



THE FUEL AND PETROCHEMICAL SUPPLY CHAINS



Moving the Fuels
and Products That
Power Progress



PETROLEUM

PURPOSE

PRODUCTS

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**FUELING
LIFE**

PEOPLE



Introduction

The United States is in the midst of an energy renaissance.

Growing domestic production of crude oil and natural gas, expanding capacity at refining and petrochemical facilities, and higher manufacturing utilization rates have increased our energy security, supported robust economic growth, spurred job creation, enabled access to affordable energy and improved the quality of life for all Americans.

For this energy renaissance to continue, crucial new infrastructure investments are essential. According to the U.S. Energy Information Administration (EIA), U.S. production of crude oil is expected to average a record 10.7 million barrels per day (b/d)^A in 2018, surpassing the previous annual record of 9.6 million b/d set in 1970.¹ EIA also estimates that crude oil production will continue to grow over the next decade, increasing by more than 15 percent.²

U.S. natural gas production has also continued to surge, and with it has come increased production of natural gas liquids (NGLs), which are valuable feedstocks for the petrochemical industry. NGL production is expected to reach 4.3 million b/d in 2018, and to grow by more than 20 percent over the next decade.³

U.S. refineries, which are among the most sophisticated and efficient in the world, are taking full advantage of increasing U.S. crude oil and natural gas production. The U.S. refining industry is expanding capacity, optimizing operations and increasing utilization rates to meet growing global demand for fuels and petrochemical feedstocks. In 2017, there were 137 petroleum refineries operating in the United States, with a total capacity of more than 18.6 million b/d, and refinery utilization averaged 91 percent. In 2018, U.S. refinery utilization is expected to average 92 percent, the highest rate in more than a decade.⁴

U.S. petrochemical manufacturers are thriving as well, expanding existing capacity

and building new plants to process increasing supplies of NGLs and other feedstocks. With access to these abundant economic feedstocks U.S. petrochemical manufacturers are well positioned to supply the increasing global demand for the many products made from petrochemical building blocks. The global petrochemical industry is expected to continue growing through the next decade, reaching a market value of more than \$800 billion in the next five years.⁵

Expanded investment in America's petroleum and petrochemical midstream infrastructure is essential to fully capitalize on America's energy renaissance.

Bringing the benefits of this energy renaissance to U.S. consumers requires "midstream infrastructure" – the integrated system of pipelines, ports and waterways, railroads, roadways, and storage facilities that support moving America's energy supplies from producer to consumer. Midstream infrastructure is the essential link between upstream production fields where oil, natural gas and NGLs are produced, to refineries and petrochemical manufacturing facilities where raw materials are turned into fuels and other essential goods. Midstream infrastructure also links refineries and petrochemical plants to consumers, moving fuels from refineries to regional storage terminals to retail outlets,

^A Barrels are a common unit for measuring liquids in the energy industry. One barrel is equal to 42 gallons.

and petrochemical products from the plants that produce them to the manufacturing facilities that turn them into myriad everyday consumer products that make modern life possible. Midstream infrastructure is vital to supporting continued growth in U.S. exports of crude oil, natural gas, refined products, and petrochemicals thus improving our trade balance. Expanded investment in America's petroleum and petrochemical midstream infrastructure is essential to fully capitalize on America's energy renaissance.

American Fuel & Petrochemical Manufacturers' (AFPM) members are investing billions of dollars in the midstream sector, building, expanding, and modernizing the energy infrastructure network needed

to safely and efficiently move and store increasing volumes of America's energy resources. As is the case with any complex integrated system, the network is only as strong as the weakest link. Continued investment is vital to strengthen the supply chains that ensure that U.S. consumers have access to ample and affordable supplies of transportation fuels and other necessary products, as well as ensure that American industry continues to thrive.

This report describes the key elements of the petroleum and petrochemical midstream sectors and discusses the vital role this infrastructure plays in delivering the fuels and consumer goods that Americans use every day.

**AFPM MEMBERS MAKE
THE PRODUCTS THAT
IMPROVE YOUR LIFE.**





Fuel and Petrochemical Supply Chains

U.S. refiners and petrochemical manufacturers rely on complex supply chains to move oil, NGLs and other feedstocks, as well as natural gas, to their facilities from producing areas in the United States and around the world.

These facilities turn raw materials into refined products, including gasoline, diesel, jet fuel, residual fuel oils, propane, lubricants, asphalt, base oils, and waxes, and into petrochemical products such as ethylene, propylene, butadiene, benzene, toluene and xylene, which are the building blocks of many consumer goods. After they are produced, refined products and petrochemicals are shipped to domestic and international markets where they supply energy or are used as inputs to produce the many products that consumers rely on for

their daily lives. America's midstream infrastructure makes this possible. By the time a gallon of refined fuel reaches the consumer, it, and the crude oil from which it was manufactured, have traveled thousands of miles along multiple modes of transport – from the wellhead to the refinery to the retail outlet. Petrochemical products travel similar distances as they move along multiple modes – from oil and gas fields to processing plants to the fabrication plants where they are turned into consumer goods.

