

Energy and Communities

Prioritizing Safety, Health and
Environmental Stewardship



energy **API**

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// Energy is fundamental to our society. Our ability to responsibly produce, safely distribute, store and efficiently consume the energy we need to maintain our standard of living while lessening the impact on the environment is crucial to our shared goal of a better future for the next generation. //

– Jack Gerard, API president and CEO

Energy and Communities

The safety, health and protection of people, the environment and communities are the top priorities for the natural gas and oil industry. Today, natural gas and oil not only power our lives, but are the building blocks for so many of the products that make modern life possible. But this energy and the amazing things derived from it – everything from clothing and cosmetics to state-of-the-art health care devices and medicines – aren't possible unless responsible development is the centerpiece of everything the industry does.

Across the board – from workplace safety to air emissions to the safety of transporting our products – the numbers tell an important story of constant improvement, investment in the future and technological innovation.

Commitment to Progress

The industry is safer than it has ever been. Even as U.S. natural gas and oil production has surged over the past decade, workplace incident rates have fallen, more than 99.99 percent of products moved by pipeline are arriving at their destination without incident and our air is cleaner than ever, thanks in part to our world-class refining sector. Because of the shale revolution, our newly abundant and affordable supply of clean-burning natural gas is allowing a rapid and remarkable transformation of the power generation sector. As use of natural gas for electricity generation has grown, cars have become more efficient and refineries have improved, U.S. carbon emissions and criteria pollutants have also fallen.

The industry's commitment to producing more energy while reducing our footprint and improving the efficiency and safety of our operations is relentless. Continuous investment in innovative technologies and new approaches to improving our operations have become the bedrock of the industry's commitment to progress, making it possible to integrate renewable energy sources into the grid while better understanding how to best manage and protect the environment.

99.99%

Even as natural gas and oil production has surged over the past decade, workplace incident rates have fallen, more than 99.99 percent of products moved by pipeline arrive at their destination without incident and our air is cleaner than ever, thanks in part to our world-class refining sector. The industry is safer than it has ever been.

145 YRS

Thanks to new technology and knowhow that have allowed the U.S. to safely tap into energy resources once thought inaccessible, we now have an oil resource that can meet 75 years of current demand and a natural gas resource that can meet up to 145 years of current demand.

Moreover, the 9.8 million women and men who hold jobs supported by the U.S. natural gas and oil industry are also members of the communities they serve. They have made health and safety core values because they want to protect their families, their neighbors, and the towns, cities and special places they call home.

Meeting Our Energy Needs Now and Well into the Future

The industry has the privilege of providing the affordable, reliable energy that is the lifeblood of our economy – and it understands that our nation’s prosperity fundamentally relies on our industry’s ability to produce more of these resources in a way that promotes healthy communities and environments. The industry’s determination to innovate and problem-solve has rewritten the nation’s energy script: Instead of entering an era of energy scarcity, which could put upward pressure on prices, we have entered an era of abundance that has lowered costs for consumers.

Thanks to new technology and knowhow that have allowed the U.S. to safely tap into energy resources once thought inaccessible, we have an oil resource that can meet 75 years of current demand and a natural gas resource that can meet up to 145 years of current demand. As our technical ability expands, so will our ability to gather more resources than currently estimated.

Today, according to the U.S. Energy Information Administration (EIA), natural gas and oil meet 67 percent of the nation’s energy needs. In 2040, they are projected to meet 68 percent of our energy needs.¹ While renewable energy is a growing and important part of our energy mix, fossil fuels will continue to shoulder the vast majority of our energy needs well into the future. Making the most of these resources means simultaneously innovating and integrating best practices to preserve public and environmental health.

American voters understand the importance of the natural gas and oil industry and the need for increased energy development. According to a survey of voters on election night, 80 percent of voters support increased development of U.S. natural gas and oil resources, and 81 percent support increased development of the country’s energy infrastructure, such as pipelines.²

Providing the fuels that power our economy and are the building blocks of so many of the products we rely on is not a responsibility the U.S. natural gas and oil industry takes lightly. The industry understands that maximizing the benefits of our plentiful natural resources means continuing to invest time and resources to protect individuals, entire communities and the environment.



Putting **SAFETY FIRST**

STANDARDS

Internationally recognized standards formalize industry safety practices to protect everyone and everything that touch the natural gas and oil industry – from the consumer to workers to the environment and public.

API's nearly 700 standards put best practices to work across the industry:



in **STATE** regulations

State of American Energy Report, American Petroleum Institute, 2017.



by **GOVERNMENT** agencies like
the Coast Guard, EPA and FTC



in **BSEE's OFFSHORE**
regulations

Standards provide the framework for securing and advancing safety, the number one priority of the natural gas and oil industry. They guide industry in protecting the personal safety of workers and the communities the industry operates in, and they establish process safety measures, covering the equipment, procedures, and training concerned with industry operations.

Importantly, safety standards also safeguard public health and the environment, ensuring that communities and habitats surrounding industry sites across the country thrive.

Leading the Industry in Cutting-edge Standards

API has been the industry leader in developing standards since 1924.

These standards are developed by a process that is accredited by the American National Standards Institute (ANSI), the body that accredits similar programs at several U.S. national laboratories. The transparent process brings together subject-matter specialists from a wide range of disciplines and backgrounds, including academics, government regulators and industry experts. Their common goal is to improve and advance the safety of energy development, even in some of the harshest and most unforgiving environments on the planet. Each standard is reviewed at least every five years.

As part of its Global Industry Services, API maintains a portfolio of more than 700 standards covering all segments of the industry, in

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45%

Bureau of Labor Statistics reports the injury and illness rate for the U.S. natural gas and oil industry fell by 45 percent from 2006 to 2015 – even as thousands of new jobs were added – and it remains well below the national average for the entire U.S. private sector.

addition to supporting a vigorous standard-setting program. Additional industry standards come from the American Society of Safety Engineers and ANSI, among others.¹

Because API standards are recognized as representing industry safety practices based on the best available science and research, they are widely cited in federal and state regulations, and sometimes incorporated into the rules themselves. Also, the standards are commonly referenced in regulations by international regulators.

As these standards are implemented and their effects measured, they add to the body of knowledge of industry best practices and lessons learned, and deliver significant improvements to system integrity, reliability and integrated safety.

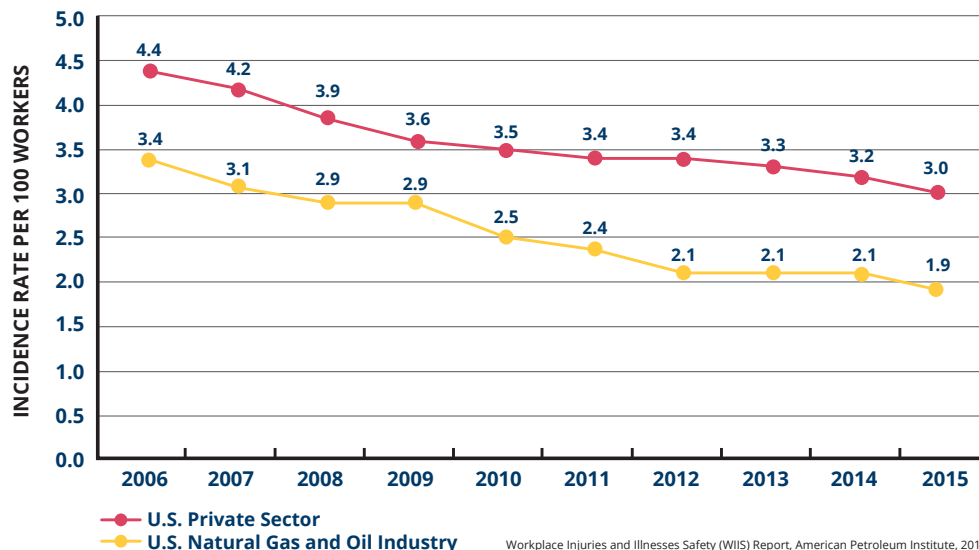
WORKPLACE SAFETY

The natural gas and oil industry's commitment to excellence in workplace safety not only protects the 9.8 million jobs supported by the industry across the country, it also keeps surrounding communities and the environment healthy and safe.

The natural gas and oil industry has an impressive and ever-improving record of reducing incidence of injury and illness in workplaces across the country. According to the latest Bureau of Labor Statistics report, the injury and illness rate for the U.S. natural gas and oil industry fell by 45 percent from 2006 to 2015 – even as thousands of new jobs were added – and it remains well below the national average for the entire U.S. private sector.²

U.S. Natural Gas and Oil Industry vs. U.S. Private Sector (2006-2015)

Injuries and Illnesses Incidence Rates



Workplace Injuries and Illnesses Safety (WIIS) Report, American Petroleum Institute, 2016.



Still, the industry is working continuously to improve safety in the workplace by means of research, standards development and implementation of an array of programs involving training, monitoring and measuring, data gathering, information transfer, and assessment. The industry collaborates with government agencies and many safety-oriented organizations – such as the American Industrial Hygienists, the American Society of Petroleum Engineers and the American Society for Testing and Materials – to improve safety across the board. Workplace safety covers a large and varied set of procedures, conditions and environments, from personal safety, which protects the individual worker, to process safety, which deals with all the functions needed to avoid major safety events.

Driving National Workplace Safety Standards

In fact, because the industry's work in this area has been so consistent and comprehensive, API's recommended practice documents for workplace safety have been incorporated into standards and guidance on Safety Hazards Associated with Oil and Gas Extraction Activities issued by the Occupational Safety and Health Administration (OSHA).³

API is also at the forefront of worker training, which is crucial to avoiding many workplace incidents. Its Global Industry Services division is the industry leader in certificate programs, giving employees and contractors the skills to stay safe in the workplace. API's WorkSafe™ training ranges from tool selection and hot work to trench and driving safety. Courses, complete with detailed curricula, training and exams, include Exploration and Production Onshore Program, Crude by Rail, Underground Storage Tank Training and Service Station Contractor Safety Training.⁴

Safety measures need to be site and job specific. On the ground, companies employ industrial hygienists and safety professionals to prepare site-specific job safety assessments (JSAs) well before work begins. JSAs outline the tasks to be performed and the specific safety measures (or controls) that are to be taken for specific risks. Communicating the hazards, training workers and stressing awareness are all vital to workplace safety. Worker protection standards and controls consider the entire picture, from tools to environment to equipment to worker fatigue. Yes, there's an API recommended practice for that. It's called the Fatigue Risk Management System.

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200

API has more than 200 exploration and production standards, more than 100 of them published or revised since 2010.

OFFSHORE SAFETY

Vast offshore resources hold the promise for a secure, affordable and reliable energy future for America. Reaching these resources safely is why the natural gas and oil industry has worked tirelessly to establish and continuously improve robust safety practices, standards and regulations to protect both people and the environment.

For the natural gas and oil industry, safely and responsibly developing offshore resources means implementing prevention, intervention and response processes that protect marine habitats, workers and communities. As a result, the industry leads in developing globally accepted safety standards, driving and adopting appropriate tight regulations and improving collaboration.

Industry standards cover everything from deep-water well design and construction to the structural integrity of fixed offshore structures and more. These standards are consistently reviewed and updated. Improvements have recently been made to standards on blowout prevention equipment systems, isolating potential flow zones during well construction, as well as subsurface safety valve equipment. In fact, API has more than 200 exploration and production standards, more than 100 of them published or revised since 2010.⁵

Following Regulations Offshore

The industry's own standards are just one part of the story. Offshore energy development is tightly regulated by organizations like the Department of the Interior and its agencies, the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement.⁶ There are more than two dozen statutory authorities and more than 80 codes of federal regulation derived from those statutes. Offshore operations are subject to dozens of

significant approvals and permits. These regulators are continuously updating regulations and incorporating standards and best practices to improve regulations for the industry as it operates offshore.

Throughout any offshore operation, protecting marine life and surrounding habitats is an important priority for the natural gas and oil industry. The industry conducts scientific research and works with federal regulators to study marine life and form mitigation plans for any potential operational impacts.

Equipment safety and innovation have also contributed significantly to both marine safety and safety of offshore operations overall. From double hull tankers to using old platforms to build artificial reefs, the natural gas and oil industry is developing new approaches to protect marine life and even enrich it.⁷

Improving Collaboration through the Center for Offshore Safety

The natural gas and oil industry recognizes that by collaborating on best practices in safety and environmental management, it can foster innovation that will continue to improve offshore operations. The Center for Offshore Safety (COS), formed in 2011, facilitates continuous improvement in offshore drilling and production operations through effective leadership, communication, teamwork, management systems, and independent third-party auditing and certification.⁸

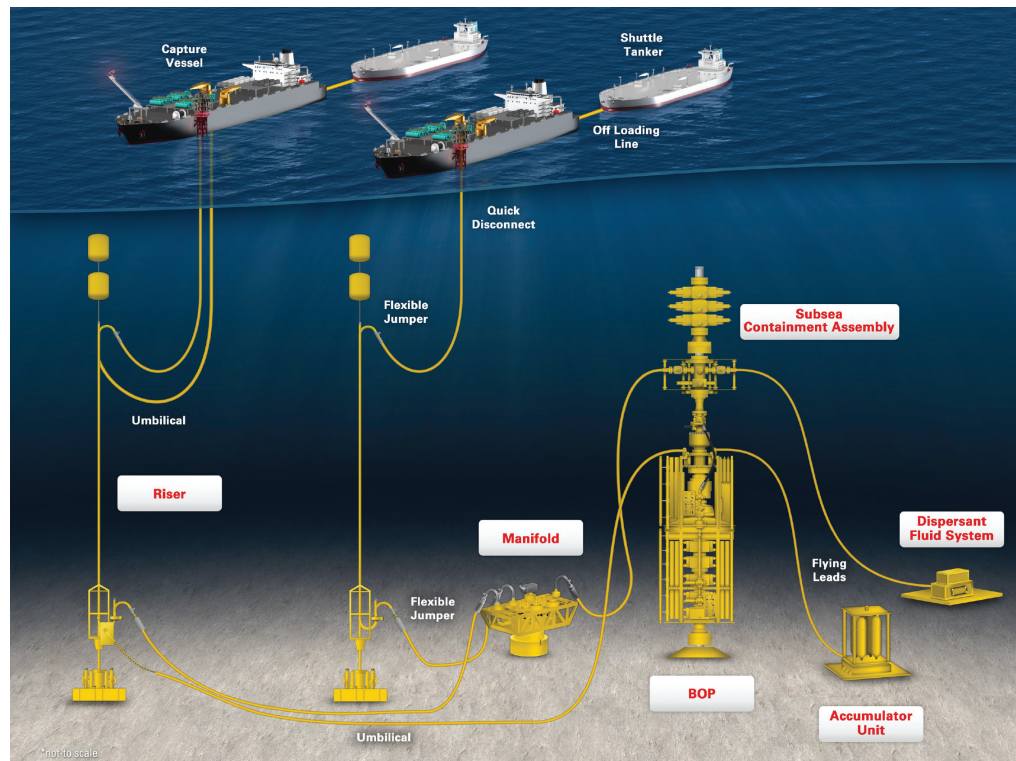
COS has proven very effective in developing industry standards, with a number of its guidelines already incorporated into regulations. The Safety and Environmental Management System (SEMS) focuses on both personnel and process safety, covering all aspects of a company's operations. It is also a key mechanism to reduce the likelihood of major incidents as well as establish barriers to prevent escalation of events that do occur.⁹

High among COS' guiding principles is that open communication and transparency of safety information be employed to build trust among stakeholders and promote collective improvement in industry safety performance. To this end, COS collects data from industry operations and independent, third-party audits to compile annual performance reports, including high points and areas needing further improvement. It also holds an annual Safety Leadership award recognition program designed to encourage, reward and share outstanding contributions to safety management that enhance the collective knowledge of the industry. Over the years, the award has recognized companies for everything from information sharing among industry partners to improving collaboration among service companies and drilling contractors.¹⁰

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The Marine Well Containment Company (MWCC) and Helix Well Containment Group (HWCG) provide containment technology and response capabilities if there is a need to cap a well that's located thousands of feet below the water's surface.

