Dynamic Delivery: America's Evolving Oil and Natural Gas Transportation Infrastructure

National Association of Regulatory Utility Commissioners (NARUC)

Gas Committee Meeting
August 17, 2020

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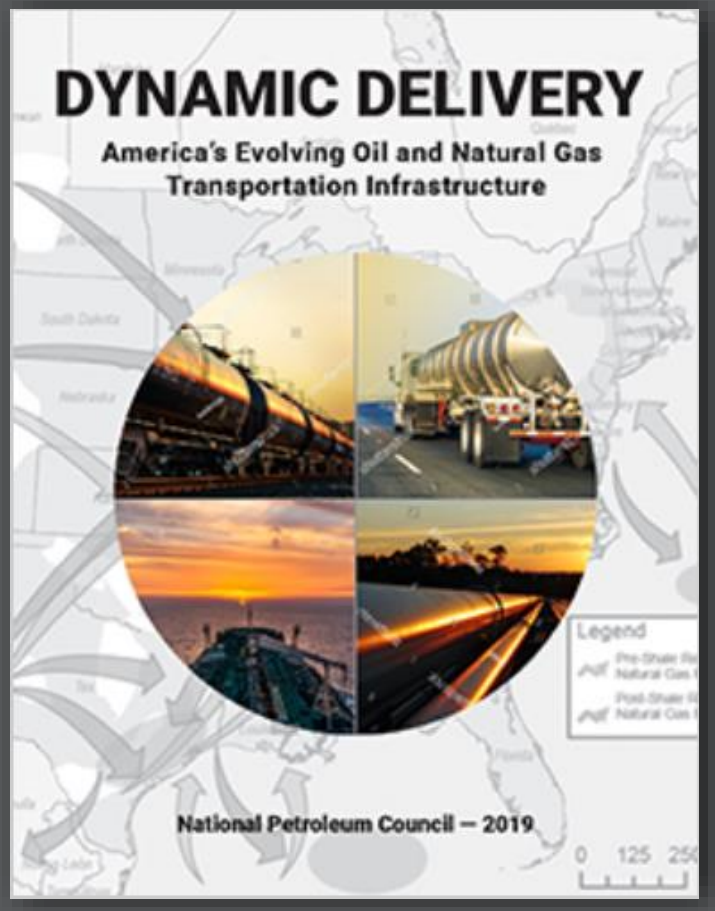
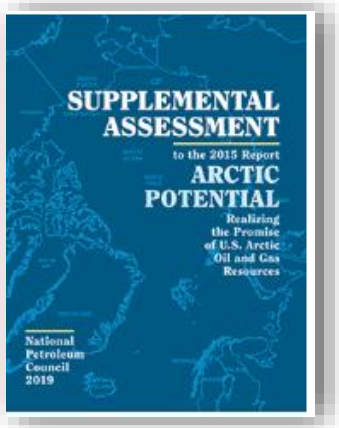


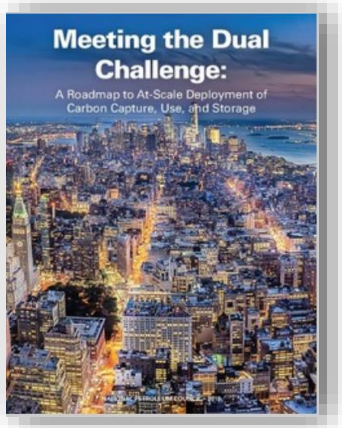
What is the National Petroleum Council?

The purpose of the National Petroleum Council (NPC) is solely to **advise**, **inform**, and **make recommendations** to the Secretary of Energy.

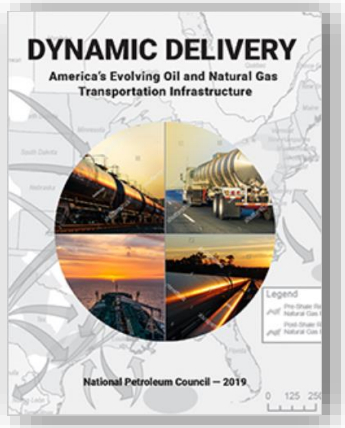
- Federally chartered **advisory committee** that advises the Secretary of Energy on matters related to oil and natural gas and the oil and natural gas industries
- **Established in 1946** at request of President Truman
- **About 200 CEO-level** executives
- Advice in form of studies with **findings and recommendations pertinent to broad public policy**
- Since its establishment, the **NPC has prepared over 200 reports** for the Department
- The NPC is a **well-balanced representation from all segments of the oil and gas industries,** and also has members with interests outside of oil or natural gas operations, including **representatives from academic, financial, research, Native American groups, and public interest organizations and institutions**.



2019



2019

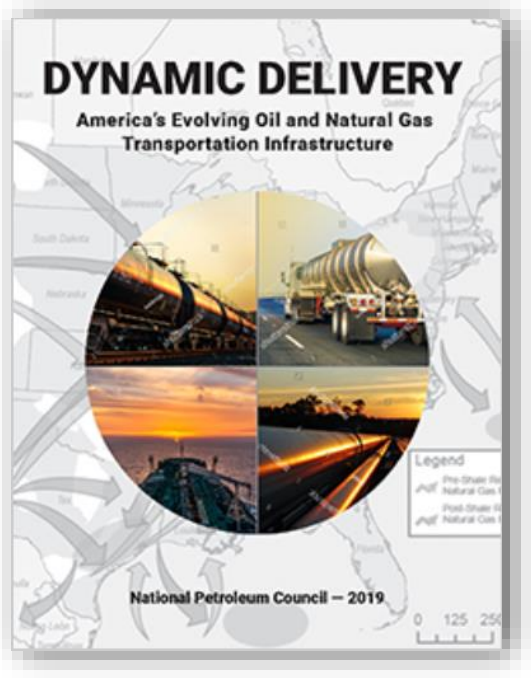


2019

NATIONAL PETROLEUM COUNCIL

Dynamic Delivery Report Overview

Dynamic Delivery: America's Evolving Oil and Natural Gas Transportation Infrastructure

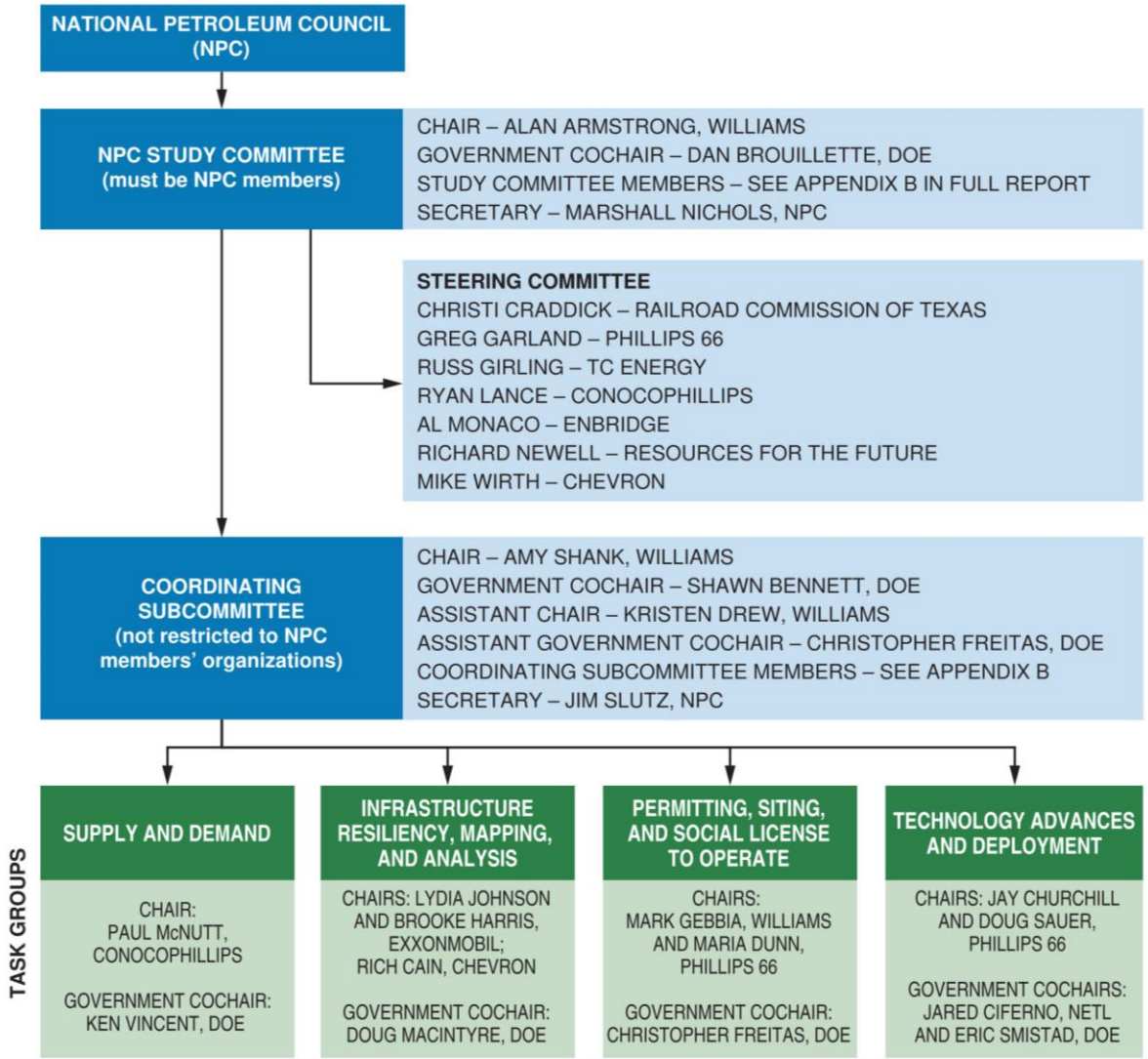


Key Questions to Be Addressed Include:

- **Infrastructure improvements** required to meet the **changes in future supply and demand patterns**
- **Advances in technology** that can improve the safety, reliability, efficiency, and environmental performance of the oil and natural gas transportation system
- **Regulatory requirements or policies that may inhibit** energy system resilience and proposed solutions
- Other **emerging issues** that policy makers should consider (e.g., cybersecurity)

Dynamic Delivery Study Organization

The study organization is rooted in strong governance and comprehensive representation from across the industry to support in-depth analysis and well-informed recommendations.