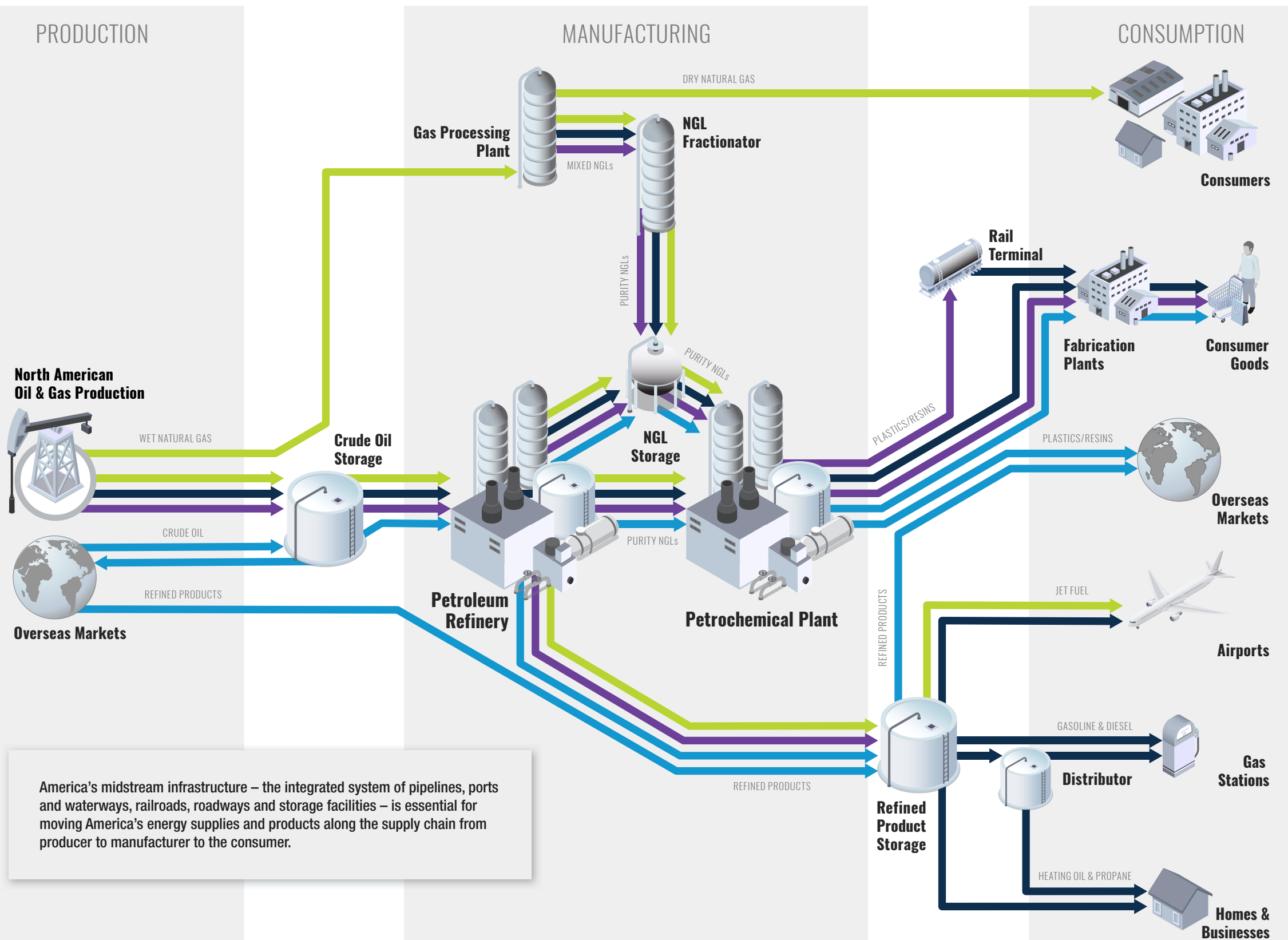


The Role of Natural Gas Infrastructure in Refining and Petrochemical Manufacturing

Pipelines that transport raw (or “wet”) natural gas – natural gas that consists of methane and entrained NGLs – are essential for the production of NGLs, which are separated from the gas stream at gas processing plants. Consumer-grade (or “dry”) natural gas – natural gas that consists of 95 percent to 98 percent methane after most NGLs and impurities have been removed – is also an important source of fuel to generate heat for refinery and petrochemical processes, and is used as feedstock to produce hydrogen, which is used in several refinery processes. Low natural gas prices over the past decade have reduced operating costs for U.S. refiners and petrochemical manufacturers, strengthening their global competitiveness. Although not a direct focus of this report, continued development of midstream infrastructure to support increased production, transportation and distribution of consumer-grade natural gas is important for the U.S. refining and petrochemical industries.

America's Fuel and Petrochemical Supply Chain

■ PIPELINE
 ■ RAIL
 ■ TRUCK
 ■ WATER



America's midstream infrastructure – the integrated system of pipelines, ports and waterways, railroads, roadways and storage facilities – is essential for moving America's energy supplies and products along the supply chain from producer to manufacturer to the consumer.

By the Numbers

Each day, about 43.3 million barrels (1.8 billion gallons) of crude oil, refined products and NGLs, and 311 million pounds of plastic resins^B move through U.S. midstream infrastructure networks.⁶ These networks include:



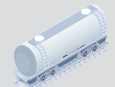
PIPELINES

207,000 miles of crude oil, NGL and refined product pipelines that move raw materials from production areas to refineries and petrochemical plants, and finished products from these plants and facilities to consumers and end users.



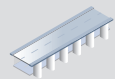
INLAND WATERWAYS

25,000 miles of inland waterways and 926 coastal and inland ports that facilitate domestic fuel movements and provide access to global import and export markets.



RAILWAY TRACK

140,000 miles of railway track and 2 million freight rail cars. Rail cars move crude oil and NGLs from areas not served by pipelines or where pipeline capacity is inadequate. Rail cars are also the standard mode of transportation for heavier refined products, such as asphalt, and solid petrochemical products.



ROADS

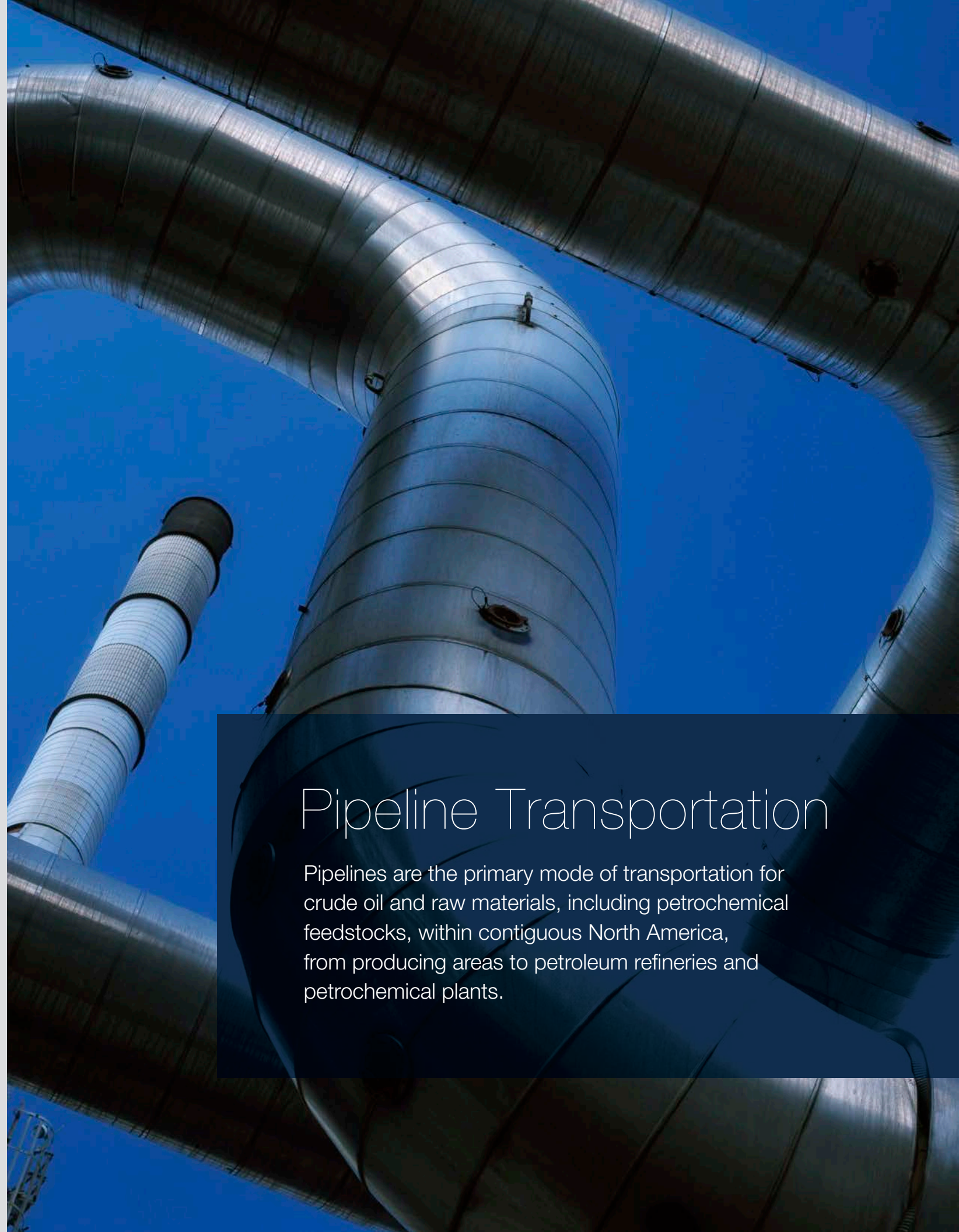
4.1 million miles of roadway that support truck shipments of fuels over the “final mile” from regional storage terminals to retail outlets, and from heating oil and propane depots directly to homes and businesses.