WELL INTERVENTION TECHNOLOGY DEVELOPED BY INDUSTRY PARTNERS



"New Containment System Fact Sheet," Chevron, ConocoPhillips and ExxonMobil, September 2010.

Preparing for Intervention

The natural gas and oil industry recognizes that in addition to its prevention efforts, effectively preparing to intervene in the case of an incident is an important component of protecting both people and the environment as it operates offshore. In its commitment to effective intervention, the industry has emphasized two key areas: technology and training.

The industry also has created organizations whose sole purpose is rapid, effective response to any oil spill. Two entities – the Marine Well Containment Company (MWCC) and Helix Well Containment Group (HWCG) – provide containment technology and response capabilities if there is a need to cap a well that's located thousands of feet below the water's surface. MWCC is an independent company, while HWCG is a consortium of deep-water operators. Both maintain quickly deployable systems designed to stop uncontrolled flows of hydrocarbons from a subsea well.¹¹

The natural gas and oil industry has invested heavily in well containment and intervention capabilities, including deep-water vessels and equipment capable of capping, stopping and offloading the flow of oil so that it minimizes impact to marine environments should there ever be a loss of well control.

When it comes to training, companies that maintain quickly deployable solutions also train other companies on the installation and operation of their systems so that they can be put into use quickly and efficiently in the event of an accident.

PIPELINE SAFETY

Nearly 100 percent of the natural gas, petroleum products and oil delivered by pipeline is delivered safely without incident. The industry is proud of its progress and is working hard to make further improvements. Best practices covering everything from technology to nuts and bolts to human behavior mean that the natural gas and oil industry keeps communities and the environment safe while delivering energy everywhere.

Pipelines are one of the safest and most efficient ways to transport liquid energy, including crude oil, petroleum products and natural gas liquids. This is especially important given the long distances these products must often travel from production areas to refineries to end use.

The overriding health and safety concern is ensuring the integrity of the pipeline, which is done through extensive inspection, monitoring, safety programs and state-of-the-art technology. The goal is to recognize pipeline issues and resolve them before they cause an incident – and to focus especially on areas where the public or sensitive environments could be affected.

With the opening of new crude oil production areas, often far from refineries, the miles of pipelines and quantity of product they carry have increased rapidly. In 2015, around 72,400 miles of pipeline transported crude oil from production areas to refineries – up 29 percent from 2011. In 2015, 18.1 billion barrels of crude and petroleum products were transported across the United States by pipeline to refineries and end users, an increase of 34 percent since 2011.¹² With this surge in growth, safety remains a paramount issue, even with the reality that more than 99.99 percent of crude oil and petroleum products were delivered safely by pipeline in 2015.¹³

In addition to crude oil pipelines, approximately 63,000 miles of pipelines carry refined liquid petroleum products, like jet fuel, gasoline, heating oil and diesel

18.1_B

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In 2016, crude oil and petroleum products reached their destination **safely by pipeline more than 99.99% of the time.**

99.99%



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fuel, from refineries to local distribution centers, where tanker trucks carry the product to its final destination.¹⁴ Some facilities, such as airports, even receive their fuel directly through pipelines dedicated to delivering the proper quantity of jet fuel needed to keep planes moving.

Natural gas and oil industry initiatives cover all aspects of pipeline safety, from technology to equipment to human behavior. For example, API and the Association of Oil Pipe Lines (AOPL) started and are sustaining the Pipeline Safety Excellence Initiative, in which an industry-wide team of senior leaders develops a multiyear strategic plan for tackling the tough issues to improve pipeline safety performance.

Supporting the Shale Revolution and Natural Gas

Natural gas pipelines share the same impressive safety record as crude pipelines. Even as capacity has grown significantly, the number of pipeline incidents has dropped 94 percent between 1984 and 2012, and material and weld leaks have dropped 20 percent between 2002 and 2014.¹⁵

In 2016, more than 99.99 percent of natural gas moved safely through interstate pipelines. In short, pipelines are incredibly safe – and getting safer all the time.¹⁶ In 2016, 25.3 trillion cubic feet of product¹⁷ moved through 300,000 miles of transmission pipes (200,000 interstate and 100,000 intrastate) plus 2.1 million miles of smaller lines that distribute gas to homes and businesses.^{18,19}

The shale revolution, which opened substantial domestic sources of natural gas to the market, resulted in the need for an increase in energy pipeline infrastructure. For example, 24,000 miles of new pipelines are needed by 2035 to meet growing natural gas demand.²⁰ This means, on average, approximately 1,200 miles of pipeline will need to be added each year through 2035.²¹

Using Technology to Avoid Incidents

Advances in technology have allowed the most striking innovation in incident prevention. Without interrupting the flow of liquid or gas, “smart pigs” travel inside the pipeline using scanning technology similar to a medical MRI. The data is analyzed to detect early signs of corrosion, dents, cracks or other problems so that maintenance can be performed before a safety issue arises.

Advanced computer systems track the operating characteristics, such as pressure and temperature, within the pipelines. If data coming into the control room indicates a potential problem, processes and procedures focused on protecting people and the environment are in place to ensure that issues are addressed in a consistent and timely fashion.

In addition, if an issue is detected or suspected, pipeline control centers can trigger shutoff valves to isolate a segment of piping. Emergency procedures are then initiated to ensure that crews are on-site as soon as possible to assess the situation and mitigate a spill, or confirm that the segment is okay for restart.

Continuing Commitment to Safety

Continuous safety management and improvement efforts also focus on operations and maintenance functions, where incidents can be caused by equipment failure, incorrect operation or excavation damage by the pipeline operator or contractor. These incidents are within the operator's control, so they are the focus of numerous industry programs aimed at creating a workplace culture of safety and safety management systems. Industry associations support committees and teams that work on safety initiatives benefiting the entire industry, providing opportunities to share lessons learned and information on near misses, to hear about the latest safety advantages, and more.

For natural gas transmission pipelines, excavation damage is the leading cause of severe incidents.²² Given the prevalence of pipelines in the ground, including local distribution lines, pipeline operators are committed to expanding their inspection and surveillance programs, as well as expanding their robust public outreach programs to ensure that the public understands how to avoid rupturing transmission pipelines (e.g., the "Call 811 Before You Dig" program), how to recognize and report signs of leaks, and what to do in case of an incident. From 2002 to 2014, excavation damage incidents declined 34 percent.²³

No matter the source of incidents (including those outside of the industry's control, such as floods, lightning and third parties), the pipeline industry continues to develop and improve its response capabilities by reaching out to local first responders and raising public awareness. Additionally, the industry has set boosting response capabilities as an ongoing strategic goal for pipelines, including initiatives for industry-wide standard setting on leak detection, emergency response training and more.²⁴

How many? How large? Where?

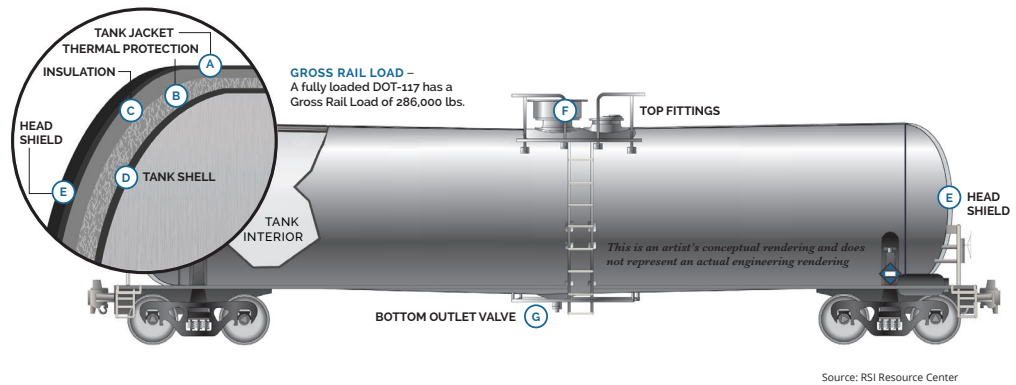
A major challenge in safety management is to understand where to focus the most attention and effort. Answers emerge from the detailed statistics that the industry supplies to the U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA). Operators are required to report all incidents to PHMSA that release five barrels or more of crude oil. Aside from knowing the number of overall incidents in the U.S., it is also important to understand the size and location of those leaks. In 2016, there were approximately 415 total incidents from liquids pipelines, a 10 percent decrease from 2015. Specifically, there were 284 facility incidents – ones that did not reach public spaces, but were wholly contained within a pipeline operator's facility (e.g., pump stations, tank farms, tanker transfer racks, etc.) – and 131 incidents outside of facilities in public spaces. Also, most pipeline leaks are small in size. For example, in 2016, 60 percent of pipeline incidents were less than five barrels and 80 percent of incidents were 50 barrels or less.²⁵



41,463

This is a smart pig. In 2015, liquids pipeline operators performed 12,936 integrity digs uncovering and checking sections of pipeline, resulting in 10,558 preventive maintenance repairs to the pipeline. In 2015, liquids pipeline operators also conducted 1,580 smart pig tool inspections, covering 41,463 miles of pipeline.

Innovating Railcars: New Safety Standards



RAIL SAFETY

99.99%

Like pipelines, the industry places the highest priority on safety, and 99.99 percent of crude oil deliveries via rail transport reach their destinations without incident.

Rail safety is at an all-time high, even as the natural gas and oil industry relies more and more on rail to transport the nation's vast energy resources across the country – all the while keeping communities and the environment safe.

Over the past five years, the United States has seen a dramatic increase in crude oil transported by train, much of it from newly developed shale resources that are located far from existing energy infrastructure. While volumes being moved by rail are currently declining, in part due to increased pipeline capacity, rail is still an important tool in supporting the nation's energy renaissance. Like pipelines, the industry places the highest priority on safety, and 99.99 percent of crude oil deliveries via rail transport reach their destinations without incident.²⁶

The transport of crude oil by rail grew from 23.8 million barrels in 2010 to 318.8 million barrels in 2015, and accounted for 20 percent of all crude oil deliveries to U.S. refineries in that year.^{27, 28} However, in the first five months of 2016, crude oil deliveries declined by 45 percent from the same period in the previous year.²⁹

The oil and railroad industries are working individually and cooperatively to ensure and improve safety of petroleum transport on many fronts. From the loading of crude onto railcars to unloading it at its destination, new standards, best practices and technology are all working in unison to improve safety. For example, the loading process is covered by API's standard for testing, transport classification and measurement of the crude oil loaded onto the railcars. Safety monitoring is in place all along the line, with early alert detectors installed at least every 40 miles to identify defects in passing railcars. Specialized vehicles ride the rails to identify defects both in the tracks and in the ground underneath.³⁰

Statistical routing models identify the overall safest and most secure routes for transporting hazardous materials. There are additional requirements for trains with more than 20 cars of crude oil, such as more track inspections and a speed limit of 50 mph – or less in certain circumstances. Also, such trains must be equipped with either distributed power (a locomotive placed at another part of the train than the front) or two-way end-of-train brake systems so that brakes can be applied from the head of the train and elsewhere farther back to stop the train faster.

Deploying Safer Railcars

One of the most effective ways to ensure safe rail travel for crude oil shipments is to have railcars that will mitigate the effects of accidents. The U.S. natural gas and oil industry, in combination with rail tank car builders and railroad carriers, has been at the forefront of developing improved designs and pushing for enhanced standards. The industry established its own stringent standards for new cars in 2011, and continues to develop and deploy new technologies and designs to improve rail safety.

The new design for all cars built after October 2015 has several layers of protection. The steel tank cylinder is thicker than in previous designs to protect against breaches. It also is covered with thermal protection to safeguard the car from overheating and lower the chance that fire will spread to intact cars. Then there's a second steel jacket covering the cylinder and the thermal protection, plus an extra shield covering each end of the car

for an additional layer to protect against punctures.³¹

Among other changes are improved pressure release valves that will open if the internal temperature gets too high and the pressure might cause a rupture. The valves open when the pressure reaches a certain level so that product is released in a controlled way and internal pressure is lowered.

Casting a Wide Net for Training

The railroads have an extensive emergency response system, with both internal teams trained in hazmat and emergency response, as well as networks of hazmat contractors and consultants located throughout their service areas that have the monitoring, container and spill response equipment needed to respond to emergencies. The American Association of Railroads (AAR) reports that railroads train more than 20,000 emergency responders annually across the country.³²

Another effort is a multi-industry safety program called Transportation Community Awareness and Emergency Response, or TRANSCAER®, that focuses on helping communities prepare to respond to a possible hazardous materials incident. API and member volunteers belong to this group, which offers classroom and hands-on training, emergency planning assistance, support for community drills and more.³³

20k

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And recently, API, AAR and their members developed a safety course specifically aimed at educating first responders about crude oil. The training video, released in August 2016, deals with the characteristics of crude oil, the railcars that contain it and response strategies to consider if crude oil is present. Also covered are firefighting and spill response, as well as the need for structured incident management.³⁴

REFINERY SAFETY

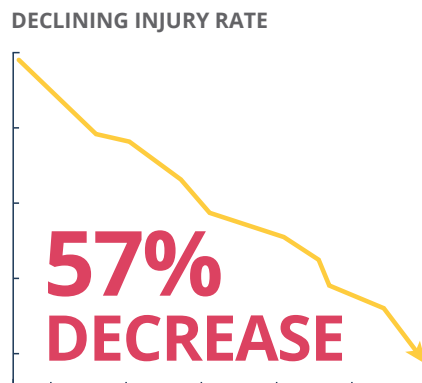
The U.S. refining industry is committed to the health and safety of workers, contractors, communities and the environment. U.S. refineries operate under stringent state and federal regulations in addition to following top-tier business standards, and their dedication to safety never ceases.