Dynamic Delivery Study Composition

The NPC Infrastructure Study is comprised of a diverse array of individuals, representing and providing the views and perspectives of a wide breath of the oil and natural gas industry and related sectors.

STUDY COMMITTEE
55 members

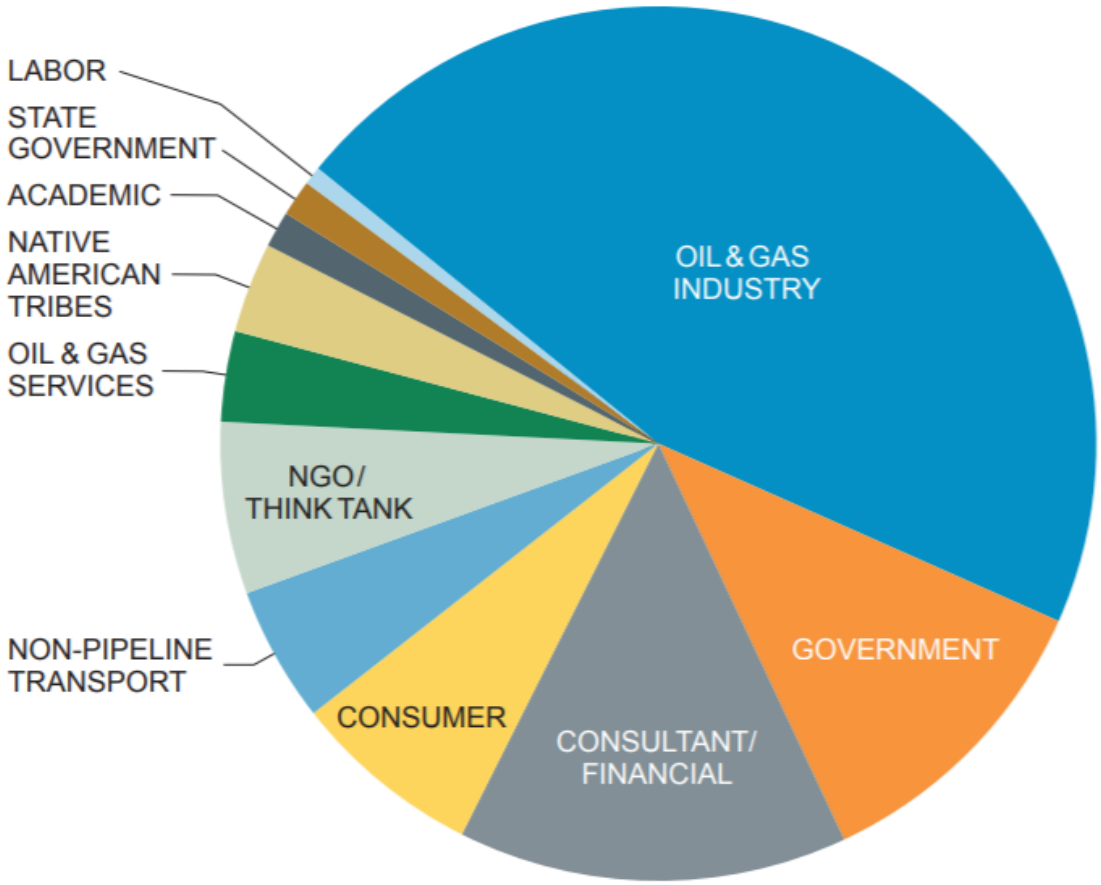
COORDINATING SUBCOMMITTEE
41 participants

SUPPLY AND DEMAND TASK GROUP
49 participants

INFRASTRUCTURE RESILIENCY, MAPPING, AND ANALYSIS TASK GROUP
32 participants

PERMITTING, SITING, AND SOCIAL LICENSE TO OPERATE TASK GROUP
45 participants

TECHNOLOGY ADVANCES AND DEPLOYMENT TASK GROUP
126 participants



Over 300 individuals from the oil and natural gas industry, consulting, financial services, government, non-government organizations, and other entities contributed to the study

Factors That Shape Oil & Natural Gas Production

Long-term projections of production show a wide range of outcomes. The variations reflect diverse assumptions about price, technology, policy, and resources.

Access to Capital

The oil and natural gas industry is **capital intensive**. Access to capital—internally within a company or from external sources—is essential to oil and natural gas production.

Access to Resource Base

Commercial scale oil and natural gas production can only take place where **resources exist in adequate volumes** and companies have **access to develop** the resources.

Costs and Resource Prices

The **price that producers plan to receive** for what they produce, and the **cost of finding and developing** oil and natural gas, are fundamental elements driving production trends.

Market Access

Successful oil and natural gas development requires **access to domestic and international markets**, which requires transportation. Market access is a key variable in the price that producers receive for oil and natural gas deliveries.

Government Policy

Policy at local, national, and international levels is an overarching influence. **Policy can impact each of the fundamental factors** that shape oil and natural gas production trends.

Technology

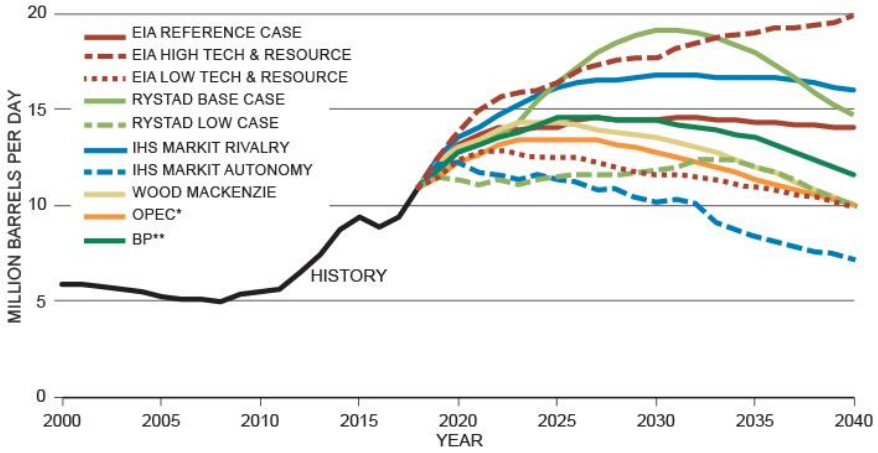
Technology to produce oil and natural gas is constantly evolving. **As technology advances, so do the frontiers of production.** For example, advances in well construction and completion are behind the growth of tight oil production in the United States.

Crude Oil and Natural Gas Production

Key Finding

The US has become the largest producer of both oil and natural gas in the world, which has provided the nation with increased employment and economic growth, reduced energy imports, and reduced greenhouse gas (GHG) emissions. Increased natural gas use replacing coal to generate electricity has been the single largest contributor to reducing U.S. CO_2 emissions by 15% since 2005.

U.S. Crude Oil Production Forecasts through 2040



* OPEC outlook released in 2018. Other outlooks from 2019. ** BP 2019 Energy Outlook, Evolving Transitions scenario.
Sources: IHS Markit; EIA *Annual Energy Outlook* 2019, Rystad Energy, IHS Markit, BP, OPEC, and Wood Mackenzie Q1 2019.

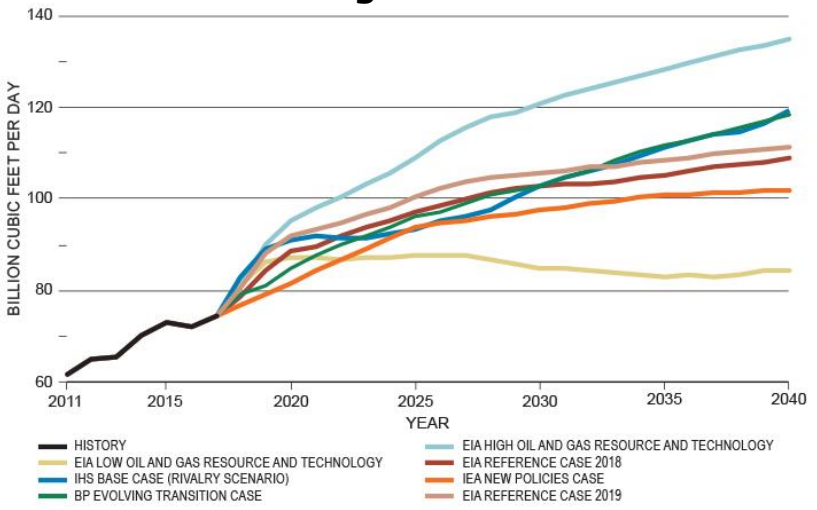
Natural Gas Production Growth

- Natural gas production started increasing in 2006, aided by technology that unlocked production from tight and shale formations

Crude Oil Production Growth

- U.S. oil production has more than doubled since 2008
- Hydraulic fracturing and directional drilling technology have helped drive the growth by enabling increased production from unconventional reservoirs

U.S. Natural Gas Production Forecasts through 2040



Sources: EIA *Annual Energy Outlook* 2018 and 2019; IHS Markit; *BP Energy Outlook* 2019; and International Energy Agency, *World Energy Outlook* 2018.

