Drill Baby Drill: Here We Go Again

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Photo credit: John Ciccarelli, BLM.

EXECUTIVE SUMMARY

President Trump has issued an executive order declaring a national energy emergency that doubles down on past "drill baby drill" policies for extracting oil and natural gas on federal public land. While the Trump Administration is duplicating many policies from the past, it has rejected protecting our environment as a policy goal, and is promoting energy dominance regardless of the cost. The pursuit of energy dominance is also inexplicably combined with serious disdain for renewable energy, conservation and efficiency – all of which are critical components of a sound energy policy regardless of one's opinion of climate change. We question whether fossil fuel dominance improves energy security and whether lack of access is a problem worth declaring an energy emergency.

In May 2025, Secretary of Interior Burgum released United States Geologic Survey (USGS) estimates of technically recoverable undiscovered oil and natural gas under federal public land in south-

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western Wyoming, and small areas in northwestern Colorado and northeastern Utah. Burgum stated that the estimates of undiscovered technically recoverable resources support job creation and domestic energy production (Burgum 2025).

Technically recoverable resource estimates alone, however, are insufficient information for estimating jobs or future energy production. This is because estimates of technically recoverable oil and natural gas lack any consideration of wellhead economics (e.g., productivity of well, drilling and production costs) or the infrastructure costs (e.g., roads, pipelines and compressor stations) and distance to market. That is, only a portion of technically recoverable oil and gas is actually economically recoverable.

If technically recoverable quantities are used for planning and policy purposes, the results will overestimate both the quantities of oil and natural gas that are economic to recover and the potential jobs created in local communities from oil and gas development.

Domestic oil and natural gas are now primarily produced from low permeability unconventional sources including oil and natural gas trapped in impermeable rock, shale oil and coal-bed methane. While technology has allowed more domestic production of unconventional oil and natural gas, it remains costly to produce. Oil and natural gas prices must be higher than drilling, production and transportation costs. Oil prices over $60 a barrel are needed to encourage investment in domestic oil and natural gas development.

Domestic producers have little incentive to invest when oil prices are at $50 per barrel – which is the suggested price from the Trump Administration. It is unlikely that $50 per barrel of oil will result in the production of more than a small fraction of the technologically recoverable resources or lead to a "drill baby drill" investment mentality. Having been burned by the financial losses from the last boom and bust cycle, banks and oil and natural gas companies are restraining capital expenditures.

At current prices only 44% of domestic offshore oil and less than 19% of domestic offshore natural gas are economically recoverable. While the economic recovery percentages do increase at higher prices, most American consumers would not consider the high price scenarios to represent affordable energy.

Estimates of economically recoverable oil and natural gas over a range of prices combined with estimates of development costs are essential information for developing U.S. energy policy and promoting more responsible oil and gas development on federal public land. Communities, concerned citizens and local politicians would be well served by demanding BLM resource management plans provide average mean estimates of economically recoverable resources. Conversely, resource estimates that have low probabilities and/or are only technically possible to recover should be viewed with skepticism.

Over the last 25 years there have been many heated debates about public lands being closed to oil and gas development that have divided communities. The focus solely on technically recoverable estimates for undiscovered resources on public land leads to debates that are divisive, but largely unnecessary. If the focus were on more realistic estimates of economically recoverable resources rather than much larger, but more uncertain estimates of technically recoverable resources, the debates would likely be less rancorous and more realistic.

Any notion that drilling in national monuments, roadless areas and critical wildlife habitat on public land will be the panacea that meets rising energy demand while reducing energy prices is misguided. The quantities of undiscovered economically recoverable oil and natural gas in these areas are too small to affect energy prices. This holds true even without considering the cost of infrastructure (i.e., roads and pipelines) and distance to markets.

There is not an abundance of oil and natural gas in public protected areas in the lower 48 states. There is no reason to trash our federal public lands in the myopic pursuit of fossil fuel dominance. Efforts to speed up the processing time for drilling permits will prove ineffective at lowering prices as industry consistently has a surplus of unused drilling permits. With 22.2 million acres under lease in the lower 48 states of which 9.9 million acres are under lease but not in production, it is clear that lack of access to public land is not a serious problem worthy of declaring an energy emergency.

The oil and natural gas industry has benefited from tens of billions in subsidies. The shale revolution would not have happened as quickly or at all without 60 years of government research, preferential treatment and subsidies.

Research and technological innovation have long time horizons which run counter to private industry's focus on short term profits and high discount rates. This is where governments long term perspective is needed to step in with research funding to improve energy security and speed up the pace and scale of discovery and innovation by the private sector.

The same logic and long-term societal benefits apply to the continuation of government research investments to spur technological innovations for harvesting renewable sources of energy. Walking away from past investments now will prove foolish in the long-run.

Whether the current administration believes in climate change or not, we are going to need renewable energy sources located close to load (e.g., rooftop solar panels), improved battery storage and more efficient delivery systems (e.g., community micro-grids) in the not-so-distant future. And finally, if job creation is to be considered, dollar for dollar there are significantly more jobs created from investments in energy efficiency and renewable energy than similar investments in oil and natural gas.

INTRODUCTION

Electricity prices are rising with forecasts for increasing demand from energy intensive data centers and the use of artificial intelligence. President Trump has issued an executive order declaring a national energy emergency, calling for increased energy production on federal lands. The Trump administration is doubling down on past "drill baby drill" policies for extracting oil and natural gas on federal public land.

While the Trump Administration is duplicating many policies from the past, it has rejected concerns about protecting our environment and is promoting energy dominance regardless of the cost. The pursuit of energy dominance is also inexplicably combined with serious disdain for renewable energy, conservation and efficiency.

We question whether the emphasis on fossil fuel dominance improves energy security and whether lack of access to public land is a serious problem worth declaring an energy emergency. We are also not convinced that rapidly producing and consuming our remaining domestic oil and natural gas resources will enhance energy security of future generations.

In Executive Orders "Unleashing American Energy"[3] and "Declaring a National Emergency[4]" federal agencies were directed to boost domestic energy production by expediting the reviews required by the National Environmental Policy Act (NEPA) and streamlining the permitting processes of the U.S. Department of Interior's Bureau of Land Management (BLM) for the development of oil and natural gas on U.S. public land. The administration also reversed restrictions on oil and gas development in the National Petroleum Reserve in Alaska, the Arctic National Wildlife Refuge and the Outer Continental Shelf. In addition, the Trump Administration ended the pause established by the Biden administration on liquefied natural gas (LNG) export projects.

Congress also passed legislation encouraging oil and natural gas drilling on federal public land. Provisions in the 2025 Reconciliation Act include mandatory quarterly lease sales on federal lands in Western states and Alaska; lowering the royalty rate; reinstating noncompetitive leasing; and eliminating the minimal $5/acre expression of interest fee.[5]

This isn't the first time we've seen forecasts of increasing demand and calls for "drill baby drill"

3 https://www.whitehouse.gov/presidential-actions/2025/01/unleashing-american-energy/

4 https://www.whitehouse.gov/presidential-actions/2025/01/declaring-a-national-energy-emergency/

5 https://www.congress.gov/bill/119th-congress/house-bill/1

policies for public land. The Trump Administration is aggressively pushing similar, but not identical, policies pursued by the Bush-Cheney Administration, including rescinding the 2001 roadless rule which limits development on 44.7 million acres of National Forest System lands.