STORAGE

1.7 billion barrels of tankage that is used to store crude oil, NGLs and refined products at regional terminals along the supply chain. These storage terminals facilitate transferring products from one transport mode to another and from one owner to another.

^B The term “plastic resin” as used in this report refers to petrochemical derivative polymers (aka plastics) that are in the form of small beads, pellets or sheets. These resins are safer to ship and have value added to make them economical. They are used to make myriad everyday consumer goods, as well as high-tech engineering materials used throughout many different supply chains.



Pipeline Transportation

Pipelines are the primary mode of transportation for crude oil and raw materials, including petrochemical feedstocks, within contiguous North America, from producing areas to petroleum refineries and petrochemical plants.

Pipelines also are the primary mode for transporting refined products to distribution terminals serving consumer markets. Pipelines provide a safe, reliable, efficient and cost-effective way to move bulk liquids, particularly over long distances. Petroleum and petrochemical pipeline infrastructure includes:

- 207,000 miles of mostly underground interstate and intrastate pipelines that carry crude oil, NGLs or petroleum products⁷;
- Pumping stations that are used to manage pipeline flow and pressure;
- Interconnection stations that allow for product to flow from one pipeline system into another; and
- Breakout tankage that provides temporary storage along the pipeline system.

Pipeline infrastructure includes numerous miles of small-diameter pipeline gathering systems that move crude oil and natural gas from the wellhead to storage, processing facilities and connections to larger pipeline systems. It also includes pipelines that transport and distribute consumer-grade natural gas to refineries, petrochemical plants and power generation facilities that support refinery and petrochemical manufacturing operations.

By the Numbers

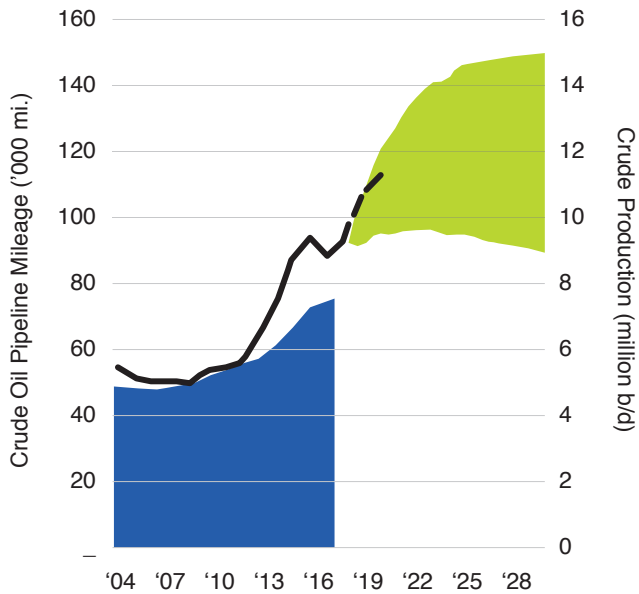
Pipelines move millions of barrels of crude oil, refined products and NGLs each day. According to the U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA), there are 76,000 miles of crude oil pipelines, 69,000 miles of NGL pipelines and 62,000 miles of refined-product pipelines in operation in the United States.⁸ As U.S. oil and gas production

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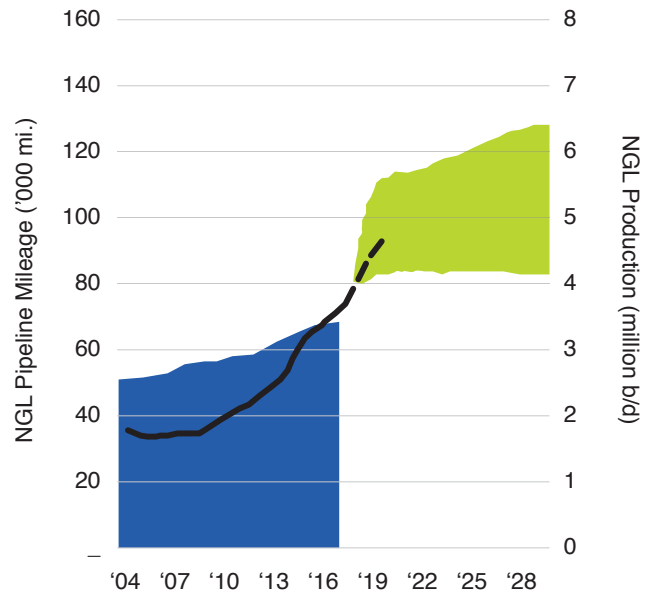
has increased, thousands of miles of new pipeline have been added. This new infrastructure includes pipelines that move crude oil and NGLs from production basins, such as the Bakken in North Dakota, the Eagle Ford and Permian in Texas, and the Marcellus and Utica shale regions in Pennsylvania and Ohio, to refineries and petrochemical processing facilities. From 2010 to 2016, crude oil and NGL pipeline mileage increased by more than 25 percent.⁹ With U.S. oil and NGL production projected to grow by more than 15 percent and 20 percent, respectively, over the next decade, significant new investments are needed to ensure that these resources can be tapped to fuel our growing economy. Needed investments include the construction of new pipelines, as well as the expansion of existing systems.

As U.S. crude oil production has grown, U.S. refiners have increased the processing of domestically produced crude. As a result, they have become increasingly reliant on pipelines for crude supply. In 2016, U.S. refineries received 10.2 million b/d of crude oil via pipeline, and 62 percent of total crude receipts, an increase in refinery pipeline receipts of more than 30 percent since 2010.¹⁰

Crude Oil Production vs. Pipeline Mileage



NGL Production vs. Pipeline Mileage



■ AEO '18 Forecast Range

■ Pipeline Mileage ('000 mi.)

