BRINGING REAL INFORMATION ON ENERGY FORWARD
Economic Considerations Associated with Regulating the American Oil and Natural Gas Industry

Prepared for:

Independent Petroleum Association of America (IPAA)

and

The Liaison Committee of Cooperating Oil and Gas Associations

Prepared by:

Advanced Resources International, Incorporated

April 24, 2009

INTRODUCTION AND SUMMARY

For the last several years, a number of environmental organizations have been pursuing an aggressive campaign to push for greater federal environmental oversight over U.S. oil and natural gas exploration and production (E&P) operations. These organizations allege that a number of federal statutes and regulations allow American oil and natural gas producers to circumvent environmental requirements imposed on other industries.[1]

The American oil and natural gas industry is quite concerned that a considerably more stringent set of regulatory proposals, if implemented, could have adverse impacts on the economics of U.S. oil and natural gas E&P operations, and thus on U.S. oil and natural gas supplies, prices, and other economic considerations.[2]

This report has been developed to provide the American public with factual information on the genuine economic value American oil and natural gas development and production brings to states and local communities, and discusses the potential energy supply and economic implications associated with the imposition of considerably more stringent regulatory requirements on American oil and natural gas producers.

A companion document to this study demonstrates how regulations currently in place adequately and appropriately protect the public and the environment, and that American producers currently pursue their operations with aggressive and measured approaches to protecting the environment.

This report shows that American oil and natural gas producers provide a significant contribution to the national economy, and that U.S. oil and natural gas supplies play an important role in ensuring the nation's energy supply needs are met, both now and in the future. Moreover, it shows that American oil and natural gas production is critical to regional economic viability throughout the U.S. Many states are highly dependent on oil and natural gas production for investment capital; jobs (both direct and indirect); royalty payments to landowners; government revenues (from severance, ad valorem, and income taxes); and overall economic output.

In addition, a number of factors impacting the American oil and natural gas industry since the mid-1980s place greater pressure on the industry to maintain economic viability. These include the growing proportion of American oil and natural gas production from low-producing "marginal" wells, a growing national dependence on natural gas supplies from more difficult-to-produce "unconventional sources," and the increasing hope being placed on the use of higher cost methods for enhancing oil recovery through the injection of carbon dioxide in depleted oil reservoirs – which holds the promise, if economically viable, to both increase American oil production and provide an opportunity for permanently storing greenhouse gases.

However, if the more stringent set of regulatory proposals advocated by environmental organizations are implemented, the impact of the increased compliance costs associated with these proposals could be significant. These costs could substantially affect oil and natural gas supplies from currently producing oil and natural gas wells, as well as potential future natural gas supplies from unconventional gas resources and crude oil supplies from carbon dioxide enhanced oil recovery (CO_2-EOR). This foregone supply potential will also have significant economic impacts on the nation and on the local communities where these supplies are or would be produced.

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[1] http://www.nrdc.org/land/use/down/contents.asp

[2] See, for example, IPAA Testimony to the House Oversight and Government Reform Committee in October 2007 (http://ipaa.org/issues/testimony/IPAATestimony-HouseOversiteGovtReform10-31-2007.pdf)

ECONOMIC VALUE OF THE AMERICAN OIL AND NATURAL GAS E&P INDUSTRY

The American oil and natural gas industry provides a significant contribution to the national economy.

America's oil and natural gas industry plays an important role in ensuring the nation's energy needs are met, both now and in the future. The U.S. ranks first in the world in the number of oil and natural gas wells drilled, second in natural gas production, third in crude oil production, sixth in natural gas reserves, and 11th in crude oil reserves. According to IPAA, the oil and natural gas production sector employs over 400,000 people throughout the U.S. [3] Based on revenue from oil and natural gas production of about $243 billion in 2007, the industry paid on the order of $30 billion to landowners (both public and private) in royalties.

Moreover, according to the 2007 Joint Association Survey on Drilling Costs (JAS) published by the American Petroleum Institute, the U.S. oil and natural gas industry investment in drilling and equipping wells in the U.S. hit an all-time record high of $226 billion in 2007, more than double the previous record set in 2006.[4] These expenditures resulted in the drilling of 54,300 oil and natural gas wells (including dry holes), a 4% increase over 2006.

Nearly all of the increase in spending on drilling and completing wells between 2006 and 2007 was a result of dramatic increases in drilling costs. For oil wells, average drilling costs increased 82%, to $4 million per well in 2007, compared with $2.2 million per well in 2006. The average cost per natural gas well was $3.9 million in 2007, up 105% over 2006's $1.9 million per well. Despite higher oil and natural gas prices, these higher drilling costs put strains on the economic viability of many American oil and natural gas development and production operations.

U.S. consumers also pay considerably for crude oil and natural gas imports.

On the other hand, the U.S. imported nearly 3.7 billion barrels of oil in 2007,[5] nearly two-thirds of American consumption. At an average oil price of $72/barrel, this amounted to a $264 billion contribution to the U.S. balance-of-trade deficit. Similarly, the U.S. imported nearly 3.8 trillion cubic feet (Tcf) (net) of natural gas in 2007. At an average natural gas price of $6.87/Mcf, this added another $26 billion to the U.S. trade deficit,[6] for a total contribution of $290 billion. Further reducing the economic viability of American oil and natural gas development and production operations could inevitably lead to even greater levels of U.S. dependence on imported oil and natural gas.

Oil and natural gas production is critical to regional economic viability throughout the U.S.

Many states benefit significantly from regional oil and natural gas development and production; these states are highly dependent on oil and natural gas production for investment capital; direct and indirect jobs; payments to landowners; government revenues from severance, ad valorem, and income taxes; and overall economic output. Table 1 illustrates this significant economic contribution for ten oil and natural gas producing states. Throughout the entire value chain -- from initial development and production to end use -- income and investment related to the oil and natural gas industry are often critical components of a state's or region's economic vitality.

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[3] Independent Petroleum Association in America, *Oil and Gas Producing Industry in Your State (2007-2008),* February 2009 (http://www.ipaa.org/reports/econreports/2007-2008IPAAOPI.pdf)
[4] http://www.api.org/Newsroom/drilling_expenditure.cfm
[5] http://tonto.eia.doe.gov/dnav/pet/pet_move_impcus_a2_nus_epc0_im0_mbbl_a.htm
[6] http://www.eia.doe.gov/oiaf/aeo/

Table 1
Economic Value of the American Oil and Natural gas Industry in Selected States

		Pennsylvania	Ohio	Texas (Ft Worth area only) [2]	Louisiana [3]	Oklahoma	Colorado	North Dakota [3]	West Virginia	Alabama [5]	Kansas
Basis Year		2007	2006	2007	2006	2007	2005	2007	2006	2002	2007
Direct Econ. Output O&G E&P	**($ million)**	$4,548	$330	$3,110	$24,600	$39,790	$22,918	$3,106	n.e.		n.e.
Total Econ. Output	**($ million)**	$7,104	$1,500	$5,164	$70,200	$68,863	n.e.	$8,229	$2,500	$242	n.e.
Direct Investment in O&G E&P	**($ million)**	$4,500	$281	$2,487	n.e.	$15,200	$20,927	$804	$585		$4,500
Employment - Direct O&G E&P	**Number**	10,538	4,045	28,493	58,278	76,297	51,778	7,719	4,535	259	7,723 [1]
Employment - Total	**Number**	26,556	14,410	55,385	320,280	n.e.	188,980	46,219	15,000	812	n.e.
Industry Salaries - O&G E&P	**($ million)**	$986	$173	$1,706	$4,200	$8,883	$3,493	n.e.	$144	$13	n.e.
Royalty Payments	**($ million)**	$215	$126	$1,209	$529	$1,855 [4]	$900	$254	$235 [4]	$50 [4]	n.e.
State Prod.Tax Payments	**($ million)**	$0	$58	$165	$708	$974	$134	$250	$85	$16	$375

n.e. = not estimated

1. Estimates from IPAA, *Oil and Gas Producing Industry in your State, 2007-2008*
2. Associated exclusively with the Barnett Shale
3. Applies to the combined E&P, pipeline, and refining sectors
4. Estimated by Advanced Resources International , Inc. for this study
5. Economic impact of the coalbed methane industry only

Specific economic benefits are summarized below for individual states.

