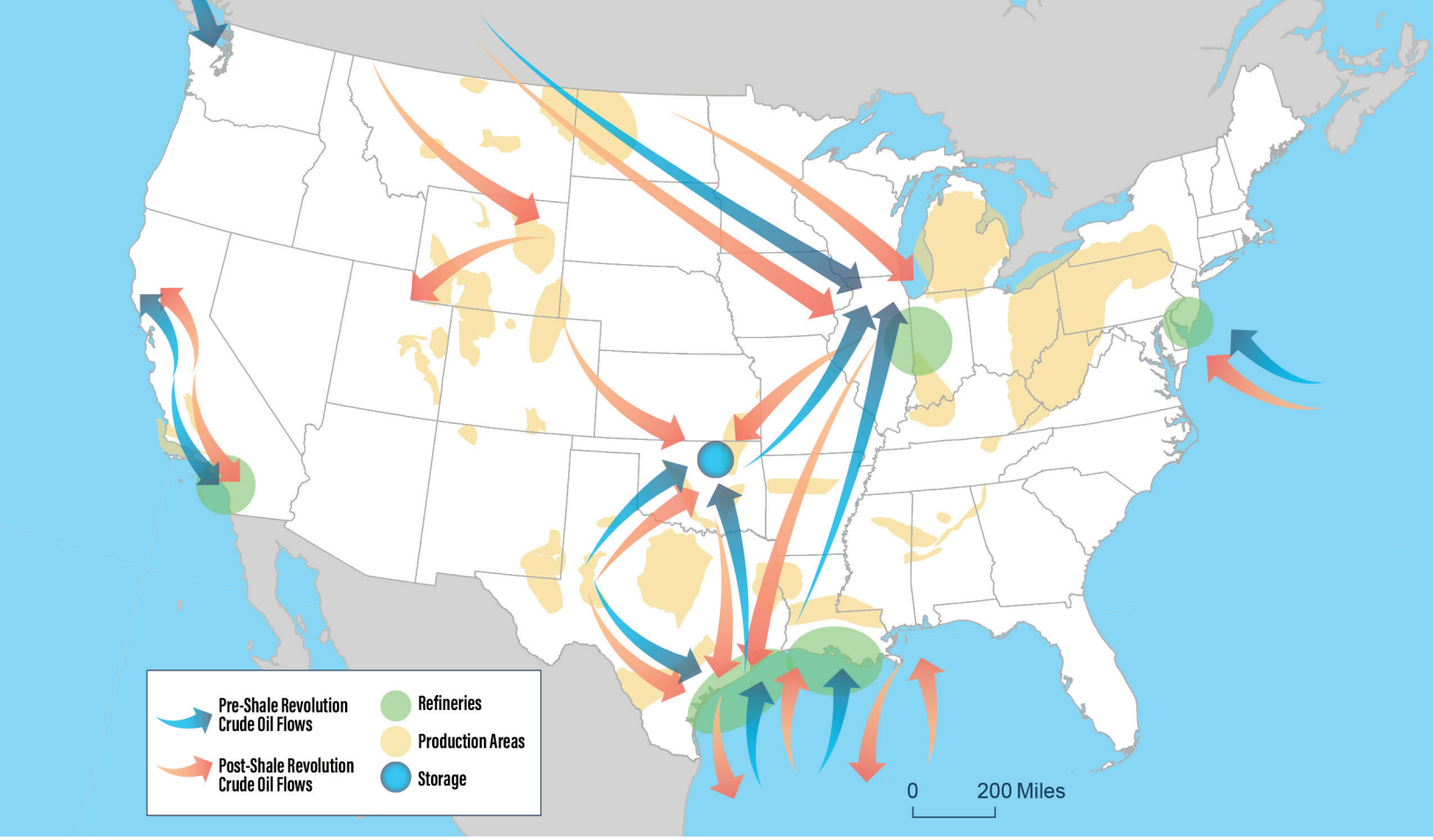


FIGURE 9. CRUDE OIL FLOWS PRE- AND POST-SHALE[37]

In early 2020, the Energy Information Administration (EIA) forecasted that domestic crude oil production will continue to grow through 2022, reaching 14 million barrels/day before leveling off. In addition, natural gas plan liquids production was projected to increase by more than 30 percent reaching 6.6 million barrels/day by 2028.[38] Table 6 shows forecasted energy commodities movement by mode through 2045 according to FAF4.

TABLE 6. FORECASTED ENERGY GOODS MOVEMENTS BY MODE[39]

(THOUSANDS OF TONS)

ENERGY	2020	2025	2030	2035	2040	2045
Truck	1,918,241	1,910,391	1,866,521	1,834,336	1,795,885	1,786,209
Rail	690,263	662,161	632,396	620,048	607,735	598,283
Water	496,094	507,152	499,519	497,738	499,255	504,131
Air (include truck-air)	119	116	110	109	112	115
Multiple modes/mail	78,384	78,109	78,431	81,418	86,539	90,856
Pipeline	3,930,926	4,214,996	4,362,591	4,492,864	4,568,574	4,690,344
Other and unknown	27,207	25,590	21,973	20,226	18,265	16,594

Rulemaking for Transport of Liquefied Natural Gas (LNG) by Rail

In June 2020, the Pipelines and Hazardous Materials Safety Administration (PHMSA), in coordination with the Federal Railroad Administration (FRA), issued a final rulemaking authorizing the bulk transportation of liquified natural gas (LNG) by rail, as required by Executive Order 13868. Historically, LNG for domestic consumption has been transported only by truck. This rulemaking will permit the bulk transportation of LNG in DOT-113 tank cars with enhanced outer tank requirements and additional operational controls.

NATURAL GAS

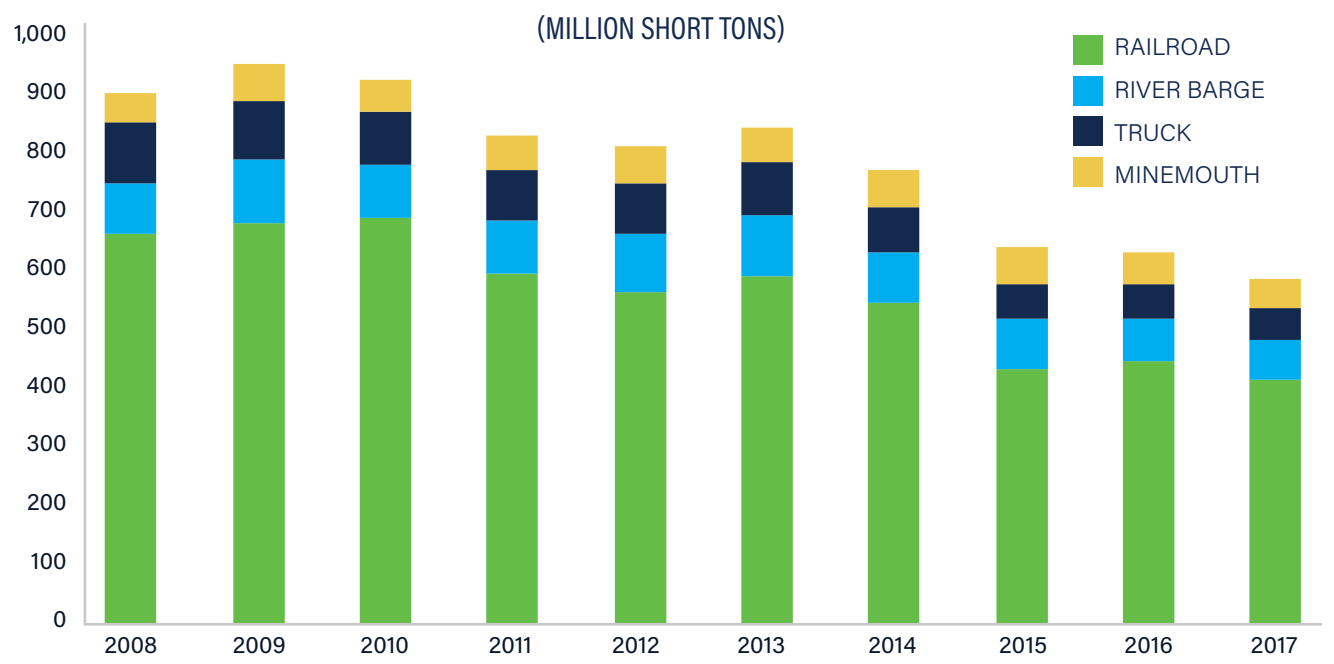
Gross exports of natural gas have also increased rapidly over the past decade. In 2018, total U.S. natural gas exports totaled 3.6 trillion cubic feet (Tcf), primarily as a result of exports to Canada and Mexico by pipeline. The EIA forecasts that U.S. natural gas trade will nearly triple over the next decade due to an increase in liquefied natural gas (LNG) exports to more distant destinations.[40] Demand for natural gas exports through U.S. LNG facilities has been the fastest-growing among all natural gas demand sectors, growing by more than 50 percent in the past two years.[41]

As a result of increasing domestic production and exports, natural gas flows have changed. Where pipelines once delivered natural gas from the Gulf Coast to the Northeast, now gas flows from Appalachia in all directions, including to the west to serve Midwestern markets, to the east to serve the Northeast, north into Canada, and south to LNG export facilities on the Gulf Coast. In addition, an increasing amount of domestically produced natural gas moves south across the border to Mexico.

COAL

According to the EIA, 69 percent of U.S. coal shipments in 2018 were delivered to their final destinations by rail. Rail moves an especially large volume of coal between the Powder River Basin in Wyoming and the Midwest. Coal shipments have historically been a significant source of revenue for railroads, accounting for 31 percent of tonnage and 16 percent of revenue for Class I railroads in 2018.[42] However, railroads shipped 42.5 percent fewer carloads of coal in 2018 than in 2008, mainly because of a decline in the use of coal for domestic electricity generation (see Figure 10).[43] Today, intermodal and chemical shipments account for more Class I railroad revenues than coal. Waterborne commerce was also a major mode of transport for coal shipments—carrying 220 million short tons in 2018.[44] The EIA forecasts that coal production in the United States will decline by approximately 11 percent over the next decade.[45]

FIGURE 10. ANNUAL COAL SHIPMENTS TO ELECTRIC POWER PLANTS BY MODE[46]



ETHANOL

The U.S. ethanol industry—and shipments of ethanol—has grown significantly over the past decade. Due to its corrosive nature, there are challenges to moving unblended ethanol by pipeline, making railroads the chief mode of transport for this commodity. Railroads account for 60 to 70 percent of ethanol movement.

An estimated 15 to 20 percent of ethanol rail movements originate on short line and regional railroads. Ethanol production is concentrated in the Midwest, but many of the major markets for ethanol are on the East Coast, in California, and in Texas, where ethanol is used as a fuel or oxygenate in mixtures with motor gasoline.[47]

Source: Adobe Stock

NATURAL RESOURCES

Natural resources include both raw and processed materials used in various industries, including ores and other minerals, timber, and sand and gravel, as well as chemicals and fertilizers. The iron and steel industry relies heavily on railroads and barges to transport materials—more than 50 percent of all metallic ore by tonnage is transported via rail, while water transport accounts for another 18 percent. The majority of integrated U.S. steel production is centered in and around the Great Lakes because commercial maritime transportation is a cost-effective way to transport large quantities of heavy iron ore from the Lake Superior region to nearby industrial hubs on the southern shores of the Great Lakes.

The lumber industry depends on trucks to transport logs to mills, although milled lumber, wood particle, and paper products are more likely to be transported by rail. Materials such as sand and gravel tend to be produced and used locally and therefore rely heavily on trucks for transportation. Rail may be used to transport raw materials from quarries to cement and concrete plants.

According to FAF4 data, trucks moved approximately half of all chemical and fertilizer tonnage shipped in 2018. Rail accounted for about a third of tonnage, and waterways and pipelines accounted for most of the remainder. After intermodal shipments and coal, chemical shipments were the third largest generator of revenue for railroads, accounting for 14.5 percent of gross revenue for Class I railroads.[48]

TABLE 7. FORECASTED NATURAL RESOURCE GOODS MOVEMENTS BY MODE[50]

(THOUSANDS OF TONS)

NATURAL RESOURCES	2020	2025	2030	2035	2040	2045
Truck	2,617,901	2,763,306	2,906,882	3,066,363	3,260,539	3,424,464
Rail	218,244	227,941	236,722	244,691	257,448	270,071
Water	107,716	112,200	116,718	120,982	125,574	129,860
Air	18	19	21	23	27	30
Multiple modes/mail	53,574	54,996	57,098	59,221	62,000	64,538
Pipeline	3,434	3,516	3,689	3,912	4,161	4,374
Other and unknown	23	25	27	28	32	34

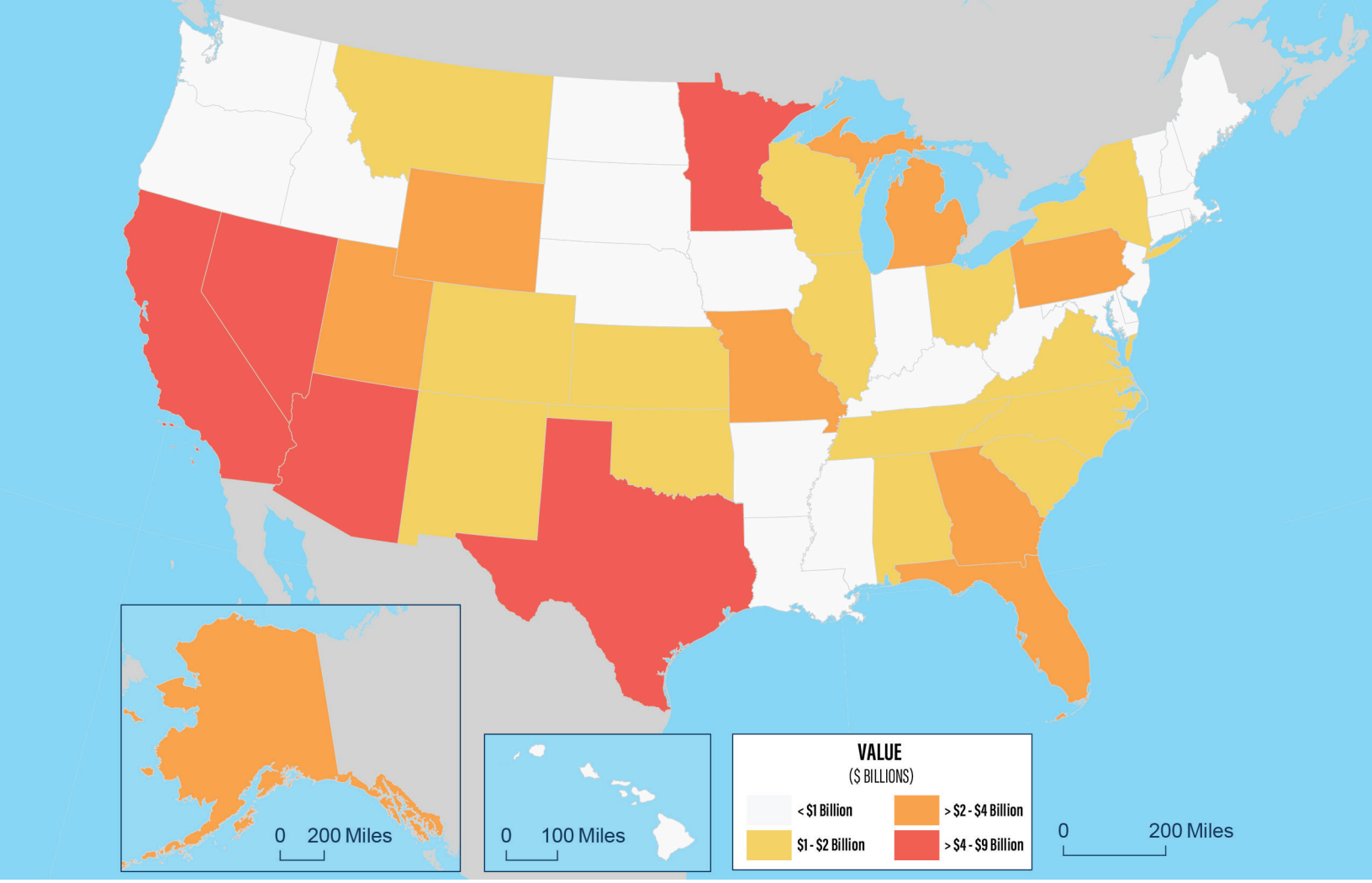


FIGURE 11. VALUE OF NONFUEL MINERALS PRODUCED IN 2019, BY STATE[51]

The boom in shale oil, produced through hydraulic fracturing, which requires vast quantities of sand and water, has increased demand for those resources in shale production areas. Hydraulic fracturing operations used approximately 200 billion pounds of sand in 2019.[49] The sand used to support hydraulic fracturing operations may be sourced locally, but much of it is mined in Wisconsin and other Midwestern States and then shipped to production sites such as the Permian Basin, Eagle Ford, and the Marcellus Formation. Demand for sand and water shipments can lead to large increases in heavy truck traffic around energy production sites with associated community impacts, such as increased traffic, and deteriorating road conditions.

MANUFACTURING AND RETAIL

Accounting for roughly 12 percent of U.S. gross domestic product (GDP), the manufacturing sector engages in the transformation of materials and components into new products at plants, factories, or mills. The retail (and wholesale) sector sells merchandise to businesses and directly to the general public for consumption. This includes establishments such as department stores, grocery stores, automotive dealers, gasoline stations, and other specialty retailers, as well as online transactions.

Transportation costs make up 9 percent of product costs in wholesale and retail trade as compared to 3.6 percent in the manufacturing sector.[52] In recent decades, retailers and manufacturers have reconfigured their supply chains[53] to minimize inventory costs and respond to changing markets. Seeking greater efficiencies, many manufacturers and retailers have adopted a distributed, on-demand model of manufacturing and inventorying. Modern manufacturing systems rely on advanced logistics systems and precise timing of shipments. As a result, when parts or materials shipments are delayed an entire production process can be adversely affected.

TABLE 8. FORECASTED MANUFACTURING GOODS MOVEMENTS BY MODE[54]

(THOUSANDS OF TONS)

MANUFACTURING	2020	2025	2030	2035	2040	2045
Truck	3,530,732	3,799,251	4,084,292	4,407,952	4,793,941	5,210,084
Rail	197,799	214,852	233,340	255,489	283,082	310,270
Water	41,125	47,389	54,207	62,836	75,200	86,002
Air	7,248	8,917	10,790	13,219	16,950	20,155
Multiple modes/mail	161,981	182,581	205,849	235,171	275,318	323,238
Other and unknown	4,650	5,778	7,087	8,764	11,176	13,788

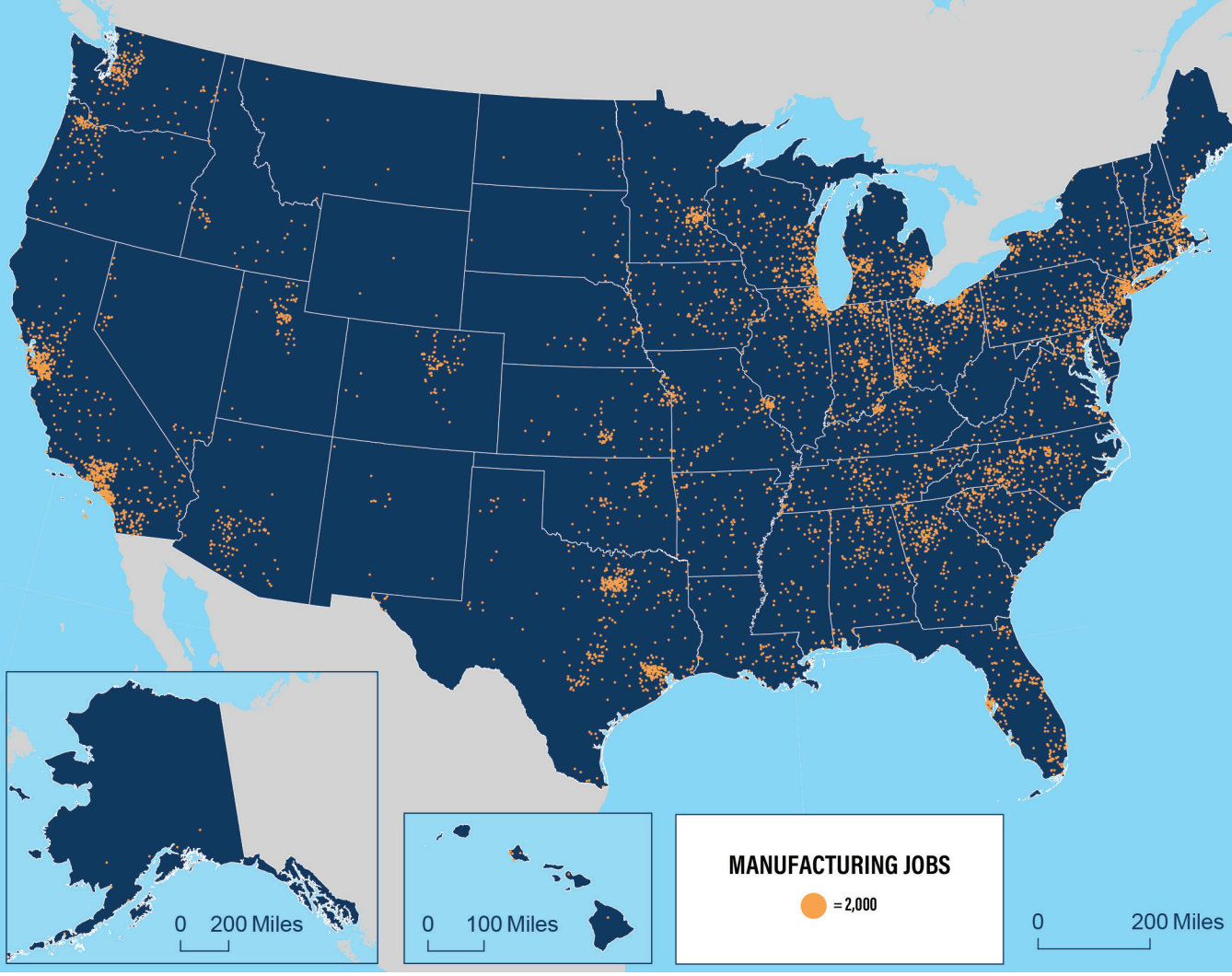


FIGURE 12. MANUFACTURING JOBS BY COUNTY

Manufacturing occurs across the country, but has higher concentrations of production in the Midwest, Northeast, California, and Texas (see Figure 12). There are also a number of manufacturing jobs concentrated in the Southeast region. From these points of origin manufactured goods flow to domestic businesses and consumers and abroad for export.