Geographic Shifts in Production

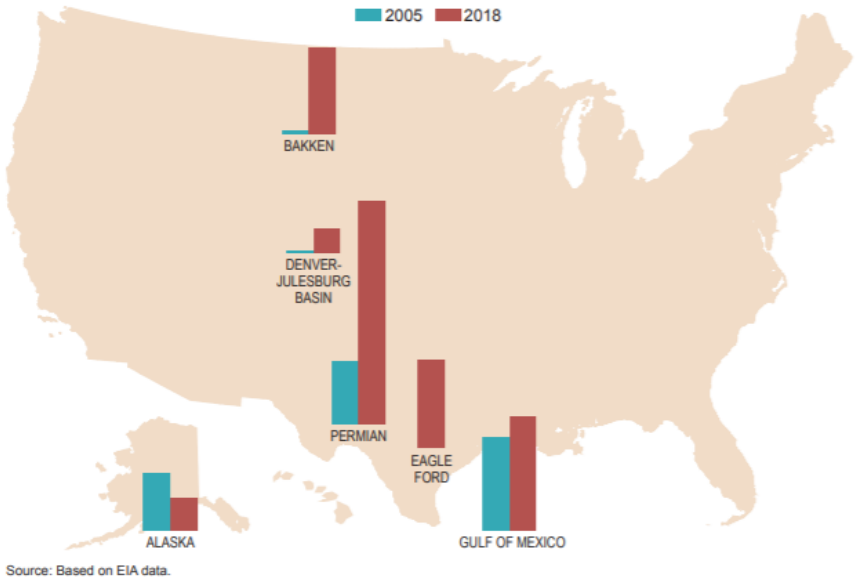
Crude oil production growth has been led by:

- Tight oil development in the **Permian Basin - West Texas and SE New Mexico**
- Shale oil production in the **Eagle Ford - South Texas and Bakken - North Dakota**

Natural Gas production has been propelled by:

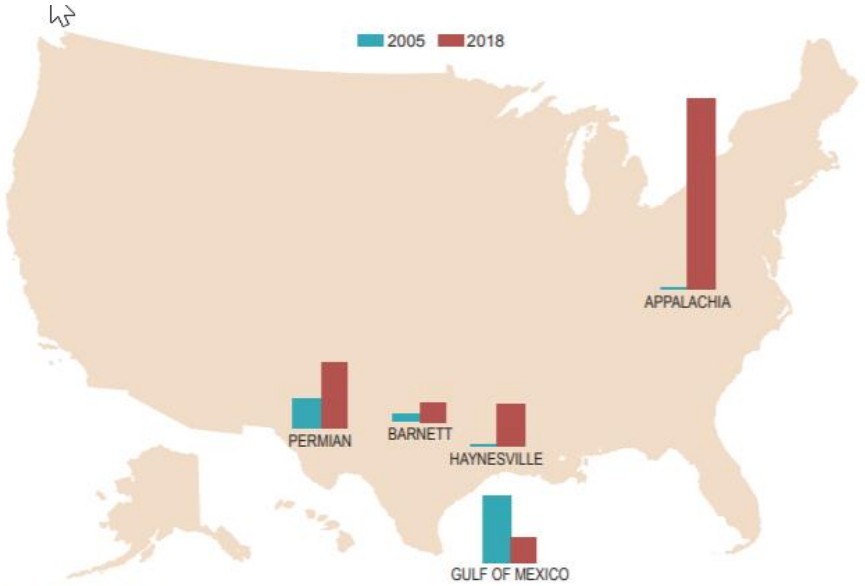
- The **Appalachian Basin** – the Marcellus and Utica formations in PA, WV, and OH.
- Increased associated natural gas production in the **Bakken, Eagle Ford, and Permian**.

Oil Production Geographic Shifts, 2005 to 2018



Source: Based on EIA data.

Natural Gas Production Geographic Shifts, 2005 to 2018

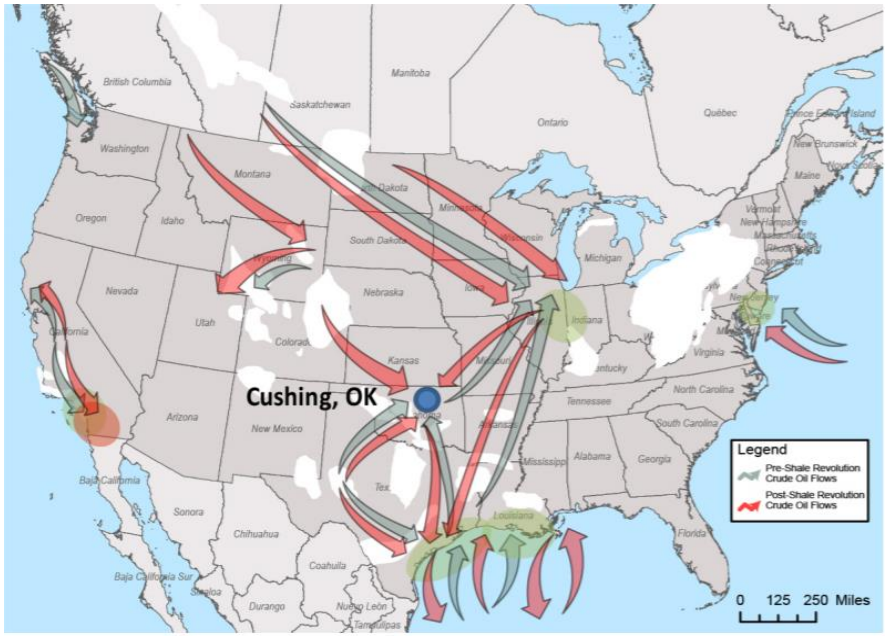


Source: Based on EIA data.

Declines in traditional production regions like Alaska (crude oil) and the Gulf of Mexico (natural gas) have partially offset the growth.

Shifting of Flows

Crude Oil Flows Pre- and Post-Shale



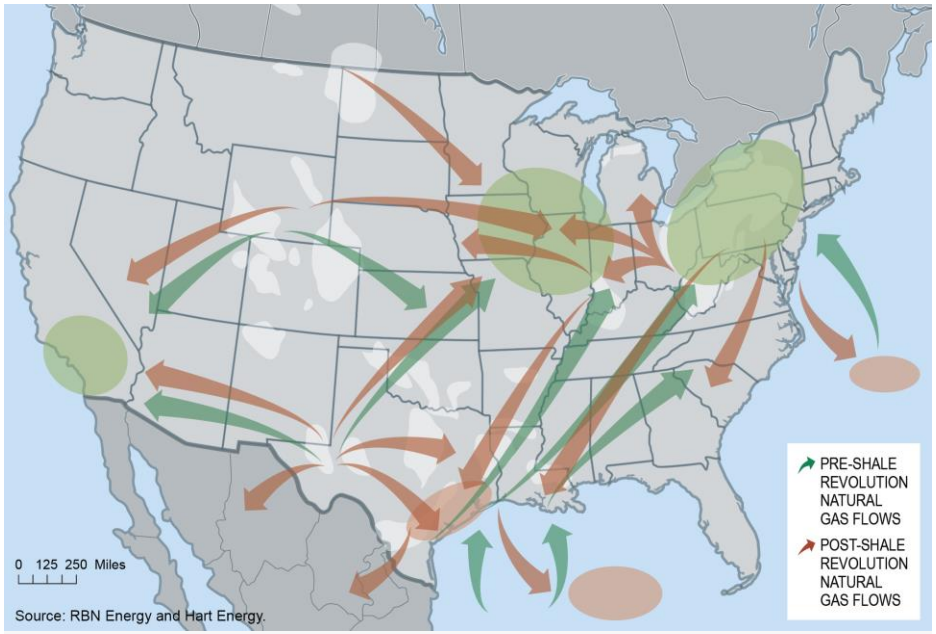
Pre-Shale

- Crude oil imports **into the U.S. Gulf Coast** and flows **toward the Great Lakes area have reversed**

Post-Shale

- Crude oil now flows **from Canada and North Dakota toward the Great Lakes and on to Oklahoma and Texas** backing out imports

Natural Gas Flows Pre- and Post-Shale



Pre-Shale

- Pipelines delivered natural gas **from Texas and Louisiana to the Northeast**

Post-Shale

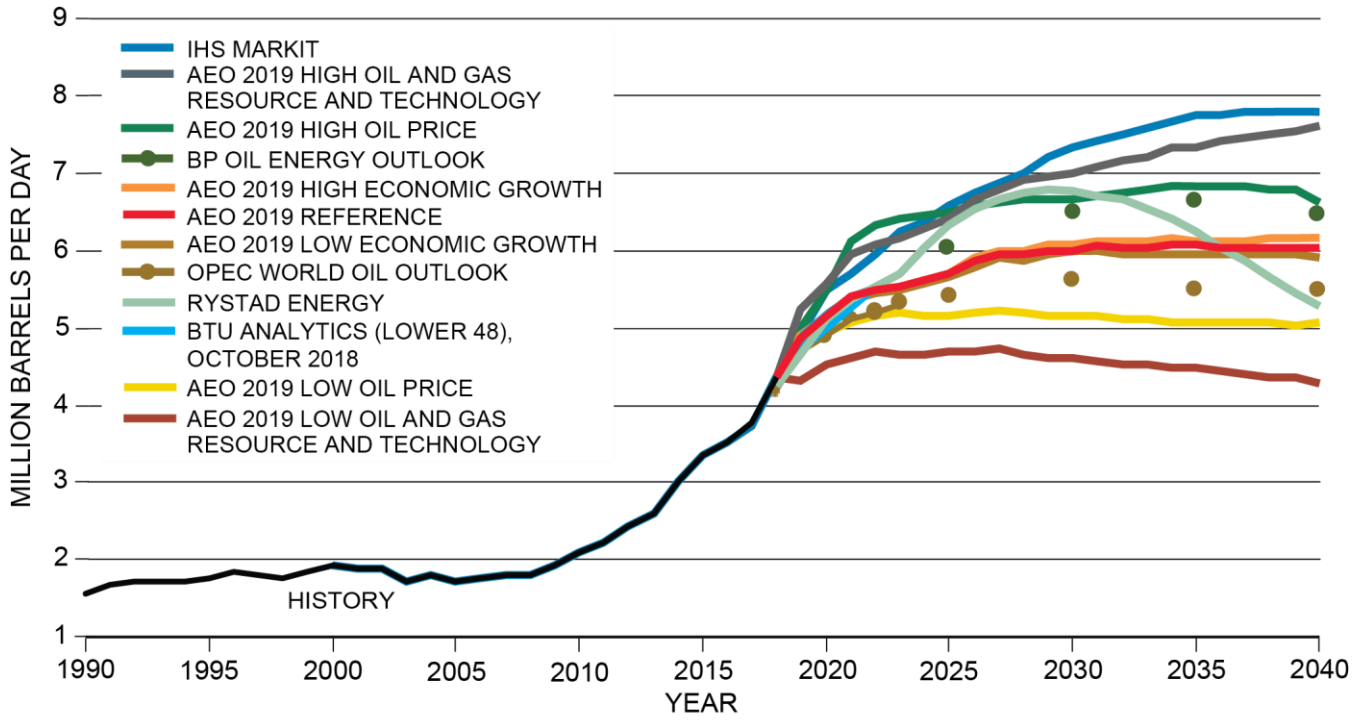
- **Large production increases in the Northeast** have resulted in natural gas flowing south and west, supporting multiple new LNG export facilities on the Gulf Coast

Geographic shifts in production have led to significant changes in traditional crude oil and natural gas flows.

