Chapter V

IMPROVING SHARED TRANSPORT INFRASTRUCTURES

This chapter examines the use—for transporting, storing, and delivering energy—of transportation modes shared by other major commodities. These modes include railroads, highways, waterways, ports, and the intermodal facilities that connect them together. The discussion is divided into four major sections. The first focuses on rail transport of energy commodities, with a consideration of ancillary use of highways. The second focuses on waterways, ports, and their connectors to other transportation infrastructure. The third section addresses conflicts due to the increased transport of energy supplies, materials and components. The final section focuses on gaps in data and analytical methods needed to understand the rapid changes occurring in the use of these transport infrastructures for energy. Each major section concludes with a discussion of major Administration initiatives underway to address the issues—especially in rail transport—and recommendations for further action.

FINDINGS IN BRIEF:
Improving Shared Transport Infrastructures

Rapid crude oil production increases have changed the patterns of flow of North American midstream (pipelines, rail, and barge) liquids transport infrastructure. Pipelines that previously delivered crude oil from the Gulf of Mexico to Midcontinent refineries have now changed direction to deliver domestic and Canadian oil to the Gulf of Mexico. In addition, oil produced in North Dakota is now being shipped to refineries on the East and West Coasts of the United States. As a result, modes of transport other than pipelines are being employed to move crude oil, including a significant increase in crude oil unit trains and barge shipments.

Limited infrastructure capacities are intensifying competition among commodities, with some costs passed on to consumers. Until new additional capacity becomes available, the competition among commodity groups for existing capacity will intensify. The proximity of Bakken crude oil movements and Powder River Basin coal movements, along with agricultural shipments in the region, affect Midwest power plants and the food industry. Typically, rail and barge service are the most cost-effective shipping methods available for moving grain and other relatively low-value, bulk agricultural commodities, and the Department of Agriculture has indicated that disruptions to agricultural shipments caused by recent unexpected shifts in supply and demand for rail services exceed even those caused by Hurricane Katrina.

Rail, barge, and truck transportation are crucial for ethanol shipment. Ethanol production in the United States has increased over the last few decades. Ethanol is typically shipped from production plants by rail and then delivered by truck (or directly by rail or barge) to petroleum product terminals. Ethanol is likely to rely on shared infrastructure for its transport for the foreseeable future.

The ability to maintain adequate coal stockpiles at some electric power plants has been affected by rail congestion. The Surface Transportation Board recently acted to require weekly reports of planned versus actual loadings of coal trains.

Funding for the U.S. freight transportation system is complex and involves a combination of Federal, state, local, and private investments. Railroad infrastructure is primarily owned and maintained by the private sector. The marine transportation infrastructure involves a mix of Federal, state, local, and private investments, and roadways are owned and maintained by a range of Federal, state, local, and—in some cases—even private entities.

Navigable waterways are essential for the movement of energy commodities, equipment, and materials, especially petroleum and refined petroleum products. Investments in construction, rehabilitation, and maintenance of this infrastructure must be balanced against other investments, including other water resource investments, such as flood and coastal storm damage reduction projects and aquatic ecosystem restoration.

Increased transportation of crude oil by rail and barge has highlighted the need for additional safeguards. For rail transport, in particular, the Federal Government has a number of efforts underway, including a rulemaking on improving the safety of rail transport of crude oil, including more robust tank car standards and operational requirements, to address these concerns.

Multi-modal shared transportation infrastructure is stressed by increased shipments of energy supplies, materials, and components. Wind turbine blades, for example, have more than tripled in length since the 1980s. Transporting components of this size (and others of significant weight and size, such as large power transformers) creates a range of challenges, including stress on roads, many of which are rural; the need to coordinate movement through ports, tunnels, overpasses, and turning areas; and additional permitting and police escort requirements.

Increased Use of Shared Transport Infrastructures for Energy

Changes in the U.S. energy marketplace are stressing the Nation's infrastructures that move energy from where it is produced to both processing and demand centers, particularly in the case of oil where the rapid increase in U.S. tight oil production is transforming conventional patterns and modes of petroleum transport in North America.

While pipelines traditionally have been the preferred mode for transporting large amounts of oil and refined products within the United States, expanded development in regions distant from refineries, where existing petroleum infrastructure is minimal, has increasingly shifted energy products to other modes of transportation. The movement of shipment of oil from the wellhead to a refinery may employ a combination of trucks, pipelines, railcars, barges, and other marine vessels—giving oil transportation in the United States an increasingly multi-modal character. Since these alternatives have been, and continue to be, used for transporting other commodities, they are considered in the Quadrennial Energy Review (QER) to be "shared transport infrastructures" for energy commodities.

The increased utilization of rail, barge, and truck for oil transport, as well as other energy supplies and materials, is contributing to increased competition among commodities on these shared transport infrastructures. This has contributed to delays in the delivery of other commodities, such as crops, fertilizers, and chemicals.[1] The same constraints have recently affected the delivery of coal to electric generators.[2]

While modal shifts are responsible for a share of the energy sector's impact on the shipment of goods around the Nation, the dramatic increases in shale oil and gas production have put additional pressure on transportation infrastructure in other ways as well. For example, developing a single well pad in the Marcellus Shale region is estimated to require roughly between 1,600 and 4,900 truck trips,[3] resulting in $13,000 to $23,000 in roadway maintenance costs per well.[4] Likewise, most of the nearly fivefold growth in rail shipments of industrial sand since 2009 can be attributed to sand used for hydraulic fracturing.[5] Drilling operations in the Marcellus region also produce significant quantities of wastewater. Disposal of this wastewater close to production sites is hindered by factors such as inappropriate geology and lack of capacity at local municipal and industrial wastewater facilities to treat adequately the high level of total dissolved solids in wastewater generated from Marcellus wells. As a result, there has been a shift to the use of underground injection wells to dispose of this wastewater, with most of those injection wells located in Ohio.[6] Truck and rail transport are options for transporting wastewater, but higher costs for those modes and the ability to move large volumes of wastewater by barge have made waterborne transport of wastewater attractive to the natural gas industry.[7] The Coast Guard is considering regulations to allow barge operators to carry produced wastewater from drilling operations.[8]

This chapter explores the impact of these changes, particularly on railroads and waterborne infrastructure (including ports). The rapid shifts in the use of shared infrastructure also raise new questions about system resilience and environmental impacts. These have been addressed in the broader discussions of those topics in Chapters II (Increasing the Resilience, Reliability, Safety, and Asset Security of TS&D Infrastructure) and VII (Addressing Environmental Aspects of TS&D Infrastructure).

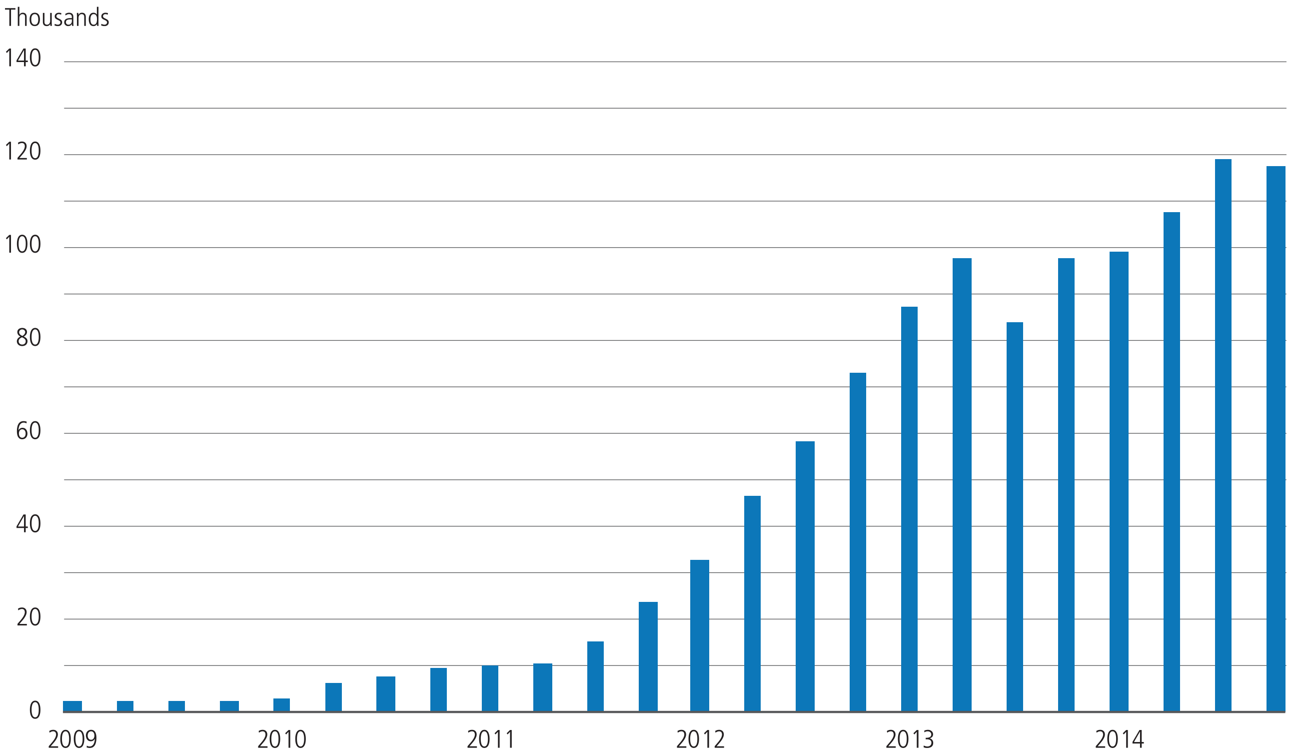
Rail Transport of Liquid Fuels: Status and Trends

Among all the shared freight transport infrastructures, the rail network may have experienced the most significant changes in the past several years. Increases in oil transport by rail are occurring on an existing system—a $60 billion plus freight rail industry that includes 140,000 rail miles operated by 7 large national (Class I) railroads,[a] 21 regional railroads, and 510 local railroads.[9]

Growth in Rail Transportation of Crude Oil

The dramatic increases in the use of rail to transport oil over the last four years can be seen in the volume of shipments, as represented by number of originated railcars carrying crude oil. In 2009, roughly 10,800 carloads of crude oil originated on U.S. Class I railroads.[10] By 2014, the volume of rail shipments had grown to more than 493,000 originated carloads of crude oil[11]—an increase of roughly 4,400 percent in 5 years (see Figure 5-1). The Energy Information Administration (EIA) estimates that, on average, more than 1,022,000 barrels of domestic and Canadian crude were moved in the United States by rail per day in 2014.[12,13]

Figure 5-1. Originated Class I Railcars of U.S. Crude Oil (2009–2014, Quarterly)[14]



The rapid increase in crude by rail is a function of the growth in new source of new oil production, particularly in North Dakota, as well as limited pipeline capacity for moving this oil to refiners on the East and West Coasts.