With the growth of international trade, supply chains have become increasingly decentralized and they are frequently outsourced to third-party logistics companies. Manufacturers in the U.S. export nearly half of their output, particularly to our North American trading partners. In 2018, Canada and Mexico purchased $500 billion of manufactured goods from the U.S., more than the next 11 largest U.S. trading partners combined. Access to international markets and efficient supply chains is required to move materials, parts, and products around the world.

Intermodal transportation of containerized goods is particularly important for the manufacturing and retail sectors. Containers, which allow goods to move easily via multiple modes, provide a flexible response

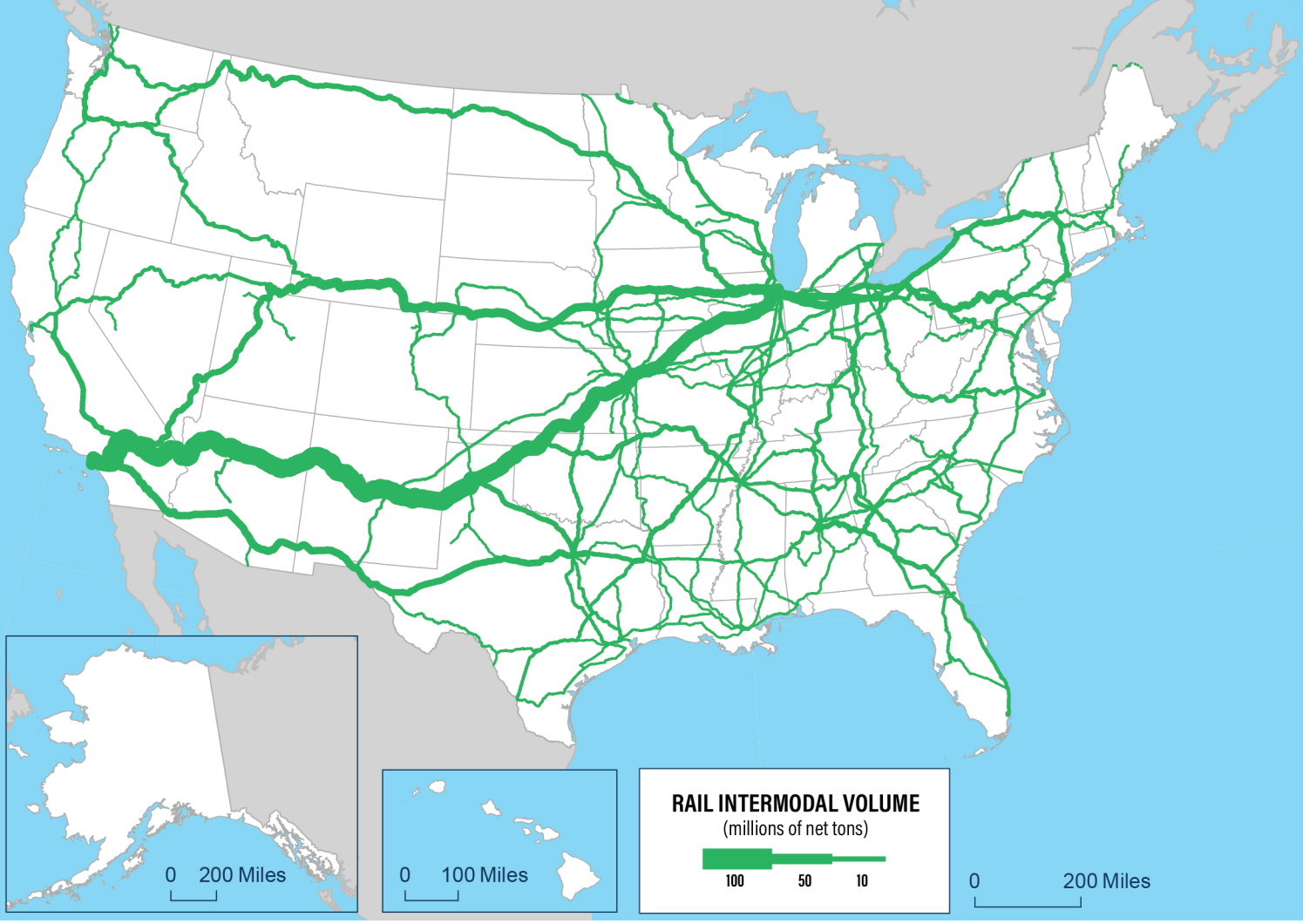


FIGURE 13. TONNAGE OF TRAILER-ON-FLATCAR AND CONTAINER-ON-FLATCAR RAIL INTERMODAL MOVES (2016)[56]

to the changing supply chain management requirements in global markets and distribution systems. An integrated intermodal transport system is a significant and critical factor in the successful execution of domestic and international supply chains. As shown in Figure 13, the largest rail intermodal traffic volume occurs on routes between Pacific Coast ports and Chicago; southern California and Texas; and Chicago and New York, as imported and exported containerized goods move to and from major intermodal ports and rail hubs (see Figure 13).[55]

A major retail trend is the emergence of e-commerce which is leading to rapid changes in supply chains. E-commerce sales make up more than 11 percent of total retail sales and are growing at double digit rates each year. This trend is described in greater detail in the following chapter.

4 KEY TRENDS

Several major economic, demographic, technological, and environmental trends are driving changes to freight supply and demand and use of the freight system. These trends are summarized in Figure 14.

Source: Adobe Stock

FIGURE 14. KEY FREIGHT TRENDS

GROWING POPULATION AND ECONOMY

The population and economy of the United States are growing at a steady pace contributing to increased demand for freight. The fastest growing regions of the country are primarily in southern and western States.

DIVERSIFYING GLOBAL SUPPLY CHAINS

International trade is growing and supply chains are becoming increasingly global, increasing congestion at ports, border crossings, and on the infrastructure that connects these trade gateways to the broader transportation system.

RISING DOMESTIC FUEL PRODUCTION

Rapidly increasing domestic fuel production requires new and expanded infrastructure to safely and efficiently move fuel from production areas to refineries and export terminals.

CHANGING URBAN-RURAL DYNAMICS

Furthering a long-term trend, the population of the United States is becoming more concentrated in increasingly congested metropolitan areas, creating challenges for delivery of goods. Declining rural populations must support critical freight corridors, while providing essential goods to sustain urban markets.

INCREASING E-COMMERCE

Online shopping is rapidly increasing as a share of retail sales, creating new demands for faster and cheaper delivery of goods straight to consumers. This trend is changing land use patterns and contributing to increased truck traffic and competition for curb space in residential areas.

ADVANCING TECHNOLOGY

Emerging technologies from automation to delivery drones to the Internet of Things have the potential to transform the freight industry, disrupting old business models and changing the nature of freight jobs.

EVOLVING WORKFORCE

Changing technologies and workforce expectations, coupled with low unemployment, are making it difficult for some freight companies and government agencies to attract and retain qualified employees.

GROWING POPULATION AND ECONOMY

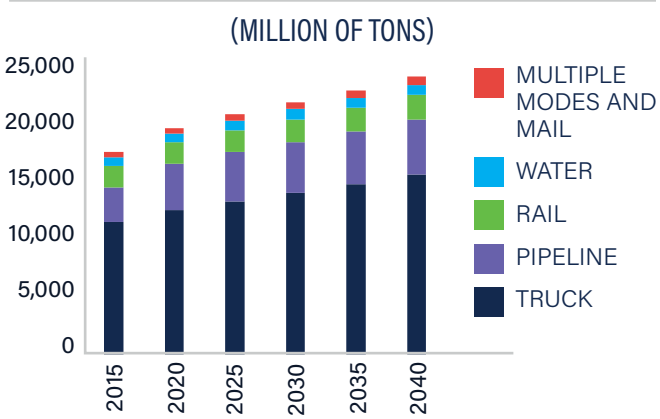
Population and economic growth are increasing demand for goods and freight transportation. If long-term economic and demographic trends continue, growth will be concentrated in the southern and western regions of the United States as well as in urban areas throughout the country. Demand for truck transportation will increase faster than demand for other modes leading to more congestion on heavily traveled truck routes.

The U.S. population grew by 16 percent between 2000 and 2018, climbing to 327 million. The U.S. economy as measured by inflation-adjusted GDP increased by 38 percent between 2000 and 2018. U.S. population is estimated to grow by 0.6 percent annually over the next 30 years, and it is projected that real GDP will increase 1.9 percent annually over the same period.[57]

Population and economic growth is unevenly distributed across the country. Since 2000, both population and economic activity have grown fastest in southern and western areas of the U.S. and in urbanized areas. This trend is expected to continue. According to one widely cited study, just three States, (Texas, Florida, and California) are expected to account for half of all population growth in the next 20 years.[58]

As our economy and population continue to grow, overall freight demand is expected to increase by approximately 1.2 percent annually over the next 20 years (see Figure 15).[59] The value of freight moved is forecast to increase faster than tonnage, rising from $1,016 per ton in 2018 to $1,455 per ton in 2045, when controlling for inflation. This increase is due to high-value, low-weight commodities growing at a faster rate than low-value, high-weight commodities. Demand for trucking is expected to grow more rapidly than other modes of freight, resulting in combination truck travel increasing at a rate of 1.5 percent annually, or by 35 percent by the year 2040.[60]

FIGURE 15. HISTORICAL AND FORECAST TOTAL FREIGHT TONNAGE[61]

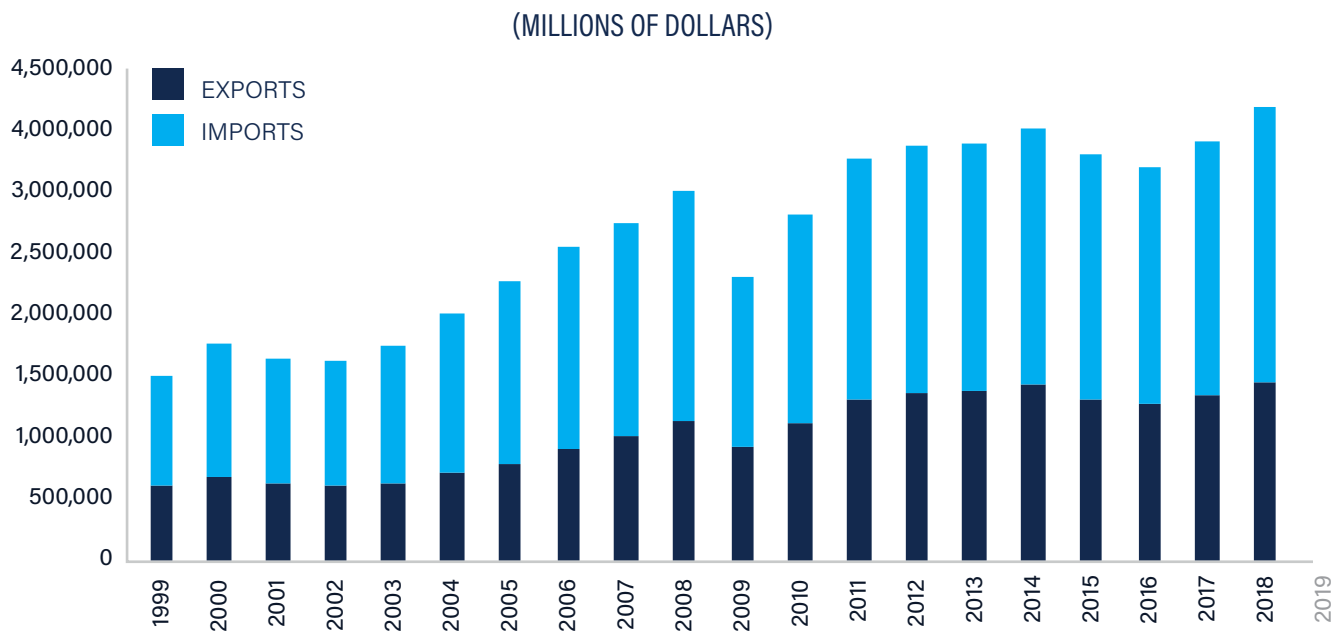


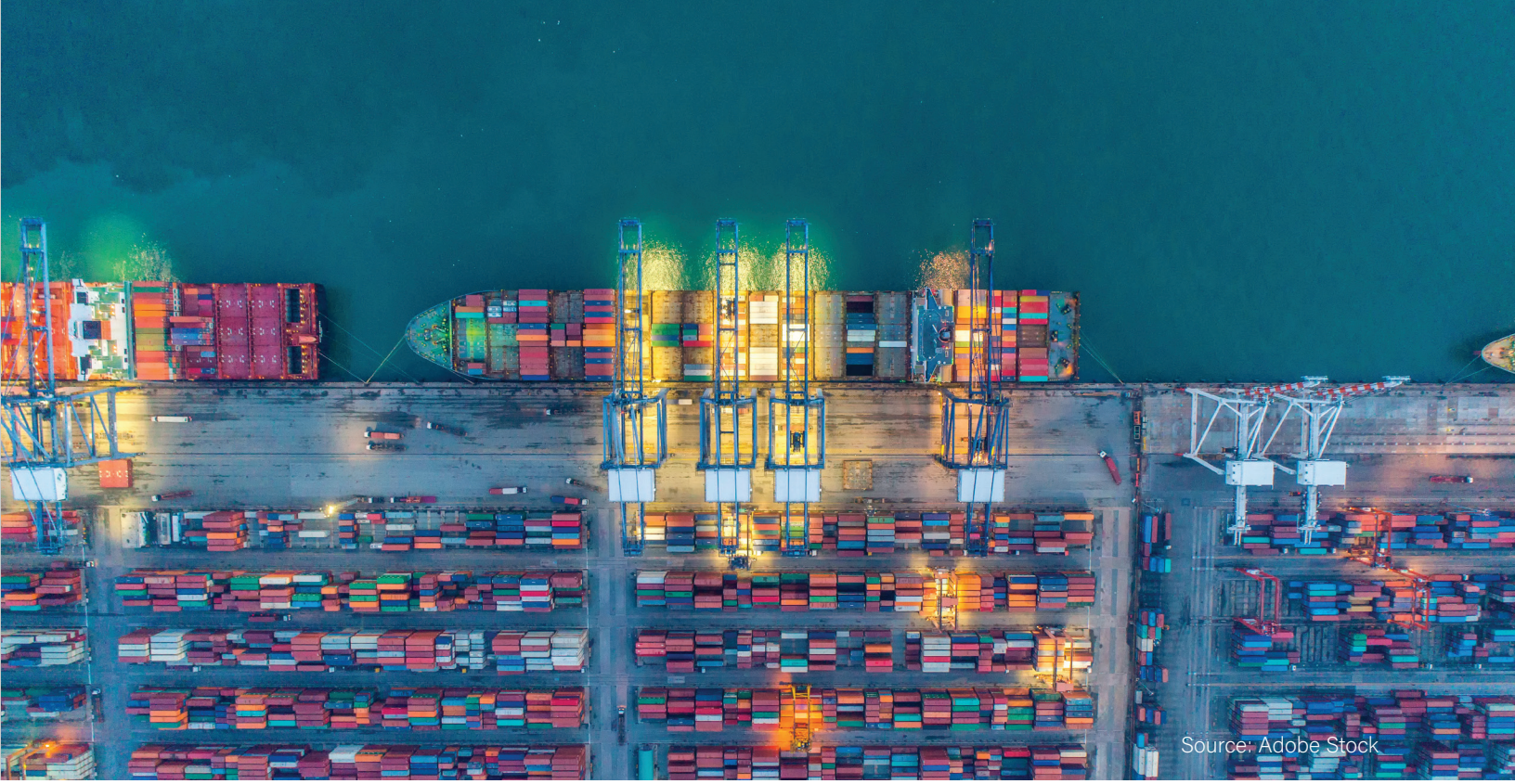
DIVERSIFYING GLOBAL SUPPLY CHAINS

Our economy depends on a mix of global and domestic supply chains to provide products and services that meet the demands of U.S. consumers. Supply chains increasingly rely on materials, technologies, labor, and production facilities located abroad. International trade is an important contributor to the Nation's economy, but increased trade places pressure on our ports, border crossings, and intermodal corridors. Growing congestion at our trade gateways could hinder the ability of American firms to integrate global supply chains and compete globally.

An increasing amount of resources and goods flow across international borders (see Figure 16). Since 1970, trade relative to GDP has grown from 10.7 percent of GDP to approximately 27.5 percent of GDP in 2018.[62] Exports and imports accounted for nearly 12 percent of the weight and 22 percent of the value of freight shipments in the U.S. in 2018. Foreign trade is forecast to generate an even greater share of freight moving throughout the U.S. in the future, reaching 18 percent of the tonnage and 39 percent of the value by 2045.[63]

FIGURE 16. U.S. TRADE IN GOODS[65]





Source: Adobe Stock

Millions of agricultural, energy, and manufacturing jobs depend on exports. The International Trade Administration estimates that nearly 11 million jobs are supported by exports nationwide, including 5.6 million manufacturing jobs.[64]

Our biggest trading partners are our neighbors. Trade with Mexico and Canada accounted for nearly 30 percent of U.S. foreign trade in 2019.[66] North American trade has also increased significantly in recent decades, intensifying congestion at border crossings. Between 2008 and 2018, total North American trade increased by 27 percent[67] and the weight of goods shipped to and from our North American neighbors by truck and train increased by 28 percent.[68] The most heavily trafficked border crossings for truck freight are in Laredo, Texas, and Detroit, Michigan, with other major crossings located at Otay Mesa, California (near San Diego); Buffalo-Niagara, New York; Port Huron, Michigan; and, El Paso, Texas. U.S. Customs and Border Protection (CBP) has reported several infrastructure constraints at land border crossings including limited inspection capacity, technological challenges, and security limitations.

Growth in foreign trade has led to increased traffic at container ports and increased demand for containerized intermodal freight.[69] Since 2008, the number of containers handled by our Nation's ports has increased by 13 percent.[70] The Nation's largest container ports are Los Angeles, Long Beach, New York and New Jersey, Savannah, Houston, Virginia (Norfolk/Portsmouth), Oakland, Charleston, Tacoma, and Seattle. All of these ports have experienced significant growth in traffic since 2008. With the opening of the expanded Panama Canal in 2016, some East Coast and Gulf Coast ports, such as Savannah and Houston, have recently experienced strong growth.[71]

Source: Adobe Stock

United States-Mexico-Canada Agreement

On November 30, 2019, The United States, Mexico, and Canada reached an agreement to modernize the North American Free Trade Agreement. The new United States-Mexico-Canada Agreement will support mutually beneficial trade leading to freer markets, fairer trade, and robust economic growth in North America.

Container ships are getting bigger as ocean carriers seek to achieve greater efficiencies. Modern container ships can carry more than 21,000 TEUs of containers. Use of these larger vessels, has significant implications for ports and connecting intermodal infrastructure.[72] Most U.S. ports have bridge or depth limitations that restrict their ability to receive megaships. The USACE estimates that full channel dimensions at the Nation's busiest 59 ports are available less than 35 percent of the time.[73] Ports may also lack capacity to efficiently dock, unload, and load larger vessels; the surge of cargo coming off megaships can also strain landside infrastructure and operations.

Fully accommodating megaships will require additional investments in infrastructure, including dredging channels, raising bridges, adding cranes, employing new technologies, and other strategies to help process container traffic more efficiently.

