Larch Occasional Paper #23 ***August 2018***

New U.S Outer Continental Shelf Oil and Gas Exploitation: Costly and Short Lived

by Andy Kerr

Abstract

The Trump administration is proposing to open up vast areas of the United States Outer Continental Shelf (OCS) to leasing for oil and gas, far larger than the area made available under the Obama administration. Such exploitation would threaten numerous economically, ecologically, and socially important oceanscapes and adjacent coasts and would have other significant environmental and social costs. At the current market price for oil (~$60/barrel) and its equivalent price for natural gas, the economically exploitable oil and gas in the OCS would fuel the United States for ~eight and ~four years respectively. The amount of carbon dioxide pollution released into the atmosphere by burning that oil and gas would be ~31 billion tonnes. As a result, atmospheric carbon dioxide levels would increase ~4.0 parts per million. The minimum cost to society as a whole of exploiting that oil and gas would be ~$1.3 trillion.

Figure 1. *Coming soon to an ocean near you? The* Deepwater Horizon *oil spill disaster started April 20, 2010. BP did not declare the well sealed until September 19, 2010.* Source: Wikipedia

Unfun Facts

The US Bureau of Energy Management (BOEM) has made estimates of how much "undiscovered" oil and gas under the US Outer Continental Shelf (OCS) could be discovered and then exploited. BOEM has estimated the total possible amount of exploitable oil and gas, which it calls undiscovered technically recoverable resources (UTRR). BOEM has also estimated how much of this oil and gas would be exploited at various price points, which it calls undiscovered economically recoverable resources (UERR). This report generally focuses on the UERR at $60/barrel of oil (and its gas equivalent of $3.20 per thousand cubic feet [Mcf]), hereafter "$60 UERR."

Amount of time the United States could be fully fueled by oil and gas from the OCS at 2017 rates of consumption:

- UTRR: **~17 years**
- $60 UERR respectively: **~8 and ~4 years**

Estimated price necessary to exploit every last UTRR barrel of oil and cubic foot of gas:

- UTRR oil: **~$390/barrel**
- UTRR gas: **~$22/Mcf**

Amount of carbon dioxide dumped into the atmosphere from the burning of:

- UTRR: **~66 billion tonnes**
- $60 UERR: **~31 billion tonnes**

Equivalent years of total 2015 US carbon dioxide pollution from:

- UTRR: **~10 years**
- $60 UERR: **~5 years**

Increase in global atmospheric carbon dioxide levels from exploiting:

- UTRR: **~8.4 parts per million**
- $60 UERR: **~4.0 parts per million**

Number of estimated chronic (frequent, relatively small, and routine) oil spills and amount of oil spilled from exploiting all $100 UERR:

- **5,571 spills**
- **~34.4 million gallons**

Number and magnitude of iconic (infrequent and catastrophic) oil spills—such as the Santa Barbara, *Exxon Valdez,* and BP *Deepwater Horizon* spills—from additional or existing US offshore oil and gas exploitation:

- unknown, but highly probable

Societal cost of carbon dioxide pollution:

- UTRR: **~$3.3 trillion**
- $60 UERR: **~$1.3 trillion**

Projected 2018 federal government expenditures: **~$3.3 trillion.**

Note: The calculation of and/or the sources of all unfun facts are fully documented in the body of this report.

Table of Contents

List of Tables

List of Figures

Abbreviations Used in this Report

b	barrel of oil (42 US gallons)
Bbo	billion barrels of oil
BOE	barrel of oil equivalent (includes both oil and gas, factoring in the energy content)
BOEM	Bureau of Ocean Energy Management
C	carbon
CH_4	methane
CO_2	carbon dioxide
GHG	greenhouse gas
Gt	gigatonne (one billion tonnes)
GtC	gigatonne of carbon
$GtCO_2$	gigatonne of carbon dioxide
GWP	global warming potential
H_20	water
O&G	oil and gas
OCS	Outer Continental Shelf
OSCLA	Outer Continental Shelf Lands Act of 1953, as amended
ppm	parts per million
SCC	Social Cost of Carbon
SC-CO2	Social Cost of Carbon-Carbon Dioxide
Tcfg	trillion cubic feet of gas
tonne	1,000 kilograms, also known as a metric ton
UERR	undiscovered economically recoverable resources
US	United States
UTRR	undiscovered technically recoverable resources

Executive Summary

This report answers five key questions about the Trump administration's proposed massive expansion of United States Outer Continental Shelf oil and gas exploitation:

Key Question #1: How long could US offshore oil and gas fuel the nation?

Key Question #2: What amount of atmospheric carbon pollution would result from burning the oil and gas in the OCS?

Key Question #3: What amount of chronic oceanic oil pollution would result from exploiting the oil and gas in the OCS?

Key Question #4: What risk of catastrophic acute oceanic oil pollution would result from exploiting the oil and gas in the OCS?

Key Question #5: What financial costs to society from increase in CO2 emissions that would result from exploiting the oil and gas in the OCS?

We begin with some background about the OCS and the oil and gas leasing plans of this and the previous administration. We then examine the location and possible extent of new offshore oil and gas wells to get an idea of how much oil and gas we're talking about. That information is a prelude to answering the five questions above. We then consider both the economics and politics of exploiting OCS oil and gas before ending with some recommendations.

This executive summary includes no links to sources, but all are fully documented in the body of this report.

The Trump Administration's Draft Proposal

The Outer Continental Shelf Lands Act of 1953 requires the administration to offer leasing plans every five years. The Trump administration has proposed a draft plan for 2019–2024, which would replace the Obama administration plan for 2017–2022. The draft Trump administration plan (Figure ES-1) would "make more than 98 percent of the OCS available to consider for oil and gas leasing during the 2019–2024 period," consisting of

> *47 lease sales in all four OCS regions and includes 25 of the 26 planning areas: 19 lease sales in the Alaska Region (3 in the Chukchi Sea, 3 in the Beaufort Sea, 2 in Cook Inlet, and 1 sale each in the 11 other available planning areas in Alaska), 7 lease sales in the Pacific Region (2 each for Northern California, Central California, and Southern California, and 1 for Washington/Oregon), 12 lease sales in the Gulf of Mexico (GOM) Region (10 regionwide lease sales for the portions of the Central, Western, and Eastern GOM planning areas that are not currently under moratorium, and 2 sales for the portions of the Central and Eastern GOM planning areas that will no longer be under moratorium in 2022),*

and 9 lease sales in the Atlantic Region (3 sales each for the Mid- and South Atlantic, 2 for the North Atlantic, and 1 for the Straits of Florida).

In contrast, the Obama plan would authorize eleven lease sales, one in Alaska next to state waters already leased, and ten more in the Gulf of Mexico.

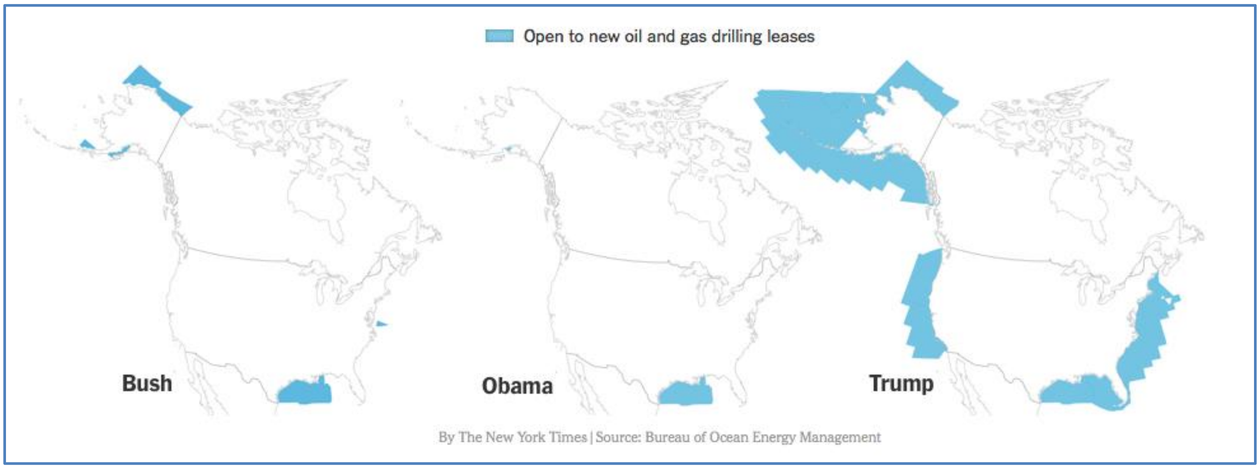


Figure ES-1. *Areas of the Outer Continental Shelf (OCS) open to new oil and gas drilling under three presidents. The Trump administration proposes opening most of the OCS to oil and gas exploitation.* Source: *New York Times*

Extent and Possible Location of "Undiscovered" Offshore Oil and Gas

The US Department of the Interior's Bureau of Ocean Energy Management (BOEM) estimates offshore oil and gas (O&G) potential by massaging existing geological information. It has created estimates for each of the twenty-six planning areas in the US OCS. Four planning areas offshore Alaska are estimated to have "negligible" petroleum potential (though a reasonable interpretation of the BOEM price and volume data suggests "negligible" could be applied to at least sixteen of the other twenty-two planning areas evaluated by BOEM). The only serious amounts of new oil and gas are in the Gulf of Mexico and offshore northern Alaska.

Still, BOEM has categorized twenty-two of its twenty-six OCS planning areas as having "undiscovered technically recoverable reserves" (UTRR) of O&G, a subset of which are "undiscovered economically recoverable reserves" (UERR). Here are BOEM's definitions:

- UTRR is *oil and gas that may be produced as a consequence of natural pressure, artificial lift, pressure maintenance, or other secondary recovery methods, but without any consideration of economic viability; primarily located outside of known fields.*

- UERR is *the portion of undiscovered technically recoverable resources that is economically recoverable under imposed economic and technologic conditions*.

This paper examines both UTRR and UERR. It assumes a UERR price of $60/barrel of oil and its equivalent price for gas. Oil is trading at ~$70/barrel in mid 2018.

While one might think it impossible to quantify something that has not even been discovered yet (if ever), this is a common practice in the fossil fuel industry. It is, at best, a best guess. BOEM projects UTRR numbers for each planning area and national totals at three different probability levels: 95 percent, mean, and 5 percent. The lowest number for oil, gas, and barrels of oil equivalent (BOE, which includes both oil and gas, factoring in the energy content) has a 95-percent probability of actually being there, while the highest number has only a 5-percent probability. In between is the expected amount of oil and gas at the mean probability between 95 percent and 5 percent, effectively a 50-percent probability or a 50-50 chance.

BOEM gives a 50-50 chance (a mean probability) that UTRR of ~90 billion barrels of oil and ~327 trillion cubic feet of gas are waiting to be discovered in federal ocean waters. In terms of energy content, roughly one-half is in the Gulf of Mexico, one-third is offshore Alaska, one-thirteenth is off the Atlantic coast, and one-twelfth is off the Pacific coast (Figure ES-2).

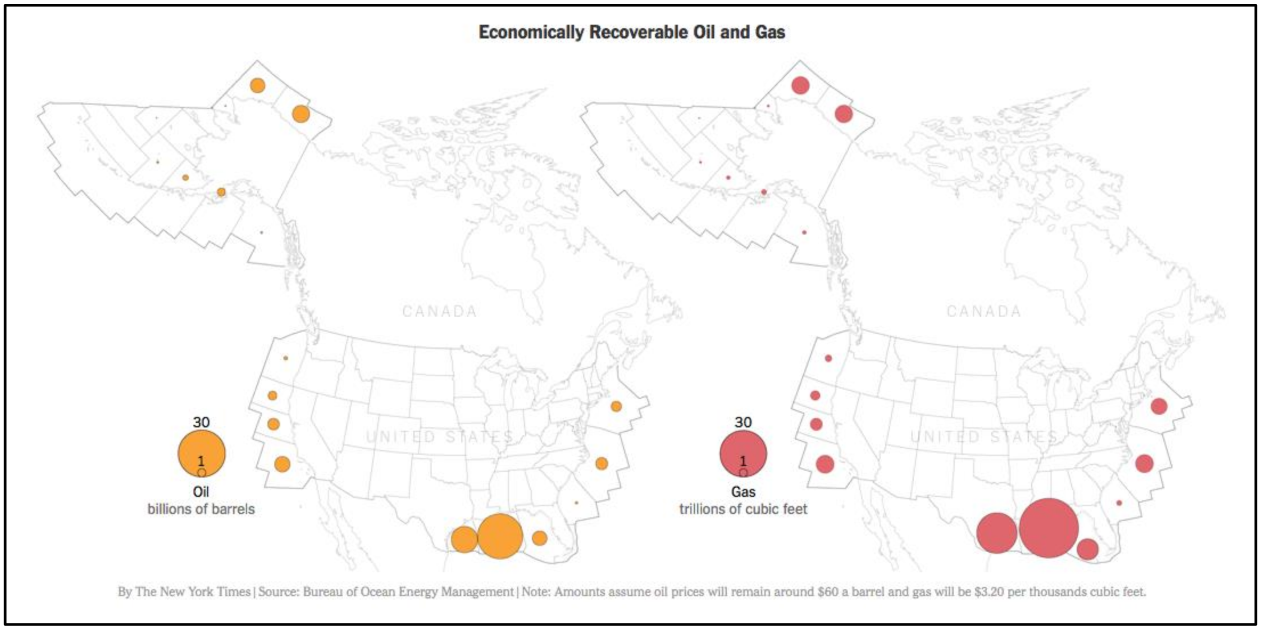


Figure ES-2. *Economically recoverable oil and gas. Most of the $60/barrel oil (and gas equivalent) is located in the Gulf of Mexico and offshore northern Alaska.* Source: *New York Times*

BOEM gives a 95-percent probability of there being UTRR of 127 billion barrels of oil equivalent (BOE), a 50-percent probability of there being UTRR of 148 billion BOE, and a 5-percent probability of there being UTRR of 171 billion BOE in the OCS. Eight planning areas have a 95-percent probability of having absolutely no fossil fuels.

Recall that UTRR assumes price is not a limit to extraction and the only limits are the presence of any oil and gas and the technology to exploit it. The amount of estimated UERR, on the other hand, varies with the expected price of oil and gas. The higher the market price of oil and gas, the more exploitable oil and gas there is.

The prices necessary to exploit every last barrel of oil and cubic foot of gas estimated to be discovered in the OCS are ~$390/barrel of oil and ~$22/Mcf of gas. The price of oil peaked at

~$120/barrel (2014 prices) during the American Civil War, which suggests that the UTRR numbers are mostly meaningless.

BOEM's 2016 national assessment projects the amount of UERR of O&G at six different price points. At $60/barrel for oil (and $3.20/Mcf for gas), the UERR in the OCS total ~59 billion barrels of oil and 101 trillion cubic feet of gas.

Potential Contribution of OCS Oil and Gas to Fueling the Nation

Key Question #1:	How long could US offshore oil and gas fuel the nation?

At 2017 total US consumption levels for oil and gas, if every last UTRR barrel of oil and cubic foot of gas were extracted from the OCS, assuming the most optimistic case (which has only a 5-percent probability), the oil and gas would fuel the nation for about seventeen years. Assuming the mean scenario (50-percent probability), this would decrease to approximately fifteen years, and assuming the most conservative scenario (95-percent probability), to about twelve years.

But economics do come into play. Based on an oil price of $60/barrel (and an equivalent gas price), the "economically recoverable" OCS O&G would fuel the nation for approximately eight and less than four years for oil and gas respectively.

Atmospheric Carbon Consequences of Exploiting Offshore Oil and Gas

The emissions from burning oil and gas extracted anywhere—not just from the US OCS—pose a problem of critical global, national, local, and intergenerational importance. Excessive amounts of carbon dioxide (CO_2) have been and are being emitted into the atmosphere by the burning of fossil fuels, thus overloading the atmosphere and causing the warming of the atmosphere, the biosphere, and the hydrosphere (a.k.a. oceans). Such climate change is an existential threat to life as we know and love it. That global warming is occurring and is primarily caused by humans—especially by the burning of fossil fuels but not limited to that cause—is settled science, so the fact of climate change won't be addressed further here.

Key Question #2	What amount of atmospheric carbon pollution would result from burning the oil and gas in the OCS?

Total carbon dioxide pollution: If all possible UTRR OCS oil and gas were exploited, burning it would result in the emission into the atmosphere of ~66 billion tonnes of CO_2. If all the $60/barrel oil (and equivalently priced gas) were exploited, burning it would result in the emission of ~31 billion tonnes of CO_2 into the atmosphere.

As a fraction of US emissions: If all $60/barrel UERR of oil (and equivalently priced gas) in the OCS were burned, the emissions would equate to nearly five years of total 2015 US emissions from all sources. If all UTRR of oil and gas were burned, the emissions would equate to more than ten years of such total 2015 US emissions.

As an increase in global atmospheric carbon dioxide levels: If all the $60/barrel UERR of oil (and equivalently priced gas) were burned, ~31 $GtCO_2$ would be released into the atmosphere, resulting in an increase of carbon in the atmosphere of ~4.0 ppm. If all the UTRR of oil and gas were burned, ~66 $GtCO_2$ would be released into the atmosphere, which would result in an increase in carbon in the atmosphere of another ~8.4 ppm.

As a fraction of the remaining carbon budget for the United States: If all the $60/barrel UERR of oil (and equivalently priced gas) were burned, the amount of CO_2 added to the atmosphere would equal 36 percent, 14 percent, and 9 percent of the low, medium, and high scenarios respectively. If all the UTRR of oil and gas were burned, the amount of CO_2 added to the atmosphere would equal 77 percent, 30 percent, and 18 percent of the low, medium, and high scenarios respectively.

Effect on the oceans: Approximately one-quarter of the carbon dioxide dumped into the atmosphere eventually finds its way into the oceans. So far, the oceans are 30 percent more acidic than at the start of the Industrial Revolution. The biological impacts are intense and far ranging. Calcifying species (such as oysters, clams, sea urchins, shallow water corals, deep sea corals, and calcareous plankton) are at risk, thereby posing a risk to the entire ocean food web, an important source of protein for more than a billion people.

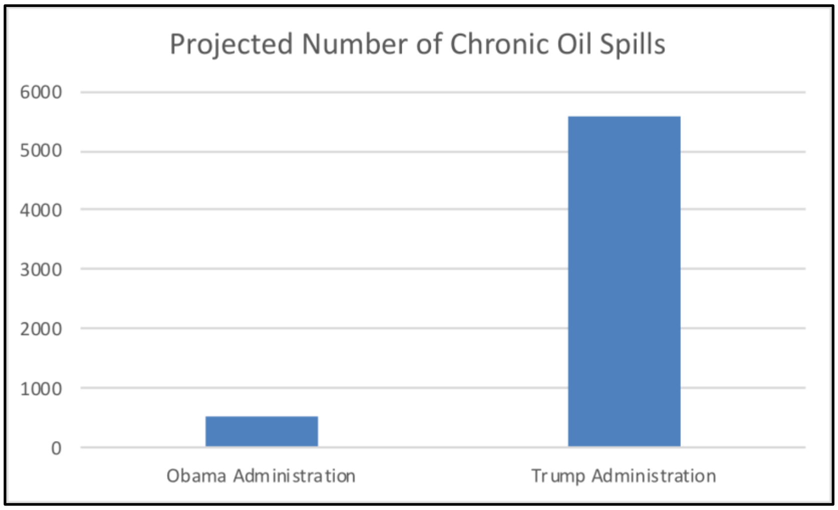
Oil Spill Consequences of Exploiting Offshore Oil and Gas

Aside from spills of gas into the atmosphere and the oceans, spills of oil into the ocean are the most obvious and well-documented problems with offshore oil and gas exploitation. Spills of oil into the ocean affect marine life. These spills can be generally categorized as chronic (frequent and relatively small) or iconic (infrequent but catastrophically large).

Key Question #3:	What amount of chronic oceanic oil pollution would result from exploiting the oil and gas in the OCS?