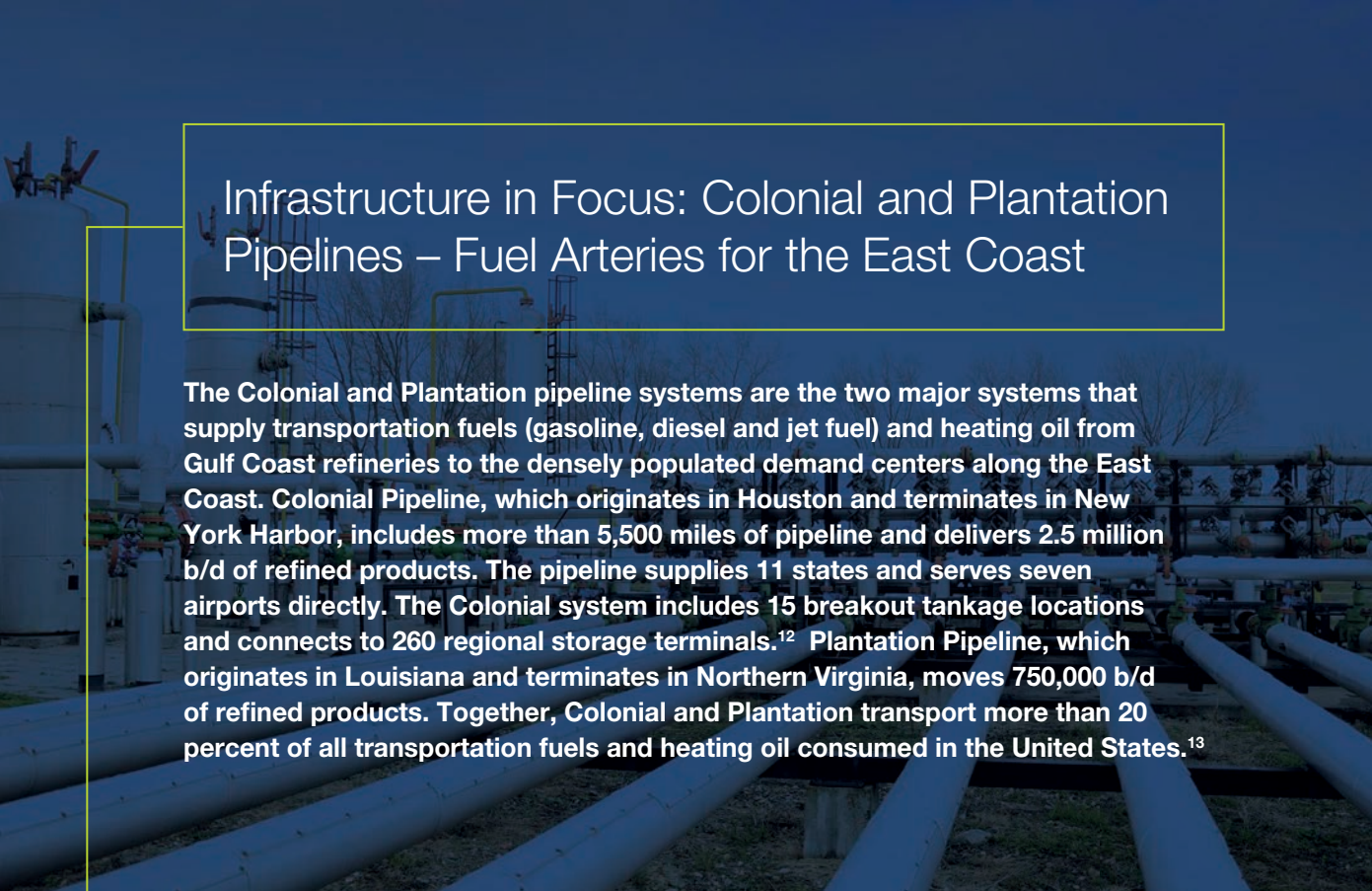
--- STEO-Mar '18 Forecast

— Actual Production

Source: Analysis of EIA 2018 Annual Energy Outlook (AEO), EIA March 2018 Short Term Energy Outlook (STEO), and Pipeline and Hazardous Materials Safety Administration (PHMSA) Annual Report Mileage Summary Statistics

Natural Gas Pipelines

In addition to liquids, pipelines also move wet natural gas, from which NGLs are extracted, and dry natural gas, which is used as input in refinery and petrochemical plant operations and for power generation. Virtually all natural gas supply is transported and distributed by pipeline. In 2016, the natural gas pipeline network included 18,000 miles of gathering pipelines at production fields, 300,000 miles of transmission pipelines that transport gas over long distances, and 2.2 million miles of distribution system pipelines that deliver gas directly to individual neighborhoods and consumers.¹¹



Infrastructure in Focus: Colonial and Plantation Pipelines – Fuel Arteries for the East Coast

The Colonial and Plantation pipeline systems are the two major systems that supply transportation fuels (gasoline, diesel and jet fuel) and heating oil from Gulf Coast refineries to the densely populated demand centers along the East Coast. Colonial Pipeline, which originates in Houston and terminates in New York Harbor, includes more than 5,500 miles of pipeline and delivers 2.5 million b/d of refined products. The pipeline supplies 11 states and serves seven airports directly. The Colonial system includes 15 breakout tankage locations and connects to 260 regional storage terminals.¹² Plantation Pipeline, which originates in Louisiana and terminates in Northern Virginia, moves 750,000 b/d of refined products. Together, Colonial and Plantation transport more than 20 percent of all transportation fuels and heating oil consumed in the United States.¹³

COLONIAL AND PLANTATION TRANSPORT MORE THAN 20 PERCENT OF ALL TRANSPORTATION FUELS AND HEATING OIL CONSUMED IN THE UNITED STATES.

Exceptional Safety

Pipelines are one of the safest modes for transporting petroleum liquids. Starting with the planning process, pipeline companies work with key stakeholders to address safety and security issues. During construction, only the highest quality materials are used, and the pipeline is inspected and tested before it goes into service according to, and often exceeding, the highest federal and engineering standards. Pipeline operators work constantly to keep their systems

safe, using cutting-edge diagnostic tools to inspect pipelines, conducting preventative maintenance, monitoring pipeline pressure to quickly detect leaks and shutdown affected systems, establishing emergency response plans, and practicing emergency response to ensure rapid action if incidents do occur. For example, robotic devices called “smart pigs” (due to the squealing sound they make as they travel through the pipeline) are used to evaluate the inside of pipelines to ensure that they are safe.

A large yellow crane is mounted on a white metal structure on a pier. The crane's arm extends across the sky. Below the pier, a red and white tanker ship is docked. The ship's name 'BOUCHARD' is visible on its side. The scene is set against a blue sky with some clouds.

Waterborne Transportation

America's extensive system of coastal and inland ports and waterways facilitates the safe and efficient transport of fuels and petrochemicals within the United States, and connects the U.S. refining and petrochemical industries to global markets.

Infrastructure that supports the waterborne movement of fuels includes:

- Tankers and barges specifically designed to transport crude oil, NGLs and refined petroleum products;
- Privately owned docks, jetties and fuel loading/unloading facilities; and
- The ports and waterways themselves, which are largely managed and maintained by the U.S. Coast Guard and U.S. Army Corps of Engineers.

America's refining and petrochemical industries are concentrated around deepwater ports, with ocean access along the Gulf, East and West coasts, to support inbound shipments of foreign crude oil and outbound shipments of domestically produced refined products.

In addition, Florida and coastal New England – both major U.S. population centers – rely on waterborne shipments of refined products because they lack in-region refineries and are not served by long-distance product pipelines. Hawaii, which has two refineries, relies on waterborne shipments of crude oil and some refined products, as does Puerto Rico, which has no refineries. Much of the interior of the United States relies on fuel deliveries via the U.S. inland river system, which includes the Mississippi, Ohio, Illinois and Hudson rivers.