Increasing international trade is also spurring an increase in intermodal traffic. According to the American Association of Railroads (AAR), at least 42 percent of the carloads and intermodal units that railroads carry are directly associated with international trade. U.S. rail intermodal volume has grown from 9 million containers and trailers in 2000 to 13.7 million units in 2017. As of 2017, intermodal traffic accounts for approximately 24 percent of revenue for major U.S. railroads, more than any other single commodity group.[74]

Los Angeles DrayFLEX Program for Ports and Distribution Centers

For the past several years, the Ports of Los Angeles and Long Beach have been using the Freight Advanced Traveler Information System (FRATIS) to optimize short-haul drayage freight between marine terminal operators (MTOs) and nearby distribution centers.

FHWA funded the original development, testing, and demonstration of FRATIS, which was shown to reduce idle times and fuel costs for drayage trucks at port facilities. The Los Angeles County Metropolitan Transportation Authority (LA Metro) expanded the functions and capabilities of FRATIS resulting as part of the Drayage, Freight, and Logistics Exchange (DrayFLEX) Program. Applying an enhanced version of FRATIS, LA Metro was able to improve route efficiency and wait times, reducing costs and increasing drayage turns for operators while improving air quality and reducing congestion on local networks throughout the Los Angeles region.

DrayFLEX uses information from marine terminal operators, trucking companies and traveler information systems to provide status updates on container availability, enable trucking companies to set up automated appointments, and provide truck drivers with the best routes to access and depart from the port. It is scheduled to deploy as a pilot program in late 2020 and will use data from MTOs, trucking companies, and traveler information systems to optimize container movements in and around the ports. LA Metro and the ports plan to use the system's information-sharing capabilities to explore connected vehicle (CV) applications in the freight sector.

LA Metro is developing and deploying DrayFLEX to build on a history of success with fleet optimization software systems at the Ports of Los Angeles and Long Beach. DrayFLEX is expected to streamline truck movements in routing and pick-up/drop-off, improving freight flows and reducing costs for operators. At the same time, real-time information systems will keep operators and truck drivers in closer communication to respond to changes in wait times at MTOs and distribution centers, as well as travel times on roadways, reducing delay and fuel costs.

FHWA funding for the FRATIS deployment was critical to its success. The Federal program not only provided critical funding, but also provided a uniform framework for the different stakeholders under which to develop system functions and build processes for system planning, design, implementation, and monitoring.

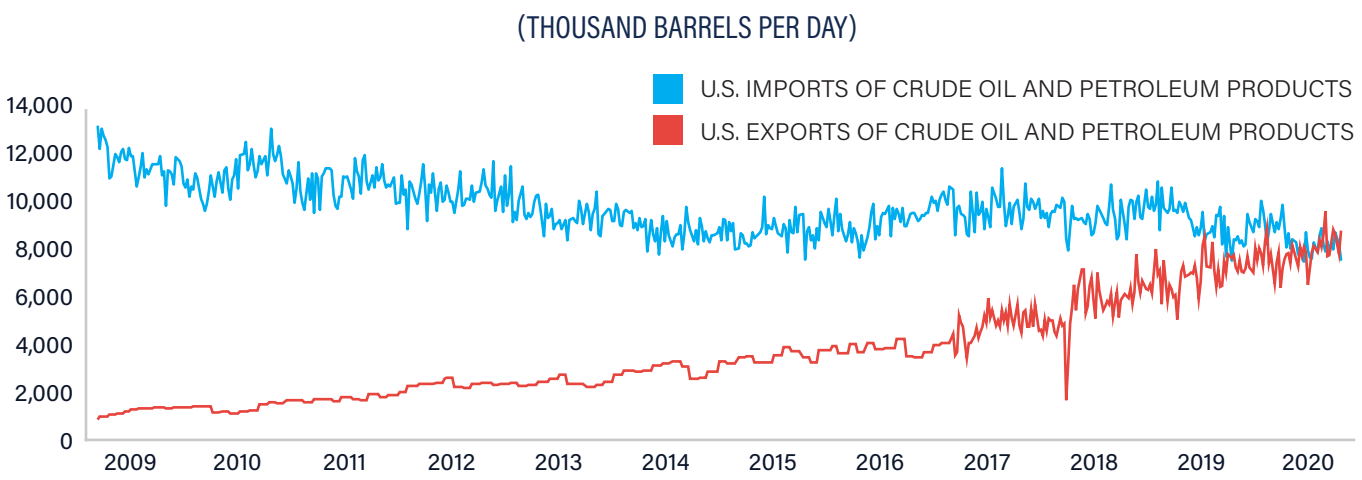
RISING DOMESTIC ENERGY PRODUCTION

Over the past decade, U.S. oil and gas production has increased dramatically. The United States has become the largest producer of oil and natural gas in the world and shifted from a net importer of energy to a net exporter. The growth of energy production in new regions and increasing fuel exports has placed new demands on the Nation's freight system. To safely and efficiently move these resources to market, the energy industry is constructing new pipelines and reconfiguring existing pipeline systems. Where pipeline capacity is unavailable, energy shippers rely on trains, trucks, and barges.

Hydraulic fracturing and directional drilling technology have enabled U.S. oil production to more than double in the past 10 years. Over the same period, natural gas production, propelled by production from shale formations in Appalachia, North Dakota, Texas, and New Mexico, has increased by more than 60 percent.[75]

In early 2020, the U.S. became a net exporter of energy for the first time since 1953 (see Figure 17). The removal of restrictions on U.S. crude oil exports at the end of 2015, combined with higher crude oil production, allowed an increase in crude oil exports in the U.S. Gulf Coast region. Petroleum terminals in the Gulf Coast that once imported large volumes of crude oil now load crude oil tankers for export to international destinations.[76] The growth of energy production in new regions and the shift to net fuel product exports has placed new demands on the national freight transportation system.

FIGURE 17. WEEKLY OIL IMPORTS AND EXPORTS[77]



State Freight Planning for the Permian Basin

The Permian Basin, located in west Texas and southeastern New Mexico, covers approximately 75,000 square miles with more than 7,000 oil and gas fields and is the 2nd largest oil and gas producer in the world as of 2019, according to the Federal Reserve Bank of Dallas. This region produces over 4 million barrels of oil per day, and, despite pipeline capacity constraints in the region, increased trucking and rail transport have allowed crude oil production to continue to grow.

Energy booms, particularly those in rural areas, lead to increased freight activity and present new challenges for transportation systems, as links between energy producers, suppliers, and consumers are created and experience used increasing levels of traffic. This has critical implications for both the region's infrastructure and the national economy.

Texas DOT (TxDOT) is developing a multimodal regional freight plan to address local and regional freight transportation system needs, specifically those associated with the petroleum energy sector. Sand, water, and other raw materials are transported via rail, highway, and local roads to extraction sites. Often the "last-mile" of the supply chain is a privately-owned road or trail in the most rural parts of the region. Oil and natural gas are then transported from the region to energy producing facilities worldwide. In areas that lack pipeline or rail infrastructure, trucks also provide this "first-mile" of transportation, hauling crude oil to centralized storage facilities that are connected to rail and pipeline infrastructure.

The heavy truck traffic associated with the petroleum industry creates varying transportation challenges, some of which may be addressed by the private sector. Many roads and intersections in the region were not designed for sustained heavy truck traffic. Local agencies may be particularly strained with the increased burden of maintaining the roadways. In addition, State and local agencies lack consistent projections of truck volumes and system needs on the region's network. This creates challenges for agencies seeking to anticipate budgetary needs for system preservation, maintenance, modernization, redesign, and expansion. For example, sand and water—two critical inputs of the hydraulic fracking process—are trucked into the basin daily, accounting for more than 600,000 new truck trips annually. These commodities are not consistently classified or counted in commonly used truck volume datasets causing an under-estimate of truck volumes in and around the basin.

As a national leader in energy production, Texas is experiencing energy-related transportation challenges at an acute level. TxDOT is responding through targeted planning and investment efforts, including mapping sector-specific supply chains and identifying specific solutions to meet the transportation needs for these industries, their workforce, and their suppliers.

CHANGING URBAN-RURAL DYNAMICS

Over the past century, economic and demographic growth has been concentrated in major U.S. metropolitan areas. In 1920, approximately half of the U.S. population lived in rural areas, while today four out of every five U.S. residents live in urban areas.[78] However, urban residents continue to rely on rural areas for agricultural and manufactured products, as well as for energy and natural resources. As the populations and the associated tax bases of rural areas decline, building and maintaining the freight infrastructure necessary to support national economic productivity and competitiveness is a growing challenge.

LAST-MILE CHALLENGES IN URBAN AREAS

Increasing populations and traffic volumes in metropolitan areas create last-mile challenges for shippers. According to one research study, the cost of providing last-mile delivery services accounts for 41 percent of overall supply chain costs.[79] Urban areas tend to have infrastructure that is harder for trucks to navigate and have higher levels of congestion, as freight and passenger traffic often compete for the use of limited infrastructure. Freight trains in urban areas often compete with passenger rail traffic along shared-use corridors or face other delays at heavily trafficked rail hubs.

Many of the Nation's most significant freight bottlenecks are at major highway interchanges in the country's largest metropolitan areas. Trucks moving through urban areas often encounter congestion and network inefficiencies due to peak period traffic volumes, special events, work zones, crashes, and other incidents.[80] In addition, the physical and operational constraints (street width, roadway design, one-way streets, time-of-day restrictions, etc.) of the urban environment, can make it difficult or impossible for larger freight delivery vehicles to use certain routes or access certain neighborhoods. Truck drivers can also have difficulty finding available on-street and off-street loading and parking areas. Finally, urban residents may have concerns about emissions and noise associated with truck movements in their communities.

Major metropolitan areas host a number of the Nation's major container ports, cargo airports, and distribution centers. Getting freight to and from these trade gateways often requires vehicles loaded with containers to navigate an

urban environment. Their surrounding land uses may also limit the ability of these ports and distribution centers to expand their facilities for increased capacity. Moving containers through urban areas can also increase the potential for safety issues stemming from conflicts between trucks and other road users.

Manufacturing production tends to be concentrated in and around major urban areas (see Figure 12). Highway congestion and unreliable travel times in these urban areas impact logistics systems and timing of shipments necessary for just-in-time manufacturing. Delayed shipments can have costly ripple effects on the production process. To mitigate delays from congestion and unreliability, shippers must allocate additional buffer time for deliveries, and manufacturers must maintain additional supply on-site as late deliveries can affect production and increase costs for these industries.

RURAL TRANSPORTATION CHALLENGES

Rural areas provide essential goods and resources to sustain rural and metropolitan markets and produce goods for export. Rural businesses and industries often specialize in resource-based sectors such as agriculture, forestry, and mining that serve as the foundation of national supply chains. In addition, some manufacturing businesses are located in rural areas due to the greater availability and lower cost of land and their proximity to raw materials and other inputs. Almost 20 percent of manufacturing jobs are located in rural counties.[81] Rural infrastructure provides a vital first link in shipping resources and commodities to market, and the last link that delivers products to rural communities.

Moving resources from their point of origin to where they are needed may involve the use of trucks for some portion of their journey. An estimated 47 percent of truck VMT occurs on rural roads,[82] causing rural roads to deteriorate more quickly than they otherwise might. Many rural areas face declining populations and corresponding declines in the tax bases required to effectively maintain these areas' transportation infrastructure. Nearly three-quarters (72 percent) of rural roads are locally owned, but many of these roads are ineligible for most Federal-aid funds due to Federal funding program eligibility requirements.[83] The combination of these factors can make it difficult to keep rural infrastructure in a state of good repair.

When infrastructure is inadequate or in poor condition, rerouting can also lead to inefficiencies. Eighty percent of closed bridges and 90 percent of posted bridges that have weight restrictions are located in rural areas.[84] When accessible bridges are not available, trucks may need to detour increasing delays in freight deliveries and raising costs for shippers and consumers.[85] In rural areas, these detours may be three times the distance of urban area detours. Detours may also be caused by seasonal or severe weather.


Source: Adobe Stock

Shortlines Railroads' Role and Needs

Shortline railroads serve predominately rural customers and originate carloads of commodities that would not be cost effective to ship to global market without the low cost that rail can offer at origin or destination. Many shortline railroads provide essential switching service between carriers, while others provide a bridge line between carriers.

Shortline railroads can be a key economic connection for rural America. About 550 shortline railroads operate in the U.S., often with older equipment and aged assets that require frequent maintenance. Most shortlines were sold off by Class I railroads around the time of the Staggers Act when they became too costly to support those lines of operation. Railroads often deferred maintenance leading up to sale. As a result, many shortlines need to modernize assets to handle modern rail car sizes and weights.

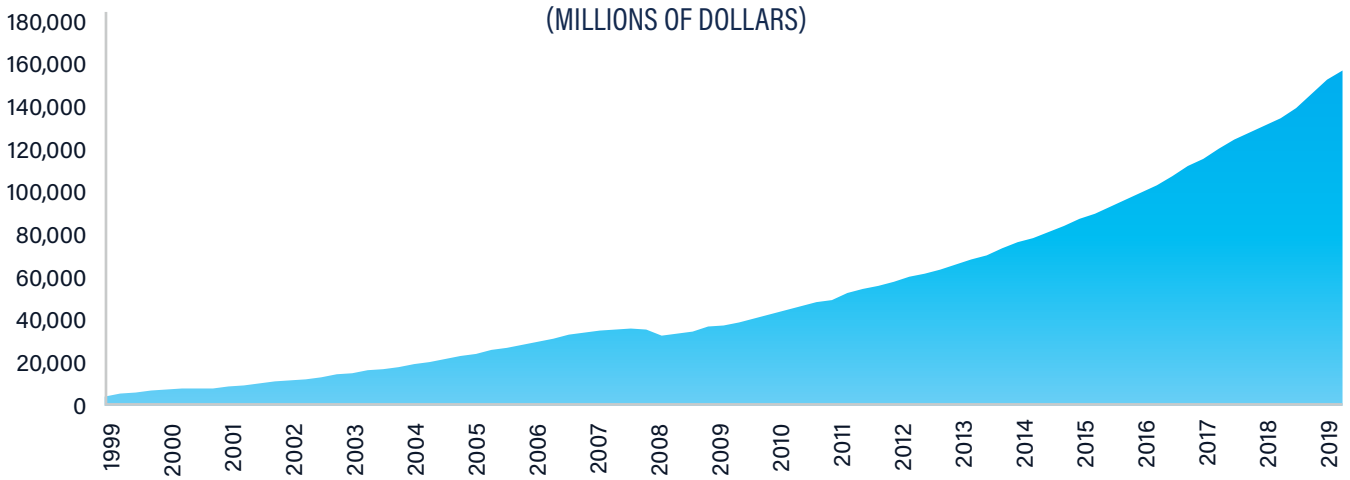
Shortline railroads face the same high capital costs as Class I's, but they do not have comparable financial and organizational strengths. While they often have high maintenance and rehabilitation needs, many shortline railroads face challenges generating sufficient private financing as they have few assets to leverage debt. To address these issues, there are several Federal assistance opportunities tailored to assist shortline railroads: RRIF financing, the 45G tax credit, and discretionary grant programs such as the Consolidated Rail Infrastructure and Safety Improvements (CRISI) program. These programs are well subscribed by shortline railroads, and there is wide interest among the industry for extending these programs.

INCREASING E-COMMERCE

The rise of e-commerce is significantly changing how retailers and consumers interact with each other. Increasingly, consumers now purchase goods online requiring retailers to determine how to deliver those purchases to the consumer's home. E-commerce sales make up more than 11 percent of total retail sales and are growing at double digit rates each year. This trend for e-commerce is increasing the number of new short-haul and last-mile trips made by trucks, straining the Nation's freight system as retailers compete to meet consumer demands.

When consumers purchase items on the internet, those items commonly bypass brick-and-mortar stores and travel directly from a warehouse or distribution center to consumers' homes. According to the U.S. Census Bureau, e-commerce sales increased 16.7 percent between the fourth quarters of 2018 and 2019, while total retail sales increased 4 percent in the same period. e-commerce sales in the fourth quarter of 2019 accounted for 11.4 percent of total sales (see Figure 18).[86] E-commerce sales are projected to increase at a compound annual growth rate of 12 percent between 2019 and 2024.[87] These trends were compounded during the recent COVID-19 pandemic, as social distancing measures led to a major shift from in-store purchases of food and household goods to home delivery.

FIGURE 18. TOTAL E-COMMERCE RETAIL SALES



Source: Adobe Stock

As retailers seek to get their products to consumers as quickly as possible, same-day delivery is now the fastest-growing service type for e-commerce deliveries.[88] The pressures associated with shorter delivery windows, and just-in-time inventory management have placed even greater importance on the reliability and timeliness of truck transportation. Growth in rapid delivery is also leading to increased demand for air cargo and for larger, more efficient air cargo terminals and processing facilities.[89] Furthermore, between 13 and 30 percent of all online orders result in the product being returned, placing further strains on the freight transportation system.[90]

E-commerce trends are also impacting land use and development patterns. To meet the demand for faster and cheaper shipping to consumers, retailers are moving inventory locations near population centers to be closer to consumers. Many companies are aggressively investing in advanced distribution and fulfillment centers along Interstate highways just outside metropolitan areas. This demand is driving up costs of warehouse space and inventory. New regional distribution hubs are also emerging in secondary markets within 250 miles of the largest transportation and population centers. These hubs include locations such as Indianapolis, Lehigh Valley, Memphis, South Florida, and Phoenix—areas that have all seen major increases in occupied warehouse space.[91] As might be expected, e-commerce is changing truck delivery patterns. Shorter, intra-regional trips, particularly in urban areas, are increasing in frequency relative to longer inter-regional trips. Since 2010, overall VMT have grown by approximately 9 percent, while truck traffic in urban areas has grown by more than 17 percent. Some of this shift represents a substitution of trips between passenger and commercial vehicles, as the "last-mile" trip for consumer goods is made by a delivery truck rather than store-to-home trips driven by consumers. The growth in urban truck traffic is exacerbating urban last-mile challenges, creating greater competition for already congested urban roadways and curb space, particularly in dense urban cores.

ADVANCING TECHNOLOGY

Advances in a wide range of technologies, including information and communications technologies, robotics, artificial intelligence, sensors, and batteries are leading to rapid changes in logistics and freight transportation. These advances have the potential to transform the freight transportation industry by increasing safety and efficiency, altering supply chains, and disrupting business models.

AUTOMATION AND CONNECTIVITY

Increasingly, industries are integrating automated technologies into their supply chains. For example, many U.S. ports are beginning to make more significant investments in automation to improve efficiency and remain competitive with ports in other countries.[93] Similarly, warehouses and distribution centers are rapidly automating in response to changing consumer expectations, increased competition, and rising labor costs.[94] Ports, warehouses, and distribution centers are increasingly using automation technologies, such as automated cranes and automated forklifts to move and manage inventories.

Over the last decade, there have been significant advancements in vehicle automation technologies including those in freight-hauling vehicles. Many of these features, such as adaptive cruise control and automatic emergency braking systems are common in new truck models; more advanced automation capabilities, such as truck platooning, are being piloted. Truck platooning uses wireless connectivity and automation technology to allow a lead vehicle to communicate its acceleration or deceleration to a vehicle (or vehicles) following it, which can then synchronize their speeds automatically and reduce their following distance. By allowing trucks to travel closely together in a connected environment, platooning may improve the safety, operating costs, and fuel efficiency of long-haul trucking. One study found that truck platooning using cooperative adaptive cruise control in three-truck platoons yielded fuel savings of 5.2 to 7.8 percent.[95]

The development of highly automated trucks[96] will likely occur over the coming decades, which will allow trucks to operate with limited human intervention for portions of long-haul trips.[97] Currently, there are significant technological and institutional barriers to the widespread adoption of highly automated trucks. However, firms are making significant investments in


Source: Adobe Stock

research and development in this area. Automation and connectivity technologies are also being utilized for freight rail shipping. In 2008, Congress mandated the adoption of Positive Train Control (PTC), a system that uses global positioning systems and radio communication to prevent collisions or derailments caused by human error. AAR expects that PTC will be fully implemented by the end of 2020.[98] Firms are also applying automated technologies to the shipping industry with successful pilots to test the use of unmanned or remotely controlled cargo liner and container ships.[99]

ADVANCING INFORMATION AND COMMUNICATIONS TECHNOLOGIES

Logistics companies are leveraging the Internet of Things (IoT)[100] to improve asset and product tracking. Using the IoT, freight brokers, carriers, shippers, and receivers can exchange real-time data, which allows the adoption of variable pricing strategies to more efficiently utilize shipping space and reduce the occurrence of empty payloads. Alongside dramatic improvements in the collection of freight data, firms are improving their ability to analyze freight data to optimize supply chains by leveraging real-time information on vehicle locations, traffic conditions, and intermodal facility capacity. Firms are looking to apply advances in artificial intelligence and machine learning to improve the performance of freight movement and delivery networks.

Digital tools may eliminate the manual processes that slow freight transactions and allow the rapid exchange of information among shippers, brokers, and carriers. This efficiency can help freight industry players make better decisions. Technology companies are entering the freight and logistics market, seeking to digitize supply chains, by introducing services such as digital shipping marketplaces, where carriers can connect directly with shippers with minimal brokerage costs. The use of digital ledger technology, or blockchain, will also influence how firms track freight transportation.