Pennsylvania. The Marcellus Shale Committee, an independent organization of oil and natural gas companies involved in developing natural gas resources of the Marcellus Shale in Pennsylvania, asked the Pennsylvania Economy League of Southwestern Pennsylvania to perform an economic impact study of the oil and natural gas industry in their state.[7] The report concludes that the oil and natural gas industry in Pennsylvania produces in excess of $7 billion in economic output annually; resulting from the direct employment, compensation and output of the oil and natural gas industry, and from the impacts of the supply and distribution chain. This includes $4.5 billion in direct investment in drilling, extraction and support activities. The industry employs over 10,500 individuals in full and part-time jobs. These employees are paid nearly $1 billion annually. In addition, for every oil and natural gas industry job, an additional 1.52 full and part-time jobs are generated. Finally, the industry pays more than $200 million annually in royalty payments to landowners across Pennsylvania, generating additional wealth in rural Pennsylvania communities.

Ohio. In 2008, the Ohio Oil and Gas Energy Education Program (OOGEEP) commissioned a study to evaluate the economic contribution of the oil and natural gas industry to the State of Ohio.[8] It shows that Ohio's oil and natural gas industry contributes over 4,000 direct and another 10,400 indirect jobs in Ohio. In 2007, the industry reinvested approximately $281 million on exploration and development, and paid nearly $58 million in state and local taxes. The industry also generated approximately $1.5 billion in Gross State Product. Ohio keeps another $1 billion per year in state by being able to buy locally produced natural gas and crude oil.

Texas (Ft. Worth Area only). A study of the impact on business activity of developing natural gas resources associated with the Barnett Shale in the area of Fort Worth, Texas concluded that this development has already contributed nearly $5.2 billion in annual output and 55,385 permanent direct and indirect jobs in the region. These effects are notable even in the region's large and diverse economy. The total direct and indirect revenue to local governments in the region (excluding royalty and lease payments) was about $228 million as of 2006, $165 million of which was derived from state severance taxes. And the future benefits are anticipated to be even larger. The study estimates that the overall effects of the activity in the Barnett Shale are likely to be responsible for an average of more than 108,000 jobs and $10.4 billion in output per year through 2015.[9]

Louisiana. According to a study commissioned by the Louisiana Mid-Continent Oil and Gas Association, the total economic impact of the oil and natural gas industry in the State of Louisiana, through direct and indirect means, exceeded $70 billion in 2006.[10] The oil and natural gas industry in the state was estimated to support $12.7 billion in household earnings, or over 15% of the total earnings in Louisiana, of which $4.2 billion was paid directly to workers involved in oil and natural gas E&P. The industry supports 320,000 jobs in the state, over 58,000 of

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[7] Pennsylvania Economy League of Southwestern Pennsylvania, LLC, *The Economic Impact of the Oil and Gas Industry in Pennsylvania*, report prepared for the Marcellus Shale Committee, November 2008 (http://alleghenyconference.org/PEL/PDFs/EconomicImpactOilGasInPA1108.pdf)

[8] Kleinhenz & Associates, *Ohio's Natural Gas and Crude Oil Exploration and Production Industry Economic Impact Study*, report prepared for the Ohio Oil and Gas Energy Education Program, January 2008

[9] The Perryman Group, *Bounty from Below: The Impact of Developing Natural Gas Resources Associated with the Barnett Shale on Business Activity in Fort Worth and the Surrounding 14-County Area*, May 2007 (http://www.bseec.org/images/PerrymanStudy.pdf)

[10] Scott, Loren, *The Energy Sector: Still a Giant Economic Engine for the Louisiana Economy,* Report prepared for the Louisiana Mid-Continent Oil And Gas Association, September, 2007 (http://www.lmoga.com/overview.html)

which were involved directly in exploration and production, and paid more than $1.4 billion in state taxes, royalties and fees, half of which were state severance taxes.

Oklahoma. A study by Oklahoma State University shows that although the state's oil and natural gas industry has downsized from the height of the oil boom in 1982, when the industry employed nearly 160,000 workers, the sector remains an important component of the Oklahoma economy.[11] Total oil and natural gas employment in the state expanded by more than 40% between 2002 and 2007, and reached a reported 76,297 workers involved in E&P in 2007, generating a total labor income of nearly $8.9 billion. Oklahoma oil and natural gas companies invested an estimated $15.2 billion in exploration and production in the state in 2007. From this amount, 73%, or $11.0 billion in value, was transacted with Oklahoma businesses. Oklahoma state severance taxes receipts totaled $974 million.

Colorado. As commissioned by the Colorado state legislature, the Colorado Energy Research Institute (CERI) at the Colorado School of Mines engaged Booz Allen Hamilton to conduct a first-ever, wide-ranging economic study of Colorado's oil and natural gas industry. The study found that the oil and natural gas industry in the state contributed $23 billion to Colorado's economy in 2007, and employed over 51,000 people directly in drilling and production, paying nearly $3.5 billion to these employees. The study showed that the industry invested over $20 billion in oil and natural gas development and production activities, paid $900 million in royalties to private landowners and state and federal government, and paid over $130 million in state severance taxes.[12]

North Dakota. A study conducted by North Dakota State University revealed the economic impact of the oil and natural gas industry in North Dakota in 2007 is over $8.2 billion, nearly twice the size found in a similar study conducted for 2005. Direct economic output associated with oil and natural gas development and production in the state was estimated to be $3.1 billion, with another $5.1 billion indirectly associated with this output. Additional measures of the petroleum industry's economic importance to the state include direct employment for 7,719 full-time jobs, with secondary employment of 38,500 full-time equivalent jobs. The study demonstrated that the state collected $250 million in state severance taxes, and an equivalent amount was paid to private and public landowners as royalties in 2007.[13]

West Virginia. In a report by the Center for Business and Economic Research at Marshall University, the oil and natural gas industry in West Virginia employed over 4,500 people directly in activities associated with oil and natural gas exploration and development, with direct and indirect jobs totaling approximately 15,000. In 2006, the industry invested nearly $600 million in E&P activities, and contributed $2.5 billion in economic output in the state. The industry also paid an estimated $85 million in state severance taxes and $235 million in royalties to landowners.[14]

Alabama. In a somewhat older 2002 study assessing the economic contribution solely associated with coalbed methane development and production in Alabama, the Center for

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[11] Snead, Mark S. and Suzette Barta, Oklahoma State University, *The Economic Impact of Oil and Gas Production and Drilling on the Oklahoma Economy*, report prepared for the Oklahoma Energy Resources Board, 2008

[12] Colorado Energy Research Institute, *Oil and Gas Economic Impact Analysis,* Report 2007-1, June 2007 (http://www.ceri-mines.org/documents/CERIOilGas.pdf)

[13] North Dakota State University , Department of Agribusiness and Applied Economics, *Petroleum Industry's Economic Contribution to North Dakota in 2007*, Agribusiness and Applied Economics Report No. 639, January 2009 (http://www.ndoil.org/)

[14] Center for Business and Economic Research, Marshall University, *The Economic Impact of the Natural Gas Industry in West Virginia*, report prepared for the West Virginia Oil & Natural Gas Association and the Independent Oil & Gas Association of West Virginia, August 21, 2008

Business and Economic Research at the University of Alabama found that the Alabama coalbed methane industry produced about 116 billion cubic feet (Bcf) of gas in 2002, employing 259 workers with a $12.5 million payroll. Total 2002 economic impacts of the CBM industry on the Alabama economy were estimated to be $242 million in output (or contribution to gross state product), and 812 direct and indirect jobs. The industry paid over $15 million in state severance taxes.[15]

Kansas. The Kansas oil and natural gas industry is nearly a $4.5 billion industry that puts tens of thousands of people all across Kansas to work each day. According to a recent study, [16] Kansas' oil and natural gas industry generated over $1 billion of economic development annually in the last several years. In addition, in 2007, the industry paid $131 million in state severance taxes (an increase of 180% since 1999) and $215 million in ad valorem taxes (an increase of 182% over the same period), along with its share of state and federal income taxes.

Current trends in the American oil and natural gas industry strain continued economic viability.

A number of factors impacting the American oil and natural gas industry since the mid-1980s place greater pressure on the industry to maintain economic viability. These important factors are described below.

Growing proportion of production from marginal wells. According to EIA, in 2006,[17] about 85% of the producing oil wells and 74% of the producing gas wells in the U.S. are marginal wells which produce less that 15 barrels per day per well of oil, or less than 90 thousand cubic feet (Mcf) per day per well of natural gas. Alternatively, "stripper wells" referred to oil wells that produce less that 10 barrels per day per well, or gas wells that produce less than 60 thousand cubic feet (Mcf) per day per well of gas. Again according to EIA, in 2006, these stripper wells represented 77% of the producing oil wells and 65% of the producing gas wells in the U.S.

