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IN THE SUPREME COURT OF PENNSYLVANIA
MIDDLE DISTRICT

No. 63 MAP 2018

SOUTHWESTERN ENERGY PRODUCTION COMPANY,
Appellant,

v.

ADAM BRIGGS, PAULA BRIGGS, HIS WIFE,
JOSHUA BRIGGS AND SARAH BRIGGS,
Appellees.

Appeal from the Order of the Superior Court, 1351 MDA 2017, filed April 2, 2018, reargument denied June 8 2018, reversing the Order of the Court of Common Pleas of Susquehanna County, No. 2015-01253, dated August 8, 2017

BRIEF OF *AMICUS CURIAE* AMERICAN PETROLEUM INSTITUTE

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The American Petroleum Institute ("API"), pursuant to Pa.R.A.P. 531(b)(1)(i), submits this *amicus curiae* brief in support of Southwestern Energy Production Company's ("Southwestern's") appeal from the Superior Court's April 2, 2018 opinion in *Briggs v. Southwestern Energy Production Company*, 184 A.3d 153 (Pa. Super. 2018).

I. INTERESTS OF *AMICUS CURIAE*.

API, doing business in Pennsylvania through its Harrisburg offices as the Associated Petroleum Industries of Pennsylvania, is the primary national trade association of America's technology-driven oil and natural gas industry. The over 625 API members are involved in all segments of the industry, including the exploration, production, refining, shipping, and transportation of crude oil and natural gas. In Pennsylvania alone, over 300,000 jobs are supported by the industry, which also provides more than $34 billion to the Commonwealth's economy. API members have invested billions of dollars in Pennsylvania's oil and natural gas industry. Together with its member companies, API is committed to ensuring a strong, viable oil and natural gas industry capable of meeting the energy needs of our Nation and the Commonwealth of Pennsylvania in a safe and environmentally responsible manner.

The Superior Court's recognition, in *Briggs*, of a trespass by fracture cause of action in this Commonwealth will disrupt existing oil and gas rights and upset

Pennsylvania's well-established adherence to the rule of capture, reliance upon which oil and gas rights were purchased and obtained by API's members and countless others. The ability of API members to utilize and enjoy their recognized property interests and realize reasonable returns on their substantial investments in the Commonwealth has been jeopardized by the Superior Court's decision.[1]

II. SUMMARY OF ARGUMENT

Changing the long-settled law to recognize a new tort, trespass by fracture, would deprive vested rights, defeat reasonable, investment-backed expectations and create a flood of unwarranted, and unanticipated, claims and litigation. The rule of capture became the law of Pennsylvania when producers were engaged in precisely the type of conduct – *i.e.*, fracturing producing formations – that the Superior Court panel in this case concluded amounted to a trespass. Despite changes in the technology used, the mechanical principles of "fracturing" tight geologic formations to release the oil and gas trapped within have not changed. Tort liability for inadvertent fractures and drainage thousands of feet below ground will impede the exploration and development of, and lead to the waste of, the Commonwealth's oil and gas resources, a result that is completely contrary to the

[1] No person or entity other than the *amicus curiae* API, its members, or counsel paid in whole or in part for the preparation of the *amicus curiae* brief or authored in whole or in part the *amicus curiae* brief.

fundamental concept of oil and gas conservation and Pennsylvania's well-established adherence to the rule of capture.

III. ARGUMENT

This Court, for the reasons advanced by Southwestern and its *amici*, should reverse the Superior Court's panel decision and reaffirm that the long-settled rule of capture applies in Pennsylvania irrespective of the technology currently in use to develop oil and gas resources.

A. The Superior Court's Failure To Consider The Historical Context Of Oil And Gas Development In Pennsylvania Led It To Wrong Conclusion.

1. Fracturing Geologic Formations To Release And Capture Hydrocarbons Is Not A Recent Development.

The Superior Court's panel decision reflects an incomplete explication of the history of oil and gas development in Pennsylvania. That incomplete explication allowed the panel to mistakenly conclude that "fracturing" of tight geologic formations to release, and allow the flow and capture of, trapped hydrocarbons is a recent development rather than a practice that has existed since the 1800s.

As the courts recognized over a century ago, "fracturing" of tight formations, by a variety of means, was an established practice during the first "oil boom" in Pennsylvania. *See Kepple v. Pennsylvania Torpedo Co.*, 7 Pa. Super. 620, 621 (Pa. Super. 1898) ("The contract involved the furnishing of the torpedo, the lowering of it to its proper position in the well and the explosion of it, so as to

secure, if possible, the result aimed at, namely, an increase in the flow of oil from the adjoining rock or sand to the point whence it could be pumped to the surface."); *Donnan v. Pennsylvania Torpedo Company*, 1904 Pa. Super. LEXIS 315, at *13-*14 (Pa. Super. May 4, 1904) (describing the "shooting" of a previously drilled well with a torpedo for the purpose of increasing production); *Roberts v. Dickey*, 1871 U.S. App. LEXIS 1806, at *16 (W.D. Pa. May 1871) (a patent infringement dispute involving well torpedo); *Smith v. Bellows*, 20 Pa. D. 383, 387 (C.C.P. Warren 1910) ("The use of nitro-glycerine in torpedoing oil wells has for many years been universally followed; particularly in this field it has been done, as it is necessary to shoot the wells, otherwise no oil would be obtained. If the defendant is not permitted to torpedo the well it will be worthless to him."). *See also Jackson v. Central Torpedo Co.*, 246 P. 426, 427 (Okla. 1926) (describing the practice of "shooting" a drilled oil well by means of a shell or torpedo loaded with nitroglycerin "in order, if possible, to increase the production thereof").

Indeed, as described in *Roberts*, the "objects" of the patented well torpedo "were to ***fracture the oil-bearing rock in proximity to the bore of the well, and for some distance around it, thus making artificial passages into seams or crevices containing oil, which, without such passages, would not be connected to the well*** …." *Roberts*, 1871 U.S. App. LEXIS 1806, at *3 (emphasis added). The end result of this patented process was "not the destruction of the well, but an increase

of its capacity to gather and hold oil *from the reservoirs surrounding it*." *Id*. at *16. *See also* J.T. Henry, *The Early and Later History of Petroleum* (1873) (excerpt attached hereto at Tab A).[2]

Despite changes in the technology used, the mechanical principles of "fracturing" tight geologic formations to release the oil and gas trapped within have not changed since the first well "shooters" dropped an explosive charge down a well in the 1860s. Then as now, the task is to deliver a powerful force to a designated depth underground, fracturing the hard rock formations around the well to stimulate the release oil or gas trapped within. The well shooter's original tools of choice were gunpowder and, later, nitroglycerin, delivered down the well within an exploding torpedo. Today's well shooters use hydraulic fracturing, whereby hydraulic fracturing fluids are forced down a well at high pressure, and under tight controls, to create fractures in rock that allow the oil and natural gas it contains to escape and flow out of a well. *See Hydraulic Fracturing, Unlocking America's Natural Gas Resources* (API, August 2017, attached hereto at Tab B). Thus, while the technology used may have changed, "fracturing" the rock to release the oil and gas has always been part of the process.

[2] Available at http://hdl.handle.net/2027/uc2.ark:/13960/t6xw4919t.

2. Fracturing Was Commonplace When The Rule Of Capture Became The Law In Pennsylvania.

The rule of capture, as recognized and articulated by this Court, also has its origins in the first "oil boom" in Pennsylvania. That is, the rule of capture became the law of Pennsylvania when producers were engaged in precisely the type of conduct – *i.e.*, fracturing producing formations – that the Superior Court panel in this case concluded amounted to a trespass. *See, e.g.*, *Westmoreland & Cambria Natural Gas Co. v. De Witt*, 18 A. 724 (Pa. 1889); *Jones v. Forest Oil Co*., 44 A. 1074 (Pa. 1900); *Barnard v. Monongahela Natural Gas Company*, 65 A. 801 (Pa. 1907); *United States Steel Corp. v. Hoge*, 468 A.2d 1380 (Pa. 1983).

The Court's decision in *Jones*, which further cemented the rule of capture as the law of this Commonwealth, acknowledged that "fracturing" rock to release the oil and gas was commonplace at the time. In that case, this Court affirmed the trial court's refusal to enjoin the defendant from operating a "gas pump" that was drawing oil from the plaintiff's land. *See Jones*, 44 A. at 1076. The gas pump was used to increase the well's production and had been installed shortly after the "well was **shot** and cleaned out" – *i.e.*, after the well had been fractured by "shooting" it with an exploding torpedo. *Id*. at 1074 (emphasis added). This Court, based on "principles which [were] very familiar, and perfectly well-settled," concluded that an oil and gas operator may "adopt any and all appliances known to the trade to make the production of his wells as large as possible," and that it is lawful to

produce oil by the "exercise of all the skill and invention of which a man is capable … however injurious or however artificial those means may be …." *Id*. at 1075-76.

3. Nothing Has Changed That Warrants Dramatic Departure From The Well-Settled Common Law Rule Of Capture.

As this Court recognized early on in *Westmoreland*, there is no complete analogy between oil and gas and any of the other physical substances found over, on, or under the surface of the land. They are a unique species of property and property rights in them must be determined upon the basis of their own "peculiar attributes." *See Westmoreland*, 18 A. 724 (Pa. 1889).

Contrary to what the Superior Court panel opinion suggests, the "peculiar attributes" of oil and gas have not changed. Oil or gas are no less fugacious, or fugitive, now than they were when the rule of capture was adopted by this Court over a century ago. *Id.* Oil and gas continues not to respect man-made private-property lines and defies the boundaries of surface ownership in their obedience to the laws of physics. Oil and gas, as a matter of those laws of physics, will continue to flow of their own accord from a location at higher pressure to a location at lower pressure. Oil and gas, as it was over a century ago, continues to be produced by means of wells drilled into the saturated underground formations. And those formations, as they were over a century ago, continue to be fractured (now primarily by water instead of by explosive torpedoes) to allow the flow and capture

of trapped hydrocarbons. The principles underlying the common-law rule of capture continue to apply to oil and gas obtained through the process of fracturing. Nothing, in short, has changed.

Because the foundations for application of the common-law rule of capture to fracturing remain, there is no reason to *now* jettison that rule and conclude, after more than a century of acceptance, that a landowner in Pennsylvania can be held liable for drainage of oil or gas from his neighbor's land resulting from otherwise legal and non-negligent producing operations, and that an operator no longer has title to all oil and gas produced from his well even though some of the oil or gas produced from his well might have been located under his neighbor's land when it was in its natural state.

B. The Superior Court's Decision Upsets Well-Settled, Investment-Backed Expectations Regarding Application Of The Rule Of Capture.

Given the historical context, oil and gas producers, including those engaged in fracturing to release trapped hydrocarbons, have for decades reasonably relied on the common-law rule of capture in Pennsylvania.[3] They have reasonably relied

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[3] Pennsylvania is not an outlier. The common-law rule of capture, where not otherwise modified by conservation statutes and regulations, is generally recognized by all states that have addressed the issue in the oil and gas context, including states with significant production reliant on the use of hydraulic fracturing technology. *See, e.g.*, *Gadeco, LLC v. Indus. Comm'n of State*, 812 N.W.2d 405, 407 (N.D. 2012); *Coastal Oil & Gas Corp. v. Garza Energy Trust*, 268 S.W.3d 1, 12-13 (Tex. 2008); *Bonner v. Oklahoma Rock Corp.*, 863 P.2d

on the stability, certainty and predictability of the law in order to site, design and drill thousands of wells across the Commonwealth. They have, likewise, reasonably relied on the rule of capture when acquiring oil and gas rights and when negotiating and entering into oil and gas leases. Changing the long-settled law to recognize a new tort, trespass by fracture, would deprive vested rights, defeat reasonable, investment-backed expectations and create a flood of unwarranted, and unanticipated, claims and litigation. *Cf. Butler v. Charles Powers Estate*, 65 A.3d 885 (Pa. 2013) (no justification for overruling or limiting the *Dunham* Rule and its longstanding progeny that have formed the bedrock for innumerable private, real property transactions for nearly two centuries).

Indeed, while the rule of capture has been criticized, it is difficult to see how any other common-law rule can, practically, be applied by the courts in this circumstance. An operator should not be required to get a court decree in order to establish a well location or to fix the amount of oil or gas that he may legally produce. Judicial processes are not appropriate to control such matters as the spacing and location of wells or to regulate the production from wells extending thousands of feet below the surface. And case-by-case judicial adjudication of these issues would almost certainly result in the expiration of a significant number of oil and gas leases, which have relatively short primary terms. Instead, these are

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1176, 1185 (Okla. 1993); *Desormeaux v. Inexco Oil Co.*, 277 So.2d 218, 220 (La. Ct. App. 1973).

matters that can only be regulated by administrative agencies with specialized expertise and under legislative authorization. If the courts, in the absence of such legislation, are called upon to entertain suits to enjoin the drilling of wells which may, through inadvertent fractures thousands of feet below the ground, cause drainage, or if they hold that landowners, or their lessees, are liable in damages for such drainage of oil and gas from beneath their neighbors' lands, the development of any oil and gas field will necessitate the filing of innumerable actions and cross-actions for the protection of property rights. As a result, the lawyers probably will profit more from the development of oil and gas than the producers. In the absence of appropriate legislation, the common-law rule of capture, and the attendant remedy of self-help, remains the more practical remedy for the landowner being inadvertently drained than the allowance of a judicial remedy either by way of an injunction or in the form of a monetary recovery of damages for drainage.