Currently, large amounts of documents accompany transactions, including bills of lading, sales contracts, letters of credit, charter party contracts, port documents, and more. For transactions that are not automated, these documents must pass through many different parties involved in the carriage, delivery, and payment processing of the cargo.[101] Blockchain technology would allow shippers to better track and secure their supply chains while improving efficiencies.

ELECTRIC AND ALTERNATIVE FUEL VEHICLES

The development and adoption of cost-effective electric vehicles could reduce fuel consumption and emissions by trucks. Battery electric vehicles are becoming more common in the light-duty passenger vehicle market, and the technology has advanced include transit bus and delivery truck applications. While battery technology continues to improve, it may be challenging to meet the operational requirements of long haul trucks with this technology, due to limitations on range; some researchers believe that fuel cells may be better able to meet the needs of this largest class of truck.[102] Both technologies would require adequate refueling infrastructure (whether from hydrogen or via electric charging stations) to serve as a commercially viable option for freight carriers.

There is also a range of alternative fuel technologies with commercial applications to freight vehicles to lower costs and emissions. These include compressed natural gas, liquefied natural gas, propane, hybrid diesel electric, and biodiesel.

Source: Adobe Stock

ALTERNATIVE DELIVERY METHODS AND EMERGING FREIGHT TECHNOLOGIES

Retailers are exploring a variety of innovative approaches to meet last mile-challenges. These include crowdsourcing delivery drivers and offering in-store, pick-up lockers for "click-and-carry" customers. In addition, carriers are experimenting with a variety of alternative delivery technologies to avoid congestion, lower emissions, and improve efficiency. These include strategies such as the use of cargo bikes, delivery robots, and unmanned aircraft systems (UAS) technologies. Unmanned aerial systems, or drones, could be used for last-mile air transport, humanitarian deliveries, disaster relief, and the transport of temperature-sensitive medicine and food, to name just a few potential uses. Currently various retailers, delivery companies, and technology firms are piloting the potential to use drones to deliver parcels to residents.[103]

Hyperloop and 3D printing are examples of emerging technologies that may have significant impacts on freight transportation in the future. The hyperloop concept would use pods or sleds to transport vehicles in vacuum-sealed tubes at high speed. While much of the focus for this technology has been for passenger transportation, concepts are also being developed that would allow it to be used for freight. However, while this technology has gone through some testing, it is still in its early stages and has not yet been commercially deployed.

Another major technology with the potential to remake the Nation's supply chain and transportation system is 3D printing. 3D printing is the process of building a 3D product by layering materials using a computer-aided design or laser scan. Materials range from metals, plastics, and cement to paper, wood, and even cells, and can incorporate recycled materials as well as produce goods that can be recycled. This may have a great impact on the shipping routes for raw materials and could reinvent the waste disposal sector. 3D printers currently have a variety of applications including developing prototypes, rare parts, and highly customized products. During disasters, 3D printers can manufacture critical equipment such as utility poles after a hurricane, using locally sourced materials. And, as part of COVID-19 emergency response, 3D printing was used to produce parts for face shields for personal protective equipment. Applied at scale, industrial-grade 3D printing could alter supply chains as businesses would not need to ship inventory or components long distances, while increasing the shipment of feedstock materials to those locations. This could lead to significant changes in freight demand and freight flows as well.

EVOLVING WORKFORCE

The transportation industry represents over 8 percent of GDP, and some 14.5 million jobs—about 9 percent of civilian workforce in the U.S.—are transportationrelated, including approximately 2.7 million people employed as truck drivers.[104] As the industry grows and the current workforce ages, millions of workers will be needed to fill vacancies. Yet many in the freight industry are experiencing serious challenges in recruiting and retaining qualified applicants with the right qualifications.

Source: Adobe Stock

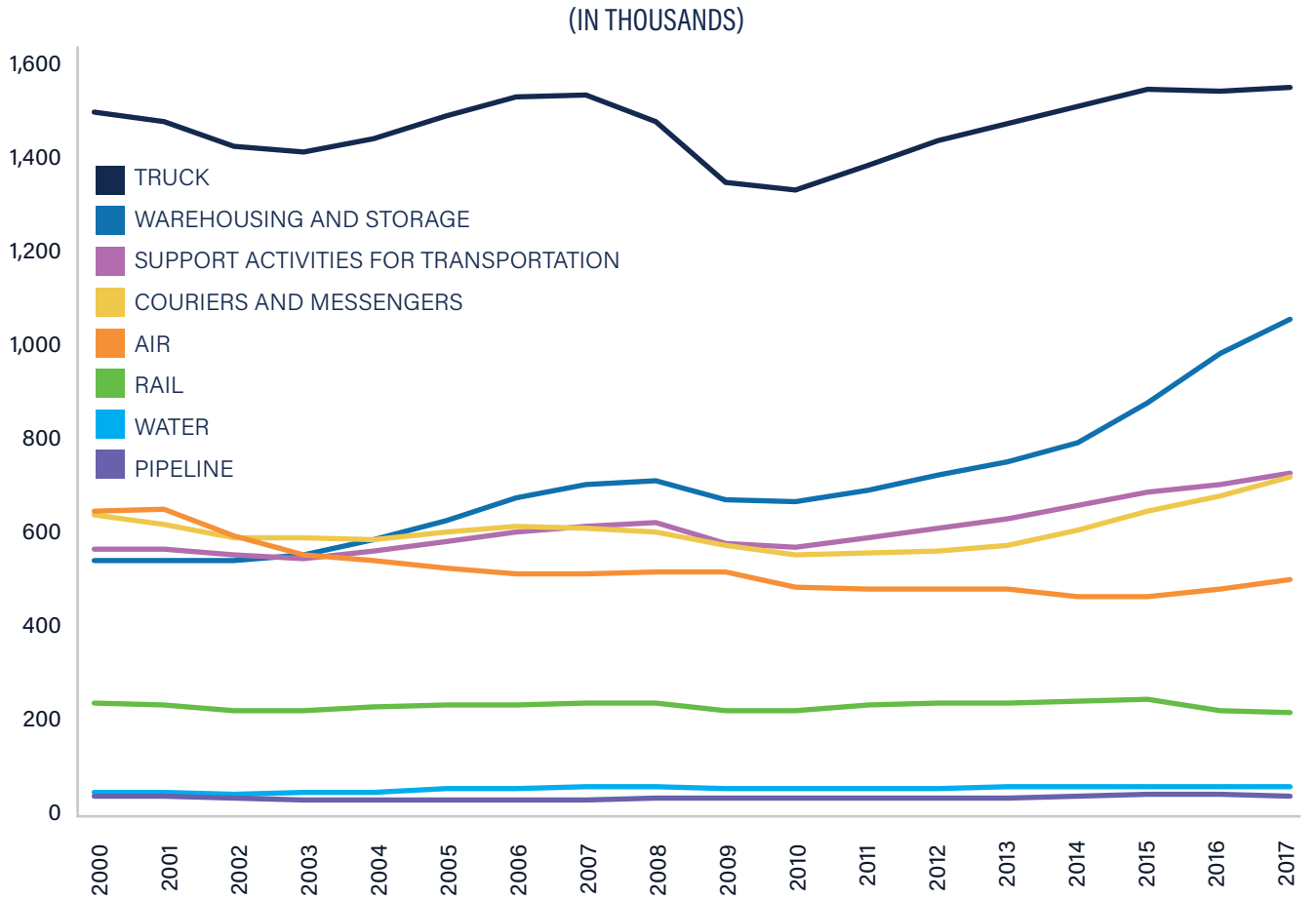
Freight workforce challenges include an aging workforce, changing labor force expectations, and rapidly evolving technologies. The freight-hauling workforce is aging, and a significant portion of the workforce employed in transportation-related jobs either are or will be eligible for retirement in the next 10 years.[105] In addition, rapidly evolving transportation technologies, such as automation, are changing the nature of transportation jobs and labor force expectations are shifting as well. Traditional learning and training programs are typically not designed to steer graduates toward the transportation sector, and existing training programs must be updated to reflect emerging technologies. In a tight labor market, recruiting and retaining qualified workers poses challenges for the freight industry.

Many transportation jobs, such as commercial airline pilots, truck drivers, locomotive engineers, and commercial mariners, require a license, a certification, or both, and obtaining these can be time consuming and expensive, potentially posing barriers to entry into those professions. The trucking industry faces a number challenges to recruiting drivers into the industry. They include commercial driver's license (CDL) and insurance requirements that make it difficult to recruit younger drivers.[106] In addition, the industry may experience difficulty attracting drivers due to its challenging lifestyle, particularly at times when unemployment is low.

To add to these challenges, the trend toward e-commerce is leading to increasing demand for short-haul delivery drivers, making it more difficult for companies to attract workers to long-haul truck driving jobs.

Figure 19 shows trends in freight sector employment. Truck transportation remains the largest source of employment in the freight sector. In recent years, however, the fastest growing sectors for freight jobs have been warehousing and storage and messenger and courier services. This reflects trends in e-commerce and just-in-time logistics that require greater warehouse labor.

FIGURE 19. EMPLOYMENT IN FOR-HIRE TRANSPORTATION[107]



UNCERTAINTY AND CHANGING TRENDS

An understanding of key trends driving change in our freight system is a critical first step to understanding the challenges and identifying the opportunities to guide Federal freight strategies. Yet, all trends are subject to varying degrees of change and uncertainty. Trends may accelerate or decelerate or they may be overestimated or underestimated. Emerging trends can fail to materialize as expected and long-term trends can be disrupted. Sources of significant change to trends can include technological breakthroughs, changes in macroeconomic conditions, natural or human-caused disasters, or changes in political leadership. Scenario planning can help decision-makers anticipate and monitor sources of change, better understand the implications of changes to trends and how trends may be interconnected, and develop adaptive strategies.

Source: Adobe Stock

All of the trends analyzed in this section may be subject to near-term or long-term changes. Considering this analysis, it is possible to envision how changes to these trends may affect our freight system. For example, a reduction in shippers' reliance on global supply chains may reduce pressure at trade gateways, divert freight traffic away from major container ports, and reduce demand for intermodal, containerized freight. An acceleration of the development and adoption of automation technologies could increase the safety and efficiency of our freight system and may lead to significant changes to the freight workforce and supply chains. Rapidly increasing frequency and intensity of weather events could cause significant disruptions to supply chains. This may prompt shippers to reassess their reliance on vulnerable freight gateways and corridors, and cause infrastructure owners and operators to employ strategies to reduce the vulnerability of infrastructure to extreme weather.

The COVID-19 pandemic is an example of an event that could significantly disrupt freight trends over both the near-term, and the long-term. In the near-term it is causing steep declines in economic demand and oil prices that are likely to slow or reverse the trends of increasing demand for freight and domestic fuel production. The pandemic may also cause shippers to rethink their reliance on global supply chains, leading them to diversify supply chains or seek suppliers closer to home. The pandemic has also had significant effects on the freight workforce, bringing to the forefront worker health and safety issues, while potentially creating opportunities to hire new workers with the end of the tight labor market. Finally, the social distancing associated with the pandemic has caused a surge in consumer reliance on e-commerce. This near-term surge may result in a long-term acceleration of the trend towards increasing use of e-commerce and home delivery.

5 CHALLENGES

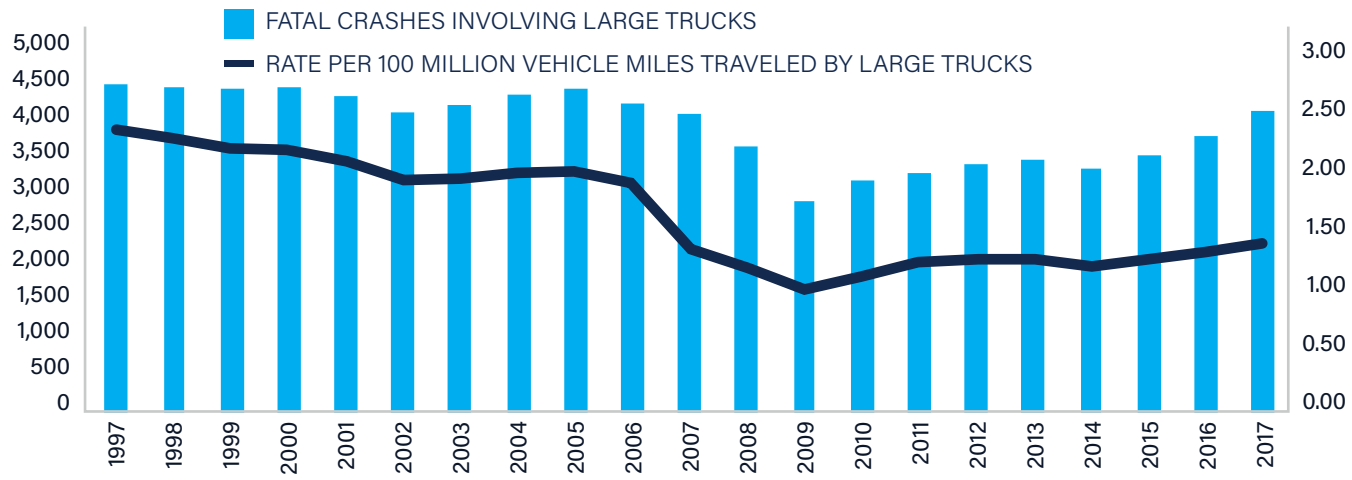
Increasing and shifting demand for freight movement is straining the multimodal freight system on which the Nation's economy and well-being depend. Challenges affecting our freight system include increasing safety risks, increased congestion, and declining infrastructure conditions. Various institutional, financial, and regulatory barriers also make it difficult to advance freight projects, which can exacerbate these challenges.

SAFETY

As freight transportation activity has increased, the number of freight transportation-related fatalities has also risen. Across all modes, 5,340 people died in freight transportation-related crashes and accidents in 2017—a nearly 24 percent increase over the 2010 total.[108]

Nationwide, truck-involved crashes accounted for 4,761 fatalities and an estimated 102,000 injuries in 2017.[109] Fatalities resulting from truck-involved crashes made up 89.2 percent of all freight transportation fatalities and 12.8 percent of all highway fatalities in 2017. After falling sharply by 34 percent between 2005 and 2009, the number of fatal crashes involving large trucks increased by 42 percent between 2009 and 2017 (see Figure 20). Approximately 57 percent of all fatal crashes involving large trucks occurred in rural areas.[110]

FIGURE 20. LARGE TRUCK-INVOLVED FATAL CRASHES (1975-2017)[111]



Key factors that may affect truck safety include increased traffic volume on the Nation's highway networks, driver performance and behavior, and insufficient truck parking in rest zones.

Parking facilities are necessary for truck drivers to take rest breaks and comply with hours of service regulations. Adequate truck parking, both public and private, is important for the safe and efficient movement of freight, but truck drivers encounter insufficient truck parking throughout the U.S. Numerous public, private, academic, and non-profit studies have been completed on the adequacy of truck parking, with some common findings including an expected growth in truck activity, severe shortages of parking for trucks, lack of information for drivers on truck parking availability, and challenges due to limited delivery windows.[112] The lack of truck parking capacity is most evident along major freight corridors and in metropolitan areas. Truck drivers may continue to drive because they have difficulty finding a place to park, or they may park at locations that are unsafe for both the truck driver and other motorists, such as a highway shoulder, exit ramps, side streets, or vacant lots. A 2014 study evaluating the adequacy of truck parking capacity in the U.S. found that 38 States reported having truck parking problems, particularly along major freight corridors and in large metropolitan areas.[113]

Truck drivers surveyed as part of the study said that truck parking problems exist in all States. The majority (75 percent) of truck drivers surveyed as part of the study reported having difficulty finding safe and legal parking during mandated rest periods.

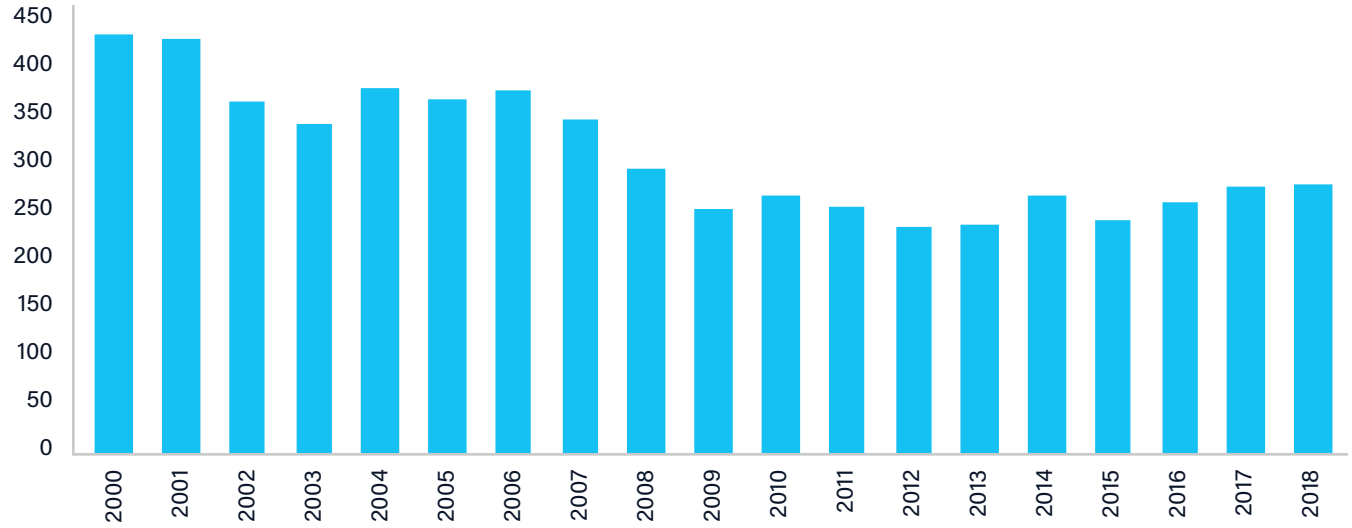
While driver impairment is a critical highway safety issue, truck drivers involved in fatal crashes are significantly less likely than drivers of passenger vehicles to test positive for drugs or alcohol. In 2017, at least one driver-related factor (such as impairment, fatigue, distraction, or speeding) was recorded for 32 percent of the drivers of large trucks in fatal crashes, as compared to 54 percent of the passenger vehicle drivers in fatal crashes.[114] For example, 16.4 percent of passenger car drivers involved in fatal crashes were cited for speeding as compared to 6.5 percent of the drivers of large trucks.[115]

Incidents on railways, including at highway-rail grade crossings, accounted for 891 fatalities in 2018. A large majority of these fatalities involved collisions at crossings (273) or trespassing (580). Since 1975, crashes at grade crossings have declined by more than 80 percent and fatalities have dropped 70 percent. However, grade crossing fatalities have been relatively flat over the past 10 years (see Figure 21).[116]

Positive Train Control

Positive Train Control (PTC) is a processor-based/communication-based train control system designed to prevent train accidents. PTC is required to be installed and implemented on Class I railroad main lines (i.e., lines with over 5 million gross tons annually) over which any poisonous- or toxic-by-inhalation hazardous materials are transported, and on any railroad's main lines over which regularly scheduled passenger intercity or commuter operations are conducted. As of the end of CY 2019, 98.7 percent of route miles on Class I railroads were governed by PTC. Once fully implemented, PTC systems will govern rail operations on approximately 58,000 railroad route miles and will involve approximately 20,000 locomotives, to help prevent train-to-train collisions and over-speed derailments.

FIGURE 21. GRADE CROSSING FATALITIES[117]



Every day, an estimated 1 million shipments of hazardous materials, or hazmat, are transported in the United States.[118] When hazmat is not properly classified, handled, or packaged, it poses significant threats to transportation workers, emergency responders, the public, and the environment, due to potential incidents and accidents. The transportation of hazardous materials is a cross-cutting safety concern. Hazardous material incidents accounted for 1.5 percent of total freight safety incidents in 2018. Truck transport had the highest percentage of total incidents (90 percent) followed by rail (8.2 percent) and air (2.9 percent).

Because most hazardous materials are transported by truck, most incidents related to the movement of hazardous materials occur on highways or in truck terminals. A small share of hazardous materials transportation incidents results from a vehicular crash or railcar derailment. Human performance errors and operational factors continue to be leading concerns for hazmat transportation. The demand for e-commerce has also increased the risk that improperly packaged hazmat, such as lithium batteries, may be moved by air and truck.

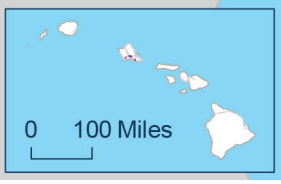
Incidents involving hazardous materials have decreased by 41 percent since 2008 as proactive safety measures have been incorporated into transportation infrastructure, technology, standards, and regulations. Historically, the U.S. pipeline industry has accommodated the increasing volumes of domestic oil and gas traffic without increased incident within the basic framework of a longstanding regulatory and safety assurance process. Unintended pipeline releases have not increased with the higher traffic volumes, and most large year-to-year fluctuations in total release volumes have been the result of occasional major incidents with no discernible pattern. In fact, liquid pipeline incidents impacting people or the environment have declined by 20 percent in the past 5 years, while pipeline mileage has grown by 12 percent in the same period.[120]

The primary reasons for recent improvement of pipeline safety and environmental performance include technology advancements in leak detection systems and pipeline inspection tools, and more stringent safety standards coupled with the industry's implementation of safety management systems.

