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# THE ENERGY BOTTLENECK

## Why America Needs More Pipelines

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# About the Author

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# Contents

# Executive Summary

America is enjoying an energy renaissance, as U.S. firms produce vast amounts of oil and natural gas that need to be shipped safely and efficiently across the country and abroad. Pipelines offer the best way to achieve this. Yet the supply of pipelines is not keeping pace with demand.

The result: a growing energy bottleneck that is forcing oil and gas companies to turn increasingly to more accident-prone and more expensive shipping alternatives, such as trucks, railroads, and tankers. This report finds, for example, that average annual accident rates during 2007–16, per billion ton-miles of oil and gas transported, were 0.66 for oil pipelines (i.e., the fewest accidents), 0.73 for natural gas pipelines, 2.20 for rail, and 7.11 for road. During the same period, annual property damage caused by pipelines ($352.89 million) was only about 0.002%—or two one-thousandths of 1%—of U.S. GDP in 2016 ($18.46 trillion).

At least 30 major new natural gas pipeline projects are under regulatory review at the Federal Energy Regulatory Commission (FERC), which must approve all interstate natural gas pipelines. (Interstate oil pipelines must secure the approval of state regulators. Pipelines extending into Mexico or Canada require presidential approval.) However, until at least two of FERC's four vacant board seats are filled, FERC will lack the quorum needed to approve new natural gas pipelines.

To maximize the benefits of America's energy renaissance, the Trump administration, Congress, and federal and state regulators should prioritize expanding and upgrading the country's inadequate pipeline infrastructure.

# THE ENERGY BOTTLENECK

## Why America Needs More Pipelines

## Introduction[1]

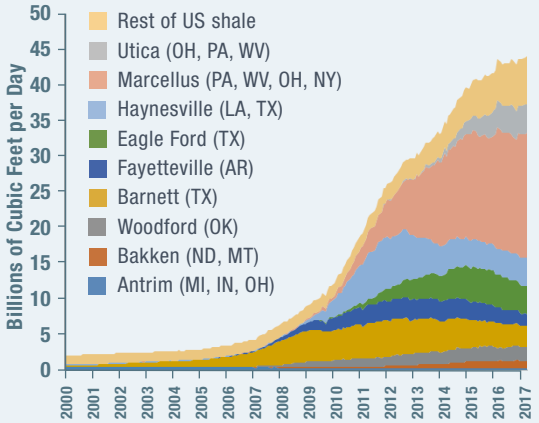
America's vast size, combined with its rapid development of new sources of energy, requires lots of new pipeline infrastructure to transport oil and natural gas from source to end destination. This report examines the growing bottlenecks in the country's pipelines. It highlights 30 major new pipeline projects that could ease the bottleneck if approved by regulators, and it explains why fears over pipeline safety are overstated.

The discovery of new sources of oil and natural gas—as well as the development of new technologies that allow these resources to be more effectively harnessed—has led to a substantial increase in U.S. energy production (**Figure 1** and **Figure 2**). From 2009 to 2017, dry shale natural gas production rose from 8.9 billion to 44 billion cubic feet per day, and field production of crude oil rose from less than 5,000 barrels per day to more than 9,300.

U.S. energy exports are increasing fast, too.[4] According to the U.S. Energy Information Administration, America exported 1.2 million barrels per day of crude oil and petroleum products (gasoline, distillate, jet fuel, petroleum coke, and hydrocarbon gas liquids) in February 2005. In February 2017, it exported 6.4 million barrels per day.[5] Yet America's aging pipeline infrastructure is ill equipped to handle rising domestic, as well as foreign, demand for U.S. energy.

FIGURE 1.

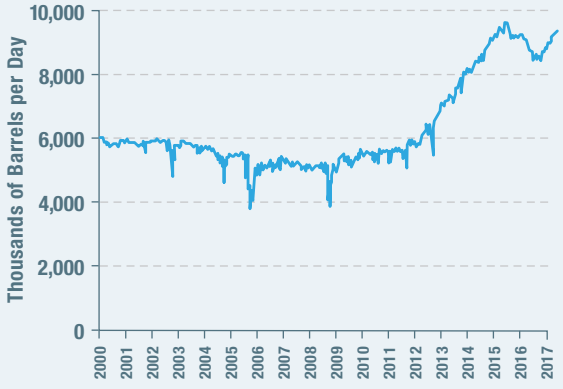
### U.S. Dry Shale Gas Production




Source: U.S. Energy Information Administration[2]

FIGURE 2.