For chronic spills, the Center for Biological Diversity estimates that the Trump OCS O&G plan could lead to 5,571 routine oil spills, dumping 34.4 million gallons of oil into the ocean. In contrast, it projects the Obama OCS O&G plan as producing 657 routine spills, dumping 4 million gallons of oil (Figures ES-3 and ES-4). The Center assumed production at $100/barrel and did not factor in any potential (if not probable) iconic spills, which are impossible to model, but quite probable to occur.

Figure ES-3. *Projected number of chronic oil spills: Obama versus Trump.* Source: [Center for Biological Diversity]



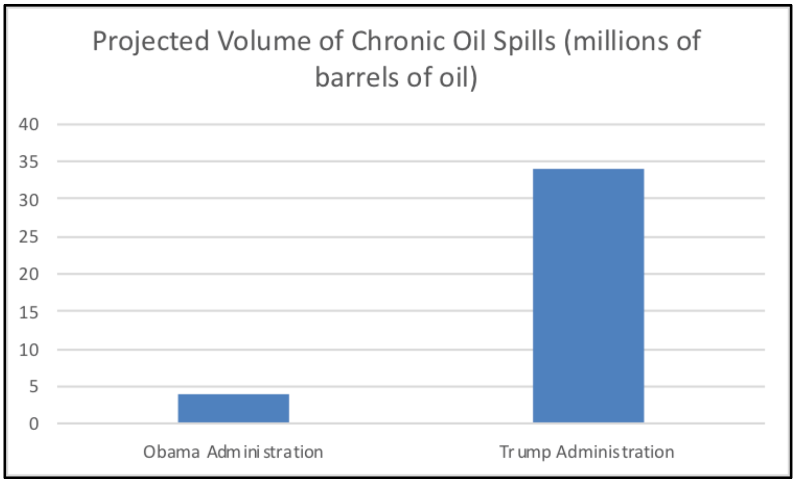


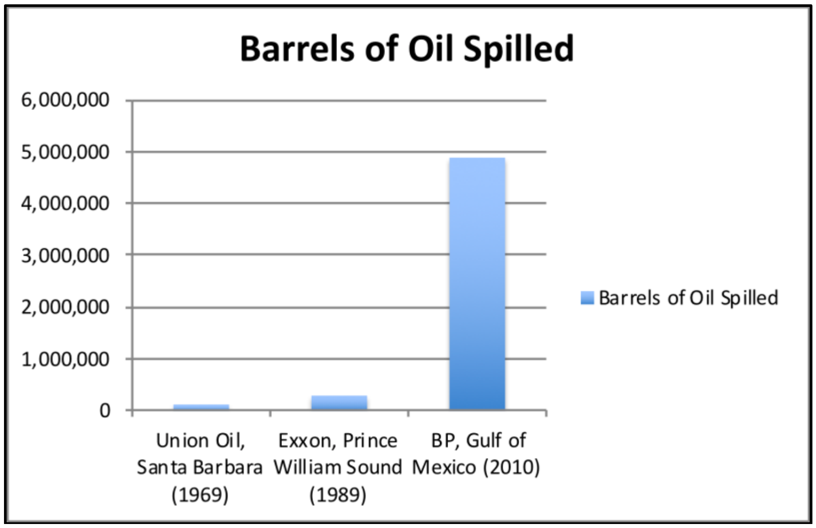
Figure ES-4. *Projected volume of oil spilled (millions of barrels): Obama versus Trump.* Source: [Center for Biological Diversity]

Key Question #4: What risk of catastrophic acute oceanic oil pollution would result from exploiting the oil and gas in the OCS?

A mere three data points is not a lot of data to average, but an unforgettable and acutely disastrous iconic oil spill has occurred in the United States on average once every two decades (Figure ES-5). Three iconic and devastating oil spill disasters are well known to the American people:

• Union Oil Santa Barbara (1969), California coast: 80,000 to 100,000 barrels of crude oil
• *Exxon Valdez* (1989), Alaska's Prince William Sound: 260,000 barrels of crude oil
• BP *Deepwater Horizon* (2010), Gulf of Mexico: 4,900,000±10 percent barrels of crude oil

Figure ES-5. *The three largest US offshore oil spills (so far).* Source: Wikipedia



Based on past experience and the facts that oil and gas exploitation is being done in increasingly harsh environments (including but not limited to several miles below the ocean surface and in ocean areas with chronically rough seas) and that humans are capable of error, it is reasonable to assume that the more drilling is done in the ocean, the more spills of catastrophic magnitude will occur.

Societal Costs of Exploiting Offshore Oil and Gas

Emitting carbon into the atmosphere costs society, and those costs should be measured.

In response to a court ruling on a fuel economy standard, the George W. Bush Administration developed the social cost of carbon (SCC, also called SC-CO_2) concept. The Obama Administration continued with the SSC, updating it in 2010 and 2013 to reflect improvements in the modeling. The National Center for Environmental Economics, under contract to the Environmental Protection Agency, explained that the SCC is

> *the present value of the marginal social damages of increased GHG emissions in a particular year—including the impacts of global warming on agricultural productivity and human health, loss of property and infrastructure to sea level rise and extreme weather events, diminished biodiversity and ecosystem services, etc.—and therefore it also represents the marginal social benefits of emissions reductions.*

For this paper, I used an SCC of $50/tonne (2018 dollars) of carbon dioxide, which is based on a 3-percent average discount rate. The choice of the discount rate is critical, not to us but to our heirs. Critics of quantifying the social cost of carbon dioxide (or methane or nitrous oxide), if it is quantified at all, should use a higher discount rate. Choosing a higher discount rate means assigning a lower value to future costs, which is appropriate if you are greedy today and don't care about the world you leave your children.

Critics also argue that because the social cost of carbon is difficult to quantify, it should not be used in evaluating government actions. Adding more CO_2 to the atmosphere will have costs borne by our successors. Though difficult to measure, the social cost of carbon is clearly not $0. It may well be much higher or lower than the $50/tonne (2018 dollars) I chose. It is better to use the best available number and be approximately right than to not use any number other than a perfect one, thereby assigning $0 cost, and be precisely wrong.

Key Question #5:	What financial costs to society from increase CO2 emissions that would result from exploiting the oil and gas in the OCS?

If all UTRR oil and gas were fully exploited, the social cost of CO_2 emitted into the atmosphere would be ~$3.3 trillion. In comparison and (co-incidentally), the projected 2018 expenditures for the US government total ~$3.3 trillion.

If all $60/barrel UERR oil (and its equivalently priced gas) in the OCS were fully exploited, the social cost of CO_2 emitted into the atmosphere would be ~$1.3 trillion.

Methane and nitrous oxide are also produced during oil and gas exploitation. Factoring in their social costs would make the social cost of OCS oil and gas exploitation even higher.

The Economics of Offshore Oil and Gas

In both markets and regulation, the general *trend* is to move away from the use of fossil fuels. As the world is awash in oil and gas, large price increases are not likely in the relatively near term. What is likely is that declining costs of production will make existing and new *onshore* O&G even more economically attractive compared to *offshore* O&G exploitation. If O&G prices were to rise, this would likely increase more cost-effective onshore exploitation rather than significantly increase the more costly offshore production. In addition, as prices rise, the attractiveness of non–fossil fuel alternatives increases, as well as the widespread implantation of existing and new energy-efficiency technologies. Increasing fossil fuel prices in the short term will likely lead to a loss of market share in the long term.

The United States is also awash in onshore oil and gas. Onshore, the cost of producing a barrel of oil has dramatically declined and is under $40. Offshore, the cost of producing a barrel of oil is increasing. According to the *Wall Street Journal*, "Drilling in the U.S. Gulf of Mexico has migrated from shallower depths to deep water, sending production costs surging as companies plumb reservoirs thousands of feet below the water's surface." The US Energy Information Administration, citing a report it commissioned, says "According to the IHS report's modeling of current deepwater Gulf of Mexico projects, full cycle economics result in breakeven prices that are typically higher than $60/b[arrel]."

The Politics of Offshore Oil and Gas

As of the date of this report, twenty-three bills pending in the current 115th Congress would limit fossil fuel exploitation in the OCS.

Twenty-two states abut the federal OCS. Five states with significant existing offshore fossil fuel infrastructure generally or somewhat favor OCS drilling (TX, LA, MS, AL, and AK). However, the governors of fifteen of the seventeen states along the Pacific and Atlantic coasts strongly oppose drilling in the OCS offshore their states (NH, MA, RI, CT, NY, NJ, MD, DE, VA, NC, SC, FL, WA, OR, and CA) (Figure ES-6). All have called on Secretary Zinke to exempt their states, as he did Florida. (Maine is in support of drilling and Georgia has taken no formal position.)

A sovereign state in these United States can either prevent or otherwise discourage federal OCS fossil fuel exploitation, enough to dissuade an oil company from proceeding. The coastal states in opposition can do much to prevent or otherwise discourage federal OCS oil and gas development, including but not limited to

- banning oil and gas development in adjacent state coastal waters, and
- refusing to permit or otherwise facilitate the development onshore of offshore energy exploitation infrastructure, including but not limited to pipelines, power lines, port facilities, and refineries.

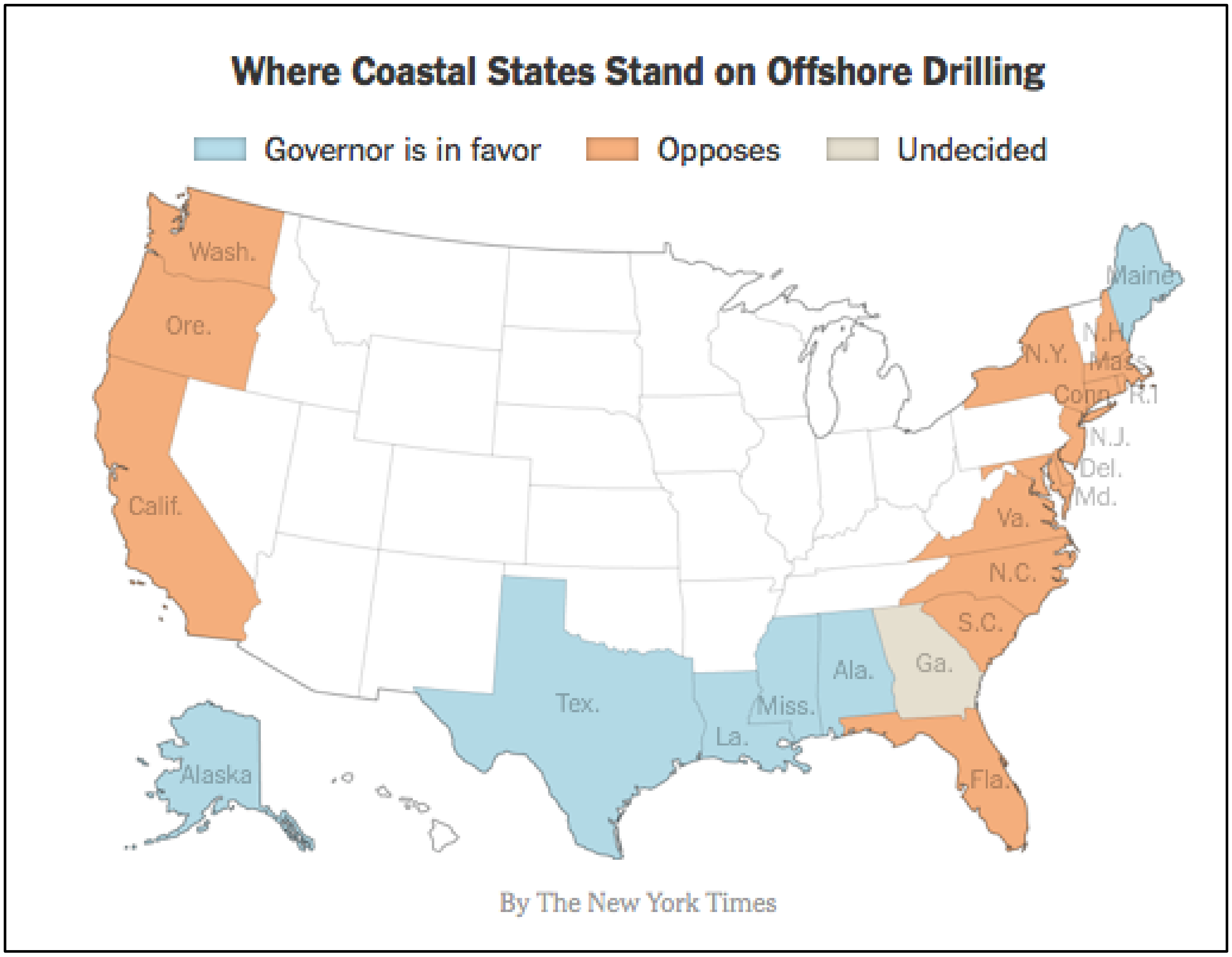


Figure ES-6. *Where coastal states stand on offshore drilling. Save for Maine, the states in favor of offshore oil and gas exploitation are the ones with existing infrastructure. Of the states against offshore drilling, only California has existing infrastructure.* Source: [New York Times]

Conclusion and Recommendations

For economic, environmental, and societal reasons equally applicable to today's and future generations, the United States should eschew any new offshore oil and gas exploitation and continue its progress toward a fossil fuel–free sustainable energy economy a decade or two earlier than it otherwise would. For the sake of the atmosphere, the biosphere, the hydrosphere, human health, and the economy, the sooner the better.

To get there from here:

- no new oil and gas leasing
- phaseout of existing oil and gas leasing
- permanent ocean protection

About the Author

Andy Kerr (andykerr@andykerr.net) is the Czar of The Larch Company (www.andykerr.net) and consults on environmental and conservation issues. The Larch Company is a for-profit non-membership conservation organization that represents the interests of humans yet unborn and species that cannot talk. Kerr received far more than his allotted fifteen minutes of fame (or, if you prefer, infamy) during the Pacific Northwest Timber Wars, which peaked in the mid-1990s and are still going on, though at a lower level of controversy. A dropout of Oregon State University, he has published two books and lectured at all of Oregon's leading universities and colleges as well as Harvard and Yale.

A fifth-generation Oregonian, Kerr was born and raised in Creswell, a recovered timber town in the upper Willamette Valley. He presently splits his time between Ashland, a recovered timber town in Oregon's Rogue Valley, and Washington DC, where the most important decisions affecting Oregon's wild lands, wildlife, and wild waters are made. A fuller biographical sketch can be found on his website.

Key Question #1:	How long could US offshore oil and gas fuel the nation?
Key Question #2	What amount of atmospheric carbon pollution would result from burning the oil and gas in the OCS?
Key Question #3:	What amount of chronic oceanic oil pollution would result from exploiting the oil and gas in the OCS?
Key Question #4:	What risk of catastrophic acute oceanic oil pollution would result from exploiting the oil and gas in the OCS?
Key Question #5:	What financial costs to society from increase in CO2 emissions that would result from exploiting the oil and gas in the OCS?

Introduction

In response to an executive order by President Trump, Secretary of the Interior Ryan Zinke has proposed offering vast portions of the US Outer Continental Shelf (OCS) for oil and gas exploitation. Such exploitation would threaten numerous economically, ecologically, and socially important oceanscapes and adjacent coasts and would have other significant environmental and social costs. This report examines the Trump administration's proposed massive expansion of OCS oil and gas exploitation, focusing on five key questions:

We begin with some background about the OCS and the oil and gas leasing plans of this and the previous administration. We then examine the location and possible extent of new offshore oil and gas wells to get an idea of how much oil and gas we're talking about. That information is a prelude to answering the five questions above. We then consider both the economics and politics of exploiting OCS oil and gas before ending with some recommendations.

The Trump Administration's Draft Proposal

The Outer Continental Shelf Lands Act of 1953 (OCSLA) defines the OCS as "all submerged lands lying seaward and outside of the area of lands beneath navigable waters . . . , and of which the subsoil and seabed appertain to the United States and are subject to its jurisdiction and control." The "lands beneath navigable waters" are those submerged lands owned by the states that generally extend 3 US nautical miles from shore. A nautical mile is 6,076.1 feet; a statute (land) mile is 5,280 feet. State jurisdiction offshore Texas and Florida's Gulf Coast extends 3 marine leagues (~9 nautical miles). Louisiana's jurisdiction extends 3 pre-1954 US nautical miles (3.455 statute miles). For all other states, jurisdiction extends 3 international nautical miles (3.452 statute miles). The most seaward extent of the US OCS is generally 200 international nautical miles from its shores except in cases where it is limited by another nation's territory.

Figure 2. *Dead pelican swimming. The state bird of Louisiana is the brown pelican.* Source: Wikipedia.

The OCSLA as amended requires the Interior Department to produce five-year OCS oil and gas leasing plans. Administrative discretion is allowed as to where and how much to lease. The current plan (labeled "Obama" in Figure 3) began in 2017 and will expire in 2022 if not revoked earlier by the Trump administration. It authorized eleven lease sales, one in Alaska's Cook Inlet adjacent to state waters already leased for oil and gas exploitation, and ten leases in the Gulf of Mexico Program Area (Western Gulf of Mexico, Central Gulf of Mexico, and Eastern Gulf of Mexico planning areas) outside the congressionally imposed Florida Gulf Coast moratorium zone.

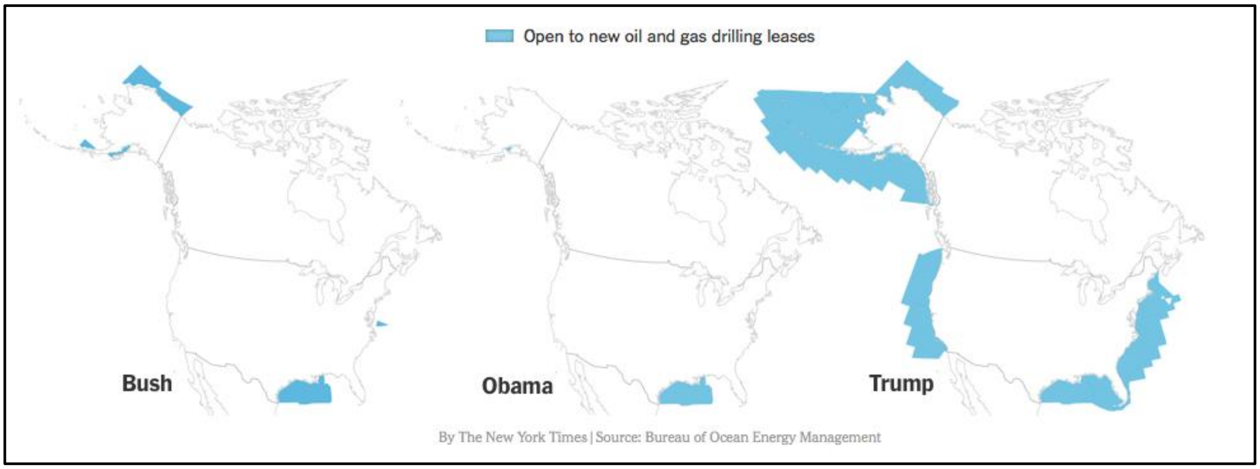


Figure 3. *Areas of the Outer Continental Shelf (OCS) open to new oil and gas drilling under three presidents. The Trump administration proposes opening most of the OCS to oil and gas exploitation.* Source: [New York Times]()

Essentially all existing US OCS oil and gas exploitation is in the Gulf of Mexico (Figures 4 and 5).