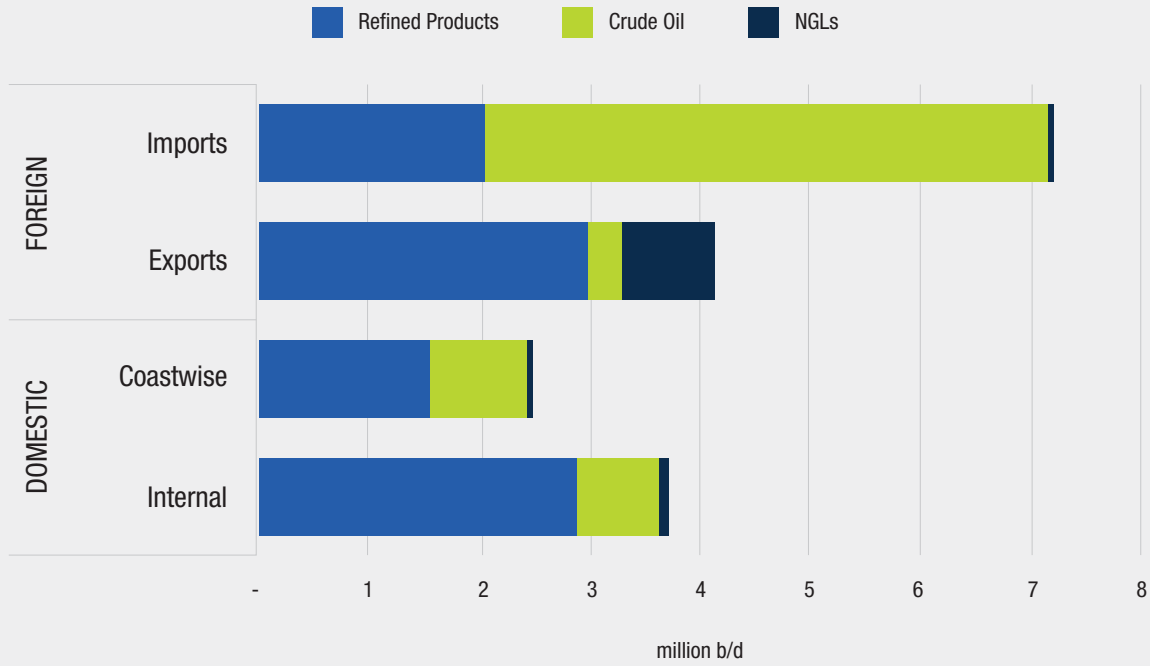
By the Numbers

The U.S. system of ports and waterways includes 926 harbors located along the coasts, Great Lakes and inland waterways; and 25,000 miles of inland waterways, which include 239 locks.¹⁴ According to the most recent data available from the U.S. Army Corps of Engineers, on average, 18.1 million b/d of crude oil, refined products and NGLs move through this system. Imports and exports dominate these volumes, and imports averaged 7.2 million b/d and exports averaged 4.8 million b/d.¹⁵ Domestic movements were 6.2 million b/d, of which 2.5 million b/d moved along the Atlantic, Pacific and Gulf coasts, and 3.7 million b/d moved on inland waterways, the Great Lakes and between docks within a port.

On average, 18.1 million b/d of crude oil, refined products and NGLs move through the U.S. system of ports and waterways.

The U.S. system of ports and waterways services both domestic movements and international trade of crude oil, NGLs and refined petroleum products. With U.S. oil, gas and NGL production increasing, and with waterborne shipments an essential part of the transportation supply chain, significant investments are needed to maintain and improve our nation's waterways.

U.S. Waterborne Petroleum & NGL Traffic, 2016



Source: Analysis of U.S. Army Corps of Engineers U.S. Waterway System: 2016 Transportation Facts & Information



Infrastructure in Focus: Florida's Ports Keep the Sunshine State Moving

Supply of refined products to Florida relies almost exclusively on tanker and barge deliveries to terminals located in the state's Gulf and Atlantic ports – primarily Tampa, Port Everglades and Jacksonville. Florida has no direct pipeline supply from Gulf Coast refining centers. In 2017, Florida ports received more than 750,000 b/d of refined products, primarily from refineries along the U.S. Gulf Coast, and supplemented by imports from the global market. Fuel supply security for Floridians and their many annual visitors requires that those key ports remain open and accessible to tankers and barges. Maintenance of docks and timely dredging of the waterways are essential for a secure and economic supply to consumers. A major project underway at Port Everglades will increase the waterway depth, which will make it possible for the port to accommodate larger, more cost-effective tankers.



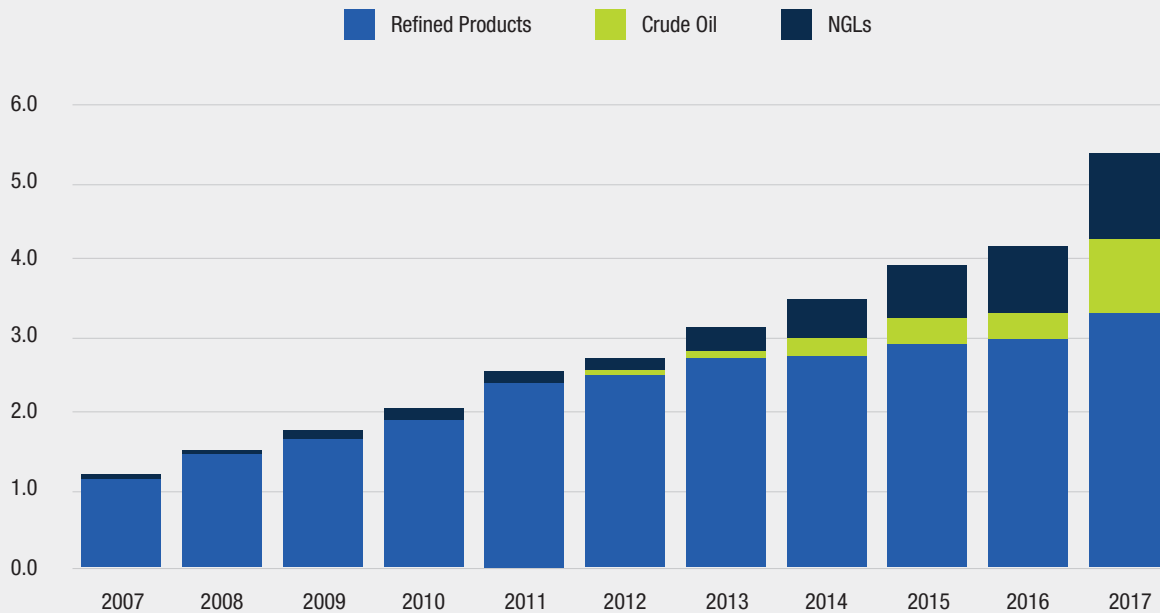
Source: Adapted from EIA East Coast and Gulf Coast Transportation Fuels Markets Study (Feb. 2016)

Serving the Surge in Exports

America's ports and waterways are increasingly important for supporting the growth in exports of refined products, crude oil and NGLs. Between 2007 and 2017, these waterborne exports increased more than fourfold, from 1.2 million b/d to nearly 5.4 million b/d, according to data from the U.S. International Trade Commission.¹⁶ The increase in refined-product exports – from 1.2 million b/d to 3.3 million b/d – has been driven by a strong domestic refining industry, expanding global demand, increasing supplies of domestic crude oil and flattening domestic demand for gasoline. Exports of NGLs have been driven by strong domestic production growth and

growing global demand for petrochemicals. The increase in U.S. crude oil exports follows the relaxation of restrictions on the export of minimally processed condensate (a form of ultra-light crude oil) in 2014, the removal of restrictions on the export of all types of crude oil in late 2015, and growing interest by refineries outside the United States to process U.S.-produced crude oil. In 2017, waterborne exports of crude oil averaged more than 0.9 million b/d, up from about 0.3 million b/d the previous year. Exports of refined products, crude oil and NGLs are expected to continue increasing over the next 10 years, requiring additional investment in America's system of ports and waterways, particularly along the Gulf Coast, where many export facilities are being constructed.