As far back as 1987, the U.S. Environmental Protection Agency (EPA), in its Regulatory Determination related to the exemption for oil, gas and geothermal exploration, development and production wastes under the Resource Conservation and Recovery Act (RCRA), recognized the unique vulnerability "stripper wells" have when faced with increased compliance requirements:[18]

> "A significant part of any overall economic impact of new requirements would be their effects on stripper wells. Stripper operations (generally wells producing 10 or fewer barrels of oil per day during the declining phase of their production cycle) cumulatively contribute about 14 percent of total domestic oil production. Generation of production wastes by strippers is more significant than would be expected, however, because many strippers produce very high ratios of water to oil. Many stripper operations are economically marginal and are thus highly sensitive to small fluctuations in market prices and cannot easily absorb additional costs for waste management. Stripper operations, therefore, constitute a special subcategory of the crude oil and natural gas industry and should be given special consideration when developing recommendations for improvements in the management of crude oil and natural gas wastes. At the same

[15] Center for Business and Economic Research at the University of Alabama, *Economic Impact of the Alabama Coalbed Methane Industry, 2002*, report prepared for the Coalbed Methane Association of Alabama, January 2004

[16] Kansas Independent Oil and Gas Association, *Kansas Oil & Gas Industry Strategic Analysis*, January 2009

[17] http://www.eia.doe.gov/pub/oil_gas/petrosystem/us_table.html

[18] Environmental Protection Agency, *Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes*, [FRL-3403-9], 53 FR 25447, July 6, 1988

time, any additional regulations must recognize the great diversity that exists within the stripper industry. The nature of stripper operations is dependent on the volume of crude oil, natural gas and wastes generated, the age of the well, the technology in use, geological, environmental, and economic considerations, and types of ownership. For example, a family-owned stripper well in a century-old field in Appalachia bears little resemblance to a field of stripper wells owned by a single large petrochemical company in California. Regulations governing wastes generated by stripper wells must be tailored to meet this great diversity."

U.S. shift from majors to independents. The basic definition of an independent oil and natural gas company is a non-integrated company which receives nearly all of its revenues from production at the wellhead.[19] Unlike many major oil producers, independent producers do not have other, major "downstream" business interests, such as crude oil refining, which can help of offset revenue losses that could result from in "upstream" production operations that could be associated with increased regulatory requirements. The tax definition published by the Internal Revenue Service (IRS) states that a firm is an "independent" if its average daily refinery runs do not exceed 75,000 barrels, or their retail sales are less than $5 million for the year. Independents range in size from large publically held companies to small proprietorships.

The concentration of the U.S. petroleum industry has decreased in recent years, despite conspicuous mega-mergers, as independents continue to gain market share. There are an estimated 16,000 "operators" that produce oil and natural gas in the U.S. – nearly all of these are classified as independents. Overall, independent producers drill 90% of America's oil and natural gas wells, produce approximately 82% of America's natural gas, and produce about 68% of America's oil. Therefore, since they have little or no downstream marketing or refining as part of their overall operations, they are generally more vulnerable than major integrated petroleum companies to compliance requirements that increase the costs of development and production.

Growing reliance on unconventional natural gas resources. *Unconventional gas* is a term commonly used to refer to natural gas contained in a low permeability reservoir that produces mainly dry natural gas. Many of the low permeability reservoirs that have been developed in the past are sandstone, but significant quantities of gas are also produced from low-permeability carbonates, shales, and coalbed formations. One way to define unconventional gas is *"natural gas that cannot be produced at economic flow rates or in economic volumes of natural gas unless the well is stimulated by a large hydraulic fracture treatment, a horizontal wellbore, or by using multilateral wellbores or some other technique to expose more of the reservoir to the wellbore."*[20]

In general, a vertical well that has been drilled and completed in an unconventional gas reservoir must be successfully stimulated to produce at commercial flow rates and recover commercial gas volumes. Normally, a large hydraulic fracture treatment is used to achieve successful stimulation. In some naturally fractured unconventional gas reservoirs, horizontal wells can be drilled, but many of these wells also need to be stimulated with hydraulic fracturing methods.

There are several types of unconventional gas that exists in formations without the permeability necessary to allow economic gas flow naturally. These include:

- Tight Gas Sands -- sandstones or carbonates with low permeability which prevents the gas from flowing naturally.

[19] http://www.ipaa.org/reports/faq.php
[20] http://www.npc.org/Study_Topic_Papers/29-TTG-Unconventional-Gas.pdf

- Coalbed Methane (CBM) – generally unmineable coal deposits where some methane is contained in the cleat and fracture system of the coal formation, but where much of the methane is adsorbed by coal particles in the formation.
- Shale Gas– fine-grained shale rock with low permeability in which gas has been adsorbed by clay particles or is held within minute pores and micro-fractures.[21]

Unconventional gas has become the single-most dominant source of U.S. natural gas, today producing about 43% of U.S. supplies, or about 28 billion cubic feet per day (Bcfd), up by 10 Bcfd in the past 10 years. And the prospects for unconventional gas, especially that in the shale gas plays, are considerably greater. Many believe that shale gas plays in the U.S. could be some of the largest gas plays in the world, and, if allowed to be developed, could fundamentally transform the U.S. natural gas market, providing secure sources of American energy supplies for many years to come.[22]

This production is expected to continue to increase steadily, but tends to have higher production costs relative to conventional natural gas supply sources. As onshore conventional and offshore gas supplies decline, unconventional gas will increasingly serve to make up a majority of U.S. natural gas production. While tight gas sands still dominate unconventional gas production, shale gas plays have become the new "hot resource." However, the replacement of higher productivity offshore wells and reserves with lower productivity unconventional gas wells means that the economics of U.S. production is becoming increasingly vulnerable to rising natural gas development and production costs, which has been the trend in recent years. In addition, the development of unconventional gas supply sources, especially shale gas plays, is occurring in regions of the country not accustomed to oil and natural gas industry activities. Working in these new areas can take additional time and resources to demonstrate that operations meet the expectations of local communities.

Growth in the application of carbon dioxide (CO_2) enhanced oil recovery (CO_2-EOR). According to the latest tabulation of CO_2-EOR activity in the U.S. published by the *Oil and Gas Journal*,[23] approximately 250,000 barrels per day of incremental U.S. oil is being produced by 100 CO_2-EOR projects, distributed across the U.S. Since 1986, when CO_2-EOR was first used in commercial production, over 1.3 billion barrels of incremental oil have been recovered using this technology. Figure 1 tracks the steady growth in CO_2-EOR production for the past 20 years, noting that although new activities are underway in the Gulf Coast and the Rockies, the great bulk of CO_2-EOR is still being produced from the Permian Basin in West Texas. In addition to facilitating the production of more oil in the U.S., CO_2-EOR presents the unique benefit of potentially helping to address concerns about global climate change. Depleted oil reservoirs can offer a key opportunity for the long-term geologic storage of CO_2. However, this potential source of future supplies is characterized by technical challenges, higher front-end costs, and greater economic uncertainty than traditional production practices. Consequently, increased development and production costs could hamper the development of this important potential source of future supply that could play a key role in both offsetting future crude oil imports in the U.S., as well as providing an economically viable opportunity for storing CO_2.

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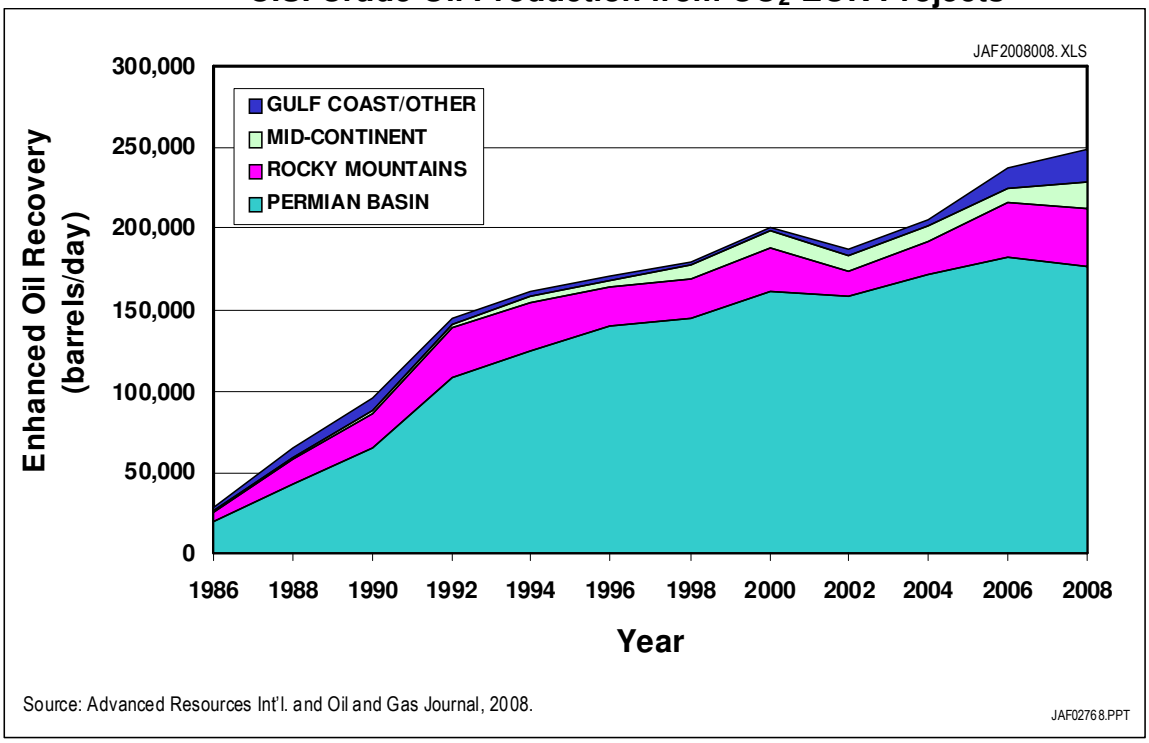
[21] http://www.enerdynamics.com/documents/Insider91807_000.pdf