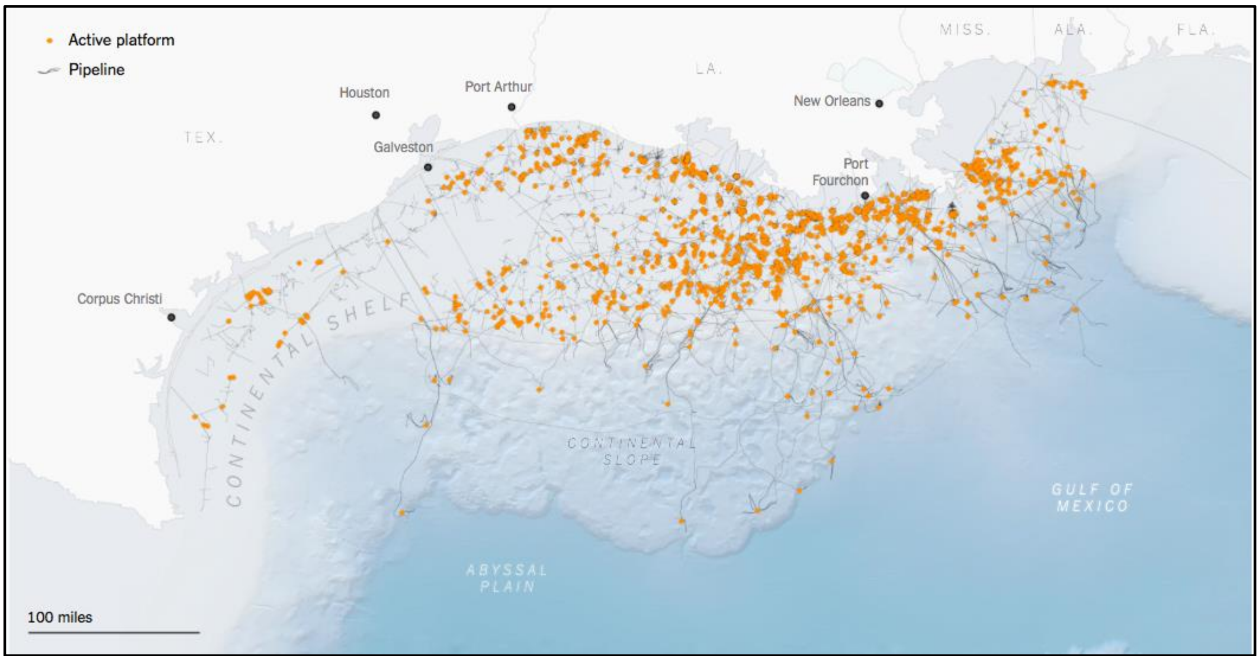


Figure 4. *Platforms and pipelines in the US Gulf of Mexico. It's really all about oil in the Gulf of Mexico*. Source: [New York Times]()

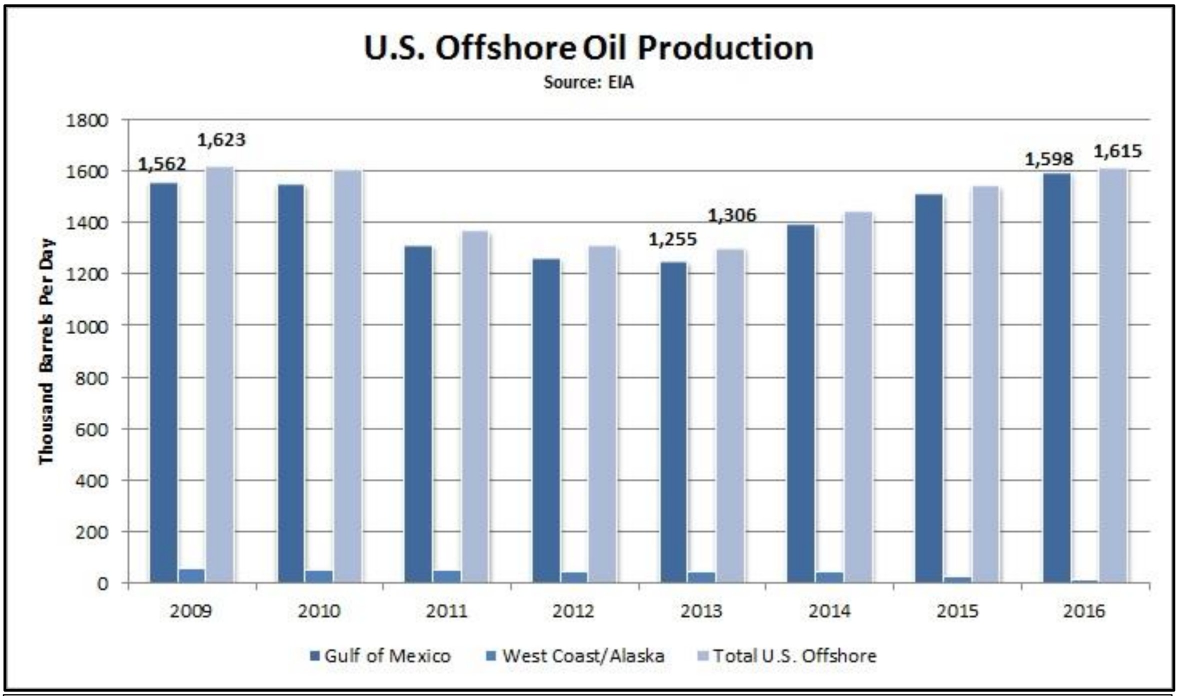


Figure 5. *US offshore oil production. It's really all about the Gulf of Mexico*. Source: www.breakingenergy.com

The new draft plan (Figure 7) would "make more than 98 percent of the OCS available to consider for oil and gas leasing during the 2019–2024 period," consisting of

> *47 lease sales in all four OCS regions and includes 25 of the 26 planning areas: 19 lease sales in the Alaska Region (3 in the Chukchi Sea, 3 in the Beaufort Sea, 2 in Cook Inlet, and 1 sale each in the 11 other available planning areas in Alaska), 7 lease sales in the Pacific Region (2 each for Northern California, Central California, and Southern California, and 1 for Washington/Oregon), 12 lease sales in the Gulf of Mexico (GOM) Region (10 regionwide lease sales for the portions of the Central, Western, and Eastern GOM planning areas that are not currently under moratorium, and 2 sales for the portions of the Central and Eastern GOM planning areas that will no longer be under moratorium in 2022), and 9 lease sales in the Atlantic Region (3 sales each for the Mid- and South Atlantic, 2 for the North Atlantic, and 1 for the Straits of Florida).*

The draft plan anticipates the expiration of the Florida Gulf Coast moratorium on June 30, 2022, and would allow leasing in the area in 2024.

Figure 6. *Turtles and oil: not compatible.* Source: Wikipedia

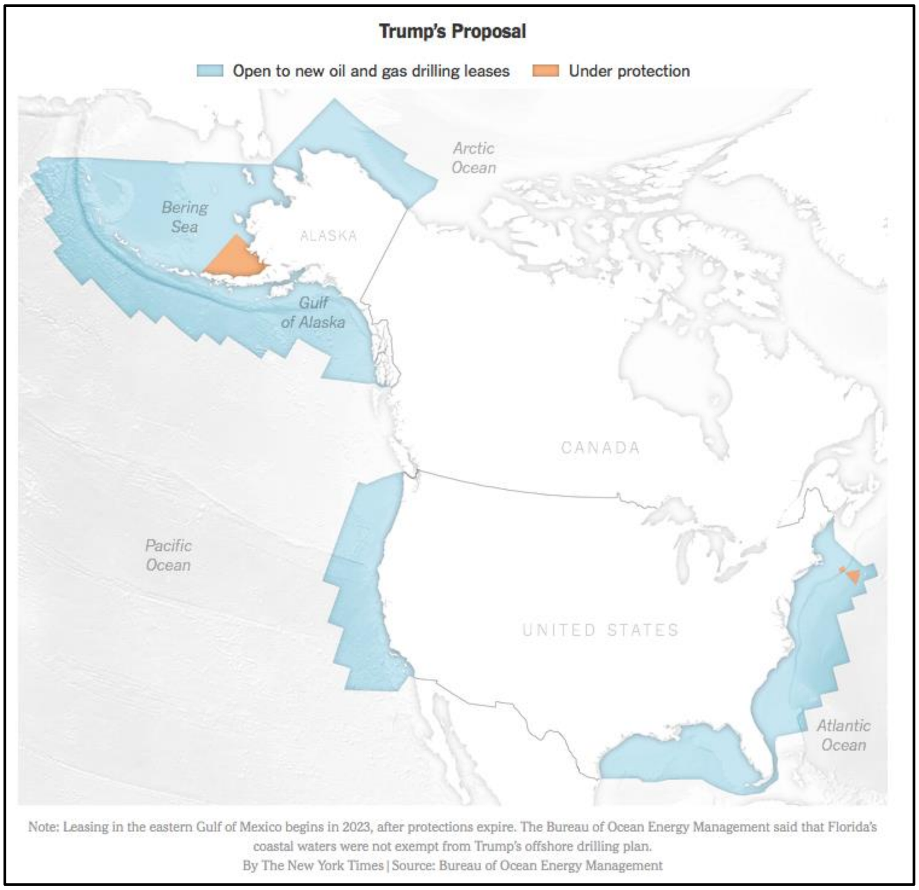


Figure 7. *The Trump proposal: presidentially unprecedented*. Source: New York Times

Extent and Possible Location of "Undiscovered" Offshore Oil and Gas

The US Department of the Interior's Bureau of Ocean Energy Management (BOEM) estimates offshore oil and gas (O&G) potential by massaging existing geological information. It has created estimates for each of the twenty-six planning areas in the US OCS. Four planning areas offshore Alaska are estimated to have "negligible" petroleum potential (though a reasonable interpretation of the BOEM price and volume data suggests "negligible" could be applied to at least sixteen of the other twenty-two planning areas evaluated by BOEM).

Still, BOEM has categorized twenty-two of its twenty-six OCS planning areas as having "undiscovered technically recoverable reserves" (UTRR) of O&G, a subset of which are "undiscovered economically recoverable reserves" (UERR). Here are BOEM's definitions:

- UTRR is *oil and gas that may be produced as a consequence of natural pressure, artificial lift, pressure maintenance, or other secondary recovery methods, but without any consideration of economic viability; primarily located outside of known fields.*

- UERR is *the portion of undiscovered technically recoverable resources that is economically recoverable under imposed economic and technologic conditions*.

This paper examines both UTRR and UERR. It assumes a UERR price of $60/barrel of oil and its equivalent price for gas. Oil is trading at ~$70/barrel in mid 2018.

The fossil fuel industry argues that there is much more offshore oil and gas than BOEM guestimates indicate, and the industry will find it if only it is allowed to explore. It is confident that seismic and other nondrilling exploration will result in far larger amounts of oil and gas being "discovered." That's actually the problem. The atmosphere and the ocean are already overfilled with carbon dioxide, primarily from the burning of fossil fuels, and there is no room for more. For the sake of the climate, the ocean, and future generations, this is a question best left unanswered.

Undiscovered Technically Recoverable Resources (UTRR)

While one might think it impossible to quantify something that has not even been discovered yet (if ever), this is a common practice in the fossil fuel industry. It is, at best, a best guess. BOEM projects UTRR numbers for each planning area and national totals at three different probability levels: 95 percent, mean, and 5 percent. The lowest number for oil, gas, and barrels of oil equivalent (BOE, which includes both oil and gas, factoring in the energy content) has a 95-percent probability of actually being there, while the highest number has only a 5-percent probability. In between is the expected amount of oil and gas at the mean probability between 95 percent and 5 percent, effectively a 50-percent probability or a 50-50 chance.

BOEM estimated the UTRR for the twenty-two planning areas evaluated in 2016 (Table 1). BOEM gives a 50-50 chance (a mean probability) that UTRR of ~90 billion barrels of oil and ~327 trillion cubic feet of gas are waiting to be discovered in federal ocean waters. In terms of energy content, roughly one-half is in the Gulf of Mexico, one-third is offshore Alaska, one-thirteenth is off the Atlantic coast, and one-twelfth is off the Pacific coast.

BOEM gives a 95-percent probability of there being UTRR of 127 billion barrels of oil equivalent (BOE), a 50-percent probability of there being UTRR of 148 billion BOE, and a 5-percent probability of there being UTRR of 171 billion BOE in the OCS. Eight planning areas have a 95-percent probability of having absolutely no fossil fuels.

Recall that UTRR assumes price is not a limit to extraction, and the only limits are the presence of any oil and gas and the technology to exploit it. The amount of estimated UERR, on the other hand, varies with the expected price of oil and gas. The higher the market price of oil and gas, the more exploitable oil and gas there is.

To discover what the price of a barrel of oil, or its gas equivalent, would have to be to exploit every barrel of oil and cubic foot of gas, I extrapolated based on a graph in BOEM's 2016 national assessment entitled "Price-supply curve of the entire United States OCS." As only the figure was available and not the underlying data, I fired up my copier; got out my scissors, Scotch® tape, and magic marker; and then extrapolated (Figure 9). This was a crude but illuminating exercise bordering on the absurd, but nowhere near as absurd as the prices necessary to exploit every barrel of oil and cubic foot of gas estimated to be undiscovered in the US OCS: ~$390/barrel of oil and ~$22/Mcf of gas.

Table 1. **Risked Undiscovered Technically Recoverable Resources (UTRR) of OCS Planning Areas**									
Region	**Oil (Bbo)**			**Gas (Tcfg)**			**BOE (Bbo)**		
Planning Area	**95%**	**Mean**	**5%**	**95%**	**Mean**	**5%**	**95%**	**Mean**	**5%**
Alaska OCS*	**19.10**	**26.61**	**36.43**	**96.51**	**131.45**	**166.85**	**36.28**	**50.00**	**66.12**
Chukchi Sea	9.30	15.38	23.08	48.88	76.77	111.44	17.99	29.04	42.91
Beaufort Sea	4.11	8.22	13.72	13.92	27.64	43.78	6.59	13.14	21.51
Hope Basin	0.00	0.15	0.45	0.00	3.77	104.00	0.00	0.82	2.30
Navarin Basin	0.00	0.13	0.42	0.00	1.22	3.67	0.00	0.35	1.07
North Aleutian Basin	0.12	0.75	1.82	1.47	8.62	17.37	0.38	2.29	4.91
St. George Basin	0.00	0.21	0.57	0.00	2.80	6.69	0.00	0.71	1.76
Norton Basin	0.00	0.06	0.17	0.00	3.06	9.65	0.00	0.60	1.89
Cook Inlet	0.25	1.01	2.01	0.50	1.20	1.97	0.34	1.23	2.36
Gulf of Alaska	0.13	0.63	1.45	0.71	4.04	9.23	0.25	1.34	3.09
Shumagin	0.00	0.01	0.05	0.00	0.49	2.04	0.00	0.10	0.42
Kodiak	0.00	0.05	0.20	0.00	1.84	7.62	0.00	0.38	1.55
*The Aleutian Arc, Aleutian Basin, Bowers Basin, and St. Matthew-Hall Planning Areas in the Alaska OCS Region were not evaluated in this study as their petroleum potential is negligible.									
Atlantic OCS	**1.15**	**4.59**	**9.19**	**12.80**	**38.17**	**68.71**	**3.43**	**11.39**	**21.41**
North Atlantic	0.06	1.77	5.11	1.08	11.76	32.74	0.25	3.86	10.94
Mid-Atlantic	0.10	2.41	5.54	2.13	24.63	50.03	0.48	6.79	14.44
South Atlantic	0.00	0.41	0.90	0.00	1.78	5.00	0.00	0.73	1.79
Gulf of Mexico OCS	**39.48**	**48.46**	**58.53**	**124.01**	**141.76**	**159.63**	**61.55**	**73.69**	**86.93**
Western Gulf of Mexico	8.20	11.57	15.56	32.09	38.99	45.65	13.91	18.50	23.68
Central Gulf of Mexico	24.67	33.25	42.74	77.72	91.27	105.65	38.50	49.49	61.53
Eastern Gulf of Mexico	2.35	3.63	5.28	7.15	11.49	16.20	3.62	5.68	8.16
Straits of Florida	0.01	0.01	0.02	0.01	0.02	0.02	0.01	0.02	0.02
Pacific OCS	**6.96**	**10.20**	**14.03**	**10.52**	**16.10**	**23.92**	**8.83**	**13.07**	**18.28**
Washington/Oregon	0.00	0.40	1.14	0.03	2.28	5.80	0.01	0.81	2.18
Northern California	1.07	2.08	3.55	2.14	3.58	5.35	1.45	2.71	4.50
Central California	1.22	2.40	3.87	1.16	2.49	4.19	1.42	2.84	4.61
Southern California	2.80	5.32	8.70	3.58	7.60	13.60	3.46	6.70	11.12
Total US OCS	**76.46**	**89.87**	**104.02**	**282.74**	**327.49**	**377.62**	**126.77**	**148.14**	**171.21**
Resource values are in billion barrels of oil (Bbo) and trillion cubic feet of gas (Tcfg). 95% indicates a 95-percent chance of at least the amount listed; 5% indicates a 5-percent chance of at least the amount listed. Only mean values are additive. Some total mean values may not equal the sum of the component values due to independent rounding. Values are for both leased and unleased lands of the federal OCS.									
Source: Bureau of Ocean Energy Management, "Assessment of Undiscovered Oil and Gas Resources of the Nation's Outer Continental Shelf, 2016a"									

This is a national average, and averages for the individual planning areas differ. For example, my eyeball estimate for the Oregon/Washington OSC Planning Area is ~$560/barrel of oil and ~$58/Mcf of gas (Figure 10). As BOEM didn't provide the data, I needed to cut and tape together five copies of the BOEM graph to get these numbers. If you want to do the same for a planning area of special concern to you, the graphs are found at the end of BOEM's "Assessment of Undiscovered Oil and Gas Resources of the Nation's Outer Continental Shelf, 2016a."

Figure 8. *Striped dolphins swimming in emulsified oil from the* Deepwater Horizon *spill*. Source: Wikipedia.

The price of oil peaked at ~$120/barrel (2014 prices) during the American Civil War, which suggests that the UTRR numbers are mostly meaningless. As this exercise confirms, it is beyond useless to think of undiscovered OCS O&G in terms of what is technically recoverable. It is more useful to consider undiscovered economically recoverable resources (UERR) of oil and gas.