U.S. Waterborne Petroleum Exports (million b/d)



Source: Analysis of U.S. International Trade Commission Interactive Tariff and Trade DataWeb



Infrastructure in Focus: Port of Corpus Christi Poised to Lead America's Energy Export Boom

The Port of Corpus Christi on the Texas Gulf Coast lies at the heart of the U.S. energy export boom and as crude oil production from the Eagle Ford Shale and Permian Basin has increased, the volume of crude oil loaded at the port has grown. In 2017, approximately 570,000 b/d of crude oil was loaded onto tankers and barges in the Port of Corpus Christi.¹⁷ Of this volume, 290,000 b/d were exported to foreign markets, accounting for approximately 25 percent of total U.S. crude oil exports.¹⁸ With \$5 billion in new pipelines under construction to bring as much as 2 million b/d of additional crude oil from the Permian Basin to Corpus Christi terminals, outbound shipments from the port are poised to take off over the next few years.¹⁹ Outbound shipments of NGLs and petrochemicals are also expected to continue growing, with an \$18 billion liquefied natural gas (LNG) export project expected to enter service in 2018. These projects will further increase traffic at the port, which is already the fourth largest in the United States by tonnage. Accommodating these surging volumes will require significant investments in publicly and privately owned port facilities, including a major project to widen the Corpus Christi Ship Channel and deepen it from 45 feet to 54 feet. The project, when complete, will allow larger ships to load at the port, reducing transportation costs and increasing the competitiveness of U.S. exports on the global market – an opportunity that is underscored by the recent expansion of the Panama Canal and the increasing availability of supertankers. The Port of Corpus Christi estimates that the project would enable an incremental \$36 billion in annual energy exports from the port, or one-tenth of the current trade deficit with China.²⁰



Rail Transportation

America's rail networks provide an extensive and flexible transportation system for refinery and petrochemical feedstocks, as well as finished and intermediate products.

Rail infrastructure includes:

- Rail cars (tank cars for liquids and gases, and hopper cars for solids, such as plastic resins) and locomotives;
- Rail car loading and unloading facilities; and
- Railway tracks and switchyards.

Crude oil and refined transportation fuels, such as gasoline and diesel, typically move by rail when they cannot be moved by pipeline or marine vessel. Certain NGLs – propane and butane – commonly move by rail, as do heavier, solid or semi-solid refined products, such as asphalt, petroleum coke and sulfur. Petrochemical products, such as plastic resins, move by rail as well, as do chemicals needed in the operation of petroleum refineries, such as acids and caustic soda. While biofuels, such as ethanol and biodiesel, can be transported by pipeline, their physical and chemical properties present operational challenges and therefore they are primarily shipped by rail. As rail transport of petroleum and petrochemical raw materials and products continues, new investments are needed to maintain and improve our nation's rail infrastructure.

By the Numbers

The U.S. rail network includes 140,000 miles of railway track.²¹ According to the American Association of Railroads,

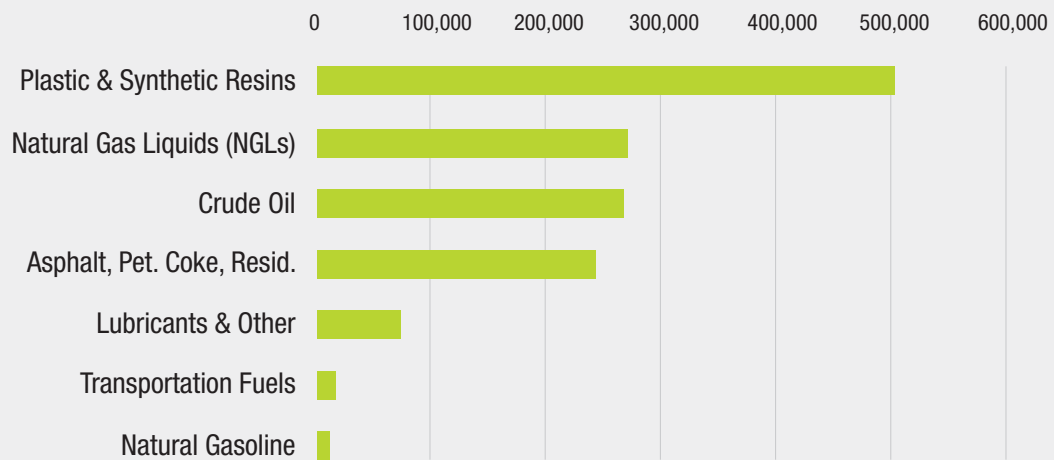
approximately 1.4 million carloads of crude oil, NGLs, refined products, plastics and synthetic resins were delivered by rail within the United States in 2016. The associated graph details carloads of crude oil, NGLs, and petroleum products.

Rail Car Retrofits Improve Safety

In 2012, the volume of crude oil moved by rail began to increase rapidly as production from the Bakken Formation in North Dakota overwhelmed the capacity of pipelines to move the crude to refining centers. To address safety concerns related to moving crude by rail, the industry, including shippers and tank car owners, began one of the largest rail tank car retrofits in U.S. history. This was later reinforced by federal regulations that required tank cars in flammable liquid service to improve puncture resistance and thermal protections. According to U.S. Department of Transportation estimates, these standards required replacing or retrofitting more than 90,000 tank cars at a total investment of \$520 million.²² Additional investment in accident prevention, including addressing track issues, equipment failures and human error, which are the primary causes of most train derailments, would further enhance the safety of moving petroleum and petrochemicals by rail.

Approximately 1.4 million carloads of crude oil, NGLs, refined products, plastics and synthetic resins were delivered by rail within the United States in 2016.

Petroleum Rail Carloads by Product, 2016



Source: Analysis of American Association of Railroads (AAR) Freight Commodity Statistics 2016

Infrastructure in Focus: American Manufacturing Relies on Rail

Petrochemical plants, which are heavily concentrated in the Gulf Coast region, produce resins – the materials that are molded or shaped into finished plastic products. These resins are typically in the form of beads, sheets or powders. The petrochemical industry relies on rail transportation to move resins from the Gulf Coast to manufacturing plants in America’s industrial heartland – stretching from New York and New Jersey in the east to Illinois and Wisconsin in the west – where the resins are turned into a wide variety of finished plastic products, ranging from car parts to medical devices to everyday items such as water bottles or food packaging containers. In 2016, more than 500,000 carloads of plastic resins were transported by rail in the United States, primarily in closed hopper cars that can each carry up to 93 tons of pellets.²³

Truck Transportation

Truck transportation infrastructure includes privately owned tank trucks of various sizes and the 4.1 million mile U.S. network of public roads, bridges and tunnels.²⁴



Trucks are often the only transportation mode that can deliver fuels on the final mile of the supply chain because retail outlets that sell fuels to consumers are numerous and spread throughout the communities where people live and work. Airport fuel trucks also move jet fuel from airport storage tanks to aircraft. In some remote production areas that lack robust pipeline gathering systems, trucks also are used to move crude oil from production sites to centralized storage terminals where the crude can be injected into pipelines or loaded into rail cars. Trucks also transport workers, equipment, water and sand in producing areas. The petrochemical industry also relies on trucks to move resins short distances from petrochemical processing plants and intermodal rail terminals to manufacturing facilities that produce consumer goods.