This commitment to safety is why refinery employees are six times less likely to be injured on the job than employees in other manufacturing sectors.³⁵ The refining industry injury rate has been steadily decreasing – including a decline of 57 percent from 2006 to 2015 for refinery job-related injuries and illnesses, including process safety accidents.³⁶

There is a combined effort within the industry to remain vigilant in preventing threats to safety and continuously improving in the fields of mechanical integrity, risk management and mitigation, safe work practices, operating practices, process hazard analysis and training. To assist in continuing to improve safety efforts, the refining industry has implemented more than 200 refining safety-related operating standards and work practices.³⁷

API is a leader in maintaining the refining industry's strong culture of safety, guided by regulations, standards and industry practices. A great example is API's Process Safety Site Assessment Program (PSSAP), which offers refineries access to independent, credible, third-party teams of industry-qualified process safety expert assessors. These experts evaluate the quality and effectiveness of a site's process safety management system, identifying improvement opportunities and providing an opportunity for refineries to share proven engineering safety practices.

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UNDERGROUND NATURAL GAS STORAGE SAFETY

Underground natural gas storage safely provides the energy communities need to heat homes during times of high energy demand, and the natural gas and oil industry has recommended practices and standards to help protect the environment and communities around storage sites.

About half of all U.S. homes use natural gas as their main heating source. Because demand for natural gas to heat homes is higher during the winter, the industry relies on underground storage to account for seasonal variations in consumption.

Maintaining a Flexible and Reliable Resource

Flexibility provided by underground storage is the key to maintaining reliable and responsive natural gas delivery to communities across the U.S. There are approximately 400 active underground storage facilities in 30 of the lower 48 states, with a working gas storage capacity – capacity that is available for withdrawal – of more than 4 trillion cubic feet of natural gas. These facilities safely store about 20 percent of all natural gas consumed each winter, energy that is produced during months when production outpaces consumption. Underground storage

can also be used to keep natural gas flowing to consumers in the event of temporary disruptions in production, and helps interstate pipeline companies balance the system supply on their long-haul transmission lines.

Prioritizing Safety in Underground Storage of Natural Gas

Underground natural gas storage operators are committed to ensuring the safety and integrity of their facilities. The industry's construction, operation and integrity management protocols are overseen by multiple agencies at the state and federal levels.

Beyond federal and state regulations, the natural gas industry has taken the initiative to work with external stakeholders to develop two recommended practices (RPs), accredited by ANSI, for underground storage. RP 1170 and 1171 provide guidance to operators on how to design, operate and ensure the integrity of underground storage for natural gas. These RPs have been adopted by the federal government in rules overseeing management of storage facilities.

Using Well Integrity Practices for Underground Storage of Natural Gas

Storage operators use a variety of methods and tools to ensure that storage facilities are managed safely. Storage operators check for weak points and leakage, and investigate suspicious indications through a variety of downhole logging techniques, including formation

There are approximately 400 active underground storage facilities with a capacity of 4 trillion cubic feet of natural gas.

evaluation tools (e.g., neutron logging), fluid movement indicators (noise and temperature surveys), casing inspections (magnetic flux leakage and ultrasonic methods), mechanical calipers, downhole cameras and cathodic protection profile surveys.

In addition to tool-based assessment methods, the industry uses pressure tests and monitoring as integrity assessment methods. Operators may employ a risk-based approach that takes into account risks and threats specific to each well when selecting well integrity practices. Commonly assessed risks or threats include the type and size of the pipe being used to inject or extract the stored gas, the type of storage being used and environmental factors that might

cause external corrosion at or near the surface (e.g., the presence of water, hydrogen sulfide, bacteria or naturally corrosive materials).

Operators also evaluate other risk factors, like whether the location of the facility is in an area prone to natural disasters, how close the facilities are to homes and schools, whether there are sensitive environmental or cultural features nearby and whether the facility is being used to provide natural gas service. These components all help the industry to ensure that communities get the energy they need while protecting the environment.³⁸



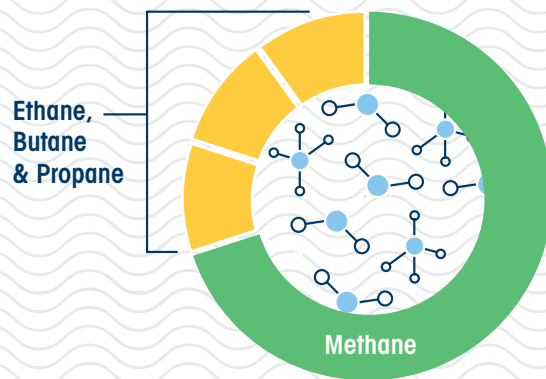
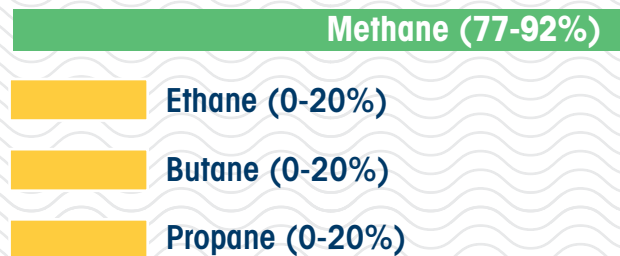


Reducing EMISSIONS

METHANE EMISSIONS

The natural gas and oil industry has led the charge to dramatically decrease methane emissions and its efforts are paying off.

Natural gas primarily consists of:

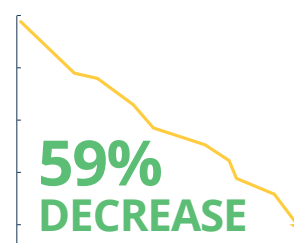


The industry's proactive approach to methane emissions reduction has allowed it to reduce total emissions even as production of natural gas and oil has surged. The U.S. Energy Information Administration (EIA) says that from 2011 through 2015, U.S. oil production increased 66.7 percent and dry natural gas output grew 18 percent.¹ Yet, methane emissions from natural gas and oil production combined decreased by 4 percent over the same period.²

Methane, a gas released when a hydrocarbon resource is extracted, used to be considered a byproduct – or even a waste product – in natural gas and crude oil production. But this is no longer the case. Today, methane is captured and used as a leading source of fuel for the nation, in the form of natural gas. Methane makes up 77 to 92 percent of natural gas, the clean-burning fuel that serves as America's leading source of electricity generation.³

The natural gas and oil industry has compiled an admirable record in reducing methane emissions, due largely to voluntarily adopting new technologies to better capture methane. Methane itself, CH₄, is a greenhouse gas, accounting for 9.9 percent of the total U.S. greenhouse gas inventory measured in terms of carbon dioxide (CO₂) equivalent.⁴ Between

FALLING METHANE EMISSIONS



Methane emissions from hydraulically fractured natural gas wells dropped 59% between 1990 and 2015.

\$90B

The natural gas and oil industry invested \$90 billion on zero- and low-carbon technologies between 2000 and 2014.

1990 and 2015, methane emissions from natural gas systems dropped 16.3 percent overall and 59 percent from hydraulically fractured natural gas wells,⁵ all while the electric power sector's natural gas consumption rose nearly 200 percent.⁶ Moreover, the natural gas and oil industry invested \$90 billion on zero- and low-carbon technologies between 2000 and 2014.⁷ U.S. natural gas and oil companies are leading the charge to reduce emissions by making investments in new technology developed by the industry.

Controlling Methane Emissions is Good for Business and the Environment

Emissions control is not just about environmental safety and health – it's also good business practice. Fugitive methane emissions are, in fact, a saleable product that can be captured and used.

Since 2015, the industry is required to perform reduced emission completions (RECs) when completing new natural gas wells, to capture the gas that would otherwise

have been released. The industry has adopted voluntary practices to reduce maintenance-related releases, including installing improved controllers and pumps, and expanding monitoring, leak inspection and data collection programs using equipment such as infrared cameras.

The natural gas and oil industry is also working with universities and nongovernmental organizations to monitor methane emissions and find ways to decrease them. Major studies by Colorado State University and by the Environmental Defense Fund (EDF) and the University of Texas found emissions leaks were low. The Colorado study of dozens of facilities found the vast majority had methane loss of less than 1 percent.⁸ The EDF/University of Texas study found methane emissions accounted for only 0.38 percent of natural gas production. Moreover, research found that most emissions stem from correctable problems with equipment, such as a faulty valve, which companies have an incentive to repair.⁹

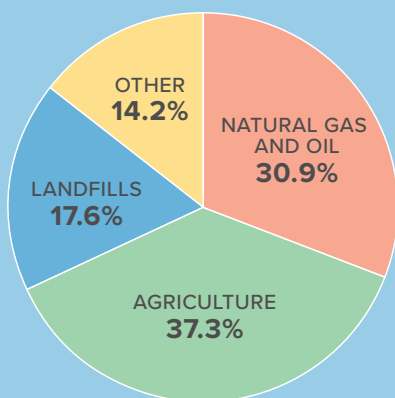


Understanding METHANE EMISSIONS

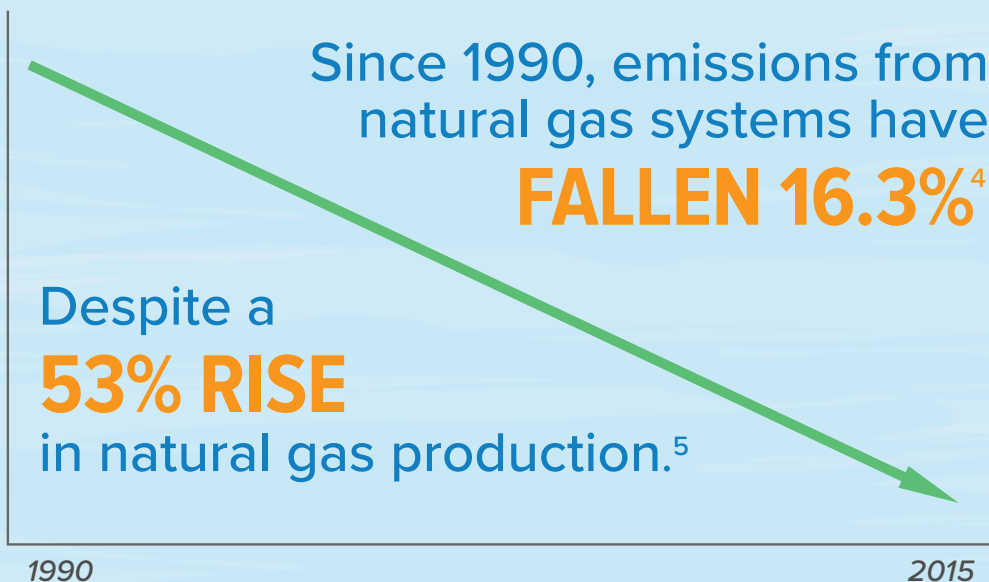
WHAT IS METHANE?

Methane (CH₄) is the main component in the natural gas that heats **NEARLY HALF OF AMERICAN HOMES** and generates a third of our electricity.¹ Every year, more than **655 MILLION METRIC TONS** CO₂ equivalent of methane enter the atmosphere from various sources in the U.S.²

WHERE DO THESE METHANE EMISSIONS COME FROM?



Dairy cows are by far the worst culprits when it comes to agricultural methane emissions. A single dairy cow **EMITS 257.4 POUNDS OF METHANE** every year—an amount **78 TIMES** that of a single pig!³



1 EIA, Winter Fuels Outlook, October 2016 https://www.eia.gov/forecasts/steo/special/winter/2016_winter_fuels.pdf
2 Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015, April 15, 2017 <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2015>
3 Greenhouse Gas Inventory, 2017 <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2015>
4 Environmental Protection Agency <https://www3.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2016-Main-Text.pdf>
5 Energy Information Administration <https://www.eia.gov/dnav/ng/hist/n9050us2a.htm>

70.1%

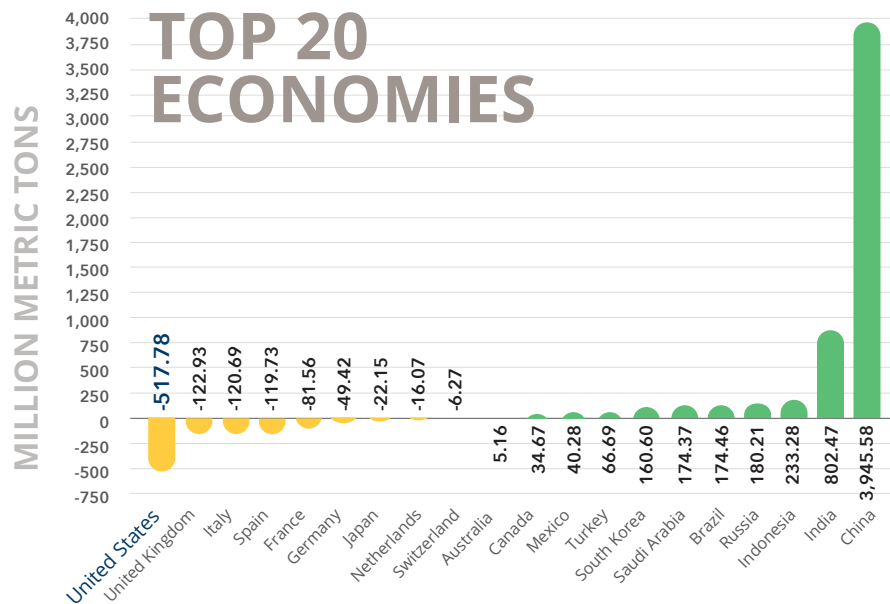
From 2005 to 2016, the amount of natural gas consumed for electricity generation grew by 70.1 percent. In the same period, CO₂ emissions from electricity generation fell 24.6 percent.

MARKET-BASED APPROACH TO REDUCING CARBON EMISSIONS

The emergence of abundant natural gas has given the U.S. the market-based tool it needs to protect public health and the environment, while providing the country with clean, affordable and plentiful energy resources.

“We no longer have to choose between more energy and a cleaner environment,” API president and CEO Jack Gerard observed during API’s 2017 State of American Energy event. Thanks to record-setting production of domestic natural gas – up 50 percent between 2005 and 2016¹⁰ – there has been a supply abundance that increasingly prompts the marketplace to turn to affordable natural gas for power generation, which has benefitted the environment and lowered costs for consumers.