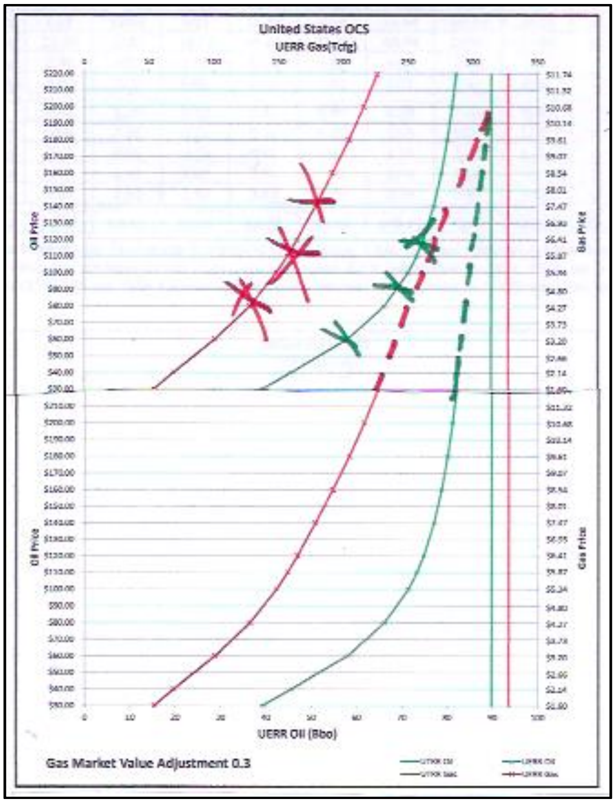


Figure 9. *A crude extrapolation to discover absurd prices. The green lines represent OCS oil and the red lines gas. The vertical lines on the right are UTRR, while the curved lines at left represent the UERR by amount (x-axis) at a given price (y-axis). To discover the crossing points where all the UTRR would become UERR, I crossed out the lines on the above (who even has White-Out® anymore?) part of the graph and then did a straight-line extrapolation off what is not quite—and never will quite be—a straight line.*

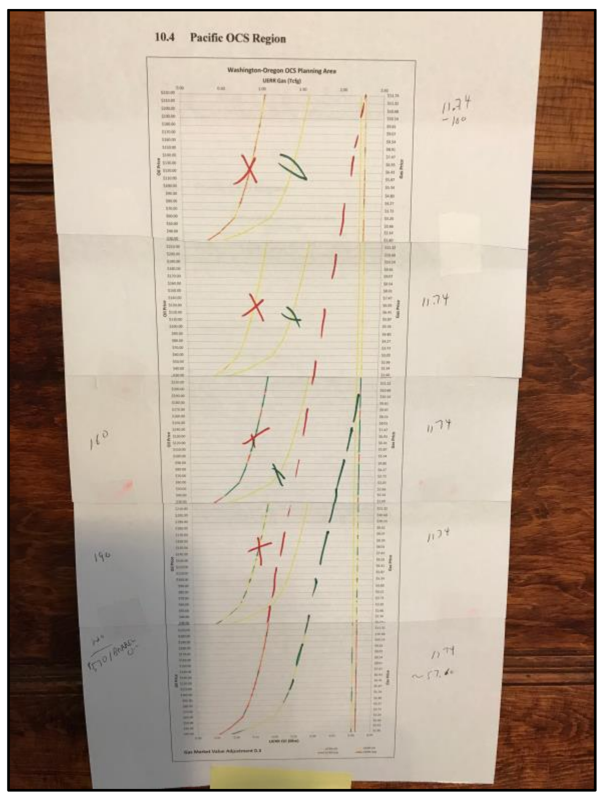


Figure 10. *A cruder extrapolation to discover absurd prices offshore Oregon and Washington.*

Undiscovered Economically Recoverable Resources (UERR)

BOEM's 2016 national assessment projects the amount of UERR at six different price points, for oil and gas respectively (Bbl = barrel, Mcf = thousand cubic feet):

$30/Bbl	$1.70/Mcf
$40/Bbl	$2.14/Mcf
$60/Bbl	$3.20/Mcf
$100/Bbl	$5.34/Mcf
$110/Bbl	$5.87/Mcf
$160/Bbl	$8.54/Mcf

The higher the market price for oil and gas, the more exploitable offshore oil and gas there is. At $60/barrel for oil (and $3.20/Mcf for gas), the total UERR in the OCS is ~59 billion barrels of oil and 101 trillion cubic feet of gas (columns in red, Table 2). Figure 11 shows where the UERR are located.

Table 2. **Risked Undiscovered Technically Recoverable Resources (UERR) of OCS Planning Areas**

Region	**$30/Bbl $1.60/Mcf**		**$40/Bbl $2.14/Mcf**		**$60/Bbl $3.20/Mcf**		**$100/Bbl $5.34/Mcf**		**$110/Bbl $5.87/Mcf**		**$160/Bbl $8.54/Mcf**	
Planning Area	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**
Alaska OCS*	**0.68**	**0.26**	**2.12**	**1.16**	**8.38**	**9.36**	**17.29**	**33.59**	**18.57**	**38.59**	**22.00**	**60.43**
Chukchi Sea	0.00	0.00	0.07	0.06	2.87	4.25	9.25	22.58	10.20	26.36	12.61	40.63
Beaufort Sea	0.07	0.03	1.02	0.66	4.01	4.15	6.08	8.09	6.33	8.80	7.09	12.64
Hope Basin	0.00	0.00	0.01	0.02	0.04	0.09	0.06	0.18	0.06	0.20	0.08	0.90
Navarin Basin	0.00	0.00	0.00	0.00	0.02	0.03	0.05	0.12	0.05	0.16	0.07	0.30
North Aleutian Basin	0.14	0.05	0.33	0.13	0.46	0.22	0.51	0.34	0.52	0.38	0.55	0.86
St. George Basin	0.00	0.00	0.02	0.02	0.07	0.07	0.10	0.15	0.11	0.17	0.13	0.66
Norton Basin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.40
Cook Inlet	0.62	0.25	0.81	0.33	0.94	0.40	0.98	0.77	0.99	0.84	1.00	1.03
Gulf of Alaska	0.00	0.00	0.00	0.01	0.07	0.20	0.31	1.62	0.36	1.93	0.47	2.73
Shumagin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Kodiak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.05	0.02	0.54
*The Aleutian Arc, Aleutian Basin, Bowers Basin, and St. Matthew-Hall Planning Areas in the Alaska OCS Region were not evaluated in this study as their petroleum potential is negligible.												
Atlantic OCS	**3.21**	**3.64**	**3.47**	**5.06**	**3.76**	**8.41**	**4.00**	**13.00**	**4.03**	**13.81**	**4.15**	**17.22**
North Atlantic	1.40	1.82	1.48	2.45	1.58	3.69	1.64	5.05	1.65	5.28	1.68	6.24
Mid-Atlantic	1.74	1.68	1.89	2.41	2.06	4.38	2.18	7.42	2.19	7.95	2.25	10.29
South Atlantic	0.08	0.14	0.09	0.20	0.12	0.35	0.18	0.52	0.19	0.56	0.22	0.07
Gulf of Mexico OCS	**31.31**	**44.48**	**35.01**	**56.09**	**39.55**	**74.67**	**42.88**	**92.04**	**43.31**	**94.51**	**44.77**	**103.47**
Western Gulf of Mexico	7.28	12.03	8.21	15.88	9.36	21.84	10.20	27.23	10.31	27.98	10.68	30.53
Central Gulf of Mexico	21.69	27.82	24.22	35.02	27.31	46.74	29.56	57.83	29.85	59.41	30.84	65.21
Eastern Gulf of Mexico	2.34	4.62	2.58	5.18	2.88	6.08	3.10	6.97	3.13	7.12	3.24	7.72
Straits of Florida	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Pacific OCS	**4.00**	**5.30**	**5.10**	**6.61**	**6.45**	**8.29**	**7.30**	**9.43**	**7.43**	**9.62**	**7.89**	**10.35**
Washington/Oregon	0.09	0.32	0.14	0.46	0.20	0.65	0.23	0.79	0.24	0.81	0.26	0.93
Northern California	0.60	0.65	0.83	0.91	1.13	1.25	1.34	1.52	1.37	1.57	1.50	1.77
Central California	1.35	1.42	1.63	1.71	1.91	2.00	2.08	2.17	2.11	2.20	2.18	2.27
Southern California	1.96	2.91	2.50	3.54	3.21	4.39	3.65	4.94	3.72	5.03	3.95	5.37
Total US OCS	**39.20**	**53.67**	**45.70**	**68.93**	**58.15**	**100.73**	**71.47**	**148.05**	**73.35**	**156.53**	**78.81**	**191.46**
Resource values are in billion barrels of oil (Bbo) and trillion cubic feet of gas (Tcfg). Some total mean values may not equal the sum of the component values due to independent rounding. Prices are in dollars per barrel ($/Bbl) for oil and dollars per thousand cubic feet ($/Mcf) for gas. Table represents a gas price adjustment of 0.3. Values are for both leased and unleased lands of the federal OCS.												
Source: Bureau of Ocean Energy Management, "Assessment of Undiscovered Oil and Gas Resources of the Nation's Outer Continental Shelf, 2016a"												

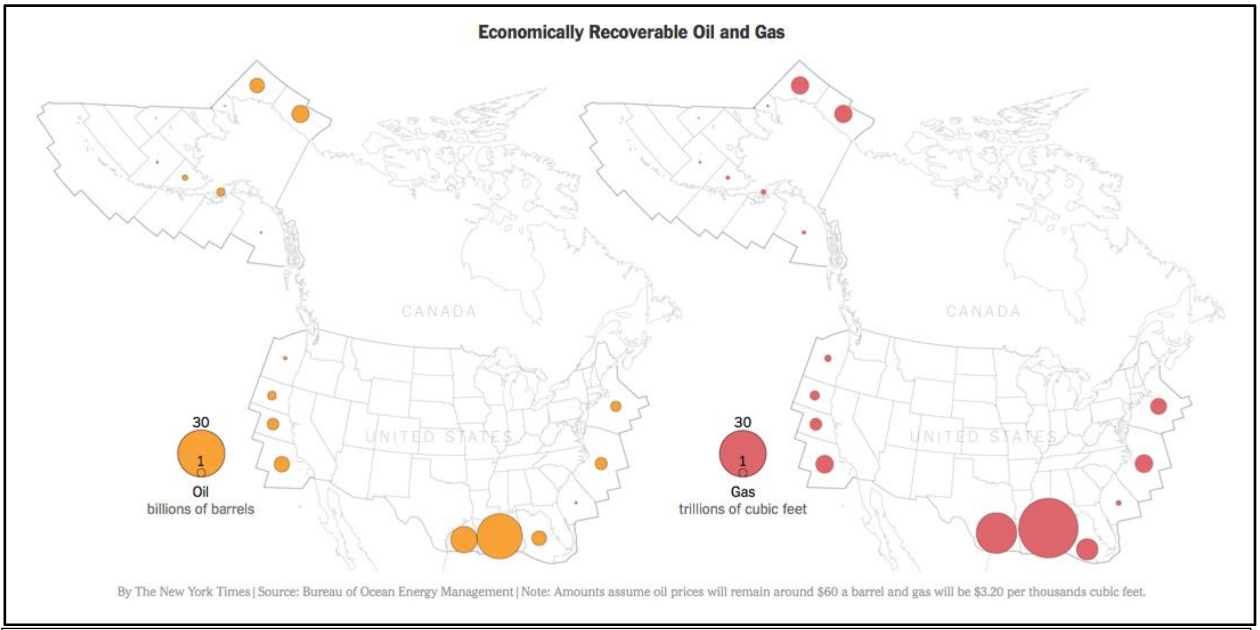


Figure 11. *Economically recoverable oil and gas. Most of the $60/barrel oil (and gas equivalent) is located in the Gulf of Mexico and offshore northern Alaska.* Source: *New York Times*

When thinking about how much OCS O&G might be economically recoverable, it is useful to consider the market prices of oil and gas over time. Of course, past prices are no promise of future prices, but it's a start. As discussed later, one should also factor in the substitution of energy efficiency (using it better), conservation (using less), and/or fuel switching (not using it at all).

Figure 12 shows historical US oil prices from 1862 to 2016 in 2016 dollars. According to this source, not even during the Arab embargo provoked by the Yom Kippur War (1973–74), Iranian production cuts early in its revolution (1978–79) combined with the beginning of the Iran-Iraq War (1980), increased Asian demand in the mid-2000s, or the Arab Spring and Libyan civil war (2011) did oil reach such heights as during the American Civil War (1861–65), when it exceeded $120 (in 2014 dollars).

Figure 13 shows recent historical US oil prices. (The corresponding numbers in Figures 12 and 13 don't quite jibe. I attribute it to differences in data sources, data averaging, and data presentation.) US oil prices are part of a world market and therefore directly affected by world events. On August 8, 2018, oil was trading in the United States at $69.09/barrel.

Though BOEM prices gas in $/Mcf (dollars per thousand cubic feet of volume), the trading markets price gas in $MMBtu (dollars per million British thermal units of energy content). The US average energy content for gas in 2017 was 1.037 million Btu per 1 Mcf. Thus, for example, natural gas trading at $2.58/MMBtu equals $2.68/Mcf. The ~3.7 percent differential is important when trading for gas but not important in this analysis, so this paper treats $/MMBtu and $Mcf as equivalent, because they approximately are—or as has been said, it's good enough for government work. Figure 14 shows recent historical US gas prices. For the most part, US gas use is part of a North American market, though with increased export of American gas, this could change. On August 8, 2018, gas was trading in the United States at $2.89/MMbtu.

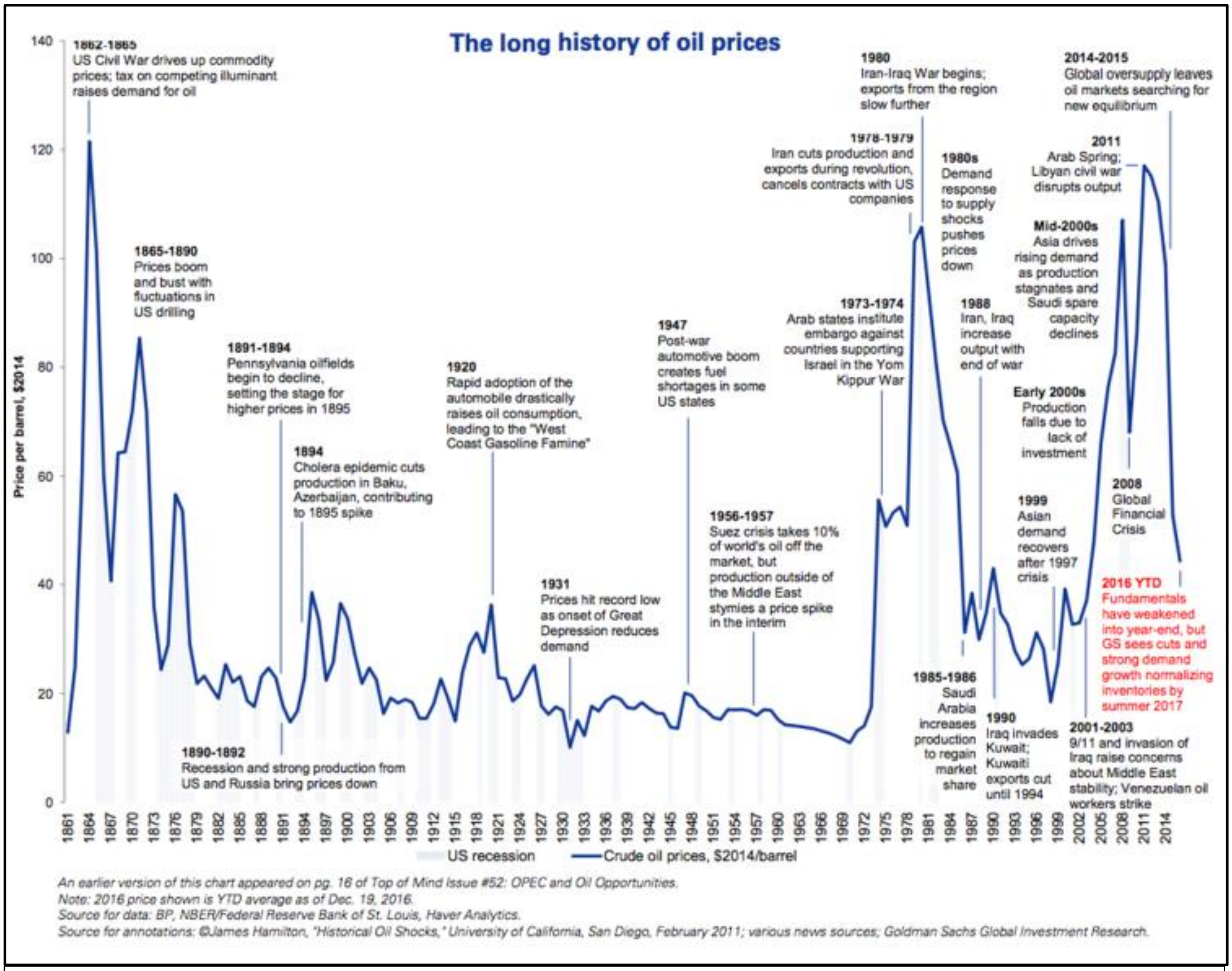


Figure 12. *History of US oil prices. Never in US history have oil prices reach the $180/barrel price point that the BOEM forecasts as economically exploitable.* Source: [Business Insider]

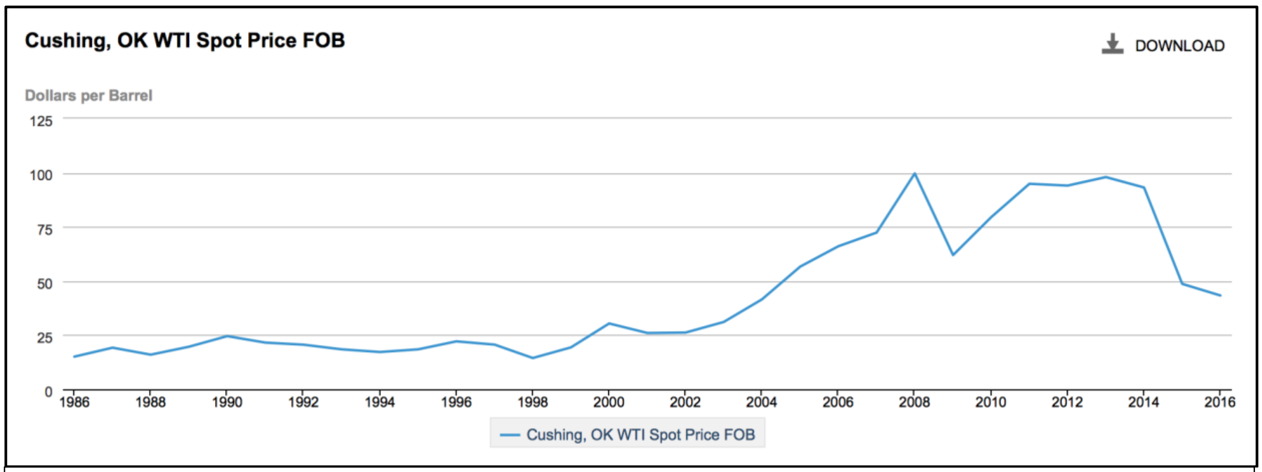


Figure 13. *Average spot prices for US oil, 1986–2016, in 2016 dollars. The maximum price has twice been $100/barrel.* Source: [US Energy Information Administration]

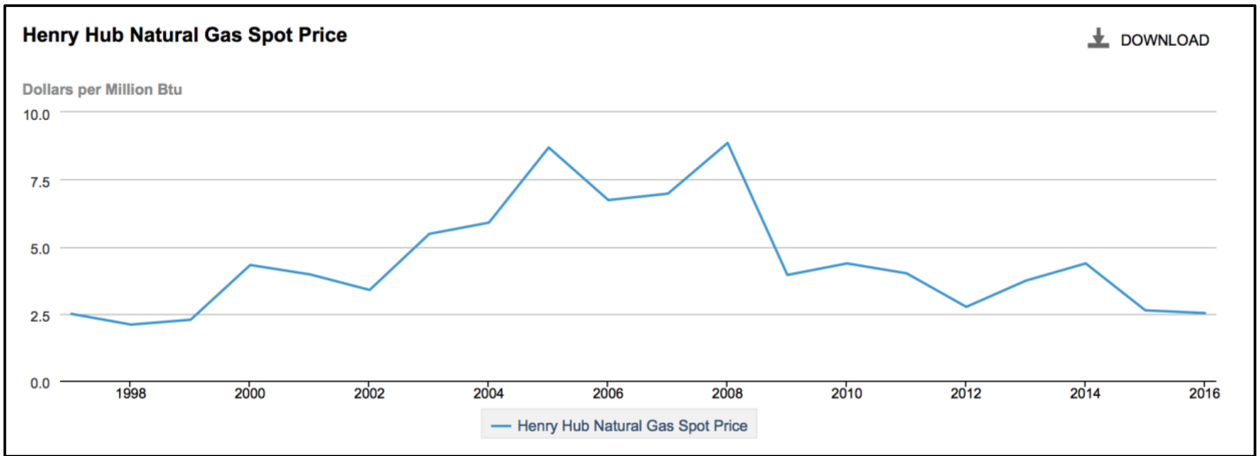


Figure 14. *Average spot prices for US gas, 1997–2016.* Source: US Energy Information Administration