However, while current political forces may favor fossil fuels, that doesn't change the economics of oil and natural gas production and how much is and isn't economically feasible to drill. To better understand current proposals from the Trump Administration, we return to 2001 when policies from the Bush-Cheney Administration encouraged domestic drilling, for historical perspectives on our current debate. Rational expectations suggest that what happened then is likely to happen again now.

In January 2001, the United States faced high natural gas prices and forecasts for rolling blackouts on the electrical grid. Energy demand was expected to increase from the additional demand associated with the dot-com bubble.[6] In response to the "energy crisis" President Bush issued Executive Orders 13211 and 13212 which required federal agencies to examine the effects of environmental regulations on energy supply and expedite the review of drilling permits on public land.[7] In March 2001, Energy Secretary Abraham stated, "The failure to meet this challenge will threaten our nation's economic prosperity, compromise our national security, and literally alter the way we live our lives" (U.S. Department of Energy 2001).

The George W. Bush Administration placed much of the blame for higher natural gas prices on Clinton Administration policies that protected roadless areas and national monuments, as well as having lease stipulations designed to protect fish and wildlife habitat (Morton et al. 2004).[8] In May 2001, Vice President Cheney's Task Force released its National Energy Plan calling for opening up more public land for oil and natural gas development and expediting environmental reviews (U.S. National Energy Policy Development Group 2001). The Energy Policy Act of 2005 included, among other things, $2.6 billion in oil and gas incentives, royalty relief for marginal oil and natural gas wells on public lands and increased access to federal lands (Congressional Research Service 2006).

In this paper we take the lessons learned from past efforts to increase domestic oil and natural gas production and provide economic background on how to speak realistically about undiscovered oil and natural gas resources and explain the difference between technically and economically recoverable resources. We examine factors guiding oil and natural gas investments, briefly summarize the history of market and non-market subsidies for oil and natural gas, and examine leasing and drilling trends on U.S. federal public land in the lower 48.

Section 2 provides background terminology followed by a discussion of factors used to guide investments in oil and natural gas in Section 3. In Section 4 we examine the historic role of market subsidies for encouraging oil and gas development with Section 5 introducing non-market subsidies. Section 6 looks at undiscovered oil and natural gas resources on public land with an analysis of drilling permits and decisions to drill in Section 7. Our paper ends with a discussion on energy policy, a review of key points and recommendations in Section 8.

2. BACKGROUND TERMINOLOGY

In May 2025, Secretary of the Interior Burgum released United States Geologic Survey (USGS) estimates of technically recoverable undiscovered oil and natural gas under federal public land in southwestern Wyoming, and small areas in northwestern Colorado and northeastern Utah (Hearon et al, 2025). Burgum stated that the estimates of undiscovered technically recoverable resources (UTRR) support job creation and domestic energy production (Burgum 2025).

6 The dot com bubble was fueled by irrational exuberance about the internet and speculative investments in startups and tech companies "that often had minimal revenues, unproven business models, and sometimes, no products or services at all" (Hren 2024). When the dot com bubble burst and the huge increase in energy demand never materialized it left many utilities with excess capacity and ratepayers footing the bill (DiGangi and Lutz 2025).

7 https://www.federalregister.gov/presidential-documents/executive-orders/george-w-bush/2001

8 Oil and gas leases include stipulations designed to protect wildlife and the environment by dictating where, how and when drilling activities may occur.

While estimates of UTRR are necessary, technically recoverable estimates alone, provide insufficient information for estimating jobs or future energy production. This is because estimates of technically recoverable oil and natural gas lack any consideration of wellhead economics (e.g., productivity of well, drilling and production costs) or the infrastructure costs (e.g., pipelines and compressor stations) and distance to market. Below we provide background terminology to better understand debates on drilling for undiscovered oil and natural gas on federal public land.

Oil is primarily used for transportation. The majority of domestic natural gas is used to generate electricity and for heating homes. A nation's total oil and natural gas endowment equals the oil and gas already produced, proven reserves and undiscovered resources. The U.S. has already produced a significant amount of oil and gas and has more producing wells than the rest of the world combined (Stanford 2024). As a result, the U.S. has depleted much of its oil and natural gas from conventional resources and is now producing a majority of its domestic oil and natural gas from unconventional resources.

Conventional oil and natural gas resources are located in substrate with naturally high permeability.[9] Unconventional resources are located in low permeability accumulations underground and require hydraulic fracturing to improve permeability and the flow of oil and natural gas (Stanford 2024). Unconventional resources include shale oil and natural gas, tight sands oil and natural gas, and coal-bed methane.

Oil and natural gas reserves are already discovered, known to exist, and are proven to be economically recoverable at current prices. In 2023, U.S. crude oil reserves were 46.4 billion barrels of oil (Bbo), with natural gas reserves of 603.6 trillion cubic feet (Tcf) (U.S. Department of Energy, Energy Information Administration 2025).[10] There is a clear distinction between discovered oil and natural gas in proven reserves and undiscovered oil and gas resources. While reserves are discovered and known to exist, estimates of undiscovered oil and gas resources are based on geologic knowledge and theory and cannot be produced until the oil and gas is proven to exist (Schenk et al. 2025).

To account for the uncertainty, undiscovered resources are estimated using a range of probabilities (Figure 1). The probabilities relate to the certainty the resource is actually there. Estimates of undiscovered resources based on a 95% probability are the smallest quantity, but the most reliable. This is because the quantity is estimated to have only a 5% chance of being incorrect (see, for example Chapter 1 in Siegel 1956). Estimated quantities based on a 5% probability are the largest but should be viewed with skepticism as the quantities are estimated to be incorrect 19 out of 20 times. Using resource estimates based on mean probability (the average with about a 50% probability of being incorrect) is a reasonable middle ground.

To illustrate the wide variability in probability-based resource estimates consider recent USGS estimates for SW Wyoming, NW Colorado and NE Utah (Table 1). The 5% probability estimate is 8 and 7 times larger than the 95% probability estimate for oil and natural gas respectively. Notably, the remaining undiscovered technically recoverable resources are almost entirely from unconventional resources; 96% and 99.5% for oil and natural gas respectively (Hearon et al. 2025).

9 With respect to oil and gas development, permeability is a measure of the relative ease of the rock, sediment, or soil for transmitting oil and gas based on how connected pore spaces are to one another. If the geologic formation has high permeability than pore spaces are connected, whereas with low permeability the pore spaces are isolated. https://geologyhub.com/permeability-definition-and-its-type/

10 Reserves estimates change from year to year because of changes to price and costs, production from existing reserves, new discoveries and improved technologies (U.S DOE EIA 2025).

Table 1. Undiscovered Technically Recoverable Oil and Natural Gas in Southwestern Wyoming Province, Wyoming, Colorado and Utah.

	95% Probability Estimate	Mean Probability Estimate	5% Probability Estimate
Undiscovered Oil (Million barrels)	117	473	962
Undiscovered Natural Gas (Billion cubic feet)	7,414	27,305	52,799

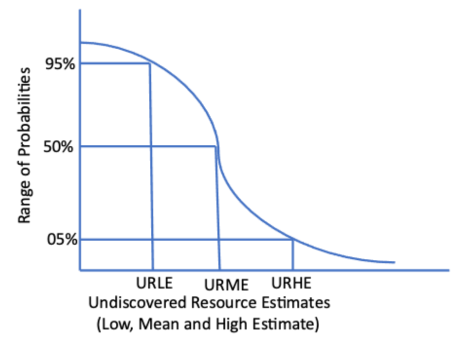
Data from Hearon et al. (2025).