CHANGE IN CARBON EMISSIONS FROM ENERGY (2005 - 2012)



As a result, U.S. energy-related greenhouse gas emissions are now at their lowest level in nearly 25 years.¹¹ From 2005 to 2016, the amount of natural gas consumed for electricity generation grew by 70.1 percent.¹² In the same period, CO₂ emissions from electricity generation fell 24.6 percent.¹³

Using Market Forces for Clean Air

Today, natural gas is the nation’s largest fuel source for electricity generation. According to data from the EIA, the fuel shift toward natural gas was responsible for more than 60 percent of the electric power sector’s CO₂ emissions reductions between 2005 and 2016.¹⁴

The impact of market-based forces on improving public safety and the environment has been recognized at the highest levels of government. For example, in an essay in *Science Magazine*, former President Barack Obama wrote, “The American electric-power sector – the largest source of greenhouse gas emissions in our economy – is being transformed, in large part, because of market dynamics. In 2008, natural gas made up approximately 21 percent of U.S. electricity generation. Today, it makes up approximately 33 percent, an increase due almost entirely to the shift from higher-emitting coal to lower-emitting natural gas, brought about primarily by the increased availability of low-cost gas due to new production techniques.”¹⁵

Instead of mandating the use of more expensive energy sources to reduce emissions, the U.S. natural gas and oil industry has provided another option: a cleaner and lower cost alternative. This market-based approach to reducing greenhouse gas emissions is the U.S. model for climate action. It’s a model other nations should look to replicate. Even as the U.S. has become the world’s largest producer of natural gas and oil, the U.S. has become the world leader in reducing emissions, too.

This success has not come by accident. It’s the product of years of investment and problem solving. The natural gas and oil industry invested \$90 billion between 2000 and 2014 in technology to reduce greenhouse gases.¹⁶ That’s more

than the combined spending of the three runner-up sectors (auto industry, electric utilities and agriculture).

INTEGRATING RENEWABLES

The natural gas industry provides critical flexible power that makes it possible for the U.S. to integrate renewable energy sources, like solar and wind, into our clean energy mix.

Flexible, dependable natural gas is allowing the U.S. to bring variable energy sources like solar and wind online. Natural gas is critical to this process because it provides on-demand, dispatchable power,

HOW MUCH DOES AMERICA PRODUCE?



Domestic natural gas production has grown 52% from 1990 to 2016. America is now the leading producer of natural gas in the world.

10.4%

Renewable energy accounted for 10.4 percent (10.16 quadrillion Btu) of total U.S. energy consumption in 2015, with solar and wind meeting roughly 3 percent of U.S. energy needs.

ramping up quickly and following real-time changes in energy load. That means it can support intermittent power from renewable sources of energy, keeping the power grid stable when the sun doesn't shine and the wind doesn't blow.

Enabling Renewables by Keeping the Lights on with Flexible Power

Renewable energy accounted for 10.4 percent (10.16 quadrillion Btu) of total U.S. energy consumption in 2016, with solar and wind meeting roughly 3 percent of U.S. energy needs.¹⁷ As more renewable generation comes online, without an efficient way to store its energy production, this new capacity will continue to need to be paired with reliable natural gas.

This role for natural gas was highlighted in a working paper published in 2016 by the National Bureau of Economic Research. The

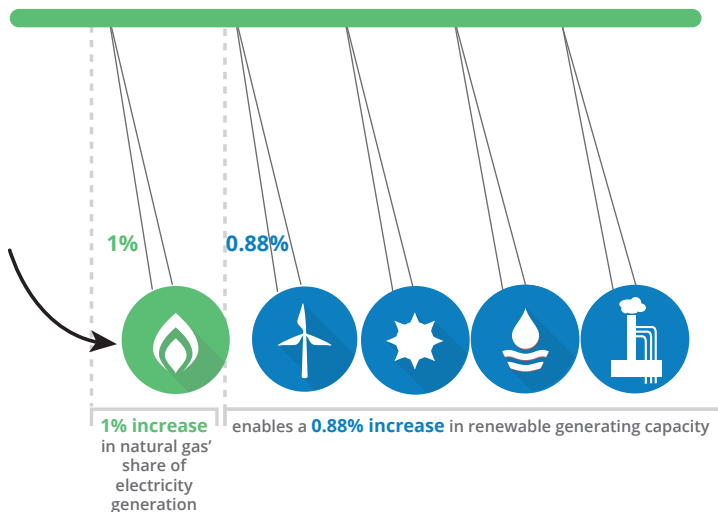
study found that, between 1990 and 2013, for every 1 percent increase in natural gas' share of electricity generation, there was a 0.88 percent increase in renewable generating capacity.¹⁸

The report concluded that renewables and natural gas "are highly complementary and should be jointly installed to meet goals of cutting emissions and ensuring a stable supply."

The natural gas pipeline system can also help integrate renewables. For example, if biogas is purified to the quality of natural gas, it can be added to the natural gas pipeline network. In the future, hydrogen, another sustainable source of energy, might also be able to share the natural gas pipeline system.¹⁹

Providing flexible power for renewable sources allows utilities to integrate zero-emission sources of energy into the power grid without sacrificing reliability or affordability.

NATURAL GAS HELPS INTEGRATE RENEWABLE ENERGY
(1990-2013)



BENEFITS OF NATURAL GAS

As a clean-burning source of energy, natural gas is improving the health of communities and environments across the U.S. by improving air quality and decreasing pollution levels.

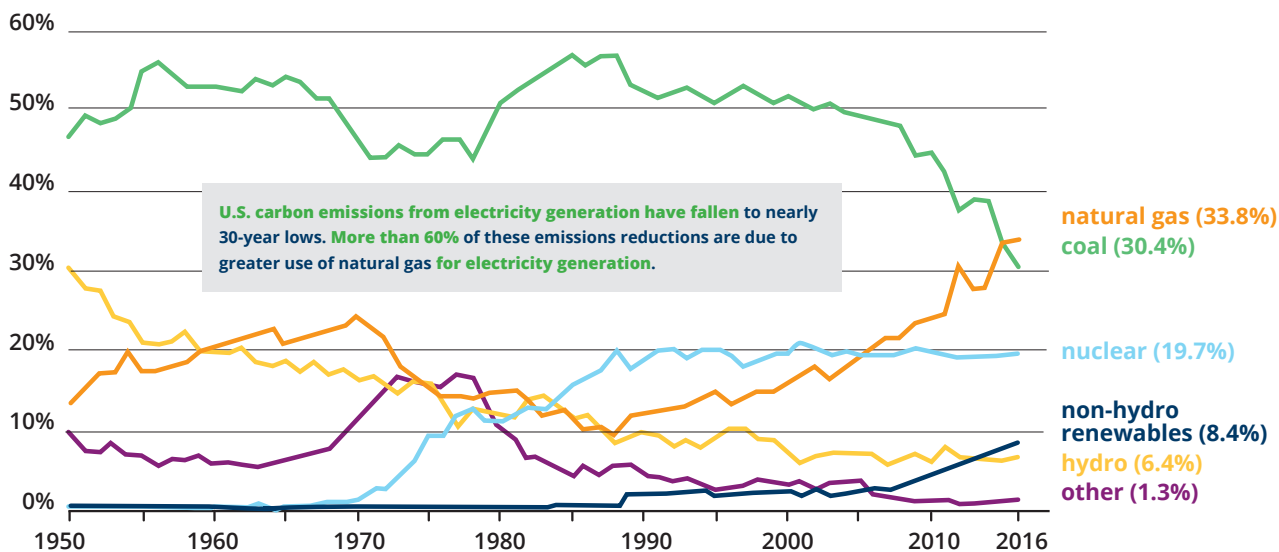
The natural gas and oil industry is mindful of the value of improving air quality, and the expanding role of natural gas has already provided

impressive results. Combustion of natural gas produces much smaller amounts of the potentially harmful pollutants found in other fossil fuels, such as mercury, particulate matter, nitrogen oxides (precursors of smog), and sulfur dioxide. The Environmental Protection Agency (EPA) has indicated that these various pollutants may affect the heart and lungs, aggravating bronchitis, emphysema, asthma and other lung conditions, and contributing to heart disease, as well as to damaged vegetation.

The increased use of natural gas in power generation, transportation and other uses has yielded notable reductions in these emissions. For example, an Independent System Operator New England study found that regional emissions dropped 56 percent for nitrogen oxide, 91 percent for sulfur dioxide and 22 percent for carbon dioxide between 2006 and 2015.²⁰

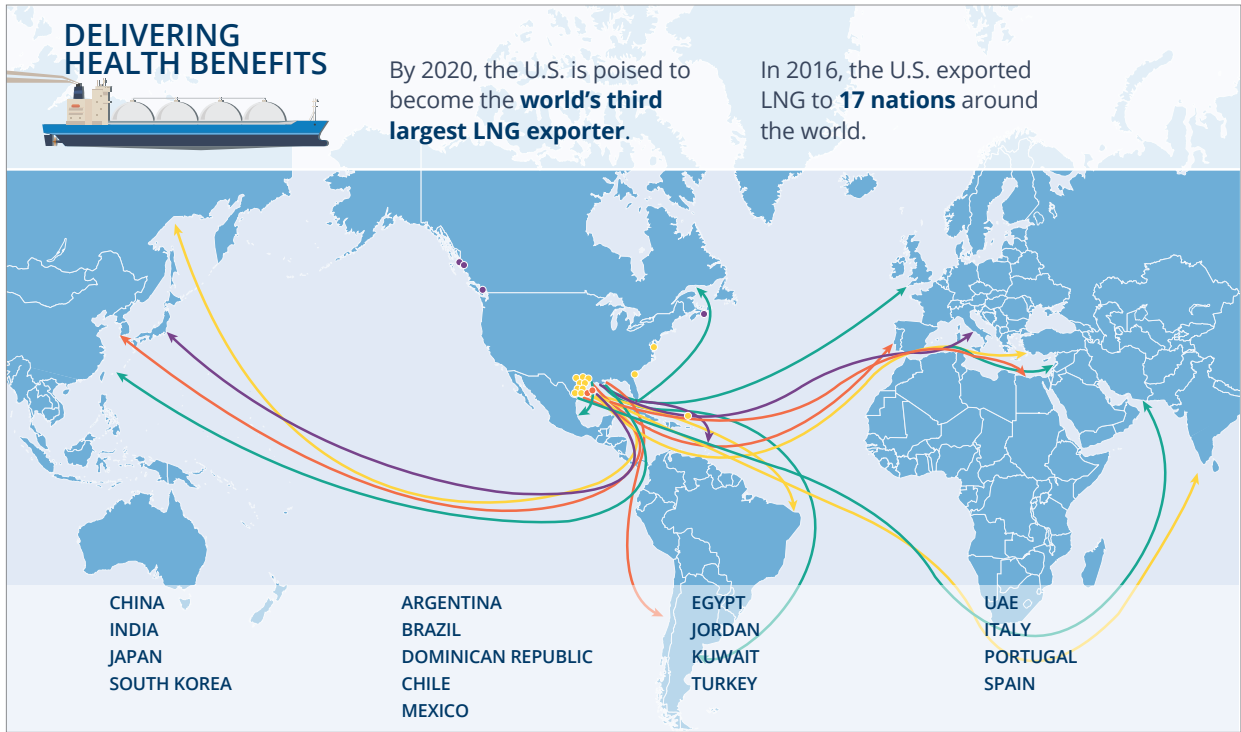
NATURAL GAS NOW GENERATES THE LARGEST SHARE OF U.S. ELECTRICITY

Annual share of total U.S. electricity generation by source (1950-2016) percent of total



Thanks in part to the increased use of natural gas, ozone concentrations in the United States have dropped 17 percent since 2000.²¹ Also, CO₂ emissions from power generation have fallen 21 percent since 2000 and are at their lowest levels in nearly 30 years.²² By 2030, CO₂ emissions from power generation are expected to drop by as much as 30 percent from 2005 levels as a result of increased fuel switching to natural gas.²³

Exporting U.S. natural gas can improve health conditions around the world. A 2014 U.S. Department of Energy (DOE) study found that exporting U.S. liquefied natural gas would reduce global greenhouse gas emissions compared to power generated from locally sourced fossil fuels, predominantly coal.²⁴ In short, the benefits of natural gas are ripe to be realized not only in the U.S., but also in countries around the world.



AMERICA'S WORLD-CLASS REFINING SECTOR

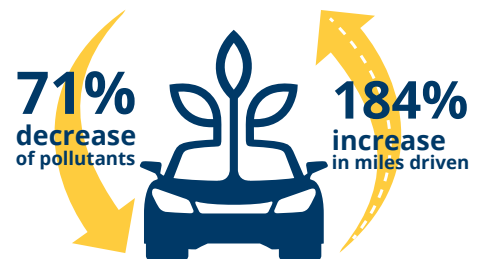
The U.S. refining sector's commitment to strong environmental performance plays an important role in keeping air clean and communities safe.

Often overlooked, America's world-class refining sector not only produces the fuels that energize our transportation sector, but also produces cleaner fuels to ensure that our air stays clean. Just as our cars have modernized, so have our fuels and the refineries that produce them.

The combination of cleaner gasoline and diesel fuels, modernized equipment and facilities, and more fuel-efficient vehicles has helped reduce U.S. air pollutants by 71 percent between 1970 and 2015.²⁵ This dramatic improvement came even as vehicle miles traveled increased by more than 184 percent.²⁶

Protecting Public and Environmental Health Through Innovation

The U.S. refining sector has become a model for efficiency and innovation. Our 141 operable refineries – less than half the number operating in 1981 – reached a 36-year high for crude distillation capacity in 2016 at 18.3 million barrels per day.²⁷ The refining industry has made major



investments to increase production and to reduce pollutants in the fuels they produce.

Refineries in the U.S. are upgrading their operations to produce cleaner fuels and meet a variety of state and local mandates for fuel formulation. Environmental expenditures are aimed at improving the environmental performance of the natural gas and oil industry's products, facilities and operations. These upgrades, costing billions of dollars, include environmental expenditures for activities to help protect our air and water, to decrease waste and to meet federal and state regulations and specifications. Between 1990 and 2012, U.S. refiners invested \$160.1 billion on environmental expenditures.²⁸

Further reductions in sulfur will continue to build on these improvements through 2020 and beyond as Tier 3 gasoline and cleaner-burning vehicles are phased in, and the vehicle fleet turns over. Diesel fuel specifications, for ultra-low sulfur diesel, require a sulfur reduction of more than 99 percent, compared to the sulfur content of highway diesel in use prior to 2008. Ultra-low sulfur diesel is now produced for all highway and non-road uses, allowing for dramatically reduced nitrogen oxide emissions from newer diesel engines.²⁹

The progress we've made is undeniable. The EPA reports that total emissions of the six criteria air pollutants in the United States have been declining since 1970³⁰ and ozone levels have decreased by 32 percent since 1980.³¹ This is partially

U.S. REFINING SECTOR'S ECONOMIC IMPACT



Provides more than
\$292 billion
to U.S. GDP –
about 1.8% of
total GDP.³²



Supports more than
1.2 million
U.S. jobs³³



Invested nearly
\$2 trillion
in U.S. capital
projects
to advance all forms
of energy, including
alternatives, since
2000.³⁴

due to the fact that refineries are consistently formulating cleaner-burning fuels without increasing their own greenhouse gas emissions, which have remained constant despite increases in production. Even as motor fuel production, the number of cars on the road and the number of miles traveled have increased, U.S. air quality has improved.