Table 3. **Number of Years the OCS UTRR Would Fuel the United States at 2017 Consumption Levels**									
Region	**Oil (Bbo)**			**Gas (Tcfg)**			**BOE (Bbo)**		
Planning Area	**95%**	**Mean**	**5%**	**95%**	**Mean**	**5%**	**95%**	**Mean**	**5%**
Alaska OCS*	**2.63**	**3.67**	**5.02**	**3.56**	**4.85**	**6.16**	**3.27**	**4.53**	**6.12**
Chukchi Sea	1.28	2.12	3.18	1.80	2.83	4.11	1.60	2.62	3.91
Beaufort Sea	0.57	1.13	1.89	0.51	1.02	1.62	0.66	1.31	2.18
Hope Basin	0.00	0.02	0.06	0.00	0.14	3.84	0.00	0.05	0.75
Navarin Basin	0.00	0.02	0.06	0.00	0.05	0.14	0.00	0.03	0.08
North Aleutian Basin	0.02	0.10	0.25	0.05	0.32	0.64	0.03	0.16	0.36
St. George Basin	0.00	0.03	0.08	0.00	0.10	0.25	0.00	0.05	0.12
Norton Basin	0.00	0.01	0.02	0.00	0.11	0.36	0.00	0.03	0.09
Cook Inlet	0.03	0.14	0.28	0.02	0.04	0.07	0.04	0.15	0.29
Gulf of Alaska	0.02	0.09	0.20	0.03	0.15	0.34	0.02	0.11	0.26
Shumagin	0.00	0.00	0.01	0.00	0.02	0.08	0.00	0.00	0.02
Kodiak	0.00	0.01	0.03	0.00	0.07	0.28	0.00	0.02	0.08
*The Aleutian Arc, Aleutian Basin, Bowers Basin, and St. Matthew-Hall Planning Areas in the Alaska OCS Region were not evaluated in this study as their petroleum potential is negligible.									
Atlantic OCS	**0.16**	**0.63**	**1.27**	**0.47**	**1.41**	**2.54**	**0.24**	**0.88**	**1.72**
North Atlantic	0.01	0.24	0.70	0.04	0.43	1.21	0.02	0.32	0.92
Mid-Atlantic	0.01	0.33	0.76	0.08	0.91	1.85	0.03	0.49	1.09
South Atlantic	0.00	0.06	0.12	0.00	0.07	0.18	0.00	0.07	0.16
Gulf of Mexico OCS	**5.44**	**6.68**	**8.07**	**4.58**	**5.23**	**5.89**	**6.26**	**7.61**	**9.11**
Western Gulf of Mexico	1.13	1.59	2.14	1.18	1.44	1.69	1.34	1.85	2.44
Central Gulf of Mexico	3.40	4.58	5.89	2.87	3.37	3.90	3.91	5.18	6.58
Eastern Gulf of Mexico	0.32	0.50	0.73	0.26	0.42	0.60	0.37	0.58	0.83
Straits of Florida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pacific OCS	**0.96**	**1.41**	**1.93**	**0.39**	**0.59**	**0.88**	**1.03**	**1.51**	**2.09**
Washington/Oregon	0.00	0.06	0.16	0.00	0.08	0.21	0.00	0.07	0.20
Northern California	0.15	0.29	0.49	0.08	0.13	0.20	0.16	0.31	0.52
Central California	0.17	0.33	0.53	0.04	0.09	0.15	0.18	0.35	0.56
Southern California	0.39	0.73	1.20	0.13	0.28	0.50	0.41	0.78	1.29
Total U.S. OCS	**10.54**	**12.39**	**14.34**	**10.44**	**12.09**	**13.94**	**12.39**	**14.54**	**16.82**
2017 US daily oil consumption in millions of barrels:									*19.88*
2017 US daily consumption of "natural" (methane) gas in billions of cubic feet:									*74.22*
Gas in cubic feet equivalent in energy to one barrel of oil:									*5,620*

Potential Contribution of OCS Oil and Gas to Fueling the Nation

Key Question #1: How long could US offshore oil and gas fuel the nation?

At 2017 total US consumption levels for oil and gas, if every last barrel of oil and cubic foot of gas were extracted from the OCS, assuming the most optimistic case (which has only a 5-percent probability), the oil and gas would fuel the nation for about seventeen years. Assuming the mean scenario (50-percent probability), this would decrease to approximately fifteen years, and assuming the most conservative scenario (95-percent probability), to about twelve years (Table 3).

But economics do come into play. Based on an oil price of $60/barrel (and an equivalent gas price), the "economically recoverable" OCS O&G would fuel the nation for approximately eight and less than four years for oil and gas respectively (red columns, Table 4).

Table 4. **Number of Years OCS UERR Would Fuel the United States at 2017 Consumption Levels**

Region	$30/Bbl $1.60/Mcf		$40/Bbl $2.14/Mcf		$60/Bbl $3.20/Mcf		$100/Bbl $5.34/Mcf		$110/Bbl $5.87/Mcf		$160/Bbl $8.54/Mcf	
Planning Area	Oil	Gas	Oil	Gas	Oil	Gas	Oil	Gas	Oil	Gas	Oil	Gas
Alaska OCS*	**0.09**	**0.01**	**0.29**	**0.04**	**1.15**	**0.35**	**2.38**	**1.24**	**2.56**	**1.42**	**3.03**	**2.23**
Chukchi Sea	0.00	0.00	0.01	0.00	0.40	0.16	1.27	0.83	1.41	0.97	1.74	1.50
Beaufort Sea	0.01	0.00	0.14	0.02	0.55	0.15	0.84	0.30	0.87	0.32	0.98	0.47
Hope Basin	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.03
Navarin Basin	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01
North Aleutian Basin	0.02	0.00	0.05	0.00	0.06	0.01	0.07	0.01	0.07	0.01	0.08	0.03
St. George Basin	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.02	0.01	0.02	0.02
Norton Basin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Cook Inlet	0.09	0.01	0.11	0.01	0.13	0.01	0.14	0.03	0.14	0.03	0.14	0.04
Gulf of Alaska	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.06	0.05	0.07	0.06	0.10
Shumagin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kodiak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
*The Aleutian Arc, Aleutian Basin, Bowers Basin, and St. Matthew-Hall Planning Areas in the Alaska OCS Region were not evaluated in this study as their petroleum potential is negligible.												
Atlantic OCS	**0.44**	**0.13**	**0.48**	**0.19**	**0.52**	**0.31**	**0.55**	**0.48**	**0.56**	**0.51**	**0.57**	**0.64**
North Atlantic	0.19	0.07	0.20	0.09	0.22	0.14	0.23	0.19	0.23	0.19	0.23	0.23
Mid-Atlantic	0.24	0.06	0.26	0.09	0.28	0.16	0.30	0.27	0.30	0.29	0.31	0.38
South Atlantic	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.03	0.02	0.03	0.00
Gulf of Mexico OCS	**4.31**	**1.64**	**4.82**	**2.07**	**5.45**	**2.76**	**5.91**	**3.40**	**5.97**	**3.49**	**6.17**	**3.82**
Western Gulf of Mexico	1.00	0.44	1.13	0.59	1.29	0.81	1.41	1.01	1.42	1.03	1.47	1.13
Central Gulf of Mexico	2.99	1.03	3.34	1.29	3.76	1.73	4.07	2.13	4.11	2.19	4.25	2.41
Eastern Gulf of Mexico	0.32	0.17	0.36	0.19	0.40	0.22	0.43	0.26	0.43	0.26	0.45	0.28
Straits of Florida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pacific OCS	**0.55**	**0.20**	**0.70**	**0.24**	**0.89**	**0.31**	**1.01**	**0.35**	**1.02**	**0.36**	**1.09**	**0.38**
Washington/Oregon	0.01	0.01	0.02	0.02	0.03	0.02	0.03	0.03	0.03	0.03	0.04	0.03
Northern California	0.08	0.02	0.11	0.03	0.16	0.05	0.18	0.06	0.19	0.06	0.21	0.07
Central California	0.19	0.05	0.22	0.06	0.26	0.07	0.29	0.08	0.29	0.08	0.30	0.08
Southern California	0.27	0.11	0.34	0.13	0.44	0.16	0.50	0.18	0.51	0.19	0.54	0.20
Total U.S. OCS	**5.40**	**1.98**	**6.30**	**2.54**	**8.01**	**3.72**	**9.85**	**5.47**	**10.11**	**5.78**	**10.86**	**7.07**
2017 US daily oil consumption in millions of barrels:											*19.88*	
2017 US daily consumption of "natural" (methane) gas in billions of cubic feet:											*74.22*	
Gas in cubic feet equivalent in energy to one barrel of oil:											*5,620*	

Atmospheric Carbon Consequences of Exploiting Offshore Oil and Gas

The emissions from burning oil and gas extracted anywhere—not just from the US OCS—pose a problem of critical global, national, local, and intergenerational importance. Excessive amounts of carbon dioxide (CO_2) have been and are being emitted into the atmosphere by the burning of fossil fuels, thus overloading the atmosphere and causing the warming of the atmosphere, the biosphere, the cryosphere (ice caps) and the hydrosphere (a.k.a. oceans). Such climate change is an existential threat to life as we know and love it. That global warming is occurring and is primarily caused by humans—especially by the burning of fossil fuels but not limited to that cause—is settled science, so the fact of climate change won't be addressed further here.

Methane and nitrous oxide produced during oil and gas exploitation are also greenhouse gases contributing to human-caused global warming. However, this section considers only the global warming potential of carbon dioxide dumped into the atmosphere during the combustion of oil and gas extracted from the OCS.

Key Question #2:	What amount of atmospheric carbon pollution would result from burning the oil and gas in the OCS?

Total carbon dioxide pollution: If all possible UTRR OCS oil and gas were exploited, burning it would result in the emission into the atmosphere of ~66 billion tonnes of CO_2. If all the $60/barrel oil (and equivalently priced gas) were exploited, burning it would result in the emission of ~31 billion tonnes of CO_2 into the atmosphere.

As a fraction of US emissions: If all $60/barrel UERR of oil (and equivalently priced gas) in the OCS were burned, the emissions would equate to nearly five years of total 2015 US emissions from all sources. If all UTRR of oil and gas were burned, the emissions would equate to more than ten years of such total 2015 US emissions.

As an increase in global atmospheric carbon dioxide levels: If all the $60/barrel UERR oil (and equivalently priced gas) were burned, ~31 $GtCO_2$ would be released into the atmosphere, resulting in an increase of carbon dioxide in the atmosphere of 4.0 ppm. If all the OCS UTRR of oil and gas were burned, ~66 $GtCO_2$ would be released into the atmosphere, which would result in an increase in carbon in the atmosphere of another ~8.4 ppm.

As a fraction of the remaining carbon budget for the United States: If all the OCS $60/barrel UERR oil (and equivalently priced gas) were burned, the amount of CO_2 added to the atmosphere would equal 36 percent, 14 percent, and 9 percent of the low, medium, and high scenarios respectively. If all the OCS UTRR of oil and gas were burned, the amount of CO_2 added to the atmosphere would equal 77 percent, 30 percent, and 18 percent of the low, medium, and high scenarios respectively.

Following is a discussion of the information used to arrive at these numbers. Also discussed is the oceanic carbon pollution that is a direct consequence of the carbon pollution of the atmosphere.

Total Carbon Dioxide Pollution

Carbon dioxide is the most prevalent greenhouse gas (GHG), accounting for 81 percent of human-caused US GHG emissions in 2016. The Environmental Protection Agency estimates that 0.43 and 0.055 tonnes of CO_2 respectively are emitted from burning a barrel of oil and a thousand cubic feet of gas. For the scale of analysis herein, that's 430 and 55 million tonnes of CO_2 emissions per billion barrels of oil and trillion cubic feet of gas respectively.

Table 5 presents the carbon dioxide emissions that would result from burning the technically recoverable oil and gas in the OCS. If all possible reserves were burned, it would result in the emission into the atmosphere of ~66 billion tonnes of CO_2.

Table 5. **CO_2 Emissions If OCS UTRR Were Fully Exploited (Billions of Tonnes)**

Region	**Oil**			**Gas**			**BOE**		
Planning Area	**95%**	**Mean**	**5%**	**95%**	**Mean**	**5%**	**95%**	**Mean**	**5%**
Alaska OCS*	**8.21**	**11.44**	**15.66**	**5.31**	**7.23**	**9.18**	**13.52**	**18.67**	**24.84**
Chukchi Sea	4.00	6.61	9.92	2.69	4.22	6.13	6.69	10.84	16.05
Beaufort Sea	1.77	3.53	5.90	0.77	1.52	2.41	2.53	5.05	8.31
Hope Basin	0.00	0.06	0.19	0.00	0.21	5.72	0.00	0.27	5.91
Navarin Basin	0.00	0.06	0.18	0.00	0.07	0.20	0.00	0.12	0.38
North Aleutian Basin	0.05	0.32	0.78	0.08	0.47	0.96	0.13	0.80	1.74
St. George Basin	0.00	0.09	0.25	0.00	0.15	0.37	0.00	0.24	0.61
Norton Basin	0.00	0.03	0.07	0.00	0.17	0.53	0.00	0.19	0.60
Cook Inlet	0.11	0.43	0.86	0.03	0.07	0.11	0.14	0.50	0.97
Gulf of Alaska	0.06	0.27	0.62	0.04	0.22	0.51	0.09	0.49	1.13
Shumagin	0.00	0.00	0.02	0.00	0.03	0.11	0.00	0.03	0.13
Kodiak	0.00	0.02	0.09	0.00	0.10	0.42	0.00	0.12	0.51
*The Aleutian Arc, Aleutian Basin, Bowers Basin, and St. Matthew-Hall Planning Areas in the Alaska OCS Region were not evaluated in this study as their petroleum potential is negligible.									
Atlantic OCS	**0.49**	**1.97**	**3.95**	**0.70**	**2.10**	**3.78**	**1.20**	**4.07**	**7.73**
North Atlantic	0.03	0.76	2.20	0.06	0.65	1.80	0.09	1.41	4.00
Mid-Atlantic	0.04	1.04	2.38	0.12	1.35	2.75	0.16	2.39	5.13
South Atlantic	0.00	0.18	0.39	0.00	0.10	0.28	0.00	0.27	0.66
Gulf of Mexico OCS	**16.98**	**20.84**	**25.17**	**6.82**	**7.80**	**8.78**	**23.80**	**28.63**	**33.95**
Western Gulf of Mexico	3.53	4.98	6.69	1.76	2.14	2.51	5.29	7.12	9.20
Central Gulf of Mexico	10.61	14.30	18.38	4.27	5.02	5.81	14.88	19.32	24.19
Eastern Gulf of Mexico	1.01	1.56	2.27	0.39	0.63	0.89	1.40	2.19	3.16
Straits of Florida	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01
Pacific OCS	**2.99**	**4.39**	**6.03**	**0.58**	**0.89**	**1.32**	**3.57**	**5.27**	**7.35**
Washington/Oregon	0.00	0.17	0.49	0.00	0.13	0.32	0.00	0.30	0.81
Northern California	0.46	0.89	1.53	0.12	0.20	0.29	0.58	1.09	1.82
Central California	0.52	1.03	1.66	0.06	0.14	0.23	0.59	1.17	1.89
Southern California	1.20	2.29	3.74	0.20	0.42	0.75	1.40	2.71	4.49
Total US OCS	**32.88**	**38.64**	**44.73**	**15.55**	**18.01**	**20.77**	**48.43**	**56.66**	**65.50**
CO_2 emissions in tonnes per barrel of oil: 0.43									
CO_2 emissions in tonnes per thousand cubic feet (Mcf) of natural gas: 0.055									

Table 6 presents the CO_2 emissions that would result from burning the reserves of oil and gas recoverable at the various BOEM price points. If all the reserves economically recoverable at $60/barrel oil (and the equivalent gas price) were burned, it would result in the emission of nearly 31 billion tonnes of CO_2 into the atmosphere (red columns, Table 6), equating to nearly five years of total 2015 US emissions.

Table 6. CO_2 Emissions If OCS UERR Were Fully Exploited (Billions of Tonnes)												
Region	**$30/Bbl $1.60/Mcf**		**$40/Bbl $2.14/Mcf**		**$60/Bbl $3.20/Mcf**		**$100/Bbl $5.34/Mcf**		**$110/Bbl $5.87/Mcf**		**$160/Bbl $8.54/Mcf**	
Planning Area	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**
Alaska OCS*	**0.29**	**0.01**	**0.91**	**0.06**	**3.60**	**0.51**	**7.43**	**1.85**	**7.99**	**2.12**	**9.46**	**3.32**
Chukchi Sea	0.00	0.00	0.03	0.00	1.23	0.23	3.98	1.24	4.39	1.45	5.42	2.23
Beaufort Sea	0.03	0.00	0.44	0.04	1.72	0.23	2.61	0.44	2.72	0.48	3.05	0.70
Hope Basin	0.00	0.00	0.00	0.00	0.02	0.00	0.03	0.01	0.03	0.01	0.03	0.05
Navarin Basin	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.01	0.02	0.01	0.03	0.02
North Aleutian Basin	0.06	0.00	0.14	0.01	0.20	0.01	0.22	0.02	0.22	0.02	0.24	0.05
St. George Basin	0.00	0.00	0.01	0.00	0.03	0.00	0.04	0.01	0.05	0.01	0.06	0.04
Norton Basin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Cook Inlet	0.27	0.01	0.35	0.02	0.40	0.02	0.42	0.04	0.43	0.05	0.43	0.06
Gulf of Alaska	0.00	0.00	0.00	0.00	0.03	0.01	0.13	0.09	0.15	0.11	0.20	0.15
Shumagin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kodiak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03
*The Aleutian Arc, Aleutian Basin, Bowers Basin, and St. Matthew-Hall Planning Areas in the Alaska OCS Region were not evaluated in this study as their petroleum potential is negligible.												
Atlantic OCS	**1.38**	**0.20**	**1.49**	**0.28**	**1.62**	**0.46**	**1.72**	**0.72**	**1.73**	**0.76**	**1.78**	**0.95**
North Atlantic	0.60	0.10	0.64	0.13	0.68	0.20	0.71	0.28	0.71	0.29	0.72	0.34
Mid-Atlantic	0.75	0.09	0.81	0.13	0.89	0.24	0.94	0.41	0.94	0.44	0.97	0.57
South Atlantic	0.03	0.01	0.04	0.01	0.05	0.02	0.08	0.03	0.08	0.03	0.09	0.00
Gulf of Mexico OCS	**13.46**	**2.45**	**15.05**	**3.08**	**17.01**	**4.11**	**18.44**	**5.06**	**18.62**	**5.20**	**19.25**	**5.69**
Western Gulf of Mexico	3.13	0.66	3.53	0.87	4.02	1.20	4.39	1.50	4.43	1.54	4.59	1.68
Central Gulf of Mexico	9.33	1.53	10.41	1.93	11.74	2.57	12.71	3.18	12.84	3.27	13.26	3.59
Eastern Gulf of Mexico	1.01	0.25	1.11	0.28	1.24	0.33	1.33	0.38	1.35	0.39	1.39	0.42
Straits of Florida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pacific OCS	**1.72**	**0.29**	**2.19**	**0.36**	**2.77**	**0.46**	**3.14**	**0.52**	**3.19**	**0.53**	**3.39**	**0.57**
Washington/Oregon	0.04	0.02	0.06	0.03	0.09	0.04	0.10	0.04	0.10	0.04	0.11	0.05
Northern California	0.26	0.04	0.36	0.05	0.49	0.07	0.58	0.08	0.59	0.09	0.65	0.10
Central California	0.58	0.08	0.70	0.09	0.82	0.11	0.89	0.12	0.91	0.12	0.94	0.12
Southern California	0.84	0.16	1.08	0.19	1.38	0.24	1.57	0.27	1.60	0.28	1.70	0.30
Total US OCS	**16.86**	**2.95**	**19.65**	**3.79**	**25.00**	**5.54**	**30.73**	**8.14**	**31.54**	**8.61**	**33.89**	**10.53**
CO_2 emissions in tonnes per barrel of oil: 0.43												
CO_2 emissions in tonnes per thousand cubic feet (Mcf) of natural gas: 0.055												

As a Fraction of US Emissions

US emissions of greenhouse gases in 2015, measured in CO_2e (carbon dioxide equivalent), totaled 6.587 billion tonnes. As we saw above, burning all UTRR would result in the emission into the atmosphere of ~66 billion tonnes of CO_2, equating to more than ten years of total 2015 US emissions. Burning all $60/barrel oil (and all equivalently priced gas) would result in the emission of nearly 31 billion tonnes of CO_2 into the atmosphere, equating to nearly five years of total 2015 US emissions.