Undiscovered technically recoverable resources (UTRR) include quantities of oil and/or natural gas in place estimated to exist in sufficient quantities for production with current technology. Undiscovered economically recoverable resources (UERR) are the portion of the UTRR estimated to be economically recoverable under current or expected future market conditions (Figure 2).[11] When estimating UERR, it is not just the price of oil or natural gas that matters. A great many assumptions must also be made about the many elements of cost, including labor, and material costs, interest rates and transportation costs.

Regions with similar amounts of UTRR may have very different amounts of UERR (U.S. Bureau of Ocean Energy Management 2021). For example, UTRR estimates for offshore Alaska amount to 24.69 Bbo with just 0.6 Bbo (2.4%) economically recoverable at $60/barrel. In comparison, offshore in the Gulf of Mexico has a similar amount of UTRR (29.59 Bbo) but a much larger amount of oil (19.84 Bbo 67%) that is economically recoverable at $60/barrel (U.S. Bureau of Ocean Energy Management 2021).

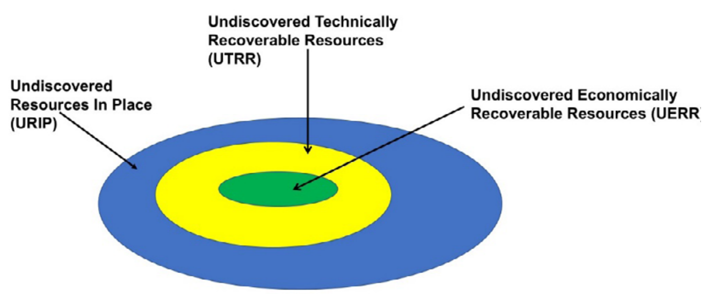
Estimates of the UERR over a range of oil and natural gas prices combined with estimates of development costs are essential information for developing U.S. energy policy and promoting more responsible oil and natural gas development on federal public land.

Figure 1. Example Graph of Relationship Between Probabilities and Estimated Quantities of Undiscovered Resources.



This figure shows the increasing estimates of undiscovered resources as probabilities of discovery decrease. There is a 95% probability of at least URLE of undiscovered oil and natural gas; a 50% probability of URME and a 5% probability of the largest estimate (URHE).

Figure 2. Categories of Undiscovered Resources.



Estimates of undiscovered economically recoverable resource (UERR) are smaller than estimates of undiscovered technically recoverable resources (UTRR) which in turn are smaller than undiscovered resources in place estimates (URIP).

3. MARKET FACTORS INFLUENCING INVESTMENTS IN OIL AND NATURAL GAS DEVELOPMENT

In the U.S., locating, drilling, and producing oil and natural gas has been revolutionized in recent years.[12] Driven by higher prices and technological change (e.g. fracking and horizontal drilling), U.S. oil and natural gas production have increased dramatically (Fitzgerald 2018). The U.S. is now the world's largest petroleum producer, became a net exporter of petroleum

11 These are all estimates in that nobody can predict what the economics will be in the future and no one really knows what is in the ground without drilling and testing.

12 Oil and natural gas drilling has caused significant environmental damage that must be acknowledged, but will not be the focus of this paper.

products in 2015,[13] and has tripled natural gas exports in the form of liquefied natural gas (LNG) since 2010 (U.S. Department of Energy, Energy Information Administration 2025).

A variety of factors influence domestic oil and natural gas investment decisions by banks, investors and industry CEOs. These include the prices of oil and gas, expected well productivity, drilling, operating and labor costs, distance to markets, global competition (e.g., OPEC production levels), changes in technology, interest rates, geopolitical conditions (e.g., military conflict in oil producing countries), market and political uncertainty.

Current oil and future oil prices are a primary factor for investing in oil and natural gas development. It is important to note that oil prices are determined in a global market and U.S. producers can only respond to world oil prices. Unlike larger OPEC nations, domestic oil producers have little control over oil prices. Domestic producers have global competitors in OPEC with further expectations of competition from international shale oil production.

In contrast, domestic natural gas prices are largely set in the US market. Efforts to increase exports of LNG will put upward pressure on natural gas prices for domestic consumers as global natural gas prices are higher. To the extent that exporting LNG increases natural gas prices for U.S. consumers, higher prices will also increase the quantities of economically recoverable resources.

A standard decision rule used by private owners is to sell more of a product as long as the product's price exceeds the incremental cost of producing (supplying) the product. If the price is less (or more) than the incremental cost, the owner would lose (or make) money producing and selling it. Economists explore this behavior by using the observed behavior of owners to analyze how they respond to various prices, by selling more or less of the product.

For oil and natural gas producers, this is an even more complex decision because of the extended timelines between permitting, exploring, drilling, and preparing wells for production. To explore oil and gas producer's behaviors, Newell and Prest (2019) collect data on how the owners of 164,000 oil and/or oil/gas wells respond to quarterly average oil and natural gas future prices from 2001 to 2015. The authors analyze three crucial oil and natural gas production decisions which must be made in order to produce more oil or gas for sale: (1) whether or not to drill a well: (2) how much time to take preparing a drilled well to produce oil and gas; and (3) how much to produce from the prepared well.

Overall, Newell and Prest (2019) find that the decision to drill is most responsive to changes in oil future prices. Decisions to drill in response to a 10% increase in oil future prices led to a 13% increase in drill completions for vertical wells and a 16% increase for horizontal wells. They also find owners of both well types respond very little to how quickly they produce from a newly drilled well and how much is produced from a prepared well. The Newell and Prest (2019) findings demonstrate that future oil prices are powerful determinants of producers' decisions to drill, but that, once the drilling decision is made, prices are less influential in well preparation and well production decisions.

While higher prices will promote investment, banks and investors do not like uncertainty. Banks and investors rely on rational expectations of future market conditions to make investment decisions. President Trump has introduced significant uncertainty as a result of his unpredictable tariff policies and the increase in geopolitical turmoil. As a result, we may be moving from rational expectations to irrational expectations leading to a more cautious investing environment.

Recent comments from oil and natural gas producers reflect this cautious attitude. The increase in uncertainty from the policies of the current administration is often cited as a problem (Federal Reserve Bank of Dallas 2025). The administration's tariffs on steel and aluminum, for example, have increased supply costs and the cost of oil and gas production. A stable and predictable tariff policy is critical for business investment planning. Another factor that

13 In 2015, Congress repealed the 1975 law that prohibited the export of crude oil produced in the United States.

can influence investment decisions are government subsidies which we cover in the next section.

SECTION 4. FEDERAL SUBSIDIES FOR OIL AND GAS DEVELOPMENT

Prices impact economically recoverable oil and gas, but subsidies do the same by either influencing the prices received, supporting technological improvements, or decreasing producers' costs. The oil and natural gas industry has a long history of benefitting from the federal government intervening in energy markets.[14] Congress has provided the oil and gas industry with tax credits, tax breaks, favorable accounting practices[15], limited liability from oil spills and exemptions from environmental laws. Below we briefly summarize studies quantifying oil and natural gas subsidies focusing on government funded research, tax credits and subsidies, low royalty rates and inadequate bonding.