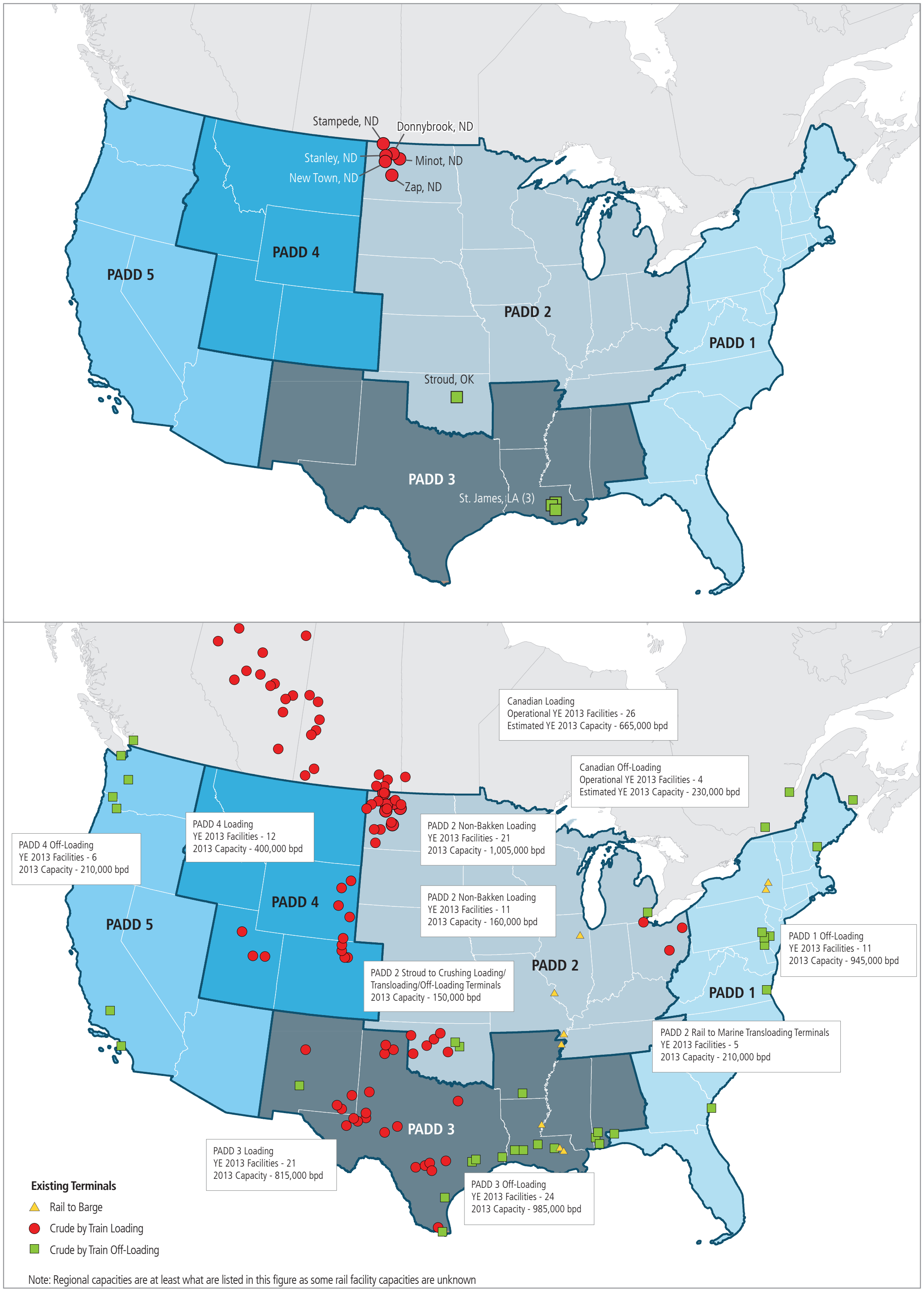
[a] Class I railroads are the Nation's largest railroads. For purposes of the accounting and reporting requirements of the Surface Transportation Board, railroads are divided into three classes. Class I is defined as those railroads with annual operating revenues (after being adjusted to compensate for inflation by a railroad revenue deflator formula) of more than $250 million. There are seven Class I railroads in the United States: Union Pacific Railroad, BNSF Railway, CSX Transportation, Norfolk Southern Railway, Canadian Pacific Railway, Canadian National Railway, and Kansas City Southern Railway.

There are several reasons for this phenomenal growth in such a short time. Railroads have an extensive existing track infrastructure, so new movements of crude oil by rail generally require only the construction of crude loading and unloading terminals and the expansion of the tank car fleet. This can be done relatively quickly compared to the time required to build or expand a pipeline. Rail also uses shorter-term contracts than the multi-year commitments required for pipeline construction, increasing the attractiveness of rail for oil producers and refiners who value such flexibility. While pipeline transport has substantially expanded to ship Midcontinent oil to the Gulf of Mexico, recent light oil production in Texas (where there has been an even larger increase than that of North Dakota) is competing for the available Gulf Coast refining capacity. Thus, East and West Coast refiners have become increasingly important customers for North Dakota oil, and this oil can travel by rail and barge to those destinations. Given these and other factors, as well as the difficulty and expense of pipeline build-out, crude by rail has become an important new component of the U.S. oil midstream, and it is anticipated that this new modal shift will have a place in the industry in the long-term.[15]

Rail shipment of oil has increased in most U.S. production areas, but it has been of particular importance for the Bakken Formation in North Dakota. As of mid-2014, rail accounted for more than 60 percent of total oil shipments from the Bakken and 100 percent of Bakken-to-West-Coast deliveries (from North Dakota to Washington State and then by barge to California).[16]

As a result of these factors, the number of crude oil loading, unloading, and barge transfer points in the United States and Canada has grown markedly in the past few years (see Figure 5-2). In 2010, there were only six rail loading facilities for oil, and no barge loading facilities. Three years later, in 2013, there were more than 60 rail loading facilities and a host of new barge loading facilities—an enormous change.

Figure 5-2. Crude Oil by Train Loading, and Offloading, and Rail-to-Barge Facilities for 2010 and 2013[17]



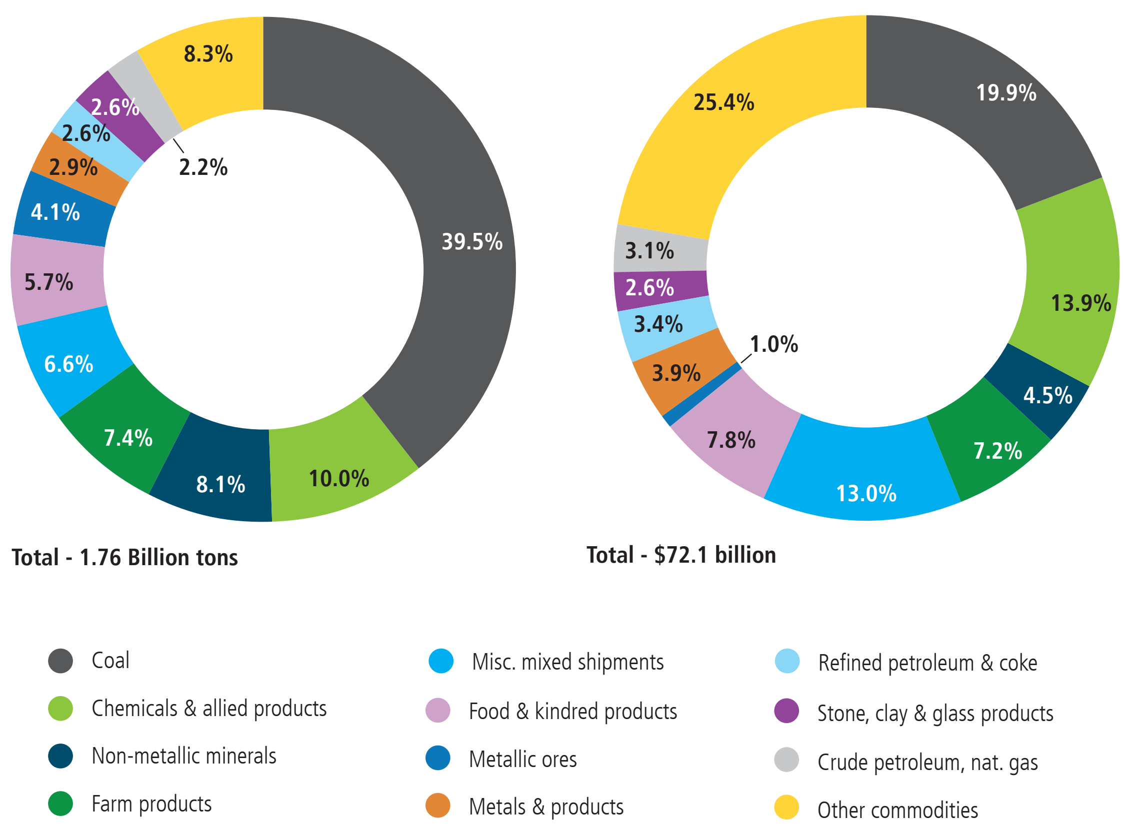
In 2010, the United States and Canada had six rail loading facilities for crude oil and four offloading facilities. By year-end 2013, crude oil by rail capacity had grown to include 65 loading facilities in Petroleum Administration Defense Districts II, III, and IV. Rail-to-barge facilities also increased.

Congestion and Competition among Commodities

This rapid increase in rail usage to transport oil has exacerbated existing capacity constraints in the rail systems, which are determined by multiple factors, including the throughput on the rails themselves, the operation of loading and unloading facilities, the number of locomotives and rail cars, train speed, and the availability of qualified employees.

The overlap of crude oil movements from the Bakken with coal moving out of the adjacent Powder River Basin, along with high volume of rail shipments of agricultural commodities from the region, present a singular set of challenges. Just as crude oil is transported to major ports for refining and export, so too are other commodities. Figure 5-3 shows the range of commodities shipped by rail in 2013, by percent of tonnage and revenue. The shipments of a number of these (such as crude petroleum, petroleum products, and sand used in hydraulic fracturing for oil and gas production, known as frac sand) have been influenced strongly by increased shale oil production in the West and development of natural gas resources in the East. For every new well, the Nation's railroads move approximately 40 rail cars of drilling material.[18] While most of the sand transported by rail is used for cement production, road building, and other construction purposes,[19] industrial sand, which includes frac sand, makes up about one-third of total carloads in this category, and this subcategory is growing about twice as fast as other sand and aggregate cargoes.[20] Frac sand makes up the bulk of this increase.[21] The need to move frac sand and other drilling inputs is a significant factor in the multi-year backlog of the production of various types of rolling stock—with back orders reaching 124,000 rail cars as of late 2014, an increase of 25 percent between June and December 2014.[22]

Figure 5-3.Class I Railroad Commodities, Percentage by Weight and Gross Revenue (2013)[23, 24]



Energy commodities and associated products account for a large portion of rail traffic. Crude oil has grown to 3 percent of national (Class I) rail revenues and more than 2 percent of tonnage. Transport of crude oil and petroleum products, chemicals, crushed stone, sand, and gravel, all of which are strongly influenced by shale oil production growth, are more significant on a regional basis, and, in those regions, tend to perturb both other energy and non-energy commodity movements on a constrained rail network.

While crude by rail may be a relatively small part of the national rail picture, on a regional basis, the constrained capacity created by oil movements emerges as a more significant issue. BNSF Railway is the largest rail carrier for both Bakken crude oil and Powder River Basin coal. BNSF currently carries about 75 percent of Bakken oil moving by rail.[25] Meanwhile, BNSF also is a major carrier for coal. More than 90 percent of coal carried by BNSF originates in the Powder River Basin.[26]

Economic Effects of Capacity Constraints

Agricultural product shippers have expressed concern that oil and coal shipments will crowd out their commodities on the already constrained rail network through the Plains States.[27] Rail service is particularly important for U.S. agriculture, as it is often the most cost-effective shipping mode available for moving grain and other relatively lower-value, bulk agricultural commodities from production areas to markets or transfer points for waterborne transportation.[28] Grain and oilseed shippers in Montana and North Dakota are particularly dependent on rail transportation because of their distance to inland waterways and the prohibitive cost of hauling grain long distances to markets by truck.[29]

In 2013 and 2014, the demand for rail service increased for most commodities, including coal, oil, intermodal containers, sand, and gravel. Near-record harvests in those years of corn, soybeans, and wheat in the Northern Plains States (Minnesota, Montana, North Dakota, and South Dakota) put additional stress on the rail transportation system, which was already operating with limited excess capacity.[30] The 2013 harvest was followed shortly by a severe winter, compounding the rail service interruptions grain shippers were experiencing. Smaller harvests in 2014 were met by improved rail service in the region.[31]

Many shippers, unable to pay the additional premiums for service, diverted more grain into storage or used alternative transportation at a higher-than-normal cost.[32] The growing imbalance between supply and demand for rail service was manifested as backlogged grain shipments and higher-than-average prices for empty grain cars sold in the secondary auction markets.[33] Based on an analysis of these markets, the Department of Agriculture's (USDA's) Agricultural Marketing Service concluded in October 2014 that "The past year was marked by both higher than anticipated demand for service and rail service disruptions….The current rail service problems have exceeded previous events in terms of both magnitude and duration, including Hurricane Katrina, which caused major disruptions throughout the entire agricultural transportation network."[34]