As an Increase in Global Carbon Dioxide Levels

In Paris in 2015, almost all the nations of the world, including the United States, agreed to this goal:

> *Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to*

1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.

An increase of 2°C and 1.5°C over pre-industrial levels translates in general terms to ~450–475 parts per million (ppm) and ~425 ppm respectively of carbon in the atmosphere. Global temperatures are ~1°C higher now than pre-industrial levels and serious problems are occurring. Former NASA scientist James Hansen, lead author of the peer-received scientific article entitled "Assessing 'Dangerous Climate Change': Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature" has said, "If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced . . . to at most 350 ppm."

In July 2018, Earth's atmosphere contained 408.31 ppm of CO2, up from 406.67 the previous July. To avoid the worst of global climate change, the world, including the United States, needs to dramatically limit its future fossil fuel emissions.

For every gigatonne (billion tonnes) of CO_2 ($GtCO_2$) that enters the atmosphere, carbon dioxide levels in the atmosphere increase 0.13 parts per million (ppm). If all the $60/barrel OCS UERR of oil (and equivalently priced gas) were burned, ~31 $GtCO_2$ would be released into the atmosphere, resulting in an increase of carbon in the atmosphere of 4.0 ppm. If all the OCS UTRR of oil and gas were burned, ~66 $GtCO_2$ would be released into the atmosphere, resulting in an increase in carbon in the atmosphere of ~8.4 ppm.

As Part of the Remaining US Carbon Budget

To avoid the worst of global warming, the world, including the United States, can emit only a limited amount of additional CO_2 into the atmosphere. For example, to have a 50-50 chance of limiting global warming to 2°C (and that really isn't low enough) over pre-industrial levels, the United States would have to limit its total emissions to 85 (low scenario), 220 (medium scenario), or 356 (high scenario) $GtCO_2e$. These allocations are the US share of the remaining global carbon budget based on three scenarios: low (equity, based on population and the fact that the United States has inordinately contributed historical CO_2 to the atmosphere), medium (blend of high and low), and high (inertia, which grandfathers in historically high contributors of CO_2 to the atmosphere).

If all the $60/barrel OCS UERR of oil (and equivalently priced gas) were burned, the amount of CO_2 added to the atmosphere would equal 36 percent, 14 percent, and 9 percent of the low, medium, and high scenarios respectively.

If all the OCS UTRR of oil and gas were burned, the amount of CO_2 added to the atmosphere would equal 77 percent, 30 percent, and 18 percent of the low, medium, and high scenarios respectively.

Carbon Pollution of the Oceans

While CO_2 atmospheric pollution is generally well understood, less so is CO_2 oceanic pollution, a direct consequence of such pollution of the atmosphere. Ocean acidification is the other carbon dioxide problem. Approximately one-quarter of the carbon dioxide emitted into the atmosphere eventually ends up in the ocean. This excess CO_2 in seawater is causing acidification of the oceans.

According to the National Oceanic and Atmospheric Administration:

> *When carbon dioxide (CO_2) is absorbed by seawater, chemical reactions occur that reduce seawater pH, carbonate ion concentration, and saturation states of biologically important calcium carbonate minerals. These chemical reactions are termed "ocean acidification" or "OA" for short. Calcium carbonate minerals are the building blocks for the skeletons and shells of many marine organisms. In areas where most life now congregates in the ocean, the seawater is supersaturated with respect to calcium carbonate minerals. This means there are abundant building blocks for calcifying organisms to build their skeletons and shells. However, continued ocean acidification is causing many parts of the ocean to become undersaturated with these minerals, which is likely to affect the ability of some organisms to produce and maintain their shells.*
> *Since the beginning of the Industrial Revolution, the pH of surface ocean waters has fallen by 0.1 pH units. Since the pH scale, like the Richter scale, is logarithmic, **this change represents approximately a 30 percent increase in acidity**. Future predictions indicate that the oceans will continue to absorb carbon dioxide and become even more acidic. Estimates of future carbon dioxide levels, based on business as usual emission scenarios, indicate that by the end of this century the surface waters of the ocean could be nearly 150 percent more acidic, resulting in a pH that the oceans haven't experienced for more than 20 million years.* [emphasis and link in the original]

The biological impacts are intense and far ranging. Calcifying species (such as oysters, clams, sea urchins, shallow water corals, deep sea corals, and calcareous plankton) are at risk, thereby posing a risk to the entire food web, an important source of protein for more than a billion people.

Key Question #3: What amount of chronic oceanic oil pollution would result from exploiting the oil and gas in the OCS?

Oil Spill Consequences of Exploiting Offshore Oil and Gas

Aside from spills of gas into the atmosphere and the oceans, spills of oil into the ocean are the most obvious and well-documented problems with offshore oil and gas exploitation. Spills of oil into the ocean affect marine life. These spills can be generally categorized as chronic (frequent and relatively small) or iconic (infrequent but catastrophically large).

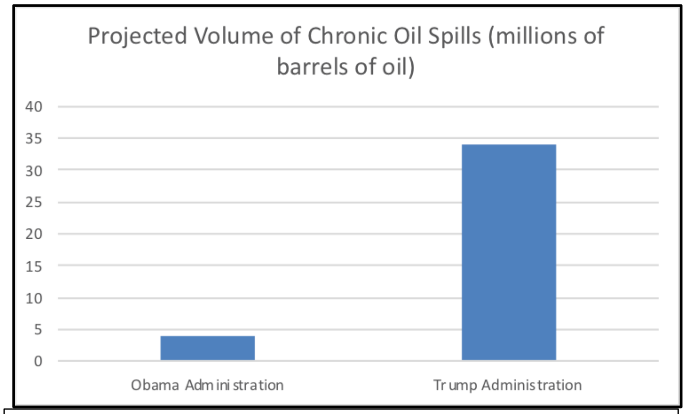


Figure 15. *Projected number of chronic oil spills: Obama versus Trump*. Source: Center for Biological Diversity

Chronic Spills

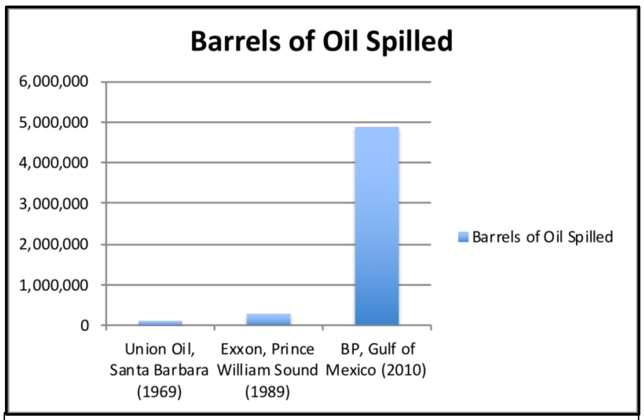


Figure 16. *Projected volume of oil spilled (millions): Obama versus Trump*. Source: Center for Biological Diversity

Chronic spills are routine and common and far lesser in magnitude than iconic spills. The Center for Biological Diversity estimates that the Trump OCS O&G plan could lead to 5,571 routine oil spills, dumping 34.4 million gallons of oil into the ocean. In contrast, it projects the Obama OCS O&G plan as producing 657 routine spills, dumping 4 million gallons of oil (Figures 15 and 16). The Center assumed production at $100/barrel and did not factor in any potential (if not probable) iconic spills, which are impossible to model, but quite probable to occur.

Key Question #4: What risk of catastrophic acute oceanic oil pollution would result from exploiting the oil and gas in the OCS?

Iconic Spills

Iconic oil spills are infrequent but catastrophic. Based on past experience and the facts that oil and gas exploitation is being done in increasingly harsh environments (including but not limited to

Figure 17. *The three largest US offshore oil spills (so far)*. Source: Wikipedia

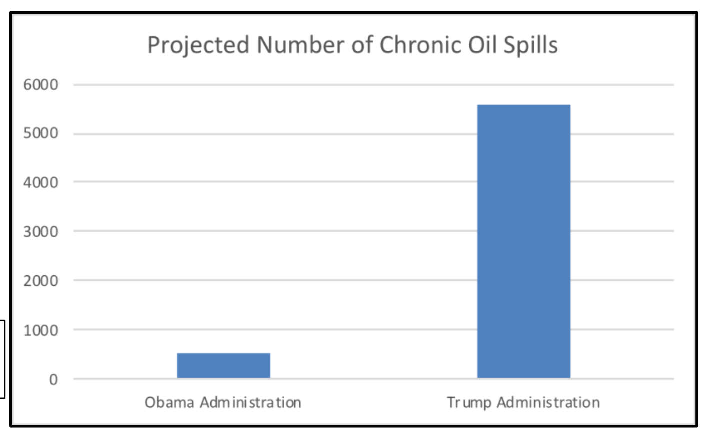


Figure 18. *Platform A offshore Santa Barbara, California*. Source: Wikipedia

several miles below the ocean surface and in ocean areas with chronically rough seas) and that humans are capable of error, it is reasonable to assume that the more drilling is done in the ocean, the more spills of catastrophic magnitude will occur.

A mere three data points is not a lot of data to average, but an unforgettable and acutely disastrous iconic oil spill has occurred in the United States on average once every two decades (Figure 17).

• Union Oil Santa Barbara *(1969), California coast: 80,000 to 100,000 barrels of crude oil*

A blowout on Union Oil's Platform A (Figure 18), located ~6 miles offshore in 188 feet of federal waters, began on January 28, 1969, and the oil continued to spill at a diminished rate until December 1970. Between 80,000 and 100,000 barrels of oil were spilled and fouled the coast from Pismo Beach to the Mexican border. Stopping the blowout on the drilling platform itself resulted in oil boiling out of five rips in the ocean floor.

Figure 19. *The* Exxon Valdez *in Alaska's Prince William Sound*. Source: Wikipedia

• *Exxon Valdez (1989), Alaska's Prince William Sound: 260,000 barrels of crude oil*

Just after midnight on March 24, 1989, the *Exxon Valdez* oil tanker (Figure 19) struck Bligh Reef, resulting in a spill of 260,000 barrels of crude oil. Soon the spill affected 1,300 miles of shoreline and 11,000 square miles of water. Between 100,00 and 250,000 seabirds were killed, along with 2,800 sea otters, ~12 river otters, 300 harbor seals, 247 bald eagles, 22 orca whales, and an unknown number of salmon and herring.

Twenty-five years later, National Oceanic and Atmospheric Administration scientists reported that some species seemed to have recovered. Concern lingers about two pods of local orcas, and scientists fear that one pod may die out. Between 16,000 and 21,000 US gallons (381 to 500 barrels) of oil remain on the beaches of Prince William Sound, some up to 450 miles away from Bligh Reef. This oil has not biodegraded at all and remains among rocks and on the land between high and low tides. The oil is mixing with seawater to form an emulsion (think mayonnaise or mousse).

• BP *Deepwater Horizon (2010), Gulf of Mexico: 4,900,000±10 percent barrels of crude oil*

On April 20, 2010, a blowout on the *Deepwater Horizon* drilling platform killed eleven people and injured seventeen, and eventually released ~4.9 million barrels of crude oil into the Gulf of Mexico (Figure 20). The platform, near the Mississippi Delta, was drilling a deep well on the Gulf of Mexico floor 5,100 feet below the water surface. After spilling for 143 days, the spill was declared sealed on September 19, 2010.

As of April 2013, dolphins and other marine life in the area of the spill continued to die in record numbers, with infants dying at six times the normal rate. A 2014 study found that tuna and amberjack exposed to the oil spill were developing deformed ears and other organs, deformities that were expected to be fatal or, at best, life shortening.

Figure 20. BP's *Deepwater Horizon* platform ablaze in the Gulf of Mexico. Source: Wikipedia

Disregarding Lessons from the* Deepwater Horizon *Tragedy

The Trump administration is proposing to eliminate or revise the drilling rig safety rules put in place after the *Deepwater Horizon* spill (again an Obama thing), saying the regulations are expensive. The Interior Department's so-called Bureau of Safety and Environmental Enforcement (BSEE) projects that the fossil fuel industry would save ~$288 million over ten years for all operating platforms. Let's do the math for the BSEE, as it apparently hasn't: ~$29 million a year spread over the ninety-five rigs in the US Gulf of Mexico would amount to ~$305,000 per rig per year—a mere rounding error when operating such a monstrosity. The Deepwater Horizon spill, due to the failure of one drilling rig, was quantified in 2016 as costing BP (formerly known as British Petroleum) $65 billion, and BP is still getting off easy.

Figure 21. *No lessons learned from the* Deepwater Horizon *tragedy?* Source: *Wikipedia*.

Societal Costs of Exploiting Offshore Oil and Gas

Key Question #5:	What financial costs to society from increase in CO2 emissions that would result from exploiting the oil and gas in the OCS?

If all UTRR of oil and gas were fully exploited, the social cost of CO_2 emitted into the atmosphere would be ~$3.3 trillion. In comparison and (co-incidentally), the projected 2018 expenditures of the US government total ~$3.3 trillion.

If all $60/barrel UERR of oil (and equivalently priced gas) in the OCS were fully exploited, the social cost of CO_2 emitted into the atmosphere would be ~$1.3 trillion.

Following is a discussion of the information used to arrive at these numbers. Also discussed is the societal cost of other greenhouse gases released into the atmosphere as a result of exploitation of OCS oil and gas.

Societal Cost of Atmospheric Carbon

Emitting carbon into the atmosphere costs society, and these costs should be measured.

In response to a court ruling on a fuel economy standard, the George W. Bush Administration developed the social cost of carbon (SCC, also called SC-CO_2) concept. The Obama Administration continued with the SSC, updating it in 2010 and 2013 to reflect improvements in the modeling. The National Center for Environmental Economics, under contract to the Environmental Protection Agency, explained that the SCC is

> *the present value of the marginal social damages of increased GHG emissions in a particular year—including the impacts of global warming on agricultural productivity and human health, loss of property and infrastructure to sea level rise and extreme weather events, diminished biodiversity and ecosystem services, etc.—and therefore it also represents the marginal social benefits of emissions reductions.*

Table 7. **Social Cost of CO_2 Emissions from Fully Exploiting OCS UTRR ($Billions)**

Region	**Oil**			**Gas**			**BOE**		
Planning Area	**95%**	**Mean**	**5%**	**95%**	**Mean**	**5%**	**95%**	**Mean**	**5%**
Alaska OCS*	**$411**	**$572**	**$783**	**$265**	**$361**	**$459**	**$676**	**$934**	**$1,242**
Chukchi Sea	$200	$331	$496	$134	$211	$306	$334	$542	$803
Beaufort Sea	$88	$177	$295	$38	$76	$120	$127	$253	$415
Hope Basin	$0	$3	$10	$0	$10	$286	$0	$14	$296
Navarin Basin	$0	$3	$9	$0	$3	$10	$0	$6	$19
North Aleutian Basin	$3	$16	$39	$4	$24	$48	$7	$40	$87
St. George Basin	$0	$5	$12	$0	$8	$18	$0	$12	$31
Norton Basin	$0	$1	$4	$0	$8	$27	$0	$10	$30
Cook Inlet	$5	$22	$43	$1	$3	$5	$7	$25	$49
Gulf of Alaska	$3	$14	$31	$2	$11	$25	$5	$25	$57
Shumagin	$0	$0	$1	$0	$1	$6	$0	$2	$7
Kodiak	$0	$1	$4	$0	$5	$21	$0	$6	$25
*The Aleutian Arc, Aleutian Basin, Bowers Basin, and St. Matthew-Hall Planning Areas in the Alaska OCS Region were not evaluated in this study as their petroleum potential is negligible.									
Atlantic OCS	**$25**	**$99**	**$198**	**$35**	**$105**	**$189**	**$60**	**$204**	**$387**
North Atlantic	$1	$38	$110	$3	$32	$90	$4	$70	$200
Mid-Atlantic	$2	$52	$119	$6	$68	$138	$8	$120	$257
South Atlantic	$0	$9	$19	$0	$5	$14	$0	$14	$33
Gulf of Mexico OCS	**$849**	**$1,042**	**$1,258**	**$341**	**$390**	**$439**	**$1,190**	**$1,432**	**$1,697**
Western Gulf of Mexico	$176	$249	$335	$88	$107	$126	$265	$356	$460
Central Gulf of Mexico	$530	$715	$919	$214	$251	$291	$744	$966	$1,209
Eastern Gulf of Mexico	$51	$78	$114	$20	$32	$45	$70	$110	$158
Straits of Florida	$0	$0	$0	$0	$0	$0	$0	$0	$0
Pacific OCS	**$150**	**$219**	**$302**	**$29**	**$44**	**$66**	**$179**	**$264**	**$367**
Washington/Oregon	$0	$9	$25	$0	$6	$16	$0	$15	$40
Northern California	$23	$45	$76	$6	$10	$15	$29	$55	$91
Central California	$26	$52	$83	$3	$7	$12	$29	$58	$95
Southern California	$60	$114	$187	$10	$21	$37	$70	$135	$224
Total U.S. OCS	**$1,644**	**$1,932**	**$2,236**	**$778**	**$901**	**$1,038**	**$2,421**	**$2,833**	**$3,275**
Social Cost of Carbon (SC-C02):		$50	In 2018 US$ at 3-percent discount rate, a moderate value in the ranges considered.						

For this paper, I started with an SCC of $40/tonne (2007 dollars) of carbon dioxide. It is the number found in the August 2016 update by the Interagency Working Group on Social Cost of Greenhouse Gases. Most specifically, it is the social cost per tonne of carbon in 2018 (in 2007 dollars) assuming a 3-percent average discount rate. The report also considered the SCC at 5-percent and 2.5-percent average discount rates ($12 and $60 per tonne respectively). It also considered a “high impact” 3-percent rate ($116/tonne) that assumes that a lower-probability but higher-impact outcome were to come to pass. While I generally think one should plan for the worst while hoping for the best, I nonetheless chose to use the middle discount rate value in my calculations. Using the inflation calculator of the US Bureau of Labor Statistics, I then adjusted the $40 in 2007 dollars to February 2018 dollars to arrive at $50/tonne—good enough for government work. The choice of the discount rate is critical, not to us but to our heirs. Critics of quantifying the social cost of carbon dioxide (or methane or nitrous oxide), if quantified at all, should use a higher discount rate. Choosing a higher discount rate means assigning a lower value to future costs, which is appropriate if you are greedy today and don’t care about the world you leave your children.