The oil and gas industry has benefited from government funded research, for example, USGS mapping the location and potential recovery of oil and gas resources. Without the subsidies and government research, the production boom from unconventional sources of oil and natural gas would not have happened as quickly, if at all.

In 1976, Congress funded the Unconventional Gas Research Program. From 1976 through 1992 the U.S. government spent $220 million on unconventional gas research that developed resource inventories, estimated recoverable reserves, and generated new technologies for finding and producing unconventional natural gas that later became commercial technologies (U.S. Department of Energy 2007).[16]

Massachusetts Institute of Technology (2010) estimated that between 1978 and 2010, the total expenditure for the Department of Energy's natural gas research program was just over $1 billion. The Federal Energy Regulatory Commission (FERC) also funded natural gas research based on a surcharge on interstate pipeline gas volumes. Starting in 1978, the surcharge created a natural gas research fund in excess $3 billion over the life of the surcharge (Massachusetts Institute of Technology 2010).

Under the Windfall Profit Tax of 1980, Section 29 of the Internal Revenue Code established production tax credits for unconventional resources including oil from shale and tar sands; and natural gas from shale and tight gas formations. The value of the credit for tight sands gas was fixed at $0.52 per Mcf which at the time represented 25% of the price of natural gas. For shale gas and coal-bed methane, the value of the credit reached $0.96 per Mcf in 1991, representing nearly 50% of prevailing gas prices. (Burwen and Flegal 2013). The Section 29 credit expired in 1992 but covered natural gas production until 2002.

The Energy Policy Act of 2005 contained significant tax incentives for fossil fuel exploration and production as well as for its infrastructure. A 2011 report from Management Information Services quantified the cumulative energy subsides from 1950 to 2010 and found that fossil fuels received 70% of federal energy incentives, nuclear energy received 9% - with hydro, wind and solar receiving 20% (Management Information Services 2011). During this time period, the oil and natural gas industry received $490 billion in federal energy incentives (Management Information Services 2011).

The U.S. Department of Energy, Energy Information Administration (EIA) (2023) estimates from 2016 to 2022, the oil and gas industry received $9.3 billion in federal subsidies – about 5% of total energy-related subsidies. Subsidies included in the EIA report include tax expenditures, direct expenditures, research and development, and other financial assistance.

Lower royalty rates are another form of subsidy as they affect the net price received by oil and natural gas producers. While the federal royalty rate

14 States also offer subsidies and tax breaks to encourage oil and natural gas development.

15 For example, the percentage depletion allowance and the deduction for intangible drilling costs.

16 As noted by Julander (2011) "The Department of Energy was there with research funding when no one else was interested and today we are all reaping the benefits. Early DOE R&D in tight gas sands, gas shales, and coalbed methane helped to catalyze the development of technologies that we are applying today."

is 12.5% on produced oil and gas, many states have higher severance taxes (e.g. Montana 16.7%, Oklahoma 18.75%, Louisiana 21.9%) as well as varying royalty rates.

Up until this point we have discussed market subsidies that are "upfront" as they represent subsidies available before and during drilling and production. Another kind of subsidy occurs after production is over when bonding amounts are inadequate to cover the costs of plugging wells and reclaiming well pads. Reclamation costs are covered by surety bonds. Effective bonding policies require bonding amounts to be sufficient enough to cover plugging and reclamation costs (Morton and Kerkvliet 2025).

Legacy costs represent the costs to taxpayers from ineffective bonding policies. Legacy costs for taxpayers represent "back-end subsidies" for the oil and gas industry. Morton and Kerkvliet (2021) estimated $1.7–$13.7 billion in back-end subsidies from inadequate bonding for oil and natural gas wells on federal public land.

Rees et al. (2025) further broadened the suite of U.S. subsidies to include not only tax credits and tax breaks, but cheap access to public lands, regulatory loopholes, and back-end subsidies required to clean up abandoned wells. Using the broader definition, the authors estimate total oil and gas subsidies of $34.8 billion each year.

Oil and gas subsidies have declined in recent years as Congress shifted subsidies to favor renewable energy, energy conservation and efficiency. It is, however, important to remember the billions in subsidies spent to encourage the production from unconventional sources of oil and natural gas.[17]

SECTION 5. NON-MARKET SUBSIDIES

The previous section examines a suite of market subsidies for oil and natural gas development. A final source of subsidy occurs when non-market environmental costs from oil and natural gas development are not reflected in the prices of oil and natural gas. Environmental costs include damage to soils and vegetation, public health costs from air and water pollution, as well as reduced recreation visitation and fragmentation of wildlife habitat.

A core principle of neo-classical economic theory is that markets are only efficient when market prices reflect all costs and benefits. Costs not reflected in market prices are called "negative externalities". Markets fail to maximize net benefits when negative externalities exist. For energy markets to be economically efficient, the negative externalities from production and distribution must be fully included in the prices of the energy products bought and sold.

Negative externalities from energy production include the ecosystem services lost or damaged from the soil disturbance associated with oil and natural gas development.

From Morton and Kerkvliet (2025):

> *"Ecosystem services are the benefits provided by nature to humans in the forms of functions and products. Although classifications are evolving (see Chen and Sloggy 2023), typically there are four recognized types of ecosystem services: provisioning (e.g., food, wood); regulating (e.g., pollination, erosion control); cultural (e.g., bird and wildlife viewing); and supporting (e.g., soil building, nutrient recycling). Although there are many challenges, economists and other environmental scientists use a variety of methods to attach monetary values to ecosystem services and aggregate these values into useful spatial and temporal scales, such as ecotypes."*

Morton and Kerkvliet (2025) calculated lost ecosystem service costs (LESC) from oil and natural gas development on federal public land range from $26,051 to $250,709 per acre. Per acre LESC vary depending on the years of energy production, interim reclamation rates, and final restoration rates. Total

17 The U.S. is not the only country to provide subsidies for oil and gas development. Black et al. (2023) also use a broad definition of subsidies to estimate global fossil fuel subsidies of $7 trillion in 2022.

LESC for all 90,298 oil and natural gas producing wells on BLM-managed public lands resulted in $13 to $51 billion in LESC. The cumulative LESC from oil and natural gas development on U.S. public land represent tens of billions of non-market subsidies.

Accounting for LESC in BLM planning is recommended and is consistent with the Federal Land Policy and Management Act (FLPMA), the organic act for the BLM. FLPMA requires "a standard of care that prevents unnecessary or undue degradation, avoids permanent impairment, and ensures sustained yield of natural resources" (Pleune et al. 2021).

Morton and Kerkvliet (2025) propose expanding the use of impact fees to compensate the public for LESC from oil and gas development on federal public land. Traditionally, local governments charge impact fees to property developers to internalize the external costs of various types of development, such as new housing and business buildings. Impact fee revenue has been used to fund transportation, water and sewer systems, parks and open space, law enforcement, emergency services and affordable housing (Libby and Carrion 2004, Burge and Ihlanfeldt 2013). Charging companies LESC impact fees internalizes the damage to ecosystem services. Charging LESC impact fees would provide companies with an economic incentive for more responsible oil and gas development.