By the Numbers

In 2017, the United States consumed 13.3 million b/d of ground transportation fuels (gasoline and diesel) and heating oil – more than 200 billion gallons for the year. Virtually every gallon moved the final mile to the consumer by tank truck.²⁵ AFPM estimates that moving this volume of fuels to consumers requires more than 22 million truck trips per year, at least 60,000 trips each day. Tank trucks deliver fuels to more than 120,000 retail outlets, where consumers purchase gasoline and diesel fuels. Smaller distribution trucks also deliver heating oil and propane used for space heating directly to 11.5 million homes.²⁶

Trucks Provide Flexibility During Energy Emergencies

When pipelines, waterways, ports and rail networks are disrupted, the extensive and interconnected U.S. highway system often provides an essential alternative for delivering fuels over long distances. Following Superstorm Sandy, when pipeline problems, port disruptions and power outages at terminals and retail outlets led to fuel supply shortages in and around New York City, trucks were essential for bringing in fuel from outside the region to supply emergency responders and other essential public services. More recently, when Hurricane Maria resulted in storm damage and power outages that closed terminals on the island of Puerto Rico, tank trucks loaded with fuel on the mainland United States were shipped to the island to supply much needed fuels for transportation and backup power generators. Trucks are also often used to provide incremental fuel supply when increased demand overwhelms the capacity of the normal supply chains. When the “polar vortex” brought extreme cold to parts of the United States in late 2013 and early 2014, Midwest space heating demand for propane surged. As pipeline and rail infrastructure that normally delivers bulk supply of propane into the Midwest struggled to keep up with demand, tank trucks supplied the needed fuel from as far away as Texas and Mississippi.

In 2017 the U.S. consumed more than 200 billion gallons of ground transportation fuels and heating oil. Virtually every gallon was moved the final mile to the consumer by tank truck.

Infrastructure in Focus: Trucks Move Crude the “First Mile” in the Permian Basin

Trucks deliver a majority of all petroleum fuels on the “last mile” of the supply chain, but in remote production areas that lack pipeline or rail infrastructure, trucks also provide the “first mile” of transportation, hauling crude oil to centralized storage facilities that are connected to rail and pipeline infrastructure. In the Permian Basin in western Texas and southeastern New Mexico, a massive region that stretches more than 53 million acres, crude oil production is climbing sharply.²⁷ EIA expects Permian production to reach 2.9 million b/d by the end of 2018, accounting for nearly 30 percent of total U.S. production. Rapidly increasing production over this large geographic area is overwhelming existing crude gathering and distribution pipeline systems. As the feverish pace of new well construction outstrips the pace of gathering line expansion, trucks are filling the gap, transporting crude from the wellhead to gathering terminals or delivering crude directly to local refiners.





Storage Terminals

Storage terminals (also referred to as distribution terminals, bulk storage facilities, tank farms or depots) link the different segments of the petroleum supply chain.

Terminals facilitate the flow of crude oil, refined products or NGLs from one transportation system to another (e.g., from pipeline to truck or from one pipeline to another pipeline). While often overlooked, terminals are essential links in the supply chain. All terminals have storage tanks and infrastructure to facilitate the movement of material into and out of the terminal. This infrastructure may include:

- Pipeline interconnections;
- Marine jetties and other marine infrastructure for loading or unloading ships or barges;
- Rail track and rail car loading and unloading infrastructure; and/or
- Truck racks for loading or unloading tank trucks.

Crude oil terminals are located at gathering points in oil-producing areas, at major pipeline interconnections and close to refining hubs. These terminals facilitate the sale of crude oil by producers to refiners and marketers. Refined-product terminals

provide the link between the wholesale and retail fuel marketers. Refined-product terminals receive bulk fuel supply by pipeline, waterborne vessels, or in some remote areas, rail or truck, and store the product until it is delivered by truck to retail outlets, large commercial consumers or distribution companies that supply heating oil and propane to residences and businesses. Refined-product terminals also typically have infrastructure to support blending biofuels (such as ethanol and biodiesel) and brand-specific additives into finished fuels.

By the Numbers

The United States has approximately 1.7 billion barrels of operating storage capacity for crude oil, petroleum products and NGLs; 539 million barrels of crude oil storage; 661 million barrels of refined-product storage; and 465 million barrels of NGL storage. More than 90 million barrels of crude oil storage, or approximately 17 percent of the nation's total crude storage capacity, is concentrated at the crude oil hub in Cushing, Oklahoma.²⁸

Infrastructure in Focus: New York Harbor Product Storage Hub

Terminal storage capacity for refined products in New York Harbor, located primarily in northern New Jersey and Staten Island, New York, exceeds 75 million barrels, accounting for approximately 12 percent of total U.S. refined-product storage capacity. New York Harbor is the largest refined-product storage and distribution hub in the United States.²⁹ Terminals in New York Harbor store products received by pipeline from Gulf Coast and East Coast refining centers and by waterborne tankers from refineries in Europe, Canada and other international locations. Products stored in New York Harbor terminals are distributed throughout the Northeast by marine vessel to smaller terminals in coastal New England and on the Hudson River in upstate New York; by pipeline to Long Island, western New York, and central and western Pennsylvania; and by truck to local markets in the greater New York City area.

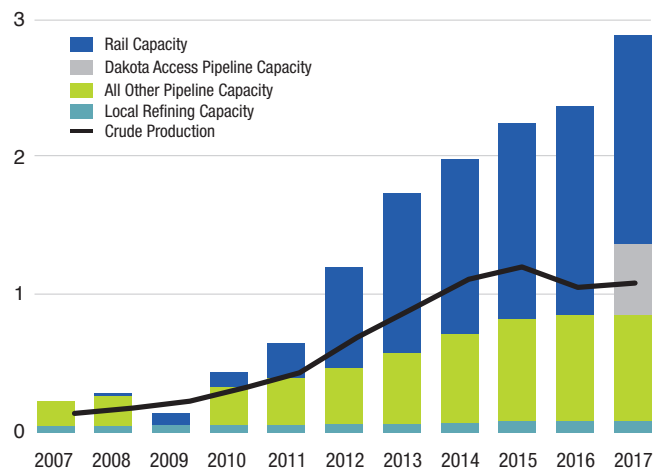
Infrastructure in Focus: The Bakken, a Case Study in a Dynamic Supply Chain

Crude oil production from the Bakken Formation in North Dakota and eastern Montana has increased rapidly over the past decade, from less than 0.2 million b/d in 2007 to a peak of more than 1.2 million b/d in 2015.³⁰ From 2011 to 2016, Bakken crude oil production outstripped the capacity of local refineries to process the crude oil and existing pipeline systems to move the crude to refineries located out of the region. Efforts to expand pipeline capacity began almost immediately; however, to support continued production while proposed pipeline projects were reviewed, approved and constructed, investments were made in rail loading terminals in the Bakken and rail unloading facilities at the refining centers on the East, West and Gulf coasts, and in new retrofitted rail cars to carry the crude. At its peak in 2014, as much as 0.8 million b/d of crude oil moved out of the Bakken by rail.³¹

As new takeaway pipeline capacity was added connecting the Bakken to the crude oil storage hub in Cushing, Oklahoma, and to refineries on the Gulf Coast, shipment of crude by rail from the Bakken declined sharply. Since the startup of the Dakota Access Pipeline in 2017, movement of crude by rail out of the Bakken has fallen to approximately less than 0.2 million b/d, with the remaining rail volumes primarily shipped to the West Coast, a destination that lacks pipeline connections to the Bakken.³²

Natural gas production in the Bakken has also grown, and along with it, the production of NGLs, which have largely moved out of the region by rail. From 2007 to 2017, NGL production in the Upper Midwest (which includes North Dakota) increased from 14,000 b/d to 222,000 b/d.³³ Expansions to pipeline infrastructure are now being planned to move NGLs from the Bakken to the NGL fractionation and storage hub in Conway, Kansas.