C. The Rule Of Capture Is An Essential Element Of Reasonable, Orderly Development Of Oil And Gas Resources In Pennsylvania, The Importance Of Which To State And Local Stakeholders Cannot Be Overstated.

The observations of the Texas Supreme Court in *Coastal Oil & Gas Corp. v. Garza Energy Trust*, are apt. 268 S.W.3d 1, 27 (Tex. 2008) (Willett, J., concurring). "Efficient energy production is profoundly important to [Pennsylvania] and to the nation." *Id*. Pennsylvania and our nation confront fast-growing energy needs, and Pennsylvania "can ill afford its finite resources, or its

law, to remain stuck in the ground." *Id*. Recognizing a claim for trespass by fracture will seriously impede oil and gas production in Pennsylvania. In particular, it would threaten the continued use of fracturing, the importance of which for oil and gas development cannot be denied. *Id.* at 16 ("Hydraulic fracturing is not optional; it is essential to recover the oil and gas in many areas….").

As it has for decades, fracturing of tight formations to allow the migration and capture of hydrocarbons maximizes production of limited oil and gas resources, while at the same time ***minimizing waste*** of those limited resources and, further, ***minimizing surface impacts*** associated with oil and gas development. "Hydraulic fracturing cannot be performed both to maximize reasonable commercial effectiveness and to avoid all drainage. Some drainage is virtually unavoidable. In this context, common law liability for a long-used practice essential to an industry is ill-advised and should not be extended absent a compelling need that the Legislature … ha[s] ignored. No such need exists." *Coastal*, 268 S.W.3d at 16.

"Allowing trespass-by-frac suits to impede what is perhaps the single most essential technique in modern oil and gas production would be a calamitous mistake." *Id*. at 31. Tort liability for inadvertent fractures and drainage thousands of feet below ground will impede the exploration and development of, and lead to

the waste of, our state's oil and gas resources, a result that is completely contrary to the fundamental concept of oil and gas conservation. This Court long ago established that anything that restricts the ability of one with rights to oil and gas reservoirs to get to those reservoirs is harmful to the public interest of the entire Commonwealth by limiting availability of and increasing the cost of producing energy resources, thereby potentially causing increased costs to the consumer. *See Chartiers Block Coal Co. v. Mellon*, 25 A. 597, 599 (Pa. 1893) ("Coal, oil, gas, and iron are absolutely essential to our common comfort and prosperity. To place them beyond the reach of the public would be a great public wrong.").[4]

As recognized by the Texas Supreme Court in *Coastal*, fracturing "is not a luxury, but a must-have recovery tool that is vital today and will remain vital tomorrow (along with other promising recovery technologies)." *Coastal*, 268 S.W.3d at 31. "Easy-to-produce reserves are increasingly uncommon, and meeting spiking demand requires advanced techniques to make uneconomical fields economical." *Id*. The court in *Coastal* also recognized that hydraulic fracturing,

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[4] Like the dominant estate principle, the rule of capture also serves the public good by promoting the beneficial use and development of property interests by private parties. In Pennsylvania this also benefits the public at large through increased tax revenues. Without it, "the public might be debarred the use of the hidden treasures which the great laboratory of nature has provided for man's use in the bowels of the earth. Some of them, at least, are necessary to his comfort. … Abounding, as our state does, with these mineral treasures, so essential to our common prosperity, the question we are considering becomes of a quasi public character. It is not to be treated as a mere contest between A and B over a little corner of earth." *Chartiers*, 25 A. at 598.

while required, is also imprecise: "Creating a fracture is itself a geological and engineering marvel; controlling its length and direction (in three dimensions) is simply beyond present capabilities." *Id*. at 33. Because operators of hydraulically fractured wells lack absolute control over the length and width of any particular induced fracture, the specter of tort liability for inadvertent fractures and drainage thousands of feet below ground "will convince many rational operators to forego fracing altogether and leave otherwise recoverable resources in the ground *to the detriment of the State as a whole*." *Id*. (emphasis added).

IV. CONCLUSION.

For the foregoing reasons, API respectfully submits that the Court should reverse the Superior Court's panel decision, hold that recognition of a trespass by fracture cause of action in this Commonwealth will disrupt existing oil and gas rights, and expressly reaffirm the existence of the rule of capture in Pennsylvania.

Respectfully submitted,

January 30, 2019

s/Christopher R. Nestor

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<u>TAB A</u>

(J.T. Henry*, The Early and Later History of Petroleum* (1873) (excerpt))

THE

EARLY AND LATER

HISTORY OF PETROLEUM,

WITH

AUTHENTIC FACTS IN REGARD

TO ITS

DEVELOPMENT IN WESTERN PENNSYLVANIA.

The Oil Fields of Europe and America. Gas Wells. Spiritual Wells. Oil Well Shafts. Petroleum Products. Oil Companies. Pipe Line Statistics. Early Modes of Transportation. Flowing Wells of 1861, to 1864. Pit Hole in 1865. The Lubricating Oil District, &c. Also, Statistics of Product, Export, and Consumption, with prices of Oil from 1859, to 1872, &c., &c.

THE PARKERS' AND BUTLER COUNTY OIL FIELDS.

ALSO, LIFE SKETCHES OF

PIONEER AND PROMINENT OPERATORS,

WITH THE

REFINING CAPACITY OF THE UNITED STATES.

BY J. T. HENRY.

PHILADELPHIA:
JAS. B. RODGERS CO., PRINTERS, 52 & 54 NORTH SIXTH ST.
1873.

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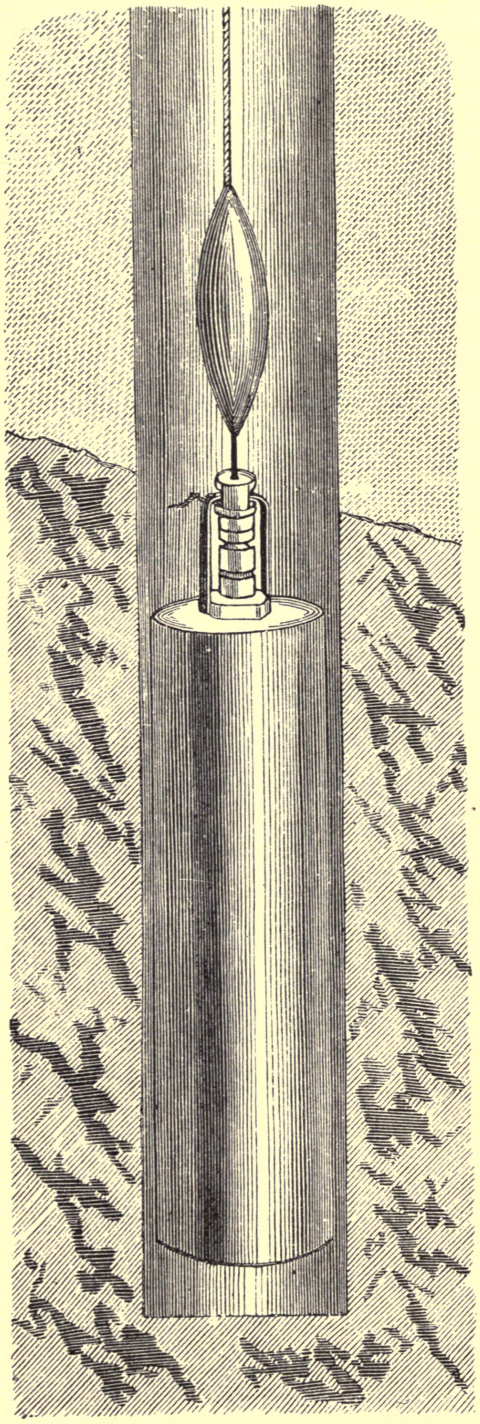
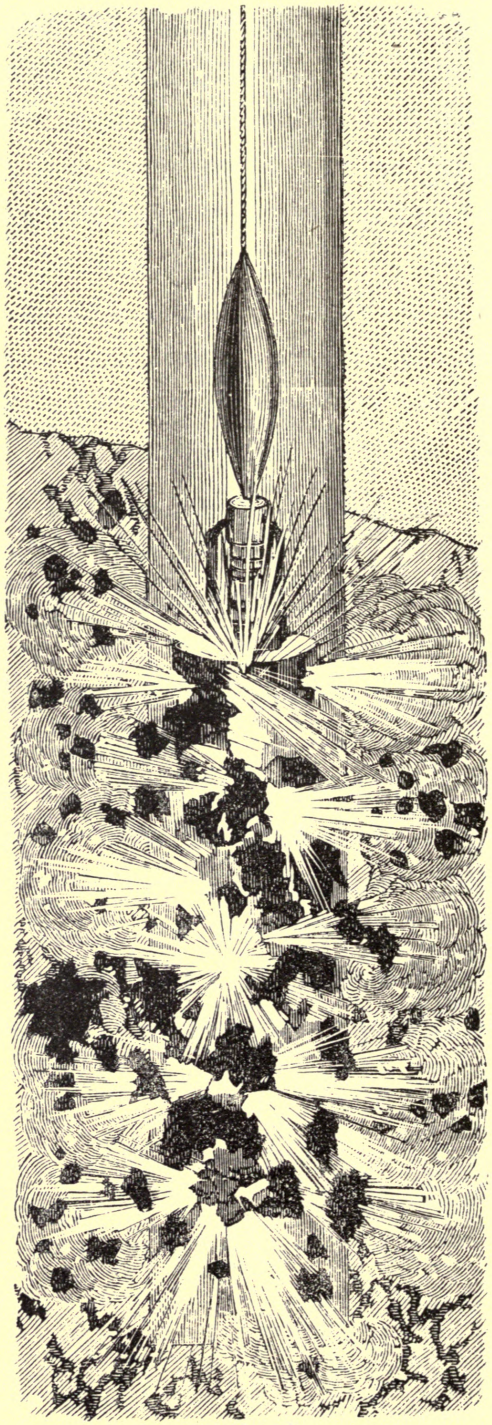


Before Explosion.



After Explosion.

THE ROBERTS TORPEDO.

TORPEDOES.

THEIR HISTORY AND POSITIVE VALUE.

"THE HISTORY OF PETROLEUM" would be singularly incomplete without mention of the Roberts Torpedo, for to this remarkable invention may be attributed, more than to any other agency, the success which has attended its prosecution. We propose, therefore, to present, as concisely as possible, a history of this invention, from its inception to the present time.

In 1862, Col. E. A. L. Roberts, then an officer in the volunteer service, and with his regiment in the Army of the Potomac, in front of Fredericksburg, conceived the idea of exploding torpedoes in oil wells, for the purpose of increasing the production. He made drawings of his invention, and in November, 1864, made application for letters patent. In the fall of the same year he constructed six torpedoes, and on the 2d of January, 1865, he visited Titusville to make his first experiment. Col. Roberts' theory was received with general disfavor, and no one desired to test its practicability at the risk, it was supposed, of damaging a well. On the 21st of January, however, Col. R. persuaded Capt. Mills to permit him to operate on the Ladies' Well, on Watson Flats, near Titusville. Two torpedoes were exploded in this well, when it commenced to flow oil and paraffine. Great excitement of course followed this successful experiment, and brought the torpedo into general notice. The result was published in the papers of the oil region, and five or six applications for patenting the same invention were immediately filed at Washington. Several suits for interference were commenced, which lasted over two years, and decisions in all cases were rendered declaring Col. Roberts the original inventor.

Notwithstanding the success of the first experiment, operators

were still very skeptical as to the practical advantages of torpedoes, and it was not till the fall of 1865, that they would permit the inventor to operate in their wells to any extent, from fear that the explosion would fill them with rock and destroy their productiveness.

In December, 1866, however, Col. R. exploded a torpedo in what was known as the "Woodin Well," on the Blood farm This well was a "dry hole," never having produced any oil. The result of the operation secured a production of twenty barrels per day, and in the following month, January, 1867, a second torpedo was exploded, which brought up the production to eighty barrels. This established for the torpedo, beyond question, all that Col. Roberts had claimed, and immediately the demand for them became general throughout the region. We present below a tabular statement of the result of the first THIRTY-EIGHT wells torpedoed:

THE RESULTS OF THE TORPEDO.