INVESTING IN LOW- AND NO-CARBON ENERGY SOLUTIONS

Almost every natural gas and oil company carries a renewable energy portfolio. That's because an all-of-the-above energy policy isn't just good for business, it also helps the industry maximize the health and environmental benefits of natural gas.

Natural gas and oil companies recognize the importance of renewables in the energy mix and support an "all-of-the-above" energy policy. According to EIA, renewable

3M

BP's global investments in renewables include wind farms across the United States that generate 2,259 MW of energy to power grids, providing a savings of nearly
3 million tons of carbon emissions in 2015 alone.

energy sources accounted for 10.4 percent of U.S. energy consumption in 2016.³²

The industry has long been involved in renewable energy and particularly in developing the technologies to make them viable energy alternatives. Since 2000, the natural gas and oil industry has invested \$15 billion in nonhydrocarbon technologies – including wind, solar, biofuels and geothermal technologies. That investment is just part of the \$90 billion the industry invested between 2000 and 2014 in zero- and low-carbon emissions technologies.³³

Taking an Early Interest in Renewables

Chevron is one of the leading producers of geothermal energy and in 2012, Chevron Technology Ventures and a consortium of companies opened a geothermal plant in Salton Sea, Calif. – bringing the latest technology to one of the world's largest and hottest resources.³⁴ This carbon-neutral facility, the John L. Featherstone Geothermal Plant, takes superheated liquid from the Earth and separates steam from the liquid to generate electricity 24/7. Now the plant is applying new technology to see whether amorphous silica, a side product of the process, can be repurposed for use in batteries.

Through six joint venture projects, Shell's Wind Energy contributes about 425 MW of renewable energy to the grid.³⁵ BP's global investments in renewables include wind farms across the United

States that generate 2,259 MW of energy to power grids, providing a savings of nearly 3 million tons of carbon emissions in 2015 alone.³⁶ As good environmental stewards, companies work with the U.S. Fish and Wildlife Service to minimize injury to birds and other animals, as well as impact on local environments. For example, one company reduces wind turbine speeds during bat migration season.³⁷

Solar technology has attracted a number of natural gas and oil companies, including Chevron, Total and Phillips 66, whose solar team set a world record for solar conversion efficiency.³⁸ Phillips 66 has been focusing on polymer-based organic photovoltaic cells since 2000. These can be printed, so they could become more affordable than conventional solar panels. They are transparent and can be used for windows and skylights.³⁹

Whether the renewable energy source is solar, wind, geothermal or another, the industry's commitment to an "all-of-the-above" energy policy is an important component not only to fostering innovation, but also to protecting public health and the environment for years to come.



Prioritizing Responsible DEVELOPMENT

WELL UNDERSTOOD, WELL REGULATED

Technological innovation and recommended practices around hydraulic fracturing and horizontal drilling have enabled the natural gas and oil industry to achieve new milestones in energy efficiency, public safety and environmental protection – all while delivering plentiful energy to communities around the country.

Stanolind Oil uses hydraulic fracturing in the Hugoton gas field in Grant County, Kansas for the first time.

Hydraulic fracturing is used more than **3,000 times a month** to increase the productivity of oil and gas wells.

George Mitchell successfully combines hydraulic fracturing with horizontal drilling in Texas to **pioneer the production** of natural gas from shale.

The U.S. surpasses Russia as **the world's largest natural gas and oil producer.**

Hydraulically fractured wells provide **two thirds** of U.S. natural gas production and half of U.S. oil production.

1947

1950s



1980-90s

2012



2015



Innovations in horizontal drilling, combined with hydraulic fracturing (fracking) have given the industry the ability to unlock vast amounts of natural gas and oil trapped in shale and other tight rock formations.

While the current surge in U.S. natural gas and oil production is a new chapter for the industry, it is built upon decades of experience with these key technologies and the emergence of new, advanced technologies to push the industry's capability forward. Fracking has been used commercially for nearly 70 years, and today incorporates the latest science and technology

for safety and efficiency. Over those seven decades the industry developed the recommended practices and standards necessary to safely develop natural gas and oil resources while providing a basis of strong safety regulations for both federal and state government.

Industry-recommended practices are formulated by the American Petroleum Institute's standards-setting program,¹ and many of these practices are cited in both federal and state regulations. More than a dozen federal agencies oversee enforcement of statutes that apply to the fracking process – statutes

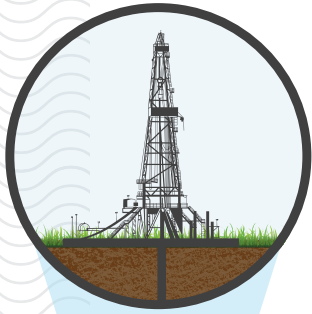
70 YRS

Fracking has been used commercially for nearly 70 years, and today incorporates the latest science and technology for safety and efficiency.

dealing with clean water, clean air, the environment, endangered species, occupational safety and more.

Effective regulation at the state level is particularly important, since state regulations can and should be tailored to local geology and hydrology, as well as to local needs. These regulations are detailed and specific, including such issues as permit review and approval; well design, location and spacing; water, air and wildlife safety; and inspection and enforcement of day to day oil and gas operations.

Despite some public perception that fracking is new, the U.S. Department of Energy (DOE) data shows that fracking has been used on more than two million natural gas and oil wells over the past seven decades.² Those many years of experience have enabled thorough study of the process. Expert consensus agrees fracking can be and is done safely. New technologies that allow operators and regulators an even better idea of what is happening deep below the surface have only strengthened these safeguards.



UNDER THE MICROSCOPE: WHAT EXPERTS ARE SAYING

"There's nothing inherently dangerous in fracking that sound engineering practices can't accomplish."

- Gina McCarthy, former EPA administrator

"Hydraulic fracturing, when done to industry standards, does not impact drinking water."

- Sen. Lisa Murkowski, chairman of the Senate Energy and Natural Resources Committee

"In California it has been used for 60 years, and actively used for 40 years, and in California there has been not one record of reported damage directly to the use of hydraulic fracturing."

- Mark Nechodom, former California Department of Conservation director

"[Hydraulic fracturing] is creating an energy revolution in the United States. I would say to everybody that hydraulic fracturing is safe."

- Ken Salazar, former Interior secretary

"I think the issues in terms of the environmental footprint of hydraulic fracturing are manageable."

- Ernest Moniz, former Secretary of Energy





GROUNDWATER PROTECTION AND WELL CONSTRUCTION

Precise design and construction of wells allows the natural gas and oil industry to reliably produce energy while protecting usable groundwater, public health and the environment.

To protect groundwater in energy production zones, natural gas and oil wells are designed with multiple layers of steel casing and cement to create multi-layered, solid barriers between energy development and groundwater resources. While steel casing serves as a primary shield to protect groundwater, specialized cement is used to create a pressure-tested seal between each layer of casing.

In between each layer of steel casing is a space that must be filled to hold the casing in place and

create a solid, sealed barrier between the well and the groundwater. Cement, developed in laboratories for the unique conditions found in oil and gas development, is used as the glue to seal these layers of the casing together. During well construction, cement is pumped down the interior of the casing, forcing the cement up from the bottom of the well so that it completely fills the space between the outside walls of the drilled hole and the casing inside of it.

The average unconventional well – used to produce natural gas and oil from shale – uses 3 million pounds of mutually reinforcing steel and cement. State regulations dictate the depth by which casing is “set” to protect groundwater.³

Before fracking begins, drillers use multiple, high-tech tools, including measuring the travel times of sound waves, to verify that cement has created a solid bond with the casing. These tools are used to verify the strength of seals in the well before any well stimulation or energy production begins.

3M

The average unconventional well – used to produce natural gas and oil from shale – uses 3 million pounds of mutually reinforcing steel and cement.

CEMENTING: A Seal for Safety

Natural gas and oil well construction relies on multiple layers of steel and cement barriers to isolate energy production from groundwater.

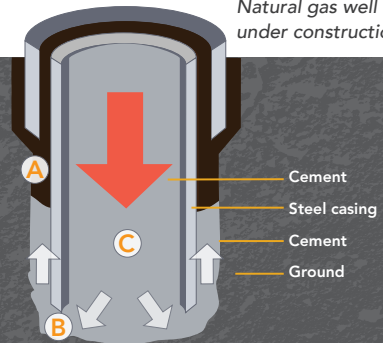


While steel casing serves as the primary shield to groundwater, specialized cement is used to create a pressure-tested seal between each layer of casing. Proper well cementing ensures safety.

Natural gas well under construction.

CEMENTING

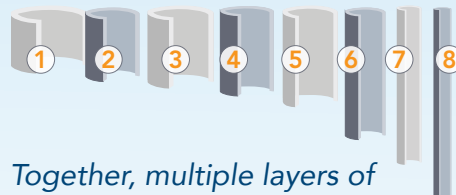
- A** In between each layer of steel casing is a space that must be filled to hold the casing in place and create a solid, **sealed barrier** between the well and groundwater.
- B** **Specialized cement**, developed in laboratories for the unique conditions found in oil and gas development, is used as the **glue to seal layers** of casing together.
- C** During well construction, cement is pumped down the interior of casing forcing the cement up from the bottom of the well so that it **completely fills** the space between the outside walls of the drilled hole and the casing inside of it.



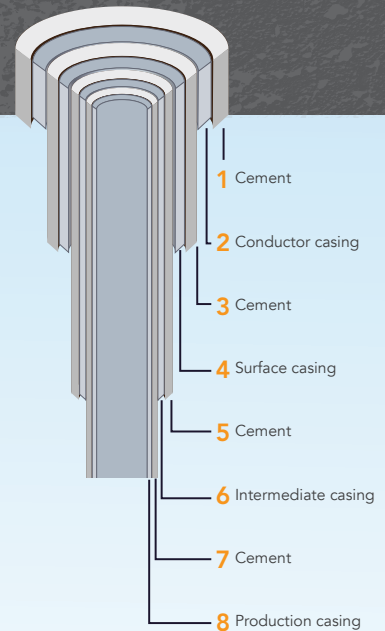
Completed well with four layers of cemented casing.

TESTING

Drillers use multiple, high-tech tools, including measuring the travel times of sound waves, to verify that cement has created a solid bond with the casing. These tools are used to verify the strength of seals in the well before energy production begins.



Together, multiple layers of cemented steel casing provide a redundant barrier to isolate energy production from groundwater.



Sources:
 *Well Construction and Groundwater Protection," Fracfocus.org.
 *Isolating Potential Flow Zones During Well Construction: API Standard 65—Part 2, Second Edition Part 2." American Petroleum Institute.

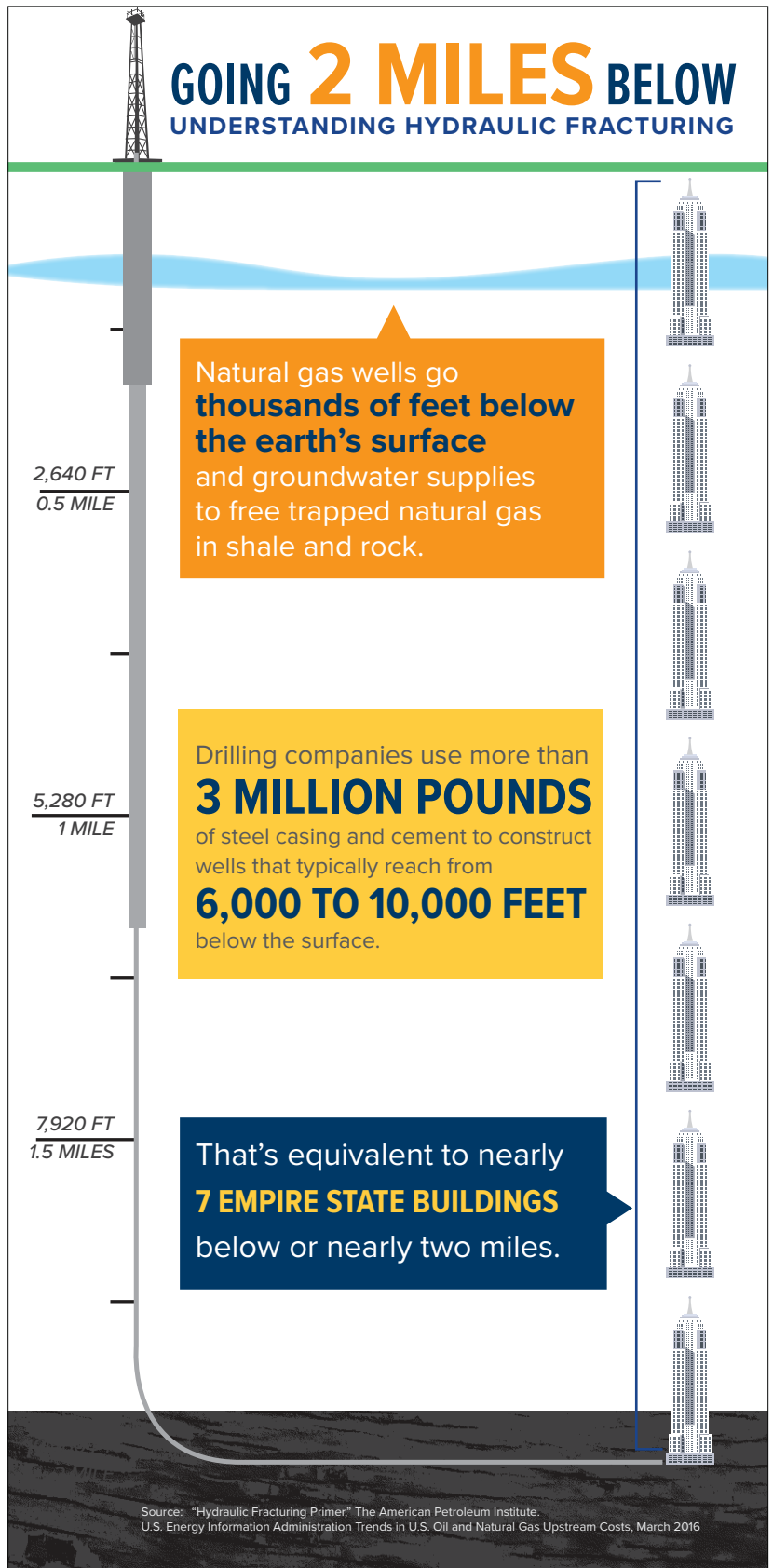
Providing Protection with Depth and Cap Rock

While the design and construction of natural gas and oil wells is critical to safeguarding groundwater resources, the depth of wells also matters. Groundwater is typically found close to the surface. Energy-bearing zones of rock, like shale formations, are often a mile or more below ground. The energy production zone can be separated from groundwater by thousands of feet of impermeable cap rock including siltstones, mudstones and shales. The impermeability of these thick rock barriers prevents hydraulic fracturing fluids, oil and/or natural gas from moving through them.⁴

EFFICIENCY AND CONSERVATION

Hydraulic fracturing and horizontal drilling innovations have positioned the U.S. as a global leader in energy production while preserving the health of communities and environments around the country.