Natural Gas Liquids

With limited exception, the consensus is for natural gas liquids (NGLs) supply growth to continue. The average growth across outlooks represents a 40% increase in total NGL production as compared to 2018.

U.S. NGL Production Forecasts Through 2040



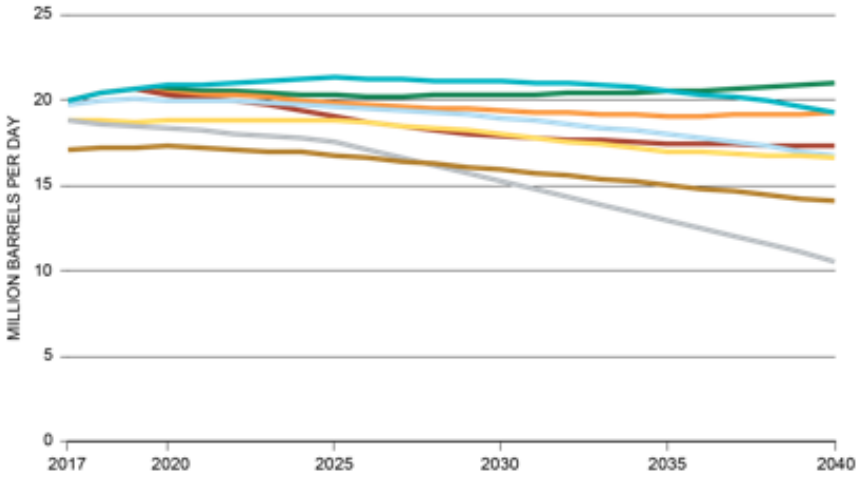
Source: IHS Markit, EIA *Annual Energy Outlook 2019*, BTU Analytics 2018, Rystad Energy, OPEC *World Oil Outlook 2018*, and *BP Energy Outlook* 2019.

By 2050, the Southwest (Permian plays) and East (Marcellus and Utica plays) regions account for more than 50% of total U.S. NGL production.

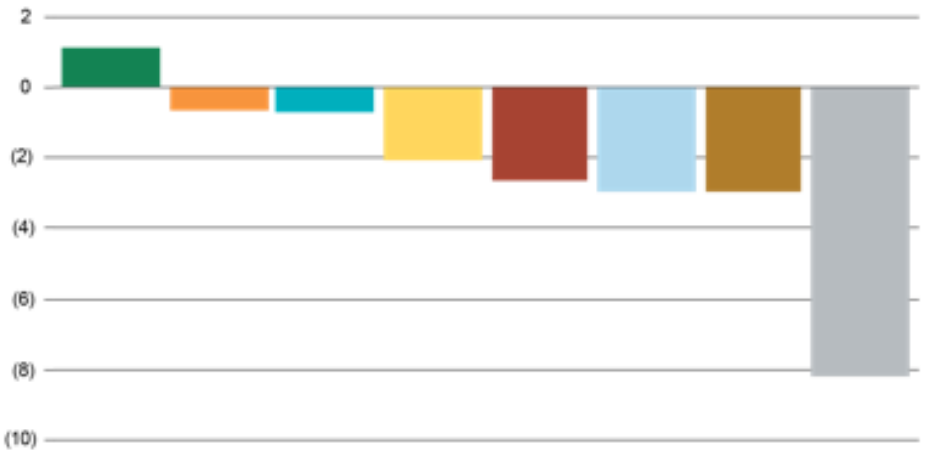
Refined Products Demand

Most outlooks reflect U.S. demand for petroleum liquids flat to declining through 2040
- Gasoline demand sees the most prominent decline
- Jet fuel demand increases in most outlooks

U.S. Liquids Consumption Outlooks



U.S. Liquids Consumption Outlooks
(Change in Liquids Demand Between 2017 and 2040)



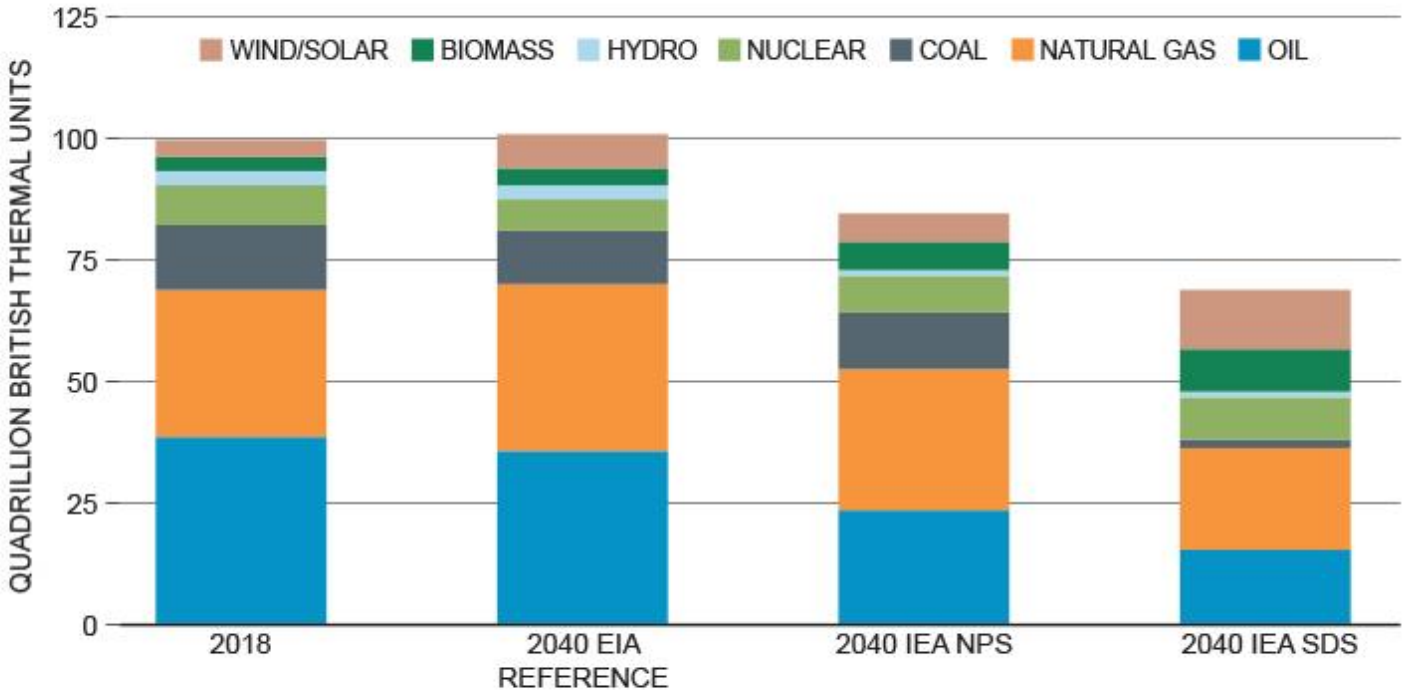
AEO 2019 – LOW OIL PRICE
AEO 2019 – REFERENCE
WOOD MACKENZIE
IEA – NEW POLICIES (EXCL. BUNKERS)
AEO 2019 – HIGH OIL PRICE
BP 2018 – EVOLVING TRANSITION
IHS – RIVALRY (REFINED PRODUCTS)
IEA – SUSTAINABLE DEVELOPMENT

Maintaining supplies of domestically manufactured jet fuel and diesel in the face of declining domestic gasoline demand will **require increased exports of gasoline**.

Implications of carbon-constrained scenarios

Key Finding

Even in energy forecasts designed to meet climate change targets, the largest energy sources continue to be oil and natural gas through at least 2040 to provide reliable and affordable energy.



Note: "Consumption" as used here does not include net exports, such as export of LNG.

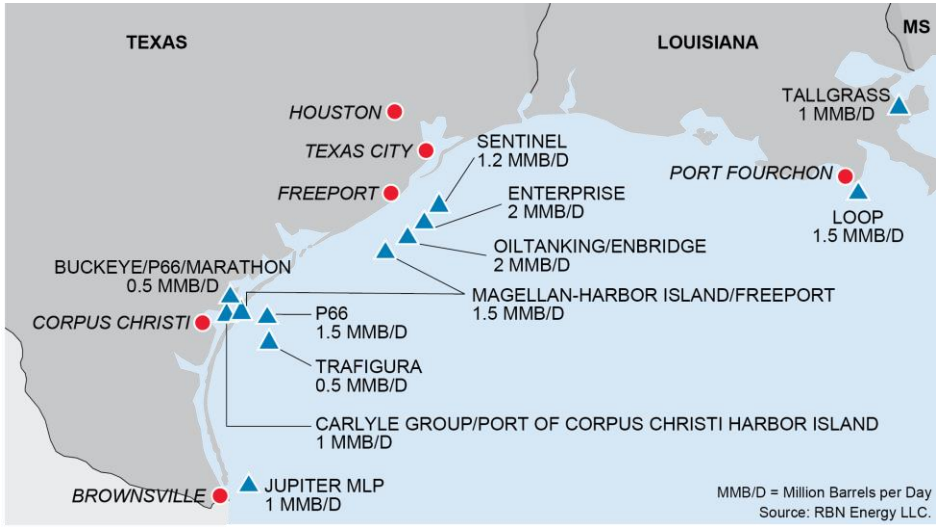
Source: The IEA New Policy Scenario and Sustainable Development Scenario are based on IEA data from International Energy Agency, *World Energy Outlook* 2018; as modified by the National Petroleum Council.