NAME AND LOCATION OF WELLS.	Increase in Bills.	Pumping & Flowing.
Woodin Well, Blood Farm	80	Pumping
Two Wells for Mr. Archer, Tarr farm	60	Pumping
Tarr Homestead, No. 1	60	Flowing
Tarr Homestead, No. 2	65	Flowing
Monitor Well, No. 2	35	Pumping
Vogan	30	Pumping
Keystone Well	185	Flowing
Sherman Homestead Well	60	Pumping
Manhattan Well, Story Farm	75	Flowing
Clara Well, Pit Hole, no increase, but made the Andy Johnson well flow	150	Pumping
Burnett Well, Tarr Farm	65	Flowing
Gardner's Well, Pioneer Run	8	Pumping
A. Aldrich, Tip Top Well, Tarr Farm	35	Pumping
Smith Well, Tarr Farm	10	Flowing
Hawkin's Well, Petroleum Centre	20	Pumping
Anderson Well, Petroleum Centre	90	Pumping
Monitor, Well No. 1, Tarr Farm. Two Torpedoes	10	Pumping
Mahaffy Well, Petroleum Centre	4	Pumping
Ennis Well, Cherry Run	35	Pumping
Hunter Well, Story Farm	20	Pumping
Hamburgh Oil Co., Story Farm	30	Pumping
Morse Well, Blood Farm	30	Pumping
Woodin Well, Blood Farm (second time)	30	Pumping
No. 8 Well, John Rynd Farm	75	Flowing
Hyde Well, Story Farm	35	Pumping
Mitchell Well, Cherry Run	10	Pumping
Parker Well, No. 1, Tarr Farm	125	Flowing
Bakery Well, No. 1, Tarr Farm	200	Flowing
Columbia Oil Co., Story Farm	10	Pumping
Refinery Well, Blood Farm	10	Pumping
Tarr Reserve Well, Tarr Farm	35	Pumping
Blanchard Well, Blood Farm	30	Pumping
Catskill Well, Cherry Run	15	Pumping
Duff Well, Tarr Farm	90	Flowing
Mahaffy, No. 2, Petroleum Centre	10	Pumping
Hays' Well, Petroleum Centre	30	Pumping
Briggs & Severence Well, Church Run	40	Pumping
Anderson Well, Petroleum Centre (second time)	125	Pumping
No. 272 Well, Petroleum Centre (second time)	200	Pumping

In 1865, immediately after operating on the Ladies' Well, a company was organized in New York for the purpose of prosecuting the business, with the following officers:

President, WILLIAM S. FOGG, 24 Fulton Street.
Vice-President, JAMES W. SIMONTON, 145 Broadway.
Secretary, W. B. ROBERTS, 47 Bond Street.
Treasurer, ERASTUS TITUS, 283 Washington Street.
Counsel, HON. GILBERT DEAN, 74 and 76 Wall Street
Superintendent, COL. E. A. L. ROBERTS, Titusville, Pa.

TRUSTEES: Walter B. Roberts, Wm. H. Dwinelle, M. D., A. G. Trask, Erastus Titus, Gilbert Dean, Wm. S. Fogg, Erastus Titus, Jr., Wm. H. Akin, James W. Simonton, Wm. H. Chapman, E. A. L. Roberts.

About the time the Woodin Well was struck (1866,) the wells of the region had materially decreased, and but little oil was produced. There was a general apprehension that the territory had been drained and would soon be quite exhausted, unless new belts were discovered. But the application of torpedoes immediately effected a revolution, and during the summer of 1867, the wells on Oil Creek were increased several thousand barrels. Immediately thereafter Col. ROBERTS introduced nitro-glycerine as an explosive for his torpedoes, and established a manufactory near Titusville, and during the last year (1872,) some twenty-five tons of this compound were used for this purpose alone.

The developments of Tidioute, Shamburg and other districts followed the operations of 1866, and the employment of torpedoes continued with the same striking success. And it may be safely stated that up to the present time nearly one-third of the oil production has been dependent upon the use of this invention.

In the summer of 1866, infringements commenced by different parties throughout the oil region, and suits were instituted by Col. R. against the parties and injunctions granted. In 1868, the Reed

Torpedo Company was organized, with several oil operators at its head, for the purpose of infringing and breaking down the Roberts patent. Suits were commenced by Col. R. against all parties and carried to a final hearing before Judge Grier of Philadelphia, and decisions given in favor of Roberts, and judgments rendered to the amount of about $10,000. Numerous other suits were commenced and final judgment rendered, among which was one against James Dickey, which was tried before Justices Strong and McKennan in Washington, in January, 1871. An elaborate opinion was rendered in this case in favor of Roberts. The case was regarded with great interest in the oil region, from the magnitude of the considerations involved, and the newspaper controversies upon the subject. Since the great Rubber suits, no patent-suit has elicited more general attention, involved so important considerations, or its termination more anxiously awaited. The sum of $50,000 had been subscribed among the producers, for the purpose of breaking down the Roberts Patent, and such a result was looked for with entire confidence. Few cases have ever enlisted higher professional ability, or been more earnestly contested. Messrs. Bakewell and Christy, of Pittsburgh, and George Harding of Philadelphia, conducted the case for Roberts, and Messrs. Kellar and Blake, of New York, were employed by the oil producing interest, for the defence. The decision was rendered in May, 1871, and was in favor of Roberts. It was made the occasion of a very elaborate and exhaustive opinion, which, as a matter of course, was received with general disapprobation on the part of the producers, and occasioned great disappointment.

Very many suits have since been brought for infringements, and over $100,000 have been expended by the inventor in protecting his legal rights. Thus far the Courts have uniformly sustained the Roberts patent.

TAB B

(Hydraulic Fracturing, Unlocking America's Natural Gas Resources)

Hydraulic Fracturing

Unlocking America's Natural Gas Resources

America's Oil and Natural Gas Industry

August 2017

For the latest report, please visit www.api.org/hydraulicfracturing and http://www.hydraulicfracturing.com

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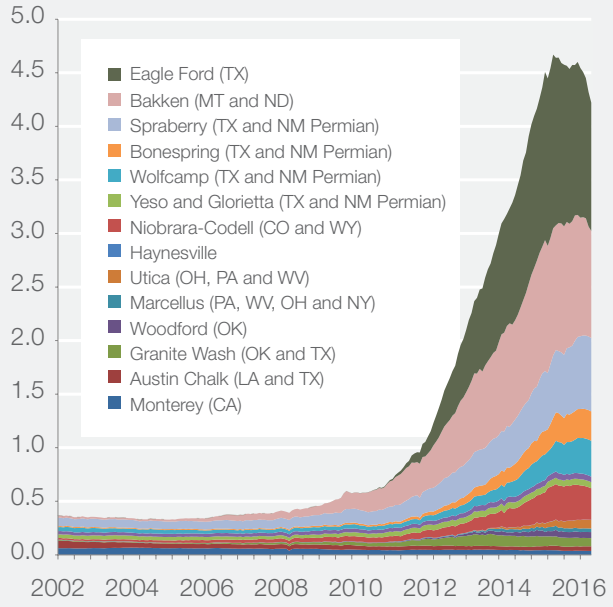
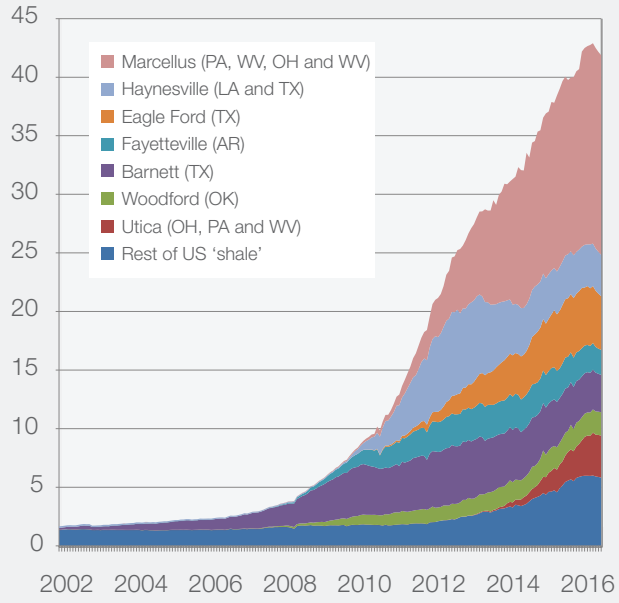
What is Fracking?

Hydraulic fracturing and horizontal drilling are safely unlocking vast U.S. reserves of oil and natural gas found in shale and other tight-rock formations. Developing energy from shale is an advanced process that uses the latest drilling technologies and equipment. As for what fracking means to the United States – the answers, are security, economic growth and jobs, jobs, jobs.

Energy and Opportunity

This change is driven by production from unconventional reserves using fracking and horizontal drilling.





The link between hydraulic fracturing and U.S. global leadership in oil and natural gas production is direct: Without fracking, there'd be no American energy renaissance – or the array of benefits it is providing to our economy, to individual households, U.S. manufacturers and other businesses. Modern hydraulic fracturing – fracking has been used commercially for nearly 70 years – is the technological engine behind surging U.S. oil and natural gas output. According to the U.S. Energy Department, up to 95 percent[1] of new wells drilled today are hydraulically fractured, accounting for two-thirds[2] of total U.S. marketed natural gas production and about half[3] of U.S. crude oil production.

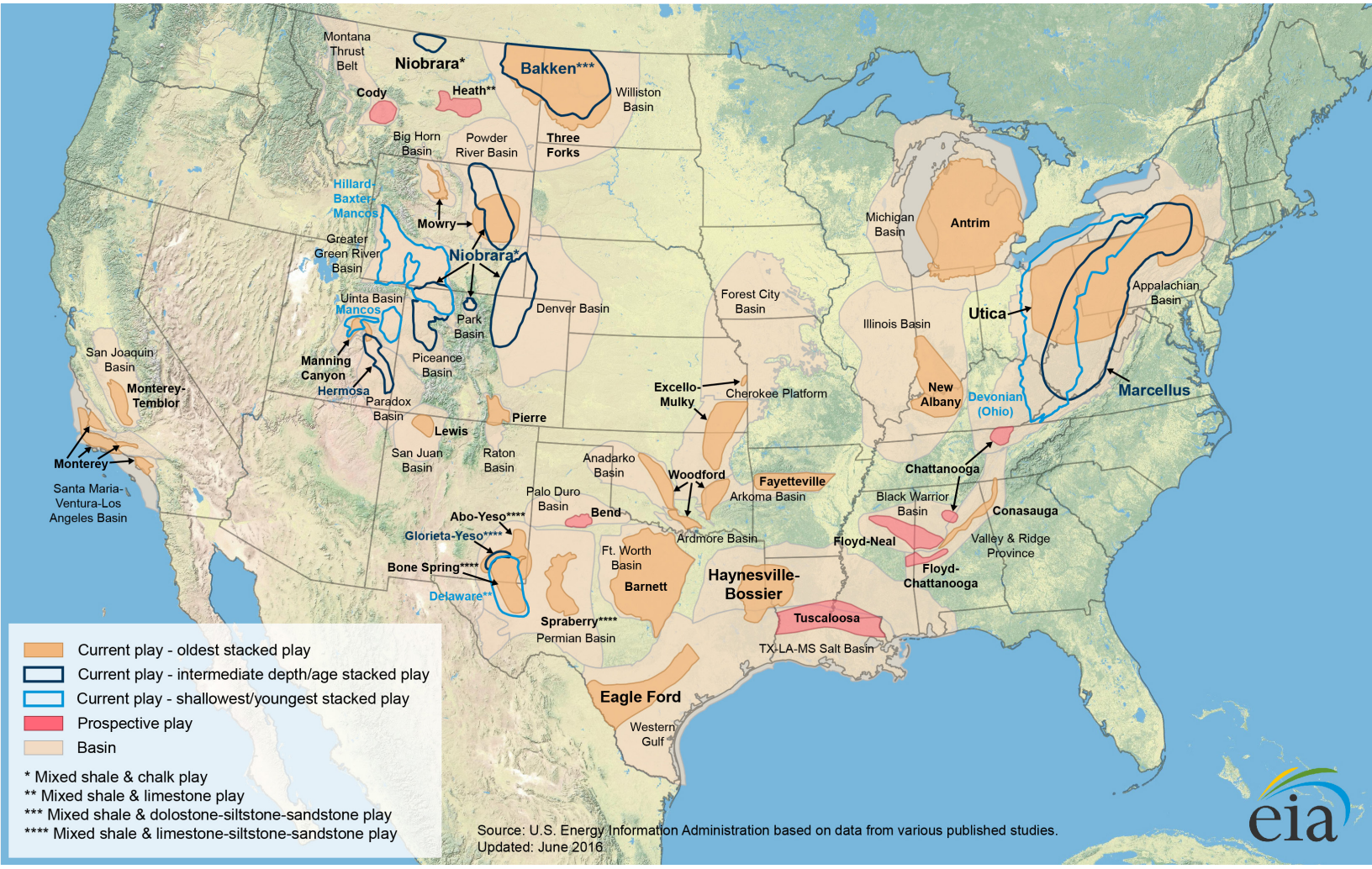
Modern hydraulic fracturing combined with horizontal drilling allows multiple wells to be drilled from one spot, reducing the size of the drilling area above ground by as much as 90 percent.[4] Fracking is the key to unlocking vast U.S. shale resources, freeing up oil and natural gas that previously was inaccessible while protecting groundwater supplies and the environment. America's shale energy revolution is privately financed and technologically driven. It's also an economic dynamo; shale natural gas and oil projects in just one region, the Marcellus shale, were responsible for more than 72 million man hours[5] of direct and indirect labor construction hours from 2008 through the first half of 2014. By helping to lower power and materials costs, as well as stimulating economic activity for a variety of businesses like service and supply companies, fracking has supported growth across an economy that has struggled in recent years.