***Table 8.* Social Cost of CO_2 Emissions from Exploiting OCS UERR ($Billions)**

Region	**$30/Bbl $160/Mcf**		**$40/Bbl $2.14/Mcf**		**$60/Bbl $3.20/Mcf**		**$100/Bbl $5.34/Mcf**		**$110/Bbl $5.87/Mcf**		**$160/Bbl $8.54/Mcf**	
Planning Area	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**
Alaska OCS*	**$15**	**$1**	**$46**	**$3**	**$180**	**$26**	**$372**	**$92**	**$399**	**$106**	**$473**	**$166**
Chukchi Sea	$0	$0	$2	$0	$62	$12	$199	$62	$219	$72	$271	$112
Beaufort Sea	$2	$0	$22	$2	$86	$11	$131	$22	$136	$24	$152	$35
Hope Basin	$0	$0	$0	$0	$1	$0	$1	$0	$1	$1	$2	$2
Navarin Basin	$0	$0	$0	$0	$0	$0	$1	$0	$1	$0	$2	$1
North Aleutian Basin	$3	$0	$7	$0	$10	$1	$11	$1	$11	$1	$12	$2
St. George Basin	$0	$0	$0	$0	$2	$0	$2	$0	$2	$0	$3	$2
Norton Basin	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1
Cook Inlet	$13	$1	$17	$1	$20	$1	$21	$2	$21	$2	$22	$3
Gulf of Alaska	$0	$0	$0	$0	$2	$1	$7	$4	$8	$5	$10	$8
Shumagin	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Kodiak	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1
*The Aleutian Arc, Aleutian Basin, Bowers Basin, and St. Matthew-Hall Planning Areas in the Alaska OCS Region were not evaluated in this study as their petroleum potential is negligible.												
Atlantic OCS	**$69**	**$10**	**$75**	**$14**	**$81**	**$23**	**$86**	**$36**	**$87**	**$38**	**$89**	**$47**
North Atlantic	$30	$5	$32	$7	$34	$10	$35	$14	$35	$15	$36	$17
Mid-Atlantic	$37	$5	$41	$7	$44	$12	$47	$20	$47	$22	$48	$28
South Atlantic	$2	$0	$2	$1	$3	$1	$4	$1	$4	$2	$5	$0
Gulf of Mexico OCS	**$673**	**$122**	**$753**	**$154**	**$850**	**$205**	**$922**	**$253**	**$931**	**$260**	**$963**	**$285**
Western Gulf of Mexico	$157	$33	$177	$44	$201	$60	$219	$75	$222	$77	$230	$84
Central Gulf of Mexico	$466	$77	$521	$96	$587	$129	$636	$159	$642	$163	$663	$179
Eastern Gulf of Mexico	$50	$13	$55	$14	$62	$17	$67	$19	$67	$20	$70	$21
Straits of Florida	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Pacific OCS	**$86**	**$15**	**$110**	**$18**	**$139**	**$23**	**$157**	**$26**	**$160**	**$26**	**$170**	**$28**
Washington/Oregon	$2	$1	$3	$1	$4	$2	$5	$2	$5	$2	$6	$3
Northern California	$13	$2	$18	$3	$24	$3	$29	$4	$29	$4	$32	$5
Central California	$29	$4	$35	$5	$41	$6	$45	$6	$45	$6	$47	$6
Southern California	$42	$8	$54	$10	$69	$12	$78	$14	$80	$14	$85	$15
Total U.S. OCS	**$843**	**$148**	**$983**	**$190**	**$1,250**	**$277**	**$1,537**	**$407**	**$1,577**	**$430**	**$1,694**	**$527**
Social Cost of Carbon (SC-C02):	$50	In 2018 US$ at 3-percent discount rate, a moderate value in the ranges considered.										

Critics also argue that because the social cost of carbon is difficult to quantify, it should not be used in evaluating government actions. Adding more CO_2 to the atmosphere will have costs borne by our successors. Though difficult to measure, the social cost of carbon is clearly not $0. It may well be much higher or lower than the $50/tonne (2018 dollars) I chose. It is better to use the best available number and be approximately right than to not use any number other than a perfect one, thereby assigning $0 cost, and be precisely wrong.

President Trump wrote in Section 5a, "Review of Estimates of the Social Cost of Carbon, Nitrous Oxide, and Methane for Regulatory Impact Analysis," in his executive order of March 27, 2017: "In order to ensure sound regulatory decision making, **it is essential that agencies use** estimates of costs and benefits in their regulatory analyses that are based on **the best available science and economics**" [emphasis added]. Then the executive order goes on to disband the Interagency Working Group on Social Cost of Greenhouse Gases and specifically withdraws "as no longer representative of government policy" six technical papers by name, including the August 2016 update upon which I rely. Though withdrawn as government policy, it is nonetheless the best available science and economics as to the facts and consequences of adding carbon to the atmosphere and is used herein.

If all the UTRR were fully exploited, the social cost of the resulting CO_2 emissions would be ~$3.3 trillion (Table 7). In comparison and (co-incidentally), the projected 2018 expenditures of the US government total ~$3.3 trillion.

If all the $60/barrel UERR of oil (and equivalently priced gas) were fully exploited, the social cost of CO_2 emitted into the atmosphere would be ~$1.3 trillion (red columns, Table 8).

Tobacco Industry Logic

Late in the Obama administration, the BOEM issued a report, OCS Oil and Natural Gas: Potential Lifecycle Greenhouse Gas Emissions and Social Cost of Carbon, that concludes that greenhouse gas emissions and social costs of carbon of new offshore production are negligible because if OCS O&G isn't exploited and combusted, onshore O&G will be—so they say it's basically a wash.

The amounts of carbon pollution and the social costs of new US offshore oil and gas exploitation calculated in this paper are directly correlated with new exploitation. If the "undiscovered" OCS O&G is exploited, it will produce an estimated amount of carbon pollution and have an estimated cost to society of having been exploited. If it is not so exploited, it will have no impact.

The problem with the BOEM reasoning is that it attempts to rationalize polluting the atmosphere and imposing costs on society for doing so by saying that it's going to happen anyway somewhere else or in some other way. Carbon pollution and its costs to society are a problem, whether the oil and gas comes from offshore or onshore. It is analogous to a tobacco company saying that its products are not harmful because even if it didn't produce and sell them, another tobacco company would.

Societal Cost of Other Greenhouse Gases

Alas, CO_2 is not the only greenhouse gas. Methane (CH_4) and nitrous oxide (N_2O) are additional culprits.

Methane (the primary component of "natural" gas) accounted for ~10 percent of human-caused US GHG emissions in 2015. Thirty-one percent of those emissions came from leakage during oil and gas extraction and distribution, both onshore and offshore. That's right—during production, transmission, and distribution of natural gas, methane leaks to the atmosphere before it is combusted. After combustion the methane is converted to the merely dangerous CO_2 and innocuous H_2O (a.k.a. water). Also, methane is a precursor to ozone, itself a greenhouse gas.

All told, approximately 1.5 percent of all methane ends up leaking into the atmosphere. In the first two decades after its release, a molecule of methane is eighty-four times more potent than a molecule of carbon dioxide in terms of how effectively it absorbs energy. Compared to CO_2 with its global warming potential (GWP) of 1 over an infinite timespan (thousands of years), methane has a GWP of 28 to 36 over a hundred-year timespan. In other words, the comparative impact of methane on the atmosphere is more than twenty-five times that of carbon dioxide per unit over a century. For all greenhouse gases, it is appropriate to give greater weight to the next two decades, as climate change is a crisis now.

Nitrous oxide accounted for ~5 percent of human-caused US GHG emissions in 2015. Fossil fuel combustion and conversion into chemicals accounted for ~11 percent of human-caused US GHG emissions in 2015. Over a century, N_2O has nearly three hundred times more atmospheric impact per unit than carbon dioxide. Alas, laughing gas is no laughing matter.

Though outside the scope of this report, it is worth mentioning the social cost of methane and nitrous oxide. The same pre-Trump Environmental Protection Agency estimated the social cost of CH_4 and N_2O. The comparable figures for the social cost are $1,200/tonne CH_4 and $15,000/tonne N_2O. Factoring in these costs would make the social cost of OCS oil and gas exploitation even higher.

The Economics of Offshore Oil and Gas

Now that we have considered five key questions about the societal and environmental consequences of exploiting OCS oil and gas, we will explore how economics and politics might impact the course of OCS oil and gas exploitation. Regarding economics, market and regulatory trends are away from fossil fuel use, and production costs favor onshore versus offshore oil and gas development.

The world is awash in oil and gas, so large price increases are not likely in the relatively near term. What is likely is that declining costs of production will make existing and new *onshore* oil and gas even more economically attractive compared to *offshore* oil and gas exploitation. If oil and gas prices were to rise, this would likely increase more cost-effective onshore exploitation rather than significantly increase the more costly offshore production. In addition, as prices rise, the attractiveness of non–fossil fuel alternatives increases, as well as the widespread implantation of existing and new energy-efficiency technologies. Increasing fossil fuel prices in the short term will likely lead to a loss of market share in the long term.

If oil and gas prices increase dramatically, the market will respond in three ways:

• conservation (using less)
• efficiency improvements (using it better)
• fuel substitution (not using it at all)

The Trend Away from Fossil Fuel Use

In both markets and regulation, the general *trend* is to move away from the use of fossil fuels. Fossil fuels are on their way out—perhaps with some fits and starts and not as soon as I would hope, but far sooner than the oil and gas industry fears. It is not a matter of if, but when. Disruption away from fossil fuels is under way and accelerating for both market and policy reasons. As demand for fossil fuels decreases, so will the price.

Market Trends

Even without the cost of oil and gas rising, fuel switching is occurring because the price of alternative energies is falling. Following are a few indicators. Whether or not these trends occur on the timelines predicted, the general trend is for society to move toward alternatives to fossil fuels.

- The movement to divest pension funds from stocks in fossil-fuel companies is growing.

- US automobiles and trucks have become more fuel-efficient and will continue to do so.

- Electric cars are becoming better and increasingly desired in the market. Bloomberg New Energy Finance said in its Electric Vehicle Outlook 2017*:* "The EV revolution is going to hit the car market even harder and faster than BNEF predicted a year ago. EVs are on track to accelerate to 54% of new car sales by 2040. Tumbling battery prices mean that EVs will have lower lifetime costs, and will be cheaper to buy, than internal combustion engine (ICE) cars in most countries by 2025–29."

- "It appears that natural gas (as well as renewables) will continue to displace coal in energy consumption," concludes an October 2017 report from the Federal Reserve Bank of St. Louis. Natural gas is very abundant, and relatively cheap, onshore.

- Although gas has topped coal as the largest producer of electricity, its dominance may be short-lived. A March 2018 *New York Times* analysis points out that natural gas as a "bridge" fuel to the fossil fuel–free future may be a shorter bridge than originally thought, noting that "technology and economics have carved a different, shorter pathway that has bypassed the broad need for some fossil-fuel plants." It further notes that "the calculus is rapidly shifting as the prices of wind and solar power continue to fall. According to the Department of Energy, power generated by natural gas declined 7.7 percent in 2017."

Table 9. **Lazard's 2017 Unsubsidized Levelized Cost of Energy Comparison ($/MWh)**		
Energy Type	**Low Bound**	**High Bound**
Alternative Energy		
Solar photovoltaic—rooftop residential	$187	$319
Solar photovoltaic—commercial and Industrial	$85	$194
Solar photovoltaic—community	$76	$150
Solar photovoltaic—crystalline utility scale	$46	$53
Solar photovoltaic—thin film utility scale	$43	$48
Solar thermal tower with storage	$98	$181
Fuel cell	$106	$167
Microturbine	$59	$89
Geothermal	$77	$117
Biomass direct	$55	$114
Wind	$30	$60
Conventional Energy		
Diesel reciprocating engine	$197	$281
Natural gas reciprocating engine	$68	$106
Gas peaking	$156	$210
Integrated gasification combined cycle	$96	$231
Nuclear	$112	$183
Coal	$60	$143
Gas combined cycle	$42	$78
Source: *Lazard's Levelized Cost of Energy Analysis—Version 11.0*		

- By 2023, onshore wind and photovoltaics will be competitive with new-build gas plants in the United States, and gas plants will increasingly act more as a source of flexible generation needed to meet peaks and provide system stability rather than as a replacement for "baseload" coal, according to *New Energy Outlook 2017*, an annual economic forecast from Bloomberg New Energy Finance.

- A growing number of utilities are choosing to use a combination of photovoltaic energy and battery storage instead of natural gas for peaking generation on the electric grid, reports a February 2018 article in *Renewable Energy World*.

- Renewable fossil fuel–free energy resources are increasingly cost-competitive with fossil fuel energy resources—without subsidies, according to Lazard, a leading global financial advisory and asset management firm. *Lazard's Levelized Cost of Energy Analysis* dated November 2017 found that the most costly wind energy is no more expensive than the least costly fossil-fuel energy source (Table 9). (I must quibble with Lazard here because while it accounts for the tax credits and other subsidies that are designed to encourage renewable energy production, which are transparent and temporary, even when Congress extends them, it fails to account for the multiple subsidies to fossil fuels that are permanent provisions of federal and state tax codes.)

Regulatory Trends

Every country on Earth except the United States is proceeding with the Paris Agreement, which has already been ratified by 175 of the 197 signatory nations. But even as the US government is walking away from responsibility for the climate, state, local, tribal, and other governments, along with other institutions and corporations, are stepping up. Bloomberg New Energy Finance notes in its *2018 Sustainable Energy in America Factbook*:

> *In response to the U.S. withdrawal from the Paris Agreement and fading federal-level climate action, sub-national actors have created alliances to support continued progress on the U.S. greenhouse gas reduction targets. The "We Are Still In" movement involves 2,642 mayors, governors, CEOs, college presidents, faith organizations, and tribal leaders (as of the time of this writing). Another group, the U.S. Climate Alliance, includes 16 governors representing over 40% of the U.S. population and $7.4 trillion in economic output. Separately, the U.S. Climate Mayors (founded at the signing of the Paris Agreement) saw its membership swell after the U.S. withdrew from Paris. It now encompasses 383 cities covering 23% of the U.S. population, half of which are in states that have not additionally joined the U.S. Climate Alliance. Together, these entities represent 2.7Gt in emissions (for comparison, total U.S. emissions stood at 6.4Gt for 2017).*

Several US states and Native American tribes, many cities (including some very large ones), and hundreds of US companies (including some very large ones) are continuing to adopt policies that discourage or prohibit fossil fuel use, despite Trump's announced intent. While it's not enough, it *is* significant enough to further move the needle against the use of fossil fuels in the United States. Emissions limitation efforts through trading are increasingly being adopted, and more US states are considering carbon taxes.

The Production Costs of Onshore versus Offshore Fossil Fuels

The United States is now the largest producer of oil and gas, mainly due to increases in onshore production. While oil and gas exploitation anywhere is an existential threat to the planet as we have known and loved it and has dramatic consequences for air quality, water quality, land health, watershed health, and human health, the world is awash in oil and gas. Alas, the only shortage of oil and gas is in my dreams. And it is available from US onshore sources and the world elsewhere at average break-even prices far less than that for US offshore oil. Thus, the economics of oil and gas exploitation in the United States mostly favors onshore rather than offshore oil and gas.

Onshore, the cost of producing a barrel of oil has declined dramatically and is under $40 (Figure 22). *Offshore*, the cost of producing a barrel of oil is increasing. According to the *Wall Street Journal*, "Drilling in the U.S. Gulf of Mexico has migrated from shallower depths to deep water, sending production costs surging as companies plumb reservoirs thousands of feet below the water's surface." The US Energy Information Administration, citing a report it commissioned, says, "According to the IHS report's modeling of current deepwater Gulf of Mexico projects, full cycle economics result in breakeven prices that are typically higher than $60/b[arrel]."

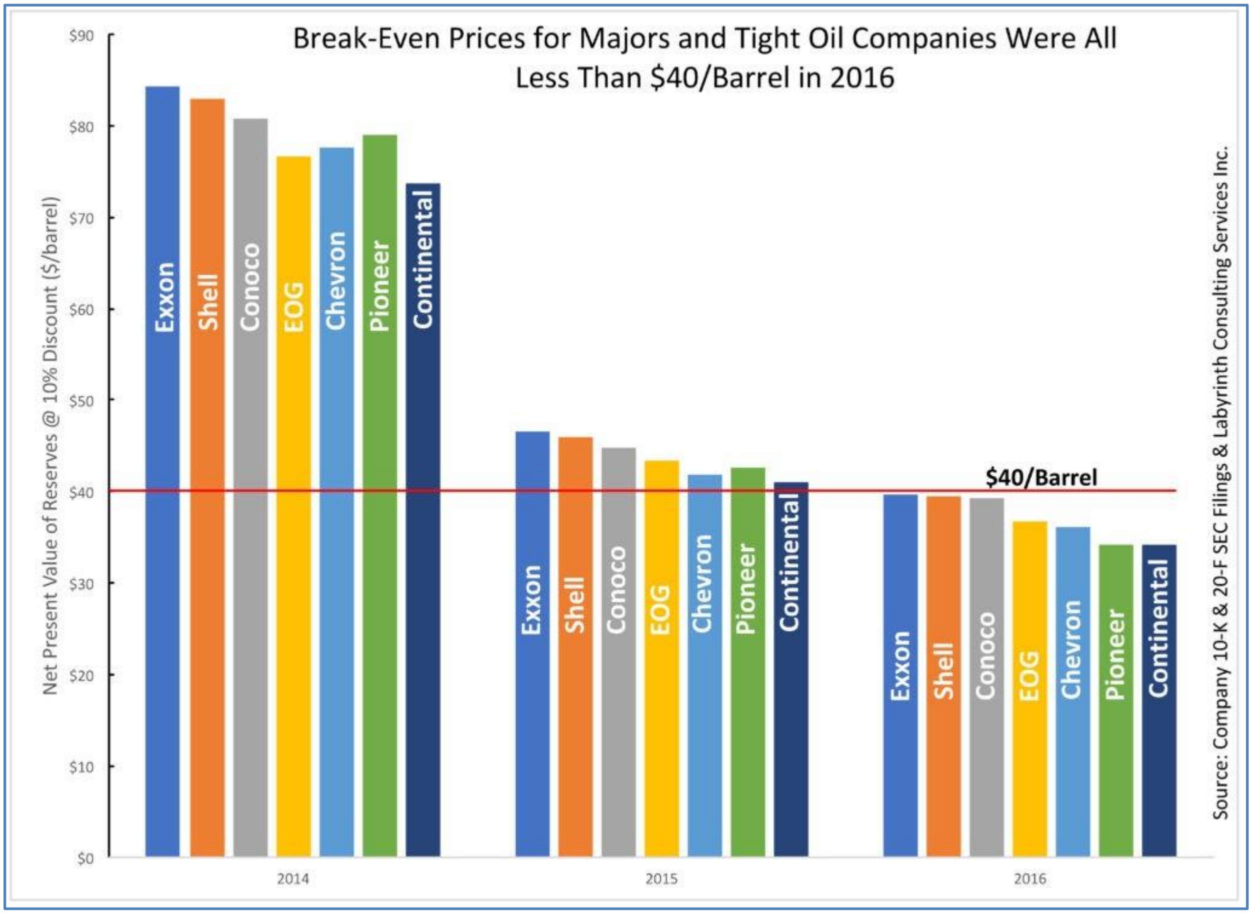


Figure 22. *Break-even prices for majors and tight oil companies in 2016*. Source: Oilprice.com

Onshore, the cost of producing gas has plummeted. Bloomberg New Energy Finance's *2018 Sustainable Energy in America Factbook* notes that "producers have achieved strong efficiency gains and reductions in drilling and completion (D&C) costs over the past two years, resulting in 'breakeven' prices of $2–4/MMBtu in most basins, assuming an internal rate of return of 20%."

The Politics of Exploiting Offshore Oil and Gas

Finally, we turn to the politics of exploiting offshore oil and gas. The Trump administration faces opposition to its offshore oil and gas leasing plan from Congress and from most of the states that abut the federal OCS. Agencies of the federal government could also serve one way or another to keep the administration's plans in check.

The Administration

While the current executive branch of the federal government is all for offshore drilling, there are agencies in the government, especially the Department of the Interior, that have statutory obligations to protect fish, wildlife, water quality, air quality, and other resources from harm, including from fossil fuel development. If these agencies do their statutorily mandated jobs, they will serve as a drag anchor on the out-of-control ship of state. If these agencies don't do their statutorily mandated jobs, they will be sued and then they will serve as a drag anchor on the out-of-control ship of state.

The Congress

As of the date of this report, twenty-three bills pending in the current 115th Congress would limit fossil fuel exploitation in the OCS (Table 10).