[22] See, for example, Spencer, Starr, "Haynesville Shale Primed to Become World's Largest Gas Field by 2020," *Rigzone*, February 12, 2009 and Gronewold, Nathanial, "U.S. shale development seen rolling global energy markets," *Greenwire*, February 12, 2009

[23] Moritis, Guntis, "SPECIAL REPORT: More US EOR projects start but EOR production continues decline," *Oil and Gas Journal*, Volume 106 Issue 15, April 21, 2008

Figure 1
U.S. Crude Oil Production from CO_2-EOR Projects



Source: Advanced Resources Int'l. and Oil and Gas Journal, 2008.

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POTENTIAL ENERGY SUPPLY AND ECONOMIC IMPACTS

The U.S. oil and natural gas industry is quite concerned that considerably more stringent regulations could have adverse impacts on the economics of American oil and natural gas development and production operations, and thus on American oil and natural gas supplies, prices, and associated economic benefits. Based on its strong interests in ensuring that U.S. energy supplies are not unnecessarily constrained and that environmental protection approaches make technical, environmental and economic sense, the U.S. Department of Energy recently published a "white paper"[24] that compiles and documents the results of previous economic impact studies prepared for industry and government that examined many of the recommendations made by various environmental organizations; updates this previous work to be consistent with current energy market outlooks, costs, and industry trends; and characterizes the potential cumulative impact of these initiatives on U.S. oil and natural gas supplies and on the related economic benefits that these supplies help facilitate.[25]

Of the numerous regulatory recommendations proposed made by the environmental organizations, the DOE "white paper" focused on the following:

- Requiring oil and natural gas E&P operations to report to the Toxic Release Inventory (TRI).
- Subjecting hydraulic fracturing of oil and natural gas wells to Underground Injection Control (UIC) program requirements, despite language excluding this in the Energy Policy Act of 2005.
- Requiring that all wastes associated with oil and natural gas development and production be addressed under RCRA "cradle-to-grave" hazardous waste (Subtitle C) provisions, including requiring that the injection of produced water and other materials associated with enhancing oil and natural gas production meet the standards of Class I injection.
- Requiring storm water permits for all oil and natural gas E&P operations, rescinding Section 323 of the Energy Policy Act of 2005.
- Requiring aggregation of the emissions of oil and natural gas E&P activities under the National Emission Standards for Hazardous Air Pollutants (NESHAP) program, and requiring EPA to review and update clean air regulations related to oil and natural gas E&P.
- The implementation of new Spill Prevention, Control, and Countermeasure (SPCC) requirements issued by EPA to "provide increased clarity," as well as to better "tailor" requirements to oil and natural gas E&P industry operations.

The previous economic impact studies used as the basis of the DOE white paper were prepared in different years (ranging from 1985 to 2008), and were based on different assumptions regarding industry activity and existing environmental compliance approaches at that time. In some cases, state and federal regulatory requirements have changed since these original assessments were performed, new technologies and approaches for addressing these

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[24] Advanced Resources International, *Potential Economic and Energy Supply Impacts of Proposals to Modify Federal Environmental Laws Applicable to the U.S. Oil and Gas Exploration and Production Industry*, prepared for the U.S. Department of Energy Office of Fossil Energy, January 2009 (http://www.fossil.energy.gov/programs/oilgas/publications/environment_otherpubs/Impacts_of_Modify_Fed._Environmental_Law.html)

[25] This assessment focuses on potential economic and energy supply impacts and does not address environmental risk, the scope and adequacy of existing state and federal regulations applicable to oil and natural gas E&P, or other factors considered in the establishment of prior regulatory determinations that resulted in federal exemptions or requirements tailored to oil and natural gas E&P operations.

environmental concerns have been developed, and/or the costs of certain approaches may have fundamentally changed.

Accordingly, *the results of the DOE assessment, representing the cumulative impacts associated with all of the compliance initiatives considered, should be interpreted as an indication of the overall order of magnitude of potential impacts*, rather than an exact prediction of impacts associated with the stringent federal scenario as defined in the analysis. Moreover, the combination of initiatives assumed in the DOE assessment, if implemented, represents a stringent set of potential federal requirements, but not necessarily a "worst case" scenario from the perspective of the U.S. E&P industry. Without doubt, alternative assumptions about potential compliance requirements, especially for some of the higher incremental cost items, could result in different potential energy supply and related economic impacts.

The impact of the potential increased compliance costs associated with the proposed initiatives was examined as they pertain to future oil and natural gas supplies from three sources:

- Currently producing oil and natural gas wells
- Potential supplies of unconventional natural gas resources
- Potential crude oil supplies from carbon dioxide enhanced oil recovery (CO_2-EOR).

For the different categories of resources, the potential impacts are reported in different ways. This is a result of both the nature of the different resource categories considered, as well as the characteristics of the analytical approaches and models used to assess the impacts for each category. Specifically, results related to currently producing oil and natural gas wells were reported in terms of first year, one-time impacts, those related to unconventional natural gas resources were reported in terms of forecast industry activity over 25 years, and those related to CO_2-EOR were reported in terms of potential volumes of economically recoverable resources and associated CO_2 storage capacity.

The energy supply and economic impacts associated with each category of the U.S. resource considered in the DOE study is summarized in the paragraphs below.

Currently producing oil and natural gas wells

The specific requirements assumed to apply to currently producing oil and natural gas wells include TRI reporting, complying with RCRA hazardous waste provisions for produced water and other associated E&P wastes, requirements for Area Source aggregation of E&P emissions under NESHAP, new requirements for engines and tanks under NESHAP, including New Source Performance Standards (NSPS) requirements for engines at area sources, and new SPCC requirements.

- The largest cost category of potential requirements is associated with the management of other associated E&P wastes under RCRA's hazardous waste provisions. While these provisions could apply to produced water, drilling wastes and other associated wastes produced in association with oil and natural gas E&P operations, this particular item refers to "other associated wastes" (not including drilling wastes and produced water) that represent a wide range of small volume waste streams
- The second largest category of costs is associated with compliance with potential new SPCC requirements. For existing producing wells, these costs represent one-time costs that would be incurred to bring existing facilities into compliance.
- The third largest category of costs would involve requiring underground injection of produced water to comply with RCRA's hazardous waste provisions (i.e., standards for Class I injection). For this category of costs, producing oil wells were assumed to bear the

full costs associated with produced water disposal (including the small proportion produced from gas wells); with 10% of produced water volumes assumed to test as hazardous under RCRA criteria.

Given the above set of regulatory requirements, estimated average annual incremental compliance costs are $24,570 per producing oil well and $22,938 per producing gas well (2007 dollars).[26] This is broken down by compliance requirement in Table 1.

TABLE 1
AGGREGATE PER WELL COMPLIANCE COSTS BY KEY REGULATORY REQUIREMENT APPLICABLE TO CURRENTLY PRODUCING WELLS UNDER THE "STRINGENT FEDERAL SCENARIO"
(2007 $)

	Producing oil wells ($/well/year)	**Producing gas wells ($/well/ year)**
TRI reporting	$318	$171
Manage other associated E&P wastes under RCRA hazardous waste provisions	$10,452	$10,452
Area Source aggregation of E&P emissions under NESHAP	$0	$575
Impose new requirements for engines and tanks under NESHAP	$4,783	$2,174
Comply w/ new SPCC requirements	$ 9,018	$9,566
TOTAL	**$24,570**	**$22,938**
Manage produced water under RCRA hazardous waste provisions **($/barrel of water produced)**	**$0.08**	

Source: Advanced Resources International[27]

[26] Unless otherwise indicated, all costs, revenues, and other financial information in this assessment is reported in 2007 dollars.