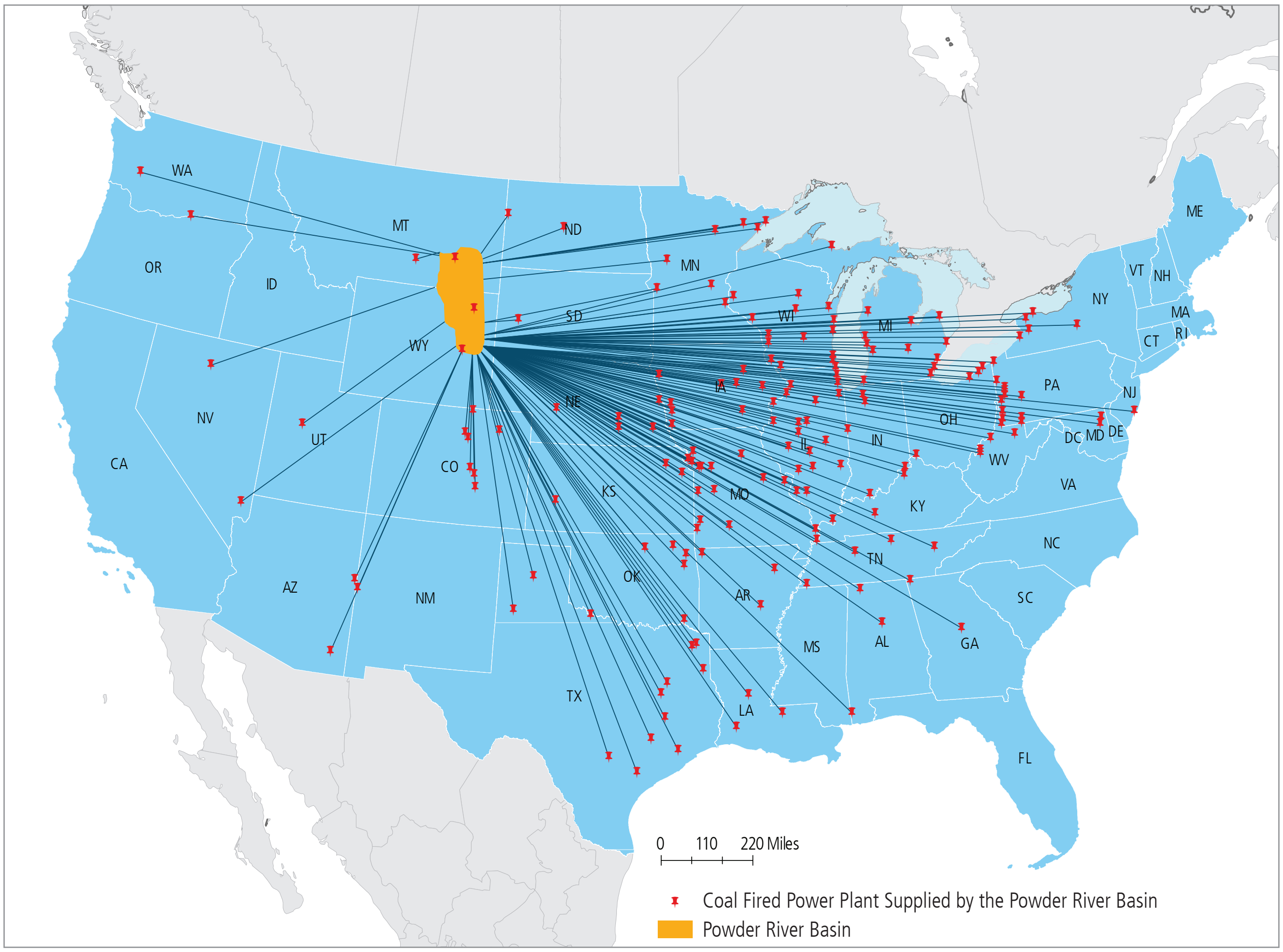
Prompted mainly by the financial struggles of U.S. railroads in a heavily regulated, economically inefficient environment, Congress passed the Staggers Rail Act in 1980. The Staggers Act has been successful in improving the financial health of the railroads, in part because carriers have become more efficient, eliminating excess capacity and redundancy and streamlining operations. Over the last 30 years (from 1980 to 2011), the number of ton-miles transported by rail has doubled, while Class I revenues per ton-mile have declined almost 40 percent in real terms.[35, 36]

The last several years, however, tell a different story. According to USDA, "Even though a recession started in December 2007, railroads continued to raise rail rates, partly to support record railroad capital investments and higher costs. Average real rail rates per ton-mile for all commodities increased 36 percent between 2004 and 2011. Real rail costs adjusted for railroad productivity increased 29 percent during the same. This indicates that most of the increase in rail rates was due to increased rail cost, but the increased rail rates also contributed to record rail profits. In comparison, real truck rates have increased 27 percent since 2004."[37] Protecting rail consumers from service disruptions is another prime factor in passage of the Staggers Act; a more streamlined rail system with limited excess capacity can, however, become overburdened when demand spikes, as it did in 2013 to 2014, which can leave shippers vulnerable to service deficiencies.

Coal Transportation by Rail

Coal represents 39.5 percent of total tonnage moved by rail and 19.9 percent of total revenues for the railroad industry, and it is viewed by many in the industry as its most important single commodity.[38] Sixty-eight percent of coal used to generate electricity is delivered to power plants by rail. Approximately 40 percent of all U.S. coal is produced in Wyoming, which is more than is produced by the next three highest-producing states combined.[39] The vast majority of Wyoming's coal is sent to power plants in 34 states, almost all of this by rail. Eight states obtain more than 90 percent of their domestic coal from Wyoming,[40] giving these states an enormous interest in ensuring reliable rail deliveries of coal. Figure 5-4 illustrates the reach of transport from the Powder River Basin to coal-fired units across the Nation.

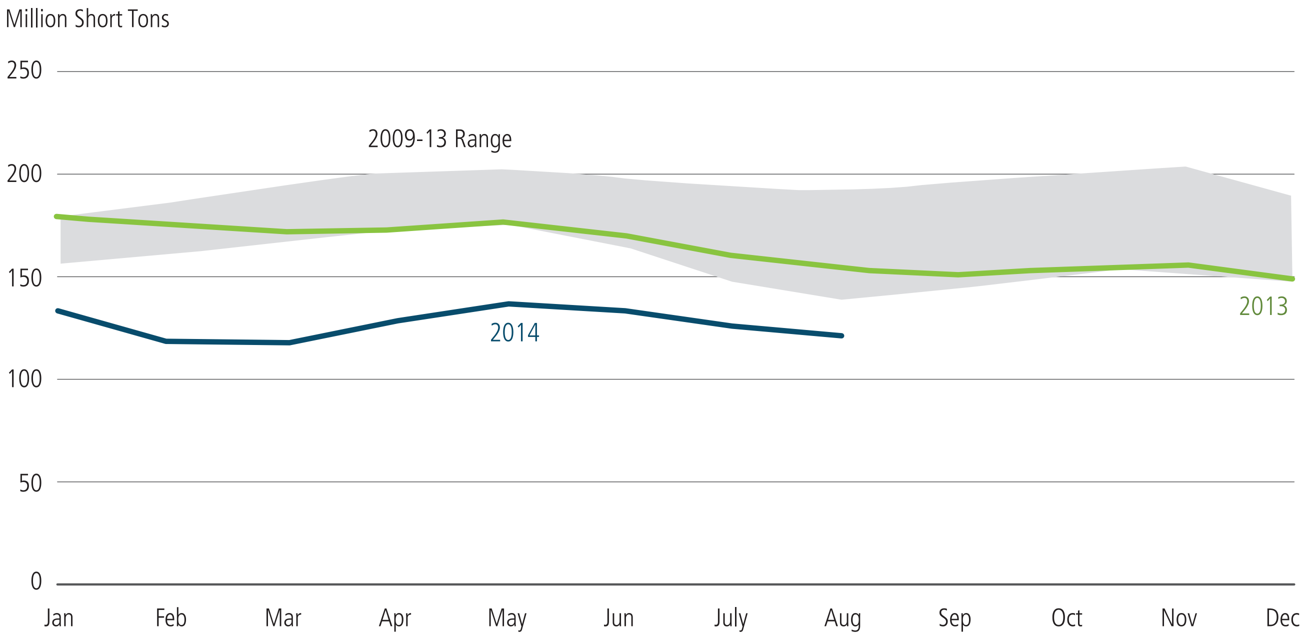
Figure 5-4. Coal-Fired Power Plants Supplied by the Powder River Basin[41]



The vast majority of Powder River coal is sent out of Wyoming to power plants in 34 other states.

The EIA's recent analysis of coal stockpile levels at electric power plants (see Figure 5-5)[42] confirms that stockpiles are low in both absolute levels and days of burn compared to recent norms—both nationally and regionally (particularly in the Upper Midwest where rail congestion has been problematic). The EIA attributes this to several causes, including record grain harvests and transport of crude oil.

Figure 5-5. Monthly U.S. Coal Stockpile Levels at Electric Power Plants, 2009–2014[43]



Stockpiles of coal at power plants in 2013 and 2014 were either at the lower end of, or below, the 5-year range of stockpile levels from 2009 to 2013.

> In recognition of the importance of ensuring adequate coal reserves for electricity, on December 30, 2014, the Surface Transportation Board issued a decision on Docket No. EP 724: "The Board directs BNSF Railway Company to submit a detailed description of the contingency plans the carrier would use to help mitigate an acute coal inventory shortage at one or more generating stations in a region."

Of those coal-fired plants served by rail, most are served by only one Class I railroad (these plants are referred to as "captive" to the single railroad).[b] The power producers that own these plants have been concerned for decades about service and rate problems based on this lack of competition. The issue of coal delivery shortfalls in some regions has recently become more pronounced as Bakken crude and other rail traffic has increased.[44] There have been numerous instances where coal-fired units have been left with a week's worth of coal or less.[45] Four small plants in Minnesota shutdown in fall 2014 to conserve coal stocks; grid operators were able to dispatch from non-coal units for use during the peak winter demand period,[46] demonstrating the value of diversity to reliable energy systems.

The railroad companies are aware of the issues concerning adequate service and have responded to service performance issues. Some of the steps they are taking to address these issues include significant orders for additional rolling stock and double tracking in some locations. On November 20, 2014, BNSF Railway announced plans for record capital spending in 2015 of $6 billion for rail updates, track replacements, and expansion projects. "Nearly $500 million of that expansion work will occur in the Northern region, which is where BNSF is experiencing the fastest growth. That region primarily serves agriculture, coal, crude oil, and materials related to crude oil exploration and production."[47]

[b] Many agricultural shippers are also captive to one railroad. According to the Department of Agriculture, "only about five percent of grain elevators are served by more than one railroad." See: Department of Agriculture and Department of Transportation. "Study of Rural Transportation Issues." April 2010. ntl.bts.gov/lib/32000/32800/32855/STELPRDC5084108.pdf.

Ethanol Transportation by Rail

Ethanol production in the United States has increased steadily over the last few decades, reaching a historically high level in 2011. By 2012, ethanol displaced approximately 10 percent of U.S. gasoline demand by volume. Ethanol production is primarily located in the Midwest where most of the corn feedstocks are grown.[48] Ethanol blending into gasoline takes place at petroleum product distribution terminals across the country, so large amounts of ethanol must be transported from production plants to the distribution terminals. These shipments from production plants to distribution terminals typically occur by rail, which accounts for around 70 percent of ethanol transport,[49] with the final product then delivered by truck to retail outlets.

Roads, rail, and waterborne infrastructures are used extensively for ethanol transport because fuel quality specifications, ethanol's water-absorbing properties, and the complications presented by multiple owners of pipelines prevent the transport of ethanol in the same pipelines as petroleum products. Ethanol is likely to rely on shared infrastructure for its transport for the foreseeable future. Attempts to construct dedicated transportation infrastructure have not been successful—a $4-billion ethanol pipeline project from the Midwest to the Northeast was explored by POET and Magellan Midstream Partners, but the project was abandoned in 2012 after it was determined to be economically infeasible.