Demand for Exports

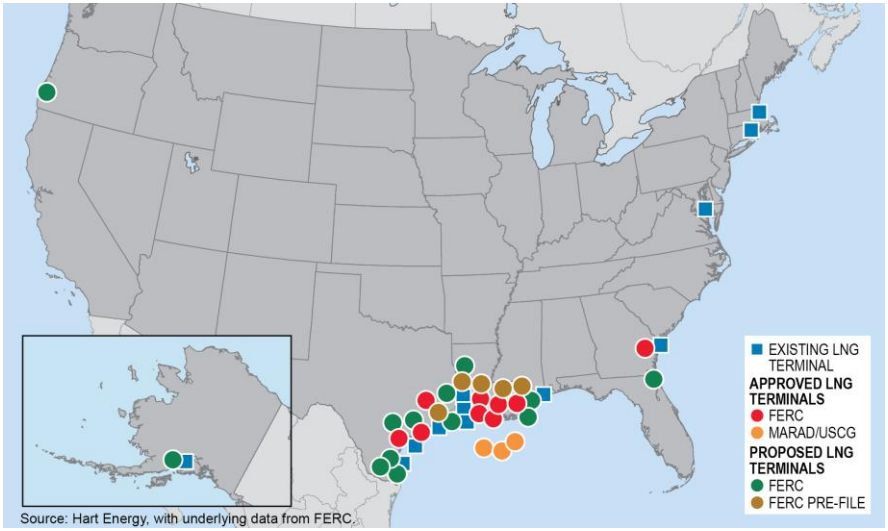
Key Finding

The. U.S. economy can benefit even further from increased export of oil and natural gas.

Planned New Gulf Coast Crude Oil Export Capacity Projects



Recent and Announced LNG Export Projects



Drivers for increased exports

- Increased U.S. production of light oil will continue to exceed the requirements of the domestic refining capacity, **driving the need for crude exports**.
- Declining domestic demand for gasoline will mean a **requirement for increased exports of gasoline** to international markets to maintain high crude oil runs and refinery capacity utilization.
- Natural gas is expected to displace higher-carbon fuel for power generation in the U.S. and overseas. The latter will drive the need for **increased Liquified Natural Gas (LNG) export capacity.**

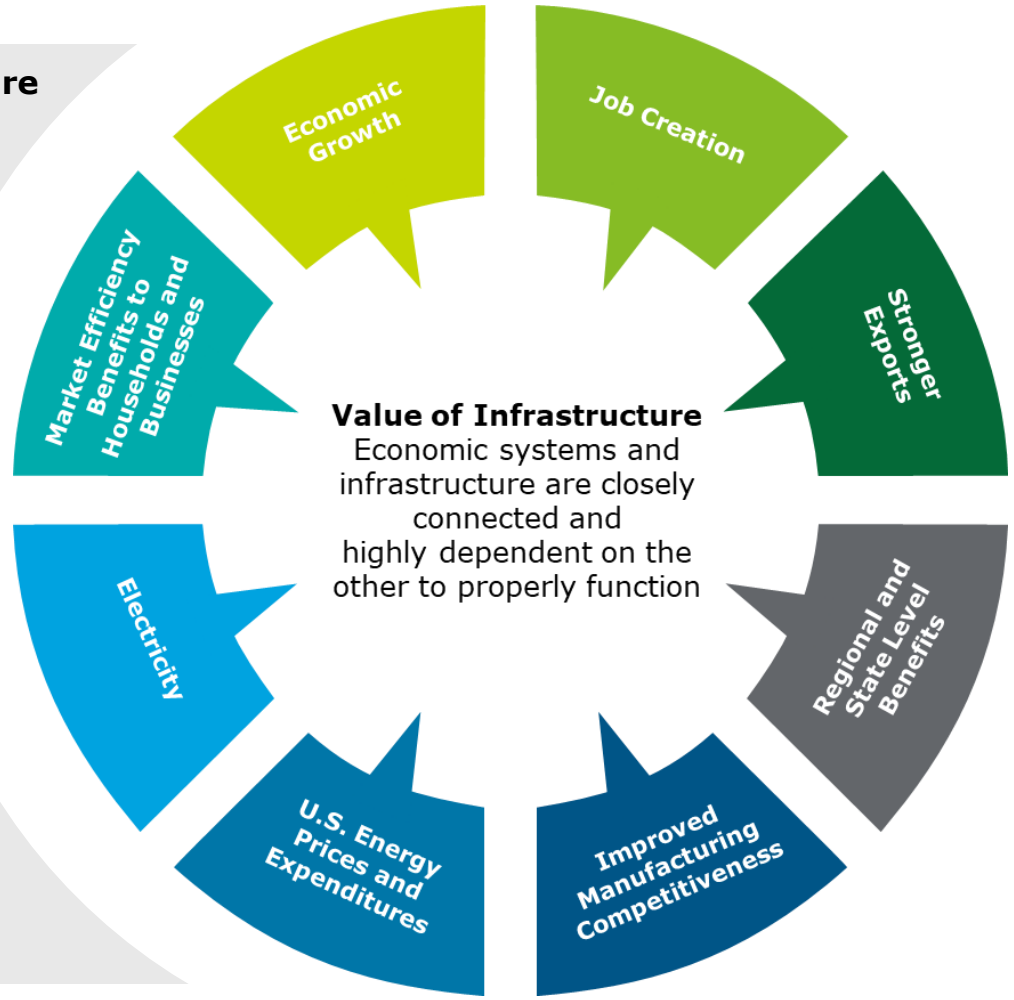
Value of Infrastructure

Key Finding

The benefits of the increase in oil and natural gas production could not have come about without the significant expansion and adaptation of transportation infrastructure capacity.

Economic Benefits of Infrastructure

- The direct economic activity resulting from infrastructure investment, and the indirect and effects on supply chains
- The jobs created from the construction and operation of midstream infrastructure
- The infrastructure investment supports higher domestic energy production
- Reliable energy infrastructure has supported growing U.S. energy production, lowering costs for domestic manufacturers
- More efficient transport of energy lowers costs to consumers, reducing energy bills

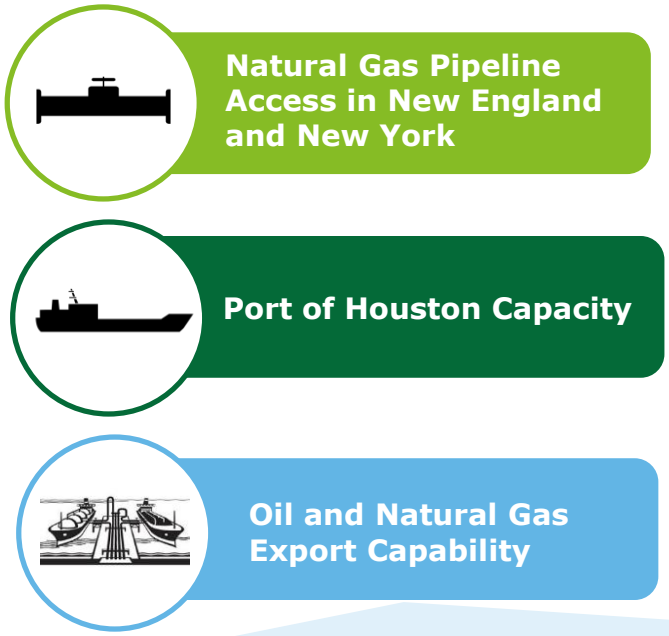


Infrastructure Constraints

Key Finding

Existing infrastructure has been modified and adapted to near-maximum capacity, requiring significant investment in new and existing pipelines, ports, rail facilities, and inland waterways.

Critical Infrastructure Bottlenecks



Takeaway Capacity Limitations

- **Lack of sufficient takeaway capacity** for crude oil, natural gas, and NGLs in certain regions can **hinder production growth and lead to increased flaring.**
- Three regions where this could continue to be a challenge are:
  - **Permian Basin**
  - **Bakken Formation**
  - **Appalachia**

Enabling US Liquids Exports will require:

- New greenfield pipelines
- Additional expansion of existing pipelines
- Increased marine terminal and waterway capacity

Enabling US LNG Exports will require:

- Additional liquefaction, terminal, storage, and waterway capacity
- Increased pipeline capacity from producing fields to the new export terminals

Labor Shortages and Lack of Specialized Skillsets

Key Finding

It is becoming increasingly challenging to keep pace with hiring and developing a well-qualified workforce to build and maintain existing and future infrastructure. This skilled labor shortage will continue to grow as the current workforce continues to retire.

The labor market is uncertain…

- Continued energy market expansion is leading to a **need for skilled workers**
- **Skilled labor shortage** is taking a toll on the oil and natural gas sector
- Skilled labor is needed to build and maintain more than **2.5 million miles of pipelines and other critical infrastructure**

- Labor issues have **impacted the Texas energy industry** in the Permian Basin
  - 15,000 jobs are found vacant at any given time.
- Oil executives fear that the **acute shortage could hinder the industry** for decades to come.

…leading to industry pressures

Infrastructure Development Recommendations

Key Recommendations

Value of Infrastructure

- To **mitigate negative impacts on interstate commerce**, **all levels of government** should have constructive dialogue about the **overall economic benefits from the nation's energy resources** and effectively engaging stakeholders and minimizing local impacts and risks.

Infrastructure Constraints

- **Congress** should **fully appropriate the revenue** coming into the Harbor Maintenance Trust Fund and the Inland Waterways Trust Fund to **restore and fully maintain all U.S port and waterways infrastructure** at their authorized dimensions.
- Where warranted, **Congress** should authorize **widening and/or deepening of channels** to **increase the capacity of ports** to safely and efficiently transport energy cargoes.