[27] Advanced Resources International, *Potential Economic and Energy Supply Impacts of Proposals to Modify Federal Environmental Laws Applicable to the U.S. Oil and Gas Exploration and Production Industry*, prepared for the U.S. Department of Energy Office of Fossil Energy, January 2009 (http://www.fossil.energy.gov/programs/oilgas/publications/environment_otherpubs/Impacts_of_Modify_Fed._Environmental_Law.html)

The process of adding the incremental costs for compliance results in costs exceeding revenues for marginal wells in certain categories. The number of wells and amount of production for these types of wells was assumed to be shut-in, since wells in the category, on average, would no longer be profitable to produce.[28]

Given the potential incremental federal compliance requirements considered, the energy supply and related economic impacts on currently producing oil and natural gas wells were evaluated assuming crude oil prices of $50 per barrel and wellhead natural gas prices of $6.00 per Mcf. These impacts are summarized as follows (all impacts are reported in 2007 dollars):

- Shut in crude oil production in the first year of compliance could amount to over 183,000 barrels per day, or 7% of U.S. Lower-48 onshore oil production. Shut in natural gas production could amount to 245 Bcf annually, amounting to 1.5% of U.S. Lower-48 onshore natural gas production.
- 57% of producing onshore oil wells in the U.S. could be shut in, as could 35% of producing onshore gas wells.
- The American oil and natural gas industry could spend nearly $10 billion annually complying with the new requirements, representing a significant investment that could otherwise be spent on developing U.S. oil and natural gas resources. At average drilling costs and reserve additions per well in 2006, this diversion of $10 billion represents the investment that could otherwise be used to drill over 5,800 wells, with corresponding reserve additions on the order of 645 million barrels of oil equivalent (BOE) in just one year. Since average drilling costs for onshore Lower 48 natural gas wells for 2007 were nearly double those relative to 2006, based on 2007 drilling costs, this would correspond to the diversion of cash to drill only half as many wells, and result in half the volume of reserve additions foregone.
- Public and private royalty holders would lose over $600 million in revenues from the lost production. State governments would lose $285 million in revenues from foregone state severance taxes, and over $500 million in revenues from foregone state income taxes. The federal government could lose as much as $4 billion in income tax receipts, estimated at the standard U.S. corporate tax rate.[29]

These results are presented in detail by state in Table 2.

[28] It is important to note that shutting in some unconventional wells would likely mean that they would never produce again, or would produce at significantly lower levels.
[29] Not taking into consideration the effect of potential tax incentives, alternative minimum tax, etc.

Table 2
SUMMARY OF IMPACTS OF INCREASED COMPLIANCE COSTS ON CURRENTLY PRODUCING OIL AND NATURAL GAS WELLS UNDER THE "STRINGENT FEDERAL SCENARIO"
(2007 $)

	Annual Volume of Shut In Oil Production	Annual Volume of Shut In Gas Production	Number of Shut in Wells		Incremental Industry Compliance Expenditures	Foregone Royalties (Public and Private)	Foregone State Severance Taxes	Foregone State Income Taxes	Foregone Federal Income Taxes
STATE	**(MBOE)**	**(MMcfe)**	**Oil**	**Gas**	**(MM $/yr)**	**(M $/yr)**	**(M $/yr)**	**(MM $/yr)**	**(MM $/yr)**
Alabama	54	542	90	295	$88	$742	$594	$7	$30
Arkansas	3	19	821	486	$54	$32	$25	$7	$43
Arizona	0	0	2	0	$1	$1	$1	$0	$0
California	2,953	818	8,577	614	$1,017	$19,072	$1,526	$94	$278
Colorado	1,152	7,622	2,091	3,556	$553	$12,918	$7,751	$35	$227
Florida	2	0	4	1	$1	$10	$6	$0	$1
Illinois	2,079		3,879		$39	$12,996	$0	$6	$37
Indiana	173		552		$15	$1,078	$86	$2	$5
Kansas	6,451	10,278	33,806	7,116	$688	$48,029	$30,739	$32	$248
Kentucky	626	11,608	4,174	5,770	$172	$12,620	$7,067	$12	$69
Louisiana	3,235	8,420	14,110	8,928	$286	$26,531	$26,531	$31	$104
Maryland		11		5	$0	$8	$8	$0	$0
Michigan	668	1,611	2,062	592	$250	$5,381	$2,583	$5	$88
Mississippi	155	232	283	112	$67	$1,141	$548	$4	$23
Missouri	55		283		$1	$345	$166	$0	$0
Montana	811	4,175	1,992	2,127	$118	$8,197	$5,902	$13	$54
Nebraska	93	55	243	22	$26	$623	$149	$2	$7
Nevada	2		8		$1	$14	$1	$0	$1
New York	133	6,948	2,678	5,602	$20	$6,045	$0	$4	$59
New Mexico	3,997	10,346	7,486	5,187	$805	$32,739	$22,263	$82	$297
North Dakota	91	97	257	82	$85	$639	$460	$6	$25
Ohio	2,615	32,816	10,049	22,904	$46	$40,957	$21,625	$16	$94
Oklahoma	4,726	18,340	20,779	9,881	$1,104	$43,295	$24,245	$74	$359
Oregon	0	4	0	1	$0	$3	$2	$0	$0
Pennsylvania	775	43,624	6,363	25,452	$93	$37,562	$19,833	$26	$150
South Dakota	3	62	8	23	$4	$66	$25	$0	$2
Tennessee	9		127		$2	$56	$21	$0	$1
Texas	34,524	36,008	76,914	18,548	$3,128	$242,781	$89,343	$0	$1,543
Utah	331	663	566	389	$153	$2,563	$615	$0	$53
Virginia	2	1,193	8	526	$103	$909	$345	$0	$38
West Virginia	448	40,242	2,819	25,826	$309	$32,981	$13,192	$47	$135
Wyoming	817	8,838	3,241	6,157	$701	$11,738	$9,390	$0	$264
Total for States	**66,983**	**244,572**	**204,272**	**150,202**	**$9,930**	**$602,071**	**$285,042**	**$505**	**$4,235**
	(Bbl/day	**(Bcf/day)**							
Total Daily Shut in Production Rate	**183,514**	**670**							

Source: Advanced Resources International. [30]

[30] Advanced Resources International, *Potential Economic and Energy Supply Impacts of Proposals to Modify Federal Environmental Laws Applicable to the U.S. Oil and Gas Exploration and Production Industry*, prepared for the U.S. Department of Energy Office of Fossil Energy, January 2009 (http://www.fossil.energy.gov/programs/oilgas/publications/environment_otherpubs/Impacts_of_Modify_Fed._Environmental_Law.html)

Table 2 (Continued)
SUMMARY OF IMPACTS OF INCREASED COMPLIANCE COSTS ON CURRENTLY PRODUCING OIL AND NATURAL GAS WELLS UNDER THE "STRINGENT FEDERAL SCENARIO"