Safety of Rail Transport of Liquid Fuels

Rail safety has become a key issue as rail transport of liquid fuels has grown. Several high-profile crude-by-rail accidents occurred since 2013, the most devastating of which killed 47 people in Lac-Mégantic, Quebec. Others, such as those in Aliceville, Alabama; Casselton, North Dakota; Lynchburg, Virginia; and Mount Carbon, West Virginia, resulted in significant environmental and property damage after tank cars derailed, ruptured, and the oil caught fire. Similar accidents involving ethanol rail shipments have also raised concerns about the safety of rail tank cars and the shipment of these flammable hazardous commodities across the United States. These accidents have highlighted the need for additional monitoring, enforcement, and inspection, as well as setting new safety design requirements for tank cars.[50]

The rail transport infrastructure for liquid fuels also faces reliability and resilience challenges, which are described in more detail in Chapter II (Increasing the Resilience, Reliability, Safety, and Asset Security of TS&D Infrastructure).

Administration Activities and Plans

The Surface Transportation Board (STB) is an independent entity within the Department of Transportation that is the successor to the Interstate Commerce Commission. It is charged with resolving railroad rate and service issues and rail restructuring transactions (such as mergers, line sales, line construction, and line abandonments). The Pipeline and Hazardous Materials Safety Administration at the Department of Transportation (DOT) regulates the transportation of hazardous materials by all modes, including rail, while the Federal Railroad Administration is responsible for rail safety.

Congestion and service. In light of the problems of rail congestion affecting shipments of key commodities:

- STB issued a decision requiring all Class I railroads to publicly file weekly data reports regarding service performance of unit trains carrying coal, crude oil, ethanol, and grain. Railroads began filing performance data in October 2014 in addition to reports on coal, grain, and intermodal trains.
- STB has begun informal interactions with the Energy Information Administration to share data and insights on overall energy flows among major U.S. regions.
- On December 30, 2014, STB issued a decision directing the BNSF Railway Company "to submit a detailed description of the contingency plans the carrier would use to help mitigate an acute coal inventory shortage at one or more generating stations in a region."[c]
- On December 30, 2014, STB initiated a formal notice and comment rulemaking proceeding for weekly performance data reporting by the Class I railroads and also the freight railroads serving the Chicago gateway. The purpose of the reporting requirements, in part, is to give both STB and shippers/stakeholders greater transparency into railroad operating conditions.
- STB has two ongoing proceedings on rail business practices. EP 711 concerns competitive access in the railroad industry and whether to revise agency rules governing shipper requests for competitive access to another railroad. EP 665 would ensure that STB's rate complaint procedures are accessible to grain shippers and provide effective protection against unreasonable freight rail transportation rates.

Safety. DOT and other Federal agencies have been taking action to respond to heightened awareness and concern over rail shipments of crude oil from the Bakken and ethanol.

- To raise awareness of local emergency responders to oil/rail accident, in July 2014 DOT released a "Lessons Learned Roundtable Report," providing key findings from a meeting of DOT and Virginia's Department of Fire Programs to affected fire chiefs and emergency management officials.
- The Federal Emergency Management Agency assessed training needs and requirements in 28 states with oil rail routes identified by DOT. Eight of these states indicated a need for training, and the Federal Emergency Management Agency is working with these states to prioritize and ensure their participation in currently available programs.
- The Pipeline and Hazardous Materials Safety Administration issued a Notice of Proposed Rulemaking on August 1, 2014, which contains comprehensive proposed standards to improve the rail transportation safety of flammable liquids, including unit trains of crude oil and ethanol. A final rule is anticipated to be issued in mid-2015.[d]
- The Pipeline and Hazardous Materials Safety Administration and the Department of Energy have entered into an agreement to conduct research and development on the properties (including behavior in fires) of unconventional crudes.
- The interagency National Response Team Training Subcommittee launched Emerging Risks Responder Awareness Training for Bakken Crude Oil to help responders better prepare for these incidents.[e] The training is available online.

* Average coal unit train loadings versus planned loadings, by coal production region.

[c] Department of Transportation, Surface Transportation Board. "United States Rail Service Issues." p. 1. Docket No. EP-724. December 30, 2014. http://www.stb.dot.gov/decisions/readingroom.nsf/WebDecisionID/43733. Accessed February 22, 2015.

[d] 79 Fed. Reg. 45016. "Hazardous Materials: Enhanced Tank Car Standards and Operational Controls for High-Hazard Flammable Trains." August 1, 2014. http://www.gpo.gov/fdsys/pkg/FR-2014-08-01/pdf/2014-17764.pdf. Accessed April 1, 2015.

[e] National Response Team. "Emerging Risks Responder Awareness Training: Bakken Crude Oil." 2015. http://www.nrt.org/production/NRT/NRTWeb.nsf/AllPagesByTitle/SP-EmergingRisksResponderAwarenessTrainingBakkenCrudeOil%282015%29?Opendocument. Accessed March 17, 2015.

QER Recommendations

RAIL TRANSPORT

In light of the significant activity undertaken by the Administration in recent years, and the fact that some of these proceedings and relevant interagency research projects are still in progress, additional major recommendations should await finalization of these initiatives before next steps can be determined. In the interim, recognizing the crucial role that rail will continue to play in energy commodity transport, we recommend continued focus on the following:

Enhance the understanding of important safety-related challenges of transport of crude oil and ethanol by rail and accelerate responses: The cooperative work of the Department of Energy (DOE) and the Pipeline and Hazardous Materials Safety Administration, as well as the forward movement of strengthened safety regulations at the Department of Transportation (DOT), should be strongly supported.

Further analyze the effects of rail congestion on the flow of other energy commodities, such as ethanol and coal: DOE, the Surface Transportation Board, and the Federal Energy Regulatory Commission should continue to develop their understanding of how rail congestion may affect the delivery of these energy commodities.

Analyze the grid impacts of delayed or incomplete coal deliveries: In assessing these issues, DOE, in coordination with relevant Federal agencies, should examine the role of freight rail in utility operations, the growing complications created by freight infrastructure constraints on multiple energy products and other bulk commodities, and whether a minimum coal stockpile for electricity reliability should be established for each coal-fired unit.

Address critical energy data gaps in the rail transport of energy commodities and supplies: This should include data on monthly movements of crude by rail. The Surface Transportation Board and the EIA should continue their cooperative work to share data and insights to improve the ability of both agencies to better understand the changes underway in energy shipments by rail. Congress should provide the EIA with the funding increase requested in the President's Budget Request for Fiscal Year 2016 to support this activity.

Waterways, Ports, and Connectors: Status and Trends

The greater Mississippi Basin and Intracoastal Waterways have more miles of navigable internal waterways than the rest of the world combined, and the U.S. Atlantic Coast has more major ports than the rest of the Western Hemisphere. The Nation's coastal ports and inland waterways are part of a larger waterborne transportation network, sometimes called the Marine Transportation System (MTS).[f] The MTS includes 25,000 miles of navigable channels and related infrastructure, such as publicly and privately-owned marine terminals, intermodal connections, shipyards, and related repair facilities.[g]

[f] Connecting land-side infrastructure includes more than 174,000 miles of rail in the 48 contiguous states, as well as Canada and Mexico; more than 45,000 miles of interstate highway, supported by more than 115,000 miles of other roadways; and more than 1,400 designated intermodal connections. Source: DOT.

[g] The 25,000 miles of navigable channels includes 12,000 miles of inland waterways (including two intracoastal waterways) with 229 lock chambers at 187 sites; and 926 coastal and inland ports (including the ports of the Great Lakes) with 13,000 miles of channels and 12 locks (not including the locks of the St. Lawrence Seaway).

Waterborne transportation of commodities and other goods is critical to international trade and the U.S. energy economy. The Nation's coastal ports and inland waterways handle almost 2.3 billion tons of commerce annually. According to DOT, coastal deep-water ports alone handle 70 percent of our Nation's imports and exports by weight. The expected growth over the next 30 years in the volume of imports and exports transported by sea will have "dramatic implications for America's ports and transportation system and will lead to greater congestion at America's coastal ports."[51]

Unlike railways or pipelines, much of the waterway infrastructure is federally maintained; landside port and connector infrastructure used in conjunction with these waterways is often operated by state and local governments and private industry. The Army Corps of Engineers (USACE) is responsible for managing and maintaining most of the Inland Marine Transportation System, including navigation locks and dams. Some locks are federally owned and maintained by DOT's Saint Lawrence Seaway Development Corporation in cooperation with the Canadian government.

Energy commodities make up the largest proportion of U.S. waterborne cargo traffic, and waterborne commerce is essential to the energy sector. In 2012, crude oil, refined petroleum products, and coal were 55 percent of all U.S. waterborne cargo traffic by weight. Nearly 15 percent of all petroleum products consumed in the United States are shipped on inland waterways.[h] Sixty percent of the oil Americans consume arrives in a U.S. port, including all of Alaska's crude.[52]

Growth in Waterborne Transport of Energy

Similar to the trends in rail transport, new domestic energy production is spurring rapid growth in the waterborne transport of energy commodities and related products, increasing the demands on the existing system. Shippers of those commodities seeking options for low-cost, high-volume transport are turning to the Nation's network of navigable costal ports and inland waterways.[53] In the near future, additional drivers of waterborne transport of energy commodities will likely include the exports of liquefied natural gas, the expansion of existing refineries, and the development of new petrochemical plants. Some estimates show greater than $125 billion in planned petrochemical plant investments, most of which will occur along the Gulf Coast and other U.S. waterways.[54]

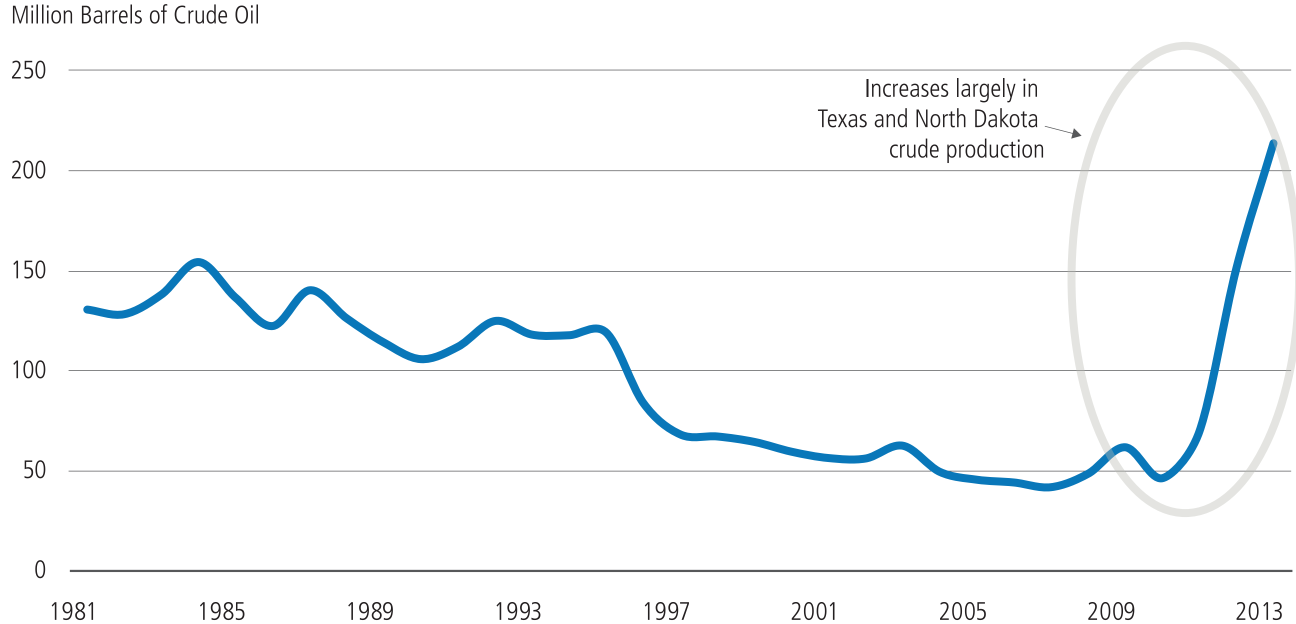
U.S. ports and inland waterways transported nearly 7 billion barrels of crude and petroleum products in 2012.[55] Of that total, 2.5 billion barrels were transported on barges on the inland waterways from port to port along the coast or on the Great Lakes—or in intra-port transfers.[i] Utilization of barges for petroleum transport has risen dramatically, as shown by the sharp increase in refinery receipts by barge from 46 million barrels of domestic crude in 2010 to more than 210 million barrels in 2013 (see Figure 5-6). Despite a decrease in oil imports, barge deliveries of foreign crude have risen more than 60 percent since 2011.[56] Barge transport of oil typically is inter-modal, where oil may travel by pipeline or rail to a terminal and then be dispatched on barges to cover the last segment of the trip to refineries.[j] This configuration is particularly important for refineries without rail access.