NETWORK EFFICIENCY

Increasing congestion, particularly on urban highways, results in billions of dollars in lost economic productivity and wasted fuel each year. Congestion costs the trucking industry an estimated $74.5 billion in 2018, equal to an entire year of productivity for more than 425,000 truck drivers.[121] Growing urban populations and increasing e-commerce can lead to increased congestion challenges for freight movements in the future.

If trends continue, chronic congestion will become increasingly widespread in the coming decades. Figure 22 shows the forecast extent of congestion on portions of the NHS with high levels of truck traffic, assuming no changes to the existing infrastructure. By 2045, future demand is projected to cause peak-period stop-and-go conditions on over 27,000 miles of the NHS, including on long stretches of Interstate system in the eastern U.S., along the West Coast, as well as in and around major metropolitan areas across the country.[122] Addressing the capacity of these Interstate segments or identifying other ways to meet the expected demand will be crucial to national mobility.



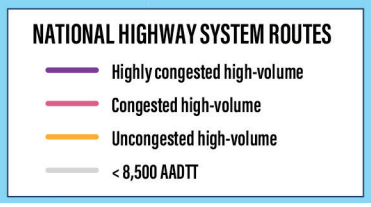


FIGURE 22. PEAK PERIOD CONGESTION ON THE NATIONAL HIGHWAY SYSTEM IN 2045[123]

BOTTLENECKS

Bottlenecks are locations on the transportation system where available infrastructure cannot meet traffic demand for extended periods of time due to capacity, operational, or regulatory constraints. Recurrent bottlenecks occur at predictable times and locations when traffic demand at peak periods exceeds a transportation system's capacity. Structural infrastructure conditions, such as inadequate bridges and tunnels, can also create bottlenecks by forcing carriers to take less efficient routes, carry smaller loads, or travel at different times.

These conditions may include:

- Road, rail, or waterway geometries, such as tight curves or steep grades, low bridge or tunnel clearances, and channel/berth depths/widths;
- Weight-restricted or length-restricted roads, tracks, or bridges;
- Infrastructure, such as tunnels, with hazardous materials restrictions;
- Throughput constraints at facilities, such as port gates, intermodal rail yards, border crossings, and weight stations.[124]

Truck Freight Bottlenecks

Freight traffic is increasing on many highways across the United States, bringing with it challenges for efficient goods movement and wider concerns about safety, infrastructure condition, and reliability of travel. Transportation performance management (TPM) requirements reflected in Title 23 of United States Code (23 U.S.C. 150) focus attention on these issues by creating national goals and by requiring FHWA to establish performance measures for which States and MPOs must set targets and report their progress.[125] As part of this reporting, State DOT's are required to identify and describe the ways in which they are addressing congestion at freight bottlenecks. A freight bottleneck inventory also is a required element of State Freight Plans (discussed in greater detail in Chapter 6).

FHWA performance management regulations define a truck freight bottleneck as "a segment of roadway identified by the State DOT as having constraints that cause a significant impact on freight mobility and reliability." FHWA has issued guidance for States on truck freight bottleneck reporting as part of TPM, as well as freight bottleneck analysis as part of broader freight planning efforts.[126]

States have flexibility in selecting their methods to comply with the truck freight bottleneck reporting requirements. In addition to the Truck Travel Time Reliability (TTTR) Index[127] required to be reported under FHWA regulations, a range of measures can be used to evaluate roadway performance in terms of travel delay or

reliability. Some of the measures that have been used by States in formulating their list of truck freight bottlenecks include:

- TTTR Index using the ratio of the 95th percentile travel time to the 50th percentile travel time.
- Truck vehicle-hours of delay per mile, based upon delay and truck volumes.
- Average ton-hours of delay per mile.
- Frequency and duration of congestion.
- Planning time index using the ratio of the actual travel time to the uncongested, free flow, or posted speed travel time.
- Volume to capacity ratio (V/C).
- Recurring urban congestion.
- Congestion based on cumulative truck delay.
- Peak hour truck travel speeds below a specified threshold.
- Low truck speeds due to terrain and grades.
- Frequent weather-related delays.
- Load, height, and width restrictions.

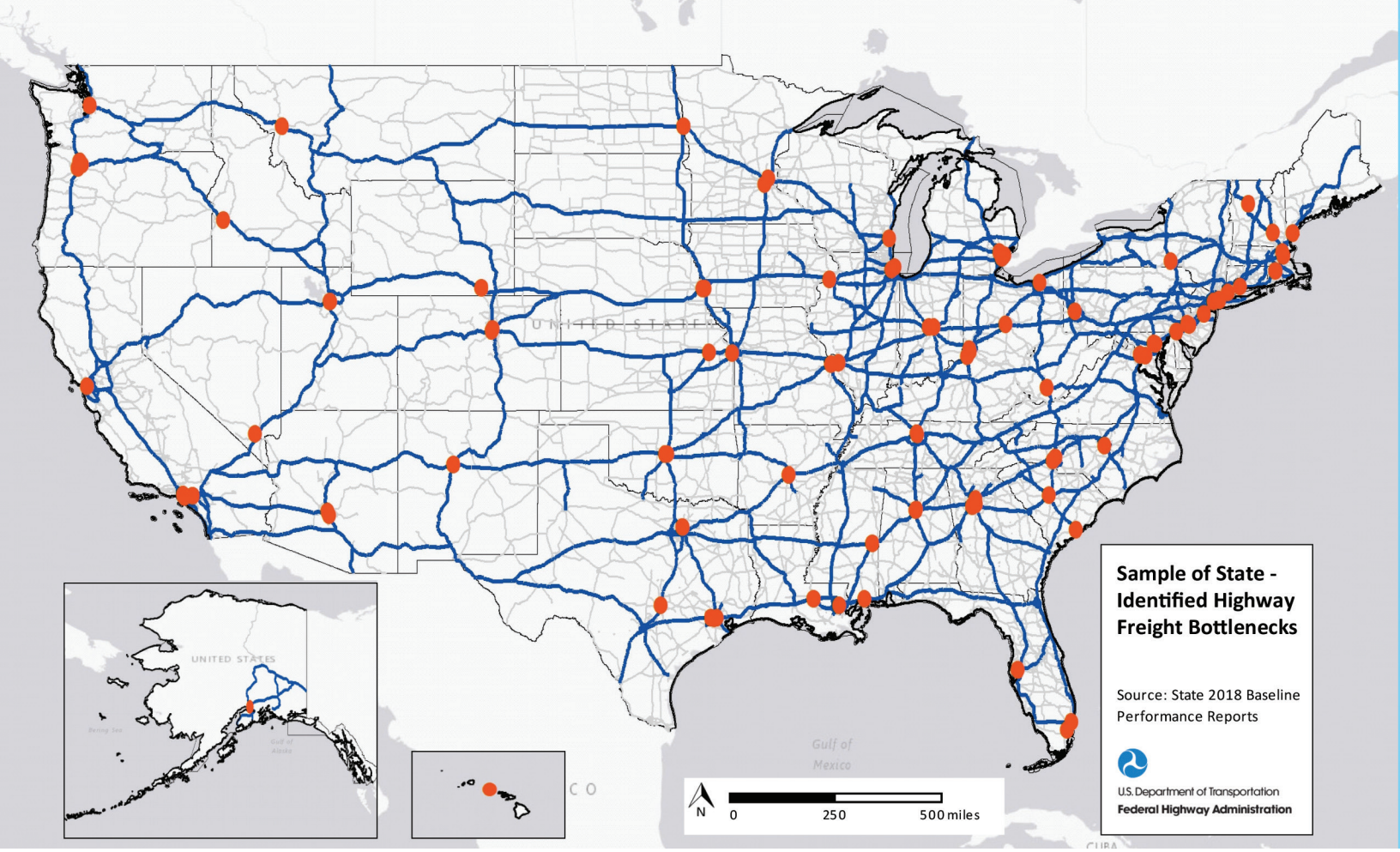


FIGURE 23. ILLUSTRATIVE MAP OF STATE-IDENTIFIED BOTTLENECKS[129]

States have identified a number of truck freight bottlenecks.[128] The following map (Figure 23) shows a representative list of 100 bottlenecks based upon State baseline performance reports. However, we note that each State used a different process for determining the most significant truck freight bottlenecks and that lack of uniformity makes it difficult to compare at a national level.

Border Crossings

Border crossings are a frequent bottleneck in the freight transportation network. In 2017, nearly $721 billion in trade passed through the Nation's land ports of entry. Required security inspections and high volumes truck traffic at land ports of entry between the U.S. and its Canada and Mexico neighbors create delays that are disruptive and costly to manufacturers, shippers, and, ultimately, consumers. For example, in 2016, average truck transit time on the U.S.-Mexico border crossing in El Paso, Texas, averaged 66 minutes.[130] In addition, predicting the time needed to transit a border crossing with any degree of certainty is often difficult.

Ports and Intermodal Connectors

Ports face a variety of bottlenecks that can limit their efficiency. Channel depth and width restrictions pose a challenge for some ports,

U.S. Customs and Border Protection FAST program

U.S. Customs and Border Protection (CBP) employ a number of practices to reduce border wait times while maintaining a high standard for inspections and enforcement. The Free and Secure Trade (FAST) program is an innovative trusted traveler/trusted shipper program, which was initiated after September 11, 2001. This program helps to expedite processing for commercial carriers who have completed background checks and met certain eligibility requirements, when entering the United States from both Canada and Mexico. The FAST program reduces border wait times by allocating lanes at ports of entry specifically for those who participate in the program, allowing inspection officers to independently prioritize FAST participants, passenger vehicles, or freight carriers not participating in FAST. For a shipment to qualify for participation in the FAST program, every link in the supply chain must be certified under the Customs-Trade Partnership Against Terrorism program, including manufacturer, carrier, driver, and importer.

CBP is also employing Non-Intrusive Inspection (NII) processes at some Ports of Entry, conducting 3.6 million inspections per year. The suite of NII tools includes an expanded use of radiofrequency identification and license plate readers, facial biometric verification, advanced radiation portal monitors, and multi-energy portal drive through imaging systems. Leveraging these technologies together allows CBP to increase throughput of motor carriers while increasing security.

In November 2016, CBP partnered with the Buffalo and Fort Erie Public Bridge Authority and launched a three-year pilot Pre-Arrival Readiness Evaluation program. Through this program, commercial vehicle drivers enter their electronic manifest into an Automated Commercial Environment Portal and pays the required fee digitally in advance of arrival at the port of entry thereby reducing wait times.

limiting their ability to accommodate larger ships. Congested or inadequate transportation infrastructure surrounding a port can limit the flow of goods, even if the port has adequate internal capacity to handle cargo. Additionally, many ports are limited in their ability to expand the footprint of the port due to competing land uses.

The imbalance of import and export flows at many American ports also results in the need to "reposition" empty containers back from the importer to the exporter. In recent years, ports have also faced challenges with the availability of chassis, or trailers, and other issues related to short-distance, intermodal freight movement known as drayage.

Source: Adobe Stock

Shortages of chassis, containers, or drivers can reduce the efficiency of the drayage services that move containers between ports and rail heads or distribution centers and create backups that slow port operations.

In 2017, FHWA released a study of freight intermodal connectors, segments of roadways connecting ports, airports, railways, and pipelines to the NHS. Based on a sample of intermodal connectors, the study found that, in 2013, trucks experienced more than one million hours of delay annually on freight intermodal connectors nationwide. The study also modeled nationwide results showing that port intermodal connectors accounted for 37 percent of the total costs of delay on freight intermodal connectors, followed by airports and rail intermodal connectors with 32 percent and 23 percent, respectively.[131]

Rail Choke Points

Railroad bottleneck locations are usually referred to as "choke points" to avoid confusion with the more conventional railroad sector use of "bottleneck" to describe locations served by only one rail carrier (e.g., the "bottleneck carrier"). While there is less publicly available data on congestion on railways, rail choke points may occur where a significant number of trains are utilizing the same track.

Railroad choke points may also be structural. Structural choke points include low-ceiling tunnels or low-clearance overcrossings that impede double-stack trains, outdated signal systems that cannot efficiently accommodate a mix of higher-speed passenger trains and slower-speed freight trains, single track rail corridors without adequate sidings, slow speeds at rail-highway grade crossings, and

CREATE Program: Chicago-Region Rail Investment Partnership

Twenty-five percent of national freight rail traffic moves through the Chicago region, so effective railroad operations through Chicago are vital to keeping the Nation's economy moving. The Chicago Region Environmental and Transportation Efficiency (CREATE) Program (www.createprogram.org) is a public-private partnership among six Class I railroads, two switching railroads, two passenger/commuter railroads, and Federal, State, county, and city Departments of Transportation.

CREATE is a $4.6 billion portfolio of 70 enhancements to the freight, passenger, and commuter rail system throughout the Chicago region that is largely funded through U.S. DOT grant programs. Effective railroad operations through Chicago are vital to keeping the Nation's economy moving. A 2015 economic impact study found that implementation of the CREATE Program will result in national economic benefits estimated at approximately $31.5 billion over a 30-year period due to reduced travel times for rail passengers and freight, reduced motorist and cargo delays on highways and local roadways, improved rail and highway safety, air quality improvements, and construction-related economic and workforce development benefits.

CREATE represents an innovative and flexible approach to project delivery that recognizes the value of industry-wide freight network effects generated by individual projects. The CREATE Program has successfully delivered 30 projects so far, and an additional 21 projects are currently underway.

CREATE has a strong track record of delivering projects at or under budget, in part due to clearly defined procedures, roles, and responsibilities for each party. CREATE partners entered into a Joint Statement of Understanding in 2003 to define roles and responsibilities and establish funding commitments for public and private partners.

The CREATE partners have established standardized project procedures for environmental, design, and construction phases, as well as project cost management controls. These standard procedures simplify project planning and implementation processes to minimize delays and redundancy in project efforts. The use of independent project management processes under a coordinated program management framework allows projects to advance when funding is secured while ensuring that the Program partners have oversight into project progress and adherence to policies and procedures for design and construction.

Source: Adobe Stock

rails and bridges that are not strong enough to safely carry today's heavier rail cars. For example, some shortline railroads have rail sections with bridges and track constructed to carry railcars weighing up to 263,000 pounds, which is insufficient to carry the 286,000-pound railcars typically used by Class I railroads. In urban areas, passenger service train trips along shared-use rail corridors, as well as heavily trafficked at-grade highway-rail crossings, can also create choke points for freight rail.[132]

Congested rail corridors in the U.S. include the Northeast Corridor and Southern California. Other significant rail choke points include major interchange locations such as Chicago, Kansas City, and Memphis, and congested rail hub facilities, including Atlanta, Houston, and Cincinnati.

Double-stack tunnel constraints are a notable example of how a few highly-localized choke points can impede traffic flow over an entire corridor or even a network. For example, on the Heartland Corridor project, clearances in 29 rail tunnels on a route connecting the Hampton Roads port region of Virginia to Chicago were raised to allow for double-stacked intermodal trains. The route opened for double-stack traffic in 2010.

Inland Waterways Bottlenecks

Although barge traffic on the Nation's inland waterways has grown over time, increases in delays are primarily attributable to lagging infrastructure maintenance and improvement needs. The Inland Waterway System includes 239 lock chambers that must be traversed, and vessels may be delayed for hours while locks are shut down for maintenance and repair. Time lost due to delays at locks and locks out of commission for repairs can be costly to shippers and is an important consideration in deciding on future investments to maintain reliable freight service. Even when locks and dams are functioning properly, they often aren't capable of handling today's longer barge chains, which must be broken up to fit through a lock or dam because the infrastructure lacks sufficient capacity to accommodate longer barge chains.

TABLE 9. AVERAGE AGE AND DELAY AT INLAND WATERWAY LOCKS[137]

INLAND WATERWAY SYSTEM	TOTAL LOCKAGES	PERCENT COMMERCIAL LOCKAGES	AVERAGE LOCK AGE (YEARS)	AVERAGE DELAY (MINUTES)	PERCENT OF VESSELS DELAYED
Arkansas River	20,763	91%	50	10	12%
Chicago River	10,822	68%	81	41	81%
Gulf Intracoastal Waterway	25,480	99%	56	498	90%
Illinois Waterway	26,848	94%	84	121	65%
Mississippi River	100,784	79%	77	173	55%
Monongahela River	17,426	88%	74	17	22%
Ohio River	98,170	94%	56	172	53%
Tennessee River	21,195	68%	72	247	48%
Tennessee Tombigbee Waterway	19,278	71%	36	20	23%
All Waterways	560,749	79%	63	211	50%

An estimated 20 percent of time lost in transportation on inland waterways is caused by scheduled and unscheduled lock outages.[133] Between 2010 and 2017, the percentage of vessels delayed increased from 35 percent to 49 percent and the average time of delay per lockage nearly doubled from 80 to 154 minutes.[134] Delays can cost up to $739 per hour for an average tow, amounting to more than $44 million per year.[135]

The number and duration of some delays indicates poor performance of navigation locks. This may be because of aging machinery or infrastructure (unreliability) or a mismatch between lock sizes and demand for vessels and cargoes (under-capacity). Delays also can occur on river segments without lock and dam infrastructure because of flood conditions or low-water periods.[136]

Energy Bottlenecks

As described earlier, some emerging areas of oil and gas production are located far from refineries and petrochemical processing centers and have had limited access to pipeline networks. As production in these areas surged in the early 2010s, producers in these areas turned to less efficient modes of transportation (trains, barges, and trucks) to move their products to market. Since that time, however, additional pipelines have been built to accommodate more of the oil, natural gas, and natural gas liquids produced from hydraulic fracturing.

Despite the successful construction of new pipeline capacity in some parts of the country, several critical energy infrastructure bottlenecks continue to exist. The northeastern United States has severe capacity constraints in its


Source: Adobe Stock

natural gas pipeline system, which supplies fuel for electricity generation and heat for homes and buildings. Along the Gulf Coast, as exports of oil and gas increase, channel width and depth at major energy exporting ports can become a bottleneck.[138] Finally, as demand for LNG exports has grown, the limited number of LNG export terminals has become a constraining factor, though many have been permitted and brought on-line in recent years.

NONRECURRING CONGESTION

In addition to the chronic congestion faced by shippers of goods and materials, a wide range of events can temporarily reduce system capacity and disrupt freight flows on an intermittent basis. The scale of these disruptions can vary tremendously, from the rollover of a single tractor-trailer to natural disasters that affect an entire region of the country. Given the interconnected nature of the freight transportation system, disruptions to one part of a modal network can have a domino effect across that mode's entire network and ultimately to the much broader multimodal transportation system.

Nonrecurring congestion can occur anywhere on a transportation network and is less predictable. Sources of nonrecurring delay include crashes, weather, work zones, and other disruptions. These events can reduce system capacity, cause a spike in travel demand, or in extreme cases necessitate re-routing or a complete halt to all travel in a corridor.

Weather, maintenance activities, and incidents have similar effects on aviation, railroads, pipelines, waterways, and ports. Aviation is regularly disrupted by local weather delays, and inland waterways may be closed by equipment failures or regional flooding. Additional sources of temporary freight congestion include equipment shortages, short-term labor disputes, and inefficient operating practices at terminals and border crossings.

System reliability is especially important to freight, which is why FHWA chose a reliability measure to assess freight movement on the Interstate system as part of its performance management regulations (see the text box below). Manufacturers rely on just-in-time delivery to maximize efficiency. However, this requires time-certain delivery targets to provide the right material, at the right time, at the right place, and in the exact amount needed in the

Truck Travel Time Reliability

Freight reliability is critical to industry for ensuring on-time deliveries. The Truck Travel Time Reliability (TTTR) Index is a measure of the average reliability for truck movement over the full extent of the Interstate system. The TTTR Index is calculated as the ratio of longer truck travel times (i.e., the 95th percentile) and normal truck travel times (i.e., 50th percentile) using truck GPS probe data from the National Performance Monitoring Research Data Set (NPMRDS). The TTTR Index is measured for five different time periods during the day and averaged over the full extent of the Interstate system to determine a National TTTR Index. A higher TTTR Index, such as 1.8, indicates there is large variation in travel times from day-to-day, making the system unreliable. A lower TTTR Index, such as 1.05, indicates travel times are more consistent or predictable from day-to-day, making the system reliable. State DOTs and MPOs will set targets for these indicators in FY 2020. Going forward, States' targets will be reviewed biennially for significant progress towards target achievement. The baseline measure for 2018 was calculated based on data submitted by State DOTs in 2018. The National TTRI Index increased from 1.36 in 2018 to 1.38 in 2019.

production cycle. If a truck is unable to make a delivery to a manufacturer or supplier due to unexpected traffic delays, this can have a costly ripple effect on production. Other common shipments that require a high degree of on-time performance include expedited or high-value shipments, perishable products, and cargo that needs to be transferred to another mode operating on a fixed schedule.

RESILIENCE

Our Nation's aging and deteriorating infrastructure is being further stressed by increases in heavy precipitation events, coastal flooding, heat, wildfires, and other extreme events. In addition, as our freight systems become increasingly reliant on interconnected systems to track global supply chains and meet the demands of just-in-time logistics, these systems also become more vulnerable to risks associated with cyber-attacks.