	Total Annual Volume of Production in the State		Annual Volume of Shut In Production		% of Total Production Shut in		Total Number of Producing Wells		Number of Shut in Wells		% of Total Wells Shut in	
	(OIL)	(GAS)	(OIL)	(GAS)	(OIL)	(GAS)	(OIL)	(GAS)	(OIL)	(GAS)	(OIL)	(GAS)
STATE	(MBOE)	(MMcfe)	(MBOE)	(MMcfe)								
Alabama	7,173	306,144	54	542	0.71%	0.18%	484	4,063	90	295	19%	7%
Arkansas	6,031	193,942	3	19	8.39%	0.52%	1,666	4,697	821	486	49%	10%
Arizona	55	611	0	0	0.20%	0.00%	23		2	0	9%	0%
California	223,449	308,730	2,953	818	1.28%	0.26%	47,197	3,692	8,577	614	18%	17%
Colorado	23,390	1,214,396	1,152	7,622	5.05%	0.63%	4,655	28,536	2,091	3,556	45%	12%
Florida	2,360	2,845	2	0	0.06%	0.01%	59	5	4	1	7%	20%
Illinois	10,323	170	2,079		7.73%		5,460		3,879		71%	
Indiana	1,731	2,921	173		9.99%		1,173		552		47%	
Kansas	35,651	372,029	6,451	10,278	19.07%	2.76%	45,530	24,543	33,806	7,116	74%	29%
Kentucky	2,340	95,320	626	11,608	24.70%	12.18%	4,778	12,617	4,174	5,770	87%	46%
Louisiana	73,483	1,378,238	3,235	8,420	4.29%	0.61%	18,635	17,102	14,110	8,928	76%	52%
Maryland	0	48		11		0.00%		7		5	0%	71%
Michigan	5,093	370,958	668	1,611	12.03%	0.43%	3,656	9,780	2,062	592	56%	6%
Mississippi	17,356	212,081	155	232	0.20%	0.11%	1,778	1,566	283	112	16%	7%
Missouri	87	0	55		0.00%		304		283		93%	
Montana	36,262	114,037	811	4,175	2.47%	3.66%	4,199	6,207	1,992	2,127	47%	34%
Nebraska	2,313	1,217	93	55	3.85%	4.54%	1,213	117	243	22	20%	19%
Nevada	426	5	2		0.49%		69		8		12%	
New York	319	55,980	133	6,948	67.75%	12.41%	2,909	6,217	2,678	5,602	92%	90%
New Mexico	59,818	1,619,528	3,997	10,346	6.59%	0.64%	15,456	4,063	7,486	5,187	48%	128%
North Dakota	39,911	62,786	91	97	0.25%	0.15%	484	36,202	257	82	53%	0%
Ohio	5,422	86,315	2,615	32,816	0.00%	0.00%	10,557	27,178	10,049	22,904	95%	84%
Oklahoma	62,841	1,688,985	4,726	18,340	7.61%	1.09%	31,016	47,021	20,779	9,881	67%	21%
Oregon	0	621		4		0.63%				1	0%	0%
Pennsylvania	3,626	158,355	775	43,624	0.00%	0.00%	6,674	35,796	6,363	25,452	95%	71%
South Dakota	1,394	10,616	3	62	0.22%	0.58%	82	135	8	23	10%	17%
Tennessee	192	1,793	9		0.00%	0.00%	205		127		62%	
Texas	397,220	6,267,366	34,524	36,008	3.66%	0.57%	136,738	104,983	76,914	18,548	56%	18%
Utah	17,910	356,038	331	663	0.51%	0.19%	2,574	5,259	566	389	22%	7%
Virginia	7	103,027	2	1,193	0.00%	0.00%	8	5,020	8	526	100%	10%
West Virginia	1,749	225,530	448	40,242	28.66%	17.84%	3,137	38,932	2,819	25,826	90%	66%
Wyoming	52,904	2,111,766	817	8,838	1.58%	0.42%	10,712	28,675	3,241	6,157	30%	21%
Total for States	**1,090,836**	**17,322,398**	**66,983**	**244,572**	**6.89%**	**1.52%**	**355,537**	**418,758**	**204,272**	**150,202**	**57%**	**36%**
			(Bbl/day	(Bcf/day)								
Total Daily Shut in Production			**183,514**	**670**								

Potential future supplies of unconventional natural gas resources

The specific requirements assumed to apply to new unconventional natural gas development and production include TRI reporting, subjecting hydraulic fracturing to federal UIC program requirements, requiring storm water permits for all new oil and natural gas E&P industry activities, managing drilling and other associated wastes under RCRA hazardous waste provisions, implementing requirements for Area Source aggregation of E&P emissions under NESHAP, implementing new requirements for engines and tanks under NESHAP, and complying with new SPCC requirements.

- The potential requirement representing the single largest cost item considered for initial compliance costs for new unconventional gas wells is potential new requirements for hydraulic fracturing. This represents over 65% of the total of all cost elements. *It is important to note that these costs do not assume that hydraulic fracturing operations would be required to use federally certified drinking water, as in the case of the Alabama requirements for fracturing coalbed methane that resulted from the LEAF case.*[31]
- The potential requirement representing the single largest operating and maintenance (O&M) cost item is that associated with the management of "other associated wastes" under RCRA hazardous waste provisions. This represents 80% of the total of all cost elements.

Given this assumed set of regulatory requirements, incremental investment costs to comply are estimated to be $152,843 per well, on average, for all new unconventional gas wells. In addition, incremental annual operating costs are estimated to total, on average, $13,013 per well. This is broken down by requirement in Table 3.

For unconventional natural gas, the energy supply and related economic impacts associated with these proposed initiatives were assessed under two scenarios – one assuming wellhead natural gas prices averaging $6.00 per Mcf and the other assuming $9.00 per Mcf. Impacts are characterized in terms of their cumulative effect over the next 25 years. Overall, these impacts could be summarized as follows (the range in impacts correspond to the two different natural gas price scenarios considered):

- Depending on natural gas prices, from 42 to 53 Tcf of otherwise economic unconventional natural gas production would not be developed, a 12% to 18% reduction.
- Overall drilling for unconventional gas could be reduced by 35% to 50%.
- Even for those unconventional gas resources that would be developed, industry would spend from $39 to $75 billion to comply with the increased requirements over 25 years.
- At average drilling costs and reserve additions per well assumed over this time period, this diverted investment could otherwise help to drill from 33,000 to 76,000 unconventional gas wells over 25 years, which could result in reserve additions corresponding to 50 to 90 Tcf.

These results are summarized in Table 4.

[31] In 1994, a suit by the Legal Environmental Assistance Foundation (LEAF) claimed that the State of Alabama should regulate hydraulic fracturing for coalbed methane development as underground injection (118 F.3d 1467 (11th Cir. 1997). LEAF petitioned EPA to withdraw Alabama's SDWA Section 1425 UIC program. EPA rejected LEAF's petition, and LEAF litigated. In 1997, the 11th Circuit Court of Appeals ruled that hydraulic fracturing of coal beds in Alabama should be regulated under the SDWA as underground injection (LEAF v. EPA, 118 F. 3d 1467). The State was required to modify its UIC program, and in December 1999, EPA approved this revision, which included the requirement that federally certified drinking water by used for hydraulic fracturing.

Table 3
AGGREGATE PER WELL COMPLIANCE COSTS BY KEY REGULATORY REQUIREMENT APPLICABLE TO UNCONVENTIONAL NATURAL GAS UNDER THE "STRINGENT FEDERAL SCENARIO"
(2007 $)

	Incremental initial investment costs (New wells only)	Incremental annual O&M costs (New wells only)
	($/well)	($/well)
TRI reporting	$258	$119
Regulate hydraulic fracturing to UIC program requirements	$100,505	$0
Require storm water permits for all O&G industry activities	$26,452	$0
Include drilling wastes from O&G E&P under RCRA hazardous waste provisions	$14,526(1)	$0
Manage other associated E&P wastes under RCRA hazardous waste provisions	$0	$10,452
Area Source aggregation of E&P emissions under NESHAP	$0	$575
Impose new requirements for engines and tanks under NESHAP	$1,537	$1,867
Comply w/ new SPCC requirements	$9,566	$0
TOTAL	**$152,843**	**$13,013**

(1) This represents the average costs for unconventional gas wells, specifically considering the depths of such wells.

Source: Advanced Resources International. [32]

[32] Advanced Resources International, *Potential Economic and Energy Supply Impacts of Proposals to Modify Federal Environmental Laws Applicable to the U.S. Oil and Gas Exploration and Production Industry*, prepared for the U.S. Department of Energy Office of Fossil Energy, January 2009 (http://www.fossil.energy.gov/programs/oilgas/publications/environment_otherpubs/Impacts_of_Modify_Fed._Environmental_Law.html)

Table 4
SUMMARY OF 25-YEAR IMPACTS OF INCREASED COMPLIANCE COSTS ON FUTURE U.S. UNCONVENTIONAL NATURAL GAS POTENTIAL UNDER THE "STRINGENT FEDERAL SCENARIO"
(2007 $)

		Tight Gas		Coalbed Methane		Shale Gas		Total Unconventional	
Category	Units	$6/Mcf	$9/Mcf	$6/Mcf	$9/Mcf	$6/Mcf	$9/Mcf	$6/Mcf	$9/Mcf
Total Production - Base Case	**Tcf**	186,739	210,940	38,020	44,273	71,908	109,021	296,667	364,234
Reduction in Cum. Production	**Tcf**	25,839	19,308	10,851	11,623	16,168	11,031	52,858	41,962
% Reduction		14%	9%	29%	26%	22%	10%	18%	12%
Foregone Reserve Additions	**Tcf**	23,105	32,644	1,808	6,910	24,707	50,312	49,620	89,866
Total Drilling - Base Case	**Wells**	150,646	193,058	42,461	61,175	35,563	87,890	228,669	342,122
Reduction in Well Drilling	**Wells**	60,053	46,045	34,827	35,263	19,139	39,540	114,019	120,848
% Reduction		40%	24%	82%	58%	54%	45%	50%	35%
Compliance Costs	**Million $**	$31,575	$51,240	$1,674	$7,297	$5,725	$16,852	$38,974	$75,389
Foregone Royalties	**Million $**	$29,069	$21,722	$8,138	$13,076	$12,126	$12,409	$49,333	$47,207