Labor Shortages & Lack of Specialized Skillsets

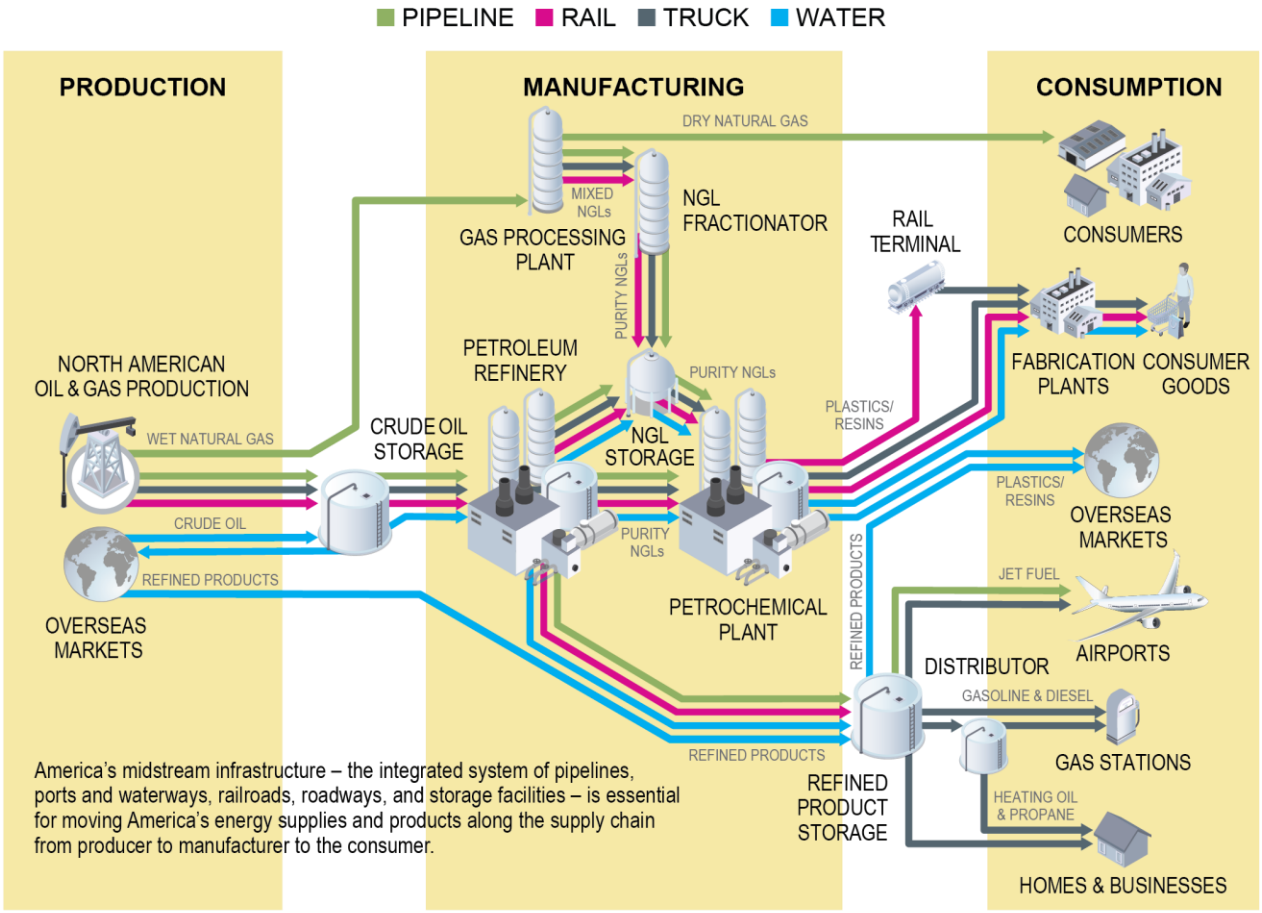
- **The U.S. government, states, local communities, secondary schools, and industry should promote vocational career education** and **technical training** of their constituents, members, and communities.
- **Industry, along with secondary and technical schools** should support **registered and accredited apprenticeship programs** to ensure an adequate supply of skilled industrial construction, operations, and maintenance workers.

Infrastructure Resiliency

Key Finding

An interdependent infrastructure system of pipelines, truck, rail, and marine transport working together with storage ensures the delivery of reliable affordable energy.

U.S. Fuel and Petrochemical Supply Chain



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.

Source: American Fuel & Petrochemical Manufacturers, *The Fuel and Petrochemical Supply Chains: Moving the Fuels and Products That Power Progress*, 2018.

Multiple Modes

The integration of various modes **(pipeline, rail, trucks, and marine)**, is a key characteristic that enables a high level of reliability and flexibility.

Storage

Storage provides resiliency at **production centers, market centers, and demand centers**.

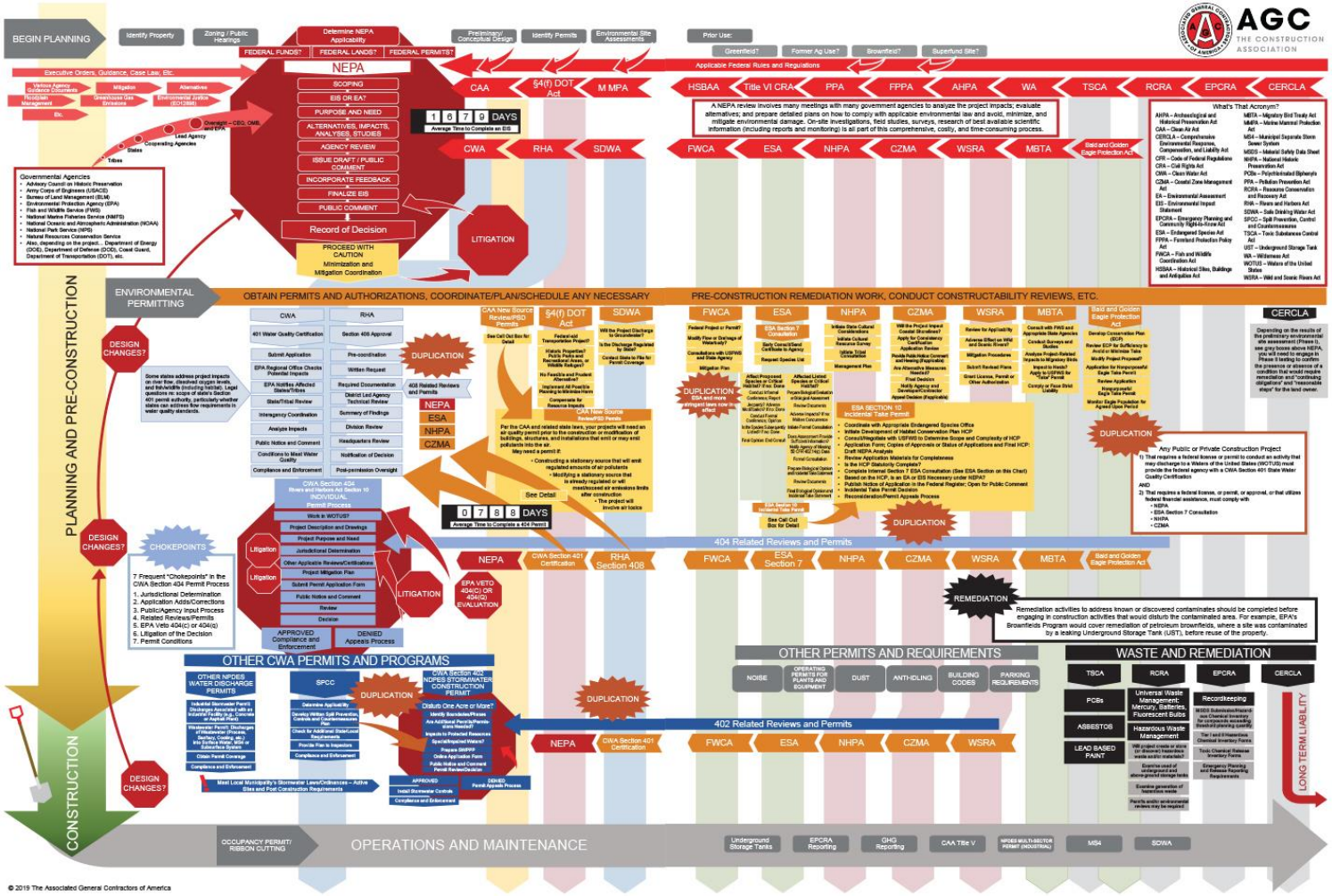
Multiple Routes

The **presence of various routes** enables hydrocarbons to reach their intended destinations.

Permitting Process Complexity

Key Finding

Overlapping and duplicative regulatory requirements, inconsistencies across federal and state agencies, and unnecessarily lengthy administrative procedures have created a complex and unpredictable permitting process.



Source: Depiction of a NEPA Permitting Process, The Associated General Contractors of America, 2019.

Interagency Coordination

Key Recommendation

Significant improvements in coordination between federal, state, and local governments and agencies are needed to reduce permitting process inefficiencies.

State / Local

- Focus **SEPA reviews to fulfill state law or delegated federal decisions** not required by law.
- Industry, state agency organizations, local governments, and interested NGOs, should collaborate to **create a model master structure for state permitting** and coordination of approvals.
- Have a **single point of contact for permit coordination** in a state.

State / Federal

- States should **leverage ECOS' relationships to facilitate common agreement between federal and state jurisdictions** when there are conflicts between NEPA and SEPA reviews.
- Congress should authorize the lead federal agency to ensure that **NEPA analyses encompass those needed for decisions by other federal and state agencies**.
- The federal government should **leverage the FPISC to encourage concurrent review by states** during the federal permitting process.
- **Incentivize states to comply with FAST-41 and OFD** in conjunction with the federal NEPA process timeline for federal permits or decisions delegated to the states (CZMA, CWA, CAA).

Federal

- Coordinate to **concurrently conduct the FERC and PHMSA regulatory reviews** for the construction **of LNG Storage facilities.**
- CEQ should incorporate elements of the OFD MOU into NEPA regulations to improve interagency coordination to **elevate delays and dispute resolution** consistently.
- CEQ should incorporate a **single multiagency permitting timetable** with specific concurrence points into the NEPA regulations.

Stakeholder Engagement

Key Finding

Successful infrastructure projects in the US will depend upon early, effective, and continuous stakeholder engagement and collaboration.

Key Stakeholder Concerns

- Safety
- Climate change
- Air and water quality
- Noise
- Traffic
- Wear and tear on roads and bridges
- Impacts on wildlife
- Environmental justice
- Loss of property use
- Eminent domain
- Historic and cultural preservation
- Promotion of local jobs and economic benefit
- Treaty rights
- Protection of sacred sites

Key Recommendations

Early Engagement

Engage early with relevant organizations to **understand and address stakeholder concerns**

Stakeholder Input

Incorporate stakeholder input and **collaborate on finding solutions**; convey reasons where an interest is difficult to accommodate

Education and Awareness

Educate communities and stakeholders to highlight the **need for infrastructure** and how it can be developed and operated with stakeholder input

Engagement Practices

Implement engagement practices regarding energy, environmental, and related public policies that **encourage responsible energy development and transport**

Permitting and Climate Change Findings

Key Findings

- The nation faces the dual challenge of providing affordable energy to support economic growth and human prosperity while addressing the environmental effects including the risks of climate change.
- Industry shares the public's concerns that climate change is a serious issue that must be addressed. Litigation of individual projects to address climate concerns is an ineffective approach.
- The permitting and construction of numerous energy infrastructure projects has been challenged, delayed, or stopped as a result of litigation by stakeholders concerned about climate change and the associated policy debate.