### U.S. Crude Oil Production




Source: U.S. Energy Information Administration[3]

# America Needs More Pipelines

The first large-diameter, long-distance pipelines were constructed in the U.S. during World War II, and approximately half of U.S. pipelines in use today were built in the 1950s and 1960s.[6] America now has 208,000 miles of onshore and offshore petroleum pipeline; 318,000 miles of natural gas gathering and transmission pipeline;[7] and almost 2.2 million miles of natural gas distribution pipeline.[8]

In the U.S., pipelines are the primary mode of transportation for crude oil, petroleum products, and natural gas. But they are not the only method. (Dry natural gas is shipped almost exclusively by pipeline.) On a ton-mile (a ton of freight moved one mile) basis, about 70% of crude oil and petroleum products are shipped by pipeline (**Figure 3**). Tankers and barges account for 23% of these shipments. Trucks (henceforth "road") account for only 4% of shipments, and rail accounts for still less.

**Figure 4** offers a more narrow view: transportation methods for just the delivery of crude oil to refineries. Despite a recent rise in their share of deliveries—a sign of the growing strain on U.S. pipeline capacity—barge, road, and rail still account for only about 10% of deliveries, compared with about 60% for pipelines and 30% for tankers.

Soaring oil and gas production has not been matched by a corresponding increase in new pipelines to transport the stuff (**Figure 5**). In the Bakken formation, for example, oil production has "outstripped the infrastructure needed to move it to refineries across the country," according to the Federal Reserve Bank of Minneapolis.[11] The Congressional Research Service reports: "[Rail only] became cost-effective [in the Bakken] because of the price discounts created by pipeline bottlenecks, which prevented available supplies from reaching the consuming markets. If additional oil pipeline capacity is constructed to connect North Dakota with consuming markets, the pipeline bottleneck will be reduced."[12]

Pipelines have distinct advantages over other forms of transportation. They are typically more cost-effective[14] and, as shown below, are generally safer. Yet without new pipelines to meet their shipment needs, oil companies are turning more frequently to alternatives—

FIGURE 3.

## Mode of Transportation for Crude Oil and Petroleum Products in U.S., 2000–09 (billions of ton-miles)

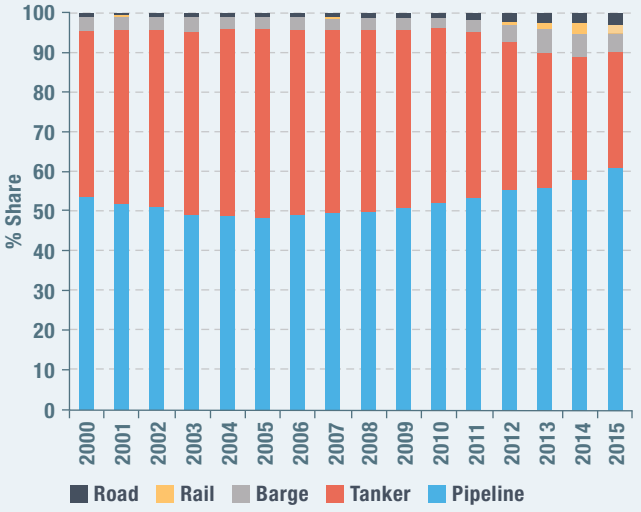
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Crude Oil, Total** | 376.0 | 377.0 | 384.0 | 380.0 | 374.1 | 376.3 | 366.0 | 335.5 | 372.0 | 336.0 |
| Pipelines | 283.4 | 277.0 | 286.6 | 284.5 | 283.7 | 293.5 | 300.5 | 266.6 | 306.3 | 268.2 |
| Water Carriers | 91.0 | 98.1 | 95.7 | 94.1 | 88.7 | 81.1 | 63.8 | 66.9 | 63.2 | 65.1 |
| Motor Carriers | 1.2 | 1.1 | 1.2 | 1.3 | 1.2 | 1.4 | 1.4 | 1.6 | 1.7 | 1.7 |
| Railroads | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.7 | 1.0 |
| **Refined Petroleum Products, Total** | 497.3 | 493.0 | 481.0 | 503.0 | 528.4 | 529.7 | 489.4 | 499.9 | 485.9 | 474.1 |
| Pipelines | 293.9 | 299.1 | 299.6 | 305.7 | 315.9 | 314.0 | 280.9 | 291.1 | 299.4 | 300.2 |
| Water Carriers | 153.4 | 145.9 | 131.9 | 146.0 | 158.2 | 159.4 | 149.3 | 149.1 | 130.8 | 121.7 |
| Motor Carriers | 30.1 | 29.7 | 29.4 | 31.9 | 33.2 | 33.4 | 33.8 | 33.5 | 33.4 | 32.2 |
| Railroads | 19.9 | 18.5 | 19.7 | 19.3 | 21.1 | 22.8 | 25.4 | 26.2 | 22.3 | 19.9 |
| **Combined Crude and Petroleum Products, Total** | 873.3 | 870.0 | 865.0 | 883.0 | 902.5 | 906.0 | 855.4 | 835.4 | 857.9 | 810.0 |
| Pipelines | 577.3 | 576.1 | 586.2 | 590.2 | 599.6 | 607.5 | 581.3 | 557.7 | 605.7 | 568.4 |
| Water Carriers | 244.4 | 244.0 | 227.6 | 240.1 | 246.9 | 240.5 | 213.1 | 216.0 | 194.0 | 186.8 |
| Motor Carriers | 31.3 | 30.8 | 30.6 | 33.2 | 34.4 | 34.8 | 35.2 | 35.2 | 35.1 | 33.9 |
| Railroads | 20.3 | 18.9 | 20.2 | 19.8 | 21.6 | 23.2 | 25.8 | 26.6 | 23.0 | 20.9 |