[h] Calculated based on 2012 data. The total petroleum products consumed are 18,000 to 19,000 barrels per day. Source: Energy Information Administration. "US Weekly Product Supplied." www.eia.gov/dnav/pet/pet_cons_wpsup_k_w.htm. Accessed January 21, 2015. The total petroleum products moved on inland waterways in 2012 was 111,129 tons. Source: Army Corps of Engineers. "Waterborne Commerce of the United States: Calendar Year 2012." Table 2-1. November 20, 2013. OMB No. 0704-0188. www.navigationdatacenter.us/wcsc/pdf/wcusnatl12.pdf. Conversion from tons to barrels based on an average product density of 8 barrels per ton.

[i] Domestic shipments by barrel were estimated using data on domestic shipment by short ton reported by the Army Corps of Engineers. Based on the composition of petroleum products in domestic shipments, average densities from the Energy Information Administration (www.eia.gov/cfapps/ipdbproject/docs/unitswithpetro.cfm) were used to estimate an average conversion of 7.0–7.5 barrels per short ton.

[j] Therefore, while refinery-receipts-by-mode is a useful metric for showing utilization of a specific mode over the last miles traveled to the refinery, it is not necessarily accurate for cross-modal comparisons.

Figure 5-6. Annual Refinery Receipts of Domestic Crude Oil by Barge[57]



Refinery receipts of crude oil by barge have increased by more than 300 percent since 2010.

Expanded use of inland waterways for the transportation of energy commodities and a corresponding increase in rail transport of many of those same products is one of the factors in the increased rates for barge shipments of grain and other commodities.[k] While barges have the lowest per-ton prices, they are geographically limited by access to navigable waterways and seasonal availability. Also, timeliness is a critical variable; it can, for example, take 11 days to move grain by barge from Minneapolis, Minnesota, to New Orleans, Louisiana, by barge but only 4 days by rail.[58]

Total domestic movements of crude oil, including coastal ocean shipping, have also risen in recent years.[59] Most of the Nation's refining capacity is located near a coastline. This allows refineries to receive, via waterborne transport, crude from foreign sources, domestic offshore production, and other port facilities, as well as to export refined products. Coastal barges and tankers, while less direct options than rail, could soon play a bigger role in moving domestic oil to East Coast or West Coast refineries.[60] The cost of using domestic port-to-port transport routes is subject to the Jones Act.[l] Utilization rates of Jones Act tankers and barges are reported to now range from 90 percent to near the maximum achievable rate of 95 percent.[61]

[k] The Mississippi River and the Illinois Waterway are the primary inland waterways for moving agricultural products by barge. They are especially important for transporting bulk grains and oilseeds from the Midwest to export ports in the New Orleans region. Other important waterways for agriculture include the Columbia River in the Pacific Northwest. Source: Department of Agriculture. "Study of Rural Transportation Issues." December 2010. Alternative overland routes by rail to ports are also available and heavily used, with shippers choosing depending on price and distance to a commercial waterway.

[l] The Jones Act refers to the Merchant Marine Act of 1920, which states that merchandise shipped between U.S. ports must be on a ship that was built in the United States, is flagged as a U.S. ship, and is owned and operated by U.S. citizens. Waivers have been issued for certain provisions of the act during national emergencies (e.g., Hurricane Katrina, Hurricane Sandy, etc.). The Jones Act also applies to merchandise transport on the Great Lakes.

The 10 U.S. ports and port systems with the most energy-related commodity shipments (coal, crude oil, and petroleum products), measured by tonnage, are shown in Table 5-1.[m]

Table 5-1. Top 10 Port Systems by Total Energy Commodity Shipments, 2013 (millions of short tons)[62]

Port Channel System	Crude and Petroleum Products	Coal	Total Energy	Energy as a Percent of Shipments
Lower Mississippi (LA)	161	47	208	48
Houston/Galveston (TX)	200	3	203	69
Beaumont/Port Arthur (TX)	115	0	115	89
Port of NY/NJ	80	<1	80	59
Delaware River	62	0	62	82
Corpus Christi (TX)	58	0	58	77
Port of Virginia	2	50	52	66
Lake Charles (LA)	49	0	50	88
LA and Long Beach (CA)	46	2	47	33
Huntington - Tristate (WV)	8	32	41	87

Energy shipment is concentrated on the Gulf Coast, but half of the 10 ports moving the most energy commodities are found elsewhere in the United States. The inland waterways are also important to the shipment of energy commodities to and from coastal ports.

The changes in energy commodity traffic are occurring as waterborne cargo volumes are increasing at some ports, a trend that will continue as the completion of the Panama Canal expansion project brings even larger "Post-Panamax"[n] cargo vessels to U.S. harbors.[63] Overall marine freight by tonnage through coastal ports is expected to increase domestically between 2010 and 2020,[64] while over the next 20 years, the total volume of imports and exports through U.S. ports could double.[65]

Future Investments in Waterborne Transportation Infrastructure

These relatively recent and rapid increases in energy-related demands for waterborne transport have brought a new focus on the Nation's port and related infrastructure. DOT's "Beyond Traffic 2045" report[66] concludes that "Looking to the future, several critical trends will have a major impact on the performance of critical marine links in our transportation systems." They include the following:

- Increasing imports and exports and containerized freight will lead to greater congestion on America's coastal and inland ports.
- Investment in ports, harbors, and waterways will be essential to meet the demand of increased trade and competition."

[m] For this analysis, Port Channel Systems refer to a group of ports on a single Federal navigation channel. Houston/Galveston comprises Houston, Galveston, Texas City, and Victoria. Lower Mississippi comprises New Orleans, Baton Rouge, Plaquemines, and the Port of South Louisiana. Port of New York/New Jersey comprises New York City; Albany; and Newark, New Jersey. Delaware River comprises Philadelphia; Marcus Hook, Pennsylvania; Paulsboro, New Jersey; Camden-Gloucester, New Jersey; New Castle, Delaware; and Wilmington, Delaware. Port of Virginia comprises Newport News and Norfolk Harbor.

[n] Post-Panamax ships are those that cannot fit through the current size of the Panama Canal. Expansion of the canal now underway will significantly increase the size of ships that can pass through it.

Funding mechanisms for maintaining or improving coastal ports, inland waterways, and related infrastructure is a shared responsibility. The available funding sources depend in part on the nature of the investment and the type of infrastructure involved.[67]

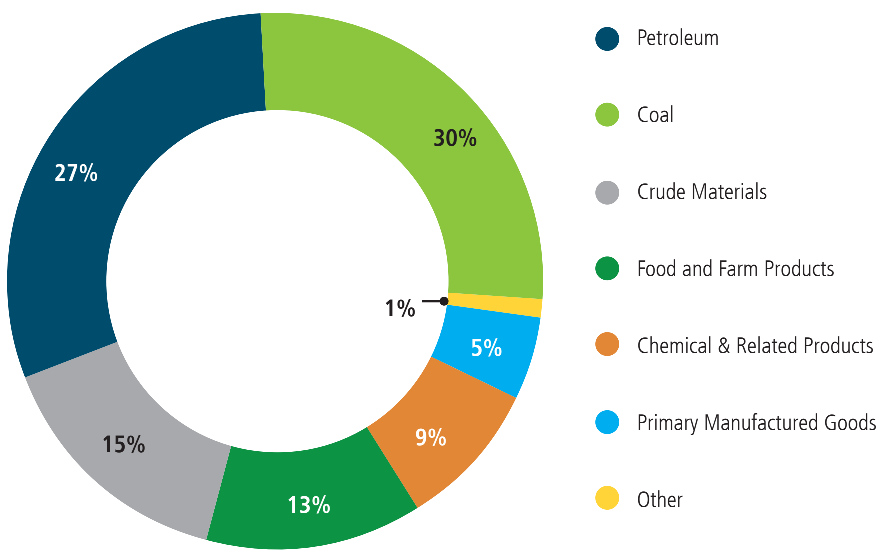
Under current law, the Federal Government is authorized to pay all operations and maintenance costs for inland waterways and generally for half the cost of the construction, replacement, rehabilitation, and expansion of locks and dams on these waterways. The other half is paid for with an excise tax on diesel fuel used on the 27 fuel-taxed inland waterways, which in effect is deposited in the Inland Waterways Trust Fund.[68]

The Federal Government is authorized to pay 100 percent of the cost of eligible operations and maintenance at coastal ports for all work at depths up to 50 feet depth. For channels at coastal ports, the Federal Government provides a 50 percent to 90 percent cost share for new construction (this varies by channel depth needs and contributions by sponsors).[69] There are two port channel systems in use or under construction that exceed 50 feet depth—Los Angeles/Long Beach and Seattle/Tacoma—both of which have limited needs for maintenance dredging. Additional ports have been authorized to depths greater than 50 feet and may require non-Federal maintenance dredging expenditure, but construction has not yet begun.

Improving Inland Waterways

The largest categories of tons of commodities shipped on U.S. inland waterways are coal and petroleum (by tonnage). Together, these energy commodities were 57 percent of goods transported on inland waterways in 2012.[70] In addition, a significant proportion of chemicals and crude materials shipped on inland waterways are energy related (see Figure 5-7).

Figure 5-7. Inland Waterborne Shipments by Commodity, 2012 (by weight)[71]

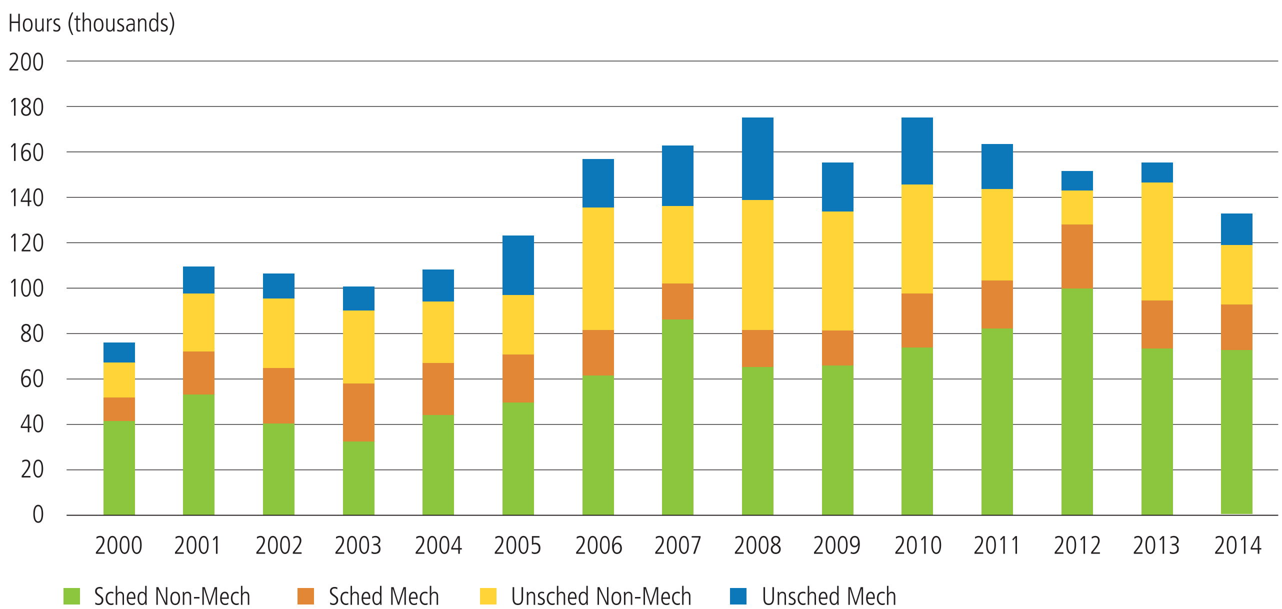


Energy commodities are the dominant commodity group in U.S. waterborne cargo traffic. In 2012, crude oil, refined petroleum products, and coal were 56 percent of all shipments by weight on U.S. inland waterways. Energy commodities were a similarly large portion by weight of all domestic and international waterborne shipments in the United States.