Hydraulic fracturing is a modern technology, safely and responsibly developing vast reserves of oil and natural gas from shale and other tight-rock formations. It's the backbone of an energy renaissance that's making the U.S. more prosperous and safer in the world today. The combination of industry standards, best practices and effective state and federal regulation is protecting communities and the environment – while making available increasing volumes of cleaner-burning natural gas that is allowing the U.S. to lead the world in reducing carbon emissions from electricity generation.

1. U.S. DOE, Energy Secretary Ernest Moniz's Statement to the Senate Committee on Appropriations on Driving Innovation through Federal Investments, April 29, 2014, accessed April 18, 2017, https://energy.gov/articles/energy-secretary-ernest-monizs-statement-senate-committee-appropriations-driving-innovation.
2. U.S. EIA, Today in Energy, May 5, 2016, accessed April 18, 2017, https://www.eia.gov/todayinenergy/detail.php?id=26112.
3. U.S. EIA, Today in Energy, March 15, 2016, accessed April 18, 2017, https://www.eia.gov/todayinenergy/detail.php?id=25372.
4. API, Reducing Surface Footprint with Horizontal Drilling, accessed April 18, 2017, http://www.api.org/~/media/Files/Policy/Hydraulic_Fracturing/API-Footprint-Infographic.pdf.
5. Public News Service, 72 Million Man-Hours of Work in Marcellus Construction Since 2008, accessed May 18, 2017, http://www.publicnewsservice.org/2014-12-05/livable-wages-working-families/72-million-man-hours-of-work-in-marcellus-construction-since-2008/a43283-1.

Shale Plays in the Lower 48 States

"More than 4 million oil and gas related wells have been drilled in the United States since development of these energy resources began nearly 150 years ago. At least 2 million of these have been hydraulically fracture-treated, and up to 95 percent of new wells drilled today are hydraulically fractured, accounting for more than 43 percent of total U.S. oil production and 67 percent of natural gas production." —U.S. Department of Energy, 2013[6]



"Hydraulic fracturing has been used in the oil and natural gas industry since the 1940s, producing more than 700 trillion cubic feet of natural gas and 15 billion barrels of oil since the practice began.[7,8] Used with modern horizontal drilling technology, fracking has unlocked vast U.S. shale reserves, launching a renaissance in oil and natural gas production, creating millions of jobs and generating economic growth. Without these advanced technologies, we would lose approximately half of our domestic oil and natural gas production, crippling our energy revolution.

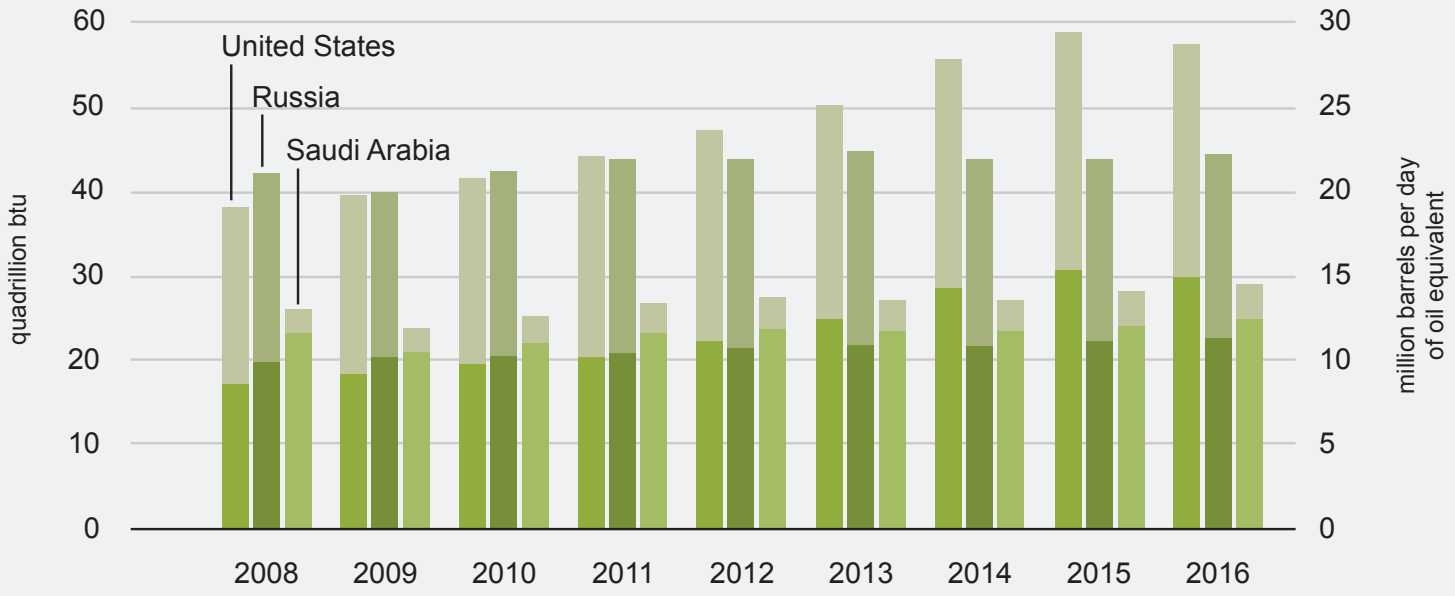
The U.S. Energy Information Agency (EIA) reports that over 1,300 trillion cubic feet of technically recoverable shale and tight natural gas and 89 billion barrels[9] of technically recoverable shale oil resources currently exist in discovered shale and tight sandstone plays. Responsibly developing these resources creates jobs and fuels our economy.

"America has abundant natural resources and recent innovations combined with horizontal drilling in shale formations has unlocked vast new supplies of natural gas, allowing the nation to get to the energy it needs today, and transforming our energy future." —Daniel Yergin, IHS vice chairman

6. U.S. Department of Energy, How is Shale Gas Produced?, Accessed April 18, 2017, https://energy.gov/sites/prod/files/2013/04/f0/how_is_shale_gas_produced.pdf
7. National Petroleum Council, Hydraulic Fracturing: Technology and Practices Addressing Hydraulic Fracturing and Completions, Paper #2-29, September 2011, accessed May 18, 2017, https://www.npc.org/Prudent_Development-Topic_Papers/2-29_Hydro_Frack_Technology_Paper.pdf.
8. EIA data for 2011 to 2016.
9. EIA, Annual Energy Outlook Assumptions, Chapter 9. Oil and Gas Supply Module, January 2017, accessed May 18, 2017, https://www.eia.gov/outlooks/aeo/assumptions/pdf/oilgas.pdf.

Securing Our Energy

Estimated Petroleum and Natural Gas Hydrocarbon Production in Selected Countries



Source: EIA.

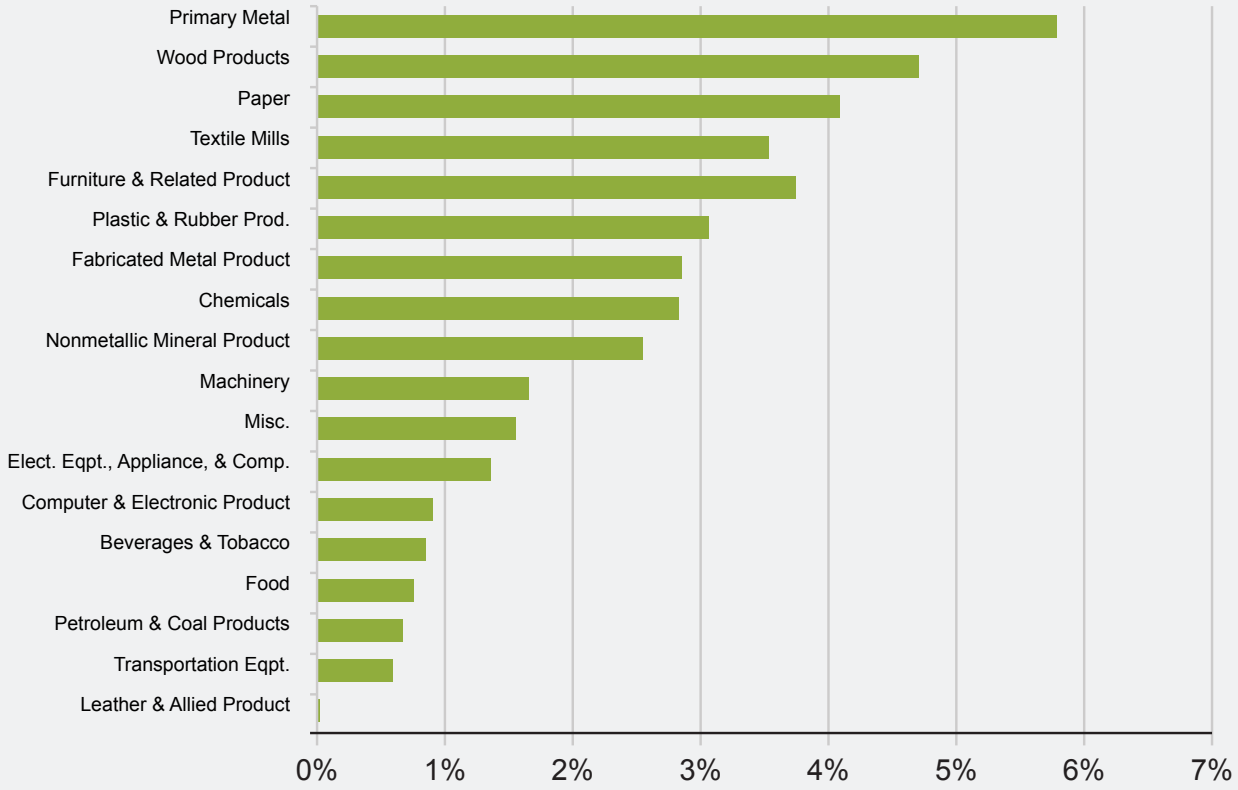
According to EIA estimates, in 2016 the United States was the world's largest producer of petroleum and natural gas hydrocarbons. For this we can thank hydraulic fracturing. Fracking has unlocked vast reserves of shale and other tight-rock formations to produce an American energy renaissance that has seen a dramatic lowering of oil imports, while shifting America from needing to import natural gas to potentially rank as one of the world's leading natural gas exporters.

As a U.S. State Department official put it: "…the U.S. will be a reliable, market-based supplier to global markets. And that's not only good for our energy security. It's good for the energy security of our partners and allies around the world.

"Every barrel of oil or cubic foot of natural gas that we produce at home instead of importing from abroad means … More jobs … Faster growth … A lower trade deficit." —Jason Furman, Chairman of the Council of Economic Advisers and Gene Sperling, Director of the National Economic Council

Jobs and the Economy

Percent Increase in Manufacturing Sector Employment from Higher Natural Gas Supply
(Average 2013-2015)



Source: IHS.

"Expanded energy access generated by the shale boom added 1.9 million jobs in 2015 alone, and demand for these resources, driven in part by new investments in manufacturing, is expected to grow by 40 percent over the next decade." —National Association of Manufacturers

According to a 2016 report from IHS Economics:

- Natural gas access contributed to 1.9 million jobs economy-wide in 2015.
- Shale gas put an extra $1,337 back in the pocket of the average American family.
- New natural gas transmission lines meant more than 347,000 jobs, with nearly 60,000 in manufacturing.
- Total natural gas demand is poised to increase by 40 percent over the next decade. Key drivers will be manufacturing and power generation.
- U.S. supply is expected to increase by 48 percent over the next decade to meet new demand.
- Because energy innovation is lowering production costs, IHS expects energy-intensive industries such as chemicals, metals, food and refining to outperform the U.S. economy as a whole through 2025.
- Shale gas production has created new flow patterns that are causing existing pipelines to reverse flow and will necessitate the construction of new pipeline capacity.

With the right policies, strong industry standards and effective state oversight, the job growth and American energy leadership can continue as we safely and responsibly build on the ongoing shale energy revolution.

What they are Saying

Former EPA Administrator Gina McCarthy
"We did say we did not have evidence of widespread systemic impacts on DW. We did clearly identify that there are potential mechanisms in the water system where impacts could occur, but also opportunities for offsetting those by taking the right preventative measures (right way to construct a well). "
Q&A of the House E&C Hearing.

Former Energy Undersecretary David Garman
"We are in the midst of a great policy reset. Our energy policy heretofore had been based on scarcity is now confronting tremendous abundance. The shale gas boom … is cause for a tremendous celebration."

Bryan Burrough, New York Times
"One could argue that, except for the Internet, the most important technological advance of the last two decades has been hydraulic fracturing, widely known as fracking. Practically overnight, it seems, this drilling technique has produced so much oil and gas beneath American soil that we are at the brink of something once thought unattainable: true energy independence."

Dan Tormey, Hydrologist, Geochemist, Civil Engineer
"The oil and gas development that's been facilitated by these new technologies – hydraulic fracturing, horizontal drilling, the ability to precisely locate within the (geologic) formation where you're drawing from – has brought undeniable benefits to the United States."