Resilience refers to the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies. The strain that increasing freight flows are placing on an aging infrastructure system with limited capacity may reduce the resilience of our freight system, increasing the effects of disruptions and slowing the speed of recovery. A resilient freight transportation system is responsive, able to provide reliable services when it encounters small disruptions, and return to service quickly after large disruptions. Disruptions to the transportation system often require the coordinated activities of the public and private sectors to ensure freight transportation flows, both for emergency response and economic recovery. The availability of alternative routes and modes allows shippers to develop contingency plans enhancing their flexibility.

Source: AP/Nati Harnik

COVID-19 and Supply Chain Resilience

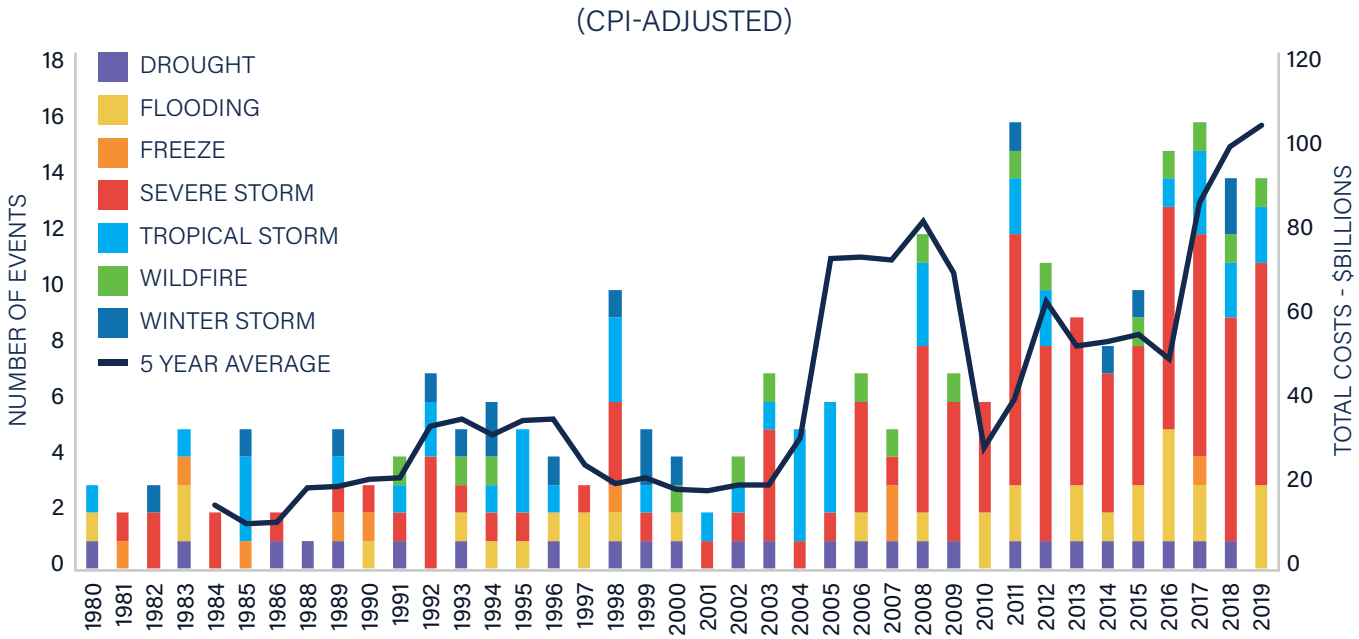
The worldwide COVID-19 pandemic has posed severe disruption risks to supply chains. Initially, the pandemic resulted in supply-side shocks to U.S. manufacturers as factories in China shut down. The spread of the pandemic has caused large reductions in overall demand worldwide, as workers and consumers have been forced to stay home. This has resulted in reduced demand for commodities, such as energy products, natural resources, and automobiles. It has also led to a surge in demand for e-commerce and home goods. As companies have moved to reduce supply chain costs, strategies such as lean manufacturing, offshoring, and outsourcing, have made them more vulnerable to supply chain disruptions. Going forward, it is clear that maintaining the health and safety of our Nation's freight transportation workforce will be essential to preserving supply chains and ensuring the continued functioning of the economy.

Manufacturers and retailers may also maintain additional inventory or seek alternative suppliers so that they may be able to maintain business operations during a disruption to their supply chains.

Major events, such as the 2019 floods in the Midwest, can disrupt or shut down critical freight infrastructure for days, weeks, and months while damages from these events can cost billions of dollars.

In 2019, there were 14 billion-dollar weather and climate disaster events across the U.S., with a total cost of $45.0 billion[139] Over the past decade, the number and average cost of major disaster events have increased significantly (see Figure 24).

FIGURE 24. U.S. BILLION-DOLLAR DISASTER EVENTS[140]



Nebraska Flood Recovery

Resilient transportation networks are critical to the economic vitality of the United States. Severe weather and other disturbances can significantly disrupt the transportation system, impacting the ability to move people and goods both in the disrupted areas and beyond. Resilient networks have the ability to minimize both immediate and "spillover" effects that can impact national commerce. State DOTs play a critical role not only in crisis response and recovery, but also in providing for the long-term sustainability and resiliency of transportation networks through planning and project prioritization.

In the spring of 2019, changing weather patterns and snowmelt caused severe flooding across the Midwest, which ultimately affected over 14 million people in 11 states. Nebraska experienced catastrophic infrastructure damage, including 3,300 highway miles under water or snow and 27 bridges damaged or destroyed by flooding. The floods had significant and immediate impacts to Nebraska's economy. Agriculture is the State's leading industry, with every dollar in agricultural exports generating $1.28 in economic activity. The industry was greatly impacted by impassible roads and bridges caused by the flooding.

Nebraska DOT (NDOT) responded to the crisis quickly, working from the Nebraska Emergency Management Agency's Emergency Operations Center and its own State Operations Center to coordinate road closures and barricade placement to aid public safety. The hydraulics and engineering teams responded within hours to assist the Districts with assessing and repairing damage to the State transportation network. With the assistance of FHWA, NDOT sent teams to assess damage and create action plans. Nebraska DOT (NDOT) worked closely with local agencies and associations such as the Nebraska Cattlemen to identify and prioritize routes for emergency work, minimizing detours for time-sensitive shipments.

The State received $26M (with an additional $67M expected) in Federal Emergency Relief funds from FHWA to restore mobility and initiate repairs on what is now estimated to be $165M in damages on the Federal-aid system. Within 30 days of the floodwaters receding, 99 percent of closed highway miles had been reopened. NDOT identified 85 projects and completed 64 of them by the end of 2019, ensuring that the State remained open for business. The railroads in Nebraska made significant investments to recover washed-out infrastructure and provided detour access over the own lines for other railroad operators most affected by the crisis.

Both crisis response and resiliency planning in transportation agencies are critical for preparing for, and addressing the impacts of, severe weather and other disruptions. Economic impacts from these events can be severe and widespread, particularly when Interstates and other critical freight routes are affected. States that are prepared for and positioned to address the effects of severe weather and other disruptions can mitigate these impacts and become more attractive locations for the siting of transportation-dependent industries.

INFRASTRUCTURE CONDITION

The amount of publicly available data on infrastructure conditions varies by mode. The Federal government collects data on bridge and pavement conditions on roads and runways, but public data on privately owned rail and pipeline conditions are far more limited. The following section briefly summarizes publicly available condition data on infrastructure of significance to freight movements.

ROAD AND BRIDGE CONDITIONS

States have made significant efforts to improve bridge conditions over the past two decades. As defined by FHWA, there are 46,163 bridges in poor condition in the U.S., making up 7.5 percent of all bridges.[141] While these bridges may not be imminently unsafe, they are in need of attention. In addition, nearly 62,000 bridges, or 10.1 percent of total bridges across the country, are "posted for load" which means there are weight restrictions or other measures in place to reduce stress on the structure.[142]

Relative to the rest of our Nation's road network, a small percentage of bridges on the NHS are in poor condition.[143] The percentage of NHS bridges (weighted by deck area) in poor condition declined from 8.2 in 2010 to 4.6 percent in 2019. There are 4,730 bridges on the NHS that are classified as in poor condition. Of the bridges on the NHS, 3.3 percent were rated in poor condition compared to 7.5 percent of all bridges nationally. Poor condition bridges are characterized by the deteriorated condition of bridge elements and reduced load-bearing capacity. In some cases, weight restrictions are placed on these bridges, which may affect freight movement.

TABLE 10. NHS BRIDGE CONDITIONS (2019)[144]

MEASURE/ CONDITION	GOOD	FAIR	POOR
By bridge count	46.0%	50.7%	3.3%
By bridge area	42.3%	53.1%	4.6%

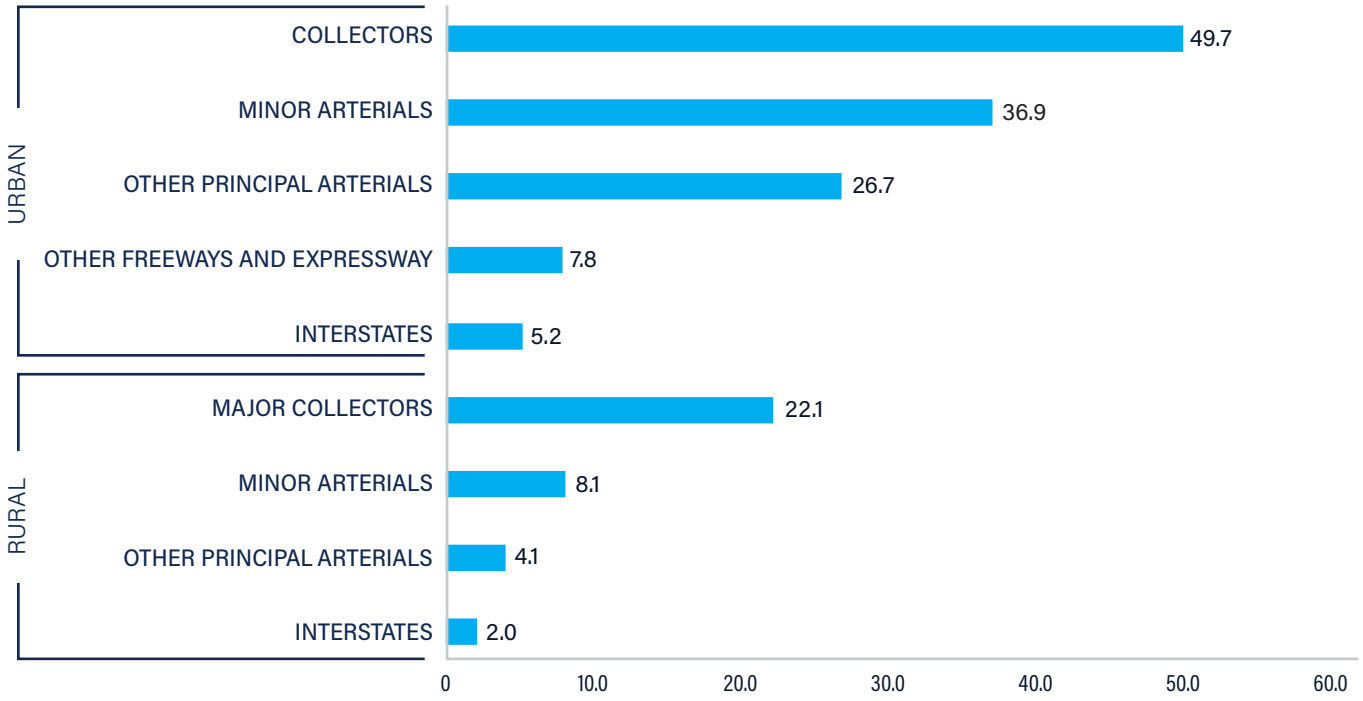
Pavement smoothness is an indicator of the physical condition of roadways. The FHWA uses the International Roughness Index to measure the roughness of pavement. The percent of roadway mileage pavement in mediocre or poor condition varies by roadway functional class—Interstates tend to be in better condition than arterials and rural roadways tend to be in better condition than urban roadways (see Figure 25). Most classes of roadways have shown improvements in pavement smoothness over the 2000 to 2017 period. Despite improvements, however, only 62 percent of vehicle miles traveled on the NHS were on pavement in "good" condition in 2018.[145]

National Highway Freight Network Conditions and Performance

FHWA has analyzed the conditions and performance of the National Highway Freight Network. The NHFN consists of 51,029 centerline miles, including 46,947 centerline miles of Interstate and 4,082 centerline miles of non-Interstate roads. Based on 2014 international roughness index (IRI) data from the Highway Performance Monitoring System (HPMS), approximately 77 percent of pavement miles were rated as having good ride quality, 19 percent had fair ride quality, and 4 percent had poor ride quality.

The National Bridge Inventory (NBI) is used to identify current bridge ratings for bridges on the NHFN. This analysis showed there are approximately 57,600 bridges on the NHFN. Around 4.3 percent of those bridges were rated as structurally deficient. Most of these structurally deficient bridges are 25 years and older, and over half are more than 50 years old. These findings have implications for future maintenance and funding needs as well as impacts to operations.
A total of 3,633 fatal crashes occurred on the Interstate portion of the NHFN in 2014, resulting in 4,094 fatalities. In 2015, fatal crashes and fatalities increased by 5.7 percent and 6.1 percent, respectively.

FIGURE 25. ROADWAY CONDITIONS: PERCENT OF MILEAGE WITH INTERNATIONAL ROUGHNESS INDEX (IRI) OVER 170 BY FUNCTIONAL CLASS (2018)[146]



Intermodal Connectors

A study of freight intermodal connectors found that 37 percent of a sample of intermodal connectors had pavement that was in poor condition.[147]

TABLE 11. INTERNATIONAL ROUGHNESS INDEX CATEGORIES[148]

PAVEMENT CONDITION	IRI RATING (INCHES/MILE)	PAVEMENT CONDITION DESCRIPTION	NUMBER OF CONNECTORS	PERCENT OF TOTAL
Very Good	<60	Newly built or resurfaced and distress-free.	14	1%
Good	60-94	Smooth surface with little to no cracking or rutting.	103	8%
Fair	95-170	Serviceable with shallow rutting and moderate cracks beginning to occur, but does not affect travel speed on the connector.	428	35%
Mediocre	171-220	Same problems as fair but worse, causing some reduction in speed.	236	19%
Poor	>220	Major problems with potholes, etc., causing substantial reductions in speed.	458	37%
Total			1,239	100%

INLAND WATERWAY CONDITIONS

The USACE reports that in 2017, the average age of all locks was 62 years. Without sufficient investment, as locks age, they become increasingly unreliable and there are more unplanned closures due to the need to repair facilities. In some cases, the failure of a single lock, such as the Poe Lock in Sault Ste. Marie, Michigan could have a crippling effect on the movement of tens of millions of tons of bulk products on the Great Lakes. Figure 26 shows authorized inland waterways projects that have yet to begin construction.

OTHER FREIGHT INFRASTRUCTURE CONDITIONS

Runway Conditions

Most airport runway pavements at commercial, reliever, and select general aviation facilities were in good condition in 2017, with 18 percent rated as fair. Only 2 percent of airport runway pavements were rated as poor.[150]

FIGURE 26. PRIORITY PROJECTS AND BOTTLENECK SITES ON THE INLAND WATERWAYS SYSTEM[149]

Railway Conditions

In 2017, railroads inspected 104,000 miles of railroad track. The FRA audits the railroad inspection program and evaluates track geometry for safety exceptions. Since 2010, the miles inspected have increased by 24.7 percent, while the total exceptions per 100 miles inspected decreased by 75.8 percent.[151]

Pipeline Conditions

While there is limited publicly available data on pipeline conditions, the Pipeline and Hazardous Materials Safety Administration (PHMSA) tracks, among other things, the number of pipeline inspections, incidents, and corrective actions.

Source: Adobe Stock

BARRIERS TO FREIGHT SYSTEM PERFORMANCE

FINANCIAL BARRIERS

America's world-class freight systems allow our industries to move goods more quickly and efficiently than those in most other nations, lowering the costs of goods to domestic consumers and improving the economic competitiveness of our exports. Increased competitiveness creates opportunities for business growth and expansion.

Maintaining a competitive edge is critical to the U.S. economy. However, over the last 15 years, public funding for infrastructure has not kept up with rising construction costs. According to the Congressional Budget Office (CBO), when adjusted for infrastructure-specific inflation, public infrastructure spending at all levels of government (Federal, State, and local) has decreased by 8 percent since it peaked in 2003.[152]

State and local governments own approximately 93 percent of public infrastructure and provide the majority of public infrastructure funding. Federal funding makes up approximately 40 percent of all public funding for capital investments in infrastructure, and 92 percent of Federal funding is distributed to State and local governments in the form of grants. State and local spending on transportation infrastructure has declined since it peaked in the early 2000s.[153]

INSTITUTIONAL BARRIERS

While overall infrastructure investment has declined relative to inflation, freight projects face special challenges when competing for funding from that limited pool of resources. Freight projects often have benefits that extend across regions or even the entire Nation, but their negative impacts, including traffic congestion, noise, and emissions, can be highly localized. Since planners tend to focus on benefits to their community or jurisdiction, inter-jurisdictional and multistate projects may not

receive sufficient consideration when prioritizing projects for funding. In addition, the scale of funding and complexity of multijurisdictional coordination required for projects of national significance may deter agencies from undertaking such efforts.[154]

Federal funds are available for highway freight projects through FHWA formula programs such as the National Highway Freight Program (NHFP), National Highway Performance Program (NHPP), the Surface Transportation Block Grant Program (STBGP), and the Highway Safety Improvement Program (HSIP). While the NHFP allows for investment in modes other than highways, State and local agencies have limited flexibility for multimodal investments due to non-Federal restrictions on their sources of matching funds. Projects to improve freight transportation infrastructure are also eligible for funding under major U.S. DOT discretionary grant programs, which include:

- Better Utilizing Investments to Leverage Development (BUILD) Grants;
- Infrastructure for Rebuilding America (INFRA) Grants;
- Consolidated Rail Infrastructure and Safety Improvements (CRISI) Grants; and
- Port Infrastructure Development Program (PIDP) Grants.

U.S. DOT's Infrastructure for Rebuilding America (INFRA) Grant Program

The Nationally Significant Freight and Highway Projects (NSFHP) program, better known as INFRA, provides Federal financial assistance to highway and freight projects of national or regional significance. First authorized in 2015 as part of the FAST Act, the Department has made awards to numerous projects across the country that improve the safety and efficiency of freight movement. For example, in 2018, the Department awarded $25 million to the Philadelphia Regional Port Authority to complete the second phase of a multi-phase improvement plan at the Packer Avenue Marine Terminal. The project will modernize the terminal, ensuring that it has sufficient berthing, crane, and capacity to meet expected market demand. Once completed, the improvements will enhance the port's capability and efficiency serving larger vessels visiting the port.

Also in 2018, the Department awarded the Utah Department of Transportation $25 million to widen 5600 West (a roadway in Salt Lake City) to five lanes, construct a grade-separated crossing over three mainline railroad tracks, and construct a new rail interchange nearby to increase rail network connectivity. The project greatly improves safety outcomes in the area while improving travel times for freight traffic accessing a major intermodal freight terminal in Salt Lake City.

State Freight Plans

The FAST Act offered a financial incentive for States to analyze and plan for their freight infrastructure needs and investments, requiring a multimodal State Freight Plan in exchange for funding under a new freight Federal aid program with broad freight eligibility. To meet this requirement, States analyzed freight movements and system conditions, described trends and challenges affecting the freight system, and identified projects and matching funds for freight investment. Through this planning process, States identified goals and strategies to guide freight system investments and improve system performance.

States used a wide range of planning approaches to meet FAST Act requirements. Although, the variety of planning approaches, data sources, and definitions used by States limits the ability to compare the trends, challenges, and corridors to identify nationally significant freight system needs, the plans do provide insights into broad challenges affecting the Nation's freight system.

Common challenges and barriers emphasized in the State Freight Plans include the following:

Physical Infrastructure Capacity Constraints

- Insufficient "secondary" infrastructure to support freight movement, such as truck lanes and parking, overweight vehicle routes, as well as declining road quality.
- Challenging roadway geometry for trucks in major highway interchanges and routes, often in urban core areas, contributing to truck bottlenecks.
- Limited intermodal connectivity and poor quality last-mile connections on important routes.

Financial, Operational, Institutional, Technological, and Regulatory Barriers

- Lacking resources to accommodate freight needs, such as real-time information, sufficient workforce, and freight-specific funding.
- Workforce challenges, including recruiting and retaining qualified workers for jobs in major freight industries like trucking, longshoreman, and others.
- Institutional barriers, including insufficient multijurisdictional coordination on regulations and requirements contributing to bottlenecks at State and national borders.
- Technological barriers, including insufficient Intelligent Transportation Systems (ITS) infrastructure and freight-specific routing needs.
- Regulatory barriers at both the State and national level, including driver-hour restrictions, licensing requirements, vehicle weight and size limits, and a lack of clarity on regulations related to innovation deployment.

State Freight Plan Requirements

The FAST Act required States to contain 10 primary elements in their freight plans.