National Environmental Policy Act (NEPA)

NEPA has become a leading basis for litigation and challenging agency decisions on energy infrastructure. The uncertainty over NEPA interpretation has led to often unnecessarily expanded reviews and delays in permitting.

A 2019 NEPA study found NEPA was the **most frequent basis for litigation** against natural gas and oil pipelines.

Frequently claimed NEPA errors include:

- Insufficient analysis of direct and indirect effects
- Insufficient review of upstream and downstream greenhouse gases and cumulative impacts.

Council on Environmental Quality (CEQ)

- CEQ oversees Federal agency implementation of NEPA
- CEQ published a proposed rule to comprehensively update and modernize its regulations for implementing NEPA. Additional details can be found at: https://www.whitehouse.gov/ceq/

Permitting and Climate Change Recommendations

Key Recommendations

Industry

- All infrastructure **companies should strive for an outstanding environmental compliance record and to reduce the intensity of GHG emissions from their operations**. Emissions reduction programs are a means of demonstrating a company's efforts to reduce methane emissions.

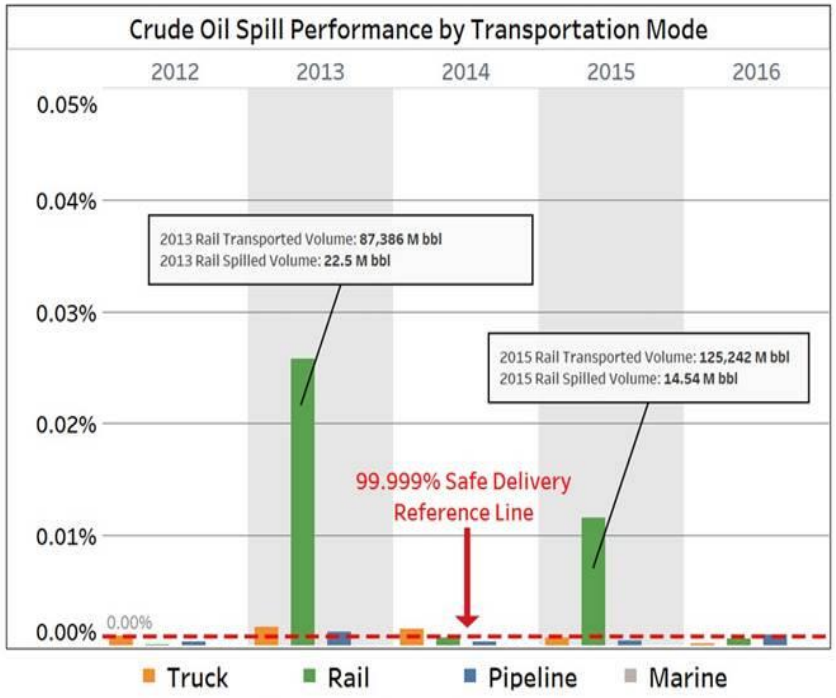
Government

- Congress should clarify that GHG assessments under NEPA, for oil and natural gas infrastructure projects, are confined to emissions that are:
  - **(1) Proximately caused by federal action** and,
  - **(2) Reasonably foreseeable**
- Congress should enact a comprehensive national policy to reduce greenhouse gas emissions and seek to harmonize federal, state, and sectoral policies to enhance efficiency. The policy should be **economy wide, applicable to all sources of emissions, market-based, transparent, predictable, technology agnostic, and internationally competitive.**

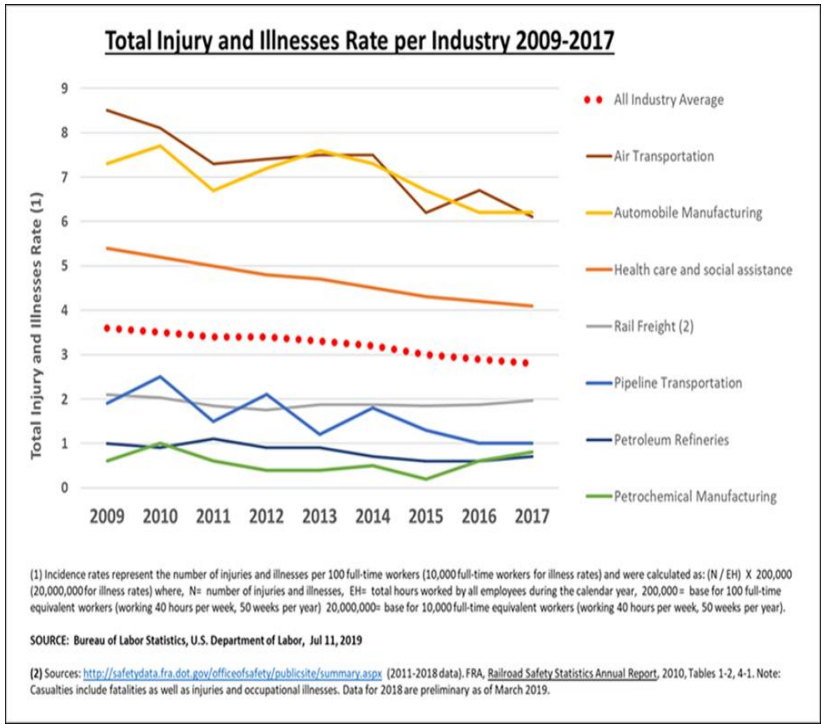
Safety of O&G Transportation Infrastructure Delivery

Key Finding

Crude oil, petroleum products, and natural gas moved by the nation's infrastructure reach their destinations with a high degree of safety, resiliency, and environmental performance. However, incidents have occurred, and oil and gas companies, the maritime, railroad, and trucking industries are committed to continuous improvement.



Source: Report on Shipping Crude Oil by Truck, Rail, Pipeline, U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety (OHMS)



Safety performance improvements will come from advancements in technology, safety management systems, and a more adaptive performance-based regulatory framework.

Pipeline Technologies

Background

Pipelines have proven to be a safe form of hydrocarbon transport; yet, additional areas exist to improve safety, operational, and environmental performance in the industry.

Recommendations

Safety Management Systems

Pipeline companies should proactively implement safety management systems and strengthen industry-wide safety culture to continuously improve performance.

In-line Inspection/ Leak Detection

Industry, working through research consortiums, should pursue a pilot program as recommended by PHMSA to advance linear monitoring systems (e.g., fiber optics, hydrocarbon detection cables) that could provide additional leak detection capabilities.

Geohazard Management through Data Sharing

DOE and DOT should work with FEMA, NOAA, USGS, or other relevant agencies to organize an information sharing effort to assist with efficient acquisition and management of industry-specific geospatial data.

Coating Systems and Pipeline Materials

DOE, working with PHMSA, industry research organizations, and coating manufacturers, should support R&D on new pipeline and repair coating systems and pipeline materials that are highly durable and damage resistant during construction.

Methane Emissions

DOE should work with industry and technology developers to advance and deploy technologies to better identify, locate, quantify, and mitigate methane emissions.

Source: Baker Hughes Company.

Crack Detection In-Line-Inspection Tool

Storage Technologies

Key Finding

Advancements in new technologies have been an important contributor to industry's safety, reliability, and environmental performance. Overcoming challenges and barriers to new technology development and deployment would accelerate these improvements.

Recommendations: Underground Storage

Casing and Cement:
DOE should lead a collaborative effort with PHMSA and industry trade associations to determine the most effective measures of casing and cement integrity and explore opportunities for casing and cement logging improvements.

Well Inspection Technology:
DOE should pursue additional R&D on well inspection technologies that can improve integrity logging, and reduce the frequency of tubing removals, which would reduce risk to personnel and the environment.

Recommendation: Aboveground Storage

Tank Integrity Monitoring:
Industry and PHMSA should consider additional research and validation on tank integrity monitoring technologies to measure floating roof stability and integrity, including:

- camera technologies and associated pattern recognition software,
- wireless sensors, and
- unmanned aerial systems (drones)

LNG Storage

Overview

- The LNG industry has advanced significantly since inception in both safety and technology and has an exemplary safety record.

- After being an importer of LNG for many years, in 2016, the United States began exporting LNG and is set to become a major player in the world export stage.

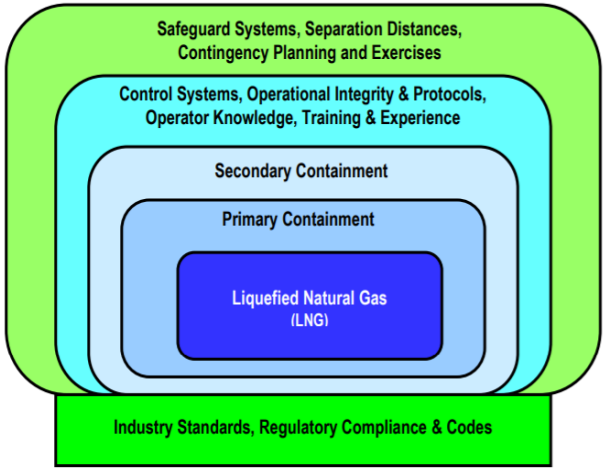


Illustration of Layers of Protection for Onshore LNG Storage and Containment Systems

Finding

Current Title 49 CFR Part 193 regulations do not recognize the latest design codes and standards in use for LNG production & export facilities.

Recommendations

Updating regulations to reflect latest standards and practices

- Pursuant to EO 13868, **PHMSA should work with the LNG industry** to update Title 49 CFR Part 193 for design, construction, and operation of LNG facilities to align with global best practices, advances in design codes, and to reflect risk-based standards.
- **Industry, through its trade associations, should work with PHMSA** to develop an inspection protocol specifically for LNG storage tanks that are built to API 625 and ACI 376, and their failure mechanisms unique to LNG storage.

Marine Technologies

Finding

Marine vessel safety has improved in the past few decades, but opportunities exist to improve operations. Additional **advancements in navigation technologies and training systems** offer the best opportunities to mitigate marine vessel accidents.