2009 is the most recent year for which data are available. The Great Recession of 2008–09 reduced demand for U.S. oil and natural gas. America's post-2009 recovery saw a big rise in oil and natural gas production but not a proportionate rise in pipeline infrastructure. See Figure 5.

Source: U.S. Department of Transportation[9]

FIGURE 4.

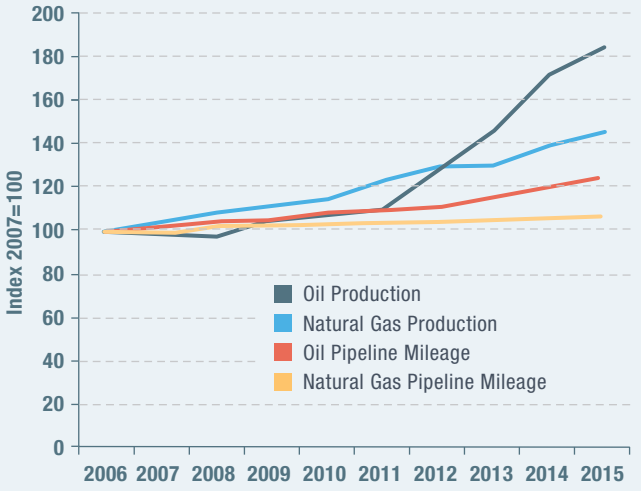
## Crude Oil Deliveries to U.S. Refineries, 2000–15




Source: U.S. Department of Transportation[10]

FIGURE 5.

## Changes in Production and Pipeline Mileage, 2006–15




Source: U.S. Department of Transportation; U.S. Energy Information Administration[13]

notably, road, rail, and barge. In response to changing market conditions, companies are also reversing the flow direction of some pipelines, and they're converting natural gas pipelines into oil pipelines.

Still, these are stopgap solutions: they place excessive stress on aging pipelines, raise maintenance costs, and do little to reduce the growing pipeline bottleneck.[15]

As America's existing pipelines become increasingly strained, repairing them could cost as much as $250 billion, says Ernest Moniz, U.S. secretary of energy under President Obama.[16]

Safety is another concern. The Congressional Research Service warns that "rapid expansion of North American oil production has led to significant challenges in transporting crudes efficiently and safely to domestic markets—principally refineries—using the nation's legacy pipeline infrastructure."[17]

America's pipeline bottleneck has not gone unnoticed by energy firms. At least 30 major new natural gas pipeline projects (**Figure 6**) are under review at the Federal Energy Regulatory Commission (FERC), which must approve all interstate natural gas pipelines.[18] FERC has pre-filings[19] for at least another 20 pipeline projects.[20] FERC recently rejected two additional pipeline projects.[21]

The 30 pipeline projects listed in Figure 6, which would cost $75 billion to build, are at various stages of the regulatory approval process.[23] FERC has requested more information from the respective pipeline firms for 18 of the projects. For the 13 other projects, FERC is receiving outside comments and is making final deliberations. As of June 2017, however, FERC lacked the three-board-member quorum—at present, FERC has only one sitting board member out of a potential five—that it needs to approve new interstate natural gas pipelines.[24]

These 30 pipelines would span the U.S., from Illinois to Texas to Pennsylvania. Many would service new or fast-developing energy sources, such as the Marcellus and Utica formations. And they would add more than 31 billion cubic feet of daily natural gas capacity and 1.5 million barrels of daily oil capacity.[25]

Still, it is not easy to build a big pipeline in America. Engineering, environmental, and eminent domain challenges are considerable. "For these larger, multi-county [pipeline projects], you are not just dealing with one wetland issue or one stream-crossing issue, you are dealing with multiple issues across multiple jurisdictions,"[26] notes Pennsylvania's Department of Environmental Protection, which approved the Mariner East 2 pipeline in February 2017.