Inland locks and dams are a critical component of the Nation's inland waterways system. More than 55 percent of the navigation lock chambers were built in the 1960s or earlier, yet almost half of the overall tonnage moving on the inland system passes through them.[72] According to a joint USDA/DOT study, "Although aging, the locks and dams on the river system are generally reliable. As locks age, however, repairs and maintenance becomes more extensive and expensive."[73] The Corps gives priority to the structures that support the most commercial traffic, and invests heavily in their maintenance and periodic rehabilitation. Maintaining the locks and dams of the inland waterways is becoming more costly over time, due primarily to two factors – the condition of some of the components, as well as cost increases in the broader economy.

The Administration has made progress in reducing time losses from lock closures in recent years. Due in part to Federal investment, the number of main lock chamber closures on high and moderate commercial use waterways (those that carry at least 1 billion ton-miles of traffic annually) due to preventable mechanical breakdowns and failures lasting longer than 1 day and lasting longer than 1 week has decreased significantly since fiscal year 2010. Non-mechanical failures—such as weather, drought, floods, ice, and current conditions—also create unscheduled lock outages, so impacts from climate change may play a role in inland waterway availability in the future (see Figure 5-8).

Figure 5-8. Hours of Lock Unavailability on U.S. Inland Waterways, 2000–2014[74]



Progress in reversing the trend of increasing outages due to unscheduled mechanical breakdown must continue for the inland waterways to remain a reliable and affordable transportation option for shippers.

A typical round trip from New Orleans to the Upper Midwest and back on the inland waterways can take up to 30 days. Although shippers expect to encounter occasional delays due to weather and equipment related conditions, according to USACE, "Shippers recognize that the inland waterways are a low-cost method of transportation...they will encounter a delay on some trips due to a weather or equipment related conditions but they remain uneasy about the reliability of this system, noting observed trends in availability. To the extent that system outages disrupt waterborne service, shippers and carriers will experience additional, sometimes unexpected, costs."[75] In spite of these risks, shippers move roughly 600 million tons of cargo annually on the inland waterways.

Inland shippers that want to move a product more quickly over long distances generally have the option to use rail. However, strong demand for rail due to increased oil, petroleum products, sand, ethanol, and more recently, coal (after a decline coal transport is on the upswing again), combined with track delays and rail speed reductions, has reduced rail transport options. According to USDA, in 2013–2014, "rail service in the United States is currently operating near full capacity as the United States recovers from the recession and production of ethanol and unconventional oil and gas are near record highs. Because railroads are operating near full capacity, transportation disruptions (e.g., adverse weather conditions or an unexpected sudden surge in demand) are likely to cause performance problems for rail transport. In addition, routine track maintenance by an individual railroad may result in longer-than-anticipated disruptions in certain areas and can lead to delays that spill over to the larger parts of the connected rail system."[76]

On the principal inland waters, which carry 90 percent of the traffic, additional capital investment beyond current funding levels will be needed to maintain the current level of performance into the future. To address this concern, the Administration has proposed legislation to reform the way that the Federal Government finances capital investment on these waterways.[77] Funding for water infrastructure is split between Federal and users of these waterways. The changing domestic energy landscape presents an opportunity for Federal and private sector investment to accommodate new needs that are not reflected in current project plans.

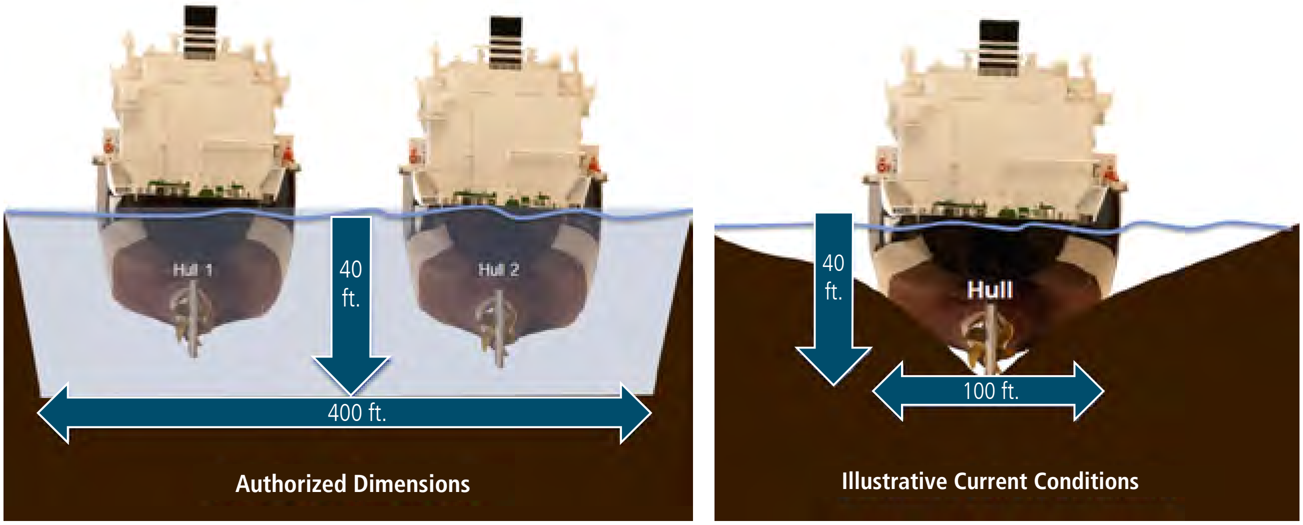
Port and Harbor Infrastructure Investments

On November 12, 2014, Vice President Biden issued a call to action for greater investment in U.S. port facilities, noting, "We are investing less than 1 percent of our gross domestic product in transportation infrastructure... ranking 28th in the world among advanced nations. That is simply unacceptable...we need to do everything we can to ensure that the whole infrastructure system is connected, especially to our ports."

Large ports generally are able to successfully handle today's levels of cargo at the current funding levels for harbor maintenance and related work, although, as noted, port traffic is expected to grow over the next decades. However, some carriers may need to proceed more slowly due to hazards, or to light load their vessels, or offload some cargo to smaller vessels. Depending on the channel conditions, tankers or other vessels may encounter arrival or departure delays (e.g., until another ship has moved through that section of the channel, or until high tide) or restrictions that reduce the recommended vessel draft (which can affect how much cargo some ships can hold).

An example can be found in Louisiana's Calcasieu Ship Channel, which provides access to the Port of Lake Charles—the 13th largest deep sea port in the Nation and an important maritime hub for the U.S. energy industry—and could be used in the near future by liquefied natural gas tankers to access federally approved gas export terminals. In 1968, USACE deepened and otherwise improved the Calcasieu River and Pass to the current authorized Federal dimensions of the channel, which are 400 feet wide and 40 feet deep. USACE dredges the most critical reaches of the channel annually, but shoaling reduces the channel to less-than-authorized dimensions (see Figure 5-9). To help address reduced depths and channel narrowing, which reduces the efficiency of commercial operations, the Calcasieu River and Pass Federal navigation project received $27.7 million of fiscal year 2015 Operation and Maintenance funds, which will allow the Corps to dredge the most vital portions of the channel to optimize safety and efficiency.

Figure 5-9. Calcasieu River Ship Channel, Illustration (not to scale) of Authorized Dimensions and Example Conditions Where Shoaling Occurs[78]



Inadequate dredging can lead to shoaling and narrowing of channels, forcing tankers and other large vessels to reduce cargos, idle until high tide, or be subjected to one-way traffic restrictions.

Another example of the role of maintenance dredging is the main channel of the lower Mississippi River between Baton Rouge and the Gulf of Mexico. In 2011, shoaling in some areas led those who are responsible for vessel operation to place restrictions on certain parts of the river, until USACE addressed the concern by performing additional maintenance dredging.[79]

USACE is working to develop better analytical tools to help determine the appropriate spending level for harbor maintenance and related work at coastal ports, based on the economic and safety return, as well as a comparison with other potential uses of available funds. The sufficiency of a channel for commercial navigation depends upon the economic and safety return from an additional potential increment of maintenance work, which in turn is a function of actual traffic utilization patterns, the condition of the channel, and other factors.

Dredging varies from port to port. Due to geographic differences, Gulf Coast ports generally silt in more quickly—and thus require much more maintenance dredging—than many ports on the East Coast or West Coast.[80] Ports in the Great Lakes region also require significant maintenance and account for a major portion of the Corps' dredging activities. Regardless of where a port is located, the proper placement of dredged material can be a significant portion of the total cost of dredging. A discussion of the environmental aspects of dredging materials is contained in Chapter VII (Addressing Environmental Aspects of TS&D Infrastructure).

Port Connector Infrastructure Improvement

Getting crude oil from the wellhead to refineries or terminals on the coasts has become increasingly multi-modal, often utilizing a combination of pipe, truck, rail, barge, and tanker transport. These infrastructure systems already play a major role in moving petroleum products, coal, biofuels, wind components, and other energy-related materials and equipment through the Nation's system of public and private ports and related facilities. In addition to the navigation-related maintenance and construction, the landside port connector infrastructures that provide largely "first and last mile" access between ports and the national freight network need investment to accommodate the increased intermodal movement of domestic petroleum. Because of the variety of infrastructures involved, however, stewardship of port connectors is complex, with improvements that may be funded through a combination of Federal, state, local, and private investments.

DOT reports that connecting roads to ports had twice the percent of mileage with deficient pavement than other non-interstate Federal highway routes, and connectors to rail terminals had 50 percent more mileage in the deficient category.[81] In a recent survey of port authorities, more than one-third of respondents said that intermodal connector congestion over the last 10 years has caused port productivity to decline by 25 percent to 50 percent.[82]

Port Connector Congestion[o]

The head of the American Association of Port Authorities recently described road congestion at the Port of Baltimore.

"In Baltimore, thousands of cargo-laden trucks annually travel an extra 5.3 million miles over some of the city's most congested roads and release an extra 175,000 tons of carbon dioxide to move cargo from the Maryland Port Administration's busy Seagirt and Dundalk marine terminals. These extra miles and emissions could be eliminated after construction of the proposed Broening Highway Corridor Improvement Project that would replace the city's Colgate Creek Bridge and create a new primary transportation link between the port and Interstate 95. The project's price tag is estimated at $32 million."

[o] Nagle, K. "Port Intermodal Connections Crucial to Supply Chain Logistics Flow." Travel & Industry Development. November 4, 2014. http://www.tradeandindustrydev.com/industry/logistics-warehousing-distribution/port-intermodal-connections-crucial-supply-chain-l-9738.

The surge in waterborne and rail shipments of crude may be a factor in delays at some inland and coastal ports. For example, freight traffic through the Port of Albany has experienced delays, reportedly due largely to a new influx of trains carrying domestic crude oil.[83] Port congestion in Baltimore is increasing the time that vessels, trains, and trucks idle, thus exacerbating air quality conditions in the area.[84] While the situation in Baltimore appears to be temporary (the port has plans to address the concern[p]), these examples show how the condition of port and related infrastructure can sometimes compromise public safety and air quality or degrade natural environments.

A more efficient system of port connectors could help address these and other problems and is discussed in the recommendations for this chapter. Funding for better emissions control technologies and strategies in ports is discussed in Chapter VII (Addressing Environmental Aspects of TS&D Infrastructure).

Economic Return from Investments in Coastal Ports, Inland Waterways, and Connectors

The Nation's coastal ports, inland waterways, and related infrastructure are part of the national freight transportation network and contribute to the economy. The condition of this infrastructure can affect the competitiveness of the U.S. economy, including the energy sector. As the level of traffic in waterborne commerce has increased, the Federal Government, states, local governments, local port authorities, and the private sector have made investments to maintain and improve the performance of this infrastructure, promoting economic efficiency. However, external analyses have found that delays due to inadequate infrastructure in inland waterways and ports have impacts on business sales and jobs; these losses are expected

[p] See, for example, the Broening Highway Corridor Improvement Project. archive.baltimorecity.gov/Government/AgenciesDepartments/Transportation/TIGER/BroeningHighwayCorridorImprovementProject.aspx.

to increase absent a focus on reversing the deterioration of inland waterways and ports.[q] Targeted high-return investments in this part of the national freight transportation network could strengthen the overall U.S. economy.

In addition, an assessment of the state of waterborne infrastructure also raises concerns about its reliability and resilience, which are described in more detail in Chapter II (Increasing the Resilience, Reliability, Safety, and Asset Security of TS&D Infrastructure).