Recommendations

Navigational Technologies

The U.S. Coast Guard (USCG) should:

- Fully **implement NTSB recommendations** that could improve Vessel Traffic Service (VTS) system ability to **reduce the risk of allisions, collisions, and groundings** within VTS areas.
- **Implement additional traffic separation schemes and traffic rules** to reduce marine traffic risk of allision, collision, and grounding.

Training and development to reduce accidents caused by human factors:

- **U.S. Coast Guard** should **extend requirements for vessels to be outfitted with Automatic Identification System (AIS)** to all commercial towing vessels with accurate tow-dimension input. Operator training should be required on model-specific AIS technology in use.
- **Local port authorities** should **adopt National Ocean Service (NOS) real-time oceanographic data and other navigation products.**
- **U.S. Coast Guard** should require that all vessels required to carry AIS "Type A" be fitted with an **electronic chart system**.

Marine Training Simulator
Source: Wärtsilä Corporation

Rail Technologies

Findings

The railroad industry has implemented additional standards, processes, and new technologies to address leading causes of accidents: track, equipment, and human error.

Recommendations

Track:

- Track safety can be improved by aggressively **implementing defect detection technologies,** which can improve flaw detection through the use of various ultrasonic, laser, optical, and infrared technologies grounding.

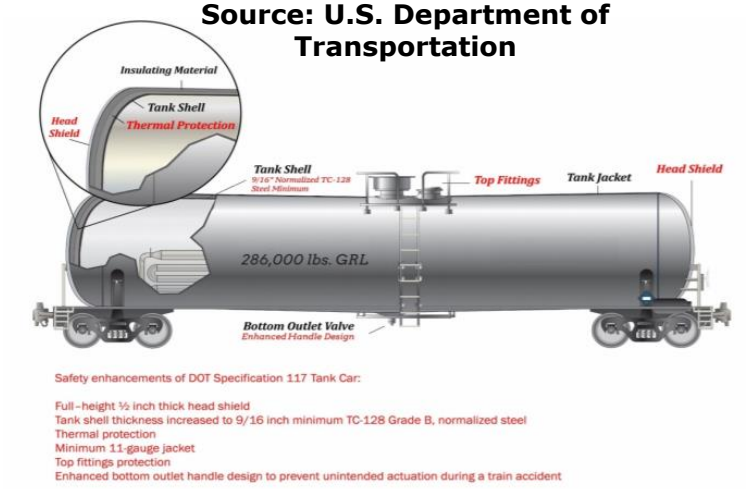
Equipment:

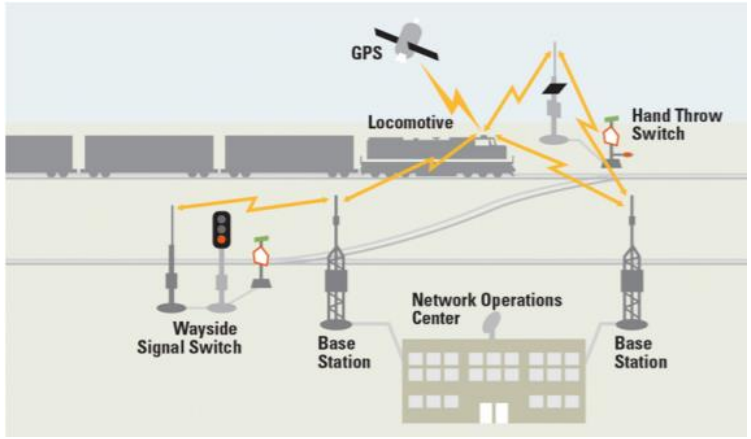
- Equipment-related improvements will be supported by **enhanced tank car standards** promulgated by PHMSA in 2015. These updated standards **require new and retrofitted tank cars**.

Human Error:

- Improvements to reduce incidents caused by human error include **deployment of technologies such as positive train control, locomotive cab technologies, and route modeling.**

Example of DOT-117 Tank Car
Source: U.S. Department of Transportation





Positive Train Control
Source: BNSF

Trucking Technologies

Background

- Sensors and computers available for trucks today can detect hazards, analyze more information, and respond to events much faster than any human being. These technologies can help reduce accidents and eliminate thousands of deaths and injuries.

Recommendations

Information Sharing:

- **National Highway Transportation Safety Administration (NHTSA), and other appropriate federal agencies**, should **sponsor a research study to confidentially gather performance data of safety technologies**.

Incentivizing Technology Deployment:

- **DOT should consider sponsoring incentive mechanisms** for the trucking industry and equipment manufacturers to **accelerate deployment of safety technologies**

Infrastructure Improvements:

- **DOT** should ensure funds are provided to **maintain proper road markings** which enable safety technologies to work properly (e.g. LDWS)

Supporting Research:

- **NHTSA** should **support research to identify technologies that improve LDWS** ability to work on snow-covered or improperly marked roads.
- **FMCSA and NHTSA** should **support research to advance fatigue and distraction detection technologies**.

Trucking Safety Technologies

Forward Collision Warning and Avoidance Systems

Lane Departure Warning and Corrective Steering (LDWS)

Fatigue and Distracted Behavior Recognition

Vehicle Camera Systems

Regulatory Barriers to Technology Deployment

Regulatory challenges can be overcome with **collaboration between government and industry**, and a regulatory framework encouraging the use of new technologies to improve safety, reliability, efficiency, and environmental performance.

Current State

Field Testing

More efficient pathways for field testing new technologies could reduce deployment time and accelerate quality and reliability improvements.

Prescriptive Regulations

Prescriptive, rules-based regulations, which can lock in old technology solutions and be slow to adopt more effective and often less costly practices, can stifle innovation.

Limited Research Funding

Research investments by individual operating companies, research consortiums, or suppliers can be limited by competing priorities that more directly impact their business model.

Recommendations

Agile Pathway

DOT should lead, while working with DOE, EPA, and U.S. Coast Guard, the creation of an agile pathway for evaluation and regulatory acceptance of new technologies to shorten the research, deployment, and adoption cycle time.

Pilot Programs and Performance-based Rules

Congress should authorize DOT to lead a collaborative effort, with support from industry, to develop pilot programs that can accelerate pipeline, storage, and LNG technology adoption based on performance-based rules to enhance public safety.

Cost Recovery

FERC and state regulatory agencies should work with DOT, DOE, and others to promote laws, regulations, and public-private partnerships that support cost recovery for oil and natural gas pipeline safety and environmental R&D.

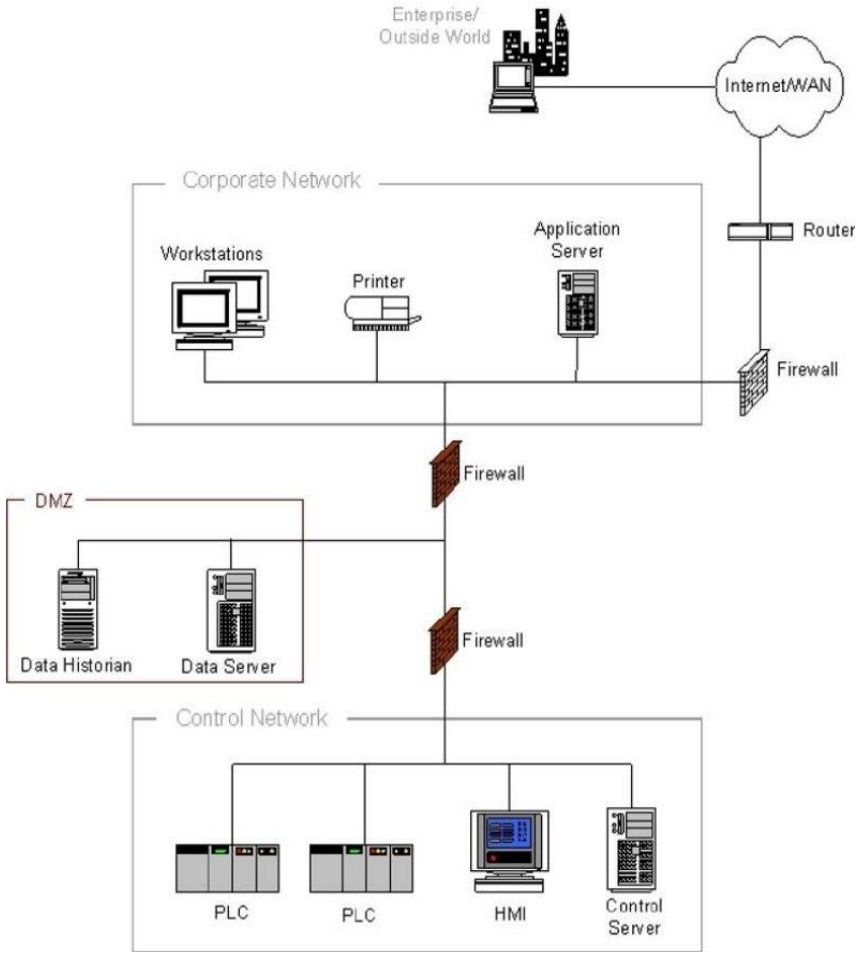
Cybersecurity Challenges

Cyber threats to energy infrastructure control systems are increasing, and security protections are being challenged due to increasing connectivity and growing malicious cyber activity.

Challenges

Convergence of Information Technology (IT) networks with Operational Technology (OT) Industrial Control System (ICS) networks has introduced greater cyber challenges to the oil and natural gas industry.

Targeted ICS attacks have increased in frequency and sophistication, furthering the risk of economic impact, operational shutdowns, damaged equipment, environmental, and safety consequences.



NIST 800-2. Firewall between Corporate Network and Control Network.

Cybersecurity Recommendations

Stakeholder support of efforts to improve digital security through technological innovation and adoption of improved operational and policy frameworks will strengthen cybersecurity defenses.

Key Recommendations

Adopt and maintain **performance-based cybersecurity management standards**

Increased government support to carry out **cybersecurity assessments and audits** on critical infrastructure.

The public and private sectors should assist sector Information Sharing and Analysis Center (ISAC's) and regional groups to **promote information sharing** including learnings from investigations.

R&D activities to address:

1) current and anticipated threats;
2) transportation types with the highest risk of cyber Operational Technology (OT) threats; and
3) funding, partnering, or incentive opportunities to reduce cyber OT risks.

Discussion – Questions

Report is available at:
dynamicdelivery.npc.org