Regulatory hurdles abound. The pending Atlantic Coast Pipeline, for example, must secure 46 permits, approvals, and consultations before construction can begin.[27] State regulators, as well as FERC, must give their approval. Other federal agencies and departments—including the U.S. Fish and Wildlife Service, National

FIGURE 6.

## Major Pending Pipeline Projects at FERC

| Natural Gas Project | Capacity (MMcf/d) | Status |
|---|---|---|
| **Rio Bravo Pipeline** | 4,500 | Further info requested by FERC |
| **Mountaineer Xpress Pipeline Project** | 2,700 | Further info requested by FERC; draft environmental impact statement (DEIS) issued on Feb. 27, 2017 |
| **Valley Crossing Pipeline** | 2,600 | Further info requested by FERC |
| **Mountain Valley Pipeline** | 2,000 | Final environmental impact statement (EIS) scheduled for Sept. 21, 2017 |
| **TransCameron Pipeline** | 1,900 | Further info requested by FERC |
| **Supply Header Project** | 1,511 | Further info requested by FERC; DEIS issued on Dec. 30, 2016 |
| **Atlantic Coast Pipeline** | 1,500 | Further info requested by FERC; DEIS issued on Dec. 30, 2016 |
| **NEXUS Gas Transmission Project** | 1,500 | Final EIS issued on Nov. 30, 2016 |
| **Delfin LNG Project** | 1,500 | Further info requested by FERC |
| **WB Xpress Project** | 1,300 | Environmental assessment (EA) approved in Mar. 2017 |
| **PennEast Pipeline Project** | 1,107 | Final EIS issued on Apr. 7, 2017 |
| **Texas Eastern Appalachian Lease Project** | 950 | Final EIS issued on Nov. 30, 2016 |
| **Gulf Xpress Project** | 860 | DEIS issued on Feb. 27, 2017 |
| **Equitrans Expansion Project** | 600 | Final EIS scheduled for Sept. 21, 2017 |
| **Gulf Connector Expansion Project** | 475 | Further info requested by FERC |
| **South Texas Expansion Project** | 400 | EA in process |
| **Lone Star Expansion Project** | 300 | Further info requested by FERC |
| **Bayway Lateral Project** | 300 | Further info requested by FERC; EA issued on July 29, 2016 |
| **Eastern Market Access Project** | 294 | Further info requested by FERC |
| **Ramsey Residue Line** | 275 | Rehearing granted by FERC for further consideration; EA issued on Apr. 21, 2015 |
| **East-West Project** | 275 | Further info requested by FERC |
| **Gulf Coast Market Expansion Project** | 240 | EA issued on Apr. 21, 2017 |
| **Wisconsin South Expansion Project** | 231 | Further info requested by FERC |
| **Eastern System Upgrade** | 223 | Further info requested by FERC; EA issued on Mar. 31, 2017 |
| **St. Charles Expansion Project** | 133 | EA issued on Mar. 3, 2017 |
| **Central Virginia Connector Project** | 45 | Further data and supplemental info requested by FERC; EA issued on Feb. 28, 2017 |
| **Line QP, Q, and Queen Storage Project** | 0 | EA in process |
| **Abandonment and Capacity Restoration Project** | Capacity estimate not available | Rehearing granted by FERC for further consideration; EA issued on Nov. 2, 2016 |
| **Cedar Station Upgrade** | Capacity estimate not available | Further info requested by FERC; EA issued on Dec. 9, 2016 |
| **B-System Project** | Capacity estimate not available | Further info requested by FERC |

MMcf/d = million cubic feet per day. Before FERC approves or rejects a new pipeline, the proposed pipeline project must pass numerous stages of review. First, the developer/operator notifies relevant stakeholders; provides a forum to hear public concerns; and incorporates concerns into its proposal to FERC. Concurrently, FERC seeks public comments and consults with relevant government agencies. Next, FERC issues a Notice of Intent for Preparation of an Environmental Assessment (EA) or an Environmental Impact Statement (EIS). FERC's EA or EIS incorporates analysis from the aforementioned sources. (FERC may also request additional data from the developer/operator.) Next, FERC sends its draft EIS or draft EA to other government agencies for review. FERC then issues a draft EIS or draft EA for public comment. After revising as necessary, FERC issues its final EIS or final EA. Last, FERC approves or rejects the proposed pipeline, based on the findings in its final EIS or final EA.

Source: Federal Energy Regulatory Commission[22]

FIGURE 7.