The analysis of potential investments can change due to several factors. For example, USACE will need to consider the changing domestic energy landscape in some of its project plans, such as where an increase in energy-related commodities through one or more of the ports, locks, and dams has occurred that may be large enough to affect an investment decision; also, energy is only one of many factors to consider when making decisions about infrastructure investments.

Opportunities for Public-Private Partnerships in Ports and Waterways

In his call to action, Vice President Biden noted that after years of underinvestment, more than $90 billion in improvements are needed to prepare for a significant increase in shipping over the next several years, saying that "Ports can expect to ship 50 percent more cargo by 2020 than they do now, and that's probably a low estimate." He also highlighted the opportunity that ports have to deliver projects through public-private partnerships.[85]

As noted, there is a distinction between responsibilities for landside and waterside facilities at ports. Landside facilities at ports are generally under the control of local port authorities. The Federal Government, however, has substantial responsibility for many waterside activities, in particular, for maintenance of the authorized Federal portion of the main channels and associated features such as turning basins, and for related work. The National Research Council, in a study of USACE funding for water projects, found that "Future Corps water resources activity will be less dedicated to construction of major new civil works, and more heavily focused on operating, maintaining, rehabilitating, and upgrading existing infrastructure…[and] deferred costs for maintaining… commercial navigation are considerable."[86] Some cases of deferred maintenance, however, reflect decisions to perform channel maintenance dredging when the incremental costs are lower with more material to dredge, or when a channel's traffic levels do not justify use of limited funds over other potential uses at that time.

Increasing demands by the users and others for more Federal investment in coastal ports, inland waterways, and related infrastructure highlight the need for additional and innovative funding mechanisms and public-private partnerships. The National Research Council's analysis of these and other issues concludes, among other things, that "The modern context for water resources management involves smaller budgets, cost sharing, an expanded range of objectives, and inclusion of more public and private stakeholders in management decisions. Two important implications of these conditions are (1) given current budget realities, the Nation may have to consider more flexible, innovative, and lower-cost solutions to achieving water-related objectives; and (2) USACE will by necessity work in settings with more collaboration and public and private partnerships than in the past."[87]

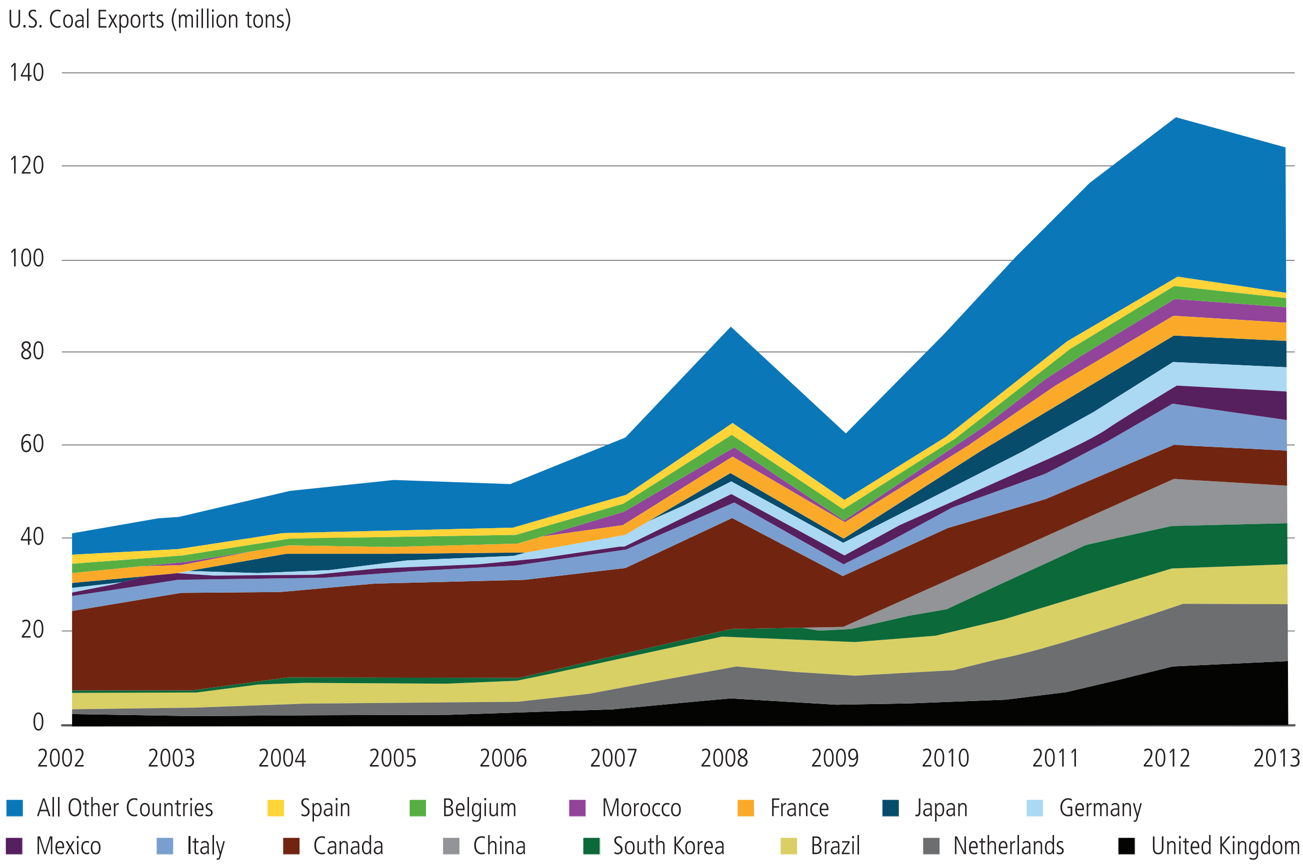
[q] A report prepared for the American Society of Civil Engineers estimated that waterborne shipping delays due to inadequate infrastructure in inland waterways and ports imposed $33 billion in costs on U.S. products in 2010; the report projected those costs (in constant 2010 dollars) to increase to nearly $49 billion in 2020 and $68 billion in 2040. Further, the report calculated that by jeopardizing the U.S. ability to provide the low-cost transportation needed to remain competitive in a global economy, the cumulative economic shortfall from deterioration of the inland waterways and ports will result in $1.3 trillion in lost business sales from 2012 to 2020; $270.0 billion in lost exports from 2012 to 2020; almost $2.0 trillion in lost exports from 2012 to 2040; 738,000 fewer jobs by 2020; and 1.4 million fewer jobs by 2040.

Uncertainty in U.S. Coal Exports

U.S. coal exports peaked in 2012;[88] in that record year, East Coast ports alone shipped 68 million tons, which was only about 65 percent of potential export capacity.[89] Exports have declined since then, dropping in the last seven quarters ending in Quarter 3 of Calendar Year 2014.[90] Notwithstanding this decrease in exports (and currently low global coal prices), companies that own and manage export terminals continue with long-range plans for expansion, focused on the potential for continued demand in Europe, Asia, and South America.[91]

Shifts in coal export destinations have produced associated shifts in the locations of ports serving the international coal trade. As shown in Figure 5-10, exports to Canada have sharply declined since 2008, which has reduced coal tonnage passing through Great Lakes customs districts (including Duluth, Detroit, and Cleveland),[92] while rising exports to Europe and the Far East have increased tonnage through Norfolk, Baltimore, New Orleans, and Seattle.[93]

Figure 5-10. U.S. Coal Exports by Destination[94]



Overall export volumes of U.S. coal have declined from recent record levels, despite growth in coal exports to countries in Europe and Asia.

Impact of Energy and Energy Component Transport on Multi-Modal Systems

The introduction of unprecedented levels of domestic and Canadian crude into interconnected pipeline, rail, barge and tanker, and roadway systems not only provides flexibility to shippers, but it has also introduced new intermodal stresses on the freight system and associated regulatory bodies.

Roadways, Short Hauls, and Energy Production

The domestic energy production boom is increasing roadway traffic for transport of both energy products and the materials and tools required to produce those energy products. For instance, a typical Bakken well completion requires roughly 2,300 drilling-related truck trips for machinery, sand, and injection fluids.[95] Trucks are also used for short-haul drayage of crude oil from the wellhead to gathering pipelines or rail loading terminals for long-distance transport. In North Dakota, well drilling has outstripped the development of gathering systems, leaving about 40 percent of Bakken production to be delivered to pipeline and rail terminals by truck. Demand for trucks has also increased downstream of production, as illustrated by the threefold increase from 2004 to 2013 in refinery receipts of crude oil by truck,[96] a substantial portion of which—because of the location of refineries—occurs on roads and highways near ports and waterways.

As a result of this new demand, trucking firms have reported a shortage of trained drivers, and firms in non-energy producing regions of the country are losing experienced drivers to the higher wages available in producing areas.[97] Trucks fill a very specific role that other transport modes are not well-suited to fill. According to the American Association of State Highway and Transportation Officials, "Local and regional cargo mostly moves by truck, since trucks are generally more efficient at short distances and provide door-to-door service to almost all freight shippers and receivers. At longer distances, typically beyond 400 to 600 miles, intermodal rail becomes increasingly more competitive and can be used as a substitute for long-haul trucking."[98] While port-related truck traffic may represent a low-share of total truck traffic in a region, it tends to be highly concentrated on certain corridors and highly visible, and—unlike rail and waterborne transport—trucks share the infrastructure with the general public, thus making it of particular importance to adjacent communities.

Another example of multi-modal stress from transporting energy supplies is found in transporting large quantities of sand for oil and gas production. In one county in Wisconsin alone, a 2012 forecast suggested that supplying sand to meet oil and gas production demand could require transport of 5 million tons to 7 million tons of sand by truck and rail, compared to 137,000 tons just 4 years earlier; 7 million tons translates into 280,000 one-way truck trips and 500 unit trains.[99] The impact of such traffic on roads, rail crossings, and tracks is significant.

Moving Large Energy Components on Shared Infrastructure

Shared infrastructure systems are also strained by movement of large components associated with other energy resources beyond petroleum, ethanol, and coal. An example is found in transport of wind turbine components. Large wind components are both domestically manufactured and imported; in 2012, 40 percent of the total value of component imports moved through the Houston-Galveston area alone,[100] placing additional burdens on the port facilities and connectors that are responsible for moving these very large components. In 2012, an estimated 689 truckloads, 140 railcars, and 8 vessels were required to carry the turbines, blades, and related components needed to complete a moderately sized 150-megawatt (MW) wind project.[101]

Turbines have increased in size to maximize generation capacity, raising a range of complications for transportation and logistics.[102] Typical turbine blade lengths in the 1980s were 5 meters to 15 meters. In the last several years, typical turbine blades have grown to 38 meters to 50 meters in length for generating capacities of 1.5 MW to 2.5 MW,[103] and many blades deployed today exceed this length. Figure 5-11 shows the transport of an 80-meter blade bound for a 7-MW offshore test turbine in Scotland. The limits of the existing transportation infrastructures are now constraining component designs as manufacturers try to balance optimal energy production with transportability.[104]

Figure 5-11. Transport of Large Wind Turbine Blade[105]

As wind turbines continue to grow in size, project developers will face greater challenges in transporting components. This 80-meter blade is being transported to a 7-MW test turbine in Scotland.

Transporting components of this size requires coordination of movement through ports, tunnels, overpasses, and turning areas,[106] and often puts significant stress on small and rural roads. The larger and more complex wind projects become, the more developers will be challenged by Federal vehicle weight limits[r] and differing state and local requirements for issuing permits for oversize and overweight vehicles. Nacelles[s] for new turbines can weigh more than 80 tons[107] and, according to the American Wind Energy Association, "A truck carrying a tower section must be able to support a load ... that is over 30 meters long and weighs over 150,000 pounds."[108] In addition to limited availability of specialized trailers for blade transport, projects are also challenged by the availability of the large mobile cranes capable of lifting the very heavy components onto tall towers, and the cranes alone may require more than 100 semi-tractor trailers to move between projects.[109]

The National Energy Renewable Laboratory has underscored these logistical concerns, noting that "The challenges and costs associated with transporting taller towers and very long blades with wide chord lengths also affects wind plant deployments and will become more constraining as wind turbines increase in size and height. Similarly, trucking heavy nacelles and blades with larger root diameters could become challenges meriting additional attention."[110] Increasingly complex logistical challenges are requiring shippers to use a variety of land transportation methods and modes, resulting in increased project costs of up to 10 percent of capital costs for some projects.[111]

[r] Federally mandated maximum weights for the National System of Interstate and Defense Highways and reasonable access thereto (23 C.F.R. § 658.17): 80,000 pounds gross vehicle weight; 20,000 pound single axle weight; 34,000 pound tandem axle weight.