Former Interior Secretary Sally Jewell
"The Bakken boom is a perfect example of how new and improved technology is allowing industry to tap previously inaccessible or unknown energy resources to create jobs, decrease our dependence on foreign oil and grow our economy. … Working hand in hand with industry, we have an opportunity to use innovative technologies to capture natural gas to power more homes with cleaner American-made energy, while reducing methane emissions and cutting carbon pollution."

The California Council on Science and Technology
"There are no publicly reported instances of potable water contamination from subsurface releases in California… Well stimulation technologies, as currently practiced in California, do not result in a significant increase in seismic hazard… Overall, in California, for industry practice of today, the direct environmental impacts of well stimulation practice appear to be relatively limited." – July 2016 CCST Independent Report: Advanced Well Stinulation Technologies in California

U.S. Energy Information Administration
"Recent U.S. production growth has centered largely in a few key regions and has been driven by advances in the application of horizontal drilling and hydraulic fracturing technologies."

USGS
A new U.S. Geological Survey study shows that unconventional oil and gas production in some areas of Arkansas, Louisiana, and Texas is not currently a significant source of methane or benzene to drinking water wells. These production areas include the Eagle Ford, Fayetteville, and Haynesville shale formations, which are some of the largest sources of natural gas in the country and have trillions of cubic feet of gas. – May 31, 2017, USGS Study: Unconventional Oil and Gas Production Not Currently Affecting Drinking Water Quality

Process, Safety, and the Environment

The members of the American Petroleum Institute are dedicated to continuous efforts to improve the compatibility of our operations with the environment while economically developing energy resources and supplying high quality products and services to consumers. We recognize our responsibility to work with the public, the government, and others to develop and to use natural resources in an environmentally sound manner while protecting the health and safety of our employees and the public.

Industry Standards

Existing regulations covering well design requirements and hydraulic fracturing operations are specifically formulated to protect groundwater.

RP100-1 Well Integrity and Fracture Containment

RP 51R Environmental Protection for Onshore Oil and Gas production Operations and Leases

RP100-2 Managing Environmental Aspects Associated with Exploration and Production Operations Including Hydraulic Fracturing

STD 65-2 Isolating Potential Flow Zones During Well Construction

Bull 100-3 Community Engagement Guidelines

INDUSTRY PRACTICES

API's ongoing workshop series "Commitment to Excellence in Hydraulic Fracturing" is one of the tools that the oil and natural gas industry uses to reinforce with regulators, remind lawmakers and educate the public on industry's commitment to and leadership on safety, health, and environmental protection. Recently in 2016, an updated version of the workshops included our revised standards related to hydraulic fracturing. This series builds on the original 2011-2012 outreach series, which focused on API's hydraulic fracturing series of industry guidance documents. The workshop presentations have been archived and are available for the public and others to view. They can be seen on the Hydraulic Fracturing section of API's website.

Safety is a core value of the oil and natural gas industry. Safety has continued to grow since the advent of hydraulic fracturing and horizontal drilling, bringing energy development to more and more areas across the country. Existing industry standards, best practices and existing regulations are minimizing emissions and protecting the health of American families and workers.

Standards provide the framework for securing and advancing safety. They guide industry in protecting the personal safety of workers as they deal with task-specific hazards, and they establish process safety measures, covering the equipment, procedures, and training concerned with avoiding major events. Importantly, safety standards also safeguard public health and the environment, ensuring that communities and habitats surrounding industry sites across the country thrive.

API has been the industry leader in developing standards since 1924. The API Standards Program is accredited by the American National Standards Institute (ANSI), the same body that accredits programs at several national laboratories, and these standards are developed by the best and brightest technical experts from government, academia, and industry.

Working through API's globally recognized standards program the industry has developed and adopted standards and practices specific to hydraulic fracturing. This includes API Standard 65 Part 2 (overseeing cementing and well construction practices) and API's Recommended Practice 100-2 (providing proven practices for planning and operating wells, and managing environmental aspects through the life of the well), two of hundreds of API standards and recommended practices cited by several federal agencies and state regulatory bodies.

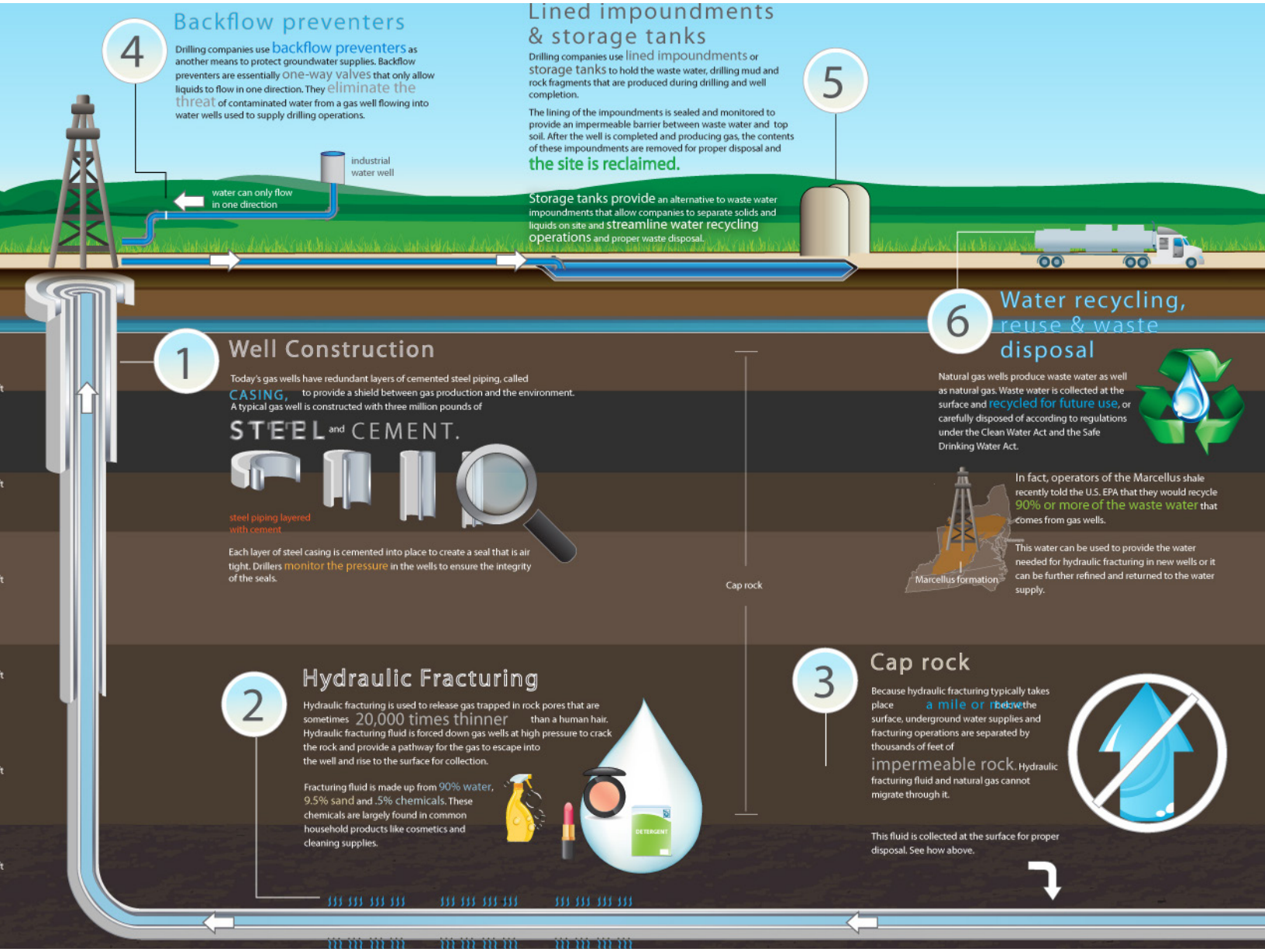
This combination of existing industry standards, best practices and effective state and federal regulation is protecting communities and the environment – while safely making available increasing volumes of cleaner-burning natural gas that is allowing the U.S. to lead the world in natural gas and oil production at the same time that the nation is a global leader in reducing carbon emissions from electricity generation.

There are 130 API standards referenced in more than 430 citations by government agencies, including Bureau of Safety and Environmental Enforcement, the U.S. Coast Guard, Environmental Protection Agency, the Federal Trade Commission, the Pipeline and Hazardous Materials Safety Administration and the Occupational Safety and Health Administration. Furthermore, there are 4,130 references in state regulations to more than 240 API standards – the most widely referenced petroleum industry standards used by state regulators.

Industry also works closely with STRONGER, a non-profit multi-stakeholder organization that helps states formulate robust environmental regulations associated with oil and natural gas development, based on a detailed review and lessons learned/improvement process.

The Drilling Process

There have been no confirmed cases of groundwater contamination from hydraulic fracturing itself in the at least 2 million wells fracked over the past 65+ years..



Developing energy from shale (and other tight-rock formations) using hydraulic fracturing and horizontal drilling takes four to eight weeks – from preparing the site for development to production itself – after which the well can be in production up to 40 years.[10] A well can be a mile or more deep and thousands of feet below groundwater zones vertically, before gradually turning horizontal. The horizontal portion then can stretch more than 6,000 feet. A single well site can accommodate numerous wells. Steel pipe known as surface casing is cemented into place at the uppermost portion of a well to protect the groundwater.

As the well is drilled deeper, additional casing is installed to isolate the formation(s) from which oil or natural gas is to be produced, further protecting groundwater from the producing formations in the well. Numerous protective measures are in place at well sites, including liners under well pads, rubber composite mats under rigs, storage tanks with secondary containment measures, and barriers to control any potential runoff.

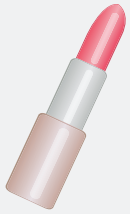
10. Encana, Drilling and Completions Fact Sheet, accessed May 18, 2017, https://www.encana.com/pdf/sustainability/2016/drilling-completions-fact-sheet.pdf.

Fracking Fluid

The fracturing mixture consists primarily of fresh water mixed with some sand and a small proportion of common chemicals.

Table salt

Laundry detergent

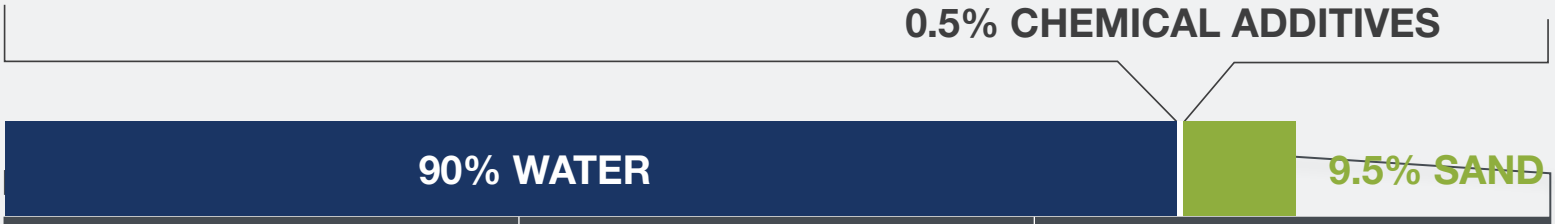


Thickener in cosmetics

Washing soda, detergent, soap

Food additive

Deodorant



Compound	Purpose	Common Application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Sodium Chloride	Allows a delayed breakdown of the gel polymer chains	Table salt
Polyacrylamide	Minimizes the friction between fluid and pipe	Water treatment, soil conditioner
Ethylene Glycol	Prevents scale deposits in the pipe	Automotive anti-freeze, deicing agent, household cleaners
Borate Salts	Maintains fluid viscosity as temperature increases	Laundry detergent, hand soap, cosmetics
Sodium/Potassium Carbonate	Maintains effectiveness of other components, such as crosslinkers	Washing soda, detergent, soap, water softener, glass, ceramics
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant, sterilization of medical and dental equipment
Guar Gum	Thickens the water to suspend the sand	Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces
Citric Acid	Prevents precipitation of metal oxides	Additive in food and beverages
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, hair coloring

Source: DOE, GWPC: Modern Gas Shale Development in the United States: A Primer (2009).

After the wells on a pad are drilled, cased and cemented, a device perforates the horizontal part of the production pipe to make small holes in the casing, exposing the wellbore to the shale. Then a mixture, commonly known as fracking fluid, of water (90 percent), sand (9.5 percent) and chemicals (0.5 percent) is pumped into the well under high pressure to create micro-fractures in the shale and free the natural gas or oil.

The sand in fracking fluid keeps the fractures open after the pressure is released, and the chemicals are chiefly agents to reduce friction and prevent corrosion.

The FracFocus.org chemical disclosure registry provides information on hydraulic fracturing fluid used in over 117,600 wells. Industry activity is subject to a number of federal and state laws, including the Safe Drinking Water Act, the Clean Water Act, the Clean Air Act and the National Environmental Policy Act.