## Pipeline Accidents, Related Injuries, and Fatalities, 1997–2016

| | Number of Accidents | Property Damage (millions) | Net Barrels of Liquids Lost | Injuries | Fatalities |
|---|---|---|---|---|---|
| 1997 | 346 | $79.76 | 103,129 | 77 | 10 |
| 1998 | 389 | $126.85 | 60,791 | 81 | 21 |
| 1999 | 339 | $130.11 | 104,487 | 108 | 22 |
| 2000 | 380 | $191.82 | 56,953 | 81 | 38 |
| 2001 | 341 | $63.09 | 77,456 | 61 | 7 |
| 2002 | 642 | $102.17 | 77,953 | 49 | 12 |
| 2003 | 672 | $139.06 | 50,882 | 71 | 12 |
| 2004 | 671 | $267.84 | 69,003 | 60 | 23 |
| 2005 | 719 | $1,245.46 | 46,246 | 47 | 17 |
| 2006 | 639 | $151.98 | 53,905 | 36 | 21 |
| 2007 | 611 | $153.90 | 68,942 | 49 | 15 |
| 2008 | 659 | $565.52 | 69,510 | 56 | 8 |
| 2009 | 627 | $179.07 | 32,308 | 64 | 13 |
| 2010 | 586 | $1,692.50 | 49,452 | 108 | 22 |
| 2011 | 592 | $426.55 | 57,375 | 56 | 14 |
| 2012 | 573 | $229.61 | 29,247 | 57 | 12 |
| 2013 | 619 | $349.96 | 85,598 | 44 | 9 |
| 2014 | 707 | $310.26 | 21,686 | 95 | 19 |
| 2015 | 715 | $344.09 | 81,953 | 49 | 12 |
| 2016 | 634 | $308.22 | 53,083 | 82 | 17 |
| **Total** | **11,461** | **$7,057.84** | **1,249,959** | **1,331** | **324** |

Source: U.S. Department of Transportation[31]

### When Is a Pipeline Accident Reported?

A pipeline accident (or "incident") must be reported to the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) if any of the following occurs:[29]

- An explosion or a fire that was not intentionally set by the operator
- The release of five gallons or more of a hazardous liquid (any petroleum or petroleum product) or carbon dioxide
- A fatality
- A personal injury necessitating hospitalization
- Property damage (including cleanup costs) and the value of lost product, or the damage to the property of the operator or others—or both—exceed $50,000

Before 2002, a pipeline spill had to be reported only if it was greater than 50 barrels of liquid or $CO_2$. However, in 2002, the limit was dropped to five gallons (with an exception for maintenance-related spills of five barrels or less confined to company sites).[30] As a result, the number of reported accidents surged, from 341 in 2001 (the 1992–2001 annual average was 383) to 642 in 2002 (the 2002–16 annual average was 644).

Park Service, Federal Aviation Administration, and National Oceanic and Atmospheric Administration—must also be consulted. Lobbying groups mount frequent legal challenges. Shifting economic conditions can lead builders to cancel a project. Even pipelines that are eventually approved can face long regulatory delays.[28] And, not least, pipelines face resistance over concerns about safety.

# Pipelines Are Safe

How safe are pipelines? During the past 20 years, the number of pipeline accidents in the U.S. has increased (largely the result of a change in accident-reporting requirements; see **sidebar**), from a low of 339 in 1999, to a high of 719 in 2005 (**Figure 7**). During this period, America's pipeline network has also grown (albeit more slowly than demand), while the ton-mileage of oil and gas shipments has risen.

When safety metrics are adjusted to reflect the distance that oil and gas are transported, pipeline accidents—already infrequent in absolute terms—become exceptionally rare. What are the costs of a pipeline accident? Figure 7 shows that annual property damage from pipeline accidents averaged $352.89 million during 1997–2016. Lost barrels of liquids averaged 62,498 annually (or about 59% of the total spilled). Injuries averaged 67 annually. And fatalities averaged 16 annually.

To put such numbers into context, average daily pipeline spills over the past 20 years (171 barrels) are equal to just 0.002%, or two one-thousandths of 1%, of the average daily current output of U.S. refineries (about 9 million barrels). Annual property damage caused by pipelines is

less than 0.002% of U.S. GDP in 2016 ($18.46 trillion).[32] And annual deaths caused by pipelines are fewer than the annual number of Americans killed by dogs (19).[33]

Moreover, the rates of "serious" pipeline accidents—those that result in a fatality or an injury requiring inpatient hospitalization—per 1,000 miles of pipeline have fallen substantially during the last 20 years (**Figure 8**). In 1997–2001, the average annual rate was 0.025 accidents; in 2012–16, it was 0.011. Likewise, in 1997–2001, fatalities averaged 0.0087 per 1,000 miles of pipeline, compared with 0.0047 in 2012–16. Meanwhile, the injury rate fell from 0.036 (1997–2002) to 0.024 (2012–16).

Next, consider "significant" pipeline accidents, a more expansive definition that includes at least one of the following:

- Fatality or injury requiring in-patient hospitalization
- At least $50,000 in total costs, measured in 1984 dollars (or about $120,000 today)

FIGURE 9.