1. Identifying significant freight system trends, needs, and issues within the State.
2. Describing freight policies, strategies, and performance measures to guide investment decisions.
3. Providing a list of designated multimodal critical rural freight facilitates and corridors and critical rural and urban freight corridors within the State.
4. Describing how the Plan will improve the State's ability to meet National Multimodal Freight Policy and National Highway Freight Program goals.
5. Describing how innovative technologies and operational strategies, including ITS, were considered.
6. Describing improvements that may be required to reduce or impede the future deterioration of roadways on which heavy freight vehicles are projected to travel.
7. Providing an inventory of facilities with freight mobility issues, such as bottlenecks, within the State and a description of strategies being employed to address them.
8. Considering any significant congestion or delay caused by freight movements and any strategies to mitigate that congestion or delay.
9. Providing a freight investment plan that includes a list of priority projects and describes how funds made available to carry out would be invested and matched.
10. In addition, the plans must be developed in consultation with the State Freight Advisory Committee, if applicable.

Planned Investments in the U.S. Freight System

As reported in the State Freight Plans, States collectively programmed more than $6.2 billion of NHFP funding between FY2016 and FY2020 (projected). This funding supported more than 1,200 distinct infrastructure projects, focused largely on expanding and modernizing highway facilities.

States programmed about one-third of NHFP funds to expand capacity on freight-heavy routes, including adding truck-only lanes, high-occupancy vehicle (HOV) lanes, turning lanes, and additional capacity on highways.[155]

In addition to capacity expansion projects, States used the funding to do highway resurfacing to maintain states of good repair, to do bridge reconstruction to improve weight tolerances and highway clearances, and to make geometry improvements on highway interchanges to accommodate large trucks. The categories accounted for more than 80 percent of the projects in the State Freight Plans. The remaining 20 percent of projects consisted of investments in ITS, operations, safety, truck parking, ports, intermodal connectors, and other important freight network needs.

The mix of freight investments at the State level may change over time as investment plans are updated. Typically, public infrastructure investments take several years to plan, fund, and deliver; however, States had just under two years to develop the plans and identify projects after the requirement was enacted into law. As a result, many States focused on "shovel-ready" freight projects already programmed in their State Transportation Improvement Programs (STIPs) and metropolitan region Transportation Improvement Programs (TIPs) in the first round of State Freight Plan investment plans.

Notable Practices

While many States have generally similar plans in terms of scope and structure, some States have taken more innovative approaches to their analysis, strategies, or investments. A few of these notable practices, include the following:

Freight Advisory Committees

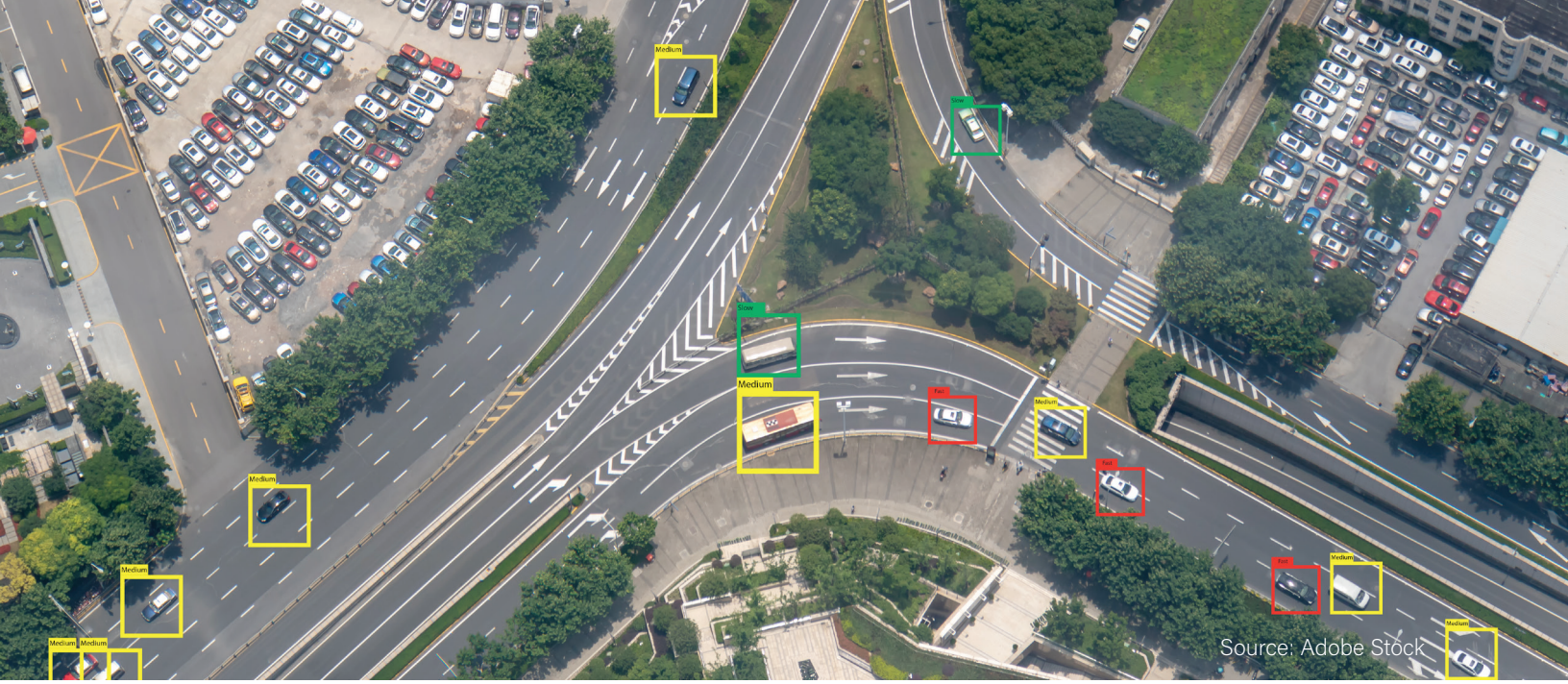
Increasing private sector freight stakeholder participation in the transportation planning process could better inform the public sector of investment needs and priorities. State Freight Advisory Committees (FACs) are not required under the FAST Act, but the legislation required States that had them to consult with FACs during the development of the State Freight Plans. These groups, composed of public officials from a variety of agencies and often freight producers, carriers, forwarders, shippers, and other representatives from across the supply chain, are meant to inform State DOTs about the on-the-ground realities of freight in their jurisdictions. A majority of State Freight Plans (about 35) were developed with the support of an FAC. States leveraged their FAC to inform analysis of the plan and identify priorities; in some States, FACs were also involved in strategy development and implementation.

State-Created Freight Data and Analysis Tools

Several datasets are commonly used to describe freight volumes, commodity types, truck speeds, and other relevant freight metrics in State Freight Plans. Some critical datasets are public, such as NPMRDS and FAF, though many States purchase private data sources. States are building their in-house freight analysis capabilities and developing tools to help them analyze these large datasets. These include freight-specific spatial analyses tools, programs that combine and analyze multiple relevant datasets, scenario planning tools, and others that help State DOTs gain new and more comprehensive insights about their freight network, allowing them to develop more targeted strategies and investment decisions.

Development of Statewide Competitive Freight Programs

Several States are using portions of their NHFP funds to develop State-administered competitive grant programs. These grants allow for more flexible use of the funding on smaller projects, leverage Federal and State funding, and enable greater participation from public and private stakeholders in the freight project planning process.



DATA AND INFORMATION BARRIERS

Data limitations inhibit the ability of public and private sector actors in the freight system to make informed decisions. Public agencies often lack access to timely, consistent, and actionable freight data that could help them justify putting a greater emphasis on freight projects. Data describing freight volumes and specific commodity movements, especially at more local or granular scales, are extremely limited. As a result, public agencies must generally rely on insufficient data, making less informed freight investment decisions as a result.

Shipper decisions are often based on the cost and logistical requirements of their individual supply chains. While some States or regions have successfully partnered with private industry or developed other methodologies to gain insights into freight movements in their own region, a standardized dataset allowing for comparisons of freight movement or network performance across metropolitan areas does not currently exist. Information on specific supply chains is generally limited to case studies, and data on the cost of shipping goods is not well understood. Proprietary concerns have traditionally inhibited the ability of public agencies to study and understand the decision-making of shippers and carriers that ultimately influence the geography of goods movement and the performance of freight transportation systems. Because data on the cost of shipping goods is not well understood, it is difficult for policymakers to integrate the cost of product transportation for businesses and consumers into transportation programming and policy decisions.[156]

Commodity Flow Survey and Freight Analysis Framework

Due to the magnitude and complexity of freight transportation, no single data collection provides a comprehensive picture of annual freight movement from origin to destination by all modes of transportation and by all commodity types. Among the various data sources, the Commodity Flow Survey (CFS), conducted by the Census Bureau for BTS, provides the most far-reaching coverage of U.S. freight flows. The CFS is the only source of nationwide data on domestic freight shipments by manufacturing, mining, wholesale, and selected retail industries covering all modes of transportation. It also is the only source of comprehensive data on domestic hazardous material shipments.

The CFS is conducted every five years. The CFS surveys thousands of shippers on the characteristics of their outbound shipments. However, the sample size is not sufficient to provide reliable data for any specific urban area. Furthermore, the survey does not record through traffic, does not distinguish between imports and domestic freight, and occurs too infrequently to identify trends in freight patterns.

The CFS is used to construct the FAF, which includes data on the amount and types of goods that move by land, sea, and air between large metropolitan areas, states, and regions. It is designed to provide information on national level freight flows across the Nation's transportation network. This information helps the public and private sectors at all levels better understand freight movement; transportation planners use it to target resources to improve operations or increase capacity.

Many State DOTs have used FAF data to analyze freight flows in their State Freight Plans. Some States supplemented FAF data with local and privately sourced data. However, while the FAF provides a comprehensive picture of freight movement at the national and regional levels, few local data collection programs exist to provide local pictures of freight movement. These data are essential for understanding local freight delivery movements, which are changing rapidly as online shopping becomes more prevalent and new distribution strategies and delivery technologies are deployed.

Source: Adobe Stock

New technology is creating a world flooded with data from satellites, cell phones, highway traffic control systems, vessel tracking systems, and "smart devices" in homes, workplaces, and in vehicles. These advancing technologies are introducing new cost-effective methods of collecting, storing, and analyzing freight data. However, new technologies also raise major privacy, confidentiality, and intellectual property issues. Significant quality issues, inadequate methods for creating effective information, and confidentiality concerns can undermine the effectiveness of these data to generate credible public statistics.

Information quality concerns go beyond data to include new analytical methods. Frequently labeled "big data analytics," these methods were originally developed to make short-term forecasts from very large datasets. These methods have been adapted by private shippers to monitor and manage supply chains, and are now being explored by public agencies as early indicators of changing social and economic conditions and of emerging safety problems. The potential for adapting these methods to long-range forecasting and to the understanding of complex, uncontrolled transportation phenomena remains in the formative stages.

STATUTORY AND REGULATORY REQUIREMENTS

Freight stakeholders often cite certain safety, environmental, and economic regulations as impediments to freight efficiency. There are often different perspectives on whether these regulations are the best way to reach their intended goals or whether the costs associated with complying with a particular regulation exceed the benefits.

Regulatory barriers commonly cited by freight industry stakeholders include:

- National Environmental Policy Act (NEPA) regulations
- Truck size and weight laws
- State truck route restrictions
- Hours of service rules
- Customs and border security rules
- Fuel and emissions standards
- Cabotage laws

In some cases, these regulations may be seen as barriers that delay the delivery of freight projects or the adoption of new freight technologies. Due to the fragmented nature of Federal and State authorities, regulatory requirements and policies across modes, sectors, and jurisdictions may not be aligned, resulting in confusion and delay. For example, some States have enacted environmental policies that restrict the construction of pipelines or otherwise limit the movement of energy products in their regions. In other cases, however, the barriers identified by stakeholders may reflect the compromise policy decisions made by decisionmakers balancing competing public goals and interests.

6 | GOALS AND STRATEGIES

VISION

The freight transportation system of the United States will strengthen our economic competitiveness with safe and reliable supply chains that efficiently and seamlessly connect producers, shippers, and consumers in domestic and foreign markets.

FEDERAL ROLE

The Federal Government has an important role in supporting and overseeing our Nation's freight system. This function derives from the commerce clause of the U.S. Constitution, which authorizes Congress to regulate commerce among States. In today's global economy, the Nation relies on interstate and international commerce to support economic growth.

More than half (52 percent) of all freight by value crosses State lines, and more than a quarter (27 percent) is made up of international imports and exports.[157] The Federal Government plays an important role to ensure the efficient movement of these goods.

The Federal Government provides significant funding and financing for freight-supporting projects, such as building and rehabilitating highways and bridges, dredging harbors, repairing locks, and improving rail safety. Much of the decision-making on how Federal dollars are spent, however, is made at the local level with oversight from Federal agencies. Historically, State and local governments did not make freight projects a top priority for investment. In part, this was due to private sector ownership of infrastructure and in part because the benefits of freight projects—in terms of more efficient supply chains—were often diffused nationally or were difficult to measure. Furthermore, freight projects are often large, complex, multimodal, and multijurisdictional, making them difficult to fund through traditional highway-focused formula programs. As a result of new and growing discretionary programs for freight and the NHFP, the Federal Government can now support more effective State and local decision-making by identifying and funding nationally and regionally significant goods movement infrastructure and encouraging multistate collaboration.

The following principles can be used to guide U.S. DOT's strategic leadership to support safe, efficient, and reliable goods movement.

1. **Modernize or eliminate unnecessary or duplicative regulations** that inhibit supply chain efficiency, reduce incentives to innovation, delay project delivery, or raise costs to shippers and consumers, while protecting safety and environmental outcomes.
2. **Improve cross-sector, multijurisdictional, and multimodal collaboration** to enhance intermodal connectivity and first- and last-mile connections, streamline interstate policies and regulations, and support multistate investment.
3. **Provide targeted Federal resources and financial assistance** to support freight projects that provide significant benefits to the national economy.
4. **Invest in freight data, analytical tools, and research** to enhance the abilities of State, regional, and local agencies to evaluate and address freight issues.

STRATEGIC GOALS

This National Freight Strategic Plan supports the priorities and strategic goals for the U.S. DOT set by the Secretary for the Department. The following section describes the strategic goals and objectives for the Department's national freight policy and highlights significant current and proposed initiatives aligned with the Department's strategic goals of Safety, Infrastructure, and Innovation.

The strategic goals of U.S. DOT's National Freight Policy are as follows:

SAFETY

Improve the safety, security, and resilience of the national freight system.

INFRASTRUCTURE

Modernize freight infrastructure and operations to grow the economy, increase competitiveness, and improve quality of life.

INNOVATION

Prepare for the future by supporting the development of data, technologies, and workforce capabilities that improve freight system performance.

Each of these goals is further defined by strategic objectives that will be used by the Department to guide freight policies, programs, and investments over the next five years. These are summarized in the table below.

TABLE 12. STRATEGIC GOALS AND OBJECTIVES OF NATIONAL FREIGHT POLICY

GOAL	STRATEGIC OBJECTIVES
Safety *Improve the safety, security, and resilience of the national freight system.*	• Support the development and adoption of automation, connectivity, and other freight safety technologies • Modernize safety oversight and security procedures • Minimize the effects of fatigue and human error on freight safety • Reduce conflicts between passenger and freight traffic • Protect the freight system from natural and human-caused disasters and improve system resilience and recovery speed
Infrastructure *Modernize freight infrastructure and operations to grow the economy, increase competitiveness, and improve quality of life.*	• Fund targeted investments in freight capacity and national goals • Improve consideration of freight in transportation planning • Prioritize projects that improve freight intermodal connectivity, and enhance freight flows on first- and last-mile connectors and at major trade gateways • Develop a methodology for identifying freight bottlenecks across modes • Advance freight system management and operation practices • Stimulate job growth and economic competitiveness in rural and urban communities • Mitigate the impacts of freight movement on communities
Innovation *Prepare for the future by supporting the development of data, technologies, and workforce capabilities that improve freight system performance.*	• Support the development and adoption of automation and connectivity, including V2X technologies • Support the safe deployment of unmanned aircraft systems (UAS) technology • Streamline or eliminate regulations to improve governance, efficiency, and economic competitiveness • Improve freight data, modeling, and analytical tools and resources • Strengthen workforce professional capacity • Invest in freight research • Support regulatory frameworks that foster freight innovation

SAFETY

Improve the safety, security, and resilience of the Nation's freight system.

Source: Adobe Stock

Safety is the U.S. DOT's top strategic goal. The U.S. DOT will work with its partners in the public and private sector to reduce safety incidents associated with freight movements and mitigate their consequences. As part of this goal, the Department seeks to protect the freight system from natural and human-caused disasters and to expedite response and recovery to quickly reestablish the safe movement of people, goods, and services. The Department will continue to engage our partners and stakeholders in safety enhancing program efficiencies and innovations with respect to freight mobility, rural safety, safe driver behavior, and accelerated recovery efforts in communities after disasters.

STRATEGIC OBJECTIVES

To meet this goal the Department will pursue activities in support of the following strategic objectives:

- **Support the development and adoption of automation, connectivity, and other freight safety technologies**
  Automation holds tremendous promise to reduce transportation-related fatalities related to human error. The Department will work closely with stakeholders in the public and private sector to advance the development and adoption of connected and automated freight technologies across each mode while ensuring their safety, particularly for vulnerable users.
- **Modernize safety oversight and security procedures**
  As transportation systems become more complex, it becomes more difficult for safety regulators to develop and oversee simple and effective rules to ensure safety. The Department will assess regulatory barriers to safe and efficient freight movement, identify and remove unnecessary regulations, provide tools and data to streamline regulatory oversight and compliance activities, and support the harmonization of State safety standards and regulations.
- **Minimize the effects of fatigue and human error on freight safety**
  Human error, fatigue, driver health, and risky human behaviors such as distracted and drunk driving continue to be a safety challenge in every form of transportation. In particular, operator fatigue is an ongoing major safety concern and a source of incidents and accidents in all modes of transportation. The Department will support policies, research and technology, and infrastructure funding to mitigate the effects of human error on safety and that improve the safety of freight transportation workers. This includes supporting the adoption of safety management systems and a safety culture at freight transportation organizations.
- **Reduce conflicts between passenger and freight traffic**
  Freight and passenger traffic often use shared right of way—trucks drive on city streets with cars, cyclists, and pedestrians, barges and cargo vessels share waters with recreational boaters and cruise ships, and freight railroad tracks regularly cross roads or share right-of-way with passenger rail systems. Many freight transportation safety incidents involve people who are not engaged in freight transportation. To improve the safety of the traveling public, the Department will support infrastructure projects and operational strategies that achieve safety improvements by physically or operationally separating freight and passenger traffic where appropriate.
- **Protect the freight system from natural and human-caused disasters and improve system resilience and recovery speed**
  Infrastructure and freight operations across the country faces risks from natural disasters, extreme weather, and security incidents that can damage and destroy infrastructure, disrupt travel and regional economies, and require costly repairs. Increasing connectivity and interdependency across the freight system raises the potential

for cyberattacks and failures that could damage critical transportation services and assets. To address the risks posed by such severe disruptions, the Department will assess vulnerabilities to the freight system, strengthen protections against security incidents, and support the development of a more resilient system.

HIGHLIGHTS

Human Trafficking

The U.S. DOT is working with other U.S. Government agencies and with transportation stakeholders across the country on initiatives to eliminate human trafficking. The Transportation Leaders Against Human Trafficking partnership is an open membership group composed of transportation and travel industry stakeholders committed to maximizing their collective effort through five key focus areas: industry leadership, industry training and education, policy development, public awareness, and information sharing and analysis.

Safety Data Initiative

Through the Safety Data Initiative, the U.S. DOT works with State, local, and tribal governments to apply advanced analytics to emerging data sources to provide new insights into transportation safety challenges. Ultimately, the tools and insights gained from this initiative will be used to guide actions that save lives. The Safety Data Initiative includes projects to use crowd-sourced data to identify traffic crashes in near-real time, research to analyze the role of speed in rural crashes, and an examination of the relationship of pedestrian fatalities to roadway characteristics and neighborhood demographics. To support the use of innovative safety data tools, the U.S. DOT awarded more than $3 million in grants to nine State, local, and Tribal governments to use innovative data tools and information to improve roadway safety.

INFRASTRUCTURE

Modernize freight infrastructure and operations to grow the economy, increase competitiveness, and improve quality of life.

Targeted transportation investments are needed to improve the efficiency and connectivity of the freight system. Investment has not kept pace with growing freight needs, and freight bottlenecks and chokepoints are multiplying across our multimodal transportation system. Unmet maintenance and modernization needs raise the cost of freight shipments and reduce our economic competitiveness.