Bakken Region Rail and Pipeline Takeaway Capacity vs. Production (million b/d)



Source: Analysis of North Dakota Pipeline Authority US Williston Basin Crude Oil Export Options (June 2017) and EIA Bakken Region Drilling Productivity Report

Challenges to Infrastructure Development

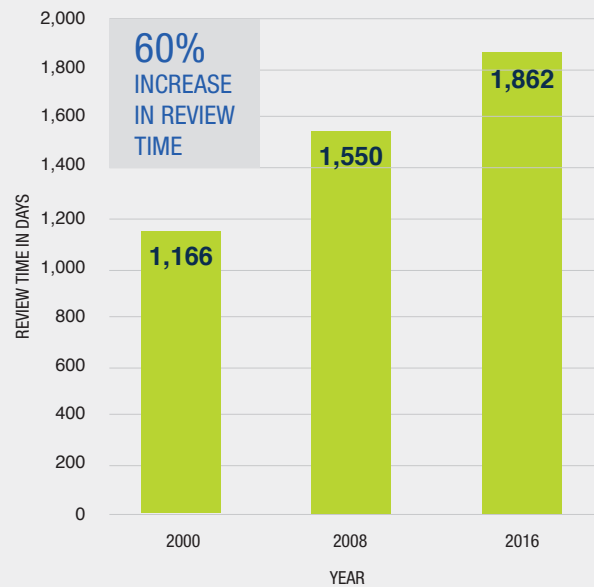
Energy infrastructure developments often face numerous challenges, including lengthy and duplicative permitting processes with multiple federal, state and local agencies; legal challenges by project opponents designed to block or delay construction from moving forward; an uncertain regulatory environment; and even attempts by project opponents to physically damage infrastructure or hinder construction.

In 2000, according to the National Association of Environmental Professionals, it took the federal government an average of 1,166 days (3.2 years) to complete the Environmental Impact Statement required by the National Environmental Protection Act.

By 2016, the time required had ballooned to 1,862 days (5.1 years) – not including the time needed for required state and regional analyses. From the time a project is conceived of to the start of construction, a developer can expect years of paperwork, bureaucratic challenges and legal complications. Put simply, it often takes longer for the government to approve a project than it takes for a developer to build it.

AFPM acknowledges the need for robust analyses of infrastructure projects to ensure that environmental impacts are appropriately considered. Yet, the current

National Environmental Protection Act Review Time



Source: National Association of Environmental Professionals Annual National Environmental Policy Act (NEPA) Report for 2016

permitting processes and regulatory requirements often hinder needed infrastructure developments. Efforts to reform permitting processes should promote accountability for reviews and ultimately reduce the costs and burdens of delayed infrastructure projects by eliminating duplicative actions, ensuring consistency in reviews and providing timely and predictable review schedules.

AFPM supports policies that streamline and enhance the ability of companies to build and maintain energy infrastructure.



Conclusion

AFPM's member companies manufacture the fuels that drive the modern economy and form the chemical building blocks that are used to create thousands of products that make modern life possible. AFPM's member companies rely on an interconnected, multimodal infrastructure network to produce and transport these essential goods. Our members, along with the U.S. consumer, depend on reliable and safe midstream infrastructure systems – pipelines, ports and waterways, railroads, roadways and storage facilities – to move

these goods from where they are produced to where they are consumed.

Maintaining, modernizing and expanding midstream infrastructure supports robust economic growth, spurs job creation and enhances the quality of life of all Americans. Investing in the midstream infrastructure that serves America's fuels and petrochemical manufacturing sectors is as important to ensuring American prosperity as investing in highways, roads and bridges. AFPM's member companies

will continue to make significant investments to ensure the continued integrity and safety of these systems. In addition, policies aimed at rebuilding our nation's infrastructure for the 21st century should take into account the essential role of the midstream sector.

AFPM fully supports state, local and federal policies that encourage the proper maintenance of existing infrastructure and the development of new infrastructure to support the refining and petrochemical industries.

Infrastructure projects, whether they are publicly or privately funded, are often very costly and highly complex. Highway and waterway infrastructure projects are typically funded by federal, state and/or local governments, or through public-private partnerships. Projects to maintain or expand energy infrastructure, railroads and many port facilities, on the other hand, are more often privately funded and thus depend largely on market forces. AFPM supports policies and programs that promote smart infrastructure investments through innovative financing

mechanisms and the removal of regulatory barriers to such investments.

Infrastructure, including midstream infrastructure serving the refining and petrochemical industries, is the backbone of the U.S. economy. It is essential to modern life. AFPM supports policies and programs that streamline the long and often complex process of planning, permitting and financing infrastructure projects to ensure that needed investments are quickly and efficiently made in the multimodal infrastructure network that drives our economy and fosters American prosperity.

Maintaining, modernizing and expanding midstream infrastructure supports robust economic growth, spurs job creation and enhances the quality of life of all Americans.



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- ² U.S. Department of Energy, Energy Information Administration. Annual Energy Outlook 2018, Reference Case, Table 11, Petroleum and Other Liquids Supply and Disposition. Accessed April 9, 2018.
- ³ Ibid.
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- ⁵ <http://globenewswire.com/news-release/2015/10/14/775973/0/en/Petrochemical-Market-Revenue-Will-Grow-To-758-3-Billion-By-2022-New-Report-By-Grand-View-Research-Inc.html>
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- ¹⁷ Port of Corpus Christi. Monthly Cargo Tonnage by Commodity Report for December 2017.
- ¹⁸ U.S. Census Bureau. USA Trade Online. Accessed April 9, 2018.
- ¹⁹ ICF assessments based on multiple company announcements, including EPIC, Magellan, Plains All American, and Phillips 66. Accessed April 9, 2018.
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²⁶ National Association of Convenience Stores. 2016 Retail Fuels Report. <http://www.convenience.org/YourBusiness/FuelsCenter/Documents/2016/2016-Retail-Fuels-Report.pdf>. Accessed April 9, 2018; and U.S. Department of Energy, Energy Information Administration. Residential Energy Consumption Survey (RECS), Table HC6.1, Space heating in U.S. homes by housing unit type, 2015. Accessed April 9, 2018.

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²⁹ U.S. Department of Energy, Energy Information Administration. State Profile and Energy Estimates, New York. Accessed April 9, 2018; and U.S. Department of Energy, Energy Information Administration. Table 3, Net Available Shell Storage Capacity of Terminals and Tank Farms as of September 30, 2016. Accessed April 9, 2018.

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³² Ibid.

³³ U.S. Department of Energy, Energy Information Administration. Refining District Minnesota-Wisconsin-North Dakota-South Dakota Field Production of Natural Gas Liquids. Accessed April 9, 2018.

This report was prepared by ICF Resources, LLC under the direction of AFPM.



A person wearing a blue denim shirt is shown from the side, with their right arm raised high, holding onto a horizontal bar. The background is a blurred interior of a train car, featuring a window and overhead lights. The overall mood is one of energy and movement.

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