## Significant Accidents, Related Injuries, and Fatalities per 1,000 Miles of Pipeline

| | Significant Accidents | Fatalities | Injuries |
|---|---|---|---|
| 1997–2001 | 0.121 | 0.009 | 0.036 |
| 2002–06 | 0.120 | 0.007 | 0.021 |
| 2007–11 | 0.106 | 0.005 | 0.024 |
| 2012–16 | 0.111 | 0.005 | 0.024 |

Source: U.S. Department of Transportation[35]

FIGURE 11.

## Injury Rates, 2007–16

Injury rates for road and rail only cover injuries involving the transport of oil and natural gas.

| | Annual Average per Billion Ton-Miles |
|---|---|
| Road | 0.548 |
| Rail | 0.020 |
| Oil Pipelines | 0.006 |
| Natural Gas Pipelines | 0.183 |

Source: U.S. Department of Transportation[40]

FIGURE 8.

## Serious Pipeline Accidents, Related Injuries, and Fatalities per 1,000 Miles of Pipeline

| | Serious Accidents | Fatalities | Injuries |
|---|---|---|---|
| 1997–2001 | 0.0254 | 0.0087 | 0.0362 |
| 2002–06 | 0.0175 | 0.0067 | 0.0212 |
| 2007–11 | 0.0147 | 0.0052 | 0.0244 |
| 2012–16 | 0.0107 | 0.0047 | 0.0237 |

Source: U.S. Department of Transportation[34]

FIGURE 10.

## Accident Rates, 2007–16

Accident rates for road and rail only cover accidents involving the transport of oil and natural gas.

| | Annual Average per Billion Ton-Miles |
|---|---|
| Road | 7.11 |
| Rail | 2.20 |
| Oil Pipelines | 0.66 |
| Natural Gas Pipelines | 0.73 |

Source: U.S. Department of Transportation[39]

FIGURE 12.

## Fatality Rates, 2007–16

Fatality rates for road and rail only cover fatalities involving the transport of oil and natural gas (onshore only).

| | Annual Average per Billion Ton-Miles |
|---|---|
| Road | 0.2931 |
| Rail | 0.0084 |
| Oil Pipeline | 0.0034 |
| Natural Gas Pipelines | 0.0065 |

Source: U.S. Department of Transportation[41]

### What Causes Pipeline Accidents?

The PHMSA provides data, from 2005 to the present, on the causes of serious pipeline accidents for gas transmission pipelines and gas distribution pipelines.[36] "Other outside force damage" accounted for 26% of serious accidents connected to gas distribution pipelines—of which the vast majority (69%) were caused by reckless drivers, unaffiliated with pipeline operators and often drunk, crashing their cars into pipelines. "Excavation damage" accounted for 26% of serious accidents connected to gas distribution pipelines—of which 84% were caused "when a person other than the pipeline operator or its contractor excavated and damaged a pipeline system." Corrosion and equipment failure accounted for 6% of serious accidents.

As for gas transmission pipelines, excavation damage accounted for 26% of serious accidents.[37] Other outside forces accounted for 16%. And "incorrect operation" (by the pipeline operators) accounted for 16%, though such mistakes led to zero fatalities. These statistics suggest that pipelines could be made even safer if there were a way to reduce third-party contact with pipelines.

- Spills of highly volatile liquids, such as propane, of at least five barrels—or spills of at least 50 barrels of non–highly volatile liquids
- Spills resulting in an unintentional fire or explosion

Once again, annual rates of significant accidents and related fatalities and injuries were substantially lower during 2012–16 than during 1997–2001 (**Figure 9**).

Pipelines are thus extremely safe but are not risk-free. How do they compare with available alternatives? **Figure 10**, **Figure 11**, and **Figure 12** convert raw accident, injury, and fatality numbers into rates based on ton-miles, which offer a more accurate picture of relative safety.[38]

- ***Accidents.*** Oil and natural gas pipelines have a significantly lower accident rate than road and rail (Figure 10): road has an accident rate nearly 10 times higher than either type of pipeline; rail has a rate three times higher.
- ***Injuries.*** Oil pipelines enjoy the lowest rate of injury, by a substantial margin (Figure 11). Rail and natural gas pipelines are second and third most safe, respectively. Road transport is by far the most dangerous.
- ***Fatalities.*** Road transport is, once again, vastly more dangerous (Figure 12). Oil pipelines are most safe, followed by natural gas and rail.