Source: Advanced Resources International.[33]

[33] Advanced Resources International, *Potential Economic and Energy Supply Impacts of Proposals to Modify Federal Environmental Laws Applicable to the U.S. Oil and Gas Exploration and Production Industry*, prepared for the U.S. Department of Energy Office of Fossil Energy, January 2009 (http://www.fossil.energy.gov/programs/oilgas/publications/environment_otherpubs/Impacts_of_Modify_Fed._Environmental_Law.html)

Potential future crude oil supplies from carbon dioxide enhanced oil recovery (CO_2-EOR)

The specific requirements assumed to apply to CO_2-EOR include TRI reporting, subjecting all CO_2 injection wells to federal UIC program requirements for Class I injection, requiring storm water permits for all O&G industry activities, managing drilling wastes and other associated E&P wastes under RCRA hazardous waste provisions, Area Source aggregation of E&P emissions under NESHAP, new requirements for engines and tanks under NESHAP, and new SPCC requirements.

Of these, the potential requirement representing the single largest cost item considered is that associated with requirements that could subject CO_2 injection wells used for CO_2-EOR to federal UIC program requirements for Class I injection of "hazardous" waste. While CO_2 itself is not considered a hazardous substance, the injected CO_2 stream may contain hazardous substances such as mercury, or the constituents of the CO_2 stream could react with ground water to produce a listed hazardous substances such as sulfuric acid. Moreover, CO_2 mixed with water forms carbonic acid, which can corrode well materials and piping. Corrosivity, along with ignitability, reactivity, or toxicity, is a characteristic that can define an injectant as hazardous under RCRA.

For purposes of the DOE assessment, new compliance costs for CO_2-EOR projects were assumed to be associated with incremental capital costs for new well drilling, for newly converted wells, for existing producers, and for existing injectors. In addition, incremental annual O&M costs are also assumed to be incurred, which were assigned to existing and new producers.

Given this assumed set of proposed regulatory requirements, average estimated incremental costs to comply with the proposed requirement in the scenario considered in this assessment, for each category of cost, are broken down by requirement in Table 5.

Table 5
AGGREGATE PER WELL COMPLIANCE COSTS BY KEY REGULATORY REQUIREMENTS APPLICABLE TO CO_2-EOR UNDER THE "STRINGENT FEDERAL SCENARIO"
(2007 $)

	Incremental Capital Costs -- New Well Drilling	Incremental Capital Costs -- Newly Converted Wells	Other Incremental Capital Costs – Existing Producers	Other Incremental Capital Costs -- Existing Injectors	Incremental Annual O&M Costs (Producers)
	(2007 $/well)	(2007 $/well)	(2007 $/well)	(2007 $/well)	(2007 $/well)
TRI reporting	$477	$477	$477	$0	$222
Conform injectors to Class I requirements	$692,694	$1,176,137	$0	$0	$60,626
Require stormwater permits for all O&G industry activities	$26,452	$26,452	$26,452	$26,452	$0
Include drilling wastes associated with O&G E&P under RCRA hazardous waste provisions	$14,198	$0	$0	$0	$0
Manage other associated E&P wastes under RCRA hazardous waste provisions	$0	$0	$0	$0	$10,452
Impose new requirements for engines and tanks under NESHAP	$7,996	$7,996	$7,996	$7,996	$3,184
Comply w/ new SPCC provisions	$9,018	$9,018	$9,018	$0	$0
TOTAL	**$750,835**	**$1,220,080**	**$43,943**	**$34,448**	**$74,484**

Source: Advanced Resources International[34]

The impacts associated with the incremental compliance costs of for this scenario on CO_2-EOR were assessed assuming crude oil prices of $50 per barrel. Depending on future costs for CO_2 and the risk industry would be willing to accept to pursue future CO_2-EOR projects, the impacts are summarized as follows:

- Lost reserves potential from CO_2-EOR would range from 5 to 9 billion barrels (13% to 30% reduction in total potential reserves potential) (Table 6). The largest proportional impacts are in the Gulf Coast, West Texas, and Appalachia.
- Approximately 103 to 173 otherwise economic EOR prospects would become uneconomic, representing 12% to 30% of the total prospective projects; a very large and diverse set of future potential CO_2 storage sites (Table 7).
- The reservoirs where reserves potential is lost represent 1,600 to 2,600 million metric tonnes of potential CO_2 storage capacity (Table 8). For reference, total U.S. CO_2 emissions in 2006 were about 6,000 million metric tonnes

[34] Advanced Resources International, *Potential Economic and Energy Supply Impacts of Proposals to Modify Federal Environmental Laws Applicable to the U.S. Oil and Gas Exploration and Production Industry*, prepared for the U.S. Department of Energy Office of Fossil Energy, January 2009 (http://www.fossil.energy.gov/programs/oilgas/publications/environment_otherpubs/Impacts_of_Modify_Fed._Environmental_Law.html)

TABLE 6
SUMMARY OF IMPACTS OF INCREASED COMPLIANCE COSTS ON FUTURE U.S. CO_2-EOR OIL RECOVERY POTENTIAL UNDER THE "STRINGENT FEDERAL SCENARIO"
(2007 $)

Oil Recovery Potential (Billion Barrels)

15% Hurdle Rate of Return

	CO_2 Cost - $1.00 per Mcf				CO_2 Cost - $2.50 per Mcf			
Basin/Area	Current Requirements	Stringent Federal Scenario	Difference	% Difference	Current Requirements	Stringent Federal Scenario	Difference	% Difference
1. Alaska	9.27	7.67	1.60	17.3%	7.28	7.18	0.10	1.4%
2. California	5.43	5.37	0.06	1.2%	4.97	4.65	0.32	6.5%
3. Gulf Coast (AL, FL, MS, LA)	2.27	1.22	1.05	46.1%	0.73	0.12	0.61	83.8%
4. Mid-Continent (OK, AR, KS, NE)	5.55	5.17	0.38	6.8%	5.07	4.57	0.50	9.9%
5. Illinois/Michigan	0.65	0.51	0.14	21.7%	0.54	0.34	0.20	37.6%
6. Permian (W TX, NM)	7.59	6.27	1.32	17.4%	4.56	0.12	4.44	97.4%
7. Rockies (CO,UT,WY)	1.85	1.65	0.20	11.0%	1.31	1.12	0.19	14.3%
8. Texas, East/Central	8.26	7.30	0.96	11.6%	7.26	6.14	1.12	15.4%
9. Williston (MT, ND, SD)	0.47	0.45	0.02	5.3%	0.39	0.32	0.07	18.3%
10. Louisiana Offshore	4.11	4.02	0.09	2.3%	1.03	0.41	0.63	60.8%
11. Appalachia (WV, OH, KY, PA)	0.07	0.01	0.06	84.7%	0.02	0.01	0.01	46.8%
TOTAL	**45.53**	**39.64**	**5.89**	**12.9%**	**33.16**	**24.97**	**8.19**	**24.7%**

Oil Recovery Potential (Billion Barrels)

25% Hurdle Rate of Return

	CO_2 Cost - $1.00 per Mcf				CO_2 Cost - $2.50 per Mcf			
Basin/Area	Current Requirements	Stringent Federal Scenario	Difference	% Difference	Current Requirements	Stringent Federal Scenario	Difference	% Difference
1. Alaska	7.67	7.18	0.49	6.4%	0.29	0.29	0.00	0.0%
2. California	5.19	4.98	0.20	3.9%	4.10	3.59	0.50	12.3%
3. Gulf Coast (AL, FL, MS, LA)	1.82	0.48	1.34	73.8%	0.25	0.01	0.24	95.8%
4. Mid-Continent (OK, AR, KS, NE)	5.36	3.75	1.61	30.0%	4.24	1.88	2.36	55.6%
5. Illinois/Michigan	0.59	0.35	0.24	40.5%	0.48	0.09	0.39	81.7%
6. Permian (W TX, NM)	6.74	4.21	2.53	37.6%	0.11	-0.05	0.16	149.7%
7. Rockies (CO,UT,WY)	1.58	1.35	0.24	15.1%	0.99	0.75	0.24	24.6%
8. Texas, East/Central	7.80	6.47	1.32	17.0%	6.19	5.21	0.98	15.9%
9. Williston (MT, ND, SD)	0.39	0.38	0.02	4.6%	0.31	0.21	0.10	32.5%
10. Louisiana Offshore	2.46	1.53	0.93	37.9%	0.00	0.00	0.00	
11. Appalachia (WV, OH, KY, PA)	0.02	0.01	0.01	46.8%	0.01	0.01	0.00	0.0%
TOTAL	**39.61**	**30.68**	**8.93**	**22.6%**	**16.98**	**11.99**	**4.99**	**29.4%**