Table 10. **Legislation Pending in the 115th Congress Limiting Fossil Fuel Exploitation in the OCS**

Bill Number	Bill Name	Total Sponsors	OCS Planning Areas Affected	Notes
H.R.728	--	4	North Atlantic (part), Mid-Atlantic (part)	
H.R.169	West Coast Ocean Protection Act	43	Oregon/Washington, Northern California, Central California, Southern California	
S.31		6		
H.R.2158	Atlantic Seismic Airgun Protection Act	38	Mid-Atlantic, South Atlantic	Would ban use of seismic airguns to search for oil, gas, or methane hydrate
S.1263		13		
H.R.2002	Florida Coastal Protection Act	8	Central Gulf of Mexico (part), Eastern Gulf of Mexico (part), Florida Straits, South Atlantic (part)	Would prohibit O&G leasing offshore Florida
S.2292		1		
H.R.2252	Coastal Economies Protection Act	3	North Atlantic, Mid-Atlantic, South Atlantic, Florida Straits	Would place a moratorium on O&G leasing until June 20, 2027
H.R.2272	COAST (Clean Ocean and Safe Tourism) Anti-Drilling Act	51	North Atlantic, Mid-Atlantic, South Atlantic, Florida Straits, Eastern Gulf of Mexico (part), Central Gulf of Mexico (part)	
S.999		20		
H.R.4474	New England Coastal Protection Act	21	North Atlantic (part)	Would prohibit O&G leasing offshore Maine, New Hampshire, Massachusetts, Rhode Island, or Connecticut
S.2298		1		
H.R.2242	Keep It in the Ground Act	20	All	
S.750		1		
S.1041	Florida Shores Protection and Fairness Act	1	Eastern Gulf of Mexico (part)	
H.R.731	California Clean Coast Act	37	Northern California, Central California, Southern California	
H.R.2248	--	42	All, save for the Western Gulf of Mexico, Central Gulf of Mexico, and Cook Inlet	Would prohibit any change to Obama 2017–2022 OCS Oil and Gas Leasing Program, which is limited to ten sales in the Gulf of Mexico and one in Cook Inlet
S.985		24		
H.R.5014	PROTECT (Preserving Recreation, Oceans, Tourism, Environment, and Coastal Towns in) Florida Act	10	South Atlantic (part), Straits of Florida, Eastern Gulf of Mexico (part), Central Gulf of Mexico (part)	Would extend existing moratorium for Eastern GOM until 2029
S.991	Stop Arctic Ocean Drilling Act	11	Beaufort Sea, Chukchi Sea, Hope Basin	
H.R.1784		62		
S.74	Marine Oil Spill Prevention Act	2	Eastern Gulf of Mexico (part)	Would extend existing moratorium until 2027
H.R.2261		18		

Even the Alaska congressional delegation doesn't favor leasing everywhere offshore Alaska. In a letter to Secretary Zinke, the delegation supported leasing in the Chukchi, Beaufort, and Cook Inlet planning areas, as proposed in the Obama 2017–2022 OCS oil and gas leasing program. They requested that the Hope Basin, Norton Basin, St. Matthew-Hall, Navarin Basin, Aleutian Basin, Bowers Basin, Aleutian Arc, St. George Basin, Shumagin, Kodiak, and Gulf of Alaska planning areas all be dropped in the final plan of the Trump administration.

The States

Twenty-two states abut the federal OCS. Five states with significant existing offshore fossil fuel infrastructure generally or somewhat favor OSC drilling (TX, LA, MS, AL, and AK). However, the governors of fifteen of the seventeen states along the Pacific and Atlantic coasts strongly oppose drilling in the OCS offshore their states (NH, MA, RI, CT, NY, NJ, MD, DE, VA, NC, SC, FL, WA, OR, and CA) (Figure 23). All have called on Secretary Zinke to exempt their states, as he did Florida. (Maine is in support of drilling and Georgia has taken no formal position.) In March 2018, 227 state legislators from seventeen coastal states signed a letter opposing the draft Trump OCS O&G plan.

Zinke and Florida and Some Other States

The Straits of Florida Planning Area has a 95-percent probability of having 0.01 billion BOE, and a 50-percent and 95-percent probability of 0.02 billion BOE, not zero but rather close to it. At those significant digits, it's better to call it 10 and 20 million barrels of oil respectively.

The numbers make clear why it was easy for Secretary Zinke to agree to the request of Florida governor Rick Scott to take the Straits of Florida (and similarly the South Atlantic [with a 95-percent probability of zero fossil fuels]) out of the leasing queue.

When asked why he exempted Florida from his draft leasing plan, Zinke said on CNN, "The coastal currents are different, the layout of where the geology is." Actually, there is not a place on Earth that doesn't have geology. What Zinke should have said was the geology of offshore Florida is rather unpromising from the standpoint of fossil fuels. All offshore areas also have currents that can spread any oil spill long distances in short periods of time. Perhaps Zinke should have mentioned the political currents, including but not limited to a very competitive US Senate election in 2018, a likely purple state in the 2020 presidential contest, and a bipartisan congressional moratorium on leasing in the Eastern Gulf of Mexico Planning Area until June 30, 2020.

Under questioning from US Senator Maria Cantwell (D-WA), Governor Kate Brown (D-OR), and US Representative Jared Huffman (D-CA), Zinke has strongly suggested he won't be leasing offshore Washington, offshore Oregon, or much of offshore California.

Speaking to Cantwell, Zinke said: "And again I put everything on so we could have a dialogue and then take what's appropriate off. I think I'm going to mark down Washington as opposed to oil and gas drilling." He added, "Our proposal will have the interests of Washington reflected in that plan. As well as Florida, the Gulf states, and where there is enormous opposition. We'll do that."

In the end, it's all about the Gulf of Mexico (and parts of offshore Alaska), because that's where the OCS O&G is.

A sovereign state in these United States can either prevent or otherwise discourage federal OCS fossil fuel exploitation, enough to dissuade an oil company from proceeding. The coastal states in opposition can do much to prevent or otherwise discourage federal OCS oil and gas development, including but not limited to

- banning oil and gas development in adjacent state coastal waters, and
- refusing to permit or otherwise facilitate the development onshore of offshore energy exploitation infrastructure, including but not limited to pipelines, power lines, port facilities, and refineries.

Governor Phil Murphy (D) [signed a bill] to block offshore drilling in New Jersey waters and to ban any infrastructure supportive of drilling in federal waters to the east. Even his predecessor, Governor Chris Christie (R), opposes OCS drilling off the Jersey shore. Similar bills are pending in several other states, including California, New York, South Carolina, and Rhode Island.

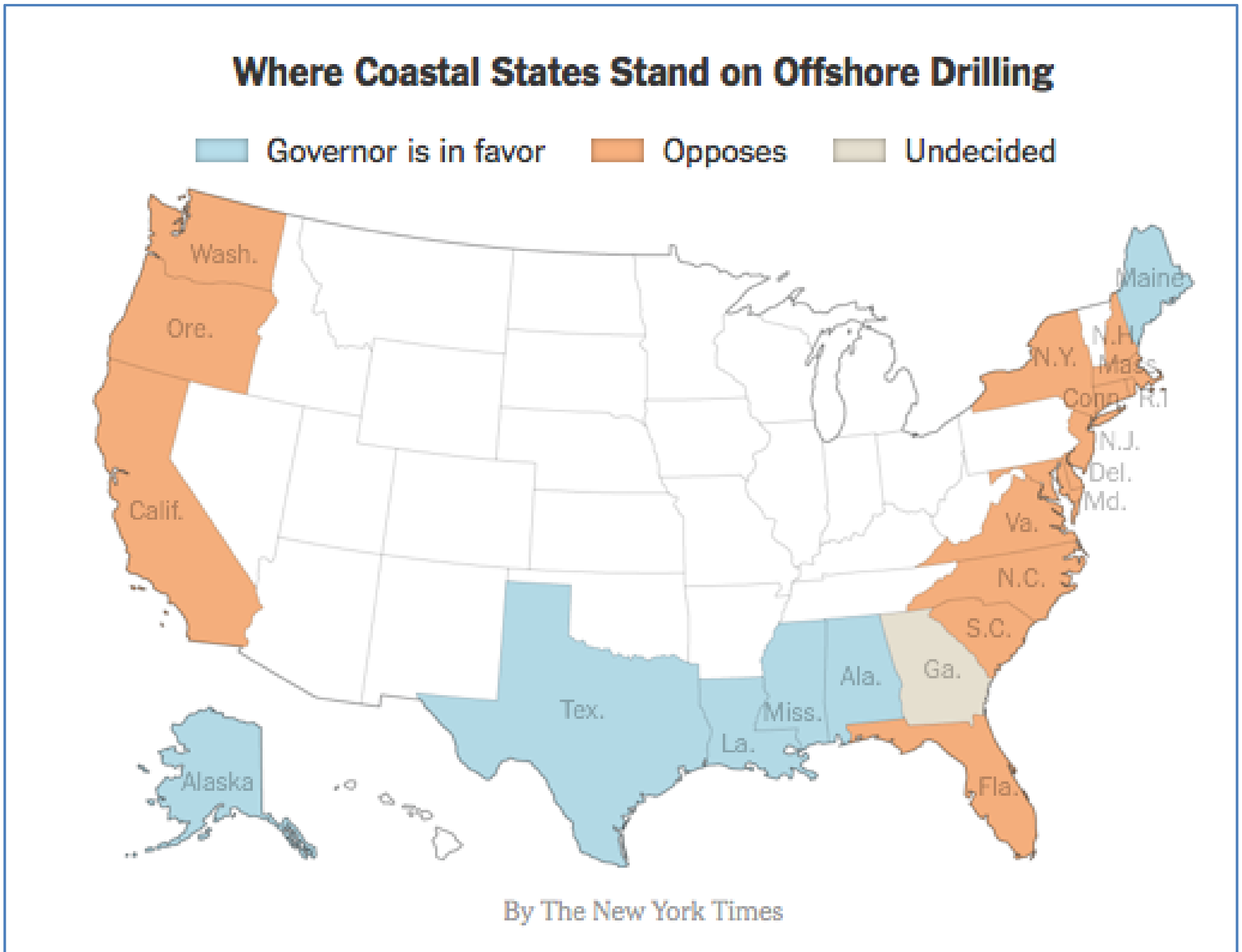


Figure 23. *Where coastal states stand on offshore drilling. Save for Maine, the states in favor of offshore oil and gas exploitation states are the ones with existing infrastructure. Of the states against offshore drilling, only California has existing infrastructure.* Source: *New York Times*

Conclusion and Recommendations

For economic, environmental, and societal reasons equally applicable to today's and future generations, the United States should eschew any new offshore oil and gas exploitation and continue its progress toward a fossil fuel–free sustainable energy economy a decade or two earlier than it otherwise would. For the sake of the atmosphere, the biosphere, the hydrosphere, human health, and the economy, the sooner the better.

Figure 24. *Just say no*. Source: Wikipedia.

To get there from here, we make three recommendations:

No new oil and gas leasing. There should be no new leasing of any waters of the United States (or any onshore public lands, for that matter) for oil and gas exploitation. The atmosphere is already overfilled with carbon dioxide, methane, and particulate pollution from the production and combustion of oil and gas. Exploitation of the US Outer Continental Shelf's nonrenewable fossil fuels jeopardizes the more sustainable renewable resources of the shelf that are more economically, environmentally, and socially valuable.

Phaseout of existing oil and gas leasing. For the same reasons, any existing oil and gas leases should not be renewed.

Permanent ocean protection. To permanently ban (as much as government can do so) fossil fuel exploitation, essentially all of the federal OCS should be designated national marine sanctuaries. Despite the name, the statute establishing the National Marine Sanctuaries System does not prohibit any type of use, but a management plan is developed to manage each sanctuary for multiple uses. Such management plans should favor renewable, sustainable, and nonpolluting uses over nonrenewable, unsustainable, and polluting uses but can also accommodate legitimate and necessary nonrenewable, unsustainable, and polluting activities when in the national interest. Additionally, certain areas of the US OCS are appropriate for designation as marine national monuments, marine national wildlife refuges, marine national parks, and other marine protected areas for the conservation and restoration of marine natural resources for this and future generations.

Figure 25. *Coming to a beach near you?* Source: Wikipedia

About the Author

Andy Kerr (andykerr@andykerr.net) is the Czar of The Larch Company (www.andykerr.net) and consults on environmental and conservation issues. The Larch Company is a for-profit non-membership conservation organization that represents the interests of humans yet unborn and species that cannot talk. Kerr is best known for his two decades with Oregon Wild (then the Oregon Natural Resources Council), the organization that brought you the northern spotted owl. He received far more than his allotted fifteen minutes of fame (or, if you prefer, infamy) during the Pacific Northwest Timber Wars, which peaked in the mid-1990s and are still going on, though at a lower level of controversy.

Kerr began his conservation career during the Ford administration. Through 2017, he has been closely involved with the establishment or expansion of forty-six wilderness areas, forty-seven wild and scenic rivers, thirteen congressionally legislated special management areas, fifteen Oregon scenic waterways, and one proclaimed (and later expanded) national monument. He has testified before congressional committees on several occasions.

A dropout of Oregon State University, Kerr has lectured at all of Oregon's leading universities and colleges as well as Harvard and Yale. He has appeared numerous times on national television news and feature programs and has published many articles on environmental matters. He authored *Oregon Desert Guide: 70 Hikes* (The Mountaineers Books, 2000) and *Oregon Wild: Endangered Forest Wilderness* (Timber Press, 2004). His articles on solar energy, energy efficiency, and public policy have appeared in *Home Power* magazine.

A fifth-generation Oregonian, Kerr was born and raised in Creswell, a recovered timber town in the upper Willamette Valley. He presently splits his time between Ashland, a recovered timber town in Oregon’s Rogue Valley, and Washington DC, where the most important decisions affecting Oregon’s wild lands, wildlife, and wild waters are made. A fuller biographical sketch can be found on his website.

Acknowledgments

My utmost thanks for my editor, Lorraine Anderson, for immeasurable help in organizing and making more readable this report. I also want to thank Rick Brown for technical review.

Major Sources Consulted

Aschwanden, Christie. February 3, 2016. Methane Is Leaking All Over the Place. FiveThirtyEight.

Bloomberg New Energy Finance. 2017. New Energy Outlook 2017.

———. 2017. Electric Vehicle Outlook 2017.

———. 2018. 2018 Sustainable Energy in America Factbook. Cruickshank, Walter. January 17, 2017. Record of Decision and Approval of the 2017–2022 Outer Continental Shelf Oil and Gas Leasing Program.

Hansen, J., P. Kharecha, M. Sato, V. Masson-Delmotte, F. Ackerman, et al. 2013. Assessing "Dangerous Climate Change": Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature. PLoS ONE 8(12): e81648.

Hobson, Margaret Kriz, and Pamela King. February 9, 2018. Interior Says $160 Oil Won't Help Most Areas; Industry Differs. E&E News.

Interagency Working Group on Social Cost of Greenhouse Gases. August 2016. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis—Under Executive Order 12866.

Intergovernmental Panel on Climate Change. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland.

Kerr, Andy. 2012, October–November. The Subsidy Game. Home Power, 74–79.

Lazard. 2017. Lazard's Levelized Cost of Energy Analysis—Version 11.0.

Le Quéré, Corrine, et al. 2018. Global Carbon Budget 2017. Earth System Science Data 10, 405–448.

Mulvaney, Dustin, Alexander Gershenson, and Ben Toscher. 2015. The Potential Greenhouse Gas Emissions from U.S. Federal Fossil Fuels. EcoShift Consulting.

Newbold, S., C. Griffiths, C. Moore, A. Wolverton, and E. Kopits. 2010. The Social Cost of Carbon Made Simple. National Center for Environmental Economics.

Raupach, Michael, et al. 2014. Sharing a Quota on Cumulative Carbon Emissions. Nature Climate Change 4, 873–879.

Tabuchi, Hiroko, and Tim Wallace. January 23, 2018. Trump Would Open Nearly All U.S. Waters to Drilling. But Will They Drill?, New York Times.

Trump, Donald J. March 27, 2017. Executive Order 13783—Promoting Energy Independence and Economic Growth.

UNFCC Parties. 2015. Paris Agreement. United Nations Framework on Climate Change.

USDI Bureau of Ocean Energy Management. 2016. 2017–2022 Outer Continental Shelf Oil and Gas Leasing Final Program.

———. 2017. 2016 National Assessment of Undiscovered Oil and Gas Resources of the U.S. Outer Continental Shelf. OCS Report BOEM 2017-038.

———. 2017. Assessment of Oil and Gas Resources: Alaska Outer Continental Shelf Region. OCS Report BOEM 2017-064.

———. 2017. Assessment of Oil and Gas Resources of the Nation's Outer Continental Shelf, 2016a. BOEM Fact Sheet RED-2017-1.

———. 2017. 2016 Assessment of Oil and Gas Resources: Assessment of the Pacific Outer Continental Shelf Region. OCS Report BOEM 2017-053.

———. 2017.Assessment of Technically and Economically Recoverable Hydrocarbon Resources of the Gulf of Mexico Outer Continental Shelf as of January 1, 2014. OCS Report BOEM 2017-005.

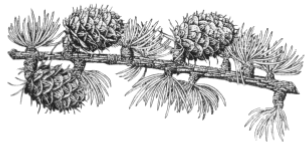
———. 2018. 2019–2014 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program.

USDOE Energy Information Administration. 2016. Trends in U.S. Oil and Natural Gas Upstream Costs.

Wolvovsky, E., and W. Anderson. 2016. OCS Oil and Natural Gas: Potential Lifecycle Greenhouse Gas Emissions and Social Cost of Carbon. BOEM OCS Report 2016-065.

(The Excel file created to derive the numbers in the tables of this report is available from the author upon request.)

Larch Occasional Papers



DEDICATED TO THE CONSERVATION AND RESTORATION OF NATURE, THE LARCH COMPANY IS A NON-MEMBERSHIP FOR-PROFIT ORGANIZATION THAT REPRESENTS SPECIES THAT CANNOT TALK AND HUMANS NOT YET BORN. A DECIDUOUS CONIFER, THE WESTERN LARCH HAS A CONTRARY NATURE.

The Larch Company has occasionally issued papers on a variety of topics.

#	*Year*	*Title*
23	2018	New U.S Outer Continental Shelf Oil and Gas Exploitation: Costly and Short Lived
22	2017	National Heritage Areas: Combining the Conservation of Nature, History, and Culture with Local Economic Development
21	2015	National *What-Have-You* Areas: Congressional Conservation of Our Public Lands
20	2015	21st-Century National Recreation Areas for Oregon's National Forests and BLM Public Lands
19	2013	Oregon Softwood Lumber Industry 1995-2012: Fewer Mills and Jobs, But Larger Timber-Processing Capacity
18	2012	Oregon Private Timberland Owners Not Paying Fair Share of Federal Income Taxes
17	2012	Oregon Private Timberland Owners Not Paying Enough State Timber Taxes
16	2012	Oregon Private Timberland Owners Not Paying Fair Share of County Property Taxes
15	2012	Native American Tribal Lands and Federal Public Forestlands in Oregon
14	2012	An Overview of Land Management Categories for Oregon Federal Public Lands Under the Northwest Forest Plan
13.5	2016	National Wild and Scenic Rivers and State Scenic Waterways in Oregon
12	2012	Special Congressional Conservation Designations in Oregon
11	2012	The National Wilderness Preservation System in Oregon: Making it Bigger and Better
10	2012	Oregon and Washington Raw Log Exports: Exporting Jobs and a Subsidy to Domestic Mills
9	2012	Pacific Northwest Offshore Oil and Gas Potential: At Best About A Month's National Supply; At Worse An Unnatural Disaster
8	2011	"Small" Wilderness: No Big Deal
7	2011	Overlapping Wilderness and Wild & Scenic River Designations Provide Optimal Conservation Protection for Federal Public Lands(co-authored with Mark Salvo)
6	2008	Establishing a System of and a Service for U.S. Deserts and Grasslands (co authored w/ Mark Salvo)
5	2007	Eliminating Forest Service Regional Offices: Replacing Middle Management with More On-the-Ground Restoration
4	2007	Forest Service Administrative Appeals: A Misallocation of Resources
3	2007	Thinning Certain Oregon Forests to Restore Ecological Function
2	2007	Transferring Western Oregon Bureau of Land Management Forests to the National Forest System
1	2007	Persuading Congress to Establish a Wilderness and/or Wild & Scenic River: A Checklist

While these papers are provided without charge, production is not without cost. If you found this paper useful, please consider sending a check in the amount of what you think it was worth payable to The Larch Company, 7126 Highway 66, Ashland, OR 97520. Alternatively, there are apps for that.

Andy Kerr (andykerr@andykerr.net, 503.701.6298 v/t).