[s] A nacelle is the box-like component that sits atop the tower that contains the majority of the approximately 8,000 components of the wind turbine, such as the gearbox, generator, main frame, etc.

There are similar logistical issues associated with moving large power transformers. Like wind turbine components, transformers require special permits for transport over highways. Though trailers for road transport are generally only around 70 feet long, large transformer units can weigh up to 400 tons.[112] Transport via rail requires a specialized car of which only roughly 30 are available in North America.[113] Estimates suggest that transportation and logistics costs represent 3 percent to 20 percent of the total cost of a large transformer.[114]

Administration Activities and Plans

New per-vessel user fee to double the size of the Inland Waterways Trust Fund. This fund currently pays 50 percent of the Federal cost for construction, replacement, rehabilitation, and expansion for inland waterways (the other 50 percent is derived from the General Fund of the Treasury). Inland Waterways Trust Fund funding is derived from a fuel tax on commercial transportation on most of the inland waterways. In December 2014, Congress authorized an increase in the fuel tax from the current $0.20 per gallon to $0.29 per gallon, to take effect after March 31, 2015. The President's Fiscal Year 2016 Budget proposes a new per-vessel user fee that will raise an additional $1.1 billion over the next 10 years from the users, effectively doubling the level of resources available in the Waterways Trust Fund. These increased resources are allocated through annual Appropriations acts (and would be matched by General Fund revenues). As such, the level of investment in inland waterways infrastructure can continue to be expanded to the extent that it is matched by appropriations from the General Fund.

Department of Transportation/Maritime Administration StrongPorts initiative. This program is developing tools and initiatives helpful to port authorities that are pursuing modernization projects, including those interested in public-private partnerships. StrongPorts initiatives include a Port Planning and Investment Toolkit that provides port authorities with a how-to guide for performing due diligence and developing an investment-grade project; a new "PortTalk" initiative aimed at helping ports to integrate these projects into state transportation department and metropolitan planning organizations' transportation infrastructure planning and funding processes; and direct technical assistance to ports interested in taking advantage of Federal grant assistance. While the StrongPorts initiative does not provide direct financial assistance, the recently released guide provides an additional resource regarding financing for ports. More information can be found at www.marad.dot.gov/ports_landing_page/StrongPorts/StrongPorts.htm.

GROW AMERICA Act multi-modal freight grant program. The Administration's Fiscal Year 2016 Budget includes a new transportation Infrastructure financing proposal—the Generating Renewal, Opportunity, and Work with Accelerated Mobility, Efficiency, and Rebuilding of Infrastructure and Communities throughout America Act (GROW AMERICA Act). This proposal includes $18 billion over 6 years to establish a new multi-modal freight grant program to fund innovative rail, highway, and port facilities that will improve the efficient movement of goods across the country. The GROW AMERICA Act also will give shippers and transportation providers a stronger role in working with states to collaborate and establish long-term freight strategic plans.

Expanded funding for the Department of Transportation TIGER grant program. The Transportation Investment Generating Economic Recovery (TIGER) program is a competitive grant program that funds state and local transportation projects across the United States. TIGER'S broad eligibility criteria make it ideal for multi-modal, multi-jurisdictional projects, such as landside infrastructure for ports and waterways, which can be difficult to fund under state block grants. Since 2009, Congress has dedicated $4.2 billion for TIGER projects, of which $400 million has gone to port-related projects. However, TIGER is currently oversubscribed; in its most recent funding round, only 72 of 797 eligible applications were funded, and 15 times the available $600 million was requested. The Administration's GROW AMERICA Act proposal will provide $7.5 billion over 6 years, more than doubling the TIGER competitive grant program.

QER Recommendations

PORTS, HARBORS AND CONNECTORS

The shared infrastructures in inland waterways and ports that are important for waterborne transport of energy commodities need to be strengthened, both to accommodate the increased use of waterborne, rail, and road transport to move energy commodities and to recognize the key role these infrastructures play in domestic commerce, generally. Accordingly, we recommend the following:

Support alternative funding mechanisms for waterborne freight infrastructure: Recognizing that no one entity or program can fully address the scale and diversity of investment requirements, the Administration should examine alternative financing arrangements for waterborne transportation infrastructure. The working group should develop strategies for public-private partnerships to finance port and waterway infrastructure. It should also coordinate and integrate Federal investment programs through DOT and USACE and consider new user fee arrangements that better allocate costs to beneficiaries, as well as potential tax incentives. The Administration should also work to encourage non-Federal involvement in ports and inland waterways, targeting the beneficiaries of infrastructure investment identified in the needs assessment. Options would be informed by findings of the one-time comprehensive energy needs assessment for coastal ports, inland waterways, and connectors, which would establish the foundation for providing additional support for projects at energy-intensive port and harbors.

Support a new program of competitively awarded grants for shared energy transport systems: Reducing congestion from additional movement of energy commodities to and from coastal ports and inland waterways, improving air quality, and enhancing public safety in and around ports and waterways will help meet competiveness, environmental, and security goals. The DOT Transportation Investment Generating Economic Recovery (TIGER) program has successfully targeted investment in port connectors but it is not specific to energy and is heavily oversubscribed; only 10 percent of past TIGER awards have gone to port connectors. A similar grant program—Actions to Support Shared Energy Transport Systems, or ASSETS—should be established and supported at DOT, operated in close cooperation with DOE; this program would be dedicated to improving energy transportation infrastructure connectors. The ASSETS program could provide significant benefits as a stand-alone measure while a new, more comprehensive infrastructure investment framework takes shape.

The estimated scale of ASSETS investment could be on the order of $2.0 billion to $2.5 billion over the next 10 years, which would likely mobilize $4.0 billion to $5.0 billion in non-Federal investment, based on typical TIGER cost shares.

Support public-private partnerships for waterborne transport infrastructure: The U.S. freight transport system is a complex blend of Federal, state, and local government and private sector assets, as well as operation and maintenance investments. Developing a set of shared investment priorities can ensure that both public and private needs are met.

Data, Modeling, and Analysis

Policymakers, investors, managers, and users of shared transportation systems require better information in order to plan new infrastructure investments and optimize current operations to minimize the cost of congestion, limit environmental impacts, and ensure safety. However, the increase in multi-modal transport of energy and other commodities presents new complexities in understanding the interplay among rail, highway, and waterborne freight transportation. Furthermore, significant gaps exist in the data collected by various Federal agencies and, even where the data is collected, there are often long lags between commodity movements and the publication of data.

As one example, the most granular source of multi-modal commodity, route, and origin and destination data now available is the Freight Analysis Framework.[115] However, as a mechanism for understanding energy commodity flows, the framework has significant limitations. For instance, it is based on the Commodity Flow Survey, a joint effort of the Bureau of Labor Statistics and the Department of Commerce's Census Bureau.[116] The survey is derived from data collected every 5 years—a frequency that does not adequately capture the rapid changes in the energy sector.

QER Recommendations

MODELING, ANALYSIS, AND DATA COLLECTION

Coordinate data collection, modeling, and analysis: DOE should lead an interagency effort with DOT, USDA, USACE, and the Coast Guard—in cooperation with other relevant agencies with data regarding marine, rail, and other energy transport modes—to improve and coordinate their respective data collection, analytical, and modeling capabilities for energy transport on shared infrastructures. For example, DOE, leveraging the technical resources and expertise of the national laboratories, should work with DOT and USACE to develop new modeling and analytical tools to establish a more comprehensive systems framework for analysis of MTS infrastructure issues. This modeling and analysis effort should apply the improvements in data on shared transportation systems recommended elsewhere in the QER and the ongoing efforts of the Committee on the MTS to improve maritime data. A concerted effort should also be made to improve the data in the Freight Analysis Framework and the Commodity Flow Survey and make this tool more useful as a mechanism for understanding energy commodity flows. This effort will enable better informed investment decisions by both government and industry through a better understanding of energy-related supply chain issues.

Assess the impacts of multi-modal energy transport: DOE, working with DOT and USACE, should conduct a one-time comprehensive needs assessment of investment needs and opportunities to upgrade the Nation's energy-related shared water transport infrastructure. The assessment should take advantage of the new analytics and modeling tools previously recommended to assess and prioritize investments from a systems perspective, taking into account the dramatic changes and projections of future use of shared water transport infrastructures due to changes in domestic energy markets, increases in vessel size, and other factors. The infrastructure investment analysis should identify the costs and benefits (including beneficiaries) in order to guide capital investment planning and identify equitable partnerships among the Federal Government, state and local governments, and the private sector infrastructure users.

QER Recommendations (continued)

MODELING, ANALYSIS, AND DATA COLLECTION

Assess energy component transportation: DOE, in coordination with relevant agencies, should examine logistical challenges in the transportation of oversized or high-consequence energy materials, equipment, and components. The study will assess the capacity of infrastructure systems, such as roadways, waterways, and railroads, to safely accommodate more frequent and larger shipments where energy analyses indicate such transport will be required. The study will also examine opportunities for coordination of Federal, state, and local permitting and other regulatory processes along affected transportation routes, as well as the role of private sector infrastructure owners and users in enhancing the safety and reliability of transporting certain energy-related materials components.

RECOMMENDATIONS IN BRIEF:
Improving Shared Transport Infrastructures

Enhance the understanding of important safety-related challenges of transport of crude oil and ethanol by rail and accelerate responses. Key activities at the Department of Energy (DOE) and Department of Transportation (DOT) should be strongly supported.

Further analyze the effects of rail congestion on the flow of other energy commodities, such as ethanol and coal. DOE, the Surface Transportation Board, and the Federal Energy Regulatory Commission should continue to develop their understanding of how rail congestion may affect the delivery of these energy commodities.

Analyze the grid impacts of delayed or incomplete coal deliveries. In assessing these issues, DOE and other relevant Federal agencies should examine whether a minimum coal stockpile for electricity reliability should be established for each coal-fired unit.

Address critical energy data gaps in the rail transport of energy commodities and supplies. Congress should fund the President's Fiscal Year 2016 Budget request for the Energy Information Administration to address critical energy transportation data gaps and continued data sharing with the Surface Transportation Board.

Support alternative funding mechanisms for waterborne freight infrastructure. The Administration should form an ongoing Federal interagency working group to examine alternative financing arrangements for waterborne transportation infrastructure and to develop strategies for public-private partnerships to finance port and waterway infrastructure.

Support a new program of competitively awarded grants for shared energy transport systems. A new grant program—Actions to Support Shared Energy Transport Systems, or ASSETS—should be established and supported at DOT, in close cooperation with DOE. This program should be dedicated to improving energy transportation infrastructure connectors. The estimated scale of ASSETS investment should be on the order of $2.0 billion to $2.5 billion over the next 10 years, which would likely mobilize $4.0 billion to $5.0 billion in non-Federal investment, based on typical TIGER cost shares.

Support public-private partnerships for waterborne transport infrastructure. Developing a set of shared priorities for investment ensures that public and private sector needs are met.

Coordinate data collection, modeling, and analysis. DOE should lead an interagency effort with DOT, the Department of Agriculture, the Army Corps of Engineers, and the Coast Guard—in cooperation with other relevant agencies with data regarding marine, rail, and other energy transport modes—to improve and coordinate their respective data collection, analytical, and modeling capabilities for energy transport on shared infrastructures.

Assess the impacts of multi-modal energy transport. DOE, working with DOT and the Army Corps of Engineers, should conduct a one-time comprehensive needs assessment of investment needs and opportunities to upgrade the Nation's energy-related shared water transport infrastructure.

Assess energy component transportation. DOE, in coordination with relevant agencies, should examine routes for transportation of system-related equipment, materials, and oversized components. The assessment would include the capacity of the Nation's transportation infrastructure systems to safely accommodate more frequent and larger shipments where analyses indicate such transport will be required.

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