Thanks to a combination of hydraulic fracturing and horizontal drilling, production of natural gas and oil from shale and other unconventional formations has surged, making the U.S. the world's largest combined producer of natural gas and oil.⁵ But more production isn't the only benefit of this combination. Increased efficiency and a much smaller surface footprint are also part of the package.






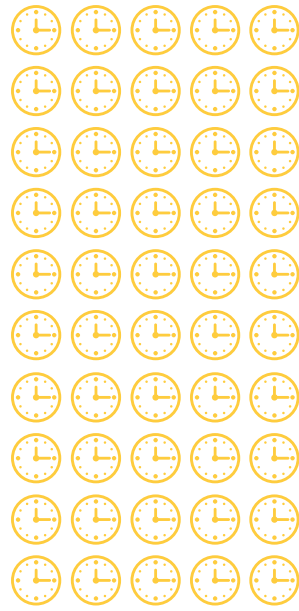
A FEW WEEKS OF WORK... DECADES OF ENERGY

The drilling and hydraulic fracturing techniques used to access natural gas and oil trapped in shale rock only account for a tiny fraction of the lifespan of a typical well.

 = 5 days


DRILLING & WELL CONSTRUCTION
50-100 DAYS


HYDRAULIC FRACTURING
2-5 DAYS

29X

ENERGY PRODUCTION
20-40 YEARS

Consolidating Wells for Greater Efficiency

Conventional vertical drilling requires many wells spaced out over a wide area to effectively produce oil or gas. In horizontal drilling, however, up to 20 wells can be built on a single well pad.⁶ Each unconventional well is drilled down to the natural gas and oil-bearing rock, up to a mile or more below the surface, and then gradually turns horizontal, moving laterally along the formation for thousands of feet. This exposes far more of the targeted rock per well than vertical drilling, permitting much higher levels of production. The advantage is multiplied as different wells can originate from the same well pad, each branching out horizontally in different directions below the surface.

Consolidating wells onto one pad site results in as much as a 90 percent reduction in overall surface presence. In addition, this allows companies to reduce the number of access roads and pipelines needed to service dozens of wells, further lowering the operation's footprint.⁷

The entire process of setting up a hydraulic fracturing/horizontal drilling operation takes approximately four to eight weeks, from preparing the site for development to beginning production. Once the drilling activities are done and the wells are flowing (for perhaps 20 to 40 years, depending on the formation), all the heavy equipment is removed.⁸ The land around the site pad is restored to its original use, and all that remains on the pad are valves, flow lines and storage tanks.

90%

In some instances, as much as 90 percent of the produced fluids from hydraulic fracturing can be reused, saving many millions of gallons of fresh water, and also reducing the need for disposal wells.

Improving Water Management and Conservation

Water plays a major role in natural gas and oil production, and companies are constantly improving their water management and conservation practices. For example, they will use alternatives to fresh water, such as brackish water or recycled water from local municipal treatment plants. Companies have also developed innovative technologies to reuse produced water, that is, flowback or fluids from the hydraulic fracturing process. In some instances, as much as 90 percent of the produced fluids from hydraulic fracturing can be reused, saving many millions of gallons of fresh water, and also reducing the need for disposal wells.⁹

U.S. companies are innovating to maximize efficiency and provide resources to communities in which they operate. One U.S. company takes the process a step further, treating its produced water and providing it to the local water district for distribution to farmers. Some companies have achieved nearly zero disposal of waste water. In other areas, companies have implemented recycling and reuse programs that can fully treat nearly 100 percent of produced water from operations. In fact, in 2014, one company recycled 99 percent of flowback and produced water in the Fayetteville and the Marcellus shale regions.¹⁰

Conservation and efficiency with water can also mean finding new and better ways to move it. Some companies are building water pipelines to reduce the number of truck trips needed to move water

to and from production sites. Ultimately, this reduces surface impact on roads and traffic in and around communities. For example, one company has implemented a water-on-demand system that consists of more than 150 miles of pipeline that is used to transport approximately 98 percent of the water used for its operations.¹¹

These are just a handful of the ways that oil and gas companies are innovating to improve communities and economies around the country.

STEWARDSHIP AND RECLAMATION

The natural gas and oil industry pursues the latest technology and strategies as part of its commitment to environmental stewardship – making sure that as it delivers plentiful energy, it's also protecting public health and the environment.

Stewardship involves caring for the environment during a period of industrial activity; reclamation involves renewing and repurposing sites when the activity is over. With natural gas and oil development and production occurring at more than 860,000 sites in 33 states, the industry has a crucial responsibility to manage waste, water, land and air quality in compliance with a wide range of federal and state regulations.¹²

Stewardship includes protection of the soils, vegetation and groundwater that surround the sites of drilling and production operations and also the land around pipelines. This responsibility begins with the design and construction of access roads and the locations of production facilities and continues through the life of the operation.¹³

Innovating Technology and Strategies for the Environment

The industry develops and adapts technologies and strategies that reduce the impacts of its operations on the surrounding environment. Hydraulic fracturing and horizontal drilling shrink the surface footprint of drilling operations, and water management strategies, along with advanced technologies, make it possible to reuse up to 90 percent of produced fluids from the fracturing process. In addition, the industry remotely monitors natural gas and oil well production through wireless sensor networks.¹⁴ The data provides real-time information so that field operations are more focused and efficient, reducing vehicle trips and disturbance of wildlife.

Enriching the Environment On- and Offshore

Reclamation involves restoring and renewing the environment and repurposing sites previously used for natural gas and oil production to benefit local communities. The industry is pursuing this mission both on- and offshore.

The industry's Rigs to Reefs program has converted more than 450 platforms into permanent artificial reefs. According to a study



by the Coastal Marine Institute, a converted eight-leg rig can offer a home to 12,000 to 14,000 fish.¹⁵ Each artificial reef creates an ecosystem that also shelters thousands of invertebrates, such as shrimp, crabs and other diverse marine species. These reefs have generated local commercial and recreational benefits, like fishing and tourism opportunities, including scuba diving. Additionally, a study from the University of California-Santa Barbara found that completely removing offshore rigs could be harmful for some heavily fished species because many benefit from the safety they offer.¹⁶

Onshore, reclamation at the well pad is carried out first in compliance with federal, state and local regulations. It can also include an agreement with the owner of the surface and mineral rights – an

agreement made long before drilling begins. Reclamation activities can include regrading and recontouring disturbed land, removing gravel pads or roads, replacing topsoil and replanting vegetation, or several other options.

Other projects involve repurposing property and buildings. For example, one U.S. company is working with state and local leaders to turn its former terminal from a brownfield (containing hazardous substances, pollutants or contaminants) into a commercial port that promises to generate much-needed jobs and revenue.¹⁷

PROTECTION OF SPECIES AND HABITATS

The natural gas and oil industry has implemented biodiversity practices driven by science-based evidence that protect critical species, their habitats and the environment.

Protection of species and habitats is part of the holistic approach to natural gas and oil development, where projects are designed, managed and operated to identify and address environmental impacts from initial exploration activities to eventual closure.

Operators work with federal and state wildlife management agencies to minimize potential impacts and identify conservation measures through science-based inquiry. Prior to construction, operators conduct reviews to identify environmentally sensitive habitats, wetlands and other protected resources, and they design projects to avoid sensitive areas to the extent possible.

Improvements in drilling and production technology have reduced the footprint of industry operations, benefiting surrounding wildlife habitat. A recent study suggests the industry's progression to horizontal drilling – which allows major production from a single well pad – has lowered surface impacts by as much as 90 percent over conventional drilling practices.¹⁸ Landowners and communities, as well as the environment, benefit from the fact that horizontal drilling limits, as much as is feasible, the size and number of well pads, roads, pipelines and other surface disturbances.

Monitoring Species and Bolstering Habitats

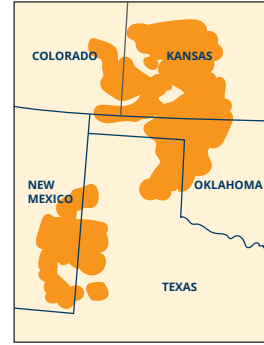
Minimizing the footprint of operations is just one part of the industry's approach to protecting species and habitats. Monitoring, or better understanding wildlife populations and habits, is also a key part of this effort. Companies often partner with state and federal agencies to monitor wildlife populations to better understand how wildlife move through or around their operations.

90%

A recent study suggests the industry's progression to horizontal drilling – which allows major production from a single well pad – has lowered surface impacts by as much as 90 percent over conventional drilling practices.



By GregTheBusker - Prairie Chicken, Puffed UpUploaded by Snowmanradio, CC BY 2.0.



● Approximate range of the lesser prairie chicken

Producers in Kansas, Oklahoma, New Mexico, Texas and Colorado are helping the lesser prairie chicken rebound by voluntarily conserving habitat on their land.

Better knowledge of wildlife means companies can tailor their operations to better protect critical species and habitats with the creation of buffers or no-go zones. For example, one company in East Texas noticed a bald eagle near one of its wells, prompting some investigation that turned up a nest just a few hundred feet from the well pad. Employees began monitoring the nest and not long after they did, an eaglet appeared. They named the young eagle “America” and continue to look out for the well-being of the family.¹⁹

Along with creating buffer zones around operations, companies are also working with conservationists and government agencies to create conservation areas to protect threatened species. For example, several companies in five western states joined to create conservation areas for the lesser prairie

chicken. In March 2014, it was estimated that these companies committed to enroll 4 million acres and provide \$21 million in conservation efforts over a three-year period. By summer 2014, 156 companies, including 110 oil and gas companies, increased acreage to about 7 million acres, with funds for conservation efforts totaling \$43 million. These conservation efforts directly resulted in growth to the lesser prairie chicken’s population.²⁰

\$43M

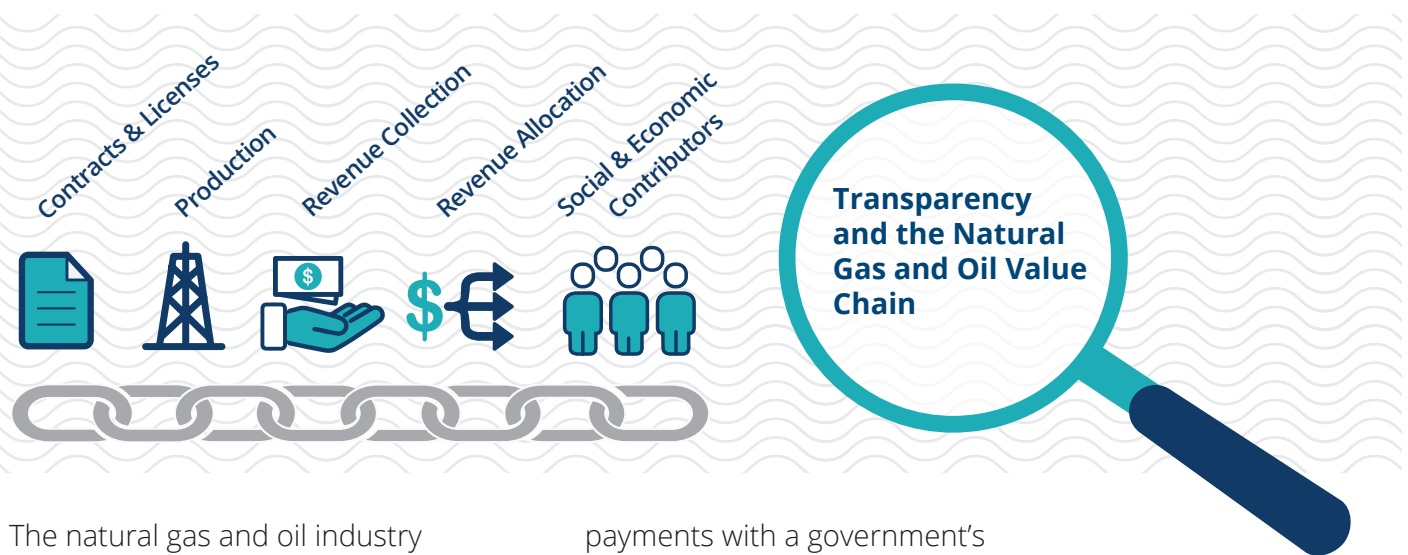
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Committing to TRANSPARENCY

AN OPEN AND ACCOUNTABLE INDUSTRY

The U.S. natural gas and oil industry has been at the forefront of developing best practices in operating transparently with the public. From supporting the Extractive Industries Transparency Initiative since its inception in 2003 to working with communities within the National Environmental Policy Act framework, companies demonstrate that transparent engagement is among the best ways to support good governance of revenues as well as public and environmental health.



The natural gas and oil industry has strongly pursued standards for transparency, not just in the U.S., but also around the world. This commitment is evident in the Extractive Industries Transparency Initiative (EITI), a globally-accepted revenue transparency initiative that is the worldwide standard for good governance of oil, gas and mineral resources.

The Initiative provides mechanisms for transparency and the independent verification and reconciliation of companies'

payments with a government's receipts. The EITI also serves as a critical vehicle for dialogue among stakeholders around the world. In each of the implementing countries, the EITI is supported by a multi-stakeholder group of representatives from government, companies and civil society. It's also overseen by an international board – also with representatives from governments, companies and civil society – which monitors the progress of countries as they implement the EITI standards.

As a result, the EITI has played a key role in providing citizens globally with access to reliable information on oil, natural gas and minerals revenues in their countries. As of April 2017, 51 countries have implemented the EITI and have disclosed over \$2.3 trillion in government revenues from oil, gas and minerals operations.¹

Engaging with Communities around Permitting

Natural gas and oil provide the majority of the energy American consumers need and, as a result, the industry has made huge investments in energy infrastructure. From pipelines, railroads, highways, waterways and ports, to job-specific sites and more, the industry follows a suite of best practices and local, state and federal regulations around transparency.