# Conclusion

To get its growing oil and gas resources efficiently to where they are needed, America urgently needs more pipelines. Encouragingly, two major pipeline projects that were previously blocked—Keystone XL and Dakota Access—have now been approved by the Trump administration. Together, they add the capacity to transport more than a million barrels of oil per day.[42]

The 30 major new natural gas pipeline projects under review at the Federal Energy Regulatory Commission could also help ease America's energy bottleneck. To avoid needless approval delays, the Trump administration and Congress should swiftly restore quorum by filling at least two of FERC's four vacant board seats.

The Congressional Research Service notes: "In general … [pipelines] provide safer, less expensive transportation [than rail and roads]."[43] If the supply of U.S. pipelines is not allowed to expand to meet demand, energy firms will increasingly switch to more dangerous and costly transportation alternatives.

# Endnotes

[1] The author thanks Daniel Banko, Jacob Gichan, Allie Howell, Navid Kiassat, Shua-Kym McLean, and Anthony Velleca for their research assistance. Any errors are his own.

[2] "U.S. Dry Shale Gas Production," U.S. Energy Information Administration.

[3] "Weekly U.S. Field Production of Crude Oil," U.S. Energy Information Administration.

[4] America exports and imports crude oil and natural gas because such decisions depend on transportation costs and the geography of production wellheads. It may make more sense for a local market that is far from domestic production centers to rely on imports, even as total U.S. exports increase overall. A more robust energy transportation network would reduce the instances where geography and transportation costs make importation a more economically reasonable choice.

[5] "Petroleum and Other Liquids: U.S. Exports of Crude Oil and Petroleum Products," U.S. Energy Information Administration, Feb. 2017.

[6] "Quadrennial Energy Review: Energy Transmission, Storage, and Distribution Infrastructure," U.S. Energy Information Administration, Apr. 2015.

[7] Gathering pipeline is of smaller diameter, and it transports from the wellhead to the processing plant or to an interconnection. Transmission pipeline is of wider diameter and longer distance, and it brings gas from where it is produced to market areas. Distribution pipeline is smaller in diameter, and it moves gas from a city gate or provider to the customers. See, e.g., "Natural Gas," U.S. Energy Information Administration; and "2010+ Pipeline Mileage and Facilities," U.S. Department of Transportation.

[8] "Pipeline Basics," U.S. Department of Transportation.

[9] Beginning in 2006, pipeline data were taken from the DOT's form F 7000–1–1. Previously, data were extracted from FERC's form No. 6, which included data for federally regulated pipelines. For 2005, data for federally regulated pipelines were estimated to include about 90% of total national ton-miles, so the pipeline statistics for 2015 were adjusted to include an additional 10% of ton-miles. During 1990–2004, the federally regulated estimate was 84%, with a 16% addition for other pipeline ton-miles. The amount carried by motor carriers is estimated. See "Table 1-61: Crude Oil and Petroleum Products Transported in the United States by Mode," U.S. Department of Transportation.

[10] See endnote 9.

[11] Phil Davies, "Busting Bottlenecks in the Bakken," Federal Reserve Bank of Minneapolis, Apr. 2013.

[12] John Frittelli et al., "U.S. Rail Transportation of Crude Oil: Background and Issues for Congress," Congressional Research Service, Dec. 4, 2014.

[13] "Annual Report Mileage for Hazardous Liquid or Carbon Dioxide Systems," U.S. Department of Transportation; "Annual Report Mileage for Gas Distribution Systems," U.S. Department of Transportation; "U.S. Dry Natural Gas Production," U.S. Energy Information Administration; and "U.S. Field Production of Crude Oil," U.S. Energy Information Administration.

[14] Rail shipment, e.g., is typically $5–$10 more expensive per barrel than shipment by pipeline. Railroads are more vulnerable to inclement weather. They also face periodic capacity constraints due to the seasonality of other products that they ship, especially during the harvest and holiday seasons. See Frittelli et al., "U.S. Rail Transportation of Crude Oil."

[15] Repairing or replacing existing pipelines typically requires the approval of federal, state, and/or local regulators.

[16] Alan Neuhauser, "Moniz: Gas Pipelines a 'Very Obvious' Vulnerability," *U.S. News & World Report*, Apr. 27, 2015.

[17] Frittelli et al., "U.S. Rail Transportation of Crude Oil."

[18] As of Feb. 2017.

[19] A "pre-filing" means, among other things, that an energy firm has completed the first stage of a pipeline project, such as studying suitable routes for the pipeline; and that FERC will seek public comment and will consult with other relevant government agencies.

[20] "FERC Certificates Several New Natural Gas Pipelines in 2017," U.S. Energy Information Administration, Mar. 7, 2017.

[21] The two recently rejected pipeline projects were the Pacific Connector Gas Pipeline (in Mar. 2016) and Downeast Pipeline (in Aug. 2016). See "Order Dismissing Dockets and Terminating Process," FERC, Aug. 17, 2016; and "Order Denying Applications for Certificate and Section 3 Authorization," FERC, Mar. 11, 2016.