STRATEGIC OBJECTIVES

To meet this goal the Department will pursue activities in support of the following strategic objectives:

- **Fund targeted investments in freight capacity**
  The Department will support investments that increase the efficiency of freight movements and business competitiveness by improving freight planning and freight

data, and identifying and addressing freight bottlenecks that hinder the reliable movement of freight. To be effective, Federal freight transportation funding needs to be sustained, multimodal, cross-jurisdictional, reliable, and specifically dedicated to freight transportation projects. Through competitive grants, formula funding, and innovative finance programs, the Department will leverage Federal funds, incentivize State and local funding, encourage multijurisdictional partnerships, and support private investment in multimodal freight infrastructure. The U.S. DOT will address congestion on our freight system through targeted, data-driven investments in projects to enhance capacity and the development and promotion of effective operational strategies and technologies to optimize existing capacity.

- **Improve consideration of freight in transportation planning**
  The benefits of freight projects are often insufficiently considered in transportation planning. The Department will advance programs, policies, and best practices that support the prioritization of freight projects in the planning process. This includes promoting freight planning best practices as well as supporting the development of data and analytical tools that improve assessment of the costs and benefits of freight projects at the local, regional, and national levels.
- **Prioritize projects that improve freight intermodal connectivity, and enhance freight flows on first- and last-mile connectors and at major trade gateways**
  Our freight system relies on the ability to make efficient, high-speed, intermodal transfers of freight. Freight bottlenecks occurring at ports, border crossings, and intermodal facilities are often the result of inadequate landside facilities, poorly maintained intermodal connectors, and inefficient security and operational procedures. Improved intermodal connectivity enhances the overall efficiency and resiliency of the freight system, expanding the choices available to shippers and enhancing competition among carriers. The Department will also work to ensure adequate capacity and quality of intermodal connectors and significant trade corridors through multimodal freight infrastructure planning and coordination with foreign partners.
- **Advance freight system management and operation practices**
  Freight system inefficiencies can be attributed not only to insufficient infrastructure capacity, but also to intermittent disruptions and deficient operations practices. The Department will continue to support the development and deployment of intelligent transportation systems and transportation systems management and operations strategies that reduce congestion and improve reliability on freight corridors.
- **Develop a methodology for identifying freight bottlenecks across modes**
  While States have largely pursued independent methods to identify truck freight bottlenecks at the State-level, more work is needed to comprehensively identify bottlenecks at the national level and across modes. To better prioritize freight funding, the Department intends to develop a methodology for comparing freight bottlenecks across modes. The U.S. DOT will

leverage existing work at the Federal, State, and local levels, as well as in academia and the private sector. The Department will also focus on improving data sources to aid in the identification of critical freight bottlenecks.

- **Improve job growth and economic competitiveness in rural and urban communities**
  Efficient freight movement is vital to job growth and the quality of life in rural and urban communities across the Nation. Metropolitan areas have fostered economic growth by improving freight system efficiency. The U.S. DOT recognizes that rural areas face challenges attracting private investment and State and local funding. Well-planned, multimodal freight systems can provide opportunities for companies to locate and grow in rural regions by offering efficient and reliable connections to major markets and ports. Intermodal facilities and logistics centers located in rural areas can benefit from lower costs than urban areas and may be strategically located at a key transfer point in a freight corridor. The Department will prioritize policies and programs connecting all users in rural communities, especially those who are transportation-disadvantaged, to economic opportunities and services.
- **Mitigate the impacts of freight movement on communities**
  Unless properly mitigated, freight movements may impose adverse impacts such as air, water, and noise pollution. The Department supports the development and deployment of technologies and best practices that reduce the environmental and congestion impacts of freight movement on local communities.

HIGHLIGHTS

Rural Opportunities to Use Transportation for Economic Success (ROUTES)

ROUTES is an initiative to address disparities in rural transportation infrastructure. Two-thirds of rail freight originates in rural areas, and nearly half of all truck VMT occur on rural roads. These industries require heavy trucks that create significantly more wear-and-tear on roadways. The challenges inherent in rural transportation infrastructure need to be considered in order to meet our Nation's priority transportation goals of safety and economic competitiveness. Improving the way the U.S. DOT engages with rural project sponsors can tangibly enhance the safety and economic competitiveness of transportation infrastructure projects throughout the country. The new ROUTES initiative will work to provide rural project sponsors with pertinent and easy-to-use information about the Department's infrastructure programs, to help overcome resource challenges that can be an impediment to competitive applications.

National Highway Freight Program

The National Highway Freight Program (NHFP) has made available more than $6.2 billion in Federal funding to improve the efficient movement of freight on the National Highway Freight Network. States that receive NHFP funding must develop a comprehensive freight plan that provides for the immediate and long-range planning activities and investments of the State with respect to freight. The program also encourages States to form Freight Advisory Committees consisting of public and private freight stakeholders to serve as a forum for discussing State decisions affecting freight mobility and advice on freight priorities, issues, projects, and funding needs.

Federal Funding Opportunities for Freight Projects

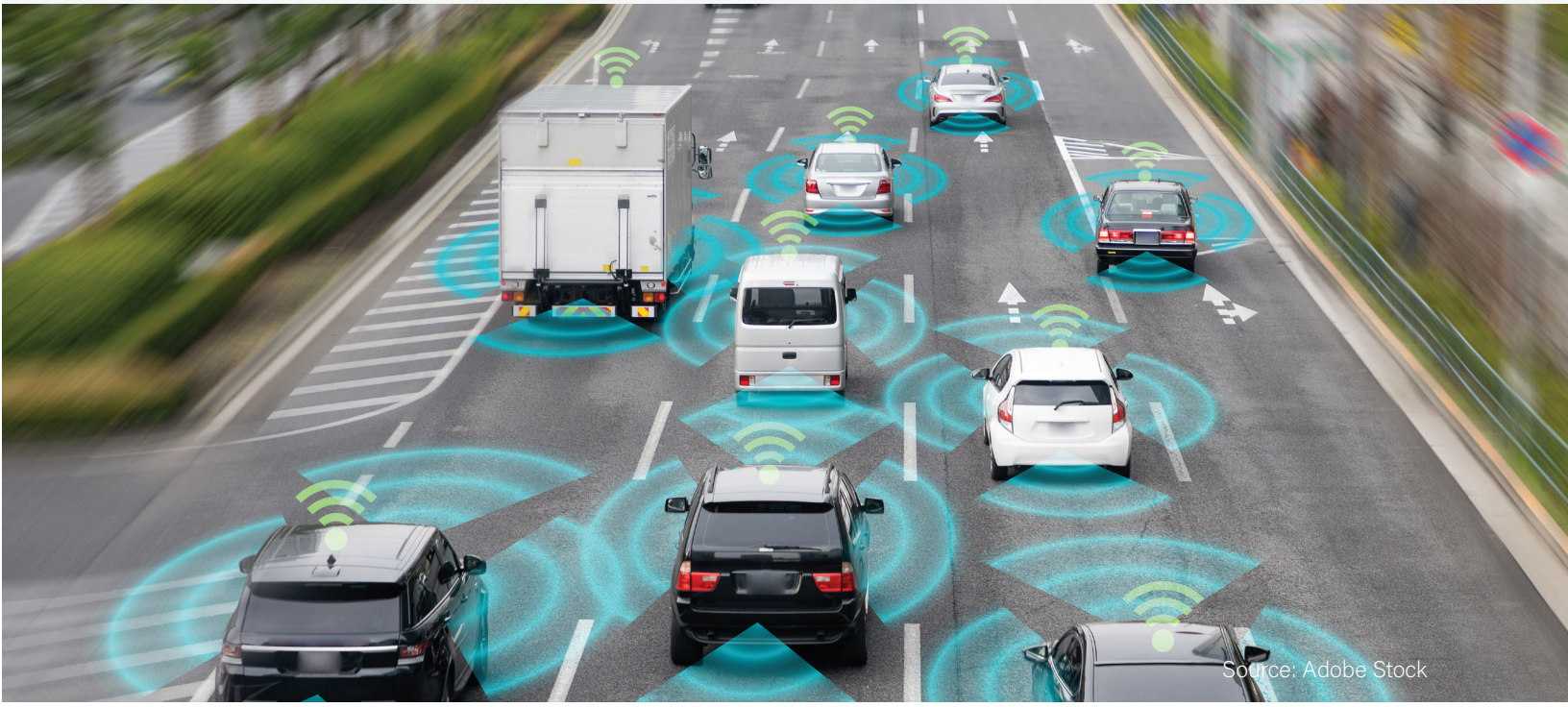
Federal funds are available for highway freight projects through FHWA formula programs such as the National Highway Freight Program (NHFP), National Highway Performance Program (NHPP), the Surface Transportation Block Grant Program (STBGP), and the Highway Safety Improvement Program (HSIP). Several major U.S. DOT discretionary grant programs also provide opportunities for Federal funding of freight transportation infrastructure improvements.

These include:

- Better Utilizing Investments to Leverage Development (BUILD) Grants;
- Infrastructure for Rebuilding America (INFRA) Grants;
- Consolidated Rail Infrastructure and Safety Improvements (CRISI) Grants; and
- Port Infrastructure Development Program (PIDP) Grants.

INNOVATION

Prepare for the future by supporting the development of data, technologies, and workforce capabilities that improve freight system performance.


Source: Adobe Stock

The overall efficiency of freight movement can be enhanced through the adoption of technology and innovative business practices. The Federal Government can serve as a catalyst for the responsible development and deployment of innovative freight transportation technologies. To improve the efficiency and safety of freight movement, the U.S. will focus on the development of innovative freight technologies, research, data, and processes.

STRATEGIC OBJECTIVES

To meet this goal, the Department will pursue activities in support of the following strategic objectives:

- **Support the development and adoption of automation and connectivity, including V2X technologies**
  With the development of automated vehicles (AVs), America has the potential to increase the safety, productivity, and efficiency of freight transportation. Automation

technologies—combined with vehicle-to-vehicle and vehicle-to-infrastructure communications—promise to save lives, and reduce traffic congestion and emissions. Connected technologies can also enable collection of data on system use and conditions, which can be used to guide investments and reduce inefficiencies. These emerging technologies will need a robust digital infrastructure.

- **Support the safe deployment of UAS technology**
  The commercial use of UAS—or drones—is also growing rapidly. As of the end of March 2020, there were more than 1.56 million registered drones, and more than 171,000 certified drone pilots in the United States.[158] To continue the safe implementation of drones into our airspace, the Department will continue to develop rules and policies to ensure the safety and security of drone technology.
- **Streamline regulations to improve governance, efficiency, and economic competitiveness**
  Building on the result of research and analysis, or to address known deficiencies or changing circumstances in the transportation system, the Department will invite and pursue changes that clarify, improve, and modernize regulatory requirements for greater effectiveness and stewardship.
- **Improve freight data, modeling, and analysis tools and resources**
  A lack of data and quantitative measures hampers the management of supply chain performance and resiliency. States and local agencies have limited access to sufficient freight data, freight travel demand models, and freight planning personnel to identify freight problems and plan investments to address them. To support enhanced freight investment decision-making, the Department will develop data sources to aid in freight-related planning and project evaluation efforts.
- **Strengthen workforce professional capacity**
  To promote economic competitiveness, the Department will adopt policies that foster the development of the freight transportation workforce. U.S. DOT will collaborate with Federal partners, universities, and industry stakeholders to develop and implement strategies that will foster the training and development of the workforce to acquire the needed skills and capabilities to meet the current and future needs of the freight industry. In this effort, U.S. DOT will encourage approaches that effectively address the effects of technology on the freight industry workforce.
- **Invest in freight research**
  To advance the understanding of freight technologies, systems, operational strategies, and their effects, and to inform policymaking, the Department will support freight research and partner with academia, State and local governments, and the private sector to foster a robust freight research agenda.
- **Support regulatory frameworks that foster freight innovation**
  The Department is committed to fostering innovation by assessing and addressing regulatory barriers to entry and enabling innovative uses of transportation technology.

HIGHLIGHTS

U.S. DOT's Freight Research and Data Strategy

Data limitations hinder the ability of public agencies to identify problems, prioritize, plan for, and program freight projects, and manage infrastructure that supports freight mobility. Data limitations include a lack of timely, granular data on freight shipment origins and destinations, freight vehicles, intermodal supply chains, freight system characteristics, congestion, and conditions, as well as information on costs to shippers. Data on freight shipments (e.g., volumes, commodity types) is often inconsistent and difficult to integrate, making it challenging to conduct multijurisdictional analysis or compare performance across modes. In addition, foundational geospatial networks used to perform geographic analyses of freight data are fragmented and inconsistent. Furthermore, a significant portion of freight data that could be useful in aiding public agency analyses is privately owned and protected for business reasons.

Reliable and comprehensive data is needed to inform and improve transportation planning and research at the Federal, State, and regional levels. Considering the multimodal and multijurisdictional nature of freight movement, accessible information on system-wide needs is crucial to directing investments toward projects that address current needs among all components of the freight system as well as anticipated future demands. Additionally, there is a need to improve public agencies' data management approaches and practices. This can help ensure that existing resources (often limited) can be leveraged to support improved freight planning and analysis.

The Department seeks to improve data management approaches and expand the availability of data to assist freight planners and practitioners and improve freight decision-making and investment. To achieve these objectives, the Department will work to leverage emerging technologies and data sources and fund targeted efforts to improve the consistency, reliability, granularity, and timeliness of current or new freight datasets.

Key areas of focus on freight data and research include the following:

Near-Term Strategies (0-3 years)

- Finalize the designation of a National Multimodal Freight Network (NMFN) that reflects the trends, challenges, and strategies identified in this Plan
- Establish a cross-modal freight data working group and develop and implement a freight data investment and management plan
- Develop and release the fifth generation of the Freight Analysis Framework (FAF5)
- Update the Vehicle Inventory and Use Survey (VIUS)
- Fund and implement an enhanced Commodity Flow Survey (CFS)
- Conduct research to understand generators of freight activity, freight agency decision-making and behaviors, and supply chains
- Advance the development of freight demand modeling and analysis of the state-of-practice to reflect current research

- Expand the use of truck probe data and weigh-in-motion systems to understand sources of truck delay and the effects of truck traffic on highway and bridge infrastructure
- Continue to develop standardized methods and tools for measuring freight congestion and identifying freight bottlenecks
- Produce a research and data plan to advance the state-of-practice and knowledge informing commercial motor vehicle size and weight policy
- Build on current efforts to create a central data repository for freight-related data and data analysis and visualization tools
- Support public agencies in identifying and sharing information on freight data noteworthy practices and success factors
- Support public agencies in identifying and leveraging Federal resources and funds for improved data collection and application
- Identify public agency data workforce needs and strategies that can address these needs
- Develop and foster partnerships with the private sector that facilitate data collection and allow data sharing with public agencies while protecting business sensitive data

Medium-Term to Long-Term Strategies (4+ years)

- Improve the relationships among various databases to enable efficient integration of freight data and allow for a better understanding of the freight system and its needs
- Create tools to improve the accessibility of freight-related transportation performance management and associated analysis and visualization capabilities
- Investigate approaches to capture and analyze real-time data to improve freight decision-making and long-term planning
- Explore the use of crowdsourced freight data to track freight system performance and assess freight system needs in areas such as truck parking
- Identify a set of multimodal freight system performance measures to support freight planning
- Develop and release an updated NFSP (v2.0)
- Integrate Federal transportation data to align with a common geospatial network
- Increase the frequency, reliability, timeliness, coverage, and granularity of CFS and FAF updates
- Improve the ability to collect performance information at ports
- Collect and share comparable data on shipping costs throughout the supply chain for different commodities and geographies
- Improve the collection of transborder freight data and border crossing delay data
- Explore the development of novel data sources using emerging technologies and practices, such as blockchain, crowdsourcing, and the Internet of Things

Ensuring American Leadership in Automated Vehicles Technologies Automated Vehicles 4.0 (AV 4.0)

The U.S. DOT is actively preparing for emerging technologies by engaging with new technologies to address legitimate public concerns about safety, security, and privacy without hampering innovation. AV 4.0 details the Federal Government's principles to protect users and communities, promote efficient markets, and to facilitate coordinated efforts to ensure a standardized Federal approach to American leadership in AVs. It also presents ongoing administration efforts supporting AV technology growth and leadership, as well as opportunities for collaboration including Federal investments in the AV sector and resources for AV sector innovators. The principles espoused in AV 4.0 will assist stakeholders in adopting innovative technology to improve the performance of the Nation's freight system.

Executive Order on Promoting Energy Infrastructure and Economic Growth

In April 2019, President Donald J. Trump issued an Executive Order promoting efficient permitting processes and reducing regulatory uncertainties that make energy infrastructure projects expensive and that discourage new investment. By promoting the development of new energy infrastructure, the United States will make energy more affordable, while safeguarding the environment and advancing our Nation's economic and geopolitical advantages. Among other activities, the Executive Order directed the Secretary of Transportation to propose a rule permitting LNG to be transported in approved rail tank cars. On October 24, 2019, PHMSA issued a Notice of Proposed Rulemaking to this effect.

Streamlining Infrastructure Permitting

The Department's Infrastructure Permitting Improvement Center works to identify and eliminate rules that unnecessarily impose costly and time-consuming burdens on those seeking permits to build new infrastructure. The Department expects to accelerate environmental review and permitting, helping to ensure that scarce taxpayer resources, including dollars devoted to the expansion and rehabilitation of freight assets, are spent in a better and more efficient manner.

7 | CONCLUSION

Our freight system is critical to our Nation's economic growth and prosperity. American consumers and businesses rely on a safe, efficient, and reliable freight system to sustain their way of life. This National Freight Strategic Plan incorporates stakeholder input from across the freight industry, in both the public and the private sector, to provide a vision for our Nation's multimodal freight system and a strategy for achieving that vision. This Plan can guide public leadership at all levels to take the steps needed to modernize our Nation's freight system. Working together, we can build a freight system that strengthens our Nation's economic competitiveness and ensures the continued well-being of our citizens.

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124. FHWA, "Truck Freight Bottleneck Reporting Guidebook," (2018) https://www.fhwa.dot.gov/tpm/guidance/hop18070.pdf

125. Implementing regulations for the performance management requirements are found at 23 CFR Part 490.

126. FHWA guidance on truck freight bottleneck reporting is available at https://www.fhwa.dot.gov/tpm/guidance/hop18070.pdf

127. Uses the ratio of the 95th percentile travel time to the 50th percentile travel time at various time segments during the day.

128. Under 23 U.S.C. 150, and specified in 23 CFR 490.107, Congress requires performance reports by States. As part of this reporting, 23 U.S.C. 150(e)(4) requires State DOTs to identify and describe the ways in which they are addressing congestion at freight bottlenecks. The performance management regulations define a truck freight bottleneck as "a segment of roadway identified by the State DOT as having constraints that cause a significant impact on freight mobility and reliability" (23 CFR 490.101). States used a variety of methods to identify bottlenecks.

129. Source: Internal FHWA report

130. BTS analysis of CBP border crossing wait time data (average of the 12 months of delay—not necessarily accurate)

131. FHWA, (2017) "Freight Intermodal Connectors Study," https://ops.fhwa.dot.gov/publications/fhwahop16057/sec5.htm

132. California State Transportation Agency and Caltrans (2019) "California Freight Mobility Plan 2020), https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/freight-cfmp-2019-draft/00-cfmpdraftchapter17final.pdf

133. Lost transportation time is the average time lost by vessel tows to unproductive transportation. It is the sum of delay and unavailability. Source: National Academy of the Sciences, (2015) "Funding and Managing the U.S. Inland Waterways System: What Policy Makers Need to Know," P.2, http://www.trb.org/Main/Blurbs/172741.aspx

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139. NOAA, National Centers for Environmental Information, "Billion-Dollar Weather and Climate Disasters: Time Series" https://www.ncdc.noaa.gov/billions/time-series

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[141] Poor Condition: This term is defined in accordance with the Pavement and Bridge Condition Performance Measures final rule, published in January of 2017, as a classification given to a bridge which has any component [Item 58, 59, 60, or 62] in Poor or worse condition [code of 4 or less].

[142] American Road & Transportation Builders Association, "2019 Bridge Report," : https://artbabridgereport.org/reports/2019-ARTBA-Bridge-Report.pdf

[143] Bridge condition is determined by the lowest rating of National Bridge Inventory (NBI) condition ratings for Item 58 (Deck), Item 59 (Superstructure), Item 60 (Substructure), or Item 62 (Culvert). If the lowest rating is greater than or equal to 7, the bridge is classified as Good; if it is less than or equal to 4, the classification is Poor. Bridges rated 5 or 6 are classified as Fair.

[144] Source: FHWA, (2019) National Bridge Inventory, https://www.fhwa.dot.gov/bridge/nbi/no10/condition19.cfm#b.

[145] FHWA, (2020), "FHWA FY 2021 Budget," https://www.fhwa.dot.gov/cfo/fhwa-fy-2021_budget_508.pdf.

[146] Source: BTS, (No date), "Freight Facts and Figures," https://data.transportation.gov/stories/s/Freight-Transportation-System-Condition-Performanc/vvk5-xjjp.

[147] FHWA, (2017), "Freight Intermodal Connectors Study," https://ops.fhwa.dot.gov/publications/fhwahop16057.

[148] Ibid.

[149] Congressional Research Service, (2018), Prioritizing Waterway Lock Projects: Barge Traffic Changes

[150] BTS, (No date), "Freight Facts and Figures: Condition of Runway Pavement" (https://datahub.transportation.gov/stories/s/Freight-Transportation-System-Condition-Performanc/vvk5-xjjp)

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