When complying with laws such as the Safe Drinking Water Act, the Clean Water Act, the Clean Air Act, the National Environmental Policy Act and more, companies aren't just being transparent, they're actively engaging with communities around sites to form customized plans that work best for the health of the public and the environment.² The industry also works within an extensive permitting process – around everything from siting new

wells to water discharge – that creates an important public record on how companies are actively complying with best practices on health and the environment.³

UNDERSTANDING FRACKING FLUID AND CHEMICAL DISCLOSURE

The natural gas and oil industry regularly demonstrates its commitment to transparency with communities around the country, all while developing the country's immense energy resources in ways that keep the public and the environment safe.

Thanks to advanced hydraulic fracturing and horizontal drilling, the U.S. is an energy superpower – and communities around the country have benefitted through jobs, expanded economies and strengthened energy security. The natural gas and oil industry understands that communities have questions about energy production and development operations, and so it has implemented information sharing protocols and processes to keep the public informed.

EXTENDING TRANSPARENCY

Transparency plays a major role in much of the natural gas and oil industry's work. For more detailed information on a variety of issues, refer to the pages listed.

Pipelines	pg. 9
Crude by Rail	pg. 12
Safety Responders	pg. 13

Understanding Fracturing Fluid

The fluid from the hydraulic fracturing process is nearly

**99.5%
WATER
& SAND.**

**9.5%
SAND**

**90%
WATER**

Typical Additives Used in Fracturing Fluid and COMMON HOUSEHOLD ITEMS

0.5%
CHEMICAL
ADDITIVES



SODIUM CHLORIDE
used in table salt



ETHYLENE GLYCOL
used in household cleaners



BORATE SALTS
used in cosmetics



**SODIUM/POTASSIUM
CARBONATE**
used in detergent



GUAR GUM
used in ice cream



ISOPROPANOL
used in deodorant

To create productive natural gas wells, companies force fluid thousands of feet below the surface at high pressure to crack shale rock and release trapped natural gas. This extraction technique is called hydraulic fracturing. The fluid used in the process is made up almost entirely of water and sand. However, it also includes a very small percentage of chemical additives that help make the process work.

To maintain a high level of transparency with communities, companies report specific information about fracking fluid used at each individual well via a voluntary, publicly accessible website: FracFocus.org.

Water is the main ingredient in fracking fluid, the mixture that is pumped into a well under high pressure to create micro-fractures in shale rock to release natural gas or oil. Sand is used to keep the fractures in the rock – often as thin as a human hair – open so that natural gas and oil can flow freely out of the rock and into the well. And chemicals are chiefly used to reduce friction and prevent corrosion throughout the process.⁴

To maintain a high level of transparency with communities, companies report specific information about fracking fluid used at each individual well via a voluntary, publicly accessible website: FracFocus.org. This chemical disclosure registry was developed by the Groundwater Protection Council and the Interstate Oil and Gas Compact Commission, two organizations comprised of state regulators that oversee the natural gas and oil industry. FracFocus.org also serves as a reporting method to meet state disclosure requirements for 23 states.⁵

In addition, every well site has readily available safety data sheets, mandated by the Occupational Safety and Health Administration. These carry safety, health and environmental information on all ingredients in all substances used during fracking, including proprietary ingredients.

RESPONSIBLY MANAGING WASTE

The industry takes seriously its commitment to waste management and engages with communities on ways to reduce, reuse, recycle or treat many waste products. In doing so, natural gas and oil companies can continue to protect public health and the environment while still providing the country with vast energy resources.

The natural gas and oil industry generally manages waste in a tiered process designed to best protect public and environmental health: reduce, reuse/recycle/treat, and dispose.

Reduction involves efforts like reducing the volume of generated waste and evaluating production chemicals to determine whether more environmentally benign but equally effective substitutes are available. The second tier involves reclaiming and reusing as much waste as possible, using treatments that minimize generated wastes, thereby reducing the amounts that have to be disposed. The third tier involves environmentally sound and responsible methods of disposing of generated waste materials.⁶

Waste from natural gas and oil activities are managed in accordance with state and federal environmental laws, as well as numerous industry

recommended practices. In many states, companies submit waste management plans as part of the permitting process to ensure that waste management options are carefully considered long before drilling ever begins.

Alternatives for Produced Water

Although much of the produced and waste water associated with natural gas and oil production is safely disposed of in deep injection wells, the industry is also finding innovative ways to recycle and reuse the water both onsite and off.

Many companies filter and reuse produced water in successive fracking operations. For example, one company operating in Pennsylvania is recycling over 90 percent of waste water produced from their exploration and production activities. And in Texas, another company has completed wells using 100 percent recycled produced water collected from previously completed wells.⁷

Recycling water saves millions of barrels of fresh water and, because it reduces the need to transport large quantities of fresh water to drilling sites, also reduces truck transportation and associated noise, emissions, and road wear and tear. Another advantage is that using treated water for hydraulic fracturing creates a sustained water use cycle, because produced water is generated continuously as long as natural gas or oil are being produced.⁸

Recycling and reuse have applications beyond the drill site. For example, in California, one company treats produced water to specific standards and then sends 20 million gallons per day to a municipal water district for agricultural use. According to a report by the U.S. Department of the Interior Bureau of Reclamation, once it is treated, produced water can be used in cooling towers in power plants, for firefighting or for rangeland restoration to reverse degradation caused by overgrazing and drought.⁹

Cuttings that come out of the wellbore can also be recycled. Cuttings are the rock and mud produced from the drilling of a well, and can help stabilize soils by enriching nutrient content and retaining water. Many exploration and production companies deliver cuttings to farmers for use as fertilizers on their fields.

20M

In California, one company treats produced water to specific standards and then sends 20 million gallons per day to a municipal water district for agricultural use.



Ongoing innovation is making it increasingly possible for the industry to produce less waste and reuse or recycle what it does produce.



Responsibly managing the waste produced from natural gas and oil production is a priority for the industry. Ongoing innovation is making it increasingly possible for the industry to produce less waste and reuse or recycle what it does produce.¹⁰ The natural gas and oil industry understands that it touches many valuable natural resources – and that’s why companies are committed to best practices on waste management.

NATURALLY OCCURRING RADIOACTIVITY

Low-levels of radiation naturally occur all around us, and the natural gas and oil industry develops best practices on naturally occurring radioactive material while working within local, state and national regulations to protect human health and the environment.

Naturally occurring radioactive material (NORM) is found in the air, soil, rock and many of our foods. Water and wastes associated with the exploration and production of natural gas and oil may develop a low level of radioactivity through contact with material present in underground formations. For decades, companies have effectively managed and disposed of NORM from production and processing equipment and waste products, like production fluid and cuttings, in compliance with federal and state regulations.

Currently, operators are responsible for identifying, storing and disposing of any radioactive material, no matter how low the levels, in compliance with state environmental laws and Occupational Safety and Health Administration (OSHA) regulations. NORM-specific regulations are left to states, but remediation guidelines for sites undergoing closure may be subject to Environmental Protection Agency (EPA) requirements about allowable soil and surface water contamination.

Generally, states distinguish between radiation that is non-hazardous (below a certain level) and hazardous (above a certain level). In any question of worker protection, state health standards and OSHA regulations determine permissible exposures. These reporting and transparency activities work together to create an environment where the natural gas and oil industry can monitor and disclose its work around NORM.

CORRECTING THE RECORD ON SEISMICITY

Advanced engineering, effective industry risk management practices and standards, and regulations have allowed hydraulic fracturing to safely drive America's energy renaissance. Induced seismicity is a complex issue, and the industry is committed to continuing to study the phenomenon while developing best practices around it.

Induced seismicity is earthquake activity triggered by environmental changes caused by human activity. Today, induced seismicity is often incorrectly associated with fracking. However, most researchers are investigating the role injection wells, particularly those used to dispose of wastewater from natural gas and oil production, play in induced seismicity.¹¹

Currently, there are nearly 172,000 Class II Underground Injection Control wells regulated by the U.S. Environmental Protection Agency (EPA) under the Safe Drinking Water Act and delegated to 31 state agencies. These wells, used for salt water disposal, enhanced oil recovery and hydrocarbon storage, serve a vital role by supporting the responsible and sustainable development of natural gas and oil resources. About 20 percent of all Class II wells are disposal wells that receive produced water – salt and mineral-rich brine – that comes to the surface during natural gas and oil extraction.¹² This brine shared the same space with natural gas and oil, having been part of the same ancient ocean. On average, about 10 barrels of brine are produced with each barrel of crude oil. Once at the surface, brine is often disposed of in injection wells.¹³

172k

Currently, there are nearly 172,000 Class II Underground Injection Control wells regulated by the U.S. Environmental Protection Agency under the Safe Drinking Water Act and delegated to 31 state agencies.

The U.S. Geological Survey (USGS) reports that “only a small fraction of those disposal wells have induced earthquakes that are of concern to the public.”

Understanding Injection Wells and Seismicity

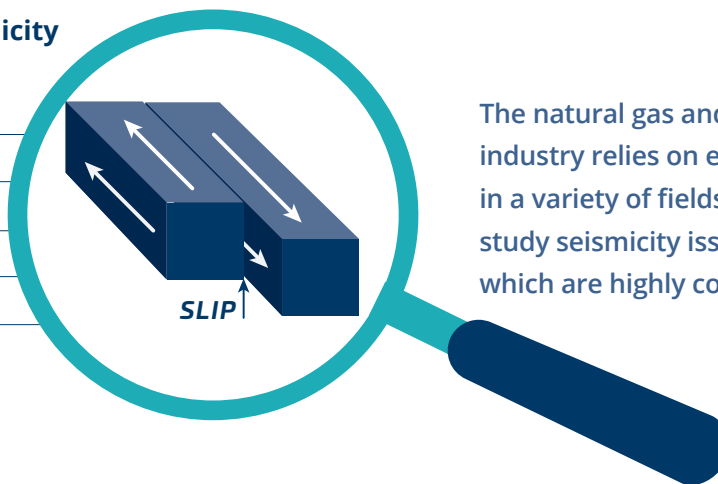
The majority of disposal wells in the United States do not pose a hazard for induced seismicity, but under some geologic and reservoir conditions a limited number of injection wells have been determined to be responsible for induced earthquakes with felt levels of ground shaking. Of the approximately (34,000 to 40,000) underground wastewater disposal wells associated with energy, the U.S. Geological Survey (USGS) reports that “only a small fraction of those disposal wells have induced earthquakes that are of concern to the public.”¹⁴

To evaluate the need for mitigation and management of the risk of induced seismic events, it is important to understand the science. Induced seismicity is a complex issue, and the knowledge base surrounding it is rapidly changing. States are developing diverse strategies for avoiding, mitigating and responding to potential risks as they locate, permit and monitor Class II disposal wells. Many state regulators work with professionals from government agencies, universities, private consultants and industry experts on these issues.¹⁵

The natural gas and oil industry is committed to using underground disposal wells in safe and environmentally reliable ways. Partnerships, such as the StatesFirst initiative, are sharing geological data and research, identifying best practices and developing risk management and risk mitigation strategies.¹⁶ Science-based measures and strategic partnerships will continue to be integral components in making energy development as safe as possible.

Studying Seismicity

Engineering
Geomechanics
Geophysics
Geology
Seismology

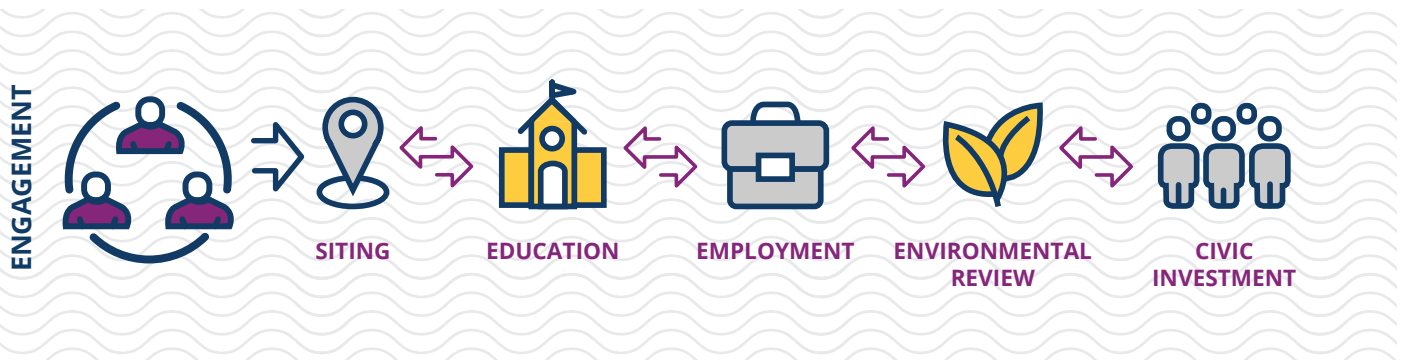




Engaging with **COMMUNITIES**

BEST PRACTICES ON STAKEHOLDER INVOLVEMENT AND COMMUNITY DEVELOPMENT

Energy development can bring undeniable benefits to communities, including economic development and enhancements to roads, schools, public services and more. By collaborating, companies and communities can best realize shared goals around public and environmental health and prosperity.



For development to be a positive experience for communities, it needs to be aligned with community concerns and priorities while remaining grounded in responsible practices. The industry has worked to gather and share best practices for community engagement and to encourage widespread company adoption as part of its commitment to the communities in which it works.

The industry's commitment to being a good neighbor throughout the full project life cycle requires integrity, transparency, consideration of community concerns and ongoing dialogue with local communities and other

key stakeholders. These principles form the basis for American National Standards Institute (ANSI)/API Bulletin 100-3 *Community Engagement Guidelines* (First Edition, July 2014).¹ The guidelines outline what local communities and other key stakeholders can expect from operators, so both sides can refer to it.

Being a Good Neighbor

Community engagement means being a good neighbor throughout the full project life cycle, fostering stakeholder involvement in every stage, considering stakeholder feedback and understanding and responding to their legitimate

State and federal regulations, in many cases driven by the industry's best practices, help industry maintain open and positive communication with communities through town hall meetings, working groups and more.

concerns. Furthermore, the natural gas and oil industry recognizes that good relationships with community members are mutually beneficial, and development is improved through community involvement.

Building positive, constructive relationships for the long term and maintaining a presence as leaders of communities with the reputation for forthrightly engaging on issues important to stakeholders are central pillars of industry best practices.

The industry understands that operating daily in a manner that protects the safety, environment and health of the community, employees and contractors is critical to building trust, as is open, two-way communication through a number of channels.