State Regulation

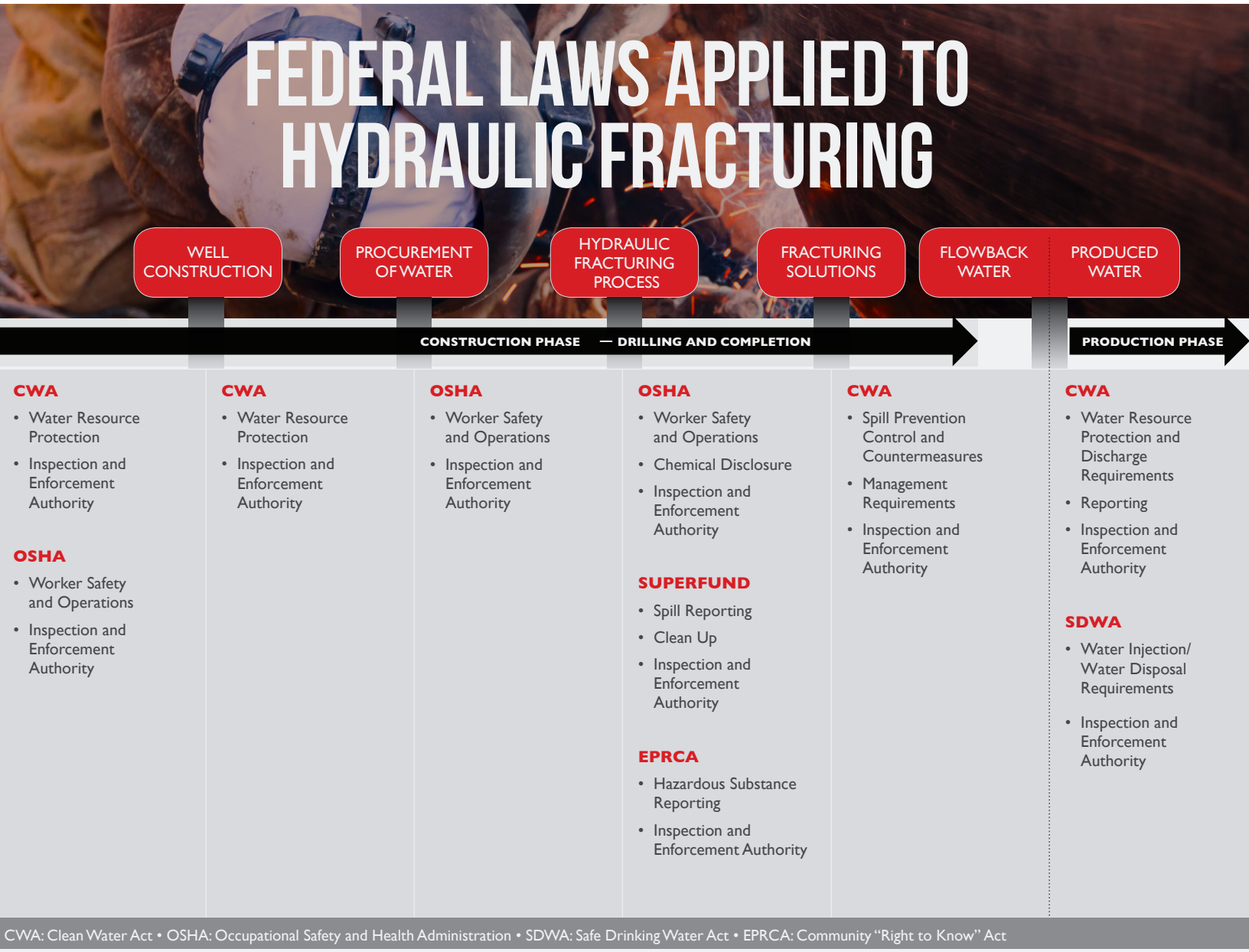
in STATE regulations

by GOVERNMENT agencies like the Coast Guard, EPA and FTC

in BSEE's OFFSHORE regulations

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

Effective hydraulic fracturing regulation can only be achieved at the state level as state regulations can be tailored to geological and local needs. Key state regulations include: Review and approval of permits; well design, location and spacing; drilling operations; water management and disposal; air emissions; wildlife impacts; surface disturbance; worker health and safety; and inspection and enforcement of day-to-day oil and gas operations. Impacts can be avoided or mitigated with proper practices.



Source http://energyindepth.org/wp-content/uploads/2009/03/Federal-Hydraulic-Fracturing-Process.pdf

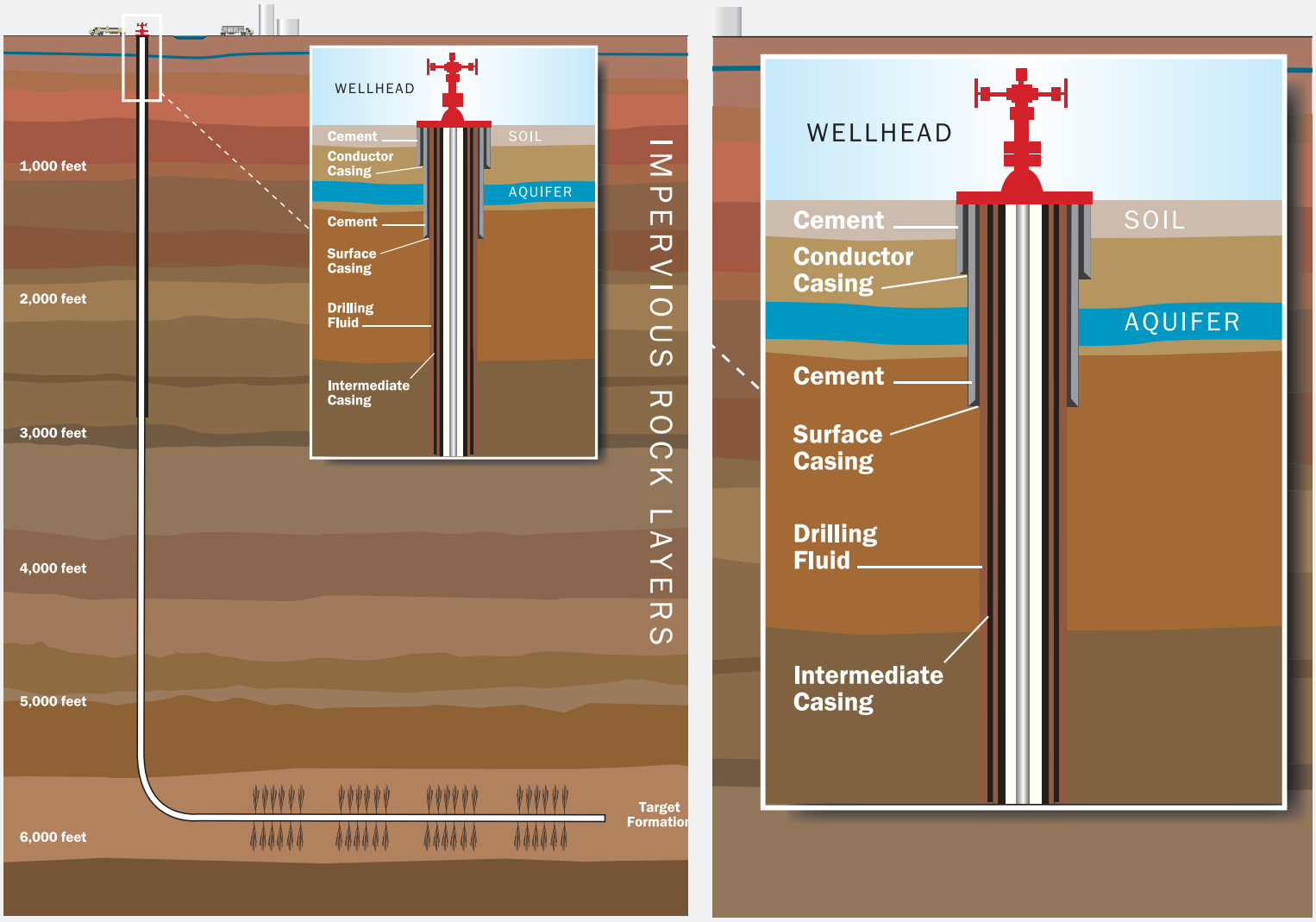
Federal regulations provide a broad regulatory foundation for energy development in the United States, including hydraulic fracturing. Key regulations governing shale development include: Clean Water Act; Clean Air Act; Safe Drinking Water Act; National Environmental Policy Act; Resource Conservation and Recovery Act; Emergency Planning and Community Right to Know Act; Endangered Species Act and the Occupational Safety and Health Act.

Federal land managers, such as the Bureau of Land Management (BLM), the U.S. Forest Service (USFS), and the U.S. Fish and Wildlife Service (USFWS) have some oversight of oil and gas activities on the lands they manage. This includes conducting environmental impact studies, scientific research to help with management options and decisions, and enforcing environmental protections.

The federal government should not use direct or indirect means to limit the innovations that have safely launched an energy revolution in the United States while reducing the environmental impacts of energy production.

Groundwater Protection

Proper well construction provides groundwater protection.



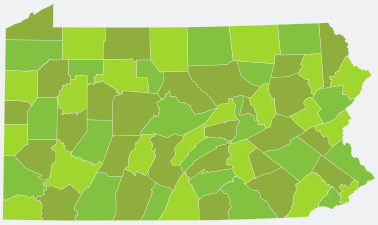
Source: http://www.api.org/~/media/Files/Policy/Exploration/HYDRAULIC_FRACT_ILLUSTRATION_121609.pdf

The key to protecting groundwater is proper well construction, and the oil and gas industry has developed detailed standards for this based on field experience and significant advances in drilling and construction techniques. In fact, there have been no confirmed cases of groundwater contamination from hydraulic fracturing itself in the at least 2 million wells fracked over the past 68 years.[11]

A typical natural gas well uses 3 million pounds of steel and cement. Each layer of steel casing is cemented in place to create an air-tight seal. Alternating layers of cement and steel casings are designed to ensure well integrity as it passes through groundwater levels thousands of feet down to the energy-holding layers of rock.

11. Lisa Jackson on camera as EPA Administrator, (Minute 1:01), https://www.youtube.com/watch?v=_tBUTHB_7Cs&feature=youtu.be.

Water Use and Conservation



PENNSYLVANIA

Annual Water Usage Example

1.42 BILLION GALLONS PER DAY

PUBLIC WATER SUPPLY

6.43 BILLION GALLONS PER DAY

THERMOELECTRIC POWER

61.8 MILLION GALLONS PER DAY

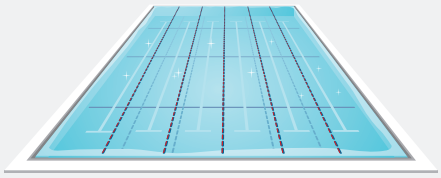
LIVESTOCK

24.3 MILLION GALLONS PER DAY

IRRIGATION

SITE LEVEL

The amount of water used during hydraulic fracturing for one well is typically the equivalent of the volume of three to six Olympic sized swimming pools



EACH AMERICAN GOLF COURSE USES MORE THAN **4 MILLION GALLONS OF WATER** PER SUMMER MONTH

Sources: U.S. Geological Survey Circular 1344. 52p. and Marcellus Shale Development Water Use: June 1, 2008 - May 21, 2010; Energy In Depth, October 8, 2012; Aboutnaturalgas.com

The industry understands that water is a valuable natural resource and is mindful of the amount of water needed for the hydraulic fracturing process. There are three main categories in which gas and oil companies' water conservation efforts generally fall; using lower quality water from nontraditional sources, reusing produced water and creating new infrastructure to transport water.

Corporate activities can vary widely depending on a variety of factors, including local water stresses, individual business needs and even the particular requirements of specific geologic formations.