SECTION 6. UNDISCOVERED OIL AND NATURAL GAS RESOURCES ON FEDERAL PUBLIC LAND

With respect to drilling for undiscovered oil and natural gas resources on public land, economically recoverable quantities are relevant. Technically recoverable amounts might guide future investments in technological innovation, but economically recoverable quantities are more likely to guide oil and gas development investment decisions. This is because technically recoverable resources must also be profitable for oil and gas developers in order for them to make the investments and pay the costs necessary to bring the resources to market. In this section, we examine past reports on undiscovered oil and gas resources on federal public land including estimates of economically recoverable resources and access to those resources.

In 2001, the Bush Administration pushed to reduce and eliminate environmental regulations in order to increase supply from undiscovered oil and natural gas resources and reduce prices for consumers. In 2003, the U.S. Department of Interior and U.S. Department of Energy completed a series of reports examining oil and gas resources "off-limits" on public land. Unfortunately, these reports relied on UTRR estimates and chose not to include any consideration of economics even though USGS at the time had published reports with UERR estimates (see Attanasi 1998).

In its push to eliminate environmental regulations, the Bush Administration ignored the economic constraints on production, and as a result, the reports exaggerated the quantity of oil and gas potentially off-limits. By relying solely on UTRR estimates, the reports overestimated the opportunity costs from national monument designation, protecting roadless and recreation areas, and lease stipulations conserving fish and wildlife habitat.

Morton et al. (2002) developed GIS mapping techniques utilizing USGS UTRR data combined with production functions based on Attanasi (1998) to estimate technically and economically recoverable quantities of undiscovered oil and natural gas. The results indicated that the quantities of undiscovered, economically recoverable oil and natural gas in National Forest roadless areas and National Monuments managed by the BLM were not significant enough to affect energy prices. The USGS in its recent oil and gas assessment relied on similar percentage-based mapping methods for allocating previous UTRR estimates to federal land.

LaTourrette et al. (2002) also developed GIS methods and an economic model for estimating "economically viable" amounts of oil and natural gas from public land. The economic model examined: 1) exploration and production costs (well head viability); 2) infrastructure and transportation costs (infrastructure viability); and 3) environmental impacts. LaTourrette et al. (2002) concluded that much of the potentially restricted undiscovered oil and natural gas resources in the west would never be developed because they have low wellhead viability and/or high infrastructure costs.

The oil and natural gas leasing stipulations dictating where, how, and when exploratory drilling may be conducted in order to protect wildlife and the environment are not, in aggregate, binding constraints on energy production (Morton et al. 2004). Table 2 summarizes the above studies examining economic recovery rates for natural gas.

Table 2. Economic Recovery Rates for U.S. Onshore Technically Recoverable Natural Gas Based on Prices of $2.30 and $3.90 (2001$) per Thousand cubic feet (Mcf)

Region	USGS Economic Recovery Rates [18]
United States	38 – 46%
Rockies and Northern Plains	13 – 18%
Southwestern Wyoming	1 – 5%

Data from Root et al. 1997, Attanasi 1998, LaTourrette et al. 2002, Morton et al. 2004.

In a RAND follow-up study for the Green River Region of Wyoming, LaTourrette et al. (2003) estimated that 35 to 45% of the UTRR of natural gas was UERR at $3/MMBtu. If prices increase to $5/MMBtu, 52 to 65% of UTRR could be economic to recover.

Fast forward to 2025, and the USGS (Schenck et al. 2025) updated its mean estimates for undiscovered oil and natural gas resources under federal onshore public lands. USGS previously included onshore estimates for both UTRR and UERR. The current USGS assessment only provides estimates for UTRR. For federal land, the USGS provides a mean estimate of 29.4 Bbo of technically recoverable oil and 391.6 Tcf of technically recoverable natural gas.

The updated totals are an increase from the USGS (1995) estimates of 7.86 billion barrels and 201.1 Tcf of technically recoverable oil and natural gas from federal public lands. The increase is because the 1995 assessment primarily examined conventional oil and gas resources, while the current assessment includes the increase in undiscovered unconventional accumulations of oil and natural gas in the last 25 years. While the increase may look substantial, assuming all of the undiscovered technically recoverable oil and natural gas under federal land are economic to produce, the total amount would only be enough oil to meet US demand for 4 years and enough natural gas to satisfy current domestic consumption for about 12 years (Schenck et al. 2025).

Unfortunately, the recent USGS assessment did not include an updated economic model to estimate whether it would be profitable to produce these resources at the wellhead. As noted (Schenck et al. 2025), the costs of the infrastructure required to produce these resources was also not considered in the assessment.

We are unaware of any recent estimates of economically recoverable oil and natural gas on federal public land in the lower 48. Given the short-term importance of oil and natural gas to the U.S. economy, it is surprising that funding USGS economists to update estimates of onshore UERR has not been a political priority for either major party. To fill the economic information void, below we briefly review recent studies to provide some indication of the gap between technologically and economically recoverable oil and natural gas.

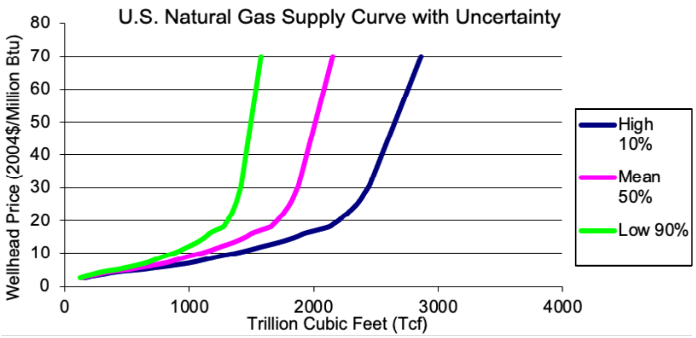
Massachusetts Institute of Technology (2010) examined the economics of domestic natural gas supply from public and private land (Figure 3). Their results indicate that much higher prices are needed to convert a majority of technically recoverable natural gas to economically recoverable natural gas.

Amadani (2010) estimated UTRR and UERR for natural gas in the Barnett shale play in Texas. The author estimated that 10% of the technically recoverable natural gas could be recovered at a natural gas price of $7.72 per thousand cubic feet (mcf), 50% at $13.67/mcf, and 90% at $68/mcf. For perspective, current natural gas prices are less than $5/mcf.[19]

18 Percent of technically recoverable natural gas in reserves and left undiscovered that is profitable to extract (before accounting for environmental-related costs). Excludes recovery rates for offshore natural gas.

19 https://www.eia.gov/dnav/ng/hist/n3035us3M.htm

Figure 3. U.S. Natural Gas Supply Curves (Public and Private Land).



Data from MIT (2011) The Future of Natural Gas. Appendix 2C, 2007 Cost Index.

Smith (2018) estimated UTRR and UERR at various price levels for the Bakken shale oil play in the Williston Basin of North Dakota (Table 3). Smith (2018) estimated 17 Bbo of undiscovered technically recoverable oil. The author estimated 50% of the remaining undiscovered technically recoverable resources could be developed at prices near $50/barrel. Recovering 71% of UTRR would require prices to rise to $128/barrel. It would take prices over $1,100 per barrel to recover 98% of UTRR oil. The high price scenarios would not be considered affordable energy to most U.S. consumers and businesses.

Table 3. Estimates of UTRR and UERR for Williston Basin of North Dakota.