[22] "Major Pipeline Projects Pending (Onshore)," FERC.

[23] Ibid.; and Catherine Traywick, "Energy Projects Worth $50 Billion Are Stalled Until Trump Fills Empty Posts," Bloomberg, May 5, 2017.

[24] "Norman C. Bay Resignation Letter," FERC, Jan. 26, 2017; and Devin Henry, "Another FERC Commissioner Announces Departure," *The Hill*, Apr. 28, 2017.

[25] "Major Pipeline Projects Pending (Onshore)," FERC; and "Final Supplemental Environmental Impact Statement for the Keystone XL Project," U.S. Department of State, Jan. 2014.

[26] Susan Phillips, "DEP Gives Sunoco Long To-Do List on Mariner East 2 Pipeline Plan," National Public Radio, Sept. 15, 2016.

[27] "Atlantic Coast Pipeline and Supply Header Project Supplemental Filing: Appendix 1—Resource Report 1," Dominion Energy, July 18, 2016.

[28] E.g., the Golden Pass pipeline—a 69-mile natural gas pipeline starting in Texas and carrying 2.5 billion cubic feet of capacity per day—was granted approval by FERC almost 28 months after filing. In 2008, backers of the Keystone XL pipeline applied for a presidential permit. In 2011, the U.S. Department of State delivered a final EIS, then delayed its decision, and ultimately rejected the project. In 2012, an alternative route was proposed. In Mar. 2017, Keystone XL was approved.

[29] "Reporting Criteria Change: 1990–Current," U.S. Department of Transportation.

[30] Ibid.

[31] "All Reported Pipeline Incidents," U.S. Department of Transportation.

[32] "GDP and Personal Income," U.S. Department of Commerce.

[33] Ricky L. Langley, "Human Fatalities Resulting from Dog Attacks in the United States, 1979–2005," *Wilderness & Environmental Medicine* 20, no. 1 (2009): 19–25.

[34] "Serious Incident 20 Year Trend," U.S. Department of Transportation.

[35] Ibid.; "2010+ Pipeline Miles and Facilities," U.S. Department of Transportation; and "Annual Report Mileage Summary Statistics," U.S. Department of Transportation.

[36] "Gas Distribution Serious Incident Cause 2005–2016," U.S. Department of Transportation.

[37] Ibid.

[38] Ton-mileage data are for 2009, the most recent year available.

[39] Ton-mileage values are based on Tables 1–50 (for natural gas pipeline) and 1–61 (for all others). See "National Transportation Statistics," U.S. Department of Transportation. For accident data for road and railway, see "Incident Reports Database Search," extracted from U.S. Department of Transportation. For pipeline release volumes, "All Reported Incidents: 20 Year Trends," U.S. Department of Transportation.

[40] "National Transportation Statistics," U.S. Department of Transportation; "Incident Reports Database Search," U.S. Department of Transportation; and "All Reported Incidents: 20 Year Trends," U.S. Department of Transportation.

[41] See endnote 40.

[42] "Final Supplemental Environmental Impact Statement for the Keystone XL Project," U.S. Department of State, Jan. 2014; and "Construction of the Dakota Access Pipeline: Memorandum for the Secretary of the Army," Federal Register, Jan. 24, 2017. Ironically, changing market conditions mean that Keystone XL is now struggling to sign up clients. See, e.g., Christopher M. Matthews and Bradley Olson, "A New Problem for Keystone XL: Oil Companies Don't Want It," *Wall Street Journal*, June 29, 2017.

[43] Frittelli et al., "U.S. Rail Transportation of Crude Oil."

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## Abstract

America is enjoying an energy renaissance, as U.S. firms produce vast amounts of oil and natural gas that need to be shipped safely and efficiently across the country and abroad. Pipelines offer the best way to achieve this. Yet the supply of pipelines is not keeping pace with demand. The result: a growing energy bottleneck that is forcing oil and gas companies to turn increasingly to more accident-prone and more expensive shipping alternatives, such as trucks, railroads, and tankers.

## Key Findings

1. Average annual accident rates during 2007–16, per billion ton-miles of oil and gas transported, were 0.66 for oil pipelines (i.e., the fewest accidents), 0.73 for natural gas pipelines, 2.20 for rail, and 7.11 for road.
2. During the same period, annual property damage caused by pipelines ($352.89 million) was only about 0.002%—or two one-thousandths of 1%—of U.S. GDP in 2016 ($18.46 trillion).
3. To maximize the benefits of America's energy renaissance, the Trump administration, Congress, and federal and state regulators should prioritize expanding and upgrading the country's inadequate pipeline infrastructure.

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