Water Treatment Technologies

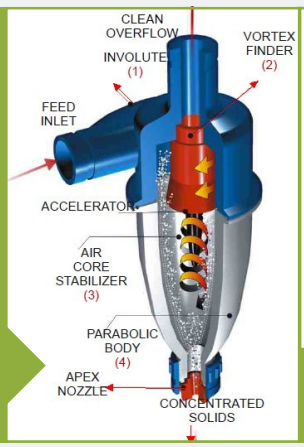
1.Chemicals

2.Ozone Oxidation

5. Deionization

3. Nano-filtration

4. Hydrocyclones



6. UV

MVR Evaporator, RO, EC…and many more

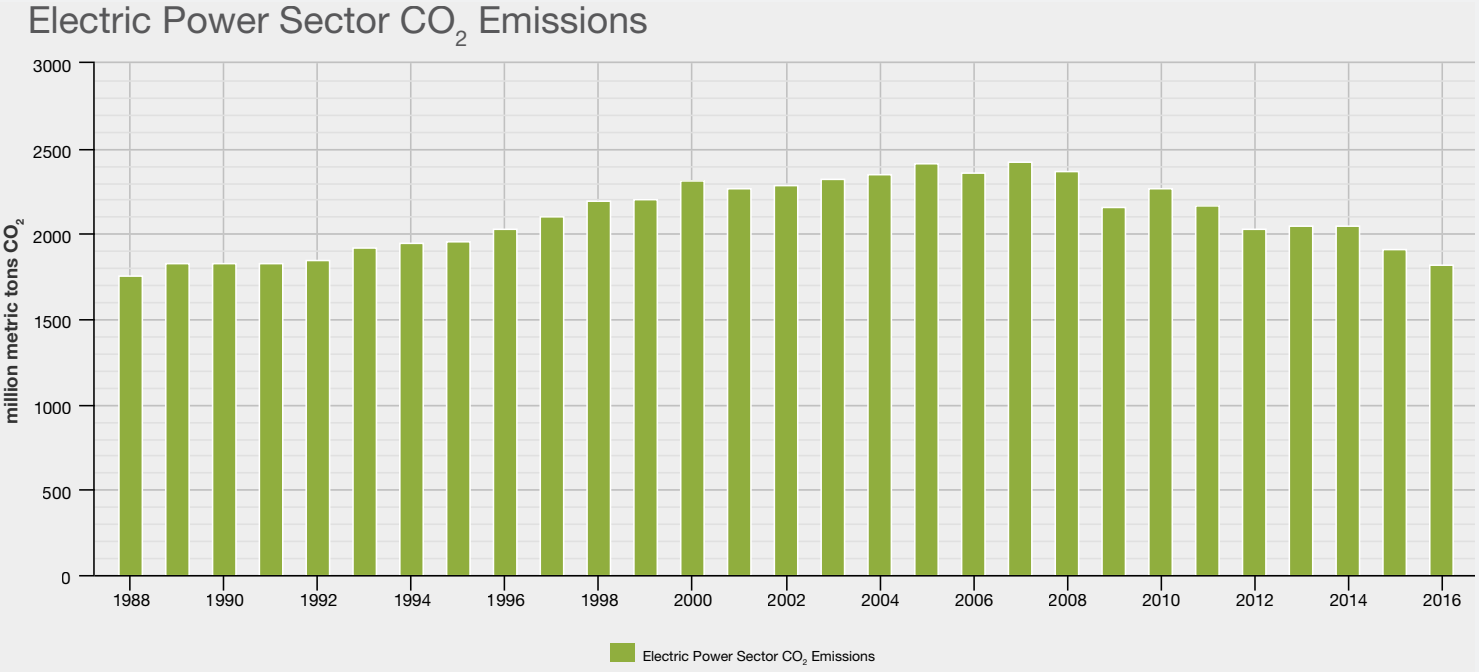
Sources: http://www.apachecorp.com/index.aspx

Innovations in water treatment allow companies to use many different types of water in their production activities. Common sources include surface water, groundwater and municipal water of varying qualities. In addition, companies are diligent about capturing water produced during the exploration and production process, and new water technologies and sophisticated fracturing chemistries help companies make use of this water more frequently as well.

Between 2010 and 2015 in Pennsylvania alone, wastewater reuse increased from 2.6 to over 22 million bbl/yr. Since 2010, Pennsylvania's wastewater recycling increased from 4.6 to over 7.8 million bbl/yr. According to the Penn State Marcellus Center for Outreach and Research, during the first half of 2013 in the Marcellus shale play, 90 percent of the more than 14 million barrels of produced fluids from fracturing was reused.[12] That represents a significant savings in the amount of new water needed for hydraulic fracturing elsewhere, and illustrates the industry's focus on environmental issues and efforts to reduce the impacts of energy development on resources and communities.

12. Business Wire, Ben Franklin's SGICC Releases Updated Study Summarizing Shale Gas Wastewater Treatment and Disposal in Pennsylvania in 2014, August 26, 2015, accessed July 17, 2017, available at: http://www.businesswire.com/news/home/20150826005673/en/Ben-Franklin%E2%80%99s-SGICC-Releases-Updated-Study-Summarizing#.Vd-YlfIViko.

Air Emissions



Source: IEA, U.S. EPA, ExxonMobil and WRI. All leakage rates, except ExxonMobil's are based on estimates and empirical; Exxon's leakage rates include actual measured data from some production and gathering operations in the Marcellus; EPA estimates are computed based on gross production reported from the EIA.Aboutnaturalgas.com

Thanks to increased use of natural gas, U.S. energy related emissions of CO_2 from power generation are at their lowest point in nearly 30 years.[13] The environmental benefits associated with natural gas go well beyond CO_2 reductions. Greater use of natural gas in power generation will also reduce NO_x, SO_2, PM, acid gasses, Hg and non-Hg heavy metal emissions.

Behind this is an industry investment of more than $321 billion that has improved the environmental performance of its products, facilities and operations between 1990 and 2015 – roughly $996 for every man, woman and child in the United States.[14]

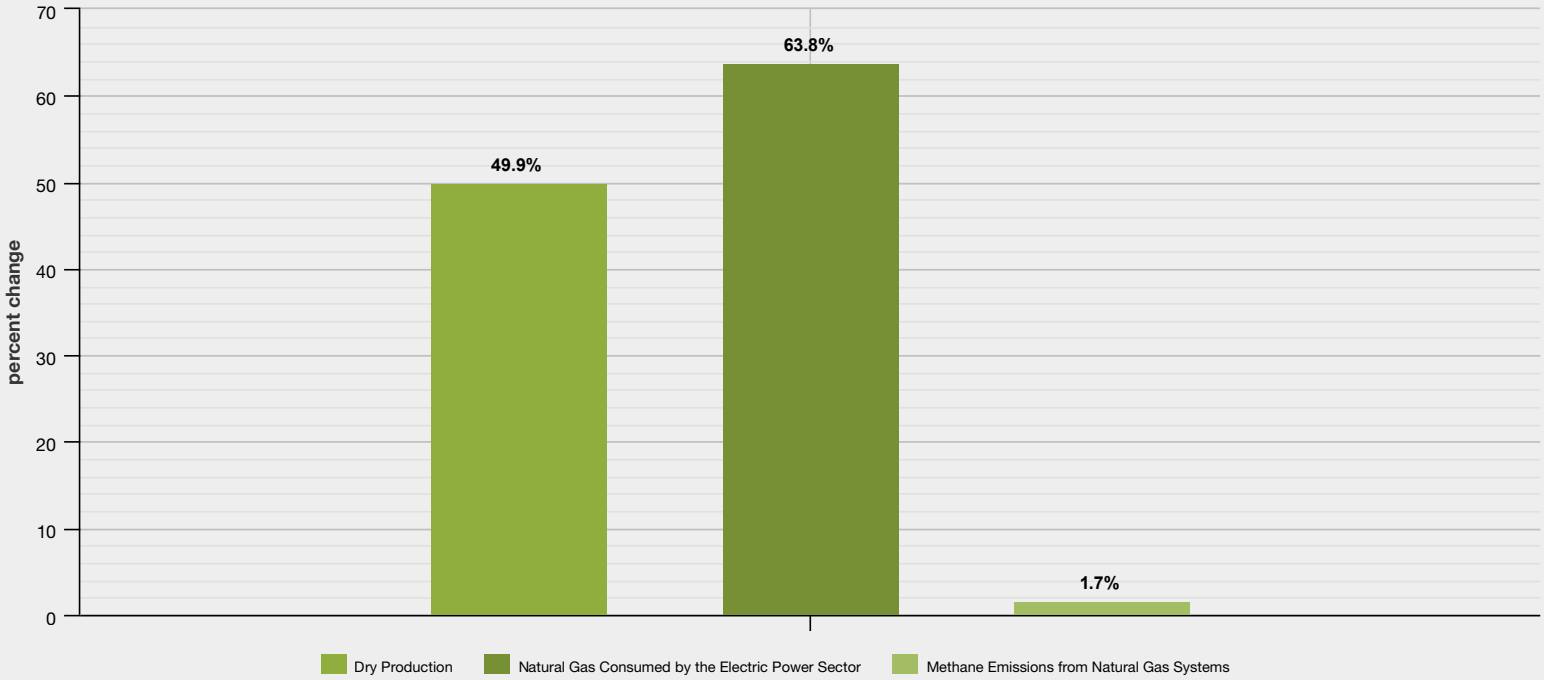
One area where industry continues to build on this success is through the development and implementation of new technologies to reduce methane released during production. For example, all new natural gas wells are required to include green completions measures to reduce emissions. Additional new requirements also will impact tanks, pneumatic devices, leak detection and leak control. EPA's current inventory estimates show the methane leakage rate for natural gas systems was 1.25 percent in 2015.[15]

Industry measures are working. The EPA recently reports that methane emissions from hydraulically fractured natural gas wells have fallen nearly 65% between 2012 and 2015.[16]

13. U.S. EIA, Monthly Energy Review, June 2017. Lowest since 1988.
14. API, "Environmental Expenditures by the U.S. Oil and Natural Gas Industry." December, 2016. http://www.api.org/~/media/Files/Publications/Environmental-Expenditures-2016.pdf
15. U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015, April, 2017; U.S. DOE, EIA, Monthly Energy Review, June 2017, 1990-2015, Gross withdrawals.
16. U.S. EPA, GHGRP Petroleum and Natural Gas Systems Sector Industrial Profile, https://www.epa.gov/ghgreporting/ghgrp-petroleum-and-natural-gas-systems-sector-industrial-profile

Methane Emissions

Methane Emissions Falling While Production Rises (2005-2015)



Sources: EPA, emissions data / EIA, production data

While natural gas production has risen, methane emissions have actually declined slightly thanks to the oil and natural gas industry's investment in new technologies.

Recent EPA data shows that industry initiatives to capture methane are effective. The EPA's annual draft inventory of U.S. greenhouse gas emissions report released in April shows that methane emissions from all petroleum systems decreased by over 28 percent since 1990 – including a decrease of emissions from petroleum production of around 8 percent from 2014 levels. EPA attributed this improvement to reductions in emissions from associated gas venting and flaring.

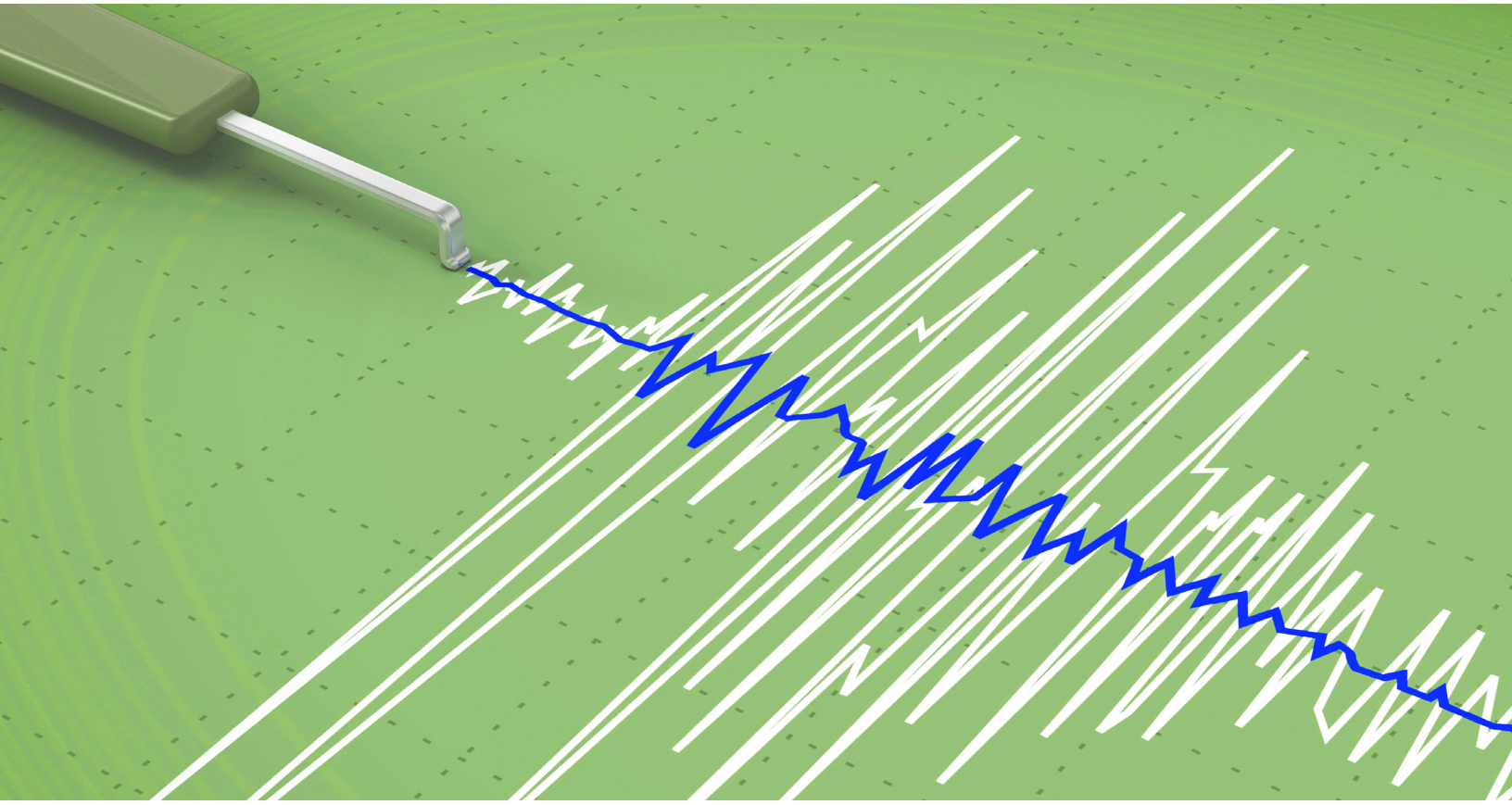
From 2005 to 2015 production of natural gas increased nearly 50 percent, while methane emissions from natural gas systems remained relatively flat, increasing by just 1.7 percent.[17] Furthermore, methane emissions from the oil and natural gas industry make up just 4 percent of total U.S. greenhouse gas emissions.[18]

17. U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015, April 2017; U.S. DOE, EIA, Monthly Energy Review, June 2017, 2005-2015, Dry Production.