UTRR Bbo	UERR (Bbo) $18/barrel	UERR (Bbo) $47/barrel	UERR (Bbo) $128/barrel	UERR (Bbo) $374/barrel	UERR (Bbo) $1,141/barrel
16.996	3.178	7.153	12.036	15.353	16.670
	19% UTRR	42% UTRR	71% UTRR	90% UTRR	98% UTRR

Data from Smith 2018.

The most recent source of information is the U.S. Bureau of Ocean Energy Management (2021) which provides estimates of both UTRR and UERR for offshore oil and natural gas using a range of prices.[20] Table 4 and 5 show the percentage of UTRR for offshore oil and natural gas that is economically recoverable at various prices.

Table 4. Estimates of UTRR and UERR for U.S. Offshore Oil.

Price Per Barrel	UTRR Offshore Oil	UERR Offshore Oil	UERR Offshore Oil
Dollars	Billions of barrels	Billions of barrels	Percent of UTRR
$30	68.79	13.88	20%
$40	68.79	21.32	31%
$60	68.79	30.11	44%
$100	68.79	40.12	58%
$160	68.79	48.95	71%

Data from U.S. Bureau of Ocean Energy Management 2021.

Table 5. Estimates of UTRR and UERR U.S. Offshore Natural Gas.

Price Per MCF	UTRR Offshore Natural Gas	UERR Offshore Natural Gas	UERR Offshore Natural Gas
Dollars	Trillion Cubic Feet	Trillion Cubic Feet	Percent of UTRR
$1.60	229.03	11.63	5%
$2.14	229.03	18.32	8%
$3.20	229.03	28.44	12%
$5.34	229.03	42.83	19%
$8.54	229.03	63.77	28%

Data from U.S. Bureau of Ocean Energy Management 2021.

20 The USGS and BOEM do not include discovered proven reserves in its estimates, nor do they include reserves that have already been produced.

Three observations about these tables. First, at current prices around 44% and 12% of the offshore oil and natural gas respectively are economically recoverable illustrating the importance of UERR estimates. Second, at the highest prices modelled, the economic recovery percentages increase to 71% for oil and 28% for natural gas. And third, most American consumers would not consider the higher price scenarios to represent affordable energy.

The consistent result from all of these studies reinforces the following: 1) there is a big difference between UTRR and UERR; 2) relying on UTRR in planning and policy will overestimate economically recoverable resources; 3) relying on UTRR for economic impact studies will overestimate jobs from oil and gas development; 4) economic recovery percentages increase at higher prices; and 5) the higher prices required for production draw into question whether domestic oil and natural gas represent affordable energy in the long term. Declining trends in leasing and drilling on public land reflect this economic reality.

SECTION 7. ANALYSIS OF LEASING AND DRILLING TRENDS ON PUBLIC LAND

In this section, we examine trends in leasing and drilling activity on public land over the last 25 years. Figure 4 shows trends beginning with the 50,000 total number of leases administered by BLM in 2001. Total leases adjust each year with expired leases subtracted and new leases added each year up to 2024, the latest year data are available. There will be a legacy with leases, because BLM issues leases with ten-year terms, but this may be extended if "qualifying drilling operations are in progress; the lease contains a well capable of producing in paying quantities; or the lease is entitled to receive an allocation of production from an off-lease well".[21]

Figure 5 shows the trend of new BLM leases issued each year from 2001 to 2024 (as compared with total leases each year). In both Figures 4 and 5, the overall trend of leasing activity is downward. In Figure 5 the trend shows more variation, with increases in new leases occurring from 2003-2007, 2010-2011, and 2016-2019. Some of these increases in new leases may be due to different administrations, but further investigation may reveal other causes. Figure 5 also illustrates oil prices measured as the price of oil futures each fiscal year, adjusted for inflation to 2024 dollars. The pattern of oil future prices is roughly the same as oil prices in Figure 4, although with a slightly more declining pattern. Despite the spike in oil prices from 2020-2022, the total number as well as the number of new leases continued to drop, revealing the declining interest in leasing public land.

21 https://www.blm.gov/programs/energy-and-minerals/oil-and-gas/leasing/general-leasing

Figure 4. Total Number of Leases on Federal Lands and Oil Prices.

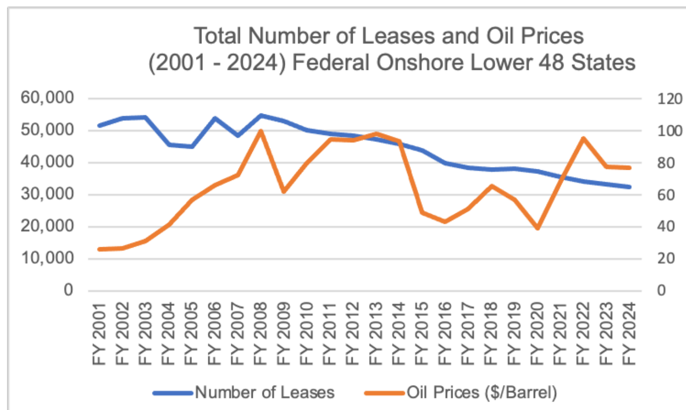


Figure 5. New Leases on Federal Lands and Oil Future Prices.

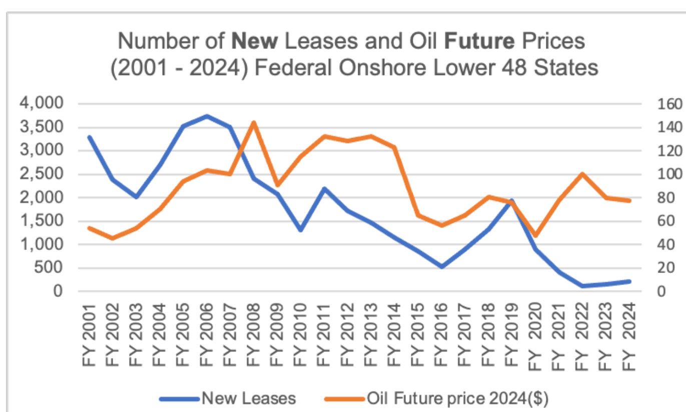


Figure 6. Acres Under Lease and Leased Acres in Production.

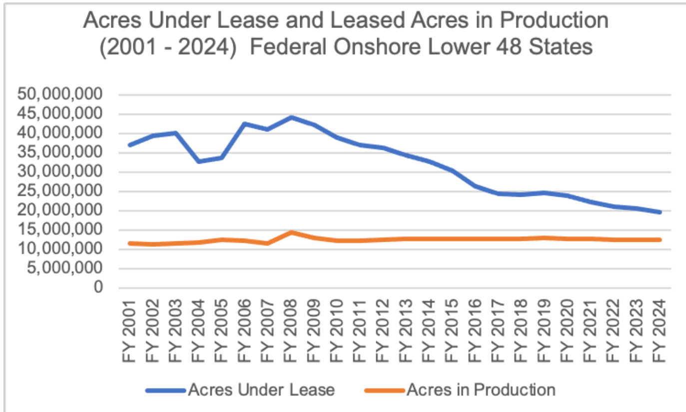
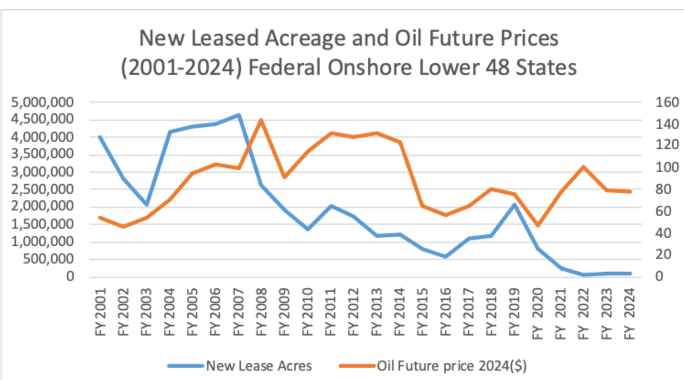


Figure 6 shows the decline in total acres under lease, while acres in production have been relatively flat. There is no lack of access, as acres leased are consistently greater than acres in production. And Figure 7 shows a similar decline in new acres leased, again suggesting a lack of interest.