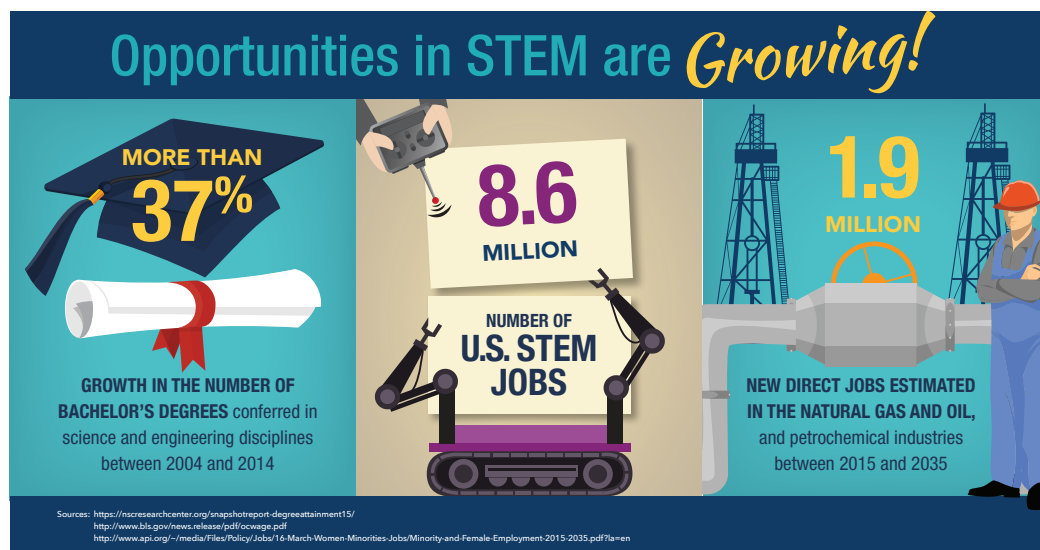
The industry strives to be aware of and sensitive to community, cultural, economic and environmental context. That means considering the norms, values and beliefs of local stakeholders and how they live and interact with one another.

Permitting, environmental review processes and state and federal regulations, in many cases driven by industry's best practices, help the industry maintain open and positive communication with communities through town hall meetings, working groups and more.

SUPPORTING STEM EDUCATION

The natural gas and oil industry's commitment to the future growth and prosperity of the country includes major efforts to foster the educational needs of the next-generation of workers, particularly in the STEM subjects: science, technology, engineering and mathematics.

A wide array of industry programs and individual company initiatives are aimed at developing student interest in STEM subjects as early





as kindergarten, and sustaining that interest through high school and into college.

Examples range from STEM summer camps to innovative district-wide programs, to intensive training for prospective and experienced teachers, to development of curricula. In addition, some companies are creating labs that introduce students to tools and technology, judging science fairs, supporting summer STEM camps and more.

One company has even developed a social media-based program, “Be an Engineer,” to help students understand the field. In its first six weeks, this program reached 19.4 million people.²

In addition, investments in community education can include underwriting STEM and energy-focused middle and high schools.

Here, as elsewhere, there is also a major focus on helping underrepresented groups along on the road to STEM degrees. As API President and CEO Jack Gerard declared in a speech at the U.S. News STEM Solutions National Leadership Conference, “[T]he natural gas and oil industry’s fundamental recommendation is as straightforward as it is simple: Make the improvement of women and minorities’ preparation in STEM-related disciplines a national priority.”³

Inspiring Teachers, Providing Resources

Industry works to give teachers the knowledge and resources they need to inspire interest in STEM. Companies often work directly with state-wide school systems, school districts or even individual schools to provide teachers with training or ideas on how to teach STEM and foster a love for learning.

19.4M

One company has developed a social media-based program, “Be an Engineer,” to help students understand the field. In its first six weeks, this program reached 19.4 million people.

707k

Of the 1.9 million available positions, 707,000 positions – or 38 percent – are projected to be held by African American and Hispanic employees, and 16 percent by women.

Some industry programs focus on future teachers. Companies in California, for example, have partnered with the California State University to offer a STEM Teacher and Research Program, giving aspiring K-12 teachers a chance to conduct authentic research and translate it into classroom practice.⁴ Other companies are working to provide resources for the classroom to provide hands on and engaging STEM lessons and to supplement often limited school resources.

Working on a broader canvas, the industry recognizes the need to develop curricula and policies to strengthen STEM programs over the long term and on a wide scale. Change the Equation, a program aiming to do just that not only supports qualified STEM teachers to inspire students to pursue STEM careers, it also advocates for rigorous state policies and practices that will produce STEM-literate high school graduates.⁵

API's Jack Gerard drew a straight line between STEM policies today and success tomorrow – for individuals, for the industry and for the nation: "Future generations are counting on us to implement policies that promote educational achievement, particularly in science, technology, engineering and math, because it will largely be those subjects that determine who will benefit most in the 21st century."

ENHANCING THE COMMUNITY

The natural gas and oil industry supports communities in obvious ways – jobs, investment and tax revenue – but also in many ways that might fly under the radar. New development helps support property values and provide royalties, and local operations help fund community projects, amenities and programs that support environmental and public health.

The U.S. natural gas and oil industry is an engine for creating jobs, supporting 9.8 million across the country. Looking ahead, the employment picture is full of potential. Due to industry growth and the historic number of worker retirements coming over the next two decades (known as the "Great Crew Change"), the industry expects to need to fill nearly 1.9 million positions by 2035. More than half of these jobs are for workers without formal college education (such as welders, electricians and truck drivers).⁶

Of the 1.9 million positions that must be filled, 707,000 positions – or 38 percent – are projected to be held by African American and Hispanic employees, and 16 percent by women. The industry has also developed an online platform, called 'Veterans Energy Pipeline,' which

helps connect veterans with oil and gas career opportunities.⁷ Veterans are a particularly valuable resource to the natural gas and oil industry as many already have highly desirable skills for the many jobs available nationwide.

Bolstering Community Development

Natural gas and oil development creates good jobs in local areas and brings economic development, increasing local income not only through direct employment but also through indirect employment and royalty payments to landowners. Local governments receive increased revenue from property taxes to develop and maintain infrastructure. In 2015 in Texas, for example, several counties got 70 percent or more of their tax revenue from the natural gas and oil industry.⁸

With new tax revenue, investment and jobs, energy development can bring extra noise, traffic and other growing pains. However, these challenges have been found to be short-lived. While there have been concerns that these issues might harm property values, the opposite has been shown to be true. Increased wages and activity increases demand for housing, thereby increasing property values.

A 2015 study in the *Journal of Environmental Economics and Management* compared two Pennsylvania counties and three New York counties along the state border. The Pennsylvania counties have seen Marcellus shale development while the three counties in New York have not, due to New York's ban on hydraulic fracturing. Before New



York's moratorium, all five counties had similar housing price patterns. But after the moratorium, housing prices in the counties in New York dropped significantly compared to those in Pennsylvania.⁹ The authors conclude that this indicates there is large and positive net valuation of shale gas development for communities.¹⁰

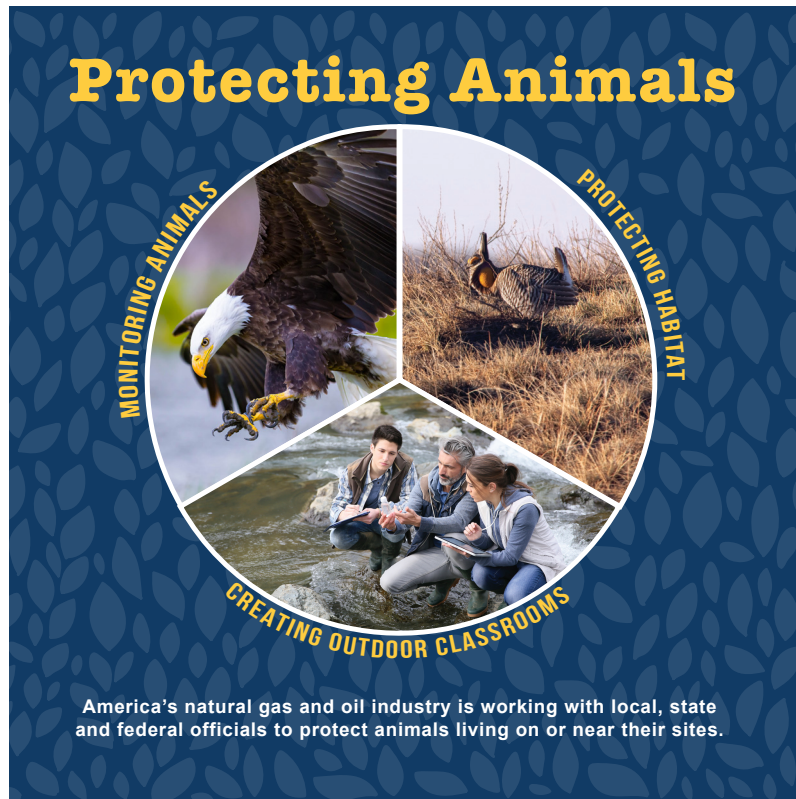
Providing Civic and Environmental Benefits

Enhancing communities goes far beyond providing new economic opportunity, new jobs, royalties and improved property values. Communities around the country are also benefiting from company good neighbor policies, including civic sponsorships, environmental conservation projects and more.

70%
In 2015 in Texas, several counties got 70 percent or more of their tax revenue from the natural gas and oil industry.

\$2.46M

In 2015 one company distributed more than \$2.46 million to 1,112 charities across North America by matching employee giving dollar for dollar, up to \$10,000 per worker, to the charity of the employee's choosing.



For several years, companies have been creating pollinator gardens to support bee populations to help communities where decreasing numbers of bees could have real impacts on domestic agriculture and more. The industry has also contributed significantly to creating safe spaces for endangered species. For example, companies have worked to protect species including the sagebrush lizard to the prairie chicken, as well as elk, bald eagles, songbirds and others.¹¹

Beyond protecting animals and the environment, companies are also closely involved in their communities. From holding community service days, sponsoring little league teams or paying to upgrade fire department equipment, the natural gas and

oil industry is investing in the communities where it operates. Many companies are also heavily involved in philanthropic work. For example, in 2015 one company distributed more than \$2.46 million to 1,112 charities across North America by matching employee giving dollar for dollar, up to \$10,000 per worker, to the charity of the employee's choosing.¹²

All of these efforts are part of being a good neighbor and a positive contributor to the communities and environments in which the industry operates.



Energy Today

Through continuous innovation and best practices development, the natural gas and oil industry has demonstrated a commitment to developing our natural resources while protecting the health of communities and the environment. As a result, the industry has laid the groundwork for the American people – as consumers, workers and citizens alike – to reap enormous benefits from this energy renaissance. From individual savings to nationwide energy security, the natural gas and oil industry has set the country on a sustainable course towards a brilliant future.

Savings and Affordable Energy

During the past decade, America transformed energy from an economic weakness into a strength by becoming the world's leading producer and refiner of natural gas and oil. American crude oil production grew 75 percent and natural gas production increased 46 percent.¹ And our world-class refining sector reached a 35-year high for distilling capacity in 2016. This transformation has produced clear benefits for consumers and the environment alike.

In 2015, drivers saved an average of \$550 in gasoline costs according to AAA.² And thanks to surging energy production from shale, one study found that consumers also have seen an additional \$1,337 in disposable income because of lower home energy costs and lower energy costs for other goods and services.³ According to the U.S. Energy Information Administration (EIA), falling natural gas and oil prices have directly reduced Americans' cost of living.⁴

Growing Our Economy While Reducing Emissions

Reduced energy costs are saving consumers money and simultaneously driving economic growth. Consider our manufacturing sector: electricity costs for manufacturers are now 30-50 percent lower than those of foreign competitors. That's helped make U.S. manufacturing costs 10 to 20 percent lower than those in Europe, and they are projected to be 2 to 3 percent lower than China by 2018.⁵ Lower energy prices are giving U.S. industries a competitive edge that is attracting new investment and bringing good jobs back to American shores.

Remarkably, we have produced lower cost energy, a magnet for industrial investment, while slashing emissions from electricity generation to near 30-year lows, primarily because of increased use of cleaner burning natural gas.⁶ Thanks to the shale revolution, the U.S. has provided the world a model for how to grow an economy while still cutting emissions.

Improved Infrastructure

Our increased energy production has meant new investments in our energy

75%

American crude oil production grew 75 percent and natural gas production increased 46 percent. And our world-class refining sector reached a 35-year high for distilling capacity in 2016.

1M

Updating America's energy infrastructure could generate up to \$1.34 trillion in new private capital investment, support up to 1 million new jobs and add \$100 billion, on average, per year to our nation's GDP between 2017 and 2035.

infrastructure, the backbone of our energy system. There are already more than 500,000 miles of transmission pipelines crossing the U.S., but that capacity must be expanded to keep pace with our changing production trends. Not only do we need to expand or upgrade existing infrastructure to get additional product where it's needed, but we also must add new infrastructure to regions that have not seen significant natural gas and oil production in decades, or perhaps ever before.

Infrastructure investment enables every American, no matter how far they are from centers of energy production, to benefit from our newfound energy abundance and the low-cost energy that is driving economic growth.

Investments in energy infrastructure are an economic engine themselves. According to a recent study by ICF, updating America's energy infrastructure could generate up to \$1.34 trillion in new private capital investment, support up to 1 million new jobs and add \$100 billion, on average, per year to our nation's gross domestic product between 2017 and 2035.⁷

Strengthened Energy Security and Geopolitical Benefits

Our new energy abundance, investment in energy infrastructure and reduced energy costs all add up to improved energy security. From 2006 to 2016, U.S. crude oil and petroleum product imports decreased by more than 3 million barrels per day.⁸ Our energy renaissance has allowed the U.S. to take a more active role in the global energy marketplace. The U.S. is projected to be a net exporter of natural gas by next year (2018)⁹ and is currently a net exporter of refined products.¹⁰

Exporting natural gas, crude oil and refined products strengthens our economy, benefits our allies and weakens the hand of nations that use energy trade as a geopolitical weapon. A study by ICF International projects that by exporting crude oil, the U.S. could add up to 300,000 jobs in 2020 and grow the economy by \$38.1 billion. Additionally, ICF calculated that exports of liquefied natural gas (LNG) could add up to 452,000 jobs nationwide by 2035 and grow the economy by \$73.6 billion.¹¹ Many of these exports could also help the global environment, allowing countries to modernize their energy infrastructure towards cleaner burning fuel.¹²

Further commitment to policies that strengthen U.S. competitiveness in the global LNG market will help make the U.S. the world's third-largest LNG supplier in five years, according to the International Energy Agency. Increased U.S. energy exports are a net benefit for the U.S. economy, our allies and global markets.

Looking Forward

As the U.S. natural gas and oil industry looks to the future, opportunities abound to help meet the nation's – and the world's – energy needs, to grow our economy and to provide affordable, secure energy to U.S. consumers. The industry is ready to continue leading the nation towards a more efficient and modern energy system while remaining a responsible steward of the natural resources that are the lifeblood of our economy. Our opportunity comes with great responsibility and that is why health, safety, and the protection of the environment and the communities in which we operate are our top priorities.



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