18. U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015, April 2017. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks

Hydraulic Fracturing and Seismic Activity

Seismicity Associated with Wastewater Disposal Wells

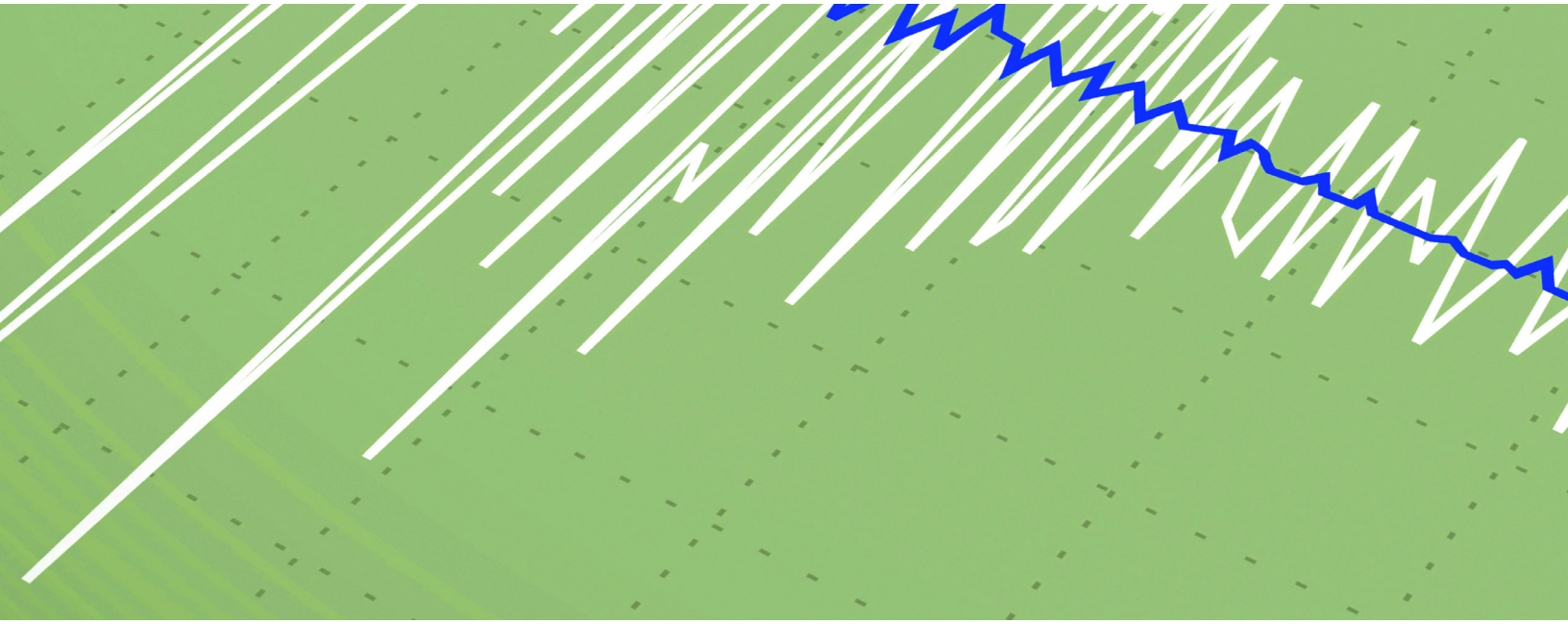


Advanced hydraulic fracturing and horizontal drilling are the technology engines driving America's ongoing energy renaissance – surging oil and natural gas production that ranks first in the world. This oil and natural gas production, enabled by hydraulic fracturing, strengthen U.S. energy security, boost the economy and lower consumer energy costs. In addition, the increased use of cleaner-burning natural gas is the main reason U.S. greenhouse gas emissions from electricity generation are at their lowest level in nearly 30 years.[19] For decades hydraulic fracturing has been used safely – thanks to proven engineering, effective industry risk management practices and standards as well as federal and state regulations.

Industry takes seriously earthquake incidents that may be associated with the disposal of produced water from energy development – salty brines and other fluids that come to the surface during oil and natural gas production. On average, about 10 barrels of brine are produced with each barrel of crude oil.[20] Once separated from the oil, brine typically is returned to the underground formation it came from (or a similar formation) via disposal wells managed under EPA Class II Underground Injection Control (UIC) regulations. In the U.S. there are roughly 35,000 active Class II wells[21] used to dispose of these fluids that are a byproduct of oil and natural gas production. These are a subset of more than 800,000 permitted UIC wells nationwide that serve the needs of many different industries and governmental entities.2[2] 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. (Hydraulic fracturing itself is not the issue here. It is understood that certain unique and limited geologic conditions combined with hydraulic

(cont)

19. EIA, Monthly Energy Review, https://www.eia.gov/totalenergy/data/monthly/.
20. Ground Water Protection Council, U.S. Produced Water Volumes and Management Practices in 2012, Page 9, April 2015, accessed May 18, 2017, http://www.gwpc.org/sites/default/files/Produced%20Water%20Report%202014-GWPC_0.pdf.
21. EPA, Class II Oil and Gas-related Injection Wells, accessed May 18, 2017, https://www.epa.gov/uic/class-ii-oil-and-gas-related-injection-wells. 20% of 180,000.
22. EPA, National Underground Injection Control Inventory-Federal Fiscal Uear 2016, accessed July 20, 2017, https://www.epa.gov/sites/production/files/2017-06/documents/state_fy_16_inventory_format_508.pdf.



fracturing may induce an earthquake felt at the surface of the earth but such events have been rare.) To evaluate the need for mitigation and management of the risk of induced seismic events, it is important to understand the science.

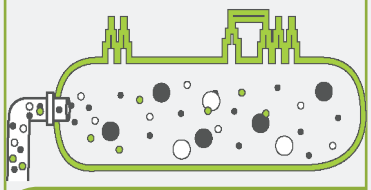
Documented since at least the 1920s, induced seismicity also has been attributed to a number of other human activities, including impoundment of large reservoirs behind dams, geothermal projects, mining extraction, construction and underground nuclear tests. In that context, the science of seismicity should be understood when discussing quake mitigation measures and/or risk management. Induced seismicity may occur when a geological fault is present and under stress. Increased pressure from fluid injection may unclamp the fault and allow slippage, resulting in surface shaking.

BOTTOM LINE: Induced seismicity is a complex issue, and the knowledge base surrounding it is rapidly changing. A one-size- fits-all approach isn't practical because of the significant differences in local geology and surface conditions – population, building conditions, infrastructure, critical facilities and seismic monitoring capabilities. As such, state regulators are best positioned to address potential issues linked to oil and gas injection wells in their state.

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 experts from government agencies, universities private consultants and industry experts on these issues. Effective planning involves identifying where there's risk of harm from a seismic event because people and property are located nearby. Again, state regulators are best able to make these assessments and plan adaptive responses in the event of a quake, such as adding seismic monitoring, adjusting injection rates and pressures, suspending injection well operations or halting injection altogether and shutting in a well.

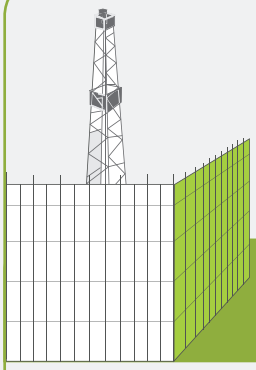
Both hydraulic fracturing and the underground disposal of produced waters from oil and natural gas operations have proven safe and environmentally reliable. Industry, academia, and government entities are clearly committed to pursuing further research to better understand the complex science and physical mechanisms associated with induced quaking events. Our companies are committed to science-based measures to reduce risk. It's an integral part of making energy development as safe as possible.

Innovations



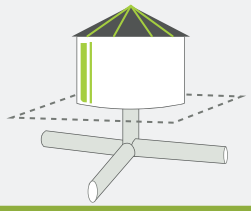
"PITLESS" DRILLING

Use of aboveground tanks for managing well fluids so that there is limited danger of well fluids getting into groundwater



SOUND CONTROL

Sound control and surface management allows for safe drilling in close proximity to people



WATER SYSTEMS

Centralized water management systems that remove trucks from roads

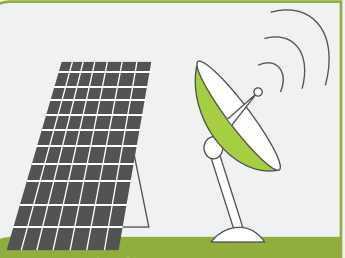
DRILLING SYSTEMS

1) Closed loop drilling systems; all drilling fluid stored in steel tanks

2) Whole site liners

"GREEN" FLUIDS

"Green" frac fluids (Example: Environmentally benign components)



SOLAR PANELS

Photovoltaic solar telemetry to transmit well date from remote locations to central office (reduces use of diesel fuels)

America's shale energy revolution is built on innovation that produced advanced hydraulic fracturing and horizontal drilling technologies and techniques. And that innovation continues, working on ways to make fracking even safer for the surrounding environment and communities. Safe and responsible drilling means site management – from multi-layer surface liners that protect the entire drilling area to closed-loop systems to maintain control of drilling fluids.

Safe operating practices and water management are just two areas for which API has developed standards to protect the environment. The shale energy surge also is spurring innovation: waterless hydraulic fracturing fluid, methods to decontaminate and recycle water used in fracking and more.

Resources

01| IHS Global: http://www.ihs.com/info/ecc/a/americas-new-energy-future.aspx

02| API Energy & Communities Report: http://www.api.org/oil-and-natural-gas/energy-primers/energy-and-communities

03| Energy Tomorrow blog posts on Public Health: http://www.energytomorrow.org/Blog?page=1&topic=public-health

04| IHS Unconventionals: http://www.api.org/~/media/Files/Policy/American-Energy/Americas_New_Energy_Future_Mfg_Renaissance_Main_Report_4Sept13.pdf

05| FracFocus: http://fracfocus.org

06| STRONGER: http://www.strongerinc.org

07| API Infographics on Pinterest - http://pin.it/L2fSo-l

08| Natural Gas Solutions: http://www.naturalgassolution.org

09| UT Methane Study: http://www.pnas.org/content/early/2013/09/10/1304880110.full.pdf+html

10| Cardno ENTRIX Study: http://www.inglewoodoilfield.com/res/docs/102012study/Hydraulic%20Fracturing%20Study%20Inglewood%20Field10102012.pdf

11| API Groundwater Protection PDF: http://www.api.org/policy-and-issues/policy-items/exploration/hydraulic-fracturing-well-construction

12| Catalyst Environmental Solutions report," SCIENTIFIC EVIDENCE IN EPA STUDY CONFIRMS SAFETY OF HYDRAULIC FRACTURING PROCESS": http://www.api.org/oil-and-natural-gas/wells-to-consumer/exploration-and-production/hydraulic-fracturing/scientific-evidence-in-epa-study-confirm

13| USGS Study, "Unconventional Oil and Gas Production Not Currently Affecting Drinking Water Quality": https://www.usgs.gov/news/unconventional-oil-and-gas-production-not-currently-affecting-drinking-water-quality

14| Hydraulic Fracturing and Seismic Activity:

- Cardno ENTRIX – Hydraulic Fracturing Study PXP Inglewood Oil Field: http://www.eenews.net/assets/2012/10/11/document_ew_01.pdf
- "The Geo-mechanical Study of Bowland Shale Seismicity": http://www.cuadrillaresources.com/news/cuadrilla-news/article/press-release-geomechanical-study/
- USGS Earthquake web site, 2012: http://earthquake.usgs.gov/learn/topics/mag_vs_int.php
- Examination of Possibly Induced Seismicity from Hydraulic Fracturing in the Eola Field, Garvin County, Oklahoma: http://www.eenews.net/assets/2011/11/02/document_pm_01.pdf
- USGS Earthquake: http://earthquake.usgs.gov/earthquakes/eqarchives/year/eqstats.php

15| EIA Shale Gas projection: http://www.eia.gov/energy_in_brief/images/charts/nat_gas_production_1990-2040-(large).jpg

16| EIA Annual Energy Outlook : https://www.eia.gov/outlooks/aeo/

17| EPA GHG Reporting Program Inventory of Greenhouse Gases: http://www.epa.gov/ghgreporting

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s/Christopher R. Nestor
Christopher R. Nestor (PA 82400)

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