Figure 7. New Acres Leased and Oil Future Prices.



In 2024, nearly 40% of lease acres were not in production (Figure 8). Hjerpe et al. (2021) estimated that non-producing leases can support 75 years of future drilling opportunities on all U.S. federal lands. Which raises the question: Why should the BLM spend taxpayer dollars to lease more public land when industry has 9.9 million acres under lease that they have chosen not to drill?

There are a variety of reasons why companies may lease land and choose not to drill. Having more acres under lease looks good on a company's balance sheet and can be used to attract investors. Companies might lease land to limit competition. The rental rates and holding costs are very low. Given the low costs, speculation is also a possibility, hoping perhaps for a buyout. And finally, companies may not drill because they determined the undiscovered oil and natural gas resources are not economically recoverable at current prices or future prices that can be reasonably expected.

Figure 8. Percent of Federal Onshore Leased Acres Not Producing.

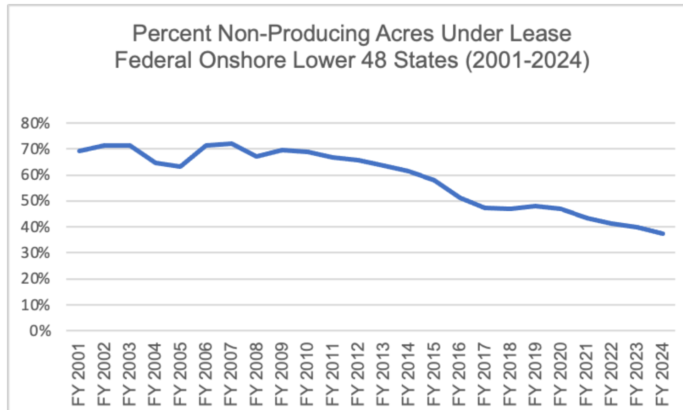
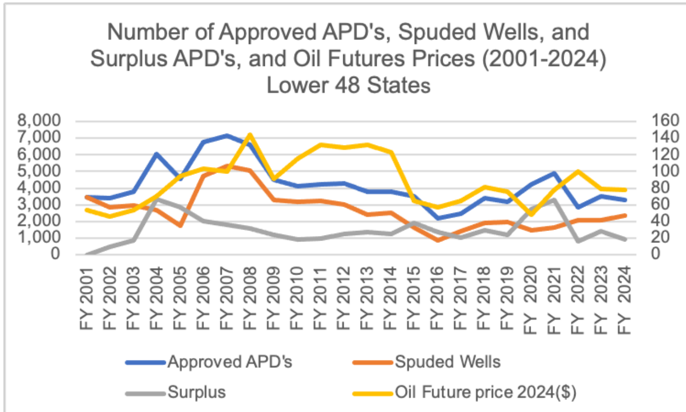


Figure 9 shows the time trend of the number of BLM approved Applications for Permit to Drill (APDs), the number of initiations of drilling (spudding), the difference between the two (surplus of unused APDs), and the price of oil futures. Before drilling can begin an operator must submit an APD and BLM must approve it. BLM approval is contingent upon the operator meeting the requirements of the National Environmental Policy Act, the National Historic Preservation Act, and the Endangered Species Act. An APD includes a Surface Management Plan, wherein the operator details the plan for interim reclamation and long-term restoration of the drill site (see Morton and Kerkvliet 2025 for details). Drilling cannot be initiated without an approved APD. Until 2026, an approved APD was valid for two years, with a two-year extension possible. After 2026, an APD will be valid for three years with no extension possible.

Figure 9. Trends in Applications for Permit to Drill (APDs) on Federal Public Land.



The time trend of APDs and well spuds is slightly downward with high points in 2005-2008 and 2020-2022. Declining APDs and well spuds continue during the high oil future prices of 2009-2015. Surplus permits per year average about 1500 and have remained fairly constant from 2008-2024 except for a spike during the first Trump Administration when oil future prices fell during the COVID pandemic. There was a similar spike in surplus APDs during the Bush-Cheney years. The increasing surplus of APDs suggests that increasing the number of APDs issued may simply increase the stockpiling of unused APDs. Industry stockpiles surplus APDs because BLM allows it and the holding costs for industry are very low.

The overall trends indicate that: 1) the number of APDs issued by the BLM are always greater than the number of wells drilled resulting in a surplus of unused APDs; 2) there is no shortage of APDs evident from the surplus of unused APDs each year; 3) there is no shortage of leased acres as industry has more acres under lease than in production; and 4) the long-term trend is a declining interest in leasing public land for oil and gas development.

SECTION 8. DISCUSSION AND CONCLUSION

U.S. energy policy has traditionally focused on three major goals: assuring a secure supply of energy, keeping energy costs low, and protecting the environment (Yacobucci 2015). The National Energy Plan (2001) developed by the Bush-Cheney Administration included the following goals: 1) modernize conservation; 2) modernize our energy infrastructure; 3) increase energy supply; 4) accelerate the protection and improvement of the environment; and 5) increase national security.

While the Trump Administration is duplicating many policies from the past, it has rejected protecting our environment as a policy goal, and is promoting energy dominance regardless of the cost or whether such a goal is even strategic.

We question whether energy dominance or energy independence are consistent with improving energy security. We are not convinced that rapidly producing and consuming our remaining domestic oil and natural gas resources will enhance energy security of future generations. Energy independence should not be confused with strengthening U.S. energy security (National Petroleum Council 2007), nor should it be confused with controlling the price of oil, as this is determined internationally.

As noted by NPC in 2007:

> *"The concept of energy independence is not realistic in the foreseeable future, whereas U.S. energy security can be enhanced by moderating demand, expanding and diversifying domestic energy supplies, and strengthening global energy trade and investment. There can be no U.S. energy security without global energy security."*

The pursuit of energy dominance is being coupled with the curtailment of renewable energy, conservation and efficiency. The Trump administration is not really pursuing energy dominance, rather it is focused on fossil fuel dominance. What happened to the "all of the above" energy policies from previous administrations?

Energy demand can be moderated by encouraging homeowner investments in energy efficiency (e.g., programmable thermostats, home weatherization, heat pumps) and renewable energy (e.g., passive solar) can directly lower heating bills for consumers.

Technological advancements continue to decrease the cost of geothermal, solar and wind power. Conservation, energy efficiency and renewable energy are critical components of a sound energy policy regardless of one's opinion of climate change.

It's a sad state of affairs when in today's political environment, the Bush-Cheney National Energy Plan would be lambasted as a "radical left green scam" with all its discussion on renewables, energy efficiency, conservation and protecting the environment.[22]

While the Trump Administration has tried to blame environmental regulations for our energy emergency, regulations might slow the process, but an unstable trade policy, tariffs and global unrest will have a greater effect on investment decisions than the costs of complying with environmental regulations.