Source: Advanced Resources International[35]

[35] Advanced Resources International, *Potential Economic and Energy Supply Impacts of Proposals to Modify Federal Environmental Laws Applicable to the U.S. Oil and Gas Exploration and Production Industry*, prepared for the U.S. Department of Energy Office of Fossil Energy, January 2009 (http://www.fossil.energy.gov/programs/oilgas/publications/environment_otherpubs/Impacts_of_Modify_Fed._Environmental_Law.html)

TABLE 7
SUMMARY OF IMPACTS OF INCREASED COMPLIANCE COSTS ON THE FUTURE NUMBER OF CO_2-EOR PROJECTS IN THE U.S UNDER THE "STRINGENT FEDERAL SCENARIO"

Number of EOR Projects
15% Hurdle Rate of Return

	CO_2 Cost - $1.00 per Mcf				CO_2 Cost - $2.50 per Mcf			
Basin/Area	Current Requirements	Stringent Federal Scenario	Difference	% Difference	Current Requirements	Stringent Federal Scenario	Difference	% Difference
1. Alaska	11	5	6	54.5%	3	2	1	33.3%
2. California	75	73	2	2.7%	66	61	5	7.6%
3. Gulf Coast (AL, FL, MS, LA)	68	38	30	44.1%	23	5	18	78.3%
4. Mid-Continent (OK, AR, KS, NE)	83	77	6	7.2%	77	63	14	18.2%
5. Illinois/Michigan	50	22	28	56.0%	43	16	27	62.8%
6. Permian (W TX, NM)	105	78	27	25.7%	65	3	62	95.4%
7. Rockies (CO,UT,WY)	67	58	9	13.4%	42	32	10	23.8%
8. Texas, East/Central	125	105	20	16.0%	96	76	20	20.8%
9. Williston (MT, ND, SD)	18	17	1	5.6%	17	14	3	17.6%
10. Louisiana Offshore	75	71	4	5.3%	19	7	12	63.2%
11. Appalachia (WV, OH, KY, PA)	5	1	4	80.0%	2	1	1	50.0%
	682	**545**	**137**	**20.1%**	**453**	**280**	**173**	**38.2%**

Number of EOR Projects
25% Hurdle Rate of Return

	CO_2 Cost - $1.00 per Mcf				CO_2 Cost - $2.50 per Mcf			
Basin/Area	Current Requirements	Stringent Federal Scenario	Difference	% Difference	Current Requirements	Stringent Federal Scenario	Difference	% Difference
1. Alaska	5	2	3	60.0%	1	1	0	0.0%
2. California	69	67	2	2.9%	52	46	6	11.5%
3. Gulf Coast (AL, FL, MS, LA)	55	13	42	76.4%	10	2	8	80.0%
4. Mid-Continent (OK, AR, KS, NE)	80	57	23	28.8%	66	33	33	50.0%
5. Illinois/Michigan	41	17	24	58.5%	29	3	26	89.7%
6. Permian (W TX, NM)	86	56	30	34.9%	3	1	2	66.7%
7. Rockies (CO,UT,WY)	54	44	10	18.5%	28	21	7	25.0%
8. Texas, East/Central	106	87	19	17.9%	76	58	18	23.7%
9. Williston (MT, ND, SD)	17	16	1	5.9%	13	10	3	23.1%
10. Louisiana Offshore	42	24	18	42.9%	0	0	0	
11. Appalachia (WV, OH, KY, PA)	2	1	1	50.0%	1	1	0	0.0%
	557	**384**	**173**	**31.1%**	**279**	**176**	**103**	**36.9%**

Source: Advanced Resources International[36]

[36] Advanced Resources International, *Potential Economic and Energy Supply Impacts of Proposals to Modify Federal Environmental Laws Applicable to the U.S. Oil and Gas Exploration and Production Industry*, prepared for the U.S. Department of Energy Office of Fossil Energy, January 2009 (http://www.fossil.energy.gov/programs/oilgas/publications/environment_otherpubs/Impacts_of_Modify_Fed._Environmental_Law.html)

TABLE 8
SUMMARY OF IMPACTS OF INCREASED COMPLIANCE COSTS ON FUTURE CO_2 DEMAND IN CO_2-EOR PROJECTS UNDER THE "STRINGENT FEDERAL SCENARIO"

CO_2 Demand for EOR Projects (Million Metric Tons)

15% Hurdle Rate of Return

	CO_2 Cost - $1.00 per Mcf				CO_2 Cost - $2.50 per Mcf			
Basin/Area	Current Requirements	Stringent Federal Scenario	Difference	% Difference	Current Requirements	Stringent Federal Scenario	Difference	% Difference
1. Alaska	2,029	1,689	340.31	16.8%	1,586	1,564	22.13	1.4%
2. California	1,375	1,361	14.68	1.1%	1,241	1,119	121.84	9.8%
3. Gulf Coast (AL, FL, MS, LA)	701	357	344.11	49.1%	204	30	174.00	85.3%
4. Mid-Continent (OK, AR, KS, NE)	1,431	1,331	100.16	7.0%	1,297	1,158	138.09	10.7%
5. Illinois/Michigan	140	107	33.45	23.8%	126	78	48.96	38.7%
6. Permian (W TX, NM)	2,896	2,473	423.03	14.6%	1,887	1,044	843.65	44.7%
7. Rockies (CO,UT,WY)	563	502	60.66	10.8%	390	341	49.46	12.7%
8. Texas, East/Central	1,950	1,679	271.69	13.9%	1,645	1,349	296.26	18.0%
9. Williston (MT, ND, SD)	125	119	5.97	4.8%	105	87	17.73	16.9%
10. Louisiana Offshore	1,454	1,420	33.97	2.3%	331	125	205.33	62.1%
11. Appalachia (WV, OH, KY, PA)	15	2	13.18	86.4%	3	2	1.06	33.8%
	12,680	**11,039**	**1,641**	**12.9%**	**8,815**	**6,897**	**1,918**	**21.8%**

CO_2 Demand for EOR Projects (Million Metric Tons)

25% Hurdle Rate of Return

	CO_2 Cost - $1.00 per Mcf				CO_2 Cost - $2.50 per Mcf			
Basin/Area	Current Requirements	Stringent Federal Scenario	Difference	% Difference	Current Requirements	Stringent Federal Scenario	Difference	% Difference
1. Alaska	1,689	1,564	125	7.4%	63	63	0	0.0%
2. California	1,313	1,252	60	4.6%	961	814	146	15.2%
3. Gulf Coast (AL, FL, MS, LA)	550	134	415	75.6%	64	2	62	97.5%
4. Mid-Continent (OK, AR, KS, NE)	1,381	947	434	31.4%	1,052	428	624	59.3%
5. Illinois/Michigan	125	79	46	36.5%	111	22	89	80.5%
6. Permian (W TX, NM)	2,596	1,838	758	29.2%	931	507	424	45.5%
7. Rockies (CO,UT,WY)	480	411	69	14.4%	302	237	65	21.6%
8. Texas, East/Central	1,802	1,438	364	20.2%	1,357	1,108	249	18.3%
9. Williston (MT, ND, SD)	105	103	2	1.6%	84	59	26	30.6%
10. Louisiana Offshore	838	513	325	38.8%	0	0	0	
11. Appalachia (WV, OH, KY, PA)	3	2	1	33.8%	2	2	0	0.0%
	10,881	**8,281**	**2,599**	**23.9%**	**4,927**	**3,241**	**1,686**	**34.2%**

Source: Advanced Resources International[37]

[37] Advanced Resources International, *Potential Economic and Energy Supply Impacts of Proposals to Modify Federal Environmental Laws Applicable to the U.S. Oil and Gas Exploration and Production Industry*, prepared for the U.S. Department of Energy Office of Fossil Energy, January 2009 (http://www.fossil.energy.gov/programs/oilgas/publications/environment_otherpubs/Impacts_of_Modify_Fed._Environmental_Law.html)