More importantly, complying with well-designed environmental regulations can lead to technological innovation. Berman and Bui (2001) found that in meeting more stringent environmental standards, oil refineries actually increased their productivity and efficiency. Managi et al. (2005) similarly found that environmental regulations induced technological change in the oil and natural gas industry.

As discussed, a nation's total oil and natural gas endowment equals the oil and natural gas already produced, proven reserves and undiscovered resources. The U.S. has already produced a significant amount of oil and natural gas primarily from conventional resources in substrate with naturally high permeability. Conventional natural gas production began to decline in the early 1970s.

U.S. oil and gas production has now transitioned to low permeability unconventional continuous accumulations (e.g., oil and natural gas trapped in impermeable rock, shale oil and coal-bed methane). A majority of domestic oil and natural gas is now produced from unconventional resources, not because they were cheaper to produce but by necessity.

Fracking and horizontal drilling technologies have made the U.S. the top producer of oil in the world. This achievement was not without effort: we have drilled more producing oil wells than the rest of the world combined. Unfortunately, domestic oil production per well is the lowest in the world (Stanford 2024).

While technology has allowed more production from unconventional sources of oil and natural gas, it is costly to produce. Prices over $60 a barrel are needed to encourage investment in domestic oil and natural gas development (Federal Reserve Bank of Dallas 2025). Domestic producers of oil located outside the best locations in the Permian Basin, need an oil price of around $80 per barrel to cover the cost of drilling wells (Hamm cited in Paraskova 2025).

Domestic producers have little incentive to invest when oil prices are at $50 per barrel – which is the suggested price from the Trump Administration. It is unlikely that $50 per barrel of oil will result in the production of more than a small fraction of the technologically recoverable resources or lead to a "drill baby drill" investment mentality. Having been burned by the financial losses from the last boom and bust cycle, banks and oil and natural gas companies are restraining capital expenditures.

With respect to onshore public land, any notion that drilling in national monuments, roadless areas and critical wildlife habitat on public land will be the panacea that meets rising energy demand while reducing energy prices is misguided. The quantities of undiscovered economically recoverable oil and natural gas in these areas are too small to affect energy prices. And that is true without even considering the cost of infrastructure (i.e., roads and pipelines) and distance to markets. There is not an abundance of oil and natural gas in public protected areas in the lower 48 states.

Efforts to speed up the processing time for APDs will not solve our energy crisis. For the last 25 years, industry has consistently had a supply surplus of unused APDs. Speeding up the APD processing time will increase the APD supply surplus but may not increase the rate of drilling especially if oil prices are $50 per barrel.

Similarly, opening up more public land for leasing may increase total acres leased, but may not in-

22 This is not an endorsement of the plan, just an observation of the current political environment.

crease drilling rates or production levels if oil and natural gas prices are less than the cost of exploration and production. Policies to increase the acres leased and to approve more APDs will be ineffective at reducing domestic energy prices.

With 22.2 million acres under lease in the lower 48 states of which 9.9 million acres are under lease but not in production (U.S. Department of the Interior Bureau of Land Management 2024a), it is clear that lack of access to public land is not a serious problem worthy of declaring an energy emergency.

A recent survey of oil and gas executives asked whether oil and natural gas production from federal land would increase as a result of the Trump Administration lowering federal royalty rates and increasing federal lease offerings. The top response was for slight increase, chosen by 58% of oil executives and 55% for natural gas. The second most selected response, for both oil and natural gas executives, was no change in production from federal lands, while only a small percentage selected significant increase (Federal Reserve Bank of Dallas 2025).

As we move forward, communities, concerned citizens and politicians would be well served by demanding BLM resource management plans provide average mean estimates of economically recoverable resources. Conversely, they should view skeptically resource estimates that have low probabilities and/or are only technically possible to recover. Continuing to rely on UTRR estimates in BLM planning will overestimate the quantities of oil and natural gas that are economically recoverable. Utilizing UTRR in economic impact studies will overestimate the potential jobs created in local communities from oil and gas development.

Over the last 25 years, there have been many heated debates about public lands being closed to oil and gas development that divided communities. In the past, BLM plans based solely on UTRR estimates for undiscovered resources on public land led to political debates that were divisive, but largely unnecessary. If BLM planners utilize more realistic estimates of economically recoverable resources rather than much larger, but more uncertain estimates of technically recoverable resources, the debates would likely be less rancorous and more realistic.

We recommend funding USGS economists to update methods and estimates of onshore UERR for federal public land. Supplemental methods should also be developed to internalize the negative externalities (e.g. air and water pollution, lost ecosystem service costs) when estimating economically recoverable quantities of oil and natural gas.

U.S. consumers have made significant investments in renewable energy, efficiency and conservation, which moderate our demand for fossil fuel energy. All those gains are in the process of being lost as a result of two energy intensive sectors: crypto currency and hyper scaling AI data centers. American consumers wanting to keep past gains can choose to not invest in crypto currencies, limit their use of AI and seriously question the construction of large data centers.

The oil and natural gas industry has benefited from tens of billions in subsidies. The shale revolution would not have happened as quickly or at all without 60 years of government research, preferential treatment and subsidies.

Research and technological innovation have long time horizons which run counter to private industry's focus on short term profits and high discount rates. This is where governments long term perspective is needed to step in with research funding to improve energy security and speed up the pace and scale of discovery and innovation by the private sector. As noted by Burwen and Flegal (2013) "Energy technology innovation is inherently uncertain, and aiming for game-changing breakthroughs requires a long-term perspective. Innovation does not occur on a linear path."

The same logic and long-term societal benefits apply to the continuation of government research investments to spur technological innovations for harvesting renewable sources of energy. Walking away from past investments now will prove foolish in the long-run.

Whether the current administration believes in climate change or not, we are going to need renewable energy sources located close to load (e.g. rooftop solar panels), improved battery storage and more efficient delivery systems (e.g., community micro-grids) in the not-so-distant future. And finally, if job creation is to be considered, dollar for dollar there are significantly more jobs created from investments in energy efficiency and renewable energy than similar investments in oil and natural gas development (See Laitner et al. 1998).

GLOSSARY

APDs = Applications for Permit to Drill

Bbo = Billion barrels of oil

Conventional resources = oil and natural gas resources located in substrate with naturally high permeability.

Economically recoverable resources = quantities of oil and natural gas estimated to be economically recoverable under current or expected future market conditions.

LNG = Liquefied natural gas

Mcf = Thousand cubic feet

Reserves = oil and natural gas reserves are known to exist, already discovered, and proven to be economically recoverable at current prices.

Tcf = Trillion cubic feet

Technically recoverable resources = quantities of oil and natural gas estimated to exist in sufficient quantities for production with current technology without consideration of economic costs or prices.

Unconventional resources = shale oil and natural gas, tight sands oil and natural gas, and coal-bed methane located in low permeability continuous accumulations. Typically requires hydraulic fracturing to improve permeability and flow of oil and natural gas.

Undiscovered resources = undiscovered oil and gas resources are based on geologic knowledge and theory and cannot be produced until the oil and gas is proven to exist.

UERR = Undiscovered Economically Recoverable Resources

UTRR = Undiscovered Technically Recoverable Resources

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